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Nature-based solutions for cities transitioning towards sustainability: A participatory evaluation through a social and environmental lens

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Abstract:

Global urbanisation trends have made people move to cities where they tend to have less access to nature. Urban nature is important for human well-being and biodiversity, therefore urban planners are increasingly integrating Nature based Solutions (NbS) projects in urban environments.

This research investigated how to support citizen engagement for NbS while evaluating the urban environment, focusing on young people as they are often excluded from decision making and planning processes.

The research design included a literature review and interviews with city planners, to develop Participatory Photo Mapping (PPM) tool to enhance resident participation and to stimulate discussion around social and environmental aspects for effective urban NbS.

The prototype tool consists of a multi-layer map combined NbS projects, locations and photos reported by participants (from two Swedish cities, Malmö and Karlskrona), and two environmental indicators: land cover and biodiversity occurrence. Participants identified locations they perceived as improving or hindering quality of life and the natural environment.

Participants valued 'nature' as the key muti-beneficial factor for the socio-ecological systems. The prototype supports strategic sustainable development by allowing holistic mapping and evaluation of the city to increase communication between the residents and municipalities and to strengthen residents' engagement in shaping their cities.

Keywords: Nature based Solutions (NbS), Strategic Sustainable development, participatory evaluation, urban, cities, biodiversity

Statement of Contribution

We as a team agree that there were individual and collective efforts to make the most while enjoying the process, both for the group's learning, goals, overall project and for our own personal and professional learning and development.

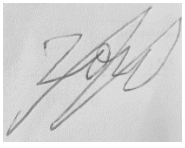
Together we created the overall plan and shared the steps needed to be done to achieve it. We shared responsibility to continue literature reviews. And for leading, facilitation and harvesting our group meetings and for any other meeting/ occasion. All of us participated in meetings and in interviews; interviews were led by all, mostly by Pear who wanted to practice her skills, then harvested by Aviv. Interview questions were created together, harvester usually generated a summary that all reviewed and agreed upon before sending to the interviewee and handled as results.

Aviv contribute to the team and process by first being an active team member. Mainly took responsibility on the participatory aspect of our research, researching the participatory concept, methods, and tools to be able to develop our tool based on it. Later leading on the data handling from the survey, make our data accessible for analyzing. In addition, I took responsibility on analyzing the data related to value this includes GDPR and Ethical considerations. In additional to support the writing Aviv took responsibility of the overall editing of the thesis draft.

Zack supported both the task and the team process by being brainstorming facilitator to bring out ideas and keep the research moving forward while staying focus on the topic based on logical planning and processes. Mainly focus on common purpose for the research project. He contributed to writing parts of the introduction, discussion, and data analysis. Worked on highlighting the participation of young citizens in the process of urban planning development. In addition, Zack brings the local perspective to the research as he served as member of the city council for one of the municipalities in the northern part of Sweden.

Pear puts all her heart into the project as her life principle is to reconnect people with nature. She explored ideas to create the concept of an interactive map based on the 5 Urban NBS principles, bringing the biodiversity aspect and NbS projects to the research. She also led in creating a media, survey marketing, and presentation. To ensure that the team would have enough data to analyze and proceed with the research, Pear engaged participants on sites in both Malmö and Karlskrona, to gain better insights and more participation. She also approached a politician and events on-field to cover all remaining questions about the research. After data collection, Pear took responsibility for analyzing the environmental condition, mapped each pinned location for tool's creation, then supported writing the thesis. This project is the first step that she sees high potential to continue for the further development towards sustainability.

Zack Assaf



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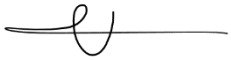

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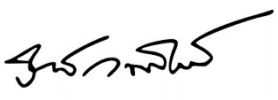

Acknowledgements

We want to thank our thesis advisors, Giles Thomson and Elaine Daly. We have high appreciation for the contribution to our research and learning process. This was an interesting, inspiring, and significant process we have being through, and your support and guidance made it a success. we see our achievements as equality yours.

Additionally, we would want to acknowledge and thank all the research participants, from different interviewees from municipalities members from Karlskrona and Malmö, through different practitioners and professionals from urban planning and residents' engagement to the core of this research- the survey participants. Without you this research idea would have not come to life.

