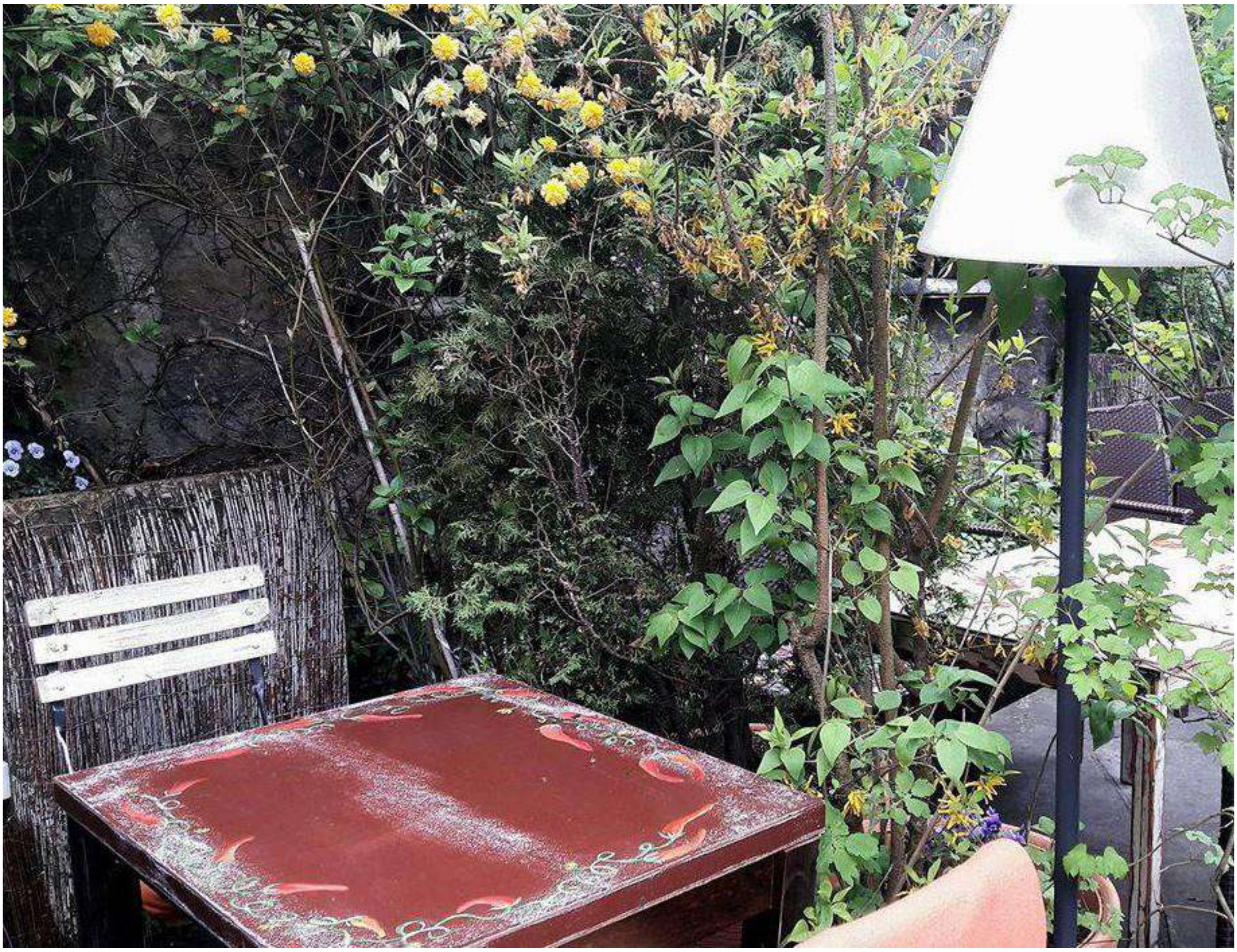
Connecting Nature

Bringing cities to life, bringing life into cities



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DOCUMENT PROPERTIES

Nature Document	Deliverable 2 Report on the outcomes of the lessons learned, mapping of emerging experiments and expert workshops, leading to a synthesis of the most promising indicators for nature-based solutions
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Contents

Executive summary

This Deliverable presents the *Connecting Nature Impact Assessment framework* and capacity building process whose aim has been to support the mainstreaming of a culture of impact evaluation and evidence-based nature-based solutions (NBS) design and implementation in cities. The framework is the result of a co-production process between academic and city council partners in the project and has been implemented in the cities, leading to the development of monitoring and evaluation plans for specific NBS exemplars at different scales. Additional capacity building tools have been created to integrate the impact assessment framework into regular urban planning processes, such as an impact assessment training programme, and a digitally-supported impact assessment tool guiding cities through the process of thinking about and designing their monitoring and evaluation strategy. We present the Connecting Nature Impact Assessment Framework, and we illustrate it with the monitoring and evaluation plans of the front-runner cities. We then focus on an analysis of the main challenges experienced and lessons learned in this process of capacity building, to enhance transferability; we present how knowledge has been transferred to fast-follower and multiplier cities, and we finalize by drawing conclusions on the most promising indicators for NBS in cities, focusing on those indicators that have already been tested in practice.

The Connecting Nature Impact Assessment Framework

As part of the overarching Connecting Nature Framework, cities and scientific experts in the project have developed a robust impact evaluation framework which has been implemented to different degrees in the partner cities. Two key objectives of Connecting Nature have been: a) to contribute to a European impact evaluation reference framework for nature-based solutions and b) to significantly increase capacities in cities for the systematic monitoring and evaluation of NBS interventions.
Deliverable 2 presents the results of the work undertaken towards these two objectives. Section 1 summarizes the Connecting Nature Impact Assessment Framework, which is a structured process developed to support cities in designing impact monitoring and evaluation plans that can then be implemented for both small-scale (street- or neighbourhood-scale) and larger (city-wide) scale projects.
Deliverable 6 presented the Connecting Nature Framework, outlining 6 elements that need to be considered in the planning, delivery and stewardship of nature-based solutions: *Technical solutions*, *Governance*, *Financing and business models*, *Nature-based entrepreneurship, Co-production*, *Reflexive monitoring* and *Impact assessment.*

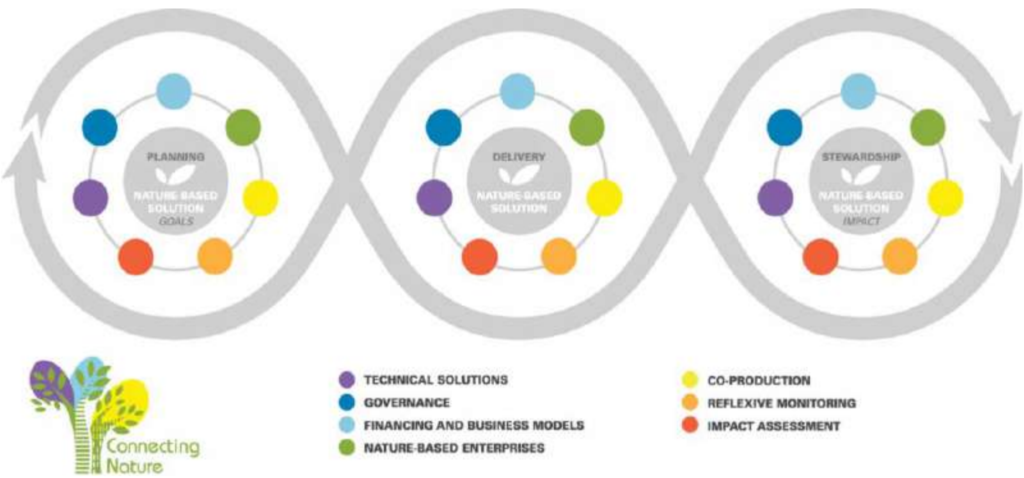

Figure 1. The Connecting Nature Framework

The Connecting Nature Impact Assessment framework unpacks the last element of the framework, by describing and operationalizing the five building blocks or steps that should be followed in the process of designing robust impact evaluation processes and plans to assess nature-based solutions at different scales.

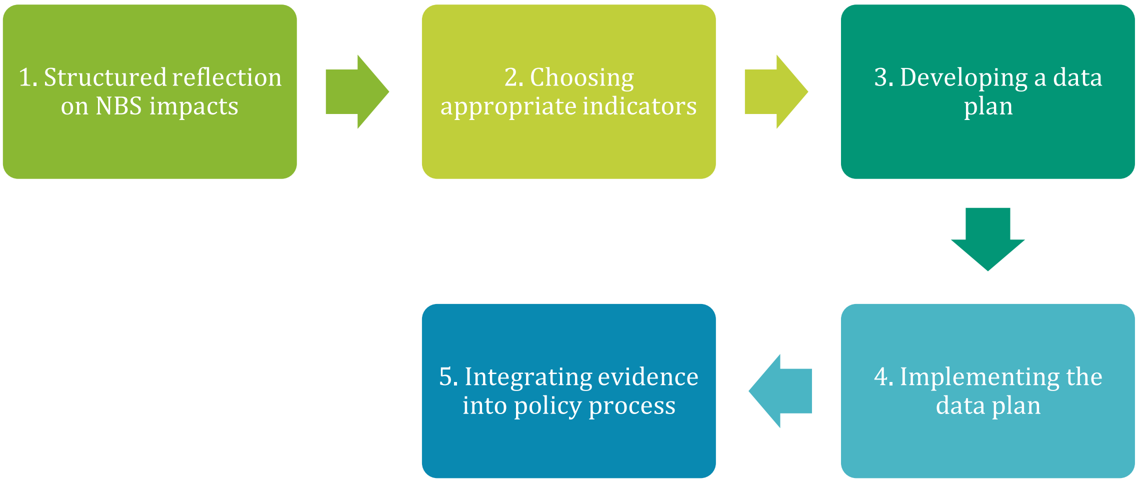

Figure 2. Building blocks of the Connecting Nature impact assessment process

Monitoring and evaluation plans and lessons learned

Section 2 of this Deliverable describes the results of the impact assessment framework implementation in the frontrunner cities, namely: **the monitoring and evaluation plans** developed. Moreover, we perform a cross-city analysis of the main difficulties encountered and the lessons learned by the cities through this process, by outlining **challenges and recommendations** for each of the steps, or building blocks, of the impact assessment framework. One of the main recommendations outlined is the creation of an **European Observatory of NBS Impact Assessment**, as a hub for impact assessment knowledge, training and capacity building, which could work towards ensuring standardization of indicators and measurements to reflect scientific advancements and advance knowledge, as well as synthesize evidence and align it with national and European level data collection efforts (Eionet, Copernicus, Eurostat etc) and policy priorities, such as the New European Green Deal and the 8th Environmental Action Plan, currently in discussion and drafting.

Main benefits of the Connecting Nature impact assessment framework

Cities experienced the Connecting Nature impact evaluation framework, and the associated structured training and knowledge transfer programme as contributing to building and mainstreaming impact assessment capacity. The following main benefits were identified by the cities:

- Learning to engage in coproduction processes with scientific partners and benefitting from their expertise
- Significant increase in impact assessment knowledge
- Significant advancements were made in incorporating a new paradigm of NBS assessment in urban planning
- Significant advances were made in building capacity for impact assessment
- New networks were created, both between in-house departments, as well as with external stakeholders in the urban ecosystem
- New data infrastructure has been created

Impact Assessment innovations and forward-looking support tools

Deliverable 6 has identified Connecting Nature innovations related to each element of the CN framework. To facilitate knowledge transfer to other cities in Europe, impact assessment innovations have been embedded in a few tools and products:

- the CN impact assessment framework has been supported by a training programme, through the UrbanByNature webinars, as well as the Impact Assessment training programme modules created
- the CO-IMPACT tool, a digitally supported tool that guides cities through a streamlined process of developing their monitoring and assessment plans for NBS. The tool, CO-IMPACT, is one of the main innovations coming out of this work, and will be presented as part of Deliverable 3, and launched publicly at the end of March 2022.
- The comprehensive set of NBS indicators have been presented in a Connecting Nature Indicator Manual, with fact-sheet like descriptions of most appropriate methodologies, which have also been included into the European Impact Assessment Handbook for Nature-based Solutions and its Appendix for Methods.

Facilitating knowledge transfer and peer-to-peer learning on impact assessment

Section 3 moves on to describe the process of transferring impact assessment knowledge to fast-follower cities, and multiplier regions through training programmes designed to speed up the process of capacity-building in cities and support them in acquiring the necessary knowledge and resources to design and implement bespoke monitoring and evaluation plans. It describes these training programmes, whose main outcome consisted in tailored and ready to use NBS monitoring and evaluation plans for the fast-follower cities.

A synthesis of most promising indicators for NBS impact assessment

Section 4 describes the most promising indicators that have been already implemented by the Connecting Nature partner cities. These are not meant to form an exhaustive list, as cities are at different stages in the process of implementing indicators, collecting and analysing data. A more advanced analysis of most promising indicators will likely come out of the efforts of the European Taskforce 2 on NBS Impact Evaluation, once funded projects take stock of how different indicators work in practice.

Conclusions and outlook

Finally, section 5 takes the results of these intense learning processes and makes a series of recommendations that will hopefully support the process of mainstreaming impact assessment of nature-based solutions in Europe.

Accompanying documents

A key objective of the project has been to take a long-term view of NBS impact assessment, in order to generate impact assessment capacities that are sustainable way beyond the end of the project. Each of the cities involved in the Connecting Nature project had a different starting point in terms of experience, knowledge and resources of NBS impact assessment processes. However, each of the front-runner cities made important advances not only in designing, but also in implementing monitoring and evaluation plans for nature-based solutions. Although still preliminary, these results are presented in extensive appendices.

Each FRC presents its preliminary evaluation results and an additional document of supplementary material describing the methodologies used in more detail, as suitable in each case (Appendices II - IV). Also, the monitoring and evaluation plans of each of the fast-follower cities are presented in appendices V - XII. In addition, adaptations of monitoring and evaluation plans for multiplier cities can be consulted (Appendices XIII - XIV). Finally, specific documents are also offered that support the information provided in the main text, such as the selection of indicators in the Connecting Nature Fast-follower cities (Appendix I), Categories and codes of the FRC focus group on transformational change (Appendix XV), the Impact Assessment Framework template (Appendix XVI), and the Connecting Nature Impact Assessment Guidebook (Appendix XVII).

1. Impact assessment in Connecting Nature cities

The European Commission defines nature-based solutions as solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions." They hold the potential to simultaneously address multiple social, economic and environmental challenges and are an important part of the European policy agenda to bring nature back to cities, revitalize them, restore biodiversity, and make them vibrant and healthy places to live and work (Dumitru & Wendling, 2021).

The EU vision for 2050, reflected in the European Green Deal, establishes 3 key objectives within the overall vision of "living well, within the limits of the planet": 1) protecting natural capital; 2) achieving resource efficiency and decarbonization; and 3) safeguarding against environmental pressures and risks to health and wellbeing (European Commission, 2015). Nature-based solutions are part of this important agenda, as they can deliver on all of these objectives, and especially objectives 1 and 3. They have been proposed as a promising policy approach to simultaneously provide social, environmental and economic benefits (Haase et al. 2014), such as climate change mitigation and adaptation, improved quality of life, physical and mental health (Kabisch et al. 2017), social cohesion, well-being (Brink et al. 2016), and a sense of belonging and place (Hartig et al. 2014; Sullivan, Kuo & de Pooter 2004; Keniger et al. 2013; Gulsrud et al. 2018). However, the evidence for their multiple benefits is rather scarce and highly fragmented, as evaluations often fail to plan for the assessment of multiple outcomes across different categories of impacts (i.e. environmental, social, economic, etc) (Brink et al. 2016; Raymond et al. 2017; Samuelsson et al. 2018). The Connecting Nature Framework proposes a framework for embedding nature-based solutions in urban planning, by connecting innovations across seven different elements of the planning, implementation and delivery cycles (Figure 1).

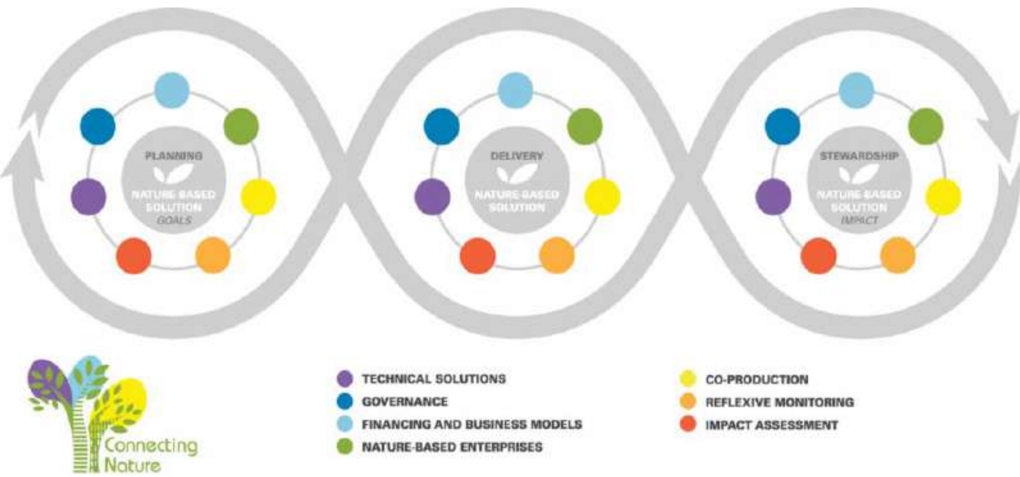

Figure 1. The Connecting Nature Framework

1.1. Development of the Connecting Nature Impact Assessment Framework

To unpack the impact assessment element of the framework, and provide guidance to cities on embedding impact assessment into NBS design and implementation, an impact assessment framework has been designed in Connecting Nature. This framework is developed along five building blocks (see Figure 2 above). These five steps are briefly summarized below, and they were described in detail in the

Connecting Nature Impact Assessment Guidebook (Dumitru et al., 2021; Appendix XVII). All Connecting Nature cities have followed this process to achieve two objectives: a) Design their evaluation and monitoring plans (all cities); b) Implement the plan (frontrunner cities and the fast-follower city of A Coruña).

1.1.1. Structured reflection on NBS impacts, pathways and trade-offs

Structured reflection supports cities in identifying context-appropriate rationales for NBS implementation and establishing evaluation objectives. Also, it contributes to the transparency of rationales behind policy decisions. The main outcome of this stage is a mapping of the "theory of change" behind a particular NBS project, which includes NBS expected outcomes, and main synergies and trade-offs between them and potential pathways between NBS actions and outcomes.

Several sequential steps are included in this process of structured reflection. First, considering that NBS interventions aim to address strategic city objectives, it is important to first identify which strategic objectives are targeted by a particular NBS project. Cities also align their strategic objectives with wider international frameworks such as the UN SDGs. Identifying how the cities objectives contribute to these is really useful in arguing for the importance of NBS impact assessment, as well as including NBS-specific indicators into existing regional and national reporting obligations. Secondly, the expected outcomes of a particular NBS project should be explicitly stated, both primary (key impacts) and secondary (sometimes referred to as co-benefits). Differentiating between outputs and outcomes is very useful at this stage as well. Nature-based solutions will not necessarily deliver on all foreseen benefits. To identify why that might be the case, assumptions about the pathways through which particular NBS actions are planned to achieve particular outcomes should be made explicit, which will allow their validity to be assessed. Making assumptions explicit also helps to identify what might be missing in NBS design. Finally, potential synergies and trade-offs between expected outcomes can be reflected upon, allow for "larger picture" tweaks and changes to be made to the original plan.

1.1.2. Choosing appropriate indicators

Based on the outputs, outcomes and the potential intermediary mechanisms or pathways identified, through which NBS actions contribute to the expected outcomes, both process and impact indicators can be selected. As nature-based solutions are normally planned to deliver on different categories of objectives and address complex systemic challenges, the selected indicators must form a coherent framework where social, economic, and environmental areas of impact are inter-connected. This process allows for a broad vision of how NBS interventions make it possible to advance on a range of objectives desired by cities. Based on a thorough assessment of the scientific literature available on the social, environmental and economic impacts of nature, as well as the co-creation process described in Deliverable 1, a range of core (essential and applicable to almost all NBS) and feature (important and applicable to some but not all NBS) indicators have been proposed in Connecting Nature. Core indicators are those most recommended for all cities in order to create a comprehensive evidence-based framework for nature-based solutions, while feature indicators offer many options to assess a diversity of outcomes and a variety of NBS projects.

1.1.3. Developing a data plan for impact assessment

Once the indicators are selected, the next step consists in developing a monitoring and evaluation plan, adjusted both to the city´s theory of change and to previously selected indicators. In order to develop a data plan, data availability must be established and clarified. Differences between two moments in time can only be gauged if data prior to implementing NBS interventions is compared with post-implementation data. On the one hand, baseline data is information that indicates the initial status of a particular indicator. On the other hand, outcome data is represented by information obtained once NBS interventions were implemented. Unlike baseline data, it is necessary to collect outcome data during or after NBS execution. Based on outcome data, a new situation generated by NBS implementation can be compared with baseline data. Available data can come from different sources: city and external sources documents, official statistics, national or international organizations data sets (e.g. Copernicus) and reports, research reports, databases of other public (or occasionally private) agencies. In the absence of baseline data, there is no possibility to explore the causal relationships between the NBS actions and the NBS impact (s) assessed. Tapping into existing data collection efforts, especially those that collect data regularly and establish time series is particularly worthwhile, although sometimes these do not have the level of granularity the NBS project might need. The data plan needs to include both existing data and their characteristics, for both baseline and outcome evaluation temporal moments, as well as identify data that needs to be collected.

1.1.4. Implementing the data plan

The next phase in assessing NBS effectiveness rests in choosing the necessary methods and instruments to measure selected indicators. Each indicator is to be assigned suitable data collection method(s). The relationship between indicator and its measurement method is determined by data quality, temporal adequacy, and a cost-benefit ratio assessment. This step also involves answering the following three questions:

1) How long should data collection take? 2) What is the expected temporal scale of the outcome?. 3) How many times is it necessary to collect data and at what points in time? Regarding data collection frequency and the temporal scale, the more times selected indicators are measured throughout NBS implementation, the greater the precision in assessing effectiveness of any expected impact. Deciding how many data collection waves are necessary also depends on the temporal scale of expected outcomes. The minimum standard would require collecting data in two different waves: before NBS implementation (i.e., baseline) and after NBS interventions had been implemented (i.e., outcome data). The golden standard, however, would demand outcome data to be collected at least at two different points in time, to be able to draw conclusions on which outcomes seem to be robust. However, it is advantageous to establish regular monitoring and evaluation over time for many indicators to ensure that benefits are retained and to inform adaptive management decisions as circumstances change. Iterative data collection can allow adjustments to be made in NBS implementation as well as to plan for new NBS -related actions that can improve or ensure adequate performance. Results can then be analysed in relation to he expected outcomes and to policy strategic objectives.

1.1.5. Integrating evidence into the policy process

The last phase of the monitoring and evaluation process consists in sharing the results with all those stakeholders belonging to the Quintuple Helix model (i.e., academia, industry, government, media, and natural environment), and also with the wider European and global communities. Unattractive data presentation does not support the achievement of effective communication between city departments and to its stakeholders. This should be done for all outcomes, independent of whether results are positive (i.e objectives were reached) or negative (i.e objectives were not reached, or not to the extent originally envisioned. It is as important to indicate that NBS contributed to desired impact(s) as it is to report when NBS interventions did not contribute to expected outcomes or even contributed to adverse consequences. This way, NBS implementation can be replicated and adapted by other cities within a continuous improvement framework.

In essence, the final objective of NBS evaluation should be to create and share greater accumulated NBS knowledge. This approach is necessary to facilitate the silo-busting of departments and the unlocking of diverse funding sources essential to the scaling up of nature-based solutions. Therefore, creation of peer to peer learning and mentoring networks is a guarantee for effective NBS replication and up-scaling. All FRCs have followed these 5 building blocks to design and (for some) implement impact assessment plans. In section 1.2, we present the monitoring and evaluation plans of the Connecting Nature frontrunner cities across the first four building blocks of the CN impact assessment framework, while the impact assessment results and possible paths of integration in policy processes can be consulted in the appendices II to IV.

2. Monitoring and evaluation plans and capacity in cities

2.1 CN Front-runner cities monitoring and evaluation plans of NBS exemplars

2.1.1. The city of Poznan

The City of Poznan developed and started implementing monitoring and evaluation plans for three nature-based solutions, two of them on a site scale (Nature-oriented playgrounds at preschools and Open garden at preschool no. 42) and one on a city scale (Pocket Parks).

Nature-oriented playgrounds use nature-based solutions in the architectural design of modern playgrounds. Their main objective is to provide enhanced opportunities for contact with nature for children and teachers, increase biodiversity, and provide opportunities for ecological education. The main aim of this project was to implement these innovative solutions in pre-school spaces, ensuring functional division and optimal use of the outdoor space to meet children's and teachers' needs. The project has been implemented in the city from 2018 onwards as a response to changes taking place in the city in the context of climate change, urbanization and limited access to greenery, which has negative effects on the health and well-being of residents, especially children.

The idea of creating **open gardens** is to make the existing greenery at various types of institutions available to a wider group of users, especially in those parts of the city where residents suffer from a lack of access to high quality greenery. The pilot Open Garden at Kindergarten No. 42 in Poznań was established on a separate part of the kindergarten outdoor space, making it also available to local residents. It is a combination of a social garden and a natural playground, open to children and adults, especially those using the kindergarten, neighbouring educational institutions, and the local community. It is a place where children can experience nature, adults can rest, and interested people can grow edible plants.

A **pocket park** is a public green space of a small size, open and accessible to all residents. It can arise, for example, on a small fragment of land between abandoned building plots. It is a green enclave in a compact city development. Pocket parks can be equipped with small architecture (benches), creating a small space for relaxation in the city, but also with playgrounds for children. Such spaces are created in cooperation with various groups of stakeholders, not only decision-makers and planners, but also representatives of the housing estate councils, students and residents.

The city of Poznan, a frontrunner in Connecting Nature, developed monitoring and evaluation plans for the three types of NBS projects they selected as exemplars, as part of the wider renaturing strategy of the city. The plans are presented below, while the results of the plan's implementation can be consulted in Appendix II.

Building block 1. Structured reflection on NBS impacts, pathways and trade-offs

A. STRATEGIC GOALS AND LINKS WITH THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS (SDGS)

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Development Strategy for the City of Poznań 2020+																	
To make Poznań a green, eco-mobile city (easily accessible green areas)			•	•		•	•	•	•	•	•	•	•		•	•	•
Improving the quality of life of all residents	•	•	•	•	•	•	•	•	•	•	•	•				•	•
Improving the importance of Poznań on the international arena (Strong Metropolis)				•				•	•		•	•				•	•

Modern entrepreneurship (modern economy in Poznań)								●	●		●	●				●	●
Community and social dialogue	●		●	●	●			●		●	●					●	
Development Strategy of the Warta River in Poznań																	
Restoring the river to the city			●			●		●	●					●	●	●	●
Landscape and nature (maintaining the natural qualities of the "green cross" in Poznań)						●					●	●	●	●	●		●
River safety						●	●		●		●	●	●	●	●		●
Connections – slow traffic and car traffic (facilitate walking and cycling on the Warta zone)			●	●	●				●							●	●
Living and working – build-up areas and open spaces (revitalizing neglected built-up areas, attract people to the river zone)	●					●	●		●		●	●	●	●	●	●	●
Tourism and recreation			●	●	●					●	●	●				●	●
Historical heritage (protect the valuable historical elements within the Warta area)				●						●						●	●
Study of Conditions and Directions of Spatial Development of the City of Poznań																	
A compact city with a framework communication system and a wedge-ring system of greenery			●	●	●	●	●	●	●	●	●	●	●		●	●	●
Ensuring a proper standard of living for residents (high-quality development parameters – spatial and environmental, network of technical infrastructure)	●	●	●			●	●		●	●	●	●				●	●
Modern city (metropolitan center)				●				●	●		●	●				●	●
European city with a high culture of everyday life and space (spatial conditions for improving the quality of life, improving the attractiveness of public spaces and the investment attractiveness of the city).	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●
Environmental Protection Program for the City of Poznań																	
Improving air quality and climate protection							●		●			●	●				●
Water management						●			●					●			●
Geological resources protection									●			●					●
Soil protection									●			●					●
Waste management and waste prevention						●			●			●					●
Natural resources (protection of biodiversity, creating protected areas)						●	●					●	●	●	●		●
Water and sewage management						●			●			●		●			●
Reducing the risk of major industrial and transport accidents									●							●	●
Electromagnetic fields									●								●
Noise pollution					●		●		●				●				●
Ecological education and pro-environmental activities				●							●					●	●
Municipal Revitalization Program for the City of Poznań – third edition																	
Eco-mobility (increasing mobility of residents and spatial accessibility of the revitalization area and improvement of environmental conditions)			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Living conditions (improvement of housing conditions)			●			●	●	●	●	●	●					●	●
Improving the acoustic climate and air quality							●		●			●	●				●
Restoration of the continuity of urban structures and the aesthetics of urban space							●		●				●				●
Public spaces and cultural heritage	●		●	●	●			●	●	●	●					●	●
Green space and recreation			●	●	●			●	●	●	●				●	●	●
Social and cultural activity			●	●	●			●		●	●					●	●
Public services (strengthening social cohesion and increasing the attractiveness of living in the area of revitalization)	●	●	●	●	●			●		●	●					●	●
Stopping the depopulation process	●	●	●	●	●			●		●	●					●	●
Strengthening the economic, cultural and social activities	●	●	●	●	●			●	●	●	●					●	●

Plan for Sustainable Development of Public Transport for the City of Poznań for 2014-2025																	
Nature protection				●		●	●		●		●	●	●	●	●		●
Quality and access to public transport	●		●		●				●	●	●					●	●
Supporting people with disabilities	●		●		●				●	●						●	●
Reduction of pollutant emissions				●			●	●	●		●	●	●			●	●
Reduction of noise emission				●			●	●	●		●	●	●			●	●
Countering the exclusion of poor people	●	●						●		●	●					●	●
Reducing transport costs								●	●		●					●	●
Attractiveness of industrial and service areas (increasing access by public transport to these areas)								●	●							●	●
Planning public transport to ensure sustainable development (planning public transport in the Poznań Agglomeration for achieving ecological, social and economic objectives)	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Municipal Plan of Adaptation to Climate Change for the city of Poznań																	
Mitigating the negative impact of extreme thermal phenomena, including pollution concentration (thermal inversions, UHI).							●	●	●		●	●	●				●
Limiting the effects of heavy rains and urban floods, droughts, storms and strong winds.						●	●		●				●				●
Informing and increasing the awareness of the citizens about the effects of climate change.				●							●	●	●		●	●	●
Institutional and organizational strengthening of the city's resilience to climate change or to extreme climatic and weather phenomena.			●							●	●	●			●	●	●

B. NATURE-BASED SOLUTIONS AND EXPECTED IMPACT

B1. NATURE-ORIENTED PLAYGROUNDS AT PRESCHOOLS

NBS Characteristics	
Type	Natural playground
Scale	City-scale (20 preschools with all natural playgrounds and 20 preschools with only part of natural and ecological equipment (only ecological demonstrators)
Location	40 different locations in Poznań (different districts, different neighborhoods)
Process of design and implementation	Until 2020 (for a total of 5 years), the Education Department of the City Hall was preparing proposals for co-financing 10 selected preschools that reported such a need for renovation or modernization of gardens at the preschool. The Education Department, based on internal criteria, selected 10 kindergartens every year. Each of these kindergartens received a certain amount of money. Project Coordination and Urban Regeneration Office (Poznań City Hall) under the CN project, provided these kindergartens with the support of a landscape architect who comprehensively prepared a garden spatial development project using natural and ecological elements. The architect is selected by us in the form of an inquiry (request of proposal). The architect prepares the conceptual design of the garden together with the management/directors and teachers of a given preschool (great emphasis on social participation). After accepting and creating the final development design, kindergartens are also responsible for carrying out an inquiry for the selection of the contractor of the elements in accordance with the design project. The design process takes half a year and the same time is spent on making an investment in the garden. We start the procedure in the same way every year, the whole process usually lasts from the end of January to the end of December of a given year.
Current deployment and deadline	The investments in 40 preschools are completed and ready for use. We are currently starting the procedure anew - a request for the will to cooperate has been sent to kindergartens and schools. Note: from 2021, there is no longer a program for financing the renovation and modernization of gardens implemented by the Department of Education. That is why this year we will start cooperation with institutions that managed to obtain, for example, funds from the Poznań Civic Budget. Until the end of February we are waiting for answers and we will plan the further process.
Financing and stewardship	Support for kindergartens: - garden development projects and workshops (meetings with directors and teachers) financed from EU funds - CONNECTING Nature project (Horizon 2020 Framework Program) - implementation of investments from the city budget (until 2020, Department of Education) The pilot implementation of a natural playground, depending on the kindergarten, amounted 70,000 PLN to 200,000 PLN gross. The development of the garden development project is on average 7,000 PLN gross. * Experience during the implementation of works shows that the use of natural elements in the playground is often relatively cheaper than the purchase of ready-made play equipment or the use of a synthetic surface. The maintenance and management is on the side of preschool institutions.

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Unsealing of the hardened surface	Breaking asphalt / concrete from the kindergarten area and / or creating diverse natural surfaces (grass, sand)	Increasing the biological active surface, improving water retention and air temperature regulation
Increasing the green area in the garden	New plantings of plants, shrubs	More shaded areas, regulation of air temperature in these areas in summer/ also improving the aesthetics of the garden
Raising ecological awareness among children	Creating places in the garden enabling the cultivation of own plants, caring for greenery (ecological demonstrators)	Improving ecological education in kindergarten / caring for the common good
Facilitate collaborative design with teachers and preschoolers	Inviting future recipients of the preschool garden to jointly create a garden design	Strengthening social participation = a jointly designed garden that will serve us all
Improving health, activity and physical fitness among children	Create a space for children for physical activity	Enabling children to come and play sports in a safe and green playground / improve health and well-being
Strengthening social ties	Creating a space for playing and relaxing with other children	Social inclusion, strengthening the sense of identity with the place
Introducing biodiversity in the preschool garden	Building houses for insects, bird feeders, creating flower meadows	Improving biodiversity in the garden, the possibility of observing birds and other animals, creating animal-friendly places in the city

B2. Open garden at Preschool no. 42

NBS Characteristics	
Type	Open garden for public
Scale	Medium scale (it intends to occupy the territory of several blocks)
Location (Geographical coordinates)	52°23'24.7"N 16°55'02.6"E (open garden at Preschool no. 42)
Process of design and implementation	During the implementation of the project on "*Active Methods of Preschool Education*", the partners involved in its implementation developed an idea based on preschool education, but also in line with urban regeneration issues and nature-based solution ideas. In the result they created an open garden in the Kindergarten No. 42 at Wilda District (Poznań). The aim of the project was to develop an open small green area and make this place available for the residents of Wilda District. The garden was created with the support of the Project Coordination and the Urban Regeneration Office (Poznań City Hall) and was officially inaugurated in March 2018. In 2018, as part of the Open Garden, workshops for families with children were organized. The main aim was to create a place where citizens will be engaged in developing it, to encourage them to work together for one place and enable them to take different activities with children and neighbours. Currently, the open garden remains in the care of the kindergarten management, but it allows residents of the densely built-up Wilda District to enjoy its attractions and relax. The garden has its own regulations, which was based on consultations with kindergarten management, parents of pre-schoolers, and residents of the Wilda District, and – importantly from a security point of view – also with the Police. The open garden has also its own opening rules: it's open at a certain times during the day and seasons.
Current deployment and deadline	The investment is completed and ready for use. Realization of open garden at Preschool no. 42 (2017 – 2018): - consultation: 2 months - project: 2 months - implementation: 7 months * We are currently looking for other kindergarten / school centers that would be interested in opening their spaces to residents.
Financing and stewardship	Investment (modernization of garden/creating open garden) in Preschool No. 42 - Budget of the City of Poznań - continuation of activities (additional equipment for the garden, designing project of the garden – landscape architecture) - Connecting Nature project (Horizon 2020) + budget of the Housing Estate Council costs of the garden: 213 PLN/m2 (gross), including: - consultation and project: 8,800 PLN (gross) - implementation: 57 760 PLN (gross) - animations after opening: 5,000 PLN (gross) The maintenance and management is on the side of preschool institutions.

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Increasing the green area in the garden	New plantings of plants, shrubs, flowers	More shaded areas, regulation of air temperature in these areas in summer/ also improving the aesthetics

		of the garden
Unsealing of the hardened surface	Breaking asphalt / concrete from the garden area and / or creating diverse natural surfaces (grass, sand)	Increasing the biological active surface, improving water retention and air temperature regulation
Facilitate collaborative design with citizens	Inviting future recipients of the open garden to jointly create a garden design	Strengthening social participation = a jointly designed garden that will serve us all; creating the common good, social inclusion
Strengthening social ties, increasing social integration	Creating a space for relaxing (hammocks, benches, table)	Strengthening the sense of identity with the place
Place attachment	Garden equipment enabling jointly plant cultivation	Planting plants, flowers, herbs, vegetables with neighbors, place for exchanging knowledge and experience with neighbors, sharing crops
Introducing biodiversity in the kindergarten garden	Building houses for insects, bird feeders, creating flower meadows	Improving biodiversity in the garden, the possibility of observing birds and other animals, creating animal-friendly places in the city
Improving the quality of life in the city, improving the well-being	Providing and opening green areas for residents of housing estates	More public green areas (good quality) for residents through the city (improvement of accessibility and distribution of green public areas)

B3. Pocket parks

NBS Characteristics	
Type	Pocket parks
Scale	Microscale
Location (Geographical coordinates)	52.387950, 16.903702, (NBS monitoring by UAM) 52.390857, 16.913825, (NBS monitoring by UAM) 52.390804, 16.900530, (NBS monitoring by UAM) 52.410431, 16.892956 52.415086, 16.894078 52.388273, 16.911289 52.411605, 16.951779 52.367245, 16.905300 52.409312, 16.921868
Process of design and implementation	Some of the pocket parks were design and implement in cooperation with the residents. Some of them were carried out in cooperation with the Jeżyce Estate Council. One of them was carried out in cooperation with the Jeżyce Estate Council and a property developer.
Current deployment and deadline	The investments are completed and ready for use.
Financing and stewardship	Poznań City Hall (Project Coordination and Urban Regeneration Office) - financing and stewardship Urban Roads Board (municipal organizational unit) - financing and stewardship Jeżyce Estate Council - financing

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Provide shady areas during heat waves	Plant deciduous trees with a large area of foliage	Improve the local microclimate and increasing air and soil humidity as well as regulation of air temperature in these areas in summer
Increase small retention at the point of rainfall	Introduction water-permeable and eco-friendly surfaces	Prevent the negative effects of urban drought and flash floods
Create a high quality and aesthetics green space for local community in dense building areas	Introduction new greenery and small architecture	Create space for passive recreation and rest in neglected urban areas (improvement of cultural/ recreational ecosystem services supply)
Improvement of habitat conditions	Degraded soil was replaced by new one	Aesthetic and biodiverse green in good condition
Prevent illegal parking of cars	Introduction the bicycle stands and new greenery	Clean up the area and restoring biological and aesthetic functions
Increase biodiversity	Introduction naturalistic and bee-friendly greenery	Increase the number of plant and animal species living in the city
Acquire your own fruit and vegetables	Establishment of dining gardens	Social inclusion, strengthening the sense of identity with the place, shaping healthy eating habits

Building Block 2. Choosing appropriate indicators & Building Block 3. Developing a data plan for impact evaluation & Building Block 4. Implementing the data plan

In the following sections, the next three building blocks are presented together, in order to make it easier for the reader to follow the details of the plans.

C. Indicators, data and Data collection plan

C1. Nature-oriented playgrounds at preschools

CODE	NAME	City selection	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data	CN Method	Budget	Data collection	Data analysis
PRIMARY INDICATORS											
PI1	Type of interaction with NBS	•	-	-	-	-	• Survey 2021 6 preschools	Survey 2021	CN personnel costs	AMU team	AMU team
PI2	Frequency of interaction with NBS	•	•	Survey 2020	Preschools voluntary participating in survey	One time	• Survey 2021 6 preschools	Survey 2020	CN personnel costs	AMU team	AMU team
PI3	Duration of interaction with NBS	•	•	Survey 2020	Preschools voluntary participating in survey	One time	• Survey 2021 6 preschools	Survey 2020	CN personnel costs	AMU team	AMU team
PI4	Perceived quality of space	•	•	Survey 2019	10 preschools	-	• Survey 2021 6 preschools	Survey 2019	CN personnel costs	AMU team	AMU team
ENVIRONMENTAL INDICATORS											
CORE											
ENV3	Air temperature change	•	•	Spring 2021 (baseline year for thermal camera images and air temperature measurement with mobile and stationary sensors/stations) 2020 (average land surface temperature calculated from Landsat 8 images from 2018-2020 – 5 scenes)	Mainly micro scale/ site scale Different sites within garden and preschool's surrounding (thermal camera images, measurements based on mobile sensors) City scale/intermediate scale (land surface temperature based on Landsat 8 input)	Continuous automatic meteo measurements (hourly recording interval (24 records a day) starting from 10.2020 Site analyses of thermal images – once a month starting from 03.2021 Land surface temperature – once a 3 year	•	meteorology measurements/ analyses of data from e.g Landsat	CN equipment costs 25 357,7 PLN CN personnel costs	AMU team	AMU team

						period					
EN V81	Soil sealing	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021)	Micro scale/ site scale	One time per case study where de-sealing was conducted	-	data from analysis of orthophotomap – city data/ field mapping – AMU team	CN personnel costs	AMU team	AMU team
					FEATURE						
EN V41	Accessibility of greenspaces	•	•	2019/2020 (spatial analysis)	Intermediate scale Micro scale/ site scale	One time	-	Survey 2020 GIS spatial analysis	CN personnel costs	AMU team	AMU team
EN V43	Ratio of open spaces to built form	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas) 2019 (BDOT10k)	City scale Intermediate scale Micro scale/ site scale	Dependent on the availability of the new datasets Urban Atlas (every 6 year) Every new release of BDOT10k (not specified)	•	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personnel costs	AMU team	AMU team
EN V55	Green space area	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas) 2019 (BDOT10k)	Micro scale/ site scale Intermediate scale City scale	Dependent on the availability of the new datasets Urban Atlas (every 6 year) Every new release of BDOT10k (not specified)	•	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personnel costs	AMU team	AMU team
EN V88	Tree shade for local heat change	•	•	2021	Micro scale/ site scale	Once a month (manual thermal camera)	(a new collection planned for 04.2021)	Data analysis/ data from manual thermal camera	CN equipment costs 9471 PLN CN personnel costs	AMU team	AMU team
					HEALTH AND WELLBEING INDICATORS						
					CORE						
HW	Mental	•	-	-	Micro	data will	•	Survey	CN	AMU	AMU

11	health and wellbeing				scale/ site scale	be collected per case study (online surveys among teachers and parents from spring 2021)	2021	2021	personnel costs	team	team/ UDC team
HW 16	Perceived restorativeness of public green space	•	-	-	Micro scale/ site scale	data will be collected per case study (online surveys among teachers and parents from spring 2021)	• 2021	Survey 2021	CN personnel costs	AMU team	AMU team/ UDC team
FEATURE											
HW 14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	•	-	-	Micro scale/ site scale	data will be collected continuously (online surveys among teachers and parents from spring 2021)	• 2021	Survey 2021	CN personnel costs	AMU team	AMU team/ UDC team
SOCIAL COHESION INDICATORS											
CORE											
SC6	Place attachment	•	-	-	Micro scale/ site scale	data will be collected continuously (online surveys among teachers and parents from spring 2021)	• 2021	Survey 2021	CN personnel costs	AMU team	AMU team/ UDC team
FEATURE											
SC10	Environmental education opportunities	•	•	2018	Micro scale/ site scale	data will be collected once a year based on case studies	•	Survey 2021	CN personnel costs	AMU team	AMU team
ECONOMIC INDICATORS											
CORE											

EC 01	New Businesses 'attracted' or started and additional rates received	•	•	2016	Micro scale/ site scale	data will be collected based on case studies	-	Surveys/ interviews 2021	CN personnel costs	AMU team/ City staff	AMU team
EC 03	Net additional jobs created/enabled by NBS	•	•	2016	Micro scale/ site scale	data will be collected based on case studies	-	Surveys/ interviews 2021	CN personnel costs	AMU team/ City staff	AMU team
EC 013	Net impact on public expenditure from NBS implementation	•	•	2016	Micro scale/ site scale	Data collected once a year	•	Surveys/ interviews 2021	CN personnel costs	AMU team/ City staff	AMU team
EC 015	Private finance attracted to the NBS site	•	•	2018	Micro scale/ site scale	Data collected once a year	•	Surveys/ interviews 2021	CN personnel costs	AMU team/ City staff	AMU team

C2. OPEN GARDEN AT PRESCHOOL NO. 42

CODE	**NAME**	**City selection**	**Baseline data**	**Source (year)**	**Granularity**	**Periodicity**	**Collection of new data**	**CN Method**	**Budget**	**Data collection**	**Data analysis**
ENVIRONMENTAL INDICATORS											
CORE											
EN V3	Air temperature change	•	•	Spring 2021 (baseline year for thermal camera images and air temperature measurement with mobile and stationary sensors/stations) 2020 (average land surface temperature calculated from Landsat 8 images from 2018-2020 – 5 scenes)	Mainly micro scale/ site scale Different sites within garden and surrounding (thermal camera images, measurements based on mobile sensors) City scale/intermediate scale (land surface temperature based on Landsat 8 input)	Continuous automatic measurement (hourly recording interval (24 records a day) starting from 10.2020 Site analyses of thermal images – once a month starting from 03.2021 Land surface temperature – once a 3 year period	•	meteorology measurements/ analyses of data from e.g Landsat	CN equipment costs 25 357,7 PLN CN personnel costs	AMU team	AMU team
EN V81	Soil sealing	•	•	2018/2021 (baseline data from analysis of	Micro scale/ site scale	One time per case study where	•	data from analysis of orthophotomap,	CN personnel costs	AMU team	AMU team

				orthophotomap of 2018 updated with data gathered from field mapping in 2021)		de-sealing was conducted		BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team			
					FEATURE						
ENV41	Accessibility of greenspaces	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas) 2019 (BDOT10k)	Micro scale/ site scale (based on orthophoto map supplemented by field mapping) City scale/ intermediate scale (based on Urban Atlas and BDOT10k)	Dependent on the availability of the new datasets Every new release of Urban Atlas (every 6 year) Every new release of BDOT10k (not specified)	•	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personnel costs	AMU team	AMU team
ENV43	Ratio of open spaces to built form	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas) 2019 (BDOT10k)	Micro scale/ site scale (based on orthophoto map supplemented by field mapping) City scale/ intermediate scale (based on Urban Atlas and BDOT10k)	Dependent on the availability of the new datasets Every new release of Urban Atlas (every 6 year) Every new release of BDOT10k (not specified)	•	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personnel costs	AMU team	AMU team
ENV55	Green space area	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas)	Micro scale/ site scale (based on orthophoto map supplemented by field mapping) City scale/ intermediate scale (based on Urban Atlas and BDOT10k)	Dependent on the availability of the new datasets Every new release of Urban Atlas (every 6 year) Every new	•	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personnel costs	AMU team	AMU team

				2019 (BDOT10k)		release of BDOT10k (not specified)					
EN V88	Tree shade for local heat change	•	-	2021	Micro scale/ site scale	Once a month (manual thermal camera)	-	Data analysis/ data from manual thermal camera	CN personel costs CN equipment costs 9471 PLN	AMU team	AMU team
ECONOMIC INDICATORS											
CORE											
ECO 1	New Businesses 'attracted' or started and additional rates received	•	•	2016	Micro scale/ site scale	data will be collected based on case studies	-	CN personel costs	AMU team/ City staff	AMU team	Surveys/ interviews 2021
ECO 3	Net additional jobs created/enabled by NBS	•	•	2016	Micro scale/ site scale	data will be collected based on case studies	-	CN personel costs	AMU team/ City staff	AMU team	Surveys/ interviews 2021
ECO 13	Net impact on public expenditure from NBS implementation	•	•	2016	Micro scale/ site scale	Data collected once a year	-	CN personel costs	AMU team/ City staff	AMU team	Data analysis – city data

C3. POCKET PARKS

CODE	NAME	City selection	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data	CN Method	Budget	Data collection	Data analysis
ENVIRONMENTAL INDICATORS											
CORE											
EN V3	Air temperature change	•	•	Spring 2021 (baseline year for thermal camera images and air temperature measurement with mobile and stationary sensors/stations) 2018-2020 (average land	Mainly micro scale/ site scale Different sites within garden and preschool's surrounding (thermal camera images, measurements based on mobile sensors) City scale/intermediate scale (land surface	Continuous automatic measurement (hourly recording interval (24 records a day) starting from 10.2020 Land surface temperature – once a 3 year	•	meteorology measurements/ thermal camera/ analyses of data from e.g Landsat	CN equipment costs 25 357,7 PLN CN personel costs	AMU team	AMU team

				surface temperature calculated from Landsat 8 images from 2018-2020 – 5 scenes)	temperature based on Landsat 8 images)	period					
EN V8	Rainfall storage (water absorption capacity of NBS)	-	-	This indicator is calculated within ENV85	-	-	-	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personel costs	AMU team	AMU team
EN V85	Change in ecosystem service provision	•	•	2018/2020/2021 baseline air quality & meteo data/ tree measurements/ calculation of ES	Micro scale/ site scale	One time based on selected case study	-	meteorology measurements/ thermal camera/ analyses of data from e.g Landsat	CN equipment costs 25 357,7 PLN CN personel costs	AMU team	AMU team
					FEATURE						
EN V1	Carbon storage OR carbon sequestration in vegetation/soil	-	-	This indicator is calculated within ENV85	-	-	-	data from analysis of orthophotomap, BDOT10k – city data/ analysis of Urban Atlas and field mapping – AMU team	CN personel costs	AMU team	AMU team
EN V41	Accessibility of greenspaces	•	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas) 2019 (BDOT10k)	Micro scale/ site scale (based on orthophotomap supplemented by field mapping) City scale/ intermediate scale (based on Urban Atlas and BDOT10k)	Dependent on the availability of the new datasets Every new release of Urban Atlas (every 6 year) Every new release of BDOT10k (not specified)	•	2018/2021 (baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021)/ analysis of Urban Atlas and BDOT10k	CN personel costs	AMU team	AMU team
EN V55	Green space	•	•	2018/2021 (baseline	Micro scale/ site	Dependent on the	•	2018/2021	CN perso	AMU team	AMU team

	area			data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021) 2012 (Urban Atlas) 2019 (BDOT10k)	scale (based on orthophotomap supplemented by field mapping) City scale/ intermediate scale (based on Urban Atlas and BDOT10k)	availability of the new datasets Every new release of Urban Atlas (every 6 year) Every new release of BDOT10k (not specified)		(baseline data from analysis of orthophotomap of 2018 updated with data gathered from field mapping in 2021)/ analysis of Urban Atlas and BDOT10k	nel costs		
EN V88	Tree shade for local heat change	•	-	2021	Micro scale/ site scale	Once a month (manual thermal camera measurements)	-	Data analysis/ data from manual thermal camera	CN equipment costs 9471 PLN CN personnel costs	AMU team	AMU team
ECONOMIC INDICATORS											
CORE											
ECO 13	Net impact on public expenditure from NBS implementation	•	•	2018	Micro scale/ site scale	Data collected once a year	•	Data analysis – city data	CN personnel costs	AUM team/ City staff	AMU team

2.1.2. The city of Glasgow

The quality of Glasgow's open spaces, and their ability to deliver a range of benefits for the city, is a key determinant of Glaswegians' quality of life. The City of Glasgow conducted the impact assessment process on one exemplar: the Open Space Strategy (OSS). The OSS sets out an approach to co-ordinate the various open space responsibilities to ensure well-managed, well-located and well-connected open spaces that operate as part of a wider green network. The OSS will help deliver the aspirations of the City Development Plan (CDP) and play a key role in developing the Council's spatial strategy in future iterations of the Plan. The draft Supplementary Guidance SG6: Green Belt and Green Network was prepared to align with the OSS and the two documents will direct the approach towards developer contributions relating to Open Space in the future. The following are two food growing projects to be undertaken on protected open space (Growchapel and Bellahouston Garden). We have decided to use these to assess the effectiveness of the OSS and NBS. In this way, we also showcase the potential of connecting neighbourhood-scale projects and their evaluation with city-scale strategies and data integration efforts.

Growchapel is a community led project aiming to use horticultural therapy as a way of helping those members of the community struggling with isolation, mental health and addiction issues. The site is situated within a deprived area in Glasgow where the availability of good quality of open spaces is limited. Growchapel originated from a local "Quality of Life Group" meeting, chaired by Police Scotland and attended by local organisations invested in the neighbourhood of Drumchapel and looking to improve the conditions and health of those living, working and visiting the area. The area was designed to bring the community together, encourage mental and physical health improvement and help combat low-level antisocial behaviour.

Bellahouston Garden is located within Bellahouston Park and was created as a means of trialling food growing about ten years ago. Due to funding limitations and the lack of a robust governance structure, the garden hasn't been able to prove the effectiveness of food growing in improving the local community, which is why as part of Connecting Nature, we decided to do some retrospective analysis and in collaboration with Growchapel provide the evidence required to upscale food growing projects.

Throughout the process of building a baseline and planning our evaluation, we encountered various limitations and issues. The granularity and periodicity of data, was often an issue, with datasets such as carbon sequestration and tourism figures available at city-level rather than neighbourhood scale, and health and wellbeing data such as life expectancy or numbers of cardiovascular disease patients, being aggregated across multiple years, therefore potentially hiding temporal trends. We also found issues around confidentiality and lack of cooperation between departments to be a major difficulty when sourcing data, whereby health data were often considered too sensitive to release or we often had to go outside of our organisation to find what we needed. We also found data were often available in difficult-to-process formats, such as reports with no geospatial information. We have, however made progress with resolving these issues, as part of our collaboration with the Corporate Data team who have helped us open doors and access previously unknown to us data. On the following pages, the monitoring and evaluation plan of the city of Glasgow is shown, structured according to the building blocks of the Connecting Nature Impact Assessment Framework. The results of the evaluated indicators can be consulted in Appendix III.

Building block 1. Structured reflection on NBS impacts, pathways and trade-offs

A. Strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A Liveable Glasgow																	
Open Space Access and Quality	●		●		●					●	●		●		●		
Open Space Quantity	●		●		●					●	●		●		●		
Setting and Amenity	●		●		●					●	●		●		●		
Views of the Public	●		●		●					●	●		●		●	●	
City Centre/Grey Open Space	●		●		●			●	●	●	●		●		●		
A Healthy Glasgow																	
Play and Education			●	●	●					●	●		●		●		
Outdoor Sports			●		●					●	●	●	●		●		
Growing Spaces	●	●	●		●			●	●	●	●	●	●		●		
Walking and Cycling			●		●					●	●	●	●		●		
Air Quality and Pollution			●		●	●				●	●	●	●		●		
A Resilient Glasgow																	
Surface Water Management			●			●				●	●	●	●	●	●		
Protecting Sites and Species												●	●	●	●		
Connecting Habitats												●	●	●	●		
Mitigating Climate Change			●			●	●			●	●	●	●	●	●		
Blue Space						●	●					●	●	●	●		

B. Nature-Based Solutions and expected impact

NBS Characteristics	
Type	Open Space Strategy
Scale	City-wide
Location	Glasgow City Centre - 55.8642° N, 4.2518° W
Process of design and implementation	To accord with PAN 65, the Scottish Government's guidance document on the relationship between the planning system and open space, the OSS has been informed by: • an audit of open space in the form of the Glasgow Open Space Map. The Open Space Map identifies the extent, type and spatial distribution of the open spaces protected through the City Development Plan;

	• an assessment of the quality of two of the most usable categories of open space shown on the Open Space Map – public parks & gardens and amenity residential space over 0.3ha; and • an analysis of accessibility to these key spaces to highlight areas that are potentially well-served by good quality spaces and those that are less so. In line with PAN 65, this analysis has been used to develop a set of open space standards for Glasgow based upon the following: (These do not apply to the City Centre, where a different approach, aligned with the City Centre Strategy, is proposed): • an **Accessibility Standard** - aimed at delivering access to a good quality open space, of >0.3ha, within a 400m walk of people's homes; • a **Quality Standard** – to ensure the open spaces used to meet the Accessibility Standard are of good quality in terms of usability and multi-functionality; and • a **Quantity Standard** – to ensure there is enough open space, per head of population, in each part of the City. Different quantity standards apply to the Inner Urban Area (where residential population densities are higher) and the Outer Urban Area. Since the OSS was approved, we have undertaken quality assessments of each open space that we think has the potential to meet these standards and are now analysing the data available to be able to cite the sites for different types of NBS.
Current deployment and deadline	We are in the process of putting the data together and assessing the suitability of sites to meet the goals we have e.g, food growing, tree planting etc. Following this analysis, we intend on consulting internally and with the public prior to making further amendments and finalising the OSS Delivery Plan map. We aim to have this finished by May 2022.

B1. Open Space Strategy

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Improve access to good quality open space for locals (quantity & quality improvements)	Analyse data to obtain understanding of best route and site improvements.	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for physical exercise - Increased opportunities for social interaction - Increased opportunities for nature enjoyment and relaxation
Have the community embrace these improvements/changes and use the spaces	Undertake public consultation on proposed improvements and changes.	Designing spaces that are being used by the community because they represent their standards
Provide sufficient open space for the city centre (creation of new spaces)	Analyse data to obtain understanding of best sites for turning into open space.	Improved open space provision for an area expected to increase its population size in the future, so that we can: - Improved mental health and wellbeing - Improved physical health - Increased opportunities for physical exercise in nature - Increased opportunities for social interaction - Increased opportunities for nature enjoyment and relaxation - Tackling air pollution - Increased opportunities for active travel
Increase opportunities for play and recreation for locals and their children	Analyse data to obtain understanding of existing play and recreation areas and improvements required.	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for physical exercise
Increase opportunities for outdoor sports	Analyse data to obtain understanding of existing sports areas and improvements required.	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for physical exercise
Increase community growing spaces	Analyse data to obtain understanding of existing food growing spaces, the public's	- Improved mental health and wellbeing

	suggestions and cite open spaces that can accommodate food growing. Improve existing sites if possible.	- Improved physical health - Improved diets - Increased opportunities for social interaction - Increased opportunities for nature enjoyment and relaxation
Increase opportunities for walking and cycling through improved active travel routes	Analyse data to obtain understanding of existing active travel network and changes required.	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for physical exercise in nature - Tackling air pollution and reducing carbon emissions
Improve air quality	Analyse data to obtain understanding of existing vegetation in open spaces and cite the best locations for planting trees and the types of trees that suit best.	- Improved physical health - Increased opportunities for nature enjoyment and relaxation
Reduce noise pollution	Analyse noise pollution data and decide where to concentrate efforts.	- Improved physical health - Increased opportunities for nature enjoyment and relaxation
Reduce floods and improve water management	Analyse existing flood modelling data and identify open spaces that can help through SuDS or other water management practices.	- Reduction in flooding - Reduction in public expenditure as a result of floods
Enhance biodiversity	Analyse existing biodiversity data and identify open spaces that can be used to enhance biodiversity.	- Improved and increased habitats for species
Increase communities' engagement with the natural world	Analyse data to obtain understanding of best sites for turning into open space.	- Increased opportunities for nature enjoyment and relaxation
Provide improved habitat connections	Analyse existing biodiversity data and identify open spaces that can be used to enhance biodiversity and promote habitat connections.	- Improved habitats for species
Deliver renewable energy and heat through open spaces	Analyse existing ParkPower and carbon emission data to identify suitable open spaces to use.	- Reduced fuel poverty - Reduced public expenditure for heating buildings - Reduced carbon emissions
Improve and protect the quality of blue spaces	Analyse data on blue spaces and ongoing projects and consider improvements/changes.	- Increased opportunities for nature enjoyment and relaxation

B2. GROWCHAPEL

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Convert derelict area to usable open space	- Undertake community consultation (done) - Draw up plans (done) - Secure funding (done) - Construct fence and procure equipment (ongoing) - Hold opening event and sign community groups/individuals up (to-do)	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for nature enjoyment and relaxation - Improved diets - Increased opportunities for social interaction - Reduced anti-social behaviour
Provide local food growing opportunity	Involve locals and community groups in garden once constructed and provide training for food growing and education around healthy diets.	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for nature enjoyment and relaxation - Improved diets - Increased opportunities for social interaction - Upskilling of community - Reduced anti-social behaviour - Police prescribing
Enhance biodiversity and habitats	- Undertake baseline survey of biodiversity on site (done) - Plant vegetation that promotes the existing biodiversity/habitats and provides shelter for new species (ongoing)	- Improved habitats for species - Increased opportunities for nature enjoyment and relaxation - Improved air quality - Environmental education provision

B3. Bellahouston Garden

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Assess performance of existing growing space	- Consult current users and their organisations - Plan improvements/changes	- Increased frequency of interaction with the garden - Improved marketing of garden - Better sense of ownership of garden, through improvements - Attract more funding - Upscale NBS across city
Promote space better	- Use improvement ideas to change the space and market it better for the community	- Improved mental health and wellbeing - Improved physical health - Increased opportunities for nature enjoyment and relaxation - Improved diets - Increased opportunities for social interaction - Upskilling of community - Reduced anti-social behaviour

Building Block 2. Choosing appropriate indicators; Building Block 3. Developing a data plan for impact evaluation; & Building Block 4. Implementing the data plan

C. Indicators, data and Data collection plan

C1. Open Space Strategy

CODE	NAME	City selection	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data
ENVIRONMENTAL INDICATORS							
CORE							
ENV8	Rainfall storage (water absorption capacity of NBS)	•	•	Various	SuDS locations - site-based SWMPs – area-specific but not covering the entire city and data not digitised GALLANT to be doing some of this work.	One-off measurements from different projects/studies	Some data to be collected as part of GALLANT project at the UoG, but not covering entire city.
ENV15	Water quality	•	•	2007-2018	Water body level	Yearly (delayed)	No
ENV19	Inundation risk for critical urban infrastructures (probability)	•	•	N/A, but it is the official modelling work for Scotland	Street level, but accuracy more suitable for strategic considerations	N/A but will have to be updated at some point.	No
ENV23	Public green space distribution	•	•	Ongoing	Each open space	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV27	Connectivity of urban green and blue spaces (structural and functional)	•	•	Ongoing	Each open space	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV29	Supporting/increasing	•	•	2017	City-wide	One-off	Yes

	biodiversity conservation			2021		measurements from different studies/projects.	
ENV35	Species diversity	•	•	2017 2021	City-wide	One-off measurements from different studies/projects.	Yes (same as above)
ENV42	Land use change and greenspace configuration	•	•	Ongoing	Each open space	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV56	Blue space area	•	•	Ongoing	Each open space	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV89	Community garden area per capita and in a defined distance	•	•	N/A	Each allotment	One-off measurement.	No
				FEATURE			
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	•	•	2015 2021	City-wide	One-off measurement.	No
ENV41	Accessibility of greenspaces	•	•	Ongoing	Each open space	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV55	Green space area	•	•	Ongoing	Each open space	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV66	Air quality change	•	•	Ongoing	City-wide	Daily	No
				HEALTH AND WELLBEING INDICATORS			
				CORE			
HW3	General wellbeing and happiness	•	•	2017-2018	Intermediate Zone	Yearly	No
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	•	•	2016-2019 aggregates 2015-2017 aggregates	City-wide Intermediate Zone	Yearly (4 year aggregates) Yearly (3 year aggregates)	No
HW11	Mental health and wellbeing	•	•	2019	Intermediate Zone	Yearly	No
HW12	Enhanced physical activity	•	•	2016-2019 aggregates	City-wide	Yearly (4 year aggregates)	No
				FEATURE			
HW1	Sustainable nutrition/adoption	•	•	2015-2018 aggregates	City-wide	Yearly (4 year aggregates)	No
HW4	Life expectancy and healthy life years expectancy	•	•	2014-2018	Intermediate Zone	Yearly (5 year aggregates)	No
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	•	•	2019 2016-2019	Intermediate Zone City-wide	Yearly Yearly (4 year aggregates)	No
HW8	Incidence of obesity /obesity rates (adults and children)	•	•	2016-2019	City-wide	Yearly (4 year aggregates)	No
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity	•	•	2019	Intermediate Zone	Yearly	No

	disorder (ADHD)						
SOCIAL COHESION INDICATORS							
CORE							
SC1	Bonding social capital	●	●	2017-2018	Area-specific	One-off measurement.	Yes
SC2	Bridging social capital	●	●	2017-2018	Area-specific	One-off measurement.	Yes (same as above)
SC4.1	Trust in community	●	Partial	2014-2015, 2017-2018 2020	Area-specific	One-off measurement.	Yes
SC5.1	Perceived safety	●	Partial	2014-2015, 2017-2018	Area-specific	One-off measurement.	Yes
SC5.2	Actual safety	●	●	2018	Intermediate Zone	Yearly	No
SC9	Empowerment	●	●	2017-2018	Area-specific	One-off measurement.	Yes
ECONOMIC INDICATORS							
CORE							
ECO1	New Businesses 'attracted' or started and additional rates received	●	●	2019	Intermediate Zone	Yearly	No
ECO3	Net additional jobs created/enabled by NBS	●	●	2019	City-wide	Yearly	No
ECO7	Increase in tourism	●	●	2019	City-wide	Yearly	No
FEATURE							
ECO8	Income/disposable income per capita	●	●	2019	City-wide	Yearly	No
ECO9	Upskilling & related earning increase	●	●	2019	City-wide	Yearly	No
ECO11	Overall economic, social and health wellbeing	●	●	2020	Data zone	Every 4 years	No

C2. GROWCHAPEL

CODE	NAME	City selection	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data
ENVIRONMENTAL INDICATORS							
CORE							
ENV8	Rainfall storage (water absorption capacity of NBS)	●	●	2021	Site-based	Before-after measurement	Yes
ENV19	Inundation risk for critical urban infrastructures (probability)	●	●	2021	Site-based	Before-after measurement	Yes
ENV29	Supporting/increasing biodiversity conservation	●	●	2020	Site-based	Before/after	No
ENV35	Species diversity	●	●	2020	Site-based	Before/after	No
ENV42	Land use change and greenspace configuration	●	●	Ongoing	Site-based	N/A but in the process of updating this ourselves as part of the OSSDP.	No
ENV89	Community garden area per capita and in a defined distance	●	●	Ongoing	Site-based	N/A but in the process of updating this ourselves as part of the OSSDP.	No
FEATURE							
ENV41	Accessibility of greenspaces	●	●	2021	Site-based	Before/after	No
HEALTH AND WELLBEING INDICATORS							
CORE							
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	●	Partial	2015-2017 2016-	Intermediate Zone	Yearly	No

				2018 2017-2019 2018-2020			
HW11	Mental health and wellbeing	•	•	2019	Intermediate Zone	Yearly	No
				FEATURE			
HW4	Life expectancy and healthy life years expectancy	•	•	2014-2018	Intermediate Zone	Yearly	No
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	•	•	2010-2019	Intermediate Zone	Yearly	No
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	•	•	2019	Intermediate Zone	Yearly	No
				SOCIAL COHESION INDICATORS			
				CORE			
SC5.2	Actual safety	•	•	2018	Intermediate Zone	Yearly	No
				ECONOMIC INDICATORS			
				CORE			
ECO1	New Businesses 'attracted' or started and additional rates received	•	•	2020	Site-based	Yearly	No
ECO3	Net additional jobs created/enabled by NBS	•	•	2020 2021	City-wide Site-based	Quarterly Before/After	Yes
ECO13	Net impact on public expenditure from NBS implementation	•	•	2021	Site-based	Yearly	No

C3. Bellahouston Garden

CODE	NAME	City selection	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data
				PRIMARY INDICATORS			
PI1	Type of interaction with NBS	•	•	2021	Site	One-off measurement	No
PI2	Frequency of interaction with NBS	•	•	2021	Site	One-off measurement	No
PI3	Duration of interaction with NBS	•	•	2021	Site	One-off measurement	No
PI4	Perceived quality of space	•	•	2021	Site	One-off measurement	No
				ENVIRONMENTAL INDICATORS			
				CORE			
ENV89	Community garden area per capita and in a defined distance	•	•	Ongoing	Site-based	N/A but in the process of updating this ourselves as part of the OSSDP.	No
				FEATURE			
ENV41	Accessibility of greenspaces	•	•	2021	Site-based	Before/after	No
				HEALTH AND WELLBEING INDICATORS			
				CORE			
HW3	General wellbeing and happiness	•	•	2017-2018 2021	Intermediate Zone Site-based	Yearly Before/After	No
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	•	Partial	2015-2017 2016-2018 2017-2019 2018-2020	Intermediate Zone	Yearly	No
HW11	Mental health and wellbeing	•	•	2019 2021	Intermediate Zone	Yearly Before/After	No

					Site-based		
HW12	Enhanced physical activity	●	●	2016-2019 aggregates 2021	City-wide Site-based	Yearly (4 year aggregates) Before/After	No
HW16	Perceived restorativeness of public green space	●	●	2021	Site-based	Before/After	No
FEATURE							
HW1	Sustainable nutrition/adoption	●	●	2021	Site-based	Before/After	No
HW4	Life expectancy and healthy life years expectancy	●	●	2014-2018	Intermediate Zone	Yearly (5 year aggregates)	No
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	●	●	2019	Intermediate Zone	Yearly Yearly (4 year aggregates)	No
HW13	Perceived chronic loneliness	●	●	2021	Site-based	Before/After	No
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	●	●	2019	Intermediate Zone Site-based	Yearly	No
SOCIAL COHESION INDICATORS							
CORE							
SC1	Bonding social capital	●	●	2021	Site-based	Before/After	No
SC2	Bridging social capital	●	●	2021	Site-based	Before/After	No
SC4.1	Trust in community	●	●	2021	Site-based	Before/After	No
SC4.2	Solidarity between neighbours	●	●	2021	Site-based	Before/After	No
SC4.3	Tolerance and respect	●	●	2021	Site-based	Before/After	No
SC5.1	Perceived safety	●	●	2021	Site-based	Before/After	No
SC5.2	Actual safety	●	●	2018 2021	Intermediate Zone Site-based	Yearly Before/After	No
SC6	Place attachment	●	●	2021	Site-based	Before/After	No
SC9	Empowerment	●	●	2021	Site-based	Before/After	No
SC11.1	Positive environmental attitudes motivated by contact with NBS	●	●	2021	Site-based	Before/After	No
FEATURE							
SC10	Environmental education opportunities	●	●	2021	Site-based	Before/After	No
SC12	Pro-environmental behaviour	●	●	2021	Site-based	Before/After	No
ECONOMIC INDICATORS							
CORE							
ECO1	New Businesses 'attracted' or started and additional rates received	●	●	2020	Site-based	Yearly	Yes
ECO3	Net additional jobs created/enabled by NBS	●	●	2020 2021	City-wide Site-based	Quarterly Before/After	Yes

2.1.3. The city of Genk

Until the end of the nineteenth century the area around Genk was an under-developed region. The sandy, arid lands were not suited for agriculture. Small settlements had emerged along the brook valleys. The Stiemer river valley, running diagonally through the city, was back then an 8 km stretch of farming activities through Genk. The mining industry and urbanisation that followed completely enclosed the valley and put it under severe pressure. In the seventies the river stream was straightened and largely lost contact with its valley. The people living around literally turned their back to the river and seemed to have forgotten about it. In that period, sewage systems were constructed in the surrounding neighbourhoods, bringing waste water to the underground collector pipes on both sides of the Stiemer river. The overflow systems on these collectors were linked to the Stiemer and as urbanisation increased, sewage overflows became more frequent. Even during moderate rainfall, waste water mixed with rainwater flew into the Stiemer, with a negative impact on the water, the environment and the neighbouring people. The accelerated and massive discharge of rainwater from the valley also caused flooding and drying of the valley ecosystem.

It was only until the nineties that a local nature organisation brought the importance of the Stiemer valley to public attention. At some locations the valley still contained valuable natural elements. As a result, large parts were protected as a recognized nature reserve in 2006. The city started to realise more and more that the valley could be an important blue-green connection between different areas of the city with a lot of potential. They created a partnership and lobbied to get support from the regional authorities. The Flemish Stiemer Valley Plan Programme (2010) of the Flemish Land Agency was born. Under impulse of this plan two areas in the valley were developed: Schansbroek, the source area of the Stiemer and Slagmolen, the area around an old water mill downstream at the other end of the city. In both areas, a nature-based redesign of the area has been recently implemented.

These developments boosted city development and revealed the need for an integral vision for the entire valley. In the 2016-2019 period a spatial masterplan with an integral long-term vision was drawn up in collaboration with the consortium Tractebel, ADR Architects/Georges Descombes and IMDC. This plan is a strategic toolbox for a step-by-step, spatial transformation of the area in which climate adaptation, biodiversity, recreation, social cohesion and sustainable mobility are important themes. It is now the city's ambition to start implementing this vision. To this end, an ambitious Stiemer programme containing the objectives and strategies for this long-term development has been developed. The overall objective is to develop a multifunctional blue-green urban valley that increases the quality of life and the resilience of the city, as part of the development strategy of the city of Genk. On the following pages, the monitoring and evaluation plan of the city of Genk is shown, structured according to the building blocks of the Connecting Nature Impact Assessment Framework. The results of the evaluated indicators can be consulted in Appendix IV.

Building block 1. Structured reflection on NBS impacts, pathways and trade-offs

A. Strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(Opportunity) poverty is decreasing in Genk	●	●		●	●				●	●							
Talent development and language skills, especially Dutch, are increasing.	●		●	●	●			●									
More residents of Genk find an appropriate answer to their need for care and support.			●														●
Living in Genk is attractive.	●	●				●	●			●	●						●
More people from Genk make use of a diverse range of leisure and experience options in Genk.			●							●	●		●		●		
The City of Genk strengthens its economic position in Flanders, for the benefit of Genk residents, the city and the region.	●							●		●							●
Genk strengthens its urban appeal, with special attention to the city center.			●						●		●				●		●
Genk is becoming more climate and environmentally friendly							●				●	●	●	●	●		●
Multimodal accessibility within and to Genk is getting better and more sustainable.			●						●	●	●		●				●
We create the city together based on mutual respect and connection between the people of Genk.			●							●	●		●			●	●
City of Genk invests in a safe city.											●					●	●
The city of Genk is organized in a high-performance, people and market oriented way.			●							●	●		●				●
the financial policy of the City of Genk is sustainable, balanced and transparent.											●						●

B. Nature-Based Solutions and expected impact

NBS Characteristics	
Type	Development of a valley (Stiemervalley)
Scale	8 km valley
Location (Geographical coordinates)	Valley located throughout entire city, stretching from north east to south west
Process of design and implementation	Propelling a co-creative city making programme building upon the ownership, engagement and activation of a variety of usual and non-usual stakeholders
Current deployment and deadline	Implementation phase from 2021
Financing and stewardship	Initiated by city of Genk; financed by Genk, regional authorities and other partners

Theory of change		
NBS Objectives	NBS Actions	NBS Expected Results
Connect nature with nature	Restore different ecotypes by nature conservation Introduce a natural stream in the valley	Increase biodiversity in the valley
Connect nature with people	Recover a climate resilient and natural water system in the urban valley Create walking and bicycle paths in the valley to connect city sites and neighbourhoods (valley as connector) Provide recreational opportunities for people (valley as destination) Implement communication strategy and stiemerdeals	Prepare the city for climate change Enable a sustainable use of the valley Maximize the social return on investment by fostering initiatives, educational activities and co-operation that add value to the valley
Connect people with people	Implement communication strategy and stiemerdeals	Strengthen social cohesion across the multiple layers of diversity in the valley Create a public culture in the valley that fuels people to embrace 'their' valley
Connect entrepreneurship with nature	Explore, identify and boost economic opportunities linked to the valley – implement stiemerdeals	Increase economic development linked to the valley

Building Block 2. Choosing appropriate indicators; Building Block 3. Developing a data plan for impact evaluation: & Building Block 4. Implementing the data plan

C. Indicators, data and Data collection plan

CODE	NAME	City selection	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data	CN Method	Budget	Data collection	Dana analysis
				PRIMARY INDICATORS							
PI1	Type of interaction with NBS	•		CN Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
PI2	Frequency of interaction with NBS	•		CN Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
PI3	Duration of interaction with NBS	•		CN Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
PI4	Perceived quality of space	•		CN Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña

ENVIRONMENTAL INDICATORS											
CORE											
ENV 15	Water quality	•		Citizen science project Stiemer lab (2020-2021) & CN Survey (2021)	Exemplar	To be decided	•	Water sampling		Local university	Local university
ENV 29	Supporting/increasing biodiversity conservation		•	Ecotope monitoring (2021)	Exemplar	Every 5 year	•	Ecotope monitoring	5000 €	Research institute nature & forest	Research institute nature & forest
ENV 35	Species diversity		•	Ecotope monitoring (2021) & CN Survey (2021)	Parcel	Every 5 year	•	Ecotope monitoring	5000 €	Research institute nature & forest	Research institute nature & forest
ENV 42	Land use change and greenspace configuration	•	•	Geopunt database (2013)	Exemplar	Every 3 year		Geopunt database		Research organisation VITO	Research organisation VITO
ENV 81	Soil sealing	•	•	Geopunt database (2015)	Exemplar	Every 3 year	•	Geopunt database		Research organisation VITO	Research organisation VITO
HEALTH AND WELLBEING INDICATORS											
CORE											
HW 3	General wellbeing and happiness	•	•	City Monitor 2017 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
HW 11	Mental health and wellbeing	•		Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
HW 12	Enhanced physical activity	•	•	City Monitor 2017 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
HW 16	Perceived restorativeness of public green space	•		Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
FEATURE											
HW 8	Incidence of obesity /obesity rates (adults and children)	•		Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
HW 13	Perceived chronic loneliness	•	•	City Monitor 2017 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SOCIAL COHESION INDICATORS											
CORE											

SC1	Bonding social capital	•	•	City Monitor 2020 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SC2	Bridging social capital	•	•	City Monitor 2020 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SC4.1	Trust in community	•	•	City Monitor 2020 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SC4.3	Tolerance and respect	•	•	City Monitor 2020 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SC5.1	Perceived safety	•	•	City Monitor 2020 & Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SC6	Place attachment	•		Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
SC9	Empowerment	•		Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
FEATURE											
SC12	Pro-environmental behavior	•		Survey (2021)	Entire city	Every 5 year	•	Questionnaire	9000 €	Research and polling agency	University of A Coruña
ECONOMIC INDICATORS											
CORE											
ECO 1	New Businesses 'attracted' or started and additional rates received	•	•	Locatus database (2016)	Street	Every year	•	Locatus database		Retail information company	Retail information company
ECO 7	Increase in tourism	•	•	Genk in cijfers (2015)	Entire city	Every year	•	Mercurius (accounting system local government)	Personnel costs	Council staff	Council staff
FEATURE											
ECO 13	Net impact on public expenditure from NBS implementation	•	•	Mercurius (2015)	Exemplar	Every year	•	Mercurius (accounting system local government)	Personnel costs	Council staff	Council staff
ECO 15	Private finance attracted to the NBS site	•	•	Mercurius (2015)	Exemplar	Every year	•	Mercurius (accounting system	Personnel costs	Council staff	Council staff

								local government)			
ECO 6	Innovation impact	•	•	Department inventory (2019)	Exemplar	Every year	•	Department inventory	Personnel costs	Council staff	Council staff
PARTICIPATORY PLANNING AND GOVERNANCE INDICATORS											
CORE											
PPG 1	Diversity of stakeholders involved	•		Stakeholder analysis	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
PPG 2	Social equity: involvement of citizens from traditionally under-represented groups	•		Stakeholder survey (2021)	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
PPG 5	Activation of public-private collaboration	•		Stakeholder survey (2021)	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
PPG 6	Trust in decision-making and decision-makers	•		Stakeholder survey (2021)	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
PPG 9	Innovative climate	•		Stakeholder survey (2021)	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
PPG 10	Open communication (internal & external)	•		Stakeholder survey (2021)	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
FEATURE											
PPG 17	Reflexivity - time for reflection	•		Stakeholder survey (2021)	Involved stakeholders	Every year	•	Stakeholder survey	Personnel costs	Council staff	Council staff
STIEMERDEAL INDICATORS											
	Number of Stiemerdeals	•	•	Department inventory (2015)	Exemplar	Every year	•	Department inventory	Personnel costs	Council staff	Council staff
	Size of the deal (number of involved parties)	•		Department inventory (2015)	Exemplar	Every year	•	Department inventory	Personnel costs	Council staff	Council staff
	Enabled capacity (investment cost or labour)	•		Department inventory (2015)	Exemplar	Every year	•	Department inventory	Personnel costs	Council staff	Council staff
	Contribution to Stiemerobjectives	•		Department inventory (2015)	Exemplar	Every year	•	Department inventory	Personnel costs	Council staff	Council staff
	Connectivity, network	•		Department inventory (2015)	Exemplar	Every year	•	Department inventory	Personnel costs	Council staff	Council staff

2.2 Mainstreaming assessment capacity: lessons learned, benefits and key innovations

In Connecting Nature**, co-creation** has been at the centre of the effort to define a sound impact assessment framework for cities. We started, as described in Deliverable 1, from an attempt to **select and apply appropriate indicators** to assess both the process and the outcomes of nature-based solutions design and implementation. From the initial stages of thoroughly reviewing the science on process and outcomes of NBS design, and doing a first selection of appropriate indicators, we took a step back and engaged into **a case-by-case, hands-on process of reflecting upon the theory of change behind NBS design** and their integration into the strategic city plans and objectives. From there, we moved into a further, **better tailored selection of indicators**, and **an analysis of synergies and trade-offs between desired outcomes**.

Once indicators were in place, each city engaged in a thorough process of **identifying existing available data**, **analyse its appropriateness** for the selected indicators, and **identify significant data gaps**. From there, cities collected additional data, with the support of scientific partners in the project. Finally, some of the cities explored **existing data integration or data communication platforms at city level**, and initiated discussions with relevant departments and stakeholders to include additional data layers that would reflect the impacts of nature-based solutions on the city's objectives. The city of Glasgow went further and pioneered the creation of **an integrated GIS based data infrastructure** that allows for further data layers to be included, as evaluation data becomes available through different urban projects and funding streams, and can orient decision-making.

Results of the monitoring and evaluation carried out in each city can be found in the Appendices to this deliverable. In them, a detailed description is provided of where each city arrived in terms of integrating monitoring and evaluation as part of their usual operations, as well as the results obtained from the monitoring and evaluation of particular exemplars. Here, we focus instead **on the lessons learned** from the arduous process of **mainstreaming nature-based solution monitoring and evaluation**, at each stage of the process, and formulate a series of recommendations that derive from them. Finally, we present the results of a focus group evaluation of impact assessment learning In Connecting Nature, where the frontrunner cities in the project reflected upon: **the benefits** of the Connecting Nature impact assessment process; and **the main impact assessment innovations** coming out of the work of Connecting Nature.

2.2.1. Lessons learned

2.2.1.1. Structured reflection on NBS impacts, pathways and trade-offs

There were three main difficulties identified in relation to this building block. First, **relating NBS specific objectives with the general strategic objectives of the city** is sometimes challenging, and cities struggle sometimes to see how and to what extent particular NBS projects will contribute to meet those. Creating **visual representations** of the relationships between objectives, including flow charts and tables, as illustrated in the frontrunner cities monitoring and evaluation plans has been very helpful, as it contributed to the breakdown of complex relationships into more manageable reflection bits.

Secondly, when specifying their theory of change, the careful analysis of **possible synergies and trade-offs between outcomes and for different social groups**, which can lead to significant complexity due to interrelations and interactions among different categories of outcomes pursued. In order to manage the inherent complexity of these relationships, cities learned that **analysing and graphically representing** the expected outcomes, synergies and trade-offs of each NBS action is helpful. Once all the individual analyses have been carried out, it is possible to have a panoramic vision of the expected impacts and trade-offs, and guide impact assessment decisions such as which indicators to select, which data to look for, and what monitoring and data collection processes to implement.

Finally, a risk cities face is related **to the lack of sufficient involvement of different stakeholder groups**, beyond academic and city council representatives. While it is sometimes not feasible for stakeholders to co-lead the design of the plans, it is really useful to have their feedback in the initial phases. Regarding citizens, the city's objective of gather evidence about urban interventions can be disseminated to facilitate their willingness to collaborate in data collection, even in citizen science projects. The active collaboration of citizens fosters **empowerment** of local communities and generates feelings of belonging that also contribute to behavioral change in ways that support urban sustainability objectives.

2.2.1.2. Choosing appropriate indicators

Choosing appropriate indicators when evaluating the impact of NBS is critical in order to assess their performance over time and make decisions about data collection investments and efforts. However, cities work with limited resources and often short political mandates, which means that longer-term thinking that might be appropriate for ongoing and additive evaluation is either not possible or not a priority. **Cities tended to be conservative in their choice of indicators**, reflecting their perception of available resources rather than choosing indicators that could properly evaluate the chosen objectives. Once this was clarified, cities went back and chose indicators for each of the relevant outcomes. Once all the indicators were selected, cities went back and decided which indicators to prioritize, based on available resources.

Another important reason to proceed this way is that once the cities start looking for available data, **they discover streams of data** they were not aware of. For example, the city of Glasgow contacted local universities and discovered interesting data sets for the evaluation of social cohesion indicators. Based on this experience, cities are encouraged **to complete the 5 building blocks of the impact assessment framework** thinking about the best possible evaluation plan for the NBS objectives, and once these are completed, an assessment of available resources can be made, considering the financial, temporal and personnel resources of the city.

The scale of impact was another important consideration for cities. Evaluating small scale projects can take up a lot of resources, and indicators that might be appropriate for some objectives, such as air quality, might be difficult to assess as it would require air quality measurements on site. Cities learned to choose the right methods for indicators at different scales, and an important recommendation here is that, in the longer term, it is more cost-effective to create an NBS impact assessment strategy at city-scale, and connect it to smaller scale monitoring and evaluation efforts.

2.2.1.3. Developing a data plan for impact evaluation

This has been one of the most challenging steps for cities, due to a number of obstacles. Some of the NBS projects cities were interested in creating a monitoring and evaluation plan for had started before the Connecting Nature project and **finding suitable data sources to assess baseline conditions**, at the appropriate level of granularity, was difficult. Secondly, **departmental silos** within city councils lead to a lack of awareness of data being collected by the city for policy priorities that might be relevant for the evaluation of NBS impacts. For example, health departments might collect data that can be used to assess health impacts of NBS, but urban planning departments might not necessarily know about which data is being collected and what the characteristics of those data are. Sometimes city councils have departments that are in charge of data in general, as it has been the case with the city of Genk, which collect data for strategic city objectives but **not necessarily adapted to the scale required by NBS projects**. Secondly, potentially relevant data is sometimes being collected by regional or even national agencies, or knowledge organizations such as universities. **Taking stock of data collection efforts of**

different stakeholders should be done as early as possible as part of the process of creating robust impact assessment frameworks in cities.

Moreover, often the problem was not in identifying existing data sources but **in accessing them**. Organizations that are custodians of data often have concerns about data security and privacy. Also, in some cases, the obstacles resided in **organizational cultures that do not support inter-departmental collaborations** or **the lack of relationships of trust.** A clear example was when a urban planning department in charge of designing the NBS evaluation plan needed to request data from another department, and either bad personal relationships were an obstacle to data access or internal resistance to data sharing was the norm. These issues can be dealt with more effectively if the **city establishes a culture of collaboration and data sharing**, creating collaboration networks, through regular meetings and mutual agreements from the beginning of the process of NBS design and implementation.

2.2.1.4. Implementing the data collection plan

New data collection has also been a challenging step for the cities. The methods to collect social, economic and environmental indicators require different types of expertise and a key challenge in the cities is the wide diversity of levels of expertise that is available in-house. Some cities had little evaluation expertise in the area of nature-based solutions, while for others, expertise in one area such as environmental indicators existed, but it was either housed in a different department or was provided by a university partner. Three different alternatives were found to be effective for the CN cities: **partnerships with local universities**, **the hiring of external consultancy companies** to do different bits of data collection, or **the hiring of city council staff specialized with data collection expertise**.

The three frontrunner cities each represented one of these models: Poznan has a long-standing collaboration with Adam Mickiewicz University, whose researchers have significant environmental indicators expertise; the city of Genk already collected data for several environmental indicators, and hired a consultancy firm to do the data collection for the selected social and health indicators; while the city of Glasgow had a staff member with expertise in GIS methodologies, with the remit to coordinate the process of data identification and organize the new data collection, through cooperation with CN academic partners. All cities plan to continue with these efforts in different ways: through securing future EU grant collaborations; through negotiations with regional authorities collecting data (such as the City Monitor survey in Genk, organized on a three year basis by the Flemish Government); through maintaining and possibly enlarging specialized staff (Glasgow); and continuing with university collaborations (Poznan). The evaluation efforts undertook by the city of Poznan exemplifying a small scale NBS addressing the needs of a particular social group (children) have also been featured as an example in the European NBS Impact Assessment Policy Summary.

Cities often work with funding that is tied to particular projects or policy priorities. This means that NBS evaluation is done for particular projects, using only a small number of indicators, prioritizing descriptive and easy to collect types of indicators (e.g. number of people passing through a particular green area), and in detriment to meaningful outcome indicators that could provide longer-term information about the performance of particular NBS, as well as to city-wide evaluation frameworks that are flexible enough to allow for new data “plug-ins” from particular projects. In this way, a better return on investment is ensured, and a culture of evidence-based policy making can be created.

However, in spite of these ad-hoc solutions that were useful for the evaluation of current NBS projects, the difficulty of the process is likely to be a deterrent for many cities and further capacity building at the European level should be encouraged. In this sense, the creation of a **European Observatory of Urban Regeneration Impact Assessment**, could become a centre for **impact assessment knowledge, training and capacity building**, **ensuring standardization of indicators** and measurements to reflect scientific advancements and advancing knowledge, as well as **synthesizing evidence** and **aligning it** with national and European level data collection efforts and policy priorities, such as the New European Green Deal.

2.2.1.5. Integrating evidence into the policy process

Using collected data to tell a meaningful story that can guide policy is not as straightforward as it might seem. Cities experienced difficulties first with the availability of trained personnel to analyse and interpret data. Depending on the solution they choose for the implementation of the data plan, data interpretation should be done jointly between the city council and the partner responsible for data collection. Secondly, although cities considered data integration platforms, especially those that include a spatial layer, were considered very useful, budget and expertise constraints were considered too great in most of the cities.

Within these integrated platforms, data is usually classified by spatial regions (for example postal codes), and therefore, allows comparison of indicator data in different areas of the city. This is useful for information purposes for citizens who can transparently verify the state of their city at an economic, environmental and social level. In addition, it is a relevant support for the scientific community and the policy process, since it allows verifying the real impact of urban interventions, such as nature-based solutions. A great example of these interactive and map-based platforms is the "London Green Infrastructure Focus". As can be consulted at the following address https://apps.london.gov.uk/green-infrastructure/, this map shows:

"*Where there is more or less need for green infrastructure interventions, based on different environmental and social issues that we know green infrastructure can help address (...) Which of the issues that can be addressed by green infrastructure, have greatest need for intervention for a particular area (...) Other issues that green infrastructure can´t necessarily help with, but that are useful context for decision making (e.g., income deprivation).”*

However, despite being aware of these benefits, creating platforms from scratch was very difficult in the FRC. A focus group was held between the FRC and the Connecting Nature experts who advised on the impact assessment process. The objective was to find out what the main difficulties in the process had been, as well as how the FRC had improved in these years. This analysis can be consulted in detail in Appendix XV. Among the main difficulties related to these platforms, the following were identified:

- Absence of available platforms to integrate data: in the event that these tools did not exist in the city, their creation required an excessive outlay of economic resources (e.g., hiring a company that offered these web services) and personal resources (e.g., enormous work time). city council staff designated for this purpose).

- Compatibility with available platforms: in some cases, within the city councils there were certain tools but it was not possible to advance in their full use for reasons such as the lack of cooperation between internal departments, or because they were not valid platforms to overlap quantitative and qualitative data with spatial data (GIS based).

- Interactivity with the user: some of the existing platforms in cities had a clear internal purpose (e.g., to categorize and organize data), but they were not valid for mainstream use by citizens, since their appearance and interaction were not user friendly.

- Data transfer: using these platforms not only requires an economic and personal effort for their design, but also involves developing databases for the indicators evaluated in the cities, and updating them periodically. This effort also translated into extra difficulty for the cities.

The city of Genk has selected the Genk in Cijfers platform, a regional online service, where data from various indicator categories can be found. For its part, Poznan has identified GeoPoz as the platform to integrate the impact results of the Connecting Nature indicators in the present and in the future. However, despite the fact that these two platforms meet the data integration and spatial visualization requirements, both Genk and Poznan have not been able to transfer their evaluation results to these online tools, due to some of the previously mentioned difficulties (compatibility with available platforms and data transfer).

Although each city used visual data representation methods such as charts, or the mapping of certain indicators on particular geographical locations, only the city of Glasgow engaged in creating a spatially explicit dashboard at city level where NBS indicators could be displayed, and thus guide the city in establishing priorities for future projects.

As part of Glasgow City Council's (GCC) work on building a baseline of health, social, economic and environmental data for impact assessment purposes, a dashboard with graphical and mapping elements was created. ESRI's ArcGIS Online platform was customised by Connecting Nature's GIS Officer so that the dashboard provides a visualisation of commonly needed datasets across these topics. This has allowed non-technical colleagues to access and interrogate data that were previously out of their reach along with raising awareness of the data gaps and data quality issues present. The dashboard has helped raise awareness of the importance of data sharing and evidence-based decision making, within GCC's teams.

Figure 3. Glasgow´s Nature-based Solutions dashboard (©Developed by Rania Sermpezi at Glasgow City Council)

Furthermore, dissemination of evaluation results is sometimes done in ways that do not reach stakeholders that ca later contribute to impact assessment efforts. It should be emphasized that the more groups and social organizations are aware of the impact of the NBS implemented in the city, the more possibilities there would be to obtain future synergies. With the help of external partners, specific dissemination plans can be developed.

The fundamental role of disseminating the results among scientific partners deserves special mention because it can facilitate a symbiotic relationship, where cities get support and advice for the impact assessment process, while universities and research organizations obtain valuable data to generate new knowledge regarding the NBS impact and its implementation.

Also, communication of specific NBS actions and their impact must be linked. Impact assessment helps secure evidence as to whether the NBS has been effective on a social, economic and environmental level. Generating a culture of evidence-based policy decisions is useful for applying for external funding on future projects, since a quality process is guaranteed in the evaluation of the usefulness of the interventions.

2.2.2. Benefits and innovations of the Connecting Nature Impact Assessment capacity building process

The University of A Coruña coordinated a focus group with frontrunner city representatives and the Connecting Nature experts who advised on the impact assessment process. The objective was to find out what the main difficulties in the process had been, as well as how the FRC had improved in these years. In order to qualitatively analyse the data obtained in this session, the transcription of the discussions held during the focus group was encoded. The main difficulties experienced by the cities have been included in the previous sections, alongside recommendations to support mainstreaming of NBS impact assessment in cities. The main benefits identified, as well as the main innovations highlighted are presented below. The qualitative analysis of the focus group, together with examples of each of the codes can be found in Appendix XV.

The following main benefits were identified by the cities as a result of the Connecting Nature impact assessment capacity building process:

- Engaging in coproduction processes with scientific partners
- Significant increase in impact assessment knowledge
- A new paradigm of assessment has been incorporated in NBS urban planning
- Enhanced assessment capacity was built
- New networks were created, both in-house and with external stakeholders
- New data infrastructure has been created

Deliverable 6 (Hölscher et al., 2022) outlined the main types of innovations that were the result of the impact assessment framework implementation in the cities.

Table 1. Impact assessment and embedded innovations (Source: Deliverable 6)

What has been done?	Which phase?	Enablers (embedded innovations)
Selecting indicators	Planning	*Knowledge innovation:* linking city strategic objectives to expected outcomes of their nature-based solution exemplars *Knowledge innovation:* identifying benefits and trade-offs *Knowledge innovation:* learning about diverse indicators for different scales and target groups
Defining data collection methods	Planning	*Knowledge innovation:* identifying existing data methods, available baseline data and gaps *Organisational innovation:* cross-departmental collaboration to identify data sources *Organisational innovation:* public-private partnerships for data collection
Integrating evidence into policy process	Stewardship	*Knowledge innovation:* capturing and communicating benefits, synergies and trade-offs *Organisational innovation:* producing templates about relevant indicators to organise and systematise data gathering

		Organisational innovation: collaboration and linkages to communicate evidence
Building skills and conditions	Planning, delivery, stewardship	*Organisational innovation:* development of new skills and expertise for impact assessment, hiring additional human resources *Organisational innovation:* cross-departmental collaboration and partnerships

To facilitate knowledge transfer to other cities in Europe, these innovations have been embedded in a few tools and products:

- the CN impact assessment framework process has been supported by a training programme, through the UrbanByNature webinars, as well as the Impact Assessment training programme modules created

- the CO-IMPACT tool, a digitally supported tool that guides cities through a streamlined process of developing their monitoring and assessment plans for NBS

- The comprehensive set of NBS indicators have been presented in a Connecting Nature Indicator Manual, with fact-sheet like descriptions of most appropriate methodologies, which have also been included into the European Impact Assessment Handbook for Nature-based Solutions and its Appendix for Methods.

Deliverable 3 describes in detail all the resources and tools developed to support NBS impact assessment in cities. These are also available on the Connecting Nature website.

3. Knowledge transfer to Fast-follower & multiplier cities: an engagement and mentoring process

3.1. Training program for fast-follower cities: designing monitoring and evaluation plan with the support of the front-runner cities

As already mentioned, the impact assessment process that took place in the front-runner cities was systematized in a training programme for cities, in order to encourage capacity building and the creation of a culture of NBS impact assessment in other European and global cities. The seven CN fast-follower cities (FFCs) underwent this training programme and developed their own monitoring and evaluation plans for NBS exemplars, in a process by which both expert-facilitated and peer-to-peer learning was encouraged. Table 2 presents the fast-follower cities and their NBS exemplars.

Table 2. FFCs and their NBS exemplars

Fast-follower cities	NBS Exemplars
A Coruña, Spain	Creating a network of urban gardens
Burgas, Bulgaria	Re-development of one of Burgas's key green space
Ioannina, Greece	Re-development of Park (what is known as Iaonnina's 'living room')
Málaga, Spain	Urban regeneration for Lagunillas
Nicosia, Cyprus	Inter-connected network of green-space
Pavlos Melas, Greece	Revitalization / development of military park
Sarajevo, Bosnia-Herzegovina	Community gardens

The training programme, titled "Create the story of your NBS from the Connecting Nature Impact Assessment Framework", was implemented in two stages: a training period, in which knowledge transfer activities were carried out to provide FFCs with the required knowledge, skills and tools to successfully design, implement and communicate results of NBS impact assessment plans; and an impact assessment plan implementation period, during which all FFCs were offered the opportunity to optimize and refine their evaluation and monitoring plan, and receive guidance and support for its implementation collecting real data for their indicators. Figure 26 shows the temporal organization of this process.

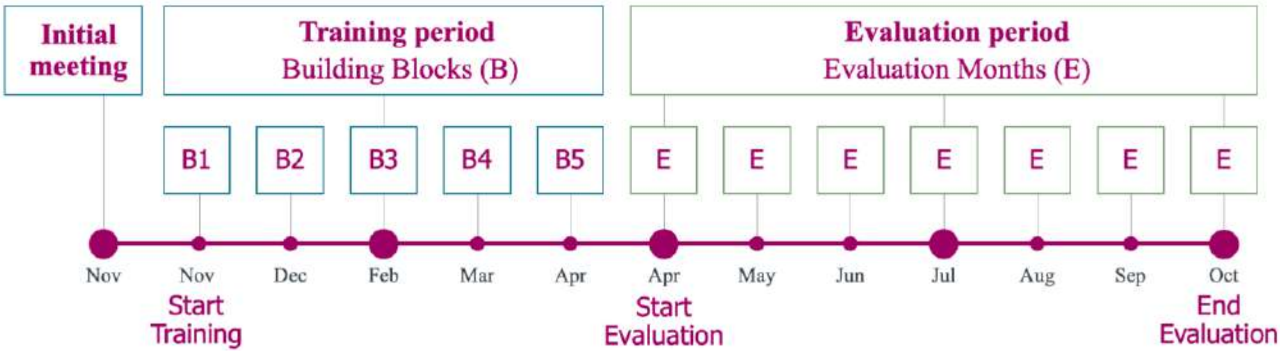

Figure 7. Timeline of "Create the story of your NBS from the Connecting Nature Impact Assessment Framework"

The training period focused on teaching cities to use the Connecting Nature Impact Assessment Framework in developing a co-created NBS impact assessment plan. The training programme included conceptual webinars for each of the framework building blocks, and hands-on problem-solving webinars, that targeted enhanced learning as cities were toiling with the development of monitoring and evaluation plans for the exemplars. In these learning spaces, frontrunner cities provided guidance, examples and mentoring to fast-follower cities. The dates of each of the sessions can be found in the following table.

To allow for practical experimentation with the CN Impact Assessment Framework, the FFCs used a series of templates with the key elements of each building block (i.e., design of the theory of change, selection of indicators...) to develop their bespoke impact assessment plans. These templates can be consulted in Appendix XVI.

Table 3. Temporary structure of the FFC training program

Date	M&E Building Block	Meeting type
9 November 2020	Framework Presentation	-
26 November 2020	M&E Building Block 1	Conceptual webinar
3 December 2020	M&E Building Block 2	Conceptual webinar
28 January 2021	M&E Building Block 1 & 2	Solving problems
18 February 2021	M&E Building Block 3	Conceptual webinar
4 March 2021	M&E Building Block 4	Conceptual webinar
18 March 2021	M&E Building Block 3 & 4	Solving problems
15 April 2021	M&E Building Block 5	Conceptual webinar
29 April 2021	M&E Building Block 5	Solving problems

Each of the partners in the training programme brought different competencies and different levels of know-how to the learning process. Their competencies are presented below.

1) Fast-follower cities

They were responsible for designing the city policies and strategies that guided the choice of the NBS and its assessment. FFC were provided with continuous support and resources to reinforce the evaluation capacities of the cities to successfully design and implement their Impact Assessment Plan. Each local team was responsible for selecting the most appropriate indicators for evaluating the city NBS. The city "monitoring and evaluation team" was composed of different local stakeholders with interest and expertise in either the Connecting Nature project, the city long-term sustainability and/or in NBS impact assessment. In most cases, they were staff from the city council and development agencies, sometimes also collaborating with local universities.

2) Front-runner cities

The three frontrunner cities (Genk, Glasgow and Poznan) provided mentorship to the FFCs by sharing the lessons learned and the expertise accumulated during the Connecting Nature project. Sharing this first-hand experience was particularly useful to accelerate the learning processes and to transfer knowledge into "a common language". During the design and implementation of their Impact Assessment Plans, the FRCs have acquired and developed a set of methodological, technical and relational competences and skills (i.e., identifying and collecting existing public data, defining strategic goals, or establishing partnerships with local actors). This learning-by-doing knowledge was transferred to the FFCs to improve the quality of impact assessment processes, create appropriate stakeholder networks and interactions and reduce the investment of time and financial resources, creating a more straightforward course of action. The impact assessment mentoring activities fit well within the larger CN city mentoring programme, defined as part of the Experiential Learning Framework of Connecting Nature. They relied on a previously established mentoring relationship between the cities, which made it easy to identify appropriate mentoring flows and connect FFCs mentoring needs with the capacities of each frontrunner city. For more information on the Experiential Learning Framework, see Connecting Nature Deliverable 12/4.1 "*Report on Knowledge Transfer Between Front Runner Cities and Fast Follower Cities, taking into account the proceedings of the knowledge transfer workshops and mentoring process*" (Xidous et al., 2021).

3) Scientific partners

Scientific partners were responsible for designing and delivering the training program and for providing support and follow-up to city teams to successfully accomplish the tasks of defining, and, in some cases, implementing their impact assessment plans. In particular, three scientific partners regularly participated in the design and delivery of the training, as well as in continuous impact assessment mentoring activities throughout the project: the University of A Coruña, the University of East London and Trinity College Dublin. Additionally, support was provided by a number of other WP1 partners (academic institutions and SMEs) with relevant expertise in impact assessment processes: GeoGraphic (GIS and RS Consulting Center Geographic), West University of Timisoara, Humboldt-Universitaet ZU Berlin, Urban Planning Institute of the Republic of Slovenia, and The Dutch Research Institute for Transitions.

4) Group facilitators

With the aim of optimizing communication with FFCs, two groups of cities were created, coordinated by two facilitators: Rania Sermpezi (Glasgow City Council) and Barbara Goličnik (Urban Planning Institute of The Republic of Slovenia). The role of the facilitators was to have a closer contact with the cities, collecting their doubts in preview of the problem-solving webinars and coordinating interactive and problem-solving sessions during both the conceptual and problem-solving webinars. For this purpose, spaces for division into small groups (breakout rooms) were established, facilitating direct communication between cities and partners.

Throughout the training program, the University of A Coruña team coordinated the preparation and implementation of the sessions, the contact between partners and the progress of the cities when developing their impact assessment plans. This work of coordination and interaction with the cities was based on the following pillars:

1. A problem-solving perspective. The training programme was designed as a continuous and iterative process of reflection, learning and discussion. The webinars were open platforms for asking questions and discussing the answers of the FRC and scientific partners. As a result of this process, all the knowledge and competencies acquired in the training program can be extended and sustained after the completion of the Connecting Nature project.

2. Collaborative team-work. The city monitoring team, the front-runner cities and the scientific partners worked in a participatory and choral way. The assessment needs in each city were identified, and collaborative and mutual support relationships were established. Finally, through learning-by-doing, cities co-created within their own teams the impact assessment plans for each of the NBS exemplars. The mentoring process has been included in the overall Connecting Nature Knowledge Transfer process, which can be consulted in greater detail in Deliverable 4.1 (Xidous et al., 2021). As a result of the Training program, all Fast-follower cities designed evaluation and monitoring plans adapted to the characteristics of their NBS. Appendices V, VII, VIII, XIX, X, XI & XII show these differentiated plans for each city, structured according to the five Building Blocks of the Connecting Nature Impact Assessment Framework. A summary of the indicators selected in these plans by each of the FFCs can be consulted in the Appendix I. Finally, only the city of A Coruña decided to participate in the second phase and started the implementation of their impact assessment plan, including collection of new data. A Coruña evaluation results can be consulted in Appendix VI.

3.2. Upscaling the Connecting Nature Impact Assessment Framework to multiplier hubs

The Connecting Nature Impact Assessment Framework has not only been transferred to the 7 fast-follower cities, but also efforts were made to upscale the 5 building blocks to other global regions through the Connecting Nature multiplier hubs. Through various conferences, workshops and seminars, the knowledge of how to design and implement an impact assessment plan was disseminated to various cities worldwide. The following table summarizes the sessions of knowledge transfer actions and links to access that content:

Table 4. Open knowledge transfer sessions on the CN Impact Assessment Framework

Action	Day	Conference / Program	Link
Conference	23/02/2021	The Nature of Cities Festival: How can we improve the availability of evidence of the impact of NBS on health?	-
Conference	24/03/2021	Glasgow Innovation Summit: Naturally smart cities – making the most of data to support nature- based solutions	https://www.youtube.com/watch?v=b4T7T_nPUro&list=PLR0PkyQ540TVbtpbVr86GzodQn0PzO-_q&index=3
Workshop	28/04/2021	Smart Technologies for NBS Workshop #2: Data: Problems for Nature-based Organisations and Opportunities for Nature-based enterprises	https://www.youtube.com/watch?v=stEYGvYCmw0
Presentation	7/05/2021	UrbanByNature Brazilian Stream -	https://www.notion.so/W

		Session 6	orkshop-6-Implement-NBS-Brazil-2021-69edc3e82a3c4638803746b2389ba4fe
Conference	30/06/2021	Poznan Enterprise Summit: Powerful evidence for nature-based solutions: identifying opportunities for NBS impact assessment	https://www.youtube.com/watch?v=VyIS0dsFX9o
Conference	14/10/2021	Innovate4Cities (Designing resilient cities: Innovative co-production and impact assessment approaches for evidence-based and inclusive nature-based solutions)	https://i4c.conference.evey.live/conferences/innovate-4-cities/stage/innovation-lab/session/110
Presentation	12/01/2022	UrbanByNature Chinese Stream - Session 5	https://connectingnature.eu/urbanbynature-china-webinar-5-monitoring-and-evaluation-nature-based-solutions-nbs-0

The global usefulness of the Impact Assessment Framework was tested out in two cities within the Caucasus hub. A collaboration was established with local partners to adapt the Connecting Nature Impact Assessment Framework to cities in Armenia and Georgia. In the case of Armenia, The Center for Ecological-Noosphere Studies (CENS) of the National Academy of Sciences of Armenia applied the first two building blocks for the city of Yerevan. On the other hand, the company GeoGraphic (GIS and RS Consulting Center Geographic), also applied the first two steps to the city of Kutaisi, in Georgia.

Both entities attended the main sessions of the training program with the fast-follower cities, and held joint meetings with the University of A Coruña to advance in the adaptation of the framework to local contexts, developing bespoke monitoring and evaluation plans. Both plans can be consulted in appendices XIII and XIV, where the theory of change for both cities is outlined in detail, selected indicators are presented, and examples of environmental outcome results are described.

4. Synthesis of most promising indicators for nature-based solutions

The development of the Connecting Nature impact assessment framework included a wide range of indicators, that were later prioritised in a co-creation process with the frontrunner cities, as described in Deliverable 1. We have described earlier in this document some of the hurdles cities face when deciding what indicators to use when evaluating the process and outcomes of nature-based solutions. Concerns about financial resources, data availability, in-house data collection and analysis skills, as well as difficulties in collaborations with other data-owning agencies and stakeholders were among those most highlighted by the cities. The Connecting Nature Impact Assessment Framework created a structured process to guide cities through the decision-making process. Frontrunner cities then went further and took action to implement the monitoring and evaluation plans. The lessons from this process were then used to create the CN impact assessment training programme, which supported fast-follower cities in overcoming some of the identified challenges, and, as a result, they were in a position to select a wider range of indicators for their plans. It is foreseeable, however, that in the process of implementation, they will have to establish priorities again based on available resources and external support they are able to draw on.

In order to see which indicators and methodologies were considered most relevant and were prioritized by the frontrunner cities, given the diversity of their exemplars, we looked at which indicators were included by at least two of the cities in their plans. These are reflected in Table 5 below.

Table 5. Connecting Nature most promising indicators and methodology used in the Front-runner cities

CODE	NAME	EU HANDBOOK	GENK	GLASGOW	POZNAN
PI1	Type of interaction with NBS	N/a	Questionnaire created in the project	Qualitative semi-structured interviews	Questionnaire created in the project
PI2	Frequency of interaction with NBS	N/a	Questionnaire created in the project	Qualitative semi-structured interviews	Questionnaire created in the project
PI3	Duration of interaction with NBS	N/a	Questionnaire created in the project	Qualitative semi-structured interviews	Questionnaire created in the project
PI4	Perceived quality of space	13.3	Questionnaire created in the project	Qualitative semi-structured interviews	Questionnaire created in the project
ENV15	Water quality	3.14	Conductivity and oxygen sensors for wastewater overflows (citizen science approach)	Sampling of Glasgow's waterbodies (SEPA)	N/a
ENV42	Land use change and greenspace	8.39	GIS analysis (GEOPUNT)	GIS analysis (GCC)	N/a

	configuration				
ENV81	Soil sealing	8.40	GIS analysis (GEOPUNT)	N/a	Orthophotomap & Field mapping
ENV41	Accessibility of greenspaces	7.1	N/a	GIS analysis (GCC) & Field mapping	GIS analysis (AMU)
ENV55	Green space area	7.2	N/a	GIS analysis (GCC) & Field mapping	GIS analysis (AMU)
HW11	Mental health and wellbeing	21.4	Standardized questionnaire	Qualitative semi-structured interviews	Standardized questionnaire
HW16	Perceived restorativeness of public green space	22.13	Standardized questionnaire	Qualitative semi-structured interviews	Standardized questionnaire
SC6	Place attachment	13.4	Standardized questionnaire	Qualitative semi-structured interviews	Standardized questionnaire
ECO1	New Businesses 'attracted' or started and additional rates received	24.1 & 24.2	Local records and reports	Local records and reports	Qualitative semi-structured interviews
ECO13	Net impact on public expenditure from NBS implementation	24.5; 24.6; 24.7; 24.8	Local records and reports	Local records and reports	Local records and reports

The fact that only a few indicators are common to the frontrunner cities' impact assessment plans illustrates the relevance of adopting a buffet-style approach to indicators, as was done in the handbook, i.e providing cities with a diversity of indicators they could choose from that would fit the scale and nature of their NBS projects. Although not many indicators were common across the cities, in the following tables we can see that many more indicators were chosen for individual exemplars. Furthermore, Appendix 1 illustrates the indicators chosen by the fast-follower cities, where we can see a trend towards choosing a larger number of indicators, which is proof to the importance of structured support in these processes, which are new and complex for many cities still. As the fast-follower cities received structured expert and peer support from CN partners, they were able to develop ambitious plans and to reflect on ways of ensuring the right financial and human resources to implement them.

Table 6. Selection of indicators in Front-runner cities

Code	Indicator	GENK	GLASGOW			POZNAN		
		Stiemervalley	Bellahouston	Growchapel	OSS (City level)	Natural playgrounds	Open garden	Pocket parks
PRIMARY - USE								
PI1	Type of interaction with NBS	●	●			●		
PI2	Frequency of interaction with NBS	●	●			●		
PI3	Duration of interaction with NBS	●	●			●		
PI4	Perceived quality of space	●	●			●		
ENVIRONMENTAL (CORE)								
ENV3	Air temperature change					●	●	●
ENV8	Rainfall storage (water absorption capacity of NBS)			●	●			
ENV15	Water quality	●			●			
ENV19	Inundation risk for critical urban infrastructures (probability)			●	●			
ENV23	Public green space distribution				●			

ENV27	Connectivity of urban green and blue spaces (structural and functional)				●			
ENV29	Supporting/increasing biodiversity conservation			●	●			
ENV35	Species diversity			●	●			
ENV42	Land use change and greenspace configuration	●		●	●			
ENV56	Blue space area				●			
ENV81	Soil sealing	●				●	●	
ENV85	Change in ecosystem service provision							●
ENV89	Community garden area per capita and in a defined distance		●	●	●			
ENVIRONMENTAL (FEATURE)								
ENV1	Carbon storage OR carbon sequestration in vegetation/soil				●			
ENV41	Accessibility of greenspaces		●	●	●	●	●	●
ENV43	Ratio of open spaces to built form					●	●	
ENV55	Green space area				●	●	●	●
ENV66	Air quality change				●			

ENV88	Tree shade for local heat change					●	●	●
HEALTH AND WELLBEING (CORE)								
HW3	General wellbeing and happiness	●	●		●			
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases		●	●	●			
HW11	Mental health and wellbeing	●	●	●	●	●		
HW12	Enhanced physical activity	●	●		●			
HW16	Perceived restorativeness of public green space	●	●			●		
HEALTH AND WELLBEING (FEATURE)								
HW1	Sustainable nutrition/adoption		●		●			
HW4	Life expectancy and healthy life years expectancy		●	●	●			
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases		●	●	●			
HW8	Incidence of obesity /obesity rates (adults and children)	●			●			
HW13	Perceived chronic loneliness	●	●					
HW14	Improvement of behavioural development and symptoms of		●	●	●	●		

	attention-deficit/hyperactivity disorder (ADHD)							
SOCIAL COHESION (CORE)								
SC1	Bonding social capital	●	●		●			
SC2	Bridging social capital	●	●		●			
SC4.1	Trust in community	●	●		●			
SC4.2	Solidarity between neighbours		●					
SC4.3	Tolerance and respect	●	●					
SC5.1	Perceived safety	●	●		●			
SC5.2	Actual safety		●	●	●			
SC6	Place attachment	●	●			●		
SC9	Empowerment	●	●		●			
SC11.1	Positive environmental attitudes motivated by contact with NBS		●					
SOCIAL COHESION (FEATURE)								
SC10	Environmental education opportunities		●			●		
SC12	Pro-environmental behaviour	●	●					
ECONOMIC (CORE)								

ECO1	New Businesses 'attracted' or started and additional rates received	●	●	●	●	●	●	
ECO3	Net additional jobs created/enabled by NBS		●	●	●	●	●	
ECO7	Increase in tourism	●			●			
ECO13	Net impact on public expenditure from NBS implementation	●		●		●	●	●
ECO15	Private finance attracted to the NBS site	●				●		
ECONOMIC (FEATURE)								
ECO6	Innovation impact	●						
ECO8	Income/disposable income per capita				●			
ECO9	Upskilling & related earning increase				●			
ECO11	Overall economic, social and health wellbeing				●			
PARTICIPATORY PLANNING AND GOVERNANCE (CORE)								
PPG1	Diversity of stakeholders involved	●						

PPG2	Social equity: involvement of citizens from traditionally under-represented groups	●						
PPG5	Activation of public-private collaboration	●						
PPG6	Trust in decision-making and decision-makers	●						
PPG9	Innovative climate	●						
PPG10	Open communication (internal & external)	●						
PARTICIPATORY PLANNING AND GOVERNANCE (FEATURE)								
PPG17	Reflexivity - time for reflection	●						

5. Conclusions

The European Green Deal (EGD) has established a series of strategic objectives which include: no net emissions of greenhouse gases by 2050; economic growth decoupled from resource use; and no person and no place left behind. To tackle these objectives, a set of policy strategies have been established, such as biodiversity restoration, transitions towards sustainable food systems, and ensuring just digital and environmental transitions. Nature-based solutions are posited as a key policy approach to respond to the serious challenges facing European cities and societies and to advance the EGD objectives.

NBS evaluation is important if sufficient evidence is to be gathered on their contribution to reaching these objectives and, in doing so, building the policy and investment case for their mainstreaming and larger scale implementation. Impact assessment has proven to be a very challenging process for cities. Although cities carry out other policy evaluation processes, and use key performance indicators to measure some of their strategic objectives, they often did not have the resources and skills to make impact assessment a key part of the planning of NBS.

The CN Impact Assessment Framework has supported cities in establishing a culture of evaluation and in building the necessary knowledge, capacities, skills and resources to be able to evaluate NBS projects, and to create the evaluation stakeholder ecosystems and relationships that are necessary to create integrated assessments and data platforms as support to policy decision-making. Cities can often benefit from collaborations with agencies and other actors at local, regional, national and European levels that can lead to streamlining evaluation efforts and establish synergies in evaluation design and data collection processes. Cities can benefit from including, among their staff, impact assessment experts and data officers that can work on establishing these collaborations.

The quality of the impact assessment framework co-created with the FRCs was further tested with seven fast-follower cities to ensure that each one of them prepared a monitoring and evaluation plan adapted to the characteristics of their NBS. These specific plans, which can be consulted in the appendices, illustrate the need to develop a robust set of indicators adapted to the needs of each city. It is worth noting the effort of several partners of the Connecting Nature project in developing a training programme that did not exceed the capacity at the level of expertise and human resources of the FFCs, and that at the same time was instructive enough to, in a few months, raise awareness and build capacity in cities. The city of A Coruña has completed this knowledge transfer process by deciding to implement the plan. Other cities have manifested their desire to follow suit. The application of the impact assessment framework was upscaled to multiplier hubs and other cities within or outside of Europe through conferences, seminars and training actions. The experience of the Caucasus hub shows how the cities of Yerevan and Kutaisi have managed to successfully apply this framework to select the most appropriate indicators in each case.

All cities are committed to continue developing their impact assessment capacities and to keep developing their data integration infrastructure in ways that can, over time, help them draw conclusions on what works and what does not and also harness public and financial support for urban regeneration through nature-based solutions. Resources created to make the CN Impact Assessment Framework easy to use in practice have been taken up by the cities and will continue to be used and further developed after the end of the project, such as the CO-IMPACT tool, the CN indicators, or the training programme. However, beyond these developments, there is a great need for further support in developing the knowledge, capacity and resources to evaluate NBS and to integrate and use data to inform sustainable urban transitions. To make use of the knowledge generated through EU projects and taskforces on nature-based solutions and to encourage adaptive and yet visionary policy-making that can steer Europe firmly on the path established by the Green Deal, a European Observatory for NBS Impact Assessment could become an ecosystem and powerhouse of tools, collaborations and peer-to-peer learning among cities in Europe and beyond.

References

Brink, E., Aalders, T., Ádám, D., Feller, R., Henselek, Y., Hoffmann, A., ... & Wamsler, C. (2016). Cascades of green: a review of ecosystem-based adaptation in urban areas. *Global environmental change*, *36*, 111-123.

Hölscher, K., Lodder, M., Allaert, K., Janssen, A., & van der Have, C. (Eds.) (2022). *Deliverable 6: Connecting Nature Framework reports for fast-follower cities.* Connecting Nature, Grant Agreement number 730222.

Dumitru, A., García-Mira, R., Lenoir-Improta, R., Connop, S., Nash, C., Haase, D., Dushkova, D., Frantzeskaki, N., Lodder, M., Sillen, D., Sulea, C., Macsinga, I., Albulescu, P., Rhodes M. L., McQuaid, S., Collier, M., Dick, G., Martin, G., & Mowat, L. (2019). *Deliverable 1.1 Report on the contributions of Tasks 1.1 to 1.4.* Connecting Nature, Grant Agreement number 730222.

Dumitru, A., Tomé-Lourido, D., Young, C., Connop, S., Rhodes, M. L., Dick, G., & Sermpezi, R. (2021). *Impact Assessment Guidebook: Developing robust monitoring and evaluation plans for nature-based solutions*. Connecting Nature, Grant Agreement number 730222. Retrieved from https://connectingnature.eu/sites/default/files/images/inline/Impact%20Asessment%20Guidebook.pdf

Dumitru, A. & Wendling, L. (2021). *Evaluating the Impact of Nature-Based Solutions. A Handbook for Practitioners*. Luxembourg: Publications Office of the European Union.

European Commission (2015). *Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities*. 1207 Final Report of the Horizon 2020 Expert Group on "Nature-based Solutions and Re-naturing Cities. Brussels.

Gulsrud, N. M., Hertzog, K., & Shears, I. (2018). Innovative urban forestry governance in Melbourne?: Investigating "green placemaking" as a nature-based solution. *Environmental Research*, *161*, 158-167.

Haase, D., Larondelle, N., Andersson, E., Artmann, M., Borgström, S., Breuste, J., ... & Elmqvist, T. (2014). A quantitative review of urban ecosystem service assessments: concepts, models, and implementation. *Ambio, 43*(4), 413-433.

Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health*, *35*, 207-228.

Kabisch, N., van den Bosch, M., & Lafortezza, R. (2017). The health benefits of nature-based solutions to urbanization challenges for children and the elderly–A systematic review. *Environmental research*, *159*, 362-373.

Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature?. *International Journal of Environmental Research and Public Health*, *10*(3), 913-935.

Raymond, C. M., Breil, M., Nita, M. R., Kabisch, N., de Bel, M., Enzi, V., ... & Berry, P. (2017). *An impact evaluation framework to support planning and evaluation of nature-based solutions projects. Report prepared by the EKLIPSE Expert Working Group on Nature-Based Solutions to Promote Climate Resilience in Urban Areas*. Centre for Ecology and Hydrology.

Samuelsson, K., Giusti, M., Peterson, G. D., Legeby, A., Brandt, S. A., & Barthel, S. (2018). Impact of environment on people's everyday experiences in Stockholm. *Landscape and Urban Planning*, *171*, 7-17.

Sullivan, W. C., Kuo, F. E., & Depooter, S. F. (2004). The fruit of urban nature: Vital neighborhood spaces. *Environment and Behavior*, *36*(5), 678-700.

Xidous, D., Tomé-Lourido, D., Lodder, M., van der Have, C., Connop, S., Nash, C., Vandergert, P., Fletcher, I., Rizzi, D., Riel, A., & González, G. (2021). *Deliverable 4.1: Report on Knowledge Transfer Between Front Runner Cities and Fast Follower Cities, taking into account the proceedings of the knowledge transfer workshops and mentoring process.* Connecting Nature, Grant Agreement number 730222.

List of appendices

Appendix I. Selection of indicators in the Connecting Nature Fast-follower cities

Authors: Adina Dumitru, David Tomé-Lourido, Eva Peralbo Rubio (University of A Coruña)

Code	Indicator	A Coruña[1]	Burgas	Ioannina	Málaga	Nicosia	Pavlos Melas	Sarajevo
PRIMARY - USE								
PI1	Type of interaction with NBS	•	•	•			•	•
PI2	Frequency of interaction with NBS	•	•	•			•	•
PI3	Duration of interaction with NBS	•	•	•			•	•
PI4	Perceived quality of space	•	•		•	•	•	•
ENVIRONMENTAL (CORE)								
ENV3	Air temperature change	•					•	•
ENV8	Rainfall storage (water absorption capacity of NBS)						•	
ENV19	Inundation risk for critical urban infrastructures (probability)	•						
ENV23	Public green space distribution	•					•	•

ENV24	Recreational value of blue-green spaces				•		•	
ENV25	Cultural value of blue-green spaces		•		•		•	
ENV29	Supporting/increasing biodiversity conservation	•	•		•	•	•	
ENV35	Species diversity	•	•		•	•	•	•
ENV42	Land use change and greenspace configuration				•			•
ENV48	Access to public amenities		•					
ENV56	Blue space area		•					
ENV81	Soil sealing	•					•	
ENV89	Community garden area per capita and in a defined distance						•	
ENVIRONMENTAL (FEATURE)								
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	•					•	
ENV17	Air temperature - Energy demand						•	
ENV26	Community accessibility		•	•	•		•	•
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies		•	•	•	•		•
ENV41	Accessibility of greenspaces	•	•		•	•		•
ENV43	Ratio of open spaces to built form					•		

ENV55	Green space area		•		•		•	
ENV58	Local food production							•
ENV61	Intensity of landuse							•
ENV66	Air quality change	•	•		•		•	•
ENV84	Noise pollution reduction	•						
ENV88	Tree shade for local heat change					•	•	
ENV90	Community garden area per child capita and in a defined distance						•	
HEALTH AND WELLBEING (CORE)								
HW3	General wellbeing and happiness	•	•	•	•		•	•
HW10	Perceived chronic stress		•					
HW11	Mental health and wellbeing	•	•				•	•
HW12	Enhanced physical activity	•	•	•	•	•	•	•
HW16	Perceived restorativeness of public green space	•	•	•				
HEALTH AND WELLBEING (FEATURE)								
HW1	Sustainable nutrition/adoption	•						
HW9	Heat reduced mortality		•					

HW13	Perceived chronic loneliness	•			•			
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)		•					
HW15	Exploratory behaviour in children				•			
SOCIAL COHESION (CORE)								
SC1	Bonding social capital	•				•	•	
SC2	Bridging social capital	•					•	
SC4.1	Trust in community	•	•		•			
SC4.2	Solidarity between neighbours		•		•			•
SC4.3	Tolerance and respect	•	•		•			•
SC5.1	Perceived safety		•	•			•	
SC5.2	Actual safety		•				•	
SC6	Place attachment		•		•	•	•	
SC9	Empowerment	•			•			
SC11.1	Positive environmental attitudes motivated by contact with NBS		•		•		•	
SC11.2	Environmental identity		•		•			

SOCIAL COHESION (FEATURE)								
SC3	Linking social capital						•	
SC10	Environmental education opportunities		•		•	•	•	•
SC12	Pro-environmental behaviour	•	•					
SC13	Connectedness to nature	•						
ECONOMIC (CORE)								
ECO1	New Businesses 'attracted' or started and additional rates received	•	•	•	•	•	•	•
ECO3	Net additional jobs created/enabled by NBS	•					•	
ECO7	Increase in tourism						•	
ECO13	Net impact on public expenditure from NBS implementation	•	•					
ECO15	Private finance attracted to the NBS site		•					
ECONOMIC (FEATURE)								
ECO2	New customers to business in proximity to NBS						•	
ECO6	Innovation impact				•			
ECO9	Upskilling & related earning increase						•	
ECO11	Overall economic, social and health wellbeing				•		•	

PARTICIPATORY PLANNING AND GOVERNANCE (CORE)								
PPG1	Diversity of stakeholders involved	•	•					•
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	•						
PPG3	Transparency of co-production	•	•			•		•
PPG4	Policies adopted to promote NBS	•				•		
PPG5	Activation of public-private collaboration		•		•	•	•	
PPG6	Trust in decision-making and decision-makers		•		•			
PPG7	Reflexivity - identified learning outcomes						•	
PPG10	Open communication (internal & external)		•					
PPG11	Collaboration between organizational members						•	
PARTICIPATORY PLANNING AND GOVERNANCE (FEATURE)								
PPG13	Facilitation skills for co-production						•	
PPG15	Governance innovations for participatory governance		•		•			
PPG16	Community involvement in NBS implementation		•		•			•
PPG17	Reflexivity - time for reflection						•	
PPG23	Team cohesion				•			

PPG25	Engagement		•		•			

1. The indicators selected by A Coruña were not only part of the city's impact assessment plan, but data was also collected to evaluate them. These results can be consulted in Appendix VI.

Appendix II. Poznan´s Evaluation Results

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This document presents the impact assessment results in the city of Poznan (Poland). As reflected in the main text of the Deliverable, through its evaluation and monitoring plan, this Front-runner city has implemented three Nature-based Solutions: two of them on a site scale (Nature-oriented playgrounds at preschools and Open garden at preschool No. 42) and one on a city scale (Pocket Parks).

This appendix begins with a main summary of the main results found in the city of Poznan. Subsequently, the results of each of the indicators evaluated in the evaluation and monitoring plan are detailed, organized by indicator categories: Environmental, Primary, Health and wellbeing, Social cohesion and Economic.

Due to the large amount of data collected, in addition to the results included in this document, for some indicators the consultation of three supplementary materials is indicated: 1) the analysis of urban forest effects and values from the i-Tree Ecosystem Analysis software; 2) Results of the ecological demonstrators' project; 3) Survey on primary, health and social indicators

Finally, at the end of this appendix, a reflection on the main conclusions of the monitoring and evaluation process in Poznan is presented.

MAIN SUMMARY

Monitoring of thermal conditions

At city scale, the distribution of green infrastructure impacts the distribution of regulating ES services such as spatial differentiation of thermal conditions. In the preschool gardens, buffer analysis shows rather low capacity to cool neighbourhood, nevertheless the results of land surface temperature analysis with use of detailed individual thermal profiles shows the cooling effect could be significantly higher, especially in the case of preschool gardens designed as natural playgrounds. The cooling effects of other small-scale nature-based solutions (e.g. pocket parks) are similar to the impact of preschool gardens. Shading by trees is an important ecosystem service, as differences in average surface temperatures between shaded and insolated land cover materials might reach 2,2 ^{o}C for high grass as well as 10 ^{o}C in the case of gravel and bark.

Green space, its availability and its usage

The accessibility (availability) of green spaces depends on their distribution and types of spaces. Since nature-oriented playgrounds in preschools are key intrest of Poznań city, the analysis focused on availability of green spaces for preschoolers. Spatial analysis and survey among preschools reveald the existing potential of preschools in providing children contact with nature on their own outdoor spaces as well as neighbooring green spaces that can be visited with preschoolers.

Contact with nature in preschools

The availability of green spaces for preschool children attending preschools in Poznań showed that preschools have diverse opportunities for providing children contact with nature that is of high importance for their physical, social and emotional development as well as cognitive skills. Preschools' own outdoor spaces are frequently used for children activities. The results of the survey carried out in 2021 in 3 schools with natural playgrounds (experimental group) and 3 schools without natural playgrounds (control group), shows how the experimental ones carry out more educational activities outdoors, and therefore, both teachers and children spend more time in the playground. The indicators also show that since the COVID-19 pandemic, teachers and children in the experimental group have increased their time in the playground, and teachers also in green spaces.

City´s expenditure for NBS exemplars

The specificity and local scale of NBS exemplars (public sector, small scale) have some limitations in the wider application of those indicators. However, further work to acquire more data is going to be taken. It is important to have the additional source of funding in the initial stage to start with pilot projects. The stable regular funding has been essential for upscaling of the initiative to more city-wide scale (municipal 5-year programme for modernization of playgrounds in preschools). The initial success and growing popularity of the NBS initiative may help to apply for more additional funding, this time from non-municipal public institutions (regional fund) and grant pools based on public participation and popular voting.

IMPACT ASSESSMENT RESULTS

Environmental indicators - CORE

ENV3. Air temperature change

a) Results obtained from analysis of Landsat 8 multispectral satellite images – analysis of land surface temperature (LST).
City scale assessment

We used Landsat 8 Provisional Surface Temperature product[1] shared by United States Geological Survey via Earth Explorer platform (https://earthexplorer.usgs.gov/). Images for Poznań were taken during clear sky weather (cloudiness 0-1%) without radiation disturbances (like precipitation, fast wind) during summer seasons in years 2018-2020 at 09.49 GMT:

1. LC08_L2SP_191023_20180607_20200831_02_T1_ST_B10.TIF
2. LC08_L2SP_190024_20190603_20200828_02_T1_ST_B10.TIF
3. LC08_L2SP_191023_20190626_20200827_02_T1_ST_B10.TIF
4. LC08_L2SP_190024_20190923_20200826_02_T1_ST_B10.TIF
5. LC08_L2SP_190024_20200808_20200917_02_T1_ST_B10.TIF

From above mentioned data we calculated average land surface temperature (^{o}C) as proposed by Majkowska et al. 2017[2] who analyzed the surface urban heat island (SUHI) in Poznań. The distribution of LST in Poznań presents Figure 1 and Table 1. The results show that NBS exemplars are located within residential estates with one of the highest temperature.

[1] This product measures the temperature of the surface of the Earth in Kelvin (K) and is an important parameter in energy balance and hydrologic modeling studies. Surface Temperature data are also useful for monitoring crop and vegetation health, and extreme heat events such as, natural disasters (e.g., volcanic eruptions, wild fires), and urban heat island studies. Provisional Surface Temperature is generated from the Landsat Collection 1 Level-1 thermal infrared bands, Top of Atmosphere (TOA) Reflectance, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Emissivity Database (GED) data, ASTER Normalized Difference Vegetation Index (NDVI) data, and atmospheric profiles of geopotential height, specific humidity, and air temperature extracted from reanalysis data. The product is processed to 30-meter spatial resolution in Albers Equal Area (AEA) projection using the World Geodetic System 1984 (WGS84) datum and gridded to a common tiling scheme. Product is delivered in Georeferenced Tagged Image File Format (.tif) files. For more see Landsat Provisional Surface Temperature Product Guide (https://www.usgs.gov/media/files/landsat-provisional-surface-temperature-product-guide).

[2] Majkowska et al. 2017: The urban heat island in the city of Poznań as derived from Landsat 5 TM. DOI 10.1007/s00704-016-1737-6

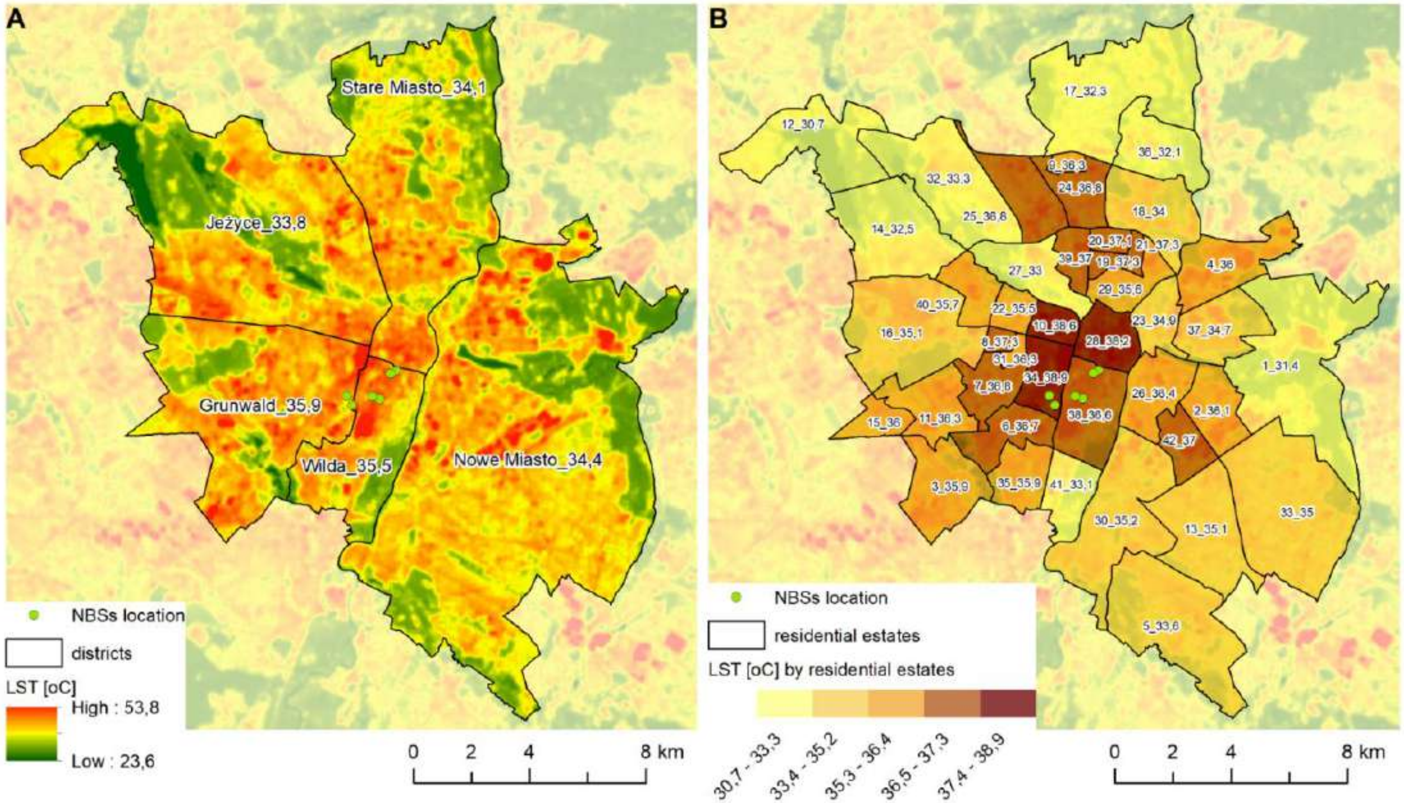


Figure 1. Land surface temperature distribution in Poznań A) by districts; B) by residential estates (residnetial estates are numbered 1-42, more information in table) Source: AMU own elaboration based on Landsat 8 products

Table 1. Average land surface temperature by residential estates

Residential estate	Number of residents	Average land surface temperature [°C]				
		min	max	range	mean	std
Antoninek-Zieliniec-Kobylepole	9700	26,54	49,26	22,72	31,39	3,64
Chartowo	22853	25,51	44,74	19,22	36,15	3,29
Fabianowo-Kotowo	1721	25,50	50,17	24,67	35,86	3,61
Główna	4241	27,38	53,81	26,43	36,02	4,21
Głuszyna	3987	27,61	41,79	14,18	33,61	2,74
Górczyn	12567	25,37	44,04	18,67	36,75	3,03
Grunwald Południe	24347	30,82	43,21	12,39	36,84	1,55
Grunwald Północ	13651	35,03	39,24	4,21	37,34	0,76
Jana III Sobieskiego i Marysieńki	9519	33,47	39,31	5,84	36,28	1,18
Jeżyce	22424	32,83	43,35	10,52	38,65	1,61
Junikowo	9355	29,54	46,04	16,50	36,33	3,02
Kiekrz	1802	23,58	38,16	14,59	30,67	3,89
Krzesiny-Pokrzywno-Garaszewo	2150	29,22	40,87	11,66	35,08	1,63
Krzyżowniki-Smochowice	7947	23,57	43,90	20,33	32,45	4,31
Kwiatowe	4479	32,16	40,34	8,18	36,01	1,92
Ławica	7246	27,88	48,38	20,51	35,13	3,71
Morasko-Radojewo	2421	27,22	41,30	14,07	32,26	2,42
Naramowice	16952	27,33	40,50	13,17	33,96	3,01
Nowe Winogrady Południe	14115	34,81	43,54	8,73	37,34	1,43
Nowe Winogrady Północ	16114	33,74	42,11	8,37	37,07	1,33
Nowe Winogrady Wschód	6034	34,79	42,05	7,26	37,32	1,24
Ogrody	6006	26,98	40,14	13,16	35,55	2,53
Ostrów Tumski-Śródka-Zawady-Komandoria	6101	26,09	42,63	16,54	34,89	2,95
Piątkowo	34837	30,83	46,65	15,82	36,79	1,82
Podolany	8013	27,90	44,45	16,55	36,79	2,28
Rataje	35482	25,50	48,11	22,61	36,40	3,07

Sołacz	4921	25,59	43,00	17,41	32,96	3,69
Stare Miasto	25888	30,95	42,64	11,69	38,17	2,07
Stare Winogrady	7666	28,66	46,37	17,72	35,57	2,86
Starołęka-Minikowo-Marlewo	9580	26,89	48,78	21,89	35,24	2,65
Stary Grunwald	3176	33,50	38,57	5,07	36,28	1,06
Strzeszyn	7731	24,53	41,41	16,88	33,30	3,45
Szczepankowo-Spławie-Krzesinki	6870	28,24	41,58	13,34	34,98	1,87
Św. Łazarz	**31937**	**31,32**	**47,39**	**16,07**	**38,92**	**2,57**
Świerczewo	13633	26,32	40,40	14,07	35,91	2,87
Umultowo	4372	26,71	40,84	14,13	32,11	2,73
Warszawskie-Pomet-Maltańskie	6861	25,56	46,03	20,47	34,69	3,98
Wilda	**26699**	**27,65**	**49,92**	**22,26**	**36,58**	**4,03**
Winiary	13690	33,00	44,80	11,80	37,03	1,96
Wola	5209	26,90	47,28	20,38	35,72	2,87
Zielony Dębiec	12713	27,22	47,10	19,88	33,07	3,70
Żegrze	16946	30,42	47,27	16,85	37,00	2,37
City of Poznań	**501956**	**23,57**	**53,81**	**30,24**	**34,48**	**3,66**

Bold *– the administrative units where NBS exemplars are located. Source: AMU own elaboration based on Landsat 8 products and SIP Poznań (GEOPOZ)*

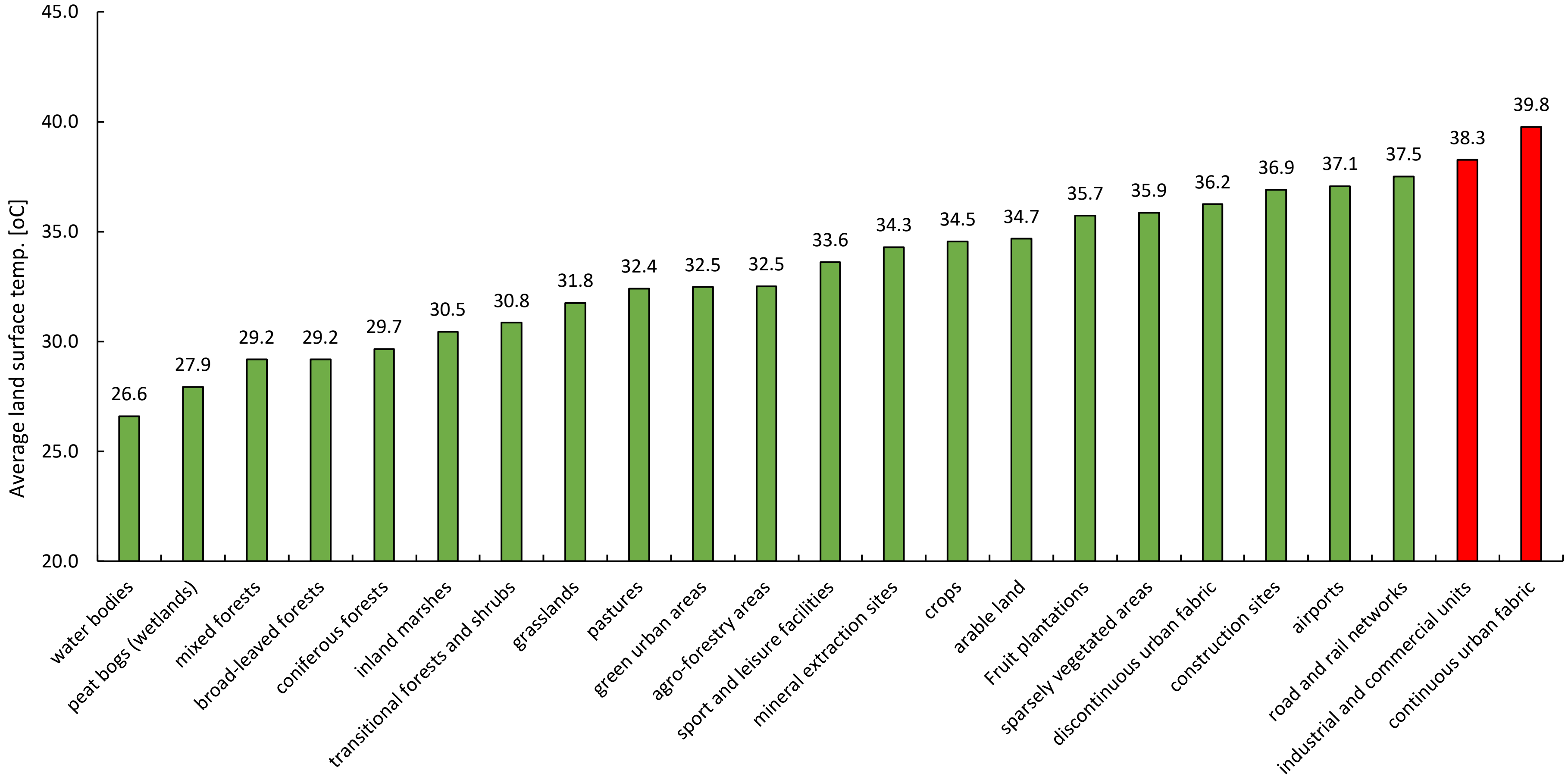


Figure 2. Average land surface temperature of land use classes in Poznań
Source: AMU own elaboration based on Landsat 8 products and LU/LC from BDOT10k (topografical map)

Site scale assessment

Thermal profile lines were designated through the area of preschools and their neighborhood to illustrate the difference in the ALST distribution. Aditionally spatial variability of NDVI was taken into account. The results are presented on figs. 3-5.