Executive Summary

Introduction

Since entering the Anthropocene epoch, from the 1950s onwards, we witnessed the "great acceleration" in human activity (Steffen 2021), causing an increase in adverse human impacts upon natural processes that "outcompete" the speed in which the biosphere can regenerate (Crutzen 2006). Land degradation and urbanization result in biodiversity loss that in turn negatively impacts human well-being, especially in cities, the so called "habitat of humankind" (Kirabo Kacyira 2012). Global population growth continues to accelerate while cities' social and economic opportunities continue to attract new residents, which drives a global trend toward increasing urbanization. To halt uncontrolled urban sprawl and minimize the adverse impacts, a shift in urban planning is needed, implementing multi beneficial urban nature areas as NbS can be part of a strategic planning approach towards sustainable urban development (UN Habitat 2018).

To better plan for urban nature we should "*increase our understanding of how people perceive and value landscapes*" (Standish, Hobbs, and Miller 2013, 1). This could support urban planners to create mutually beneficial cities. For example, re-greening urban areas helps to bridge the gap between humans and nature. It supports ecosystems and humans by creating habitats for biodiversity to flourish, providing food sources, lowering air and noise pollution, moderating local temperature, and supporting resident's well-being in terms of both physical and mental health (Kolokotsa et al. 2020; Standish, Hobbs, and Miller 2013).

"*The main actors in urban planning are city inhabitants, but unfortunately, they are not usually included in urban development planning until the end of the process*" (González-Méndez et al. 2021, 9). Resident participation, especially among youth, remains a main challenge in decision-making. Urban environments influence youth development, health, and identity which emphasizes the importance of participatory methods for engaging youth and communities in an interactive participant-led process (Dennis et al. 2009; Teixeira and Gardner 2017). Increasing the accessibility of quality information on participants' surroundings supports decision-making planning (Bennett and Lantz 2014). Therefore, mapping and understanding the urban environment through the eyes of residents and specifically youth can potentially influence and integrate their needs into the urban development processes and to help shape the cities they want to live in. (Teixeira and Gardner 2017; Smith et al. 2015; Sprague Martinez et al. 2018).

Nature-based Solutions (NbS) is an approach that can strengthen resilience and support cities transition toward sustainability (European Commission 2015). NbS are defined as, *"Actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"* (Cohen-Shacham et al. 2016, 5). It can be used as an element for strategic action, helping transform conditions for the socio-ecosystems, integrating nature to revive biodiversity and to increase human well-being while strengthening residents' awareness and shifting the perceived value of nature. Integration of NbS in cities for strategic sustainable development should consider, "*reaching deeper leverage points in systemic transitions ... they cannot only be regarded as physical infrastructure but need to be embedded in a societal process*" (Kabisch, Frantzeskaki, and Hansen 2022, 1390). For example, NbS planning needs to consider different spatial scales and land

ownership to steer decisions for multi beneficial solutions (Goddard, Dougill, and Benton 2010). To ensure comprehensive NbS outcomes and effectiveness, while avoiding trade-offs, there is a need for a holistic assessment (Raymond et al. 2017).

To support NbS potential in cities, Kabisch, Frantzeskaki, and Hansen (2022) offer a holistic framework for planning urban NbS through five interlinked principles: (1) Systemic understanding, (2) Benefiting people and biodiversity, (3) Inclusive solutions for the long term, (4) Context conditions, and (5) Communication and learning. Our research utilizes these 5 urban NbS principles as core guidelines for dealing with the complexity of the system, to support NbS and promote participatory process in cities transitioning towards sustainability.

Cities represent a micro setting of the earth's complex biosphere, fostering both social and ecological systems. Balancing these two requires a system thinking approach to understand the dynamic relations between the systems and identify leverage points for sustainable development (Meadows 1999). In our research, we address a variety of leverage points directly and indirectly, following four "*realms of leverage*" from Abson et al. (2017). We believe that the main leverage point in our research is in the "system design", e.g., making information widely accessible through evaluation tool and strengthening the possibility of usually unheard residents to influence urban NbS solutions. We hope this will eventually support a shift in values and reinforce a leverage point to further shift the system's intent and accelerate more strategic actions towards sustainability (Abson et al. 2017; Fischer and Riechers 2019).