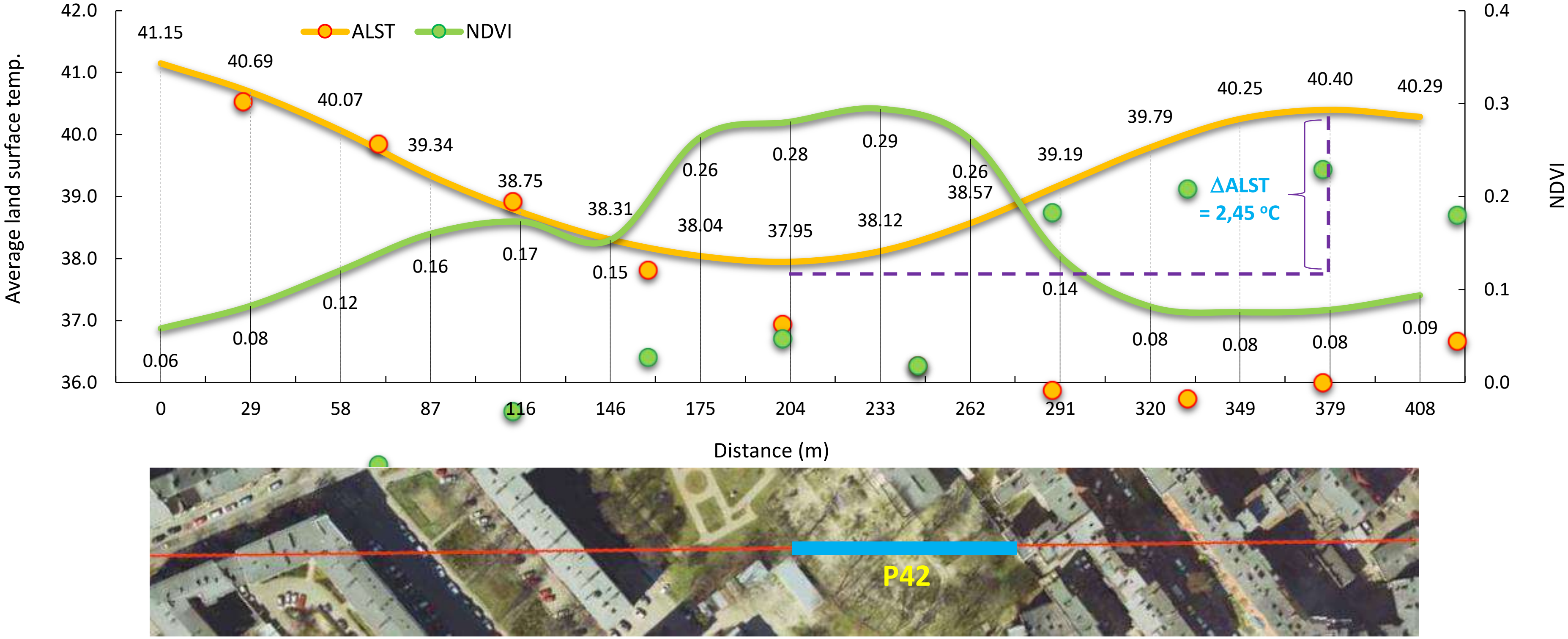


Figure 3. Impact of natural-oriented playground in Preschool No. 42 on the reduction of land surface temperature and indirectly air temperature in near surrounding

Source: AMU own elaboration based on Landsat 8 products and orthophotomap shared by SIP Poznań (GEOPOZ)

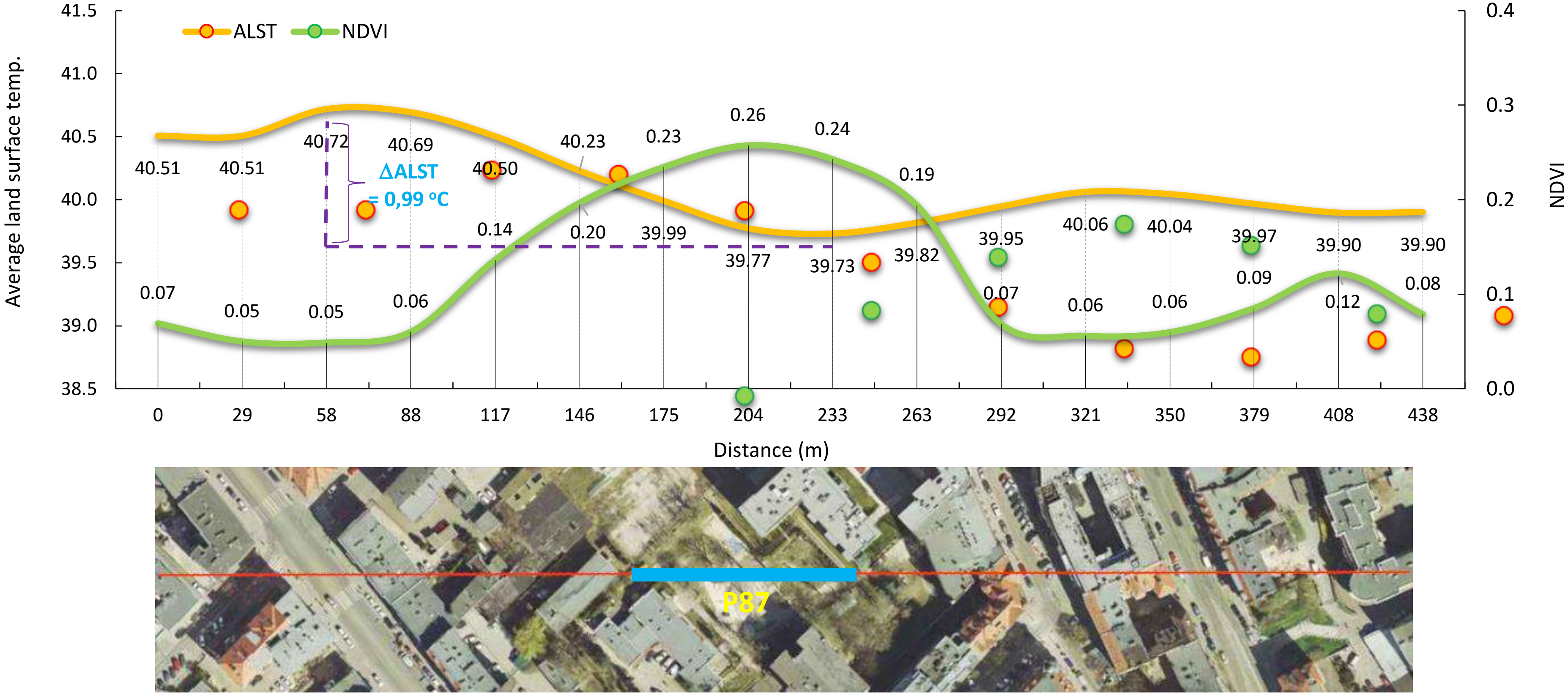


Figure 4. Impat of natural-oriented playground in Preschool No. 87 on the reduction of land surface temperature and indirectly air temperature in near surrounding

Source: AMU own elaboration based on Landsat 8 products and orthophotomap shared by SIP Poznań (GEOPOZ)

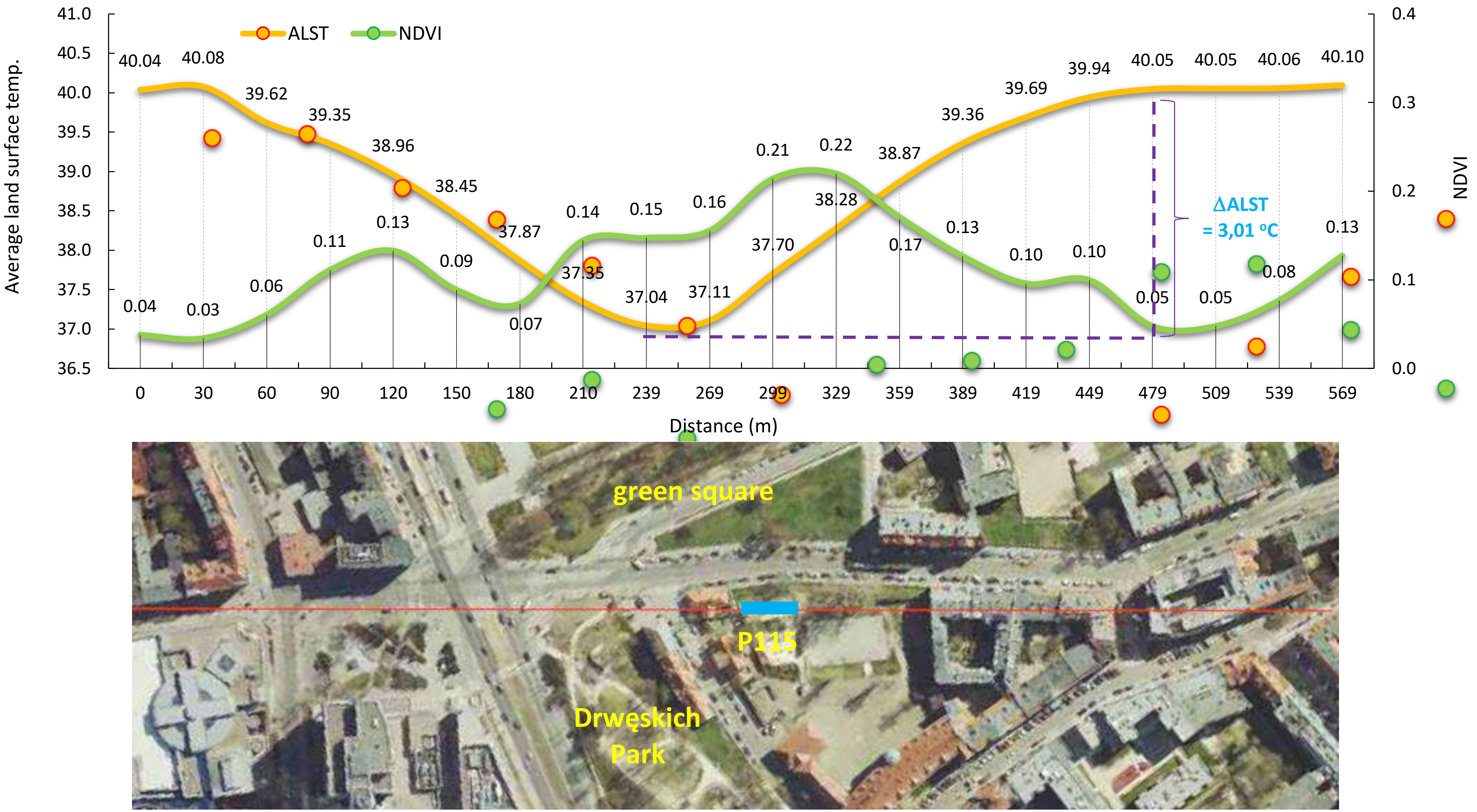


Figure 5. Cumulative impat of natural-oriented playground in Preschool No. 115, Drwęskich Park and local green square on the reduction of land surface temperature and indirectly air temperature in near surrounding
Source: AMU own elaboration based on Landsat 8 products and orthophotomap shared by SIP Poznań (GEOPOZ)

Table 2. Average LST calculated for pocket parks and preschools with natural oriented playgrounds and their buffer zones

Nature-based solution	Area [m²]	Average land surface temperature [°C]		
		inside NBS	**outside zone 0-25 m**	**outside zone 25-50 m**
Pocket parks				
Pocket Park at Kolejowa Street	8654,91	37,22	37,34	37,53
Pocket Park at Uminskiego/Sikorskiego Corner	836,73	38,43	38,52	38,55
Pocket Park at Potockiej Street	677,62	36,87	37,01	36,93
Preschools (building + garden + other outdoor area not accessed for children)				
Preschool No. 42 with nature oriented playground	4644,87	38,28	38,43	38,65
Preschool No. 87 with nature oriented playground	4666,67	40,02	40,23	40,43
Preschool No. 115 with nature oriented playground	9240,78	38,23	38,08	38,01
Preschools (garden only)				
Nature-based solution	**Area [m²]**	**Average land surface temperature [°C]**		
		inside NBS	**outside zone 0-45 m***	
Nature oriented playground in Preschool No. 42	3446,30	38,26	38,55	
Nature oriented playground in Preschool No. 87	2852,61	39,80	39,96	
Nature oriented playground in Preschool No. 115	1029,22	37,74	37,59	

* Landsat 8 L1T products (including OLI and TIRS) are characterised by 41 meter circular error (90% confidence global accuracy for TIRS). Thus in our work we assumed first buffer with a radius of 45 meters to update the calculations.
Source: AMU own elaboration based on Landsat 8 products

The average LST value in the case of pocket parks and preschools No. 42 and 87 is lower than the average LST value calculated for their near surrounding (buffers 0-25 m and 25-50 m) – see table 2. Only in the case of Preschool No. 115, there is the opposite situation but the differences of average LST values are quite small. This preschool is located near the city park (Drwęskich Park) which could be considered an important cold spot in this part of the city (northern Wilda District) (the park is colder than a nature-oriented playground). We have updated thermal analysis in mentioned preschools taking into account granularity of Landsat 8 data and spatial limitations regarding circular error of 41 m by 90% confidence global accuracy for TIRS products. We included new buffer radius of 45 m and updated previous calculations. The situation is quite similar as before this process – two of preschools have potential to cool down the surrounding (Preschools No. 42 and 87). For the third one (Preschool No. 115) as it is located near by the large urban park this effect was not detected (garden warmer than surrounding) – see table 2.

As part of monitoring activities we recognized thermal conditions of preschool gardens (230 of 264 preschools have own outdoor area) in Poznań based on the land surface temperature distribution in the city in relation to NDVI. Below we present the core results of our analysis (Fig.6).

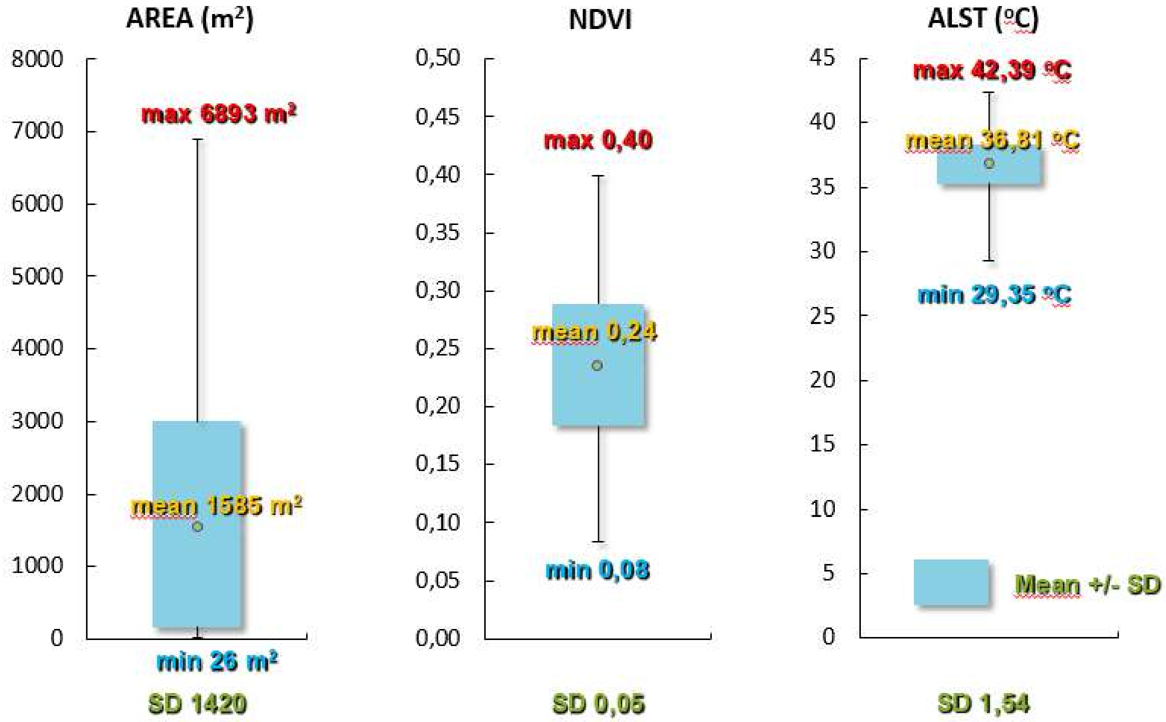


Figure 6. Characteristics of preschools' own outdoor areas – area, vegetation index (NDVI) and average land surface temperature (N=230)
Source: AMU own elaboration based on Landsat 8 products

Preschools outdoor areas in Poznań are quite diverse regarding area, share of greenery (measured with vegetation index) and surface temperature (ALST). There are preschools with a large outdoor area (max of 6893 m^2) as well as with small terraces or micro gardens (min of 26 m^2). NDVI of those gardens varies from 0,08 to 0,4, what shows that not all have a green outdoor giving children possibility for contact with nature without need for using of surrounding greenspaces. Its affects directly the distribution of the surface temperature within preschools outdoor areas. ALST of those gardens varies a lot from 29,4 $^{\circ}$C to over 42 $^{\circ}$C with mean of 36,81 $^{\circ}$C (weighted with gardens area) – see figure 6.

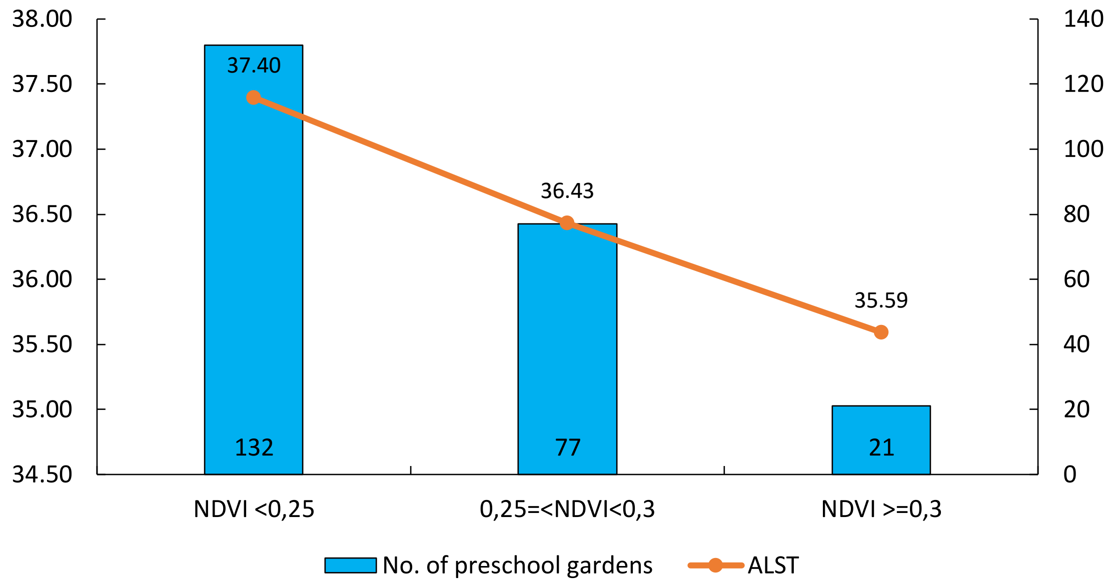


Figure 7. Differentiation of ALST in preschool gardens with own outdoor area depending on vegetation measured with NDVI (N=230)
Source: AMU own elaboration based on Landsat 8 products

Our study confirmed for Poznań that the NDVI is an important factor affecting ALST distribution and this is in line with the findings of other studies for different cities and regions (eg. Majkowska et. al 2017, Walawender et al. 2014, Vidrih and Medved 2013, Cao et al. 2010). As it is presented on figure 7 the differences in ALST values for preschool gardens regarding NDVI characteristics (gardens with NDVI <0,25 vs. gardens with NDVI ≥ 0,3) are nearly 2 ^{o}C.

On the basis of Cao et al. (2010) methodology we compared the ALST of preschool gardens with ALST measured for its surrounding buffer zone with radius of 45 m. As a result we recognised 131 preschool gardens having the lower ALTS that their surrounding (mean value of 0,15 ^{o}C; min 0,01 ^{o}C; max 0,51 ^{o}C). In the case of 99 preschools higher ALST was indicated (see figure 8).

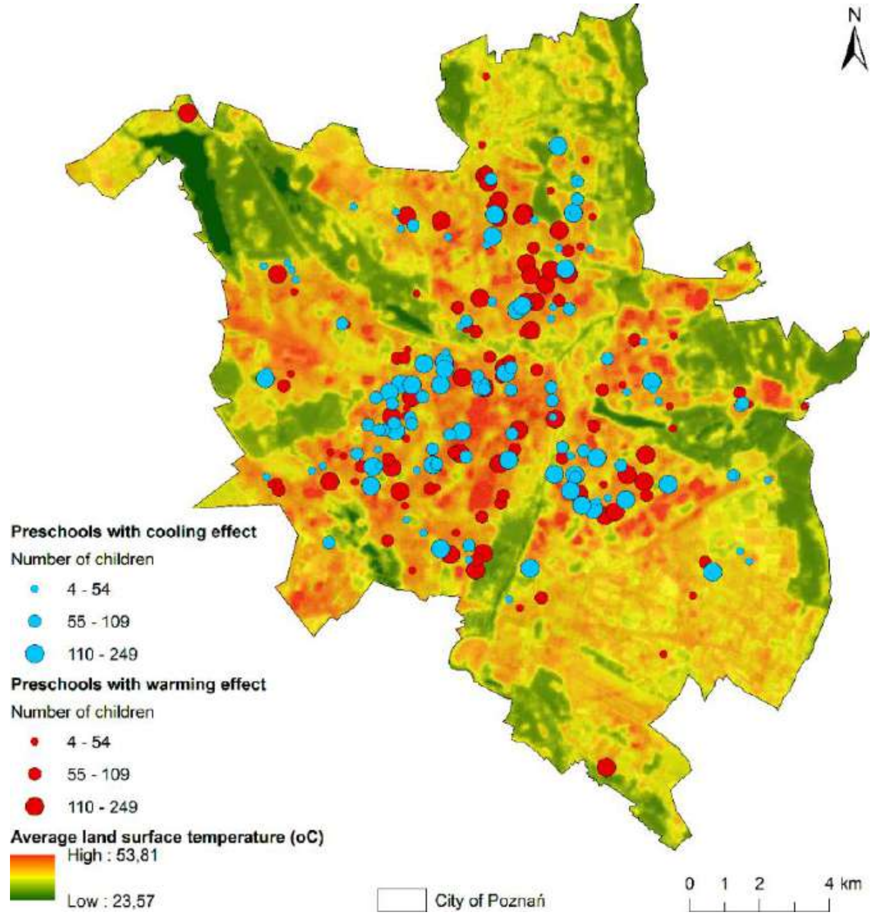


Figure 8. Preschool gardens with lower and higher ALST in comparison to their neighborhood
Source: AMU own elaboration based on Landsat 8 products and data on preschoolers shared by City of Poznań Hall

We also investigated ALST (summer season, radiation weather conditions) of preschool gardens where preschoolers are exposed to diverse outdoor thermal conditions. As it is presented on the figure 9 almost whole population of preschoolers is exposed to ALST over 33 °C and near 7% of them to ALST over 39 °C.

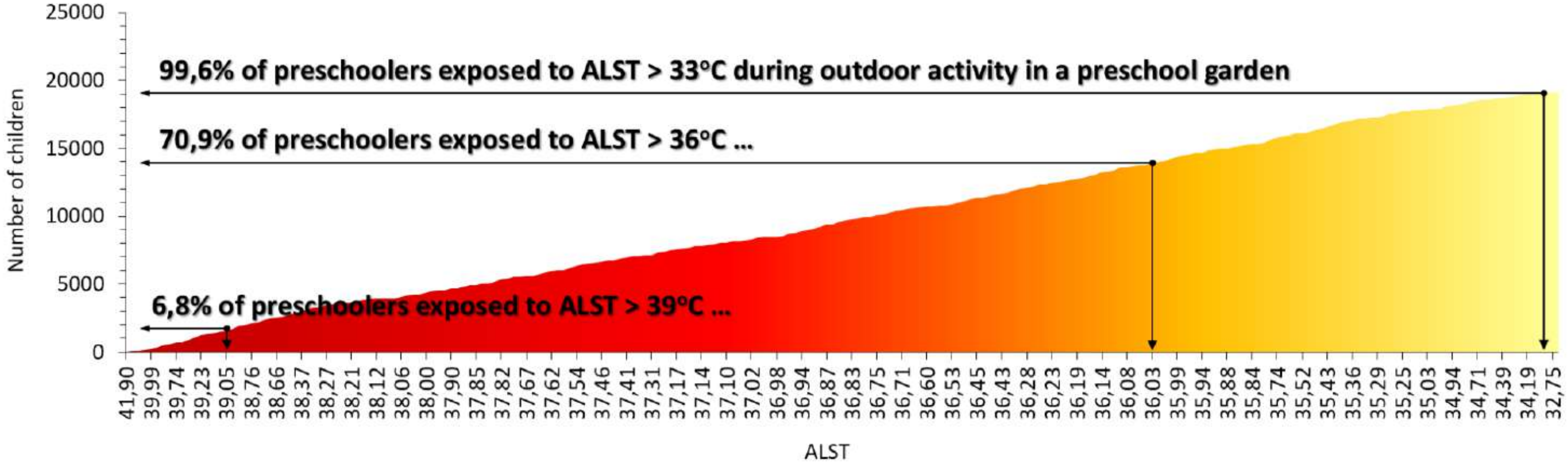


Figure 9. Children exposition to urban heat (ALST) in preschools (N=264)
Source: AMU own elaboration based on Landsat 8 products and data on preschoolers shared by City of Poznań Hall

Important factor impacting the children exposition to urban heat is a share and quality of vegetation. The more greenery/vegetation in the preschool garden, the smaller the share of children exposed to high temperatures and the risk of heat stress (see figure 10).

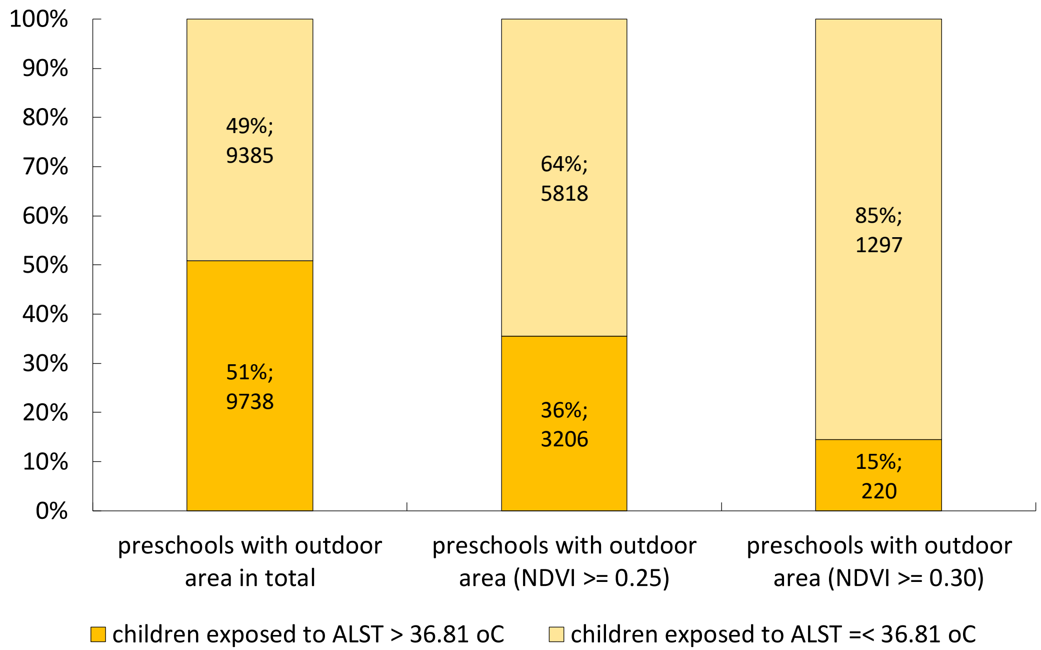


Figure 10. Children exposition to urban heat in preschools in relation to the vegetation index (NDVI)
Source: AMU own elaboration based on Landsat 8 products and orthophotomap shared by SIP Poznań (GEOPOZ)

b) Results of air temperature distribution based on data series obtained in field using Onset HOBO U23-001A sensors[3] and Davis Vantage Pro 2 meteorological stations[4]

[3] See https://www.onsetcomp.com/products/data-loggers/u23-001a/.
[4] See https://www.davisinstruments.com/vantage-pro2/.

Location and characteristic of measurement points

Figure 11. Location of measurement points in preschool gardens
Source: AMU own elaboration based on field measurement

Figure 12. Location of measurement points in pocket parks
Source: AMU own elaboration based on field measurement

Table 3. Characteristic measurement points where air temperature and humidity were measured with the use of ONSET HOBO mobile sensor sets.

No.	Measurement points	Description	Sequence of measurements
Preschool no. 115 Sportowa Drużyna (P115)			
1	P115stacja	Open space, surface covered with lawn, elevated in relation to road on the East.	P115z1, P115z2, P115w1, P115w2, P115z3, P115z4
2	P115w1	Busches at western side of garden at the gentle slope, sheltered in the lowering.	
3	P115w2	Central part of garden with playground, between building and tree.	
4	P115z1	Large open space, surface covered with concrete surface between school building and preschool garden.	
5	P115z2	Large open spaces, surface covered with artifical sport ground Boisko.	
6	P115z3	Street corridor, surrounded by school buildings on one side and park at the other side of street, pavement covered with concrete tiles at ul. Niedziałkowskiego.	
7	P115z4	Street, half-open space without the buildings on one side and with earth embankments on the other, pavement covered with concrete tiles at ul. Górna Wilda.	
Preschool no. 42 Kwiaty Polskie (P42)			
8	P42stacja	Lawn in the middle of the preschool garden.	P42z1, P42z2, P42z3, P42w8, P42w7, P42w6, P42w9, P42w5, P42w4, P42w10, P42w1, P42w2, P42w3
9	P42w1	Open garden, open space, close to building with Surface covered with stones.	
10	P42w10	The terrace of the preschool building. Surface covered with concrete.	
11	P42w2	Open garden, open space, surface covered with concrete pavement.	
12	P42w3	Open garden, open space, surface covered with lawn.	
13	P42w4	Open space, close to building, surface covered with pavement.	
14	P42w5	Open space of playground, surface covered with sand C-W.	
15	P42w6	Small hill under trees, surface covered with bare ground, partly covered with grass Located S-E.	
16	P42w7	Open space, surface covered with sparse lawn.	
17	P42w8	Open space, close to trees, surface covered with lawn. Located in N-E.	
18	P42w9	Lawn in the middle of the preschool garden, close to bushes. Located in the center.	
19	P42z1	Pavement located between tenant house and road with small roadside lawn. Located on the west.	
20	P42z2	Concrete space between preschool and road, surrounded by buildings, impervious fences, trees. Closed space.	

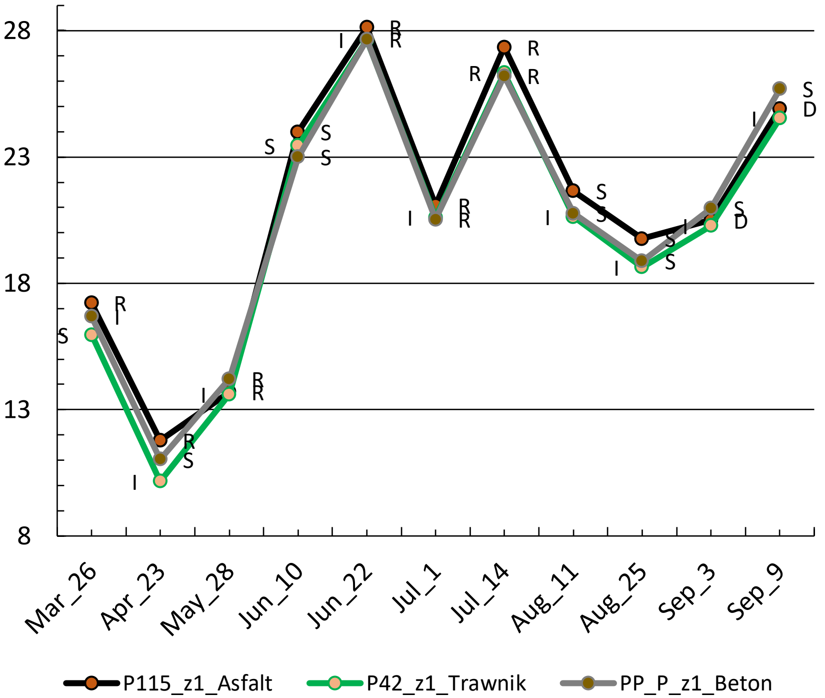
21	P42z3	Concrete surface at the back of the preschool building. Surrounded by trees, and buildings. Closed space.	
Preschool no. 87 Jacusia i Agatki (P87)			
22	P87stacja	Open space, surface covered with lawn, close to tree row.	P87z1, P87z2, P87w1, P87w2, P87w3, P87w4, P87w5, P87w6, P87w7, P87w8, P87w9
23	P87w1	Narrow path between trees and dense bushes, surface covered with bare ground and vegetation.	
24	P87w2	Concrete surface surrounded by buildings, located in front of the preschool.	
25	P87w3	Space between preschool building and concrete open space, surface covered with lawn.	
26	P87w4	Concrete pavement in the preschool garden, close to trees and building.	
27	P87w5	Hill in the eastern side of garden, close to neighboring building and trees.	
28	P87w6	Half-open space located in the eastern part of garden, surrounded by neighboring building, surface covered with flower meadow (seasonally).	
29	P87w7	Sand pit located in the northern part of the preschool garden, close to neighboring building.	
30	P87w8	Space close to building (stairs), surface covered with concrete .	
31	P87w9	Space in the middle of preschool garden, under trees, Surface covered with bare ground.	
32	P87z1	Street corridor, surrounded by buildings, Surface covered with concrete pavement at ul. Poplińskich/Św. Czesława.	
33	P87z2	Car park surrounded by buildings, surface covered with bituminous surface.	
Pocket Park at Kolejowa street (PPK)			
34	Kw1	Unmaintained lawn at the edge of PP, open space, surrounded by concrete pavement.	Kz4, Kz3, Kw7, Kw6, Kw5, Kw4, Kw3, Kw2, Kw1, Kz2, Kz1, Kz6, Kz5
35	Kw2	Dirt path surrounded by bushes on one side and trees on the other side, open space.	
36	Kw3	Cultivated lawn, open space close to bituminous road at Kolejowa street	
37	Kw4	Sparse lawn below the dense tree canopy.	
38	Kw5	Dirt path in the center of PP.	
39	Kw6	Tall ornamental grasses.	
40	Kw7	Lawn in open space, limited by tree stand in south and bushes in the north.	
41	Kz1	Concrete pavement and lawn at Hetmańska street.	
42	Kz2	Concrete pavement at Hetmańska street.	
43	Kz3	Closed old asphalt road.	
44	Kz4	Concrete car park.	
45	Kz5	Concrete pavement with sparse lawn, on the other side of ul. Kolejowej. Surrounded by large road and market place.	

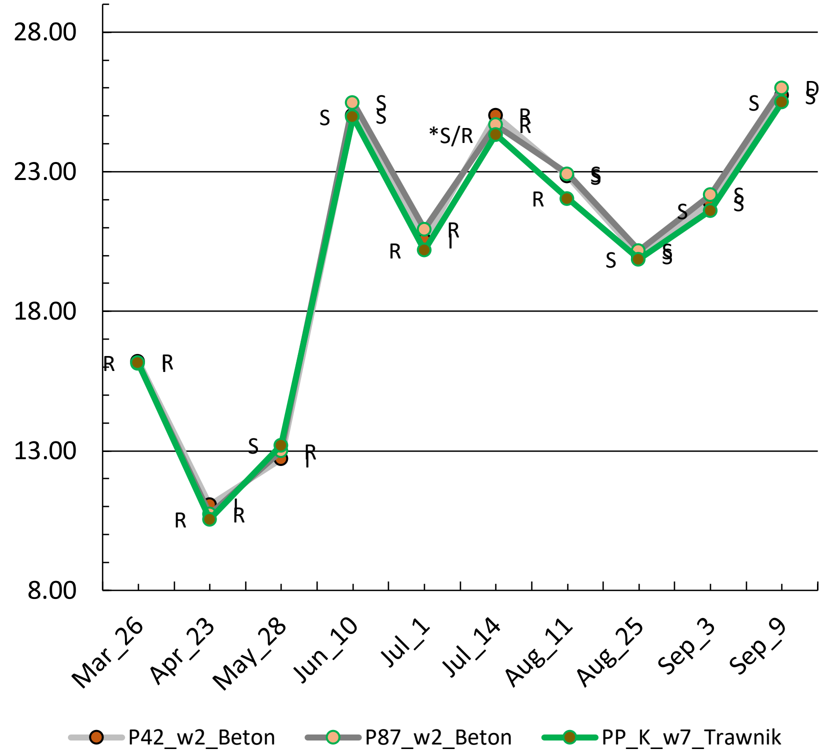
46	Kz6	Pavement with sparse lawn, on the other side ul. Kolejowej/Hetmańskiej. Surrounded by large road and market place.	
Pocket Park at Potockiej street (PPP)			
47	Pw1	Thickets under the tree (humid space).	Pz1, Pz2, Pw1, Pw2, Pz3, Pw3, Pz4
48	Pw2	Lawn in close proximity to building.	
49	Pw3	Lawn in close proximity to building.	
50	Pz1	Local road between buildings, Surface covered with concrete pavement.	
51	Pz2	Sparse lawn, between two block of flats, close to row of trees.	
52	Pz3	Concrete pavement, between lawn, close to building and trees.	
53	Pz4	Lawn, open space.	
Pocket Park on the corner of Sikorskiego and Umińskiego streets (PPSU)			
54	SUw1	Young bushes planted at surface covered with bark, located next to the building.	SUz1, SUw1, SUw2, SUw3, SUz2, SUz3
55	SUw2	Dirt path in the center of PP, close to young tree.	
56	SUw3	Young bushes planted at surface covered with bark, located next to the mature tree.	
57	SUz1	Small road-side lawn at ul. Umińskiego, surrounded by concrete pavement and bituminous road.	
58	SUz2	Pavement at the open space of crossroads of ul. Sikorskiego/Umińskiego, Surface covered with concrete.	
59	SUz3	Concete pavement at ul. Sikorskiego, next to PP.	

„z" – measurement points in the surrounding of NBSs (external to NBS); „w" measurement points within NBS area, „stacja" – location of stationary meteorological station.
Source: AMU own elaboration based on field measurement

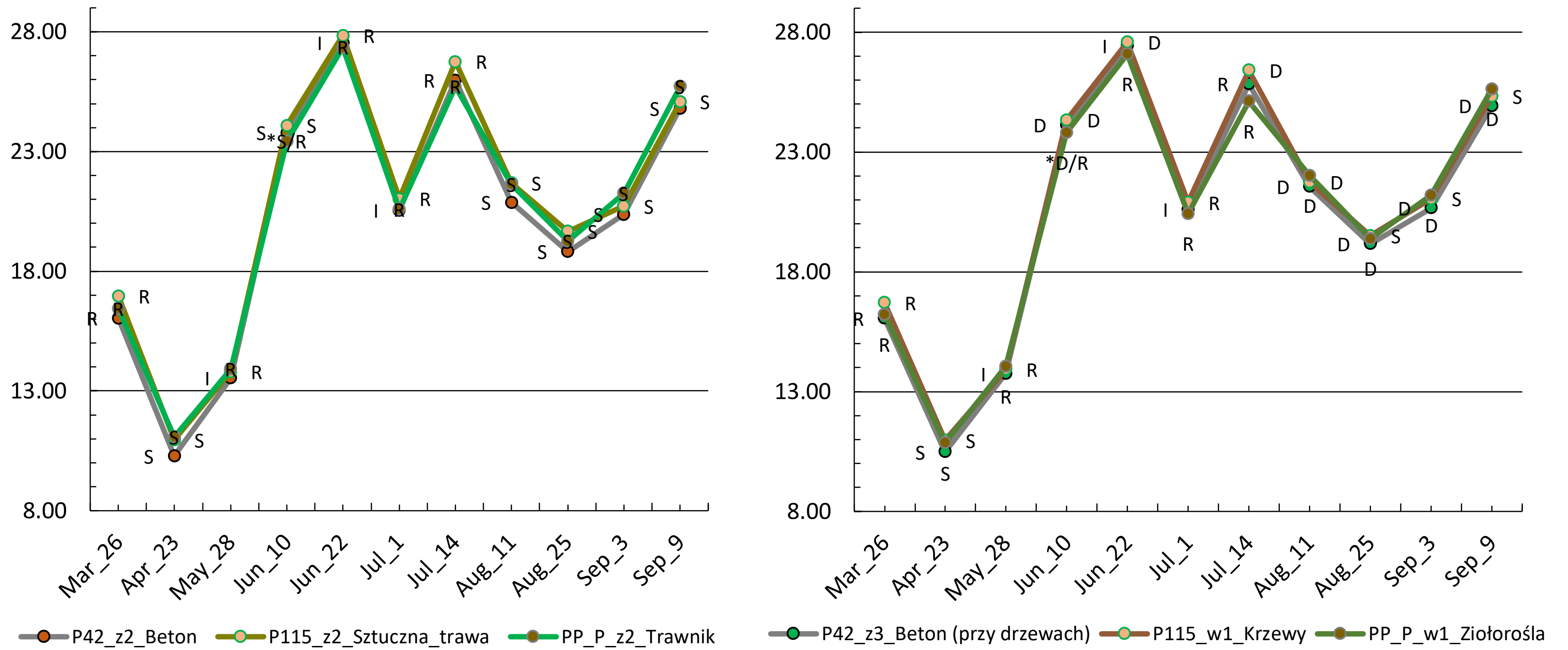
Thermal condition comparison among sites

Site measurements of air temperature were conducted at the same time in 3 NBS and its surroundings. Therefore, we compare thermal condition between 3 measurement points from different location that were taken at similar time. To capture patterns of temperature diversity among sites we have juxtaposed 17 measurements moments in a diverse combination of measurements points. The results indicate a detected pattern in temperature differences (cooler or warmer site at each measurement in the year) or no visible pattern of cooler or warmer spots among the compared site.





Descriptions and locations of measurement points are presented in table 3 and figures 11-12. Labels indicate the sunlight conditions: S - sensor insolated; D - sensor shaded by a tree; I - sensor shaded by other objects, eg. building; R - diffuse radiation from the sun (clouded sky).
Figure 13. Average air temperatures (5 minutes measurements with a 1-minute interval in each point, HOBO U23-001A sensors, ᵒC) measured at a height of 1,5 m (1-3 PM) in different locations.
Source: AMU own elaboration based on field measurement



Descriptions and locations of measurement points are presented in table 3 and figures 11-12. Labels indicate the sunlight conditions: S - sensor insolated; D - sensor shaded by a tree; I - sensor shaded by other objects, eg. building; R - diffuse radiation from the sun (clouded sky); S/R, D/R – changing lighting conditions during mesurement.

Figure 14. Average air temperatures (5 minutes measurements with a 1-minute interval in each point, HOBO U23-001A sensors, °C) measured at a height of 1,5 m (1-3 PM) in different locations.

Source: AMU own elaboration based on field measurement

Detected cooling effect or hot spots:

- Large artificial or concrete surfaces located in open space with no trees are hot spots in the urban space. Measurements located in concrete assembly square in front of P115 show temperature on average higher by 0,75^{0}C than in the surrounding of P42 (street corridor) and by 0,41^{0}C than in surrounding of PP at Potockiej Street. The maximum detected temperature differences reach 1.62^{0}C among sites (Fig. 13). This highlights the issue of an old type of schoolyard arrangements that should be subject to green revitalization that would replace concrete surface where possible and/or shade the space with trees providing shade and cooling effect;
- Air temperature at the spacious artificial sport ground of P115 was higher than temperature of built-up and sealed surrounding of P42 and lawn among multifamily housing buildings surrounding PP at Potocka Street (with two exceptions). The average differences in temperature were 0,54-0,34^{0}C. This highlights the issue of an schoolyard arrangements where artificial surface covers large space that is not shaded by trees (Fig. 14);
- Temperature detected in road corridor close to P115 is higher than temperature in P42 (open space covered with grit) (min. 0,33^{o}C; max. 1,54^{o}C) and lawn among multifamily buildings in close proximity to PP Potockiej (min. 0,14^{o}C; max. 1,90^{o}C).
- Comparison of air temperature measurements among surrounding of PP at Kolejowa Street (open space, closed bituminous road) and preschool no. 87 garden (path surrounded by green spaces - bushes and trees) showed that temperature is higher on site with bituminous surface (min. 0,03; max. -0,79).
- Temperature in the side part of P87 garden (bare ground in close proximity to surrounding building and trees) is cooler than in the central point of young PP at Umińskiego Street. The differences in temperature is from 0 to 0,92^{0}C.
- Comparison of air temperature among sites in P87 (side part of garden, covered with lawn surrounded by trees), P115 (central open space of garden), PP at Potockiej Street (lawn in central part of PP) revealed that less abundant green space of P115 is warmer on average than two other sites by 0.37-0.55^{o}C.
- The air temperature in P42 (side lawn surrounded by trees) is cooler than P115 (central part of garden with open space). Differences vary between 0,06-0,64^{0}C.

No visible pattern of air temperature diversity among measurements sites:

- P115 (street corridor), surrounding of PP at Potockiej Street (pavement with green space among multifamily buildings), and P42 (small hill in the garden surrounded by trees from one side and open space from the other side) showed relatively high differences in temperature values, without a visible pattern.
- PP at Kolejowa Street and P87 (concrete squares (car parks)) as well as open garden in P42 (open areas with surface covered with stones close to building of preschool) .

- P42 (lawn in open space), P87 (concrete assembly with open space surrounded by building and concrete fence) and PP at Kolejowa Street (high decorative grass surrounded by trees from one side and open space from the other).
- P87 (lawn in close proximity to preschool building), surrounding of PP at Umińskiego (road corridor with strep of lawn and single tree), PP at Kolejowa Street (central part of the park of open space and dirt square).
- PP at Umińskiego Street (young bushes), P87 (a concrete path surrounded by trees), PP at Kolejowa Street (central part of the park with sparse lawn under tree canopy).
- P87 (side part of garden with flower meadow (sesonal) in close proximity to building, PP at Kolejowa Street (side part with dirt path surrounded on one side by trees and open space on the other side), surrounding of PP at Umińskiego Street (crossroad with open space and paved surface) .
- P87 (sandpit in open space), surrounding of PP at Umińskiego Street (road corridor, open space with paved surface), PP at Kolejowa Street (side part with lawn at open space).
- P87 (paved path next to preschool building), surrounding of PP at Kolejowa Street (open space with concrete pavement close to road), and PP at Kolejowa Street (side part with lawn and open space).
- PP at Kolejowa Street (open space with concrete pavement close to road), P87 (central part of garden with bare ground under trees), surrounding of PP at Kolejowa Street (pavement on the other side of road, close to allotment garden).
- P87 (side part of garden, covered with lawn surrounded by trees) and PP at Potockiej Street (lawn in central part of PP)
- the surrounding of PP at Kolejowa Street (open space, closed bituminous road) and open garden (open space with a concrete surface).
- PP at Kolejowa Street (lawn in open space close to Kolejowa Street), PP at Umińskiego Street (central part of dirt square), P87 (side part with bare ground surrounded by building and trees).

The results showed that air temperature measured at sites very often showed relatively high differentiation among sites and differentiation in pattern through the measurements during the year. Site measurements might be influenced by diverse factors such as exposition to sun, wind conditions, shade, presence of mature trees, state of vegetation due to season, closed or open space, land cover in the surrounding. Therefore results from site measurements require a further extension and continuation to capture under which conditions small scale green spaces act as a cooling spots.

Thermal condition distribution in preschool gardens and surrounding area

In order to compare the air temperatures measured at various points in the afternoon (1-3 PM) in preschool gardens (NBS) and their vicinity using Hobo U23-001A sensors, we have corrected the collected data for the temperature change during the measurement hours, based on reference values from stationary weather stations (Davis Vantage Pro2) located in the above-mentioned gardens. On this basis we calculated average air temperatures at height of 1,5 m for two groups of measurement points and each of 10 measurement series:

1) points located externally to a preschool garden (in the surrounding area of a given NBS) – “z” labeled,
2) points located within a garden (inside the preschool garden) – “w” labeled.
We excluded from the analysis the data collected on 22nd June 2021 due to the storm-induced data distortion and cancellation of afternoon measurement.

Figures 15 and 16 show differences in average air temperature distribution between a given preschool garden (preschools No. 87 and 115) and its surrounding area.

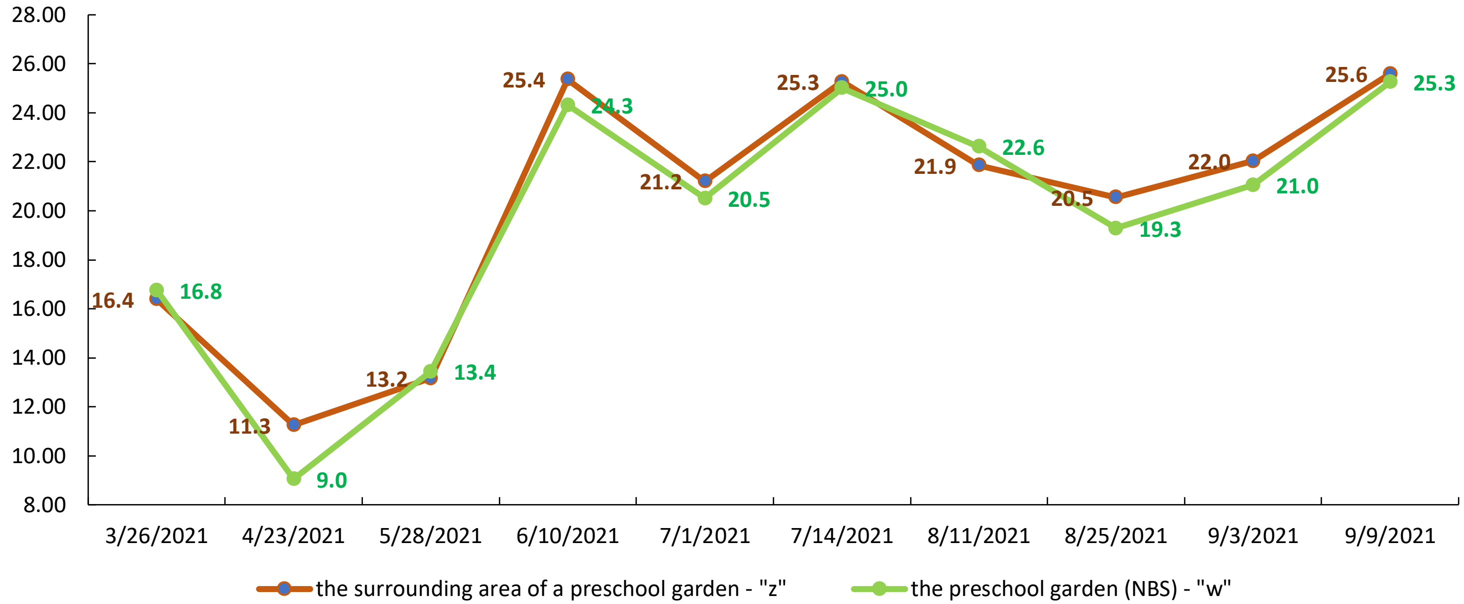


Figure 15. Distribution of average air temperature (°C) in a preschool garden No. 87 and its surrounding.
Source: AMU own elaboration based on field measurement

The average difference in air temperatures between the garden and its surrounding was estimated at -0,54 °C in total (the garden of the preschool No. 87 is cooler than its surrounding). The difference is not constant and changes over the measurement periods from -2,2 °C in April to almost 0,8 °C in

June (11.06) according to the weather conditions especially sunlight conditions. Except for the measurements on May 28th and August 11th, the analyzed garden could be considered as a cool island in relation to its nearest vicinity.

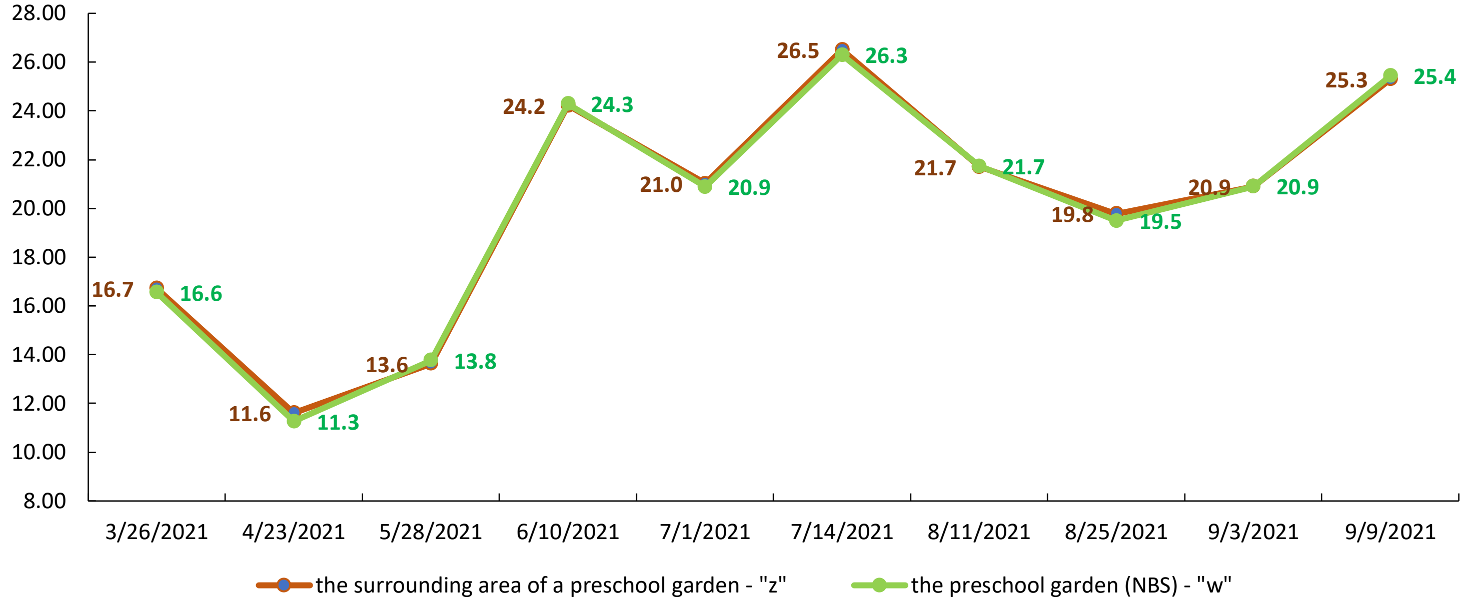


Figure 16. Distribution of average air temperature (°C) in a preschool garden No. 115 and its surrounding.
Source: AMU own elaboration based on field measurement

In the case of preschool No. 115, the average difference in air temperatures between the garden and its surrounding was estimated at -0,07 °C in total (the garden seems to be of similar temperature like its surrounding). The difference changes over time from -0,34 °C in April to 0,15 °C on September 9th according to the weather conditions - especially sunlight. Topography (garden located in the open space connected with the upper terrace of the river valley of Warta), as well as the vicinity of the large urban park (Drwęskich Park in the north), are factors considered as lowering the differences of air temperatures between the garden and its surrounding. On May 28th, June 10th, August 11th, September 3rd, and 9th the air temperatures in the analyzed garden were almost the same as in the nearest buffer zone (0,08 °C higher on average). In the rest of the measurement days (5) the garden was 0,22 °C cooler on average.

The presented results evidence that given preschool gardens have various potential to impact the thermal conditions on a local/site scale in the city settings. Inevitably, site measurements are influence by diverse factors such as exposition to sun, shade, state of vegetation due to season, closed or open space, land cover in the surrounding. The results from site measurements corresponds with thermal profiles that shows the differences between temperature between preschool gardens and built-up surroundings within further distance (preschool no 115, 87, 42).

ENV81. Soil sealing

a) The case study of Preschool no. 42

Preschool no.42 have a large outdoor space available for children. Based on ortophotomap from 2016 and photographs it was possible to map the land cover from before transformation. The current state of land cover after creation of nature-oriented playground was mapped based on field mapping and tree canopy data realeased by GEOPOZ in 2021.

Before transformation into nature-oriented playground the outdoor space was arranged with a 920.9 m^2 of concrete surface (Figure 17).

Figure 17. Outdoor area of Preschool no. 42 before transformation. Pracownia k. A.Komorowska

The baseline studies of land cover showed that concrete surface covered 27.8% of outdoor space associated with preschool building. The transformation of preschool garden allowed for transformation of 882 m^2 concrete area into biologically active surface and lead to reduction in concrete impervious surface of the garden by 26.64%. The concrete surface were to large extent replaced by dirt paths (that increased the share of bare ground in land cover structure). The detail changes in share of land cover structure are presented in Table 4.

Table 4. Change in share of land cover type due to transformation into nature-oriented playground [%]

Land cover types	**2016**	**2021**	**change**	**2016**	**2021**	**change**
		[m²]			**[%]**	
bare ground	92,7	663,0	570,3	2,8	20,0	17,2
build-up	567,4	567,4	0,0	17,1	17,1	0,0
concrete surface	920,9	39,2	-881,7	27,8	1,2	-26,6
flowerbed	39,1	55,0	15,9	1,2	1,7	0,5
grass	1480,1	1432,9	-47,2	44,7	43,3	-1,4
hedges	253,4	259,6	6,2	7,7	7,8	0,2
long grass, herbs	418,7	368,6	-50,1	12,6	11,1	-1,5
sand	95,5	401,0	305,5	2,9	12,1	9,2
wooden platform	9,7	43,9	34,2	0,3	1,3	1,0
biowaste	0	4,7	4,7	0	0,1	0,1
gravel	0	31,3	31,3	0	0,9	0,9
vegetables, fruits and herbs	0	10,8	10,8	0	0,3	0,3

Source: AMU own elaboration

EN85. Change in ecosystem service provision

Change in ecosystem services (ES) provision was analysed in pilot assessment for one of NBSs – Pocket Park at Kolejowa Street. We focused on the ES provided by trees and used the i-Tree Eco methodology[5] to estimate selected regulating ES like carbon storage, carbon sequestration, oxygen production, and avoided runoff. Below we present short summary of study. The full report is attached to this document as an external file (Supplementary material 1_Ecosystem_services_of Pocket_Park_at_Kolejowa_Street(i-Tree_report)). AMU is still working to include pollution removal ES in the analysis.

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. Field work and detail trees measurement was conducted in 2020. An assessment of the vegetation structure, function, and value of the Kolejowa urban pocket park with a use of i-Tree Eco was conducted in 2021. We applied tree measurements from 2020 and meteorological data for year 2018 (which is the most actual year for which the software provide data entry). Data from 108 trees located throughout Kolejowa pocket park were analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station:

- Number of trees: 108;
- Tree Cover: 24,6 %;
- Most common species of trees: Tilia tomentosa, Celtis occidentalis, Robinia pseudoacacia 'Frisia';
- Percentage of trees less than 6" (15.2 cm) diameter: 2,8%;
- Pollution Removal: currently not calculated;
- Carbon Storage: 115,8 tons (80,3 thousand PLN);
- Carbon Sequestration: 2,058 tons (1,43 thousand PLN/year);
- Oxygen Production: 5,487 tons/year;
- Avoided Runoff: 30,4 cubic meters/year (241 PLN/year);
- Building energy savings: N/A – data not collected;
- Avoided carbon emissions: N/A – data not collected.

[5] See https://www.itreetools.org/.

Environmental indicators - FEATURE

ENV41. Accessibility of greenspaces

a) Accessibility (availability) of green spaces for pupils of preschools in Poznań

To identify the opportunity for contact with nature for preschools' pupils in Poznań we have analyzed the distribution of preschools at the background of available green infrastructure. We took into account the share of GI in the close vicinity (300m) of preschools (Fig. 18). To have a deeper view on the surrounding areas we have analyzed the share of GI in different distances of 100m, 300m, 500m (Fig. 19).

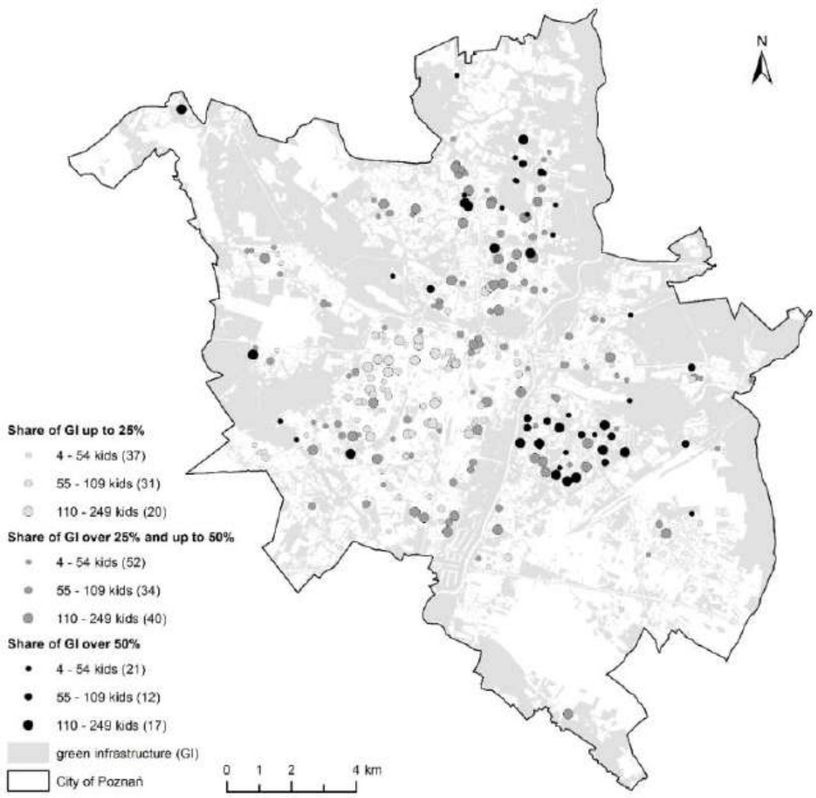


Figure 18. Location of preschools in Poznań including the number of children and green infrastructure distribution (shares of GI in preschool buffers r = 300 m).
Source: AMU own elaboration

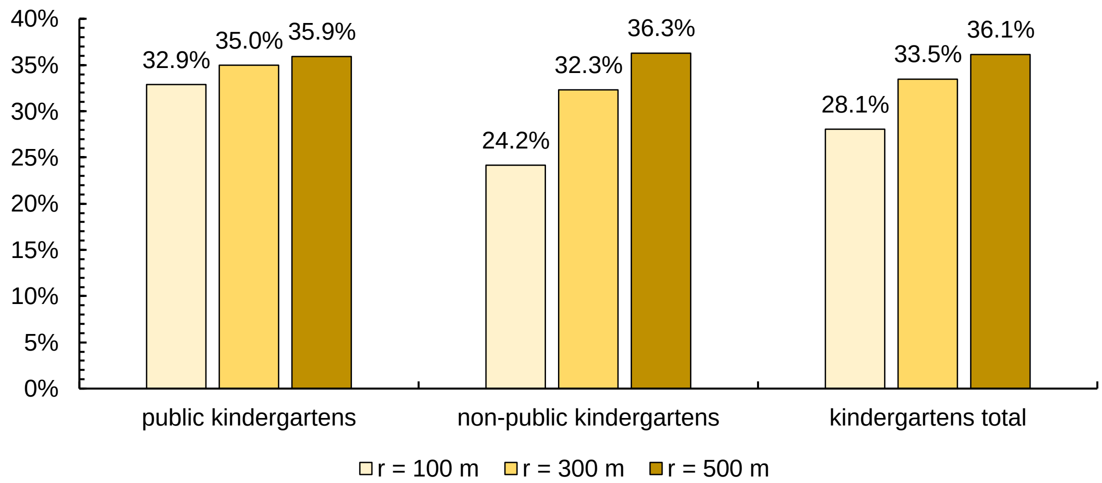


Figure 19. Average share (%) of green infrastructure in preschool buffers (r = 100, 300, 500 m).
Source: AMU own elaboration.

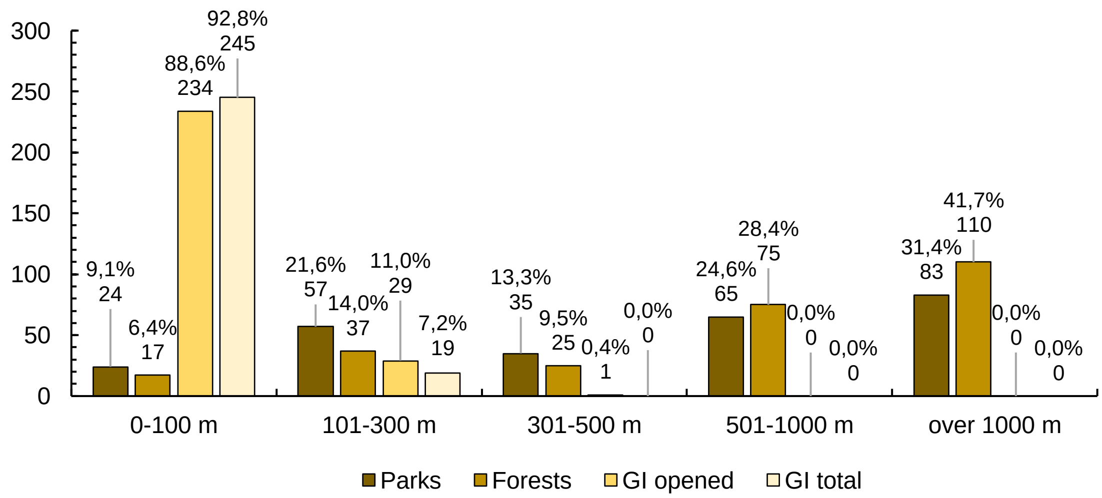


Figure 20. Distribution of the preschools (number) with respect to selected types of green areas. *Source: AMU own elaboration*

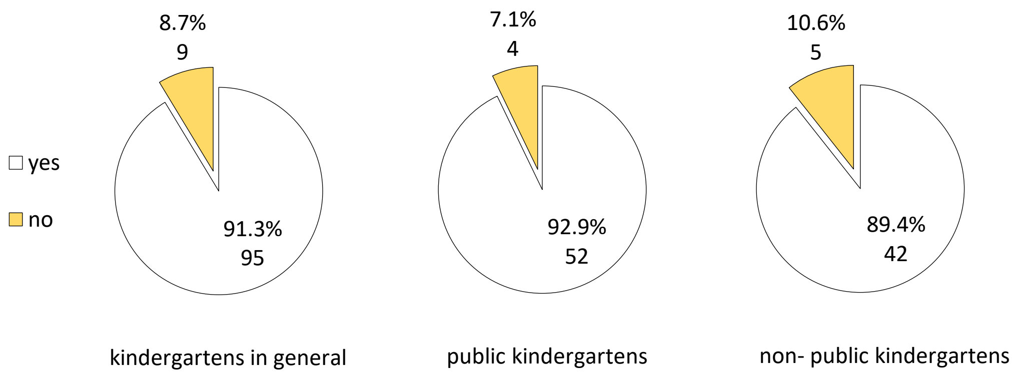


Figure 21. Availability of preschool own outdoor area? (N=104)
Source: AMU own elaboration

b) Accessibility (availability) of green spaces for pupils of selected preschools with nature-oriented playgrounds

Spatial indicators illustrating the availability of green spaces in the surrounding of preschools with their own outdoor areas where exemplars of NBS are monitored are presented in table 5.

Table 5. Availability of green spaces in the surrounding of preschools selected for NBS monitoring

Assessment parameters	Preschool No. 42 "Kwiaty Polskie"	Preschool No. 87 "Jacusia i Agatki"	Preschool No. 115 "Sportowa Drużyna"
Spatial characteristics			
Distance to the nearest park [m]	348,31	124,06	50,68
Distance to the nearest GI total [m]	9,04	0,00	2,33
Distance to the nearest GI total (surface =>2 ha) [m]	149,00	124,06	50,68
Distance to the nearest forest [m]	1853,01	2457,43	2504,16
Distance to the nearest park or forest [m]	348,31	124,06	50,68
Distance to the nearest GI open [m]	9,04	0,00	2,33
Total area of GI total in preschool buffer zone (r = 100 m) [ha]	0,76	0,40	1,10
Average share (%) of GI total in preschool buffer zone (r = 100 m)	24,10	12,90	35,03
Total area of GI total in preschool buffer zone (r = 300 m) [ha]	4,39	5,07	8,52
Average share (%) of GI total in preschool buffer zone (r = 300 m)	15,55	17,94	30,15
Total area of GI total in preschool buffer zone (r = 500 m) [ha]	13,47	14,82	17,43
Average share (%) of GI total in preschool buffer zone (r = 500 m)	17,16	18,88	22,20
Total area of GI total (min object area 2ha) in preschool buffer zone (r = 100 m) [ha]	0,00	0,00	0,51
Average share (%) of GI total (min object area 2ha) in preschool buffer zone (r = 100 m)	0,00	0,00	16,12
Total area of GI total (min object area 2ha) in preschool buffer zone (r = 300 m) [ha]	1,21	3,00	3,67
Average share (%) of GI total (min object area 2ha) in preschool buffer zone (r = 300 m)	4,28	10,63	12,99
Total area of GI total (min object area 2ha) in preschool buffer zone (r = 500 m) [ha]	2,79	5,18	7,57
Average share (%) of GI total (min object area 2ha) in preschool buffer zone (r = 500 m)	3,55	6,60	9,64
Total area of forests in preschool buffer zone (r = 100 m) [ha]	0,00	0,00	0,00
Average share (%) of forests in preschool buffer zone (r = 100 m)	0,00	0,00	0,00
Total area of forests in preschool buffer zone (r = 300 m) [ha]	0,00	0,00	0,00

Average share (%) of forests in preschool buffer zone (r = 300 m)	0,00	0,00	0,00
Total area of forests in preschool buffer zone (r = 500 m) [ha]	0,00	0,00	0,00
Average share (%) of forests in preschool buffer zone (r = 500 m)	0,00	0,00	0,00
Total area of forests and parks in preschool buffer zone (r = 100 m) [ha]	0,00	0,00	0,51
Average share (%) of forests and parks in preschool buffer zone (r = 100 m)	0,00	0,00	16,12
Total area of forests and parks in preschool buffer zone (r = 300 m) [ha]	0,00	3,00	3,67
Average share (%) of forests and parks in preschool buffer zone (r = 300 m)	0,00	10,63	12,99
Total area of forests and parks in preschool buffer zone (r = 500 m) [ha]	0,85	4,33	7,21
Average share (%) of forests and parks in preschool buffer zone (r = 500 m)	1,09	5,51	9,18
Total area of parks in preschool buffer zone (r = 100 m) [ha]	0,00	0,00	0,51
Average share (%) of parks in preschool buffer zone (r = 100 m)	0,00	0,00	16,12
Total area of parks in preschool buffer zone (r = 300 m) [ha]	0,00	3,00	3,67
Average share (%) of parks in preschool buffer zone (r = 300 m)	0,00	10,63	12,99
Total area of parks in preschool buffer zone (r = 500 m) [ha]	0,85	4,33	7,21
Average share (%) of parks in preschool buffer zone (r = 500 m)	1,09	5,51	9,18
Total area of GI open in preschool buffer zone (r = 100 m) [ha]	0,70	0,40	0,99
Average share (%) of GI open in preschool buffer zone (r = 100 m)	22,41	12,90	31,49
Total area of GI open in preschool buffer zone (r = 300 m) [ha]	2,23	4,76	7,11
Average share (%) of GI open in preschool buffer zone (r = 300 m)	7,87	16,86	25,15
Total area of GI open in preschool buffer zone (r = 500 m) [ha]	6,05	10,73	14,05
Average share (%) of GI open in preschool buffer zone (r = 500 m)	7,70	13,66	17,89

Source: AMU own elaboration

ENV43. Ratio of open spaces to built form

The baseline data illustrating the distribution (Fig. 22) and share of built-up areas and green and blue infrastructure (Fig. 23) at the city scale and at the local administrative unit level is calculated based on land cover data from BDOT10k database (2019) available for Poznań.

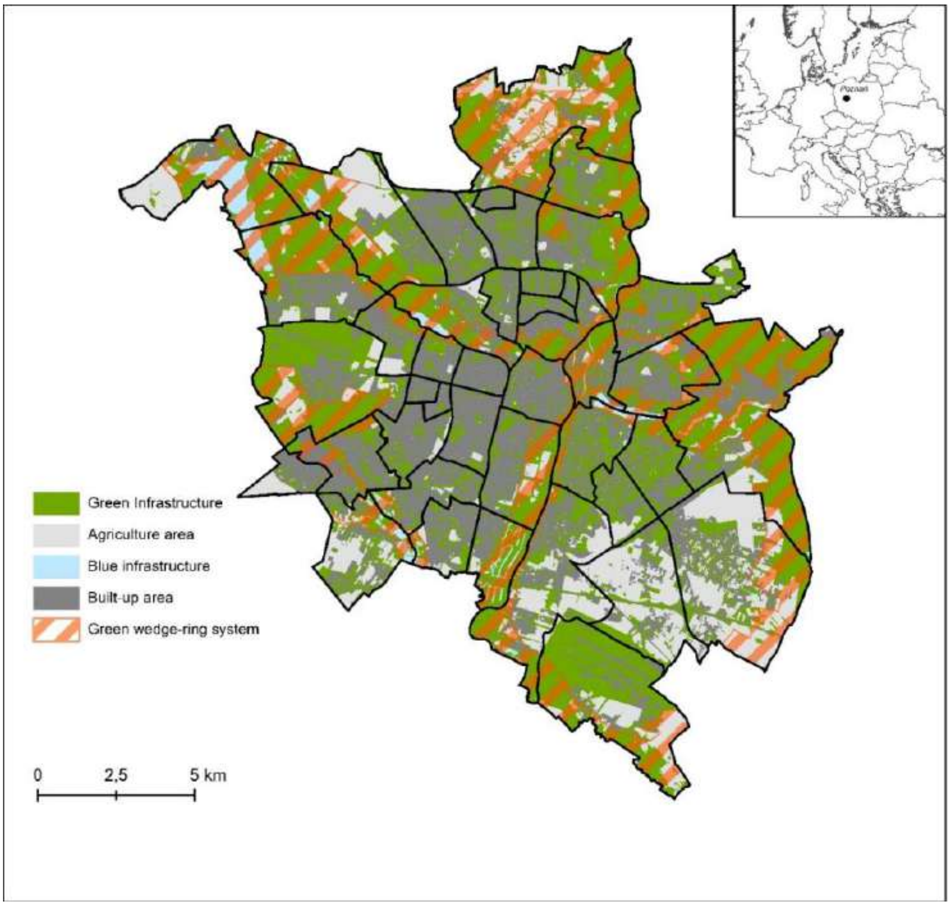
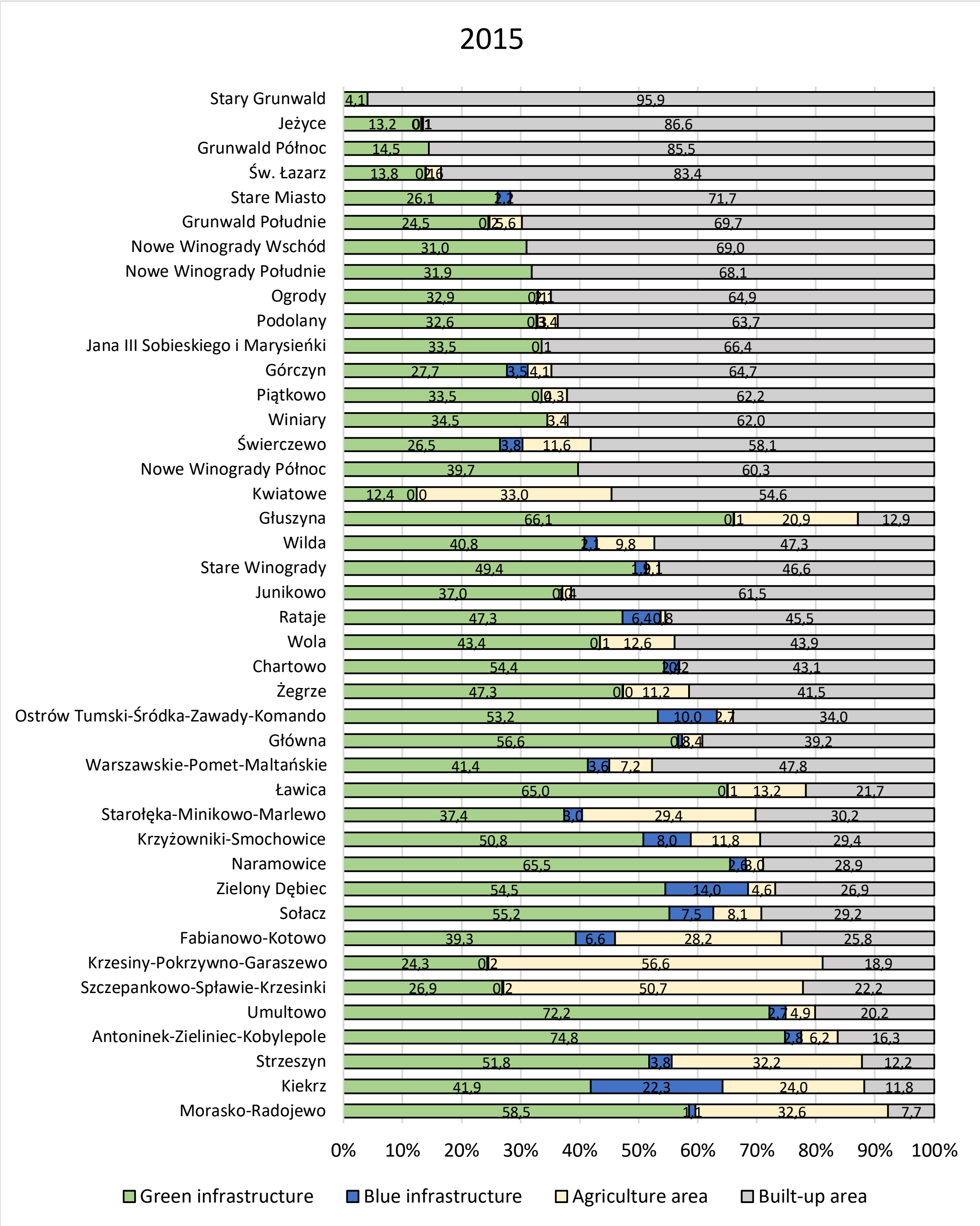


Figure 22. Distribution of built-up areas at the background of green and blue infrastructure
Source: AMU own elaboration based on BDOT10k (2019)

Figure 23 present the share of green infrastructure, blue infrastructure, agriculture area and built-up area at the local administrative unit level for year 2015 and 2019. It is visible that share of green infrastructure in the areas where municipality interventions are located share of green infrastructure increased (Wilda – 0.8%, Św. Łazarz – 2.6%).


2015
Stary Grunwald
Jeżyce
Grunwald Północ
Św. Łazarz
Stare Miasto
Grunwald Południe
Nowe Winogrady Wschód
Nowe Winogrady Południe
Ogrody
Podolany
Jana III Sobieskiego i Marysieńki
Górczyn
Piątkowo
Winiary
Świerczewo
Nowe Winogrady Północ
Kwiatowe
Głuszyna
Wilda
Stare Winogrady
Junikowo
Rataje
Wola
Chartowo
Żegrze
Ostrów Tumski-Śródka-Zawady-Komando
Główna
Warszawskie-Pomet-Maltańskie
Ławica
Starołęka-Minikowo-Marlewo
Krzyżowniki-Smochowice
Naramowice
Zielony Dębiec
Sołacz
Fabianowo-Kotowo
Krzesiny-Pokrzywno-Garaszewo
Szczepankowo-Spławie-Krzesinki
Umultowo
Antoninek-Zieliniec-Kobylepole
Strzeszyn
Kiekrz
Morasko-Radojewo
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Green infrastructure
Blue infrastructure
Agriculture area
Built-up area

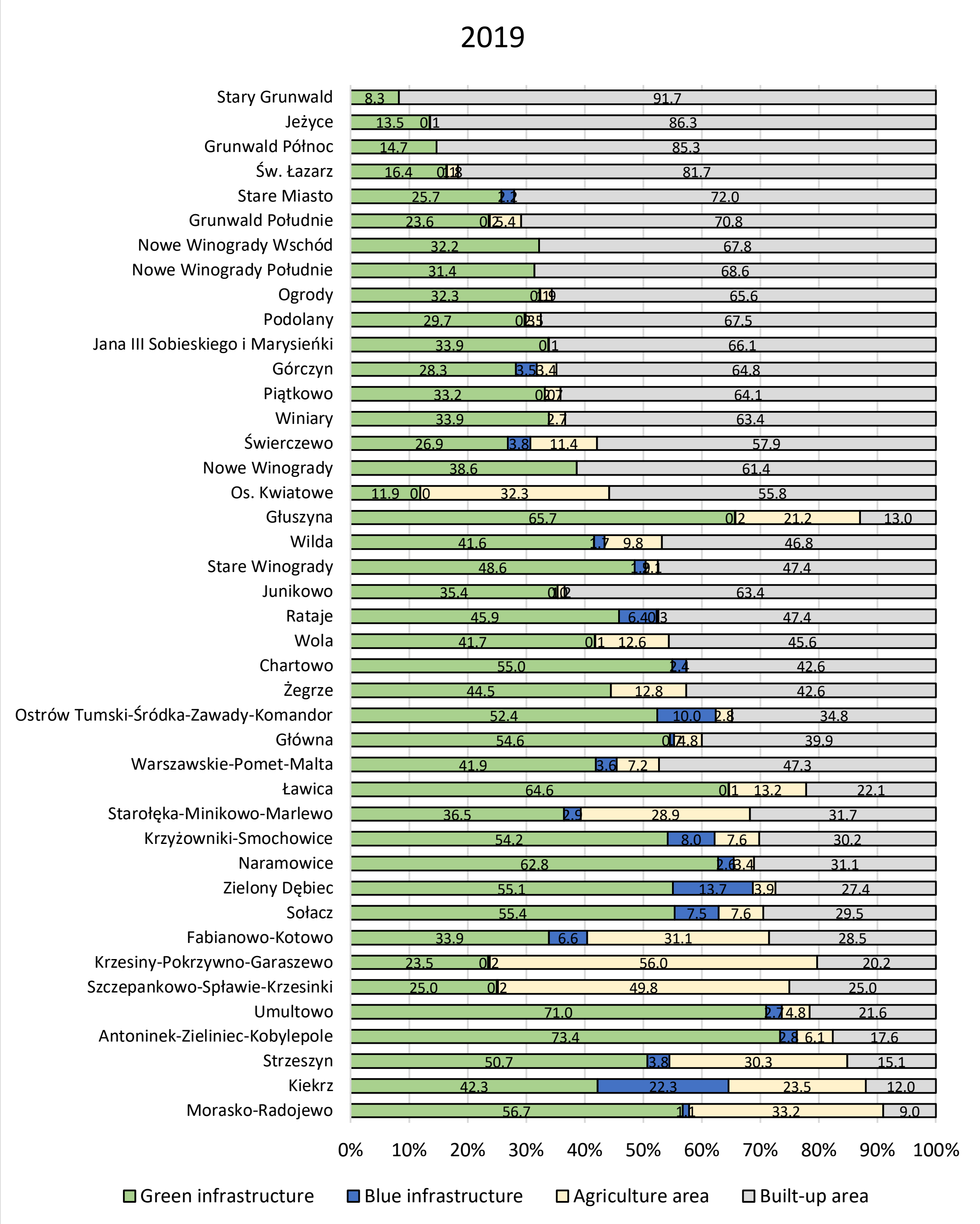


Figure 23. Share of built-up, agriculture and green & blue infrastructure in different administrative units of Poznań city in 2015 and in 2019.
Source: AMU own elaboration based on BDOT10k (2015, 2019)

ENV55. Green space area

a) *The case study of Preschool no. 42*

The green space area in preschool no. 42 were assessed based on calculation of Urban Green Factor [UGF]. The UGF were calculating according to formula:

$$UGF = \frac{Area\ of\ land\ cover\ type\ with\ tree\ crown\ cover\ X\ eological\ value\ factor}{Total\ area}$$

Methodology was adopted from Greater London Authority Urban Greening Factor for London - Research Report (2017) and adjusted to local conditions.
The results showed that replacing sealed surface with previous land cover allowed to increase the UGF from 0.27 to 0.32. The results showed also significant role of mature trees in greening the space. Tree canopy cover contribute significantly to greening the area what is mirrored in UGF. UGF calculated for 2016 year including tree canopy cover increased from 0.27 to 0.63. while UGF calculated for 2021 increased from 0.32 to 0.73. Detail elements of land cover included in UGF for 2016 and 2021 year are presented in Tables 6 and 7.

Table 6. Urban Green Factor calculation for land cover in 2016 (before unsealing)

Land cover type	Area [m^2]	UGF factor	Area x UGF factor
bare ground	92,7	0,25	23,2
build-up	567,4	0,00	0,0
concrete surface	920,9	0,00	0,0
flowerbed	39,1	0,70	27,4
grass	1480,1	0,40	592,0
hedges	253,4	0,60	152,0
long grass, herbs	418,7	0,50	209,3
sand	95,5	0,25	23,9
wooden platform	9,7	0,10	1,0
tree canopy cover	1747,0	0,80	1397,6
Total Area	**3877,4**		1028,79
Total Area with tree canopy cover			2426,4
UGF (land cover)			0,27
UGF (including tree canopy cover)			0,63

Source: AMU own elaboration

Table 7. Urban Green Factor calculation for land cover in 2021 (after unsealing)

Land cover type	Area [m^2]	UGF factor	Area x UGF factor
bare ground	663,02	0,25	165,41
biowaste	4,67	0,25	1,19
build-up	567,37	0,00	0,00
concrete brick	39,23	0,05	1,96
flowerbed	55,03	0,70	38,52
grass	1432,89	0,40	572,64
gravel	31,30	0,25	7,82
hedges	259,61	0,60	158,36
long grass, herbs	368,56	0,50	184,53
sand	400,96	0,25	100,24
vegetables, fruits and herbs	10,84	0,60	6,50
wooden platform	43,89	0,10	4,39
Tree canopy cover	1985,97	0,80	1588,78
Total Area	**3877,4**		1241,59

Total Area with tree canopy cover	2830,36
UGF (land cover)	0,32
UGF (including tree canopy cover)	0,73

Source: AMU own elaboration

The illustration of land cover and tree canopy cover in 2016 and in 2021 is presented on Figures 24-25.

Figure 24. Land cover and tree canopy cover in Preschool no. 42 in 2016
Source: AMU own elaboration

Figure 25. Land cover and tree canopy cover in Preschool no. 42 in 2021
Source: AMU own elaboration

b) Preschools in Poznań

The survey conducted in 2020 among preschools in Poznań allowed for gathering information about their own green spaces available in outdoor spaces. The respondents were asked about the share of different types of green spaces available outdoor. The results are presented in table 8 showing the contemporary situation in preschools' own outdoor spaces.

Table 8. Share of green areas in preschools own outdoor spaces.

Status of preschool	Number of preschools (count) with a declared share of a given surface				
	very large share (>50%)	large share (26-50%)	moderate share (11-25%)	small share (10-0,1%)	lack of a given surface (0%)
Permeable surfaces					
All, *N = 95**	70	17	2	4	2
Public, *N = 52*	42	8	2	0	0
Non-public, *N = 42*	27	9	0	4	2
Surface below tree canopy					
All, *N = 95**	6	22	35	19	13
Public, *N = 52*	2	15	26	7	2
Non-public, *N = 42*	4	6	9	12	11
Shrubs					
All, *N = 95**	5	13	39	29	9
Public, *N = 52*	0	9	27	15	1
Non-public, *N = 42*	5	4	12	13	8
Lawns					
All, *N = 95**	41	25	20	3	6
Public, *N = 52*	19	19	14	0	0
Non-public, *N = 42*	21	6	6	3	6
Flowerbeds					
All, *N = 94**	0	5	25	49	15
Public, *N = 52*	0	4	13	30	5
Non-public, *N = 41*	0	1	12	18	10
Crops (vegetable / herb / fruit garden)					
All, *N = 95**	1	2	8	47	37
Public, *N = 52*	0	1	4	30	17
Non-public, *N = 42*	1	1	4	16	20

* one institution did not indicate their status, hence N_{all} is higher than the sum of N_{public} and $N_{non-public}$

Source: AMU own elaboration

Table 8 shows that almost 92% of preschools' outdoor spaces have a very large (>50%) or a large (26-50%) share of permeable surfaces. Lawns are most often the most spacious type of green spaces. As much as 69% of preschools have a very large (>51%) or large (26-50%) share of lawns in their outdoor spaces. The share of shrubs is within 0.1- 25% of space in 71,6% of preschools' gardens. The flowerbeds and crops are mostly small, but despite it, those surfaces are present in 84% and 61% of a preschools' gardens, respectively. From preschools, 60% have a moderate (11-25%) or a large (26-50%) share of the surface below tree canopy, while 20% have a small share (0,1-10%) and 13.7% do not have any of this kind of surface.

The space available per child is presented in Table 9. On average, child have available 19 m^2 of outdoor spaces, but this vary from only 0,1 m^2 to 119 m^2.

Table 9. Area of outdoor spaces per child in preschools of Poznań (N=89)

Area available per child [m^2]	Number of preschools
up to 10 m	35
10-20 m	16
20-30 m	20
30-40 m	11
above 40m	7
All preschools	89

Source: AMU own elaboration

EN88. Tree shade for local heat change

The impact of tree shade for local heat reduction is analysed with the use of thermal camera imaging – Testo 871 thermal imager[6]. With this device we take images of places which are partly insolated and partly shaded by trees. Below we present a thermal images and profiles of selected surfaces in the Pocket Park at Kolejowa Street, Pocket Park at Potockiej Street and Preschool No. 115 in Poznań.

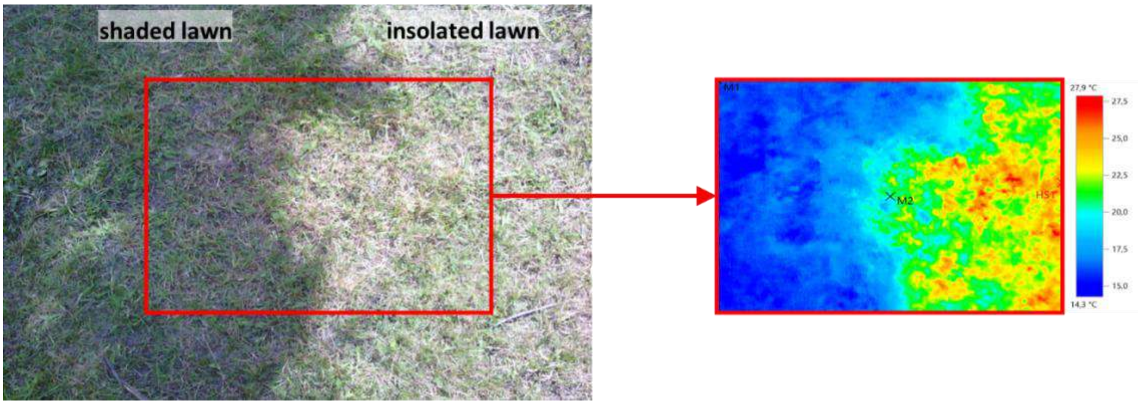


Figure 26. Thermal image of insolated and shaded lawn (Pocket Park at Kolejowa Street, 08.09.2020)

Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app

The surface temperature of insolated lawn in September 2020 (pilot studies) ranged from 20 °C to 27,9 °C while the temperature of the shaded part has been much lower and ranged from 14,3 °C to 20 °C (Figure 26). The extreme amplitude was very high – 13,6 °C. The preliminary results of the pilot study show an important role of tree shade in reducing land surface temperature and indirectly air temperature.

Below we present a series of figures and tables with data from thermal imaging of selected NBSs in Poznań from March to September 2021. In this period we collected and analysed 1582 thermal images taken in different weather conditions, seasons, months, and parts of a day. On the basis of this material, we developed a surface temperature database with 2707 entries linked with a database on air temperature (Hobo sensors). Results of thermal monitoring provide evidence on the important role of 1) insolation conditions (including shade) and 2) land cover type in regulation of surface temperature and indirectly air temperature.

[6] See https://www.testo.com/en/testo-871/p/0560-8712.

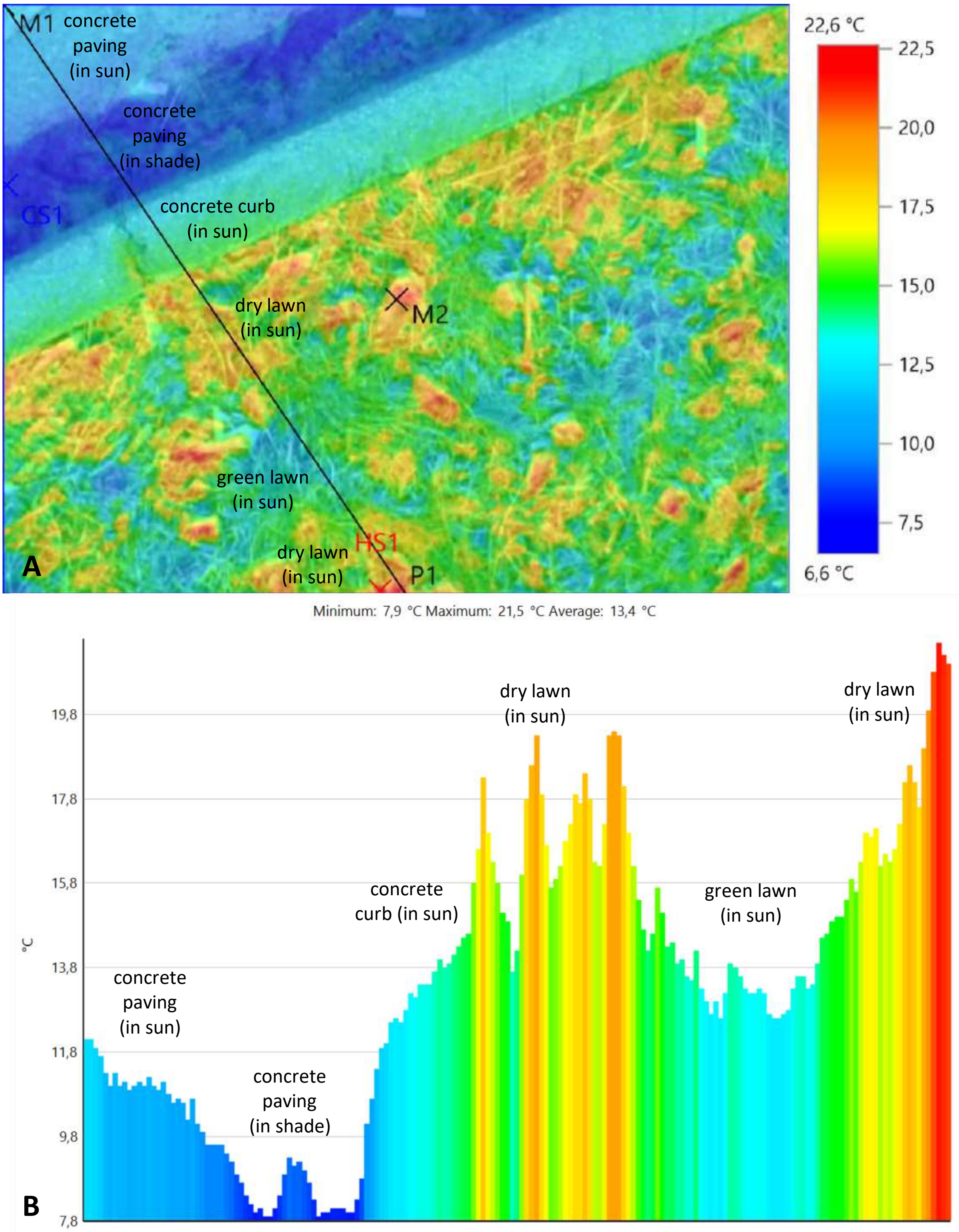
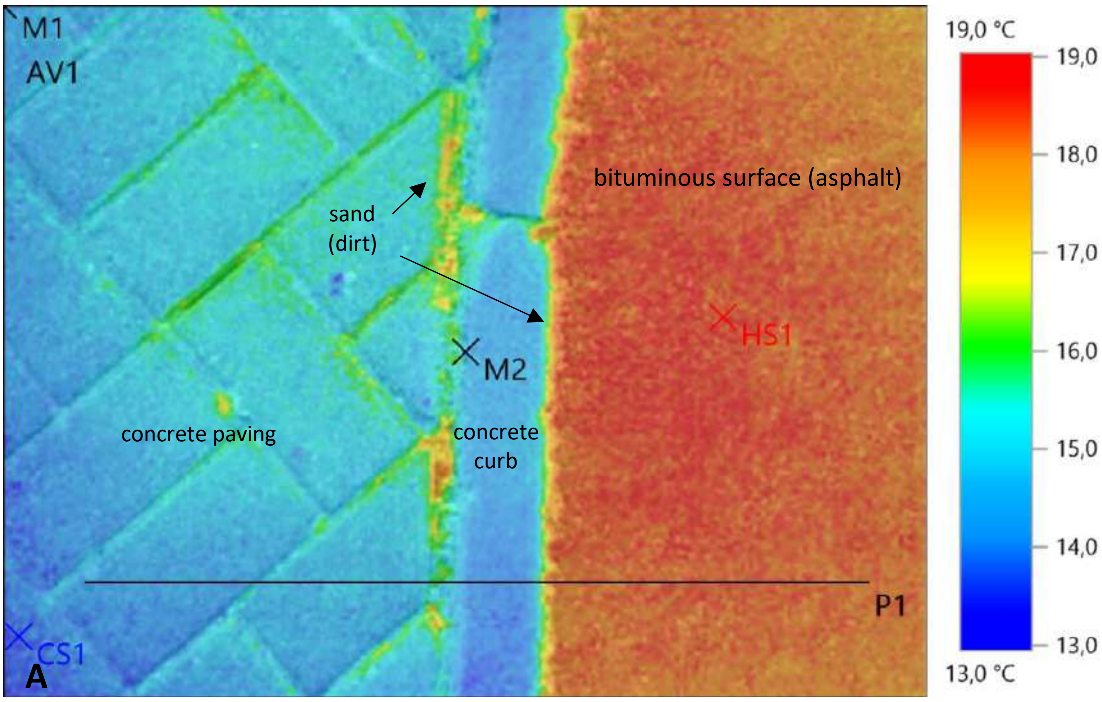


Figure 27. Thermal image (A) and profile of land (B) at the measuring spot "z1" (Pocket Park at Kolejowa Street, 26.03.2021, 14:53 PM) Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Figure 27 shows that a surface temperature of a lawn might be higher than the surface temperature of concrete materials. The difference in the case of green lawn is about 1 °C (in sun) and in the case of dry lawn about 6-7 °C (in sun). It is probably an effect of differences in the thermal inertia and thermal capacity of materials. Lawns (both green and dry) heat up as well cool down faster than concrete materials. The thermal inertia of a lawn is low, unlike the concrete. In the early spring, the insolation periods during the day are quite short and the concrete or bituminous surfaces heat up slower than lawn or in general plants. It is also a function of the fragmentation of material.



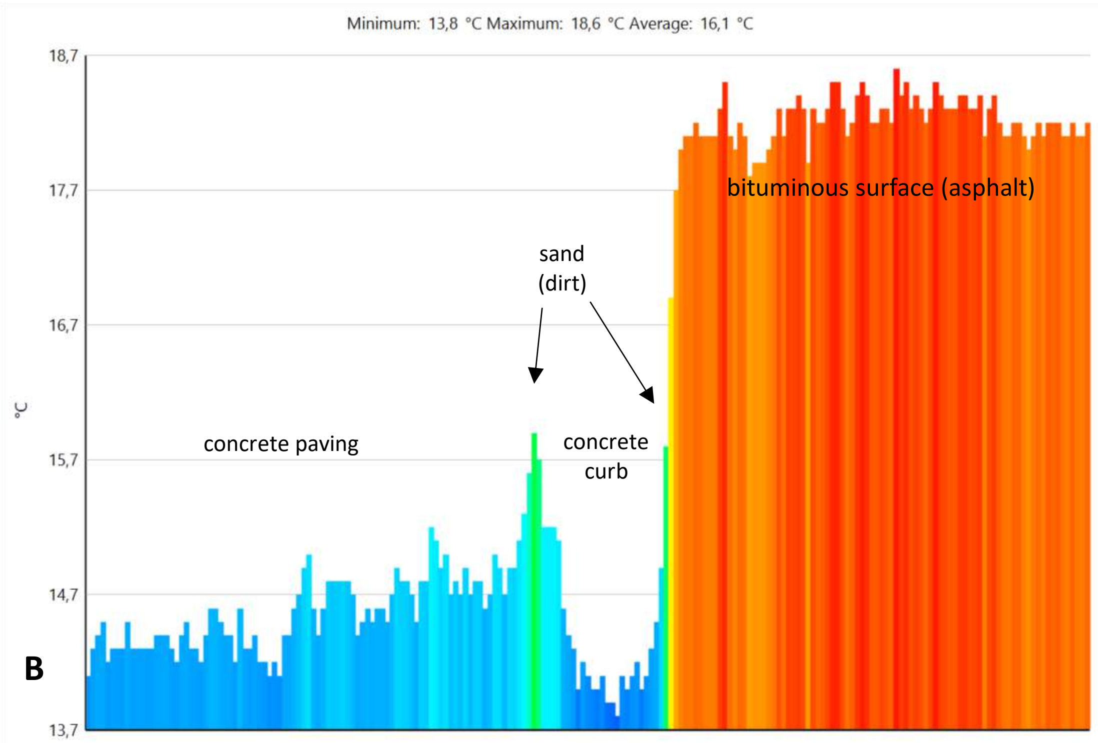


Figure 28. Thermal image (A) and profile of land (B) at the measuring spot "z2" (Pocket Park at Kolejowa Street, 26.03.2021, 14:44 PM) Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Our measurements show that the surface temperature of concrete materials is mostly lower than bituminous ones like asphalt (see Figure 28). This results from the factors mentioned before but also from the albedo (reflection of the solar radiation) which is lower for the darker materials e.g. asphalt ("0" for the dark body - that absorbs all incident radiation) and higher for brighten ones ("1" corresponding to a body that reflects all incident radiation).

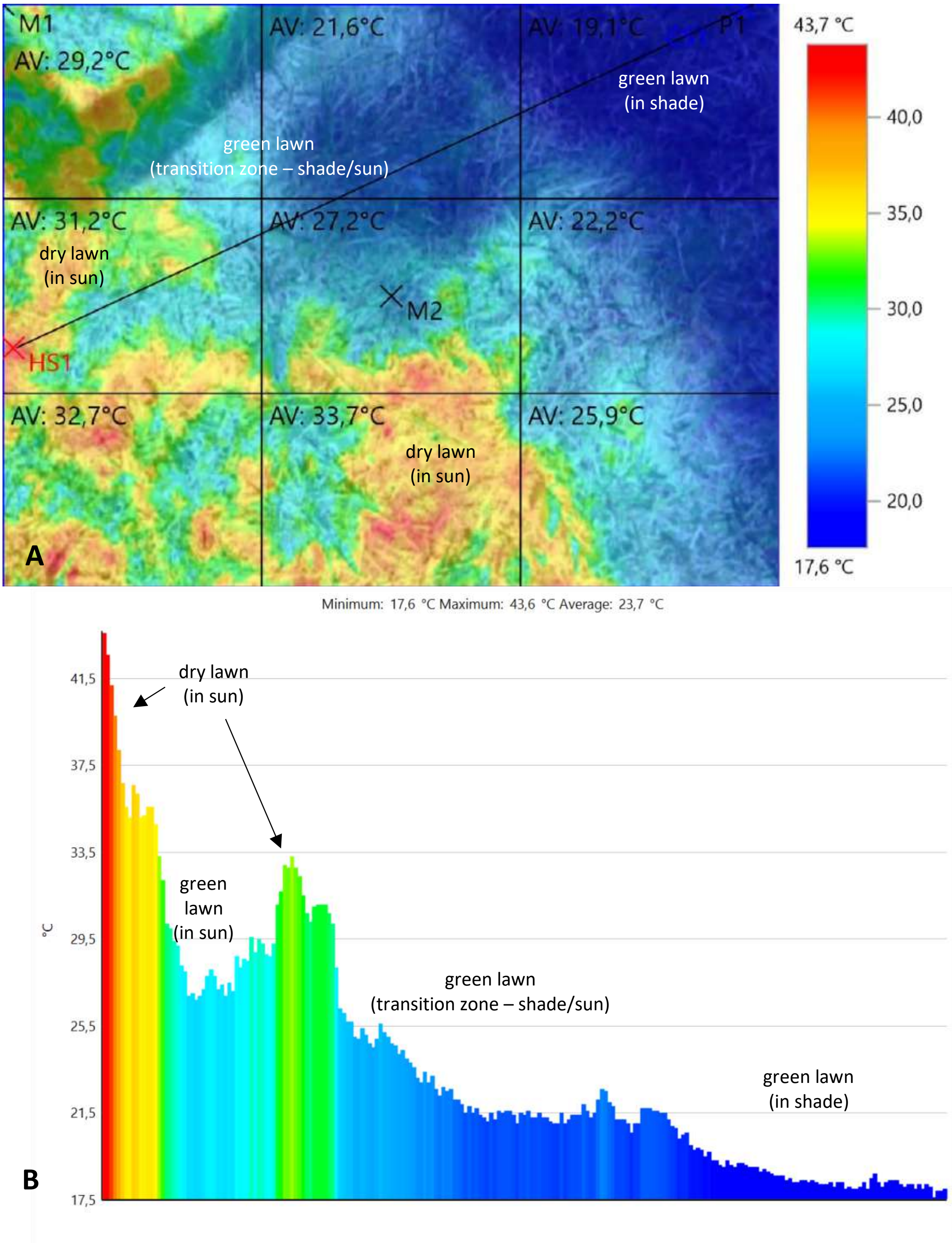


Figure 29. Thermal image (A) and profile of land (B) at the measuring spot "z2" (Pocket Park at Potockiej Street, 10.06.2021, 13:10 PM) Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Figure 29 shows that green and dry lawns are characterized by different surface temperatures. Dry lawns turn out to be warmer than green and healthy ones. The amplitude reaches 5-9 °C. It is also visible on the thermal profile (B) that the shaded parts of the green lawn could be 8-9 °C cooler than the insolated parts.

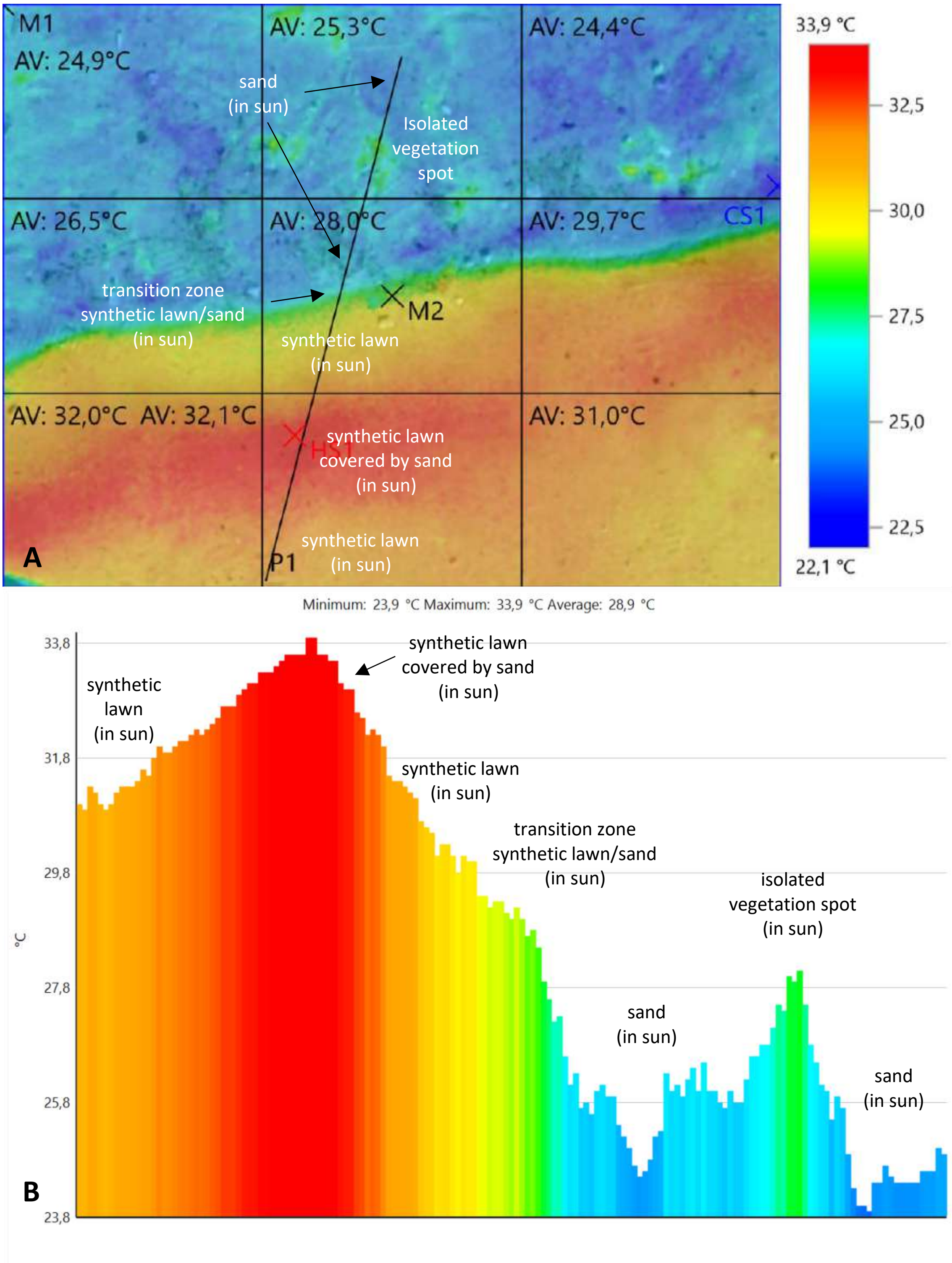


Figure 30. Thermal image (A) and profile of land (B) at the measuring spot "z2" (Preschool No. 115, 03.09.2021, 13:09 PM) Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Figure 30 shows differences between insolation of sand, small isolated vegetation, and synthetic lawn. The highest difference reaches almost 10 °C between synthetic lawn covered with sand and sand. The surface temperature of a synthetic lawn is about 31 °C and is 2,5 °C cooler than a synthetic lawn covered by sand. Probably a thin and dry sand cover (or dirt) isolated from deeper sand layers (by synthetic material) heat up more than a thick homogenous layer of sand (most likely characterized by a higher humidity).

Data in table 10 show that the relation between surface temperatures of shaded and insolated land cover materials is the same in different seasons and months. Surface temperatures of insolated parts are higher than of shaded ones (compare tables 12 and 13). Although differences in surface temperature analysed as percentages (temperatures of insolated materials as reference points - 100%) seems to be greater in early spring (March 26th) than in summer (June-September) when the air temperatures are much higher (compare surface temperatures of lawn, wooden materials and concrete surfaces).

Table 10. Average surface temperatures on the basis of field measurements

Land cover (surface materials)	**Average surface temperature [°C] by different insolation conditions:**	
	direct solar radiation	**tree shade**
1-3 PM, March 26th, 2021, mean air temperature 16,8 °C		
bare soil	14,0	-
bark	24,2	19,3
bituminous surfaces (asphalt)	20,0	-
concrete surfaces (curb)	16,6	11,1
concrete surfaces (large blocks)	-	10,2
concrete surfaces (monolith)	-	-
concrete surfaces (small blocks)	15,1	10,0
gravel	14,8	11,1
lawn	16,3	11,8
metallic surfaces	-	-
sand	-	8,9
sparse lawn	18,7	-
sparsely vegetated soil	18,3	-
wooden surfaces	16,8	13,2
1-3 PM, June 10th, 2021, mean air temperature 24,6 °C		
bare soil	40,8	-
bark	46,2	34,6
bituminous surfaces (asphalt)	40,0	31,6
concrete surfaces	37,2	29,2
concrete surfaces white painted	30,8	-
herbaceous vegetation	21,5	-
lawn	30,6	24,0
lawn with dry grass	42,7	-
lawn with tall gras	24,0	21,5
metallic surfaces	37,9	25,1
sand	41,8	31,4
shrubs	29,5	-
sparsely vegetated soil	36,6	24,6
stone	27,5	16,1
wooden surfaces	36,6	29,9

1-3 PM, June-September, 2021, mean air temperature ≥ 25 °C		
bare soil	40,8	28,3
bark	46,2	30,0
bituminous surfaces (asphalt)	37,4	28,7
concrete surfaces	37,2	26,9
concrete surfaces white painted	30,8	-
herbaceous vegetation	21,5	-
lawn	30,6	24,9
lawn with dry grass	42,7	-
lawn with tall gras	24,0	23,0
metallic surfaces	37,9	-
sand	41,8	27,1
shrubs	29,5	-
stone	27,5	-
wooden surfaces	36,6	31,6

Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

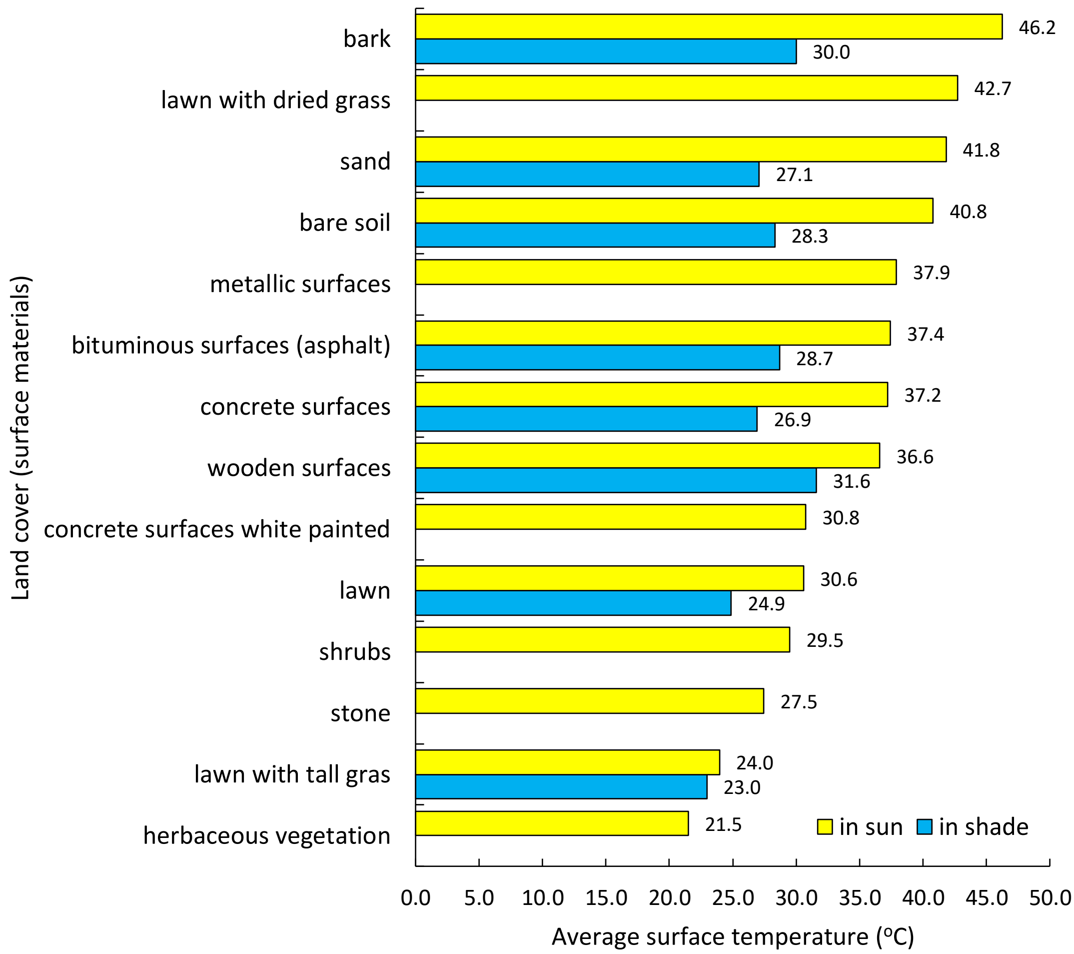


Figure 31. Average surface temperatures in pocket parks and their surrounding – mean values based on measurements at $T_{air} \geq 25$ °C (June-September, 1-3 PM) Source: AMU own elaboration based on thermal image taken with Testo 871 device and IRSoft app.

As presented in table 10 and figure 31 the surface temperatures of land cover materials (in shade and in sun) are linked with air temperature. If the air temperature is higher the surface temperature is also high. In the case of measurements taken in sun at T_{air} ≥ 25 °C it could be observed that only the average surface temperature of herbaceous vegetation might be lower than the air temperature. If we consider the same air temperature conditions and measurements taken in the shade it is visible that the average surface temperature of a green lawn especially with tall grass is also lower than the air temperature. It shows that plant cover has potential in the mitigation of urban heat.

In the case of surfaces covered with bark we observe very high surface temperatures during warm days with T_{air} ≥ 25 °C (see Figure 31). The surface temperature of insolated bark reaches 46,2 °C, shaded 30 °C. In our opinion, it is a result of fragmentation and albedo. Small pieces of dark bark heat up faster and absorb more energy.

Tables 11-13 present average land surface temperatures of different materials in general as well as for parts of a day (morning, afternoon) seasons (spring, summer), and months (March-September 2021). Values in Table 11 include all measurement data (all weather conditions) while in table 12 measurements of insolated land cover (direct solar radiation) and in Table 13 measurements of shaded materials. Part of the presented values (marked with *, **, and ***) is uncertain due to a lack of measurement data for all of the included conditions determined by land cover materials, temporal scales, and weather conditions (insolation).

Taking all measurement data into account it is observed that surface temperatures taken in the mornings are lower than those taken afternoons and this is a direct result of the apparent change of sun position over the horizon and daily changes of solar energy provision (Tables 11-13).

The most important in estimating tree shade effects are data presented in Tables 12-13. The results of the comparison show that the differences in surface temperature between insolated and shaded land cover material vary a lot from 2,2 °C for lawn with tall grass to about 10 °C for gravel and bark as well. High differences in temperatures are characterized for stone (8,9°C), bituminous materials (like asphalt, 7,2 °C), wooden surfaces (6,4 °C), and concrete (5,9 °C). Lower for shrubs (5,5 °C), green lawn (4,9 °C), bare soils (4,2 °C) and sand (4 °C), herbaceous vegetation (3,8 °C), lawn with dry grass (2,7 °C) as well as for metallic (3,5 °C) and plastic materials (2,9 °C). Taking into account measurement data limitations most certain evidence was gathered for bare soils, lawn, wooden, bituminous, and concrete surfaces.

Results show that natural materials, especially vegetation cover (trees, shrubs, green lawn, lawn with tall grass) are characterized by lower surface temperatures than artificial materials. Hence the introduction of plants (greenery) and the use of other natural materials in the development of city tissue should be considered as one of the most effective mechanisms for adaptation to climate change.

Table 11. Average surface temperatures of selected materials (including all insolation conditions)

Land cover (surface material)	**Sample (count)**	**Average surface temperature (°C)**											
		Total			**By months**							**By seasons**	
		Total	**Morning**	**Afternoon**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Spring**	**Summer**
bare soils	482	19,1	13,9	24,5	8,3	2,9	15,4	21,7	21,4	19,1	22,7	11,7	20,9
sand	320	20,1	10,3	26,1	7,8	5,6	10,1	35,2	24,4	18,0	20,2	23,0	19,2
gravel	56	**16,1	8,9	21,5	9,0	ND	16,9	21,8	ND	27,7	7,1	*12,8	*22,1
stone	86	**21,2	11,1	26,6	ND	13,7	ND	23,7	20,0	19,6	26,3	**18,0	21,8
lawn	1432	17,9	12,7	22,1	8,5	4,9	14,0	22,1	19,5	18,9	20,9	12,2	19,9
lawn with dry grass	52	***28,7	25,0	33,0	ND	ND	ND	31,6	ND	18,0	19,3	***38,4	*25,8
lawn with tall gras	46	**19,2	14,3	21,3	ND	9,7	14,6	22,4	ND	18,1	11,5	*20,6	*16,1
synthetic lawn	12	***19,4	6,9	25,7	ND	ND	ND	ND	ND	19,1	19,6	ND	**19,4
herbaceous vegetation	118	**16,2	13,4	20,3	ND	5,8	8,0	22,6	ND	16,3	10,3	*10,8	*16,6
shrubs	44	***19,1	14,8	22,7	ND	ND	10,7	21,1	ND	19,0	16,4	**20,7	*18,8
bark	208	*24,6	15,8	29,1	17,7	10,1	ND	34,2	22,1	27,6	24,0	*24,5	24,7
wooden surfaces	408	21,8	11,6	28,6	10,9	6,5	15,0	27,1	21,5	21,8	24,9	16,8	22,8
bituminous surfaces (asphalt)	370	23,5	15,2	30,4	13,9	5,9	19,7	31,0	26,1	23,7	24,3	18,3	24,7
concrete surfaces	1244	20,9	13,8	26,7	9,8	7,3	16,1	28,5	23,7	21,5	22,3	16,4	22,7
plastic surfaces	60	***21,2	11,4	28,7	ND	ND	ND	ND	ND	19,3	23,1	ND	**21,2
rubber surfaces	16	***15,4	10,7	29,4	ND	ND	ND	ND	ND	16,4	12,2	ND	**15,4
metallic surfaces	172	22,0	14,5	28,7	12,8	5,5	31,8	26,2	22,7	20,2	24,6	19,0	22,7

Average values uncertain due to the lack of measurement data from one*, two** and tree or more*** months. ND – no data.

Measurements taken in a period from 26.03.2021 – 09.09.2021 at 6.30-8.30 AM and 1.00-3.00 PM. Results based on 1242 thermal images (2707 records in a database). Measurements were conducted once (Mar., Apr., May) or twice a month (Jun., Jul., Aug., Sep.) in the same spots.

Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Table 12. Average surface temperatures of selected materials exposed to the direct solar radiation (insolated spots only)

Land cover (surface material)	**Sample (count)**	**Average surface temperature (°C)**											
		Total			**By months**							**By seasons**	
		Total	**Morning**	**Afternoon**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Spring**	**Summer**
bare soils	182	22,2	12,9	27,5	11,3	5,0	22,0	33,4	27,1	22,5	25,8	13,6	24,2
sand	118	**24,3	6,2	31,1	0,4	-3,7	ND	41,8	ND	21,1	25,9	**29,8	*23,1
gravel	32	***18,8	9,8	22,9	9,2	ND	21,7	19,0	ND	33,2	ND	**14,9	**27,5
stone	32	***29,2	9,0	30,5	ND	22,0	ND	27,5	ND	28,4	34,0	***24,7	*30,7
lawn	454	22,4	12,6	26,9	10,4	6,6	22,8	29,6	24,6	23,4	25,9	16,4	24,7
lawn with dry grass	24	***30,4	25,9	39,6	ND	ND	ND	36,0	ND	ND	19,3	***42,7	**26,3
lawn with tall gras	16	***21,5	13,0	24,3	ND	ND	ND	24,0	ND	20,3	11,6	***24,0	*17,4
synthetic lawn	8	***25,7	ND	25,7	ND	ND	ND	ND	ND	19,1	32,3	ND	**25,7
herbaceous vegetation	30	***20,1	14,0	25,5	ND	ND	ND	21,9	ND	19,9	ND	***21,5	**20,0
shrubs	16	***22,3	13,8	25,1	ND	ND	ND	29,5	ND	21,0	21,9	***29,5	*21,3
bark	70	*32,7	13,8	38,3	16,6	12,0	ND	46,2	25,9	36,0	30,4	*33,1	32,5
wooden surfaces	150	29,3	10,6	34,3	12,4	7,2	21,3	36,6	25,9	30,8	32,0	18,3	30,9
bituminous surfaces (asphalt)	188	*26,8	15,3	33,9	15,3	0,2	ND	34,5	29,8	25,9	28,8	*20,1	27,6
concrete surfaces	524	25,7	15,5	30,6	14,1	11,4	25,0	32,9	29,2	25,0	26,9	23,8	26,2
plastic surfaces	22	***30,1	6,9	32,4	ND	ND	ND	ND	ND	26,6	33,0	ND	**30,1
rubber surfaces	6	***21,3	5,2	29,4	ND	ND	ND	ND	ND	21,3	ND	ND	**21,3
metallic surfaces	78	***24,4	12,6	32,7	9,6	1,1	31,8	34,6	24,6	23,3	30,4	13,8	26,3

Average values uncertain due to the lack of measurement data from one*, two** and tree or more*** months. ND – no data.
Measurements taken in a period from 26.03.2021 – 09.09.2021 at 6.30-8.30 AM and 1.00-3.00 PM. Results based on 1242 thermal images (2707 records in a database). Measurements were conducted once (Mar., Apr., May) or twice a month (Jun., Jul., Aug., Sep.) in the same spots.
Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Table 13. Average surface temperatures of selected materials shaded by trees (shaded spots only)

Land cover (surface material)	Sample (count)	Average surface temperature (°C)											
		Total			By months							By seasons	
		Total	Morning	Afternoon	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Spring	Summer
bare soils	110	18,0	8,6	22,5	2,0	0,9	15,2	29,2	25,5	17,4	25,7	5,8	20,4
sand	78	*20,3	5,9	23,5	8,9	-3,9	ND	31,4	ND	20,0	20,2	*21,1	*20,1
gravel	6	***8,7	3,9	11,1	8,7	ND	ND	ND	ND	ND	ND	**8,7	ND
stone	10	***20,3	11,9	22,4	ND	ND	ND	16,1	ND	24,6	20,2	***16,1	*21,3
lawn	230	*17,5	9,5	21,1	10,1	3,9	16,4	24,4	ND	18,2	19,8	12,4	*19,1
lawn with dry grass	6	***27,7	27,7	ND	ND	ND	ND	27,7	ND	ND	ND	ND	***27,7
lawn with tall gras	16	***19,3	12,6	21,5	ND	ND	ND	21,5	ND	13,8	11,4	***21,5	*12,6
synthetic lawn	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
herbaceous vegetation	8	***16,3	11,1	21,5	ND	ND	ND	ND	ND	16,3	ND	ND	***16,3
shrubs	4	***16,8	12,2	21,3	ND	ND	ND	ND	ND	21,3	12,2	ND	***16,8
bark	50	**22,9	11,4	27,3	19,3	11,9	ND	34,6	ND	19,7	21,7	*27,9	*20,5
wooden surfaces	84	22,9	7,4	25,0	13,2	7,0	14,2	29,9	28,0	20,8	27,5	18,7	23,7
bituminous surfaces (asphalt)	38	**19,6	11,7	25,4	ND	-3,5	ND	31,6	ND	21,4	19,5	**14,1	*20,3
concrete surfaces	144	*19,8	15,0	22,2	10,5	7,1	ND	29,0	26,1	19,9	20,8	*16,0	20,8
plastic surfaces	6	***27,2	ND	27,2	ND	ND	ND	ND	ND	ND	27,2	ND	***27,2
rubber surfaces	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
metallic surfaces	18	***20,9	10,6	29,1	ND	ND	ND	25,1	27,3	19,0	17,7	***25,1	19,6

Average values uncertain due to the lack of measurement data from one*, two** and tree or more*** months. ND – no data.
Measurements taken in a period from 26.03.2021 – 09.09.2021 at 6.30-8.30 AM and 1.00-3.00 PM. Results based on 1242 thermal images (2707 records in a database). Measurements were conducted once (Mar., Apr., May) or twice a month (Jun., Jul., Aug., Sep.) in the same spots.
Source: AMU own elaboration based on thermal image taken with Testo 871 thermal camera and IRSoft app.

Primary indicators

2020 SURVEY DATA

PI2. Frequency of interaction with NBS

a) Frequency of visits in green spaces neighboring preschools

The contact with nature is important for children's health and wellbeing. To acquire baseline data about the frequency of outdoor activities of preschoolers in preschools' own green spaces and neighboring green spaces we have conducted online survey in preschools of Poznań (January-March 2020; just before COVID-19 pandemic). The results are presented in figures 32-33.

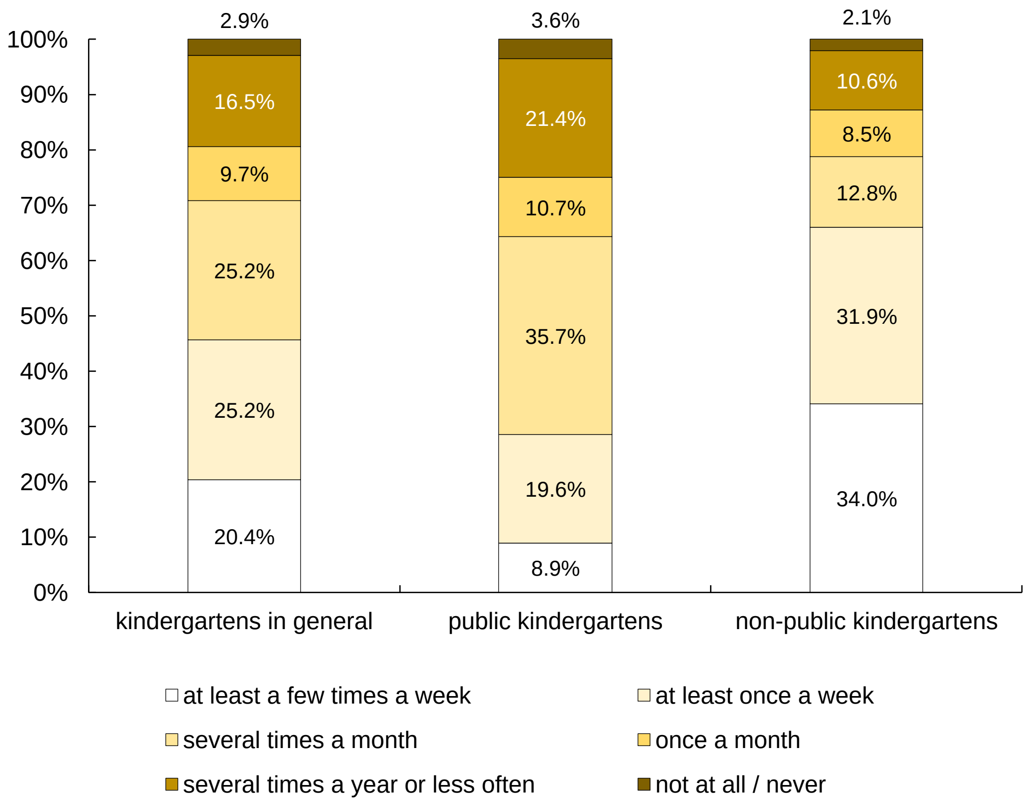


Figure 32. How often from spring to autumn are children taken outside the preschool to enjoy the neighbouring green areas? (N=103). Source: AMU own elaboration

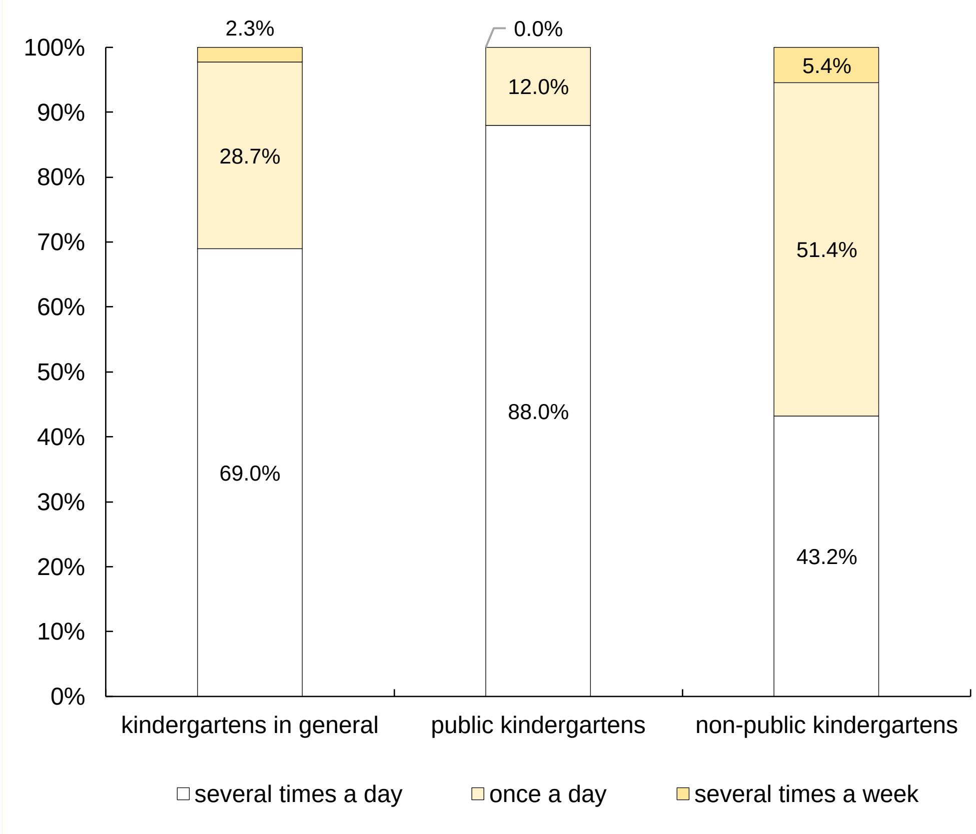


Figure 33. How often from spring to autumn are children taken to the preschool garden to enjoy the green areas? (N=87) Source: AMU own elaboration

b) Frequency of visits in green spaces neighboring preschools selected for monitoring

The results of survey conducted in 2020 related to preschools with NBS exemplar are presented in Table 14.

Table 14. Frequency of visits in green spaces neighboring preschools selected for monitoring

Assessment parameters	Preschool No. 42 "Kwiaty Polskie"	Preschool No. 87 "Jacusia i Agatki"	Preschool No. 115 "Sportowa Drużyna"
Questionnaire survey results			
How often from spring to autumn are children taken to the preschool garden to enjoy the green areas?	several times a day	once a day	n/a
Whether and how the COVID-19 pandemic has changed the frequency of using the pre-school area (garden)?	no changes - with the same frequency as before the epidemic	no changes - with the same frequency as before the epidemic	n/a
How often from spring to autumn are children taken outside the preschool to enjoy the neighbouring green areas?	several times a year or less often	once a month	n/a

Whether and how the COVID-19 pandemic has changed the frequency of using outdoor areas (going outside the preschool)?	much less often than before the epidemic (no visits outside)	no changes - with the same frequency as before the epidemic	n/a
At what distance is the green area most often visited with children from the preschool? [m]	1000	500	n/a
Number of preschoolers	123	99	119

Source: AMU own elaboration

PI3. Duration of interaction with NBS

a) Duration of stay in preschools' own outdoor area

The contact with nature is important for children's health and wellbeing. To acquire baseline data about the duration of outdoor activities of preschoolers in preschools' internal green spaces and external green spaces we have conducted online survey in preschools of Poznań (January-March 2020; just before COVID-19 pandemic). The results are presented on figures 34-35.

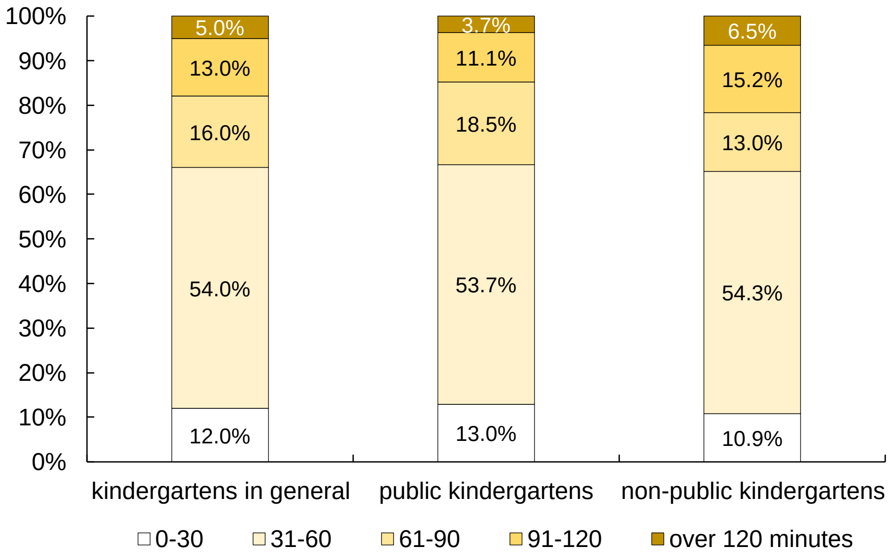


Figure 34. How long does a single stay of children in the outdoor preschool area last? (N=95).
Source: AMU own elaboration

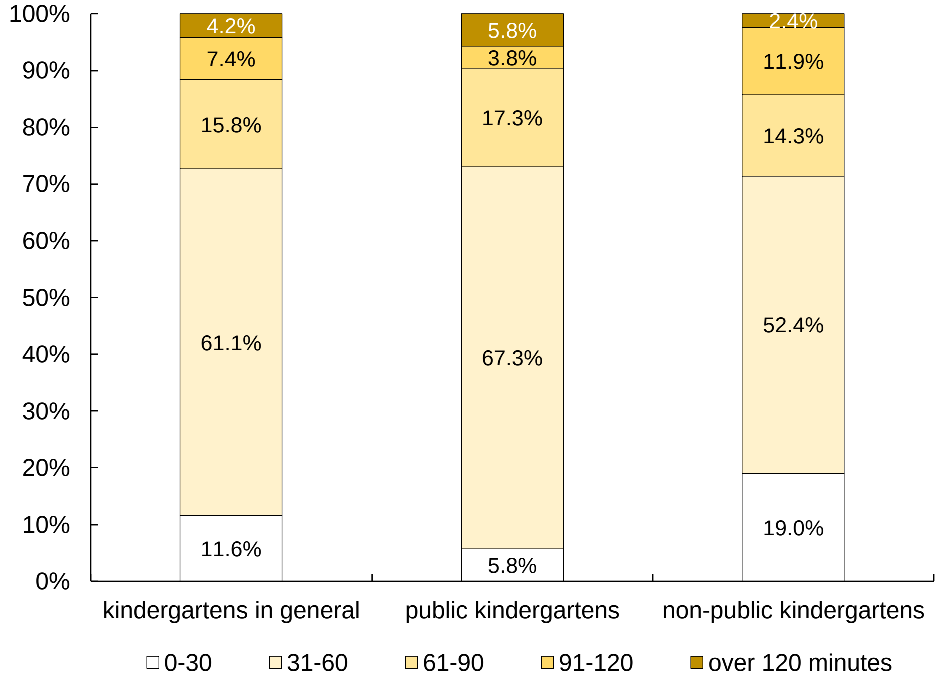


Figure 35. How long on average takes a single visit with children in external green areas? (N=101). Source: AMU own elaboration

b) Duration of interaction with NBS in preschools selected for monitoring

The results of survey conducted in 2020 related to preschools with NBS exemplar are presented in table 15.

Table 15. Duration of interaction with NBS in preschools selected for monitoring

Assessment parameters	Preschool No. 42 "Kwiaty Polskie"	Preschool No. 87 "Jacusia i Agatki"	Preschool No. 115 "Sportowa Drużyna"
Questionnaire survey results			
Does the preschool have an own outdoor area?	yes	yes	n/a
How long does a single stay of children in the preschool area last?	120 minutes	75 minutes	n/a
How often from spring to autumn are children taken outside the preschool to enjoy the neighbouring green areas?	several times a year or less often	once a month	n/a
How long on average takes a single visit with children in external green areas?	120 minutes	75 minutes	n/a
Number of preschoolers	123	99	119

Source: AMU own elaboration

PI4. Perceived quality of space

The quality of eco-demonstrators introduced in the preschools was analysed in a pilot qualitative assessment conducted by the City of Poznań in 2019. Below we present short summary of study. The full report is attached to this document as an external files (Supplementary material 2_The results of the ecological demonstrators project evaluation carried out in ten preschools in Poznań.pdf).

The results of the survey show that the project met the expectations both of children and teachers. The eco-demonstrators enrich the garden space and encourage preschoolers to have fun, free play and experience nature on their own. The project was highly rated by teachers. The eco-demonstrators and lesson plans are very useful and valuable tools, thanks to which the children's development and their sensitivity to the surrounding environment can be supported. Teachers shared their observations and concerns related to the eco-demonstrators. As a result, we have acquired a huge knowledge of what worked out and what did not perform well and should be fixed in the future. The most popular eco-elements are living tables, willow huts and vegetable beds. Preschoolers can use them during eco-educational classes as well as free play.