Research purpose This is a design action research project integrating the five principles for urban NbS (Kabisch, Frantzeskaki, and Hansen 2022) as a conceptual framework to transcend governance gaps in young resident's participation and stimulate discussion around social and environmental aspects for effective urban NbS planning. This as NbS have the potential to support multi-beneficial cities and improve social-ecological well-being, transitioning cities towards strategic sustainable development. Our research aims to develop and prototype a communication and urban evaluation tool to check current reality for strategic planning, that integrates residents perceived quality of life with an ecological indicator to investigate the impact of urban biodiversity on resident's perceived quality of life. The tool shifts the usual participatory process between residents and municipalities to continues conversation from residents' perception toward their city experience. The residents' participation promotes their civic engagement, strengthening their democratic rights, while supporting the practitioners and decision makers in making informed decision, based on a detailed, holistic understanding of the city.

Aiming to develop and prototype our tool, we focused on these research question: *What might a tool that can enhance resident's participation for NbS and urban planning evaluation look like?*

Research design

To answer the research question, a qualitative action research approach was chosen. We focused our scope on two cities in Sweden; Malmö that actively incorporates NbS projects, and Karlskrona a city without NbS strategies but located in a natural environment. Within those cities, we focus on youth and young adults, between 15 to 35 years old. As youth are mostly excluded from decision making and planning process, their participation can inspire action, creating the city that

they want to live in. This research focuses on Sweden and youth, but the developed tool can be modified for many contexts.
The data collection method we used is a modified version of Participatory Photo Mapping (PPM) (Teixeira and Gardner 2017; Dennis et al. 2009). PPM involves collecting participants photos, locations and text to get rich data about resident's perception of their city experience. Our PPM tool incorporated an online survey, to map "places that improve/hinder residents' quality of life and the natural environment".
Our research, as mapped in Figure 1 included four main phases: (1) Conceptual framework and project scoping, (2) Development of the tool, (3) Data collection, and (4) Validation. The first step aims to gather insights and needs from literature and practitioners to develop the tool's concept. The second step was designed to support the tool development through literature review and interviews about participatory research and planning. Step three was designed for collecting data by the PPM survey and from the Global Biodiversity Information Facility (GBIF) open-source database (biodiversity occurrences data). The fourth step was to focus on validation of the tool through research participants' feedback.

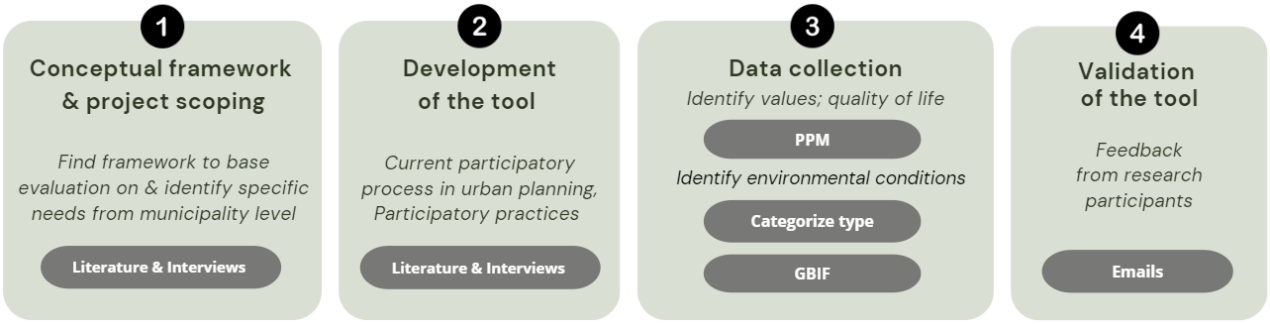

Figure 1: Research process

Research results
To address the first step 'conceptual framework and project scoping' we started by identifying the necessary requirements for our conceptual tool based upon the literature and approaching both municipalities for feedback and insights. All municipalities' interviewees mentioned interest in such a tool, mentioning that there is a gap in urban ecosystem evaluation, specifically biodiversity.

Focusing on the second step, we identified challenges in participatory processes in both cities. When asked about participatory processes, specifically with youths, both cities considered the efficacy of participatory processes and collecting the voices of the young generation as major challenges and a priority to address. Both the literature and our respondents emphasized the difficulty of effective participation approaches.

Through the third step we mapped residents' perceptions on how urban places improve their quality of life. Our survey was conducted during April 2022 and collected 35 responses. In scope data included 18 participants from Karlskrona and 14 from Malmö. In total 58 locations were reported, the majority as places that "improve quality of life and the natural environment" (48 responses). From this, we identified core values that people shared in both cities; "natural elements, aesthetics, activities, accessibility, facilities." Additional value unique to Karlskrona was 'mood' and for Malmö 'safety' was emphasized. For environmental conditions we analyzed the locations identified by respondents to define the type of place by land cover using the following categories:

‘urban’, ‘urban-nature’, and ‘nature’. Each of the categories were based on the level of human infrastructure and natural land cover.

Type of place & quality of life; Identifying the relationship between the type of place and its potential to improve or hinder resident’s quality of life. The majority of Karlskrona’s participants reported ‘nature’ and ‘urban-nature’ as places that improve their quality of life and the environment (45%, 48%). By contrast, in Malmö, participants reported mostly ‘urban-nature’ (88%). For the places that hinder their quality of life; in Karlskrona, ‘urban’ areas were mostly mapped (43%), followed by ‘nature’ and ‘urban-nature’ (29%, 28%). While in Malmö only ‘urban-nature’ areas were reported (100%).

Environmental conditions in reported places; For each location reported by respondents we extracted biodiversity data from the GBIF database. From the results we can see two trends; ‘nature’ and ‘urban-nature’ have overall higher biodiversity occurrences, but several ‘urban’ locations also indicated high biodiversity rates. In both cities, places that were reported as ‘improving’ quality of life, are associated with higher biodiversity occurrences data. The data was integrated into the maps of the cities (see figures/detailed map).

Feedback for validation of the prototyped tool was requested from research participants. We have received feedback from one municipality worker from Karlskrona and one survey participant. Both saw the importance of the resident’s value and biodiversity layers, saying that if this tool was launched, they would use, add places, and share with friends. Asking for their impression of the tool the resident replied, “Interesting! Gives me inspiration for beautiful places to go to and raises awareness on where change is needed. Increases my understanding of the place and new perspectives to the city”. The municipality worker said: “Would be very interesting if the municipality could continue to develop this project”.

Discussion

We structured our discussion around Kabisch, Frantzeskaki, and Hansen's (2022) 5 NbS principles. The key findings from the research include:

1 System understanding: We developed our research and tool for a better understanding of the interconnected social and ecological systems. Using a systems thinking approach enables open space for collaboration in cross sectors to help overcome siloed thinking in city’s planning and gain a holistic view to tackle sustainability challenges together with citizens. Although Malmö and Karlskrona both have different geographical conditions, both cities share a vision of sustainable development and identify the need to strengthen the ecological system. Applying the PPM approach can help city planners to gather context specific information relevant to their city and appropriately integrate NbS.

2 Benefiting people & Biodiversity: Mapping indicators for both social and ecological systems, has shown ‘nature’ as a shared theme for improving perceived well-being. The tool allows the city planners to realize resident’s (and in our proof of concept, young residents') perceptions while understanding environmental conditions in the valued locations. This supports urban planners in identifying the need for strategic multi beneficial solutions, such as NbS. This can increase accessibility to common spaces for nature and human, creating human connections and ecosystems

networks, to improve social and ecological well-being. Both cities emphasized that the biodiversity issue is critical. However, for the biodiversity assessment there is still a gap of high quality and reliable data. The data in hand, demonstrates the need of further research to consider and promote biodiversity and ecosystems in urban planning.

3 Inclusive solutions for the long-term: The developed tool is an online interactive platform that is accessible for everyone. The chosen platform can increase youth participation, as they are familiar with online activity. This tool allows residents to freely express ideas and thoughts about how they perceive the city and what can be improved. This strengthens social sustainability by giving residents the power to have influence in the system they are a part of.

4 Context consideration: Each city is unique in its environmental conditions and historical-cultural values so considering local insights can assist planning for integration of NbS in cities. The tool helps to map and understand what is meaningful and valuable for residents in their city. For example, in Malmö, participants highlight picnics, activities in the sun and on the urban setting as modern and futuristic. In Karlskrona, participants focused on individual activities, the quietness and wilderness from nature, and on historical elements. This feeling of meaning can increase residents' participation, wishing to protect their valued places, or even create other meaningful places. This relates to the different city settings and supports decision makers with information on how they can enhance NbS design that fit in the specific context.

5 Communication & Learning: At the core, the tool is a communication device to support the evaluation of urban planning and promote integration of NbS. Through the participatory process, it creates conversation between decision makers and residents. Municipalities can learn from residents' insights and environmental aspects to work towards strategic sustainable development. Consideration of their insights will encourage residents to participate, feeling capable of their influence. In addition, the tool enables residents to learn about urban NbS and explore their local environment and biodiversity which can help promote a shift in values and foster environmental protection. This can generate a positive feedback loop to adapt NbS transformations towards sustainability.