2021 SURVEY DATA

In a 2021 survey was conducted with 79 parents and 23 teachers from preschools with nature-oriented playgrounds (experimental group), and 64 parents and 35 teachers from preschools without natural playgrounds (control group). Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 3_Survey on primary, health and social indicators 2021).

Confounding variables

The variables included in this section were analysed to verify that the results were not biased or influenced by other activities that the children or teachers carried out in other green spaces, outside the kindergarten playground. Analogously, it was also analysed whether the influence of the COVID-19 pandemic increased or decreased the use of green spaces by children and teachers.

a) Parents

Regarding the activities carried out in green spaces accompanied by their children, the results in percentage terms were very similar between the parents of the experimental group (those who belonged to schools with a natural playground), compared to the parents of the control group (schools without natural playground).

Table 16. Activities in green environments accompanied by their children

	Never		**Less than once a month**		**1-3 times a month**		**1-3 times a week**		**Every day**	
	EXP	CON	EXP	CON	EXP	CON	EXP	CON	EXP	CON
Physical activities and to spend excess energy (climbing, jumping…)	2.5%	1.6%	5.1%	6.3%	10.1%	10.9%	57%	46.9%	25.3%	34.3%
To play with elements of the playground (swings, slides…)	1.3%	0%	0%	1.6%	11.4%	9.4%	58.2%	53.1%	29.1%	35.9%
Social activities (playing with friends, participating in team games)	7.6%	3.1%	11.4%	6.3%	20.3%	32.8%	43%	42.2%	17.7%	15.6%
Relax, enjoy the weather and the fresh air, and centre their attention again when tired	0%	0%	1.3%	0%	17.7%	9.4%	40.5%	28.1%	40.5%	62.5%
To experience nature	0%	0%	2.5%	0%	22.8%	14.1%	43%	34.3%	31.6%	51.6%
To receive education in nature	2.5%	0%	5.1%	6.3%	34.2%	21.9%	38%	37.5%	20.3%	34.3%
To attend organized events	7.6%	1.6%	44.3%	53.1%	36.7%	37.5%	10.1%	7.8%	1.3%	0%

Similarly, no differences were found between these groups for the impact of COVID-19 on the use of green spaces, the results being moderate in both cases.

Table 17. COVID-19 impact on green spaces use (Scale range: 1-5)

	EXP		CON	
	M	SD	M	SD
The COVID-19 pandemic has increased my child's use of green spaces	2.58	1.14	2.52	1.2
The COVID-19 pandemic has decreased my child's use of green spaces	2.7	1.3	2.91	1.38

Note. There were no statistically significant differences

b) Teachers

In the same way as with the parents, the realization of activities in green spaces by the teachers was similar in both groups of the research. On the contrary, there were significant differences in terms of the influence of COVID-19 on the use of greenspaces and the playground. The experimental group significantly increased their use of the playground, the children's use of the playground and the general use of green spaces, compared to the control group.

Table 18. Activities in green environments

	Never		**Less than once a month**		**1-3 times a month**		**1-3 times a week**		**Every day**	
	EXP	CON	EXP	CON	EXP	CON	EXP	CON	EXP	CON
Physical activities (walking, cycling, hiking, exercising, playing team sports walking the dog)	0%	0%	4.3%	16.7%	13%	0%	52.2%	25%	30.4%	58.3%
Social activities (meeting family or friends, chatting with neighbours, having a picnic, playing board games)	8.7%	25%	30.4%	8.3%	39.1%	33.3%	21.7%	33.3%	0%	0%
Relaxation and quietness (to be in a peaceful and quiet place, reading, resting, watching people)	4.3%	8.3%	8.7%	8.3%	30.4%	0%	43.5%	16.7%	13%	66.7%
To experience nature (observing flora and fauna, enjoying the weather and the fresh air)	4.3%	0%	8.7%	8.3%	21.7%	16.7%	47.8%	0%	17.4%	75%
To take children out to play	39.1%	50%	4.3%	0%	8.7%	0%	8.7%	8.3%	39.1%	41.7%
To attend organized events	21.7%	41.7%	56.5%	41.7%	21.7%	8.3%	0%	8.3%	0%	0%

Table 19. COVID-19 impact on green spaces use and playground (Scale range: 1-5)

	EXP		CON	
	M	**SD**	**M**	**SD**
The COVID-19 pandemic has increased my use of the playground[1]	3.22	1.04	1.92	.67
The COVID-19 pandemic has decreased my use of the playground	2.09	.79	2.58	1.16
The COVID-19 pandemic has increased children's use of the playground[2]	3.3	1.02	2.08	.79
The COVID-19 pandemic has decreased children's use of the playground	2.13	.97	2.75	1.22
The COVID-19 pandemic has increased my use of green spaces[3]	3.57	.99	2.5	1.24
The COVID-19 pandemic has decreased my use of green spaces	2	.8	2.25	1.22

Note. Significant differences:
1. ($t_{(31.371)}$=4.474; p<.001)
2. ($t_{(27.814)}$=3.908; p=.001)
3. ($t_{(33)}$=2.764; p=.009)

PI1. Type of interaction with NBS & PI2. Frequency of interaction with NBS

b) Teachers

Both the experimental group and the control group teachers interact with the children in the playground several times a week watching and looking after them, actively joining their play and organizing their activities. The results between both groups are similar.

Table 20. Interactions with children in the playground

	Never		**Less than once a month**		**1-3 times a month**		**1-3 times a week**		**Every day**	
	EXP	CON	EXP	CON	EXP	CON	EXP	CON	EXP	CON
To watch and look after the children	0%	0%	0%	0%	0%	0%	17.4%	8.3%	82.6%	91.7%
To actively join their play	0%	8.3%	8.7%	0%	8.7%	8.3%	43.5%	16.7%	39.1%	66.7%
To organize their activities	0%	0%	8.7%	0%	13%	16.7%	43.5%	16.7%	34.8%	66.7%

Again, the results between the two groups are similar in terms of the motivations for going out to the playground. Among them, accompany and supervise children stands out, but also a high percentage of teachers go to the playground to stretch walk, exercise for a few minutes or to relax briefly.

Table 21. Teachers´ motivations to go out to the playground

	Never		**Less than once a month**		**1-3 times a month**		**1-3 times a week**		**Every day**	
	EXP	CON	EXP	CON	EXP	CON	EXP	CON	EXP	CON
To stretch, walk or exercise for a few minutes	39.1%	33.3%	4.3%	8.3%	0%	0%	21.7%	16.7%	34.8%	41.7%
To chat with colleagues during breaks	43.5%	50%	13%	0%	4.3%	0%	30.4%	33.3%	8.7%	16.7%
To relax briefly (reflect, rest, enjoy the weather and the fresh air)	17.4%	8.3%	8.7%	0%	8.7%	16.7%	21.7%	25%	43.5%	50%
To get away from momentary work stresses (to be in a peaceful and quiet place)	30.4%	33%	4.3%	25%	8.7%	8.3%	17.4%	8.3%	39.1%	25%
To accompany and supervise children during breaks or activities	4.3%	0%	4.3%	0%	0%	0%	21.7%	25%	69.6%	75%

Considering the children, their activities carried out in the playgrounds are similar between both types of kindergartens, highlighting that every week and practically every day they perform physical activities, play with the elements of the playground, socialize and relax. The least frequent activity was attendance at organized events, with no notable differences between the two groups.

Within the experimental group, a frequent use of experiencing nature stands out, and above all, more than half of the children received education in nature each week.

Table 22. Types of activities of children on the playground and frequency

	Never		**Less than once a month**		**1-3 times a month**		**1-3 times a week**		**Every day**	
	EXP	CON	EXP	CON	EXP	CON	EXP	CON	EXP	CON
Physical activities and to spend excess energy (climbing, jumping…)	0%	0%	0%	0%	0%	0%	17.4%	25%	82.6%	75%
To play with elements of the playground (swings, slides…)	0%	0%	0%	0%	0%	0%	17.4%	16.7%	82.6%	83.3%
Social activities (playing with friends, participating in team games)	0%	0%	4.3%	0%	0%	0%	21.7%	25%	73.9%	75%
Relax, enjoy the weather and the fresh air, and centre their attention again when tired	0%	0%	0%	8.3%	0%	0%	17.4%	16.7%	82.6%	75%
To experience nature	0%		0%		0%		26.1%		73.9%	
To receive education in nature	0%		13%		34.8%		21.7%		30.4%	
To attend organized events	0%	8.3%	43.5%	33.3%	43.5%	33.3%	0%	25%	13%	0%

PI3. Duration of interaction with NBS

b) Teachers

In schools with a natural playground, almost twice as much time was devoted to outdoor educational activities (more than an hour and a half a day), compared to just under 1 hour in schools without a natural playground.

Table 23. Time in the daily education program allocated to outdoor activities (assuming good weather conditions)

Minutes per day	**M**	**SD**
Experimental group	98.23	55.28
Control group	51.17	14.1

Note. There is a significant difference $t_{(25.6)}$=3.775; p=.001)

Along the same lines, both teachers and children spend more time on the playground every day in those kindergartens with a natural playground. In both cases, the time is greater than one hour, while in kindergartens without natural playgrounds the average time is less than one hour.

Table 24. Time spent in the playground per day

Minutes per day	**EXP**		**CON**	
	M	**SD**	**M**	**SD**
Teachers[1]	79.17	44.5	47.75	11.9
Children[2]	96.96	51.45	47.75	11.9

Note. Significant differences:
1. ($t_{(27.417)}$=3.176; p=.004)
2. ($t_{(26.193)}$=4.368; p<.001)

PI4. Perceived quality of space

a) Parents

The parents of children who attended kindergartens with natural playgrounds, systematically valued the playground better, both in a general way, as well as specific aspects such as elements of small architecture, aesthetic qualities, organized events and the capacity of the playground to arouse the curiosity of children.

Table 25. Parents´ perceived quality of the playground (Scale range: 1-5)

	EXP		CON	
	M	**SD**	**M**	**SD**
Elements of small architecture (e.g. outdoor furniture, playground, fountain)[1]	4.04	1	3.3	1.13
Ecodemonstrators (objects present in the playground that serve to explain concepts or processes of nature)	3.96	1.14		
Abundance of greenery	4.44	.91		
Aesthetic qualities[2]	4.14	.99	3.6	1.12
Events that are organized[3]	3.87	1.26	3	1.29
Ability to arouse the curiosity of my child / children[4]	4.3	.9	3.38	1.18
Overall quality of the playground[5]	4.21	.86	3.49	1

Note. Significant differences:
1. ($t_{(140)}$=4.102; p<.001)
2. ($t_{(139)}$=3.031; p=.003)
3. ($t_{(125)}$=3.844; p<.001)
4. ($t_{(116.251)}$=5.177; p<001)
5. ($t_{(138)}$=54.548; p<.001)

b) Teachers

The teachers followed the same trend, those who worked in kindergartens with a natural playground rated their aesthetic qualities, organized events and ability to arouse curiosity more positively, compared to the kindergartens teachers without a natural playground.

Table 26. Teachers' perceived quality of the playground (Scale range: 1-5)

	EXP		CON	
	M	**SD**	**M**	**SD**
Elements of small architecture (e.g. street furniture, playground, fountain)	3.83	1.15	3.58	.9
Ecodemonstrators (objects present in the playground that serve to explain concepts or processes of nature)	3.95	1.05		
Abundance of greenery	4.7	.7		
Aesthetic qualities[1]	4.35	.57	3.83	.84
Events that are organized[2]	4.05	.9	3.08	1.38
Ability to arouse the curiosity of the children[3]	4.57	.59	3.67	.89
Overall quality of the playground	4.18	.91	3.67	.65

Note. Significant differences:
1. ($t_{(33)}$=2.1516; p=.039)
2. ($t_{(32)}$=2.464; p=.019)
3. ($t_{(33)}$=3.588; p=.001)

Although the teachers' perception of the perceived quality of the playground for children was higher in kindergartens with natural playgrounds, these differences did not reach statistical significance.

Table 27. Teachers' perception of children's perceived quality on the playground (Scale range: 1-5)

	EXP		CON	
	M	**SD**	**M**	**SD**
Elements of small architecture (e.g. street furniture, playground, fountain)	4.39	.72	4.33	.88
Ecodemonstrators (objects present in the playground that serve to explain concepts or processes of nature)	3.9	.94		
Abundance of greenery	4.27	.7		
Aesthetic qualities	4.26	.81		
Events that are organized	3.83	.94	3.33	1.23
Ability to arouse the curiosity of the children	3.95	.94	3.5	1.24
Overall quality of the playground	4.77	.43	4.5	.67

Note. There were no statistically significant differences

Finally, and only evaluating the teachers of the experimental group, the results show strong evaluations of the effects of the natural playground developed in children, with high scores on the benefits of being in contact with nature for their attention, hyperactivity, and behavioral problems, or developmental problems.

Table 28. Teachers' perception of the effects of the playground in the children of the experimental group (Scale range: 1-5)

	EXP	
	M	**SD**
Children prefer the natural elements of the playground	4.13	.76
Being in contact with nature on the playground helps children with attention and hyperactivity problems to focus more	4.22	.8
Being in contact with nature on the playground helps children with behavioural problems by calming them down	4.52	.59
Being in contact with nature on the playground helps children with autism and other developmental problems with their social integration	4	.95

<u>Health and wellbeing indicators - CORE</u>

Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 3_Survey on primary, health and social indicators 2021).

The experimental group showed slightly higher scores in both Health and wellbeing and perceived restorativeness, but these differences did not reach statistical significance.

HW11. Mental health and wellbeing

b) Teachers

Table 29. Mental healt and wellbeing

	M	SD
Experimental group	3.77	.34

	M	SD
Control group	3.68	.65

Note. There were no statistically significant differences; Scale range: 1-5

HW16. Perceived restorativeness of public green space

b) Teachers

Table 30. Perceived restorativeness of public green space

	EXP		CON	
	M	SD	M	SD
Fascination subscale	3.91	.82	3.47	.66
Being away subscale	3.57	.75	3.31	.76

Note. There were no statistically significant differences; Scale range: 1-5

<u>Health and wellbeing indicators - FEATURE</u>

Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 3_Survey on primary, health and social indicators 2021).

HW14. Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)

The parents of kindergartens with natural playground reported lower scores on signs and symptoms of ADHD than those of the control group, although statistical significance was only reached for the Peer subscale.

a) Parents

Table 31. Improvement of behavioural development and symptoms of ADHD

	EXP		CON	
	M	SD	M	SD
Hyperactivity	1.74	.51	1.9	.51
Emotional	1.25	.34	1.27	.27
Conduct	1.43	.35	1.46	.32
Peer[1]	1.25	.29	1.37	.37
Antisocial	1.46	.45	1.56	.36

Note. Scale range: 1-5. Significant difference:
1. ($t_{(117.481)}$=2.144; p=.034)

<u>Social cohesion indicators - CORE</u>

Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 3_Survey on primary, health and social indicators 2021).

SC6. Place attachment

b) Parents

This indicator was only calculated for the experimental group, and the parents' perception indicates that they believe that their children have a high attachment to the playground.

Table 32. Parents' perception of children's place attachment to the playground (Scale range: 1-5)

	M	SD
Experimental group	4.6	.59

Social cohesion indicators - FEATURE

2020 SURVEY DATA

SC10. Environmental education opportunities

City of Poznań equipped preschools in eco-demonstrators that support preschoolers education during outdoor classes. In 2018, 10 preschools with 1274 preschoolers received 50 eco-demonstrators (Figure 36). In 2019, 2658 preschoolers from next 20 preschools received 84 eco-demonstrators.

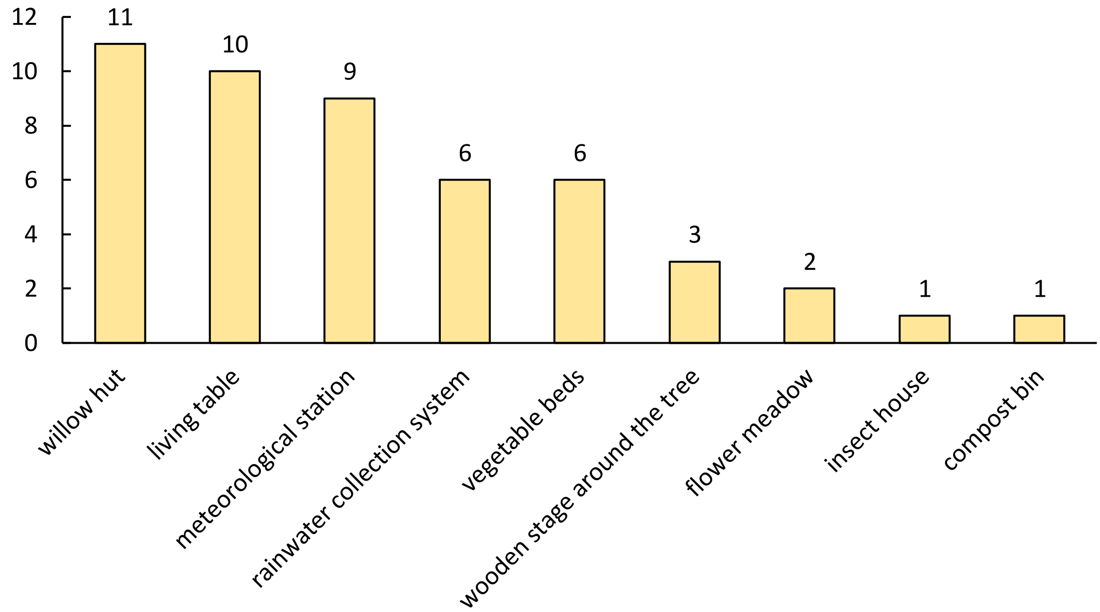


Figure 36. Number of eco-demonstrators implemented in 2018
Source: AMU own elaboration

In 2019, 10 preschools with 1430 preschoolers received 54 elements of eco-demonstrators, including wooden landing, living table, blueberry, wooden garden chests, willow huts as well as secret gardens and bird feeders (Figure 37).

Figure 37. Number of eco-demonstrators implemented in 2019
Source: AMU own elaboration

In 2020, additional 44 eco-demonstrators were deployed in 11 preschools serving 1130 children.

The self-assessment of preschool own outdoor spaces within survey conducted in March 2020 showed that 17% out of 94 preschools assessed their outdoor space as entirely natural, 28.7% assessed it as rather natural. In opposition 14.9% of preschool stated that their outdoor space is predominantly not natural playspace/natural playground while 4.3% states that it is definitely not natural. Most common was the answer that preschool outdoor spaces is mix of natural and manmade space (35.1%).
The preschools' managers were also asked to indicate what kind of natural elements are available for children in their own outdoor spaces. The results are presented in Fig. 38.

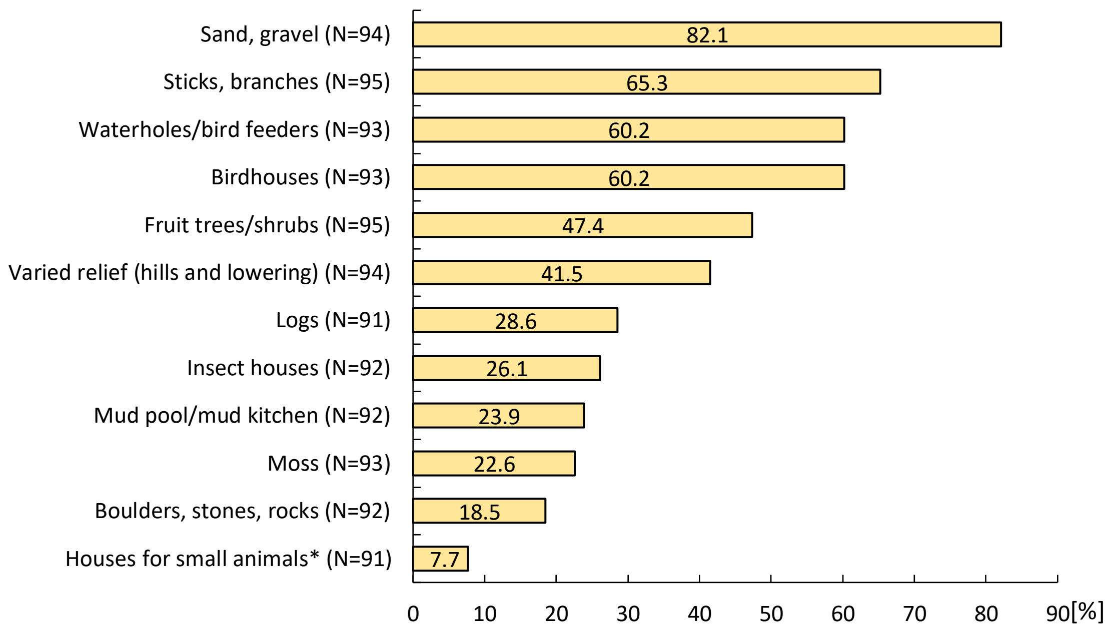


Figure 38. Share of preschools with natural elements available for children
Source: AMU own elaboration

The results showed that the most common natural elements available for children in preschool outdoor areas are sand and gravel (present in 82.1% of preschools). On the other hand, fruit plants are available only in 47.4% of surveyed preschools, water elements such as mud pools or mud kitchen are present only in 23.9% of surveyed preschools. Limited presence of less popular natural elements indicate space for improvements to provide children more opportunities for contact with nature.

The preschools were also asked about availability of play equipment, recreational and sport facilities of natural and artificial character. As shown in Fig. 39 preschools are equipped in mix of natural and artificial elements, with more emphasis on natural material.

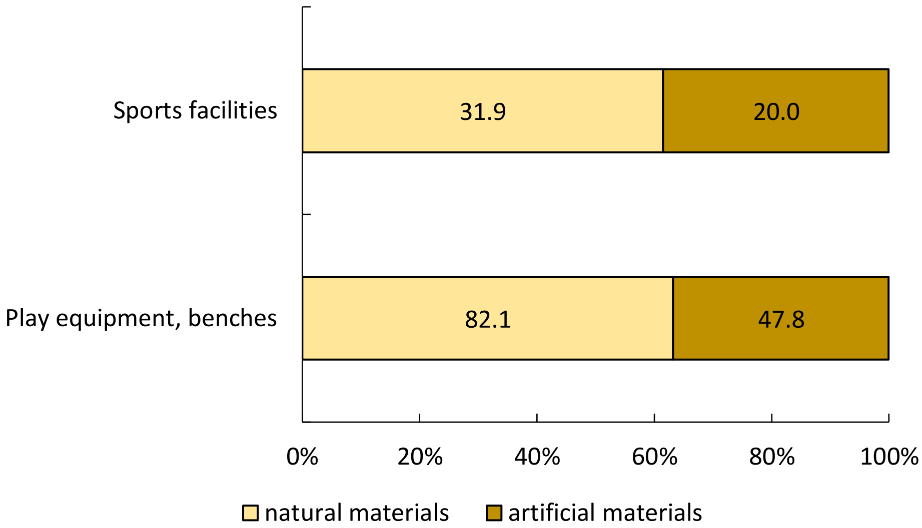


Figure 39. Share of preschools where natural or artificial facilities are available for children.
Source: AMU own elaboration

<u>2021 SURVEY DATA</u>

Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 3_Survey on primary, health and social indicators 2021).

SC13. Connectedness to nature

a) Parents

No statistically significant differences were found in the connection to the nature of parents or children, between the experimental or control group. However, higher connectedness to nature scores in children were related to lower levels of the ADHD antisocial behavior subscale. These Pearson´s correlation occurred in both the experimental and control groups, although they were generally more intense in the group of children who had a natural playground in kindergarten. When analysing this correlation analysis, it is necessary to mention the existing limitation due to the small sample of participants.

Table 33. Parents´ connectedness to nature (Scale range: 1-5)

	M	SD
Experimental group	3.7	.46
Control group	3.82	.55

Note. There were no statistically significant differences

Table 34. Children's´ connectedness to nature (Scale range: 1-5)

	EXP		CON	
	M	**SD**	**M**	**SD**
Enjoyment	4.14	.69	4.32	.46
Empathy	4.14	.66	4.05	.63
Responsibility	4.17	.71	4.1	.59
Awareness	3.91	.67	3.94	.65

Note. There were no statistically significant differences

Table 35. Correlations between connectedness to nature (CN) and other indicators for the experimental group

	Parents´ CN	Place attachment	Hyperactivity (ADHD)	Emotional (ADHD)	Conduct (ADHD)	Peer (ADHD)	Antisocial (ADHD)
Enjoyment	.19	.107	-.153	.011	-.193	-.105	-.313**
Empathy	.23*	.179	-.172	-.131	-.154	-.175	-.228*
Responsibility	.382**	.137	-.296**	-.067	-.194	-.226*	-.351**
Awareness	.25*	.123	-.149	-.078	-.229*	-.138	-.307**

**. The correlation is significant at the .05 level (bilateral); **. The correlation is significant at the .01 level (bilateral).*

Table 36. Correlations between connectedness to nature (CN) and other indicators for the control group

	Parents´ CN	Hyperactivity (ADHD)	Emotional (ADHD)	Conduct (ADHD)	Peer (ADHD)	Antisocial (ADHD)
Enjoyment	.496**	-.268*	-.203	-.002	-.022	-.250*
Empathy	.236	-.186	-.030	-.142	-.032	-.199
Responsibility	.326**	-.348**	-.235	-.319*	-.229	-.444**
Awareness	.407**	-.356**	-.293*	-.107	-.163	-.304*

**. The correlation is significant at the .05 level (bilateral); **. The correlation is significant at the .01 level (bilateral).*

b) Teachers

Again, there were no significant differences in the levels of connectedness to nature between the teachers between the groups with and without a natural playground. Regarding the relationships with other variables, the experimental group showed more intense and significant relationships than the control group in the relationship between Connectedness to Nature and the Perceived restorativeness subscales. It should be noted that in the control group a positive and significant relationship was established between the levels of mental health and wellbeing with connectedness to nature and the fascination subscale. When analysing this correlation analysis, it is necessary to mention the existing limitation due to the small sample of participants.

Table 37. Teachers´ connectedness to nature (Scale range: 1-5)

	M	SD
Experimental group	3.9	.61
Control group	3.86	.47

Note. There were no statistically significant differences

Table 38. Correlations between connectedness to nature (CN) and other indicators for the experimental group

	Restoration_Fascination	Restoration_Being away	Mental health and wellbeing
Connectedness to Nature	.612**	.293	-.117
Restoration_Fascination	1	.607**	-.259
Restoration_Being away	.607**	1	-.254

***. The correlation is significant at the .01 level (bilateral).*

Table 39. Correlations between connectedness to nature (CN) and other indicators for the control group

	Restoration_Fascination	Restoration_Being away	Mental health and wellbeing
Connectedness to Nature	.589*	.231	.717**
Restoration_Fascination	1	.474	.695*
Restoration_Being away	.474	1	.46

**. The correlation is significant at the .05 level (bilateral); **. The correlation is significant at the .01 level (bilateral).*

<u>Economic indicators - CORE</u>

In initial stage of monitoring 5 indicators were chosen to reflect the significance and impact of Nature-based solutions (NBS) in the city of Poznań:

- ECO1: New Businesses 'attracted' or started and additional rates received
- ECO3: Net additional jobs created/enabled by NBS
- ECO6: Innovation impact
- ECO13: Net impact on public expenditure from NBS implementation
- ECO15: Private finance attracted to the NBS site

In case of natural playgrounds and eco-demonstrators the reliable quantitative data are available only in case of ECO13 and ECO15 indicators. The data on ECO1, ECO3 and ECO6 have mostly qualitative character as there are derived from direct face-to-face interviews with owners of two companies that were involved in the process of designing and constructing of natural playgrounds and eco-demonstrators.

ECO1, ECO3, ECO6. Impact on private sector

The assessment of impact of natural playgrounds and eco-demonstrators on creation or expansion of businesses, jobs and innovations has been based on direct interviews with owners of two companies involved in the project:

- Company A – design and construction of eco-demonstrators
- Company B - design and construction of natural playgrounds

Company A is a small family business that actively took part in design and construction of eco-demonstrators, specializing in all kinds of constructions made of willow trees. After completion of projects for preschools (10 yearly on average) basing on this experience they expanded their portfolio of offered products. Now (2021) they work for many clients (around 20 projects per year) from public and private sector, introducing innovative forms of using willow tree constructions for different purposes. The owner stressed the importance of public procurement from city of Poznań for design and construction of eco-demonstrators for the expansion of his own business. However, the rise in number and scope of projects being realized by his company has not resulted so far in creation of new jobs. This is because of specific character of the willow tree constructions that require the in-person involvement from the owner

Company B has been involved in construction of 15 natural playgrounds in preschools in Poznań. The company was established 10 years ago and used to specialize mainly in realization of traditional gardens with only some elements of nature-based facilities for children. The experience gained at the construction of first 3 natural playgrounds for preschools in 2018 as the pilot stage with prototype facilities helped to develop more standardized versions of these elements (8 products) for implementation in further projects. However, even if some basic construction framework of facilities for natural playgrounds is standardized they must be individualized for each location and also individually certified for children usage in certain place. Therefore the mass production of such constructions is rather difficult to implement. All projects were realized by the stable and experienced staff of full-time employees (usually 5-7 people depending on scope of the project) and no additional jobs were created in the company specifically for these projects. But in some cases external services were needed (e.g. demolition of old concrete elements, additional wooden elements), yet their impact on creation of new jobs in other companies is rather impossible to measure. The more important effect of projects completed in preschools in Poznań on expansion of the business is that the company has been hired to construct new playgrounds outside of the city in neighbouring municipalities.

ECO13. Net impact on public expenditure from NBS implementation

In case of this indicator the public expenditure from city of Poznań on natural playgrounds and eco-demonstrators in 2018-2020 was analysed (Fig. 40, Table 40).

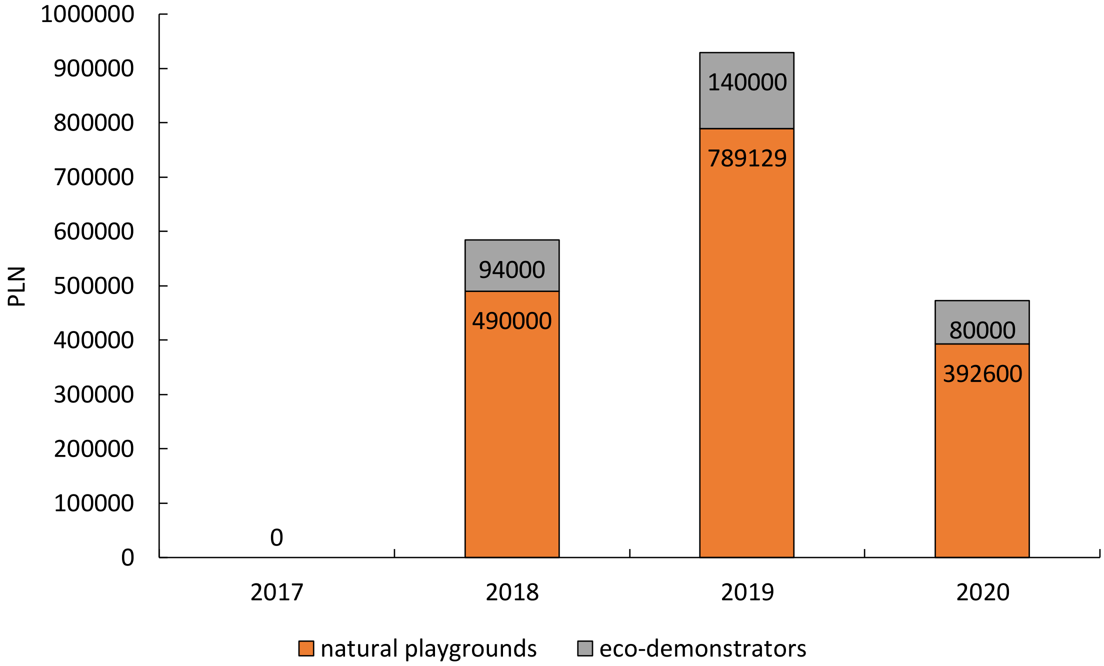


Figure 40. Public expenditure from city of Poznań on natural playgrounds and eco-demonstrators in 2017-2020 in PLN
Source: City of Poznań, Bureau of Project Coordination and Urban Regeneration

Table 40. Public expenditure from city of Poznań on natural playgrounds and eco-demonstrators in 2018-2020 in PLN

Year	Natural playgrounds	Eco-demonstrators	Total
2018	490000	94000	584000
2019	789129	140000	929129
2020	392600	80000	472600

Source: City of Poznań, Bureau of Project Coordination and Urban Regeneration

The initiative for design and construction of natural playgrounds in preschools was strongly linked to 5-year municipal "Programme for modernization of playgrounds in preschools 2016-2020" and much inspired and supported by Connecting NATURE project. After successful implementation of pilot projects of natural playgrounds in 3 preschools (mainly in Wilda neighbourhood, with complimentary project of open garden in Preschool No. 42) in 2018, there was substantive rise in expenditure in 2019 when 12 preschools joined the initiative (10 within municipal programme and 2 basing on winning projects from Participatory Budget public voting). However in the final year of 5-year programme (2020) the interest in natural playgrounds was lower (3 preschools within municipal programme, 2 in Participatory Budget) what had also influence on level of public expenditure on this projects. The main reason was that some preschools seeing year 2020 as a last chance to make use of the programme (which had no clear prospects for continuation) chose to refurbish the existing facilities on their playgrounds rather than rebuild them towards more 'natural' form. Since 2021 due to the worse financial situation of the city expenditure from municipal budget for playgrounds in preschools is set not in the form of 5-year programme but at the yearly basis what may result in less stable financing of NBS initiatives in preschools.

The gathered data on natural playgrounds and eco-demonstrators in preschools give a possibility to divide public expenditure into stage of planning (design) and development (Table 41) however it is impossible to retrieve data on maintenance of NBS from the general cost of infrastructure maintenance in preschools.

Table 41. Expenditure on NBS in preschools by project stages in PLN

NBS	Planning	Development	Maintenance
Natural playgrounds	131 729	1 050 000	n/d
Eco-demonstrators	38 000	276 000	n/d

The amount of public expenditures on planning, development and maintenance of interventions related to NBS exemplars is presented in Table 42.

Table 42. Public expenditure (in PLN) on NBS intervention

NBS exemplar	2017	2018	2019	2020	Notes
Natural playground – Preschool no. 42 & open garden	250 000				Value for the whole project (planning 2017, development 2017-2018)
Natural playground – Preschool no. 87	120 000				Value for the whole project (planning 2017, development 2017-2018)
Natural playground – Preschool no. 115			100 000		Including 8.500 zł within CONNECTING project for planning
Pocket park – Kolejowa/Hetmańska			405 769	26 000	2019 – development, 2020 – operation/maintenance

Pocket park – Sikorskiego/Uminskiego			24 047	96 598	
Pocket park "Ogród Łazarz"	36 000	51 300	93 000	60 000	Originally developed within Generator Malta project (2013). Then maintained by Grunwald housing cooperative. Additional funding from the city of Poznań for cultural events (in table)

Baseline natural playground & open garden 2016 – 0 PLN
Baseline pocket park 2018 – 0 PLN

ECO15. Private finance attracted to the NBS site (additional funding)

The interesting observation about natural playgrounds and eco-demonstrators in Poznań is a rising share of additional funding secured for this initiative in 2018-2020 period, supporting regular funds for modernization of playgrounds in preschool managed by municipal Department of Education (Fig. 41 and 42, Table 43). Three main sources of additional funding have been identified:

- CONNECTING nature project
- grants from Regional Fund for Environment Protection and Water Management (eco-demonstrators)
- grants secured within Participatory Budget in public voting among citizens (natural playgrounds)

In 2018 the additional funding from all sources had only 12% share in all expenditure for natural playgrounds and eco-demonstrators while in 2020 it made more than a half of total sum.

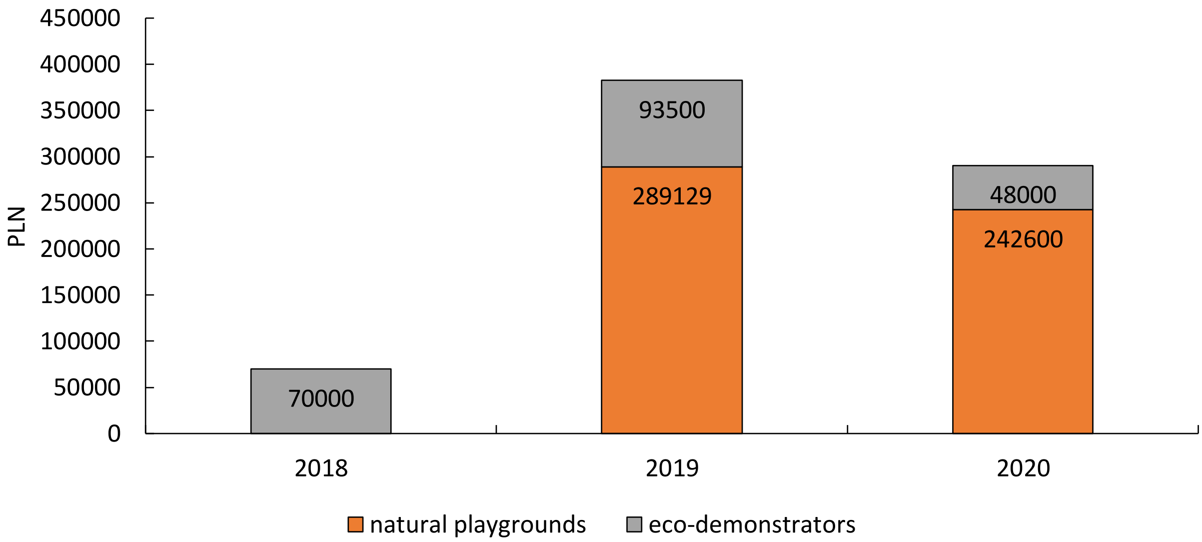


Figure 41. Additional funding secured for natural playgrounds and eco-demonstrators in Poznań in 2018-2020 in PLN
Source: City of Poznań, Bureau of Project Coordination and Urban Regeneration

Table 43. Additional funding secured for natural playgrounds and eco-demonstrators in Poznań in 2018-2020 in PLN

Year	Natural playgrounds	Eco-demonstrators	Total
2018		70000	70000
2019	289129	93500	382629
2020	242600	48000	248000

Source: City of Poznań, Bureau of Project Coordination and Urban Regeneration

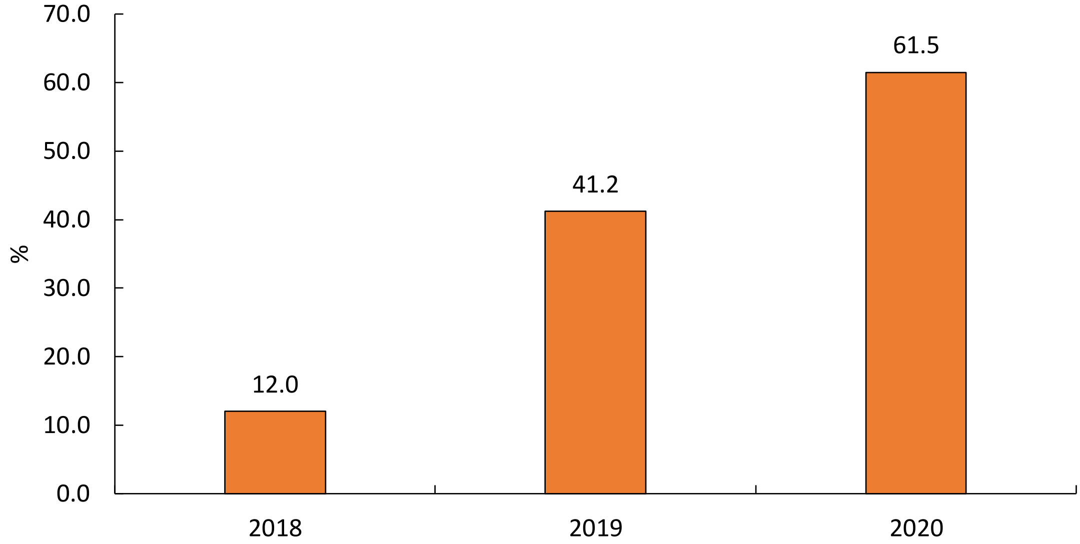


Figure 42. Share of additional funding secured for natural playgrounds and eco-demonstrators in all expenditure in 2018-2020
Source: City of Poznań, Bureau of Project Coordination and Urban Regeneration

GENERAL CONCLUSIONS

a) Potential synergies and trade-offs

The distribution of green infrastructure impacts the distribution of regulating ES services such as regulation of thermal conditions. Important elements of interventions towards NBS are trees that generate multiple ecosystem services crucial for urban resilience.

- Trees with large crown diameter contribute not only to increase in green space area but also provide shade that reduce the surface temperature and positively impact on cooling potential of green space, while contributing to local biodiversity and delivering diverse ecosystem services.
- Changing the impervious land cover material of artificial character to previous of natural character contribute not only to surface temperature reduction but also to surface water runoff and in case of playgrounds also adds to opportunities for contact with nature that benefit in children development.
- The green space arrangement in the dense urban structure limits the opportunity to introduce more green spaces. Implementation of trees and vertical green spaces can add to the overall volume of green space but it also have limitations due to architectural barriers in the space.
- Maintenance of mature trees is crucial for safety reasons and this is particularly the case of preschool gardens.
- Development of recreation facilities usually require introduction of man-made equipment and it is often linked with some reduction of previous surface. This however can be limited by using previous land cover material.
- The trades-off always array from the limited space and choices to be made in space arrangement.

b) Main conclusions

City of Poznan as a partner of CONNECTING Nature project implements and develops urban nature-based solutions such as nature-oriented playgrounds at preschools, open garden, pocket parks being small-scale nature-based solutions.

The nature-oriented playgrounds promote nature-based solutions in architectural design and the modernization of playgrounds. It also enhances ecological knowledge of children and teachers and brings more biodiversity into green spaces of preschool premises. In the frame of the CONNECTING Nature project we complement regular modernization of preschool playgrounds in Poznań. Simultaneously, we are testing the pilot project of an open garden in one of the selected preschools located in the densely urbanized district of Wilda. We have noticed that many public institutions in our city have very attractive green spaces that are not accessible to "usual users" – residents of Poznań. We assume that the (at least) partial opening of such spaces to citizens who are usually restricted from coming to these premises is an innovative way of providing residents with access to green spaces. Another green solution which is developing in the city are pocket parks which create multifunctional green spaces in the densely built-up area of the city.

The city of Poznań aims to create good quality and accessible green spaces in the city, which will bring multifunctional benefits. The creation and scaling of nature-oriented playgrounds and other kinds of nature-based solutions can provide many potential health and well-being benefits, including social and health aspects. It focuses on mental health and well-being of pre-schoolers and ecological education and the quality of life of children in the city. The open garden or pocket parks have the potential to improve social inclusion and social participation, as well as place attachment. Unfortunately, due to COVID-19 and pandemic open garden and pocket parks operate in a very limited way, preventing regular visits; many places were temporarily closed to residents. It also prevented us from conducting research and monitoring under the CN project.

A real lack of specific and directed indicators for our specific examples, as well as significant data gaps necessitates the collection of new data. This required cooperation across different city departments as well as researchers and scientists from Adam Mickiewicz University, who support us and conduct research, gather the data and develop indicators. Moreover, the solutions implemented in Poznań are of local character: pre-school gardens, open garden and pocket parks. As such, the effects of this type of intervention are difficult to capture in the scale of the whole city. This means that the monitoring of the impact of small green interventions on the environment, wellbeing and social cohesion in dynamic terms can only be implemented on a site scale. Thus, it is important to adapt the indicators to the scale of nature-based solutions implemented in Poznań.

The Nature-Based Solutions Monitoring Plan for Poznań

The Nature-Based Solutions Monitoring Plan for Poznań has been created within CONNECTING Nature Project. Poznań as a front-runner city reflect and evaluate its own practice and experience from nature-based solution (NBS) implementations, including an evaluation and assessment of existing nature-based solutions.

The monitoring is to cover the NBS aspect of:
1. Environmental performance
2. Social issues including health, quality of life, social cohesion
3. Economic conditions

The monitoring is considered at three levels:
1. Monitoring of NBS implemented under CONNECTING Nature (on a local scale)
2. Monitoring, which provide evidence of the benefits of nature-based solutions in general (not necessarily as a result of implementation under CONNECTING Nature)
3. Monitoring of long-term changes (assessment of the current state-of-the-art) on a city scale

The procedure of monitoring and evaluation of NBS in Poznań consist of 4 main steps:
1. Preparation of draft monitoring plan – first stage based on the review of the proposed indicators and methodology (CONNECTING Nature). It requires selection of the NbSs that are used as examples that provide evidences of their performance (including preschools, open garden, pocket parks). At this stage selection of indicators, methods and research instruments for monitoring is completed.
2. Preparation for implementation – at this stage selection of research equipment, its installation and testing was conducted and methodology of survey was prepared. At this stage data sources are verified, draft monitoring plan is adjusted according to needs.
3. Monitoring – is a stage of data gathering, conducting surveys.
4. Results and synthesis – final stage of data elaboration, preparation of result publication.

The plan for NBS monitoring in Poznań has been launched in Autumn 2020, however some of the data has been collected earlier. Due to local scale of intervention most of data for NBS exemplars is based on case studies. Data at the site scale are usually not collected by the city administration or other institutions on regular basis. The standard unit for which data are available is city scale, district scale or estate unit. Therefore all baseline data for the site scale have to be collected within Connecting Nature project.

Poznań implements and develops a number of small-scale NBS such as nature-oriented gardens in preschools, open garden or pocket parks that aim to fill the urban tissue with multifunctional green spaces in the densely built-up area of the city. Therefore we conclude the effects of those actions together.

Environmental indicators

Conclusions from city scale monitoring of thermal conditions:

- The initial results showed that the distribution of green infrastructure in Poznań is uneven. This impacts the distribution of regulating ES services such as spatial differentiation of thermal conditions. The difference in average land surface between continuous urban fabric and urban green areas reaches 7,3 ^{o}C.
- The pattern of land cover resulting from urban planning policies shape the thermic pattern of the city.
- The city districts with limited share of GI should be priority areas for NBS interventions at the local scale. Such hot spots are particularly important as a target areas for NBS that can benefit local communities. The distribution of preschools and pocket parks that are monitored under CONNECTING Nature monitoring plan, at the background of urban GI shows that in districts with dense built-up located in the center of the city the NBS can be of particular importance in regulating local microclimate.

Conclusions of NBSs monitoring regarding thermal conditions of preschool gardens:

- Buffer analysis shows rather low capacity to cool neighborhood (mean of 0,15 ^{o}C), nevertheless the results of land surface temperature analysis with use of detailed individual thermal profiles shows the cooling effect could be significantly higher (1-2,5 ^{o}C), especially in the case of preschool gardens designed as natural playgrounds (e.g. Preschool No. 42 and Preschool No. 87).
- 87% of preschools in Poznań (230/264) have their own outdoor area. As many as 131 of them (57%) have lower ALST than the closest surrounding area (mean value difference of 0,15 ^{o}C (min 0,01 ^{o}C and max 0,51 ^{o}C)).
- The analysis of average land surface temperature shows that in the summer, around noon and during radiation weather, preschoolers are exposed to urban heat (measured as ALST) in all preschool gardens in Poznań regardless of greenery quantity and quality measured with NDVI.
- Nevertheless, the children exposition is lower in preschool gardens characterized with higher share of greenery especially mature trees - gardens with high mean NDVI value (high share of greenery) might be 1,8 ^{o}C cooler than gardens with low mean NDVI value (low share of greenery).
- Cooling effect of preschool gardens varies a lot and depends on the share of greenery (measured with NDVI) as well as LU/LC conditions in the nearest neighbourhood.
- The cooling effects of other small scale nature-based solutions (e.g. pocket parks) are similar to the impact of preschool gardens.

Main conclusions resulting from thermal imaging of different surface materials and tree shade at the local scale:

- Shading by trees is an important ecosystem service affecting the distribution of solar energy resulting in differentiation of surface and air temperatures. As it is presented in the report, differences in average surface temperatures between shaded and insolated land cover materials might reach 2,2 °C for high grass as well as 10 °C in the case of gravel and bark. Differences in temperatures are characterized for stone (8,9°C), bituminous materials (like asphalt, 7,2 °C), wooden surfaces (6,4 °C), and concrete (5,9 °C). Lower for shrubs (5,5 °C), green lawn (4,9 °C), bare soils (4,2 °C) and sand (4 °C), herbaceous vegetation (3,8 °C), lawn with dry grass (2,7 °C) as well as for metallic (3,5 °C) and plastic materials (2,9 °C). Taking into account measurement data limitations most certain evidence was gathered for bare soils, lawn, wooden, bituminous, and concrete surfaces. Therefore, tree shade is of particular importance in lowering the temperature in places where surface is artificial.
- Results show that natural materials, especially vegetation cover (trees, shrubs, green lawn, lawn with tall grass) are characterized by lower surface temperatures than artificial materials. Hence the introduction of plants (greenery) and the use of other natural materials in the development of city tissue should be considered as one of the most effective mechanisms for adaptation to climate change.
- Analysed differences are visible in the distribution of current, monthly as well as seasonal average land surface temperatures of given materials. The results shows that, local space management especially concerning trees distribution and maintenance plays a crucial role in shaping local microclimate conditions.

Conclusions regarding ecosystem services provided by trees in pocket park at Kolejowa Street at site scale:

- Our pilot results in pocket park at Kolejowa street gives evidence of ecosystem services delivered by trees. It shows that even small pocket park with 108 trees contribute to Carbon Storage of 115,8 tons/year, Carbon Sequestration of 2,058 tons/year, produce 5,487 tons/year of oxygen and contribute to avoided Runoff of 30,4 cubic meters/year. That gives clear evidence for policymakers to protect existing green spaces and develop small-scall NBS.

Conclusions regarding soil sealing and green space in Preschool no. 42 at site scale:

- The transformation of preschool garden allowed for transformation of 882 m^2 concrete area into biologically active surface and lead to reduction in concrete impervious surface of the garden by 26.64% (from 27.8% of imprevious land cover associated with preschool building).
- The results showed that replacing sealed surface with previous land cover allowed to increase the Urban Green Factor (UGF) from 0,27 to 0,32.
- The results showed also significant role of mature trees in greening the space. Tree canopy cover contribute significantly to greening the area what is mirrored in UGF. UGF calculated for 2016 year including tree canopy cover increased from 0,27 to 0,63, while UGF calculated for 2021 increased from 0,32 to 0,73.

Conclusions regarding green space, its availablility and its usage:

- The accessibility (availability) of green spaces depends on their distribution and types of spaces. Since nature-oriented playgrounds in preschools are key intrest of Poznań city, the analysis focused on availability of green spaces for preschoolers. Spatial analysis and survey among preschools reveald the existing potential of preschools in providing children contact with nature on their own outdoor spaces as well as neighbooring green spaces that can be visited with preschoolers.

- To ensure children contact with nature, preschools use their own outdoor areas as well as external green spaces in their neighbourhoud. Preschools have various opportunities to use external green spaces due to their location at the background of the urban tissue and GI. Preschoolers are generally taken to visit neighbouring green spaces located within 300 m (50.5%); 94.6% visits did not exceed 1 km.
- Most frequently (54%), outdoor visits to external green spaces lasted between 30 and 60 minutes. This indicates the importance of spatial planning in ensuring the presence of neighbouring green spaces as a part of space for early-stage education.
- As many as 97.7% of the preschools in the study declared that their pupils enjoyed their outdoor spaces at least once a day, spending a daily average of 103 minutes outdoors in the spring-autumn season and 54% of preschoolers spend at least 2 hours daily outdoors in the preschool.
- The results showed that the most common natural elements available for children in preschool outdoor areas are sand and gravel (present in 82.1% of preschools). On the other hand, fruit plants are available in 47.4% of surveyed preschools, and water elements such as mud pools or mud kitchen are present only in 23.9% of surveyed preschools. Limited presence of diverse natural elements indicate space for improvements to provide children more opportunities for contact with nature.
- Part of the results from monitoring in preschools can also be found in publication **Zwierzchowska I., Lupa P., 2021. Providing contact with nature for young generation - A case study of preschools in the City of Poznań, Poland. Urban Forestry & Urban Greening 65 (2021) 127346.**

<u>Health and wellbeing & Social cohesion indicators</u>

The city of Poznań develops small scale solutions such as pocket parks or open garden as well as nature-oriented playground providing better accessibility to green spaces for local inhabitants and opportunity for contact with nature in densely built-up area. This action focus on creating new green spaces or improving quality and multi-functionality of existing spaces. New arrangement of existing green spaces with facilities for recreation infrastructure allows inhabitants for enjoying benefits provided by urban nature.

The availability of green spaces for preschool children attending preschools in Poznań showed that preschools have diverse opportunities for providing children contact with nature that is of high importance for their physical, social and emotional development as well as cognitive skills. Preschools' own outdoor spaces are frequently used for children activities; however COVID-19 pandemic require some additional safety procedures to be implemented. At the same time most of preschools significantly limit visits of neighboring green spaces. Therefore, development of nature-oriented playgrounds contribute to enhancement of existing potential for children-nature interaction during they stay in preschool.

The results of the survey carried out in 2021 in 3 schools with natural playgrounds (experimental group) and 3 schools without natural playgrounds (control group), shows how the experimental ones carry out more educational activities outdoors, and therefore, both teachers and children spend more time in the playground. The indicators also show that since the COVID-19 pandemic, teachers and children in the experimental group have increased their time in the playground, and teachers also in green spaces.

The perception of quality of the natural playgrounds is superior to the preschools of the control group, both at the level of parents and teachers, on a general scale or in specific

elements such as elements of small architecture, aesthetic qualities, events organized or ability of the playground for arouse the curiosity of the children.
Finally, and despite the limitations of the sample size, there is a relationship between higher levels of children's connectedness to nature and lower levels of and symptoms of "attention-deficit / hyperactivity disorder (ADHD)". These relationships are more intense within the experimental group, with lower levels of problems derived from ADHD with peer in preschools with natural playgrounds.

Economic indicators

The conclusions form the economic monitoring of NBS in Poznań with regard to natural playgrounds and eco-demonstrators can be summarized in following points:

- The economic indicators are based on documents presenting the city's expenditures for NBS exemplars. The specificity and local scale of NBS exemplars (public sector, small scale) have some limitations in the wider application of those indicators. However, further work to acquire more data is going to be taken.
- It is important to have the additional source of funding in the initial stage to start with pilot projects (in Poznań: CONNECTING Nature)
- The stable regular funding has been essential for upscaling of the initiative to more city-wide scale (municipal 5-year programme for modernization of playgrounds in preschools)
- The initial success and growing popularity of the NBS initiative may help to apply for more additional funding, this time from non-municipal public institutions (regional fund) and grant pools based on public participation and popular voting (Participatory Budget)
- The NBS initiative of this kind may be vulnerable to changes in municipal financing – the end of 5-year programme with no continuation in following period slowed down the dynamic expansion from previous years
- The green public procurement may be a significant factor for creation and expansion of private businesses specializing in delivery of NBS but it is sometimes difficult to move on with innovative products from hand-made constructions to mass production.

Limitation that occur during monitoring:

- Lack of relevant data (especially at site scale),
- Various temporal accuracy and granularity (resolution) of available data,
- Necessity of time-consuming collection of data, conducting measurements in field that require specific equipment and trained staff,
- Need for application of new data collection methods and approaches
- COVID-19 pandemic impact the possibility of NBS monitoring (e.g. closed open garden, temporary closed preschools).

Reference to urban policy and goals

The conducted research and the results obtained at the moment are in line with the assumed goals of the NBS, as well as the strategic goals of the city. All nature-based solutions realized in Poznań are compatible with the objectives and priorities included in local strategic documents. The overall city policies are very much greenery-oriented. The creation of open garden nature-oriented playgrounds as well as pocket parks have a meaningful potential for other city development goals and are included into strategic objectives like developing a green city, supporting ecological education for citizens and influencing on the quality of the city and the health and wellbeing of its residents. This shows how nature-based solutions can offer creative, innovative and effective ways to deliver on many city strategic goals, and how nature-based solutions can be embedded across a range of policies. There are strong linkages between Poznań's strategic goals and nature-based solution goals formulated and pursued at European level. This supports the planning of nature-based solutions and the evaluation of their multifunctional benefits.

Reflections and lessons learnt about process of gathering data, indicators and impact measurement

- it is a very time-consuming and demanding process to analyse what data is available in the city, at what level of generalization – many indicators has not been developed, especially those that relate to our examples of nbs. Together with AMU team we have to collect a lot of data from "zero": socio-environmental and economic data,
- cooperation with different stakeholder and Universities is a key and great opportunity for us to collect qualitative, quantitative and spatial data and develop indicators. Thanks to it is feasible to create truly valuable measures of the effectiveness of activities in the city – the choice of relevant hotspots, priorities and indicators must occur through stakeholders and expert's engagement,
- the collected data and developed indicators will also become the basis for us to show the effectiveness of activities in the city and a chance to raise funds for further activities in the field of nature-based solutions,
- the lack of data and indicators is a certain gap, but it is considered as a field for further development, data collection and the creation of new indicators,
- the list of indicators developed within CONNECTING Nature should be treated as a guideline and inspiration for possibilities, however the indicators applied in NbS monitoring should be adopted to the local condition, data availability and city needs.
- to calculate various ecosystem services supplied by small-scale NBS, new data collection and measurements are necessary e.g. detail tree measurements/database.

i-Tree
Ecosystem Analysis

Connecting Nature Poznań

Urban Forest Effects and Values

marzec 2021

Summary

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. An assessment of the vegetation structure, function, and value of the Connecting Nature Poznań urban forest was conducted during 2021. Data from 108 trees located throughout Connecting Nature Poznań were analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station.

- Number of trees: 108
- Tree Cover: 24,6 %
- Most common species of trees: Tilia tomentosa, Celtis occidentalis, Robinia pseudoacacia 'Frisia'
- Percentage of trees less than 6" (15.2 cm) diameter: 2,8%
- Pollution Removal: 0 metric tons/year (z dashed l0/year)
- Carbon Storage: 115,8 metric tons (z dashed l80,3 thousand)
- Carbon Sequestration: 2,058 metric tons (z dashed l1,43 thousand/year)
- Oxygen Production: 5,487 metric tons/year
- Avoided Runoff: 30,4 cubic meters/year (z dashed l241/year)
- Building energy savings: N/A – data not collected
- Avoided carbon emissions: N/A – data not collected
- Structural values: z dashed l1,98 million

Metric ton: 1000 kilograms
Monetary values z dashed l are reported in Zlotys throughout the report except where noted.
Ecosystem service estimates are reported for trees.

For an overview of i-Tree Eco methodology, see Appendix I. Data collection quality is determined by the local data collectors, over which i-Tree has no control.

Table of Contents

I. Tree Characteristics of the Urban Forest

The urban forest of Connecting Nature Poznań has 108 trees with a tree cover of 24,6 percent. The three most common species are Tilia tomentosa (44,4 percent), Celtis occidentalis (20,4 percent), and Robinia pseudoacacia 'Frisia' (14,8 percent).

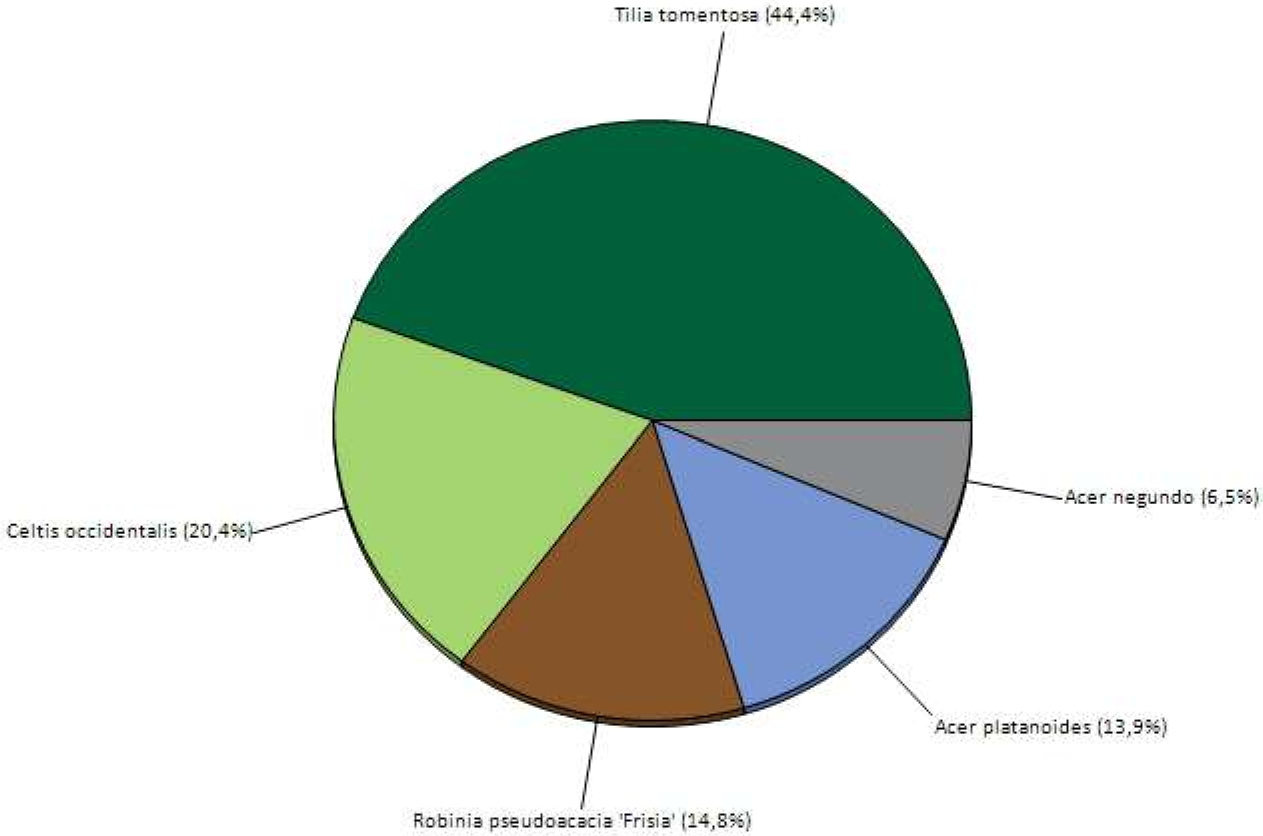


Figure 1. Tree species composition in Connecting Nature Poznań

The overall tree density in Connecting Nature Poznań is 105 trees/hectare (see Appendix III for comparable values from other cities).

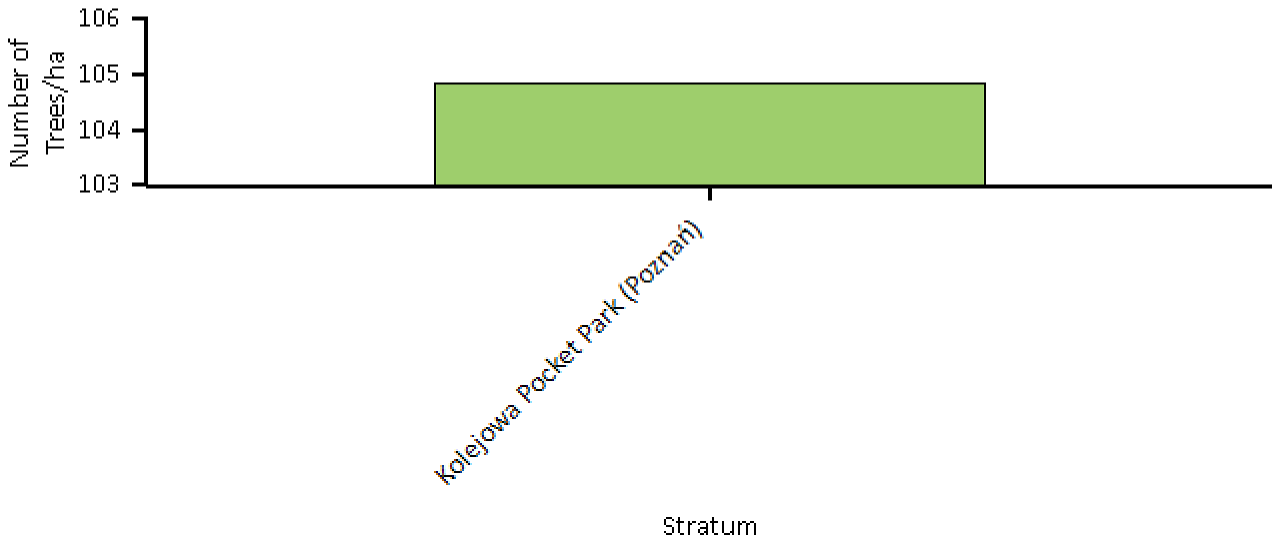


Figure 2. Number of trees/ha in Connecting Nature Poznań by stratum

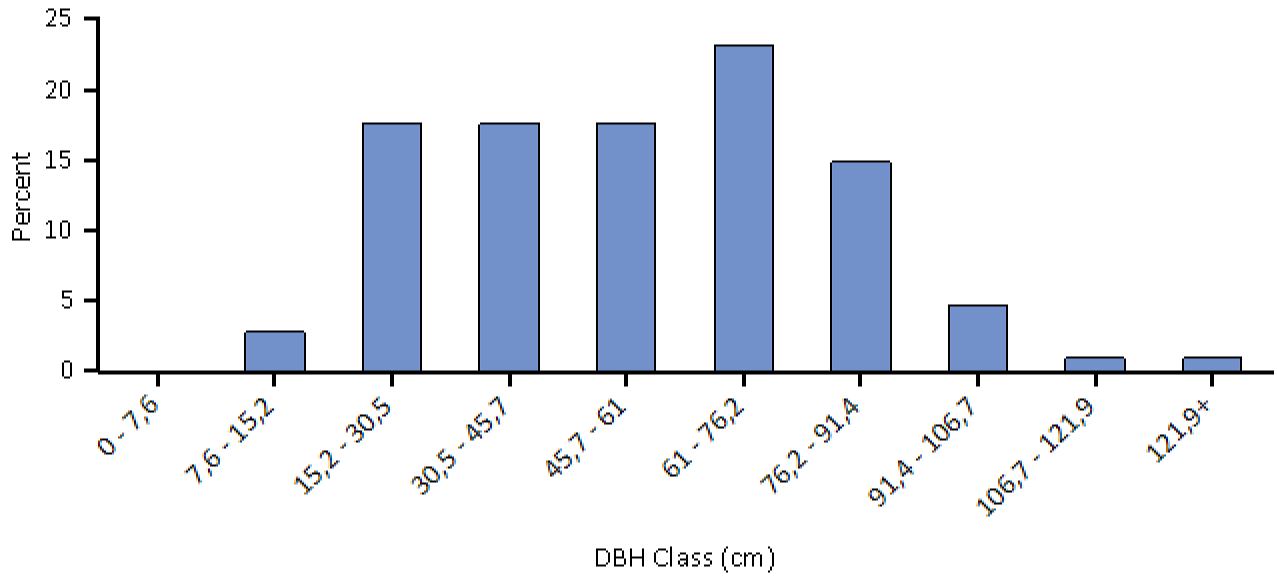


Figure 3. Percent of tree population by diameter class (DBH - stem diameter at 1.37 meters)

Urban forests are composed of a mix of native and exotic tree species. Thus, urban forests often have a tree diversity that is higher than surrounding native landscapes. Increased tree diversity can minimize the overall impact or destruction by a species-specific insect or disease, but it can also pose a risk to native plants if some of the exotic species are invasive plants that can potentially out-compete and displace native species. In Connecting Nature Poznań, about 0 percent of the trees are species native to Europe. Most trees have an origin from Europe & Asia (58 percent of the trees).

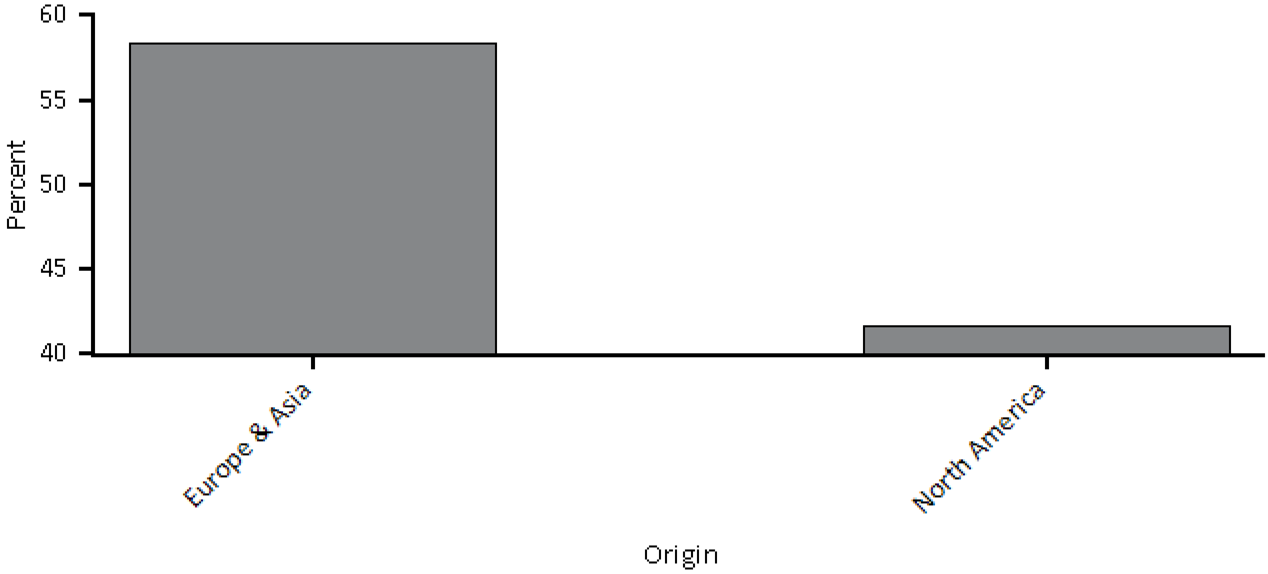


Figure 4. Percent of live tree population by area of native origin, Connecting Nature Poznań

Invasive plant species are often characterized by their vigor, ability to adapt, reproductive capacity, and general lack of natural enemies. These abilities enable them to displace native plants and make them a threat to natural areas.

II. Urban Forest Cover and Leaf Area

Many tree benefits equate directly to the amount of healthy leaf surface area of the plant. Trees cover about 25 percent of Connecting Nature Poznań and provide 2,108 hectares of leaf area. Total leaf area is greatest in Kolejowa Pocket Park (Poznań).

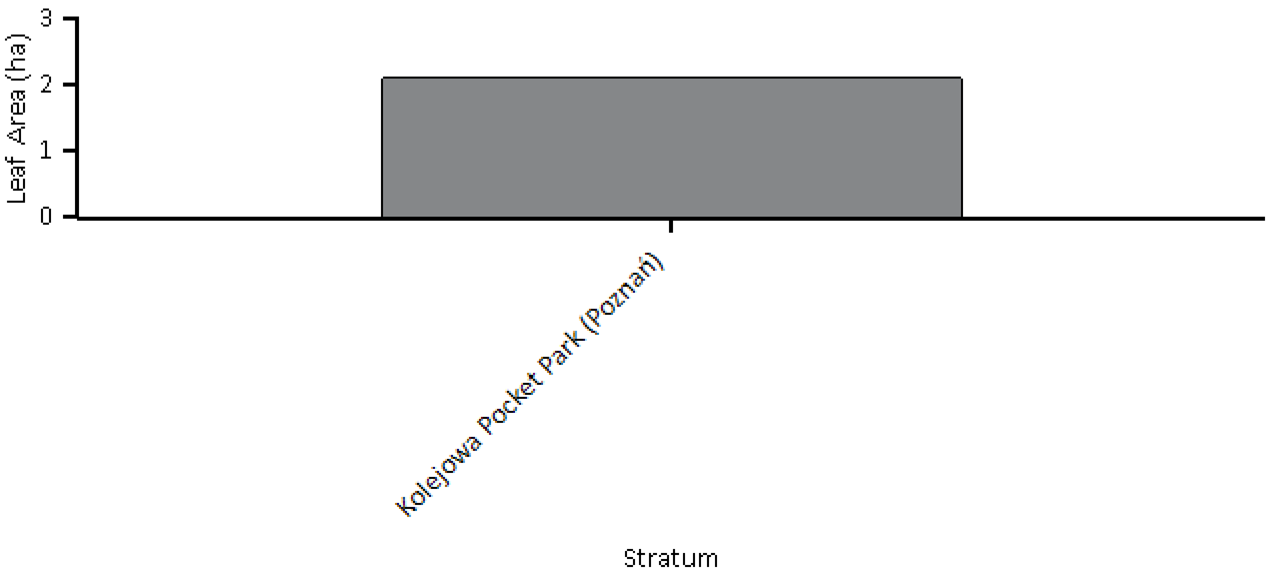


Figure 5. Leaf area by stratum, Connecting Nature Poznań

In Connecting Nature Poznań, the most dominant species in terms of leaf area are Tilia tomentosa, Robinia pseudoacacia 'Frisia', and Acer platanoides. The 5 species with the greatest importance values are listed in Table 1. Importance values (IV) are calculated as the sum of percent population and percent leaf area. High importance values do not mean that these trees should necessarily be encouraged in the future; rather these species currently dominate the urban forest structure.

Table 1. Most important species in Connecting Nature Poznań

Species Name	*Percent Population*	*Percent Leaf Area*	*IV*
Tilia tomentosa	44,4	42,3	86,8
Robinia pseudoacacia 'Frisia'	14,8	27,2	42,0
Acer platanoides	13,9	18,2	32,1
Celtis occidentalis	20,4	1,2	21,5
Acer negundo	6,5	11,1	17,6

Common ground cover classes (including cover types beneath trees and shrubs) in Connecting Nature Poznań are not available since they are configured not to be collected.

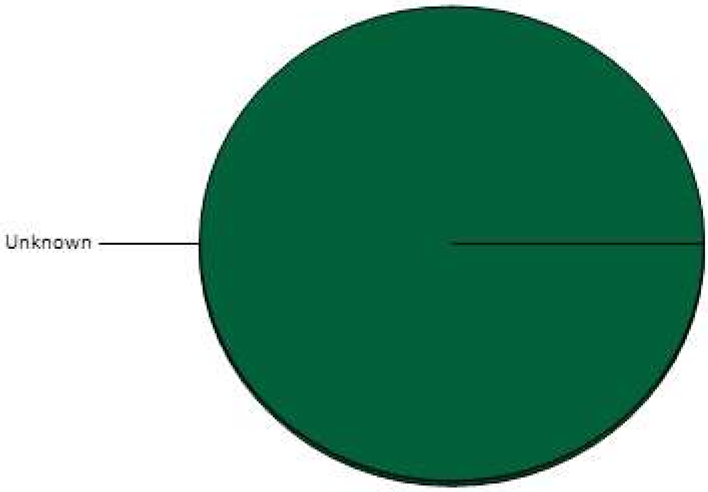


Figure 6. Percent of land by ground cover classes, Connecting Nature Poznań

III. Air Pollution Removal by Urban Trees

Poor air quality is a common problem in many urban areas. It can lead to decreased human health, damage to landscape materials and ecosystem processes, and reduced visibility. The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from the power sources. Trees also emit volatile organic compounds that can contribute to ozone formation. However, integrative studies have revealed that an increase in tree cover leads to reduced ozone formation (Nowak and Dwyer 2000).

Pollution removal[1] by trees in Connecting Nature Poznań was estimated using field data and recent available pollution and weather data available. Pollution removal was greatest for carbon monoxide (Figure 7). It is estimated that trees remove 0 metric tons of air pollution (ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO2), particulate matter less than 2.5 microns (PM2.5)[2], and sulfur dioxide (SO2)) per year with an associated value of z dashed l0 (see Appendix I for more details).

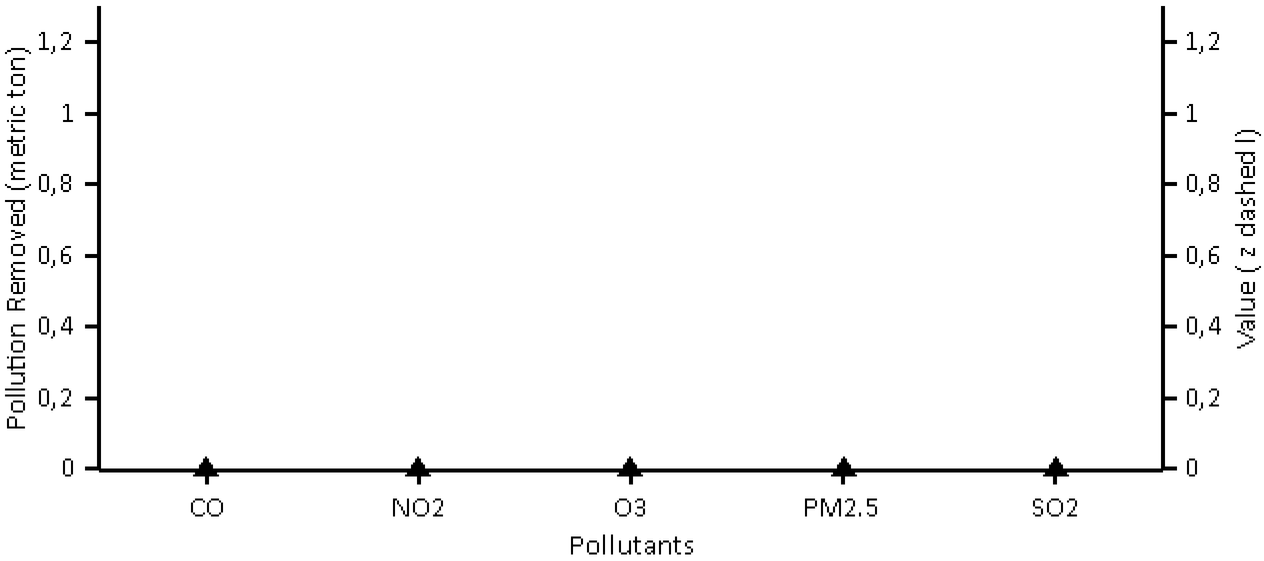


Figure 7. Annual pollution removal (points) and value (bars) by urban trees, Connecting Nature Poznań

[1] Particulate matter less than 10 microns is a significant air pollutant. Given that i-Tree Eco analyzes particulate matter less than 2.5 microns (PM2.5) which is a subset of PM10, PM10 has not been included in this analysis. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

[2] Trees remove PM2.5 when particulate matter is deposited on leaf surfaces. This deposited PM2.5 can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors (see Appendix I for more details).

In 2021, trees in Connecting Nature Poznań emitted an estimated 6,86 kilograms of volatile organic compounds (VOCs) (2,554 kilograms of isoprene and 4,306 kilograms of monoterpenes). Emissions vary among species based on species characteristics (e.g. some genera such as oaks are high isoprene emitters) and amount of leaf biomass. Ninety- one percent of the urban forest's VOC emissions were from Robinia pseudoacacia 'Frisia' and Acer negundo. These VOCs are precursor chemicals to ozone formation.[3]

General recommendations for improving air quality with trees are given in Appendix VIII.

[3] Some economic studies have estimated VOC emission costs. These costs are not included here as there is a tendency to add positive dollar estimates of ozone removal effects with negative dollar values of VOC emission effects to determine whether tree effects are positive or negative in relation to ozone. This combining of dollar values to determine tree effects should not be done, rather estimates of VOC effects on ozone formation (e.g., via photochemical models) should be conducted and directly contrasted with ozone removal by trees (i.e., ozone effects should be directly compared, not dollar estimates). In addition, air temperature reductions by trees have been shown to significantly reduce ozone concentrations (Cardelino and Chameides 1990; Nowak et al 2000), but are not considered in this analysis. Photochemical modeling that integrates tree effects on air temperature, pollution removal, VOC emissions, and emissions from power plants can be used to determine the overall effect of trees on ozone concentrations.

IV. Carbon Storage and Sequestration

Climate change is an issue of global concern. Urban trees can help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide) in tissue and by altering energy use in buildings, and consequently altering carbon dioxide emissions from fossil-fuel based power sources (Abdollahi et al 2000).

Trees reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. The amount of carbon annually sequestered is increased with the size and health of the trees. The gross sequestration of Connecting Nature Poznań trees is about 2,058 metric tons of carbon per year with an associated value of z dashed l1,43 thousand. See Appendix I for more details on methods.

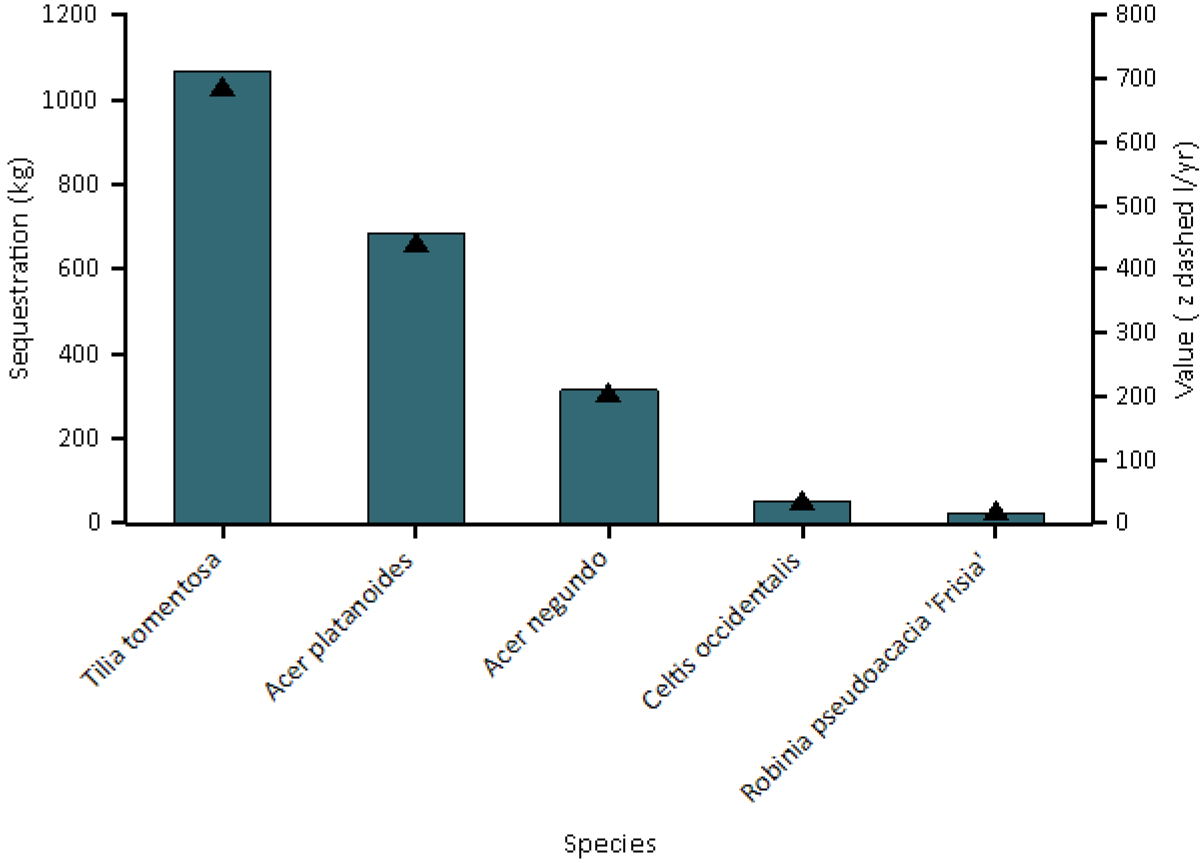


Figure 8. Estimated annual gross carbon sequestration (points) and value (bars) for urban tree species with the greatest sequestration, Connecting Nature Poznań

Carbon storage is another way trees can influence global climate change. As a tree grows, it stores more carbon by holding it in its accumulated tissue. As a tree dies and decays, it releases much of the stored carbon back into the atmosphere. Thus, carbon storage is an indication of the amount of carbon that can be released if trees are allowed to die and decompose. Maintaining healthy trees will keep the carbon stored in trees, but tree maintenance can contribute to carbon emissions (Nowak et al 2002c). When a tree dies, using the wood in long-term wood products, to heat buildings, or to produce energy will help reduce carbon emissions from wood decomposition or from fossil-fuel or wood-based power plants.

Trees in Connecting Nature Poznań are estimated to store 116 metric tons of carbon (z dashed l80,3 thousand). Of the species sampled, Robinia pseudoacacia 'Frisia' stores the most carbon (approximately 36,7% of the total carbon stored) and Tilia tomentosa sequesters the most (approximately 49,9% of all sequestered carbon.)

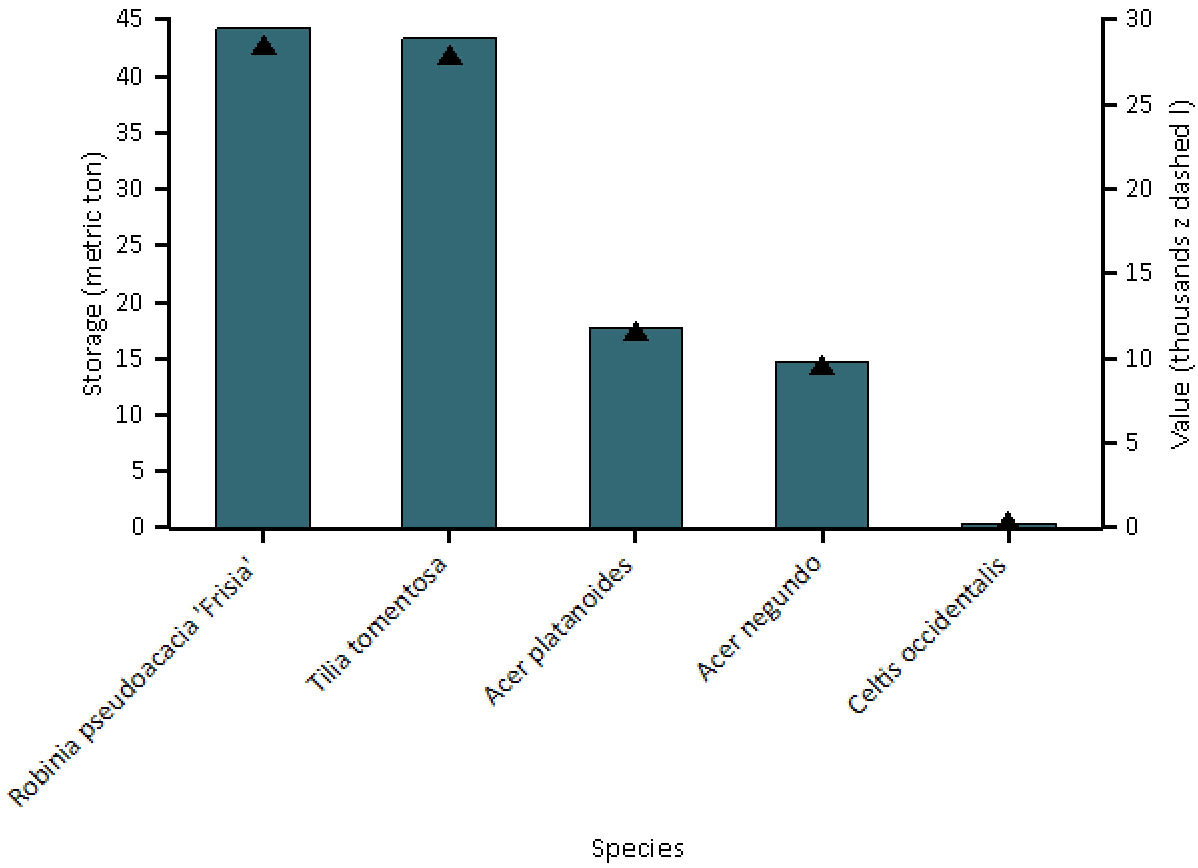


Figure 9. Estimated carbon storage (points) and values (bars) for urban tree species with the greatest storage, Connecting Nature Poznań

V. Oxygen Production

Oxygen production is one of the most commonly cited benefits of urban trees. The annual oxygen production of a tree is directly related to the amount of carbon sequestered by the tree, which is tied to the accumulation of tree biomass.

Trees in Connecting Nature Poznań are estimated to produce 5,487 metric tons of oxygen per year.[4] However, this tree benefit is relatively insignificant because of the large and relatively stable amount of oxygen in the atmosphere and extensive production by aquatic systems. Our atmosphere has an enormous reserve of oxygen. If all fossil fuel reserves, all trees, and all organic matter in soils were burned, atmospheric oxygen would only drop a few percent (Broecker 1970).

Table 2. The top 5 oxygen production species.

Species	*Oxygen (metric ton)*	*Gross Carbon Sequestration (kilogram/yr)*	*Number of Trees*	*Leaf Area (hectare)*
Tilia tomentosa	2,74	1 027,35	48	0,89
Acer platanoides	1,75	657,60	15	0,38
Acer negundo	0,81	302,50	7	0,23
Celtis occidentalis	0,13	48,96	22	0,02
Robinia pseudoacacia 'Frisia'	0,06	21,30	16	0,57

VI. Avoided Runoff

Surface runoff can be a cause for concern in many urban areas as it can contribute pollution to streams, wetlands, rivers, lakes, and oceans. During precipitation events, some portion of the precipitation is intercepted by vegetation (trees and shrubs) while the other portion reaches the ground. The portion of the precipitation that reaches the ground and does not infiltrate into the soil becomes surface runoff (Hirabayashi 2012). In urban areas, the large extent of impervious surfaces increases the amount of surface runoff.

Urban trees and shrubs, however, are beneficial in reducing surface runoff. Trees and shrubs intercept precipitation, while their root systems promote infiltration and storage in the soil. The trees and shrubs of Connecting Nature Poznań help to reduce runoff by an estimated 30,4 cubic meters a year with an associated value of z dashed l240 (see Appendix I for more details). Avoided runoff is estimated based on local weather from the user-designated weather station. In Connecting Nature Poznań, the total annual precipitation in 2018 was 37,6 centimeters.

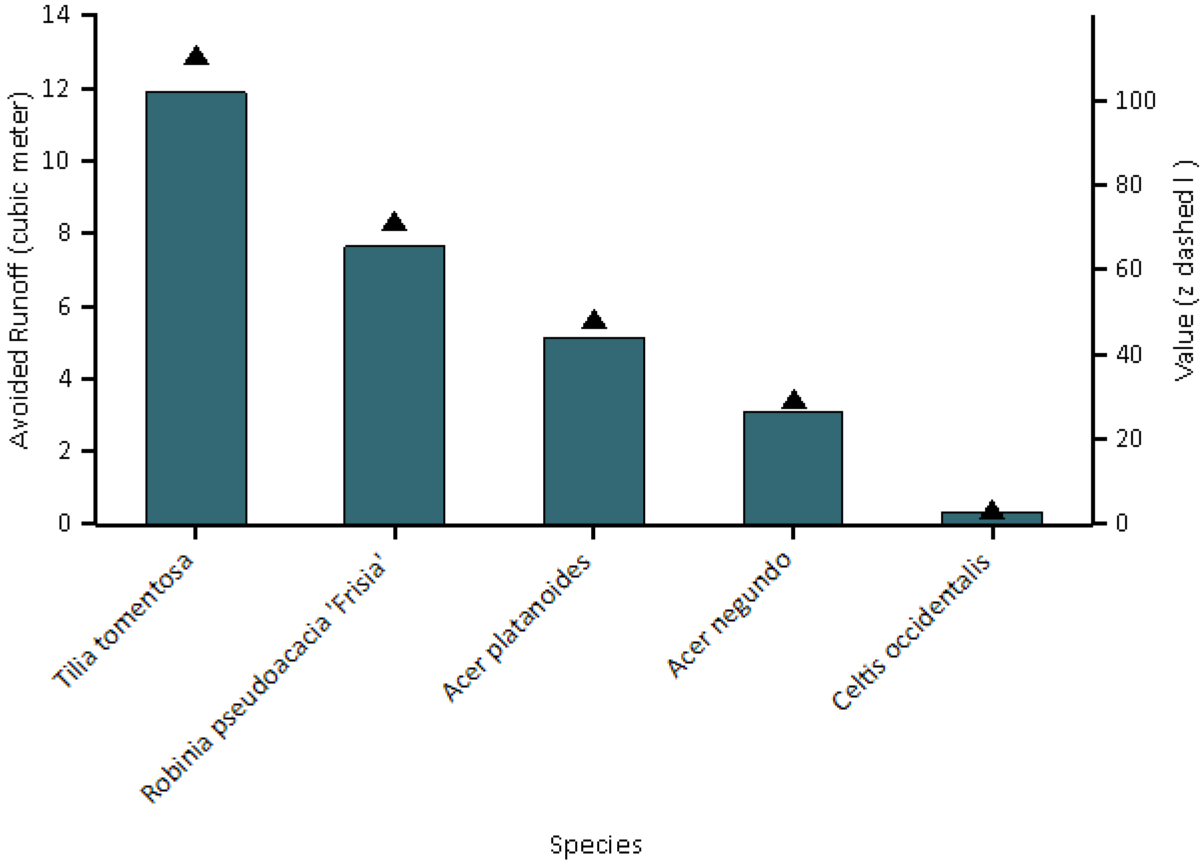


Figure 10. Avoided runoff (points) and value (bars) for species with greatest overall impact on runoff, Connecting Nature Poznań

VII. Trees and Building Energy Use

Trees affect energy consumption by shading buildings, providing evaporative cooling, and blocking winter winds. Trees tend to reduce building energy consumption in the summer months and can either increase or decrease building energy use in the winter months, depending on the location of trees around the building. Estimates of tree effects on energy use are based on field measurements of tree distance and direction to space conditioned residential buildings (McPherson and Simpson 1999).

Because energy-related data were not collected, energy savings and carbon avoided cannot be calculated.

Table 3. Annual energy savings due to trees near residential buildings, Connecting Nature Poznań

	Heating	*Cooling*	*Total*
MBTU[a]	0	N/A	0
MWH[b]	0	0	0
Carbon Avoided (kilograms)	0	0	0

[a]MBTU - one million British Thermal Units
[b]MWH - megawatt-hour

Table 4. Annual savings [a](z dashed l) in residential energy expenditure during heating and cooling seasons, Connecting Nature Poznań

	Heating	*Cooling*	*Total*
MBTU[b]	0	N/A	0
MWH[c]	0	0	0
Carbon Avoided	0	0	0

[b]Based on the prices of z dashed l690 per MWH and z dashed l51,7600001448934 per MBTU (see Appendix I for more details)
[c]MBTU - one million British Thermal Units
[c]MWH - megawatt-hour

[5] Trees modify climate, produce shade, and reduce wind speeds. Increased energy use or costs are likely due to these tree-building interactions creating a cooling effect during the winter season. For example, a tree (particularly evergreen species) located on the southern side of a residential building may produce a shading effect that causes increases in heating requirements.

VIII. Structural and Functional Values

Urban forests have a structural value based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform.

The structural value of an urban forest tends to increase with a rise in the number and size of healthy trees (Nowak et al 2002a). Annual functional values also tend to increase with increased number and size of healthy trees. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Urban trees in Connecting Nature Poznań have the following structural values:

- Structural value: z dashed l1,98 million
- Carbon storage: z dashed l80,3 thousand

Urban trees in Connecting Nature Poznań have the following annual functional values:

- Carbon sequestration: z dashed l1,43 thousand
- Avoided runoff: z dashed l241
- Pollution removal: z dashed l0
- Energy costs and carbon emission values: z dashed l0

(Note: negative value indicates increased energy cost and carbon emission value)

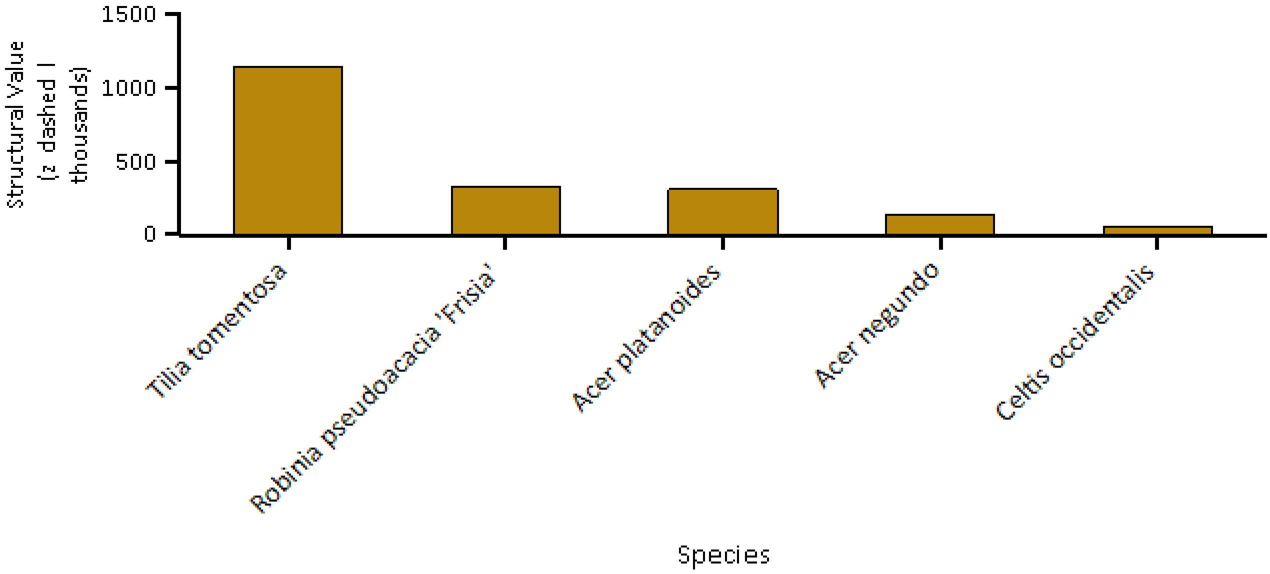


Figure 11. Tree species with the greatest structural value, Connecting Nature Poznań

IX. Potential Pest Impacts

Various insects and diseases can infest urban forests, potentially killing trees and reducing the health, structural value and sustainability of the urban forest. As pests tend to have differing tree hosts, the potential damage or risk of each pest will differ among cities.Thirty-six pests were analyzed for their potential impact.

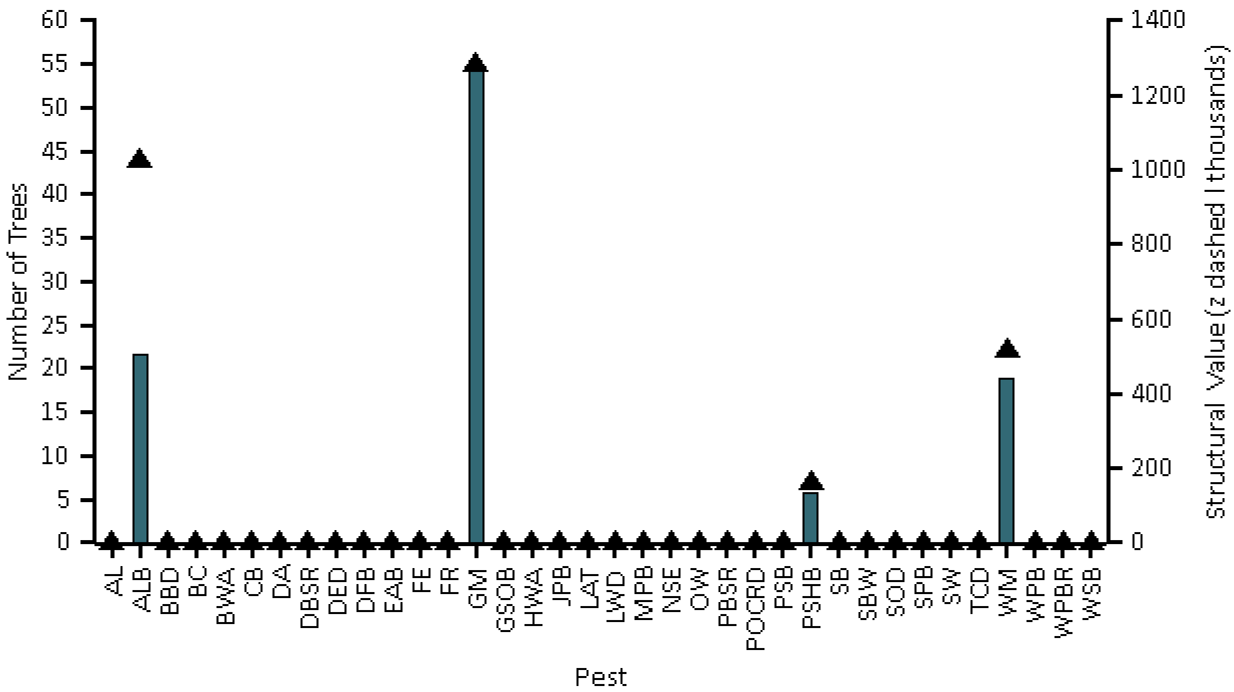


Figure 12. Number of trees at risk (points) and associated compensatory value (bars) by potential pests, Connecting Nature Poznań

Aspen leafminer (AL) (Kruse et al 2007) is an insect that causes damage primarily to trembling or small tooth aspen by larval feeding of leaf tissue. AL has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

Asian longhorned beetle (ALB) (Animal and Plant Health Inspection Service 2010) is an insect that bores into and kills a wide range of hardwood species. ALB poses a threat to 40,7 percent of the Connecting Nature Poznań urban forest, which represents a potential loss of z dashed l503 thousand in structural value.

Beech bark disease (BBD) (Houston and O’Brien 1983) is an insect-disease complex that primarily impacts American beech. This disease threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

Butternut canker (BC) (Ostry et al 1996) is caused by a fungus that infects butternut trees. The disease has since caused significant declines in butternut populations in the United States. Potential loss of trees from BC is 0,0 percent (z dashed l0 in structural value).

Balsam woolly adelgid (BWA) (Ragenovich and Mitchell 2006) is an insect that has caused significant damage to the true firs of North America. Connecting Nature Poznań could possibly lose 0,0 percent of its trees to this pest (z dashed l0 in structural value).

The most common hosts of the fungus that cause chestnut blight (CB) (Diller 1965) are American and European chestnut. CB has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

Dogwood anthracnose (DA) (Mielke and Daughtrey) is a disease that affects dogwood species, specifically flowering and Pacific dogwood. This disease threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

Douglas-fir black stain root disease (DBSR) (Hessburg et al 1995) is a variety of the black stain fungus that attacks Douglas-firs. Connecting Nature Poznań could possibly lose 0,0 percent of its trees to this pest (z dashed l0 in structural value).

American elm, one of the most important street trees in the twentieth century, has been devastated by the Dutch elm disease (DED) (Northeastern Area State and Private Forestry 1998). Since first reported in the 1930s, it has killed over 50 percent of the native elm population in the United States. Although some elm species have shown varying degrees of resistance, Connecting Nature Poznań could possibly lose 0,0 percent of its trees to this pest (z dashed l0 in structural value).

Douglas-fir beetle (DFB) (Schmitz and Gibson 1996) is a bark beetle that infests Douglas-fir trees throughout the western United States, British Columbia, and Mexico. Potential loss of trees from DFB is 0,0 percent (z dashed l0 in structural value).

Emerald ash borer (EAB) (Michigan State University 2010) has killed thousands of ash trees in parts of the United States. EAB has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

One common pest of white fir, grand fir, and red fir trees is the fir engraver (FE) (Ferrell 1986). FE poses a threat to 0,0 percent of the Connecting Nature Poznań urban forest, which represents a potential loss of z dashed l0 in structural value.

Fusiform rust (FR) (Phelps and Czabator 1978) is a fungal disease that is distributed in the southern United States. It is particularly damaging to slash pine and loblolly pine. FR has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

The gypsy moth (GM) (Northeastern Area State and Private Forestry 2005) is a defoliator that feeds on many species causing widespread defoliation and tree death if outbreak conditions last several years. This pest threatens 50,9 percent of the population, which represents a potential loss of z dashed l1,28 million in structural value.

Infestations of the goldspotted oak borer (GSOB) (Society of American Foresters 2011) have been a growing problem in southern California. Potential loss of trees from GSOB is 0,0 percent (z dashed l0 in structural value).

As one of the most damaging pests to eastern hemlock and Carolina hemlock, hemlock woolly adelgid (HWA) (U.S. Forest Service 2005) has played a large role in hemlock mortality in the United States. HWA has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

The Jeffrey pine beetle (JPB) (Smith et al 2009) is native to North America and is distributed across California, Nevada, and Oregon where its only host, Jeffrey pine, also occurs. This pest threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

Quaking aspen is a principal host for the defoliator, large aspen tortrix (LAT) (Ciesla and Kruse 2009). LAT poses a threat to 0,0 percent of the Connecting Nature Poznań urban forest, which represents a potential loss of z dashed l0 in structural value.

Laurel wilt (LWD) (U.S. Forest Service 2011) is a fungal disease that is introduced to host trees by the redbay ambrosia beetle. This pest threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

Mountain pine beetle (MPB) (Gibson et al 2009) is a bark beetle that primarily attacks pine species in the western United States. MPB has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

The northern spruce engraver (NSE) (Burnside et al 2011) has had a significant impact on the boreal and sub-boreal forests of North America where the pest's distribution overlaps with the range of its major hosts. Potential loss of trees from NSE is 0,0 percent (z dashed l0 in structural value).

Oak wilt (OW) (Rexrode and Brown 1983), which is caused by a fungus, is a prominent disease among oak trees. OW poses a threat to 0,0 percent of the Connecting Nature Poznań urban forest, which represents a potential loss of z dashed l0 in structural value.

Pine black stain root disease (PBSR) (Hessburg et al 1995) is a variety of the black stain fungus that attacks hard pines, including lodgepole pine, Jeffrey pine, and ponderosa pine. Connecting Nature Poznań could possibly lose 0,0 percent of its trees to this pest (z dashed l0 in structural value).

Port-Orford-cedar root disease (POCRD) (Liebhold 2010) is a root disease that is caused by a fungus. POCRD threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

The pine shoot beetle (PSB) (Ciesla 2001) is a wood borer that attacks various pine species, though Scotch pine is the preferred host in North America. PSB has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

Polyphagous shot hole borer (PSHB) (University of California 2014) is a boring beetle that was first detected in California. Connecting Nature Poznań could possibly lose 6,5 percent of its trees to this pest (z dashed l134 thousand in structural value).

Spruce beetle (SB) (Holsten et al 1999) is a bark beetle that causes significant mortality to spruce species within its range. Potential loss of trees from SB is 0,0 percent (z dashed l0 in structural value).

Spruce budworm (SBW) (Kucera and Orr 1981) is an insect that causes severe damage to balsam fir. SBW poses a threat to 0,0 percent of the Connecting Nature Poznań urban forest, which represents a potential loss of z dashed l0 in structural value.

Sudden oak death (SOD) (Kliejunas 2005) is a disease that is caused by a fungus. Potential loss of trees from SOD is 0,0 percent (z dashed l0 in structural value).

Although the southern pine beetle (SPB) (Clarke and Nowak 2009) will attack most pine species, its preferred hosts are loblolly, Virginia, pond, spruce, shortleaf, and sand pines. This pest threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

The sirex woodwasp (SW) (Haugen and Hoebeke 2005) is a wood borer that primarily attacks pine species. SW poses a threat to 0,0 percent of the Connecting Nature Poznań urban forest, which represents a potential loss of z dashed l0 in structural value.

Thousand canker disease (TCD) (Cranshaw and Tisserat 2009; Seybold et al 2010) is an insect-disease complex that kills several species of walnuts, including black walnut. Potential loss of trees from TCD is 0,0 percent (z dashed l0 in structural value).

Winter moth (WM) (Childs 2011) is a pest with a wide range of host species. WM causes the highest levels of injury to its hosts when it is in its caterpillar stage. Connecting Nature Poznań could possibly lose 20,4 percent of its trees to this pest (z dashed l442 thousand in structural value).

The western pine beetle (WPB) (DeMars and Roettgering 1982) is a bark beetle and aggressive attacker of ponderosa and Coulter pines. This pest threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

Since its introduction to the United States in 1900, white pine blister rust (Eastern U.S.) (WPBR) (Nicholls and Anderson 1977) has had a detrimental effect on white pines, particularly in the Lake States. WPBR has the potential to affect 0,0 percent of the population (z dashed l0 in structural value).

Western spruce budworm (WSB) (Fellin and Dewey 1986) is an insect that causes defoliation in western conifers. This pest threatens 0,0 percent of the population, which represents a potential loss of z dashed l0 in structural value.

Appendix I. i-Tree Eco Model and Field Measurements

i-Tree Eco is designed to use standardized field data and local hourly air pollution and meteorological data to quantify urban forest structure and its numerous effects (Nowak and Crane 2000), including:

- Urban forest structure (e.g., species composition, tree health, leaf area, etc.).
- Amount of pollution removed hourly by the urban forest, and its associated percent air quality improvement throughout a year.
- Total carbon stored and net carbon annually sequestered by the urban forest.
- Effects of trees on building energy use and consequent effects on carbon dioxide emissions from power sources.
- Structural value of the forest, as well as the value for air pollution removal and carbon storage and sequestration.
- Potential impact of infestations by pests, such as Asian longhorned beetle, emerald ash borer, gypsy moth, and Dutch elm disease.

Typically, all field data are collected during the leaf-on season to properly assess tree canopies. Typical data collection (actual data collection may vary depending upon the user) includes land use, ground and tree cover, individual tree attributes of species, stem diameter, height, crown width, crown canopy missing and dieback, and distance and direction to residential buildings (Nowak et al 2005; Nowak et al 2008).

During data collection, trees are identified to the most specific taxonomic classification possible. Trees that are not classified to the species level may be classified by genus (e.g., ash) or species groups (e.g., hardwood). In this report, tree species, genera, or species groups are collectively referred to as tree species.

<u>Tree Characteristics:</u>

Leaf area of trees was assessed using measurements of crown dimensions and percentage of crown canopy missing. In the event that these data variables were not collected, they are estimated by the model.

An analysis of invasive species is not available for studies outside of the United States. For the U.S., invasive species are identified using an invasive species list for the state in which the urban forest is located. These lists are not exhaustive and they cover invasive species of varying degrees of invasiveness and distribution. In instances where a state did not have an invasive species list, a list was created based on the lists of the adjacent states. Tree species that are identified as invasive by the state invasive species list are cross-referenced with native range data. This helps eliminate species that are on the state invasive species list, but are native to the study area.

<u>Air Pollution Removal:</u>

Pollution removal is calculated for ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide and particulate matter less than 2.5 microns. Particulate matter less than 10 microns (PM10) is another significant air pollutant. Given that i-Tree Eco analyzes particulate matter less than 2.5 microns (PM2.5) which is a subset of PM10, PM10 has not been included in this analysis. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

Air pollution removal estimates are derived from calculated hourly tree-canopy resistances for ozone, and sulfur and nitrogen dioxides based on a hybrid of big-leaf and multi-layer canopy deposition models (Baldocchi 1988; Baldocchi et al 1987). As the removal of carbon monoxide and particulate matter by vegetation is not directly related to transpiration, removal rates (deposition velocities) for these pollutants were based on average measured values from the literature (Bidwell and Fraser 1972; Lovett 1994) that were adjusted depending on leaf phenology and leaf area. Particulate removal incorporated a 50 percent resuspension rate of particles back to the atmosphere (Zinke 1967). Recent updates (2011) to air quality modeling are based on improved leaf area index simulations, weather and pollution processing and interpolation, and updated pollutant monetary values (Hirabayashi et al 2011; Hirabayashi et al 2012; Hirabayashi 2011).

Trees remove PM2.5 when particulate matter is deposited on leaf surfaces (Nowak et al 2013). This deposited PM2.5 can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors. Generally, PM2.5 removal is positive with positive benefits. However, there are some cases when net removal is negative or resuspended particles lead to increased pollution concentrations and negative values. During some months (e.g., with no rain), trees resuspend more particles than they remove. Resuspension can also lead to increased overall PM2.5 concentrations if the boundary layer conditions are lower during net resuspension periods than during net removal periods. Since the pollution removal value is based on the change in pollution concentration, it is possible to have situations when trees remove PM2.5 but increase concentrations and thus have negative values during periods of positive overall removal. These events are not common, but can happen.

For reports in the United States, default air pollution removal value is calculated based on local incidence of adverse health effects and national median externality costs. The number of adverse health effects and associated economic value is calculated for ozone, sulfur dioxide, nitrogen dioxide, and particulate matter less than 2.5 microns using data from the U.S. Environmental Protection Agency's Environmental Benefits Mapping and Analysis Program (BenMAP) (Nowak et al 2014). The model uses a damage-function approach that is based on the local change in pollution concentration and population. National median externality costs were used to calculate the value of carbon monoxide removal (Murray et al 1994).

For international reports, user-defined local pollution values are used. For international reports that do not have local values, estimates are based on either European median externality values (van Essen et al 2011) or BenMAP regression equations (Nowak et al 2014) that incorporate user-defined population estimates. Values are then converted to local currency with user-defined exchange rates.

For this analysis, pollution removal value is calculated based on the prices of z dashed l0 per metric ton (carbon monoxide), z dashed l0 per metric ton (ozone), z dashed l0 per metric ton (nitrogen dioxide), z dashed l0 per metric ton (sulfur dioxide), z dashed l0 per metric ton (particulate matter less than 2.5 microns).

<u>Carbon Storage and Sequestration:</u>

Carbon storage is the amount of carbon bound up in the above-ground and below-ground parts of woody vegetation. To calculate current carbon storage, biomass for each tree was calculated using equations from the literature and measured tree data. Open-grown, maintained trees tend to have less biomass than predicted by forest-derived biomass equations (Nowak 1994). To adjust for this difference, biomass results for open-grown urban trees were multiplied by 0.8. No adjustment was made for trees found in natural stand conditions. Tree dry-weight biomass was converted to stored carbon by multiplying by 0.5.

Carbon sequestration is the removal of carbon dioxide from the air by plants. To estimate the gross amount of carbon sequestered annually, average diameter growth from the appropriate genera and diameter class and tree condition was added to the existing tree diameter (year x) to estimate tree diameter and carbon storage in year x +1.

Carbon storage and carbon sequestration values are based on estimated or customized local carbon values. For international reports that do not have local values, estimates are based on the carbon value for the United States (U.S. Environmental Protection Agency 2015, Interagency Working Group on Social Cost of Carbon 2015) and converted to local currency with user-defined exchange rates.

For this analysis, carbon storage and carbon sequestration values are calculated based on z dashed l693 per metric ton.

<u>Oxygen Production:</u>

The amount of oxygen produced is estimated from carbon sequestration based on atomic weights: net O2 release (kg/yr) = net C sequestration (kg/yr) × 32/12. To estimate the net carbon sequestration rate, the amount of carbon sequestered as a result of tree growth is reduced by the amount lost resulting from tree mortality. Thus, net carbon sequestration and net annual oxygen production of the urban forest account for decomposition (Nowak et al 2007). For complete inventory projects, oxygen production is estimated from gross carbon sequestration and does not account for decomposition.

Avoided Runoff:

Annual avoided surface runoff is calculated based on rainfall interception by vegetation, specifically the difference between annual runoff with and without vegetation. Although tree leaves, branches, and bark may intercept precipitation and thus mitigate surface runoff, only the precipitation intercepted by leaves is accounted for in this analysis.

The value of avoided runoff is based on estimated or user-defined local values. For international reports that do not have local values, the national average value for the United States is utilized and converted to local currency with user-defined exchange rates. The U.S. value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series (McPherson et al 1999; 2000; 2001; 2002; 2003; 2004; 2006a; 2006b; 2006c; 2007; 2010; Peper et al 2009; 2010; Vargas et al 2007a; 2007b; 2008).

For this analysis, avoided runoff value is calculated based on the price of z dashed l7,93 per m³.

Building Energy Use:

If appropriate field data were collected, seasonal effects of trees on residential building energy use were calculated based on procedures described in the literature (McPherson and Simpson 1999) using distance and direction of trees from residential structures, tree height and tree condition data. To calculate the monetary value of energy savings, local or custom prices per MWH or MBTU are utilized.

For this analysis, energy saving value is calculated based on the prices of z dashed l690,00 per MWH and z dashed l51,76 per MBTU.

Structural Values:

Structural value is the value of a tree based on the physical resource itself (e.g., the cost of having to replace a tree with a similar tree). Structural values were based on valuation procedures of the Council of Tree and Landscape Appraisers, which uses tree species, diameter, condition, and location information (Nowak et al 2002a; 2002b). Structural value may not be included for international projects if there is insufficient local data to complete the valuation procedures.

Potential Pest Impacts:

The complete potential pest risk analysis is not available for studies outside of the United States. The number of trees at risk to the pests analyzed is reported, though the list of pests is based on known insects and disease in the United States.

For the U.S., potential pest risk is based on pest range maps and the known pest host species that are likely to experience mortality. Pest range maps for 2012 from the Forest Health Technology Enterprise Team (FHTET) (Forest Health Technology Enterprise Team 2014) were used to determine the proximity of each pest to the county in which the urban forest is located. For the county, it was established whether the insect/disease occurs within the county, is within 400 kilometers of the county edge, is between 400 and 1210 kilometers away, or is greater than 1210 kilometers away. FHTET did not have pest range maps for Dutch elm disease and chestnut blight. The range of these pests was based on known occurrence and the host range, respectively (Eastern Forest Environmental Threat Assessment Center; Worrall 2007).

Relative Tree Effects:

The relative value of tree benefits reported in Appendix II is calculated to show what carbon storage and sequestration, and air pollutant removal equate to in amounts of municipal carbon emissions, passenger automobile emissions, and house emissions.

Municipal carbon emissions are based on 2010 U.S. per capita carbon emissions (Carbon Dioxide Information Analysis Center 2010). Per capita emissions were multiplied by city population to estimate total city carbon emissions.

Light duty vehicle emission rates (g/mi) for CO, NOx, VOCs, PM10, SO2 for 2010 (Bureau of Transportation Statistics 2010; Heirigs et al 2004), PM2.5 for 2011-2015 (California Air Resources Board 2013), and CO2 for 2011 (U.S. Environmental Protection Agency 2010) were multiplied by average miles driven per vehicle in 2011 (Federal Highway Administration 2013) to determine average emissions per vehicle.

Household emissions are based on average electricity kWh usage, natural gas Btu usage, fuel oil Btu usage, kerosene Btu usage, LPG Btu usage, and wood Btu usage per household in 2009 (Energy Information Administration 2013; Energy Information Administration 2014)

- CO2, SO2, and NOx power plant emission per KWh are from Leonardo Academy 2011. CO emission per kWh assumes 1/3 of one percent of C emissions is CO based on Energy Information Administration 1994. PM10 emission per kWh from Layton 2004.
- CO2, NOx, SO2, and CO emission per Btu for natural gas, propane and butane (average used to represent LPG), Fuel #4 and #6 (average used to represent fuel oil and kerosene) from Leonardo Academy 2011.
- CO2 emissions per Btu of wood from Energy Information Administration 2014.
- CO, NOx and SOx emission per Btu based on total emissions and wood burning (tons) from (British Columbia Ministry 2005; Georgia Forestry Commission 2009).

Appendix II. Relative Tree Effects

The urban forest in Connecting Nature Poznań provides benefits that include carbon storage and sequestration, and air pollutant removal. To estimate the relative value of these benefits, tree benefits were compared to estimates of average municipal carbon emissions, average passenger automobile emissions, and average household emissions. See Appendix I for methodology.

<u>Carbon storage is equivalent to:</u>

- Amount of carbon emitted in Connecting Nature Poznań in 0 days
- Annual carbon (C) emissions from 90 automobiles
- Annual C emissions from 37 single-family houses

<u>Carbon monoxide removal is equivalent to:</u>

- Annual carbon monoxide emissions from 0 automobiles
- Annual carbon monoxide emissions from 0 single-family houses

<u>Nitrogen dioxide removal is equivalent to:</u>

- Annual nitrogen dioxide emissions from 0 automobiles
- Annual nitrogen dioxide emissions from 0 single-family houses

<u>Sulfur dioxide removal is equivalent to:</u>

- Annual sulfur dioxide emissions from 0 automobiles
- Annual sulfur dioxide emissions from 0 single-family houses

<u>Annual carbon sequestration is equivalent to:</u>

- Amount of carbon emitted in Connecting Nature Poznań in 0,0 days
- Annual C emissions from 0 automobiles
- Annual C emissions from 0 single-family houses

Appendix III. Comparison of Urban Forests

A common question asked is, "How does this city compare to other cities?" Although comparison among cities should be made with caution as there are many attributes of a city that affect urban forest structure and functions, summary data are provided from other cities analyzed using the i-Tree Eco model.

I. City totals for trees

City	*% Tree Cover*	*Number of Trees*	*Carbon Storage (metric tons)*	*Carbon Sequestration (metric tons/yr)*	*Pollution Removal (metric tons/yr)*
Toronto, ON, Canada	26,6	10 220 000	1 108 000	46 700	1 905
Atlanta, GA	36,7	9 415 000	1 220 000	42 100	1 509
Los Angeles, CA	11,1	5 993 000	1 151 000	69 800	1 792
New York, NY	20,9	5 212 000	1 225 000	38 400	1 521
London, ON, Canada	24,7	4 376 000	360 000	12 500	370
Chicago, IL	17,2	3 585 000	649 000	22 800	806
Phoenix, AZ	9,0	3 166 000	286 000	29 800	511
Baltimore, MD	21,0	2 479 000	517 000	16 700	390
Philadelphia, PA	15,7	2 113 000	481 000	14 600	522
Washington, DC	28,6	1 928 000	477 000	14 700	379
Oakville, ON , Canada	29,1	1 908 000	133 000	6 000	172
Albuquerque, NM	14,3	1 846 000	301 000	9 600	225
Boston, MA	22,3	1 183 000	290 000	9 500	257
Syracuse, NY	26,9	1 088 000	166 000	5 300	99
Woodbridge, NJ	29,5	986 000	145 000	5 000	191
Minneapolis, MN	26,4	979 000	227 000	8 100	277
San Francisco, CA	11,9	668 000	176 000	4 600	128
Morgantown, WV	35,5	658 000	84 000	2 600	65
Moorestown, NJ	28,0	583 000	106 000	3 400	107
Hartford, CT	25,9	568 000	130 000	3 900	52
Jersey City, NJ	11,5	136 000	19 000	800	37
Casper, WY	8,9	123 000	34 000	1 100	34
Freehold, NJ	34,4	48 000	18 000	500	20

II. Totals per hectare of land area

City	*Number of Trees/ha*	*Carbon Storage (metric tons/ha)*	*Carbon Sequestration (metric tons/ha/yr)*	*Pollution Removal (kg/ha/yr)*
Toronto, ON, Canada	160,4	17,4	0,73	29,9
Atlanta, GA	275,8	35,7	1,23	44,2
Los Angeles, CA	48,4	9,4	0,36	14,7
New York, NY	65,2	15,3	0,48	19,0
London, ON, Canada	185,5	15,3	0,53	15,7
Chicago, IL	59,9	10,9	0,38	13,5
Phoenix, AZ	31,8	2,9	0,30	5,1
Baltimore, MD	118,5	25,0	0,80	18,6
Philadelphia, PA	61,9	14,1	0,43	15,3
Washington, DC	121,1	29,8	0,92	23,8
Oakville, ON , Canada	192,9	13,4	0,61	12,4
Albuquerque, NM	53,9	8,8	0,28	6,6
Boston, MA	82,9	20,3	0,67	18,0
Syracuse, NY	167,4	23,1	0,77	15,2
Woodbridge, NJ	164,4	24,2	0,84	31,9
Minneapolis, MN	64,8	15,0	0,53	18,3
San Francisco, CA	55,7	14,7	0,39	10,7
Morgantown, WV	294,5	37,7	1,17	29,2
Moorestown, NJ	153,4	27,9	0,90	28,1
Hartford, CT	124,6	28,5	0,86	11,5
Jersey City, NJ	35,5	5,0	0,21	9,6
Casper, WY	22,5	6,2	0,20	6,2
Freehold, NJ	94,6	35,9	0,98	39,6

Appendix IV. General Recommendations for Air Quality Improvement

Urban vegetation can directly and indirectly affect local and regional air quality by altering the urban atmosphere environment. Four main ways that urban trees affect air quality are (Nowak 1995):

- Temperature reduction and other microclimate effects
- Removal of air pollutants
- Emission of volatile organic compounds (VOC) and tree maintenance emissions
- Energy effects on buildings

The cumulative and interactive effects of trees on climate, pollution removal, and VOC and power plant emissions determine the impact of trees on air pollution. Cumulative studies involving urban tree impacts on ozone have revealed that increased urban canopy cover, particularly with low VOC emitting species, leads to reduced ozone concentrations in cities (Nowak 2000). Local urban management decisions also can help improve air quality.

Urban forest management strategies to help improve air quality include (Nowak 2000):

Strategy	*Result*
Increase the number of healthy trees	Increase pollution removal
Sustain existing tree cover	Maintain pollution removal levels
Maximize use of low VOC-emitting trees	Reduces ozone and carbon monoxide formation
Sustain large, healthy trees	Large trees have greatest per-tree effects
Use long-lived trees	Reduce long-term pollutant emissions from planting and removal
Use low maintenance trees	Reduce pollutants emissions from maintenance activities
Reduce fossil fuel use in maintaining vegetation	Reduce pollutant emissions
Plant trees in energy conserving locations	Reduce pollutant emissions from power plants
Plant trees to shade parked cars	Reduce vehicular VOC emissions
Supply ample water to vegetation	Enhance pollution removal and temperature reduction
Plant trees in polluted or heavily populated areas	Maximizes tree air quality benefits
Avoid pollutant-sensitive species	Improve tree health
Utilize evergreen trees for particulate matter	Year-round removal of particles

Appendix V. Invasive Species of the Urban Forest

Invasive species data is only available for the United States. This analysis cannot be completed for international studies because of a lack of necessary data.

Appendix VI. Potential Risk of Pests

Pest range data is only available for the United States. This analysis cannot be completed for international studies because of a lack of necessary data.

References

Abdollahi, K.K.; Ning, Z.H.; Appeaning, A., eds. 2000. Global climate change and the urban forest. Baton Rouge, LA: GCRCC and Franklin Press. 77 p.

Animal and Plant Health Inspection Service. 2010. Plant Health – Asian longhorned beetle. Washington, DC: U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

Baldocchi, D. 1988. A multi-layer model for estimating sulfur dioxide deposition to a deciduous oak forest canopy. Atmospheric Environment. 22: 869-884.

Baldocchi, D.D.; Hicks, B.B.; Camara, P. 1987. A canopy stomatal resistance model for gaseous deposition to vegetated surfaces. Atmospheric Environment. 21: 91-101.

Bidwell, R.G.S.; Fraser, D.E. 1972. Carbon monoxide uptake and metabolism by leaves. Canadian Journal of Botany. 50: 1435-1439.

British Columbia Ministry of Water, Land, and Air Protection. 2005. Residential wood burning emissions in British Columbia. British Columbia.

Broecker, W.S. 1970. Man's oxygen reserve. Science 168(3939): 1537-1538.

Bureau of Transportation Statistics. 2010. Estimated National Average Vehicle Emissions Rates per Vehicle by Vehicle Type using Gasoline and Diesel. Washington, DC: Burea of Transportation Statistics, U.S. Department of Transportation. Table 4-43.

Burnside, R.E.; Holsten, E. H.; Fettig, C.J.; Kruse, J. J.; Schultz, M.E.; Hayes, C.J.; Graves, A.D.; Seybold, S.J. 2011. Northern Spruce Engraver. Forest Insect & Disease Leaflet 180. Washington, DC: U. S. Department of Agriculture, Forest Service. 12 p.

California Air Resources Board. 2013. Methods to Find the Cost-Effectiveness of Funding Air Quality Projects. Table 3 Average Auto Emission Factors. CA: California Environmental Protection Agency, Air Resources Board.

Carbon Dioxide Information Analysis Center. 2010. CO2 Emissions (metric tons per capita). Washington, DC: The World Bank.

Cardelino, C.A.; Chameides, W.L. 1990. Natural hydrocarbons, urbanization, and urban ozone. Journal of Geophysical Research. 95(D9): 13,971-13,979.

Childs, R. 2011. Winter Moth Identification and Management. Amherst, MA: University of Massachusetts Amherst, Landscape, Nursery & Urban Forestry Program.

Ciesla, W. M. 2001. Tomicus piniperda. North American Forest Commission. Exotic Forest Pest Information System for North America (EXFOR).

Ciesla, W. M.; Kruse, J. J. 2009. Large Aspen Tortrix. Forest Insect & Disease Leaflet 139. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Clarke, S. R.; Nowak, J.T. 2009. Southern Pine Beetle. Forest Insect & Disease Leaflet 49. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

Cranshaw, W.; Tisserat, N. 2009. Walnut twig beetle and the thousand cankers disease of black walnut. Pest Alert.

Ft. Collins, CO: Colorado State University.

Seybold, S.; Haugen, D.; Graves, A. 2010. Thousand Cankers Disease. Pest Alert. NA-PR-02-10. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

DeMars, C. J., Jr.; Roettgering, B. H. 1982. Western Pine Beetle. Forest Insect & Disease Leaflet 1. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

Diller, J. D. 1965. Chestnut Blight. Forest Pest Leaflet 94. Washington, DC: U. S. Department of Agriculture, Forest Service. 7 p.

Eastern Forest Environmental Threat Assessment Center. Dutch Elm Disease. http://threatsummary.forestthreats.org/threats/threatSummaryViewer.cfm?threatID=43

Energy Information Administration. 1994. Energy Use and Carbon Emissions: Non-OECD Countries. Washington, DC: Energy Information Administration, U.S. Department of Energy.

Energy Information Administration. 2013. CE2.1 Fuel consumption totals and averages, U.S. homes. Washington, DC: Energy Information Administration, U.S. Department of Energy.

Energy Information Administration. 2014. CE5.2 Household wood consumption. Washington, DC: Energy Information Administration, U.S. Department of Energy.

Federal Highway Administration. 2013. Highway Statistics 2011.Washington, DC: Federal Highway Administration, U.S. Department of Transportation. Table VM-1.

Fellin, D. G.; Dewey, J. E. 1986. Western Spruce Budworm. Forest Insect & Disease Leaflet 53. Washington, DC: U.S. Department of Agriculture, Forest Service. 10 p.

Ferrell, G. T. 1986. Fir Engraver. Forest Insect & Disease Leaflet 13. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Georgia Forestry Commission. 2009. Biomass Energy Conversion for Electricity and Pellets Worksheet. Dry Branch, GA: Georgia Forestry Commission.

Gibson, K.; Kegley, S.; Bentz, B. 2009. Mountain Pine Beetle. Forest Insect & Disease Leaflet 2. Washington, DC: U. S. Department of Agriculture, Forest Service. 12 p.

Haugen, D. A.; Hoebeke, R. E. 2005. Sirex woodwasp - Sirex noctilio F. (Hymenoptera: Siricidae). Pest Alert. NA-PR-07-05. Newtown Square, PA: Department of Agriculture, Forest Service, Northern Area State and Private Forestry.

Heirigs, P.L.; Delaney, S.S.; Dulla, R.G. 2004. Evaluation of MOBILE Models: MOBILE6.1 (PM), MOBILE6.2 (Toxics), and MOBILE6/CNG. Sacramento, CA: National Cooperative Highway Research Program, Transportation Research Board.

Hessburg, P. F.; Goheen, D. J.; Bega, R.V. 1995. Black Stain Root Disease of Conifers. Forest Insect & Disease Leaflet 145. Washington, DC: U.S. Department of Agriculture, Forest Service.

Hessburg, P. F.; Goheen, D. J.; Bega, R.V. 1995. Black Stain Root Disease of Conifers. Forest Insect & Disease Leaflet 145. Washington, DC: U.S. Department of Agriculture, Forest Service.

Hirabayashi, S. 2011. Urban Forest Effects-Dry Deposition (UFORE-D) Model Enhancements, http://www.itreetools.org/eco/resources/UFORE-D enhancements.pdf

Hirabayashi, S. 2012. i-Tree Eco Precipitation Interception Model Descriptions, http://www.itreetools.org/eco/resources/iTree_Eco_Precipitation_Interception_Model_Descriptions_V1_2.pdf

Hirabayashi, S.; Kroll, C.; Nowak, D. 2011. Component-based development and sensitivity analyses of an air pollutant dry deposition model. Environmental Modeling and Software. 26(6): 804-816.

Hirabayashi, S.; Kroll, C.; Nowak, D. 2012. i-Tree Eco Dry Deposition Model Descriptions V 1.0

Holsten, E.H.; Thier, R.W.; Munson, A.S.; Gibson, K.E. 1999. The Spruce Beetle. Forest Insect & Disease Leaflet 127. Washington, DC: U.S. Department of Agriculture, Forest Service. 12 p.

Houston, D. R.; O'Brien, J. T. 1983. Beech Bark Disease. Forest Insect & Disease Leaflet 75. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Interagency Working Group on Social Cost of Carbon, United States Government. 2015. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. http://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf

Kliejunas, J. 2005. Phytophthora ramorum. North American Forest Commission. Exotic Forest Pest Information System for North America (EXFOR).

Kruse, J.; Ambourn, A.; Zogas, K. 2007. Aspen Leaf Miner. Forest Health Protection leaflet. R10-PR-14. Juneau, AK: U. S. Department of Agriculture, Forest Service, Alaska Region.

Kucera, D. R.; Orr, P. W. 1981. Spruce Budworm in the Eastern United States. Forest Pest Leaflet 160. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.

Layton, M. 2004. 2005 Electricity Environmental Performance Report: Electricity Generation and Air Emissions. CA: California Energy Commission.

Leonardo Academy. 2011. Leonardo Academy's Guide to Calculating Emissions Including Emission Factors and Energy Prices. Madison, WI: Leonardo Academy Inc.

Liebhold, A. 2010 draft. Personal communication on the geographic distribution of forest pest species.

Lovett, G.M. 1994. Atmospheric deposition of nutrients and pollutants in North America: an ecological perspective. Ecological Applications. 4: 629-650.

McPherson, E.G.; Maco, S.E.; Simpson, J.R.; Peper, P.J.; Xiao, Q.; VanDerZanden, A.M.; Bell, N. 2002. Western Washington and Oregon Community Tree Guide: Benefits, Costs, and Strategic Planting. International Society of Arboriculture, Pacific Northwest, Silverton, OR.

McPherson, E.G.; Simpson, J.R. 1999. Carbon dioxide reduction through urban forestry: guidelines for professional and volunteer tree planters. Gen. Tech. Rep. PSW-171. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 237 p.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Crowell, A.M.N.; Xiao, Q. 2010. Northern California coast community tree guide: benefits, costs, and strategic planting. PSW-GTR-228. Gen. Tech. Rep. PSW-GTR-228. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Vargas, K.E.; Maco, S.E.; Xiao, Q. 2006a. Coastal Plain Community Tree Guide: Benefits, Costs, and Strategic Planting PSW-GTR-201. USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Vargas, K.E.; Xiao, Q. 2007. Northeast community tree guide: benefits, costs, and strategic planting.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Gardner, S.L.; Cozad, S.K.; Xiao, Q. 2006b. Midwest Community Tree Guide: Benefits, Costs and Strategic Planting PSW-GTR-199. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Gardner, S.L.; Vargas, K.E.; Xiao, Q. 2006c. Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting PSW-GTR 200. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Maco, S.E.; Xiao Q.; Mulrean, E. 2004. Desert Southwest Community Tree Guide: Benefits, Costs and Strategic Planting. Phoenix, AZ: Arizona Community Tree Council, Inc. 81 :81.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Scott, K.I.; Xiao, Q. 2000. Tree Guidelines for Coastal Southern California Communities. Local Government Commission, Sacramento, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q. 1999. Tree Guidelines for San Joaquin Valley Communities. Local Government Commission, Sacramento, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q.; Maco, S.E.; Hoefer, P.J. 2003. Northern Mountain and Prairie Community Tree Guide: Benefits, Costs and Strategic Planting. Center for Urban Forest Research, USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Xiao, Q.; Pittenger, D.R.; Hodel, D.R. 2001. Tree Guidelines for Inland Empire Communities. Local Government Commission, Sacramento, CA.

Michigan State University. 2010. Emerald ash borer. East Lansing, MI: Michigan State University [and others].

Mielke, M. E.; Daughtrey, M. L. How to Identify and Control Dogwood Anthracnose. NA-GR-18. Broomall, PA: U. S. Department of Agriculture, Forest Service, Northeastern Area and Private Forestry.

Murray, F.J.; Marsh L.; Bradford, P.A. 1994. New York State Energy Plan, vol. II: issue reports. Albany, NY: New York State Energy Office.

Nicholls, T. H.; Anderson, R. L. 1977. How to Identify White Pine Blister Rust and Remove Cankers. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry

Northeastern Area State and Private Forestry. 1998. How to identify and manage Dutch Elm Disease. NA-PR-07-98. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

Northeastern Area State and Private Forestry. 2005. Gypsy moth digest. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

Nowak, D.J. 1994. Atmospheric carbon dioxide reduction by Chicago’s urban forest. In: McPherson, E.G.; Nowak, D.J.; Rowntree, R.A., eds. Chicago’s urban forest ecosystem: results of the Chicago Urban Forest Climate Project. Gen. Tech. Rep. NE-186. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 83-94.

Nowak, D.J. 1995. Trees pollute? A "TREE" explains it all. In: Proceedings of the 7th National Urban Forestry Conference. Washington, DC: American Forests: 28-30.

Nowak, D.J. 2000. The interactions between urban forests and global climate change. In: Abdollahi, K.K.; Ning, Z.H.; Appeaning, A., eds. Global Climate Change and the Urban Forest. Baton Rouge, LA: GCRCC and Franklin Press: 31-44.

Nowak, D.J., Hirabayashi, S., Bodine, A., Greenfield, E. 2014. Tree and forest effects on air quality and human health in the United States. Environmental Pollution. 193:119-129.

Nowak, D.J., Hirabayashi, S., Bodine, A., Hoehn, R. 2013. Modeled PM2.5 removal by trees in ten U.S. cities and associated health effects. Environmental Pollution. 178: 395-402.

Nowak, D.J.; Civerolo, K.L.; Rao, S.T.; Sistla, S.; Luley, C.J.; Crane, D.E. 2000. A modeling study of the impact of urban trees on ozone. Atmospheric Environment. 34: 1601-1613.

Nowak, D.J.; Crane, D.E. 2000. The Urban Forest Effects (UFORE) Model: quantifying urban forest structure and functions. In: Hansen, M.; Burk, T., eds. Integrated tools for natural resources inventories in the 21st century. Proceedings of IUFRO conference. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 714-720.

Nowak, D.J.; Crane, D.E.; Dwyer, J.F. 2002a. Compensatory value of urban trees in the United States. Journal of Arboriculture. 28(4): 194 - 199.

Nowak, D.J.; Crane, D.E.; Stevens, J.C.; Hoehn, R.E. 2005. The urban forest effects (UFORE) model: field data collection manual. V1b. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station, 34 p. http://www.fs.fed.us/ne/syracuse/Tools/downloads/UFORE_Manual.pdf

Nowak, D.J.; Crane, D.E.; Stevens, J.C.; Ibarra, M. 2002b. Brooklyn's urban forest. Gen. Tech. Rep. NE-290. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 107 p.

Nowak, D.J.; Dwyer, J.F. 2000. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, John, ed. Handbook of urban and community forestry in the northeast. New York, NY: Kluwer Academics/Plenum: 11-22.

Nowak, D.J.; Hoehn, R.; Crane, D. 2007. Oxygen production by urban trees in the United States. Arboriculture & Urban Forestry. 33(3):220-226.

Nowak, D.J.; Hoehn, R.E.; Crane, D.E.; Stevens, J.C.; Walton, J.T; Bond, J. 2008. A ground-based method of assessing urban forest structure and ecosystem services. Arboriculture and Urban Forestry. 34(6): 347-358.

Nowak, D.J.; Stevens, J.C.; Sisinni, S.M.; Luley, C.J. 2002c. Effects of urban tree management and species selection on atmospheric carbon dioxide. Journal of Arboriculture. 28(3): 113-122.

Ostry, M.E.; Mielke, M.E.; Anderson, R.L. 1996. How to Identify Butternut Canker and Manage Butternut Trees. U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

Peper, P.J.; McPherson, E.G.; Simpson, J.R.; Albers, S.N.; Xiao, Q. 2010. Central Florida community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-230. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Peper, P.J.; McPherson, E.G.; Simpson, J.R.; Vargas, K.E.; Xiao Q. 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. PSW-GTR-219. Gen. Tech. Rep. PSW-GTR-219. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Phelps, W.R.; Czabator, F.L. 1978. Fusiform Rust of Southern Pines. Forest Insect & Disease Leaflet 26. Washington, DC: U. S. Department of Agriculture, Forest Service. 7 p.

Rexrode, C. O.; Brown, H. D. 1983. Oak Wilt. Forest Insect & Disease Leaflet 29. Washington, DC: U.S. Department of Agriculture, Forest Service. 6 p.

Schmitz, R. F.; Gibson, K. E. 1996. Douglas-fir Beetle. Forest Insect & Disease Leaflet 5. R1-96-87. Washington,DC: U. S. Department of Agriculture, Forest Service. 8 p.

Smith, S. L.; Borys, R. R.; Shea, P. J. 2009. Jeffrey Pine Beetle. Forest Insect & Disease Leaflet 11. Washington, DC: U. S. Department of Agriculture, Forest Service. 8 p.

Society of American Foresters. 2011. Gold Spotted Oak Borer Hitches Ride in Firewood, Kills California Oaks. Forestry Source 16(10): 20.

U.S. Environmental Protection Agency. 2010. Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards. Washington, DC: U.S. Environmental Protection Agency. EPA-420-R-10-012a

U.S. Environmental Protection Agency. 2015. The social cost of carbon. http://www.epa.gov/climatechange/EPAactivities/economics/scc.html

U.S. Forest Service. 2005. Hemlock Woolly Adelgid. Pest Alert. NA-PR-09-05. Newtown Square, PA: U. S. Department of Agriculture, Forest Service, Northern Area State and Private Forestry.

U.S. Forest Service. 2011. Laurel Wilt. Atlanta, GA: U. S. Department of Agriculture, Forest Service, Forest Health Protection, Southern Region.

University of California. 2014. Polphagous Shot Hole Borer. Sacramento, CA: University of California, Division of Agriculture and Natural Resources.

van Essen, H.; Schroten, A.; Otten, M.; Sutter, D.; Schreyer, C.; Zandonella, R.; Maibach, M.; Doll, C. 2011. External Costs of Transport in Europe. Netherlands: CE Delft. 161 p.

Vargas, K.E.; McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Xiao, Q. 2007a. Interior West Tree Guide.

Vargas, K.E.; McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Xiao, Q. 2007b. Temperate Interior West Community Tree Guide: Benefits, Costs, and Strategic Planting.

Vargas, K.E.; McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Xiao, Q. 2008. Tropical community tree guide: benefits, costs, and strategic planting. PSW-GTR-216. Gen. Tech. Rep. PSW-GTR-216. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Worrall, J.J. 2007. Chestnut Blight. Forest and Shade Tree Pathology.
http://www.forestpathology.org/dis_chestnut.html

Zinke, P.J. 1967. Forest interception studies in the United States. In: Sopper, W.E.; Lull, H.W., eds. Forest Hydrology. Oxford, UK: Pergamon Press: 137-161.

Poznań, 15.04.2020r.

The results of the ecological demonstrators' project evaluation carried out in ten preschools in Poznań.

The first edition of the ecological demonstrators' project took place in 2018 and was implemented by the Project Coordination and Urban Regeneration Office (Poznań City Hall) in cooperation with the Made in Art Foundation from Poznań. In total, ten preschools took part in the project. They were selected in 2018 by the Department of Education in the *Program for the modernization and extension of playgrounds in kindergartens in 2016-2020* (local government program).