Further research and development: After completing the first round of research the researchers reflected upon the tool and believe it has potential, but it needs further development. Considering the 5 principles for urban NbS, our developed tool should be further researched and developed to enhance participation and generate holistic view of cities urban environment. This should be done on three aspects of the tool: database, tool's use, and impact. The biodiversity database could be developed with a global strategic biodiversity assessment. The approach to participants should be explored, to make the tool more accessible and encourage high response rates, potentially through gamification and incentives. Considering the tool's impact, evaluation the aimed paradigm shift in urban planning, policies and practices and identifying appropriate integration of NbS in cities is needed. Note that we identified many more research directions, we have chosen to mention the leading topics in our opinion.

Conclusion

This research has found potential in interactive mapping to support a much-needed shift in urban planning, toward greater integration of nature in cities through NbS. To help answer our research

question, we prototyped a tool to support this integration and permits civic engagement to enhance the relationship between the ecological and social systems. The tool assists citizen participation in urban and NbS planning. Further research is needed to find a more reliable ecological indicator for mapping urban biodiversity system understanding. Nevertheless, in its current form, the tool raises awareness about biodiversity and the relationship between social-ecological systems. Furthermore, our results supported the notion that human and ecological well-being are mutually beneficial in cities. Participant responses highlighted those locations with more 'nature' were also highly valued for their wellbeing benefits. Human values are context dependent therefore opportunities for NbS integration should be locally identified and appropriate to the existing social system – we trialed the tool in two cities and were successfully able to map local residents' values. Our research demonstrates that the PPM tool is a useful method to better understand citizen values in any local context.

Providing the answer to enhancing participation, municipalities and participants feedback support the potential for the tool's implementation to support communication and learning for better city planning. We hope this will create a positive feedback loop; whereby citizen input informs municipality action that reinforces citizen participation as they feel capable of influencing the future development of their city.

Glossary

- GBIF- the Global Biodiversity Information Facility—is an international network and data infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth. https://www.gbif.org/what-is-gbifhttps://
- IPBES- The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body established by States to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. It was established in Panama City, on 21 April 2012 by 94 Governments. It is not a United Nations body. https://ipbes.net/about
- IUCN- International Union for Conservation of Nature (IUCN) is a membership Union composed of both government and civil society organizations. It harnesses the experience, resources and reach of its more than 1,400 Member organizations and the input of more than 18,000 experts. This diversity and vast expertise makes IUCN the global authority on the status of the natural world and the measures needed to safeguard it. https://www.iucn.org/about
- NATURVATION- Nature-based Urban innovation is a 4-year project, funded by the European Commission and involving 14 institutions across Europe in the fields of urban development, geography, innovation studies and economics. NATURVATION eek to develop understanding of what nature-based solutions can achieve in cities, examine how innovation can be fostered in this domain, and contribute to realizing the potential of nature-based solutions for responding to urban sustainability challenges by working with communities and stakeholders. https://naturvation.eu/
- UNA- The Urban Nature Atlas was developed in 2017 as an output of the NATURVATION project. The Atlas was developed by the Central European University (CEU) in collaboration with the Ecologic Institute, and with further support being provided by Durham University. The Urban Nature Atlas sought to collect evidence on nature-based solutions in order to provide a basis for the analysis of socio-economic and innovation patterns associated with the implementation of urban nature-based solutions in Europe. It also sought to provide an interactive online platform via which inspiring cases of nature-based solutions could be showcased and accessed on the NATURVATION project website. https://una.city/about

List of Abbreviations

- SSD- Strategic Sustainable Development
- NbS- Nature Based Solutions
- IUCN- The International Union for Conservation of Nature
- GI- Green Infrastructure
- ES- Ecosystem services
- UNA- Urban Nature Atlas
- PPM- Participatory Photo Mapping
- GBIF- the Global Biodiversity Information Facility

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1.Introduction

1.1. The sustainability challenge

The sustainability challenge is probably the most urgent and complex problem humanity has faced throughout history. It is occurring because of the dominant structures of society that are systematically degrading the ecological and social systems – in other words unsustainable development (Robèrt et al. 2019). “We have entered the Age of Disruption” (Scharmer and Kaufer 2013, 1), as human activities increase, the planetary boundaries are being crossed; ecological degradation including deforestation, water, air and soil pollution are increasing biodiversity loss and climate change influencing the social system, creating resource shortages, e.g., water and food scarcity, that in turn add to the social challenges causing inequality, poverty, depletion of trust and harming health and wellbeing. (Steffen et al. 2015, Scharmer and Kaufer 2013; Seto, Guneralp, and Hutyra 2012; Standish, Hobbs, and Miller 2013; Broman and Robèrt 2017). Society’s unsustainable development is “increasing risk of tipping the biosphere into a state where it would be difficult or impossible to maintain the human civilization” (Broman and Robèrt 2017, 17).