The eco-demonstrators' project was financed by the international CONNECTING Nature project (Horizon 2020).

The eco-demonstrators are elements made of natural materials (plant, wood) presenting ecological and environmental phenomena, e.g. meteorological stations, insect houses, vegetable beds filled with compost soil, willow huts, numerous climbers (plants) or fruit bushes, etc. Lesson plans were also prepared, which can support teachers in conducting ecological education with the use of eco-demonstrators installed in preschool gardens.

The main goal of the project is to increase ecological awareness and knowledge about environmental processes occurring in the environment among preschool children and preschool staff. Eco-demonstrators show how nature works and how to shape the natural environment easily and adequately to the age of children. Besides, children will have the opportunity to much frequent contact with nature during the lessons and free play, which will have a positive effect on their development.

Each kindergarten received five ecological demonstrators, which were installed in the garden. The whole project was implemented from March to November 2018. Besides, teachers received lesson plans for ecological education and participated in practical workshops.

Tab. 1 Kindergartens participating in the ecological demonstrators project covered by the evaluation.

No	The name of the preschool	Address	District (city of Poznań)	No of preschoolers	Surveys
Financed by CONNECTING Nature project					
1.	Przedszkole nr 14 „Polne Kwiaty”	ul. Tczewska 11	Smochowice	130	completed
2.	Przedszkole nr 22 „Chatka Puchatka”	ul. Orzechowa 2B	Dębiec	100	completed (in total 4 answers)
3.	Przedszkole nr 28 „Małych Astronomów”	ul. Galileusza 7	Grunwald	109	-
4.	Przedszkole nr 42 „Kwiaty Polskie”	ul. Prądzyńskiego 15A	Wilda	123	completed
5.	Przedszkole nr 43 im. Krasnala Hałabały	ul. Wiązowa 5	Wilda	122	-
6.	Przedszkole nr 46	ul. Księżycowa 10	Grunwald	170	-

7.	Przedszkole nr 87 im. Jacusia i Agatki	ul. Świętego Czesława 6a	Wilda	99	completed
8.	Przedszkole nr 113 „Mali sportowcy”	Os. Rzeczypospolitej 7	Rataje	123	-
9.	Przedszkole nr 160 „Biały Orzeł”	Os. Tysiąclecia 69	Rataje	135	completed
10.	Przedszkole nr 186 „Mieszkańcy Łąki”	Os. Stare Żegrze 1	Żegrze	163	completed

Source: own elaboration.

The eco-demonstrators in 2018 – elements:

1. **“Living table**” – a wooden table covered with vegetation: various and nondemanding species of perennial, evergreen plants. Also, a revisory chamber was installed in the middle of the table, which allows children to observe the soil profile and vegetation layers.
2. “**A simple rainwater collection system**” – micro-installation related to a simple rainwater management system. It consists of a connection of gutter and watering cans of various sizes, which allow collect and store the rainwater. Their appropriate setting will create a system of connected vessels, enabling them to collect much water and present the water cycle.
3. **“Willow hut**” – micro-installation constructed of willow shoots and a wooden platform. This is an example of a living structure that can develop and evolve, creating a natural hut, and thus a place of play, observation of nature, as well as a place to relax and calm down.
4. **“Meteorological station**” – micro-installation presenting a mini meteorological station. It is constructed of wooden elements; the whole form resembles an Indian teepee. The station is equipped with the most important instruments for measuring temperature, humidity, wind directions, precipitation, etc.
5. **“The Mine of Vitamins**" – micro-installation in the form of two vegetable beds. The main goal is to show children the cultivation of edible plants, mainly vegetables and herbs. Thanks to the design, children will be able to observe the full cycle of plant cultivation.

Prepared graphics and concepts of ecological demonstrators were consulted with the preschool management at individual meetings in preschool gardens. These meetings were aimed at diagnosing the garden and its assessment in terms of environmental and spatial conditions. The consultation meeting allowed the analysis of the possibility of spacing a complete set of installations. If the garden was too small or there was much recreational equipment, the contractor proposed alternative elements.

Tab. 2 Preschool institutions with a list of eco-elements installed in individual gardens.

The name of the preschool	**Eco-demonstrators**
Przedszkole nr 14 "Polne Kwiaty"	willow hut, living table, rainwater collection system, meteorological station, wooden stage around the tree (instead of vegetable beds)
Przedszkole nr 22 "Chatka Puchatka"	willow hut, living table, meteorological station, rainwater collection system, vegetable beds

Przedszkole nr 28 "Małych Astronomów"	willow hut, living table, meteorological station, rainwater collection system, vegetable beds
Przedszkole nr 42 "Kwiaty Polskie"	willow hut x2 (instead of vegetable beds), living table, meteorological station, flower meadow (instead of rainwater collection system)
Przedszkole nr 43 im. Krasnala Hałabały	willow hut, living table, meteorological station, vegetable beds, wooden stage around the tree (instead of rainwater collection system)
Przedszkole nr 46	willow hut x2 (instead of rainwater collection system), living table, vegetable beds, meteorological station
Przedszkole nr 87 im. Jacusia i Agatki	willow hut, living table, flower meadow (instead of vegetable beds), insect house (instead of meteorological station), compost bin (instead of rainwater collection system)
Przedszkole nr 113 "Mali sportowcy"	willow hut, living table, meteorological station, rainwater collection system, vegetable beds
Przedszkole nr 160 "Biały Orzeł"	willow hut, living table, meteorological station, rainwater collection system, vegetable beds
Przedszkole nr 186 "Mieszkańcy Łąki"	living table, wooden stage around the tree (instead of willow hut), wooden treillage/trellis (instead of vegetable beds), meteorological station, rainwater collection system

Source: own elaboration.

Evaluation of the eco-demonstrators' project.

On the second of September 2019, an email with an evaluation survey was sent to ten preschools. The survey was addressed to kindergarten management and staff of preschool institutions. The survey was aimed at summarizing the completed project, assessing usability, as well as examining what effects of the eco-demonstrators project were noted. The survey was also to collect opinions on the quality of the eco-elements as well as the educational materials.

The survey was to provide information on whether the project's objectives were achieved:

- enabling and facilitating an experience of nature by children,

- increase of ecological awareness and interest in nature among the children,

- to boost creativity among children,

- enabling access to nature during ecological lessons and free play using eco-elements,

- increase of the competence of preschool staff by equipping them with tools (eco-demonstrators, educational scenarios).

The survey encompassed six open-ended questions:

1. The general assessment of product quality, workmanship, aesthetics and durability.
2. Do you see any links between eco-elements and ecological scenarios? Do they provide opportunities to conduct outdoor classes with children?
3. Is it possible to lead outdoor classes with children using the eco-installation?
4. Did the workshop for teachers meet your expectations? How do you assess the course and lesson plans (what you liked, what you lacked)?

5. Other comments/observations/suggestions (do you have any concerns about the eco-demonstrators? Do you have any suggestions on how to improve the project in the future?)
6. Does the project seem innovative to you and does it have the application potential?

We also proposed the extra task, which was directed to preschoolers, who could draw their favourite eco-demonstrators or describe which eco-elements they like the most (or dislike). However, this task was left to consider and carry out by teachers as far as possible, related to the curriculum.

Initially, two deadlines were set for sending responses: September 16 and September 30. During this period, only three answers were received. Therefore, after a telephone reminder and a short conversation with kindergarten management of ten preschools, it was agreed that the deadline would be extended to the end of 2019.

The feedback was received from six preschools (out of ten). In total, 9 responses were received (Kindergarten No. 22. completed 4 surveys in total).

Evaluation of project usefulness.

1. The general assessment of product quality, workmanship, aesthetics and durability.

Respondents assessed the eco-demonstrators as durable and aesthetic elements, made of high-quality natural resources (wood, waste wood, vegetation). According to them, eco-demonstrators are not only educational elements but also garden decorations. The eco-elements have been designed and installed fitting ideally into the space of preschool gardens, creating the type of an ecological playground. By their appearance, eco-demonstrators encourage children to observe growing plants on the living table, observe insects (insect house), as well as play in a willow hut.

Respondents also noted a few elements that did not work in the garden, and which proved to be impractical. For instance, such eco-demonstrators involved a rainwater collection system, which was dismantled in Preschool no. 22. Besides, due to the very dry and rainless summer, and despite watering and caring for plants, a few willows withered (in Preschools no. 42 and 160).

Preschool institutions maintain and repair equipment on their own (maintenance, wood finishing, repairing).

2. Do you see any links between eco-elements and ecological scenarios? Do they provide opportunities to conduct outdoor classes with children?

The respondents see strong linkages between lesson plans (scenarios) and the installed eco-demonstrators. Scenarios give the possibilities of conducting various and practical classes in the preschool garden. According to respondents, scenarios also allow for more frequent fieldwork. They serve as an inspiration and enable undertaking innovative methods of conducting ecological topics in preschool education. The lesson scenarios are valuable materials for teachers, who can also modify it dependently on the needs and subjects of research projects.

Lesson scenarios are the support for teachers during nature observation with children, learning to conclude, and also help to summarize the environmental topics presented by the eco-demonstrators in the garden.

According to the collected data, teachers allow children to experience nature on their own. Preschoolers use the eco-elements during free play, often surprising teachers with their innovative solutions and how it might be differently used. The eco-demonstrators give children unlimited possibilities of independent playing, being a source of inspiration and ideas for teachers as well.

According to respondents, the most popular children's plays are planting vegetation, observing the growth of vegetables and flowers, playing in layers of the soil (ground), recognizing insects, hiding and seeking in a willow hut.

3. Is it possible to conduct classes in the garden with children using the eco-installation?

All teachers agreed, that they can regularly conduct outdoor classes according to provided lesson plans and eco-demonstrators. It depends frequently on the weather on given days. During classes in the garden, the most often used eco-demonstrators encompass vegetable beds, where children cultivate season fruit, herbs and flowers, they can observe their growth and learn how to care for vegetations almost all year round. The second one is the living table, where children, through the revisory chamber, can explore and observe the root system. On the other hand, the meteorological station allows teachers to conduct classes on topics related to atmospheric phenomena (measure temperature, humidity, make observations, etc.). Teachers encourage children to use eco-demonstrators systematically. According to them, all eco-elements allow the implementation of numerous research projects with children.

4. Did the workshop for teachers meet your expectations? How do you assess the course and lesson plans (what you liked, what you lacked)?

The meeting was assessed positively by eight respondents. The workshop did not meet the expectations of teachers of one preschool – in their opinion, they could not work out properly the various ways of using the scenarios with eco-demonstrators and despite multi interesting information, they felt unsatisfied. On the other hand, as noted in one of the surveys, the prepared materials leave teachers a wide field for activity, the possibility of modifying the scenarios to their own needs, adapting them to the curriculum and the opportunity to build new course proposals.

The workshops and scenarios have presented how to use eco-demonstrators. The workshop leader – Mrs. Magdalena Garczarczyk – was highly rated by teachers. She demonstrated great knowledge of the subject. She told not only how to use eco-demonstrators for outdoor classes with children, but also suggested interesting ideas for ecological lessons. She answered comprehensively the questions asked by teachers. The respondents also drew attention to additional materials brought by Mrs. Garczarczyk – literature for children on natural and ecological topics, which was a great source of inspiration. Several titles were purchased for the library in Preschool no. 87.

All respondents confirmed that the provided lesson plans are very helpful tools at work, they were professionally prepared and enriched the teacher's workshop.

5. Other comments/observations/suggestions (do you have any concerns about the eco-demonstrators? Do you have any suggestions on how to improve the project in the future?)

This question was answered by six respondents. The teachers pointed out several proposals for creating new elements, e.g. the planetary system, solar energy, expanding the diversity, etc. The respondents also shared their concerns about the eco-demonstrators. One of them is the durability of the product – how long they will use it. Some doubts occurred concerning insect houses – teachers pointed out that some children are allergies to venom and pollen (and maybe it is not a good idea to install such eco-demonstrators in the preschool garden).

In this question, the respondents mentioned again the rainwater collection system. They assess it as a nonfunctional and poorly made product. Some teachers claim that the meteorological station is not well equipped. In another preschool, kindergarten management decided to buy new (larger) measuring instruments – without the teacher's support children found difficulty in reading the measurements.

Overall, eco-demonstrators are a compelling, educational and visual complement to preschool gardens.

6. Does the project seem innovative to you and does it have the application potential?

The respondents assessed the eco-demonstrator as a very original and practical project, facilitating children with the experience of nature. As reported by teachers, the project inspires to take up new activities in the preschool garden, and children can practically consolidate the acquired knowledge. The project of ecological demonstrators allows teachers to plan educational work on natural and ecological subjects for the coming years. According to the respondents, the project is also innovative because similar eco-elements have not appeared in kindergartens in Poznań so far. Moreover, parents are very interested in the project and pay attention to the eco-demonstrators during choosing a daycare facility for their children (source: Kindergarten No. 87).

The additional task was undertaken only by two preschools. We received numerous colorful artworks created by children from preschool no. 160. Many drawings present preschool playgrounds with eco-demonstrators like meteorological stations or willow huts. In kindergarten no. 87 there was a small-talk with children about what they liked about eco-demonstrators. Examples of children's quotes:

“I like playing in willow hut very much because I can hide there.”

“I like that we have our gardens where we have tomatoes and other food.”

“I would like to observe insects in their house, but… they are not there.”

Conclusions and recommendations.

The results of the survey show that the project met the expectations both of children and teachers. The eco-demonstrators enrich the garden space and encourage preschoolers to have fun, free play and experience nature on their own.

The scenarios present numerous alternative lesson topics in the field of preschool environmental education, which can be lead in gardens. The workshop was very valuable because teachers could familiarize themselves with the operation of eco-demonstrators.

The project was highly rated by teachers. The eco-demonstrators and lesson plans are very useful and valuable tools, thanks to which the children's development and their sensitivity to the surrounding environment can be supported.

Teachers shared their observations and concerns related to the eco-demonstrators. As a result, we have acquired a huge knowledge of what worked out and what did not perform well and should be fixed in the future. The most popular eco-elements are living tables, willow huts and vegetable beds. Preschoolers can use them during eco-educational classes as well as free play.

Recommendations:

It seems advisable to prepare a guidebook for teachers with proposals for gardening and nature/ecological topics for preschoolers, as well as prepare the list with positions of children's literature, which would enrich the education during the year.

It would be worth developing brief instructions for employees, for instance how to:

- upkeep the plants during the year (because according to collected data, workers ("handymen") are not always specialized gardeners),

- maintain and preserve the eco-demonstrators (that they could serve for years).

It is also worth encouraging teachers and kindergarten management to organize peer-to-peer sessions with staff from different public preschools to exchange knowledge and good practices in the field of natural and ecological education.

Appendix 1 – analysis of surveys in the excel spreadsheet (in Polish)

Elaborated by: Agnieszka Dziubała, Project Coordination and Urban Regeneration Office, Poznań City Hall, agnieszka_dziubala@um.poznan.pl

Supplementary material 3_Survey on primary, health and social indicators (Poznań 2021)

Katarzyna Fagiewicz, Lidia Poniży (Adam Mickiewicz University), Adina Dumitru, David Tomé Lourido, Eva Peralbo-Rubio (University of A Coruña)

This supplementary material contains the methodological information related to the survey carried out in preschools to evaluate the impact of the NBS (Nature-oriented playgrounds). The participants, procedure, instruments and data analysis performed in this research are detailed below.

Participants

To investigate how the development of preschool areas influences their use and how it is reflected in the health and well-being of children, we conducted research in six preschools in Poznań. Three of them were preschools with nature-oriented playgrounds, located in densely built-up areas, mainly with tenement houses, in the Wilda district in Poznań. Additionally, three control preschools with traditional playgrounds were selected for the survey. These three preschools were also located in a similar setting in Wilda and Grunwald districts. The number of children and teachers in the individual preschools are presented in the table.

Number of children and teachers in the preschools		
Preschools with nature-oriented playgrounds		
	children	teachers
Preschool No. 42	124	10
Preschool No. 87	100	8
Preschool No. 115	111	10
sum	**335**	**28**
Preschools without natural playgrounds		
	children	teachers
Preschool No. 44	100	12
Preschool No. 89	78	9
Preschool No. 103	121	20
sum	**299**	**41**
Total	**634**	**69**

178 responses were collected in the survey of all establishments (143 from parents and 35 from teachers) which means that about 22 % of parents and 50 % of preschool teachers took part in the research.

Number of questionnaires returned by parents and teachers		
Preschools with nature-oriented playgrounds	Parents	Teachers
	79	23
Preschools without natural playgrounds	Parents	Teachers
	64	12
Total	**143**	**35**

The final composition of the sample is as follows:

Parents

143 parents (79 experimental group and 64 control group) aged between 23 and 46 years (M = 35.63; SD = 4.33), being 83.2% women and 11.2% men. The ages of their children were between 3 and 7 years (M = 4.78; SD = 1.14, with 54.5% being boys, 40.6% girls, while .7% identified with other sex. Children had a mean of 2.06 years attending Kindergarten (SD = 1.06).

88.1% of the parents lived in an apartment and 6.3% in a house, while 66.4% owned their home, and 23.8% were rented. Regarding educational level, 1.4% of the sample had a maximum level of Primary school, 18.9% High school, while 75.5% had university studies (including 62.2% of participants with a master's degree and 4.2% with a PhD).

7.7% of the sample earned less than € 600 per month per household, 35% of the participants earned up to € 3,000, 18.9% up to € 6,000 and 11.9% more than € 6,001 per month.

Teachers

35 staff (23 experimental group and 12 control group) aged between 25 and 68 years (M = 47.41; SD = 10.98), being 94.3% women and the remaining 5.7% preferred not to answer. The staff had a mean of 17.96 years working in kindergarten (SD = 11.72), and a mean of 21.97 years working with children (SD = 12.33). 51.4% of the staff lived in an apartment and 25.7% in a house, while 57.1% owned their home, and 14.3% were rented.

Procedure

The study on the characteristics of preschools playgrounds and their impact on health and well-being was based on the questionnaire. The survey was targeting two groups of respondents, parents and preschool teachers in two types of preschools - with nature-oriented playgrounds and with traditional playgrounds (as the control ones). As a result, four types of forms were prepared with an adapted range of questions. The research procedure was planned as an online questionnaire prepared on the Google Forms platform.

The specificity of the survey was due to the limited possibilities of reaching representative groups of respondents (Personal Data Protection Act). A key role in this stage of the research was played by the preschool's Heads, who were involved in the distribution of the questionnaires through internal communication channels with parents and teachers (mailing list, social media groups). The survey was launched on 15 March 2021, with a target completion date of 15 April 2021. The epidemic situation related to Covid-19, lockdown, closure of preschools during that period, and the resulting insufficient involvement of respondents forced a revision of the survey timeframe. Eventually, its completion date was moved to 25 June (the beginning of the summer break). The research was extended to a hybrid mode using printed questionnaires, which were distributed among parents and teachers with preschool's Heads help. This formula was used by 42 parents and 8 teachers. The data collected on the printed questionnaires were entered into Google Forms by the AMU Team.

All surveys were conducted in accordance with the principles of the GDPR and were filled in anonymously after the respondent has given consent to participate in the research.

Instruments

The following table shows a summary of the instruments used to measure the variables under study:

CODE	INDICATOR	INSTRUMENT
PI1	Type of interaction with NBS	Questions prepared ad hoc within the Connecting Nature project (Dumitru et al., 2021)
PI2	Frequency of interaction with NBS	
PI3	Duration of interaction with NBS	
PI4	Perceived quality of space	
HW11	Mental health and wellbeing	General Health Questionnaire (GHQ-12) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997)
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	Strengths and Difficulties Questionnaires (SDQ, Goodman, 1997)
HW16	Perceived restorativeness of public green space	Perceived Restorativeness Scale (the short, PRS - 11) (Pasini et al., 2014)
SC6	Place attachment	Items prepared ad hoc for this research: . My child likes the playground at school . My child often speaks positively about the playground at school . If given a choice, my child would spend more time on the playground at school . My child loves the natural elements on the playground
SC13	Connectedness to nature (adults)	Connectedness to nature scale (Mayer & Frantz, 2004)
SC13	Connectedness to nature (children)	Fascination and Being away subscales of Connectedness to nature index—parents of preschool children (Sobko et al., 2018)

Data analysis

The data were analysed with the IBM SPSS 25.0 statistical package. The analyses included the calculation of descriptive statistics, comparisons of means through Student's t test, and Pearson's correlations.

References

Dumitru A., Tomé-Lourido, D., & Peralbo-Rubio, E. (Eds.) (2021). *Connecting Nature Indicator Reviews*. Connecting Nature, Grant Agreement number 730222. SBN Number: 978-1-9161451- 8-4

Goldberg, D., Gater, R., Sartorius, N., Ustun, T., Piccinelli, M., Gureje, O., & Rutter, C. (1997). The Validity of two Versions of the GHQ in the WHO Study of Mental Illness in General Health Care. *Psychological Medicine, 27*, 191-7. doi: 10.1017/S0033291796004242.

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry, 38*, 58 1-586.

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*(4), 503-515.

Pasini, M., Berto, R., Brondino, M., Hall, R., & Ortner, C. (2014). How to measure the restorative quality of environments: The PRS- 11. *Procedia-Social and Behavioral Sciences, 159*, 293-297.

Sobko, T., Jia, Z., & Brown, G. (2018). Measuring connectedness to nature in preschool children in an urban setting and its relation to psychological functioning. *PloS one, 13*(11), e0207057.

Appendix III. Glasgow´s Evaluation Results

Authors: Rania Sermpezi, Gillian Dick (Glasgow City Council), Adina Dumitru, David Tomé Lourido, Eva Peralbo Rubio (University of A Coruña)

This document presents the impact assessment results in the city of Glasgow (Scotland). As reflected in the main text of the Deliverable, through its evaluation and monitoring plan, this Front-runner city has implemented one Nature-based Solution, the Open Space Strategy on a city scale, with two main exemplars: Growchapel and Bellahouston

This appendix begins with a main summary of the main results found in the city of Glasgow. Subsequently, the results of each of the indicators evaluated in the evaluation and monitoring plan are detailed, organized by indicator categories: Environmental, Primary, Health and wellbeing, Social cohesion, and Economic.

Due to the large amount of data collected, in addition to the results included in this document, for some indications the consultation of supplementary material is indicated, with more data, graphs and maps that expand the evidence gathered in the city.

Finally, at the end of this appendix, a reflection on the main conclusions of the monitoring and evaluation process in Glasgow is presented.

MAIN SUMMARY

In the City of Glasgow, we have gathered baseline data across all aspects of NBS, encompassing environmental, health and socio-economic trends. As the OSS was only approved in the start of 2020 and is a plan of 'aspirations', we have had to work on creating the Delivery Plan (OSSDP) which specifies the priority of actions. As such, it hasn't been possible to collect outcome data and see how the OSS is performing, yet, however even following the establishment of the OSSDP, we expect that its effects will not be felt in the nearest future, as the scale of our work (city-wide) is too large for direct relationships shortly after implementation. In Glasgow, competing priorities for land in terms of housing or business use, is another reason why the OSS' effects may not be immediate, with the requirement to raise awareness and incorporate the OSSDP's vision into the processes and thinking of developers. Therefore, we have concentrated on gathering as much of the baseline data as are available in order to build a strong evidence-base to continue assessing the OSSDP's effects in the future and improve things as necessary.

Before we consider any potential synergies and trade-offs between indicators, it is important to note the gaps in the quality and quantity of our baseline data. Environmental and social cohesion data are often the result of individual studies and are at a scale that is rarely useful when looking at the effects on communities. There is therefore, a question of how we can replicate such studies and maintain datasets so they remain relevant at a time when resources and metadata are scarce. Our health and wellbeing data have largely been the result of a successful collaboration with the research wing of our National Health Service, however these data have often been extracted from secondary care and so can only be used as 'proxies' in terms of health trends in the city, while primary care data are unavailable due to lack of consistent reporting practices. Economic data on the other hand are publicly available for most indicators, although scale and periodicity were often a cause of concern when looking at a city-wide effects.

Nevertheless, our baseline data paint some picture of what may be current trends across the city, with the majority of the most deprived communities being situated within areas of Glasgow that are currently identified as 'deficient' in good quality open space and are showing higher numbers of prescription medication usage (mental health and respiratory). We will continue to monitor these trends to see whether these suspected patterns evolve in the future and hope we will have more data to confirm/reject them. We are working closely with partners who are establishing a green infrastructure database of the city which will incorporate tree locations, canopy, shade etc., therefore providing another layer of baseline which may connect environmental and socio-health effects. In the spirit of caution, however, it is important to note that many of these data can be interpreted in various ways, hence our use of words such as 'suspected' and 'potential' in terms of patterns. The data indicate, for example an overall increase in mental health prescriptions across the city in the past 5 years, and although this may initially appear to be negative news, it may instead mean that awareness around mental health issues and support is rising and as such, more medical professionals are willing to prescribe medication to their patients. Therefore, we are currently only looking at the results from the perspective of identifying trends rather than cause and effect, and continue to search for datasets that may be used as proxies to indicate the 'angle' we should be taking forward for future causality analysis. We have learned a lot as a City through this process and see the great benefits of impact assessment which we are committed to continue working on post Horizon 2020.

IMPACT ASSESSMENT RESULTS

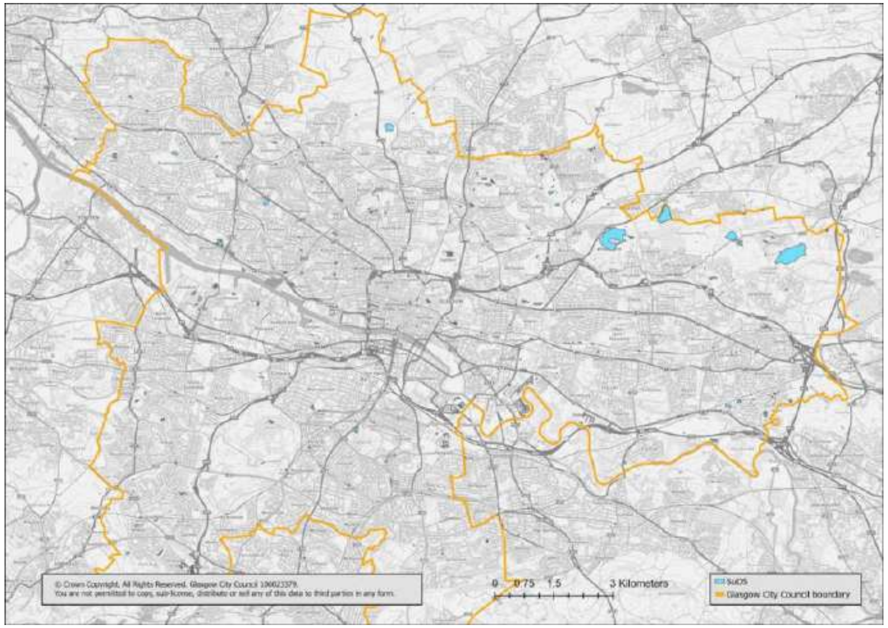
A. OPEN SPACE STRATEGY

Environmental indicators - CORE

ENV8. Rainfall storage (water absorption capacity of NBS)

Glasgow has been implementing Sustainable Drainage Systems ("SuDS") to increase rainfall storage and ease the potential of floods in the city. The left map shows the current locations of SuDS in the city.

Glasgow City Council has commissioned studies to produce Surface Water Management Plans ("SWMPs") for the city to help concentrate on the areas that need it the most. An example of a SWMP for Yoker is available in the right map, whereby three options are considered as part of the plan.



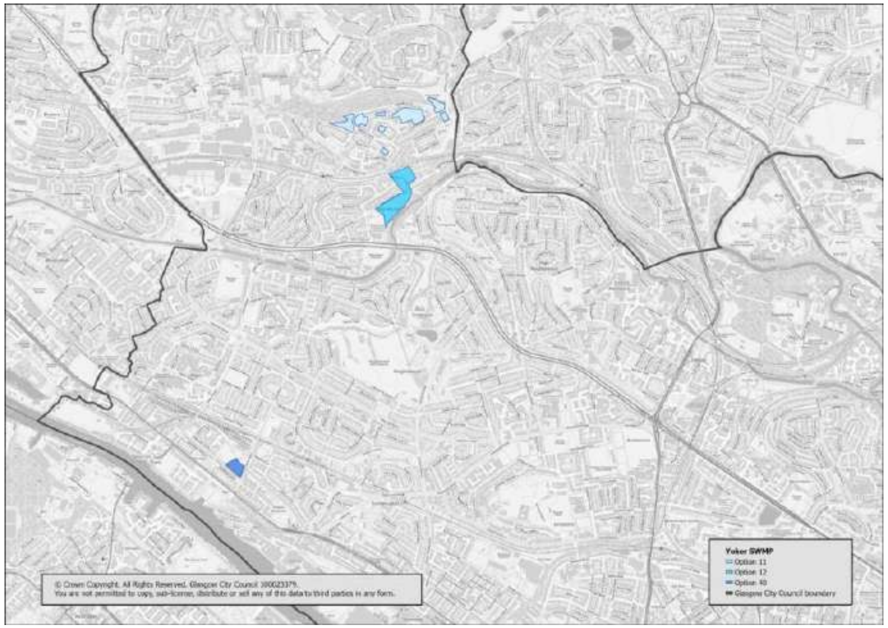


Figure 1 –. Surface Water Management Plan for Yoker.

For more maps of SWMP options being considered, please consult the Supplementary material section.

ENV15. Water quality

The Scottish Environmental Protection Agency ("SEPA") undertake yearly sampling of Glasgow's waterbodies and publish results per parameter but also in terms of their overall status. Data are available through the [Water Classification Hub](). Water quality data for the Clyde Estuary – Inner waterbody is provided below:

Water classification data for selected water body

ID	Name	Parameter	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
200510	Clyde Estuary - Inner (inc Cart)	1: Overall status	Bad	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…	Moderate ecol…
		1-1: Pre-HMWB status	-	Bad	Bad	Bad	Bad	Bad	Poor	Poor	Poor	Poor	Poor	Poor	Poor
		1-3: Overall ecology	Bad	Bad	Bad	Bad	Bad	Bad	Poor	Poor	Poor	Poor	Poor	Poor	Poor
		1-3-1: Physico-Chem	Bad	Poor	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Poor
		1-3-1-4: Dissolved Oxygen	Poor	Poor	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
		1-3-1-8: Dissolved inorganic nitrogen	Bad	Good	Moderate	Moderate	Good	Good	Good	Good	Good	Good	Good	Moderate	Poor
		1-3-2: Biological elements	Bad	-	-	-	-	Good	Good	Good	Good	Good	Good	Good	Good
		1-3-2-5: Fish	-	-	-	-	-	Good	Good	Good	Good	Good	Good	Good	Good
		1-3-2-7: Macroalgae	High	-	-	-	-	-	-	-	-	-	-	-	-
		1-3-3: Specific pollutants	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail	Fail	Fail	Fail
		1-3-3-8: Copper	Pass	Pass	Pass	Pass	-	-	Pass	Pass	Pass	Pass	Pass	Good	Pass
		1-3-3-9: Zinc	-	-	-	-	-	-	-	-	-	-	-	Good	-
		1-3-3-15: Unionised ammonia	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
		1-3-3-16: Chromium	-	-	-	-	-	-	-	-	Fail	Fail	Fail	Fail	Fail
		1-3-4: Hydromorphology	Bad	Bad	Bad	Bad	Bad	Bad	Poor	Poor	Poor	Poor	Poor	Poor	Poor
		1-3-4-1: Morphology	Bad	Bad	Bad	Bad	Bad	Bad	Poor	Poor	Poor	Poor	Poor	Poor	Poor

Figure 2 - Clyde Estuary - Inner waterbody water quality ([Water Classification Hub, 2021]()).

Water quality data for all of Glasgow's waterbodies is available in the Supplementary material section.

ENV19. Inundation risk for critical urban infrastructures (probability)

SEPA has undertaken modelling of flood risk for Scotland and has produced a web-based interactive map showing flood likelihood from rivers, the sea and surface water in 2014. Glasgow City Council have full access to the raw data and a map of the city's flood risk is provided below:

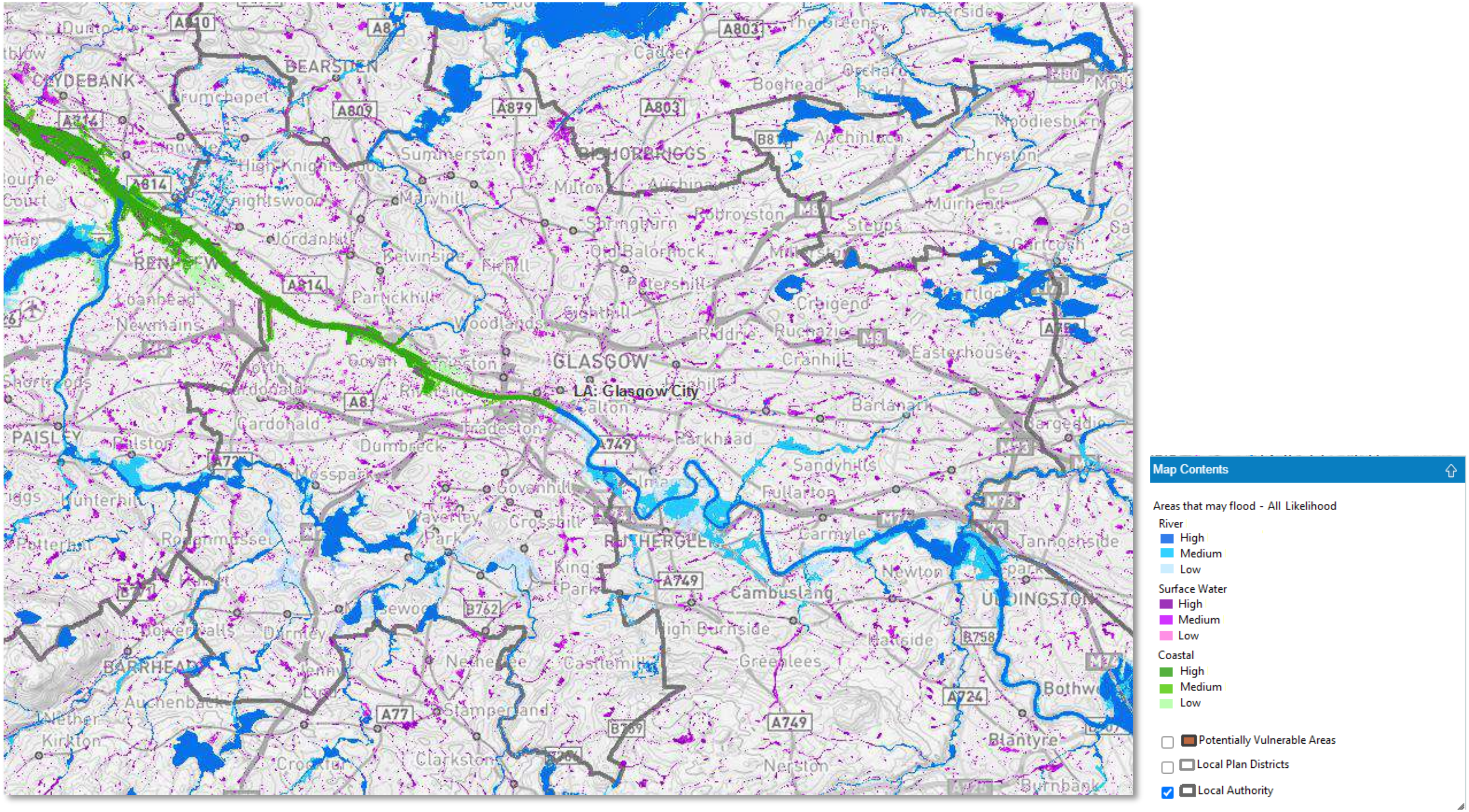


Figure 3 - Glasgow [Flood Map, SEPA. 2014](). ©Crown Copyright. SEPA Licence Number 100016991 (2021). All Rights Reserved. This map was developed using data from various sources. Full acknowledgement of data providers and participating parties is available [here]().

Please note that this modelling work is meant for strategic and national-scale work and as such, flood probability at street level may not be fully accurate. However, this is sufficient for our work on the Open Space Strategy because we can concentrate our efforts on high-risk hot spots at a city-level. For more information on SEPA's flood risk modelling work, please consult SEPA's Flood Maps page.

ENV23. Public green space distribution

We mapped our protected open spaces (green, blue and grey) in 2012 and have just undertaken an update which is currently going through the approval process with our Council's Committee. A map of the existing version can be seen below:

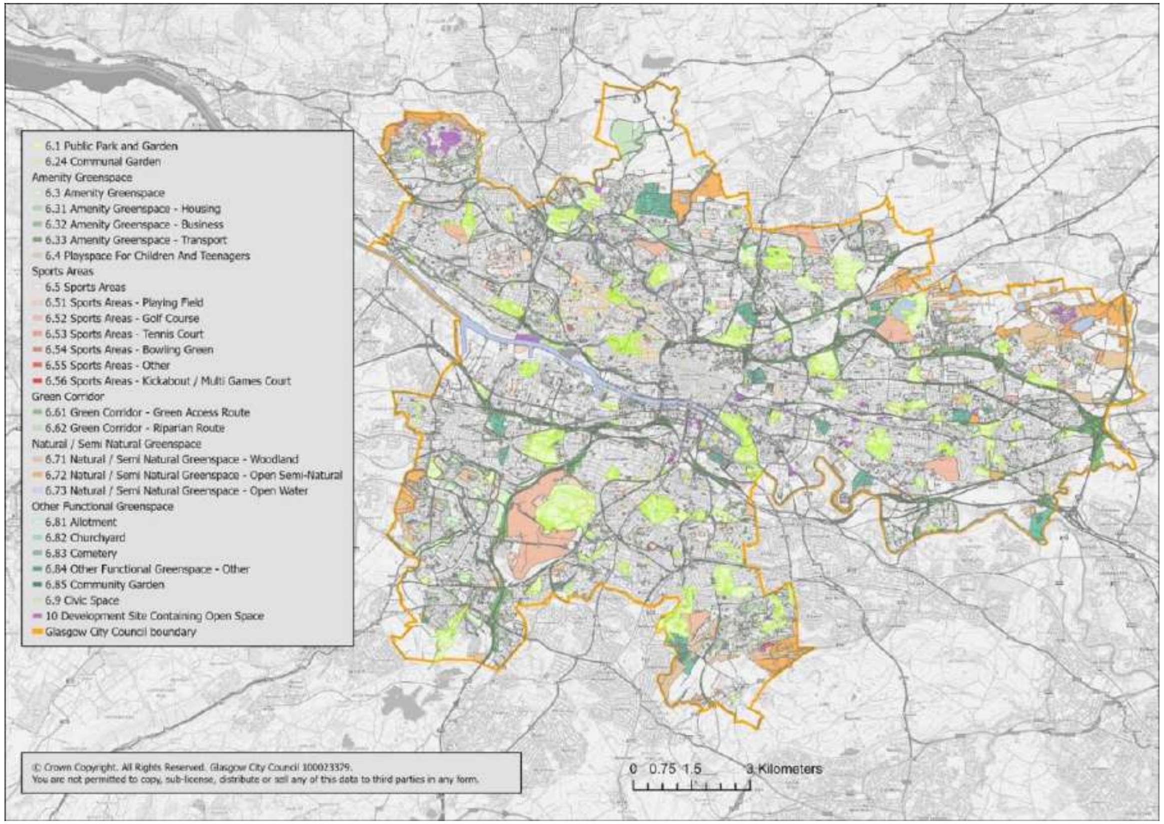


Figure 4 - PAN65 Open Space map of Glasgow, GCC, 2021.

An interactive version of the above map can be found through [this web-map](#).

As part of the Open Space Strategy, we undertook site surveys of our open spaces and scored them based on their potential to meet the Open Space Strategy's standard of access to good quality space within 400m of everyone's homes. Open spaces that have the potential to meet the standard are named 'community spaces' as they have a multi-use character and therefore have the potential to serve the community well.

We then wanted to understand what is the distribution and access to these community spaces and so, we undertook some GIS analysis to map accessibility within 400m of people's homes. This was coupled with population distribution mapping, which allowed us to map areas deficient in community spaces. This has resulted in us working on an Open Space Strategy Delivery Plan that focuses on deficient areas and generally improves the multi-purpose nature of open spaces in the city.

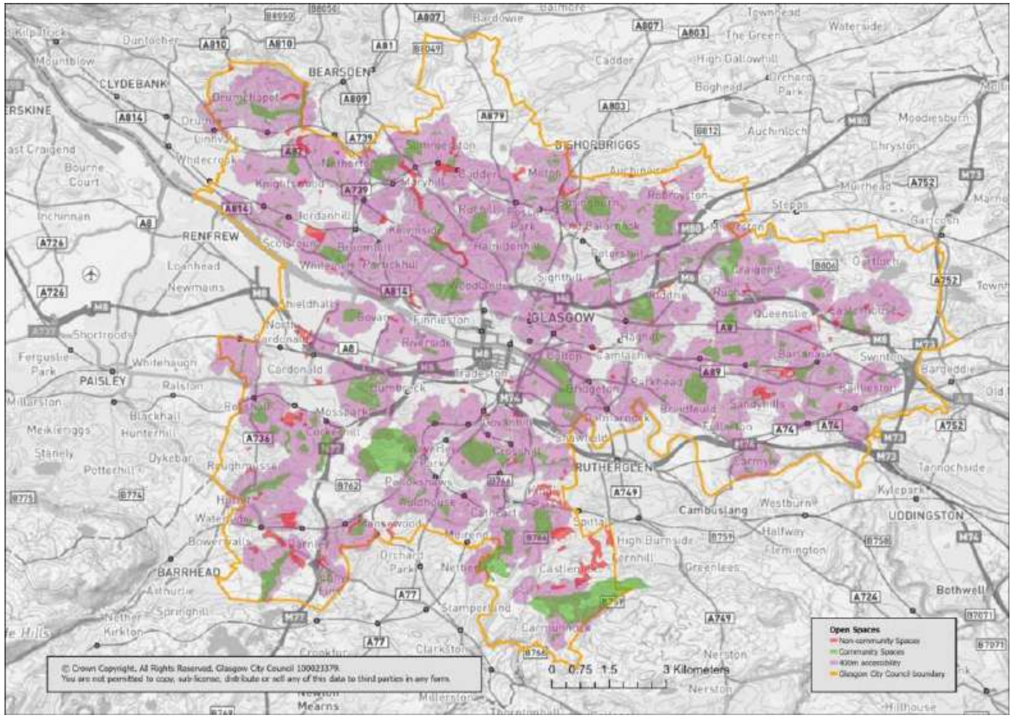


Figure 5- Glasgow's 400m accessibility to Community Spaces.

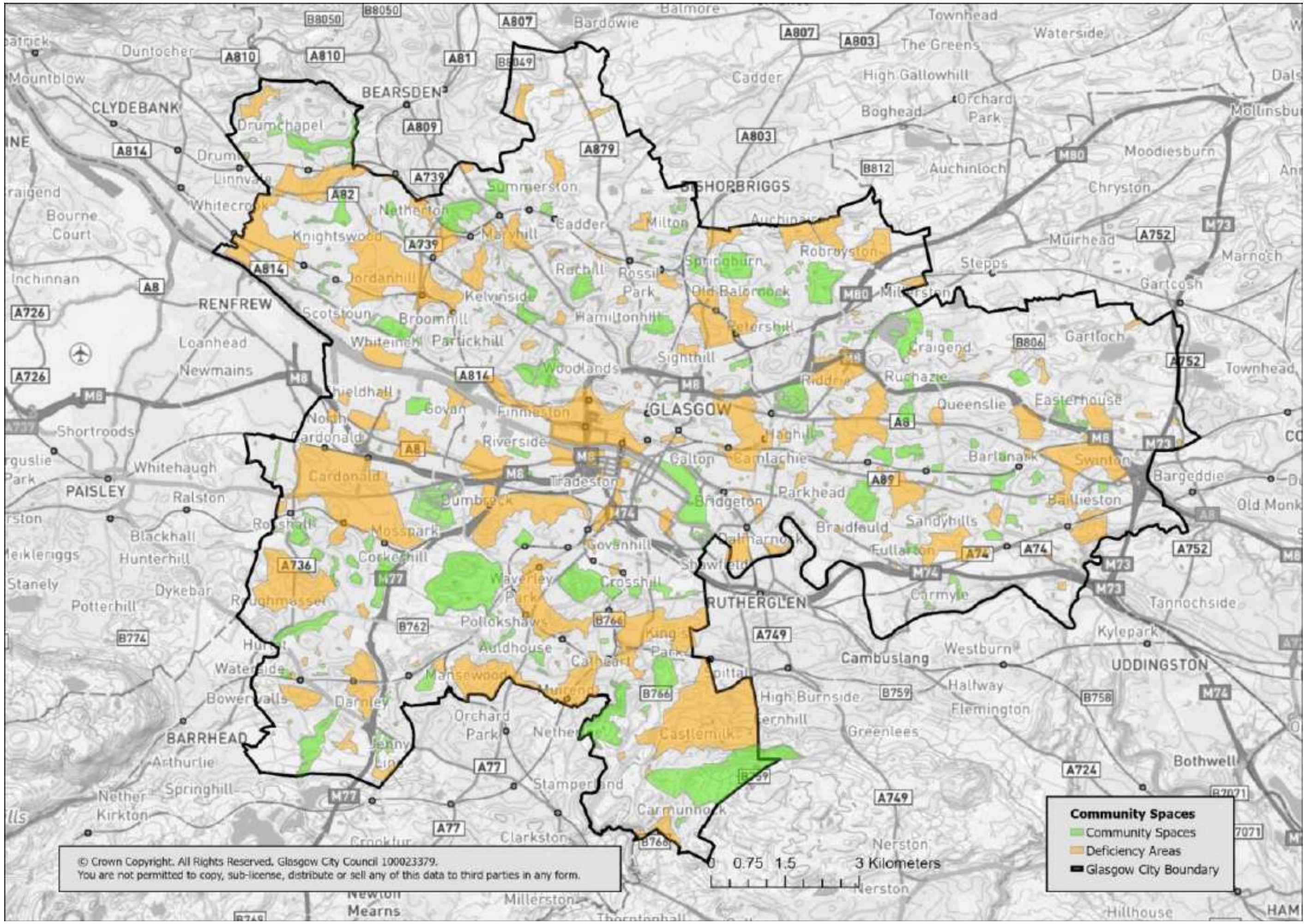


Figure 6 - Areas in Glasgow that are deficient in good quality open space.

ENV27. Connectivity of urban green and blue spaces (structural and functional)

Same as ENV23.

ENV29. Supporting/increasing biodiversity conservation

Glasgow City Council holds records of sites that are part of environmental designations such as Sites of Importance to Nature Conservation along with modelling undertaken by Glasgow Clyde Valley Green Network Partnership on mapping habitats, their networks, critical connections and opportunity areas. All data are mapped on [Glasgow's Connecting Nature Dashboard] and a screenshot of some of these maps is available below:

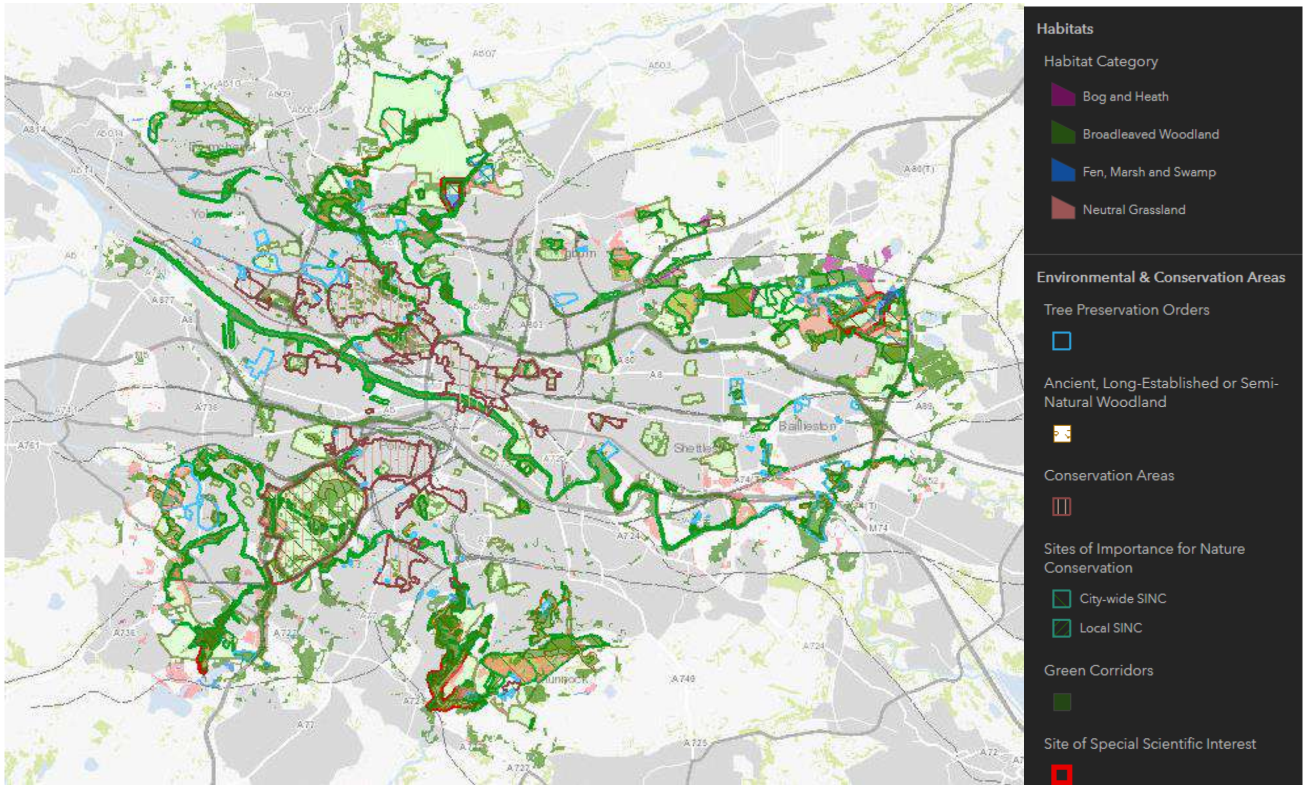


Figure 7 –. Example of the [Glasgow's Connecting Nature Dashboard]

ENV35. Species diversity

Please refer to **ENV29.**

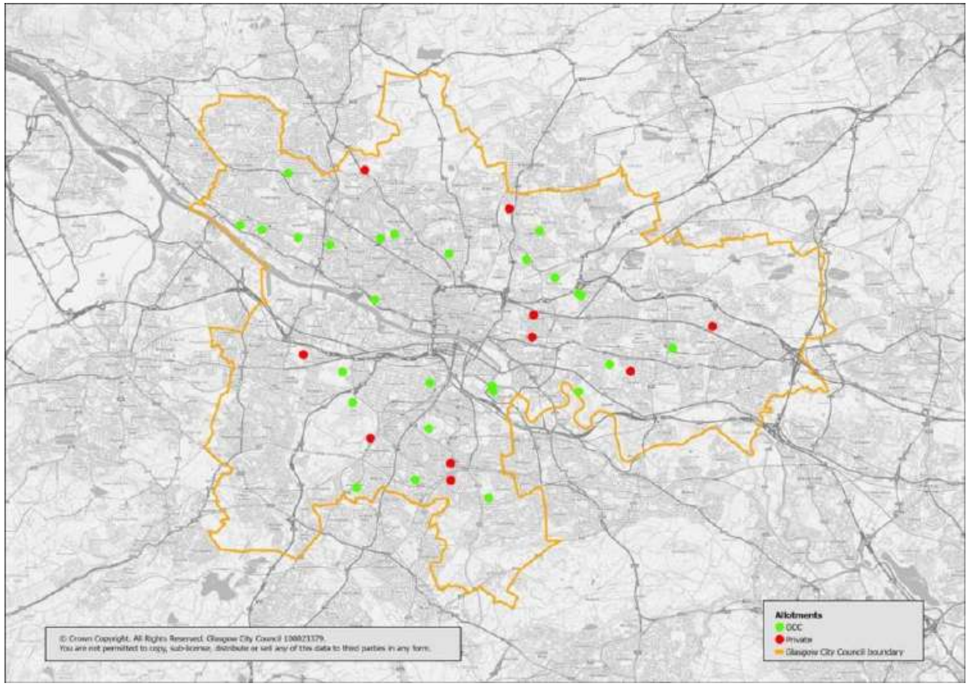
ENV42. Land use change and greenspace configuration

Please refer to **ENV23. Public green space distribution** and *Figure 4 - PAN65 Open Space map of Glasgow, GCC, 2021.*

ENV56. Blue space area

Please refer to **ENV23. Public green space distribution** and *Figure 4 - PAN65 Open Space map of Glasgow, GCC, 2021.*

ENV89. Community garden area per capita and in a defined distance



Community garden spaces in the city have been mapped and can be seen in the Figure 8. Their reach is limited and so the Open Space Strategy is aiming to increase the number of community growing spaces to help communities. Accessibility of these spaces has been mapped and deficient areas based on 400m accessibility have been identified as per **ENV23. Public green space distribution**.

Figure 8 - Glasgow's allotments (GCC, 2021)

Environmental indicators - FEATURE

ENV1. Carbon storage OR carbon sequestration in vegetation/soil

Forest Research (government organisation) and Treeconomics (social enterprise) undertook a study to put a value on ecosystem services provided by trees in Glasgow and get a figure for carbon sequestration in 2013. The work included some limited tree sampling and subsequent input of these sample points into i-Tree, a software suite from the USDA Forest Service that provides urban and community forestry analysis. The ecosystem services provided by Glasgow's trees were estimated at £4.5 million per year based on a 15% urban tree cover and an estimated 183,000 tonnes of carbon being stored in Glasgow's trees.

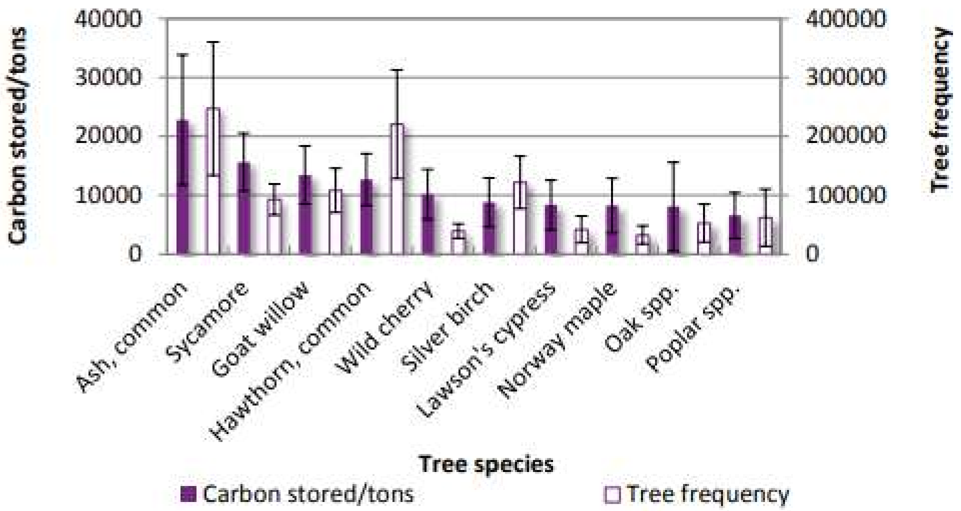


Figure 9 - Amount of carbon stored in Glasgow's urban forest and the frequency of each species in Glasgow. Only the ten trees with the highest storage rates are displayed ([Forest Research, 2015, p. 25]).

More information about the study and Glasgow's carbon sequestration figures is available from [Forest Research's report of 2015].

ENV41. Accessibility of greenspaces

Please refer to **ENV23. Public green space distribution**and *Figure 5- Glasgow's 400m accessibility to Community Spaces.*

ENV55. Green space area

Please refer to **ENV23. Public green space distribution** and *Figure 4 - PAN65 Open Space map of Glasgow, GCC, 2021.*

ENV66 – Air quality change

Air quality in Glasgow is measured hourly/daily in various locations across the city for pollutants such as NO2, CO, etc. and compared against national objectives and strategies to ascertain whether exceedances have taken place. As can be seen in the table below, there has only been one instance of NO2 exceedances in Glasgow so far this year.

Table 1 - Number of NO2 exceedances in Glasgow in 2021 (Air Quality Scotland, 2021).

Air Quality Strategy Objective for 2005 (NO2) Annual Mean > 40 microgrammes per metre cubed 2021 List of monitoring sites exceeding the objective	
Site	Number of Exceedences
Glasgow Anderston	0
Glasgow Byres Road	0
Glasgow Dumbarton Road	0
Glasgow Great Western Road	0
Glasgow High Street	0
Glasgow Kerbside	1
Glasgow Nithsdale Road	0
Glasgow Townhead	0
Glasgow Waulkmillglen Reservoir	0

For more data on air quality in Glasgow for different pollutants and over the years, please refer to the Air Quality in Scotland web-page.

Health and wellbeing - CORE

HW3. General wellbeing and happiness

General health and wellbeing has been investigated as part of NHSGGC's health and wellbeing survey in 2017/2018. All data can be found in the Supplementary material section with some key indicators provided in the table below.

Table 2 - General wellbeing and happiness results from NHSGGC's health and wellbeing survey in 2017/2018 (NHSGGC, 2019)

Indicator	Percentage of respondents
Long-term limiting condition or illness	28.6%
Receiving treatment for at least one condition	41.4%
Current Smokers	24.4%
Isolated from family and friends	15.2%
Experienced discrimination	6.7%

HW6. Prevalence, incidence, morbidity, and mortality of cardiovascular diseases

Data on the existence of cardiovascular conditions for the city are made available through the Scottish Health Survey (annual) in aggregated form, with the latest figures showing 15% of Glasgow's population having some kind of cardiovascular condition for the four years between 2016 and 2019, having slightly reduced from 2015-2018's 16% (Scottish Health Survey, 2020).

Additionally, data at intermediate zone level on coronary heart disease patients is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard in aggregated form between 2016/2017 and 2018/2019. The dashboard also gives a comparison between the latest figures and those from previous years. A screenshot of the dashboard's graph is available below:

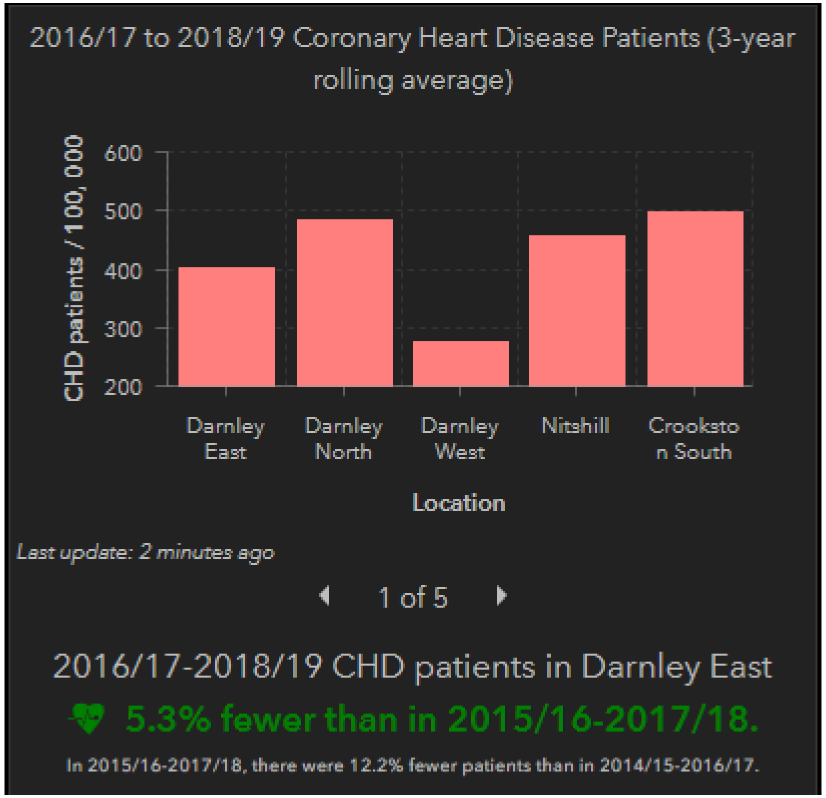


Figure 10 - Number of coronary heart disease patients per 100,000 population per intermediate zone in Glasgow for 2016/2017 to 2018/2019 (ScotPHO, 2019).

Please note that the data are on hospitalisations rather than patients diagnosed with coronary heart disease, therefore the results must be considered with caution as they likely portray trends across the city and cannot be taken as absolute figures. For more information on the data, please consult ScotPHO's Indicator Definitions page.

HW11. Mental health and wellbeing

Data on mental health and wellbeing for the city are made available through the Scottish Health Survey (annual) in aggregated form, with the latest mean WEMWBS score at 48.4 for the four years between 2016 and 2019, having slightly reduced from 2015-2018's mean of 48.5 (Scottish Health Survey, 2020). For more information on these data, please consult the Indicators & Methods webpage.

NHSGGC's health and wellbeing survey of 2017/2018 looked at mental health and wellbeing for a limited sample of citizens (approximately 4500) with some results being presented below.

Table 3 -Mental health results from NHSGGC's health and wellbeing survey in 2017/2018 (NHSGGC, 2019)

Indicator	Percentage of respondents
Positive perception of mental/emotional wellbeing	83.9%
Positive view of general health	72.9%
Positive perception of physical wellbeing	79.1%

As previously mentioned, the sample size of the survey is limited and its distribution is displayed in *Figure 12*.

Additionally, and as part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on mental health prescriptions (anti-depressants, anxiolytics and anti-psychotics) per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding mental health patterns in the city. As can be seen in the map below, we are seeing worrying numbers of mental health prescriptions across the city, with the lowest prescription rates being 9.15% and the highest reaching almost 35%.

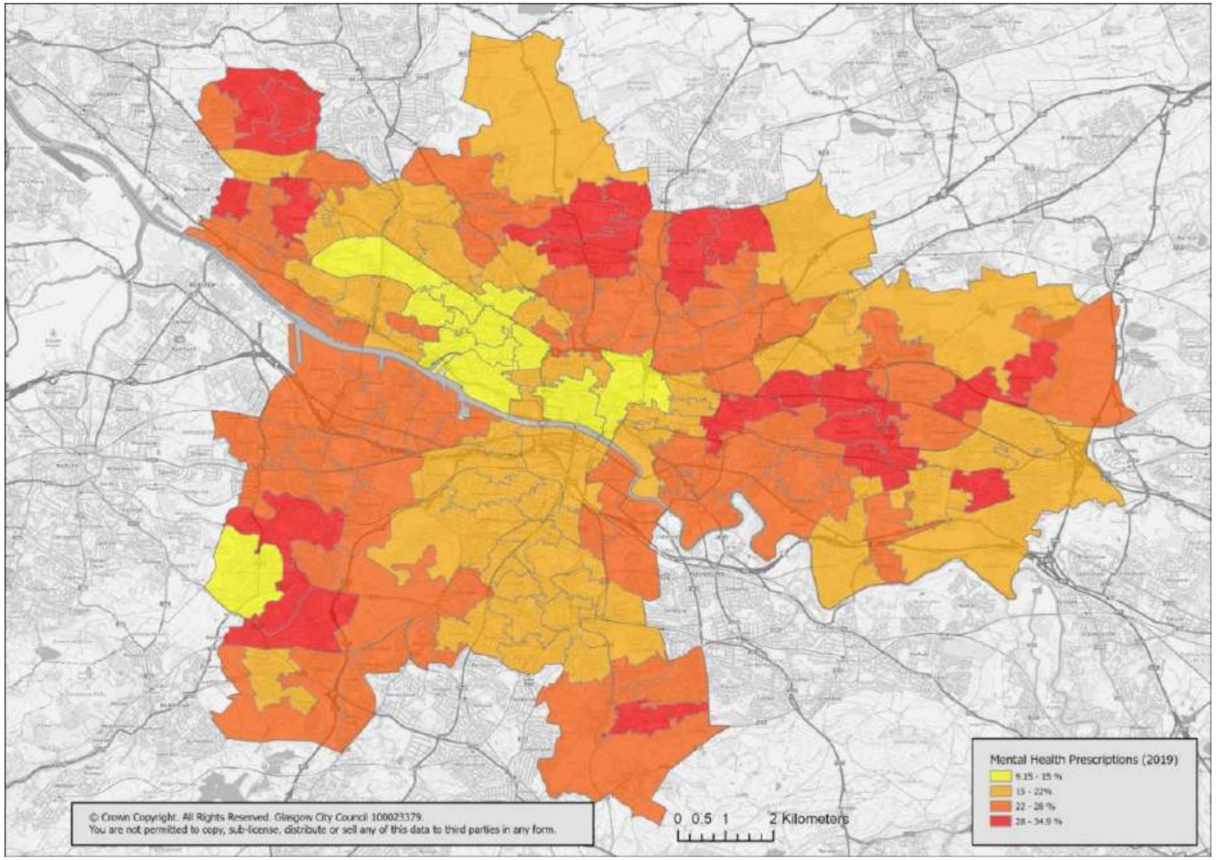


Figure 11 - Mental health prescriptions across Glasgow's intermediate zones for 2019 (Safe Haven, 2021)

As previously noted, the data only displays secondary-care based prescriptions and therefore does not take into account diagnosis and non-medication-related treatment. The raw data were matched from postcode to intermediate zone level and as some patients' postcodes were not recorded, these records were excluded from the data used. Such records accounted for approximately 0.2% of all records. It is therefore imperative that the figures displayed above are considered with caution as they do not represent absolute numbers of patients suffering from mental health illness, but rather they can be used to identify wider spatial patterns in mental health and wellbeing.
For more maps of the previous 5 years of data, please consult the Supplementary material section.

HW12. Enhanced physical activity

NHSGGC's health and wellbeing survey of 2017/2018 looked at one indicator around physical activity with a focus on at least 150 minutes per week. The results are available below:

Table 4 - NHSGGC's health and wellbeing survey results for 150 minutes + per week of physical exercise (NHSGGC, 2019)

Indicator	Percentage of respondents
150 minutes+ per week of physical activity	64.8%

For a graph of the sample size distribution of this survey across Glasgow, please consult *Figure 12*.

Data on activity levels for the city are also made available through the Scottish Health Survey (annual) in aggregated form, with the latest figures presented below (Scottish Health Survey, 2020).

Table 5 - Activity levels as per the Scottish Health Survey (2020)

Activity level	Percentage of respondents	
	2015-2018	2016-2019
Very low activity	22 %	23 %
Low activity	5 %	4 %
Some activity	10%	11 %
Meets recommendations	62%	62 %

For more information on the definitions of the above activity levels, please consult the Scottish Health Survey's Indicators & Methods page.

Health and wellbeing - FEATURE

HW1. Sustainable nutrition/adoption

NHSGGC undertook a health and wellbeing survey in 2017-2018 with a sample size of just over 4500 people in Glasgow City. They investigated topics such as perception of health and illness, health behaviours, general social health, social capital and financial wellbeing all linked to deprivation and demographics. The full results and data are available in the Supplementary material section, with some interesting findings showing in the next table.

Table 6 – Vegetable consumption per day.

Indicator	Percentage of respondents
Consumes 5+ portions of fruit/vegetables per day	38.8%

However, the sample size of the survey is limited and as such, these results must be considered alongside other data which are presented in later sections. A graph of sample size across intermediate zones is presented below to illustrate the potential data limitations.

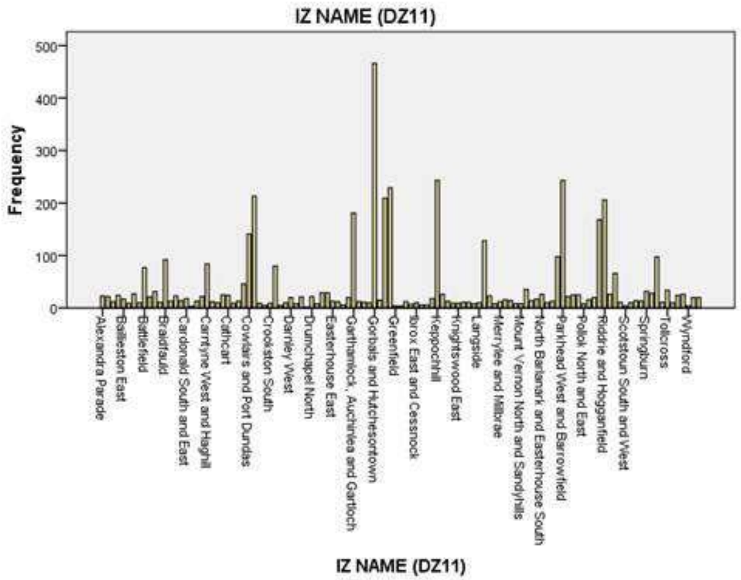


Figure 12 - NHSGGC health and wellbeing survey 2017/2018 sample distribution across the city (GCC, 2021)

HW4. Life expectancy and healthy life years expectancy

Data at intermediate zone level on life expectancy is made available from the Scottish Public Health Observatory's website ([ScotPHO]) and has been presented graphically and spatially on [Glasgow's CN dashboard] in aggregated form between 2014 and 2018. The dashboard also gives a comparison between the latest figures and those from previous years. A screenshot of the dashboard's graph is available below:

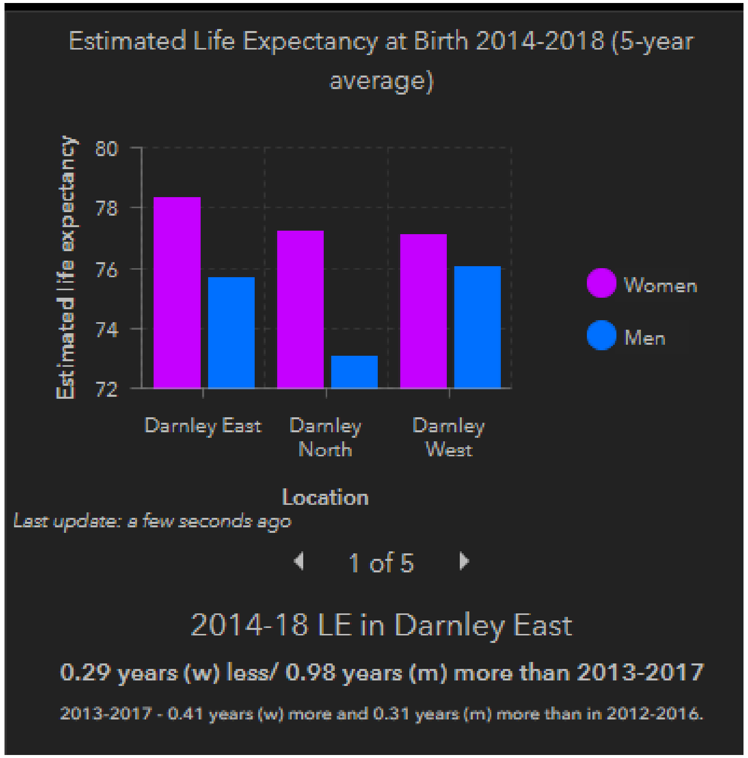


Figure 13 - Estimated life expectancy at birth per intermediate zone in Glasgow for 2014-2018 in Glasgow (ScotPHO, 2019).

For more information on the data, please consult ScotPHO's Indicator Definitions page.

HW7. Prevalence, incidence, morbidity, and mortality of respiratory diseases

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on respiratory prescriptions (a list of medication is available as part of the Supplementary material section) per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding respiratory illness in the city. As can be seen in the map below, we are seeing worrying numbers of respiratory prescriptions across the city, with the lowest prescription rates being 11% and highest reaching just over 39%.

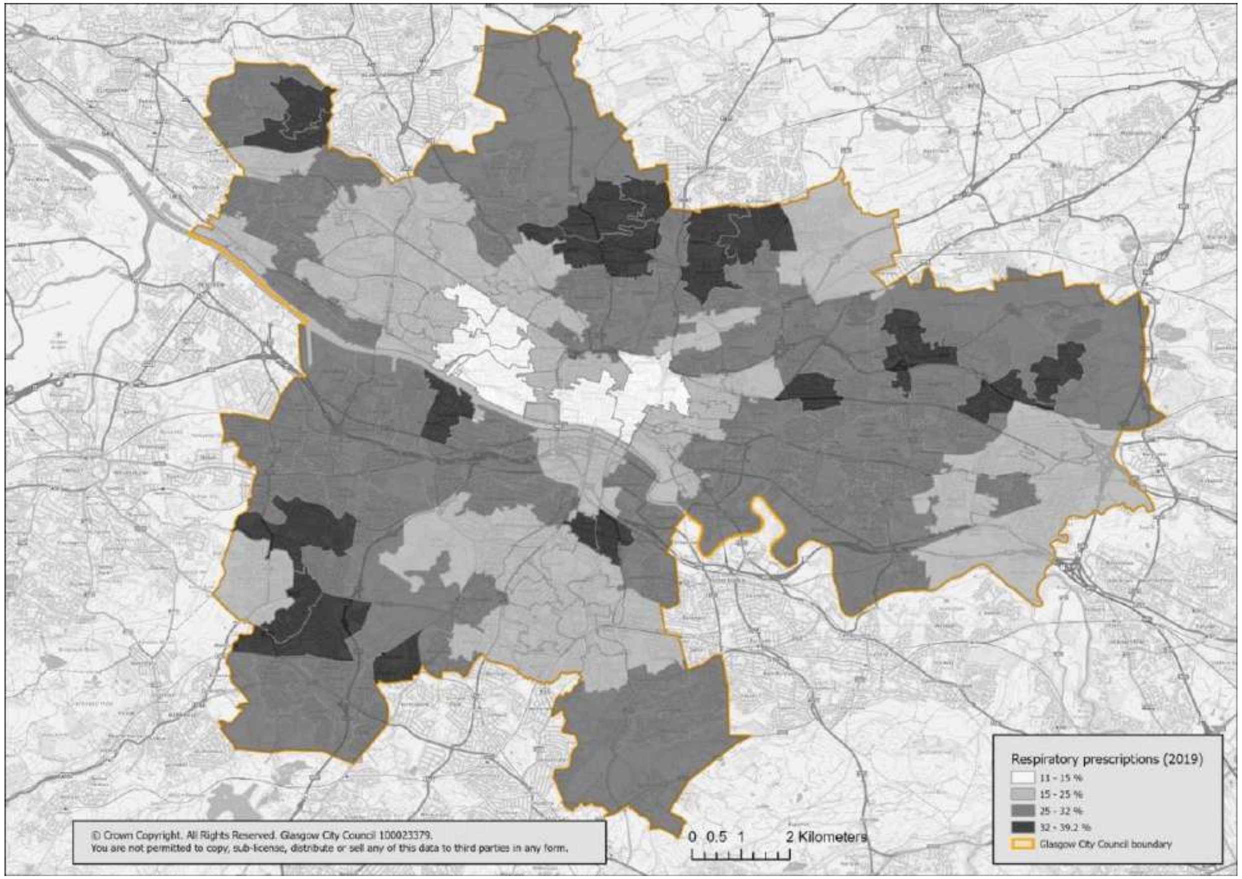


Figure 14 - Respiratory prescriptions per intermediate zone for 2019 (Safe Haven, 2021).

As previously noted, the data only displays secondary-care based prescriptions and therefore does not take into account diagnosis or primary care. The raw data were matched from postcode to intermediate zone level and as some patients' postcodes were not recorded, these records were excluded from the data used. Such records accounted for approximately 0.2% of all records. It is therefore imperative that the figures displayed above are considered with caution as they do not represent absolute numbers of patients suffering from respiratory illness, but rather they can be used to identify wider spatial patterns in health and wellbeing.

For more maps of the previous 5 years of data, please consult the Supplementary material section.

HW8. Incidence of obesity /obesity rates (adults and children)

Data on obesity rates for the city are made available through the Scottish Health Survey (annual) in aggregated form, with the latest figures showing 27% of adults are obese for the four years between 2016 and 2019, having slightly reduced from 2015-2018's 28% obesity (Scottish Health Survey, 2020). Rates for overweight people, including obese persons has also slightly reduced from 62% between 2015 and 2018 to 61% between 2016 and 2019.

For more information on the obesity and overweight data from the Scottish Health Survey, please consult the Indicators & Methods webpage.

HW14. Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on ADHD prescriptions per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding patterns in the city. As can be seen in the map below figures are consistently below 1% in all areas, with the highest prescriprion percentages mostly coinciding with areas of high mental health prescriptions (please see **HW11. Mental health and wellbeing**).

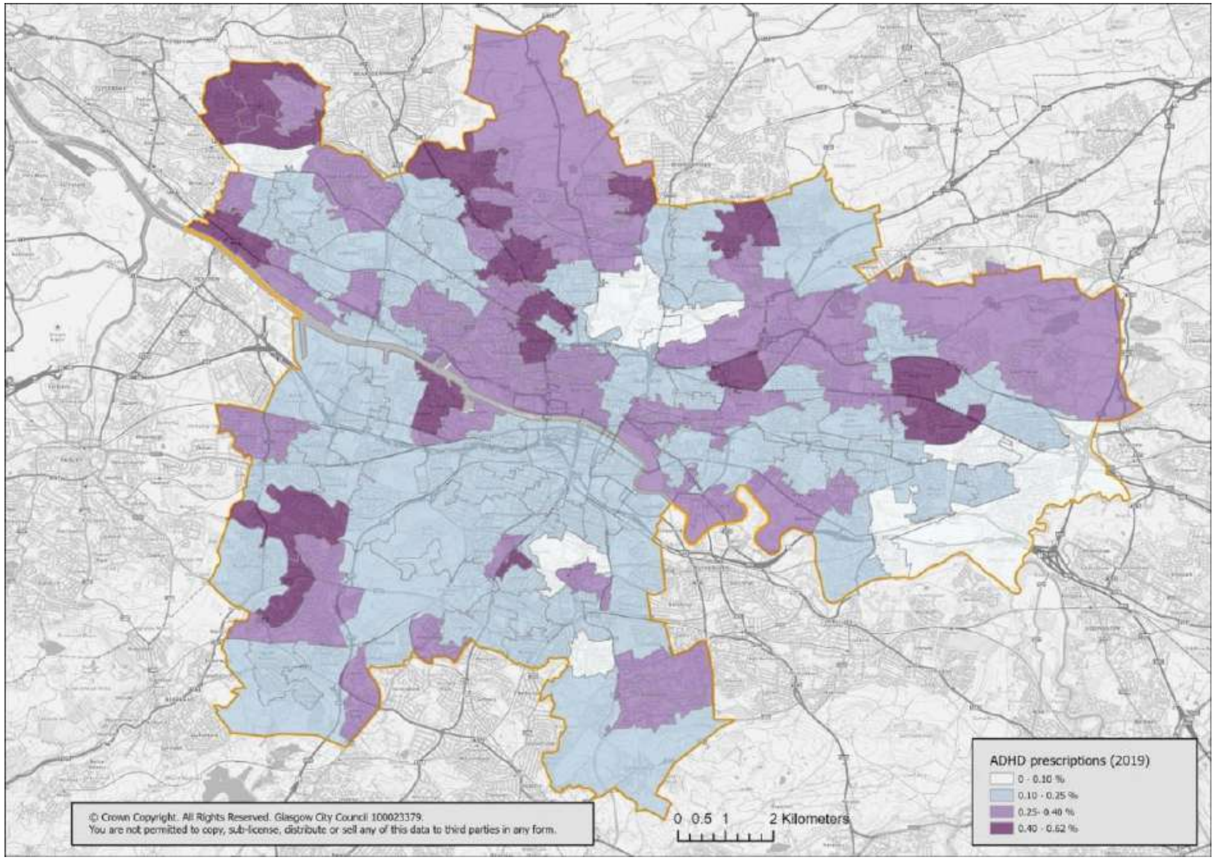


Figure 15 - ADHD prescriptions per intermediate zone population for 2019 (Safe Haven, 2021).

The data only displays secondary-care based prescriptions and therefore does not take into account diagnosis and persons who do not use medication. The raw data were matched from postcode to intermediate zone level and as some patients' postcodes were not recorded, these records were excluded from the data used. Such records accounted for approximately 0.2% of all records. It is therefore imperative that the figures displayed above are considered with caution as they do not represent absolute numbers of patients suffering from ADHD, but rather they can be used to identify wider spatial patterns in mental health and wellbeing.
For more maps of the previous 5 years of data, please consult the Supplementary material section.

Social cohesion - CORE

SC1. Bonding social capital

NHSGGC's health and wellbeing survey of 2017/2018 looked at social capital for a limited sample of citizens (approximately 4500) with some results being presented below.

Table 7 -Social capital results from NHSGGC's health and wellbeing survey in 2017/2018 (NHSGGC, 2019)

Indicator	Percentage of respondents
Positive perception of reciprocity	74.3%
Positive perception of trust	77%
Value local friendships	72.9%
Positive perception of social support	82.6%
Volunteered in last year	20%
Belong to clubs, associations or groups	26%
Engaged in social activism in last year	6.9%

As previously mentioned, the sample size of the survey is limited and its distribution is displayed in *Figure 12*. Therefore, no direct relationships should be made between the community and these limited results.

SC2. Bridging social sapital

Please refer to **SC1. Bonding social capital**.

SC4.1. Trust in community

NHSGGC's health and wellbeing survey of 2017/2018 looked at social health for a limited sample of citizens (approximately 4500) with some results being presented below.

Table 8 -Social health results from NHSGGC's health and wellbeing survey in 2017/2018 (NHSGGC, 2019)

Indicator	Percentage of respondents
Feel belong to the local area	75.9%
Feel valued as a member of the community	61.2%

As previously mentioned, the sample size of the survey is limited and its distribution is displayed in *Figure 12*. Therefore, no direct relationships should be made between the community and these limited results.

SC5.1. Perceived safety

NHSGGC's health and wellbeing survey of 2017/2018 looked at social health and namely, perceived safety for a limited sample of citizens (approximately 4500) with some results being presented below.

Table 9 - Perceived safety results from NHSGGC's health and wellbeing survey in 2017/2018 (NHSGGC, 2019)

Indicator	Percentage of respondents
Feel safe using local public transport	90.2%
Feel safe walking alone in local area even after dark	74.6%

The sample size of the survey is limited and its distribution is displayed in *Figure 12*. Therefore, no direct relationships should be made between the community and these limited results.

SC5.2. Actual safety

Data at intermediate zone level on crime rates is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard for 2018. The dashboard also gives a comparison between the 2018, 2017 and 2016 figures. A screenshot of the dashboard's graph for one of Glasgow's intermediate zones (Bridgeton) is available below:

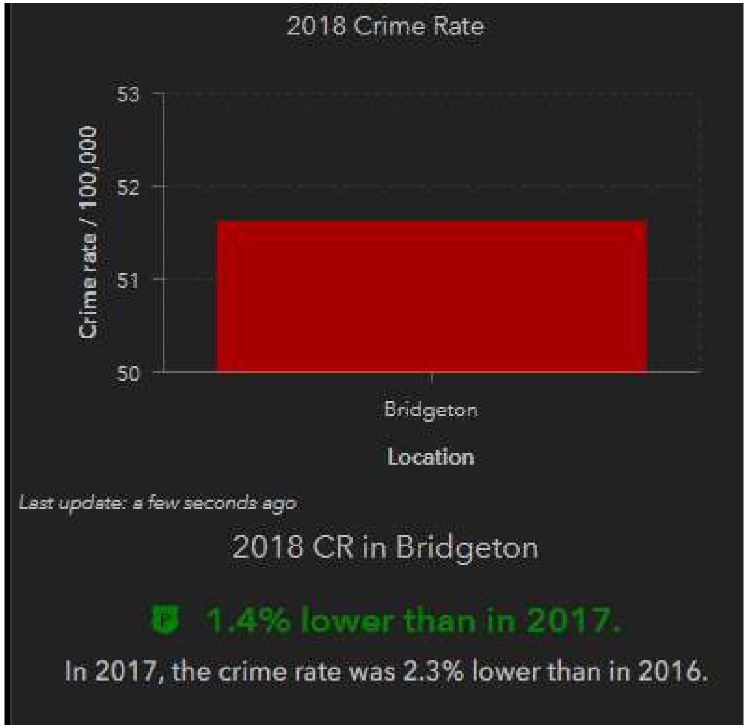


Figure 16 – Crime rate per 100,000 population in Bridgeton in 2018 (ScotPHO, 2019).

For more information on the data, please consult ScotPHO's Indicator Definitions page.

SC9. Empowerment

NHSGGC's health and wellbeing survey of 2017/2018 looked at social health namely, one question on empowerment for a limited sample of citizens (approximately 4500) with results being presented below.

Table 10 - Empowerment results from NHSGGC's health and wellbeing survey in 2017/2018 (NHSGGC, 2019).

Indicator	Percentage of respondents
Feel local people can influence local decisions	69.5%

The sample size of the survey is limited and its distribution is displayed in *Figure 12*. Therefore, no direct relationships should be made between the community and these limited results.

Economic - CORE

ECO1. New Businesses 'attracted' or started and additional rates received

We have access to data on the location and type of businesses across Glasgow, based on their registered address. These were procured from Companies House in 2020. A map showing all active businesses across Glasgow in 2020 is available below.

Please note that the data are based on the address each business is registered at. It is likely there are businesses operating in Glasgow which are registered elsewhere and vice versa, thus there is a level of error incorporated in these data. However, as a baseline, they provide a general understanding of business density in the city and can be used in future with updated data to see whether there is a difference in numbers of businesses within specific wards/zones.

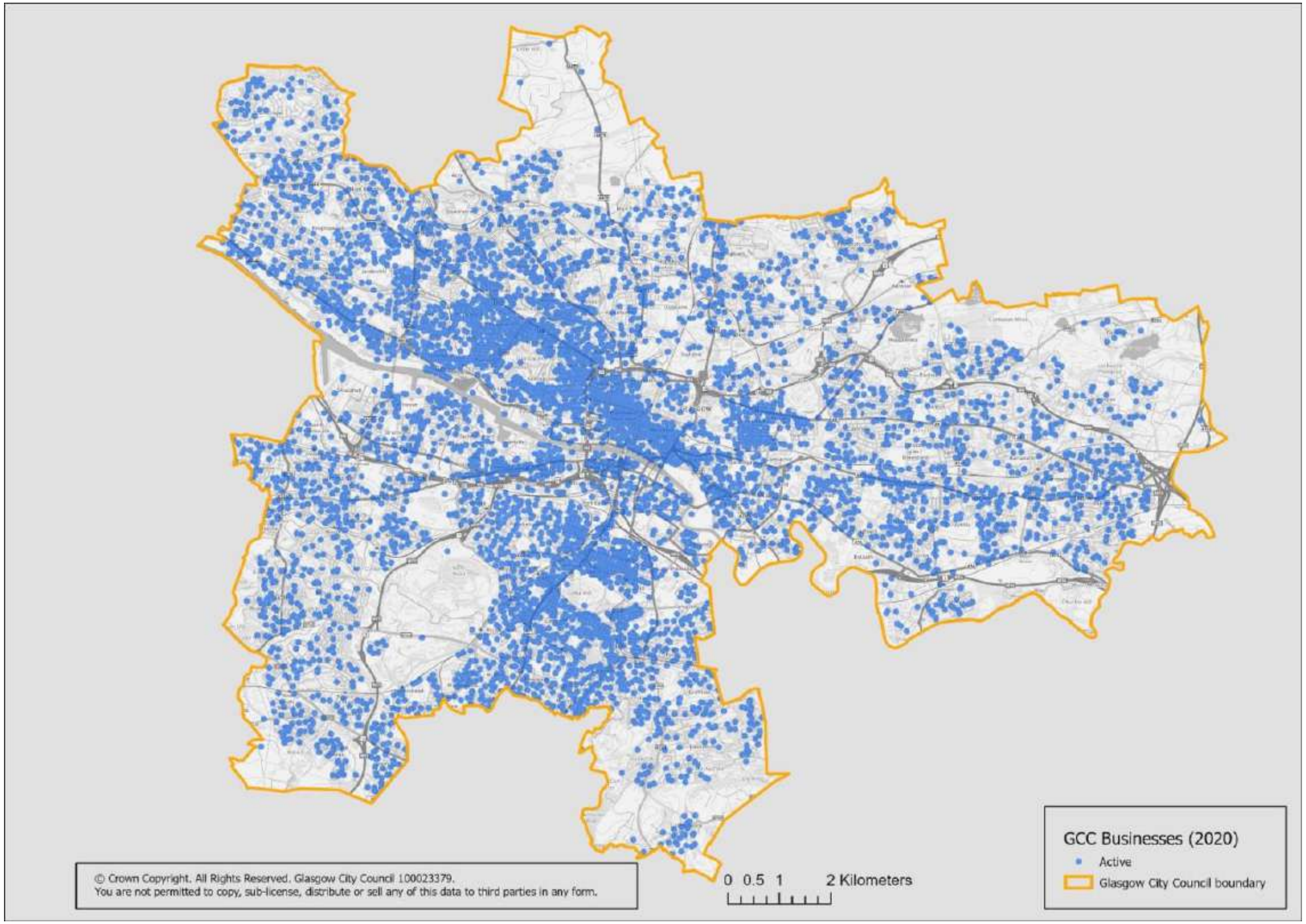


Figure 17 - Active businesses in Glasgow City in 2020 ([Companies House, 2020](#)).

ECO3. Net additional jobs created/enabled by NBS

The Office for National Statistics' Business Register and Employment Survey records the number of jobs held by employees broken down by full/part time working patterns on a yearly basis. Jobs are recorded at the location of an employee's workplace and are available at data zone, intermediate zone and city level. Glasgow's number of employees are presented below:

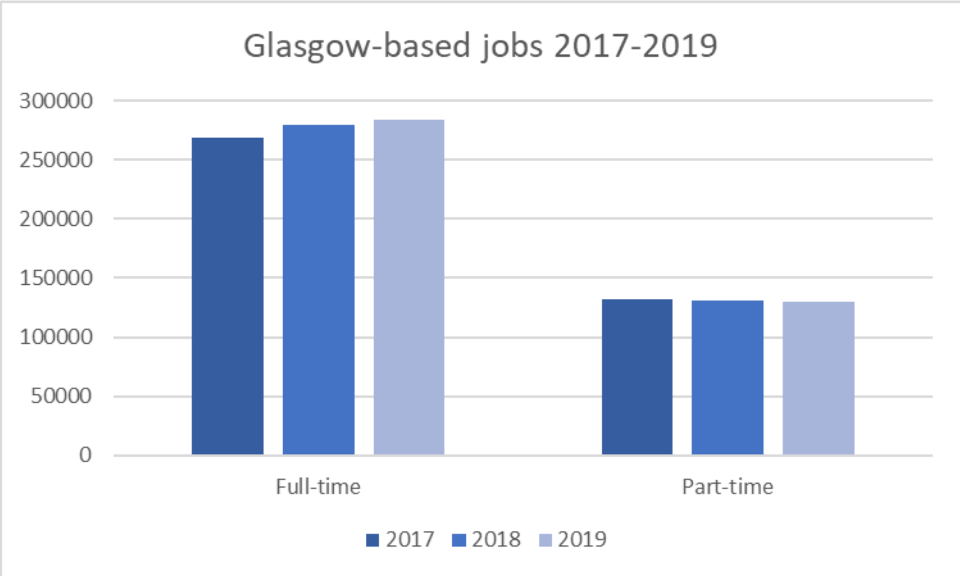


Figure 18 - Numbers of jobs in Glasgow between 2017 and 2019 (NOMIS, 2021).

For more information on the survey and the methodologies employed, please consult NOMIS.

Additionally, the Office for National Statistics' Annual Population Survey is available in yearly intervals for Glasgow City and contains data on economic activity for all people between 16-64 years of age (economically active, in employment, employees, self-employed, unemployed, and inactive). The data for the last three years available (2018-2020) are displayed below and show a consistent upwards trend in employment/economic activity:

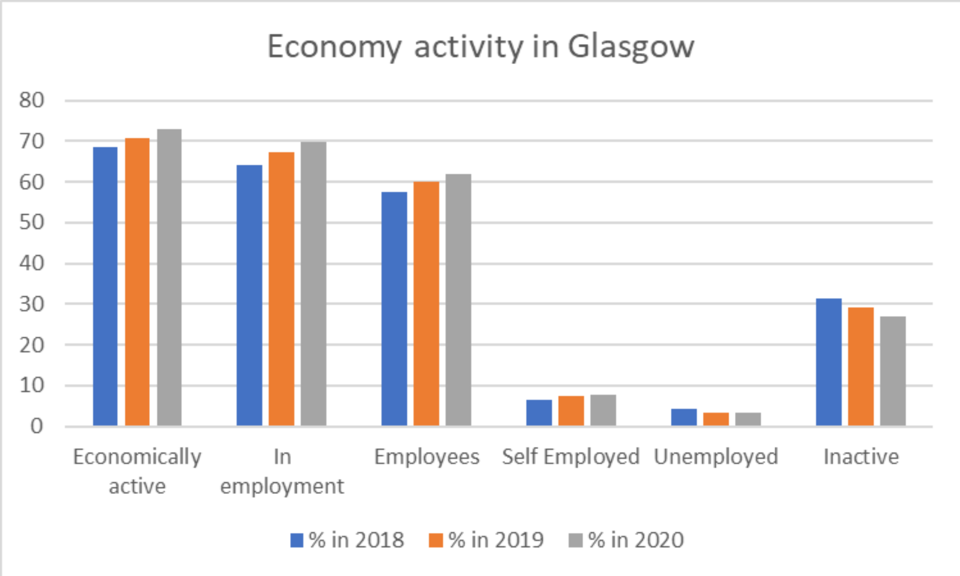


Figure 19 – Economy activity in Glasgow over the past three years (NOMIS, 2021)

As any annual statistical survey, the Annual Population Survey is based on a sample of approximately 320,000 people across the UK, so the coverage within Glasgow City is limited, however the results have been deemed 'robust' and are able to portray the right trends for the city. For more information on the methodology of the survey, please consult the Office of National Statistics' APS QMI page.

ECO7. Increase in tourism

Glasgow Life collect yearly tourism figures around numbers of trips, nights spent and total amount of money spent for the year after analysing data from Visit Britain's Domestic Overnight Visitors and International Visitor Trips surveys, along with the Office for National Statistics' International Passenger Survey which present their data at regional level. Due to the sample size and difficulties in calculating visits/nights and spend, the latest available data are presented as three-year averages (2016-2018) according to Glasgow Life and industry advice. These figures are available below:

Table 11 - Average tourism figures for 2016-2018 in Glasgow City (Glasgow Life, 2020).

3-yr average 2016-18	Trips	Nights (000s)	Spend (£m)
International	761	4020	£302
Domestic	1554	3600	£361
International & Domestic	2315	7620	£663

Table 12 - Average tourism day visits for 2016-2018 in Glasgow City (Glasgow Life, 2020).

Tourism Day Visits	3-yr average 2016-18
Trips	18,670
Spend	947

Economic - FEATURE

ECO8. Income/disposable income per capita

The Office for National Statistics conducts an Annual Survey of Hours and Earnings looking at annual, weekly and hourly earnings for both full time and part-time workers. As per NOMIS, median earnings are recommended instead of mean earnings as they are 'influenced less by extreme values and because of the skewed distribution of earnings data'. The below graphs show median gross annual pay over the last three years (2018-2020) in Glasgow:

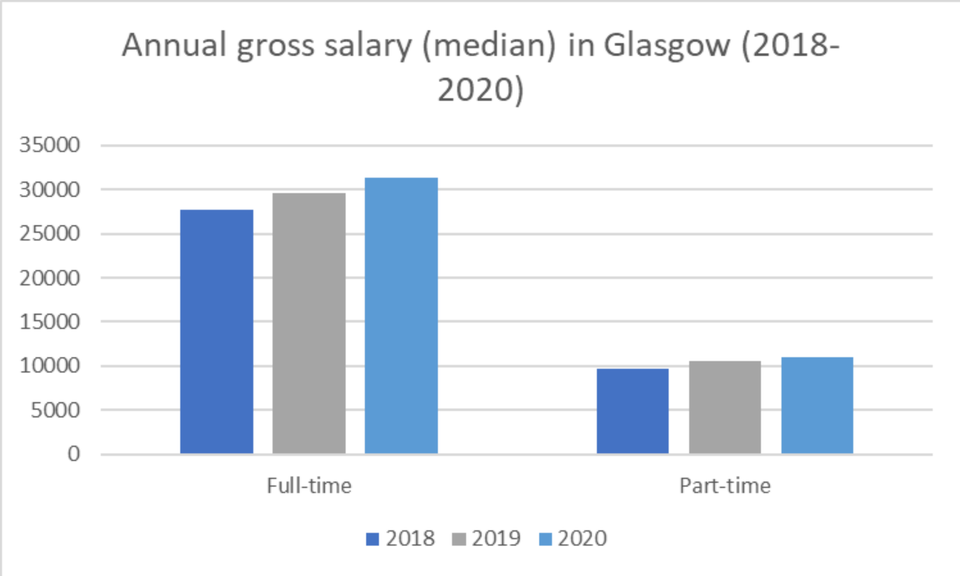


Figure 20 - Annual gross median pay in Glasgow over the past three years (NOMIS, 2021).

The survey is based on a sample of jobs taken from HM Revenue & Customs PAYE records and does not cover self-employed or employees not paid within its reference period (April each year). For more information on the survey, please consult NOMIS.

ECO9 - Upskilling & related earning increase

The NOMIS Annual Population Survey is available in yearly intervals for Glasgow City and contains data on the level of qualifications of Glasgow's population that's between 16-64 years of age (GCSE grades A-C or equivalent, GCE A-level or equivalent, in-higher education, degree or equivalent, and other qualifications). The data for the last three years available (2018-2020) are displayed below and show an upwards trend in terms of degree qualifications but a less clear pattern when looking at all other categories:

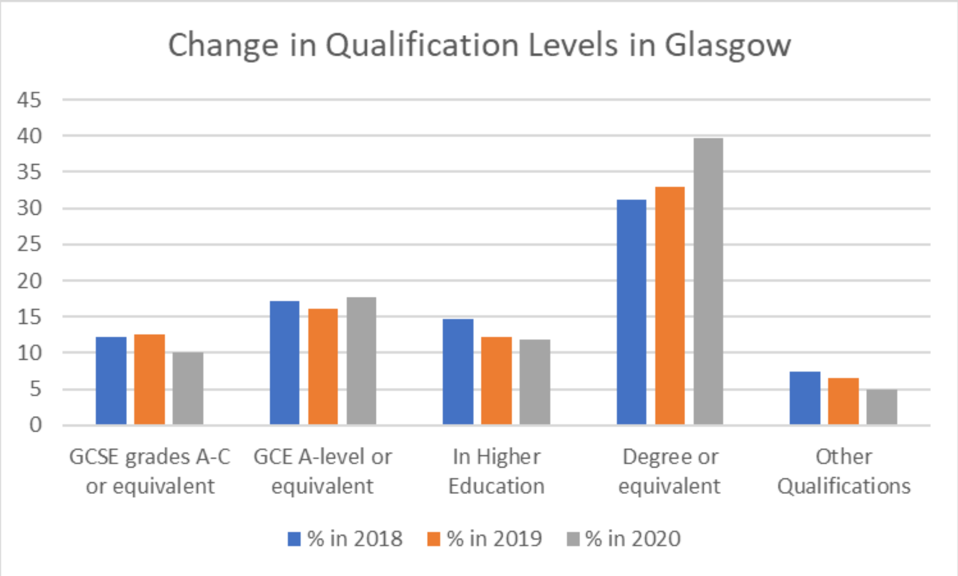


Figure 21 - Qualification levels for Glasgow's population (NOMIS, 2021).

As any annual statistical survey, the Annual Population Survey is based on a sample of approximately 320,000 people across the UK, so the coverage within Glasgow City is limited, however the results have been deemed 'robust' and are able to portray the right trends for the city. For more information on the methodology of the survey, please consult the [Office of National Statistics' APS QMI page].

ECO11. Overall economic, social and health wellbeing

The population's overall economic, social and health wellbeing is measured through the Scottish Index of Multiple Deprivation ("SIMD") which is computed every 4 years by the Scottish Government at data zone level, based on various national and local indicators. The following image is a map showing SIMD deciles with the lowest values indicating higher levels of deprivation and higher values showing more affluent areas (financially, socially and health-related). The darkest colour indicates the 20% most deprived areas in Glasgow, and the lightest colour shows the 20% least deprived areas in the city.

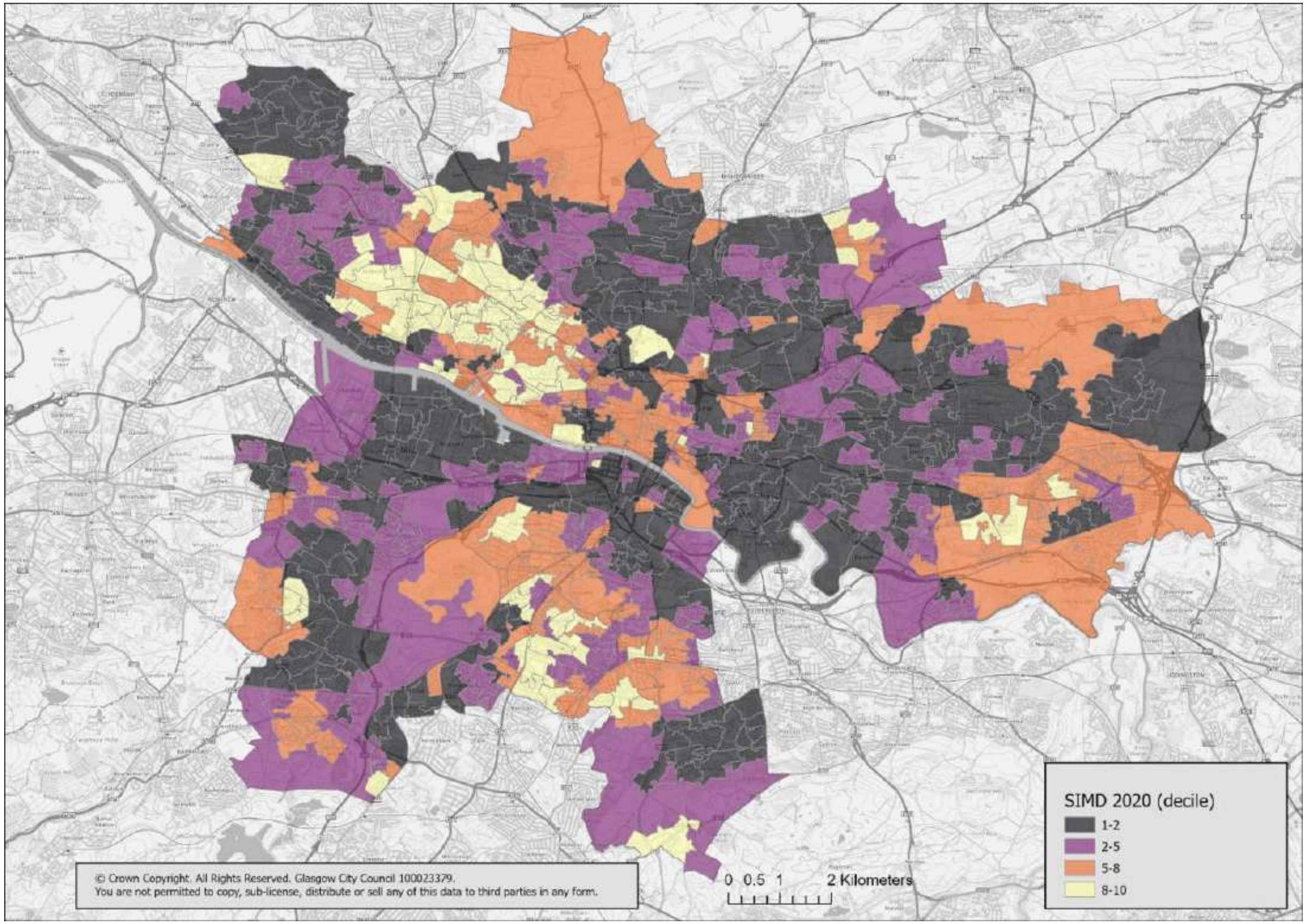


Figure 22 - SIMD map of Glasgow (SG, 2020).

For more information on the data making up the SIMD and the methodology behind it, please consult the Scottish Government's page on SIMD from 2020.

B. GROWCHAPEL

Environmental indicators - CORE

ENV8. Rainfall storage (water absorption capacity of NBS)

A SuDS assessment was undertaken prior to the site being developed, as the site was laying vacant and didn't have any drainage systems in place. The SuDS report can be viewed in the Supplementary material section.

ENV19. Inundation risk for critical urban infrastructures (probability)

Please refer to **Error! Reference source not found.**.

ENV19. Supporting/increasing biodiversity conservation

A habitats and biodiversity survey of the site was carried out by GCC biodiversity officers in summer 2020 prior to any construction work being undertaken on site. The results can be viewed in the following map and notes:

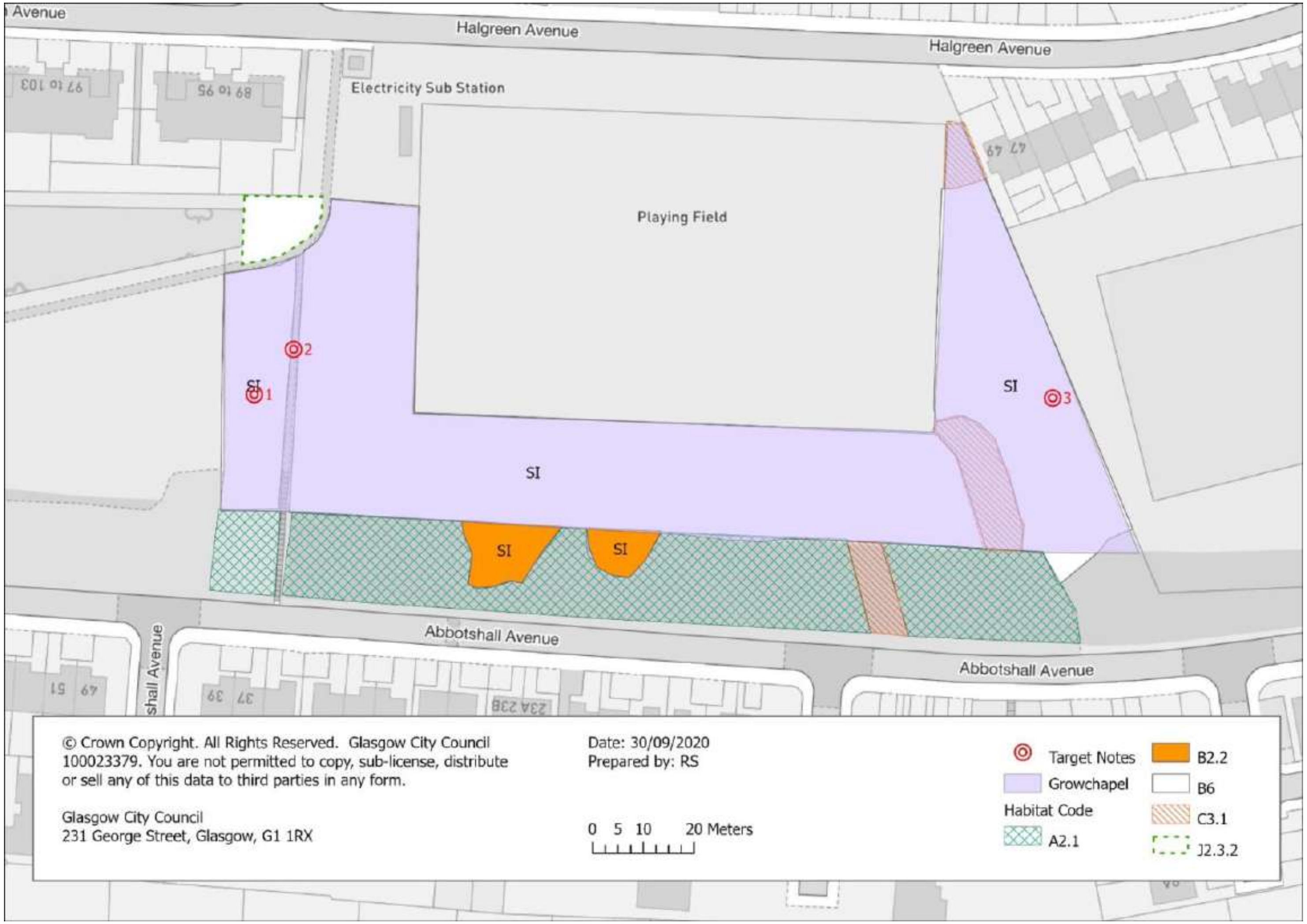


Figure 23 - Growchapel biodiversity survey (GCC, 2020)

Table 13 - Growchapel biodiversity survey target notes (GCC, 2020)

Target Note	Description
1	Grassland to west of entrance path – grasses slightly finer e.g. Fescues and Yorkshire Fog with Cat's-ear (*Hypochaeris radicata*). Despite greater variety of grasses still poor semi-improved grassland though.
2	Entrance path edges – ephemeral/ short perennial vegetation along path edges. Typical of urban sites with high compaction of soils. Marsh Foxtail grass growing in damper areas along with following mix of herbs: • Daisy - *Bellis perennis* • Common knotgrass - *Polygonum aviculare* • Pineappleweed - *Matricaria discoidea* • Broad-leaved plantain – *Plantago major*.
3	North of playing field – beyond bank of Creeping Thistle – very damp grassland with some rushes and some open water in a ditch. Borderline marshy grassland but surrounding species all indicative of poor semi-improved grassland. Following additional species recorded: • Floating sweet grass – *Glyceria fluitans* • Compact Rush – *Juncus conglomeratus* • Soft Rush – *Juncus effuses* • Yellow Flag (one plant) - *Iris pseudocorus* • Common Mouse-ear – *Cerastium fontanum* • Common Nettle – *Urtica dioica* • Hairy Tare – *Vicia hirsute* • Great Hairy Willowherb - *Epilobium hirsutum* • Marsh Woundwort – *Stachys palustris*.

The classification and symbols were taken from the Joint Nature Conservation Committee's Phase 1 Habitat Survey Handbook (2016) which is included in the Supplementary material section.

ENV 35. Species diversity

Please refer to **ENV19. Supporting/increasing biodiversity conservation**.

ENV42. Land use change and greenspace configuration

The Growchapel site was originally an overgrown derelict site that was part of amenity greenspace in the open space map. The area around it comprises of some woodland, a derelict sports pitch and another area of overgrown grass, as per the below map:

Figure 24 - Growchapel current land use (GCC, 2016)

Following the development of the site into a community garden, the land use has changed from derelict and overgrown amenity greenspace to a community garden with regards to protected open space. Options are being looked at to see whether the garden can expand into neighbouring open spaces which are also derelict to provide more usable space for the community.

ENV89. Community garden area per capita and in a defined distance

Growchapel has been sited in the Drumchapel ward in Glasgow, which has only had one community garden/growing space at the southern bit of the ward, therefore only serving a small number of people as can be seen in the following map.

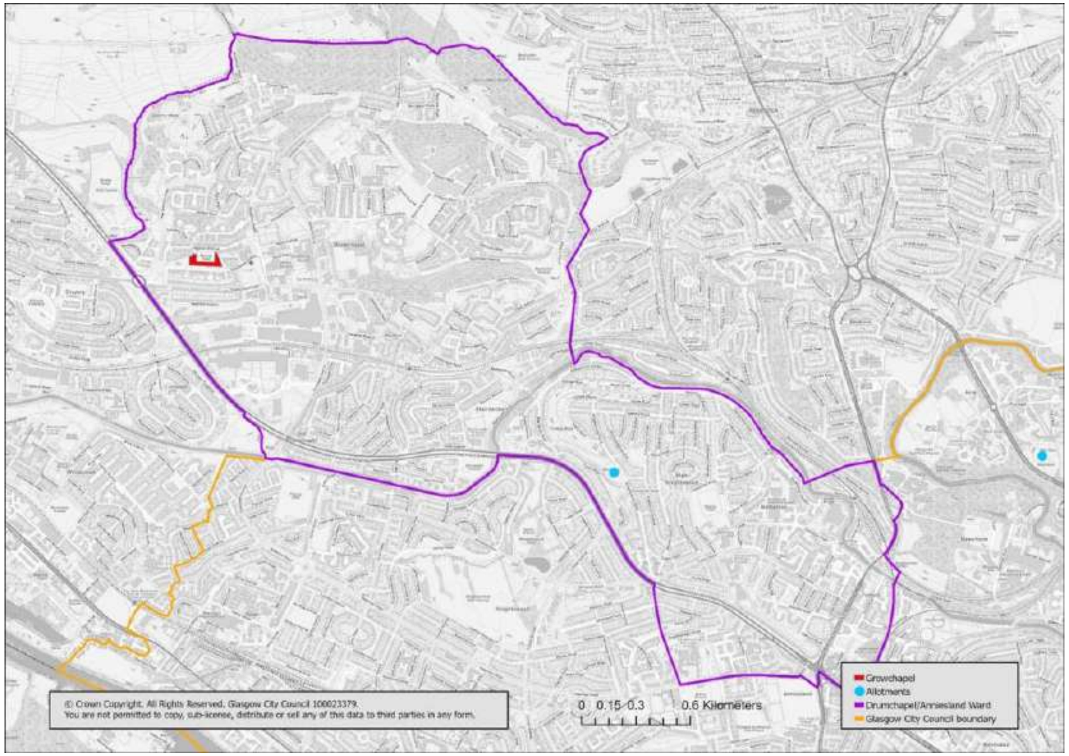


Figure 25 – Growchapel community garden area per capita and in a defined distance

Growchapel has increased access to a community garden for the Drumchapel ward, as previously there was only one community garden in the ward which only serves the south of the ward.

<u>Environmental indicators - FEATURE</u>

ENV41. Accessibility of greenspaces

Accessibility of the site prior to its development was limited due to it being an overgrown derelict site with no paths or formal entrances. We undertook site visits to assess the quality of our open spaces and the site scored below the standard expected with accessibility scoring a low 1 out of 5, as per below:

Open Space Area

Ref No: **142**
Site Name:
Type: **Open Space** Study Area: **Drumchapel**
Surveyed: **Yes** Size Hectares: **1.18**

From an initial assessment do you think that the space could meet the quality standard?: **Yes**

Percentage Pass: **52.50** %

b) Configuration: **4 Little less useful**
c) Surveillance: **3 many overlooked**
d) Accessibility: **1 access poor**
e) Aspect: **5 all parts benefit**
f) Place Quality: **2 little visual amenity**
gi) Informal Sport/Recreation: **4 flat? 1ha some**
gii) Children's Play: **1 no opportunities**
giii) Relaxation: **1 no obvious quieter areas**
giv) Biodiversity: **4 areas for nature, connected, some habitats**

Figure 26 - Growchapel pre-development site survey results (GCC, 2019-2020)

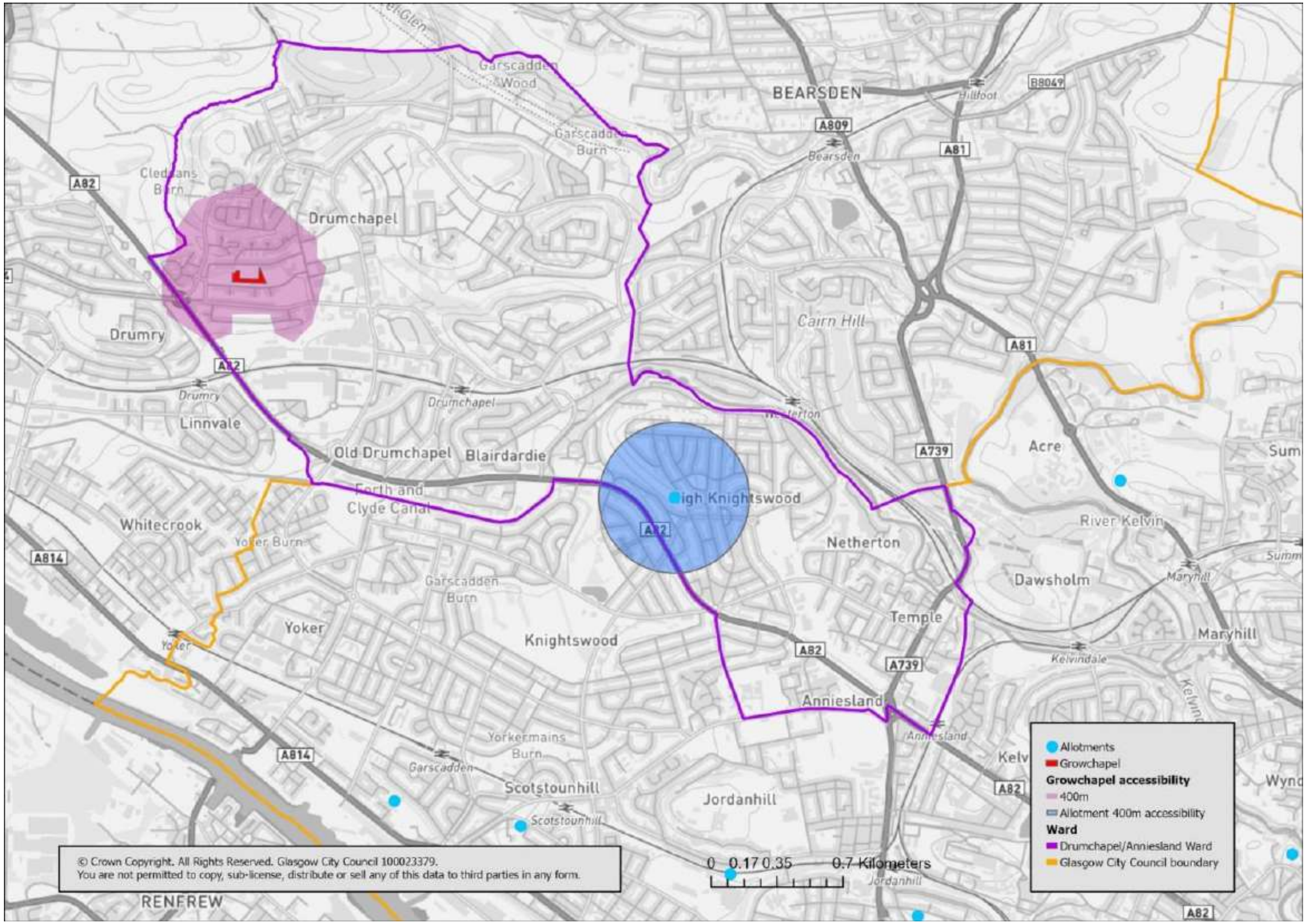


Figure 27 - Accessibility for existing community garden and new Growchapel garden in the Drumchapel ward (GCC, 2021)

Health and wellbeing indicators - CORE

HW6. Prevalence, incidence, morbidity, and mortality of cardiovascular diseases

Data at intermediate zone level on coronary heart disease patients is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard in aggregated form between 2016/2017 and 2018/2019. The dashboard also gives a comparison between the latest figures and those from previous years. A screenshot of the dashboard's graph for Growchapel's intermediate zone (Drumry West) is available below:

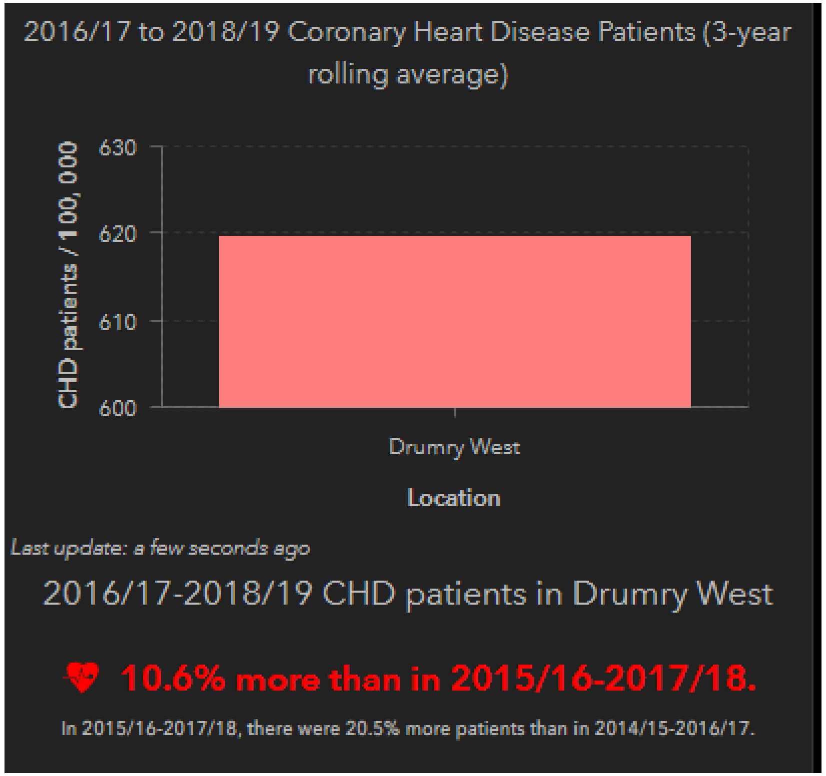


Figure 28 - Number of coronary heart disease patients per 100,000 population in Drumry West for 2016/2017 to 2018/2019 (ScotPHO, 2019).

Please note that the data are on hospitalisations rather than patients diagnosed with coronary heart disease, therefore the results must be considered with caution as they likely portray trends across the city and cannot be taken as absolute figures. For more information on the data, please consult ScotPHO's [Indicator Definitions page](#).

HW11. Mental health and wellbeing

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on mental health prescriptions (anti-depressants, anxiolytics and anti-psychotics) per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding mental health patterns in the city.
For the intermediate zone that Growchapel is in, it appears that prescriptions for mental health drugs were given to 27.4% of the zone, which represents the second highest bracket of prescriptions across the city for 2019.

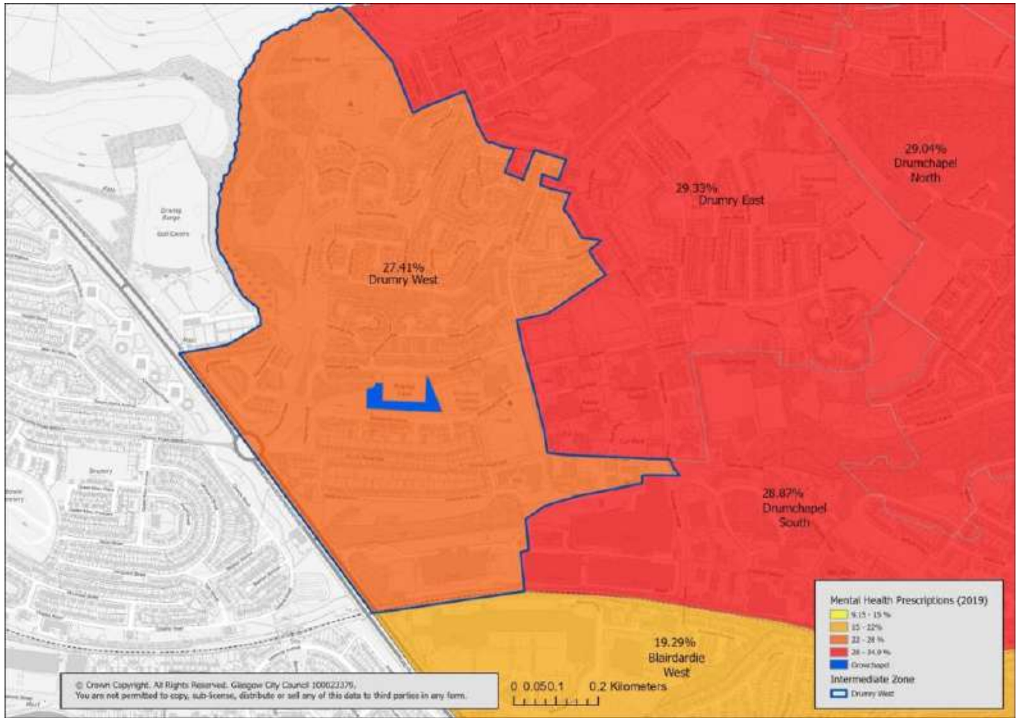


Figure 29 - Mental health prescriptions for Drumry West in 2019 (Safe Haven, 2021)

As the data cover entire intermediate zones, no direct relationships can be made with the community around Growchapel. However, now that the Growchapel garden is open, we are planning on undertaking surveys with the users and collecting mental health data to see how the direct community is affected and whether Growchapel is helping people heal. For more information on the above data and its limitations, please consult the OSS' HW7 section. To see how prescription percentages change over the years (2015 onwards) please refer to the Supplementary material section.

Health and wellbeing indicators - FEATURE

HW4. Life expectancy and healthy life years expectancy

Data at intermediate zone level on life expectancy is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard in aggregated form between 2014 and 2018. The dashboard also gives a comparison between the latest figures and those from previous years. A screenshot of the dashboard's graph for Growchapel's intermediate zone (Drumry West) is available below:

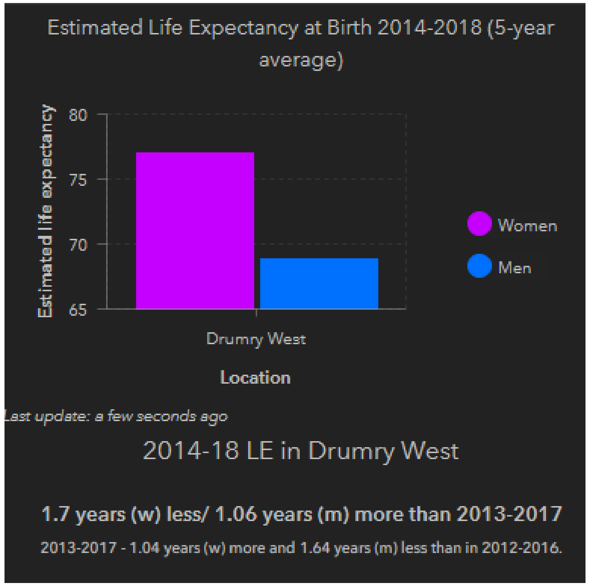


Figure 30 - Estimated life expectancy at birth for Drumry West between 2014-2018 in Glasgow ([ScotPHO, 2019](#)).

For more information on the data, please consult ScotPHO's [Indicator Definitions page](#).

HW7. Prevalence, incidence, morbidity, and mortality of respiratory diseases

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on respiratory prescriptions per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding respiratory patterns in the city.

For the intermediate zone that Growchapel is in, it appears that prescriptions for respiratory medication were given to 29.33% of the zone, which represents the second highest bracket of prescriptions across the city for 2019.

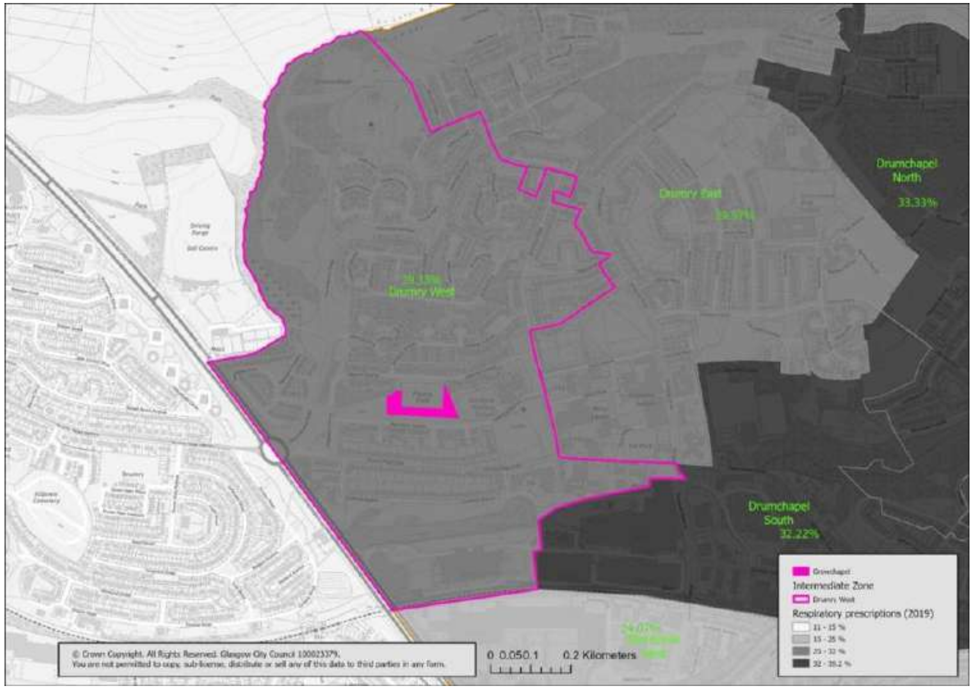


Figure 31 - Respiratory prescriptions in Drumry West for 2019 (Safe Haven, 2021).

As the data cover entire intermediate zones, no direct relationships can be made with the community around Growchapel.
However, now that the Growchapel garden is open, we are planning on undertaking surveys with the users and collecting health and wellbeing data to see how the direct community is affected and whether Growchapel is helping people heal.

For more information on the above data and its limitations, please consult the OSS'
HW7. Prevalence, incidence, morbidity, and mortality of respiratory diseases section. To see how prescription percentages change over the years (2015 onwards) please refer to the Supplementary material section.

HW14. Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on ADHD prescriptions per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding patterns in the city. For the intermediate zone that Growchapel is in, it appears that prescriptions for mental health drugs were given to 0.59% of the zone, which represents the highest bracket of prescriptions across the city for 2019.

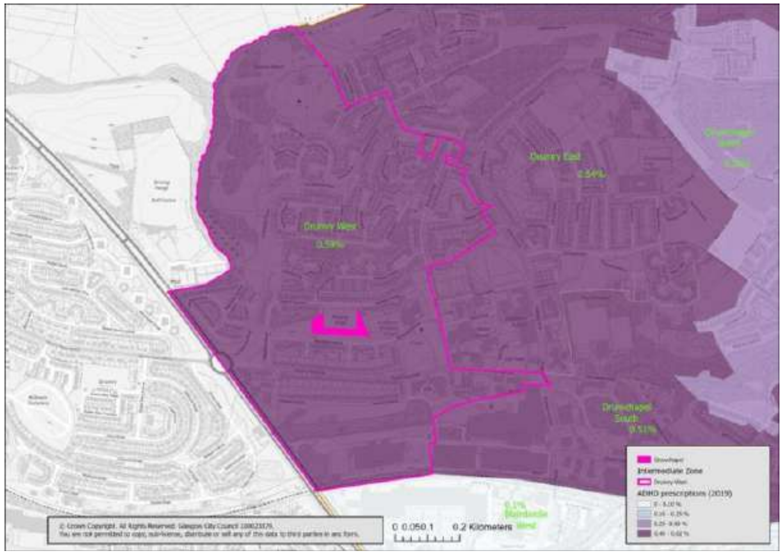


Figure 32 - ADHD prescriptions within Drumry West in 2019 (Safe Haven, 2021)

As the data cover entire intermediate zones, no direct relationships can be made with the community around Growchapel. However, now that the Growchapel garden is open, we are planning on undertaking surveys with the users and collecting mental health data to see how the direct community is affected and whether Growchapel is helping people heal. For more information on the above data and its limitations, please consult the OSS' **HW14.** section. To see how prescription percentages change over the years (2015 onwards) please refer to the Supplementary material section.

Social cohesion indicators - CORE

SC5.2. Actual safety

Data at intermediate zone level on crime rates is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard for 2018. The dashboard gives a comparison between the 2018, 2017 and 2016 figures for Growchapel's intermediate zone, Drumry West. A screenshot is provided below:

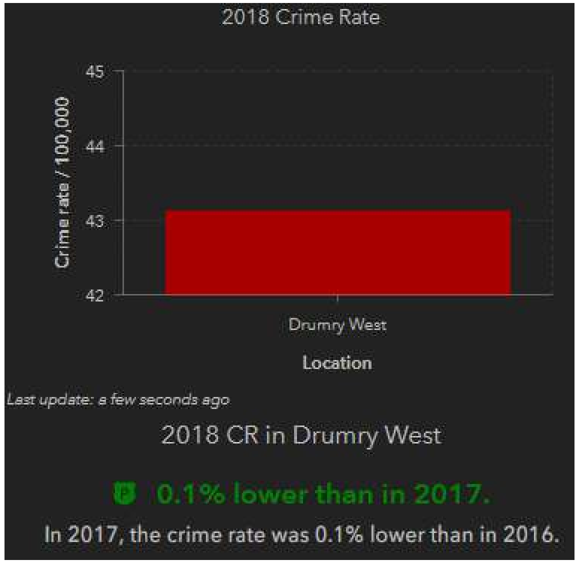


Figure 33 – Crime rate per 100,000 population in Drumry West in 2018 (ScotPHO, 2019). For more information on the data, please consult ScotPHO's Indicator Definitions page.

Economic indicators - CORE

ECO1. New Businesses 'attracted' or started and additional rates received

There are 33 active businesses within 400m of Growchapel ranging from hairdressers to wildlife management. A full list of the types of businesses operating in the vicinity of the Growchapel garden is available in the Supplementary material section. These data were extracted from Companies House and are based on 2020 figures of companies' registered address. A map showing all active businesses within 400m of Growchapel (red points) is displayed below:

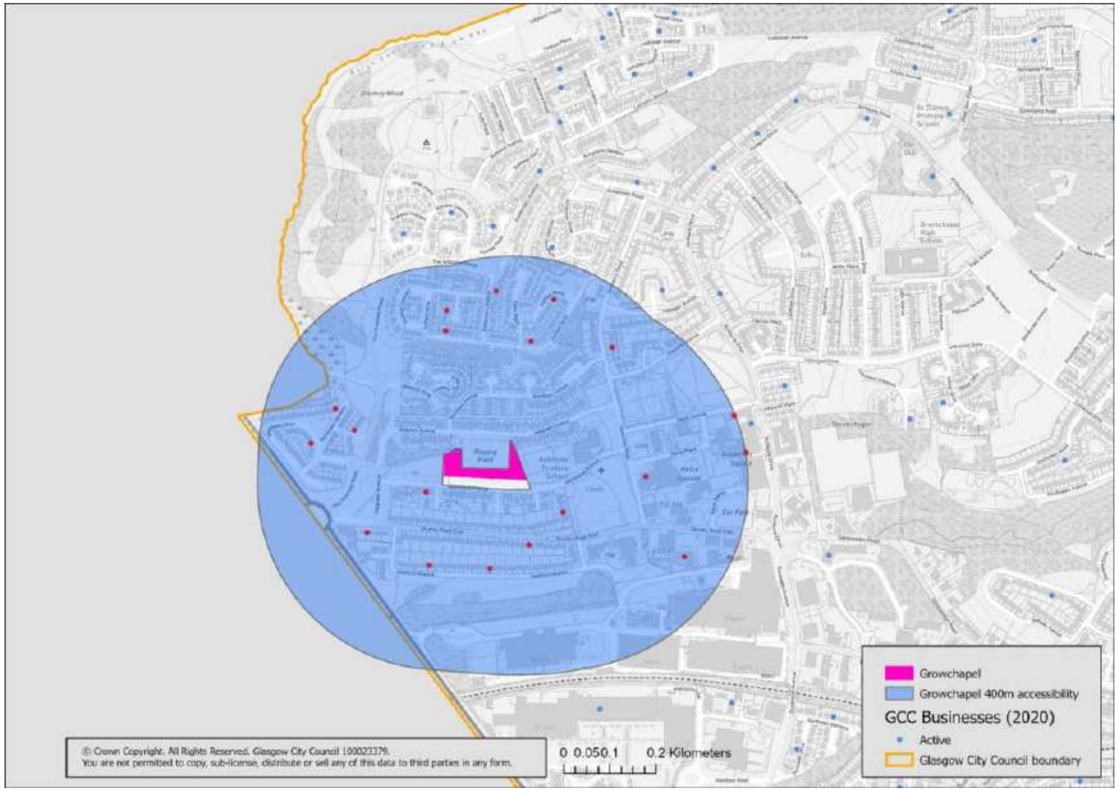


Figure 34 - Active businesses within 400m of Growchapel Garden in 2020 ([Companies House, 2020]).

Please note that the data are based on the address each business is registered at. It is likely there are businesses operating within the 400m accessibility for Growchapel which are registered elsewhere and vice versa, thus there is a level of error incorporated in these data.

ECO3. Net additional jobs created/enabled by NBS

The Office for National Statistics' Business Register and Employment Survey records the number of jobs held by employees broken down by full/part time working patterns on a yearly basis. Jobs are recorded at the location of an employee's workplace and are available at data zone and intermediate zone level. Due to the small sample size of some data zones, the data for intermediate zones is being used instead and presented below for Growchapel's Drumry West intermediate zone:

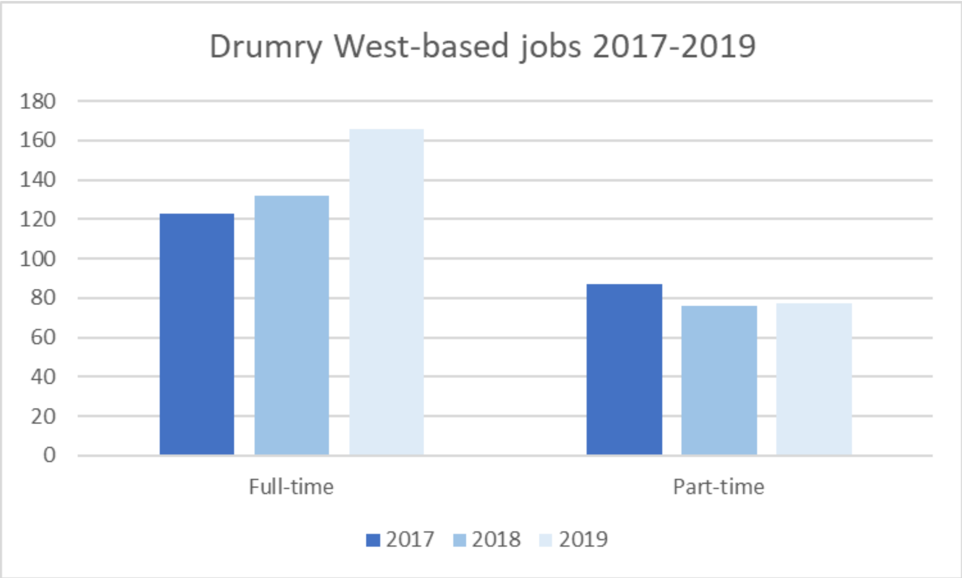


Figure 35 - Numbers of jobs in Drumry West between 2017 and 2019 (NOMIS, 2021).

For more information on the survey and the methodologies employed, please consult NOMIS.

ECO13. Net impact on public expenditure from NBS implementation

The vacant space in Drumchapel cost Glasgow City Council approximately £11,000 per annum in terms of maintenance costs (cutting grass, litter picking, infrastructure repairs such as fence/path, etc.), prior to its conversion into a food growing garden for the community. The construction contract for the Growchapel garden was £120,000 and maintenance costs will be monitored as the site grows and evolves into what we hope will be a self-sustaining community garden.

C. BELLAHOUSTON GARDEN

C.1. DATA FROM EXISTING SOURCES IN THE CITY

Bellahouston is an existing community garden, which was set up around ten years ago as a demonstration project to test the impacts of community gardens on citizens. No impact assessment was undertaken as part of this and so acquiring baseline data as part of Connecting Nature has been difficult, compared to the Growchapel garden which has only just broken ground. The garden has also been out of commission during the 2020-2021 pandemic which has complicated matters further in terms of gaining access to the garden and getting in touch with users. Nevertheless, we are keen to investigate the effects of the garden and improve its impact on the community in terms of the environment, economics, the society and health and wellbeing and so we present the following limited data:

Environmental indicators - CORE

ENV89. Community garden area per capita and in a defined distance

Within the Pollokshields Ward, there are two more community gardens. After undertaking network analysis on GIS, we were able to see the reach these gardens have in terms of the 400m accessibility requirement in the Open Space Strategy with regards to population distribution. As per the below map, the gardens were catering to just over 1300 residential properties, mapped as red dots.

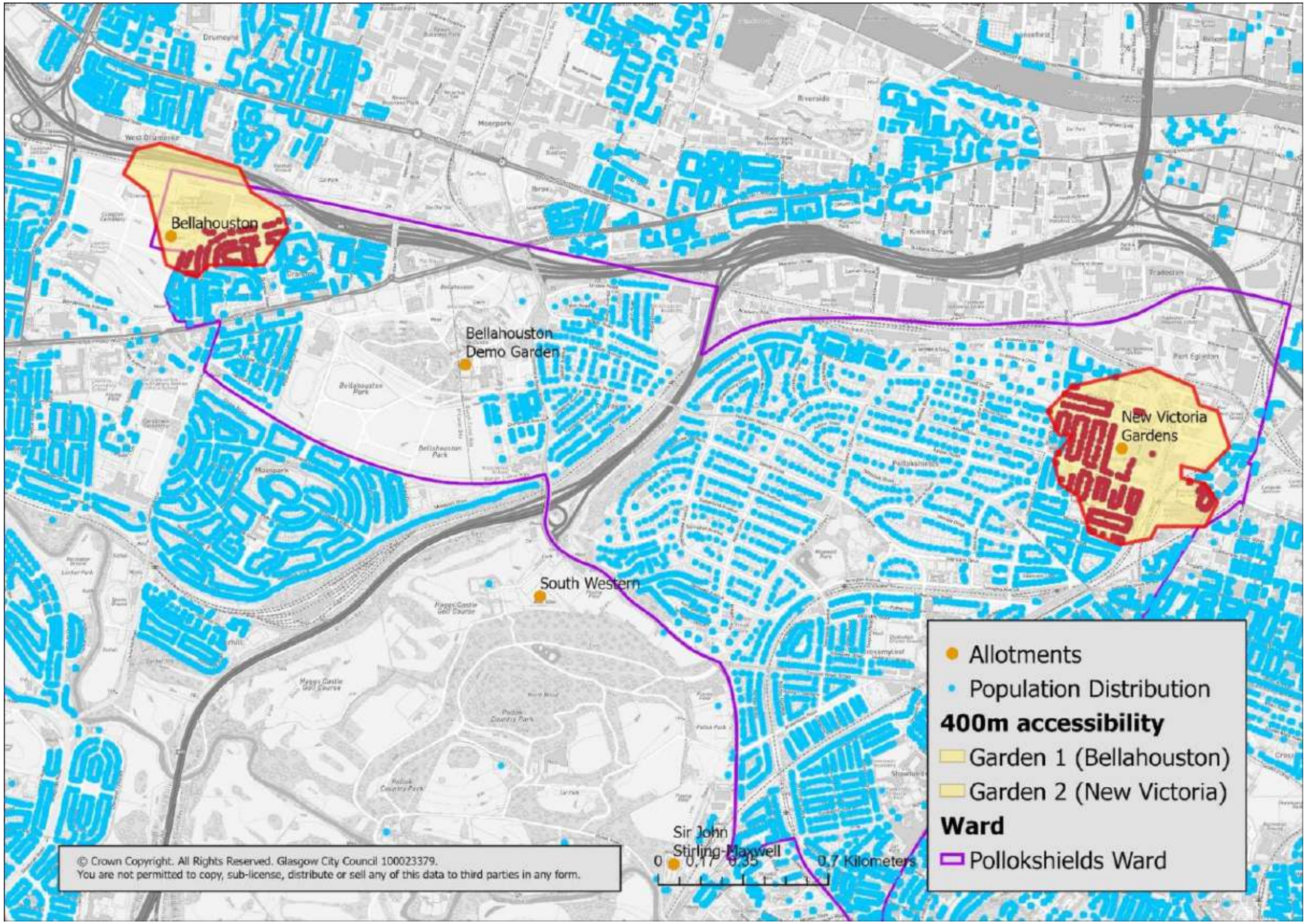


Figure 36 - 400m accessibility and population coverage of community gardens in Pollokshields Ward (GCC, 2021)

Environmental indicators - FEATURE

ENV41. Accessibility of greenspaces

The addition of Bellahouston garden, has allowed for 40 additional residential properties to have access to a community garden within 400m as can be seen in red in the below map:

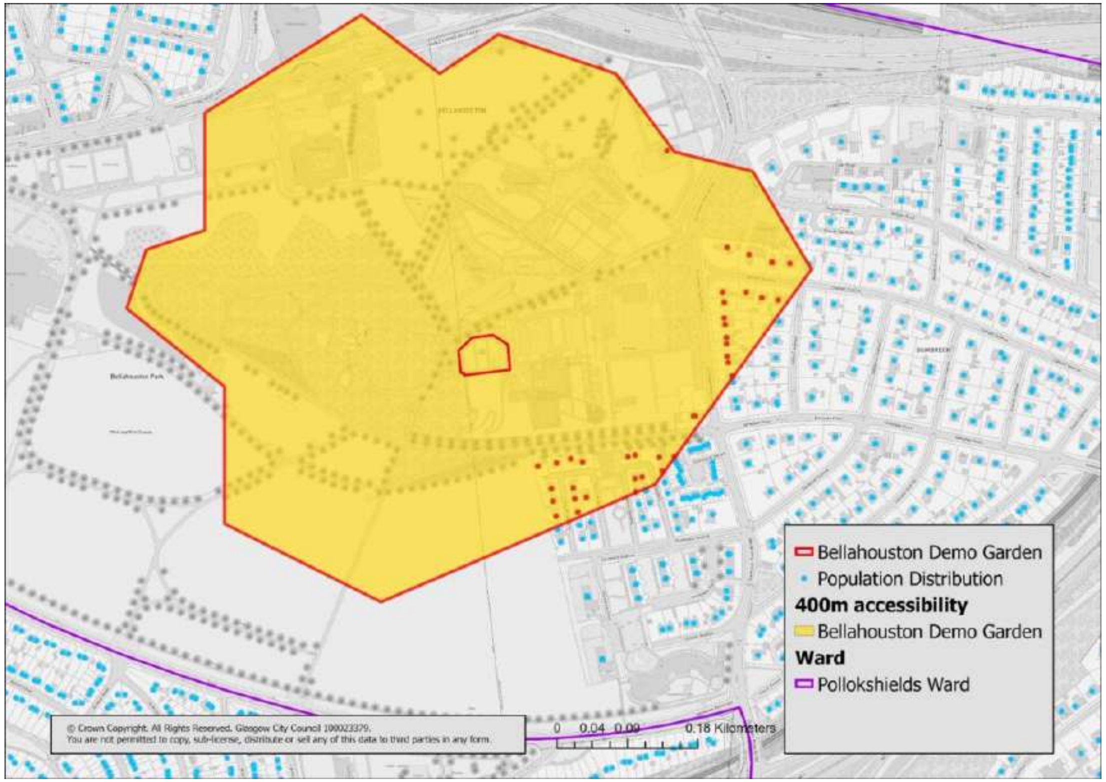


Figure 37 - Bellahouston demo garden accessibility and population distribution (GCC, 2021)

Health and wellbeing indicators - CORE

HW6. Prevalence, incidence, morbidity, and mortality of cardiovascular diseases

Data at intermediate zone level on coronary heart disease patients is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard in aggregated form between 2016/2017 and 2018/2019. The dashboard also gives a comparison between the latest figures and those from previous years. A screenshot of the dashboard's graph for Bellahouston Garden's intermediate zone (Mosspark) is available below:

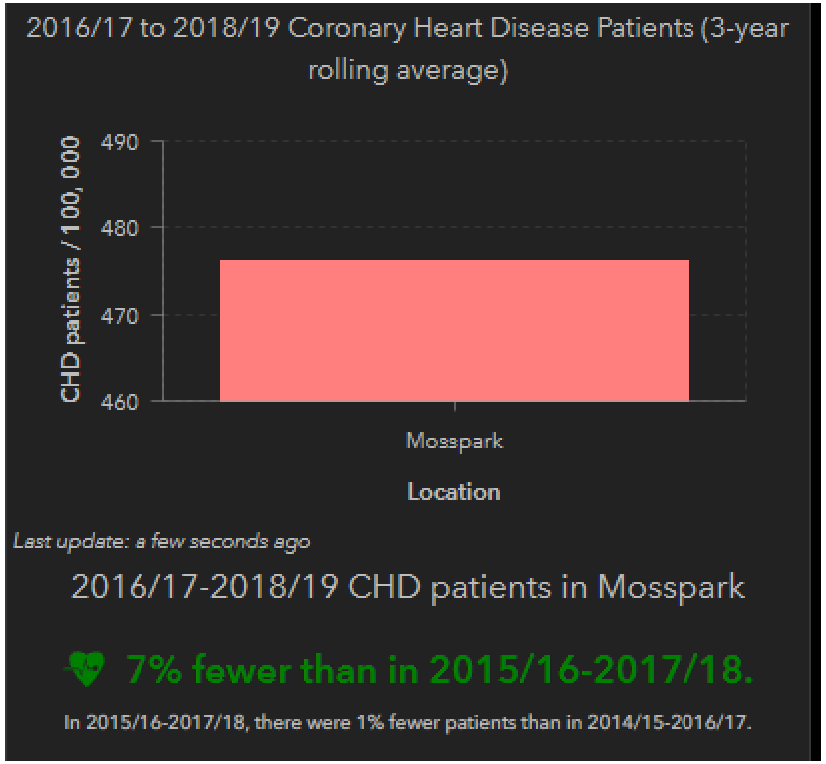


Figure 38 - Number of coronary heart disease patients per 100,000 population in Mosspark for 2016/2017 to 2018/2019 (ScotPHO, 2019).

Please note that the data are on hospitalisations rather than patients diagnosed with coronary heart disease, therefore the results must be considered with caution as they likely portray trends across the city and cannot be taken as absolute figures. For more information on the data, please consult ScotPHO's [Indicator Definitions page](#).

HW11. Mental health and wellbeing

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on mental health prescriptions (anti-depressants, anxiolytics and anti-psychotics) per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding mental health patterns in the city. For the intermediate zone that Bellahouston is in, it appears that prescriptions for mental health drugs were given to 22.7% of the zone, which is just over the bracket of the second least prescribed areas of the city for 2019.

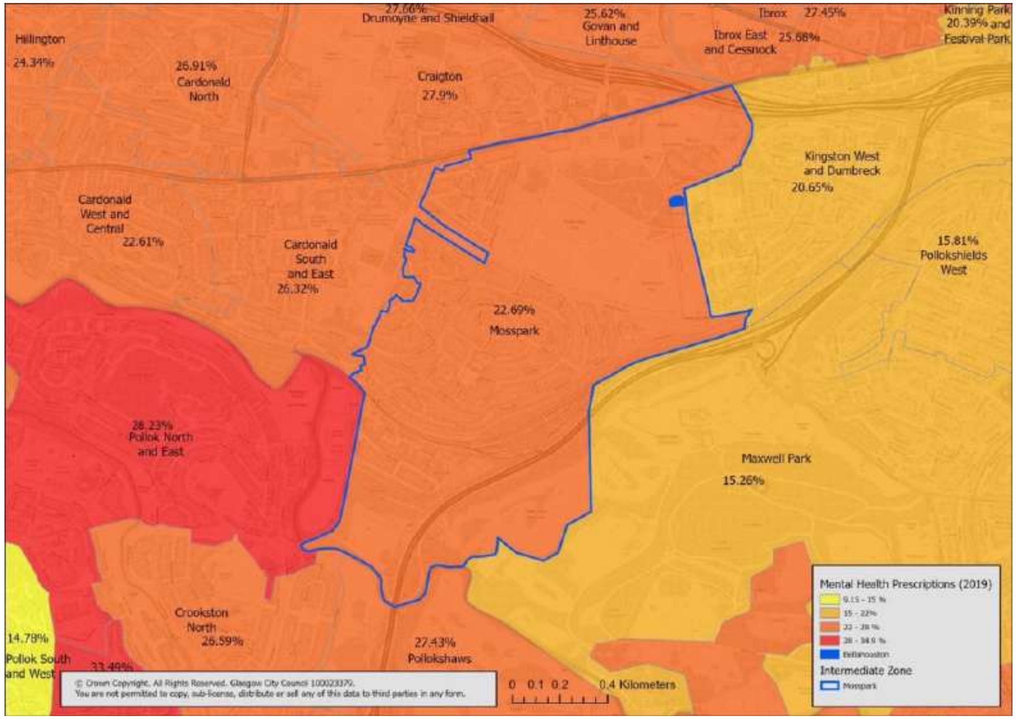


Figure 39 - Mental health prescriptions for Mosspark in 2019 (Safe Haven, 2021)

As the data cover entire intermediate zones, no direct relationships can be made with the community around Bellahouston Garden.

For more information on the above data and its limitations, please consult the OSS' HW7 section. To see how prescription percentages change over the years (2015 onwards) please refer to the Supplementary material section.

<u>Health and wellbeing indicators - FEATURE</u>

HW4. Life expectancy and healthy life years expectancy

Data at intermediate zone level on life expectancy is made available from the Scottish Public Health Observatory's website ([ScotPHO]) and has been presented graphically and spatially on [Glasgow's CN dashboard] in aggregated form between 2014 and 2018. The dashboard also gives a comparison between the latest figures and those from previous years. A screenshot of the dashboard's graph for Bellahouston Garden's intermediate zone (Mosspark) is available below:

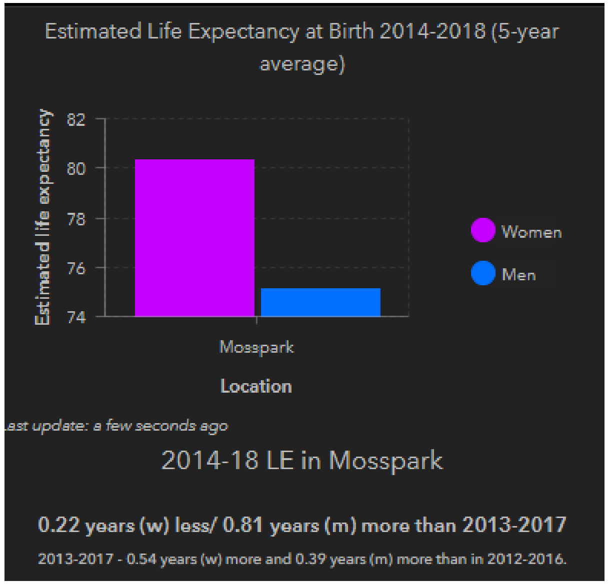


Figure 40 - Estimated life expectancy at birth for Mosspark between 2014-2018 in Glasgow ([ScotPHO, 2019](#)).

For more information on the data, please consult ScotPHO's [Indicator Definitions page](#).

HW7. Prevalence, incidence, morbidity, and mortality of respiratory diseases

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on respiratory prescriptions per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding respiratory patterns in the city. For the intermediate zone that Bellahouston is in, it appears that prescriptions for mental health drugs were given to 27.5% of the zone, which is within the bracket of the second most prescribed areas of the city for 2019.

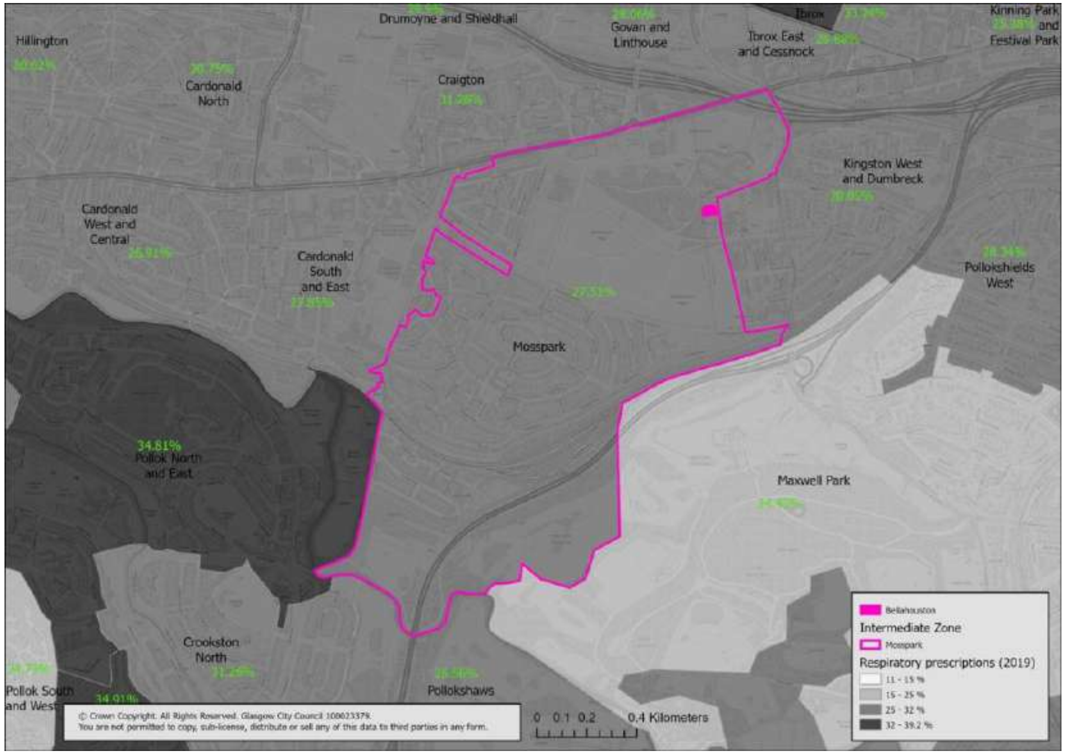


Figure 41 - Respiratory prescriptions in Mosspark for 2019 (Safe Haven, 2021).

As the data cover entire intermediate zones, no direct relationships can be made with the community around Bellahouston Garden. For more information on the above data and its limitations, please consult the OSS'HW7 section. To see how prescription percentages change over the years (2015 onwards) please refer to the Supplementary material section.

HW14. Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)

As part of our collaboration with NHSGGC's Safe Haven research colleagues, we have been able to acquire data on ADHD prescriptions per intermediate zone from secondary care providers within the city for the last ten years (2010-2019), which can be used as proxies to understanding patterns in the city. For the intermediate zone that Bellahouston is in, it appears that prescriptions for mental health drugs were given to 0.25% of the zone, which represents the second lowest bracket of prescriptions across the city for 2019.

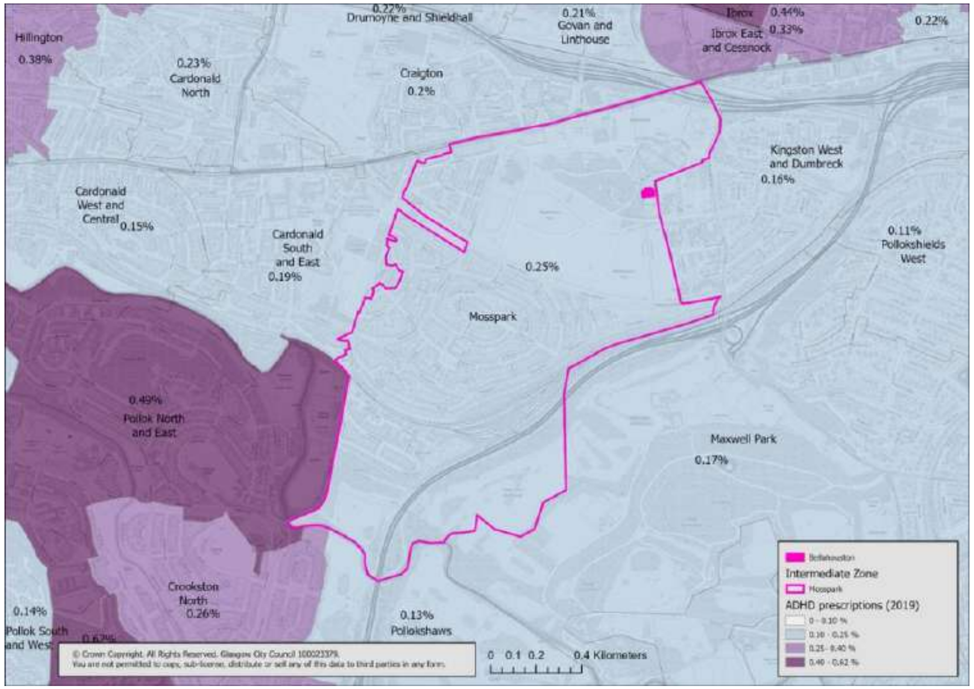


Figure 42 - ADHD prescriptions in Mosspark for 2019 (Safe Haven, 2021).

As the data cover entire intermediate zones, no direct relationships can be made with the community around Bellahouston. For more information on the above data and its limitations, please consult the OSS' HW14. section. To see how prescription percentages change over the years (2015 onwards) please refer to the Supplementary material section.

Social cohesion indicators - CORE

SC5.2 Actual safety

Data at intermediate zone level on crime rates is made available from the Scottish Public Health Observatory's website (ScotPHO) and has been presented graphically and spatially on Glasgow's CN dashboard for 2018. The dashboard gives a comparison between the 2018, 2017 and 2016 figures for Bellahouston's intermediate zone, Mosspark. A screenshot is provided below:

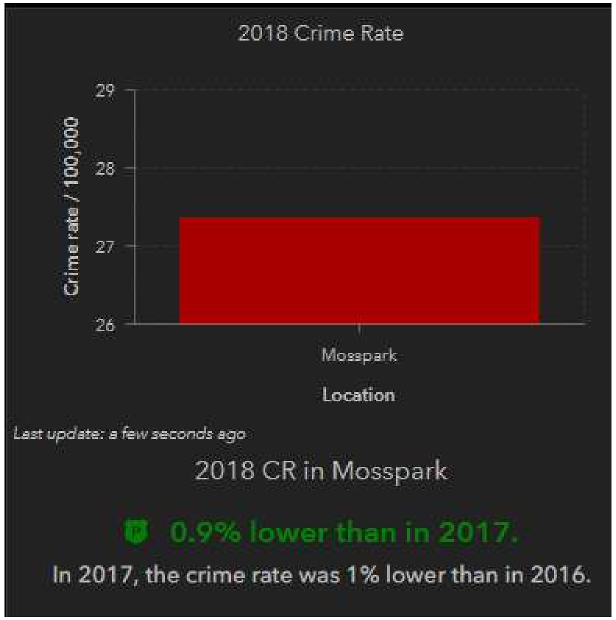


Figure 43 – Crime rate per 100,000 population in Drumry West in 2018 (ScotPHO, 2019).

For more information on the data, please consult ScotPHO's [Indicator Definitions page].

Economic indicators - CORE

ECO1. New Businesses 'attracted' or started and additional rates received

There are 16 active businesses within 400m of Bellahouston ranging from a hospice to property management services. A full list of the types of businesses operating in the vicinity of the Bellahouston garden is available in the Supplementary material section. These data were extracted from Companies House and are based on 2020 figures of companies' registered address. A map showing all active businesses within 400m of Bellahouston (red points) is displayed below:

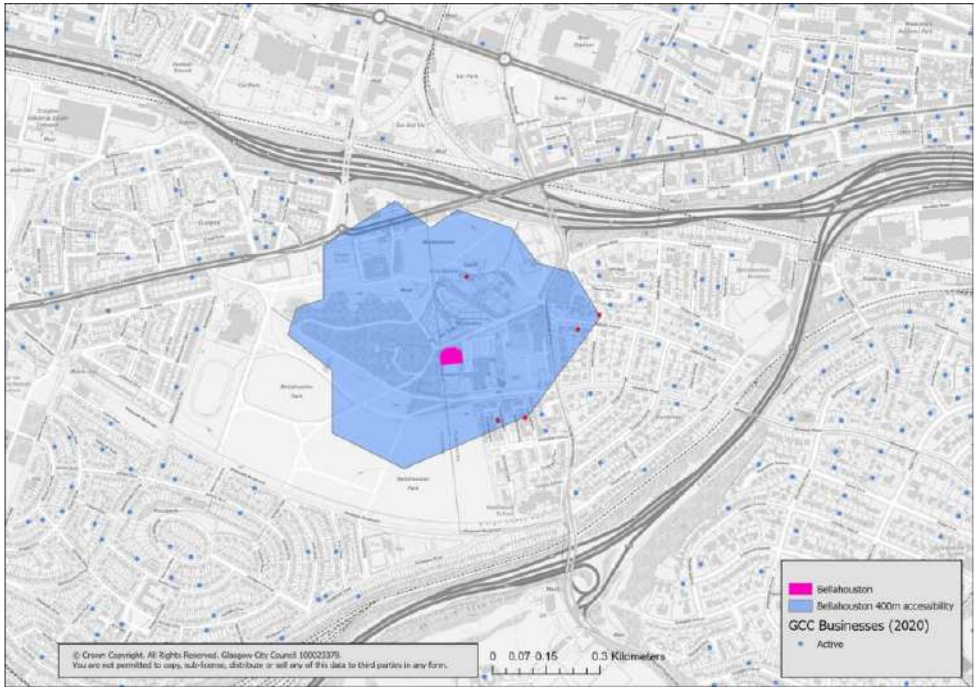


Figure 44 - Active businesses within 400m of Bellahouston Demonstration Garden in 2020 (Companies House, 2020).

Please note that the data are based on the address each business is registered at. It is likely there are businesses operating within the 400m accessibility for Bellahouston which are registered elsewhere and vice versa, thus there is a level of error incorporated in these data.

ECO3. Net additional jobs created/enabled by NBS

The Office for National Statistics' Business Register and Employment Survey records the number of jobs held by employees broken down by full/part time working patterns on a yearly basis. Jobs are recorded at the location of an employee's workplace and are available at data zone and intermediate zone level. Due to the small sample size of some data zones, the data for intermediate zones is being used instead and presented below for Bellahouston's Mosspark intermediate zone:

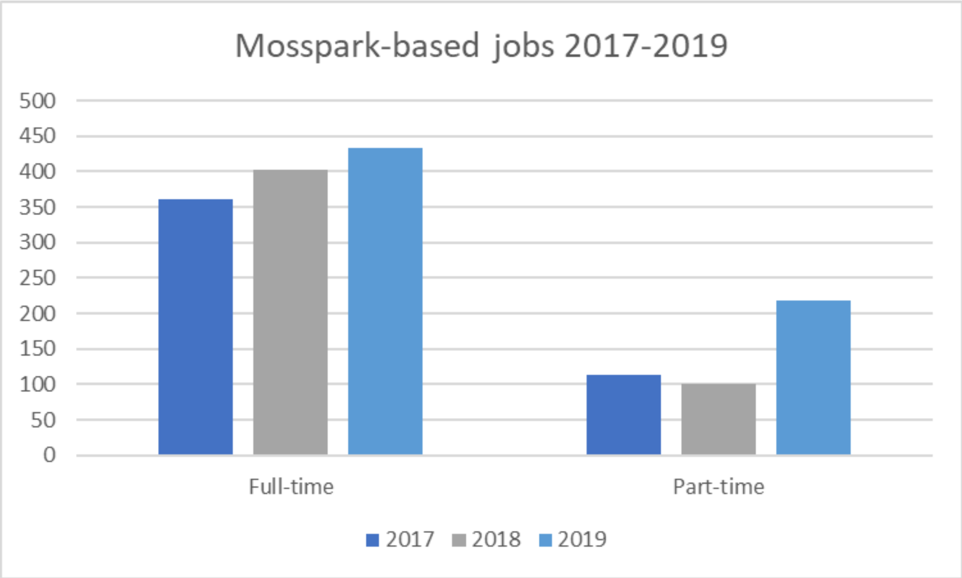


Figure 45 - Numbers of jobs in Mosspark between 2017 and 2019 (NOMIS, 2021).

For more information on the survey and the methodologies employed, please consult NOMIS.

C.2. Data from qualitative interviews conducted on the site

Methods

First, Glasgow City Council contacted the charities that regularly use the growing space to find out about their roles in Bellahouston and their willingness to participate in an impact assessment process. After a representative sample of charities agreed to participate, individual semi-structured interviews were conducted with representatives from each of them. Among the participants, there were two types of charities: those aimed at social inclusion and promoting the well-being of adults with physical and / or mental health problems; and other administrative institutions that worked in the education of minors. During the interviews, questions developed from the following categories of the Connecting Nature indicators were formulated: Primary, Health and wellbeing, and Social cohesion. Before beginning each of the interviews, the participants were informed of the objective of the research, of its anonymous and voluntary nature. Their express consent was also obtained to participate in the research and record the interviews. A total of 6 interviews were conducted with a duration between 40 and 88 minutes, with great variability in duration depending on whether one or two representatives of the charities attended. The interviews were conducted by the same person, Glasgow City Council staff, using an interview guide with the main questions and follow-up questions. A member of the University of A Coruña supervised the operation of all the interviews. These interviews were recorded and later transcribed by a native English person for qualitative analysis by a different researcher.

The initial analysis consisted of coding each one of the sentences of the transcripts with possible benefits derived from the attendance to the growing space of the members of the charities. In this first coding cycle, the phrases referring to other types of interactions with Bellahouston were also identified. Once the transcripts of all the interviews were coded, and based on grounded theory, a codebook was created with the citations of all the codes and the superordinate categories in which they were classified. All interviews were then re-reviewed to reassess the assignment of codes and categories. Once the coding of benefits and interactions of the participants with the growing space was completed, a second cycle was carried out that focused on identifying the processes that underlie those benefits. As in the previous coding cycle, a new codebook was created with superordinate citations, codes and categories. Finally, a second review of the processes extracted from the transcribed interviews was carried out.

Results

The results are presented below, differentiating between the benefits and interactions perceived by the participants, and the processes that underlie these mechanisms. Subsequently, each of the codes are explained with examples and linked to the Connecting Nature indicators to which they refer.
<u>Benefits and other interactions</u>

The frequency rates of these codes can be consulted in Table 14, where the presence of each code in each of the six charities is specified, as well as its proportion as a function of the total number of quotes, or its prevalence among the participants. These results can also be visualized in Figure 46, where the size of the circles represents the frequency of the codes on a scale of 1: 13.3.

Table 14 - Benefits and other interactions rates

Category	Code	A	B	C	D	E	F	Total	Proportion of total quotes (%)	Prevalence in participants (%)
Social cohesion	Positive social interaction	6	7	6	2	3	4	28	8.86	100
	Sense of community/community identity	5	1		2	4	3	15	4.75	83.33
	Pro-environmental behaviour	8	2		1	4		15	4.75	66.67
	Social inclusion	5	1	3	3	1	2	15	4.75	100
	Social responsibility				5	6	1	12	3.8	50
	Tolerance and respect		1	1		1	1	4	1.27	66.67
	Trust			1			2	3	.95	33.33
Quality of space	Perceived quality	4	4		2	6	2	18	5.7	83.33
	Green space awareness/education		2	7	7		1	17	5.38	50
	Activity in nature		2	6	1			9	2.85	50
	Place attachment	1	2		5		1	9	2.85	66.67
	Perceived safety	2	2	1	2	1		8	2.53	83.33
Health and wellbeing	Restoration	3	5	2	3		2	15	4.75	83.33
	Enjoyment of nature	3		5		5		13	4.11	50
	Increased wellbeing	4			3	3	2	12	3.8	66.67
	Decreased loneliness	5	1		1	2	1	10	3.16	83.33
	Enhanced physical activity		4	1	1		1	7	2.22	66.67
Sustainable nutrition/adoption	Healthy nutrition awareness	2	7	3	5	4		21	6.65	83.33
	Consumption of fresh products	2	2	2	2		1	9	2.85	83.33
	Food growing	1	1	3	3			8	2.53	66.67
Personal growth	Autonomy	3	1		1	3		8	2.53	66.67
	Emotional and behavioural regulation				4	1		5	1.58	33.33
	Increased self-efficacy	2					3	5	1.58	33.33
	Upskilling		1				3	4	1.27	33.33
Place-person interaction	COVID-19 impact	1	7	1	3	5	2	19	6.01	100
	Frequency of interaction	3	2	2	2	2	2	13	4.11	100
	Risk assessment				4	1	1	6	1.9	50
	Initial resistance/difficulties	1		1	3			5	1.58	50
	Duration of interaction	1	1	1				3	.95	50

Note. From A to F are the names of the associations participating in the interviews.; % = Presence of the code in relation to all interviews.

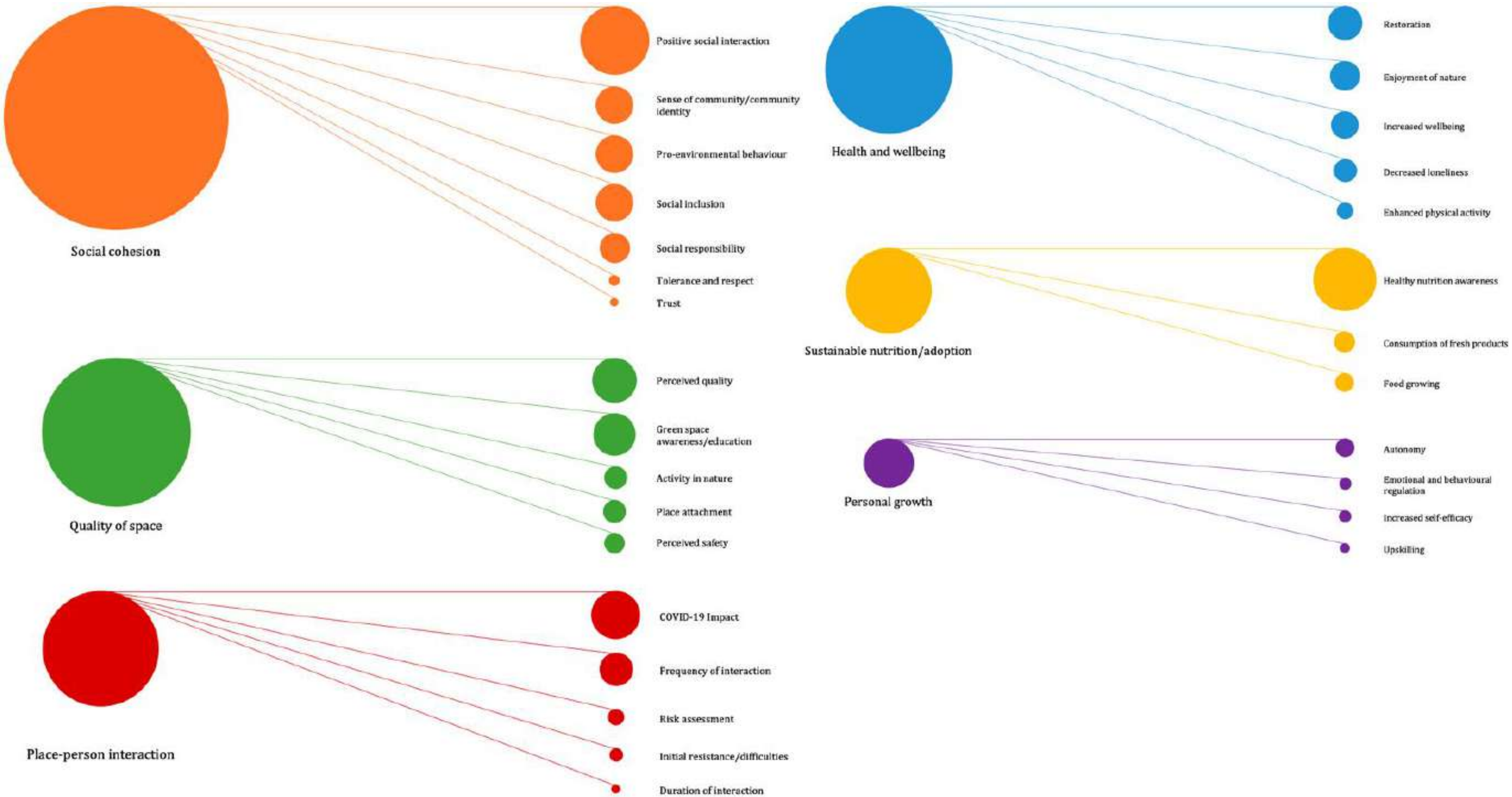


Figure 46- Benefits and other interactions rates

Social cohesion

Positive social interaction. A large part of the social benefits reported by the participants were encompassed within this code, used to group the generic definitions of the participants on how the inter-personal relationships between the members who worked in the growing space entailed positive consequences.

It's not therapeutic in that way where we sit and talk about each other's mental health problems, it's a chance to talk about something different for a couple of hours during the week (…) The group team is just meant for people for that extra bit of socialisation, but they're able to talk because there's more time then, we can sit in the garden and talk about ' this is what's going on in my life and this is why I like this space'.

They're enjoying sitting as a group, having a conversation and discussing plans about what they're going to do and they seem to know so much about each other's background (…) They see it as the opportunity to have a conversation and it's like therapy for them.

Links to Connecting Nature indicators: SC1 Bonding social capital, SC2 Bridging social capital

Sense of community/community identity. Many of the interactions that took place in the growing space were reported as collaborative and beneficial to the community. Being able to share work time in the garden allows them to identify with a community and cooperate for a better development of the space.

It wasn't about trying to grow the best produce but what came out of it was the extra benefit and the icing on the cake. And the thing about the allotment is that other plot owners helped you out as well and so we did get a few bits and pieces of help in terms of our produce (…) I think on the social connection aspect, one of the things I love about the situation of the project itself is that it's in a community setting so those barriers that maybe exist for people with dementia, like people not accepting or not understanding, kind of just melted away a wee bit because there was the opportunity to be part of a wider community but it would be very normal.

Links to Connecting Nature indicators: SC4.1 Trust in community, SC4.2 Solidarity between neighbours

Pro-environmental behaviour. Participation in the growing space promoted a series of behaviours that were respectful of the environment and that contributed to improving the sustainability of the orchards. The code includes actions that were operating rules, but also suggestions that came from the participants.

We have our own mugs that we use on a regular basis instead of disposable cups and then that becomes a job for people to wash them all out and cleaning up and stuff as well (…) So we have been slowly changing what we've been buying. We do get a lot of donated equipment through which saves us buying brand new so that solves the recycling aspect of it.

The participants were bringing along their own biodegradable bags and were saying 'why don't we put our names on our individual disposable cups and *not throw them away and keep this space beautiful..' (…) It was just accepted that this was the way we liked to run things and we'd try to limit the stuff that we throw away from the garden. I think it also comes from being in the garden and realising how nice these spaces are and people want to protect these for the future.*

Link to Connecting Nature indicator: SC12 Pro-environmental behaviour

Social inclusion. The social interaction between the participants of the growing space allowed people from different cultural and socioeconomic backgrounds to meet in the same space, and to interact in a positive way. Social inclusion allowed participants to interact with new people while sharing the common goal of growing food.

Because you have people coming from all different areas of the city, all different backgrounds, all different mental health issues who come together, and obviously there are different pointers from different socio-economic areas they are coming from, and I think they kind of form together themselves what you might call a participation ethos together.

They're from the deepest, darkest corners of Glasgow and a lot of them stay in flats and don't have gardens. And especially in these times when they've not had the chance to go out, during lockdown, they've literally been locked down. I mean, I'm lucky enough that I spent much of the first lockdown in my garden but they don't have that benefit. So for me, them seeing the allotment was a huge benefit for me and them getting the fresh air.

Links to Connecting Nature indicators: SC4.1 Trust in community, SC4.2 Solidarity between neighbours

Social responsibility. This code includes the actions of common responsibility on the part of the growing space users. Many of them were included in the maintenance of the space, indicating a tendency to be considerate of the rest of the charities participants, but also keeping in mind the rest of the organizations that use Bellahouston.

They all have their sense of ownership and responsibility (…) So even just building that positive relationship and realising that their actions would have consequences and we are going every week so we're accountable for it.

Links to Connecting Nature indicators: SC4.1 Trust in community, SC4.2 Solidarity between neighbours

Tolerance and respect. In addition to responsibility, the social interaction between the participants originated perceptions of tolerance for the other, fostering a common understanding and empathy in the face of users who presented difficulties. Many of the participants had physical and mental health dysfunctionalities, but they found the respect of the rest of the members of the organizations.

I think it's really raised tolerance amongst the group but we will be working to integrate them more fully with the other groups using the growing space.

Link to Connecting Nature indicator: SC4.3 Tolerance and respect

Trust. Not only were feelings of tolerance generated, but also of trust, forging interpersonal relationships in which mutual help was provided. Participation in the growing space contributed to eliminating prejudices and social barriers, fostering collaboration between participants.

The opportunity for the men to support each other, they take a lot of comfort in that, they've built up trust in each other (…) they know that no matter what's said or what happens when they're in the garden and that, they know they have the support from their colleagues.

Link to Connecting Nature indicator: SC4.1 Trust in community

Quality of space

Perceived quality. Positive ratings of the space where the growing space was located were included in this code. Some of these personal evaluations were directed to the amenities available in Bellahouston, but also to the general space, its natural characteristics and vegetation.

I think it's a great facility and we're fortunate we have the space for allotments, the location is great from the point of view of them getting there, it's safe and obviously we know it's a secure allotment so you can go in and out and we're in control of that (…) I couldn't fault it in the fact that you're looking for a friendly environment and that's what I see (…) I was pleasantly surprised even to see concrete paths, let alone having the accessible toilets and kitchen facilities and places to sit.

Link to Connecting Nature indicator: PI4 Perceived quality of space

Green space awareness/education. Growing food and spending time in a green space facilitated learning about natural processes such as the development of plant foods or the biodiversity that exists in Bellahouston. Many of the participants had little notions of this type of natural environment, but they learned through their daily work in the garden or educational actions.

They were studying the species of birds that could be found in the allotment so they were able to start identifying the birds and the fauna and the trees as well (…) We went round during the berry picking period and they wondered why we were picking them – they didn't know that there were berries that could be eaten round there and beside the allotment there are wild raspberries and they were all berry picking one day and they managed to take some *home (…) So they realise now that these things are edible and good for you.*

Links to Connecting Nature indicators: SC10 Environmental education opportunities, SC11.1 Positive environmental attitudes motivated by contact with NBS

Activity in nature. One benefit commonly reported by the charities was to hold outdoor activities in a natural setting. Although the growing space entailed numerous social and health outcomes, the participants positively highlighted the mere fact of being in a green environment and being able to carry out activities in it.

I was looking for a different curriculum for them as well to go along with the curriculum which we normally participate in in the morning. So in the afternoon we normally do something more practical so Bellahouston is ideal for us because it's not too far away (…) we progressed to growing wildflowers for the species of birds that were there (…) We built bird boxes and then in the spring we put them out in our area.

We'd make different worksheets for them, so like a treasure hunt and things and they love it and they see it as learning without the boring textbook and pencil.

Links to Connecting Nature indicators: SC10 Environmental education opportunities, SC11.1 Positive environmental attitudes motivated by contact with NBS

Place attachment. This code encompasses the emotional connection that users established with the growing space. Being or thinking in this green environment generates positive feelings and bonding that favour their weekly participation in Bellahouston. Attachment was reported in participants of all ages, from children to the elderly.

We just used to have people coming along and they would come along and say 'I love it here' and you just want to capture that because that's the essence of how the garden makes people feel.

The children have loved it, they really have (…) The children love the days they go to the allotments and they're very disappointed if there's ever a day we need to cancel it (…) We've got benches and because we're higher up on the hill with a great view, they love it, and they would draw pictures, look for different birds, look for squirrels, they quite like doing a nosey at other plots as well to see what things are growing (…) They loved that and when they went up to the allotment they were really proud.

Link to Connecting Nature indicator: SC6 Place attachment

Perceived safety. The Bellahouston growing space was perceived as a safe place by users. The features that gave it security were its structural and physical characteristics, but also that it was a space where there were no prejudices and its actions were not going to have a negative or quality evaluation. The participants stated that the growing space allowed them to be in a physically and psychologically safe environment.

So it's about having this defined space where you feel safe, that was a big part for people.

They feel safe, they know that they have a structured and safe environment when they come to school.

The garden removes the barriers of anything that they maybe find intimidating about the school, it's outdoors so it's maybe less threatening.

Link to Connecting Nature indicator: SC5.1 Perceived safety

Health and wellbeing

Restoration. The participants found Bellahouston a place to get mental relaxation, reduce stress and forget about their daily problems. The cause of this relaxation would be in the natural characteristics of the space, such as vegetation, fresh air or the presence of local biodiversity.

This is a place where they've realised you can sit and have absolute peace of mind in the city and you can sit and hear nothing and it was beautiful (…) You can free your mind for a while and get away from the struggles of daily life.

It has helped in making them more relaxed outside (…) they feel quite relaxed when they're in there, pretty relaxed yeah.

It's a very tranquil place and the children have said that as well (…) It was just something different for them and I think being outdoors, fresh air, I think it was great for their happiness but there was a calmness as well.

Link to Connecting Nature indicator: HW16 Perceived restorativeness of public green space

Enjoyment of nature. By growing food, interacting socially, or simply playing around (in the case of minors), Bellahouston fostered a sense of fun. The charities reported that this enjoyment in nature was very beneficial at the wellbeing level.

You could see that the instincts were still there to be handling the plants and touching the soil and they would get pleasure and joy. You could just see on *peoples' faces as well how much pleasure and joy (…) They were coming back and saying how much they enjoyed using them and they were like the best potatoes because home grown potatoes are always the best potatoes.*

But slowly, slowly they started enjoying going out to the allotment (…) So they were enjoying that. Before that they were afraid of touching anything that they found.

Links to Connecting Nature indicators: SC10 Environmental education opportunities, SC11.1 Positive environmental attitudes motivated by contact with NBS

Increased wellbeing. The code encompasses the general statements of the charities about how participation in the growing space benefited the happiness, mental health and satisfaction of users.

For me, the main thing for the allotments, obviously for him, he's very excited about the food growth and potential which is obviously a huge part of it, but for me, that's more about the long game and not the immediate effects. It's going to take the youths a long time to see those benefits and it's about keeping them engaged up to that moment. So, for me the allotments are more about, it was the health and wellbeing for me that was the main thing that screamed out. More so because a lot of our youths are from deprivation (…) it's the health and wellbeing and it's the mental health side of it which is huge for me rather than the sustainability.

They're really clear that if they couldn't be at Bellahouston they're happiness would be negatively impacted.

Links to Connecting Nature indicators: HW3 General wellbeing and happiness, HW11 Mental health and wellbeing

Decreased loneliness. Social interaction not only promoted meeting new people and generating social capital, but also contributed to reducing the feeling of loneliness or isolation for many participants.

If you're suffering from loneliness and isolation it's like double impact, you're meeting folk and you're meeting them in a space where you think god this is lovely.

If we're talking about loneliness and communicating then this gave the children the opportunity to work with people out with their class and to have a sense of purpose.

Link to Connecting Nature indicator: HW13 Perceived chronic loneliness

Enhanced physical activity. Growing food and having to exert yourself in the natural environment favoured the physical activity of the users. Working in the garden was in many cases the only source of weekly exercise along with the trips that users made on foot to get to Bellahouston.

The young people in their environment tend to be really inactive physically and with our encouragement with what they're eating I'm assuming that this is impacting on them.

Link to Connecting Nature indicator: HW12 Enhanced physical activity

Sustainable nutrition/adoption

Healthy nutrition awareness. This code complements that of "green space awareness/education", but is specific to the benefits of a healthy eating. As they grew food, users became aware of the importance of proper nutrition as well as ideas and options for preparing healthy meals.

I think it took a lot of time at the start, you know people are sceptical of things they don't know or they don't see or they don't grow but then another couple of service users we have, had a better idea of nutrition I'd say and they'd say – 'oh this is good for your iron, vit D' – or whatever and it was a learning process amongst each other (…) If someone's telling me at the start that they don't know what a courgette is and then 6 weeks later they're telling me about the ratatouille that they've made then that's a good result, right?

They were very wary of picking berries because they didn't know what they were. Also we discussed the berries and the goodness of the berries and they were able to tie up what's being bombarded on TV programs and things about healthy foods, they were able to make the link. And they were doing this themselves (...) We did do a drive on that out with the allotment about healthy eating, that was one of the programs and when they go out to the shops, some of them have money to be able to go and buy the food, thinking about what they're going to buy before they spend their money.

Link to Connecting Nature indicator: HW1 Sustainable nutrition/adoption

Consumption of fresh products. Users began incorporating plant foods into their regular diet. In addition to nutritional awareness, users had the opportunity to bring a variety of foods home and prepare meals with them. This availability of free vegetables increased the options for participants to eat them.

Having that space where they would have the fruit and the veg that they could take home and they would make soup and even something as simple as potatoes (…) Even something as simple as before they even got a bag of produce home, when the berry season hit and having folk going around and having *the berries off the bushes and having those tastes and connections back to the garden.*

I would like to think that everybody who is visiting the garden on a regular basis has the opportunity to take fresh produce home that supplements their diet.

Link to Connecting Nature indicator: HW1 Sustainable nutrition/adoption

Food growing. This is a clear but consistent benefit among charities. Participation in Bellahouston made it possible to grow edible food. All the organizations that reported it said they were successful in getting quality and abundant food for their users.

Yes the food growing aspect is a spin-off. They saw that they were able to grow things and this year we had planned to grow more strawberries and we were going to make a strawberry trough and grow more vegetables (…) We had some success and some failure but the main point was that they were able to do this and to grow these things that normally the only place they would see them would be in a shop.

Link to Connecting Nature indicator: HW1 Sustainable nutrition/adoption

Personal growth

Autonomy. Growing food in Bellahouston promoted the ability of users to make decisions freely and feel that they had some ownership of the space. In addition, the participants could decide to do other activities in the growing space such as walking in the park, without being led by the charities.

They would really just do what they felt like they wanted to do (…) It was about taking the ownership of the space and making sure that, obviously different plots are doing different things but the main thing we wanted to do was make the families feel like it was their garden so they if they wanted they could just come and sit and explore the surrounding gardens or even just sit and enjoy being outside, we wanted to give them that safe space to do so.

I think it gives them another opportunity to have a voice.

Link to Connecting Nature indicator: SC9 Empowerment

Emotional and behavioural regulation. Benefit associated with underage participants. Physical exercise and the concentration required to perform cultivation tasks improved the users' attentional and emotional self-regulation.

We're talking about children with potential high-level behaviour, exhibiting their emotions in maybe a more physical or verbal way and ironically it was probably those children that demonstrated respect the most (…) Yes we still line the children up partly to do a head count and take a few deep breaths before we enter. I think the children are aware that different people go there for different reasons and I think it is something that they're quite mindful of when they enter.

Link to Connecting Nature indicator: HW14 Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)

Increased self-efficacy. The participants not only improved their autonomy, but also felt more capable, improving their self-esteem and their positive assessment of their own abilities. Through food cultivation, they improved their self-confidence.

For mental health, the guys with brain injuries have lost so many things in their lives, you know, they've lost their independence and things like that and I think being able to come to the garden and be successful with their planting and their ability to grow crops have just given so much back to their confidence (…) The ones that are physically able, they take a lot of pride and their confidence has grown because they're able to support other attendees.

Link to Connecting Nature indicator: SC9 Empowerment

Upskilling. While users' personal ratings improved, so did their food cultivation capabilities. Through interaction with the growing space they developed a new ability that they can transfer to other places, such as their own gardens.

Its upskilling them. We have 2 educational gardeners who teach gardening skills and horticulture and encourage people to take that into their own lives so they could be growing things in their own gardens and in window boxes (…) So even people with really really low em kind of practical or written skills can see in a picture how their chart is changing the more they interact.

Link to Connecting Nature indicator: SC9 Empowerment

Place-person interaction

COVID-19 impact. The interference of the pandemic derived from SARS COVID-19 was a fact unanimously commented on in all charities. Participants had to either prevent their attendance at Bellahouston or greatly decrease its use. This was a widely regretted circumstance that modified the development plans of the organizations.

Now with the COVID we were given a routine and other groups had theirs' so that we didn't bump into each other because of COVID and to stay safe. That was the only sad part, it would have been nice to have more community connections, bigger social networks for people and less isolation through that again.

Obviously COVID totally quashed the plans we had, we had planned for them to go in about once a month and we had big plans – the youths had completed a survey of what they wanted to grow (…) Certainly during COVID we've only managed a few times but as soon as this lockdown is done our intention is to get straight back to the allotments.

Link to Connecting Nature indicator: PI1 Type of interaction with NBS

Frequency of interaction. Each charity also mentioned how often they came to the growing space. In general, it used to be once or twice a week, every week of the month.

So it was weekly (...) but this new term when we started back, we had 2 half day slots there so we were going up and doing different things.

Link to Connecting Nature indicator: PI2 Frequency of interaction with NBS

Risk assessment. Some organizations made assessments about the potential dangers that user participation could have in Bellahouston. In addition to constant supervision, the organizations tried to enlist the help of experienced gardeners.

We do have an individual risk assessment for the allotment. I'd say there are 2 main points from a school point of view and these are physically getting to the allotment and using the tools safely (...) I think every year the class teacher probably does need to go through children working with the tools, particularly in education there's a lot of things we're not allowed to plant, and then gloves and washing hands and making sure we're quite rigorous I things like that but also explaining to the children why.

Link to Connecting Nature indicator: PI1 Type of interaction with NBS

Initial resistance/difficulties. The participation of charities in the Bellahouston growing space has been a relatively new phenomenon, for which it initially required adaptations and continuous learning. This code also includes the initial reluctance of some participants when they began to attend the growing space.

It was quite challenging at first because they were not really wanting to go to the allotment.

Link to Connecting Nature indicator: PI1 Type of interaction with NBS

Duration of interaction. The duration varied greatly depending on the user group and charity. Some organizations spent several hours in Bellahouston, interspersing groups of users, while others came punctually with their specific group of participants.

The first person might start arriving at 12:15 and then the last person would leave maybe the longest we had they were still there at 4 / 4:15.

Link to Connecting Nature indicator: PI3 Duration of interaction with NBS

Processes

The processes and mechanisms rates that are underlying the previous benefits are presented in Table 15. In this case, each superordinate code and category are not presented from highest to lowest according to frequency, but is ordered logically, starting with the influence of growing space characteristics and ending with its derivations. Many of the mechanisms were already mentioned in the definition of benefits, but exemplary quotes from the participants are established again.

Table 15 - Process rates

Category	Code	A	B	C	D	E	F	Total	Proportion of total quotes (%)	Prevalence in participants (%)
Influence of growing space characteristics	The quality of growing space fosters restoration	4	5	1	1			11	7.97	66.67
Influence of growing food	Growing food improves well-being by promoting enjoyment	2		4		2	1	9	6.52	66.67
	Growing food fosters consumption of fresh products and nature awareness	3	4	6	7	2	1	23	16.67	100
	Growing food fosters engagement in active participation at the green space	7	1			2		10	7.25	50
Influence of active participation	Active participation in the growing space fosters autonomy and self-efficacy	3	3		4	1	4	15	10.87	83.33
	Active participation in the growing space fosters emotional and behavioural regulation				5	1		6	4.35	33.33
	Active participation in the garden fosters physical activity		1	1	1			3	2.17	50
	Enhanced physical activity fosters wellbeing		1				1	2	1.45	33.33

	Positive social interaction reduces perceived loneliness	1	2			1	1	5	3.62	66.67
	Positive social interaction fosters well-being		3		1	1	5	10	7.25	66.67
Influence of social processes	Positive social interaction fosters social inclusion and sense of community/community identity	10	2	5	6	8	4	35	25.36	100
	Sense of community/community identity fosters pro-environmental behaviour	3	2		1	2	1	9	6.52	83.33

Note. From A to F are the names of the associations participating in the interviews.; % = Presence of the code in relation to all interviews.

Influence of growing space characteristics

The quality of growing space fosters restoration

Yeah from the actual hardware and the way the garden is set up, we're so close to other allotment spaces that if we have someone who has maybe come along and is more restless that day and the hustle and bustle in our areas is too busy for them then the garden is set up in such a lovely way that you can literally just walk across the walkway and you're already then in a quieter area away from the chat which is maybe where our space is and you're completely immersed in what else is growing and there are so many talking points – you've obviously got the trees that are lining round the outside and then you can weave through everybody else's plots and then if you're really lucky another group is maybe already there doing harvest.

Influence of growing food

Growing food improves well-being by promoting enjoyment

You can see the enthusiasm throughout all the groups – youths, adult and coordinators – because I'm genuinely quite excited about it I think it's a fantastic opportunity. And I think the ones that have been there and saw it when it was 6ft high grass and have seen it taken down, there is an excitement there. And Kim who's great with her camera has got all these wonderful pictures of the work that we've done from start to finish and we've got that on our social media page and you can see the enthusiasm that that's generated albeit some of them haven't been yet but they're excited to get there because they've seen the transformation and they know the plans that we've got and I think that's echoed through the coordinators as well.

Growing food fosters consumption of fresh products and nature awareness

As for the last few years, we've been a bit more mindful of what we've planted and when, and have allowed the children to actually watch that growing. So it's probably only been the last few years that we've actually been able to grow vegetables and different things (…) We've taken vegetables back to the school and our Nurture department they made soup with a targeted group – certain children not a full class. They went up, they were able to pick and then came back and they prepared a vegetable soup (…) I think even the simplicity about growing the food and then making the soup and the children having a *hand in that and realising it's not too difficult (…) So things like split peas and runner beans and things like that we would grow because they're not too expensive and the children can then see and then there's not too much preparation in that too and so they're quite fresh. One of the days we came back, I had asked the children what was there, what they could eat, what they enjoyed to eat so we do focus lessons around it so that it's meaningful for them as well.*

Growing food fosters engagement in active participation at the green space

What you found was that once people started, you'd have the 'keeners' – who were really really into their gardening and wanted to get stuck in there and once they started after every session, even the people who were just sort of sitting, they would end up just grabbing a tool and would even just go over and get involved and they would be sitting chatting with whoever was working at the time and stuff and it was probably quite infectious, if that's the word! (…) It was very supportive in that way where there was no pressure but at the same time the sort of hustle and bustle of that activity was more encouraging for people to get involved. So yeah I honestly think that even if we looked at every individual family, they would all have that aspect of the garden that was maybe theirs and then with new people coming in there was not…, even in the height of growing season, we were keen that everybody could get involved.

Influence of active participation

Active participation in the growing space fosters autonomy and self-efficacy

I think for me it's more about having a freedom. You know, the individual that I'm thinking about stayed in a flat so the reality is of her being out in a garden doing something positive wasn't really a factor for her but it seemed to me a freedom of doing things and a better way of expressing themselves and the fact that they were out in the fresh air…yes we were asking them to do certain things but there was no expectations you know, you could help out as much as you wanted to do but the reality was that the more frequently they went the more that they wanted to do something. I think it was a bit of everything so the freedom to express themselves, and just being out in that natural fresh air.

Active participation in the growing space fosters emotional and behavioural regulation

So, it's been really good especially for targeted groups, so maybe children who had social and emotional behavioural problems and maybe didn't have access to outdoor gardens, maybe stayed in flats…so this let them experience things that perhaps they couldn't within our playground as well as it's all concrete so for growing in the school, it's not feasible.

Active participation in the garden fosters physical activity

A lot of people are sitting about 24/7 other than when using this space and a lot of people are choosing to walk from places in the city that you wouldn't believe, some people are walking 2 hours to get there and 2 hours to get back and they're saying this is their exercise during the week because they have no other reason other than that to get out at the moment as well so they're using that space to get there and to get back and discovering new green spaces around the city as well just by getting to the garden and back because there's not anything else that they have to be doing so they'd be checking out other parks. Also, I think it piqued peoples' interest in other parks and greenspaces near them, to actually go and use them more often so I think that was a big aspect of it. And it was a lot to do with the exercise part of it and their health. When you're at the garden as well you can get involved and muck in and there is a lot of physical things to be doing.

Enhanced physical activity fosters wellbeing

I like to think that the physical aspect and the…because people come to the garden and they might tell you about new medication they've been started on and they'll say 'oh it's not working because I'm still not sleeping' or whatever it is and you think it's not magic, these things aren't magic and if you don't tire yourself out with some physical exertion during the day and aren't eating the right diet with some of these high calorie meals and no exercise, it doesn't matter what somebody gives you, it needs to be a holistic approach with all these things combining to affect someone's mental health. If your physical health is taking a big hit I don't see how this could not be affecting your mental health.

Influence of social processes

Positive social interaction reduces perceived loneliness

Having the opportunity to come to the garden as a group and, you know, discuss their interests and specifically about the garden and growing their produce, that helps them overcome that loneliness.

Positive social interaction fosters well-being

This is a safe space and they've got the opportunity to meet people, the opportunity to have basic conversations, learn things…there's just so many aspects to the garden and you could probably talk forever about the different opportunities that it creates for people, especially now because we're using it for everything. We used to have buildings where we would do men's groups, women's groups, art groups and now the garden is the sole space we have and it couldn't mean more to people. So opportunity and socialisation are the 2 biggest factors that contribute to peoples' wellbeing and mental health being on a positive run.

Positive social interaction fosters social inclusion and sense of community/community identity

So there's that sense of community that the children can witness as well (…) It's about that community spirit as well, I think in some particular areas around about the school, they've maybe lost that aspect of working together and they maybe don't have that idea of everybody chipping in for the greater cause. I think it's about that too, really seeing everybody wanting the best for an area.

Sense of community/community identity fosters pro-environmental behaviour

We would sometimes divide things if there were too many herbs or too many little strawberries as well so you would send people home with things to plant in their own space whether it was a container of their own garden and that would give you something to talk about the next time they came back. So there was that sort of level of sustainability as well, that things were being shared and not really going to waste. There were several times that I would be out and see something in a shop and think 'oh I'll get that for the allotment'. So, it wasn't just about the food produce. And there's the sustainability and sharing of knowledge as well, I've tried new things too.

The interview guide with the questions asked to the participants can be found in the Supplementary material section.

GENERAL CONCLUSIONS

In the City of Glasgow, we have gathered baseline data across all aspects of NBS, encompassing environmental, health and socio-economic trends. As the Open Space Strategy (OSS) was only approved in the start of 2020 and is a plan of 'aspirations', we have had to work on creating the Delivery Plan which specifies the priority of actions for our open spaces so that they benefit those that most need this resource. As such, it hasn't been possible to collect outcome data and see how the OSS is performing, yet, however even following the establishment of the Delivery Plan, we expect that its effects will not be felt in the nearest future, as the scale of our work (city-wide) is too large for direct relationships shortly after implementation.

In Glasgow, competing priorities for land in terms of housing or business use, is another reason why the OSS' effects may not be immediate, with the requirement to raise awareness and incorporate the OSS Delivery Plan's vision into the processes and thinking of developers. Therefore, we have concentrated on gathering as much of the baseline data as are available in order to build a strong evidence base to continue assessing the Delivery Plan's effects in the future and improve things as necessary.

Before we consider any potential synergies and trade-offs between indicators, it is important to note the gaps in the quality and quantity of our baseline data. Environmental and social cohesion data are often the result of individual studies and are at a scale that is rarely useful when looking at the effects on communities. There therefore, a question of how we can replicate such studies and maintain datasets so they remain relevant at a time when resources and metadata are scarce and often missing, respectively. Our health and wellbeing data have largely been the result of a successful collaboration with the research wing of our National Health Service, however these data have often been extracted from secondary care and so can only be used as ‘proxies’ in terms of health trends in the city, while primary care data are unavailable due to lack of consistent reporting practices and privacy concerns. Economic data on the other hand are publicly available for most indicators, although scale and periodicity were often a cause of concern when looking at a city-wide strategy’s effects.

Nevertheless, our baseline data paint some picture of what may be current trends across the city, with the majority of the most deprived communities being situated within areas of Glasgow that are currently identified as ‘deficient’ in good quality open space and are showing higher numbers of prescription medication usage (mental health and respiratory). We will continue to monitor these trends to see whether these suspected patterns evolve in the future and hope we will have more data to confirm/reject them. We are working closely with partners who are establishing a green infrastructure database of the city which will incorporate tree locations, canopy, shade etc., therefore providing another layer of baseline which may connect environmental and socio-health effects.

In the spirit of caution, however, it is important to note that many of these data can be interpreted in various ways, hence our use of words such as ‘suspected’ and ‘potential’ in terms of patterns. The data indicate, for example an overall increase in mental health prescriptions across the city in the past 5 years, and although this may initially appear to be negative news, it may instead mean that awareness around mental health issues and support is rising and as such, more medical professionals are willing to prescribe medication to their patients. Therefore, we are currently only looking at the results from the perspective of identifying trends rather than cause and effect, and continue to search for datasets that may be used as proxies to indicate the ‘angle’ we should be taking forward for future causality analysis. We have learned a lot as a City through this process and see the great benefits of impact assessment which we are committed to continue working on post Horizon 2020.

Appendix IV. Genk´s Evaluation Results

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This document presents the impact assessment results in the city of Genk (Belgium). As reflected in the main text of the Deliverable, through its evaluation and monitoring plan, this Front-runner city has implemented one Nature-based Solutions: the Stiemervalley on a city scale.

This appendix begins with a main summary of the main results found in the city of Genk. Subsequently, the results of each of the indicators evaluated in the evaluation and monitoring plan are detailed, organized by indicator categories: Environmental, Primary, Health and wellbeing, Social cohesion, Economic, Participatory Planning and Governance, and Stiemerdeals indicators.

Due to the large amount of data collected, in addition to the results included in this document, for some social and health indicators the consultation of one supplementary material is indicated: Survey on primary, health and social indicators

Finally, at the end of this appendix, a reflection on the main conclusions of the monitoring and evaluation process in Genk is presented.

MAIN SUMMARY

The indicators evaluated in the city of Genk are based on an unprecedented effort by the local team to collect available data and locate possible partners to analyse results. The data that appears on the following pages covers all the categories of indicators proposed in Connecting Nature: Primary, Environmental, Health and Wellbeing, Social Cohesion, Economic, Participatory Planning and Governance. However, for most of these indicators it has not been possible to carry out a suitable evaluation, where the outcome data is compared with the previous baseline.

The local council staff has managed to collect data for many indicators, but due to limited resources and specialized personnel, not with the necessary requirements to infer causality in the implementation of Nature-based solutions. However, a data infrastructure has been established to continue the evaluation and make good comparisons beyond the project.

Regarding the environmental results, the efforts to measure the water quality of the Stiemer River through a collaborative citizen science project stand out. Considering the social and health indicators, the survey of 500 participants allowed knowing the status of some indicators during the summer 2021. In some of these indicators, an attempt has been made to broadly compare the results obtained with the data available from the City Monitor, a periodic survey carried out by Stad Genk on some social and health indicators. Since it was not possible to align the efforts of the City Monitor with the Connecting Nature impact assessment, only qualitative and indicative comparisons can be made, but in no case assumptions of causality.

The economic indicators do allow longitudinal comparisons to be made, where it can be seen how the public funds expended in the Stiemer program have increased over the years, or the evolution of business in the Stiemervalley. The participatory planning and governance indicators explore the configuration of collaborations with local stakeholders, while the Stiemerdeals indicators configure a unique category of indicators in this city, which allow to quantify the number and quality of agreements with local entities that have a common objective related to the Stemer Valley.

IMPACT ASSESSMENT RESULTS

Environmental indicators - CORE

ENV15. Water quality

In 2020 a 2-year citizen science project on water quality, coordinated by a local university, started in the Stiemervalley. 55 volunteers play an active role in the maintenance of the sensors and the water sampling. Based on the continuous conductivity and oxygen measures of the sensors the negative impact of wastewater overflows on water quality is clearly shown. During rainfall the water level rises because of waste overflow. The influx of wastewater increases the conductivity and decreases the dissolved oxygen. After the first flush the conductivity decreases strongly because of the rainwater.

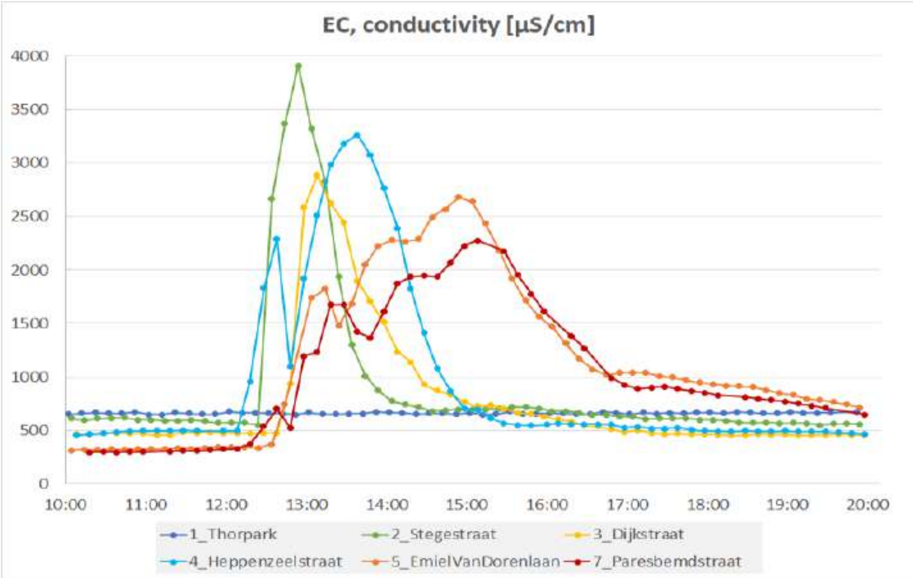


Figure 1. Water conductivity at different Genk locations

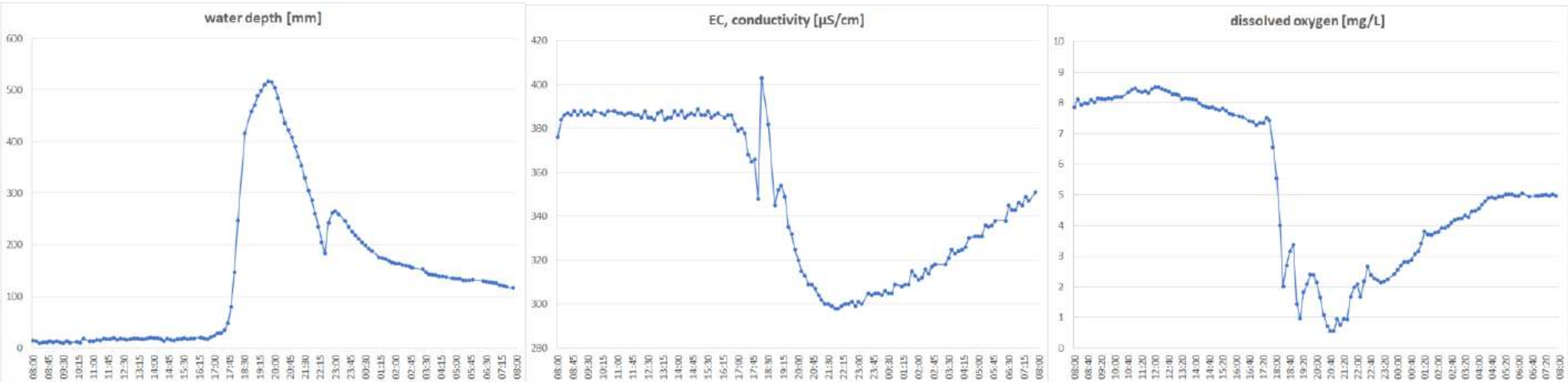


Figure 2. Temporal analysis of water depth, conductivity and dissolved oxygen

Regarding the perception of citizens, in a survey carried out in the summer of 2021 with 500 participants (more information on Supplementary material 1_Survey on primary, health and social indicators Genk 2021), the estimated results of water quality were moderately positive.

Table 1. Water quality estimation

	M	**SD**
How do you estimate the water quality of the Stiemer?	2.96	.77

ENV29. Supporting/increasing biodiversity conservation

The Stiemervalley is an urban nature reserve and is - seen its location in the middle of the city - an area of contrasts, with on the one hand biologically fewer valuable elements and on the other hand very valuable nature. Despite human negative impact on the area, 73% of the area still consists of biologically valuable to very valuable nature. The most valuable nature elements are older deciduous forests, semi-natural grasslands, reed beds, heath relics, ponds and fens.

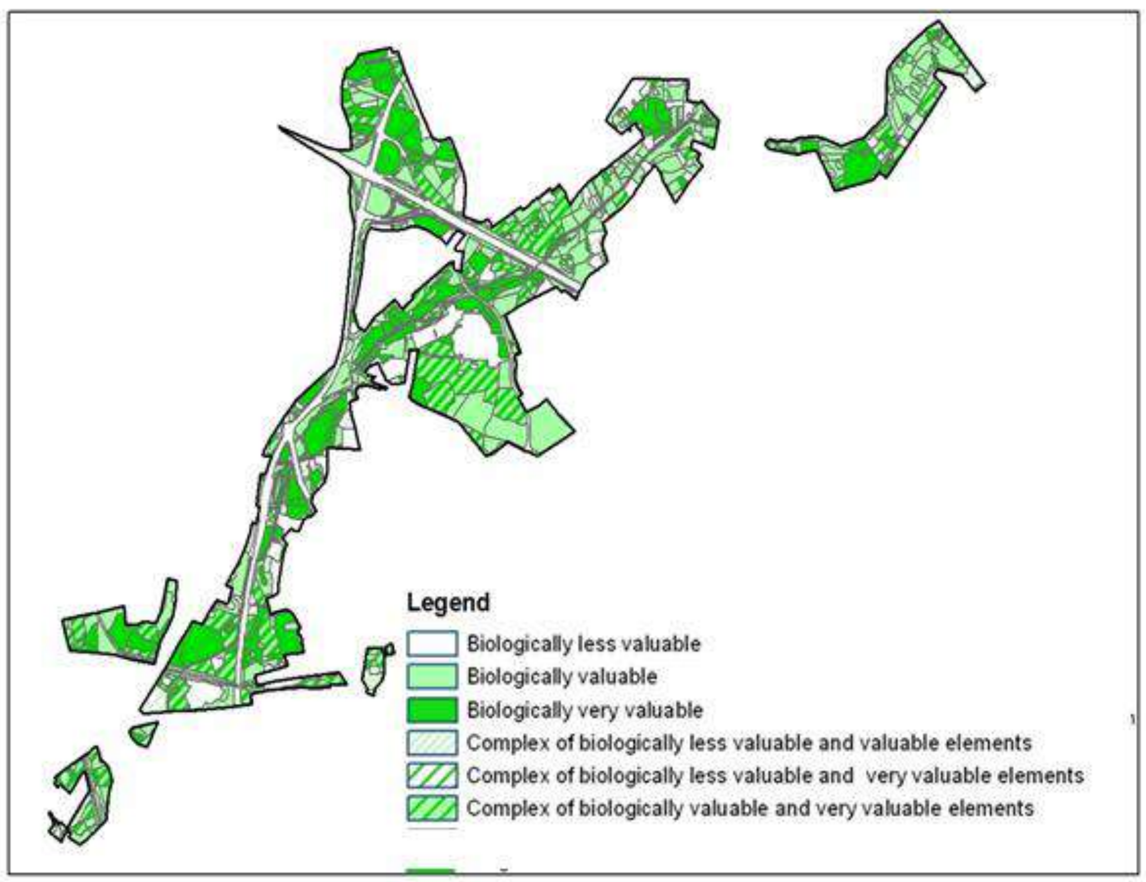


Figure 3. Distribution of areas of biological value in the Stiemervalley

ENV35. Species diversity

The Stiemervalley in Genk covers a total area of about 340 ha, running through the entire city from the northwest to the southeast. The most abundant ecotope is woodland and shrubs, more than 57% of the area. Furthermore, the area consists of about 9% grasslands, 3% waterbodies and 2% inland marshes.

48ha of the area (14%) houses European protected Natura2000 habitats with Atlantic acidophilous beech forests (20 ha) as the most abundant ecotope. A few very rare and unique species are found in the area eg. forest horsetail, juniper, red heather, yellow-green sedge, peat mosses, etc.

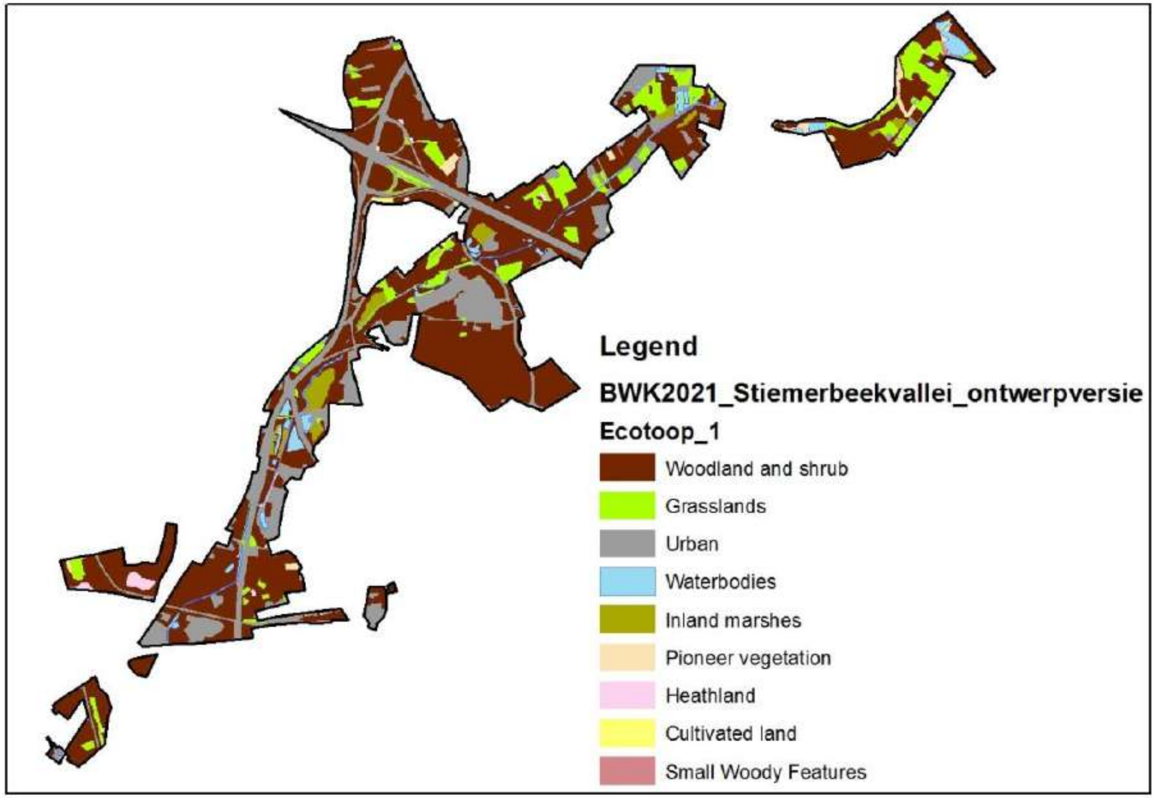


Figure 4. Distribution of plant species in the Stiemervalley

Citizen perception of the number of species observed was also an aspect included in the survey (Supplementary material 1). The following figure shows the 4 most viewed species, ordered from highest to lowest.

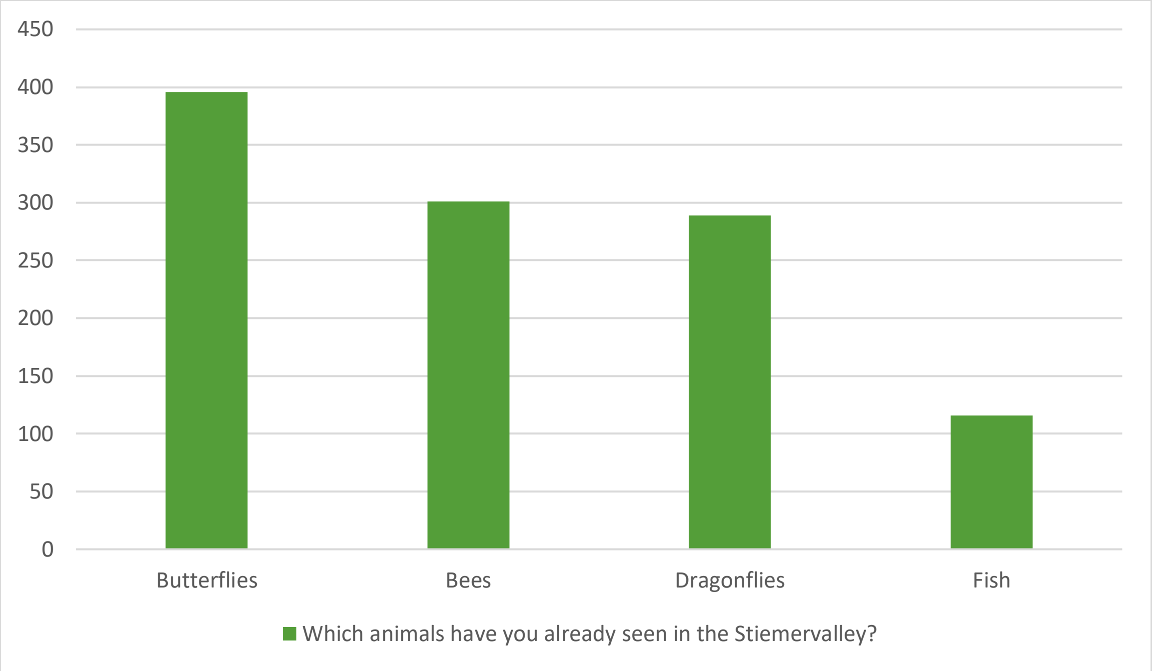


Figure 5. Species most observed by citizens in the Stiemervalley

ENV42. Land use change and greenspace configuration

The top 3 of functions in land use in the Stiemervalley are: (1) housing/gardens, (2) transport infrastructure and (3) forest. In 2019 the hard functions increased with 20 ha compared to 2013; this is an increase of about 1% in 6 years.

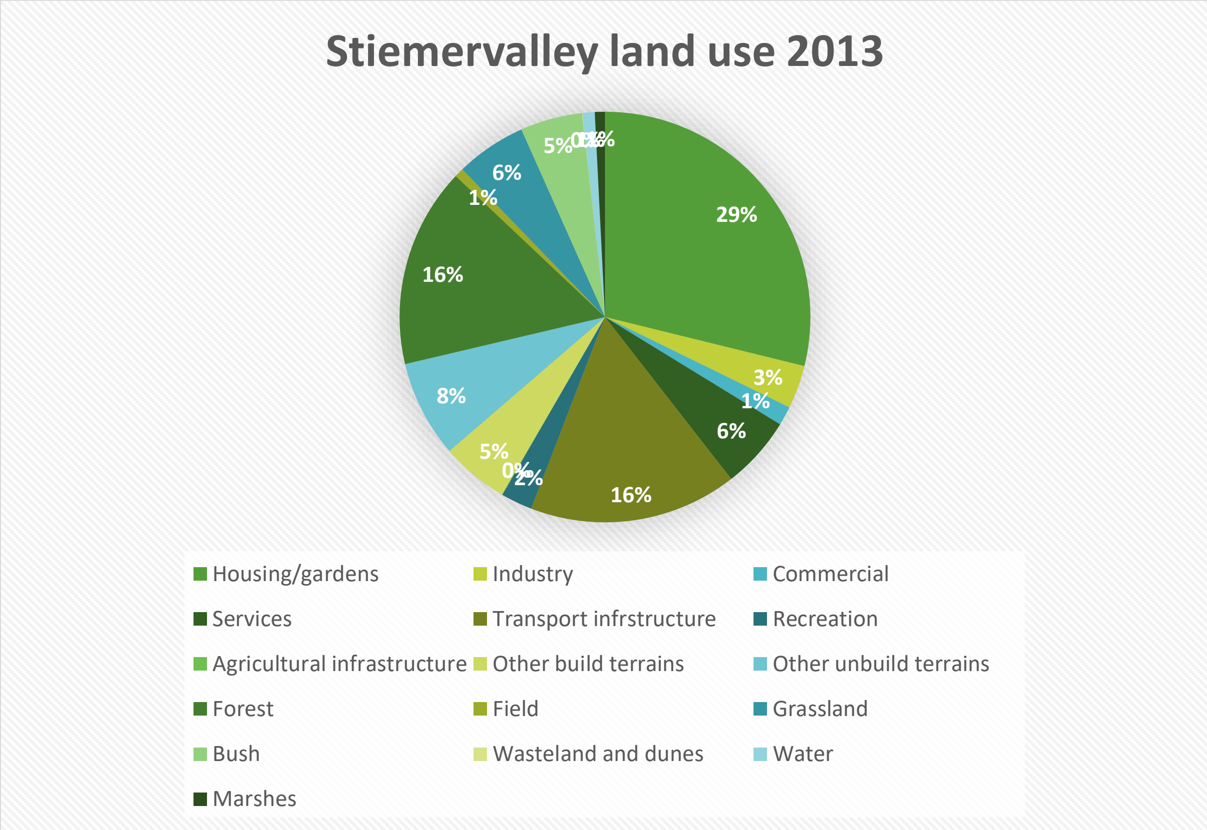


Figure 6. Stiemervalley land use

ENV81. Soil sealing

Sealed surface in the Stiemervalley increased with 6% between 2015-2018. The increase in sealed soil during the same period on a city level was 4%. City development between 2015-2018 seemed to be slightly more intense in the Stiemervalley than in the rest of the city.

Table 2. Sealed surface distribution

	Stiemervalley		Genk	
Year	2015	2018	2015	2018
Ha	214.801	256.872	841.726	982.934
%	28%	34%	24%	28%

Primary indicators

The data presented in this section derives from a survey conducted in the city of Genk during the summer of 2021 on 500 adult participants. Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 1_Survey on primary, health and social indicators Genk 2021).

Confounding variable

Before analysing the use that citizens made of the Stiemervalley, they were asked if the COVID-19 pandemic had increased or decreased its use. The responses in Table 3 show moderate results, with a slight tendency to increase visits to this NBS.

Table 3. COVID-19 impact on Stiemervalley use (Scale range: 1-5)

	M	SD
Due to COVID-19 I visit the Stiemervallei more often	3.1	1.22
Due to COVID-19 I visit the Stiemervallei less often	2.02	.99

PI1. Type of interaction with NBS & PI2. Frequency of interaction with NBS & PI3. Duration of interaction with NBS

Table 4 shows the results for the activities that the participants carry out in the Stiemervalley, as well as their monthly frequency and average duration in minutes. The results of this analysis should be taken with special caution since of the total sample of participants (n = 500) only a few answered these questions and in a not consistent way. That is, it cannot be inferred if the non-responses indicate a non-performance of the activity or not wanting to provide this information. This low response rate has not happened with the rest of the indicators in the Health and wellbeing & Social cohesion categories, with response rates always close to 100%.

Table 4. Types and frequencies of activities in Stiemervalley

	Average number of times per month			Average time per visit in minutes		
	n	**M**	**SD**	**n**	**M**	**SD**
Physical activities (walking, cycling, sports, …)	299	5.86	6.95	296	49.99	49.85
Social activities (meeting family, friends, neighbours; picnicking…)	97	2.43	3.46	96	49.7	49.11
Enjoying peace and/or quiet (relaxing, reading, sitting, meditating...)	140	4.5	6.48	140	40.74	31.79
Experiencing nature (observing plants and/or animals, enjoying the weather or fresh air…)	180	5.46	7.45	178	49.96	40.13
Playing outside with the kids	69	3.35	5.67	69	36.22	37.04
Attending organized activities or events	51	.86	1.21	52	33.56	39.97

However, when interpreting these partial results, physical activities and experiencing nature stand out as the most performed activities. Participants report doing them an average of between 5 and 6 times a month. The average duration of these activities would be very close to 50 minutes per visit.

Wanting to estimate the average number of visits per month and the average time of each one of them, a subsample of those participants who consistently responded to the use of Stiemervalley was selected both in autumn and winter, as well as in spring and summer. The results of Table 5 show a significant difference in the highest number of visits (9.12) and mean time per visit (58.51 minutes) in the summer seasons.

Table 5. Differences in the use of the Stiemervalley by seasons of the year

	Average number of times per month (n=246)		Average time per visit in minutes (n=261)	
	M	**SD**	**M**	**SD**
During fall and winter	6.91	10.32	50.49	67.14
During spring and summer	9.12	10.48	58.51	55.694

Note. The increase in the spring and summer seasons is significant for both the number of visits per month ($t_{(245)}$=9.845; p<.001)and the average time per visit ($t_{(60)}$=2.815; p=.005)

PI4. Perceived quality of space

The perceived quality of the Stiemervalley is shown in Table 6. In general, the perception of citizens is positive, highlighting the beauty of the environment, its accessibility or perceived safety. On the other hand, in Table 7 it can also be seen that citizens are proud of the Stiemervalley, feel it as their own and are willing to contribute to its development.

Table 6. How would you rate the following qualities of the Stiemervalley? (Scale range: 1-5)

	M	SD
The visual quality, the beauty of the environment	3.57	.79
The accessibility (easy to reach)	3.5	.79
The safety	3.37	.8
Maintenance (cleanliness, maintenance of paths, infrastructure and greenery)	3.16	.8
The events in the valley	2.73	.86
Attractiveness in terms of sound and smell	3.14	.91
Overall quality	3.36	.69

Table 7. Stiemervalley knowledge and identity (Scale range: 1-5)

	M	SD
I know the Stiemervalley well	3.04	.91
I am proud of the Stiemervalley	3.5	.78
As an inhabitant of Genk, the Stiemervalley feels as my valley	3.25	.88
I am willing to contribute to the Stiemervalley	3.57	.81
I am aware of city of Genk´s plans to redevelop the Stiemervalley	3.11	1.11

Finally, and in terms of distance perception, Figure 7 shows the responses of how far the Stiemervalley is from their homes. The most frequent response was “Under 5km” while the least frequent was “Under 500m”.

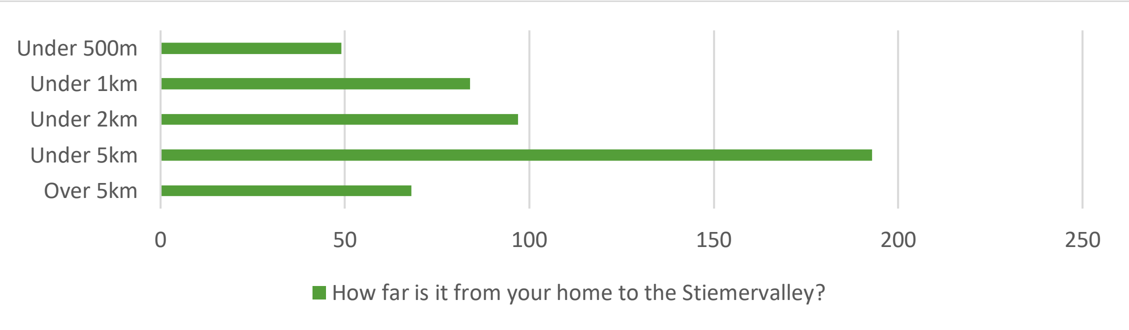


Figure 7. Perceived distance from Stiemervalley to home

Health and wellbeing indicators - CORE

The data presented in this section derives from a survey conducted in the city of Genk during the summer of 2021 on 500 adult participants. Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 1_Survey on primary, health and social indicators Genk 2021).

HW3. General wellbeing and happiness

The general wellbeing of the citizens was asked through two items in the survey. First (Table 8), the participants showed a moderately high level of perceived happiness. Subsequently, the results for perceived general health (Table 9) were also mostly positive.

Table 8. Perceived happiness (Scale range: 1-10)

	M	SD
Do you feel happy in general?	7.43	1.52

Table 9. Perceived health (Scale range: 1-5)

	M	SD
How do you estimate your general health?	3.41	1.72

Furthermore, these results can be compared with a survey carried out at the city level in Genk in 2017 (City Monitor 2017), the results of which can be consulted through the city's data integration and presentation platform (Genk in Cijfers): https://genk.incijfers.be/dashboard/dashboard/ In the case of Figure 8, the proportion of Genk City residents who considered themselves to be in good health was also moderately positive.

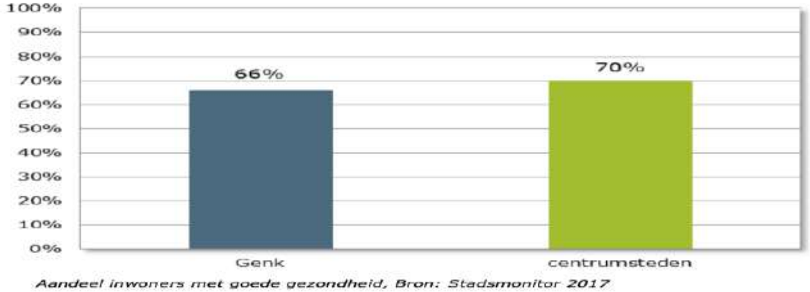


Figure 8. Share of residents in good health, Source: City Monitor 2017

HW11. Mental health and wellbeing

This indicator summarizes mental health through the levels of anxiety and depression in the participants. The results in Table 10 indicate that mental health in the participant sample is moderately positive. This indicator will be especially relevant in the last section of the social and health indicators to see its relationship with other fundamental variables. (See Table 24. Pearson's correlations between social and health indicators).

Table 10. Mental health and wellbeing (Scale range: 1-5)

	M	**SD**
Mental health and wellbeing	3.79	.53

HW12. Enhanced physical activity

Physical activity in the Stiemervalley is interpreted from Table 11 and its visual representation in Figure 9. In both, it can be seen how the participants do perform weekly physical activity in the Stiemervalley. As expected, the least frequent is intense activity, but with an average of almost 1 day a week. Moderate activity was carried out on almost 2 days a week, while walking did exceed two days on average, with an average duration of 32.18 minutes on each occasion.

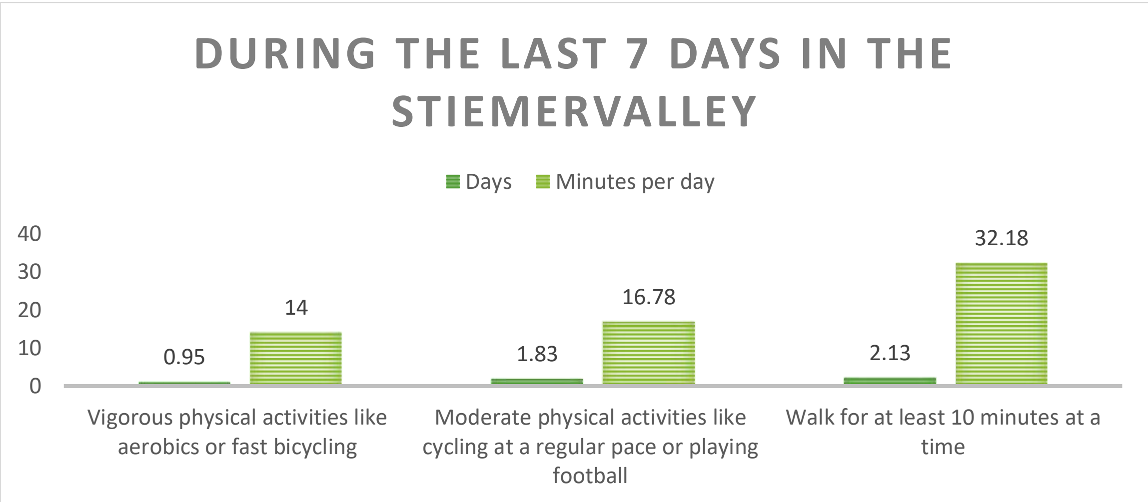


Figure 9. Physical activity in the Stiemervalley

Table 11. Physical activity in the Stiemervalley

	M	SD
During the last 7 days, how many days did you do vigorous physical activities[1] like aerobics or fast bicycling in Stiemervalley?	.95	1.94
How long did you usually spend doing vigorous physical activities on one of those days? (minutes per day)	14	28.49
During the last 7 days, how many days did you do moderate physical activities[2] like cycling at a regular pace or playing football in Stiemervalley?	1.83	2.39
How long time did you usually spend doing moderate physical activities on one of those days? (minutes per day)	16.78	26.25
During the last 7 days, how many days did you walk for at least 10 minutes at a time in Stiemervalley?	2.13	2.41
How much long did you usually spend walking on one of those days? (minutes per day)	32.18	37.43

Weekly, at least 29% of the participants performed vigorous physical activity, 51% moderate physical activity, while 64.92% walked. These results are in line with the City Monitor survey in 2017 (Figure 10), where 41% of those surveyed reported actively exercising at least weekly.

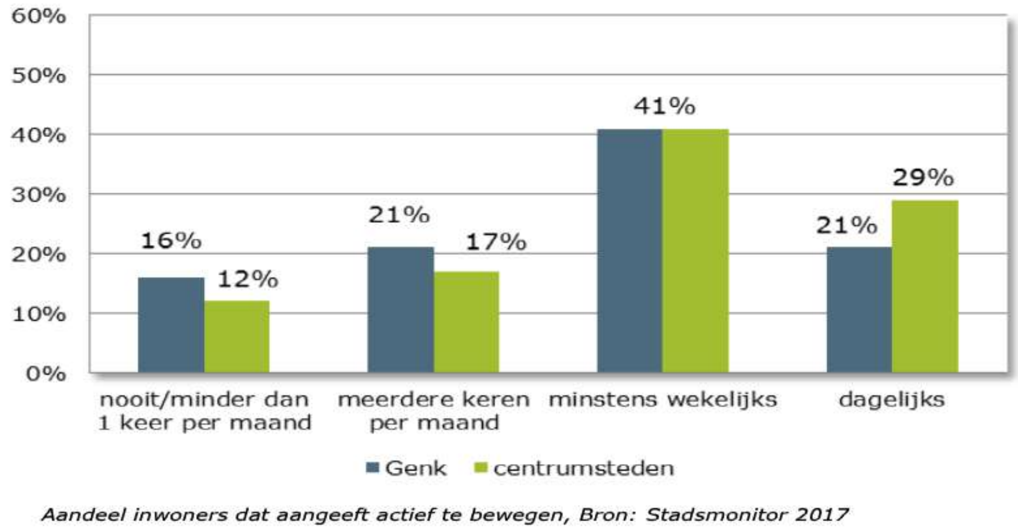


Figure 10. Share of residents who indicate that they actively exercise, Source: City Monitor 2017

[1] Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.

[2] Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal

Finally, and focusing the study of physical activity on that derived from traveling by bicycle to move around the city of Genk, Table 12 indicates that the participants consider that many places in Genk are easy to reach by bicycle, and even a good perception that they can cycle through the entire Stiemervalley. These levels drop when participants report their daily bicycle use. However, this level is similar when they mention the frequency of movements around Genk and along a piece of the Stiemer.

Table 12. Perception on bike connectivity and use (Scale range: 1-5)

	M	**SD**
Many places in Genk are easy to reach by bike	3.96	.85
You can cycle well through the entire Stiemervalley	3.21	.89
Frequency of cycling on daily trips	2.75	1.25
Frequency of cross the Stiemervalley and move around in Genk	2.85	1.03
Frequency of cycle (a piece) along the Stiemer when you move in Genk	2.33	1.03

HW16. Perceived restorativeness of public green space

The levels of mental restoration induced by Stiemervalley (Table 13) are moderately positive. As with the HW11 indicator, these results will be of great interest to analyse the relationships between the variables (See Table 24).

Table 13. Perceived restorativeness of Stiemervalley (Scale range: 1-5)

	M	**SD**
Perceived restorativeness of Stiemervalley	3.65	.63

Health and wellbeing indicators - FEATURE

HW8. Incidence of obesity /obesity rates (adults)

Obesity levels were calculated from the height and weight of the participants, using the body mass index (Table 14). The mean results indicate a slight surpassing of the healthy range of this variable (18.5-24.9) established by the WHO. The next range (25-29.9) indicates the existence of pre-obesity.

Table 14. Body mass index

	M	SD
Weight in kg	74.87	14.76
Height in m	1.72	.92
Body mass index	25.22	4

Note. For more information on the body mass index ranges consult https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

HW13. Perceived chronic loneliness

The chronic loneliness results of the participants are at moderate levels (Table 15), again in line with those indicated in the City Monitor 2017 survey (https://genk.incijfers.be/dashboard/dashboard/), where it was pointed out that 16.3% of the elderly suffer from severe feelings of loneliness.

Table 15. Perceived chronic loneliness (Scale range: 1-5)

	M	SD
Perceived chronic loneliness	2.06	.76

Social cohesion indicators - CORE

The data presented in this section derives from a survey conducted in the city of Genk during the summer of 2021 on 500 adult participants. Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 1_Survey on primary, health and social indicators Genk 2021).

SC1. Bonding social capital & SC2. Bridging social capital

The survey participants interacted with people they considered similar to them, or at least as similar as they were different (Table 16). In general, the people they interacted with were similar on the level of religion, gender, or cultural group. Satisfaction with both people who were the same as with those who were different was moderately positive (Table 17).

Table 16. Thinking about people you interact with in Stiemervalley, how similar are they to you in terms of... (Scale range: 1-3)

	M	SD
...religion	2.14	.54
...gender	2.04	.35

	M	SD
...age	1.86	.53
...ethnic or linguistic group/race/caste/tribe	2.05	.54
...occupation	1.72	.51
...educational background or level	1.84	.46
...income	1.87	.46

Table 17. Quality of interactions (Scale range: 1-5)

	M	SD
Thinking about those people that are mostly as the same as you, how would you rate the quality of your interactions with them?	3.48	.659
Thinking about those people who belong to different categories than you, how would you rate the quality of your interactions with them?	3.34	.645

These results are in line with those found in the City monitor (2017) on the pleasantness of talking to people close to them in the city of Genk (Figure 11).

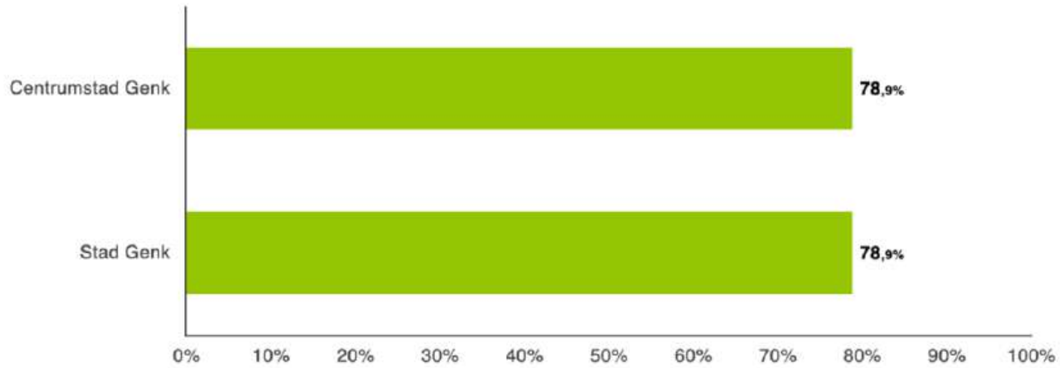


Figure 11. Pleasantness of talking to people close to you

SC4.1. Trust in community

The mean score of the sample (Table 18) generally indicates they perceive that they can trust most of Genk's people. Again this result highlights what was found in the City Monitor, both in relation to trust with others (Figure 12), and in the strength of social cohesion (Figure 13), indicated by trust, help, contact and feelings of be at home among the local residents.

Table 18. Trust in community (Scale range: 1-5)

	M	SD
Most people in Genk can be trusted	3.46	.79

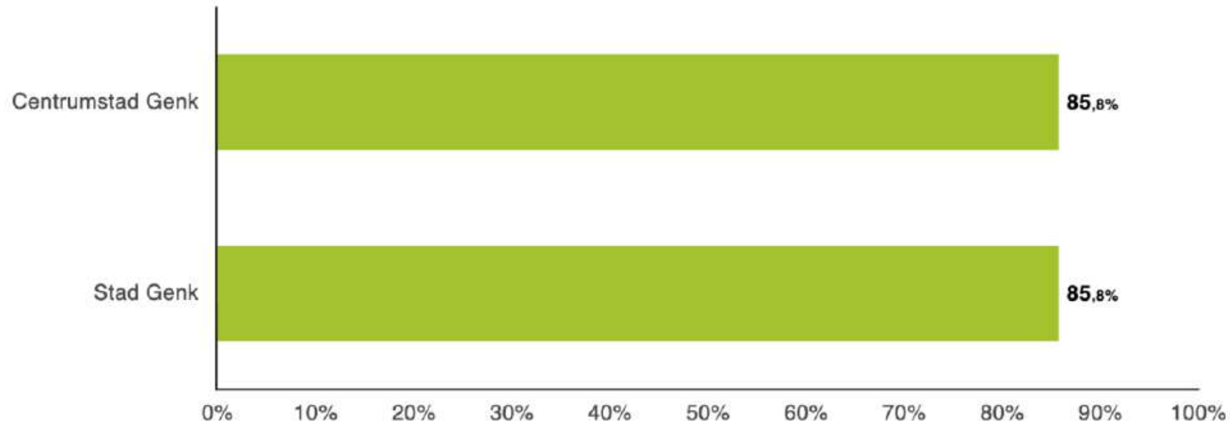


Figure 12. Trust in others

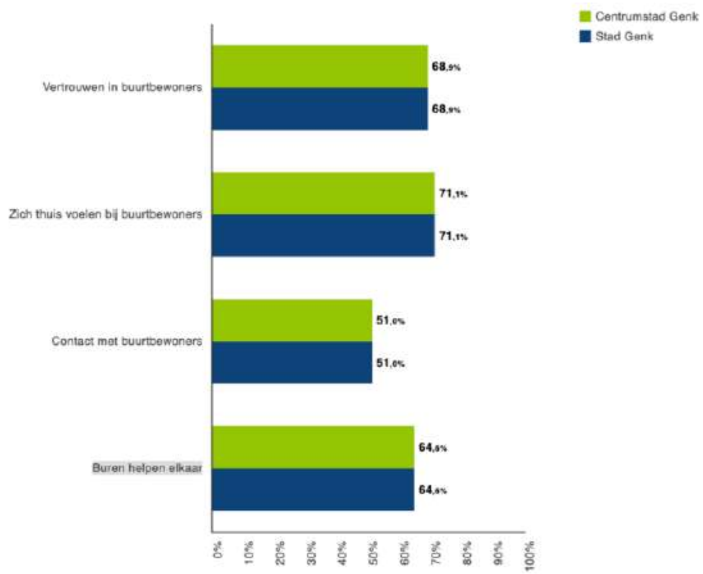


Figure 13. Social cohesion. Note. Order of variables: Trust in local residents; Feel at home with local residents; Contact with local residents; Neighbours help each other

SC4.3. Tolerance and respect

Following the same trend, tolerance and respect levels also reached moderately positive values (Table 19), although an average score is presented when considering that there are people in Genk who do not belong to the place.

Table 19. Tolerance and respect (Scale range: 1-5)

	M	SD
People in Genk are tolerant of others who are not like them	3.45	.86
In Genk there are some people who belong and some who don't	2.48	1.61

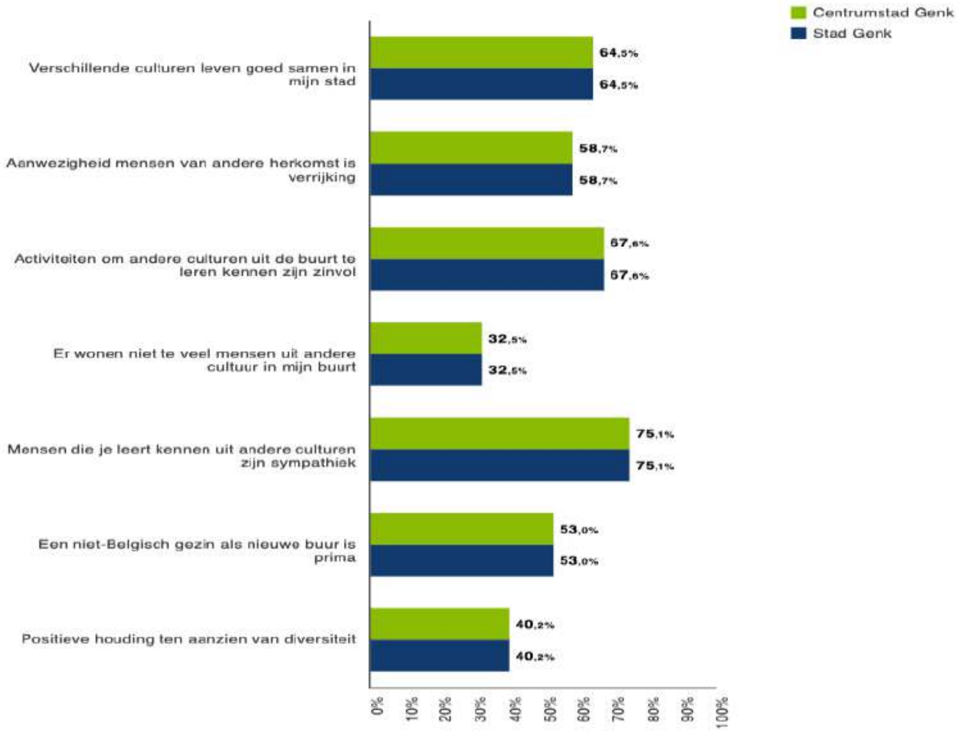


Figure 14. Attitude towards different cultures in the city of Genk

Comparing these data with the City Survey (Figure 14), citizens' attitudes are generally positive towards other cultures, diversity and their inclusion in the neighbourhood. The percentages in agreement with the statements about other cultures were: Different cultures level well together in my city (64.5%); Presence of people of different origin is enrichment (58.7%); Activities to get to know other cultures in the neighbourhood are useful (67.5%); There aren't too many people from other cultures living in my neighbourhood (32.5%); People you get to know from other cultures are sympathetic (75.1%); A non-Belgian family as a new neighbour is fine (53%); Positive attitude towards diversity (40.2%).

SC5.1. Perceived safety

Stiemervalley is perceived as a highly safe environment during the day, it has moderate levels of security at night and the presence of incivilities, but the levels of feeling threatened are moderately low (Table 20).

Table 20. Perceived safety (1-5)

	M	SD
Stiemervalley is safe in the day time	3.91	.7
Stiemervalley is safe after dark	2.88	.87
I often witness incivilities at Stiemervalley (i.e., illegal littering, vandalism…)	2.62	1
I have felt threatened in Stiemervalley	1.97	.86

These levels are consistent with the City Monitor (2017) data on feeling at home in the neighbourhood (Figure 15) and the general feeling of insecurity and avoidance of certain places. (Figure 16)

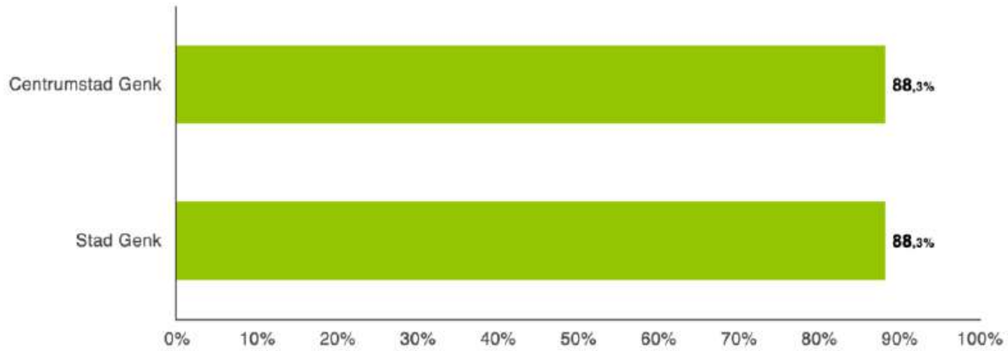


Figure 15. Feeling at home in the neighbourhood

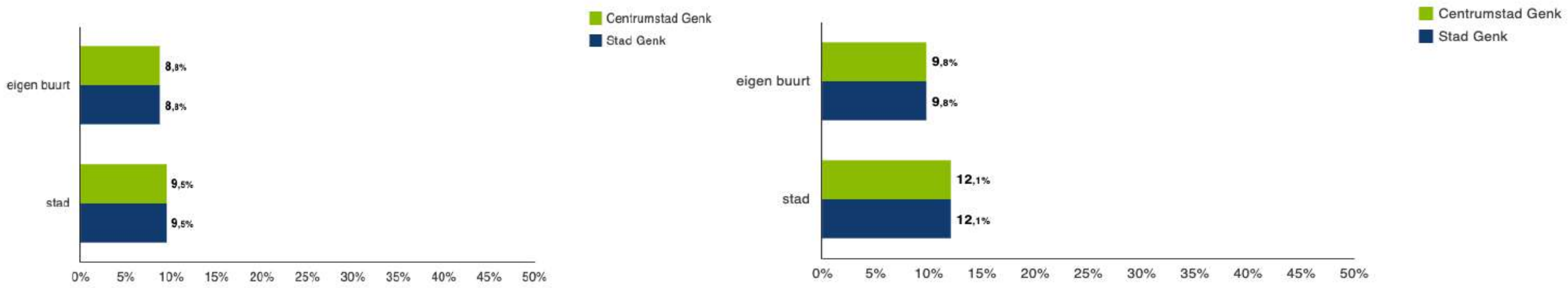


Figure 16. General feeling of insecurity & Avoidance of certain places

SC6. Place attachment

The levels of attachment to the Stiemervalley are moderately positive (Table 21). These results are important to analyze the relationships between the variables (See Table 24).

Table 21. Attachment to Stiemervalley (Scale range: 1-5)

	M	SD
Attachment to Stiemervalley	3.06	.85

SC9. Empowerment

The sample participants consider that they have moderate control when it comes to making decisions that affect the city or make Genk a better place to live (Table 22).

Table 22. Empowerment in the city of Genk

	M	SD
How much control do you feel you have in making decisions that affect Genk? (Scale range: 1-5)	1.97	.9
Do you feel that you have the power to make important decisions that change Genk? (Scale range: 1-5)	2.54	1.01
Overall, how much impact do you think you have in making Genk a better place to live? (Scale range: 1-3)	1.74	.59

Social cohesion indicators - FEATURE

SC12. Pro-environmental behaviour

In general, the levels of pro-environmental behavior shown in Table 23 are moderately positive, highlighting the use of reusable bags, saving water and walking or cycling for short distances.

Table 24. Pro-environmental behaviour (Scale range: 1-5)

	M	SD
When you visit the grocery store, how often do you use reusable bags?	4.49	.72
How often do you conserve water when showering, cleaning clothes, washing dishes, watering plants, or during other activities?	3.84	.92
How often do you discuss environmental topics, either in person or with online posts (Facebook, Twitter, etc.)?	3.16	.88
When you buy clothing, how often is it from environmentally friendly brands?	2.72	.91
How often do you engage in political action or activism related to protecting the environment?	2.23	.99
How often do you educate yourself about the environment?	3.32	.93
How often do you walk or cycle for distances of less than 2 km?	3.61	1.1
Total	3.34	.58

Correlations between the main social and health indicators

Table. 24 Pearson´s correlations between some social and health indicators

	Perceived health	HW3	HW11	SC6	SC12	HW16
Perceived health	1					
HW3. General Wellbeing and Happiness	.376**	1				
HW11. Mental health and wellbeing	.412**	.649**	1			
SC6. Place attachment	.111*	.180**	.136**	1		
SC12. Pro-environmental behaviour	.211**	.093*	.163**	.260**	1	
HW16. Perceived restorativeness of public green space	.068	.156**	.109*	.587**	.169**	1

**. The correlation is significant at the .05 level (bilateral); **. The correlation is significant at the .01 level (bilateral).*

The previous correlations show that the variables object of this survey maintain statistically significant relationships between them. On the one hand, the positive relationships between perceived health, with general well-being, mental health, the attachment to Stiemervalley and pro-environmental behaviour stand out. There are also positive and significant relationships between Stiemervalley's attachment, its restorative capacity, and pro-environmental behaviour.

Economic indicators - CORE

ECO1. New Businesses 'attracted' or started and additional rates received

Two important shopping streets are located in the Stiemervalley, both connected to a former mining site. We analysed the new businesses in these streets and added another street located in the Stiemervalley and connected to one of the main shopping streets mentioned before. An interesting finding is that the business in some premises change almost every year.

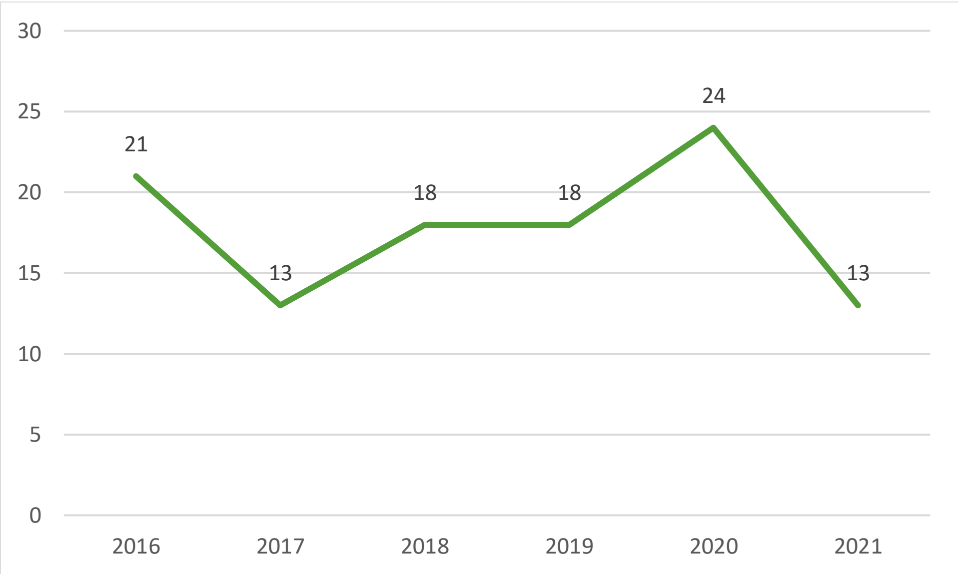


Figure 17. New businesses in the Stiemervalley

ECO7. Increase in tourism

We see a decline in the overnight stays in the city of Genk, according to the department of tourism due to a decrease in number of facilities. However this decline is also visible in the numbers of visitors (individual and groups) to several touristic sites in the city. Even the newest site, La Biomista with 39.056 individuals visitors in 2019 and 35.715 visitors in 2020 could not reverse the decline.

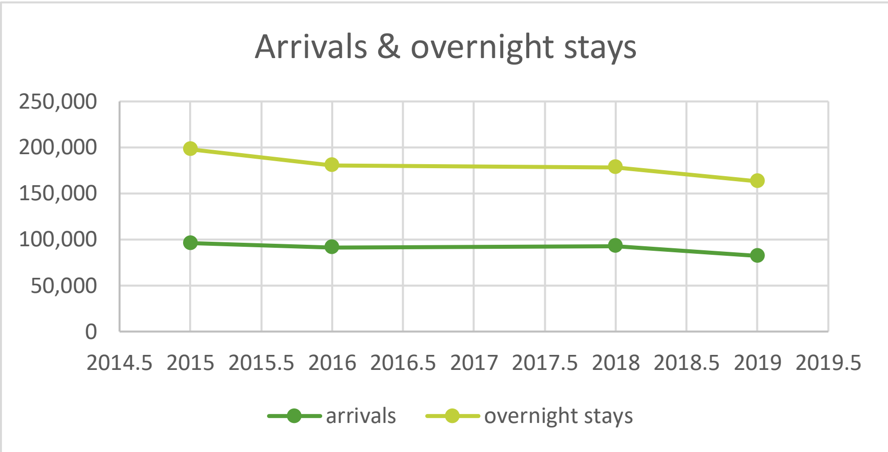


Figure 18. Increase in tourism

<u>Economic indicators - FEATURE</u>

ECO13. Net impact on public expenditure from NBS implementation

In the period 2015-2020 the city of Genk invested in the Stiemer program about 476.000 € in planning, 638.000 € in development and 6.200 € in operation. Investing in planning started in 2016 with the development of a masterplan, that was approved in 2018. From 2019 on there is a clear shift to implementation: development budget increases clearly compared to planning budget.

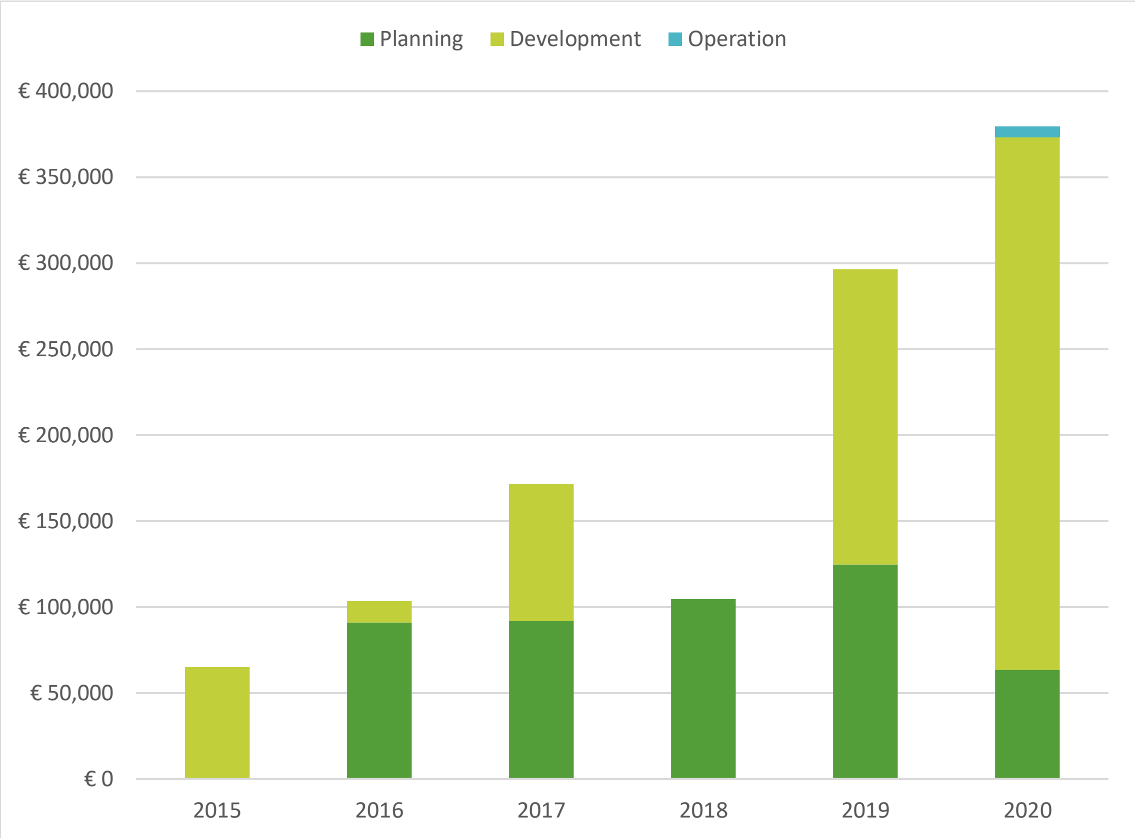


Figure 19. Public funds expended (2015-2020)

ECO15. Private finance attracted to the NBS site

In the period 2015-2020 the city of Genk attracted in total about 11 mio € additional funds for the Stiemer program. 90% of these funds are to be used for the spatial transformation of the area (development). 40% of these funds are direct investments by partners in the area, the rest are subsidies. In 2015-2016 the additional funds were used for the development of 2 areas in the valley (Schansbroek/Slagmolen). These projects were a catalyst for the development of an integrated, valley wide approach. In 2016 a spatial masterplan was initiated and through the Connecting Nature, started in 2017, a more strategic program approach and governance model was developed. These elements were crucial for attracting additional funds. A clear return of investment can be seen as of 2019 with a peak in 2020.

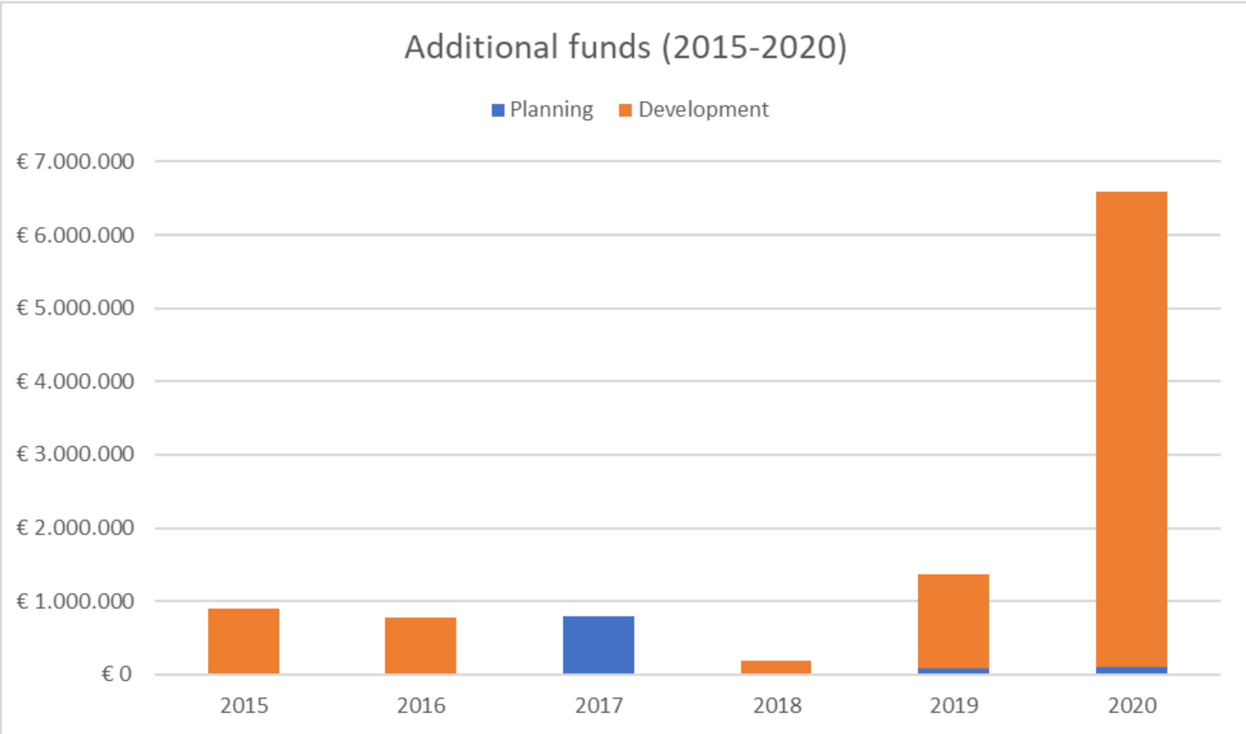


Figure 20. Additional funds (2015-2020)

ECO6. Innovation impact

The development of the Stiemervalley inspired some entrepreneurs to develop new products. Since 2019 we have stiemer icecream, stiemerhoney, stiemerbeer, etc. But also new bicycle tours, menus, decoration products, etc. In total 15 new products have been developed in connection to the Stiemervalley since 2019.

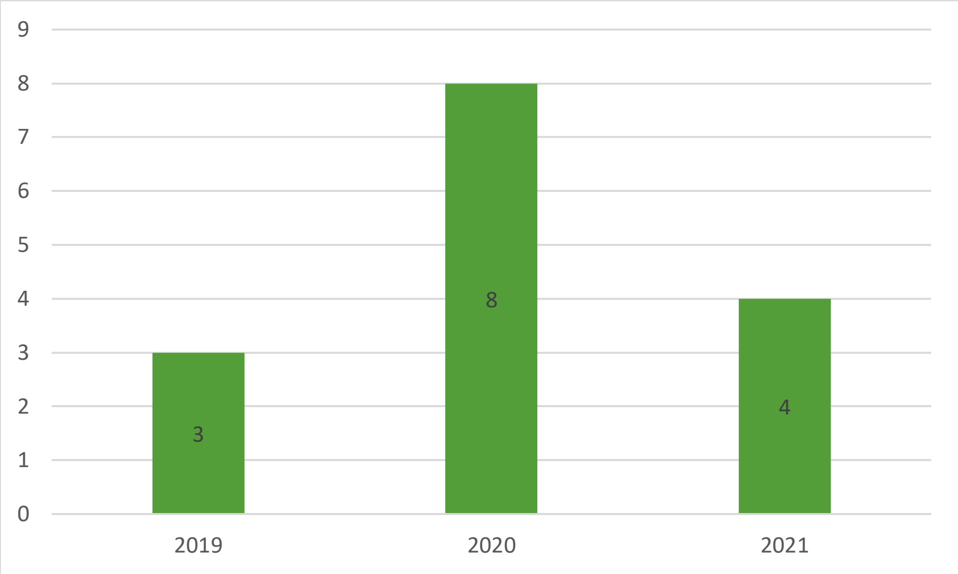


Figure 21. Number of new products (2019-2021)

<u>Participatory planning and governance indicators - CORE</u>

PPG1. Diversity of stakeholders involved

In the Stiemer program there are at least 55 stakeholders involved. This can be explained by to the complexity of the exemplar, the integrated approach and the fact that coproduction is a guiding principle. The stakeholders are almost equally divided over 5 categories of the Quintuple Helix.

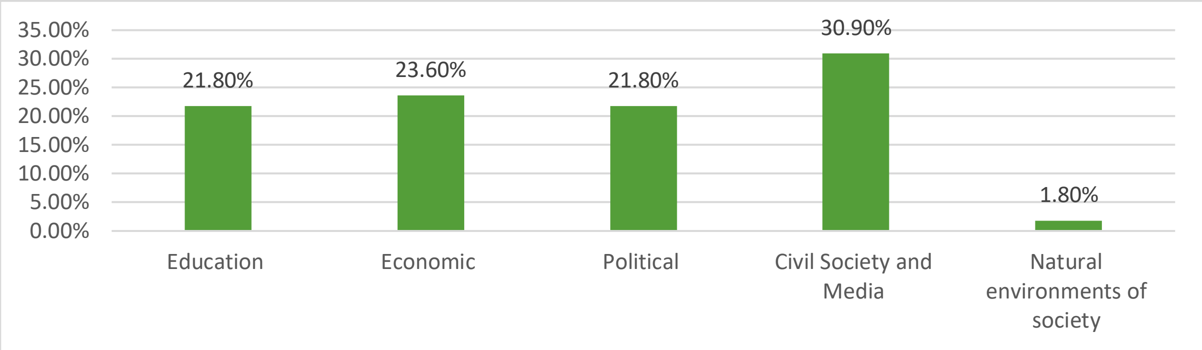


Figure 22. Number of stakeholders per category

PPG2. Social equity: involvement of citizens from traditionally under-represented groups

The involved stakeholders consider the social equity in the Stiemer program between 'poor' and 'fair' with a mean score of 2.5. This is an adequate reflection of the reality as involving citizens of traditionally underrepresented groups is a continuous challenge. Via cooperation with certain associations some of these groups have been involved.

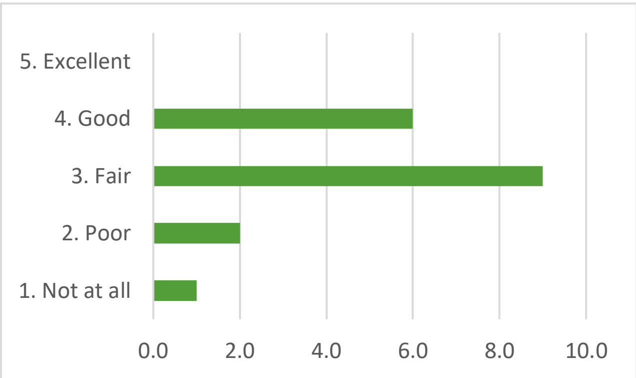


Figure 23. Social equity

PPG5. Activation of public-private collaboration

In total we have identified 21 public-private collaborations with several private partners in the three stages of the process of realization of NBS. Next to these NBS-linked collaborations there are 44 extra public-private StiemerDeals. A Stiemerdeal is an agreement between the city and another party in which it is agreed how they will work together towards a common goal related to the Stiemer Valley. StiemerDeals are public-private collaborations with no direct link to the spatial development, but rather to the socio-economic development of the Stiemervalley. Therefore, they cannot be linked to a stage (planning-delivery-stewardship) in the process.

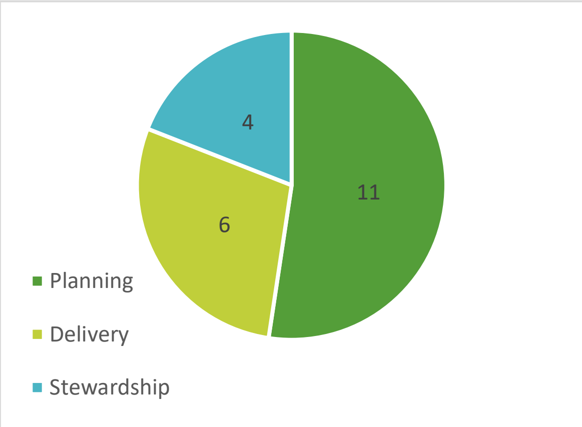


Figure 24. Number of public - private collaborations

PPG6. Trust in decision-making and decision-makers

We checked the trust in decision-making and decision-makers via a survey to our external stakeholders on three aspects: the perceived competence, benevolence and integrity. They gave their opinion on some statements on a 1-5 scale (1= strongly disagree – 5=strongly agree). Most results are located around the neutral position. These results are based on 19 completed surveys.

Table 25. Trust in decision-making and decision-makers

Perceived competence		Perceived benevolence		Perceived Integrity	
Municipality is capable	3.9	Local politicians act in interest of citizens	3.25	Local politicians tell the truth	3.12
Municipality wastes money	2.8	Municipality carries duties out well	3.5	Gvmt officials tell us as little as they can	2.6
Local politicians know what they are doing	3.3	Local politicians keep to commitments	3.25	Local politicians admit mistakes	2.8

PPG9. Innovative climate

In a survey to all the involved internal colleagues we checked the innovative climate in the administration of the City of Genk. Based on 10 completed forms we see again that there is a moderate innovative climate in the administration of the city of Genk based on the answers on a scale from 1 (strongly disagree) to 5 (strongly agree).

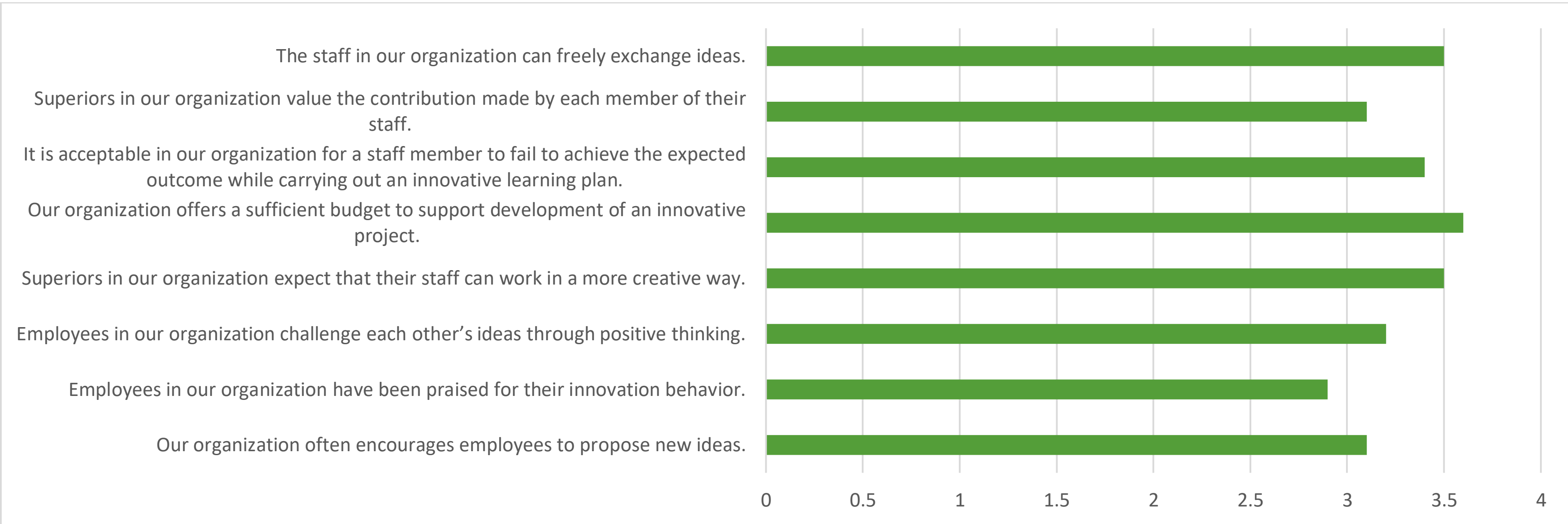


Figure 25. Innovative climate

PPG10. Open communication (internal & external)

In a survey to all the involved internal colleagues we checked the innovative climate in the administration in the City of Genk. Colleagues rather disagree that there is open communication in the administration. It is interesting to see in the graphic below that the sources of information are colleagues and informal communication.

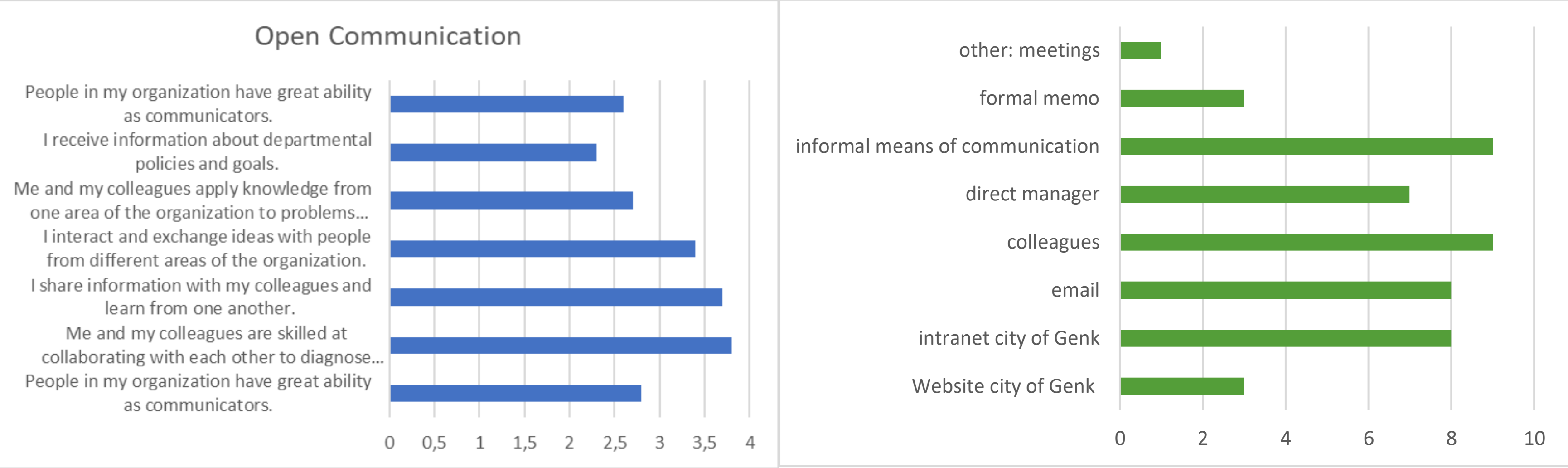


Figure 26. Open communication & Sources of information about what is relevant for your work

<u>Participatory planning and governance indicators - FEATURE</u>

PPG17. Reflexivity - time for reflection

Reflexive monitoring is an important part of the Stiemer program. It allows the Stiemerteam to rise above day-to-day issues by zooming out and reflecting on the general progress of the programme from a strategic and systemic point of view. The learning process would ensure that the right things are done while the project management ensures that things are done right. The Stiemer team spends 0.5 days each month on reflexivity.

Stiemerdeals indicators

A Stiemerdeal is an agreement between the city and another party in which it is agreed how they will work together towards a common goal related to the Stiemer Valley. It is important that this not only fulfills our objective, the development of the Stiemer Valley, but also the dream of the citizen, association or entrepreneur. Within the survey conducted in the city of Genk during the summer of 2021 on 500 adult participants, citizens were asked if they knew the Stiemerdeals. The moderate levels of this variable indicate that it is a concept that can still be disseminated to a larger number of the population (Table 26).

Tabla 26. Stiemerdeals awareness

	M	**SD**
I've heard about the Stiemerdeals	2.36	1.06

Number of Stiemerdeals

In the period 2015-2021 we have closed 44 Stiemerdeals in total. 29 deals are ongoing while 15 have ended. The majority of the Stiemerdeals have been closed in 2020. In 2021 the Covid pandemic was responsible for a decline.

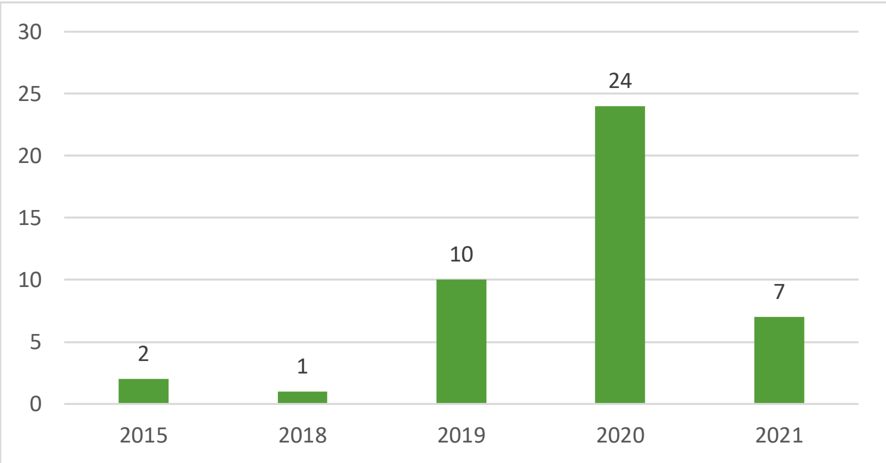


Figure 27. Number of Stiemerdeals

Size of the deal (number of involved parties)

The size of a Stiemerdeal is measured by the number of partners involved. Most Stiemerdeals are one-on-one deals with the city of Genk. Some are collaborations of several partners. Natuurpunt, the ngo responsible for the management of the nature reserve of the Stiemervalley is the partner that is mostly involved in different Stiemerdeals. The mean size of a Stiemerdeal is the involvement 1.33 partners.

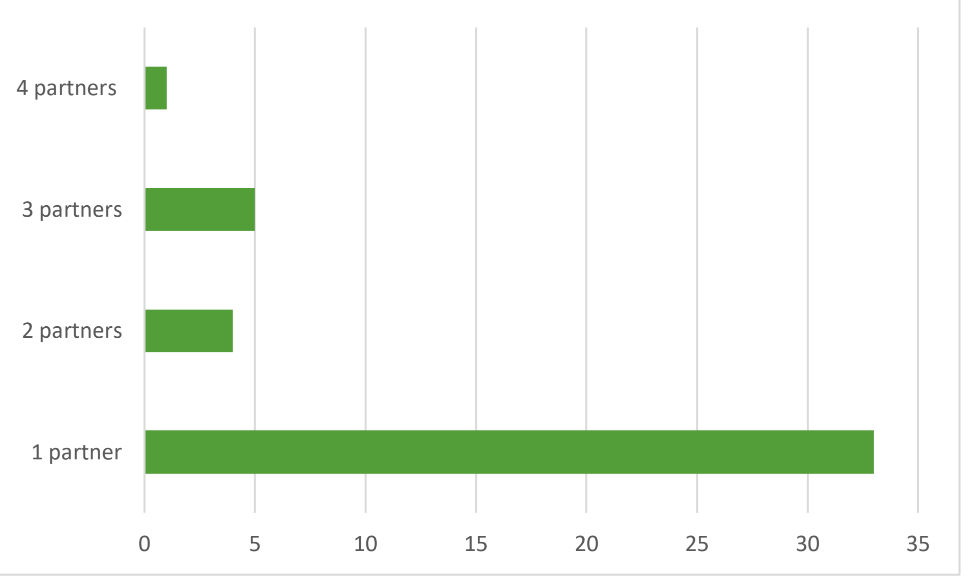


Figure 28. Size of the Stiemerdeals

Enabled capacity (investment cost or labour)

The Stiemerdealpartners were asked to give an estimation of their investment (financial and labour) in the Stiemervalley. Only 21 answered this question, some only partially. This means that these numbers are only a small part of the effort done by all Stiemerdealpartners, certainly because some partners with a large engagement, such as Natuurpunt and Neos Genk, didn't send us an estimation.
The 21 mentioned Stiemerdealpartners reported an investment of **4844h** and **€197.627** in the Stiemervalley. Some of these investments are recurrent; so they were multiplied for the length of the deal until now.

Contribution to Stiemerobjectives

The win for the Stiemerprogram (city of Genk) in a Stiemerdeal is of course a contribution to the objectives. So this is a necessary condition to close a new Stiemerdeal. Most deals contribute to multiple objectives. The majority helps us to connect people with nature.

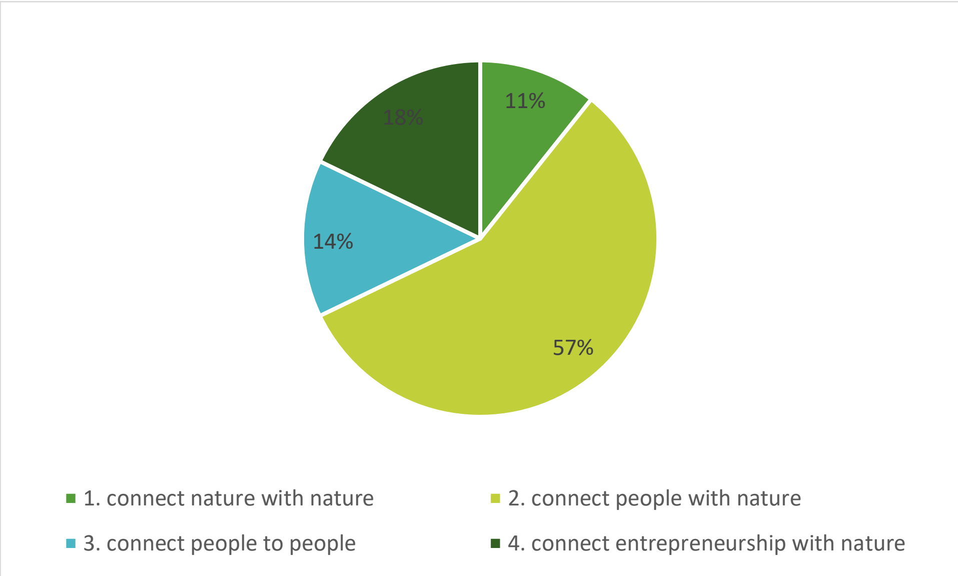


Figure 29. Contribution to Stiemerobjectives

Connectivity, network

We measure the connectivity of the Stiemerdeals by counting the deals that have led to another deal. 11 of 44 Stiemerdeals have led to a new deal.

General conclusions

Environmental impact

The results of the environmental indicators show the importance of the Stiemer river for the city of Genk and how it influences the quality of the water, and its perception by the citizens. The Stiemer channel, which creates the Stiemervalley, is a green and blue buffer that favours the areas with the greatest biological value in Genk. In its about 340 hectares the most abundant ecotope are woodland and shrubs. 48ha of the area (14%) houses European protected Natura2000 habitats with Atlantic acidophilous beech forests (20 ha) as the most abundant ecotope. Among the animal species most seen by citizens are butterflies, bees, dragonflies and fish. 29% of land use is allocated to housing and gardens and 16% to transport infrastructure, highlighting an increase in hard functions in 2019. In the same sense, sealed surface in the Stiemervalley increased with 6% between 2015-2018.

Social and health impact

The results of social and health indicators measured through the survey of 500 citizens show how the use of the Stiemervalley increases in summer and spring, with respect to autumn and winter, reaching 9 visits per month on average with approximately 1 hour of duration in every visit. Citizens really appreciate the quality of the Stiemervalley, especially its visual appearance, the accessibility (most of them living within 5Km) and the security they feel in it. The happiness and perceived health (physical and mental) of citizens is quite high, positively related to attachment to Stiemervalley and pro-environmental behaviour. This link with the Stiemervalley is also related to its restorative capacity, to provide mental relaxation. The rest of the social cohesion variables measured in the survey are in line with the City Monitor's previous baseline in 2017. Genk continues to stand out for its high levels of trust in the community, tolerance and respect for cultural diversity.

Economic impact

Over the years, the businesses analysed around the Stiemervalley remained constant or even increased, until the year of the COVID-19 pandemic. Tourism has been in moderate decline for years, while public funds expended have increased over time, with particular emphasis on the development phase of the Stiemervalley. Private funds have also increased over the years with a clear return of investment in 2019 with a peak in 2020. Innovation has also improved over time (with the exception of the year of COVID-19). In total 15 new products have been developed in connection to the Stiemervalley since 2019.

Participatory planning and governance impact

The indicators in this category reflect the complexity of the Stiemervalley exemplar and how different stakeholders, from various categories, have participated in its co-production. The participatory process has been considered equitable, with numerous public-private collaborations. Trust in the institutions and the decision-making process is moderately positive, allowing a climate of innovation, with moderate open communication. In addition, the Stiemerteam always dedicates an amount of time per month to perform reflexive monitoring procedures.

Stiemerdeals

A Stiemerdeal is an agreement between the city and another party in which it is agreed how they will work together towards a common goal related to the Stiemer Valley. It is important that this not only fulfills our objective, the development of the Stiemer Valley, but also the dream of the citizen, association or entrepreneur. Although only an average proportion of the citizens surveyed know about Stiemerdeals, each year (with the exception of COVID-19) the number of Stiemerdeals has increased, involving on average more than one partner. Stiemerdealpartners reported an investment of 4844h and € 197,627 in the Stiemervalley. These Stiemerdeals help connect people involved with nature and and can extend the network, as 25% of the Stiemerdeals contributed to a new one.

Supplementary material_Survey on primary, health and social indicators (Genk 2021)

Authors: Mien Quartier, Peter Vos and Katrien Van de Sijpe (Genk), Adina Dumitru, David Tomé Lourido, Eva Peralbo Rubio (University of A Coruña)

This supplementary material contains the methodological information related to the survey carried out in the city of Genk to evaluate the impact of the NBS (Stiemervalley). The participants, procedure, instruments and data analysis performed in this research are detailed below.

Participants

500 participants aged between 18 and 96 years (M = 50.11; SD = 17.86), being 48.9% women and 51.1% men. 20.1% of the participants lived in an apartment, 78.8 in a house with a garden and 1.2% in a house without a garden, while 84.3% owned their home, and 15.7% were rented. The following tables show the time that the participants had been living in their neighborhood, their educational level and economic status.

	Less than 1 year	**Between 1 and 2 years**	**Between 3 and 5 years**	**Between 6 and 10 years**	**More than 10 years**
Percentage of participants	3.6	7.1	10	7.5	71.8

	Percentage of participants
No education / preschool	2
Primary school	2.1
High school	27.5
Vocational training	12.6
University degree	35.6
Master´s degree	18.8
PhD	1.4

	Percentage of participants
Between 601 € – 1.500 €	6.6
Between 1.501 € – 3.000 €	22.4
Between 3.001 € – 4.500 €	24.1
Between 4.501 € – 6.000 €	13.8
More than 6.001 €	4
I don´t want to disclose	29.1

Procedure

First of all, Genk city council staff contacted a company specialized in conducting population surveys. After the agreement, the company was in charge of distributing the instruments to the sample during the summer of 2021. The criteria of spatial representativeness and age were used to obtain a representative sample of the entire territory of the city, and distributed equally in terms of sex and age. Participation in the survey was voluntary and anonymous. At all times the data protection of the responses was guaranteed, in accordance with the laws in force in Belgium and at the level of the European Union.

Instruments

The following table shows a summary of the instruments used to measure the variables under study:

CODE	INDICATOR	INSTRUMENT
PI1	Type of interaction with NBS	Questions prepared ad hoc within the Connecting Nature project (Dumitru et al., 2021)
PI2	Frequency of interaction with NBS	
PI3	Duration of interaction with NBS	
PI4	Perceived quality of space	
HW3	General wellbeing and happiness	Abdel-Khalek (2006)
HW11	Mental health and wellbeing	General Health Questionnaire (GHQ-12) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997)
HW12	Enhanced physical activity	International physical activity questionnaire (Craig et al., 2003)
HW16	Perceived restorativeness of public green space	Perceived Restorativeness Scale (the short, PRS - 11) (Pasini et al., 2014)
HW8	Incidence of obesity /obesity rates (adults)	Items about the participant's height and weight, to calculate the body mass index
HW13	Perceived chronic loneliness	Three-Item Loneliness Scale (Hughes et al., 2004)
SC1	Bonding social capital	Anucha et al. (2006)
SC2	Bridging social capital	

SC4.1	Trust in community	Stafford et al. (2003)
SC4.3	Tolerance and respect	
SC5.1	Perceived safety	Integrated Questionnaire for the Measurement of Social Capital (Grootaert et al., 2004)
SC9	Empowerment	
SC6	Place attachment	Williams & Vaske (2003)
SC12	Pro-environmental behaviour	Brick et al. (2017)

Data analysis

The data were analysed with the IBM SPSS 25.0 statistical package. The analyses included the calculation of descriptive statistics, comparisons of means through Student's t test, and Pearson's correlations.

References

Abdel-Khalek, A. M. (2006). Measuring happiness with a single-item scale. *Social Behavior and Personality: an International Journal*, *34*(2), 139-150.

Anucha, U., Dlamini, N. S., Yan, M. C., & Smylie, L. (2006). Social capital and the welfare of immigrant women: *A multi-level study of four ethnic communities in Windsor*. Ottawa, Ontario: Status of Women Canada.

Brick, C., Sherman, D. K., & Kim, H. S. (2017). “Green to be seen” and “brown to keep down”: Visibility moderates the effect of identity on pro-environmental behavior. *Journal of Environmental Psychology, 51*, 226-238.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., ... & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise, 35*(8), 1381-1395.

Dumitru A., Tomé-Lourido, D., & Peralbo-Rubio, E. (Eds.) (2021). *Connecting Nature Indicator Reviews*. Connecting Nature, Grant Agreement number 730222. SBN Number: 978-1-9161451- 8-4

Goldberg, D., Gater, R., Sartorius, N., Ustun, T., Piccinelli, M., Gureje, O., & Rutter, C. (1997). The Validity of two Versions of the GHQ in the WHO Study of Mental Illness in General Health Care. *Psychological Medicine, 27*, 191-7. doi: 10.1017/S0033291796004242.

Grootaert, C., Narayan, D., Jones, V.N., & Woolcock, M. (2004). *Measuring Social Capital: An Integrated Questionnaire*. World Bank Working Paper 18. Washington D.C.: World Bank.

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging, 26*(6), 655- 672.

Pasini, M., Berto, R., Brondino, M., Hall, R., & Ortner, C. (2014). How to measure the restorative quality of environments: The PRS- 11. *Procedia-Social and Behavioral Sciences, 159*, 293-297.

Stafford, M., Bartley, M., Sacker, A., Marmot, M., Wilkinson, R., Boreham, R., & Thomas, R. (2003). Measuring the social environment: social cohesion and material deprivation in English and Scottish neighbourhoods. *Environment and Planning A, 35*(8), 1459-1475.

Williams, D. R., & Vaske, J. J. (2003). The measurement of place attachment: Validity and generalizability of a psychometric approach. *Forest science, 49*(6), 830-840.

A CORUÑA

Impact Assessment Plan

URBAN GARDENS NETWORK

43°21'47.2"N 8°25'40.1"W

Antonio Prieto González, María González Vázquez, Guillermo Leira Nogales

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Organize the territory and make a rational use of the land, conserve it and protect it.		●				●					●			●	●		
Avoid urban sprawl and revitalize the existing city.			●			●	●		●		●						
Prevent and reduce the impacts of climate change and improve resilience.	●	●	●								●		●	●	●		
Sustainable management of resources and promote the circular economy.	●	●				●	●		●		●	●					
Promote proximity and sustainable mobility.			●						●		●		●				
Promote social cohesion and seek equity.	●			●						●	●					●	
Promote and favour the Urban Economy.	●	●			●			●	●			●					
Guarantee access to housing.										●	●					●	
Lead and promote digital innovations.					●				●	●	●					●	
Improve intervention instruments and governance.				●							●	●				●	

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 730222

NBS DESCRIPTION

Type

Urban Garden Network

Scale

Small urban gardens throughout the city

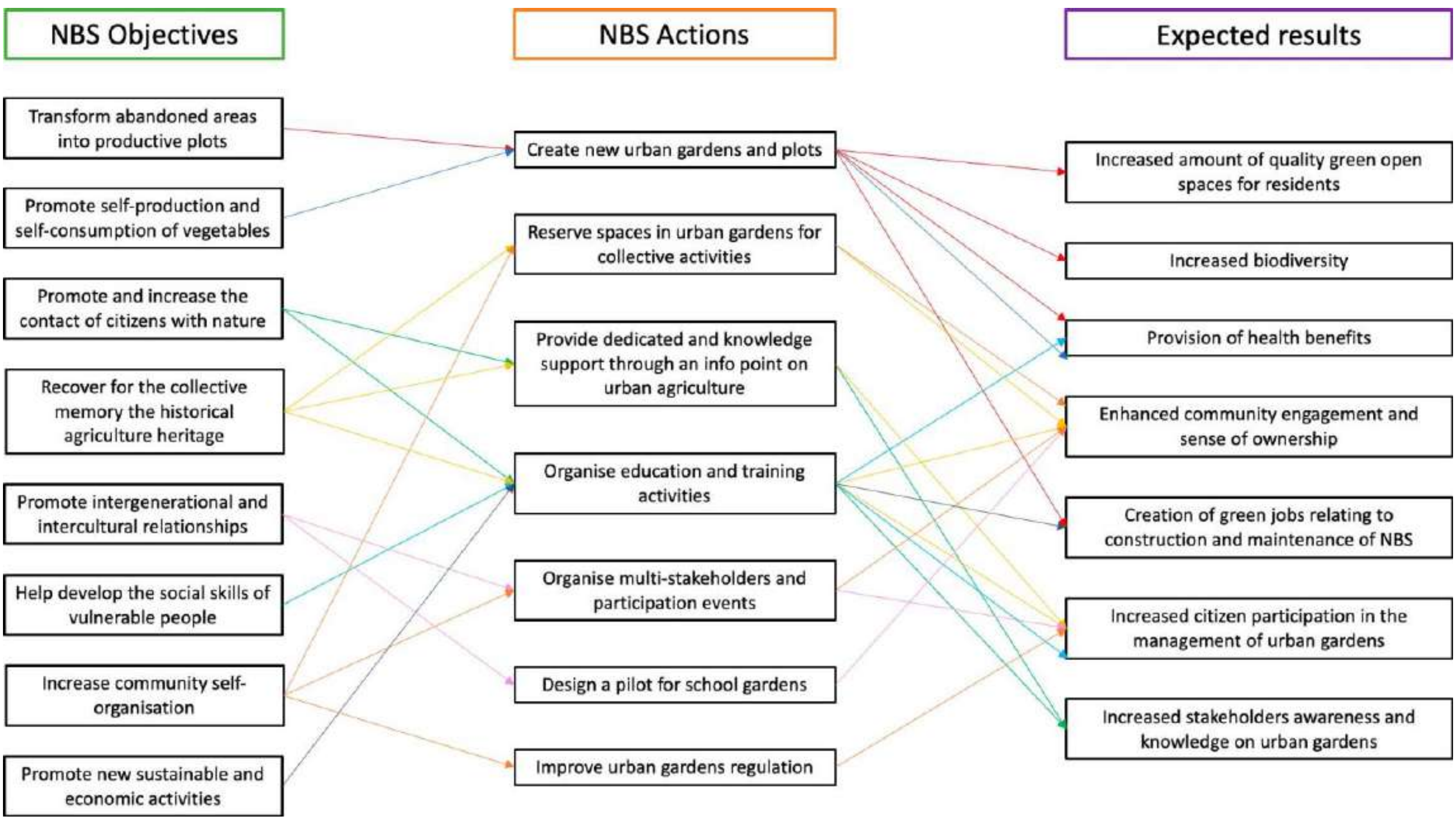
Context description

Build a network of urban gardens, enlarging the existing ones and creating new ones.

Process of design and implementation

The implantation of the municipal Urban Gardens started as an open participatory process to define the location of the plots. Citizens and associations were involved from the beginning, in a co-production process which selected the most suitable spaces for the new urban gardens, how they should be designed and which services needed to be provided.

A Coruña´s Theory of Change



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Assumptions, synergies and trade-offs

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Create new urban gardens and plots	Increased amount of quality green open spaces for residents	There are a lot of citizens waiting for a garden plot	Urban gardens can promote community engagement, by providing people with opportunities to form connections and friendships with others	
Create new urban gardens and plots	Increased biodiversity	Urban gardens connect fragmented habitats in the city and support urban fauna and flora	The perception of biodiversity can produce therapeutic effects improving human wellbeing	Possible cultivation of invasive / alien species if not controlled Potential Increase in allergic sensitivity and asthma rates
Create new urban gardens and plots	Creation of green jobs relating to construction and maintenance of NBS	Urban gardens can offer new opportunities and markets for local enterprises and SMEs		Bigger companies / multinational corporations might hoard the new market minimizing opportunities for local SMEs
Create new urban gardens and plots	Provision of health benefits	Neighbours will like to have a better access to fresh and healthy vegetables Neighbours will be in contact with nature and engage in moderate physical activity	Urban gardens can generate a sense of shared personal commitment to sustainability, enhancing community engagement and sense of ownership	Soil and water quality must be monitored to avoid food contamination.
Reserve spaces in urban gardens for collective activities	Enhanced community engagement and sense of ownership	Gardeners need common areas to establish social bonds and for a sense of community to be created	Social interactions will favour the green space's perceived quality	Potential risks associated to community gatherings (damaging crops, bbq starting a fire, etc). Liability issues.
Provide dedicated and knowledge support through an info point on urban agriculture	Increased stakeholders' awareness and knowledge on urban gardens	An info point will be a clear reference for citizens that might be interested in the topic but don't know which door to knock on.		Financing of this resource can be complicated as it implies different government areas (environment, education, etc.)
Organise education and training activities	Increased stakeholders' awareness and knowledge on urban gardens	Gardeners will improve their capacities on organic agriculture	Capacity building will increase citizens involvement and sense of attachment and ownership	
Organise multi-stakeholders and participation events	Enhanced community engagement and sense of ownership	The participatory process will favour social interactions and contribute to create a sense of community	The process will enable key stakeholders to meet each other and possibly start new projects together	
Organise multi-stakeholders and participation events	Increased citizen participation in the management of urban gardens	If citizens participate in the co-design of the gardens and the management model, they will feel more satisfied with the final results		
Design a pilot for school gardens	Creation of green jobs relating to construction and maintenance of NBS	Expanding existing school gardens and creating new ones will help generate new businesses and jobs.	The presence of an urban garden will increase the perceived quality of the school facilities	Bigger companies / multinational corporations might hoard the new market minimizing opportunities for local SMEs
Design a pilot for school gardens	Enhanced community engagement and sense of ownership	Contact with urban gardens since childhood will result in more attachment to the territory and green areas	Engagement of children will encourage their parents to get involved too	
Improve urban gardens regulation	Increased citizen participation in the management of urban gardens	A clearer regulation co-created with the gardeners will increase legitimacy		

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CODE	NAME	NBS expected result	Selection reasoning
PI1	Type of interaction with NBS	Increased amount of quality green open spaces for residents	Important to know how citizens interact with the NBS
PI2	Frequency of interaction with NBS	Increased amount of quality green open spaces for residents	Important to know how often citizens interact with the NBS
PI3	Duration of interaction with NBS	Increased amount of quality green open spaces for residents	Important to know for how long citizens interact with the NBS
PI4	Perceived quality of space	Increased amount of quality green open spaces for residents	Know the perceived quality of the urban gardens
ENV3	Air temperature change	Increased amount of quality green open spaces for residents	Influence on air temperature
ENV19	Inundation risk for critical urban infrastructures (probability)	Increased amount of quality green open spaces for residents	Know the flood risk of urban areas
ENV23	Public green space distribution	Increased amount of quality green open spaces for residents	Know the number of existing, modified and new urban gardens
ENV24	Recreational value of blue-green spaces	Increased amount of quality green open spaces for residents	Urban gardening as a leisure activity
ENV29	Supporting/increasing biodiversity conservation	Increased biodiversity of the area	Find out if there are more efforts to improve biodiversity
ENV35	Species diversity	Increased biodiversity of the area	Know the number of species currently in the urban gardens
ENV81	Soil sealing	Increased amount of quality green open spaces for residents	Contribution of urban gardens to reverting/preventing soil sealing
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	Increased amount of quality green open spaces for residents	Reduction of carbon emissions on food chain production (self-cultivated vs store-bought vegetables)
ENV41	Accessibility of greenspaces	Increased amount of quality green open spaces for residents	Accesibility to urban gardens is important for us
ENV59	Cultivated crops	Provision of health benefits	Relevant for urban gardens
ENV66	Air quality change	Increased amount of quality green open spaces for residents	Influence on air temperature
ENV84	Noise pollution reduction	Increased amount of quality green open spaces for residents	Know if green space is a noise barrier
HW11	Mental health and wellbeing	Provision of health benefits	Urban gardening as a therapeutical role
HW12	Enhanced physical activity	Provision of health benefits	Urban gardening as a moderate physical activity
HW16	Perceived restorativeness of public green space	Provision of health benefits	Not sure about what this means
HW1	Sustainable nutrition/adoption	Provision of health benefits	Impact of urban gardening on nutrition habits
HW13	Perceived chronic loneliness	Provision of health benefits	Hard to measure/access data
SC1	Bonding social capital	Enhanced community engagement and sense of ownership	Study how social relations inside of the same social groups function
SC2	Bridging social capital	Enhanced community engagement and sense of ownership	Study how social relations between different social groups function
SC4.1	Trust in community	Enhanced community engagement and sense of ownership	Verify if garden users have higher levels of trust
SC4.2	Solidarity between neighbours	Enhanced community engagement and sense of ownership	Verify if garden users are more solidary towards neighbors
SC4.3	Tolerance and respect	Enhanced community engagement and sense of ownership	Verify if garden users have higher levels of tolerance and respect (how to measure?)
SC9	Empowerment	Enhanced community engagement and sense of ownership	Verify if garden users feel more empowered

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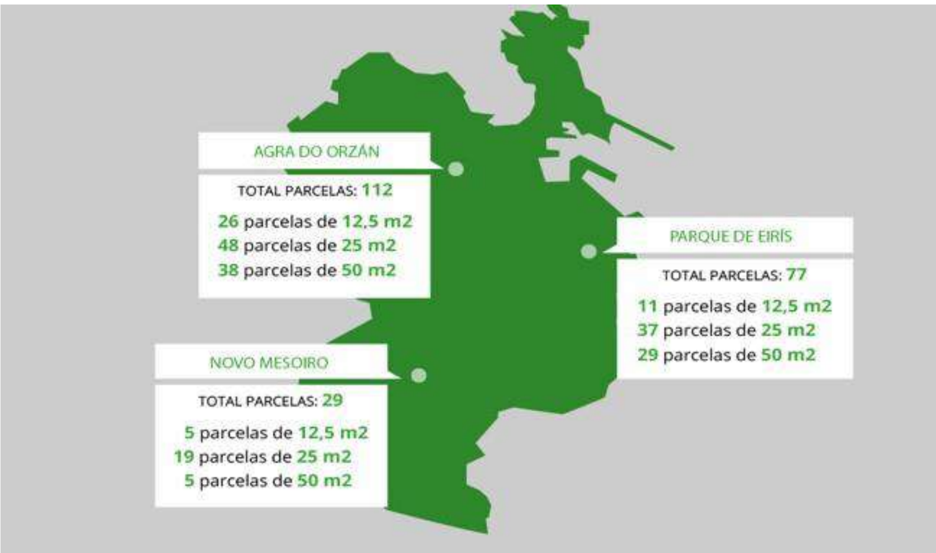
SC12	Pro-environmental behaviour	Enhanced community engagement and sense of ownership	Check if urban gardens promote this behaviour among their users
SC13	Connectedness to nature	Enhanced community engagement and sense of ownership	Check if urban gardens promote this connection among their users
ECO1	New Businesses 'attracted' or started and additional rates received	Creation of green jobs relating to construction and maintenance of NBS	Establish if there are new businesses since the creation of new urban gardens
ECO3	Net additional jobs created/enabled by NBS	Creation of green jobs relating to construction and maintenance of NBS	Verify the number of jobs created
ECO13	Net impact on public expenditure from NBS implementation	Creation of green jobs relating to construction and maintenance of NBS	Public expenditure costs of the NBS
PPG1	Diversity of stakeholders involved	Increased stakeholders awareness and knowledge on urban gardens	Verify if the involved stakeholders come from varied backgrounds
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	Increased stakeholders awareness and knowledge on urban gardens	Verify if under-represented members are involved
PPG3	Transparency of co-production	Increased citizen participation in the management of urban gardens	Evaluate the transparency of the processes
PPG4	Policies adopted to promote NBS	Increased citizen participation in the management of urban gardens	Check current policies to promote urban gardens
PPG5	Activation of public-private collaboration	Increased stakeholders awareness and knowledge on urban gardens	Verify if there are any public-private collaborations



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Available baseline in the city of A Coruña

CODE	NAME	Baseline data	Source (year)	Granularity	Periodicity
ENV3	Air temperature change	•	AEMET (2018)	City level	Every year
ENV19	Inundation risk for critical urban infrastructures (probability)	•	Galicia-Costa Hydrographic Demarcation (2018)	Neighbourhood level	Specific study
ENV23	Public green space distribution	•	A Coruña Green Infrastructure Strategy plan (2018)	Neighbourhood level	Specific study
ENV29	Supporting/increasing biodiversity conservation	•	A Coruña Green Infrastructure Strategy plan (2018)	Neighbourhood level	Specific study
ENV35	Species diversity	•	A Coruña Biodiversity Map (2017)	Neighbourhood level	Specific study
ENV81	Soil sealing	•	A Coruña Green Infrastructure Strategy plan (2018)	Neighbourhood level	Specific study
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	•	City's Strategy Against Climate Change (2010)	City level	Specific study
ENV41	Accessibility of greenspaces	•	City's Strategy Against Climate Change (2010)	City level	Specific study
ENV66	Air quality change	•	A Coruña Green Infrastructure Strategy plan (2018)	Neighbourhood level	Specific study
ENV84	Noise pollution reduction	•	Strategic Noise Map (2016)	Neighbourhood level	Specific study

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New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Baseline method	Connecting Nature method
PI1	Type of interaction with NBS		Questionnaire (ad hoc)
PI2	Frequency of interaction with NBS		Questionnaire (ad hoc)
PI3	Duration of interaction with NBS		Questionnaire (ad hoc)
PI4	Perceived quality of space		Questionnaire (ad hoc)
ENV3	Air temperature change	•	
ENV19	Inundation risk for critical urban infrastructures (probability)	•	
ENV23	Public green space distribution	•	
ENV24	Recreational value of blue-green spaces		Questionnaire (ad hoc)
ENV29	Supporting/increasing biodiversity conservation	•	
ENV35	Species diversity	•	
ENV81	Soil sealing	•	
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	•	
ENV41	Accessibility of greenspaces	•	Accesibility to urban gardens is important for us
ENV59	Cultivated crops		Questionnaire (ad hoc)
ENV66	Air quality change	•	
ENV84	Noise pollution reduction	•	
HW11	Mental health and wellbeing		General Health Questionnaire (GHQ-12) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997)
HW12	Enhanced physical activity		International Physical Activity Questionnaire (IPAQ)
HW16	Perceived restorativeness of public green space		Perceived Restorativeness Scale (the short, PRS - 11) (Pasini et al., 2014)
HW1	Sustainable nutrition/adoption		Adaptation from Environmental behaviors: Reducing emissions. (Brick & Lewis, 2016)
HW13	Perceived chronic loneliness		Three-Item Loneliness Scale (Hughes et al., 2004)
SC1	Bonding social capital		2 items measuring the presence type of connections, and respondent's perception of quality of interactions (Anucha et al., 2006)
SC2	Bridging social capital		2 items measuring the presence type of connections, and respondent's perception of quality of interactions (Anucha et al., 2006)
SC4.1	Trust in community		Trust and Solidarity" scale (SC-IQ) (Grootaert et al., 2004)
SC4.2	Solidarity between neighbours		Items measuring perception of solidarity from "Trust and Solidarity" scale (SC-IQ) (Grootaert et al., 2004)
SC4.3	Tolerance and respect		Neighbourhood Social Cohesion – 'Tolerance or Respect' Scale (Stafford et al., 2003)
SC9	Empowerment		"Empowerment and Political Action" (SC-IQ) (Grootaert et al., 2004)
SC12	Pro-environmental behaviour		Recurring Environmental Behavior Scale (Brick et al., 2017)
SC13	Connectedness to nature		Connectedness to nature scale (Mayer & Frantz, 2004)
ECO1	New Businesses 'attracted' or started and additional rates received		No. of new start-ups in 'close proximity' to NBS
ECO3	Net additional jobs created/enabled by NBS		Number change in Full Time Employment (FTEs) or the number of 'decent' jobs or jobs providing 'adequate livelihood'
ECO13	Net impact on public expenditure from NBS implementation		Implementation cost per unit of outsourced
PPG1	Diversity of stakeholders involved		MAP or Quintuple helix model
PPG2	Social equity: involvement of citizens from traditionally under-represented groups		Five-point Likert scale (Wendling et al., 2021)
PPG3	Transparency of co-production		Questionnaire (ad hoc)
PPG4	Policies adopted to promote NBS		Five-point Likert scale (Bosch et al., 2017

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PPG5	Activation of public-private collaboration	Measurement or count data for number of collaborations activated

Note. Some indicators will be measured with the same methods of the baseline

BUILDING BLOCK 5. INTEGRATING EVIDENCE INTO THE POLICY PROCESS

CODE	NAME	Documentary report	Visual chart	Spatial dashboard	Scientific partners	Economic sector	Higher political levels	Media	Citizens
PI1	Type of interaction with NBS	●			●	●	●		●
PI2	Frequency of interaction with NBS	●			●	●	●		●
PI3	Duration of interaction with NBS	●			●	●	●		●
PI4	Perceived quality of space	●			●	●	●		●
ENV3	Air temperature change	●	●	●		●	●		●
ENV19	Inundation risk for critical urban infrastructures (probability)	●	●	●		●	●		●
ENV23	Public green space distribution	●		●	●		●	●	●
ENV24	Recreational value of blue-green spaces	●		●	●		●	●	●
ENV29	Supporting/increasing biodiversity conservation	●		●	●		●	●	●
ENV35	Species diversity	●		●	●		●	●	●
ENV81	Soil sealing	●		●	●		●	●	●
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	●		●	●		●	●	●
ENV41	Accessibility of greenspaces	●		●	●				●
ENV59	Cultivated crops	●			●			●	●
ENV66	Air quality change	●	●	●	●		●	●	●
ENV84	Noise pollution reduction	●	●	●	●		●	●	●
HW11	Mental health and wellbeing	●			●		●	●	●
HW12	Enhanced physical activity	●			●		●	●	●
HW16	Perceived restorativeness of public green space	●			●		●	●	●
HW1	Sustainable nutrition/adoption	●			●		●	●	●
HW13	Perceived chronic loneliness	●			●		●	●	●
SC1	Bonding social capital	●			●				●
SC2	Bridging social capital	●			●				●
SC4.1	Trust in community	●			●				●
SC4.2	Solidarity between neighbours	●			●				●
SC4.3	Tolerance and respect	●			●				●
SC9	Empowerment	●			●				●
SC12	Pro-environmental behaviour	●			●		●		●
SC13	Connectedness to nature	●			●		●		●
ECO1	New Businesses 'attracted' or started and additional rates received	●	●		●	●	●	●	●

ECO3	Net additional jobs created/enabled by NBS	●	●		●	●	●	●	●
ECO13	Net impact on public expenditure from NBS implementation	●	●		●	●	●	●	●
PPG1	Diversity of stakeholders involved	●			●		●		●
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	●			●		●	●	●
PPG3	Transparency of co-production	●			●		●	●	●
PPG4	Policies adopted to promote NBS	●			●		●	●	●
PPG5	Activation of public-private collaboration	●			●	●	●	●	●

Local, regional or national strategies in which the city considers it would be interesting to include the results of the selected indicators

. A Coruña - Urban Agenda

. A Coruña - Green Infrastructure Strategy

. A Coruña - Biodiversity Strategy

Local, regional or national organizations to which the city considers it would be interesting to provide the results of the selected indicators to improve the decision-making process

. A Coruña City Council

. Deputación da Coruña (regional government)

. Xunta de Galicia (regional government)

. University of A Coruña

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Appendix VI. A Coruña´s Evaluation Results

Authors: Antonio Prieto González, María González Vázquez, Guillermo Leira Nogales (A Coruña), Adina Dumitru, David Tomé Lourido, Eva Peralbo Rubio (University of A Coruña)

This document presents the impact assessment results in the city of A Coruña (Spain). As reflected in the main text of the Deliverable, through its evaluation and monitoring plan, this Front-runner city has implemented one Nature-based Solution: Urban Gardens Network, on a scale of small exemplars, distributed throughout the city.

This appendix begins with the results of each of the indicators evaluated in the evaluation and monitoring plan are detailed, organized by indicator categories: Environmental, Primary, Health and wellbeing, Social cohesion, and Economic.

Due to the large amount of data collected, in addition to the results included in this document, for some indicators the consultation of two supplementary materials is indicated: 1) Maps with indicators at the exemplar level; 2) Survey on primary, health and social indicators

Finally, at the end of this appendix, a reflection on the main conclusions of the monitoring and evaluation process in Glasgow is presented.

IMPACT ASSESSMENT RESULTS

<u>Environmental indicators - CORE</u>

ENV3. Air temperature change

As shown in the graph below, both the values of daily insolation and annual radiation have been constantly increasing during the last 30 years, which, together with the average annual temperature, also with an upward trend, are an indicator of the consequences that climate change is having in the area. As for precipitation, trends are downward, which is also indicative of the new climate scenarios we are facing. Both the annual precipitation and the number of days of rainfall are clearly decreasing in the municipality.

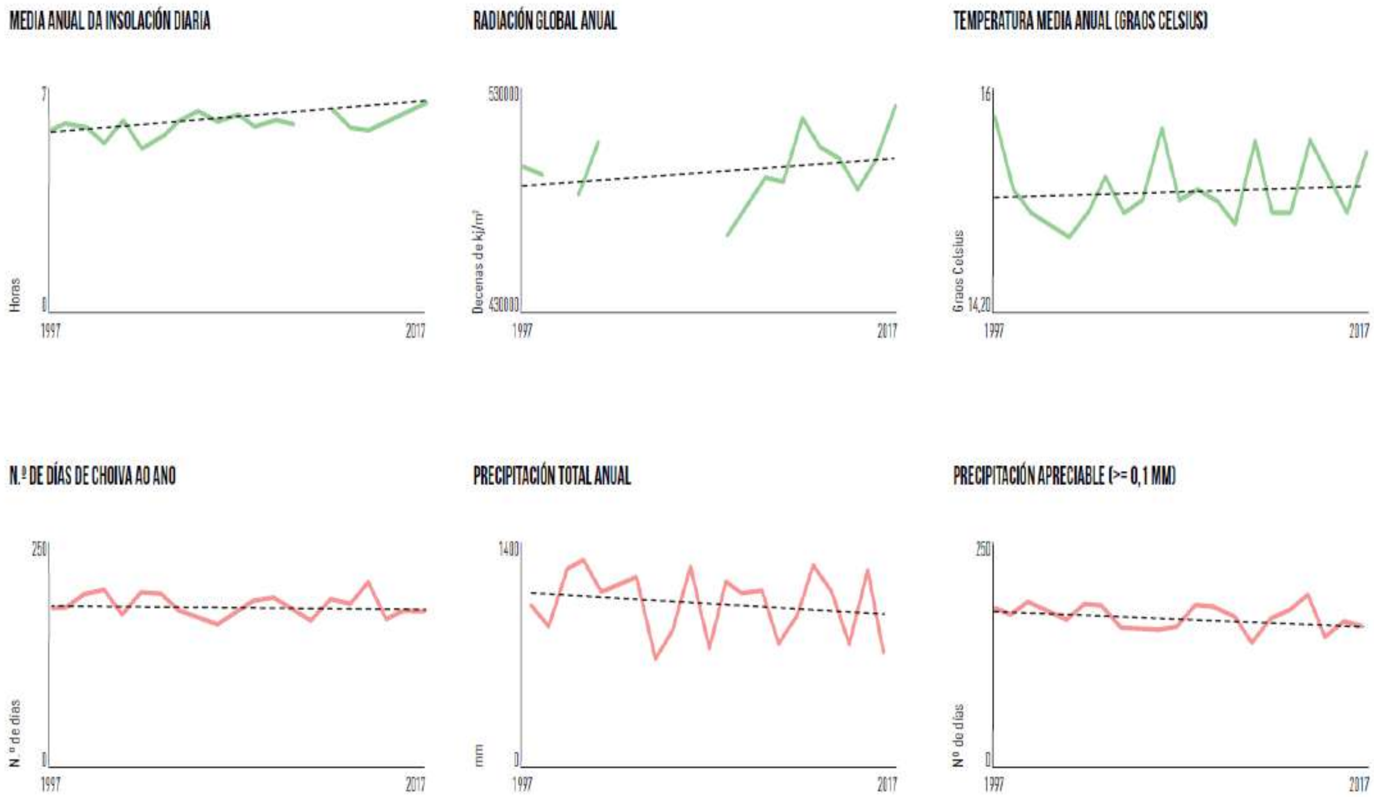


Figure 1. Evolution of data 1997-2017 on annual insolation, radiation, temperature, number of days of rainfall, annual precipitation and number of days with significant rainfall. Green Infrastructure Strategy, A Coruña City Council, 2018. (Data from AEMET)

ENV19. Inundation risk for critical urban infrastructures (probability)

Galicia-Costa Hydrographic Demarcation has undertaken modelling of flood risk with a new interactive tool called MERLIN. The data is accessible in GIS format in this link. A map of the city's flood risk is provided below:

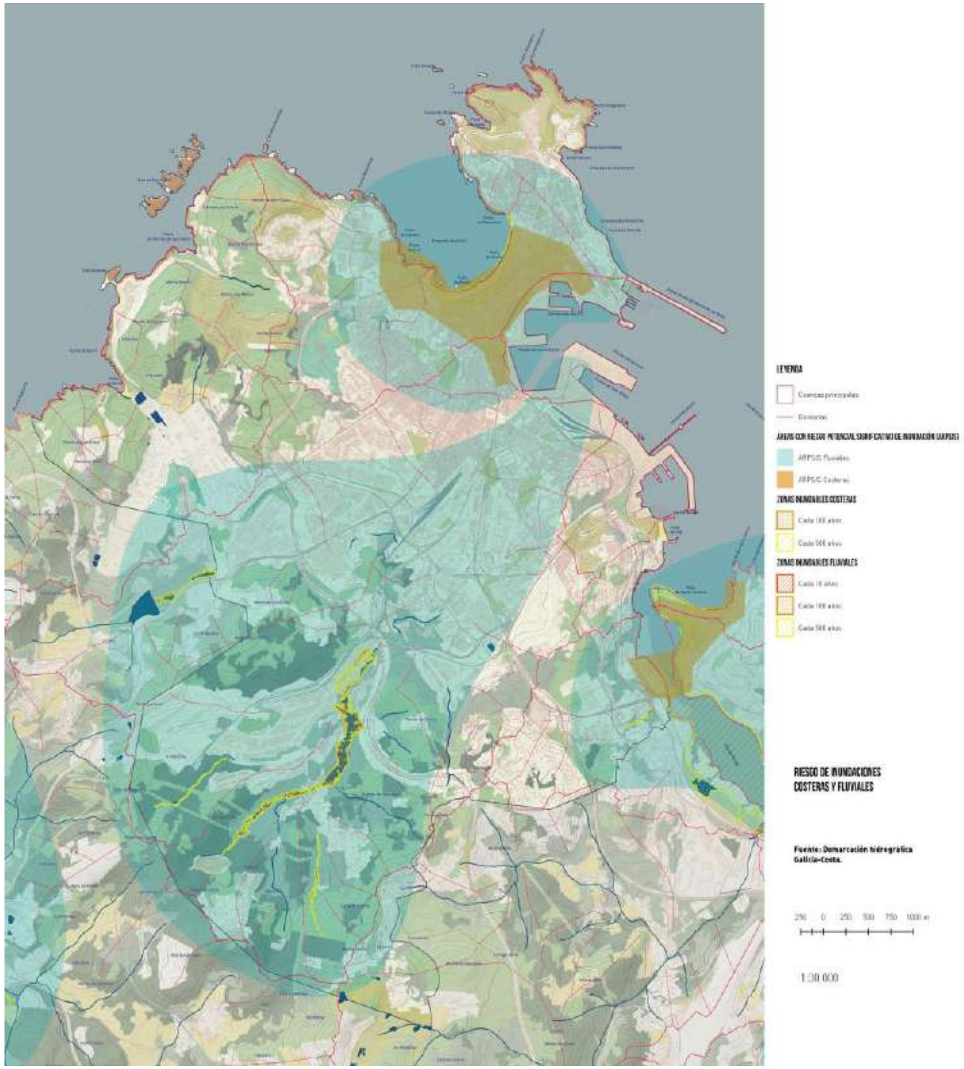


Figure 2. A Coruña flood risk map. Green Infrastructure Strategy, A Coruña City Council, 2018.

ENV23. Public green space distribution

The green spaces of the city have been mapped in 2018 for the Green Infrastructure Strategy plan, available in GIS format. There is an intention to make this map accessible to all citizens, but as of now, this GIS map is only available to municipal staff and maintenance companies. Only the static plan below is public.

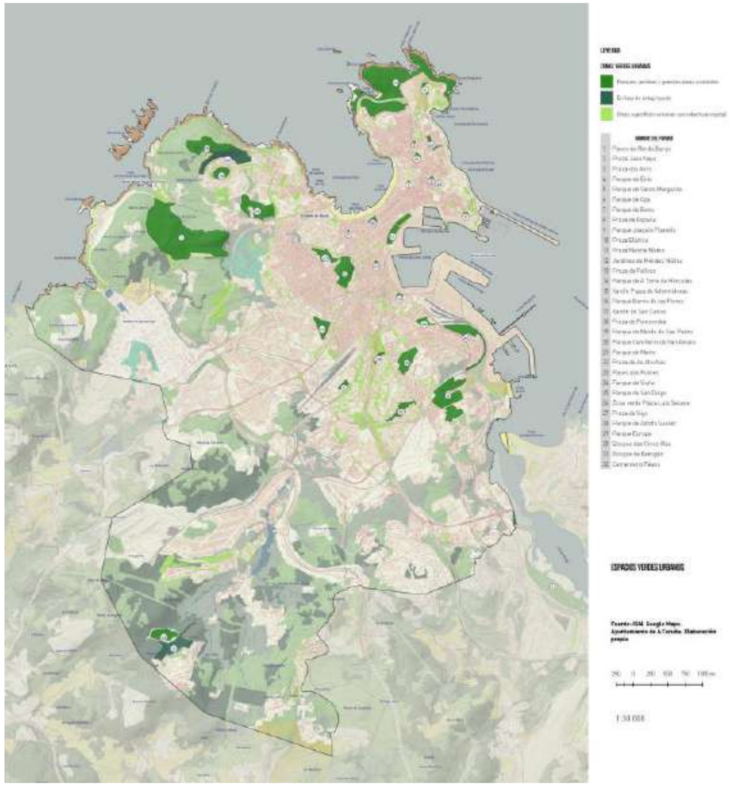


Figure 3. Green space distribution, Green Infrastructure Strategy, A Coruña City Council, 2018.

ENV29. Supporting/increasing biodiversity conservation

The municipality of Coruña is located in an area of high natural value. It is surrounded (although it is not part of it) by the biosphere reserve of the Mariñas Coruñesas and the Mandeo area. The city has two areas within a figure of environmental protection for its high heritage value, natural interest and biodiversity: the area of the islands of San Pedro and natural surroundings of the Tower of Hercules. There are also three protected singular trees or tree clusters.

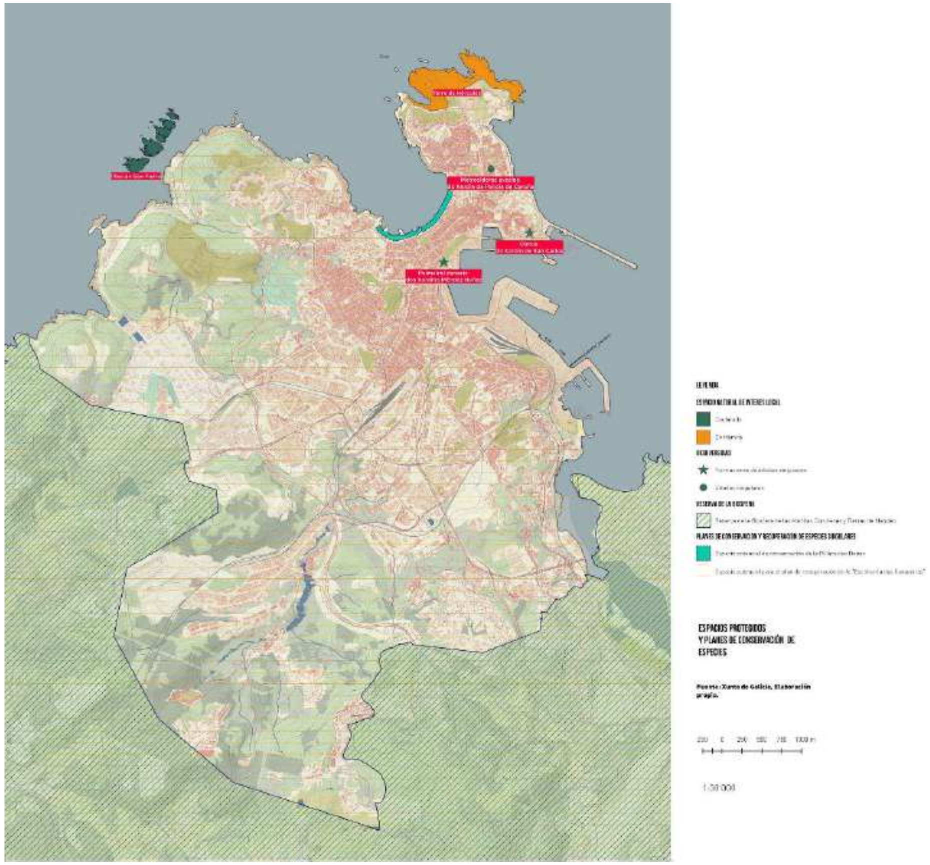


Figure 4. Protected Natural Areas of Local Interest, Green Infrastructure Strategy, A Coruña City Council, 2018.

In addition to these two areas, the data of the Biodiversity map elaborated in 2017 allows the identification of the areas of Feáns, Castro de Elviña and Ría do Burgo as areas of high natural value. Within the areas of medium natural value we find the Palavea and Mero hills, the Espinle hills (north and south), the Rañas forest, the Moitos stream and the outskirts of the Coruña and Oza harbors.

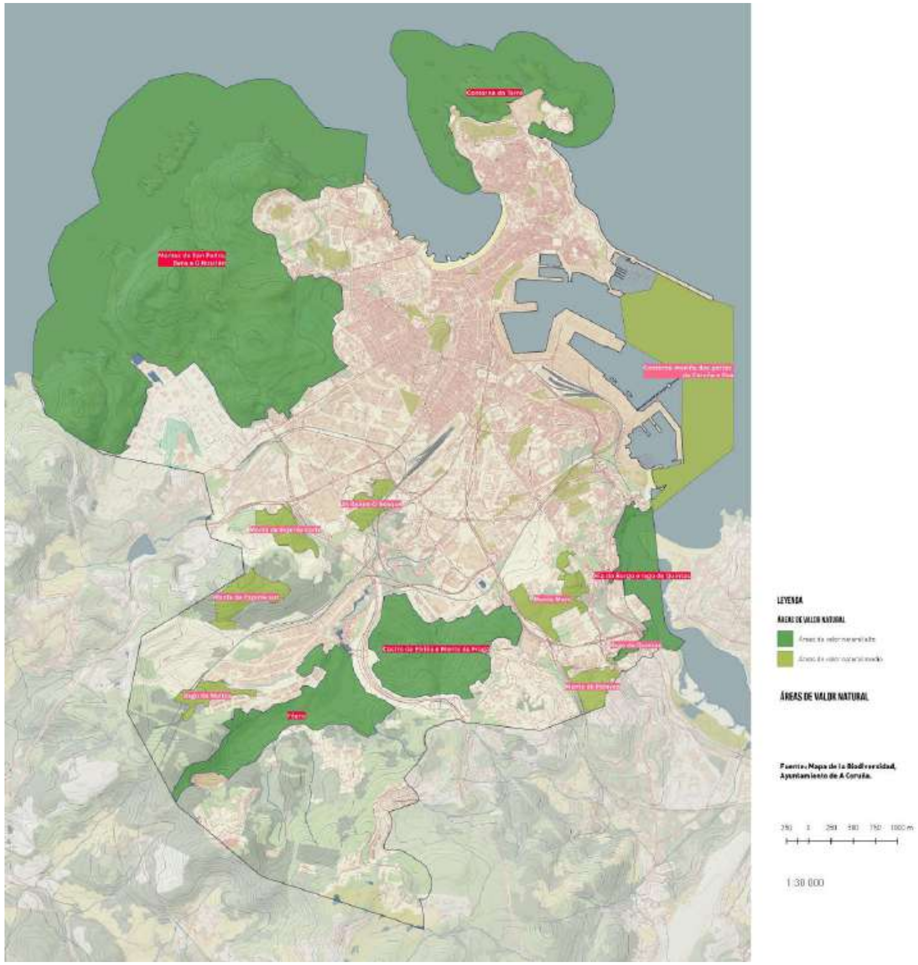


Figure 5. Areas of natural value, Green Infrastructure Strategy, A Coruña City Council, 2018.

The map below shows the ecological integrity of the different natural spaces, considering the risk they face due to their exposure to noise and environmental pollution.

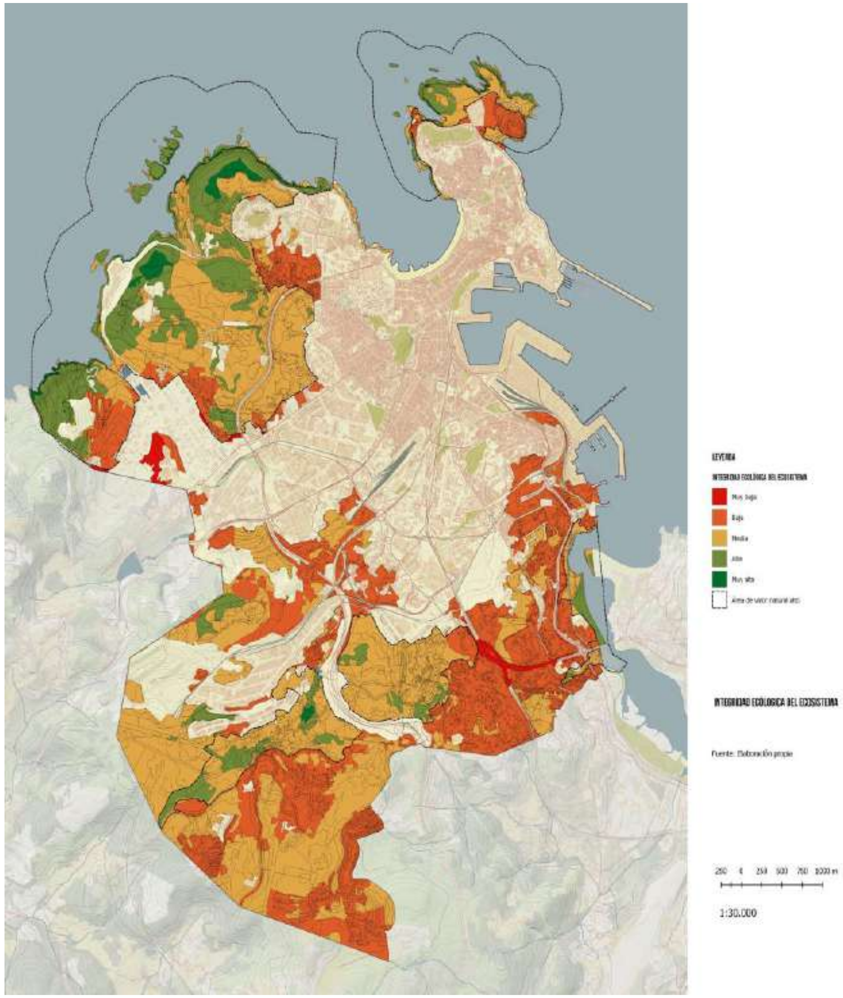


Figure 6. Ecological integrity of the ecosystems, Green Infrastructure Strategy, A Coruña City Council, 2018.

ENV35. Species diversity

The species present in the city have been mapped in 2017 for the city's biodiversity map. The city was divided into a 1x1km grid so the species observed were assigned to the correspondent area. A total of 42725 registries were recorded, corresponding to a total of 3279 species.

Table 1. Species Diversity – total number of species,
A Coruña Biodiversity Map, A Coruña City Council, 2017.

Present species	
Native algae	398
Non-native algae	2
Amphibians	13
Arachnids	59
Native birds	306
Non-native birds	20
Bryophytes	8
Crustaceans	46
Fungi	137
Hepatic	4
Native insects	663
Non-native insects	3
Other invertebrates	211
Lyches	35
Native mammals	50
Non-native mammals	7
Mollusks	140
Native plants	506
Non-native plants	530
Native fish	122
Non-native fish	4
Native Reptiles	13
Non-native Reptiles	2
TOTAL	**3,279**

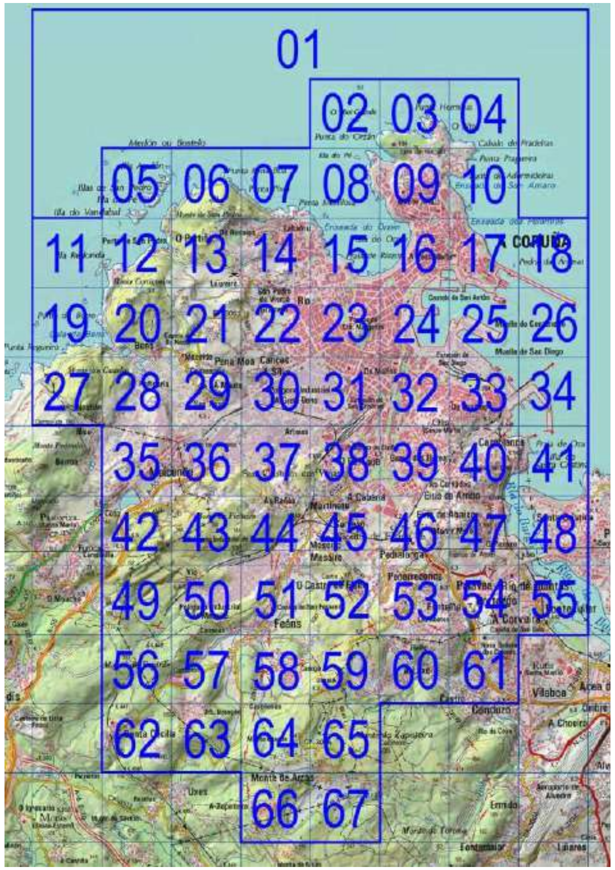


Figure 7. Area of study, with 66 1x1-km-UTM squares, plus the maritime zone at the north of the city, numbered correlatively from north to south and from west to east, A Coruña Biodiversity Map, A Coruña City Council, 2017.

Table 2. Species Diversity – number of species per grid area, A Coruña Biodiversity Map, A Coruña City Council, 2017.

Grid/area		Number of species
Sea area:		
01	*"Mar de María Antonia"*	*262*
Land area:		
02	*O Boi e As Eiras*	*116*
03	*A Torre*	*684*
04	*O Cabalo de Pragueira*	*173*
05	*Illas de San Pedro*	*235*
06	*A Zambela e monte de San Pedro*	*478*
07	*Elevador de San Pedro*	*171*
08	*Illa do Pé e As Amorosas*	*142*
09	*Monte Alto*	*633*
10	*Adormideiras e Santo Amaro*	*322*
11	*Illa Redonda oeste*	*100*
12	*O Portiño (mar)*	*281*
13	*O Portiño (terra) e subida a Visma*	*253*
14	*Labañou e Visma*	*220*
15	*San Roque de Fora e Riazor*	*413*
16	*Orzán e Pescadería*	*338*
17	*Cidade Vella*	*398*
18	*Dique Barrié de la Maza (centro)*	*109*
19	*Punta do Burro e Furna do Navío*	*127*
20	*Monte Cortigueiro e Bens aldea*	*188*
21	*Parque de Bens*	*292*
22	*Agramela*	*212*
23	*Santa Margarida e Cidade Xardín*	*469*
24	*Linares Rivas e porto (interior)*	*465*

25	*Castelo de Santo Antón e O Centenario*	*327*
26	*Dique Barrié de la Maza (punta)*	*153*
27	*Monte dos Castelos e Nostián (aldea)*	*151*
28	*Refinería de REPSOL (oeste)*	*116*
29	*A Moura e refinería de REPSOL (leste)*	*99*
30	*Agrela e A Silva*	*148*
31	*Os Mallos e A Sardiñeira*	*219*
32	*Monelos*	*292*
33	*Os Castros e San Diego*	*209*
34	*Peirao de Oza*	*88*
35	*Meicende*	*139*
36	*ALCOA*	*44*
37	*O Bosque e Marineda*	*150*
38	*O Birloque*	*262*
39	*Barrio das Flores e Matogrande*	*240*
40	*Parque de Eirís e Casablanca*	*280*
41	*Praia de Oza e baía de Santa Cristina*	*372*
42	*Encoro de Meicende e rego da Furoca*	*174*
43	*Monte da Fieiteira*	*93*
44	*As Rañas e PO.CO.MA.CO (norte)*	*165*
45	*Someso e Campus de Elviña*	*275*
46	*San Vicente de Elviña e Ofimático*	*207*
47	*Monte Mero e As Xuvias*	*170*
48	*Santa Cristina e ponte da Pasaxe*	*195*
49	*Monte de Vío*	*109*
50	*Vío e Novo Mesoiro*	*287*
51	*Feáns e rego de Campos*	*401*
52	*Castro de Elviña*	*552*
53	*Monte da Fraga e Penarredonda*	*451*

54	*Palavea e o Portádego*	*321*
55	*Río de Quintas e Fonteculler*	*569*
56	*Monte de Espinle*	*91*
57	*Cemiterio de Feáns*	*255*
58	*Urbanización Obradoiro*	*195*
59	*Urbanización Ultreia*	*166*
60	*A Laxe*	*149*
61	*Conduzo e Rutis (oeste)*	*209*
62	*Santa Cecilia*	*96*
63	*Urbanización Breogán*	*171*
64	*Monte Grande e Castiñeiras*	*127*
65	*Monte da Zapateira*	*172*
66	*Urbanización A Zapateira*	*162*
67	*Monte de Arcas e campo de golf*	*103*
Other areas:		
A	*Concello de Arteixo (outside the study area)*	*650*
B	*Ría do Burgo (unspecified if it is inside or outside the study area)*	*140*
C	*Concello de Culleredo (out of the study area)*	*165*
O	*Concello de Oleiros (out of the study area)*	*675*
R	*Ría da Coruña (unspecified if it is inside or outside the study area)*	*121*
X	*Concello da Coruña (not located in a grid)*	*79*
UTM 10x10 km grid:		
NH49		*212*
NH59		*154*
NJ40		*408*
NJ50		*136*
TOTAL		**3279**

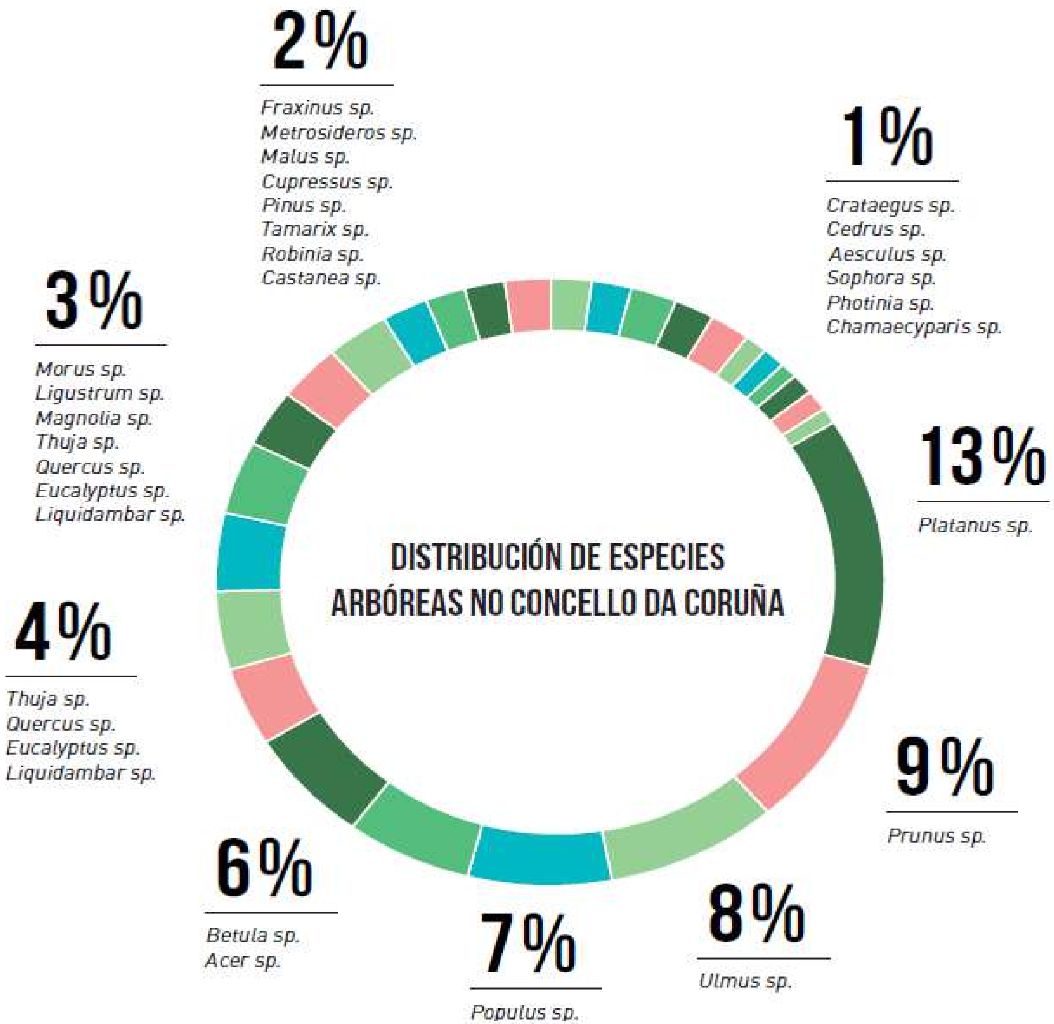


Figure 8. Diversity of tree species – tree species with over a 1% presence over the total, Green Infrastructure Strategy, A Coruña City Council, 2018.

ENV81. Soil sealing

The percentage of green spaces and naturalized surfaces reaches 55% of the area of the municipality. The definition of the predominant coverages inside the natural environment is calculated wit data from the Spanish Information System on the Occupation of Land (SIOSE) at scale 1:25000 (data from 2014).

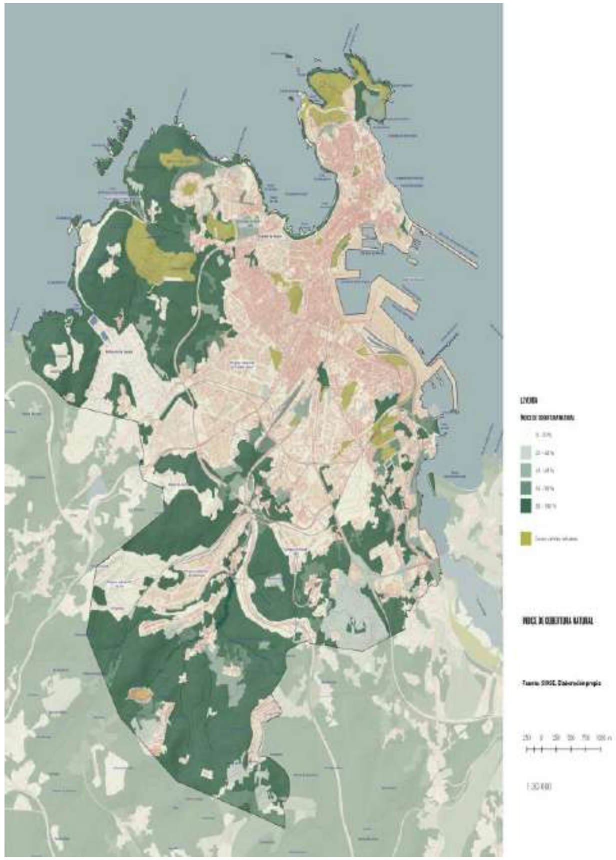
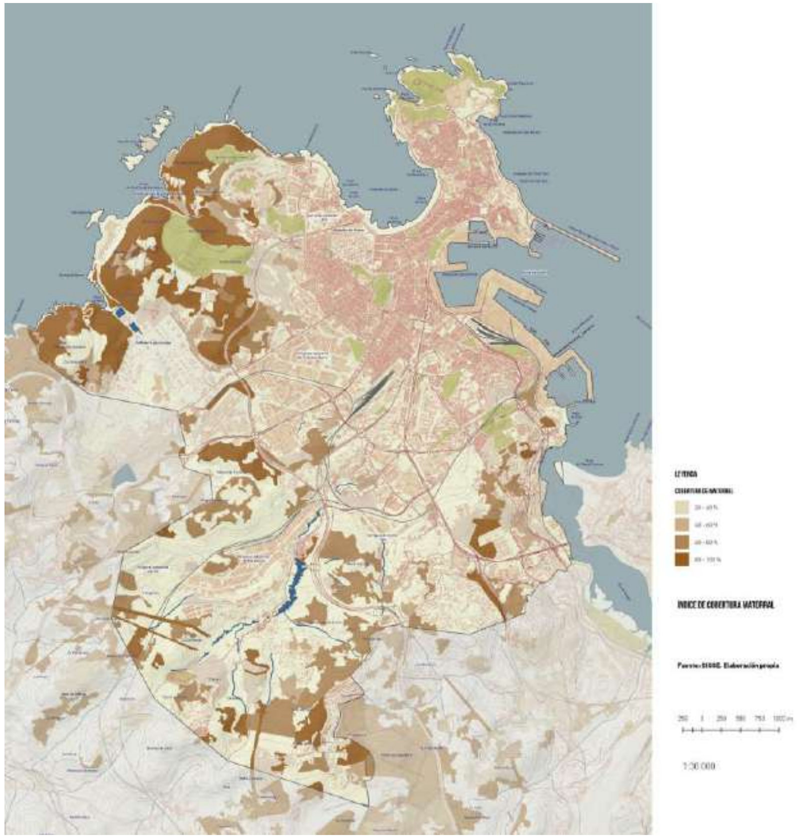


Figure 9. Index of natural coverage, Green Infrastructure Strategy, A Coruña City Council, 2018.

Figure 10. Index of forestal coverage, Green Infrastructure Strategy, A Coruña City Council, 2018.

Around 45% of the area of the municipality has a high level of natural coverage. Within this coverage we distinguish the forest coverage, shrublands, herbaceous, pastures and meadows, and finally urban parks and green areas. Regarding the forest cover, the wood masses of the municipality are in clear regression and, at present, account for 18% of the total natural coverage, and are composed predominantly of pine and eucalyptus trees, which account for more than 50% of the entire forest mass. In addition, this forest mass is concentrated in the area around Feáns. The shrublands are more widely distributed throughout the municipality than forestry and account for almost half of the green area, although there is a significant concentration in the axis between the San Pedro and Castelos hills.



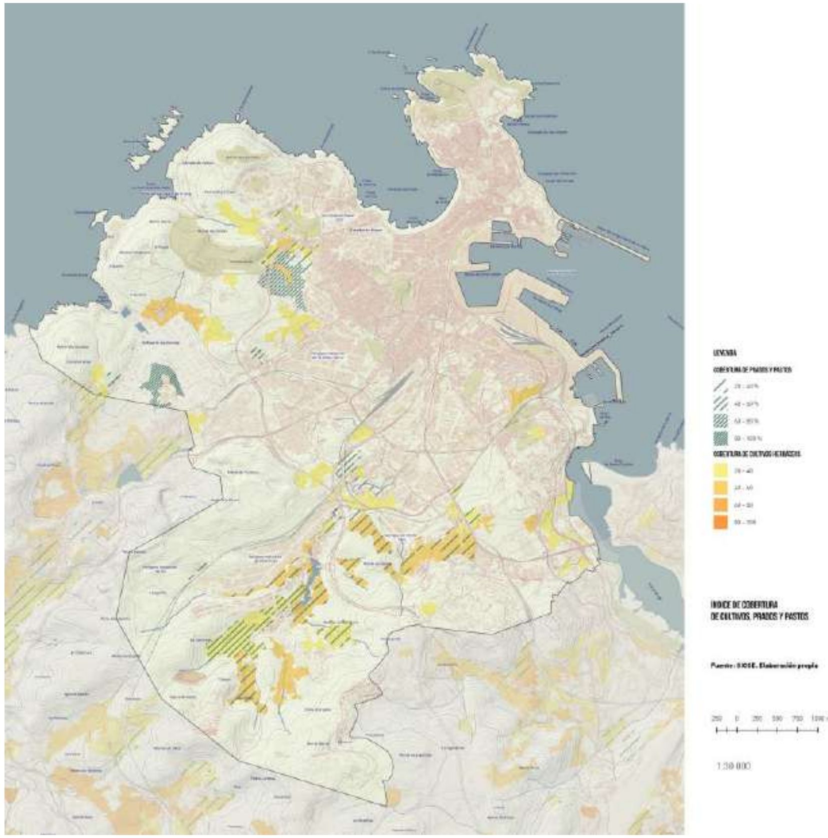


Figure 10 (left). Index of shrubland coverage, Green Infrastructure Strategy, A Coruña City Council, 2018.
Figure 11 (right).Index of pastures, meadows and herbaceous crops coverage, Green Infrastructure Strategy, A Coruña City Council, 2018.

Environmental indicators - FEATURE

ENV1. Carbon storage OR carbon sequestration in vegetation/soil

The city's Strategy Against Climate Change includes an calculation of the potential of the vegetable covered surfaces and soils to capture CO2, taking into account the percentage of crop areas, grass, forest surfaces and built areas and the different indexes for each of them. This results in an estimated carbon sequestration potential of 10.156,34 TCO2e/year.

Figure 12. Potential of carbon sequestration in A Coruña by type of vegetation coverage *(A Coruña's Strategy Against Climate Change, p. 13)*

ENV41. Accessibility of greenspaces

An assessment of the accessibility to green spaces was undertaken as part of the Green Infrastructure Strategy plan. In order to assess accessibility to green spaces, the following indicators defined by the Platform for Sustainable Urban Models CAT- MED were used:
- Between 1000 and 5000 m2 of surface area: 300 meters of distance.
- Between 5,000 and 10,000 m2 of surface area: 500 meters of distance.
- More than 1 hectare of surface area: 900 meters of distance.

The natural spaces of the municipality which present a percentage of natural coverage of at least 90% were considered (cliff areas, beaches, large periurban forest masses and green areas). With the CAT-MED criteria, it is concluded that the entire population of the municipality is within established CAT-MED minimum ranges. Therefore, enhancement coefficients were applied to these areas, classifying the different zones as optimal, good or improvable, depending on their accessibility.

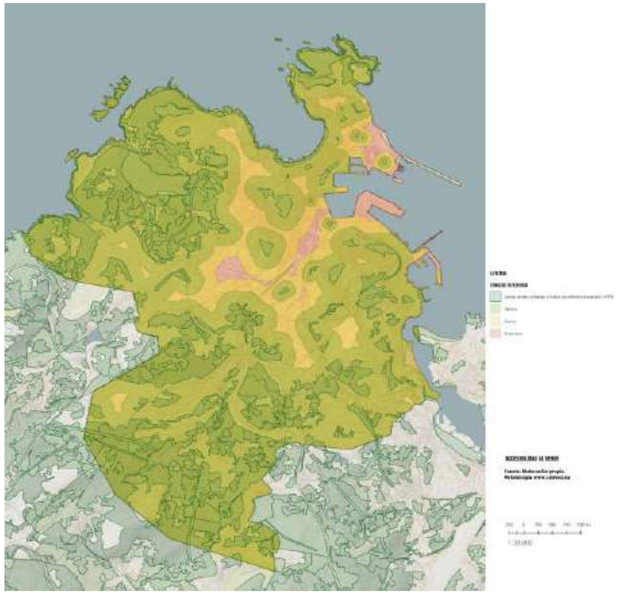


Figure 12. Accessibility to Green Space, Green Infrastructure Strategy, A Coruña City Council, 2018. (Dark green: green spaces; Light green: optimal accessibility; Yellow: good accessibility; Red: improvable accessibility)

ENV66. Air quality change

The Green Infraestructure Plan includes a contamination risk assessment which is based on the dispersion data available at the City Council of A Coruña and accessible to all citizens in this webpage. The following pollutants were selected for this analysis:

- SO2
- NO2
- Benzene
- CO
- NH3
- PM10 and PM2.5

Pollution in the municipality seems to be mainly associated with road traffic, as well as industrial and port activity.
The data provided is at the city level, to see the data at the exemplar level (Urbans garden network) see supplementary material 1.

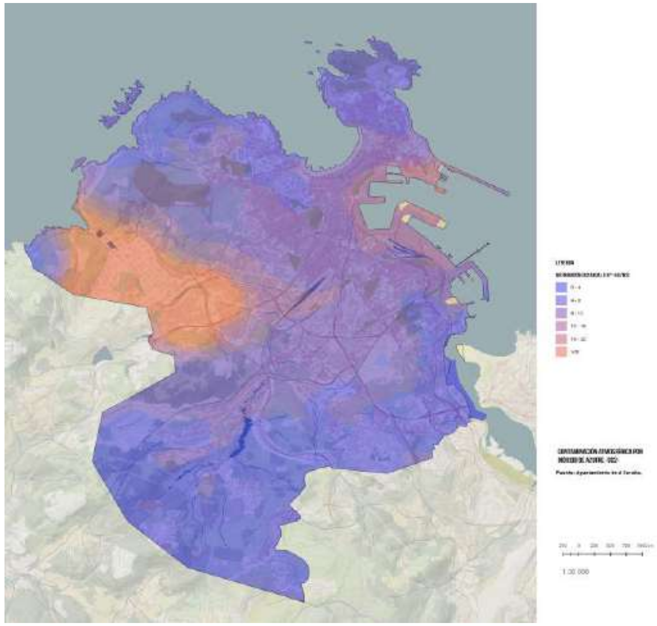
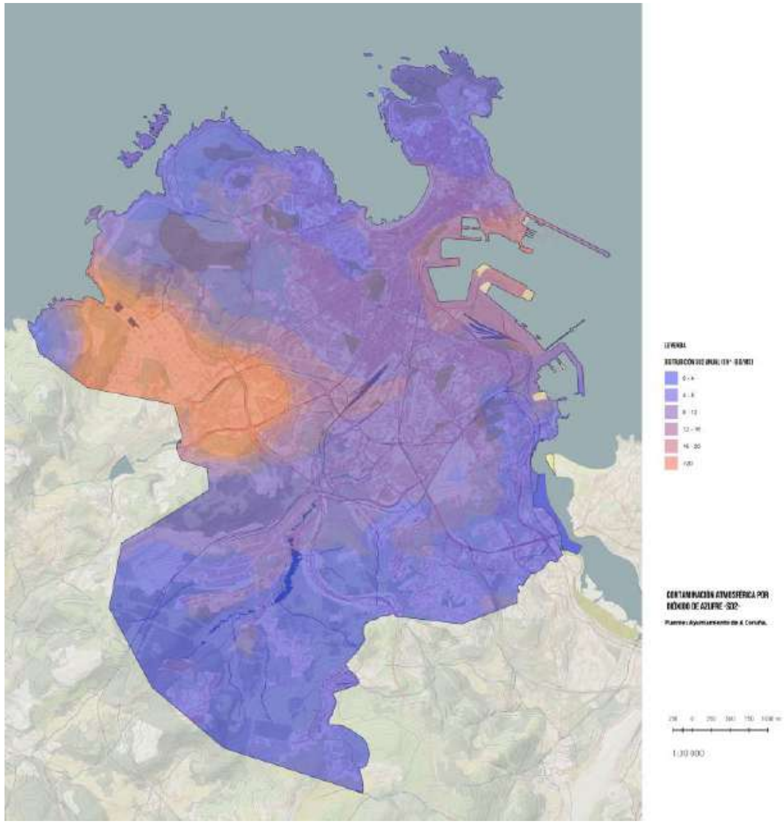


Figure 13. SO2 levels, Green Infrastructure Strategy, A Coruña City Council, 2018.

SO2 is mainly produced to the west of the municipality in the industrial area and affects its entire perimeter. The sulfur dioxide (SO2) is an important primary pollutant. It is a colorless, non-flammable gas, with a strong and irritating odor. Its half-life in the atmosphere is short, from 2 to 4 days, and it is one of those responsible for the acid rain phenomenon. High SO2 concentrations cause irritation of the eyes, affect the respiratory system and aggravate existing respiratory and cardiovascular diseases.



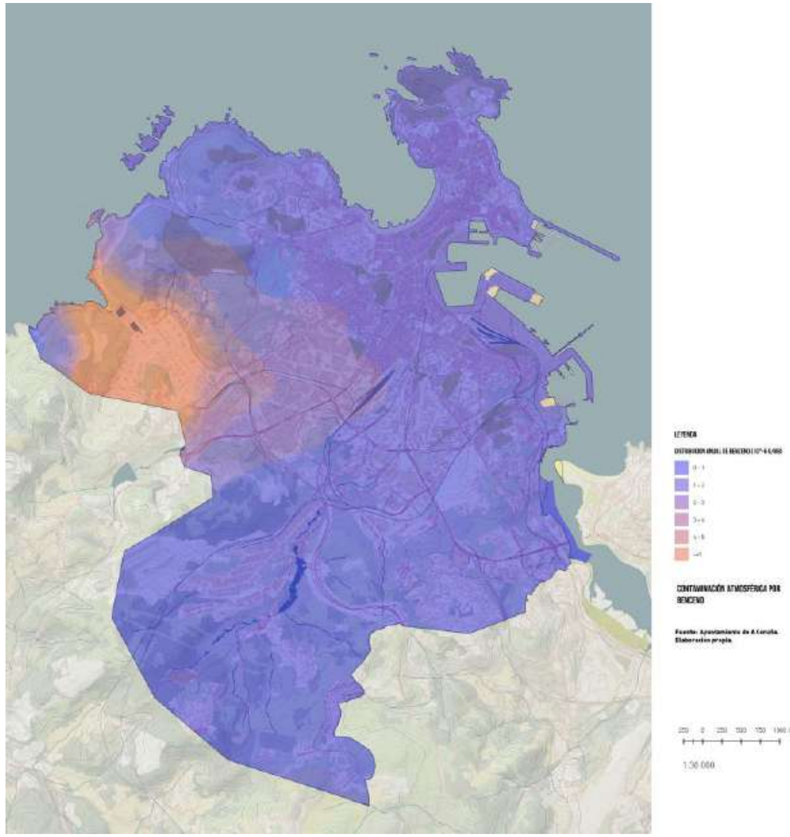


Figure 14 (left). NO2 levels, Green Infrastructure Strategy, A Coruña City Council, 2018.
Figure 15 (right). Benzene (C6H6) levels, Green Infrastructure Strategy, A Coruña City Council, 2018.

NO2 is the main source of NO oxidation. Its effects on human health are inflammation of the airways and affections to the liver, spleen or immune system which, in turn, causes pulmonary infections and respiratory insufficiencies. In addition, it produces adverse effects on the environment and acidification processes can affect buildings. Finally, it acts as a precursor in the reactions that produce tropospheric ozone, which is very harmful to health. The concentration of NO2 in the municipality is again associated with the industrial area of Grela-Bens and road traffic, especially in high-capacity roads such as Alfonso Molina, and affects the surroundings of these major sources.

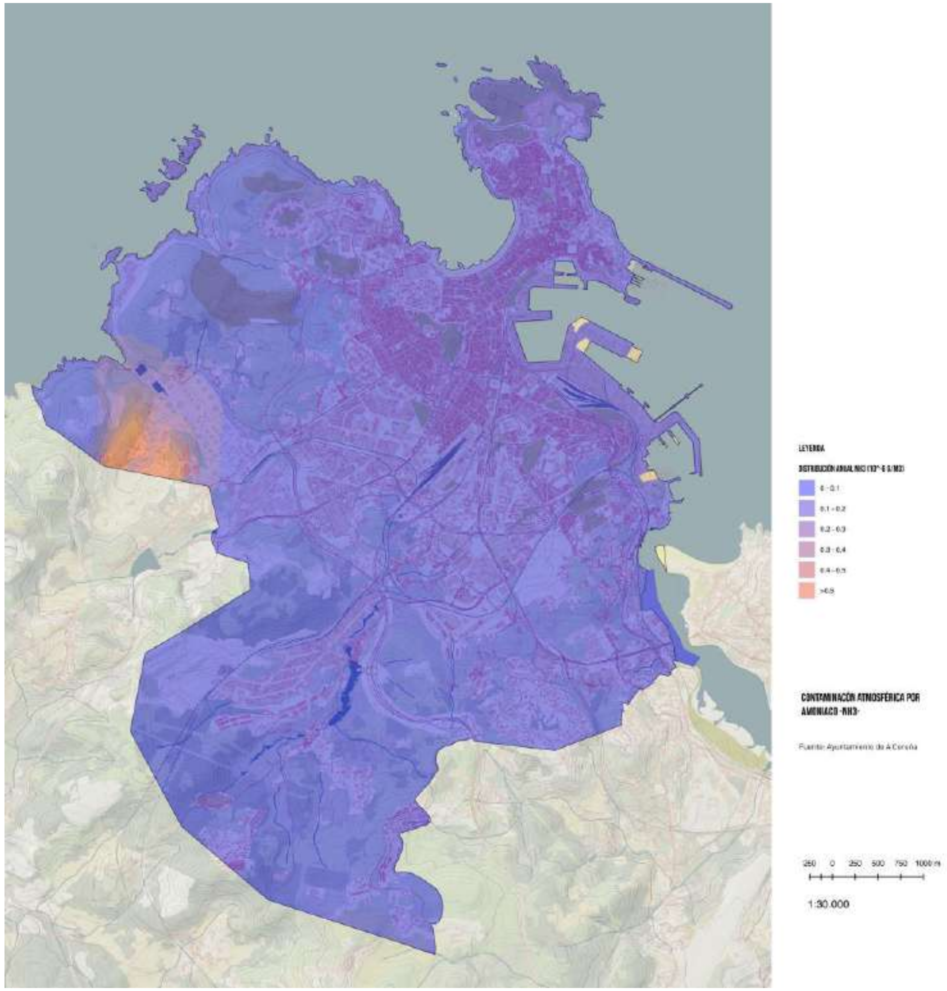


Figure 16. NH3 levels, Green Infrastructure Strategy, A Coruña City Council, 2018

Benzene and NH3 contamination is mainly confined to the refinery and affects its closest surroundings.

Benzene is a volatile organic compound (VOC), an organic substance that contains carbon and evaporates at room temperature. VOCs are compounds whose effects on humans are related to the type of substance, time, exposure conditions and other individual factors of the exposed person. The mildest and most immediate consequences are irritation of the eyes, nose or throat, but there are other more serious consequences that manifest themselves in the long term; for example, it is considered to be a precursor of cancer or aplastic anaemia. In addition, they contribute decisively to the formation of photochemical smog or toxic fog.

NH3 is considered an acidifying gas that can cause great damage to natural ecosystems sensitive to acidification and which, when reacting with NOx and SO2, forms ammonium sulphate and ammonium nitrate particles. Ammonia can cause skin, ear and respiratory diseases.

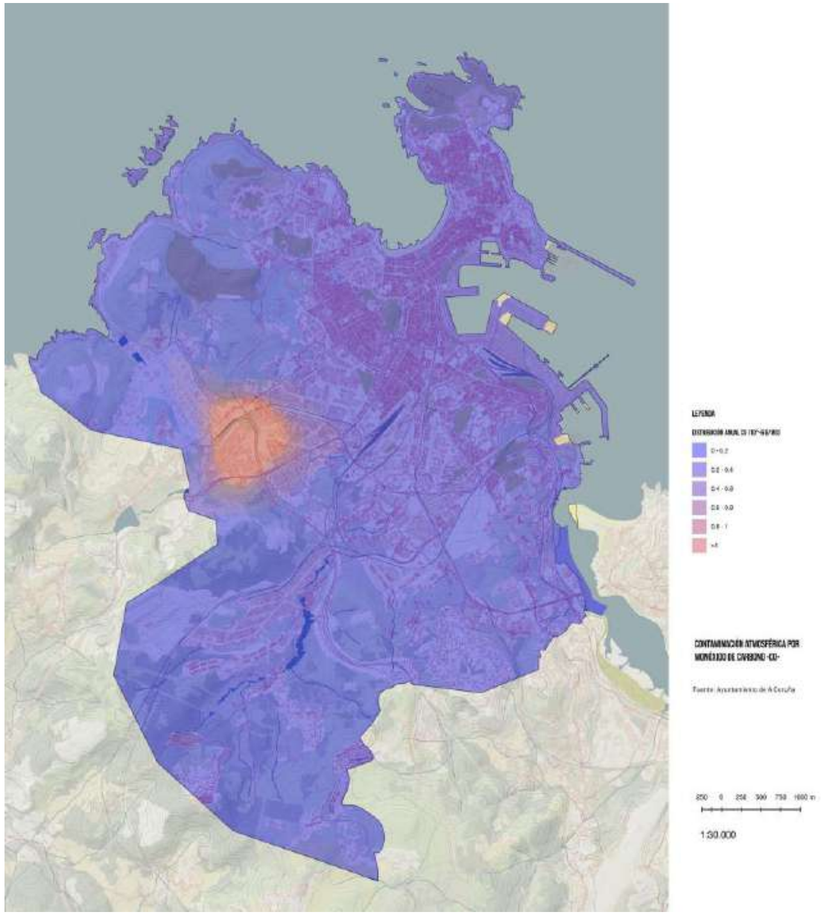
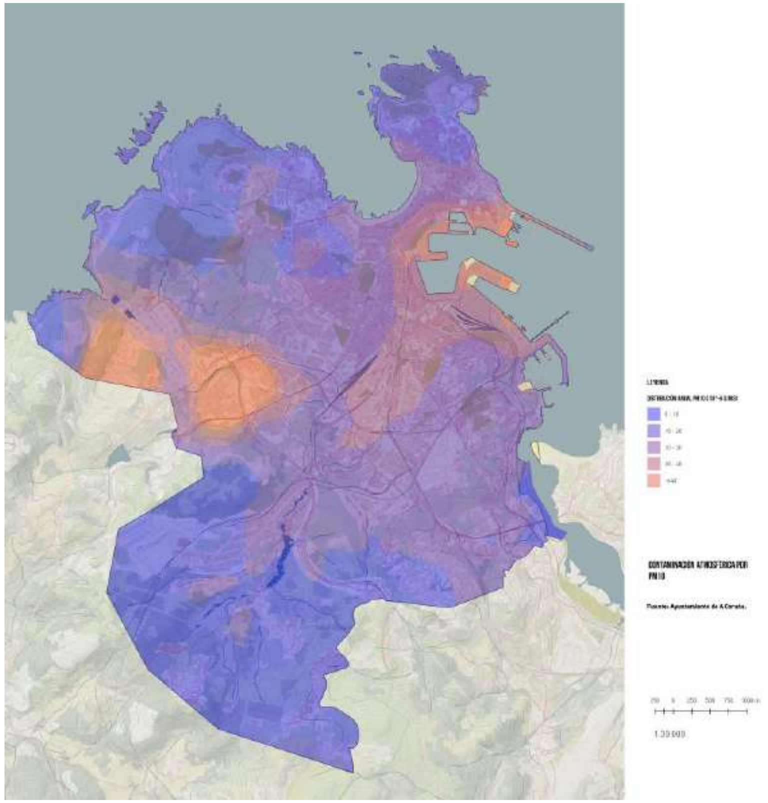


Figure 16. –C= levels, Green Infrastructure Strategy, A Coruña City Council, 2018

CO is a frequent compound in the polluted urban atmosphere. Formed by incomplete combustion processes, it is highly harmful to health if it reaches high concentrations, since it prevents the correct oxidation of organic acids. It is an indicator of traffic intensity, although in this case the greatest contribution comes from the industrial sector.



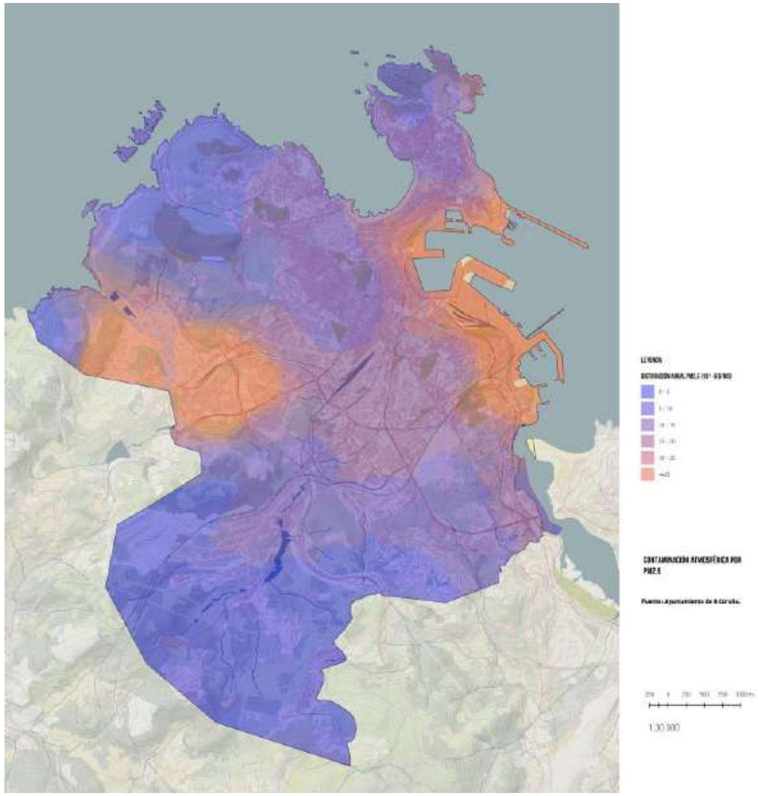
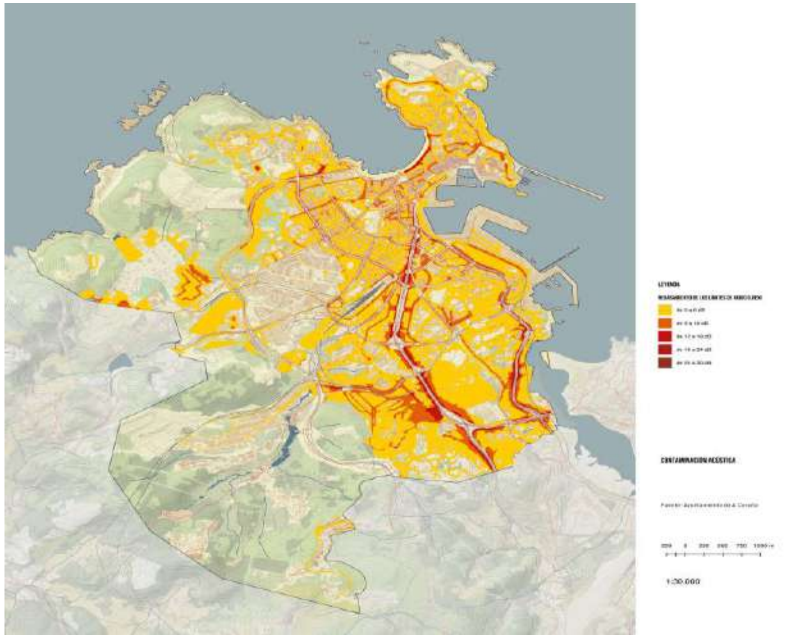


Figure 17 (left). PM10 levels, Green Infrastructure Strategy, A Coruña City Council, 2018
Figure 18 (right). PM2.5 levels, Green Infrastructure Strategy, A Coruña City Council, 2018

Finally, with regard to PM particulate matter (PM10 and PM2.5), PM10 particles can penetrate into the lower respiratory tract and PM2.5 particles can penetrate into the gas exchange zones of the lungs. This is the most serious problem in our cities due to its incidence for the respiratory tract and lungs. Primary particles are emitted directly by the source, generally by fires, construction sites, chimneys or non-paved roads. Secondary particles, such as iron dioxide and nitrogen oxides, are formed in chemical reactions and are emitted by power plants, industries and automobiles, and constitute the majority of fine particle pollution (PM2.5). In A Coruña, the concentration of PM particles is associated with the port, the refinery, the aluminium industry and the main roads. There are large areas in the municipality affected by this type of pollution: the territory of Nostián and A Artística, and the immediate vicinity of the port (San Diego, Os Castros, Casabranca, Oza...), although in the case of PM10 it covers a wider area.

ENV84. Noise pollution reduction

A Coruña City Council has a 2017 Action Plan Against Noise, based on the Strategic Noise Map prepared in 2016 (accessible through this link), and whose objective is to improve the acoustic quality of the city council. In the studies elaborated for the Noise Map, it was established that 25% of the population of the municipality is subjected to noise levels (Ln) above 55 dB(A), objective value of acoustic quality for the night period. Noise has effects on the organism beyond hearing loss. It can cause psychological disorders such as irritability and aggressiveness, stress and produce physiological effects such as increased heart rate, blood pressure and respiratory rate. The determination of the health risk zones has been carried out using data from the city council and considers the noise pollution regulations and the conflict zones defined in the noise map. The highest noise levels are associated with road traffic, rail traffic and industrial activity. The recommended limits are exceeded in practically all the urbanized area of the municipality and the situation goes worse as we get closer to communication routes such as Avenida da Mariña, Avenida do Alcalde Alfonso Molina, as well as next to large industrial infrastructures. To see the data at the exemplar level (Urbans garden network) see supplementary material 1.



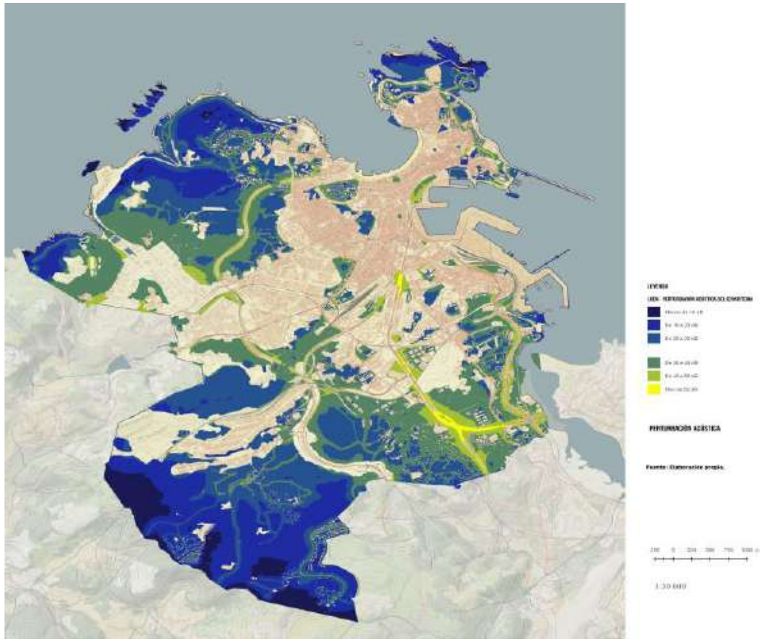


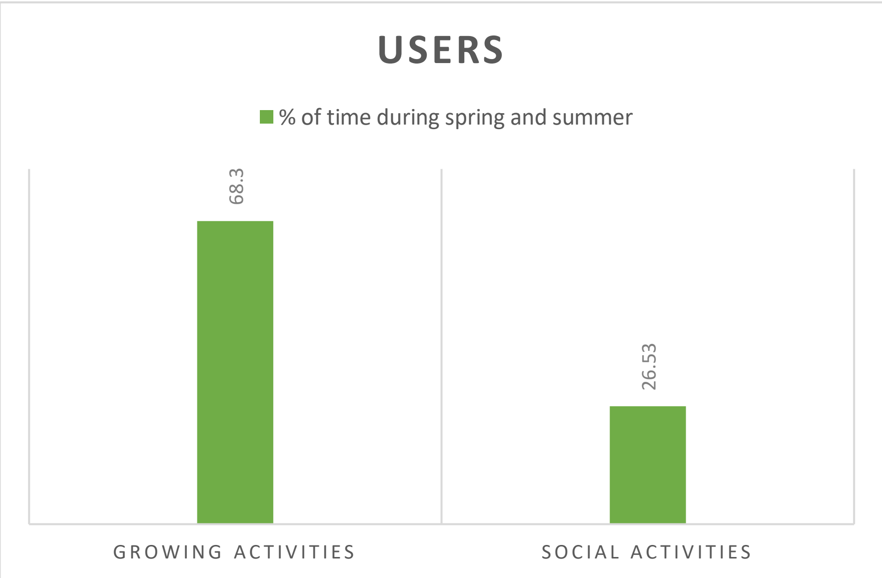
Figure 19. Noise pollution map. Green Infrastructure Strategy, A Coruña City Council, 2018.
Figure 20. Noise pollution influence on the ecosystems (acoustic disturbance). Green Infrastructure Strategy, A Coruña City Council, 2018.

Primary indicators

The data presented in this section, as well as that of the rest of social and health indicators, derives from two surveys conducted in the city of A Coruña during the summer and autumn of 2021 on 870 adult participants (61 from the group of users of urban gardens and 809 from the control group of citizens). Detailed data on these participants and the procedure can be consulted in the external file (Supplementary material 2_Survey on primary, health and social indicators A Coruña 2021).

PI1. Type of interaction with NBS

Figure 21 shows that users spend most of their time on the NBS on cultivation-related activities, and less time on social activities such as chatting with other users. On the part of citizens (Figure 22), the highest activity carried out in natural spaces is physical activities, followed by relaxation activities, and social activities. In both cases, the participants were asked to consider their interaction with the spaces during the spring-summer season.



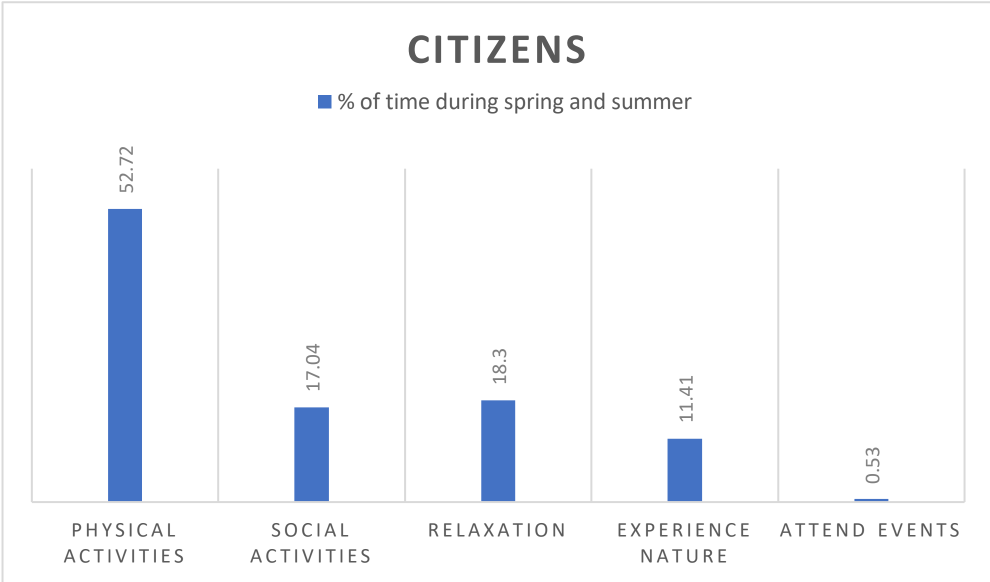
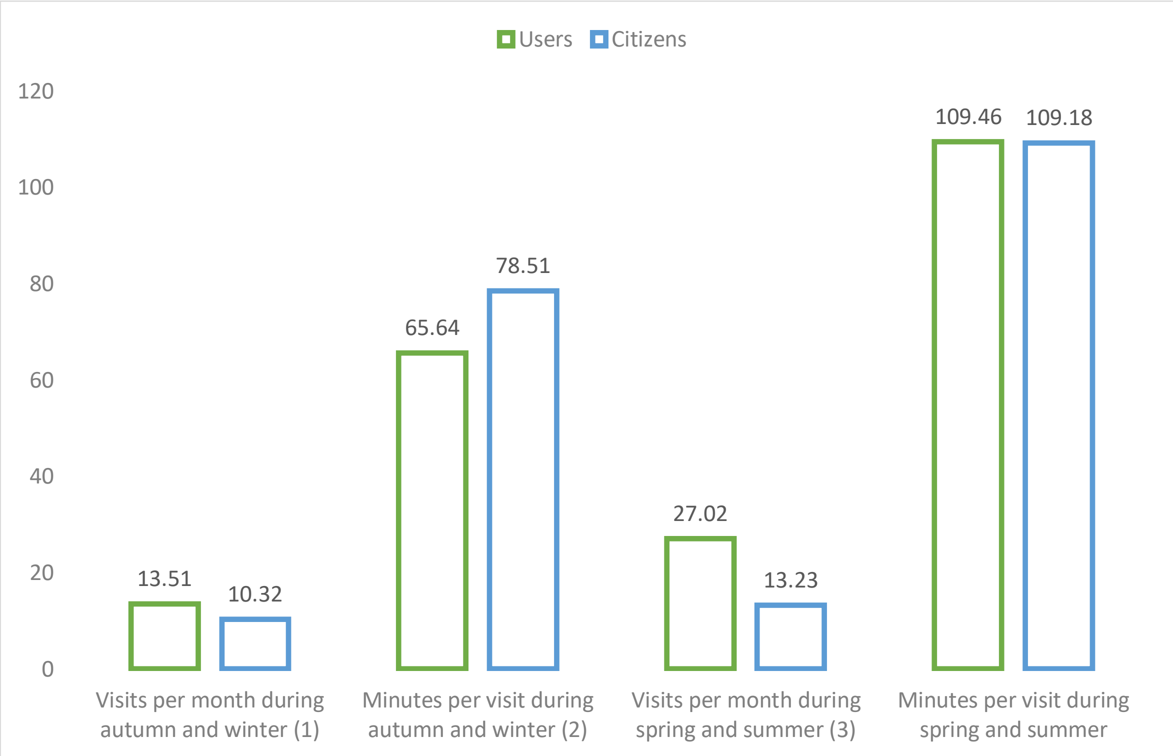


Figure 21 (left). Users´ type of interaction with NBS
Figure 22 (right). Citizens´ type of interaction with natural spaces

PI2. Frequency of interaction with NBS & PI3. Duration of interaction with NBS

Users of urban gardens make more visits to this space than in general the rest of citizens to its most frequented green space, both during the autumn and winter season, and during the spring and summer season, where they practically go to the NBS everyday. On the other hand, citizens spend more time on average during the autumn and winter season than users. These results can be seen in Figure 23.

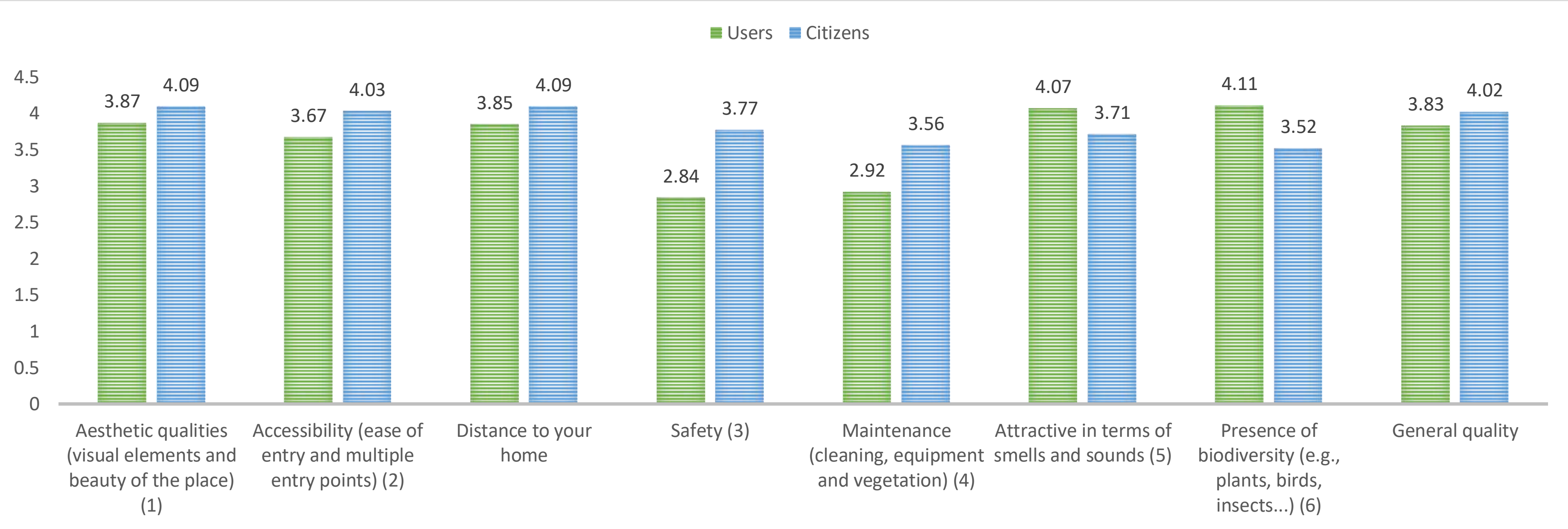


(1) $t_{(868)}=2.285$; p=.023
(2) $t_{(73.802)}=2.234$; p=.029
(3) $t_{(60.571)}=2.451$; p=.017

Figure 23. Frequency and duration of interaction with NBS/natural spaces

PI4. Perceived quality of space

When comparing the perceived quality of urban gardens with the natural space that citizens visit the most (Figure 24), citizens value aesthetic qualities, safety, and maintenance to a greater extent, while users value the attractive in terms of smells and sounds or the presence of biodiversity. However, it is necessary to be very cautious when establishing strong conclusions based on these analyses since the urban spaces valued by citizens are different, and each one of them has different confounding variables such as the location in the city or its maintenance.



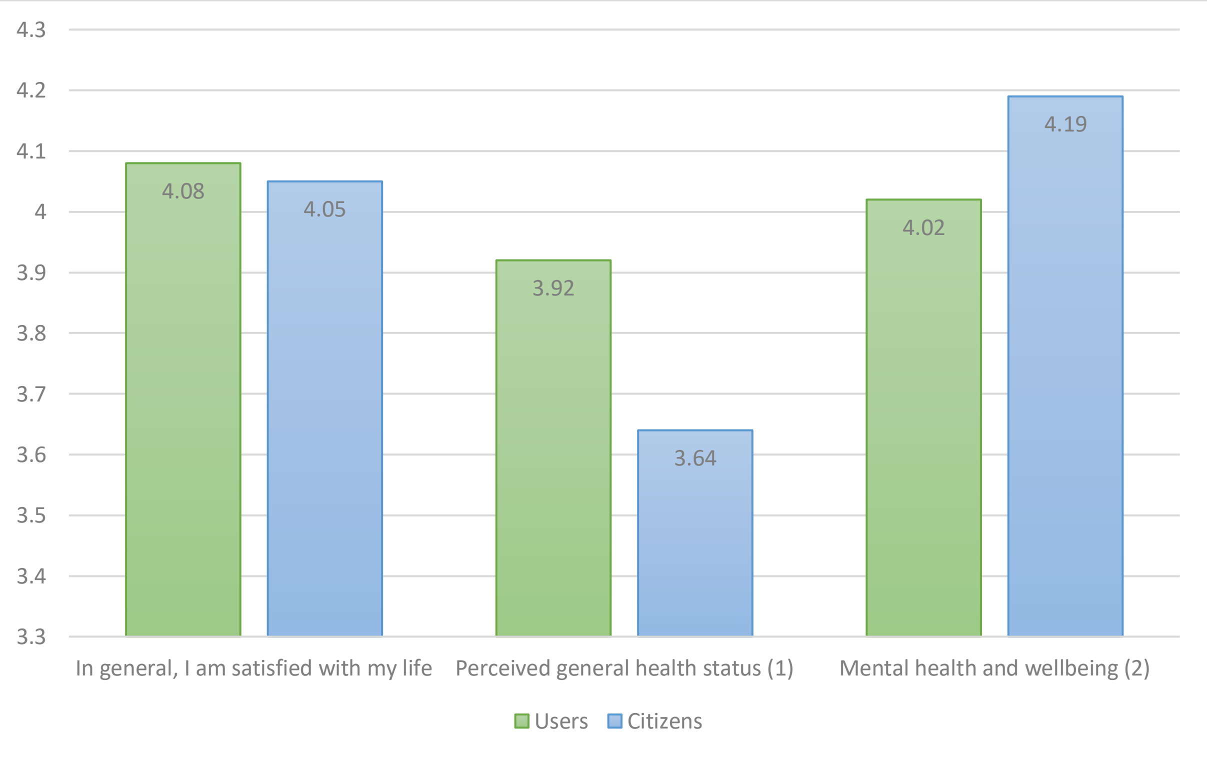
(1) $t_{(767)}=2.023$; $p=.043$
(2) $t_{(66.995)}=2.754$; $p=.008$
(3) $t_{(65.604)}=5.636$; $p<.001$
(4) $t_{(766)}=4.756$; $p<.001$
(5) $t_{(767)}=2.952$; $p=.003$
(6) $t_{(73.53)}=5.278$; $p<.001$

Figure 24. Perceived quality of urban gardens and natural spaces in the city of A Coruña (scale range: 1-5)

Health and wellbeing indicators - CORE

HW3. General wellbeing and happiness & HW11. Mental health and wellbeing

The perceived general health status is significantly higher among users of urban gardens than among citizens, however citizens present higher levels of mental health (Figure 25). In any case, these levels, as well as those of satisfaction with life, are relatively high in both groups.



(1) $t_{(868)}=2.427$; $p=.015$
(2) $t_{(77.439)}=2.612$; $p=.011$

Figure 25. Mental health, wellbeing and perceived general health (scale range: 1-5)

HW12. Enhanced physical activity

There were no statistically significant differences between the levels of physical activity of users and citizens. In both cases, the participants performed approximately 4 days of moderate physical activity, with a minimum of 30 minutes (Figure 26).

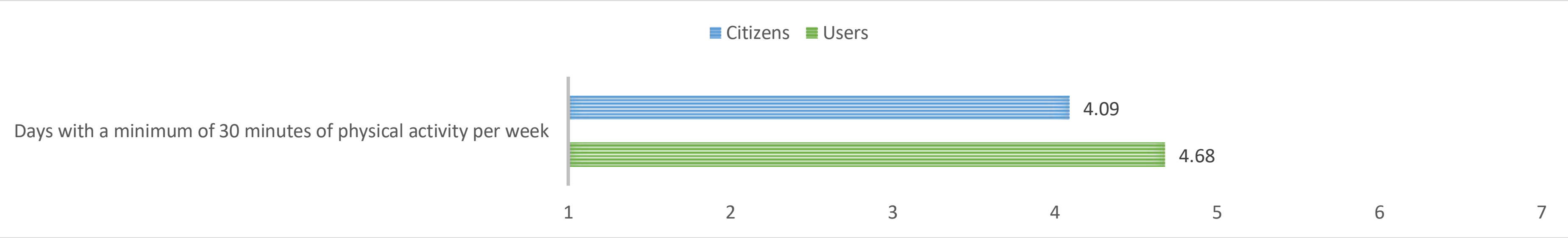
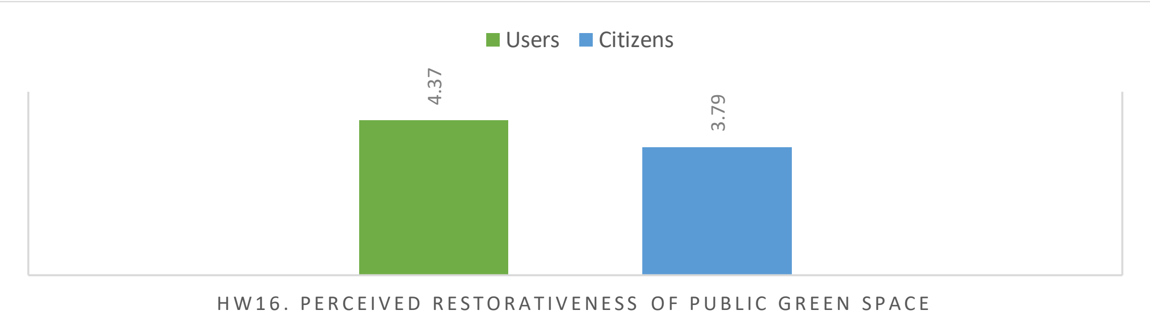


Figure 26. Days with moderate physical activity per week

HW16. Perceived restorativeness of public green space

Users of urban gardens reported significantly higher levels of perceived restoration to the NBS than citizens to the natural spaces they visited the most. User restoration levels are high, considering the possible response range (Figure 27).



Note. $t_{(76.741)}=7.518$; $p<.001$

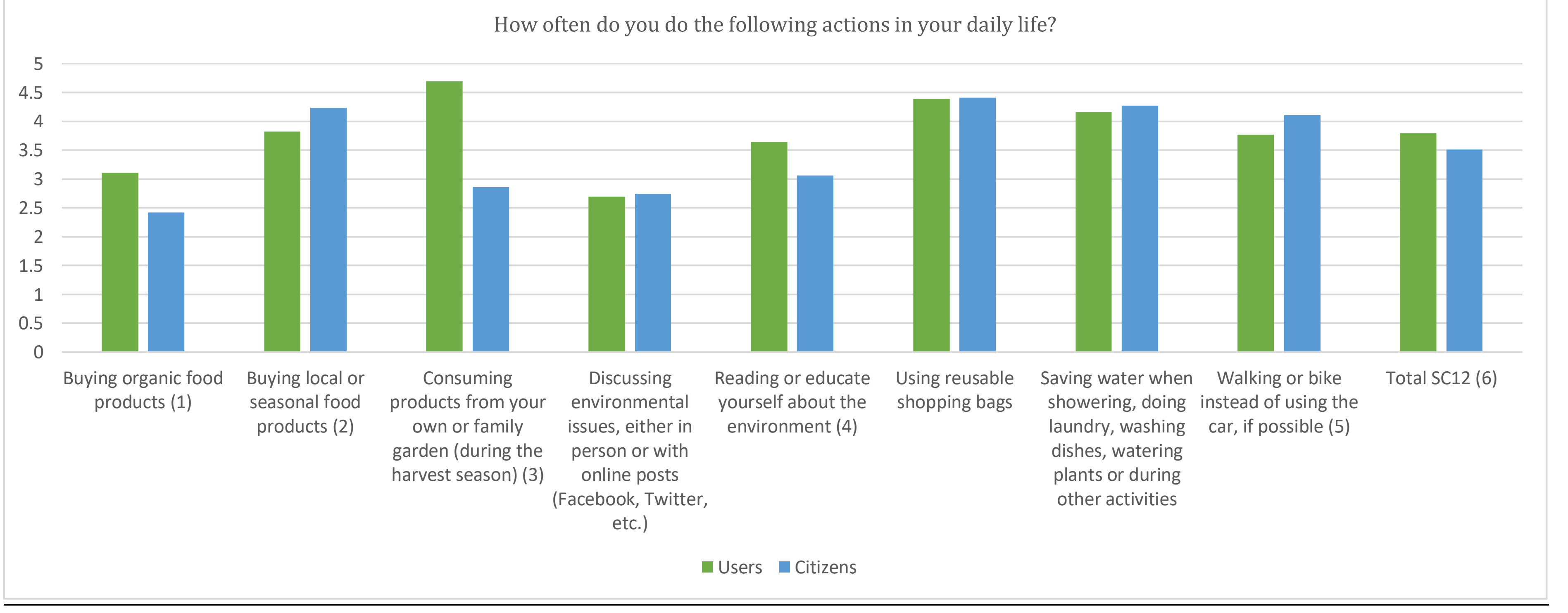
Figure 27. Perceived restorativeness of NBS / public green space (scale range: 1-5)

Health and wellbeing indicators - FEATURE

HW1. Sustainable nutrition/adoption & SC12. Pro-environmental behaviour

The first three actions in Figure 28 refer to sustainable nutrition practices, where users outperform citizens when buying organic food products and consuming products from the own garden. Citizens present higher levels of buying local or seasonal food products, although it is a result in line with the previous ones because as most of these products are of plant origin, users can already obtain them from their growing spaces.

Regarding the rest of the actions, users present higher levels of educating oneself about the environment, as well as the total level of pro-environmental behavior. Citizens obtain higher scores in walking or using the bicycle instead of the car.

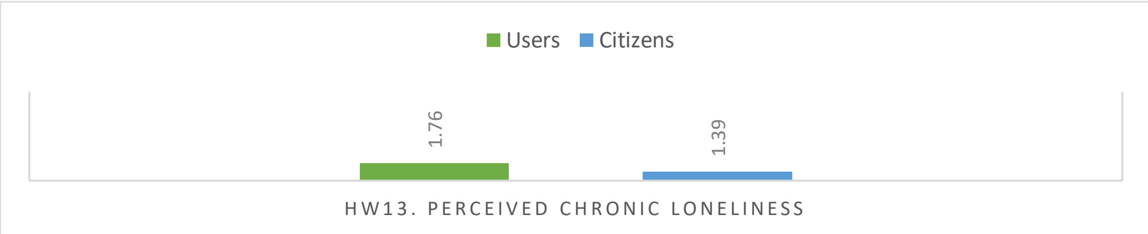


(1) $t_{(78.362)}=6.163$; $p<.001$
(2) $t_{(74.288)}=4.406$; $p<.001$
(3) $t_{(129.691)}=18.93$; $p<.001$
(4) $t_{(868)}=3.538$; $p<.001$
(5) $t_{(868)}=2.249$; $p=.025$
(6) $t_{(69.55)}=3.987$; $p<.001$

Figure 28. Sustainable nutrition/adoption and pro-environmental behaviour (scale range 1-5)

HW13. Perceived chronic loneliness

Despite the fact that the levels of this indicator are quite low for both groups, the user group showed higher levels of chronic loneliness compared to the citizens (Figure 29).



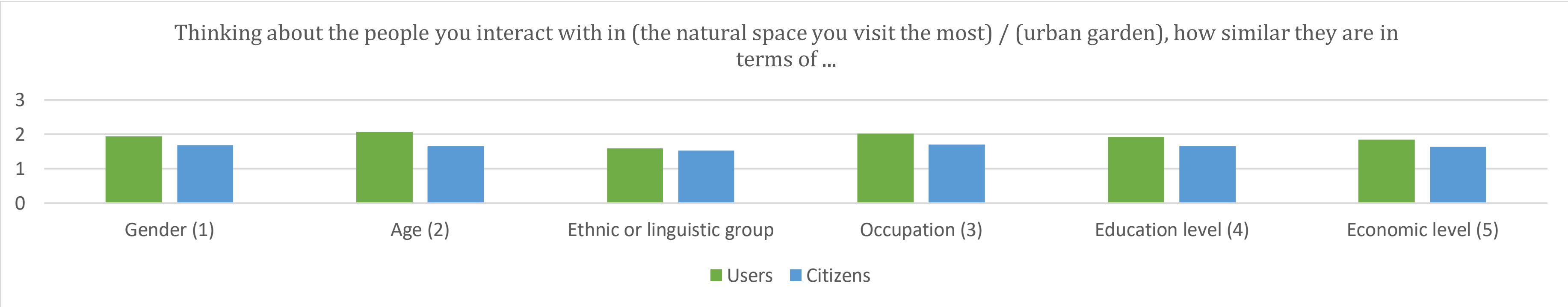
Note. $t_{(64.964)}=3.604$; $p=.001$

Figure 29. Levels of perceived chronic loneliness (scale range: 1-5)

Social cohesion indicators - CORE

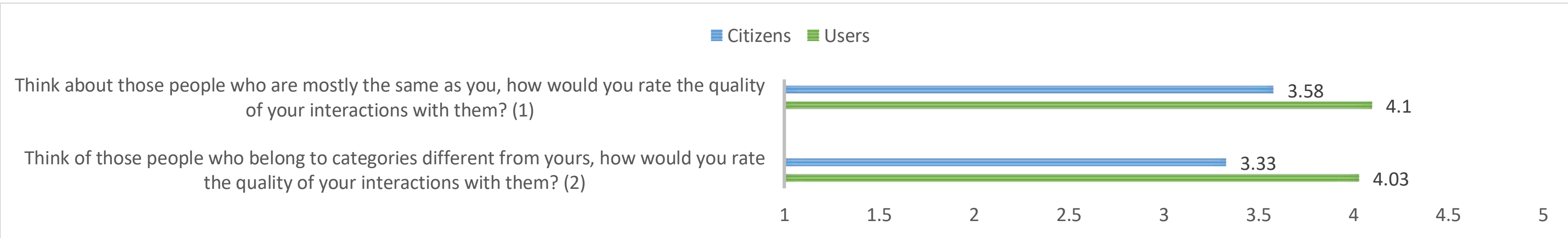
SC1. Bonding social capital & SC2. Bridging social capital

In general, users of urban gardens interact with people who are more similar to them in terms of gender, age, occupation, education and economic level (Figure 30). However, both groups have scores in all conditions higher than 1.5, considering the possible range of response (1-3), it implies that the participants hardly interact with people very different from them. On the other hand, Figure 31 shows that users show higher levels of quality of interactions with people who are most the same as them, as well as with the most different people. In both groups, the levels of perceived quality of interactions are moderately positive.



(1) $t_{(80,47)}=3.92$; $p<.001$
(2) $t_{(73.826)}=5.085$; $p<.001$
(3) $t_{(785)}=3.203$; $p=.001$
(4) $t_{(71.371)}=3.157$; $p=.002$
(5) $t_{(74.022)}=2.58$; $p=.012$

Figure 30. Bonding and bridging social capital (scale range: 1-3)

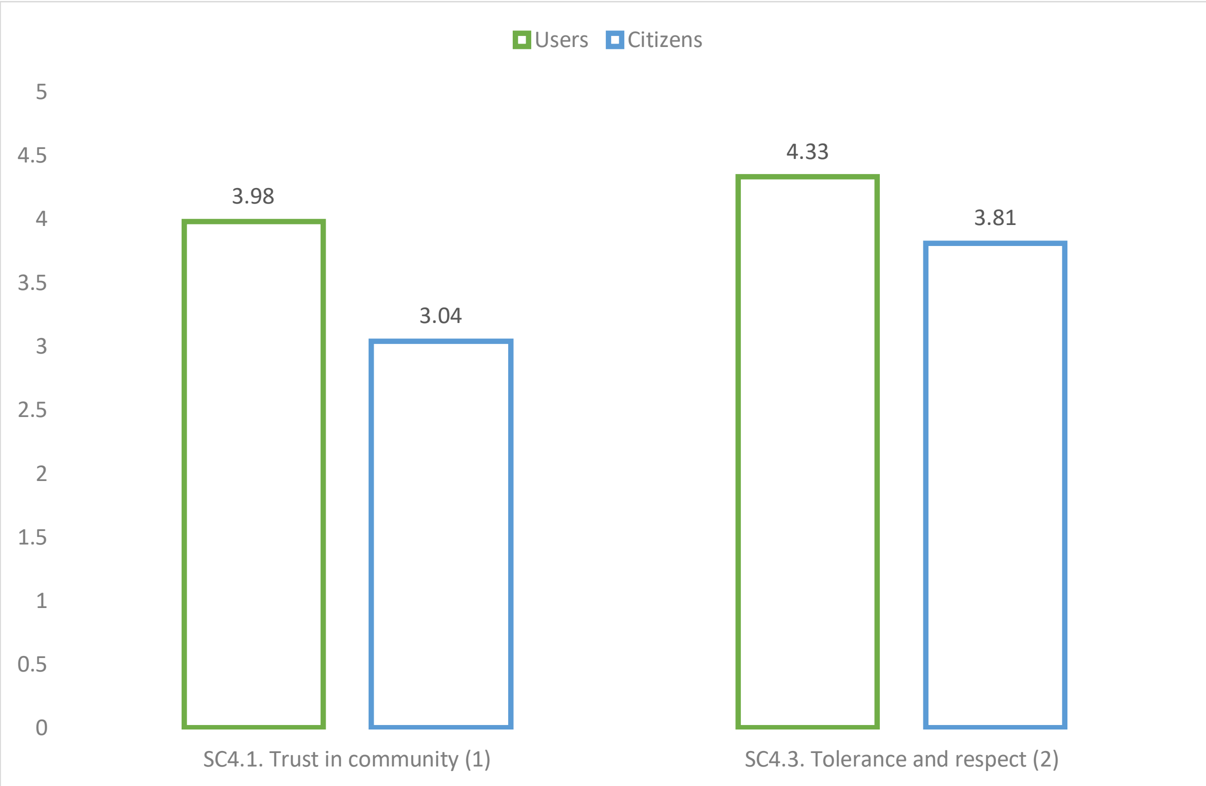


(1) $t_{(86.9)}=4.038$; $p<.001$; (2) $t_{(84.485)}=5.282$; $p<.001$

Figure 31. Perceived quality of social interactions (scale range: 1-5)

SC4.1. Trust in community & SC4.3. Tolerance and respect

Levels of trust in the community as well as tolerance and respect for others are significantly higher in the user group compared to citizens (Figure 32). In both cases, the levels of both indicators are moderately positive.

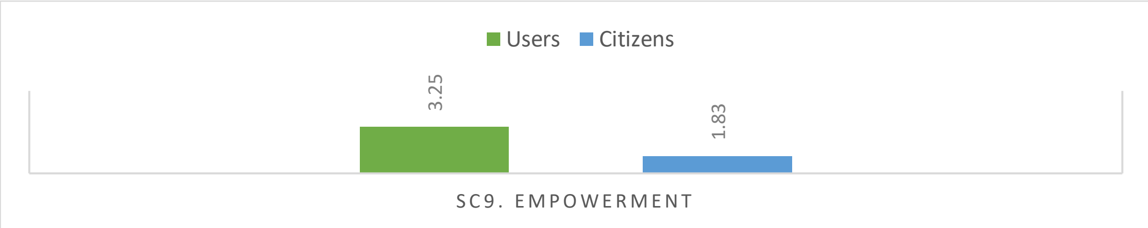


(1) $t_{(107.903)}=10.276$; $p<.001$
(2) $t_{(105.401)}=5.338$; $p<.001$

Figure 32. Levels of Trust in community & Tolerance and respect (scale range: 1-5)

SC9. Empowerment

Users showed higher scores when asked if they felt they had the power to influence important decisions affecting the growing space, compared to citizens, on their perceived ability to influence the natural space they visit the most (Figure 33). The user score is moderately positive, while that of the citizens is moderately negative.



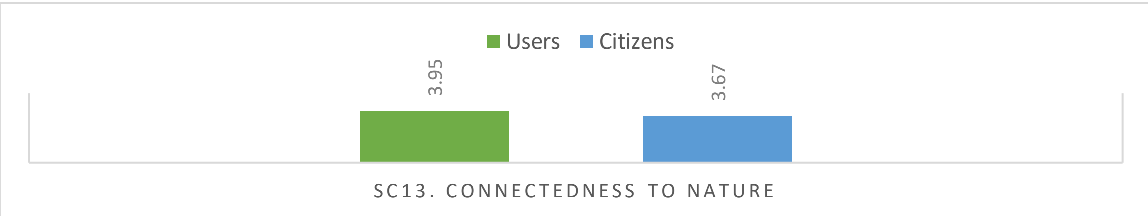
Note. $t_{(77.708)}=10.987$; $p<.001$

Figure 33. Levels of empowerment (scale range: 1-5)

Social cohesion indicators - FEATURE

SC13. Connectedness to nature

Finally, users of urban gardens also presented significantly higher levels of connection with nature, compared to citizens. Both groups showed moderately positive levels (Figure 34).



Note. $t_{(866)}=3.635$; $p=.009$

Figure 34. Levels of connectedness to nature (scale range: 1-5)

Correlations between the main social and health indicators

When establishing the relationships that some indicators establish with others through Pearson's correlations, the analysis was divided into two to analyse, on the one hand, the relationships between mental health with frequency of use, perceived restoration, pro-environmental behaviour and connectedness to nature (Tables 3 and 4); While on the other hand, the relationship between mental health, frequency of use and levels of trust in the community, tolerance and respect, as well as empowerment was analysed (Tables 5 and 6).

The results of the first set of indicators show that in the user group only moderately positive significant correlations are established between perceived restoration, pro-environmental behaviour and connectedness to nature (Table 3). The group of citizens maintains these relationships, although to a lesser degree, but also shows positive relationships between them and mental health and frequency of use. These relationships are of a lesser degree but statistically significant.

Table 3. Pearson´s correlations between mental health, frequency of use, restoration, pro-environmental behaviour and connectedness to nature in USERS

	HW11	**PI2**	**HW16**	**SC12**	**SC13**
HW11. Mental health and wellbeing	1	.026	.168	.257	.254
PI2. Frequency of interaction with NBS	.026	1	.213	.114	.251
HW16. Perceived restorativeness of public green space	.168	.213	1	.462**	.578**
SC12. Pro-environmental behaviour	.257	.114	.462**	1	.65**
SC13. Connectedness to nature	.254	.251	.578**	.65**	1

***. The correlation is significant at the .01 level (bilateral).*

Table 4. Pearson´s correlations between mental health, frequency of use, restoration, pro-environmental behaviour and connectedness to nature in CITIZENS

	HW11	**PI2**	**HW16**	**SC12**	**SC13**
HW11. Mental health and wellbeing	1	.163**	.171**	.268**	.206**
PI2. Frequency of interaction with NBS	.163**	1	.107**	.294**	.226**
HW16. Perceived restorativeness of public green space	.171**	.107**	1	.234**	.278**
SC12. Pro-environmental behaviour	.268**	.294**	.234**	1	.532**
SC13. Connectedness to nature	.206**	.226**	.278**	.532**	1

***. The correlation is significant at the .01 level (bilateral).*

Regarding the second set of indicators, in the group of users only a high positive correlation was established between the levels of trust in the community and those of tolerance and respect (Table 5). On the contrary, within the group of citizens, in addition to maintaining the relationship between these two variables, there were significant positive correlations between mental health, frequency of use and the rest of the variables, although of very little magnitude (Table 6). The only exception was a low negative correlation between frequency of use and level of perceived empowerment.

Table 5. Pearson´s correlations between mental health, frequency of use, trust in community, tolerance and respect, and empowerment in USERS

	HW11	**PI2**	**SC4.1**	**SC4.3**	**SC9**
HW11. Mental health and wellbeing	1	.026	.157	.16	-.026
PI2. Frequency of interaction with NBS	.026	1	.237	.148	-.069
SC4.1. Trust in community	.157	.237	1	.671**	.052
SC4.3. Tolerance and respect	.16	.148	.671**	1	-.134
SC9. Empowerment	-.026	-.069	.052	-.134	1

***. The correlation is significant at the .01 level (bilateral).*

Table 6. Pearson´s correlations between mental health, frequency of use, trust in community, tolerance and respect, and empowerment in CITIZENS

	HW11	**PI2**	**SC4.1**	**SC4.3**	**SC9**
HW11. Mental health and wellbeing	1	.163**	101**	.191**	-.040
PI2. Frequency of interaction with NBS	.163**	1	.073*	.064	-.112**
SC4.1. Trust in community	.101**	.073*	1	.669**	.173**
SC4.3. Tolerance and respect	.191*	.064	.669**	1	.102**
SC9. Empowerment	-.04	-.112**	.173**	.102**	1

**. The correlation is significant at the .05 level (bilateral); **. The correlation is significant at the .01 level (bilateral).*

Economic indicators - CORE

ECO1 New Businesses 'attracted' or started and additional rates received & ECO3. Net additional jobs created/enabled by NBS

After the implementation of the network of urban gardens, a new company specialized in the maintenance of urban and school gardens has emerged, as well as 2 new paid jobs.
One person works for the new company created and the other person was hired by an NGO that carries out projects with vulnerable groups).

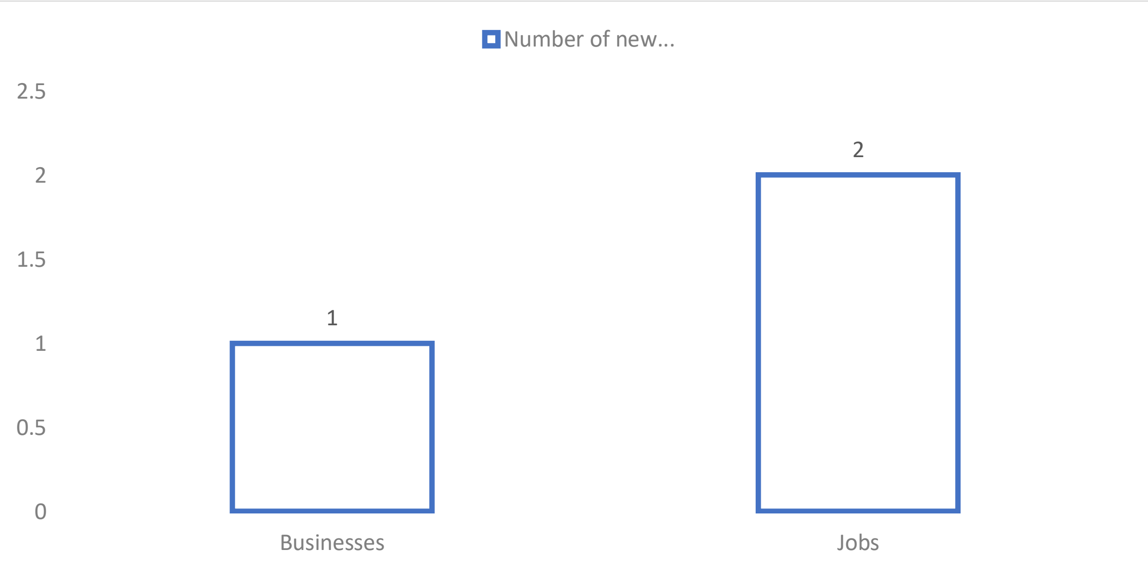


Figure 35. New businesses and jobs enabled by NBS

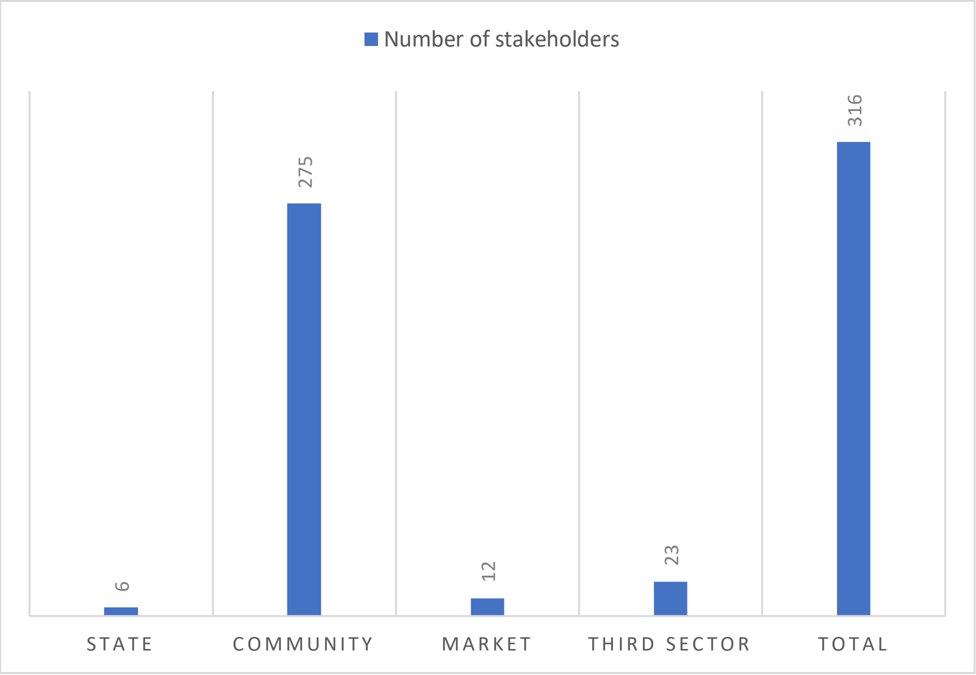
ECO13. Net impact on public expenditure from NBS implementation

The total public expenditure for the implementation of the NBS was € 360k. € 60K for pilot projects in school gardens and € 300K for new urban gardens called "Adolfo Suárez" (Participatory budgets € 50k, Eidus Coruña_80% ERDF € 250k).

Participatory Planning and Governance indicators - CORE

The evaluation of this category of indicators by the city of A Coruña was carried out through internal evaluations within the work team in charge of designing the impact evaluation plan and gathering data for the environmental and economic indicators. Therefore, some of the following indicators do not show quantitative conclusions but rather reflect the perception of the people involved in the process of managing the day-to-day life of the NBS and the impact assessment process.

PPG1. Diversity of stakeholders involved



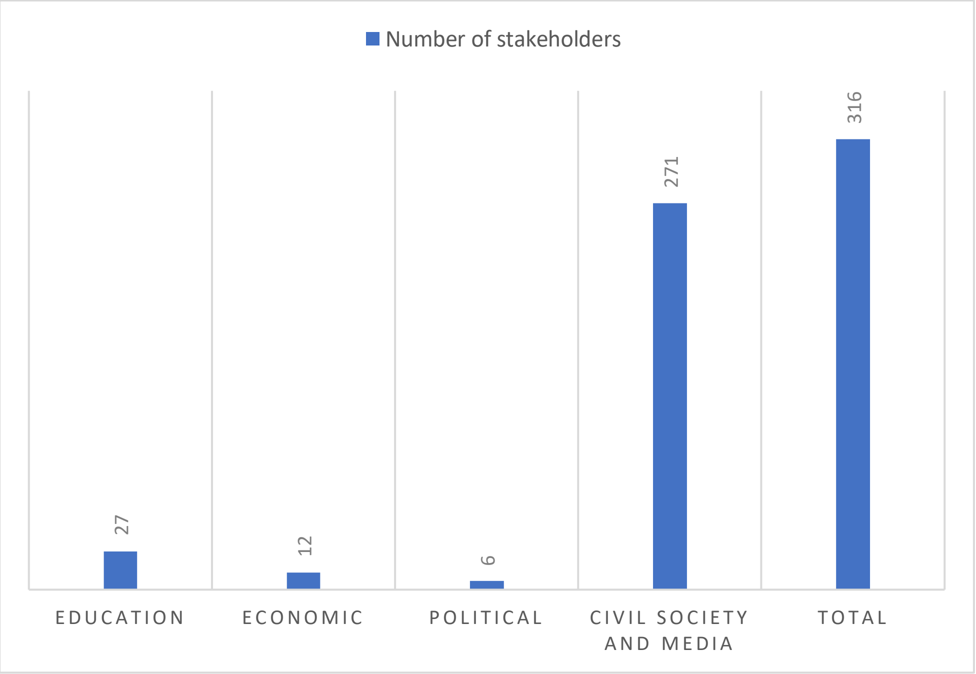


Figure 36 (left). Number of stakeholders per sector (multi-actor perspective)
Figure 37 (right). Number of stakeholders per system (quintuple helix perspective)

PPG2. Social equity: involvement of citizens from traditionally under-represented groups

Measured by: Five-point Likert scale (Dumitru et al., 2021). A. Dumitru & L. Wendling (Eds.). *Evaluating the Impact of Nature-based Solutions: A Handbook for Practitioners. Appendix of Methods*. Luxembourg: Publications Office of the European Union. 2021.

Question: To what extent do you feel that the participation of traditionally underrepresented or vulnerable groups has been achieved in the overall NbS project or in specific NBS project activities ?

Answer: Good: the project has significantly increased the participation of groups not well represented in society.

PPG3. Transparency of co-production

Measured by: Five-point Likert scale Bode & Hölscher PPG3 (2021) in Dumitru A., Tomé-Lourido, D., & Peralbo-Rubio, E. (Eds.) (2021). Connecting Nature Indicator Reviews. Connecting Nature, Grant Agreement number 730222. SBN Number: 978-1-9161451- 8-4

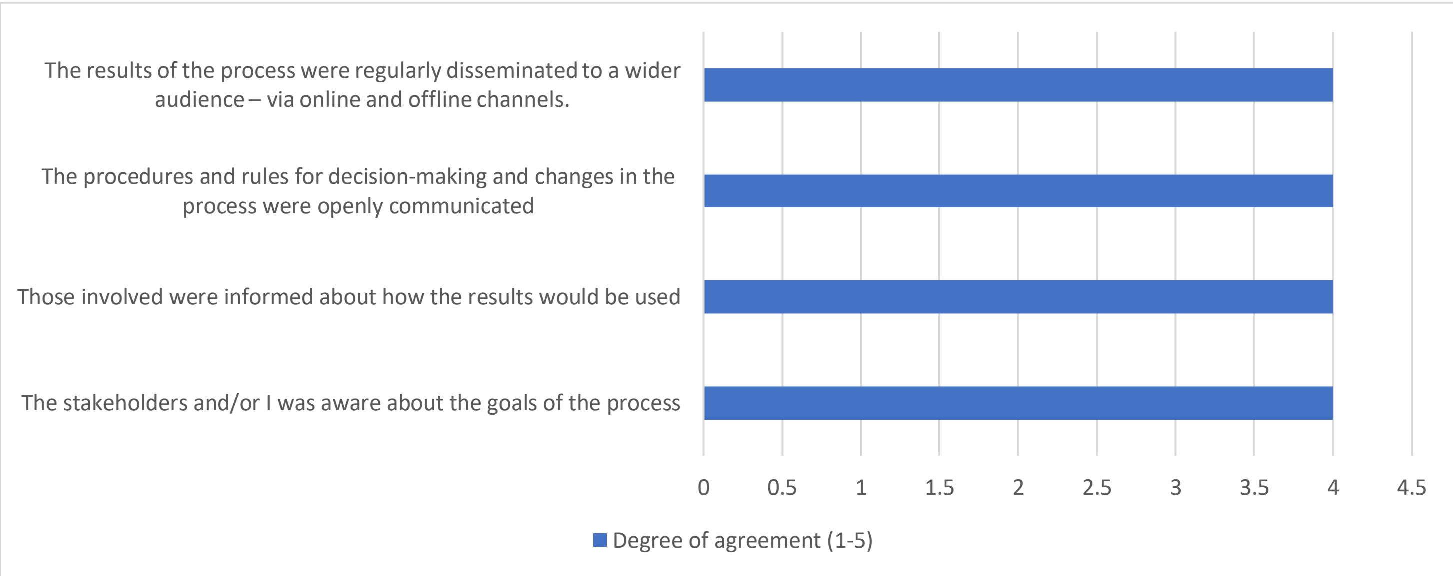


Figure 38. Degree of agreement with the transparency of the co-production process

PPG4. Policies adopted to promote NBS

Five-point Likert scale (Bosch et al., 2017). Bosch, P., Jongeneel, S., Rovers, V., Neumann, H.-M., Airaksinen, M., & Huovila, A. (2017). *CITYkeys indicators for smart city projects and smart cities*. CITYkeys D1.4. Retrieved from http://nws.eurocities.eu/MediaShell/media/CITYkeysD14Indicatorsforsmartcityprojectsands martcities.pdf

STEP 1. Identification of policies

Question: To what extent has the NBS project at any stage, inspired changes in municipal rules and regulations?

Answer: Some impact: the project has led to public discussion, leading to a change in municipal rules and regulations.

STEP 2. Qualitatively describing policies: policy design

Table 7. Policy design

Policy identified	Design and regulation of urban gardens
Source of authority	Public, government-led and sanctioned, e.g. law, administrative guidelines, regulations
Type of instrument	Regulation, legal obligations
Policy target	Citizens & Other
Type of policy	Planning wherein the identified policy encourages/requires targets to change how and when it undertakes planning activities

STEP 3. Qualitatively describing policies: goals and/or principles

Table 8. Goals and/or principles

Goal policy	Social goals (e.g. wellbeing, health) & Environmental goals (e.g. resilience to climate change, biodiversity regeneration, pollution reduction) & Economic goals (e.g. supporting local businesses)

General conclusions

Environmental impact

The results of the environmental indicators reflect the city's effort to gather data from numerous sources to build the data infrastructure on key indicators such as air temperature, inundation risk, green space distribution or biodiversity. The data show that the city of A Coruña has specific areas with deficits where recommended levels of contamination, soil sealing or absence of biodiversity are exceeded. Noteworthy is the noise pollution in the city, where the limits are exceeded in practically all the urbanized area of the municipality. Although within the supplementary material concrete maps are offered where the NBS of the city (urban gardens) appear, the scale of the data does not allow to establish causal conclusions about its influence on the indicators.

Social and health impact

The two surveys conducted in the city of A Coruña during the summer and autumn of 2021 on 870 adult participants (61 from the group of users of urban gardens and 809 from the control group of citizens), do allow comparisons between the group of users of urban gardens and a representative sample of the city that were not users. In terms of interaction with green spaces, users visit their NBS more times during all seasons of the year than citizens visit their most visited natural space. In addition, users present higher levels of perceived general health status, perceived restorativeness, sustainable nutrition, pro-environmental behavior, chronic loneliness, bonding and bridging social capital, trust in community, tolerance and respect, empowerment and connectedness to nature. However, the absence of a baseline or randomized control trials limits the assumptions of causality.

Economic impact

The economic indicators show how after the implementation of the NBS new paid jobs have emerged, as well as a company specialized in the maintenance of urban gardens. In addition, the public expenditure from NBS implementation reached € 360k.

Participatory planning and governance impact

Finally, these indicators present the large number of stakeholders involved in the design and implementation of the NBS (316) and their different origins based on multi-actor and quintuple helix perspectives. Similarly, the internal reflections of the local team show suitable co-production practices, involving good levels of social equity and transparency.

Supplementary material_Survey on primary, health and social indicators (A Coruña 2021)

Authors: Adina Dumitru, David Tomé Lourido, Eva Peralbo Rubio (University of A Coruña)

This supplementary material contains the methodological information related to the survey carried out in the city of A Coruña to evaluate the impact of the NBS (Network of urban gardens). The participants, procedure, instruments and data analysis performed in this research are detailed below.

Participants

870 participants (61 from the group of users of urban gardens and 809 from the control group of citizens). Within the group of users, the ages were between 21 and 78 (M = 53.8; SD = 12.94), with 59% being women. The ages of the group of citizens were between 18 and 100 years old (M = 52.29; SD = 18.28), with 54.1% being women. The following tables show the type of dwelling of the users, if they are owners, the educational level, and monthly net income per household.

	Percentage of users	Percentage of citizens
Apartment / flat	100	99.6
House with garden	0	.2
House without garden	0	.1
Owner	65.6	65.3
Rental	32.8	30.9

	Percentage of users	Percentage of citizens
No education / preschool	1.6	2
Primary school	4.9	15.8
High school (Basic level)	4.9	11
High school (Advanced level)	19.7	18.5
Vocational training	13.1	18.2
University degree	37.7	27.1
Master´s degree	9.8	5.8
PhD	6.6	1.4

	Percentage of users	Percentage of citizens
Less than 600 €	1.6	4.8
Between 601 € – 1.500 €	24.6	26.8
Between 1.501 € – 3.000 €	49.2	33.7
Between 3.001 € – 4.500 €	9.8	11.1
Between 4.501 € – 6.000 €	0	2
More than 6.001 €	1.6	.4
I don´t want to disclose	3.3	21.1

Procedure

The data from the user sample was collected by the University of A Coruña. In the first place, all the associations of users of urban gardens in the city of A Coruña were contacted to explain the objectives of the research and request their collaboration. Subsequently, questionnaires were delivered to respond individually.

The data from the sample of citizens were collected by a specialized company. The criteria of spatial representativeness and age were used to obtain a representative sample of the entire territory of the city, and distributed equally in terms of sex and age. In both cases, data collection took place between July and November 2021.
Participation in the survey was voluntary and anonymous. At all times the data protection of the responses was guaranteed, in accordance with the laws in force in Spain and at the level of the European Union.

Instruments

The following table shows a summary of the instruments used to measure the variables under study:

CODE	INDICATOR	INSTRUMENT
PI1	Type of interaction with NBS	Questions prepared ad hoc within the Connecting Nature project (Dumitru et al., 2021)
PI2	Frequency of interaction with NBS	
PI3	Duration of interaction with NBS	
PI4	Perceived quality of space	
HW3	General wellbeing and happiness	Adaptation of Diener et al. (1985)
HW11	Mental health and wellbeing	General Health Questionnaire (GHQ-12) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997)
HW12	Enhanced physical activity	Adaptation of international physical activity questionnaire (Craig et al., 2003)
HW16	Perceived restorativeness of public green space	Adaptation of Nordh et al. (2008) and Wood et al. (2018)
HW1	Sustainable nutrition/adoption	Adaptation of Brick et al. (2017)
HW13	Perceived chronic loneliness	Three-Item Loneliness Scale (Hughes et al., 2004)
SC1	Bonding social capital	Anucha et al. (2006)
SC2	Bridging social capital	
SC4.1	Trust in community	Adaptation of social cohesion and trust scale (Sampson et al., 1997)
SC4.3	Tolerance and respect	Adaptation of Stafford et al. (2003)
SC9	Empowerment	Integrated Questionnaire for the Measurement of Social Capital (Grootaert et al., 2004)
SC12	Pro-environmental behaviour	Brick et al. (2017)
SC13	Connectedness to nature	Nisbet & Zelenski (2013)

Data analysis

The data were analysed with the IBM SPSS 25.0 statistical package. The analyses included the calculation of descriptive statistics, comparisons of means through Student's t test, and Pearson's correlations.

References

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The Satisfaction with Life Scale. *Journal of Personality Assessment, 49*(1), 71-75.

Anucha, U., Dlamini, N. S., Yan, M. C., & Smylie, L. (2006). Social capital and the welfare of immigrant women: *A multi-level study of four ethnic communities in Windsor*. Ottawa, Ontario: Status of Women Canada.

Brick, C., Sherman, D. K., & Kim, H. S. (2017). “Green to be seen” and “brown to keep down”: Visibility moderates the effect of identity on pro-environmental behavior. *Journal of Environmental Psychology, 51*, 226-238.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., ... & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise, 35*(8), 1381-1395.

Dumitru A., Tomé-Lourido, D., & Peralbo-Rubio, E. (Eds.) (2021). *Connecting Nature Indicator Reviews*. Connecting Nature, Grant Agreement number 730222. SBN Number: 978-1-9161451- 8-4

Goldberg, D., Gater, R., Sartorius, N., Ustun, T., Piccinelli, M., Gureje, O., & Rutter, C. (1997). The Validity of two Versions of the GHQ in the WHO Study of Mental Illness in General Health Care. *Psychological Medicine, 27*, 191-7. doi: 10.1017/S0033291796004242.

Grootaert, C., Narayan, D., Jones, V.N., & Woolcock, M. (2004). *Measuring Social Capital: An Integrated Questionnaire*. World Bank Working Paper 18. Washington D.C.: World Bank.

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging, 26*(6), 655- 672.

Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: a new brief measure of nature relatedness. *Frontiers in Psychology*, *4*, 813.

Nordh, H., Hartig, T., Hagerhall, C. M., & Fry, G. (2009). Components of small urban parks that predict the possibility for restoration. *Urban forestry & urban greening, 8*(4), 225-235.

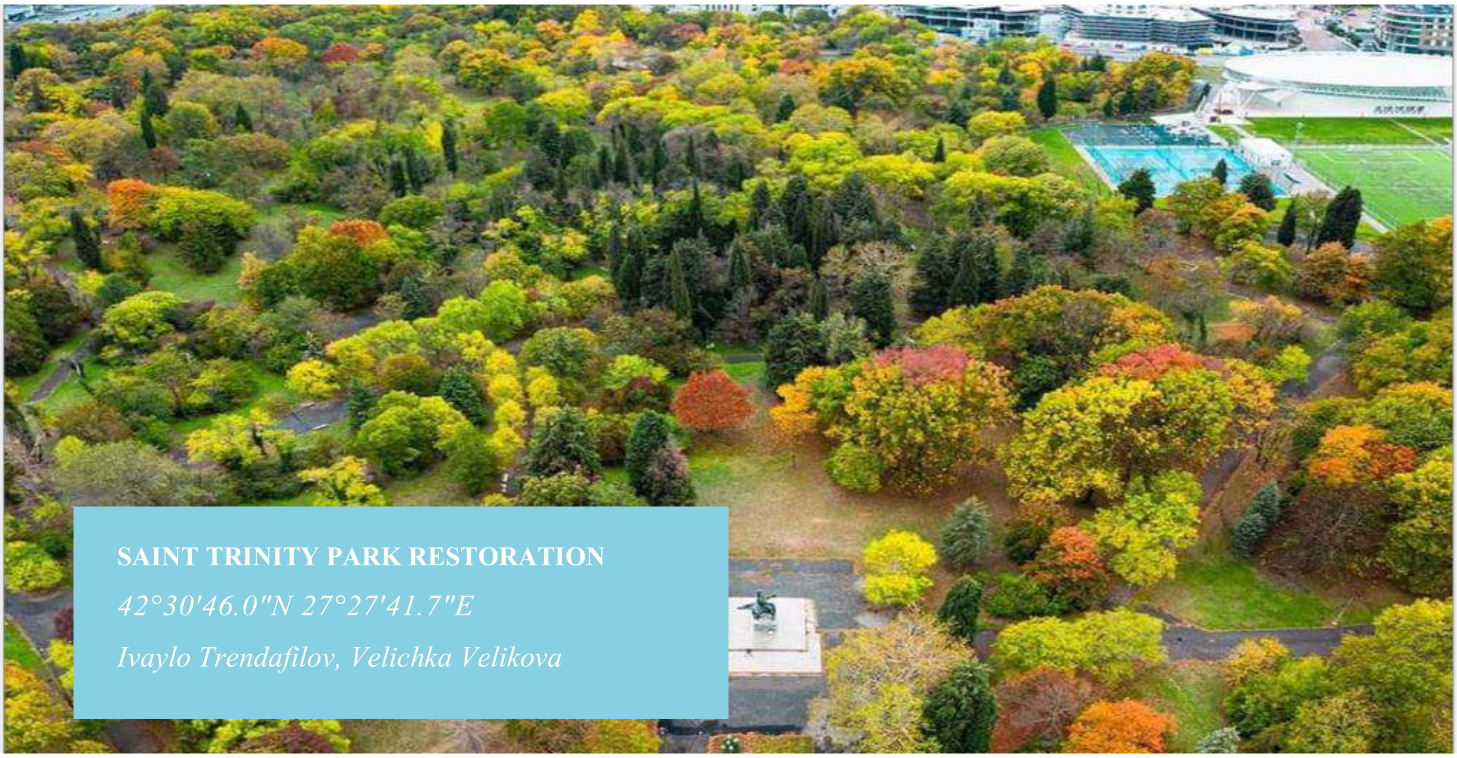
Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science*, *277*(5328), 918-924.

Stafford, M., Bartley, M., Sacker, A., Marmot, M., Wilkinson, R., Boreham, R., & Thomas, R. (2003). Measuring the social environment: social cohesion and material deprivation in English and Scottish neighbourhoods. *Environment and Planning A, 35*(8), 1459-1475.

Wood, E., Harsant, A., Dallimer, M., Cronin de Chavez, A., McEachan, R. R., & Hassall, C. (2018). Not all green space is created equal: biodiversity predicts psychological restorative benefits from urban green space. *Frontiers in Psychology*, *9*, 2320.

BURGAS

Impact Assessment Plan



SAINT TRINITY PARK RESTORATION

42°30'46.0"N 27°27'41.7"E

Ivaylo Trendafilov, Velichka Velikova

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Burgas Municipality Development Plan 2014 - 2020																	
Achieve sustainable development on the territory of the municipality and preserving the environment focusing towards infrastructural connectivity, renovation and public works for improving the living environment.									•		•						
Increasing the quality of life with a focus on people and public services. The accent is on access of quality healthcare and education, inclusion and fighting poverty, further development of social services, improved living environment and development of cultural sector.	•		•	•						•	•						
Support economic growth through effective public services. The main focus is to stimulate entrepreneurship, creating conditions for development of economic incentives for growth, increasing business competitiveness and establishment of partnerships in compliance with the general principals of good governance.									•								•

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City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Burgas Municipality Development Plan 2014 - 2020																	
Effective utilization of renewable energy resources in the municipal and housing buildings.	•						•				•	•	•				
Raising awareness and encouraging private investment in the construction of renewable energy installations in city of Burgas.											•	•					•
Providing the necessary conditions for effective planning, implementation and monitoring of policies for promotion and utilization of energy from renewable sources.																	•

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

NBS DESCRIPTION

Type

Urban park

Scale

The scale of the park is large (146 411 sq. m). It is located in heavily urbanizes area surrounded by several neighbourhoods, shopping centres, hospitals.

Context description

Renovation of urban park in the wide centre of the city

Process of design and implementation

Several public discussions were held through the years about the renovation of the park. As part of these, people have expressed ideas about what they want to see in the area. Currently we are developing a concept for the renovation of the area, which will be discussed again with stakeholders. Once we all agree on the measures for the future renovation we will develop a detailed design for the renovation of the park and after that proceed with the implementation of measures foreseen in the technical project.

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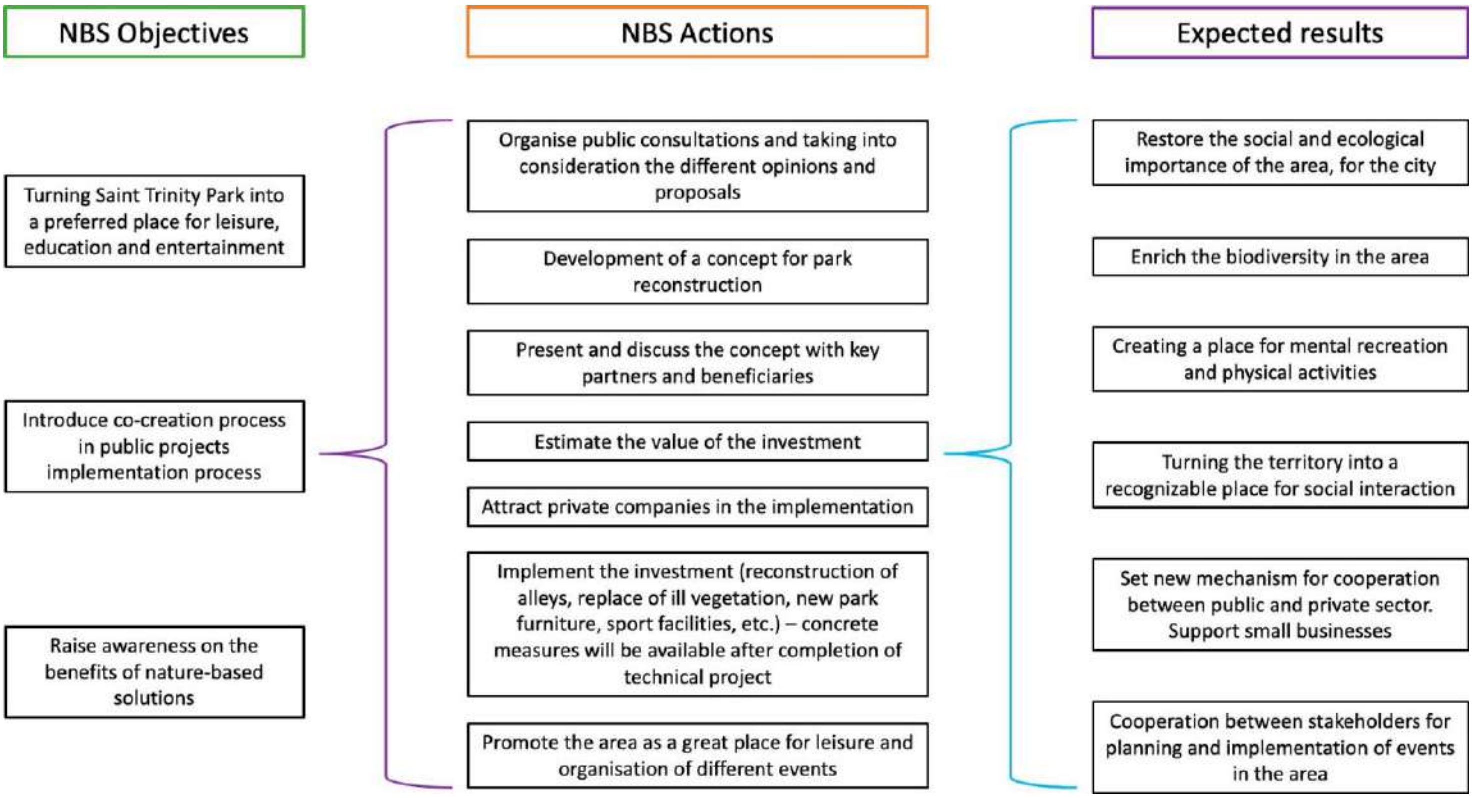
Burgas´ Theory of Change



Assumptions, synergies and trade-offs

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Action 1. Organise public consultations and taking into consideration the different opinions and proposals	- Restore the social and ecological importance of the area, for the city. - Cooperation between stakeholders for planning and implementation of events in the area.	- It is important, the reconstruction of the park to satisfy as much as possible the desires of stakeholders.	If people see their proposals and ideas turned into reality, they will be more engaged into protecting the area afterwards.	Most probably, some of received proposals will not be implemented, which will leave a feeling of dissatisfaction in some people.
Action 2. Development of a concept for park reconstruction	Restore the social and ecological importance of the area, for the city.	Considering the location of the park and its size, the area has the potential to turn into one of the most visited places in the city, along with the Sea garden.	Searching for the opinion of people, will increase the trust in city administration.	Most probably, some of received proposals will not be implemented, which will leave a feeling of dissatisfaction in some people.
Action 3. Present and discuss the concept with key partners and beneficiaries	- Cooperation between stakeholders for planning and implementation of events in the area. - Turning the territory into a recognizable place for social interaction.	- It is important, the reconstruction of the park to satisfy as much as possible the desires of stakeholders. - After the completion of the project we aim the park to be "full of life".	Searching for the opinion of people, will increase the trust in city administration. If people see their proposals and ideas turned into reality, they	Most probably, some of received proposals will not be implemented, which will leave a feeling of dissatisfaction in some people.

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			will be more engaged into protecting the area afterwards.	
Action 4. Estimate the value of the investment	Restore the social and ecological importance of the area, for the city.	A detailed budget will allow a better planning of foreseen restoration activities	Knowing the cost of each activity will allow us to plan our work, depending on the available budget.	It is possible to implement the project in several phases, because of limitations of city budget.
Action 5. Attract private companies in the implementation	- Set new mechanism for cooperation between public and private sector. Support small businesses. - Cooperation between stakeholders for planning and implementation of events in the area.	Private companies should contribute for the city development. Their participation with financial and technical resources will speed up the restoration process of the area. Restored park will become a very popular place, which is a good precondition for small local businesses to develop.	Attracting private finances will allow the local authority to complete more work with less public resources. New economic activities on the territory will facilitate the future maintenance of the territory.	There is a chance the local authority to make compromises with its vision and satisfy the demands of business.
Action 6. Implement the investment (reconstruction of alleys, replace of ill vegetation, new park furniture, sport facilities, etc.) – concrete measures will be available after completion of technical project.	- Enrich the biodiversity in the area. - Creating a place for mental recreation and physical activities. - Turning the territory into a recognizable place for social interaction.	Replacing ill vegetation and planting new one, will contribute for healthy and rich biodiversity. New facilities, attractions, events, etc. will attract people to spend time in the park.	Rich biodiversity along with improving the conditions for visitors will increase the quality of the territory as a whole.	Some big old trees will have to be cut down, because they are ill and dangerous, either for people, as well as the other plant species in the park,
Action 7. Promote the area as a great place for leisure and organisation of different events.	- Turning the territory into a recognizable place for social interaction. - Cooperation between stakeholders for planning and implementation of events in the area.	New facilities, attractions, events, etc. will attract people to spend time in the park.	Spending more time in the park, will contribute to more social interaction.	Most probably the cost for maintenance of the park will increase significantly.

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CODE	NAME	NBS expected result	Selection reasoning
PI1	Type of interaction with NBS	Type of different events, happenings, usage of the park.	It is important to monitor how people use the renovated space and is it as initially planned. Thus, we will be able to make additional rearrangements, as well as support us in future design of places.
PI2	Frequency of interaction with NBS	Number of same events and initiatives organised in the park?	Receive feedback of did we manage to make the place attractive enough and how we can further develop it.
PI3	Duration of interaction with NBS	How many hours place is being occupied? At what time and day it is most visited.	To understand how popular the place is? Does it serve its functions, as initially planned? Provide information when it is most appropriate to organise events of public interest.
PI4	Perceived quality of space	Improved quality of green space.	More quality green spaces, means the quality of the park is preserves and further improved.
ENV3	Air temperature change	Decreased temperatures in the area.	The replacement of old vegetation will contribute for maintaining the low temperatures in the park. With its renovation, areas surrounding it are/ will be renovated as well, incl. planting new trees, which contributes for temperatures reduction.
ENV8	Rainfall storage (water absorption capacity of NBS)	Prevention of floods. Reuse of rain water.	Our ambitions are the park to serve as an example for optimal use of natural resources. Tanks for storage of rain water are planned as well park alleys will be made of a material which absorbs the water and this contribute for the watering of green spaces.
ENV23	Public green space distribution	Access to green spaces.	Important to assure access of people to quality green spaces.
ENV24	Recreational value of blue-green spaces	Access to blue- green spaces.	Important to assure access of people to quality green spaces with blue infrastructure (artificial lakes, fountains etc.).
ENV25	Cultural value of blue-green spaces	Agriculture or everyday life style culture and if places are designed so that some programmes providing cultural events are possible	For the moment it is not foreseen to have a blue infrastructure there
ENV29	Supporting/increasing biodiversity conservation	Enrich biodiversity by introducing new plants and take care of the existing ones.	. Important to take care and enrich the green system . Biodiversity is directly linked with green areas and planting trees
ENV35	Species diversity	Biodiversity increase, air pollution decrease	. Improve biodiversity in the area . Biodiversity is directly linked with green areas and planting trees.
ENV42	Land use change and greenspace configuration	Number of visitors to different park zones.	It is important to carefully plan the different zones in the park, so that visitors can enjoy the area, according to their needs.
ENV48	Access to public amenities	Number of visitors.	How visitors evaluate the infrastructure in the park.
ENV56	Blue space area	Increase the attractiveness of the park. Support the biodiversity.	Blue spaces add additional comfort and attractiveness of the area.
ENV17	Air temperature - Energy demand	Decreased temperatures in the area.	The replacement of old vegetation will contribute for maintaining the low temperatures in the park. With its renovation, areas surrounding it are/ will be renovated as well, incl. planting new trees, which contributes for temperatures reduction.
ENV26	Community accessibility	Increase the attractiveness of the park.	It is important to return the attractiveness of the place.
ENV38	Mapping ecosystem services	Enrich the biodiversity in the area.	Well maintained urban green spaces, support

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	and spatial-temporal biodiversity legacies		biodiversity.
ENV41	Accessibility of greenspaces	Increase the attractiveness of the park.	It is important to return the attractiveness of the place.
ENV55	Green space area	Enrich the biodiversity in the area. what is the current land use	More green urban areas, support biodiversity.
ENV66	Air quality change	Biodiversity increase, air pollution decrease	To see if we can decrease air pollution during winter time
ENV88	Tree shade for local heat change	Biodiversity increase, air pollution decrease, temperature decrease.	Monitor if measures have contributed to better air quality, increase of biodiversity and temperatures reduction.
ENV90	Community garden area per child capita and in a defined distance	Number of quality green spaces.	Green areas in close proximity to people.
HW3	General wellbeing and happiness	. Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation . Place for mental recreation and physical activities.	. Number of people involved . Mental and physical health are important for general wellbeing and happiness
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	Decrease in the number of patients and hospitalisation.	The physical and mental health of citizens is the most important indicator.
HW10	Perceived chronic stress	Place for mental recreation and physical activities.	Green areas are proven to decrease stress
HW11	Mental health and wellbeing	. Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation . Place for mental recreation and physical activities.	. Number of people involved . Mental and physical health are important for general wellbeing and happiness
HW12	Enhanced physical activity	Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation	. Number of people involved . Parks are perfect place for physical activities.
HW4	Life expectancy and healthy life years expectancy	Increased life expectancy. Decreased number of hospitalisation.	The physical and mental health of citizens is the most important indicator.
HW5	Prevalence and incidence of chronic autoimmune diseases	Decreased number of hospitalisation.	The physical and mental health of citizens is the most important indicator.
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	Decreased number of hospitalisation.	The physical and mental health of citizens is the most important indicator.
HW8	Incidence of obesity /obesity rates (adults and children)	Decreased number of hospitalisation.	The physical and mental health of citizens is the most important indicator.
HW9	Heat reduced mortality	Decreased number of hospitalisation.	The physical and mental health of citizens is the most important indicator.
HW13	Perceived chronic loneliness	Decreased number of hospitalisation and psychiatric visits.	The physical and mental health of citizens is the most important indicator.
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	Decreased number of hospitalisation and psychiatric visits.	The physical and mental health of citizens is the most important indicator.
SC4.1	Trust in community	Recognizable place for social interaction.	The more visitors and social happenings in the area is an indicator for the built trust in the community.
SC4.2	Solidarity between neighbours	cross generation networking, creating cooperation with various stakeholders	Establish networks between various users and stakeholders, number of meetings and events
SC4.3	Tolerance and respect	cross generation networking, creating cooperation with various stakeholders	Establish networks between various users and stakeholders, number of meetings and events
SC5.1	Perceived safety	Recognizable place for social interaction.	More visitors is linked to the safety.
SC5.2	Actual safety	Recognizable place for social interaction.	More visitors is linked to the safety.

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SC6	Place attachment	Recognizable place for social interaction.	More visitors and events is a sign that people feel attached to the place.
SC11.1	Positive environmental attitudes motivated by contact with NBS	Recognizable place for social interaction.	More visitors and events is a sign that people like the nature and approve NBS.
SC11.2	Environmental identity	Recognizable place for social interaction.	More visitors and events is a sign that people like the nature.
SC10	Environmental education opportunities	cross generation networking, creating cooperation with various stakeholders . Recognizable place for social interaction.	Establish networks between various users and stakeholders, number of meetings and events More visitors and events is a sign that people approve what is done in the area.
SC12	Pro-environmental behaviour	Recognizable place for social interaction.	More visitors and events is a sign that people approve what is done in the area.
ECO1	New Businesses 'attracted' or started and additional rates received	. Increase of the work for SMEs active in environmental protection and creation and implementation of the green solution . New mechanism for cooperation between public and private sector. Support small businesses.	. Number of NBEs participating . Attracting private capital for reconstruction activities, as well as attracting new businesses on the territory is a sign for the change of the mind-set both of business and public authorities.
ECO3	Net additional jobs created/enabled by NBS	Number of people hired.	New high quality green spaces are positive for the local economy.
ECO7	Increase in tourism	Number of people visiting Burgas.	New high quality green spaces contribute for increasing the popularity of the region.
ECO13	Net impact on public expenditure from NBS implementation	New mechanism for cooperation between public and private sector. Support small businesses.	Participation of private stakeholders could lead to reducing the implementation and maintenance costs. Attracting new businesses in the area can decrease the load on municipal budget for maintenance.
ECO15	Private finance attracted to the NBS site	New mechanism for cooperation between public and private sector. Support small businesses.	Participation of private stakeholders could lead to reducing the implementation and maintenance costs. Attracting new businesses in the area can decrease the load on municipal budget for maintenance.
PPG1	Diversity of stakeholders involved	. Transparency and open process . Cooperation between stakeholders for planning and implementation of events in the area.	.Public interest in the exemplar .Including more stakeholders is a good initial sign for cooperation.
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	Increased number of participants cooperating on common objective.	Public interest in the exemplar
PPG3	Transparency of co-production	Transparency and open process	Public interest in the exemplar
PPG5	Activation of public-private collaboration	Cooperation between stakeholders for planning and implementation of events in the area.	Attracting private funds, as well expertise in the management of the area will give new opportunities for development of public environment
PPG6	Trust in decision-making and decision-makers	Cooperation between stakeholders for planning and implementation of events in the area.	Including more stakeholders is a good initial sign for cooperation.
PPG10	Open communication (internal & external)	Cooperation between stakeholders for planning and implementation of events in the area.	Including more stakeholders is a good initial sign for cooperation.
PPG15	Governance innovations for participatory governance	Cooperation between stakeholders for planning and implementation of events in the area.	Including more stakeholders is a good initial sign for cooperation.
PPG16	Community involvement in NBS implementation	Transparency and open process	Public interest in the exemplar
PPG25	Engagement	Cooperation between stakeholders for planning and implementation of events in the area.	Including more stakeholders is a good initial sign for cooperation.
PPG26	Organizational trust	Cooperation between stakeholders for planning and implementation of events in the area.	Including more stakeholders is a good initial sign for cooperation.

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Available baseline in the city of Burgas

CODE	NAME	Baseline data	Source (2020)	Granularity	Periodicity
PI1	Type of interaction with NBS	•	City registry of events. Counting the number of people visiting the park, as well as observations from installed video surveillance and registration system.	Entire city	Every year
PI2	Frequency of interaction with NBS	•	City registry of events. Counting the number of people visiting the park, as well as observations from installed video surveillance and registration system.	Entire city	Every six months
PI3	Duration of interaction with NBS	•	City registry of events. Counting the number of people visiting the park, as well as observations from installed video surveillance and registration system.	Entire city	Every six months
PI4	Perceived quality of space	•	Questionnaire.	Entire city	Every 2 years
ENV3	Air temperature change	•	Data from mobile and stationary air quality stations - http://87.126.141.158/burgas/	Neighbourhood	Every year
ENV8	Rainfall storage (water absorption capacity of NBS)	•	Amount of water used in the park for watering.	Park	Every year
ENV23	Public green space distribution	•	City's GIS software.	Entire city	Every year
ENV24	Recreational value of blue-green spaces	•	Questionnaire.	Park	Every year
ENV25	Cultural value of blue-green spaces	•	City registry of events. Counting the number of people visiting the park, as well as observations from installed video surveillance and registration system.	Park	Every year
ENV29	Supporting/increasing biodiversity conservation	•	City's GIS software.	Park	Every year
ENV35	Species diversity	•	Report on the biodiversity.	Park	Every year
ENV42	Land use change and greenspace configuration	•	Questionnaire on satisfaction of visitors to the park.	Park	Every year
ENV48	Access to public amenities	•	Counting the number of people visiting the park from installed video surveillance and registration system.	Park	Every year
ENV56	Blue space area	•	Report on the biodiversity.	Park	Every year
ENV17	Air temperature - Energy demand	•	Flats microclimate monitoring system	Neighbourhood	Every year
ENV26	Community accessibility	•	Counting the number of people visiting the park from installed video surveillance and registration system.	Park	Every year
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	Municipal registry on green areas	Park	Every year
ENV41	Accessibility of greenspaces	•	Counting the number of people visiting the park from installed video surveillance and registration system.	Entire city	Every year
ENV55	Green space area	•	Report on the biodiversity.	Park	Every year
ENV66	Air quality change	•	Data from mobile and stationary air quality stations - http://87.126.141.158/burgas/	Park and area around it	Every year
ENV88	Tree shade for local heat change	•	Thermal imaging	Park	Every 3 years
ENV90	Community garden	•	Municipal registry on green areas	Entire city	Every year

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	area per child capita and in a defined distance				
HW3	General wellbeing and happiness	•	Questionnaires and social surveys.	Entire city	Every year
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW10	Perceived chronic stress	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW11	Mental health and wellbeing	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW12	Enhanced physical activity	•	Number of participants in sport clubs and Burgas Municipality sport events.	Entire city	Every year
HW4	Life expectancy and healthy life years expectancy	•	Statistics from National Statistical Institute.	Entire city	Every year
HW5	Prevalence and incidence of chronic autoimmune diseases	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW8	Incidence of obesity /obesity rates (adults and children)	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW9	Heat reduced mortality	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
HW13	Perceived chronic loneliness	•	Registry of psychiatric hospital.	Entire city	Every year
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	•	Registry of hospitals and Regional Health Inspectorate.	Entire city	Every year
SC4.1	Trust in community	•	Registry of number of community events in the park.	Neighbourhood	Every year
SC4.2	Solidarity between neighbours	•	Registry of number of community events in the park.	Neighbourhood	Every year
SC4.3	Tolerance and respect	•	Registry of number of community events in the park.	Entire city	Every year
SC5.1	Perceived safety	•	Registered accidents in and around the park.	Park and areas around it	Every year
SC5.2	Actual safety	•	Registered accidents in and around the park.	Park and areas around it	Every year
SC6	Place attachment	•	Registry of number of community events in the park and number of visitors.	Park and areas around it	Every year
SC11.1	Positive environmental attitudes motivated by contact with NBS	•	Registry of number of community events in the park and number of visitors.	Entire city	Every year
SC11.2	Environmental identity	•	Registry of number of events.	Entire city	Every year
SC10	Environmental education opportunities	•	Registry of number of events.	Entire city	Every year
SC12	Pro-environmental behaviour	•	Registry of number of events.	Entire city	Every year

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ECO1	New Businesses 'attracted' or started and additional rates received	•	Registry of new economic activities in the area.	Park and areas around it	Every year
ECO3	Net additional jobs created/enabled by NBS	•	Registry of new economic activities in the area.	Park and areas around it	Every year
ECO7	Increase in tourism	•	Registry of visitors.	Entire city	Every year
ECO13	Net impact on public expenditure from NBS implementation	•	Costs for maintenance of the park.	Entire city	Every year
ECO15	Private finance attracted to the NBS site	•	Number of projects implemented.	Entire city	Every year
PPG1	Diversity of stakeholders involved	•	Registry of number of events in the park and number of visitors.	Entire city	Every year
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	•	Registry of number of events in the park and number of visitors.	Entire city	Every year
PPG3	Transparency of co-production	•	Registry of number of events in the park and number of visitors.	Entire city	Every year
PPG5	Activation of public-private collaboration	•	Number of joint initiatives.	Entire city	Every year
PPG6	Trust in decision-making and decision-makers	•	Number of joint initiatives.	Entire city	Every year
PPG10	Open communication (internal & external)	•	Number of joint initiatives.	Entire city	Every year
PPG15	Governance innovations for participatory governance	•	Number of joint initiatives.	Entire city	Every year
PPG16	Community involvement in NBS implementation	•	Registry of number of events in the park and number of visitors.	Entire city	Every year
PPG25	Engagement	•	Registry of number of events in the park and number of visitors.	Entire city	Every year
PPG26	Organizational trust	•	Registry of number of events in the park and number of visitors.	Entire city	Every year

Note. Baseline data is provided by Burgas Municipality, Burgas Airport, hotels, Health system, Eurostat, Bulgarian Society for Protection of Birds and Biodiversity Foundation, and National Meteorological Institute.

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New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Baseline method	Procedure	Sample	Data management	Budget
PI1	Type of interaction with NBS	•	Data will be collected by city registers about the different events organised in the park, as well as short questionnaires handed to people entering the park, as well as on site observations by municipal staff.	1000 people above 18 years.	The data will be collected by municipality staff and will be analysed by the Urban Planning department in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation.
PI2	Frequency of interaction with NBS	•	Data will be collected by the video surveillance system in the park. An application for monitoring each individual entering the park and connected to the free Wi-Fi network there will be developed.	1000 people above 18 years.	The data will be collected by municipality staff and will be analysed by the Urban Planning department in the municipality.	15 000 EUR for development of application for monitoring each individual visitor to the park, who connects to park Wi-Fi.
PI3	Duration of interaction with NBS	•	Questionnaires handed to people entering the park. Application for monitoring each individual entering the park and connected to the free Wi-Fi network there.	1000 people above 18 years.	The data will be collected by municipality staff and will be analysed by the Urban Planning department in the municipality.	15 000 EUR for development of application for monitoring each individual visitor to the park, who connects to park Wi-Fi. 500 EUR for preparing a questionnaire. In-house for data collection and evaluation
PI4	Perceived quality of space	•	Questionnaires handed to people entering the park.	1000 people above 18 years.	The data will be collected by municipality staff and will be analysed by the Urban Planning department in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
ENV3	Air temperature change	•	"Smart" lamp posts with integrated weather stations will be placed at several places within the park.	3 lamp posts	The data will be collected by municipality staff and will be analysed by the Environmental Protection department in the municipality.	17 000 euro for each smart lamp post. data collection and evaluation
ENV8	Rainfall storage (water absorption capacity of NBS)	•	"Smart" lamp posts with integrated weather stations will be placed at several places within the park.	3 lamp posts	The data will be collected by municipality staff and will be analysed by the Environmental Protection department in the municipality.	17 000 euro for each smart lamp post. data collection and evaluation
ENV23	Public green space distribution	•	GIS green system is already functional.	The whole territory of Burgas Municipality.	The data will be collected by municipality staff and will be analysed by the Urban Planning	2 experts /3000 euro each/ to perform necessary assessment.

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					department in the municipality.	
ENV24	Recreational value of blue-green spaces	•	Questionnaires handed to people entering the park.	1000 people above 18 years.	The data will be collected by municipality staff and will be analysed by the Urban Planning department in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
ENV25	Cultural value of blue-green spaces	•	Data will be collected by city registers about the different events organised in the park, as well as short questionnaires handed to people entering the park, as well as on site observations by municipal staff.	1000 people above 18 years.	The data will be collected by municipality staff and will be analysed by the Urban Planning department in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation.
ENV29	Supporting/increasing biodiversity conservation	•	On site observations made by experts from Bulgarian Society for protection of Birds and Biodiversity Foundation will be performed every 6 months. Review information from Birds Watching Applications (e.g. SmartBirds Pro).	Territory of the park and area surrounding it.	The data will be collected and analysed by experts in the field.	2 experts / 1000 euro per year, per expert.
ENV35	Species diversity	•	On site observations made by experts from Bulgarian Society for protection of Birds and Biodiversity Foundation will be performed every 6 months. Review information from Birds Watching Applications (e.g. SmartBirds Pro).	Territory of the park and area surrounding it.	The data will be collected and analysed by experts in the field.	2 experts / 1000 euro per year, per expert.
ENV42	Land use change and greenspace configuration	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
ENV48	Access to public amenities	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
ENV56	Blue space area	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
ENV17	Air temperature - Energy demand	•	Microclimate monitoring system is planned to be installed in several apartments in multi-family buildings near the parl.	10 families.	The data will be collected and analysed by Energy Efficiency and Environmental Protection departments in the municipality.	7 000 euro for monitoring system. In- house for data collection and evaluation.
ENV26	Community accessibility	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
ENV38	Mapping ecosystem services and spatial-temporal biodiversity	•	Data analyses once per year made by Urban Planning department	The whole territory of Burgas	The data will be collected and analysed by the Urban Planning	In- house.

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	legacies		experts	Municipality.	department in the municipality.	
ENV41	Accessibility of greenspaces	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
ENV55	Green space area	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
ENV66	Air quality change	•	Data analyses are performed every month.	The park and area around it.	The data is collected and analysed by Environmental Protection department in the municipality.	In- house.
ENV88	Tree shade for local heat change	•	Drone mapping of the territory will be bade every 3 years (in winter and summer)	The park and area around it.	The data will be collected and analysed by Greening department in the municipality.	5000 euro for territory mapping.
ENV90	Community garden area per child capita and in a defined distance	•	Data analyses once per year made by Urban Planning department experts	The whole territory of Burgas Municipality.	The data will be collected and analysed by the Urban Planning department in the municipality.	In- house.
HW3	General wellbeing and happiness	•	Social survey will be performed every 3 years	500 people above 18 years.	The data will be collected and analysed by sociological company.	5000 EUR for Social survey.
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	•	Social survey will be performed every 3 years	500 people above 18 years.	The data will be collected and analysed by sociological company.	5000 EUR for Social survey.
HW10	Perceived chronic stress	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW11	Mental health and wellbeing	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW12	Enhanced physical activity	•	Collect data from Sports department in the municipality. Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	The park and area around it.	Data will be analysed by Sports department in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
HW4	Life expectancy and healthy life years expectancy	•	Data is published every year by Regional Health Inspectorate and National Statistical Institute.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW5	Prevalence and incidence of chronic autoimmune diseases	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW8	Incidence of obesity /obesity rates (adults and children)	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.

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HW9	Heat reduced mortality	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW13	Perceived chronic loneliness	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	•	Data is published every year by Regional Health Inspectorate.	The whole territory of Burgas Municipality.	Data will be analysed by health department in the municipality.	In- house.
SC4.1	Trust in community	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC4.2	Solidarity between neighbours	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC4.3	Tolerance and respect	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC5.1	Perceived safety	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC5.2	Actual safety	•	Collect data from Municipal Police.	-	Data is being analysed by Municipal Police.	In- house.
SC6	Place attachment	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC11.1	Positive environmental attitudes motivated by contact with NBS	•	Social survey will be performed every 3 years	500 people above 18 years.	The data will be collected and analysed by sociological company.	5000 EUR for Social survey.
SC11.2	Environmental identity	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC10	Environmental education opportunities	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation
SC12	Pro-environmental behaviour	•	Questionnaires handed to people entering the park, as well as on site observations by municipal staff.	500 people visiting the park.	Data will be analysed by different departments in the municipality.	500 EUR for preparing a questionnaire. In-house for data collection and evaluation

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ECO1	New Businesses 'attracted' or started and additional rates received	•	Gathering data annually from the Economic department in the Municipality.	The park and territory around it.	Data will be analysed by Economic department in the municipality.	In house.
ECO3	Net additional jobs created/enabled by NBS	•	Gathering data annually from the Economic department in the Municipality.	The park and territory around it.	Data will be analysed by Economic department in the municipality.	In house.
ECO7	Increase in tourism	•	Gathering data annually from the Tourism department in the Municipality.	The whole territory of Burgas Municipality.	Data will be analysed by Tourism department in the municipality.	In house.
ECO13	Net impact on public expenditure from NBS implementation	•	Gathering data annually from the Economic department in the Municipality.	The park and territory around it.	Data will be analysed by Economic department in the municipality.	In house.
ECO15	Private finance attracted to the NBS site	•	Gathering data annually from the Economic department in the Municipality.	The park and territory around it.	Data will be analysed by Economic department in the municipality.	In house.
PPG1	Diversity of stakeholders involved	•	Municipal register of events organised in the park.	Park.	Data will be analysed by Culture and public relations department in the municipality.	In house.
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	•	Municipal register of events organised in the park.	Park.	Data will be analysed by Culture and public relations department in the municipality.	In house.
PPG3	Transparency of co-production	•	Municipal register of events organised in the park.	Park.	Data will be analysed by Culture and public relations department in the municipality.	In house.
PPG5	Activation of public-private collaboration	•	Social survey will be performed every year.	1000 participants.	Data will be analysed by the management of the municipality.	5000 euro for social survey.
PPG6	Trust in decision-making and decision-makers	•	Social survey will be performed every year.	1000 participants.	Data will be analysed by the management of the municipality.	5000 euro for social survey.
PPG10	Open communication (internal & external)	•	Joint initiatives			
PPG15	Governance innovations for participatory governance	•	Joint initiatives			
PPG16	Community involvement in NBS implementation	•	Joint initiatives			
PPG25	Engagement	•	Joint initiatives			
PPG26	Organizational trust	•	Social survey will be performed every year.	100 participants.	Data will be analysed by the management of the municipality.	3000 euro for social survey.

Note. All indicators will be measured with the same methods of the baseline

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CODE	NAME	Documentary report	Visual charts	Spatial Dashboard	Scientific partners	Economic sector	Higher political levels	Media	Citizens
PI1	Type of interaction with NBS	●		●	●		●		●
PI2	Frequency of interaction with NBS	●		●	●		●		●
PI3	Duration of interaction with NBS	●		●	●		●		●
PI4	Perceived quality of space	●	●		●		●		●
ENV3	Air temperature change		●	●	●		●	●	●
ENV8	Rainfall storage (water absorption capacity of NBS)		●	●	●		●	●	●
ENV23	Public green space distribution		●	●	●		●	●	●
ENV24	Recreational value of blue-green spaces		●	●	●		●	●	●
ENV25	Cultural value of blue-green spaces		●	●	●		●	●	●
ENV29	Supporting/increasing biodiversity conservation		●	●	●		●	●	●
ENV35	Species diversity		●	●	●		●	●	●
ENV42	Land use change and greenspace configuration		●	●	●		●	●	●
ENV48	Access to public amenities		●	●	●		●	●	●
ENV56	Blue space area		●	●	●		●	●	●
ENV17	Air temperature - Energy demand		●	●	●		●	●	●
ENV26	Community accessibility		●	●	●		●	●	●
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies		●	●	●		●	●	●
ENV41	Accessibility of greenspaces		●	●	●		●	●	●
ENV55	Green space area		●	●	●		●	●	●
ENV66	Air quality change		●	●	●		●	●	●
ENV88	Tree shade for local heat change		●	●	●		●	●	●
ENV90	Community garden area per child capita and in a defined distance		●	●	●		●	●	●
HW3	General wellbeing and happiness	●	●		●		●	●	●
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	●	●		●		●	●	●
HW10	Perceived chronic stress	●	●		●		●	●	●
HW11	Mental health and wellbeing	●	●		●		●	●	●
HW12	Enhanced physical activity	●	●		●		●	●	●
HW4	Life expectancy and healthy life years expectancy	●	●		●		●	●	●
HW5	Prevalence and incidence of chronic autoimmune diseases	●	●		●		●	●	●
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases	●	●		●		●	●	●
HW8	Incidence of obesity /obesity rates (adults and children)	●	●		●		●	●	●
HW9	Heat reduced mortality	●	●		●		●	●	●
HW13	Perceived chronic loneliness	●	●		●		●	●	●

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HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)	•	•		•		•	•	•
SC4.1	Trust in community	•	•		•		•	•	•
SC4.2	Solidarity between neighbours	•	•		•		•	•	•
SC4.3	Tolerance and respect	•	•		•		•	•	•
SC5.1	Perceived safety	•	•		•		•	•	•
SC5.2	Actual safety	•	•		•		•	•	•
SC6	Place attachment	•	•		•		•	•	•
SC11.1	Positive environmental attitudes motivated by contact with NBS	•	•		•		•	•	•
SC11.2	Environmental identity	•	•		•		•	•	•
SC10	Environmental education opportunities	•	•		•		•	•	•
SC12	Pro-environmental behaviour	•	•		•		•	•	•
ECO1	New Businesses 'attracted' or started and additional rates received		•	•	•	•	•	•	•
ECO3	Net additional jobs created/enabled by NBS		•	•	•	•	•	•	•
ECO7	Increase in tourism		•	•	•	•	•	•	•
ECO13	Net impact on public expenditure from NBS implementation		•	•	•	•	•	•	•
ECO15	Private finance attracted to the NBS site		•	•	•	•	•	•	•
PPG1	Diversity of stakeholders involved	•	•		•		•		
PPG2	Social equity: involvement of citizens from traditionally under-represented groups	•	•		•		•		
PPG3	Transparency of co-production	•	•		•		•		
PPG5	Activation of public-private collaboration	•	•		•		•		
PPG6	Trust in decision-making and decision-makers	•	•		•		•		
PPG10	Open communication (internal & external)	•	•		•		•		
PPG15	Governance innovations for participatory governance	•	•		•		•		
PPG16	Community involvement in NBS implementation	•	•		•		•		
PPG25	Engagement	•	•		•		•		
PPG26	Organizational trust	•	•		•		•		

Note. Columns 3, 4 and 5 show how the city wants to disseminate the results obtained. The last 5 columns indicate to whom the city will communicate the impact of its NBS assessment.

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Local, regional or national strategies in which the city considers it would be interesting to include the results of the selected indicators

. Burgas Municipality Development Plan 2021-2027

. Climate Strategy of the city 2030

. Regional strategy for development 2021-2027

Local, regional or national organizations to which the city considers it would be interesting to provide the results of the selected indicators to improve the decision-making process

. Other departments of the Burgas City Council

. Non-governmental organizations (e.g., Environmental NGOS)

. Regional Inspectorate for Environmental Protection

. Bulgarian Ministry of Environment (regionally located in Burgas)

. National Directorate for water management

. Professional groups (e.g., city planners, architects ...)

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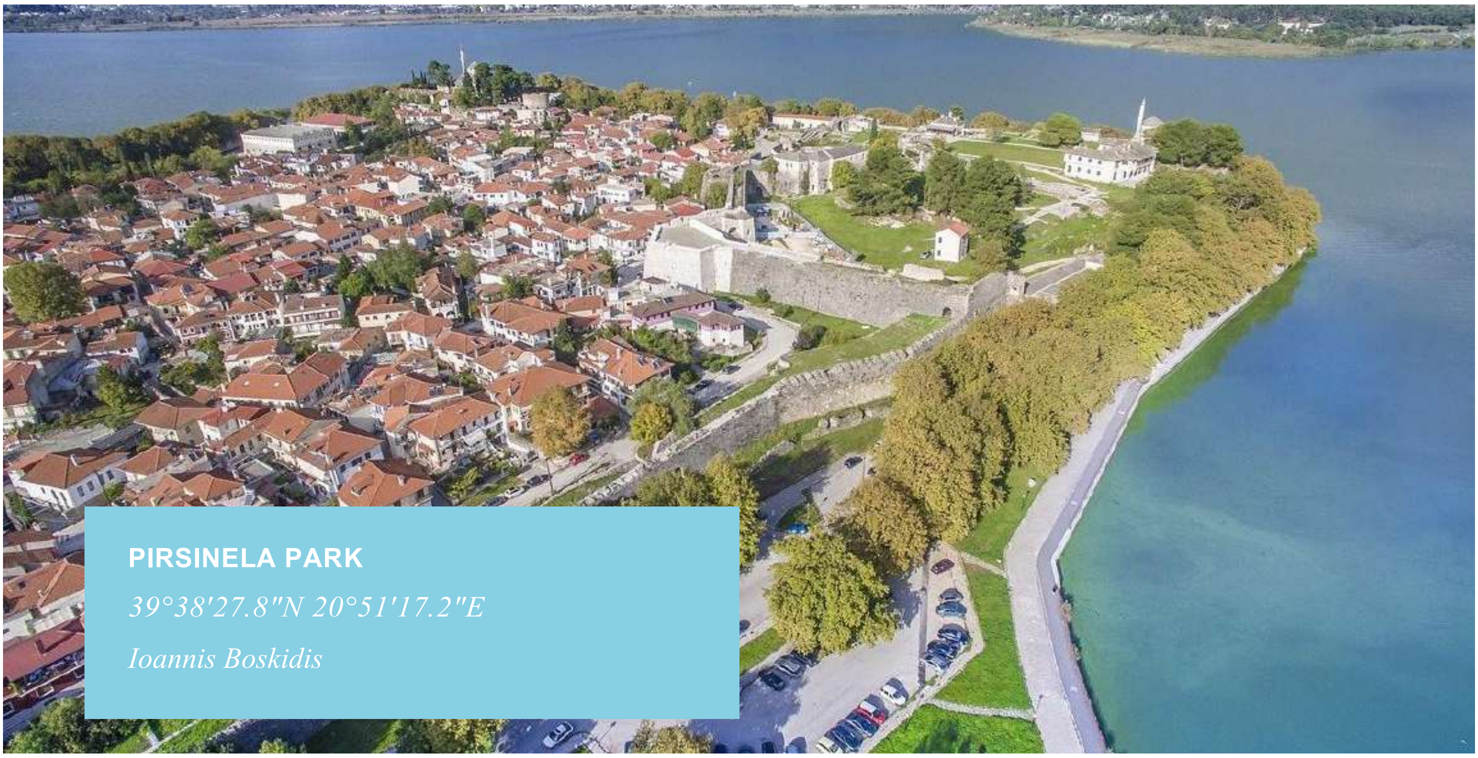
IOANNINA

Impact Assessment Plan



PIRSINELA PARK

39°38'27.8"N 20°51'17.2"E

Ioannis Boskidis

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Increase and improve green spaces			•								•		•		•		
Increase cultural, sports and educational activities			•	•							•						
Upgrade the quality of city's life			•														
Improve citizens' wellbeing			•														

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NBS DESCRIPTION

Type

Urban park

Scale

25 hectares

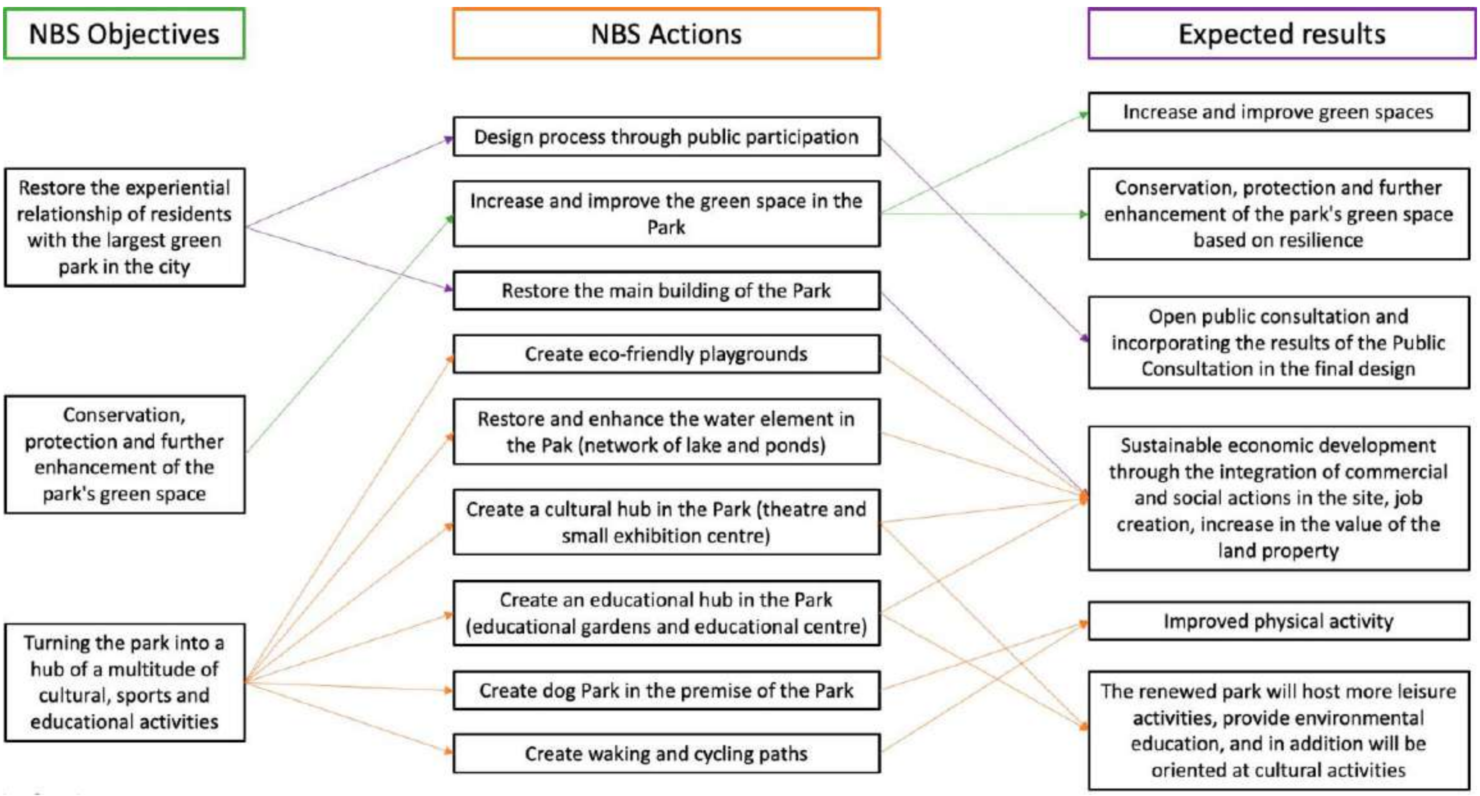
Context description

Restoration of Pirsinela Park, the biggest park in the city and the largest area or existing greenspace (25 ha)

Process of design and implementation

1. Prepare a draft design with the key proposed features of the park, 2. Present the draft design to the Mayor, Vice Mayors and Technical Department for remarks and approval, 3. Present the project to the local community - open public consultation, Incorporating the results of the Public Consultation and finalising the design 4. Presenting the final Park Design to the City Council for approval 5. Approval of the Park's Master Plan from the City Council

Ioannina´s Theory of Change



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Assumptions, synergies and trade-offs

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Design process through public participation	Open public consultation and incorporating the results of the Public Consultation in the final design	If citizens participate in the co-design of the park they will like the final result more	If citizens like the park they will use it more for social activities and exercise	None
Increase and improve the green space in the Park	Increase and improve green spaces	Citizens will like to see the park with dense vegetation, many trees and shady places	If citizens like the park they will use it more for social activities and exercise	Depending on the species it can increase allergies
Restore the main building of the Park	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Citizens will like a place which could host educational and cultural activities	If citizens like the park they will use it more for social activities and exercise	None
Create eco-friendly playgrounds	Sustainable economic development through the integration of commercial and social actions in the site, job creation, increase in the value of the land property	Citizens will like to see a safe and eco-friendly place for their kids to play	If citizens like the park they will use it more for social activities and exercise	None
Restore and enhance the water element in the Pak (network of lake and ponds)	Sustainable economic development through the integration of commercial and social actions in the site, job creation, increase in the value of the land property	Citizens will appreciate a more versatile environment combining green and blue elements	If citizens like the park they will use it more for social activities and exercise	None
Create a cultural hub in the Park (theatre and small exhibition cente)	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Citizens will like a place which could host educational and cultural activities	More opportunities for social interaction between citizens	None
Create an educational hub in The Park (educational gardens and educational center)	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Citizens will like a place which could host educational and cultural activities	More opportunities for social interaction between citizens	None
Create dog Park in the premise of the Park	Improved physical activity	Citizens will like a safer and more organised place for them and their pets	If group physical activity is favoured, social interaction will increase	It may increase noise in the Park
Create waking and cycling paths	Improved physical activity	Citizens will like a greener place for physical activities in the city	If group physical activity is favoured, social interaction will increase	None

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CODE	NAME	NBS expected result	Selection reasoning
PI1	Type of interaction with NBS	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Measure what type of activities the citizens more often do in the Pak
PI2	Frequency of interaction with NBS	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Measure how frequently the citizens visit the Park
PI3	Duration of interaction with NBS	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Measure how much time the citizens spend in the Park
ENV23	Public green space distribution	Increase and improve green spaces	Measure how the Pak affected the green space distribution in the city fabric
ENV89	Community garden area per capita and in a defined distance	Sustainable economic development through the integration of commercial and social actions in the site, job creation, increase in the value of the land property	Measure how the Pak affected the green space distribution in the city fabric
ENV26	Community accessibility	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Measure the ease of access to the Pak
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	Increase and improve green spaces	Measure how the Pak affected the green space distribution in the city fabric
HW12	Enhanced physical activity	Improved physical activity	Establish the amount of physical activity that the residents of the park do
SC1	Bonding social capital	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Know how are the social relations between the same social groups
SC5.1	Perceived safety	Sustainable economic development through the integration of commercial and social actions in the site, job creation, increase in the value of the land property	Know how the restoration of the Pak affected the feeling of safety in the area
SC11.1	Positive environmental attitudes motivated by contact with NBS	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Know how the Park changed the citizens' relationship with nature
SC10	Environmental education opportunities	The renewed park will host more leisure activities, provide environmental education, and in addition will be oriented at cultural activities	Measure the new education activities conducted in the Park
ECO1	New Businesses 'attracted' or started and additional rates received	Sustainable economic development through the integration of commercial and social actions in the site, job creation, increase in the value of the land property	Establish if there are new businesses since the implementation of the park
ECO2	New customers to business in proximity to NBS	Sustainable economic development through the integration of commercial and social actions in the site, job creation, increase in the value of the land property	Establish how the rest of the businesses in the area affected since the implementation of the park
PPG3	Transparency of co-production	open public consultation and incorporating the results of the Public Consultation in the final design	Know the public perception of whether the park implementation process was transparent

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BUILDING BLOCK 3. DEVELOPING A DATA PLAN FOR IMPACT EVALUATION

Ioannina does not have an available baseline for the selected indicators. The data plan will consist of the new data collections, specified in Building Block 4

BUILDING BLOCK 4. IMPLEMENTING THE DATA PLAN

New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Connecting Nature method	Data management
PI1	Type of interaction with NBS	Questionnaire (ad hoc)	The data will be collected by external expert
PI2	Frequency of interaction with NBS	Questionnaire (ad hoc)	The data will be collected by external expert
PI3	Duration of interaction with NBS	Questionnaire (ad hoc)	The data will be collected by external expert
ENV23	Public green space distribution	Aerial photography combined with census data	Analysis will be conducted by the municipality's Technical Depatment
ENV89	Community garden area per capita and in a defined distance	GIS distance to greenspace (mapping buffer areas of 330 and 660m)	Analysis will be conducted by the municipality's Technical Depatment
ENV26	Community accessibility	ArcGIS ModelBuilder environment: actual proximity to green spaces	Analysis will be conducted by the municipality's Technical Depatment
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	Light Detection And Ranging (LiDAR) data	Analysis will be conducted by the municipality's Technical Depatment
HW12	Enhanced physical activity	International Physical Activity Questionnaire (IPAQ)	The data will be collected by external expert
SC1	Bonding social capital	2 items measuring the presence type of connections, and respondent's perception of quality of interactions (Anucha et al., 2006)	The data will be collected by external expert
SC5.1	Perceived safety	Criminal Victimization and Perceptions of Community Safety Survey(Smith et al., 1999)	The data will be collected by external expert
SC11.1	Positive environmental attitudes motivated by contact with NBS	Environmental Attitudes Inventory (EAI – Milfont & Duckitt, 2010)	The data will be collected by external expert
SC10	Environmental education opportunities	Ethnographic case study	The data will be collected by external expert
ECO1	New Businesses 'attracted' or started and additional rates received	No. of new start-ups in 'close proximity' to NBS	The data will be collected by external expert
ECO2	New customers to business in proximity to NBS	Conversion rate is defined the proportion of shop/area visitors who actually make a purchase	The data will be collected by external expert
PPG3	Transparency of co-production	Questionnaire (ad hoc)	The data will be collected by external expert

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BUILDING BLOCK 5. INTEGRATING EVIDENCE INTO THE POLICY PROCESS

CODE	NAME	Documentary report	Visual charts	Spatial Dashboard
PI1	Type of interaction with NBS	•		
PI2	Frequency of interaction with NBS	•		
PI3	Duration of interaction with NBS	•		
ENV23	Public green space distribution	•	•	•
ENV89	Community garden area per capita and in a defined distance	•	•	•
ENV26	Community accessibility	•	•	•
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	•	•
HW12	Enhanced physical activity	•		
SC1	Bonding social capital	•		
SC5.1	Perceived safety	•		
SC11.1	Positive environmental attitudes motivated by contact with NBS	•		
SC10	Environmental education opportunities	•		
ECO1	New Businesses 'attracted' or started and additional rates received	•		
ECO2	New customers to business in proximity to NBS	•		
PPG3	Transparency of co-production	•		

Note. Columns 3, 4 and 5 show how the city wants to disseminate the results obtained.

Local, regional or national strategies in which the city considers it would be interesting to include the results of the selected indicators

Green space strategy

Local, regional or national organizations to which the city considers it would be interesting to provide the results of the selected indicators to improve the decision-making process

Ioannina City Council

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MÁLAGA

Impact Assessment Plan

LAGUNILLAS LAS YUCAS ORCHARD

37°00'25.7"S 174°54'13.6"E

Jesús Terrazas, Cristian García-Espina, Mariano Morán, Virginia Walch

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Employment rate			●	●	●												●
Meeting point			●		●						●						●
Gender equality				●							●						●
Reduce loneliness			●							●							●
Co-production in urban settings			●								●						●
CO2 reduction							●						●				

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NBS DESCRIPTION

Type

Urban garden

Scale

400 m2

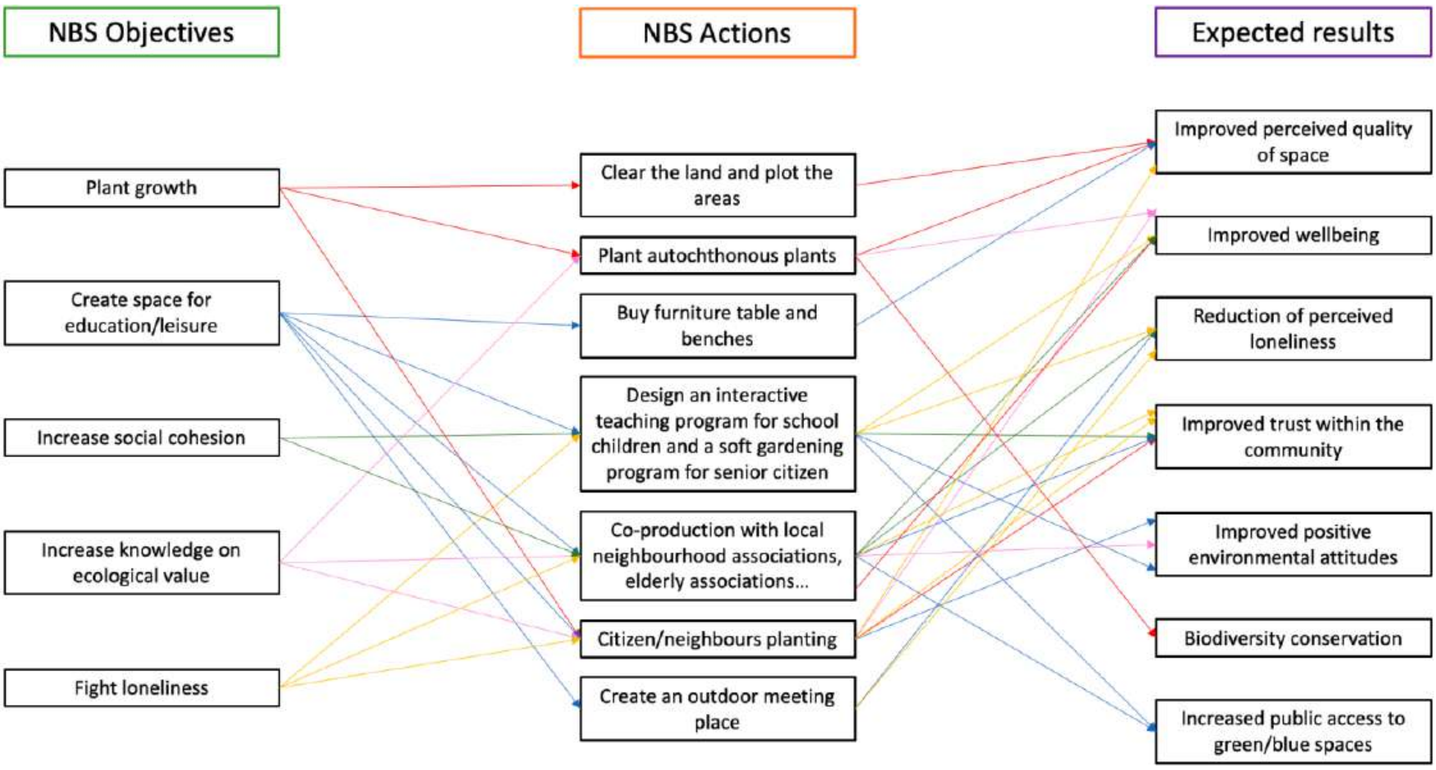
Context description

In the city center, in Lagunillas Neighbourhood

Process of design and implementation

It’s a public plot in a poor neighbourhood where little green is found. The idea was to create a plot to plant and cultivate autochthonous plants and insects from the area as well has having a meeting point for the neighbours. Several meetings have been taken place between local authorities and neighbourhood associations. The idea was to build urban garden for the neighbourhoods and for the children to learn in an interactive and interesting way. This plot was also pursuing other objectives, like training and upscaling educational programs, dissemination of NbS among neighbours, neighbour’s involvement and commitment, citizen planting and maintaining.

Málaga´s Theory of Change



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Assumptions, synergies and trade-offs

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Clear the land and plot the areas	Improved local participation and perceived quality of space	Regular activity will fight loneliness	Neighbours will have a periodic activity to look for → could generate wellbeing and happiness	None
Plant autochthonous plants	Improved perceived quality of space	neighbours will have the sense of belonging	they will care and take care of the space → trust and access in the community	Rivalry among neighbours may arise.
Plant autochthonous plants	Environmental education opportunities	Will help to assess the importance of green and its usefulness.	generate positive environmental attitudes motivated by contact with NbS.	None
Buy furniture table and benches	Improved social cohesion	Neighbours will have a place to talk and interact	Will improve interaction and fight loneliness	None
Buy furniture table and benches	Improved perceived quality of space	Neighbours will have a nice meeting point	Will improve state of mind of neighbours as well as facilitate easier access to the community	May cause new disputes among neighbours.
Design an interactive teaching program for school children and a soft gardening program for senior citizen	Improved education and knowledge	Will help to assess the importance of green and its usefulness.	Will improve level of knowledge and interaction and generate positive environmental attitudes motivated by contact with NbS	None.
Co-production with local neighbourhood associations, elderly associations….	Improved confidence and sense of belonging	Build up neighbours' expectations.	Neighbours will show more interest in the project. and generate positive environmental attitudes motivated by contact with NbS.	None
Co-production with local neighbourhood associations, elderly associations….	Improved integration of neighbours and facilitate social interaction	Fight loneliness	improve social cohesion and facilitates relationship among neighbours as well as trust in the community	With time could lose interest
Citizen/neighbours planting	Fight loneliness	Users will interact with each other	Will improve social cohesion and trust in the community	Could create disputes among users.
Create an outdoor meeting place	Improved perceived quality of space	Will fight loneliness and improve	Will generate wellbeing and happiness	None
Create an outdoor meeting place	Recreational value of green spaces	Will improved perceived quality of green spaces	Will create positive environmental attitudes motivated by contacts with NbS	None
Create an outdoor meeting place	Facilitate community accessibility	Will facilitate interaction among users	Will fight loneliness and improve social cohesion	Could create conflicts or group divisions as relationships grow

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CODE	NAME	NBS expected result	Selection reasoning
PI4	Perceived quality of space	Improved perceived quality of green space	Know the perceived quality of the new park
ENV24	Recreational value of blue-green spaces	Improved perceived quality of green space	Measure decrease loneliness among users
ENV25	Cultural value of blue-green spaces	Improved perceived quality of green space	Measure the level of engagement of neighbours
ENV29	Supporting/increasing biodiversity conservation	Positive environmental attitudes motivated by contact with NBS	Plant autochthonous plants and disseminate for support
ENV35	Species diversity	Improved perceived quality of green space	Will improve positive environmental attitudes towards NbS
ENV42	Land use change and greenspace configuration	Improved perceived quality of green space	Try to measure the perceived quality of green spaces
ENV26	Community accessibility	Trust in community	Will this improve relationship between community members? Between users?
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	Improved perceived quality of green space	Questionnaire to the neighbors
ENV41	Accessibility of greenspaces	Community accessibility	Questionnaire to the neighbors
ENV55	Green space area	Improved perceived quality of green space	Since the establishment of the plot what has improved?
ENV66	Air quality change	Improved perceived quality of green space	Since the establishment of the plot what has improved?
HW3	General wellbeing and happiness	Improved perceived quality of green space	Try to find out neighbors perception
HW12	Enhanced physical activity	Community accessibility	Questionnaire to the neighbours
HW13	Perceived chronic loneliness	Decrease loneliness	Benefits of community planting
HW15	Exploratory behaviour in children	Improved perceived quality of green space	Can we establish a new way to teach children?
SC4.1	Trust in community	Community accessibility	Measure wellbeing and happiness
SC4.2	Solidarity between neighbours	Trust in community	Try to find out how relationship between neighbors has improved. Factors
SC4.3	Tolerance and respect	Trust in community	Direct link between trust in community and general wellbeing and happiness
SC6	Place attachment	Decrease loneliness	How does place attachment decrease loneliness
SC9	Empowerment	Trust in community	Show link between empowerment and trust in community
SC11.1	Positive environmental attitudes motivated by contact with NBS	General wellbeing and happiness	Measure the degree of happiness related to NbS activity
SC11.2	Environmental identity	Positive environmental attitudes motivated by contact with NBS	Measure the degree of happiness related to NbS activity
SC10	Environmental education opportunities	Positive environmental attitudes motivated by contact with NBS	How to manage educational opportunities for all age layers.
ECO1	New Businesses 'attracted' or started and additional rates received	Positive environmental attitudes motivated by contact with NBS	Positive effect on neighbourhood future employment?
ECO6	Innovation impact	Positive environmental attitudes motivated by contact with NBS	How will this motivate/generate positive attitude in a typical neighbourhood?
ECO11	Overall economic, social and health wellbeing	General wellbeing and happiness	Show how to improve all those factors
PPG5	Activation of public-private collaboration	Trust in community	Evaluate cooperation
PPG6	Trust in decision-making and decision-makers	Trust in community	Is this a participatory process, who is involved?
PPG15	Governance innovations for participatory governance	Community accessibility	What can be done to improve the participatory gevernance
PPG16	Community involvement in NBS implementation	Trust in community	How to improve effectiveness of this process
PPG23	Team cohesion	Trust in community	What measures do we need to implement to reach team cohesion
PPG25	Engagement	Trust in community	Try to integrate all stakeholders in project development

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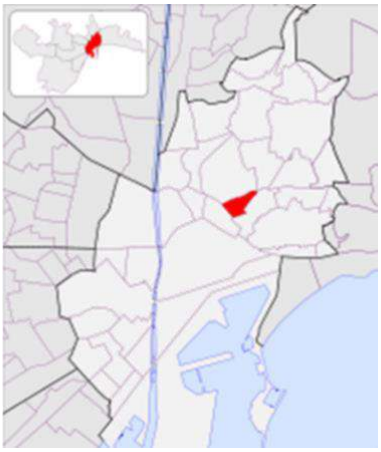
Available baseline in the city of Málaga

CODE	NAME	Baseline data	Source (year)	Granularity	Periodicity
ENV24	Recreational value of blue-green spaces	•	Datos abiertos - Málaga (2021)	City	Specific study
ENV25	Cultural value of blue-green spaces	•	SIG - Málaga (2021)	City	Specific study
ENV29	Supporting/increasing biodiversity conservation	•	OMAU - Málaga (2009)	City	Specific study
ENV35	Species diversity	•	OMAU - Málaga (2009)	City	Specific study
ENV42	Land use change and greenspace configuration	•	OMAU - Málaga (2019)	District	Every year
ENV26	Community accessibility	•	OMAU - Málaga (2019)	District	Every year
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	OMAU - Málaga (2019)	District	Every year
ENV41	Accessibility of greenspaces	•	OMAU - Málaga (2019)	District	Every year
ENV55	Green space area	•	OMAU - Málaga (2019)	District	Every year
ENV66	Air quality change	•	OMAU - Málaga (2019)	District	Every year
HW12	Enhanced physical activity	•	OMAU - Málaga (2019)	City	Every year
HW13	Perceived chronic loneliness	•	OMAU - Málaga (2019)	City	Every year
PPG5	Activation of public-private collaboration	•	Datos abiertos - Málaga (2021)	City	Specific study

Note. By clicking on the information in the "Source" column, you can access the original data.



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New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Baseline method	Connecting Nature method
PI4	Perceived quality of space		Questionnaire (ad hoc)
ENV24	Recreational value of blue-green spaces	•	
ENV25	Cultural value of blue-green spaces	•	
ENV29	Supporting/increasing biodiversity conservation		Biodiversity monitoring programme Pocock et al. (2015)
ENV35	Species diversity		Urban Biodiversity Inventory Framework (UBIF 2017)
ENV42	Land use change and greenspace configuration	•	
ENV26	Community accessibility	•	
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	
ENV41	Accessibility of greenspaces	•	
ENV55	Green space area	•	
ENV66	Air quality change	•	
HW3	General wellbeing and happiness		Satisfaction with Life Scale (Diener et al., 1985)
HW12	Enhanced physical activity		International Physical Activity Questionnaire (IPAQ)
HW13	Perceived chronic loneliness	•	
HW15	Exploratory behaviour in children		Ethnographic case study (e.g., Stanley, 2011)
SC4.1	Trust in community		Trust and Solidarity" scale (SC-IQ) (Grootaert et al., 2004)
SC4.2	Solidarity between neighbours		Items measuring perception of solidarity from "Trust and Solidarity" scale (SC-IQ) (Grootaert et al., 2004)
SC4.3	Tolerance and respect		Neighbourhood Social Cohesion – 'Tolerance or Respect' Scale (Stafford et al., 2003)
SC6	Place attachment		Place Identity Scale (Williams & Vaske, 2003)
SC9	Empowerment		"Empowerment and Political Action" (SC-IQ) (Grootaert et al., 2004)
SC11.1	Positive environmental attitudes motivated by contact with NBS		Environmental Attitudes Inventory (EAI – Milfont & Duckitt, 2010)
SC11.2	Environmental identity		Environmental Identity Scale (Clayton, 2003)
SC10	Environmental education opportunities		Ethnographic case study
ECO1	New Businesses 'attracted' or started and additional rates received		No. of new start-ups in 'close proximity' to NBS
ECO6	Innovation impact		Annual revenue arising for sales of new products / services;
ECO11	Overall economic, social and health wellbeing		Human Development Index
PPG5	Activation of public-private collaboration		Measurement or count data for number of collaborations activated
PPG6	Trust in decision-making and decision-makers		Questionnaire (ad hoc)
PPG15	Governance innovations for participatory governance		Questionnaire (ad hoc)
PPG16	Community involvement in NBS implementation		Questionnaire based on Arnstein's (1969) ladder of citizen participation
PPG23	Team cohesion		Social support scale from The Job Demands-Resources Questionnaire (Bakker, & Demerouti, 2014)
PPG25	Engagement		Utrecht Work Engagement Scale Short version (Schaufeli, Shimazu, Hakanen, Salanova, & De Witte, 2019)

Note. Some indicators will be measured with the same methods of the baseline

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BUILDING BLOCK 5. INTEGRATING EVIDENCE INTO THE POLICY PROCESS

CODE	NAME	Documentary report	Visual chart	Spatial dashboard	Scientific partners	Higher political levels	Media
PI4	Perceived quality of space	•		•		•	
ENV24	Recreational value of blue-green spaces	•	•			•	
ENV25	Cultural value of blue-green spaces	•	•			•	
ENV29	Supporting/increasing biodiversity conservation	•		•	•	•	•
ENV35	Species diversity	•		•	•	•	•
ENV42	Land use change and greenspace configuration			•		•	
ENV26	Community accessibility			•		•	
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies			•		•	
ENV41	Accessibility of greenspaces			•		•	
ENV55	Green space area			•		•	
ENV66	Air quality change			•		•	
HW3	General wellbeing and happiness	•	•		•	•	
HW12	Enhanced physical activity	•	•		•	•	
HW13	Perceived chronic loneliness	•	•		•	•	
HW15	Exploratory behaviour in children	•	•		•	•	
SC4.1	Trust in community	•	•		•	•	
SC4.2	Solidarity between neighbours	•	•		•	•	
SC4.3	Tolerance and respect	•	•		•	•	
SC6	Place attachment	•	•		•	•	
SC9	Empowerment	•	•		•	•	
SC11.1	Positive environmental attitudes motivated by contact with NBS	•	•		•	•	
SC11.2	Environmental identity	•	•		•	•	
SC10	Environmental education opportunities	•	•		•	•	
ECO1	New Businesses 'attracted' or started and additional rates received		•	•		•	
ECO6	Innovation impact		•	•		•	
ECO11	Overall economic, social and health wellbeing		•	•		•	
PPG5	Activation of public-private collaboration	•				•	
PPG6	Trust in decision-making and decision-makers	•				•	
PPG15	Governance innovations for participatory governance	•				•	
PPG16	Community involvement in NBS implementation	•				•	
PPG23	Team cohesion	•				•	
PPG25	Engagement	•				•	

Note. Columns 3, 4 and 5 show how the city wants to disseminate the results obtained. The last 3 columns indicate to whom the city will communicate the impact of its NBS assessment.

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NICOSIA

Impact Assessment Plan

URBAN NETWORK OF OPEN AND GREEN SPACES & ADOPT A PARK SCHEME

35°07'39.2"N 33°23'23.9"E

Eleni Malekkidou, Eleftherios Loizou

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Increase green spaces			•								•						
Increase the physical activity of citizens			•														
Co-production in urban interventions			•														•
Increase Accessibility to open and green spaces			•								•				•		
Improving quality of citizens life																	
Improve social cohesion			•							•							

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NBS DESCRIPTION 1

Type	Scale
Urban network of Linked Open and Green spaces (District level)	District level

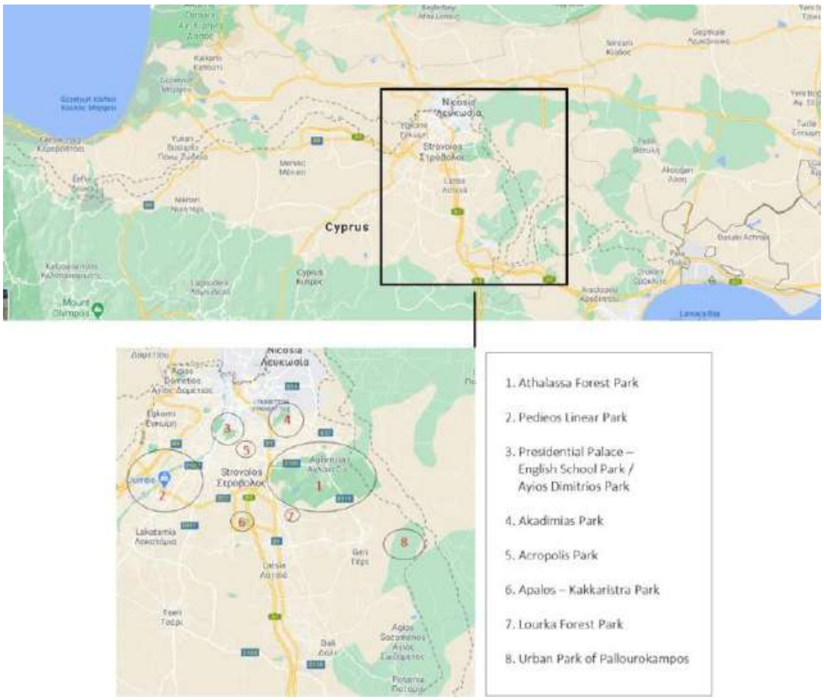
Context description

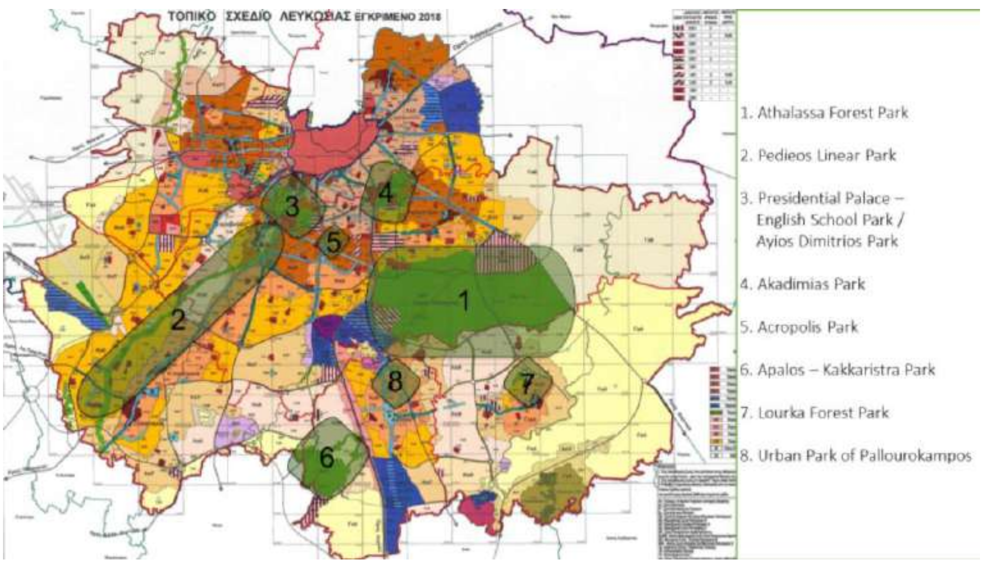
Creation of a network of Open and Green spaces with strong mobility linkages.

Process of design and implementation

The idea was based on the need expressed by all our member municipalities to create new open and green spaces for their citizens in order to improve their quality of life and the available options provided in their area for physical activity, fan etc. The proposed plan is included to the Local Strategic Sustainable Development Plan that will be submitted for funding at the Directorate General for European Programmes, Coordination and Development.

A number of meetings were held and still planned to be held with different stakeholders (Municipalities – municipal officers, Government departments such as Department of Forest, Department of Planning and Development, Department of Environment etc, politicians, universities, experts and citizens). A public participatory process has been already done in December.





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NBS DESCRIPTION 2

Type

Adopt a park scheme

Scale

The scale of the park is small / medium

Context description

Partnerships between city government and businesses and enterprises. There were limited opportunities to involve business (the large parks are funded by city/government) so we found these smaller parks/smaller green spaces. The smaller parks are owned by the municipality – more flexible in cooperating with the private sector. At the moment we have identified 200 spaces. A call will be announced of these 200 spaces to be adopted in early 2021. The plan is being developed – and the business adopter will need to meet the guidelines set in order to adopt the park. (Part of the CSR strategies)

Process of design and implementation

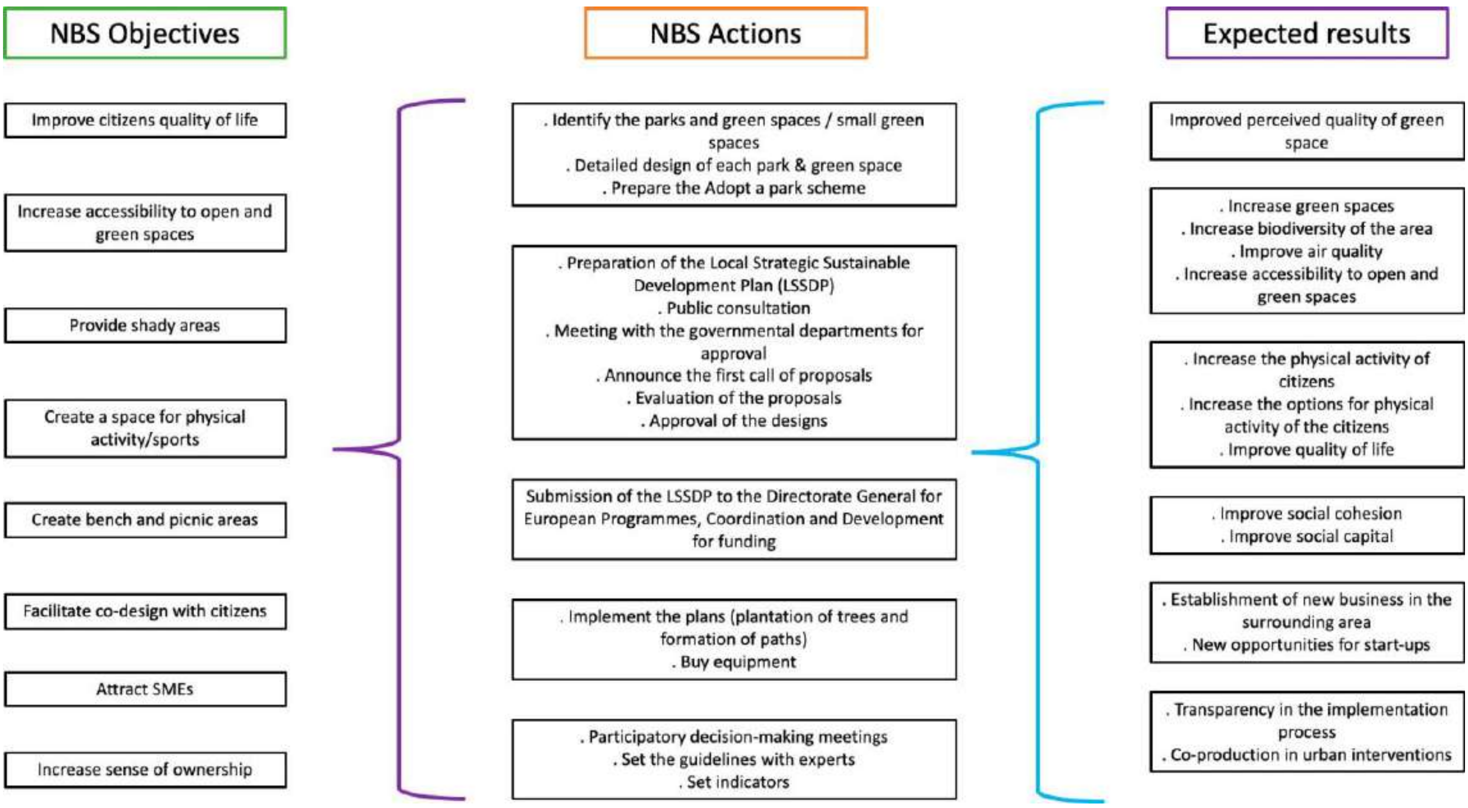
The idea was based on the need identified: limited opportunities to involve business (the large parks are funded by city/government).

A number of meetings with businesses and member municipalities were held in order to find the optimal way of cooperation.

The team is trying to build a win-win situation. Give to the businesses/enterprises incentives to invest in our project. (Corporate Social Responsibility Strategies)

The scheme is been prepared and the first call for adoption (the first 200 spaces) will be announced in early 2021

Nicosias´s Theory of Change



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Assumptions, synergies and trade-offs

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Identify the parks and green spaces	Find the most appropriate spaces all over the area of intervention in order to create the most functional network for the use of citizens.	The identification and selection of the right spaces and design of the proper linkages, will help to the success of the proposed network.	More people will use the parks for family gatherings, fan/socialise in general, physical activity, relaxation etc.	Garbage can increase.
Preparation of the Local Strategic Sustainable Development Plan	The plan will include the proposed network and that will help the municipalities to find the funding for implementation.	With the approval of the Plan municipalities along with Nicosia Development Agency will be able to implement faster the proposed activities.	This will help the municipalities to save some of the annual budget for other crucial activities and plans they have.	None
Public Consultation	Transparency in the implementation process	If the design is participatory, access to information will be simpler and more complete	Transparency in implementation will favour perceived quality	None
Submission of the Local Strategic Sustainable Development Plan to the Directorate General for European Programmes, Coordination and Development for funding.	Source of finance.	Quicker implementation.	The involvement of the Directorate General for European Programmes, Coordination and Development will help to the promotion of the network.	None
Detailed design of each of the park & green space	Collaboration of experts.	The detailed design will help to be more accurate when preparing the budgets / expected costs.		None
Set of indicators	Be able to adopt quickly possible changes.		Good management of the plans.	None
Meetings with the Governmental departments for approval	Transparency in the implementation process – More expertise	Secure all the necessary permissions from the government (Planning and building permissions, Environmental permissions etc)	Transparency in implementation will favour perceived quality.	None
Implement the plans – Proceed with the Plantation of trees and formation of paths	Increased biodiversity of the area	Dense vegetation will allow the survival of a greater number of species	Increasing biodiversity will favour a greater perception of quality.	Depending on the species it can increase allergies
Buy Equipment	New jobs in the surrounding area	If more people spend time to the parks this may generate business for the sale either of food and drink, bike rentals, sports equipment, etc	New businesses near the park will favour its perceived quality	If there are no recycling facilities, garbage can increase.
Participatory decision-making meetings	Improved social capital	Being a participatory process, citizens will interact socially with others	Using the park to interact socially will favour its perceived quality	None

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BUILDING BLOCK 2. CHOOSING APPROPRIATE INDICATORS

CODE	NAME	NBS expected result	Selection reasoning
PI4	Perceived quality of space	Improved perceived quality of green space in the district of Nicosia	Know the perceived quality of the new park
ENV29	Supporting/increasing biodiversity conservation	Increased biodiversity of the area	Find out if there are more efforts to improve biodiversity
ENV35	Species diversity	Increased biodiversity of the area	Know the number of species currently in the parks – measure the change after the enrichment
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	Increase of urban green space in the district of Nicosia	Nicosia is a grey city and the increase of green spaces is a very important indicator for the selected NBS
ENV41	Accessibility of greenspaces	Improve accessibility of greenspaces (parks)	Ensure the accessibility of all social
ENV43	Ratio of open spaces to built form	Improve accessibility of greenspaces (parks)	Ensure the accessibility of all social
Env88	Tree shade for local heat change	Increase tree shade	The climate in Cyprus requests this kind of interventions. Find out how the implementation of the NBS helped in numbers the improvement of the current situation
HW12	Enhanced physical activity	Improved physical activity	Establish the amount of physical activity that the citizens of Nicosia near the parks do.
SC1	Bonding social capital	Improved social capital	Know how are the social relations between the same social groups
SC6	Place attachment	Increase the feeling of place attachment (citizens)	Establish and empower the feeling of place attachment of the citizens with the parks in their area.
SC10	Environmental education opportunities	Increase the feeling of place attachment (citizens)	Establish and empower the feeling of place attachment of the citizens with the parks in their area.
ECO1	New Businesses 'attracted' or started and additional rates received	New jobs in the area	Establish if there are new businesses since the implementation of the green network and the adopt a park scheme
PPG3	Transparency of co-production	Transparency in the implementation process	Know the public perception of whether the green network implementation process was transparent
PPG4	Policies adopted to promote NBS	Improve / increase the PP Collaborations	Adopt a Park Scheme
PPG5	Activation of public-private collaboration	Improve / increase the PP Collaborations	Adopt a Park Scheme

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Available baseline in the city of Nicosia

CODE	NAME	Baseline data	Source (year)	Granularity	Periodicity
PI4	Perceived quality of space	•	Study from a local university (2019)	Entire city	Specific study
ENV29	Supporting/increasing biodiversity conservation	•	Study from a local university (2019) Forest Department Sensors (24 hours census) (2018) Birdlife Cyprus	Entire city	Every year
ENV35	Species diversity	•	Landstat (2018-2021) Forest Department (2016-2021)	Entire city	Every 5 yrs
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	Municipal Technical Departments	Entire city	Every year
ENV41	Accessibility of greenspaces	•	Municipal Technical Departments	Entire city	Every year
ENV43	Ratio of open spaces to built form	•	Municipal Technical Departments	Entire city	
Env88	Tree shade for local heat change	•	Study from the University of Cyprus (Department of Architecture) (2018)	Street	Specific study
HW12	Enhanced physical activity	•	Study from the University of Cyprus (Department of Architecture) & Department of health services - statistics (2018)	Street	Specific study
SC1	Bonding social capital	•	Study from the University of Cyprus (Department of Architecture) (2018)	Entire city	Specific study
SC6	Place attachment	•	Study from the University of Cyprus (Department of Architecture) (2018)	Street	Specific study
SC10	Environmental education opportunities	•	Forest Department (statistics – visitors/month/year of Environmental centres – schools etc) Department of Environment Ministry of Education Study from a local university (2017)	Entire city	Every year
ECO1	New Businesses 'attracted' or started and additional rates received	•	Cyprus Chamber Of Commerce and Industry (2018) Ministry of Finance	ZIP Code	Every year
PPG3	Transparency of co-production	•	Municipalities	Entire city	
PPG4	Policies adopted to promote NBS	•	Ministry of Finance	ZIP Code	Every 5 yrs
PPG5	Activation of public-private collaboration	•	Ministry of Finance Ministry of Interior	Municipal level	Every year

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BUILDING BLOCK 4. IMPLEMENTING THE DATA PLAN

New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Baseline method	Data collection season	Procedure	Data management
PI4	Perceived quality of space	•	Indifferent	Collaboration with the University of Cyprus	Collaboration with the University of Cyprus on the analysis of the results.
ENV29	Supporting/increasing biodiversity conservation	•	Warm season vs Cold	. Data collected from the Forest department sensors - (24-hour census), recording as many species as possible . Observations – Reports of Forest Department	All records analysed by the team of ANEL in collaboration
ENV35	Species diversity	•	Warm season vs Cold	. The Landsat satellite images will be reviewed by registering on the web and accessing the years 2018-2021 . Forest Department Reports and Analysis available from 2016 – 2021	Collaboration with the University of Cyprus on the analysis of the results
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	Indifferent	Collaboration with Municipal Technical Departments	Collaboration with the University of Cyprus on the analysis of the results
ENV41	Accessibility of greenspaces	•	Indifferent	Collaboration with Municipal Technical Departments	Collaboration with the University of Cyprus on the analysis of the results
ENV43	Ratio of open spaces to built form	•	Indifferent	Collaboration with Municipal Technical Departments	Collaboration with the University of Cyprus on the analysis of the results
Env88	Tree shade for local heat change	•	Indifferent	Collaboration with the University of Cyprus	The data will be collected and analysed by ANEL
HW12	Enhanced physical activity	•	Warm season vs Cold	Collaboration with the University of Cyprus	Collaboration with the University of Cyprus on the analysis of the results
SC1	Bonding social capital	•	Indifferent	Collect Available data from the University of Cyprus and European University. (2018) Collect data from the Department of health services - statistics	Collaboration with the University of Cyprus on the analysis of the results
SC6	Place attachment	•	Indifferent	Collect Available data from the University of Cyprus	Data Analysis by ANEL
SC10	Environmental education opportunities	•	Indifferent	Available data from the Environmental Centres (managed by the Forest Department) Available data from the Environmental Centres (managed by Department of Environment) Available data from the Ministry of Education	The data will be collected and analysed by ANEL
ECO1	New Businesses 'attracted' or started and additional rates received	•	Indifferent	Cyprus Chamber of Commerce and Industry registers	The data will be collected and analysed by ANEL
PPG3	Transparency of co-production	•	Indifferent	Available data from the Municipalities (In 2019 – 2020 the Union of Municipalities made a research on the topic in collaboration with ANEL and the Centre of Expertise for Local Government Reform of the European Council	Data Analysis by ANEL
PPG4	Policies adopted to promote NBS	•	Indifferent	Analysis of the available policies updates related to NBS	The data will be collected and analysed by ANEL
PPG5	Activation of public-private collaboration	•	Indifferent	Data available from Ministry of Interior (Department of Planning) and Municipalities related to PPC	The data will be collected and analysed by ANEL

Note. All indicators will be measured with the same methods of the baseline

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BUILDING BLOCK 5. INTEGRATING EVIDENCE INTO THE POLICY PROCESS

CODE	NAME	Documentary report	Visual charts	Spatial Dashboard	Scientific partners	Economic sector	Higher political levels	Media	Citizens
PI4	Perceived quality of space	•	•		•	•		•	•
ENV29	Supporting/increasing biodiversity conservation	•		•	•		•	•	•
ENV35	Species diversity	•		•	•		•	•	•
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•		•	•		•	•	•
ENV41	Accessibility of greenspaces	•	•			•	•	•	•
ENV43	Ratio of open spaces to built form	•		•	•		•	•	•
Env88	Tree shade for local heat change	•	•		•		•	•	•
HW12	Enhanced physical activity	•			•		•	•	•
SC1	Bonding social capital	•	•		•				•
SC6	Place attachment	•						•	•
SC10	Environmental education opportunities	•			•		•	•	
ECO1	New Businesses 'attracted' or started and additional rates received	•	•		•	•	•	•	
PPG3	Transparency of co-production	•			•		•	•	
PPG4	Policies adopted to promote NBS	•			•	•	•	•	•
PPG5	Activation of public-private collaboration	•	•		•	•	•	•	

Note. Columns 3, 4 and 5 show how the city wants to disseminate the results obtained. The last 5 columns indicate to whom the city will communicate the impact of its NBS assessment.

Local, regional or national strategies in which the city considers it would be interesting to include the results of the selected indicators

Local Strategic Sustainable Development Plans (OXA) – (3 OXA in Nicosia District), Local Plans (Planning Department and Housing of the Ministry of Interior), Republic of Cyprus' Development Strategy, Government Programme, Municipal Development Plans – Strategy, The National Authority for Cohesion Policy, Development Strategy Framework, Action Plan for Growth(national)

Local, regional or national organizations to which the city considers it would be interesting to provide the results of the selected indicators to improve the decision-making process

Local Strategic Sustainable Development Plans (OXA) – (3 OXA in Nicosia District), Local Plans (Planning Department and Housing of the Ministry of Interior), Republic of Cyprus' Development Strategy(national), Government Programme(national), Municipal Development Plans – Strategy, National Authority for Cohesion Policy(national), Development Strategy Framework (national), Action Plan for Growth(national), Recovery and Resilience Plan (national)

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PAVLOS MELAS

Impact Assessment Plan

METROPOLITAN PARK OF PAVLOS MELAS

40°39'36"N 22°56'19"E

Maria Mavroudi

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Protection and promotion of natural environment			•								•	•	•		•		
Increase of public spaces			•														
Development of degraded areas			•								•		•		•		
Reduction of urban pollution			•								•		•		•		
Promotion of city identity through the protection of historical - archeological sites and monuments			•								•						
Tackling the humanitarian crisis, combating discrimination and social exclusion	•		•					•			•						
Support of local economy, entrepreneurship and the unemployed								•									
Strengthening the administrative capacity of the Municipality					•						•						•

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NBS DESCRIPTION

Type

Urban Metropolitan Park

Scale

The scale of the park is large, corresponding to 332.104 m2

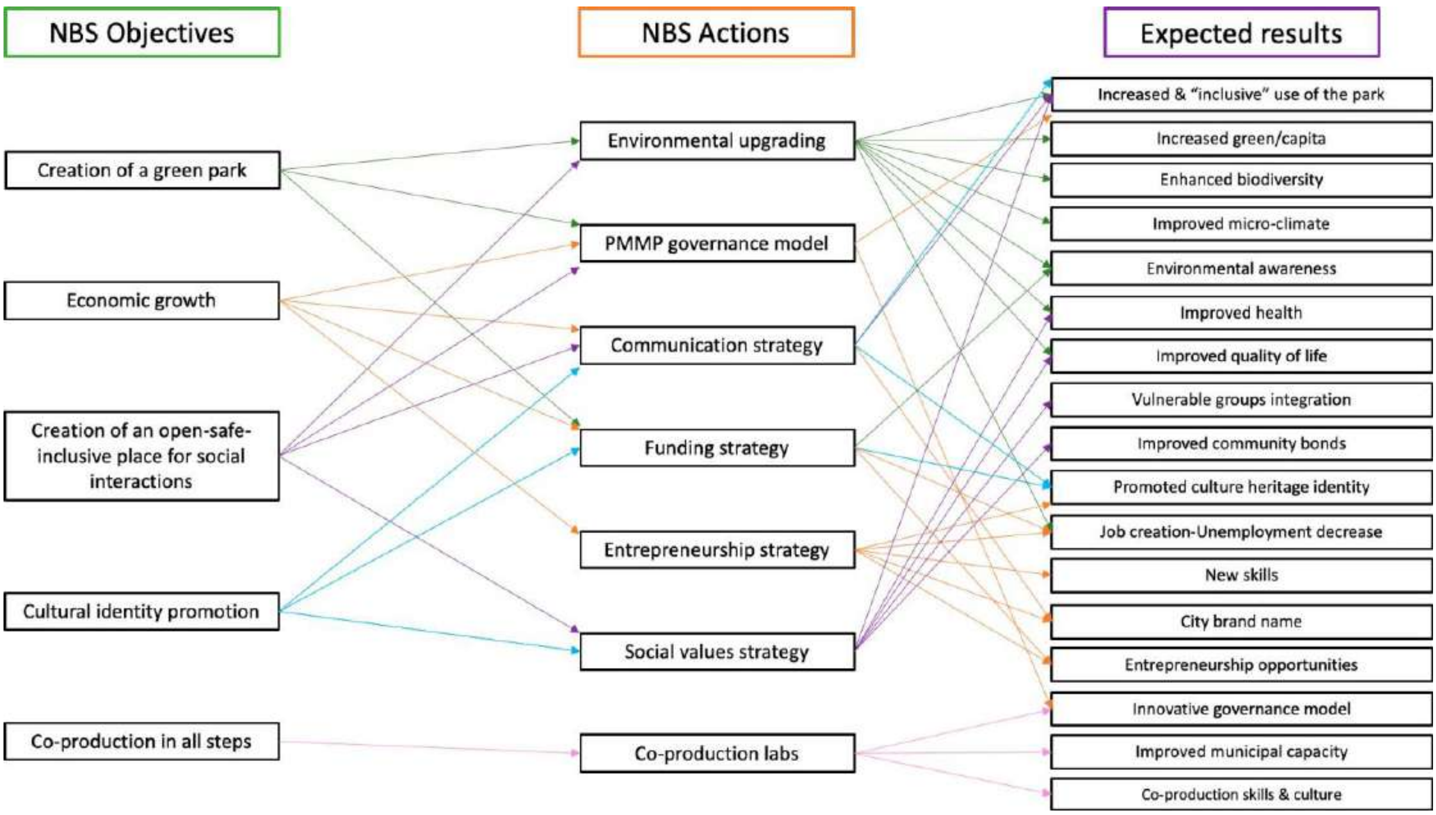
Context description

Transition of an ex-camp, a place of historical and environmental value, into a metropolitan park.
Pavlos Melas former military camp was established by the Turkish army at the end of the 19th century and it was used as a concentration and execution camp during the Second World War and as a military base up to 2006 when it was abandoned. Nowadays is an 'Urban Gap' in the city center and contributes at the deprivation of the area. In addition, Pavlos Melas ex-camp concession have been strongly claimed by the administrative mechanisms of the Municipality and the local community, based on the significant shortages in land for the development of public and green spaces. Finally, the concession was completed in 2017 aiming officially at the integration of the former camp into the urban fabric and social life of the city, as a supra-local green space, and at the same time, the area protection and promotion as a cultural heritage site.

Process of design and implementation

The strategic regeneration planning was based in different steps and procedures, with increased dialogue and cooperation of key stakeholders and community. The "Strategic plan for the regeneration of the former Pavlos Melas camp in a green space of metropolitan scope" sets out the objectives, pillars, basic planning principles and the implementation steps in phases, recognizing that the intervention is a multi-year, costly and complex administrative program that is feasible and imperative to be implemented in phases.
The first phase of regeneration focuses on the environmental upgrade of the open space and the appropriate infrastructure to ensure accessibility and safe use by the public. Operational difficulties during the COVID-19 pandemic crisis have delayed the start of phase A, which is ongoing and will be completed with the designation of the successful tenderer in the next period. According to the schedule, the works will be completed within 18 months from the day of their start.
The later phase(s) projects will load the metropolitan park with a diversity of functions. Except public uses (new Town Hall, museums, environmental awareness & sustainability development center, etc.), other uses that could attract private investment (sport & leisure, social/creative/nature-based economy, hotel, conference center, etc.) could be foreseen for specific locations. The projects will focus on the renovation of the preserved buildings (no new construction is permitted) and further development of outdoor spaces.

Pavlos Melas´ Theory of Change



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Assumptions and synergies

NBS Actions	Expected results	Assumptions	Synergies
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Increased use of the park	A green park attracts much more visitors than an abandoned ex-camp	If citizens use park, they will improve their health and wellbeing, they will interact more with others and more opportunities for enterprises will be created
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Increased green/capita	The planting of more than 6000 plants will increase the ratio of green per capita in the city	More vegetation in the park will enhance the biodiversity and improve the micro-climate
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Enhanced biodiversity	Dense and planned vegetation will allow the introduction and survival of a greater number of species	Increasing biodiversity will favour a greater number of visitors
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Improved micro-climate	A green park functions as a green lung that affects climatic conditions locally	Improving local climatic conditions will bring more visitors in the park
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Enhanced environmental awareness	The use of a green place and the contact with nature arises environmental awareness	Environmental awareness will enhance responsibility towards the biodiversity
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Improved health	The contact with nature and the opportunities for physical activities in the park improves mental and physical health	Good health will contribute in better quality of life
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Improved quality of life	An upgraded environment, even the visual and aesthetic upgrade, as well as a greener environment creates better living conditions	If the quality of life is improved, social bonds are stronger
Phase A project actions (environmental upgrading actions & basic infrastructure development)	Job creation - Unemployment decrease	The implementation and stewardship of PMMP will create new jobs and opportunities for economic growth in the area	New jobs will contribute in better quality of life
PMMP governance model	Increased use of the park	A governance model that ensures the park viability, the compliance with regulations and the public security will bring more visitors to the park	If citizens use the park, they will improve their health and wellbeing, they will interact more with others and more opportunities for enterprises will be created
PMMP governance model	Governance exemplar	A governance model that will ensure the added values of the park will formulate an exemplar of governance for urban NBS	If the governance model ensures sustainability, the park will attract more visitors and will support economic growth
Communication strategy	Increased use of the park	Communication will bring more visitors from metropolitan and regional district and more opportunities for economic activity	If citizens use the park, they will improve their health and wellbeing, they will interact more with others and more opportunities for enterprises will be created
Communication strategy	Promoted culture heritage identity	A tailormade communication strategy of the park can promote the local culture heritage identity	A local culture identity will strengthen the community bonds and it can be an element of the city brand name
Communication strategy	City brand name	The communication strategy can promote the generation of a city brand name	A city brand name will bring more park users and more opportunities for economic activity
Funding strategy	Enhanced environmental awareness	Funding will ensure the creation of the sustainability and environmental awareness center in the park	Environmental awareness will enhance responsibility towards the biodiversity
Funding strategy	Promoted culture heritage identity	A culture heritage promotion program needs funds	A local culture identity will strengthen the community bonds and it can be an element of the city brand name

Funding strategy	Decreased unemployment-job creation	The funding of the rest phases of the project will enhance the entire project implementation and will create more jobs	New jobs will contribute in better quality of life
Funding strategy	Entrepreneurship opportunities	The funding and implementation of the rest phases of the project will create more opportunities for economic development	The operation of new enterprises will create new skills and new jobs
Strategy of entrepreneurship	Promoted culture heritage identity	A culture-related entrepreneurship strategy will enhance the promotion of local cultural identity	A local culture identity will strengthen the community bonds and it can be an element of the city brand name
Strategy of entrepreneurship	Decreased unemployment-job creation	The municipality will create opportunities for new jobs through entrepreneurship initiatives	New jobs will contribute in better quality of life
Strategy of entrepreneurship	Entrepreneurship opportunities	The municipality will create opportunities for new enterprises based on PMMP potential	The operation of new enterprises will create new skills and new jobs
Strategy of entrepreneurship	New skills development	A strategy for a nature-based, circular, creative economy will enhance the development of new skills	New skills will decrease the unemployment
Strategy of entrepreneurship	City brand name	The city brand name could be based on the thematic innovation promoted by the entrepreneurship strategy, i.e. NBS, technology, culture…	A city brand name will bring more park users and more opportunities for economic activity
Creation of social values strategy	Increased & “Inclusive” use of the park	Tailormade social programs will bring more users of the park	If citizens use the park, they will improve their health and wellbeing, they will interact more with others and more opportunities for enterprises will be created
Creation of social values strategy	Improved health	Social interaction will help mental health improvement	Good health will contribute in high quality of life
Creation of social values strategy	Improved quality of life	Social interaction will help wellbeing improvement	If the quality of life is improved, social bonds are stronger
Creation of social values strategy	Vulnerable groups integration	Tailormade social programs will integrate vulnerable groups into the stewardship and use of the park	An inclusive park will strengthen community bonds
Creation of social values strategy	Improved community bonds	Having a space where people meet, gaining the sense of common use and of sharing a cultural identity will facilitate social interaction	If strong bonds are established in the community, the quality of life will be improved
Creation of social values strategy	Promoted culture heritage identity	Programs for the history and identity of Pavlos Melas camp will help build a local culture identity and will contribute in making the citizens proud of it	A local culture identity will strengthen the community bonds and it can be an element of the city brand name
Co-production labs	Governance exemplar	The participatory process will create and support alternatives in governance	If the governance model ensures sustainability, the park will attract more visitors and will support economic growth
Co-production labs	Municipal capacity empowerment - Silos degradation - Transparency	The participatory process will promote inter-departmental collaboration, transparency and will strengthen the municipal capacity	If the municipal capacity is improved, co-production processes and governance alternatives will be supported further
Co-production labs	Co-production culture & skills	The participatory planning, implementation and stewardship of the park will create co-production culture and skills	The participatory process will create alternatives in governance and transparency in administration

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BUILDING BLOCK 2. CHOOSING APPROPRIATE INDICATORS

CODE	NAME	NBS expected result	Selection reasoning
PI1	Type of interaction with NBS	Increased & "Inclusive" use of the park	Know the actual usage of Pavlos Melas Metropolitan Park (PMMP)
PI2	Frequency of interaction with NBS	Increased & "Inclusive" use of the park	Know the actual usage of PMMP
PI3	Duration of interaction with NBS	Increased & "Inclusive" use of the park	Know the actual usage of PMMP
PI4	Perceived quality of space	Increased & "Inclusive" use of the park	Know the perceived quality of the new park
ENV3	Air temperature change	Improved micro-climate	Know the cooling effect of NBS
ENV8	Rainfall storage (water absorption capacity of NBS)	Co-benefit of Increased green/capita	Know the stormwater performance of NbS
ENV23	Public green space distribution	Increased green capita	Measure green area in relation to population
ENV24	Recreational value of blue-green spaces	Increased & "Inclusive" use of the park	Measure of the recreational benefits of PMMP
ENV25	Cultural value of blue-green spaces	Promoted culture heritage identity	Measure of the cultural benefits of PMMP
ENV29	Supporting/increasing biodiversity conservation	Enhanced biodiversity	Find out if there are more efforts to improve biodiversity
ENV35	Species diversity	Enhanced biodiversity	Know the number of species currently in the park
ENV81	Soil sealing	Enhanced biodiversity & improved microclimate	Mapping impermeable surfaces
ENV89	Community garden area per capita and in a defined distance	Increased green capita	Measure green area in relation to population
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	Increased green/capita	Measure the carbon removed by NBS in soil and vegetation
ENV17	Air temperature - Energy demand	Improved microclimate	Measure the peak air temperatures reduction
ENV26	Community accessibility	Increased & "Inclusive" use of the park	Evaluate the accessibility of PMMP
ENV55	Green space area	Increased green/capita	Measure green area in relation to population
ENV66	Air quality change	Co-benefit of increased green/capita	Know the change in air quality
ENV88	Tree shade for local heat change	Improved microclimate	Know the cooling effect of NBS
ENV90	Community garden area per child capita and in a defined distance	Increased green capita	Measure green area in relation to population
HW3	General wellbeing and happiness	Improved quality of life	Know the state of wellbeing and happiness
HW11	Mental health and wellbeing	Improved health	Estimate the impact on the mental health of the park users
HW12	Enhanced physical activity	Improved health	Establish the amount of physical activity that the visitors of the park do
SC1	Bonding social capital	Improved community bonds	Know how are the social relations between different social groups
SC2	Bridging social capital	Improved community bonds	Know how are the social relations between different social groups
SC5.1	Perceived safety	Increased & "Inclusive" use of the park Vulnerable groups integration	Know the perceived safety of the park
SC5.2	Actual safety	Increased & "Inclusive" use of the park Vulnerable groups integration	Know the actual safety of the park
SC6	Place attachment	Promoted cultural heritage identity	Estimate the link between people and park
SC11.1	Positive environmental attitudes motivated by contact with NBS	Enhanced environmental awareness	Estimate resources for environmentally responsible behaviors and impact of environmental education initiatives
SC3	Linking social capital	Improved community bonds	Find out if there is a relationship between neighbours and power groups
SC10	Environmental education opportunities	Enhanced environmental awareness	Measure environmental education opportunities

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ECO1	New Businesses 'attracted' or started and additional rates received	Decreased unemployment-job creation Entrepreneurship opportunities	Establish if there are new businesses since the implementation of the park
ECO3	Net additional jobs created/enabled by NBS	Decreased unemployment-job creation	Establish if there are new jobs created/enabled by NBS
ECO7	Increase in tourism	Local economy growth	Increase in tourism could be a co-benefit, not of strategic priority
ECO2	New customers to business in proximity to NBS	Local economy growth	Estimate any increased footfall in the area
ECO9	Upskilling & related earning increase	New skills development	Estimate the new skills related to the NBS (ideally)
ECO11	Overall economic, social and health wellbeing	Improved quality of life	Estimate the quality of life in the vicinity of the NBS
PPG5	Activation of public-private collaboration	Innovative governance model	Know the degree of collaboration and co-production among stakeholders
PPG7	Reflexivity - identified learning outcomes	Improved municipal capacity	Improved administrative & operational capacity of the Municipality - Silos degradation -Transparency
PPG11	Collaboration between organizational members	Improved administrative & operational capacity of the Municipality - Silos degradation -Transparency	Establish the interactions between individuals from the same departments or different departments
PPG13	Facilitation skills for co-production	Co-production culture & skills	Know the skills of collaboration and co-production among stakeholders
PPG17	Reflexivity - time for reflection	Improved municipal capacity	Improved administrative & operational capacity of the Municipality - Silos degradation -Transparency

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BUILDING BLOCK 3. DEVELOPING A DATA PLAN FOR IMPACT EVALUATION

Pavlos Melas does not have an available baseline for the selected indicators. The data plan will consist of the new data collections, specified in Building Block 4

BUILDING BLOCK 4. IMPLEMENTING THE DATA PLAN

New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Connecting Nature method
PI1	Type of interaction with NBS	Observational study-GIS
PI2	Frequency of interaction with NBS	Observational study-GIS
PI3	Duration of interaction with NBS	Observational study-GIS
PI4	Perceived quality of space	Questionnaire (ad hoc)
ENV3	Air temperature change	Blackbody flux (Landsat 8)
ENV8	Rainfall storage (water absorption capacity of NBS)	Soil moisture sensors and pressure sensors
ENV23	Public green space distribution	Aerial photography combined with census data
ENV24	Recreational value of blue-green spaces	Register of available facilities
ENV25	Cultural value of blue-green spaces	Registration of cultural events in close proximity to NBS
ENV29	Supporting/increasing biodiversity conservation	Biodiversity monitoring programme Pocock et al. (2015)
ENV35	Species diversity	Urban Biodiversity Inventory Framework (UBIF 2017)
ENV81	Soil sealing	Satellite images from Landsat and Normalised Difference Built-up Index (NDBI)
ENV89	Community garden area per capita and in a defined distance	GIS distance to greenspace (mapping buffer areas of 330 and 660m)
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	i-Tree Eco (2019)
ENV17	Air temperature - Energy demand	On-site temperatures from the local weather-station

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ENV26	Community accessibility	ArcGIS ModelBuilder environment: actual proximity to green spaces
ENV55	Green space area	Satellite images from Landsat
ENV66	Air quality change	On-site data from the local weather-station
ENV88	Tree shade for local heat change	Thermal cameras
ENV90	Community garden area per child capita and in a defined distance	GIS distance to greenspace (mapping buffer areas of 330 and 660m) in relation to census data
HW3	General wellbeing and happiness	Satisfaction with Life Scale (Diener et al., 1985)
HW11	Mental health and wellbeing	General Health Questionnaire (GHQ-12) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997)
HW12	Enhanced physical activity	International Physical Activity Questionnaire (IPAQ)
SC1	Bonding social capital	2 items measuring the presence type of connections, and respondent's perception of quality of interactions (Anucha et al., 2006)
SC2	Bridging social capital	2 items measuring the presence type of connections, and respondent's perception of quality of interactions (Anucha et al., 2006)
SC5.1	Perceived safety	Criminal Victimization and Perceptions of Community Safety Survey(Smith et al., 1999)
SC5.2	Actual safety	Crime rate per area (i.e., in and around NBS) for time frame (i.e., before and after NBS implementation)
SC6	Place attachment	Place Identity Scale (Williams & Vaske, 2003)
SC11.1	Positive environmental attitudes motivated by contact with NBS	Environmental Attitudes Inventory (EAI – Milfont & Duckitt, 2010)
SC3	Linking social capital	2 items measuring the presence type of connections, and respondent's perception of quality of interactions (Anucha et al., 2006)
SC10	Environmental education opportunities	Ethnographic case study & No. of educational activities in 'close proximity' to NBS
ECO1	New Businesses 'attracted' or started and additional rates received	No. of new start-ups in 'close proximity' to NBS
ECO3	Net additional jobs created/enabled by NBS	Number change in Full Time Employment (FTEs) or the number of 'decent' jobs or jobs providing 'adequate livelihood'
ECO7	Increase in tourism	Number change in visitors to the area
ECO2	New customers to business in proximity to NBS	Asking businesses to report the number of total customers per period (month / year / quarter)
ECO9	Upskilling & related earning increase	"21st Century Skills" or 'competencies' (Soland et al 2013)
ECO11	Overall economic, social and health wellbeing	Human Development Index
PPG5	Activation of public-private collaboration	Measurement or count data for number of collaborations activated
PPG7	Reflexivity - identified learning outcomes	Number of identified reflexive learning outcomes per month or year that can be specified in number of changes in the context based on reflexivity type (rules, and/or relations, and/or practices and/or discourse)
PPG11	Collaboration between organizational members	Team Boosting behavior scale (Fortuin, van Mierlo, Bakker, Petrou & Demerouti, 2021)
PPG13	Facilitation skills for co-production	Items aimed at assessing facilitator's skills (Weyers and Rankin 2007; Bens 2009)
PPG17	Reflexivity - time for reflection	Counting number of hours spent on reflection per week/month

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BUILDING BLOCK 5. INTEGRATING EVIDENCE INTO THE POLICY PROCESS

CODE	NAME	Visual chart	Scientific partners	Economic sector	Higher political levels	Media	Citizens
PI1	Type of interaction with NBS	●		●	●	●	●
PI2	Frequency of interaction with NBS	●		●	●	●	●
PI3	Duration of interaction with NBS	●		●	●	●	●
PI4	Perceived quality of space	●		●	●	●	●
ENV3	Air temperature change	●	●	●	●		●
ENV8	Rainfall storage (water absorption capacity of NBS)	●	●	●	●		●
ENV23	Public green space distribution	●	●	●	●		●
ENV24	Recreational value of blue-green spaces	●	●	●	●		●
ENV25	Cultural value of blue-green spaces	●	●	●	●		●
ENV29	Supporting/increasing biodiversity conservation	●	●	●	●		●
ENV35	Species diversity	●	●	●	●		●
ENV81	Soil sealing	●	●	●	●		●
ENV89	Community garden area per capita and in a defined distance	●	●	●	●		●
ENV1	Carbon storage OR carbon sequestration in vegetation/soil	●	●	●	●		●
ENV17	Air temperature - Energy demand	●	●	●	●		●
ENV26	Community accessibility	●	●	●	●		●
ENV55	Green space area	●	●	●	●		●
ENV66	Air quality change	●	●	●	●		●
ENV88	Tree shade for local heat change	●	●	●	●		●
ENV90	Community garden area per child capita and in a defined distance	●	●	●	●		●
HW3	General wellbeing and happiness	●	●	●	●		●
HW11	Mental health and wellbeing	●	●	●	●		●
HW12	Enhanced physical activity	●	●	●	●		●
SC1	Bonding social capital	●	●	●	●		●
SC2	Bridging social capital	●	●	●	●		●
SC5.1	Perceived safety	●	●	●	●		●
SC5.2	Actual safety	●	●	●	●		●
SC6	Place attachment	●	●	●	●		●
SC11.1	Positive environmental attitudes motivated by contact with NBS	●	●	●	●		●
SC3	Linking social capital	●	●	●	●		●
SC10	Environmental education opportunities	●	●	●	●		●
ECO1	New Businesses 'attracted' or started and additional rates received	●	●	●	●		●
ECO3	Net additional jobs created/enabled by NBS	●	●	●	●		●

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ECO7	Increase in tourism	•	•	•	•		•
ECO2	New customers to business in proximity to NBS	•	•	•	•		•
ECO9	Upskilling & related earning increase	•	•	•	•		•
ECO11	Overall economic, social and health wellbeing	•	•	•	•		•
PPG5	Activation of public-private collaboration	•			•		•
PPG7	Reflexivity - identified learning outcomes	•			•		•
PPG11	Collaboration between organizational members	•			•		•
PPG13	Facilitation skills for co-production	•			•		•
PPG17	Reflexivity - time for reflection	•			•		•

Note. Column 3 shows how the city wants to disseminate the results obtained. The last 5 columns indicate to whom the city will communicate the impact of its NBS assessment.

Local, regional or national strategies in which the city considers it would be interesting to include the results of the selected indicators

. Future operational programs of the municipality of Pavlos Melas
. Future adaptations of the "Strategic plan for the regeneration of the former camp of Pavlos Melas in a green space of metropolitan scale"
. Future Integrated Territorial Investments Plans

Local, regional or national organizations to which the city considers it would be interesting to provide the results of the selected indicators to improve the decision-making process

Major Development Agency of Thessaloniki S.A.

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SARAJEVO

Impact Assessment Plan

URBAN GARDEN AT CHILDREN´S HOUSE AND CENTRE FOR HEALTHY AGEING

43°51'09.4"N 18°23'54.2"E

Belma Pasic, Nermina Suljevic, Lejla Beslagic

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
The balance between urban development and environmental protection													•				
Protection and development of urban green areas			•														
Quality of life of the citizens			•														
Environment in the function of development and raising the quality of life of people			•														

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NBS DESCRIPTION

Type

Urban garden

Scale

200 m2

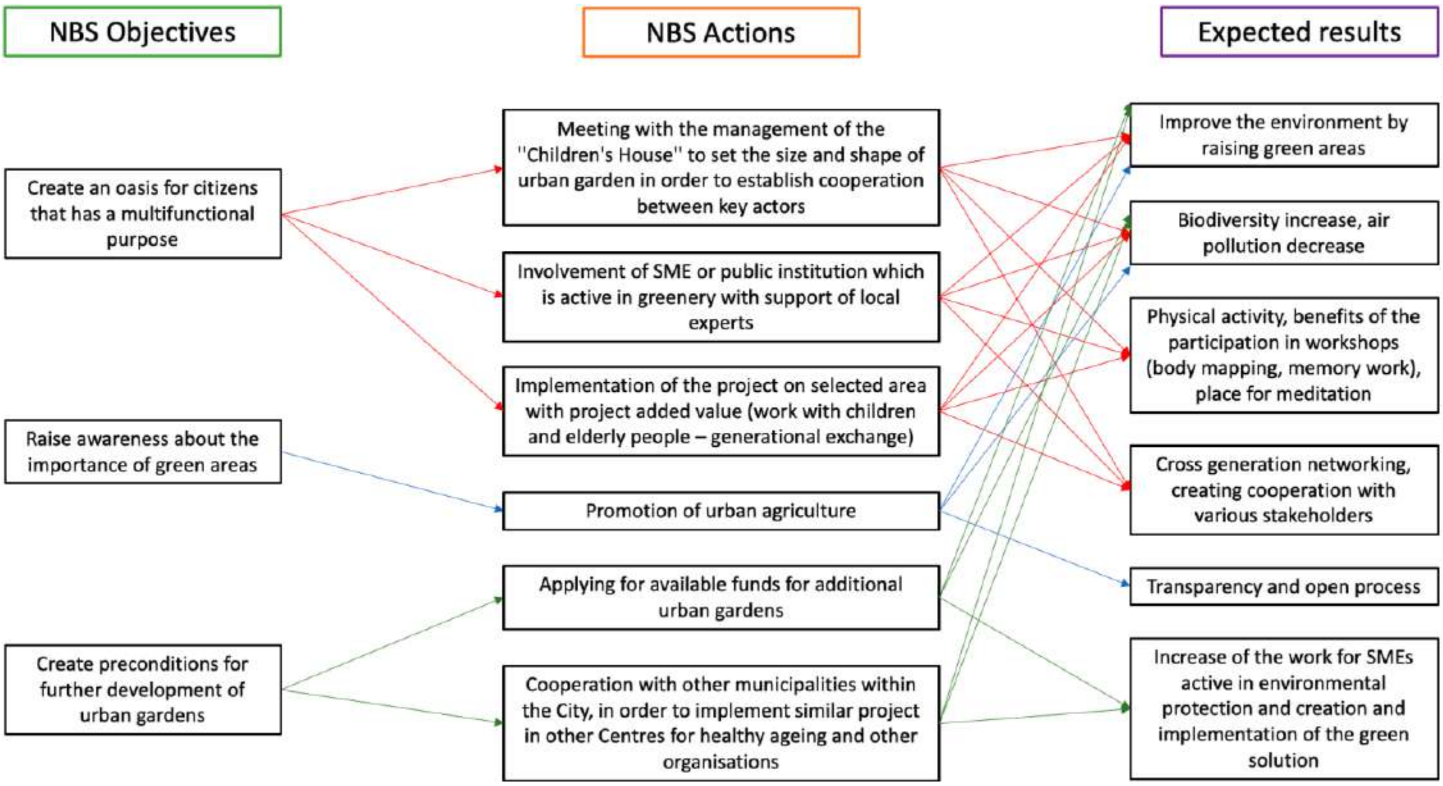
Context description

The main aim of exemplar is to create a green area within the urban part of the city, which will be a pilot project and replicable in other areas. The exemplar includes implementation of an urban garden within the "Children's House" area or Centre for healthy ageing area (close by), where it is planned to jointly create and maintain the garden and to provide cross generational exchange.

Process of design and implementation

Decision on the exemplar which includes implementation of a green garden is based on real needs of the city (lack of green areas), but also as a tool for solving issues detected by government such as air pollution due to heating system, traffic, deforestation, etc.

Sarajevo´s Theory of Change



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Assumptions, synergies and trade-offs

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Meeting with the management of the "Children's House" to set the size and shape of urban garden in order to establish cooperation between key actors	Improve the environment by raising green areas	Interest of the School and other relevant actors	Support of the School is guarantee of the exemplar success	None
Involvement of SME or public institution which is active in greenery with support of local experts	Biodiversity increase, air pollution decrease	Involvement of key experts	More content will provide participation of the various target groups	If SME make mistake with greenery, it can produce problems with sustainability
Implementation of the project on selected area with project added value (work with children and elderly people – generational exchange)	Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation	Citizens and other target groups will have place for various activities	Social activities will be increased	None
Promotion of urban agriculture	Cross generation networking, creating cooperation with various stakeholders	Urban agriculture as a toll for community building	If citizens like the urban garden, government will continue to support it	None
Applying for available funds for additional urban gardens	Increase of the work for SMEs active in environmental protection and creation and implementation of the green solution	Support to SMEs will increase number exemplars in other areas	Support through donors can ensure larger number of urban gardens and its promotion	None
Cooperation with other municipalities within the City, in order to implement similar project in other Centres for healthy ageing and other organisations	Transparency and open process	Developed social cohesion, trust in process and government	Transparency and open process bring back trust of the citizens and provide quality	None

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CODE	NAME	NBS expected result	Selection reasoning
PI1	Type of interaction with NBS	Active engagement of various target groups	Number of people participating, number of events
PI2	Frequency of interaction with NBS	Active engagement of various target groups	Number of people participating
PI3	Duration of interaction with NBS	Active engagement of various target groups	Functionality of the exemplar
PI4	Perceived quality of space	Improve the environment by raising green areas	Number of green areas – new urban gardens
ENV3	Air temperature change	Improve general conditions of local habitants	Not sure if this is appropriate – we don't know how to measure it and we do not plan to seed big trees, but more plants and vegetables
ENV23	Public green space distribution	Improvement of general conditions for local habitants	What is that and how to measure it?
ENV35	Species diversity	Biodiversity increase, air pollution decrease	Improve biodiversity in the area
ENV42	Land use change and greenspace configuration	Biodiversity increase	Improve biodiversity in the area and provide more green spaces
ENV26	Community accessibility	Improvement of general conditions for local habitants	Involve more local habitants
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	Biodiversity increase	Improve biodiversity in the area and provide more green spaces
ENV41	Accessibility of greenspaces	Improvement of general conditions for local habitants	Provide more green areas within the city
ENV58	Local food production	Support to small business	Increase number of business and support domestic production
ENV61	Intensity of landuse	Biodiversity increase	Improve biodiversity in the area and provide more green spaces
ENV66	Air quality change	Biodiversity increase, air pollution decrease	See if we can decrease air pollution during winter time
HW3	General wellbeing and happiness	Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation	Number of people involved
HW11	Mental health and wellbeing	Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation	Number of people involved
HW12	Enhanced physical activity	Physical activity, benefits of the participation in workshops (body mapping, memory work), place for meditation	Number of people involved
SC4.2	Solidarity between neighbours	Cross generation networking, creating cooperation with various stakeholders	Establish networks between various users and stakeholders, number of meetings and events
SC4.3	Tolerance and respect	Cross generation networking, creating cooperation with various stakeholders	Establish networks between various users and stakeholders, number of meetings and events
SC10	Environmental education opportunities	Cross generation networking, creating cooperation with various stakeholders	Establish networks between various users and stakeholders, number of meetings and events
ECO1	New Businesses 'attracted' or started and additional rates received	Increase of the work for SMEs active in environmental protection and creation and implementation of the green solution	Number of NBEs participating
PPG1	Diversity of stakeholders involved	Transparency and open process	Public interest in the exemplar
PPG3	Transparency of co-production	Transparency and open process	Public interest in the exemplar
PPG16	Community involvement in NBS implementation	Transparency and open process	Public interest in the exemplar

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Available baseline in the city of Sarajevo

CODE	NAME	Baseline data	Source (year)	Granularity	Periodicity
ENV3	Air temperature change	•	Meteorological institute (2020)	City	Monthly
ENV23	Public green space distribution	•	Annual Report of public company for green areas in the Canton/City (2020)	City	Every year
ENV35	Species diversity	•	Local faculty of natural science (2020)	Neighbourhood	Every year
ENV42	Land use change and greenspace configuration	•	Annual Report of public company for green areas in the Canton/City (2020)	City	Every year
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	Annual Report of public company for green areas in the Canton/City (2020)	City	Every year
ENV41	Accessibility of greenspaces	•	Annual Report of public company for green areas in the Canton/City (2020)	City	Every year
ENV61	Intensity of landuse	•	Canton/city regulation plan (2020)	City	Every year
ENV66	Air quality change	•	Meteorological institute (2020)	City	Monthly
ECO1	New Businesses 'attracted' or started and additional rates received	•	Institute for statistics of Canton Sarajevo (2020)	City	Every year
PPG1	Diversity of stakeholders involved	•	Local records of number of participants (2020)	City	Specific study

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BUILDING BLOCK 4. IMPLEMENTING THE DATA PLAN

New data collection on the exemplar scale from the methods proposed in the Connecting Nature Indicator Reviews

CODE	NAME	Baseline method	Connecting Nature method
PI1	Type of interaction with NBS		Observational study-GIS
PI2	Frequency of interaction with NBS		Observational study-GIS
PI3	Duration of interaction with NBS		Observational study-GIS
PI4	Perceived quality of space		Questionnaire (ad hoc)
ENV3	Air temperature change	•	
ENV23	Public green space distribution	•	
ENV35	Species diversity	•	
ENV42	Land use change and greenspace configuration	•	
ENV26	Community accessibility		GIS distance to and use of greenspace
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•	
ENV41	Accessibility of greenspaces	•	
ENV58	Local food production		Quantify the amount of food production within the city
ENV61	Intensity of landuse	•	
ENV66	Air quality change	•	
HW3	General wellbeing and happiness		Satisfaction with Life Scale (Diener et al., 1985)
HW11	Mental health and wellbeing		General Health Questionnaire (GHQ-12) (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997)
HW12	Enhanced physical activity		International Physical Activity Questionnaire (IPAQ)
SC4.2	Solidarity between neighbours		Items measuring perception of solidarity from "Trust and Solidarity" scale (SC-IQ) (Grootaert et al., 2004)
SC4.3	Tolerance and respect		Neighbourhood Social Cohesion – 'Tolerance or Respect' Scale (Stafford et al., 2003)
SC10	Environmental education opportunities		Ethnographic case study
ECO1	New Businesses 'attracted' or started and additional rates received	•	
PPG1	Diversity of stakeholders involved	•	
PPG3	Transparency of co-production		Questionnaire (ad hoc)
PPG16	Community involvement in NBS implementation		Questionnaire based on Arnstein's (1969) ladder of citizen participation

Note. Some indicators will be measured with the same methods of the baseline

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BUILDING BLOCK 5. INTEGRATING EVIDENCE INTO THE POLICY PROCESS

CODE	NAME	Documentary report	Visual chart	Scientific partners	Economic sector	Higher political levels	Media	Citizens
PI1	Type of interaction with NBS	•			•	•	•	•
PI2	Frequency of interaction with NBS	•				•	•	•
PI3	Duration of interaction with NBS	•			•	•		
PI4	Perceived quality of space	•	•	•		•	•	•
ENV3	Air temperature change		•	•		•		•
ENV23	Public green space distribution	•				•		
ENV35	Species diversity	•		•		•		
ENV42	Land use change and greenspace configuration	•				•		
ENV26	Community accessibility	•				•		•
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies	•				•		
ENV41	Accessibility of greenspaces	•			•	•		•
ENV58	Local food production	•			•			•
ENV61	Intensity of landuse		•	•		•		
ENV66	Air quality change	•	•	•		•		•
HW3	General wellbeing and happiness	•		•		•	•	
HW11	Mental health and wellbeing	•		•		•	•	
HW12	Enhanced physical activity	•		•		•	•	
SC4.2	Solidarity between neighbours	•		•		•	•	
SC4.3	Tolerance and respect	•		•		•	•	
SC10	Environmental education opportunities	•		•		•	•	
ECO1	New Businesses 'attracted' or started and additional rates received	•	•	•		•	•	
PPG1	Diversity of stakeholders involved	•		•		•	•	
PPG3	Transparency of co-production	•		•		•	•	
PPG16	Community involvement in NBS implementation	•		•		•	•	•

Note. Columns 3 and 4 show how the city wants to disseminate the results obtained. The last 5 columns indicate to whom the city will communicate the impact of its NBS assessment.

Local, regional or national strategies in which the city considers it would be interesting to include the results of the selected indicators

Development Strategy of Canton Sarajevo 2021-2027, Development Strategy of City of Sarajevo, Integrated development strategy of Novo Sarajevo Municipality, Green Action Plan of Sarajevo Canton

Local, regional or national organizations to which the city considers it would be interesting to provide the results of the selected indicators to improve the decision-making process

Canton Sarajevo and relevant ministries, City of Sarajevo, NGOs, Environmental Fund of Federation of BiH, educational institutions

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YEREVAN

Impact Assessment Plan

SHUSHANIK ASMARYAN, LILIT SAHAKYAN, GEVORG TEPANOSYAN, GAREGIN TEPANOSYAN, VAHAGN MURADYAN

Center for Ecological-Noosphere Studies of the National Academy of Sciences of Armenia

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Increase viable green spaces and corridors, connectivity and public amenities			•								•		•		•		
Increase biodiversity in urban spaces			•								•		•		•		
Prevent and/or reduce heat island effect and other impacts of climate change			•								•		•		•		
Increase physical activity, recreation, walking.			•								•		•		•		
Noise reduction & air quality improvements (e.g., $PM_{2.5}$) via green spaces, walls, barriers with ecologically tolerant plant species (gas and dust resistant plant phytophilters)			•								•		•		•		
Pilot NBS at kindergartens, schools and higher education institutions (HEI)			•	•							•		•		•		•

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NBS DESCRIPTION

Type

Target tree planting program for Yerevan by CENS

Scale

City level, district level, street level

Context description

City of Yerevan is the capital and largest city of Armenia with population about 1,075 million. Yerevan is the administrative, cultural, and industrial centre of the country covering the total area of 220 sq. km and where about 35 % of total population of the country is concentrated. (a) The goal of the current Master Plan of Yerevan aimed at creation of favourable living conditions and provision of sustainable development. Here we can say that the philosophy of the Master plan of Yerevan coincides with that of Connecting Nature project, which is to support **the optimizing the planning structure, reducing environmental risks for human health and so, improving living conditions.**
Center for Ecological-Noosphere Studies of the National Academy of Sciences of Armenia (CENS) enables to contribute to the challenge of urban resilience and sustainability using multidisciplinary approaches. The cooperation of CENS and Yerevan Municipality enables to develop an NBS plan: a Target tree Planting program for the Municipality.
The NBS_Target tree planting program is oriented to improve urban thermal conditions. One of the approaches to assess the effectiveness of NBS is to perform satellite remote sensing survey on monitoring the Yerevan's thermal conditions using urban thermal field variance index (UTFVI), which reflects and quantitatively describes the Surface Urban Heat Island effect on the ecological comfort level of cities. UTFVI is the most common thermal comfort index derived from the satellite images for the ecological evaluation of urban environments and is directly related to land surface temperature (LST). The last remains a good indicator of Urban thermal comfort. (b)
Briefly, Yerevan has shared almost an equal percentage of land for the excellent and the worst categories of the UTFVI ecological evaluation index. From 1989 to 2018, the changes from the excellent to the worst category of UTFVI ecological evaluation index are located in agricultural areas and urban forests and are mainly related to the loss of green space.

Process of design and implementation

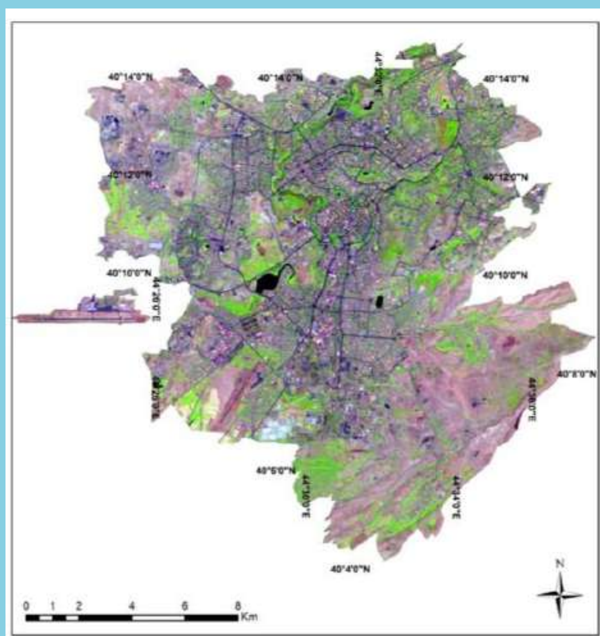
The Target tree planting program, developed 2007-2008 by CENS, supposed to investigate the urban air, soil, and plant pollution, to map the green spaces in Yerevan using satellite imagery. CENS also identified Gas- and dust resistant and metal cumulating species of plants and provide a set of tree and shrub species to be planted in Yerevan parks and squares based on the type and level of pollution of each urban site. Now the Municipality implementing consistently the program planting the species provided by CENS at city level, district and street level.
CENS develops a method of monitoring the urban LST and the level of urban thermal comfort using satellite and UAV remote sensing.

Current deployment and deadline

Now the Municipality is implementing consistently the program planting the species provided by CENS at city level, district and street level.
Since 2018 CENS started developing approaches to monitor the state of the urban thermal comfort using satellite and UAV remote sensing.

Financing and stewardship

The financing and stewardship of Target tree planting program was provided by Yerevan Municipality. The continuous implementation of the planting process is also funded by own resources of Yerevan.
The funding of the research studies on development of the method to assess the urban comfort using remote sensing data is provided by the State Committee of Science of MESCS of Armenia and conducted in the frames of two projects supplementing Connecting Nature project: **(i) Grant number: 18T-1E085; (ii)ML4GEO project, Grant number: 20TTCG-1E009**



Yerevan and green areas from satellite image Sentinel 2A

(a) https://www.yerevan.am/uploads/media/default/0001/72/e7224f93ad7096478f9aaddb96ba61ea0ca693c9.pdf

(b) Tepanosyan et al (2021). https://doi.org/10.1016/j.buildenv.2020.107390

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Yerevan´s Theory of Change

NBS objectives	NBS actions	NBS expected results
Increase viable green spaces, create corridors, connectivity and public amenities	. Identify and map candidate green spaces and assess their ecological state. . Undertake corridors and connectivity analysis. . Design & provide public amenities in identified spaces.	. Increased area of blue spaces. . Improved connectivity of natural areas. . Increased use of green spaces.
Increase biodiversity in urban spaces	. Identification and planting ecologically tolerant species of plants taking into account their decorativeness and longevity . Modify green area management to benefit biodiversity.	. Increased green space areas and their network. . Community engagement in biodiversity enhancement. . Ensuring longevity of plants
Prevent and/or reduce heat island effect and other impacts of climate change	. Planting trees in open areas and along open pedestrian areas. . Promote building retrofitting for natural ventilation. . Identification of heal island areas for targeted action.	. Reduced heat island effect via increasing park and other green areas . Improved air quality through decreased heat . Provision of thermal comfort zones
Increase physical activity, recreation, walking.	. Provide additional green spaces for recreation	. Improved health from Increased physical activity. . Increased safety of pedestrians . Enhance recreation opportunities.
Noise reduction & air quality improvements (e.g., $PM_{2.5}$) via green spaces, walls, barriers with ecologically tolerant plant species (gas and dust resistant plant phytophilters)	. Planting trees in open areas and along open pedestrian areas taking into account the Gas- and dust resistant properties of plants (phytophilters).	. Improved air quality via reduction of noise and particulates. . Ensuring longevity of plants . Biodiversity enhancement.
Pilot projects on developing NBS at kindergartens, schools and higher education institutions (HEI)	. Private initiatives at kindergartens, schools and higher education institutions (HEI) involving staff and students in design, construction & operation. . Subsidise green wall installations. Fund NBS provision for kindergartens, schools, HEIs.	. Mitigate heat and dust pollution at kindergartens, schools and higher education institutions via green walls. . Capacity building and further dissemination by HEI. . Increased knowledge and acceptance of NBS. . Young generation learning NBS by doing.

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CODE	CORE INDICATORS	CODE	FEATURE INDICATORS
	ENVIRONMENTAL		
ENV3	Air temperature change	ENV1	Carbon storage OR carbon sequestration in vegetation/soil
ENV23	Public green space distribution	ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies
ENV24	Recreational value of blue-green spaces	ENV41	Accessibility of greenspaces
ENV25	Cultural value of blue-green spaces	ENV55	Green space area
ENV27	Connectivity of urban green and blue spaces (structural and functional)	ENV59	Cultivated crops
ENV29	Supporting/increasing biodiversity conservation	ENV61	Intensity of landuse
ENV35	Species diversity	ENV63	Landuse mix
ENV42	Land use change and greenspace configuration	ENV66	Air quality change
ENV85	Change in ecosystem service provision	ENV88	Tree shade for local heat change
	HEALTH AND WELLBEING		
HW3	General wellbeing and happiness	HW9	Heat reduced mortality
HW11	Mental health and wellbeing	HW15	Exploratory behaviour in children
HW12	Enhanced physical activity		
	SOCIAL COHESION		
SC1	Bonding social capital	SC10	Environmental education opportunities
SC4.1	Trust in community	SC12	Pro-environmental behaviour
SC5.1	Perceived safety		
SC5.2	Actual safety		
SC11.1	Positive environmental attitudes motivated by contact with NBS		
SC11.2	Environmental identity		
	ECONOMIC		
ECO13	Net impact on public expenditure from NBS implementation	ECO2	New customers to business in proximity to NBS
ECO15	Private finance attracted to the NBS site	ECO6	Innovation impact
		ECO11	Overall economic, social and health wellbeing
		ECO17	Social return on investment
	PARTICIPATORY PLANNING AND GOVERNANCE		
PPG4	Policies adopted to promote NBS	PPG16	Community involvement in NBS implementation
PPG5	Activation of public-private collaboration	PPG18	Strategic approach
PPG6	Trust in decision-making and decision-makers	PPG26	Organizational trust
PPG7	Reflexivity - identified learning outcomes		
PPG8	Common vision		
PPG9	Innovative climate		
PPG11	Collaboration between organizational members		

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NBS RESULTS

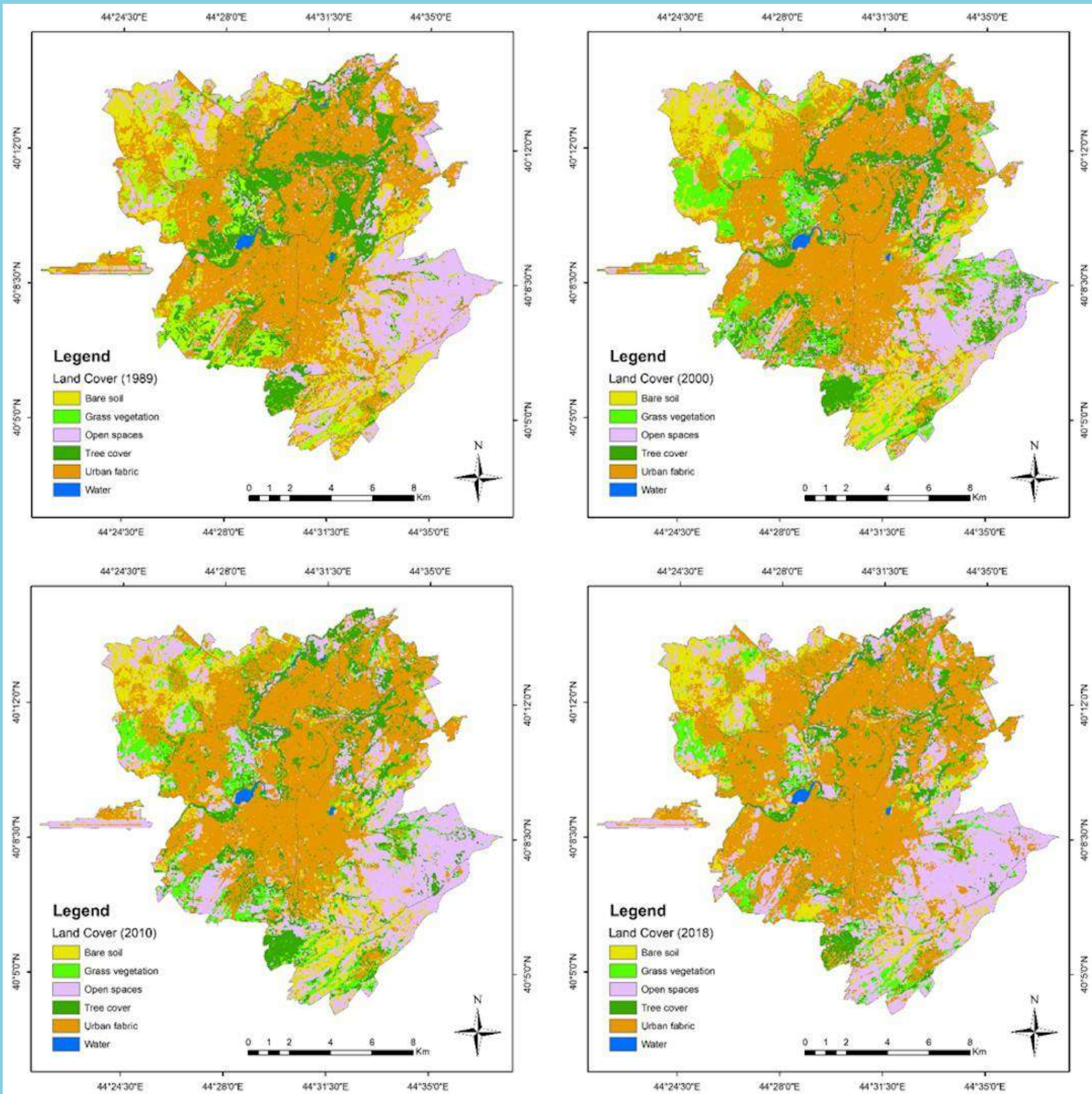

Figure 1. LC maps of the Yerevan for the years 1989, 2000, 2010 and 2018 derived from Landsat 8 OLI satellite data

Important example of NBS indicator is provided on Figure 1, measuring long term change of land surface temperature and vegetation cover. This illustrates utility of this parameter important in climate change context, as well as to show loss or gain of essential ecosystem functions.

Now the Municipality is implementing consistently the program planting the species provided by CENS at city level, district and street level. CENS as a leading research institution will consistently go on with an additional research to enhance remote sensing method of monitoring urban comfort for Yerevan, to conduct deep study of the relationships between heat emission, climatic data and LST.

The NBS_Target tree planting program is oriented to improve urban thermal conditions. One of the approaches to assess the effectiveness of NBS is to perform satellite remote sensing survey on monitoring the Yerevan's thermal conditions using urban thermal field variance index (UTFVI), which reflects and quantitatively describes the Surface Urban Heat Island effect on the ecological comfort level of cities. UTFVI is the most common thermal comfort index derived from the satellite images for the ecological evaluation of urban environments and is directly related to land surface temperature (LST). The last remains a good indicator of Urban thermal comfort.

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Briefly, Yerevan has shared almost an equal percentage of land for the excellent and the worst categories of the UTFVI ecological evaluation index (fig 2). The figures 1 and 2 shows that Grass Vegetation and Tree Cover enjoy an excellent thermal condition, while Open Space and Bare Soils are the most favourable land cover types for the worst thermal condition. Urban Fabric has shared almost an equal percentage of land for the excellent and the worst categories in 1989, and mainly the excellent category in 2018, which can be explained by the reduction/cessation of heat emission from industrial factories, closed down (or operating below their full capacity) after the collapse of the Soviet Union. The figure 2 also show that from 1989 to 2018, the changes from the excellent to the worst category of UTFVI ecological evaluation index are located in agricultural areas and urban forests and are mainly related to the loss of green space. (c)

Now the Municipality is implementing consistently the program planting the species provided by CENS at city level, district and street level. CENS as a leading research institution will consistently go on with an additional research to enhance remote sensing method of monitoring urban comfort for Yerevan, to conduct deep study of the relationships between heat emission, climatic data and LST.

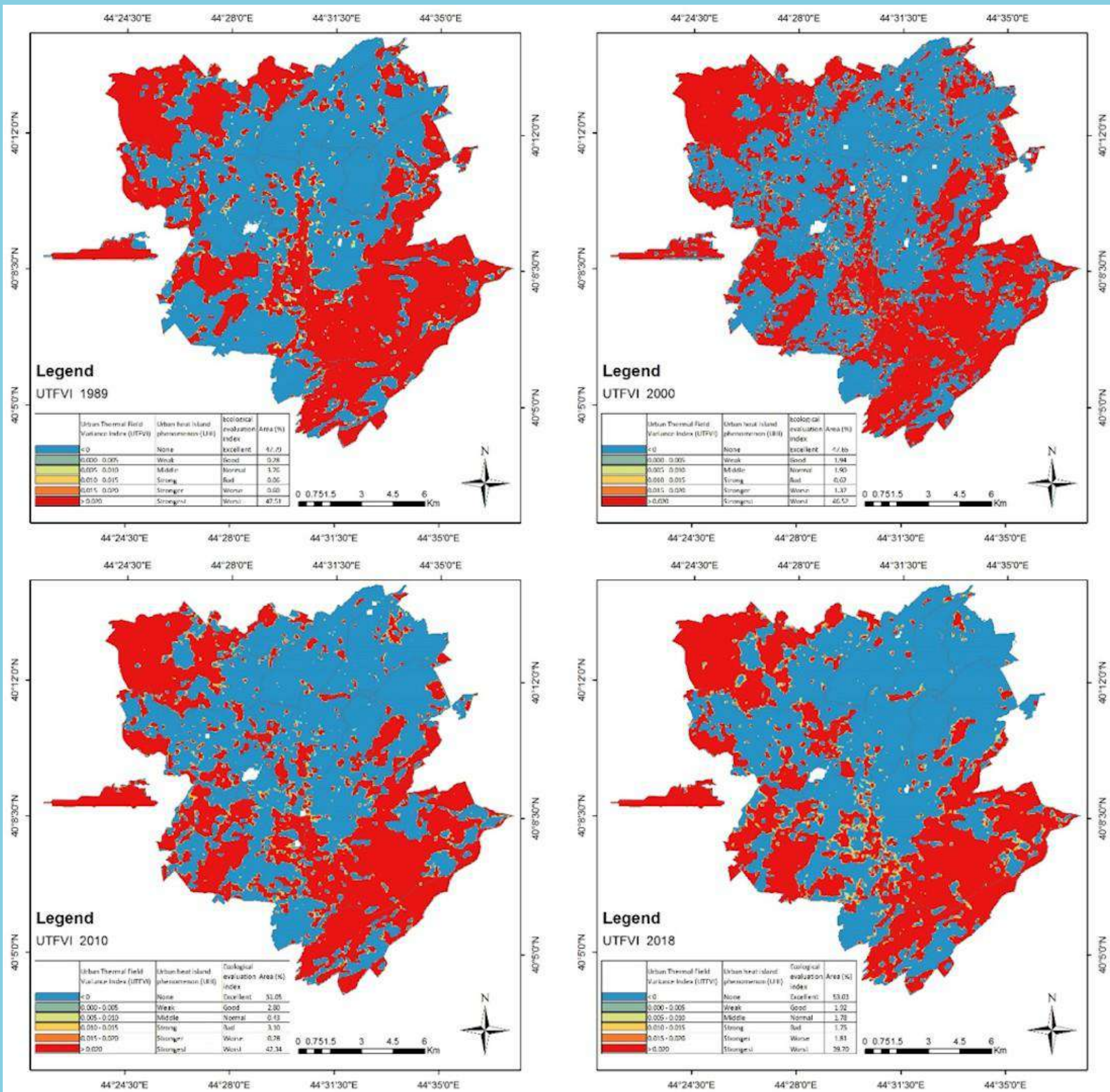

Figure 2. Ecological evaluation indices of the Yerevan for the years 1989, 2000, 2010 and 2018.

(c) Tepanosyan et al (2021). https://doi.org/10.1016/j.buildenv.2020.107390

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KUTAISI

Impact Assessment Plan

Tamar BAKURADZE, Mamuka GVILAVA

GeoGraphic, GIS & RS Consulting Center

BUILDING BLOCK 1. ENGAGE IN STRUCTURED REFLECTION ON NBS IMPACTS, PATHWAYS AND TRADE-OFFS

City´s strategic goals and links with the United Nations Sustainable Development Goals (SDGs)

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
Increase viable green and blue spaces and corridors, connectivity and public amenities			●			●					●		●		●			●
Increase biodiversity in urban spaces			●								●		●		●			●
Stimulate conservation in peri-urban and urban areas			●								●		●		●			●
Enhance peri-urban agriculture and stimulate urban agriculture	●	●	●		●			●			●	●	●		●			●
Prevent and/or reduce heat island effect and other impacts of climate change			●		●		●			●	●	●	●		●			●
Increase physical activity, recreation, cycling, walking, alternative mobility, grow foods		●	●		●					●	●	●	●					●
Stimulate energy efficiency and alternative energy solutions (biosolar)			●		●		●	●	●	●	●	●	●					●
Implement organic waste collection, composting and reuse systems		●						●			●	●			●			●
Brownfield utilisation, biodiversity enhancement and conversion	●		●		●			●	●	●	●	●	●		●		●	●
Vacant building utilisation with novel social and commercial functions	●		●		●			●	●	●	●	●						●
Noise reduction & air quality improvements (eg $PM_{2.5}$) via green spaces, walls, barriers			●		●			●	●	●	●		●		●			●
Stormwater reduction through NBS, rainwater harvesting and groundwater recharge						●	●		●	●	●	●	●		●			●
Piloting NBS wastewater systems such as constructed wetlands			●		●	●	●	●	●	●	●	●	●		●			●
Piloting and testing a range of NBS	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●
Address climate change induced hazards such as flooding, erosion, landslides			●		●						●		●				●	●
Stimulate green economy though e.g. public-private NBS entrepreneurship initiatives	●			●	●			●	●	●	●	●					●	●
Pilot NBS in kindergartens, schools and higher education institutions (HEI)			●	●	●			●		●	●		●				●	●
Implement green public/private procurement including for NBS			●	●				●	●		●	●	●			●		●
Provide for pubic initiatives, volunteering and co-production in NBS interventions			●		●			●		●	●					●	●	●
Guidelines, tools and training for NBS implementation by public and private actors				●				●	●		●	●	●			●		●

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1. No poverty
2. Zero hunger
3. Good health and wellbeing
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

Note. Green sign indicates Covid-19 safe objectives

Kutaisi´s Theory of Change

NBS objectives	NBS actions	NBS expected results
Increase viable green and blue spaces and corridors, connectivity and public amenities	. Identify and map candidate green and blue spaces. . Undertake corridors and connectivity analysis. . Design & provide public amenities in identified spaces.	. Increased area of blue and green spaces. . Improved connectivity of natural areas. . Increased use of green and blue spaces.
Increase biodiversity in urban spaces	. Mobilise small community grants for pocket parks. . Develop community driven biodiverse pocket parks. . Modify green area management to benefit biodiversity. . Production and provision of local seeds and seedlings. . Production and provision of bird and insect houses.	. Increased green space areas and their network. . Community engagement in biodiversity enhancement. . Positive trends in plant, insect etc. biodiversity counts. . Increased settlements of bids, animal species in urban areas.
Stimulate conservation in peri-urban and urban areas	. Establish urban protected area (city south) and provide connectivity with urban green spaces.	. Effective urban system of open green and blue spaces
Enhance peri-urban agriculture and stimulate urban agriculture	. Linking peri-urban agriculture with urban consumers. . Pilot urban agriculture schemes (rooftops, urban farms) . Social leasing of peri-urban areas to support food grow	. Increased availability of local produce against imported . Permanent employment of peri-urban population. . Reduced costs of quality food due to reduced imports. . Social assistance with access to land to grow own food.
Prevent and/or reduce heat island effect and other impacts of climate change	. Vegetation planting along open pedestrian areas. . Promote building retrofitting for natural ventilation. Identification of heal island areas for targeted action. . Subsidise biosolar roof and green wall installations. . Private initiatives e.g. at KTU campuses (staff and students involved in design, construction & operation).	. Reduced heat island effect. . Reduced energy consumption/costs of air conditioning. . Priority heat stress intervention areas identified. . Improved energy efficiency, alternative energy sources. . Mitigate heat at KTU with biosolar, green walls, wetland. . Capacity building and further dissemination by KTU.
Increase physical activity, recreation, cycling, walking,	. Provide new and safe bike lanes. . Allocate safe transportation lanes for electric scooters	. Improved health from Increased physical activity. . Increased safety of pedestrians, bikers,

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NBS objectives	NBS actions	NBS expected results
alternative mobility, grow foods	. Provide and increase transport free pedestrian areas. . Provide additional green and blue spaces for recreation . Subsidise electric drive gig food distribution services. . Allocate social support lands for own food production.	scooters. . Enhance recreation opportunities. . Noise/air pollution reduction from gig food distributors . Increased social care, reduction in child hunger rates.
Stimulate energy efficiency and alternative energy solutions (biosolar)	. Demonstrate rooftop biosolar installations. . Subsidise and support building retrofitting schemes.	. Reduced consumption of energy and reduced costs. . Improved air quality. Reduced carbon emissions.
Implement organic waste collection, composting and reuse systems	. Implementation of organic waste collection system. . Pilot projects of urban composting and gardening.	. Reduced waste volumes to landfill. Reduced mixing of biological substances with pollutants. Reduced costs. Reduced loss of organic matter. Enhanced soil fertility.
Brownfield utilisation, biodiversity enhancement and conversion	. Brownfield biodiversity enhancement projects . Alternative environmental & social uses of brownfields.	. Optimal utilisation of land resources. New habitats. Reduced vacant land areas. . Biodiversity enhancement.
Vacant building utilisation with novel social and commercial functions	. Conversion of vacant buildings into new functions. . Buildings with Innovative social, commercial functions.	. New and alternative entrepreneurial opportunities. . Reduction in antisocial behaviour. Youth engagement.
Noise reduction & air quality improvements (eg $PM_{2.5}$) via green spaces, walls, barriers	. Supporting community green barriers to reduce noise. . Biodiverse vegetation, mulching, to reduce particulates	. Noise level reduction. . Temperature reduction. . Reduction of particulates. . Biodiversity enhancement.
Stormwater reduction through NBS, rainwater harvesting and groundwater recharge	. Implementing Sustainable Drainage Systems (SuDS). . Supporting rainwater harvesting retrofits. Recharging rainwater into swales and gardens, native plants.	. Reduced stormwater management costs. . Enhanced biodiversity (plants, insects, birds, small animals). . Water conservation enhancements. Reduced flood risk.
Piloting NBS wastewater systems such as constructed wetlands	. Implement pilot constructed wetlands WWT in selected small urban communities. Restore wetlands of Kutaisi international technical university, implementing closed and open constructed wetlands to treat its wastewater. Engage students and teachers in design and in overseeing construction and operation.	. Reduced costs of WWT by redirecting volumes of wastewater from urban WWTP. . Enhanced biodiversity. Wetlands damaged during construction restored and provide ecosystem as well as WWT functions. Capacity building of students and teachers in NBS design, construction and operation (constructed wetland).
Piloting and testing a range of NBS schemes	. Piloting range of NBS to test viable local schemes. . Develop NBS catalogue based on local/best practices. . Stimulate voluntary private NBS application schemes.	. Increased experience of NBS enterprises. . Accumulated knowledge with viable NBS schemes. . Voluntary implementation of NBS catalogue/checklist.
Address climate change induced hazards such as	. Implementing Sustainable Drainage Systems (SuDS). Drainage schemes (bioswales, etc.). Renaturing	. Reduced flood risk. Reduced landslide risks. Green and blue corridors, enhanced biodiversity. . Reduced

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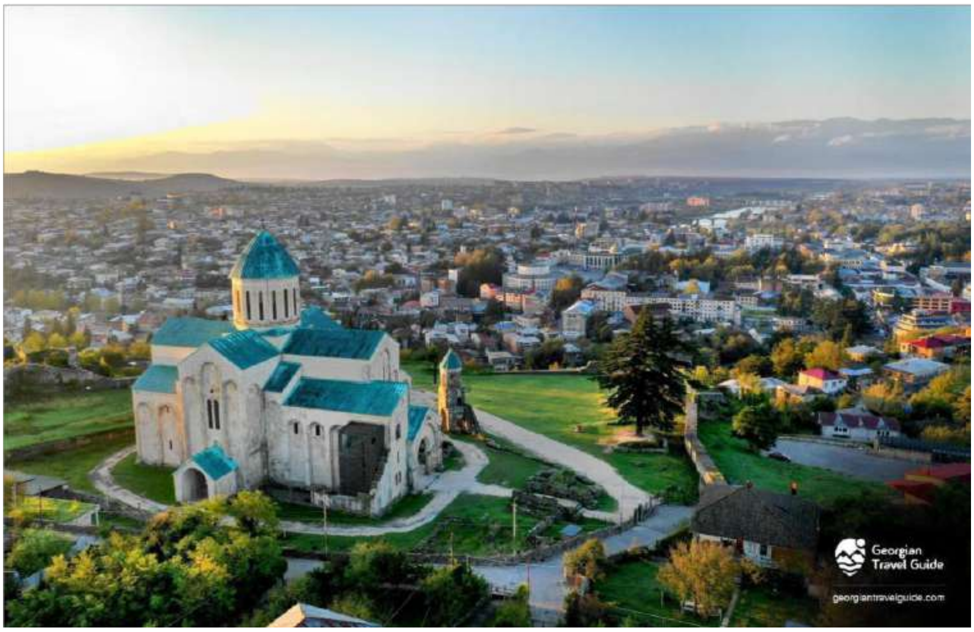
NBS objectives	NBS actions	NBS expected results
flooding, river bank erosion, landslides.	riverbanks. Landslide biostabilisation.	erosion.
Stimulate green economy though e.g. public-private NBS entrepreneurship initiatives	. Support NBS Enterprises (NBEs) with capacity and capability building. Engage private companies in NBS.	. Increased experience and capabilities of NBEs. . Reduced costs by procuring NBS on competitive basis.
Pilot NBS in kindergartens, schools and higher education institutions (HEI)	. Involve professional and young specialists in designing NBS for kindergartens, schools, HEIs. . Fund NBS provision for kindergartens, schools, HEIs.	. Professionals/young specialists learning NBS by doing. . Exposure of young generation to NBS knowledge.
Implement green public/private procurement including for NBS	. Training public specialists in procuring NBS. . Stimulating green procurement across the board. . Approve green procurement standards and guidelines.	. Reduced costs enhanced NBS procuring experience. . Reduced costs by avoiding pollution of environment. . Increased quality of procurement and public services.
Provide for pubic initiatives, volunteering and co-production in NBS interventions	. Transparent procedures for NBS implementation. . NBS co-production, co-design procedures for citizens.	. Increased participation and trust by citizens. . Enhanced volunteering for NBS maintenance. Reduced vandalism. Enhanced community acceptance and ownership of NBS. Voluntary implementation of NBS.
Guidelines, tools and training for NBS implementation by public and private actors	. Develop tools such as NBS catalogue and share design blueprints for successful NBS tested at local level.	. Increased knowledge and acceptance of NBS. Improved long term maintenance of NBS schemes.



NBS DESCRIPTION

Type

NBS integration into city Master Plan and SEA

Scale

City level, district level, street level

Context description

City of Kutaisi (Georgia), with population about 147.5 thousand, at the order of its Mayor and elected City Council is engaged in land-use Master Plan preparation within the city boundaries, following the national planning legislation/code. The Environmental Assessment Code of Georgia, in harmonisation with European Strategic Environmental Assessment (SEA) Directive, requires such plans to be subjected to SEA. The contact was established on behalf of the Mayor with selected company GIS and RS Consulting Centre GeoGraphic to undertake the first planning stage, which includes the preparation of Master Plan Concept and undertaking SEA Environmental Scoping in the format of the Scoping Report, which together with the Concept will form the basis for the preparation of the Master Plan and SEA. These final planning documents would have to be prepared in the next stage by the company selected separately for the preparation of the Master Plan and its SEA. Master Plan Concept and SEA Scoping Report identify Nature Based Solutions (NBS) as necessary component of the Master Plan and SEA.

Process of design and implementation

For the purposes of specification of particular Nature-Base Solutions the NBS Impact Assessment Framework is applied, comprising of 5 building blocks and based on the most recent European methodologies (a). Impact assessment framework is closely following the guidance and building block templates for elaborating the NBS evaluation and monitoring plan, specified for the implementation in Master Plan and its SEA, subject to submission and approval by Kutaisi City Council. Building blocks 1-3 are completed as part of the scoping process, while blocks 4 and 5 are to be implemented as part of the Master Plan and SEA.

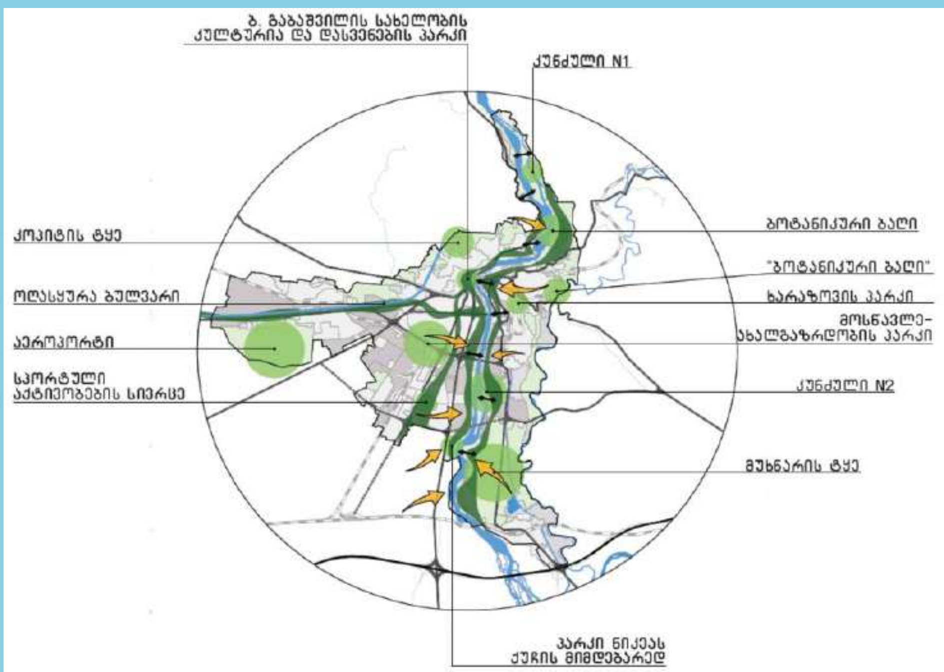
Current deployment and deadline

There are prerequisites in the Kutaisi for the implementation of basic NBS measures, but planned efforts are indeed required to mainstreaming and implementation of NBS into realm of the city.

Financing and stewardship

The financing and stewardship are to be provide with own resources of Kutaisi, with support of funding institutions both international and national, public and private partnership initiatives, non-governmental organisations and last but not least, volunteers, city residents and public.

Map of green and blue spaces (source: draft Kutaisi Master Plan Concept)



(a) https://connectingnature.eu/innovations/connecting-nature-framework
https://connectingnature.eu/innovations/impact-assessment
See also https://op.europa.eu/s/pb1Z and https://op.europa.eu/s/pb10

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CODE	CORE INDICATORS	CODE	FEATURE INDICATORS
	PRIMARY		
PI1	Type of interaction with NBS		
PI2	Frequency of interaction with NBS		
PI3	Duration of interaction with NBS		
PI4	Perceived quality of space		
	ENVIRONMENTAL		
ENV3	Air temperature change	ENV17	Air temperature - Energy demand
ENV8	Flood peak reduction/delay	ENV20	Flood damage (economic)
ENV9	Water quality	ENV26	Community accessibility
ENV15	Inundation risk for critical urban infrastructures (probability)	ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies
ENV23	Public green space distribution	ENV41	Accessibility of greenspaces
ENV27	Connectivity of urban green and blue spaces (structural and functional)	ENV43	Ratio of open spaces to built form
ENV29	Supporting/increasing biodiversity conservation	ENV55	Green space area
ENV35	Species diversity	ENV58	Local food production
ENV42	Land use change and greenspace configuration	ENV59	Cultivated crops
ENV48	Connectivity of urban green and blue spaces (structural and functional)	ENV66	Air quality change
ENV81	Supporting/increasing biodiversity conservation	ENV88	Tree shade for local heat change
ENV89	Species diversity	ENV90	Community garden area per child capita and in a defined distance
	HEALTH AND WELLBEING		
HW3	General wellbeing and happiness	HW4	Life expectancy and healthy life years expectancy
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases	HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases
HW11	Mental health and wellbeing	HW8	Incidence of obesity /obesity rates (adults and children)
HW12	Enhanced physical activity	HW9	Heat reduced mortality
		HW13	Perceived chronic loneliness
	SOCIAL COHESION		
SC4.2	Solidarity between neighbours	SC12	Pro-environmental behaviour
SC5.2	Actual safety		
SC6	Place attachment		
SC11.1	Positive environmental attitudes motivated by contact with NBS		
	ECONOMIC		
ECO3	Net additional jobs created/enabled by NBS	ECO6	Innovation impact
ECO13	Net impact on public expenditure from NBS implementation	ECO8	Income/disposable income per capita
ECO15	Private finance attracted to the NBS site	ECO10	Renewable energy produced

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		ECO11	Overall economic, social and health wellbeing
		ECO12	Change in natural capital
		ECO14	Reduced/avoided flood damage costs
		ECO16	Change in commuting times
		ECO17	Social return on investment

PARTICIPATORY PLANNING AND GOVERNANCE			
PPG3	Transparency of co-production	PPG12	Procedural fairness
PPG4	Policies adopted to promote NBS	PPG16	Community involvement in NBS implementation
PPG5	Activation of public-private collaboration	PPG26	Organizational trust
PPG6	Trust in decision-making and decision-makers		
PPG7	Reflexivity - identified learning outcomes		

NBS RESULTS

Important example of NBS indicator is provided on Figure 1, measuring long term change of land surface temperature and vegetation cover. This illustrates utility of this parameter important in climate change context, as well as to show loss or gain of essential ecosystem functions.

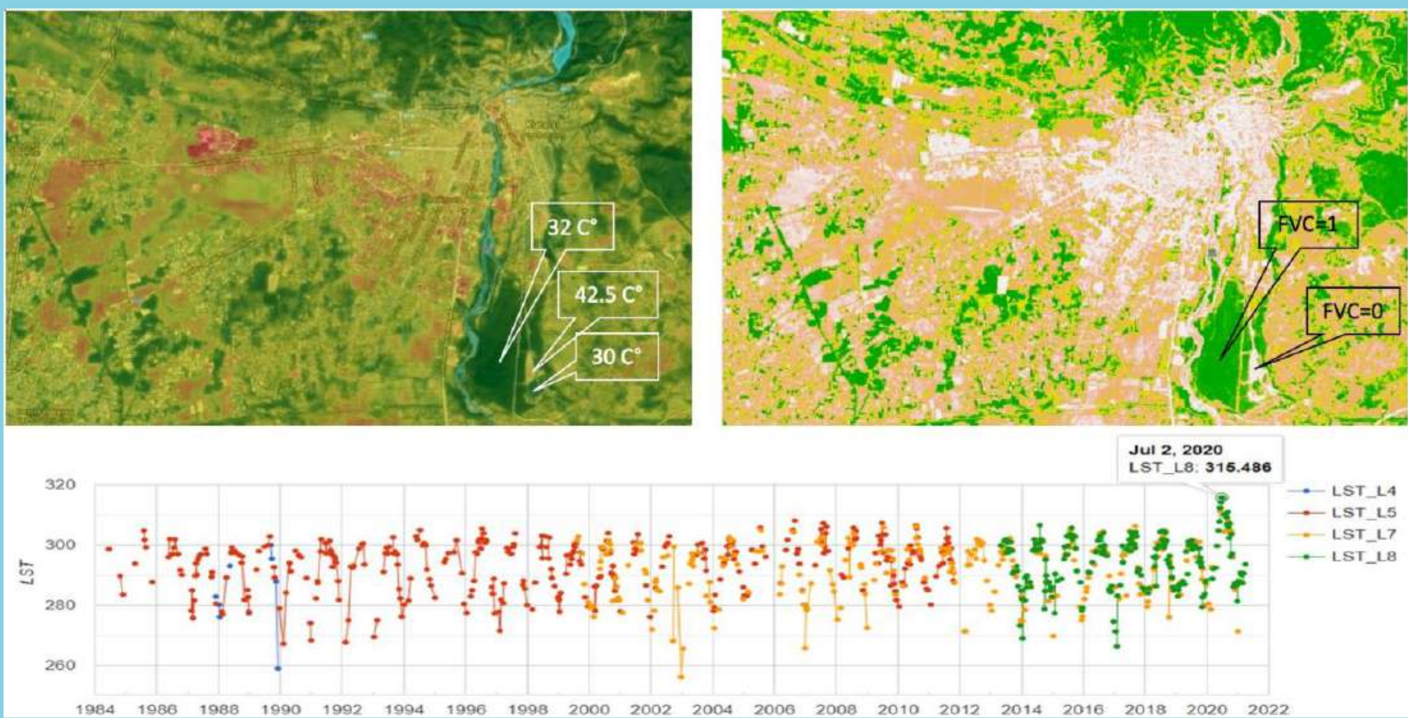

Figure 1. (a) Land Surface Temperature (LST), (b) Fractional Vegetation Cover (FVC) and (c) LST time series at 42.5 C° point in Kutaisi, Georgia. Note significant (>10°) uptick of LST to 315.5 K° (42.5 C°) in 2021 due to major wetland clearance (source: (a) and (b) Landsat 2020.07.02 and (c) Landsat 4, 5, 7, 8, observation period 1982.08.01-2021.04.21, observation location Lat 42.208664 Lon 42.714204) (see Ermida et al. 2020) (b)

(b) Remote Sensing | Free Full-Text | Google Earth Engine Open-Source Code for Land Surface Temperature Estimation from the Landsat Series | HTML (mdpi.com)

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APPENDIX XV. FRC FOCUS GROUP ON TRANSFORMATIONAL CHANGE

Authors: Adina Dumitru, Eva Peralbo Rubio, David Tomé Lourido (University of A Coruña)

The University of A Coruña coordinated a focus group between the FRC and the Connecting Nature experts who advised on the impact assessment process. The objective was to find out what the main difficulties in the process had been, as well as how the FRC had improved in these years. In order to qualitatively analyse the data obtained in this session, the transcription of the discussions held during the focus group was encoded. As a result, Table 1 shows the main topics discussed, differentiating between the main difficulties, benefits, recommendations and innovations.

Table 1. Code rates present in the focus group between FRC and Connecting Nature experts

Category	Code	Genk	Glasgow	Poznan	Experts	Total	Prevalence in Participants (%)	Proportion of total quotes (%)
Main difficulties	Lack of experience	9	11	8	6	34	100	7.67
	Lack of data infrastructure	7	11	4	6	28	100	6.32
	Data scale	8	5	3	3	19	100	4.29
	Limitations of the methods	4	6	4	3	17	100	3.84
	Lack of co-production	2	8	1	5	16	100	3.61
Main benefits	Co-production processes	8	10	12	8	38	100	8.58
	Increase in evidence-based knowledge	7	3	14	14	38	100	8.58
	New resources	5	13	13	5	36	100	8.13
	Spatial data	1	12	0	4	17	75	3.84
	New data infrastructure	2	1	5	5	13	100	2.93

Recommendations on process overview	Complexity of indicators	2	1	3	9	15	100	3.39
	Stakeholder perspective	8	0	0	7	15	50	3.39
	Monitoring pilot projects	3	1	3	4	11	100	2.48
	Long-term evaluation	1	2	3	2	8	100	1.81
	Integrate evidence into policy process	5	2	0	0	7	50	1.58
Recommendations on data collection	Look for local partners and experts	1	6	5	5	17	100	3.84
	Start by identifying goals	6	5	2	3	16	100	3.61
	Search for quality data at the scale needed	5	2	5	2	14	100	3.16
	Limit the number of indicators	1	1	1	7	10	100	2.26
	Hire expert staff	2	3	3	0	8	75	1.81
Connecting Nature innovations	Citizen involvement in the projects	6	0	11	6	23	75	5.19
	Citizen behavioural change	8	5	0	1	14	75	3.16
	Creation of networks	3	4	0	5	12	75	2.71
	New paradigm of assessment	3	1	3	3	10	100	2.26
	Enhanced assessment capacity	3	0	1	3	7	75	1.58

Below are examples of the codes present in the previous table:

Main difficulties

Lack of experience

"I think we have had very little experience compared to data, so in that sense we didn't have systems in place".

"I basically came into my role and was given these horrible spreadsheets and it was like, ok, find all the data and get the planning going and it was so scary, you know because I didn't know what half of them meant".

Lack of data infrastructure

"It was a very time-consuming and demanding process to analyse both data available in the city and what level of generalizations, and actually in the city many indicators has not been developed, especially those that relate to our examples, to our nature-based solutions and actually together with our team we had to collect and still collect a lot of data from 0".

"We had very few data available, so it has been a major challenge for us, which also turned out to be very resource intensive both in terms of time and cost to make progress on this".

Data scale

"Of course, that will not give us the huge result because the small solution cannot generate like on their own like the huge effect".

"It's sometimes hard to get fairly local data which can relate or can identify causal relationships on a very small scale, so that's very hard".

Limitations of the methods

"All these tools and things they don't fix everything. You still need to have a very like you're saying localized perspective and you still need to deal with things".

"Removing some of these horrible spreadsheets you know which did have a function at the time, but you know, we've learned a lot of lessons that we don't need them now".

Lack of co-production

"We also kind of realized through it that people didn't actually know what we were doing".

"When you're trying to roll this out to other cities that don't have this support network, it's perhaps going to be an even greater challenge".

Main benefits

Co-production processes

"At different cities might have different data or different expertise and be able to provide different parts of that kind of puzzle, and together you can build this kind of holistic database on nature-based solutions, but individually it's a very daunting challenge to lay on onto cities".

"We learned it´s that this cooperation with different stakeholders and specially with universities, and with expert is a key and a great opportunity for us to collect this qualitative, quantitative and spatial data and develop these indicators".

Increase in evidence-based knowledge

"We know that there is a big lack of data and indicators and it is a certain gap, but we considered it as a field for our further development and data collection and the creation of new indicators in the city".

"We are explicitly thinking about how what the monitoring strategy will be, and I think this will increase our experience and our expertise and as I said, because you also have the citywide evolution".

New resources

"I think it's because we were still triggered by the super easy datasheet, because it's sometimes in this massive cloud of complexity, it makes it manageable somehow, or something that you can start with and can grow from there and I think we need some kind of starting point, and I think, yeah in that sense, it's definitely useful".

"This template allows us to organize this entire data gathering process. Also check what we already have, what we have are already collected and analysed within the correct connecting nature project and work with the research".

Spatial data

"I think the spatial data will be crucial not just for being able to visualize and understand the data, but fundamentally we will not be able to establish causal links with nature-based solutions unless we have spatial data".

"We're also trying to get Google data, so the University should get the Google tracking data so we can see when people are in spaces. And where they're coming from and why they're using those spaces, we can add that into the policy".

New data infrastructure

"We did a huge step forward to get more detailed data that we can use. So, in general in the city we have a, let's say, good value of data at the cityscape".

"I think in many places there's somebody has that level of data and in small units, and increasingly I think with the ability to get satellite data at really small units, if it's worth getting, it's available".

Recommendations on process overview

Complexity of indicators

"Cities are trying to go to those processes and they are struggling how to understand this and that, and how to transform certain information into spatial representation".

“It's sometimes hard to get fairly local data which can relate or can identify causal relationships on a very small scale, so that's very hard”.

Stakeholder perspective

“If we want to get investors to go into this, I think those are four different perspectives, and rationalizing them is something we might stand back and we could add value by trying to say where we think there's synergies”.

“Our policymakers are very much interested in data for policy evaluation and there's an overlap, but is also differences perspective so, and that's something that's not always easy for us to deal with”.

Monitoring pilot projects

“It's quite easy to do the pilot study, because we have 1, 2, 3 nature-based solution, we have places, we are preparing the monitoring plan and then we are collecting data and analysing them. But I would say that that's the first step”.

“It's said to be also in the pilot projects that we set up we reserve budget for monitoring somehow, so there's also new, that's something that we did not do before”.

Long-term evaluation

“I think this collaboration is beneficial for both sides, so the city is receiving data that they can interpret for the planning and the management of the site”.

“These developed indicators and this collected data, and for us will be also the basis for us to show this effectiveness of activities and chance, for example, to raise funds for Farber activities in the spirit of nature and nature-based solutions”.

Integrate evidence into policy process

“While we feel that's within our city, there is also a lot of pressure to be to do more of impact evaluation, or at least, yeah, some policy evaluation, but they mostly would like to be able to show to, which extends the things that we have done are successful and that does not always match the things you would like to see in an increasingly evidence base, so it can stop turn times be much more limited to few things, or also sometimes more like performance based indicators or these kind of things.”

"So as a planner, when I'm creating policy, the old way was all about economic and nothing else. We now have to think about the health and wellbeing and the social cohesion, but we always had to. But it was seen as less value, it was lower down the pecking order".

Recommendations on data collection

Look for local partners and experts

"That's the biggest lesson learned. Identify the right people from the start and It's not very easy to identify them, but when you do, it's gonna open a lot of doors for you".

"There is a growing awareness of how important it is to have specialists who can actually review well, collect data, review the data and then analyse and provide results".

Start by identifying goals

"We're now trying to tell fast follower studies to do it, which is, you know, identify your goals and then translate them into indicators and then do your work this way and I think it was very messy, and it's only now that we're finally deciding exactly what indicators we're going to be doing, because we're finally aware of what we want to achieve with each project that we're doing".

"The key issue, from my perspective, for the city is to know what for you're collecting those data and how you're going to use it".

Search for quality data at the scale needed

"You can have a ton of data, but if it's not get any quality behind it, it's as much use as a chocolate teapot when you're trying to deal with a space in a place".

"We couldn't find the data, because we couldn't find it the level we needed it".

Limit the number of indicators

"Once you see the entire list of environmental indicators it's perhaps a bit daunting, and by breaking it down into subcategories, it might make it a little bit more manageable and accessible to cities, especially if they don't have the support of connecting nature academics".

"Limit yourself to a manageable amount of indicators, like don't start with a list of 100 but start 10 or something like it's something that you feel comfortable with, so I think that can be reassuring for cities".

Hire expert staff

"We will need to have people who will be responsible for checking it, for governing this data from this metrological station, because I think that it would be also the most important".

"We need more GIS specialists or more people to understand how we unlock this data".

Connecting Nature innovations

Citizen involvement in the projects

"I was quite afraid at the beginning that the Kindergartens will not be very happy to have installed such equipment that might disturb the children, but that was very nice. Surprised at all directors of the kindergarten so it's very open, very happy to have this equipment that children also used to learn".
"It's also about involving citizens, it's about multiple values, or multiple value proposition that you try to achieve with a citizen science project and, yeah, and it's now up and running and it's running well and we have very nice visualizations and very good data. A lot of enthusiasm, both departments and with the citizens as well".

Citizen behavioural change

"A lot of what local governments do it's trying to also work on behavioural change within its citizens. And also there, evidence could be a reason, you could demonstrate that's ok if you do this, then this will be the results, so please do this as well, like this behaviour change".

“A lot of these partner projects, even if they don't have the capacity to get engaged in citizen science program, might be very open to kind of providing access at in exchange for access to data and data sharing and knowledge sharing. And it's a really important part of this raising environmental awareness, and engaging kids in their local environment”.

<u>Creation of networks</u>

“It became a corporate kind of action to collect data and analyse things and that, kind of connected us to other organizations like the NHS, though we would have not been able to infiltrate before”.

"I think if you provide the city with the list of 126 indicators, or however many we're on now, and the potential that they can deliver all of them it is very small. But if you work as a network, a regional network, or a national network, then across cities, perhaps collaboratively, you can start to build up the evidence base that you need”.

<u>New paradigm of assessment</u>

“Using connecting nature to establish a baseline for that is very good and as nature-based solutions become mainstream, that will be a very effective way of generating data on nature-based solution performance”.

“How to behave as a city beyond the connecting nature and what I see as the advantage if you've done what had been done so far. It can also help you to, if you go on with this data or to identify where you might have a problem actually already having the data right now”.

<u>Enhanced assessment capacity</u>

“The cities could reasonably deliver with their capacity, and let's not forget this is capacity that was enhanced by being part of the Connecting Nature project and having some of these partnerships like with the university embedded and paid for”.

“At some point we will be able to, or I am confident that will lead to more also data driven policy somehow and then it will be and especially, like from us is fuelled by Connecting Nature, so I think we will be able to continue this and be able to connect with its evolution”.

Impact Assessment Framework Template

Welcome to the Impact Assessment Framework Template of your city! Throughout the following guide you will find a series of simple tables to fill in all the necessary information to complete the evaluation and monitoring plan of your NBS.

This Template is organized in the Building Blocks of the Connecting Nature Impact Assessment Framework, which can be consulted in the Impact Assessment Guidebook.

In all the steps you will find examples to help you complete the evaluation and monitoring plan for your city.

Building Block 1. Engage in structured reflection on NBS impacts, pathways and trade-offs

LIST YOUR CITY´S STRATEGIC GOALS AND LINK THEM WITH THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Use the following table, and in the first column list all the strategic goals of your city. After that, select their bindings to the SDGs by marking an X in the 17 available boxes. You can consult the information regarding the SDGs here. Please add as many rows as you need!

1. No poverty
2. Zero hunger
3. Good Health and wellbeing
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice Strong Institutions
17. Partnerships to achieve the Goal

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
…																	

Example

City´s strategic goals	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Increase green spaces			X								X		X		X		
Increase the physical activity of citizens			X														
Reduce loneliness			X														
Co-production in urban interventions			X		X												

CHARACTERISTICS OF YOUR NBS AND EXPECTED IMPACT

Describe your NBS (or urban intervention) from the elements in the following table. In case your city is implementing more than one, please copy and paste the table as many times as exemplars.

Brief narrative description (context, motivation, importance for the city ...)
Please write a brief narrative description here

NBS Characteristics	
Type	
Scale	
Location (Geographical coordinates)	
Process of design and implementation	
Current deployment and deadline	
Financing and stewardship	

Example

Brief narrative description (context, motivation, importance for the city ...)	
The new urban park will be created in a deprived area with little green space. This NBS is part of the city's strategic plan to recover marginal areas and return them to the communities so that residents can obtain social and economic benefits. In addition, the design of the park will contribute to respond to the environmental challenges that the city faces.	
NBS Characteristics	
Type	Urban park
Scale	Creation of an urban park in a peripheral neighbourhood of the city
Location (Geographical coordinates)	The scale of the park is medium, it intends to occupy the territory of one block
Process of design and implementation	37°00'25.7"S 174°54'13.6"E
Current deployment and deadline	It was based on an initial design of the town hall. Subsequently, open meetings were held for different stakeholders and citizens. Proposals were collected and four final designs were submitted. After a public participatory process, the final solution was chosen. It began to be implemented at the end of 2019.
Financing and stewardship	The initial construction of the park will be developed from public funds. In later phases, it will be sought to link the new facilities of the park to local business initiatives.

Now, list the objectives, actions and expected results of your NBS. Please add as many rows as you need, and if your city is implementing more than one NBS, copy and paste the table as many times as exemplars.

NBS Objectives	NBS Actions	NBS Expected Results
...	...	...

Example

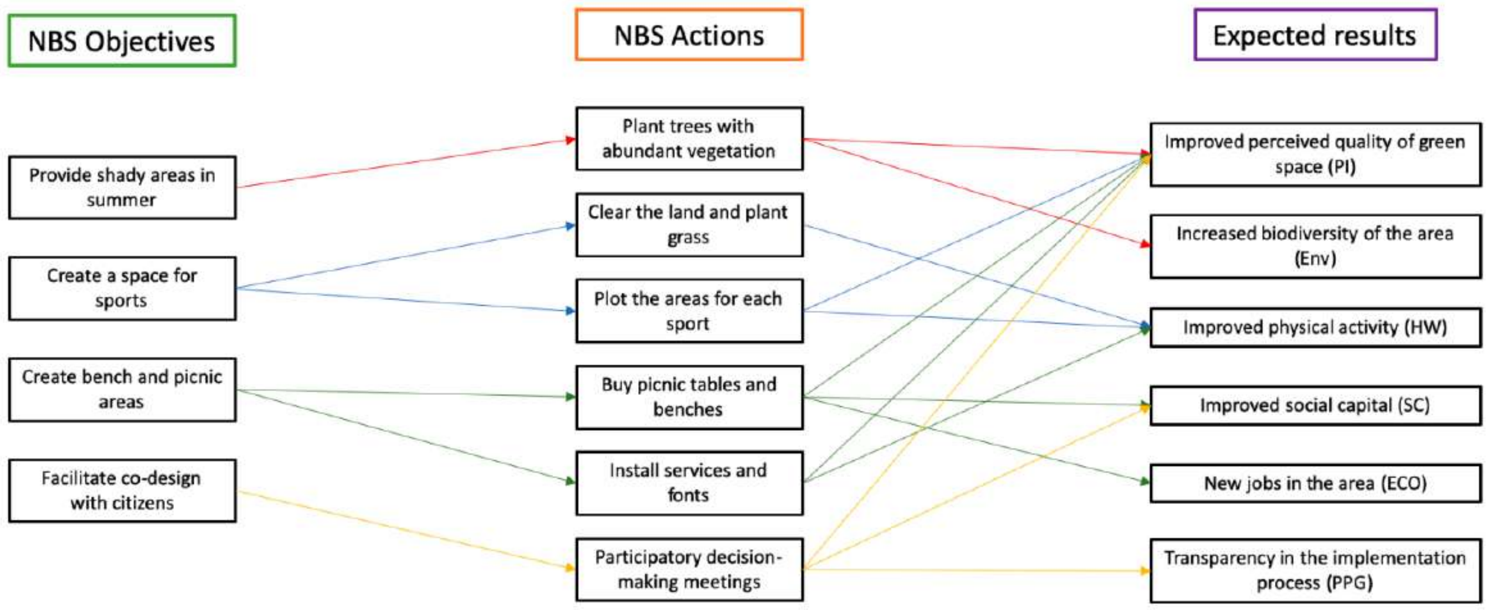
NBS Objectives	NBS Actions	NBS Expected Results
Provide shady areas in summer	Plant trees with abundant vegetation	Improved perceived quality of green space
Create a space for sports	Clear the land and plant grass	Increased biodiversity of the area
Create bench and picnic areas	Plot the areas for each sport	Improved physical activity

Facilitate co-design with citizens	Buy picnic tables and benches	Improved social capital
	Install services and fonts	New jobs in the area
	Participatory decision-making meetings	Transparency in the implementation process

ESTABLISH THE THEORY OF CHANGE FOR YOUR CITY

It is time to relate the previous objectives of the NBS, its concrete actions and the expected results! We will create a diagram with three columns: first, make connections between NBS objectives and actions. In some cases, the same goal may be related to more than one action. To make it easier to interpret, we advise you to use the same colour to trace the connections for each block. To deepen the theory of change, now relate the NBS actions to the expected results.

Example



REFLECT ON THE ASSUMPTIONS AND SPECIFY THE POSSIBLE SYNERGIES AND TRADE-OFFS

Once you have visually related the actions of the NBS with their expected results, let´s write the assumptions of why a certain action causes a certain result. In addition, please detail if the results can present synergies with others (a positive effect in one result also has a positive effect in another impact) or trade-offs (achieving a positive effect in one result brings a negative effect in another or a positive effect on a social group entails a negative effect for another).

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Action 1				
Action…				

Example

NBS Actions	Expected results	Assumptions	Synergies	Trade-offs
Plant trees with abundant vegetation	Improved perceived quality of green space	Citizens will like to see the park with dense vegetation, many trees and shady places	If citizens like the park they will use it more for social activities and exercise	Depending on the species it can increase allergies
Plant trees with abundant vegetation	Increased biodiversity of the area	Dense vegetation will allow the survival of a greater number of species	Increasing biodiversity will favour a greater perception of quality	Depending on the species it can increase allergies
Clear the land and plant grass	Improved physical activity	The lawn is more comfortable for physical exercise	If group physical activity is favoured, social interaction will increase	Clearing vegetation can reduce its biodiversity
Plot the areas for each sport	Improved perceived quality of green space	Citizens will like to see concrete facilities, it will give the feeling of planning	If citizens like the park they will use it more for social activities and exercise	None
Plot the areas for each sport	Improved physical activity	The sports facilities will favour the practice of specific modalities (i.e., football pitches)	If group physical activity is favoured, social interaction will increase	None
Buy picnic tables and benches	Improved perceived quality of	Citizens will welcome a clean	If citizens like the park they will	If there are no recycling

	green space	and safe place to sit and chat	use it more for social activities and exercise	facilities, garbage can increase
Buy picnic tables and benches	Improved social capital	Having a quiet and comfortable space where people meet will facilitate social interaction	Using the park to interact socially will favour its perceived quality	If there are no recycling facilities, garbage can increase
Buy picnic tables and benches	New jobs in the area	The possibility of eating in the park may generate business for the sale of food and drink	New businesses near the park will favour its perceived quality	If there are no recycling facilities, garbage can increase
Install services and fonts	Improved perceived quality of green space	These facilities will be appreciated by the citizens who will be able to spend more time in the park	If citizens like the park they will use it more for social activities and exercise	None
Install services and fonts	Improved physical activity	The fact of being able to use services and have drinking water favours exercise	If group physical activity is favoured, social interaction will increase	None
Participatory decision-making meetings	Improved perceived quality of green space	If citizens participate in the co-design of the park they will like the final result more	If citizens like the park they will use it more for social activities and exercise	None
Participatory decision-making meetings	Improved social capital	Being a participatory process, citizens will interact socially with others	Using the park to interact socially will favour its perceived quality	None
Participatory decision-making meetings	Transparency in the implementation process	If the design is participatory, access to information will be simpler and more complete	Transparency in implementation will favour perceived quality	None

Building Block 2. Choosing appropriate indicators

Based on your NBS expected results, select the following indicators if they have been used previously to measure this NBS impact, or if they will be measured in the future. Mark them with an "X" in the *City selection* box of the table containing all the Connecting Nature indicators.

In the following web page you can consult descriptions of each of the indicators, as well as consult their factsheets, where detailed explanations of its content and method of measurement will appear. In case your city is implementing more than one NBS, please copy and paste the table as many times as exemplars.

Building Block 3. Developing a data plan for impact evaluation

In this same table, develop the data plan for each of the indicators, detailing the following characteristics:

- Baseline data: mark with an "X" if you have available baseline that can be reported in this Deliverable.

> ***. Source (year):*** indicate the source of that baseline, and the point (year) that will serve as a reference for comparisons with the new data collections.
>
> ***. Granularity:*** specify what level the baseline data refers to (i.e., street, district, neighbourhood or the entire city).
>
> ***. Periodicity:*** how often the baseline data is collected (i.e., every month, every year, every change of local government).

- Collection of new data: finally mark with an "X" if the city will make new data collections for this indicator.

Code	Name	NBS expected result	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data
PRIMARY INDICATORS							
PI1	Type of interaction with NBS						
PI2	Frequency of interaction with NBS						
PI3	Duration of interaction with NBS						
PI4	Perceived quality of space						
ENVIRONMENTAL INDICATORS							
CORE							
ENV3	Air temperature change						
ENV8	Rainfall storage (water absorption capacity of NBS)						
ENV9	Flood peak reduction/delay						
ENV15	Water quality						
ENV19	Inundation risk for critical urban infrastructures (probability)						
ENV23	Public green space distribution						
ENV24	Recreational value of blue-green spaces						
ENV25	Cultural value of blue-green spaces						
ENV27	Connectivity of urban green and blue spaces (structural and functional)						
ENV29	Supporting/increasing biodiversity conservation						
ENV35	Species diversity						
ENV42	Land use change and greenspace configuration						
ENV48	Access to public amenities						
ENV56	Blue space area						
ENV81	Soil sealing						
ENV85	Change in ecosystem service provision						
ENV89	Community garden area per capita and in a defined distance						

FEATURE							
ENV1	Carbon storage OR carbon sequestration in vegetation/soil						
ENV7	Albedo						
ENV17	Air temperature - Energy demand						
ENV20	Flood damage (economic)						
ENV26	Community accessibility						
ENV38	Mapping ecosystem services and spatial-temporal biodiversity legacies						
ENV41	Accessibility of greenspaces						
ENV43	Ratio of open spaces to built form						
ENV55	Green space area						
ENV58	Local food production						
ENV59	Cultivated crops						
ENV61	Intensity of landuse						
ENV63	Landuse mix						
ENV66	Air quality change						
ENV88	Tree shade for local heat change						
ENV90	Community garden area per child capita and in a defined distance						
HEALTH AND WELLBEING INDICATORS							
CORE							
HW3	General wellbeing and happiness						
HW6	Prevalence, incidence, morbidity, and mortality of cardiovascular diseases						
HW10	Perceived chronic stress						
HW11	Mental health and wellbeing						
HW12	Enhanced physical activity						
HW16	Perceived restorativeness of public green space						
FEATURE							
HW1	Sustainable nutrition/adoption						
HW4	Life expectancy and healthy life years						

	expectancy						
HW5	Prevalence and incidence of chronic autoimmune diseases						
HW7	Prevalence, incidence, morbidity, and mortality of respiratory diseases						
HW8	Incidence of obesity /obesity rates (adults and children)						
HW9	Heat reduced mortality						
HW13	Perceived chronic loneliness						
HW14	Improvement of behavioural development and symptoms of attention-deficit/hyperactivity disorder (ADHD)						
HW15	Exploratory behaviour in children						
SOCIAL COHESION INDICATORS							
CORE							
SC1	Bonding social capital						
SC2	Bridging social capital						
SC4.1	Trust in community						
SC4.2	Solidarity between neighbours						
SC4.3	Tolerance and respect						
SC5.1	Perceived safety						
SC5.2	Actual safety						
SC6	Place attachment						
SC9	Empowerment						
SC11.1	Positive environmental attitudes motivated by contact with NBS						
SC11.2	Environmental identity						
FEATURE							
SC3	Linking social capital						
SC10	Environmental education opportunities						
SC12	Pro-environmental behaviour						

SC13	Connectedness to nature						
ECONOMIC INDICATORS							
CORE							
ECO1	New Businesses 'attracted' or started and additional rates received						
ECO3	Net additional jobs created/enabled by NBS						
ECO7	Increase in tourism						
ECO13	Net impact on public expenditure from NBS implementation						
ECO15	Private finance attracted to the NBS site						
FEATURE							
ECO2	New customers to business in proximity to NBS						
ECO4	Local economy GDP						
ECO5	Improved business sentiment						
ECO6	Innovation impact						
ECO8	Income/disposable income per capita						
ECO9	Upskilling & related earning increase						
ECO10	Renewable energy produced						
ECO11	Overall economic, social and health wellbeing						
ECO12	Change in natural capital						
ECO14	Reduced/avoided flood damage costs						
ECO16	Change in commuting times						
ECO17	Social return on investment						
PARTICIPATORY PLANNING AND GOVERNANCE INDICATORS							
CORE							
PPG1	Diversity of stakeholders involved						
PPG2	Social equity: involvement of citizens from traditionally under-represented groups						

PPG3	Transparency of co-production						
PPG4	Policies adopted to promote NBS						
PPG5	Activation of public-private collaboration						
PPG6	Trust in decision-making and decision-makers						
PPG7	Reflexivity - identified learning outcomes						
PPG8	Common vision						
PPG9	Innovative climate						
PPG10	Open communication (internal & external)						
PPG11	Collaboration between organizational members						
FEATURE							
PPG12	Procedural fairness						
PPG13	Facilitation skills for co-production						
PPG14	Strategic alignment						
PPG15	Governance innovations for participatory governance						
PPG16	Community involvement in NBS implementation						
PPG17	Reflexivity - time for reflection						
PPG18	Strategic approach						
PPG19	Task significance						
PPG20	Dealing with uncertainty						
PPG21	Support, appreciation of merits and diversity, recognition						
PPG22	Task and skill variety						
PPG23	Team cohesion						
PPG24	Good workload management						
PPG25	Engagement						
PPG26	Organizational Trust						

Example

"City selection" is related to each of the NBS expected results of Building Block 1

Code	Name	City selection (reasoning)	Baseline data	Source (year)	Granularity	Periodicity	Collection of new data
PI4	Perceived quality of space	Improved perceived quality of green space	X	Citizen satisfaction survey with urban green spaces (2017)	District	Specific study	X
ENV29	Supporting/increasing biodiversity conservation	Increased biodiversity of the area	X	National biodiversity observatory (2019)	City	Every year	X
ENV35	Species diversity	Increased biodiversity of the area	X	Eurostat (2017)	City	Every three years	X
HW12	Enhanced physical activity	Improved physical activity	X	Regional health service statistics (2018)	Zip code	Unknown	X
SC1	Bonding social capital	Improved social capital	X	Study from a local university (2016)	Street	Specific study	X
SC2	Bridging social capital	Improved social capital	X	Study from a local university (2016)	Street	Specific study	X
SC3	Linking social capital	Improved social capital	X	Study from a local university (2016)	Street	Specific study	X
ECO1	New Businesses 'attracted' or started and additional rates received	New jobs in the area	X	Business registration of the employers' association (2019)	ZIP Code	Every year	X
PPG3	Transparency of co-production	Transparency in the implementation process	X	Citizen satisfaction survey with urban green spaces (2017)	Neighbourhood	Specific study	X

Building Block 4. Implementing the data plan

Next, and based on the previously selected indicators for your city, write in the following table which of the methods, proposed in the Connecting Nature factsheets, your city will choose for the new data collections. If you are not sure about it, you can consult the indicators factsheets in this web page, looking at the section called "Measurement procedure and tool".

Then, for each indicator, indicate the procedure, whether it will be possible to geo-locate the data, the people or partners in charge of data management, and the types of data analysis to be performed (quantitative and/or qualitative). Please add as many rows as you need, and if your city is implementing more than one NBS, copy and paste the table as many times as exemplars.

Code	Indicator	Connecting Nature method	Procedure	Geolocation	Data management	Statistical analysis	Budget
…	…	…	…	…	…	…	…

Example

Code	Indicator	Connecting Nature method	Procedure	Geolocation	Data management	Statistical analysis	Budget
PI4	Perceived quality of space	Maintenance assessment, sense of security, and attractiveness of the area for a specific use (Factsheet PI4 scales)	The data will be collected between April and May 2021. Participants will be contacted at their homes		The data will be collected by city council staff and will be analysed by the Data department of the regional government	Quantitative & Qualitative	€ 500 to manage the collection material
Env29	Supporting/increasing biodiversity conservation	NHM Bioblitz – community bioblitz (24-hour census), recording as many species as possible	A series of community visits will be organized between February and October 2021, instructing the participants of an observation protocol	X	All records will be delivered to the Data department of the regional government for analysis	Quantitative	€ 1,000 to buy environmental equipment
Env35	Species diversity	Landsat - satellite data	The Landsat satellite images will be reviewed by registering on the web	X	The images will be analysed by the local university, who will	Quantitative	€ 500 in a collaboration agreement with the

			and accessing the years 2015-2020		report the results to us		university
HW12	Enhanced physical activity	International Physical Activity Questionnaire	Data will be collected between April and May 2021. Participants will be contacted at their homes		The data will be collected by city council staff and will be analysed by the Data department of the regional government	Quantitative	Same as PI4
SC1	Bonding social capital	Measuring social capital: An integrated questionnaire	Data will be collected between February and March 2021. Participants will be contacted by email		The data will be collected by a local company, which will deliver the results already analysed to the city council	Quantitative & Qualitative	€ 1,000 to hire a company to collect social and health data
SC2	Bridging social capital	Measuring social capital: An integrated questionnaire	Data will be collected between February and March 2021. Participants will be contacted by email		The data will be collected by a local company, which will deliver the results already analysed to the city council	Quantitative & Qualitative	Same as SC1
SC3	Linking social capital	Measuring social capital: An integrated questionnaire	Data will be collected between February and March 2021. Participants will be contacted by email		The data will be collected by a local company, which will deliver the results already analysed to the city council	Quantitative & Qualitative	Same as SC1
ECO1	New Businesses 'attracted' or started and additional rates received	Business records - local government data	Data that refer to the economic year 2020 will be collected by contacting the local trade cluster, and requesting access to its business registry	X	The data will be collected and analysed by the City Council itself	Quantitative	€ 100 to manage travel
PPG3	Transparency of co-production	Four survey questions using a Likert scale (Factsheet PPG3)	Data will be collected between April and May 2021. Participants will be contacted at their homes		The data will be collected by city council staff and will be analysed by the Data department of the regional government	Quantitative & Qualitative	Same as PI4

Building Block 5. Integrating evidence into the policy process

In this template, we ask you to reflect on how to represent the evaluation results of your indicators. Fill in the following table indicating how you would like to present those results. Which method do you find most interesting for the NBS in your city? Remember that it is not about selecting the method based on the current resources of your city, but the ideal way to represent the evaluation data of your NBS. Also indicate to which stakeholders you would disseminate the results you obtained.

Mark with an X in each of the columns. Remember that the results can have more than one form of representation, and can be disclosed to more than one stakeholder.

Code	**Indicator**	**Results presentation**			**Disclosure to stakeholders**				
		Documentary report	Visual charts	Spatial Dashboard	Scientific partners	Economic sector	Higher political levels	Media	Citizens
...	...	...	...	...	...	...	...	...	...

Example

Code	**Indicator**	**Results presentation**			**Disclosure to stakeholders**				
		Documentary report	Visual charts	Spatial Dashboard	Scientific partners	Economic sector	Higher political levels	Media	Citizens
PI4	Perceived quality of space	X	X		X	X		X	X
Env29	Supporting/increasing biodiversity conservation	X		X	X		X	X	X
Env35	Species diversity	X		X	X		X	X	X
HW12	Enhanced physical activity	X	X		X		X	X	X
SC1	Bonding social capital	X	X		X				X
SC2	Bridging social capital	X	X		X				X
SC3	Linking social capital	X	X		X				X
ECO1	New Businesses 'attracted' or started and additional rates received	X	X	X	X	X	X	X	X
PPG3	Transparency of co-production	X	X		X		X		X

Finally, we ask you to answer the following questions in order to integrate evidence into the policy process.

In which local, regional or national strategies of your country would you find it interesting to include the indicators you have selected?

For which local, regional or national organizations would it be interesting to have these data for decision-making?

Example

In which local, regional or national strategies of your country would you find it interesting to include the indicators you have selected?

- Annual report of the Ministry of the Environment on biodiversity

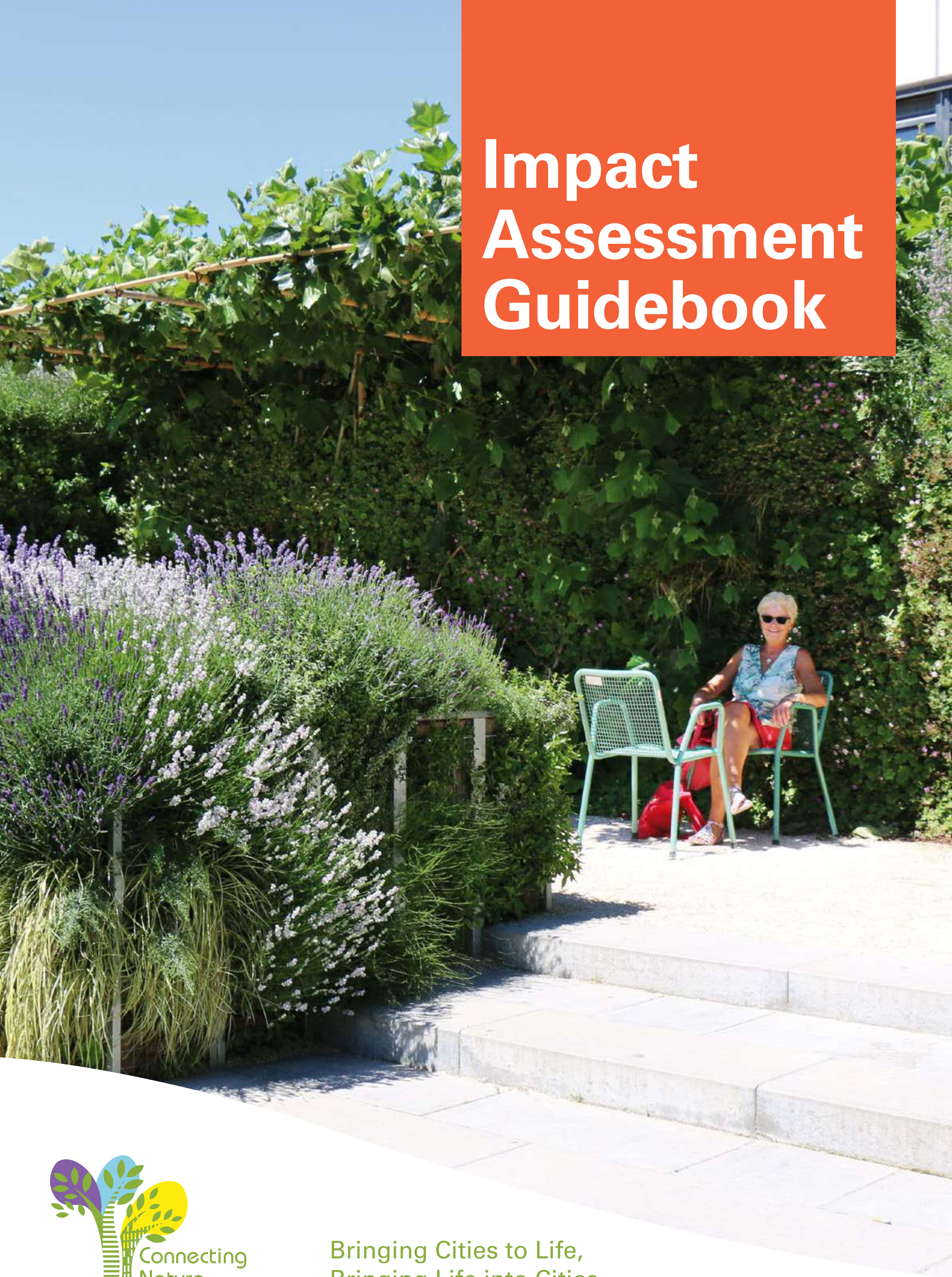
- Local Observatory on Citizen Satisfaction

For which local, regional or national organizations would it be interesting to have these data for decision-making?

- Regional government, in particular the environment and economy sections

- Local NGOs and neighbourhood associations linked to the city's green spaces

Impact Assessment Guidebook



Connecting Nature

Bringing Cities to Life,
Bringing Life into Cities

Acknowledgments

The Connecting Nature Impact Assessment Framework: developing robust monitoring and evaluation plans for nature-based solutions

This guidebook presents the Connecting Nature process of developing robust monitoring and evaluation plans for nature-based solutions. Robust evaluation supports planners and decision-makers in building solid evidence-based understanding as to the impact of nature-based solutions and enhancing cost-effective and socially beneficial policy, building a foundation for scaled up delivery.

The Connecting Nature impact assessment framework has been co-produced by academic partners and representatives of three European cities in Connecting Nature, which are frontrunners in the implementation of nature-based solutions. The framework aims at contributing to the development of a European standard for nature-based solutions monitoring and evaluation.

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Contents

1 | Introduction

What are Nature Based Solutions?

The European Commission defines nature-based solutions as solutions to societal change that are:

> ***"inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions."***

Hence, nature-based solutions must benefit biodiversity and support the delivery of a range of ecosystem services."

What is the Connecting Nature Framework?

Designing and implementing nature-based solutions on a scale that delivers economic, environmental and social co-benefits, while also building resilience and benefiting biodiversity is complex with many different issues to consider.

Many questions arise and need answers.

What is the best solution for the area?

Who will manage it?

How will it be financed?

Who needs to be involved in the planning, delivery and stewardship?

Will it support innovation and generate jobs?

How to measure the economic, environmental and social impact?

How can we manage change?

Even identifying where to start can often be a challenge!

In response to this uncertainty, Connecting Nature has developed the **Connecting Nature Framework** - a process tool to help cities and other organisations navigate the path towards implementation of nature-based solutions on a large scale.

The Framework identifies **three distinct phases of development** for a nature-based solution: **planning**, **delivery** and **stewardship**.

Throughout each phase there are **seven separate elements** that cities and other entities need to consider when shaping their individual nature-based solution: **technical solutions**, **governance**, **impact assessment**, **finance**, **entrepreneurship**, **co-production** and **reflexive monitoring**.

Cities may choose to start with any element of the Framework process and consider the others in the order that suits their context. What emerges from the Framework process is a comprehensive 360° overview of each stage of development of the nature-based solution.

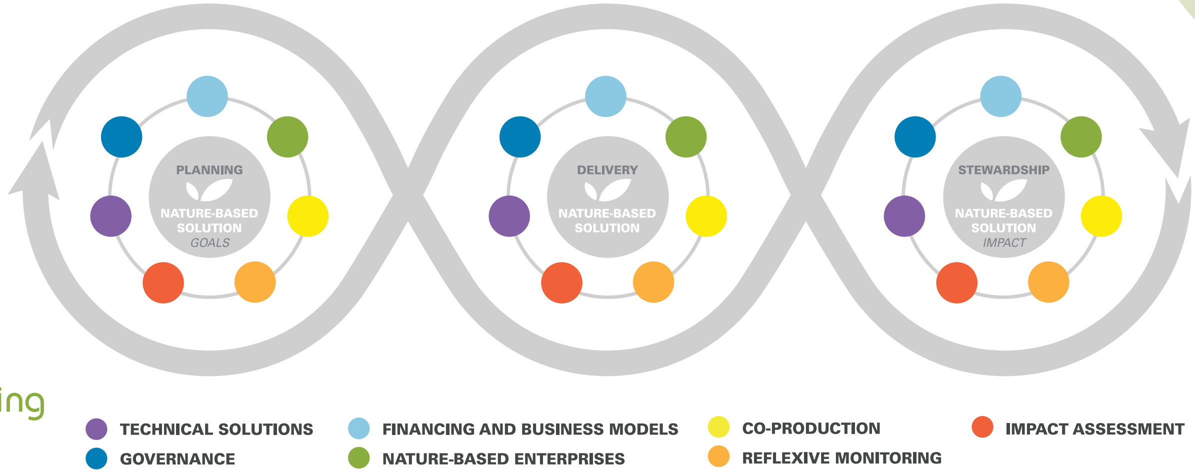
Guidebooks

To assist you in developing your nature-based solution, Connecting Nature has produced a series of guidebooks. The overall Connecting Nature Framework Guidebook is a good starting point. There is also a guidebook for each element of the framework process describing the implementation steps and providing case studies to show how it works in practice. A step-by-step how-to manual on the Connecting Nature Framework process is also available.

All the Connecting Nature guidebooks and the manual may be downloaded from **www.connectingnature.eu.**

Connecting Nature Framework

Connecting Nature



2 | What is the Connecting Nature Impact Assessment Framework?

Developing an impact assessment framework for nature-based solutions

A robust impact assessment framework entails careful reflection and planning of monitoring and evaluation processes which pertain to the design of nature-based solutions. By definition, nature-based solutions are multifunctional. NBS assessment is central to evaluating the strengths and weaknesses of specific interventions against strategic city goals. The ultimate goal is to gather long-term solid evidence about nature-based solutions performance in particular urban contexts and for different social groups. In turn, this evidence can support smart policy decisions and adaptive co-management aspects of the NBS stewardship once installed, as well as enhance sustainability, wellbeing, and resilience in cities.

The Connecting Nature Impact Assessment Framework is a process aimed at supporting cities in developing and successfully implementing robust monitoring and evaluation plans that can deliver systematic and comparable evidence as to NBS effectiveness. This framework represents an essential tool for adapting NBS design and implementation in real time. Consequently, NBS interventions performance increases and NBS can be maintained and revitalized over time.

Evaluating effectiveness of NBS interventions is also useful in developing cost-effective policies which supports cities in advocating for pertinent investments, including exploitation of broader funding streams. Monitoring and evaluation processes advance the arguments as to the benefits that NBS can deliver. We have also learned that effective assessment will require changing current ways of planning for social resilience and regeneration that are still dominated by redundancies that derive from understanding ecological, social and economic objectives as separate and sometimes at odds with each other and reflected in the siloed thinking and structure of policy practice.

The NBS evaluation and monitoring process is developed along five steps, incorporating indicators selection and assessment. Throughout this mini-guidebook, each step is detailed with examples so that cities and stakeholders can develop their own NBS assessment plans. The five steps are represented in Figure 1.

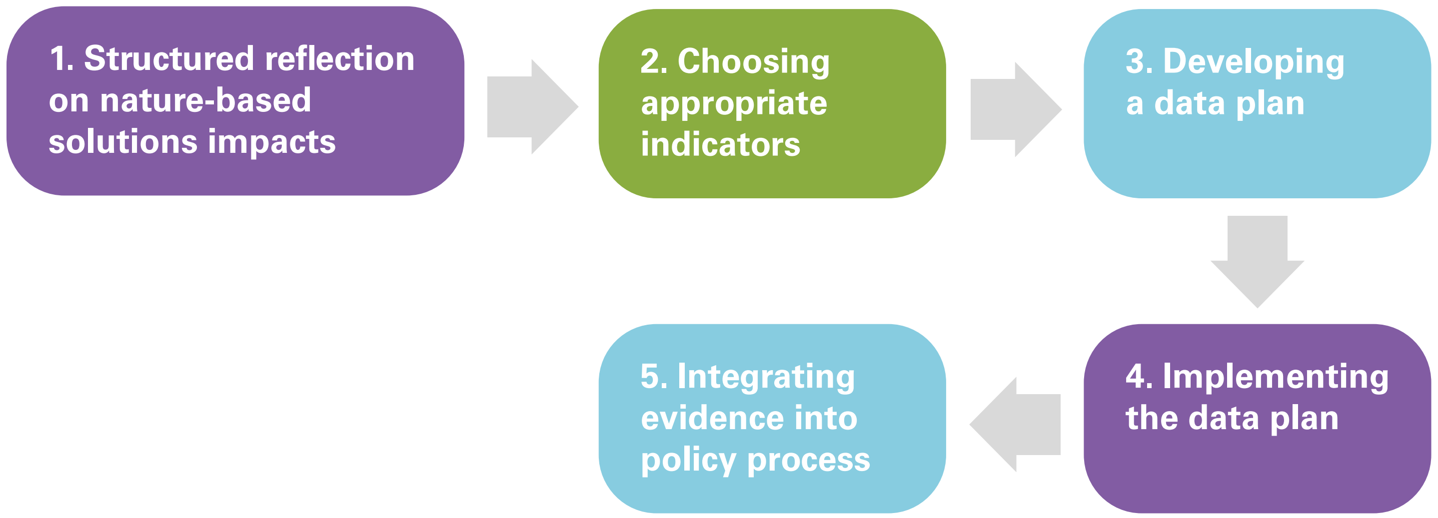


Figure 1. *Steps in the nature-based solutions monitoring and evaluation process.*

3 | Steps in the NBS monitoring and evaluation process

3.1. Step 1. Engage in structured reflection on NBS impacts, pathways and trade-offs

3.1.1. Matching NBS expected impacts to the city´s strategic objectives

Engaging in structured reflection is of paramount importance in designing a functional monitoring and evaluation plan for NBS. Structured reflection supports cities in identifying context-appropriate rationales for NBS implementation and establishing evaluation objectives. Also, it contributes to the transparency and justification of policy decisions. Considering that NBS are interventions that aim to address strategic city objectives, it is important to first identify the objectives targeted by the intervention. Many times, there are some main identified objectives for the intervention (benefits), and others that are considered secondary (co-benefits).

City strategic objectives are normally defined in broad terms, while NBS will need to clarify their expected impact more specifically – geographically, demographically and over time. Nature-based solutions are expected to deliver a multi-layered impact (i.e., increased health and wellbeing for residents, increased social cohesion, new economic opportunities or environmental net gain including biodiversity). However, NBS will not necessarily deliver on all foreseen benefits. Thus, making assumptions explicit helps to identify what might be missing in NBS design. For example, if a city designs a network of urban gardens, how are these designed to support physical and mental health? Through an increase in physical activity? Through increase in social interactions? Specifying the expected benefits further facilitates appropriate planning, design, monitoring and evaluation.

Therefore, the main NBS intervention impact should be clearly stated. It can be understood as primary and secondary long-term effects resulting from a chain of events, to which intervention has contributed (CGIAR IEA, 2015). The chain of events constitutes the intervention pathway, a course of several actions that should be implemented to obtain expected results. The first phase of the process consists of identifying those expected results based on the city's objectives, while differentiating between outcomes and outputs.

Outcomes are results you want to achieve while outputs are actions that contribute to outcome. Outcomes are the difference made by outputs (Mills-Scofield, 2012). Using a growing space as an example, actions that are implemented to create the spaces would be outputs and outcomes would be impact that the creation of those spaces have (i.e., greater satisfaction perceived by citizens or higher levels of healthy eating). This reflection on NBS consequences and associated outcomes depends on how each city approaches its specific "theory of change".

For more information on mapping local contexts and policies see Connop et al. (2019) and Hölscher et al. (2019). When planning, it is also important to keep in mind what the objectives for the use of the data are, since planning and evaluation have multiple objectives: to assess performance vs intended benefits, to align NBS outcomes with city strategic priorities, to plan more effective NBS, to develop a data management plan, and to adapt tweak solutions over time. A good robust geographical based evidence base will help to change the policy direction of travel and could have political influence on national and regional policy as well as at local level.

3.1.2. Theory of change: identify your assumptions and map causal pathways

Approaching the city's "theory of change" requires identifying city´s assumptions as to how NBS actions and the context within which are taken will relate to expected impacts. It is necessary to build an integrated vision with regard to the NBS implementation impact on different health and wellbeing, social, economic and environmental dimensions (Qui et al., 2018), and the relations among them, while contemplating the temporal, demographic and spatial aspects. The following terms are essential in determining the theory of change for a NBS intervention:

Terms	Description
Assumptions	Initial suppositions of how certain actions will generate the desired impact
Synergies	A positive effect in one category also has a positive effect in another impact category
Trade-offs	Achieving a positive effect in one category brings a negative effect in another or a positive effect on a social group entails a negative effect for another

Table 1. *Theory of change essential terms (based on Dumitru et al., 2020).*

Understanding the interrelation between health and well-being, social, economic and environmental spheres allows for the identification of actions that will cause synergies with others (i.e., a greater number of green spaces could create improvements in air quality and higher levels of perceived well-being), but also trade-offs (i.e., a greater amount of green spaces can cause gentrification phenomena). Planning to prevent negative and incorporate positive trade-offs and synergies into the NBS intervention will enable cities to avoid unintended consequences.

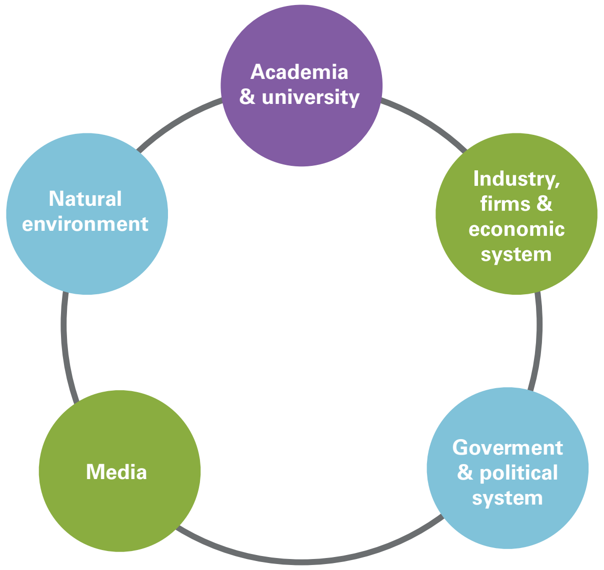


Figure 2. *Quintuple Helix Stakeholders (adapted from Carayannis, Barth, & Campbell, 2012).*

Collaboration between different stakeholders is essential to carry out this assessment. All components in the Quintuple Helix model should be considered (Figure 2). The objective of reaching a co-production process, understood as a deep participation that considers expert, tacit, and decision-makers knowledge, while seeking sustainable solutions that generate social resilience. Bringing together stakeholders with different knowledge is also a key driver of innovation (Frenken 2017; Handeman et al., 2015).

Each stakeholder has a particular vision of reality and how the actions carried out are interrelated. For example, the vision environmental organizations may have on how to create more green spaces to improve citizens' quality of life is not the same as the entrepreneurs' vision on how to create green businesses in the area. Therefore, all these points of view should be debated to correctly identify the assumptions and the pathways from interventions to expected outcomes. This joint debate process must include a phase of identifying possible candidate actions. Once direct and indirect effects on expected results have been identified, stakeholders can detect possible gaps that result from the implementation process (Qiu et al., 2018).

Within Connecting Nature Project, the mapping of the theory of change of each Front-runner city took place from joint workshops (Dumitru et al., 2019). First, a common language was established to identify city's key strategic objectives. Then, with the help of the academic partners, the association was made between these objectives and the specific associations of the NBS. The next phase was to associate the cities' objectives with specific indicators.

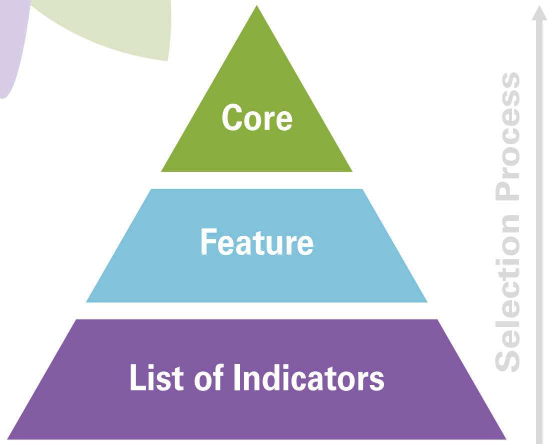


Figure 3. *Indicator selection process.*

3.2. Step 2. Choosing appropriate indicators

3.2.1. Characteristics of good indicators

Indicators are selected to measure the expected outcomes and outputs related to project strategic objectives. Indicators should be chosen based on the previous mapping process, where the relationship between NBS actions and the expected impact (i.e., health and well-being, social, economic and environmental dimensions) was determined.

Indicators selection process, conducted by local authorities, must be based on the state-of-the-art scientific evidence on NBS impacts while also engaging different stakeholders in a co-production process between cities and different stakeholders (i.e., collaboration between cities with universities can be and effective way of delivering this issue). The list of selected indicators cannot be disjointed. That is, the indicators selection process should not attempt to evaluate complex situations as if different aspects of reality could be analysed in isolated silos. Notably, synergies and trade-offs previously established must be considered. Therefore, the selected indicators must form a coherent framework where social, economic, and environmental areas of impact are inter-connected. This process allows for a broad vision of how NBS interventions make it possible to advance on the range of objectives desired by cities (i.e., improving the quality of life of citizens, but also their economic possibilities and environments).

At the European level, efforts are underway to create a common framework of indicators, based on the experience of the cities and their collaboration with the different stakeholders. Therefore, a European Handbook for Practitioners is currently being elaborated and will be published soon as a cooperation of European nature-based solution projects.

Sometimes, it is very difficult to apply all indicators initially selected (i.e., for reasons of economic efficiency, time constraints, personnel resources, etc.). In collaboration with stakeholders, cities must consider what is essential to evaluate in order to understand the NBS process and results. Prioritizing the most relevant indicators as well as gathering expressions of interest for testing different methods facilitates the process of establishing a final list of indicators used to evaluate NBS interventions (Dumitru et al., 2019).

The procedure of choosing indicators by the Connecting Nature Front-runner cities was carried out through a review of literature and a co-production process where cities have made a priority ranking to differentiate between indicators that are critical to evaluating all NBS (i.e., core) and indicators that align closely with city strategic priorities but are not relevant to all NBS (i.e., feature) (Figure 3). Core indicators are recommended for all cities in order to create a holistic evidence-based framework for nature-based solutions, while feature indicators are recommended to all cities but might not be relevant to all NBS projects.

Once the final list of indicators was obtained, cities established the alignment of each indicator with the specific objectives, and its area of influence regarding the population. As a result of this process, the theory of change can be represented for each indicator through causal maps, where the previous actions of each one and their associated consequences can be visualized (Figure 4). These causal maps could be customized to the specific context of each city.

Figure 4. *Indicator causal map.*

3.2.2. Types of indicators

When selecting indicators, it is not only important to plan the assessment of the NBS impacts on social, environmental and economic dimensions, but it is also important to know the uses that citizens make of exemplars, or how their design and implementation process has been. Table 2 provides descriptions and examples of these three types of indicators.

Having presented the different types of indicators, it is time to focus on outcome indicators that facilitate an evaluation of NBS impact on health and well-being, social, economic, and environmental dimensions. Based on scientific and grey literature review, and through workshops with different experts and cities, Connecting Nature selected four categories of outcome indicators: Health and Well-being, Social Cohesion and Justice, Environment, and Economic. Each of these four categories presents a comprehensive list of indicators (core and feature) which allow for a thorough assessment of expected outcomes.

	Description	Classification and Examples
Outcome Indicators	They are used to measure the expected nature-based solutions results. Based on the scientific and grey literature review, as well as through workshops with cities, the Connecting Nature project has identified four categories of outcome indicators. Each of the four categories presents an exhaustive list of indicators, which would provide sufficient information to assess the broad range of possible outcomes from nature-based solutions.	• Health and Wellbeing (i.e. General Wellbeing and Happiness) • Social Cohesion and Justice (i.e. Empowerment) • Environmental (i.e. Air Temperature Reduction) • Economic (i.e., New Businesses 'attracted' or started and additional rates received)
Primary Indicators	NBS uses are measured by these indicators, which allow defining their intervention's area of influence, by knowing the communities directly involved in it, and those that may be influenced by indirect effects This analysis can be done through NBS mapping, using GIS or remote devices strategies.	• Type, frequency and duration of interaction with nature-based solutions • Perceived quality of nature-based solutions
Participatory Planning and Governance Indicators	These indicators measure the outputs and outcomes from the nature-based solutions design and implementation process. These indicators are not intended to evaluate the final results of the interventions. However, they are considered fundamental to understand the underlying drivers of success or failure of the nature-based solutions.	• Co-production (i.e. openness or inclusivity) • Governance capacities (i.e. skills or resources) • Actionable knowledge (i.e. policy learning) • Organisational development (i.e. leadership skills)

Table 2. *Types of nature-based solutions indicators.*

All indicators have their own factsheets with detailed descriptions of methodology that will be available on the project website (https://connectingnature.eu/). More elaborated list of indicators will be also available on the European Handbook for Practitioners. The core indicators selected for each of the four Connecting Nature categories are presented below:

Health and Well-being

Concerning Health and Wellbeing category, the following six core indicators were selected: General wellbeing and Happiness; Prevalence, Incidence, Morbidity, and Mortality of Cardiovascular Diseases (CVD); Prevalence, Incidence, Morbidity of Chronic Stress; Mental Health Wellbeing; Enhanced Physical Activity; Perceived Restorativeness.

Social Cohesion and Justice

NBS social impact can be evaluated through eleven core indicators: Bonding Social Capital; Bridging Social Capital; Trust in Community; Solidarity between Neighbours; Tolerance and Respect; Perceived Safety; Actual safety; Place Attachment; Empowerment; Positive Environmental Attitudes Motivated by Contact with NBS; Environmental Identity.

Environmental

Within the category of Environment Indicators, 17 indicators were considered priorities with respect to NBS environmental impact evaluation: Air temperature reduction; Rainfall storage (water absorption capacity of NBS); Flood peak reduction/delay; Water quality improvement; Reduction of inundation risk for critical urban infrastructures (probability-economic); Public green space distribution; Recreational value of blue-green spaces; Cultural value of blue-green spaces; Connectivity of urban green and blue spaces (structural and functional); Supporting/increasing biodiversity conservation; Species diversity; Land use change and greenspace configuration; Access to public amenities; Blue space area; Soil sealing; Change in ecosystem service provision; Community garden area per capita and in a defined distance.

Economic

For the evaluation of NBS impact in the economic dimension, five indicators were deemed to be core: New Businesses 'Attracted' or Started and Additional Rates Received; Net Additional Jobs Created/ Enabled by NBS; Increase in Tourism; Net Impact on Public Expenditure from NBS Implementation; Private Finance Attracted to NBS/Bioeconomy.

3.3. Step 3: Developing a data plan for impact evaluation

3.3.1. Baseline vs outcome data

Once the indicators are selected, the next step consists in developing a plan for impact evaluation. Implementing a good data plan is essential to correctly analyse the intervention results and establish their effectiveness. This data plan must be adjusted both to city´s theory of change and to previously selected indicators.

In order to develop a data plan, data availability must be established and clarified. Differences between two moments in time can only be gauged if data prior to implementing NBS interventions is compared with data subsequent to NBS implementation. Baseline data is information that indicates the initial (i.e., prior to NBS implementation) status of a particular indicator. Baseline information can be obtained in two ways:
1. Accessing data available in official reports (i.e., obesity rates or nitrogen dioxide levels), or 2. Collecting data before NBS implementation. On the other hand, outcome data is represented by information obtained once NBS interventions were implemented. Unlike baseline data, it is necessary to collect outcome data during or after NBS execution. Based on outcome data, a new situation generated by NBS implementation can be compared with baseline data (Figure 5).

Available data can come from different sources: city and external sources documents, official statistics, national or international organizations reports, peer-reviewed articles, books, and research reports. In this phase, the co-production process is again of relevance, since collaboration between stakeholders belonging to the Quintuple Helix model fosters efficient access to available data in order to evaluate the NBS.

City of Genk´s co-production workshops offers a fine example of this stage in the process. City team members held several workshops aimed at “bringing together stakeholders to identify existing data” (Dumitru et al., 2019). In this case, available data relevant to assessing NBS effectiveness was varied: prevalence or incidence of diseases statistics, physical activity reports, crimes reporting, economic indicators of local business associations, or indexes of meteorological stations in the city.

The NBS monitoring and evaluation process is ongoing and continuous over time. Once this stage of the framework process is complete, outcome data can become baseline information for future NBS interventions. If we do not have baseline data or a control situation (a similar context but without the NBS), there is no possibility to explore the causal relationships between the NBS actions and the NBS impact (s) assessed. In the absence of baseline data, one can only provide descriptive accounts (i.e., the environmental pollutants levels in an area) or draw momentary comparisons between sub-groups (i.e., differences in physical activity levels across different population groups). If baseline data is located or collected, NBS implementation effects can be effectively explored and reach valid conclusions.

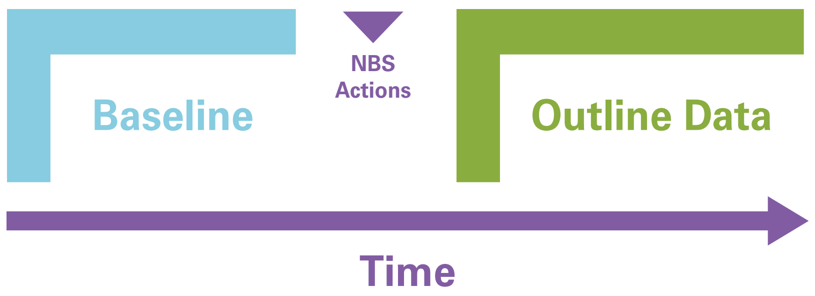


Figure 5. *Baseline vs Outcome data.*

3.3.2 Things to consider in drawing valid conclusions on NBS impacts

Valid conclusions assumption is the most important criterion in establishing the presence of expected impact upon NBS implementation. That is, check that what was intended with the NBS interventions has been achieved, as impacts are determined by multiple factors. When planners and decision-makers implement a policy through an NBS, at the same time there could be multiple other phenomena that act on the expected result (i.e., creating a park in a neighbourhood to encourage physical activity vs other community sports club programs, which are conducted at the same time, and which also seek to increase physical activity levels).

Therefore, not only it is necessary to consider direct and indirect effects between the actions, and the pathways of synergies and trade-offs previously discussed, but also to identify causality between the actions carried out in NBS implementation and different dimensions of health and well-being, social, environmental, and economic impact (i.e., the creation of a new green area has really been the cause of increased physical activity in neighbours and not another one). To document these impacts, it is important to compare the situations before and after the intervention or between similar contexts and user groups (i.e., compare the levels of physical activity in a neighbourhood where the new park was created vs. other neighbourhoods where there are no parks or gyms to exercise in).

The in-depth analysis required by this step is fundamental to data interpretation and NBS impact assessment. This step takes considerable amounts of time and commitment. Therefore, we recommend allotting proper time to navigate this phase in a way that ensures robust impact assessment. Once causal chains were considered, causality analysis facilitates valid conclusions on NBS interventions. On the whole, we recommend close contact with academic partners for indicators selection and accessing their expertise in causality analysis to monitor and evaluate NBS impact.

3.4. Step 4: Implementing the data plan

3.4.1. Characteristics of appropriate method(s)

The next phase in assessing NBS effectiveness rests in choosing the necessary methods and instruments to measure selected indicators. Here too, collaboration with academic partners and universities (or data analysts in relevant consulting/ public bodies) in setting up appropriate methodologies is highly recommended. Each indicator is to be assigned suitable data collection method(s). As shown in Table 3, relationship between indicator and its measurement method is determined by data quality, temporal adequacy, and cost-benefit ratio assessment. Connecting Nature indicator factsheets include methodologies that follows these criteria.

Optimally, data collection requires attending to numerous indicators with multiple methods, instruments, and data sources. Hence, collaboration among different stakeholders is essential to developing and implementing the data plan. First, citizen collaboration is needed not only to apply the instruments, but also to obtain knowledge about NBS evolution throughout implementation phases. Citizens can become empowered in relation to their local spaces. Secondly, collaboration with partners in the industry can provide valuable information for measuring economic indicators, while media can help in data collection and disseminating the importance of evaluation. Industry can also generate data to support product development, marketing and decision-making. Finally, the universities are an indispensable partner in executing all steps along the process. If managed well, the process evolves along symbiotic dynamics where all entities benefit. On one hand, local governments obtain the necessary information to evaluate their interventions. On the other hand, the academic sector capitalizes on useful data and knowledge which can be further disseminated to advance the state of the art in social, environmental and economic research worldwide.

	Description
Data Quality	The data quality has to be scientifically valid; it determines the possibility of performing causality analyses. To obtain quality data, it is highly recommended to select standardised instruments (scientifically tested).
Temporal Adequacy	Really exhaustive standardised instruments allow having very precise information on certain indicators (e.g. a 240-item questionnaire on levels of well-being and mental health). However, this comprehensiveness can be time consuming, which may be excessive if other instruments have to be applied to evaluate different indicators.
Cost Benefit Ratio	The ideal situation is to use the best scientific methodologies, but sometimes cities have to choose based on their economic capacity and resources. However, the choice of methodology should never be unscientific.

Table 3. *Factors to consider when choosing a method.*

3.4.2. Temporality of data collection and automatization

Data collection temporality involves answering the following three questions: 1) How long should data collection take?; 2) How many times is it necessary to collect data?; and (3) What is the expected temporal scale of the outcome?. The duration can be set based on a minimum amount of information (i.e., a fixed number of citizens representative of the general population or a sufficient number of measurements on environmental parameters). Setting a date as time limit can also be based on city specific and economic resources.

Regarding data collection frequencies and the temporal scale, the more times selected indicators are measured throughout NBS implementation, the greater the precision of assessing the effectiveness of any expected impact. It is not necessary to wait for the end of NBS implementation to explore the changes produced and their direction (i.e., expected vs. unexpected). However, each city should estimate a timeline for expected outcomes.

A good compromise could be to collect data twice: first time, before NBS implementation (i.e., baseline) and then, after NBS interventions had been implemented (i.e., outcome data).

However, it is advantageous to establish regular monitoring over time for many indicators to ensure that benefits are retained and to inform adaptive management decisions as circumstances change. Iterative data collection can allow adjustments to be made in the actions that could create a more cost-effective action. Temporality is also closely related to automatization, as data collection is repeated over time (i.e., on a trimester or yearly basis) and requires the investment of far fewer resources (i.e., personal - time, financial, etc.). It is highly beneficial to connect data collection with official national and international reporting, since good temporal overlap permits updating information relevant to NBS evaluation and monitoring.

3.5. Step 5: Integrating evidence into the policy process

3.5.1. Data analysis

NBS assessment data can be of two types: (1) quantitative: the information is collected and represented in numerical format, and facilitates the exploration of statistical relationships between different indicators (i.e., data on incidence of cardio-vascular disease) and (2) qualitative: the information is conceptual, based on descriptions, and can be organized on topics (i.e., the investigation of trust in a community during and following NBS implementation). Depending on data type, three strategies of data analysis can be employed: quantitative, qualitative, or mixed analysis (i.e., results and conclusions of quantitative and qualitative methods are integrated for a deep understanding in assessment evaluation (for more information, consult Creswell & Creswell (2017). Cities can also consider approaches based on citizen science methods, both quantitative or qualitative.

Furthermore, within the quantitative analysis, two different ways of understanding the information provided by assessed indicators can be identified. On one hand, evaluators can present descriptive data analysis which indicates the most representative elements of the analysed data set (i.e., number of people who use a park, the average level of well-being in a community, etc.). On the other hand, we can rely on inferential analysis to explore relationships between indicators (i.e., if more green area in a city is related to lower temperatures in summer.), compare population groups (i.e., nutrition quality in an area with several NBS growing spaces compared to other non-NBS areas), or predict how some of indicators will behave in the future (i.e., if increasing the number of parks enhances the physical activity performed by members of a community).

3.5.2. Presenting data analysis results in an integrated and visual way

Unattractive data presentation (i.e., long texts without visuals does not support the achievement of effective communication between city departments and to its stakeholders (e.g., academic partners, industry, or media). For this purpose, it is highly recommended to provide visual presentations. Thus, information can be efficiently consulted, verified, and compared. Dashboards for results integration can help with possible confusion about sources of information, which dimensions are under evaluation, or what population group is assessed. Dashboards can also allow spatial and temporal integration of the information of different impacts (i.e., see the level of physical activity by neighbourhood, in different years). The Glasgow Connecting Nature Dashboard (Figure 6) offers a good example of visually unifying and integrating different results sources.

Figure 6. *Glasgow Dashboard.*

3.5.3. Linking results with the initial theory of change and objectives

Presented results must be related to initial city objectives to see if they were adequately met. It is necessary to review the city´s theory of change and the NBS impact intended. Synergies and trade-offs between different actions should be considered when relating results to initial objectives. Next, the evidence produced is processed and fed back into the policy planning process. That is why NBS evaluation results can be used in the process of reflexing monitoring.

Reflexing monitoring is a methodology for facilitating and capturing learning-by-doing and doing-by-learning when co-producing NBS (Hölscher et al., 2019). This process is about learning in real time and in situ, not retrospectively. A more detailed description is available in the Connecting Nature Framework guidebook (Hölscher et al., 2020). Consequently, all the information collected during the intervention process should be used to make new decisions, re-evaluate objectives and theories of change, propose alternative explanations, and create a flow process between NBS information and desired new actions. The monitoring process will not only provide fruitful information for future projects, but involves continuous contact with data which informs NBS adjustments and empirical evidence updates.

In the overall analysis, it is necessary to be careful when modifying proposed actions due to absence of expected results. On certain occasions, expected outcomes surface along a longer time-frame than initially planned. An intervention that aims to increase de-sealing to reduce the heat island effect could verify short term impact, but an intervention that aims to enhance empowerment through community spaces can only verify the effects on social aspects on a longer time-frame.

4 | Transferring NBS evaluation process and results to other cities

The last phase of the monitoring and evaluation process consists in sharing the results with all those stakeholders belonging to the Quintuple Helix model (i.e., academia, industry, government, media, and natural environment), and also with the wider European and global communities. Several joint collaborative actions can help to disseminate results: scientific articles, official reports from administrations, congresses, open conferences, webinars, talks, citizen meetings, or interviews.

This phase should be covered even if results do not reflect desired impact NBS objectives. It is as important to indicate that NBS contributed to desired impact(s) as it is to report when NBS interventions did not contribute to expected outcomes or even contributed to adverse consequences. By employing ethical research and data dissemination practices, NBS actions can be objectively analysed to see how NBS worked. This way, NBS implementation can be replicated and adapted by other cities within a continuous improvement framework.

In essence, the final objective of NBS evaluation should be to create and share greater accumulated NBS knowledge. This approach is necessary to facilitate the silo-busting of departments and the unlocking of diverse funding sources that is essential to scaling up nature-based solution delivery. Therefore, creation of learning and mentoring links between cities is a guarantee for effective NBS replication within a framework of ongoing improvement and adaptation.

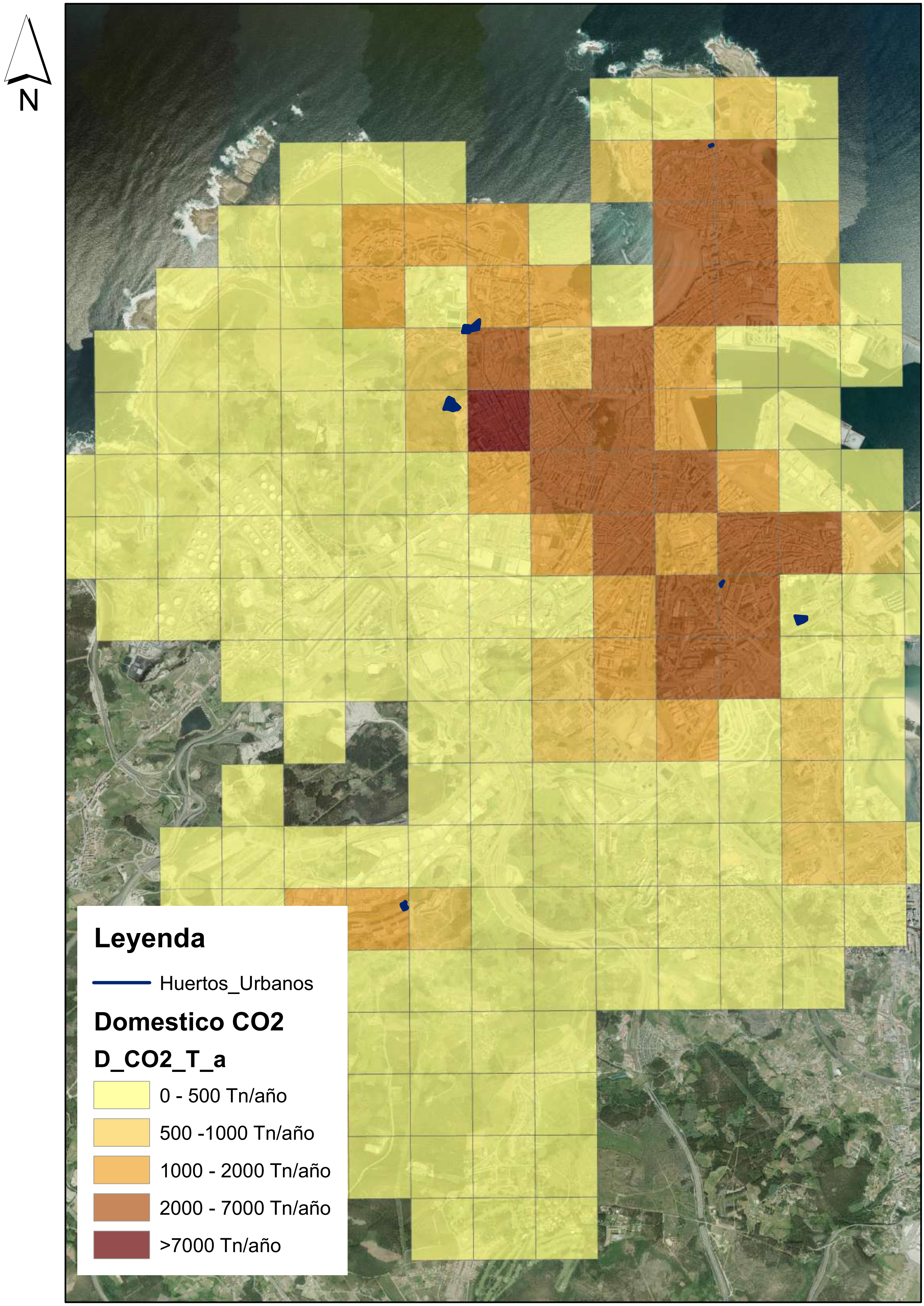
The Oppla platform, an NBS repository of the European Union, is an indispensable resource in sharing information on NBS implementation between cities. Oppla (2019) aims to simplify the creation, acquisition, and transfer of knowledge for a better management of the environment. This free access platform is designed for the benefit of different sectors (i.e., science, policy and practice; public, private and voluntary sectors; organizations large and small; private individuals).

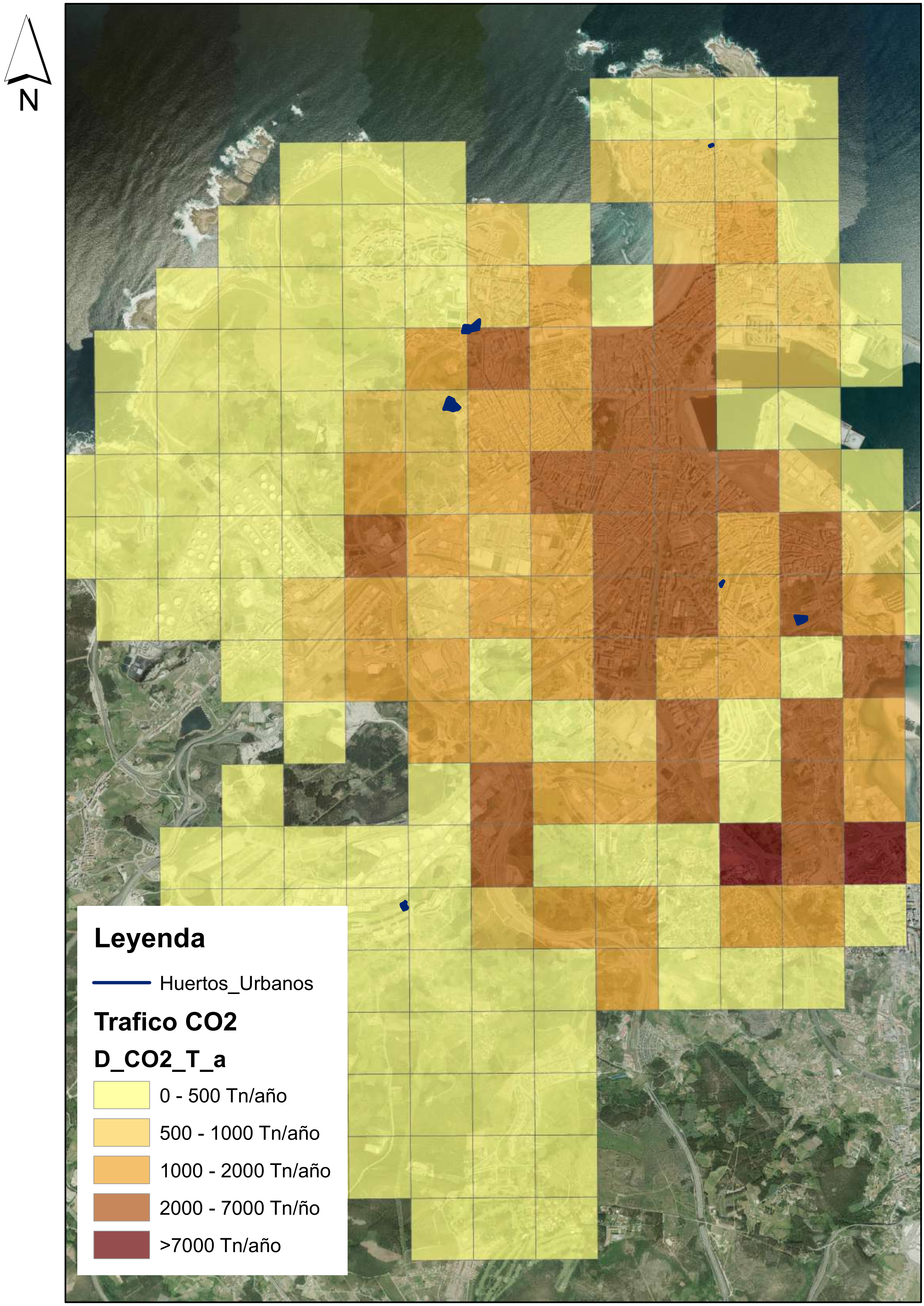
The process of knowledge transfer is the essence of the Connecting Nature Project which seeks to forge the relationship between cities with great experience in NBS establishment, evaluation and monitoring (i.e., Front-runner Cities) and cities that pursue such knowledge (i.e., Fast-follower and Multiplier Cities). In order to support the scaling up of NBS across Europe, the sharing of learning and experiences is critical. European cities could become examples of well evaluated and monitored NBS interventions, and informational hubs for acquired knowledge dissemination and transfer.

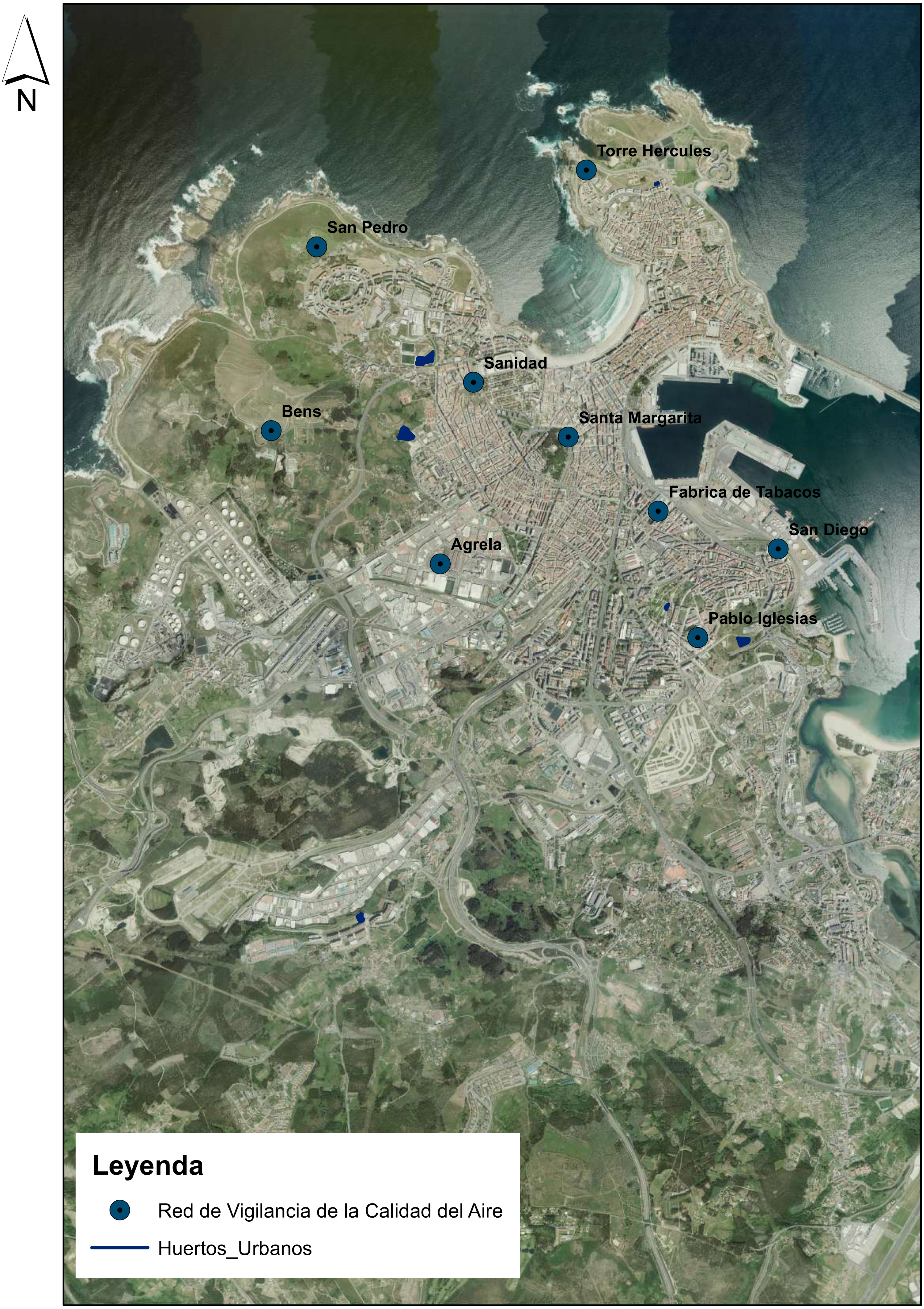
References

- Connop, S., Dick, G., Dziubala, A., Fagiewicz, K., Haas, E., Hill, A., Jelliman, S., Kamplemann, S., Lupa, P., Madajczyk, N., Nash, C., Poniży, L., Vandergert, P., van der Sijpe, K., Vos, P., & Zwierzchowska, I. (2019). Nature-Based Solutions Initiating Scaling Guidebook. Connecting Nature, Grant Agreement number 730222.
- Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications.
- Dumitru, A., García-Mira, R., Lenoir-Improta, R., Connop, S., Nash, C., Haase, D., Dushkova, D., Frantzeskaki, N., Lodder, M., Sillen, D., Sulea, C., Macsinga, I., Albulescu, P., Rhodes M. L., McQuaid, S., Collier, M., Dick, G., Martin, G., & Mowat, L. (2019). Deliverable 1.1 Report on the contributions of Tasks 1.1 to 1.4. Connecting Nature, Grant Agreement number 730222.
- Dumitru, A., Frantzeskaki, N., & Collier, M. (2020). Identifying principles for the design of robust impact evaluation frameworks for nature-based solutions in cities. Environmental Science & Policy, 112, 107-116.
- Carayannis, E. G., Barth, T. D., & Campbell, D. F. (2012). The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. Journal of Innovation and Entrepreneurship, 1(1), 1-12.
- CGIAR IEA. (2015). CGIAR standards for independent external evaluation. Retrieved from http://iea.cgiar. org/wp-content/uploads/2016/10/Standards.pdf
- Frenken, K. (2017). A complexity-theoretic perspective on innovation policy. Complexity, Innovation and Policy, 3(1), 35-47.
- Hardeman, S., Frenken, K., Nomaler, Ö., & Ter Wal, A. L. (2015). Characterising and comparing innovation systems by different 'modes' of knowledge production: A proximity approach. Science and Public Policy, 42(4), 530-548.
- Hölscher, K., Frantzeskaki, N., Lodder, M., Sillen, D., Notermans, I., McQuaid, S., Dushkova, D., Haase, D., Vandergert, P., Abulescu, P., Macsinga, I., Sulea, C., Quartier, M., van der Sijpe, K., Vos, P., Dick, G., Dziubala, A., Madajczyk, N., & Osipiuk, A. (2019). Deliverable 4: Report on outcomes of meetings, consultations, webinars and workshops leading to the publication of a 'Co-creation for cities' guidebook and infographics. Connecting Nature, Grant Agreement number 730222.
- Hölscher, K., Lodder, M., Collier, M., Frantzeskaki, N., Allaert, K., Sillen, D., Dumitru, A., Connop, S., Vandergert, P., McQuaid, S., Quartier, M., van der Sijpe, K., Vos, P., Dick, G., Kelly, S., Mowat, L., Sermpezi, R., Dziubala, A., Madajczyk, N., & Osipiuk, A. (2020). The Connecting Nature Framework: facilitating and connecting innovations for the large-scale implementation of nature-based solutions. Connecting Nature, Grant Agreement number 730222.
- Qiu, J., Game, E. T., Tallis, H., Olander, L. P., Glew, L., Kagan, J. S., Kalies, E. L., Michanowicz, D., Phelan, J., Polasky, S., Reed, J., Sills, E. O., Urban, D., & Weaver, S. K. (2018). Evidence-based causal chains for linking health, development, and conservation actions. Bioscience, 68(3), 182-193.
- Mills-Scofield, D. (2012). It's not just semantics: Managing outcomes vs. outputs. Harvard Business Review, 26.
- Oppla (2019). Oppla is the EU Repository of Nature-Based Solutions. Retrieved from https://oppla.eu/about

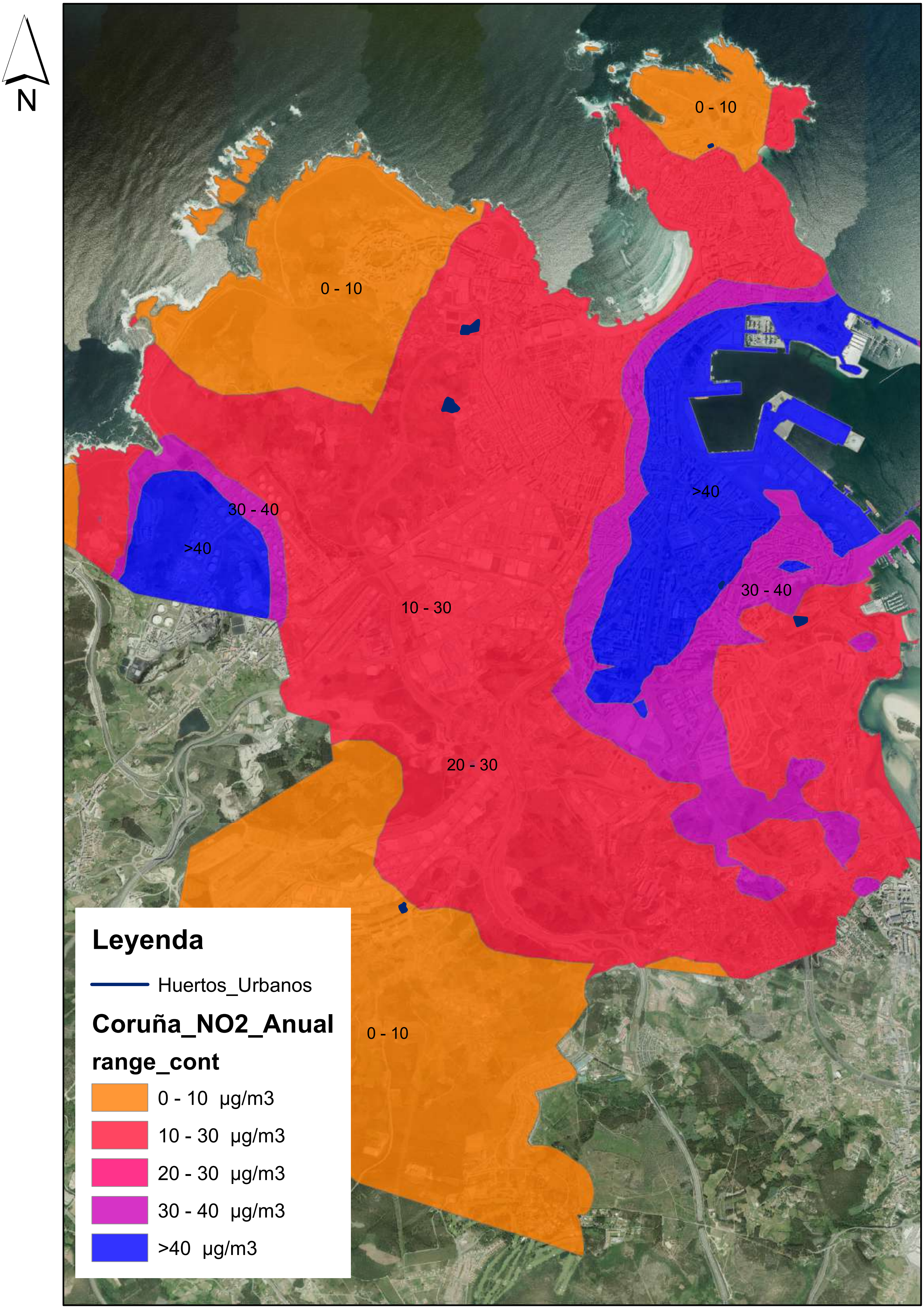
APPENDIX XVIII. LA CORUÑA SUPPLEMENTARY MATERIAL


N
Leyenda
Huertos_Urbanos
Domestico CO2
D_CO2_T_a
0 - 500 Tn/año
500 -1000 Tn/año
1000 - 2000 Tn/año
2000 - 7000 Tn/año
>7000 Tn/año


N
Leyenda
Huertos_Urbanos
Trafico CO2
D_CO2_T_a
0 - 500 Tn/año
500 - 1000 Tn/año
1000 - 2000 Tn/año
2000 - 7000 Tn/ño
>7000 Tn/año



N
Torre Hercules
San Pedro
Sanidad
Bens
Santa Margarita
Fabrica de Tabacos
San Diego
Agrela
Pablo Iglesias
Leyenda
Red de Vigilancia de la Calidad del Aire
Huertos_Urbanos


N
0 - 10
0 - 10
30 - 40
>40
>40
30 - 40
10 - 30
20 - 30
0 - 10
Leyenda
Huertos_Urbanos
Coruña_NO2_Anual
range_cont
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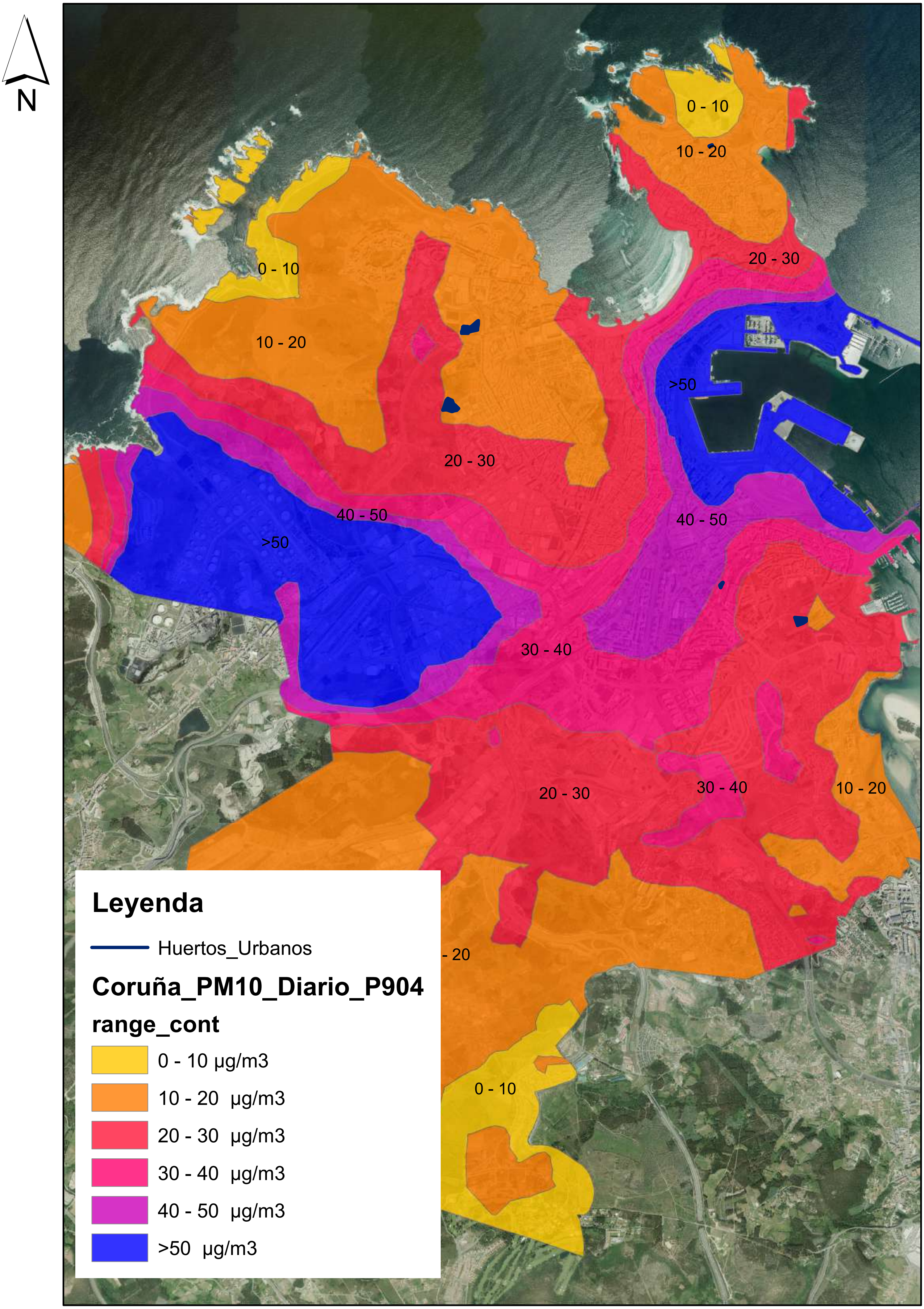
10 - 30 µg/m3
20 - 30 µg/m3
30 - 40 µg/m3
>40 µg/m3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10 - 20
20 - 30
0 - 10
10 - 20
>50
20 - 30
40 - 50
>50
40 - 50
30 - 40
20 - 30
30 - 40
10 - 20
- 20
0 - 10
Leyenda
Huertos_Urbanos
Coruña_PM10_Diario_P904
range_cont
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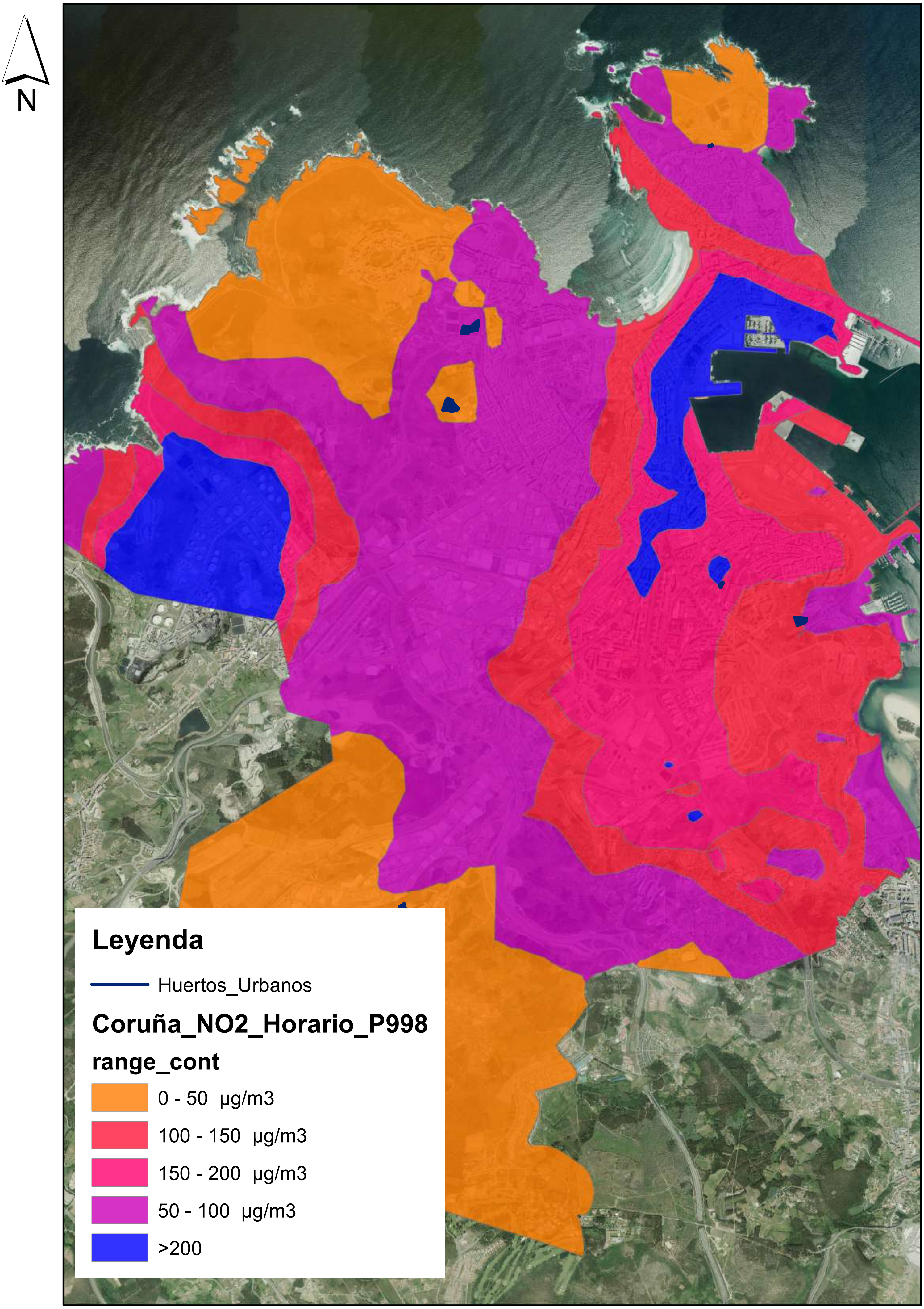
>50 µg/m3


N
Leyenda
Huertos_Urbanos
Coruña_NO2_Horario_P998
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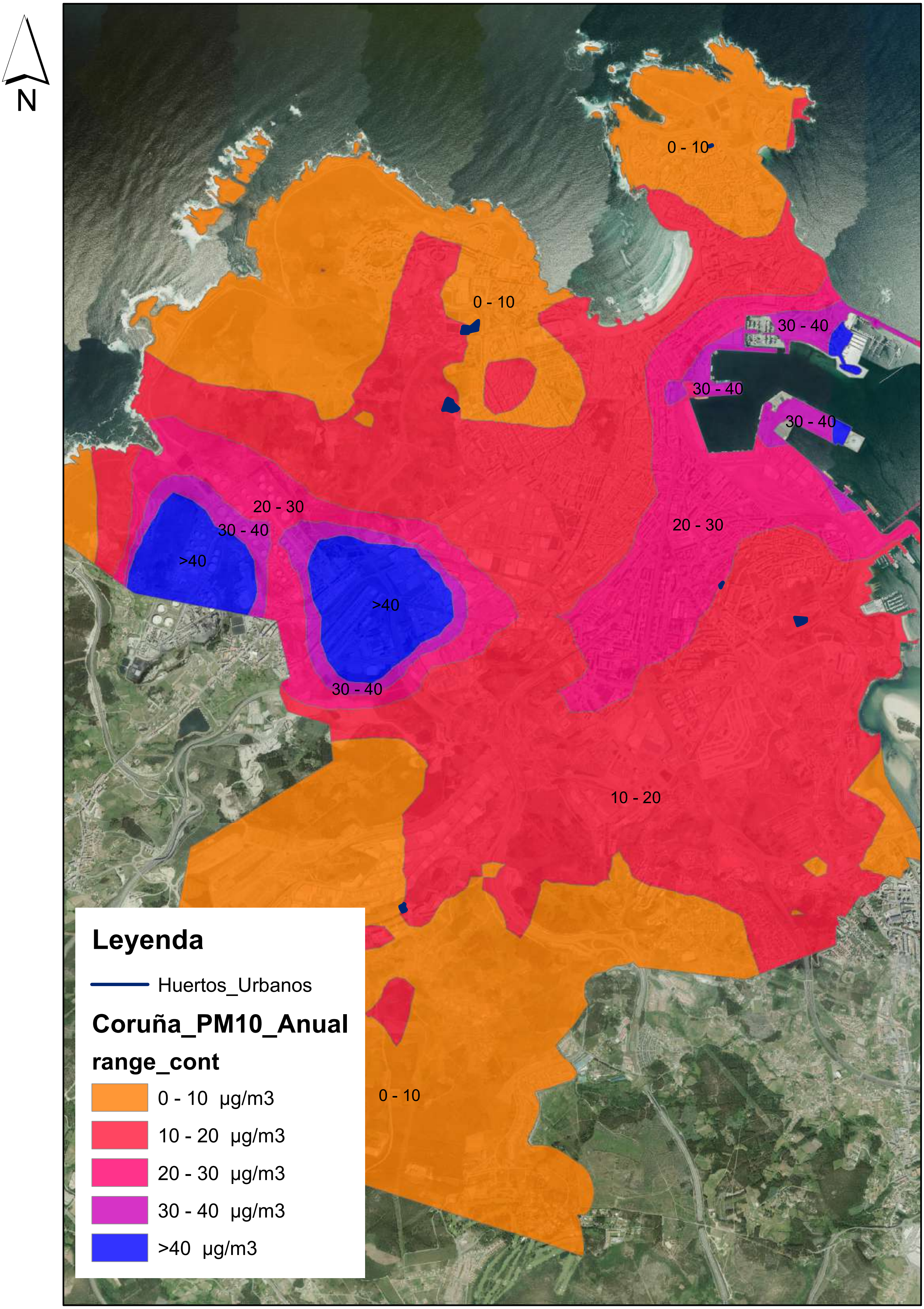
150 - 200 µg/m3
50 - 100 µg/m3
>200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0 - 10
30 - 40
30 - 40
30 - 40
20 - 30
30 - 40
>40
>40
30 - 40
20 - 30
10 - 20
0 - 10
Leyenda
Huertos_Urbanos
Coruña_PM10_Anual
range_cont
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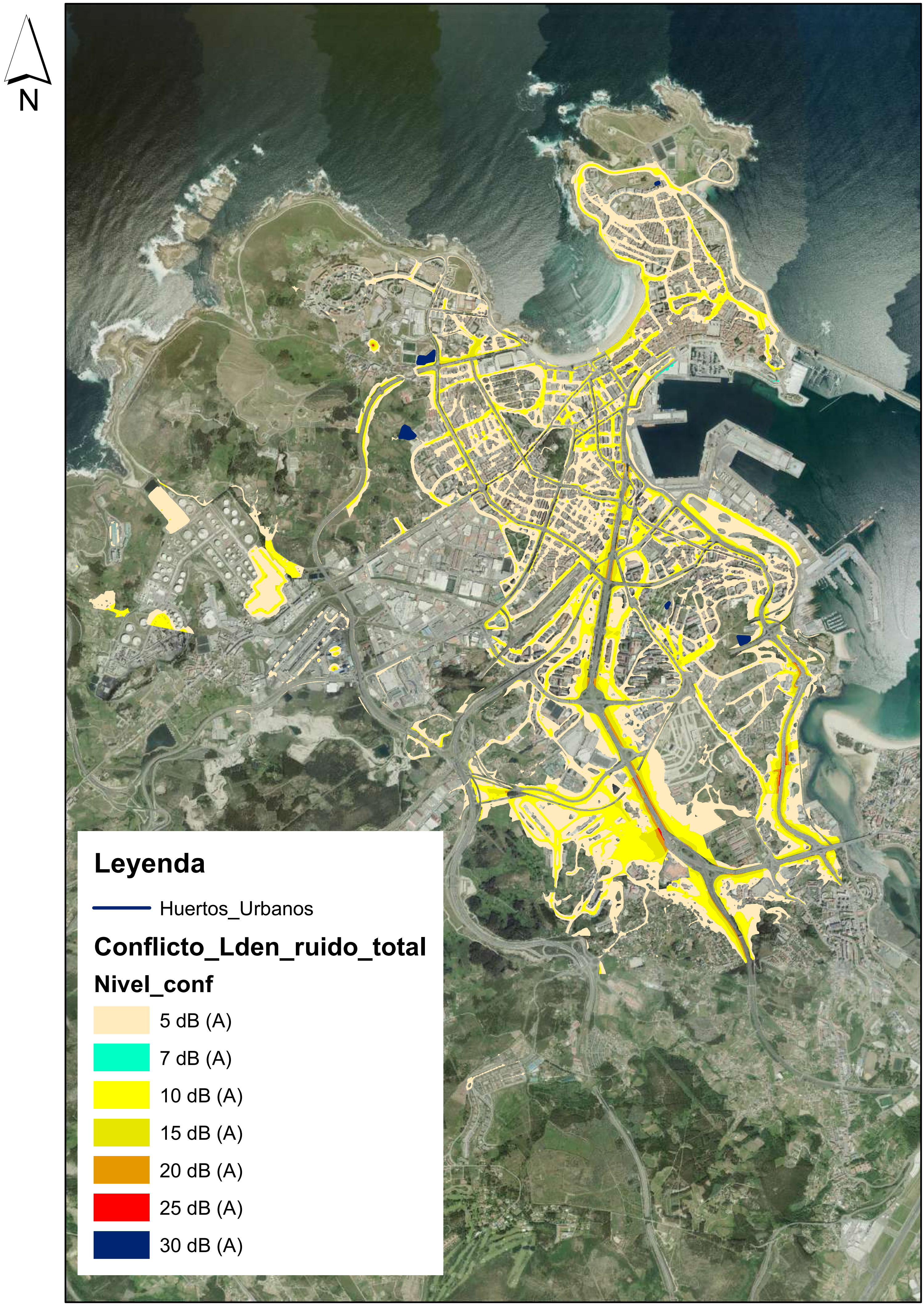
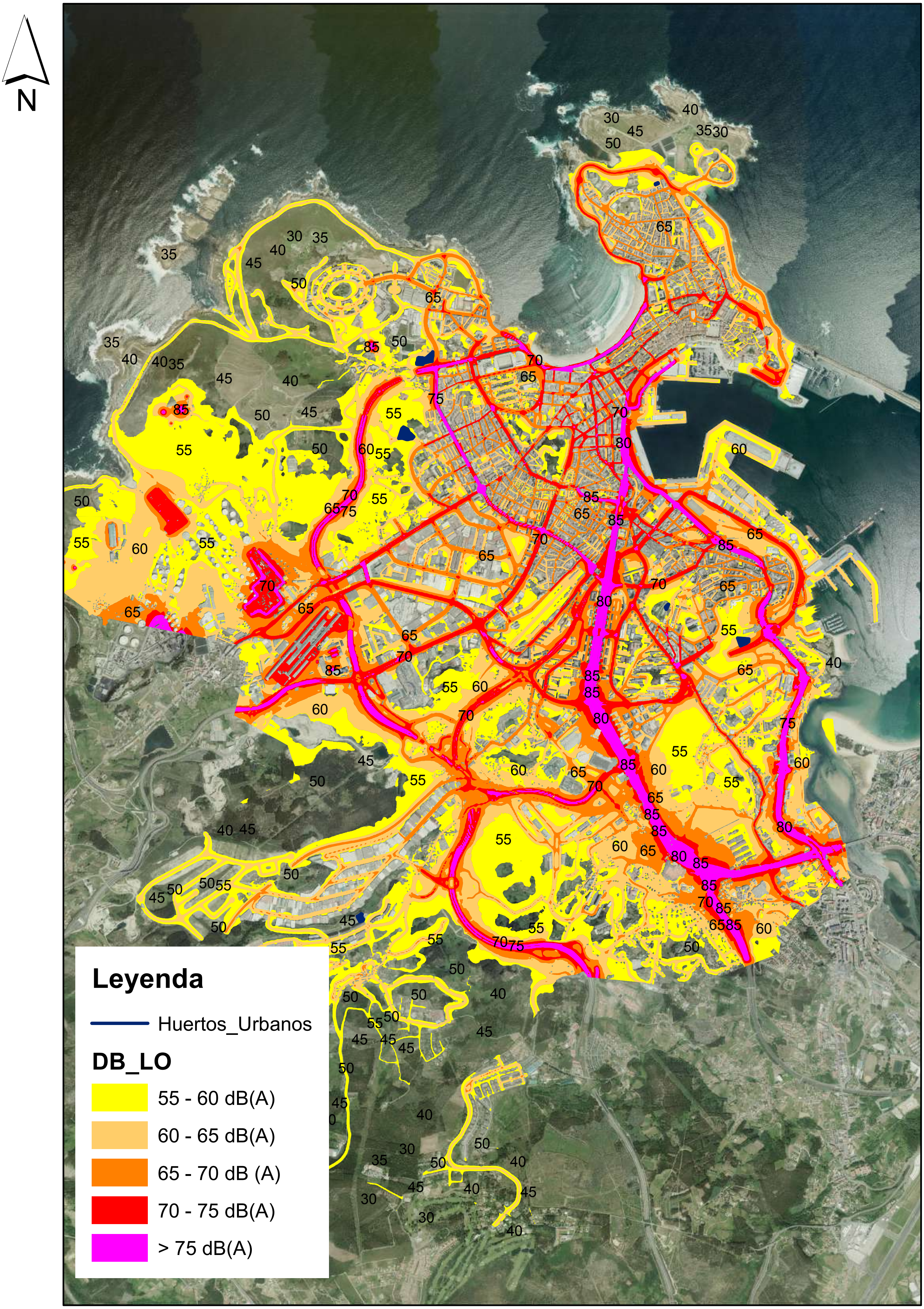
10 - 20 µg/m3
20 - 30 µg/m3
30 - 40 µg/m3
>40 µg/m3


N
Leyenda
Huertos_Urbanos
Conflicto_Lden_ruido_total
Nivel_conf
5 dB (A)
7 dB (A)
10 dB (A)
15 dB (A)
20 dB (A)
25 dB (A)
30 dB (A)


N
Leyenda
Huertos_Urbanos
DB_LO
55 - 60 dB(A)
60 - 65 dB(A)
65 - 70 dB (A)
70 - 75 dB(A)
> 75 dB(A)