The sustainability challenge is a complex problem. that requires a system thinking approach to address the challenge in a dynamic, systemic and strategic way. The “funnel metaphor” (Figure 1.1), allows a simplified explanation to describe the sustainability challenge. The funnel walls represent the limits of global resources, that decrease as society continues unsustainable development. Population growth accelerates the rate of resource depletion to further weaken the social and ecological systems, closing the funnel and decreasing humanity capacity to handle the different challenges as biodiversity loss and climate change (Robèrt et al. 2019). The illustration also indicates that by adopting a strategic sustainable development (SSD) approach this systematic depletion can be stopped and reversed, the transition to a sustainable society can reopen the walls of the funnel to build resilience in the planetary system. To strategically move towards strategic sustainable development there are 8 sustainability principles (SP’s) that define the basic conditions for keeping the social-ecological systems within the walls of the funnel; "In a sustainable society, nature is not subject to systematically increasing; (1) concentrations of substances extracted from the Earth's crust; (2) concentrations of substances produced by society; (3) degradation by physical means; and people are not subject to structural obstacles to; (4) health; (5) influence; (6) competence; (7) impartiality and (8) meaning-making” (Robèrt et al. 2019, 42–43).

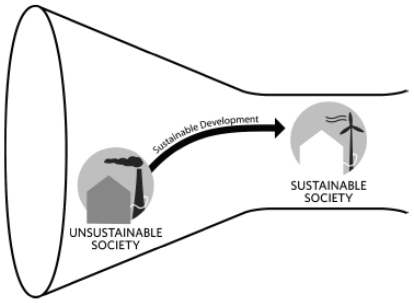


Figure 1.1; The “Funnel” Transforming from unsustainable society to sustainable

1.2. Urbanization in the sustainability challenge

Cities represent a micro setting of the earth’s complex biosphere, fostering both social and ecological systems. Balancing these two requires a system thinking approach to understand the

dynamic relations between the systems and identify leverage points for sustainable development (Meadows 1999). Adopting a strategic sustainable development approach can utilize cities' potential to become efficient, multi-beneficial areas that support both social and ecological needs, strengthening resilience and keeping the systems within the funnel walls and the planetary boundaries, avoiding the risk of systems collapse (Robèrt et al. 2019; Wang-Erlandsson et al. 2022; Steffen et al. 2015, Kirabo Kacyira 2012; UN Habitat 2018; Standish, Hobbs, and Miller 2013; Van den Berg, Hartig, and Staats 2007; Wu 2010)

Urbanization is defined as "the spatial expansion of the built environment that is densely packed by people and their socioeconomic activities" (Wu 2010). The twentieth century witnessed rapid urbanization, since 2007, half the world's population has lived in cities. This pattern is continuing and the United Nations (UN) predicts that by 2030, the percentage of global population living in cities will rise to 60% and will continue increasing in the foreseen future, mostly within less developed nations and regions (UN-Habitat 2019). For this reason, cities have been described as the "habitat of humankind" (Kirabo Kacyira 2012) they continue to attract residents for the social-economic opportunities they offer. But poor planning and managing of the urban environment, local ecosystems, waste, water, housing, mobility etc. together with the overburden of those systems, can harm human health and well-being, spatial inequality, increased migration and conflict, and hinder inclusive prosperity and economic development, simultaneously with weakening ecosystems, decreasing biodiversity, and increasing climate change (Kolokotsa et al. 2020; Van den Berg, Hartig, and Staats 2007; UN Habitat 2018).

In addition, the high concentration of population within urban environments makes many cities and residents vulnerable to climate change and natural disasters. Therefore, the UN's Sustainable Development Goals (SDGs) included SDG 11 – a goal for cities - to "make cities and human settlement inclusive, safe, resilient and sustainable" with a focus on improving services and facilities accessibility, increasing civic engagement, and strengthening overall resilience. (UN-Habitat 2019)

A sub-goal of SDG 11 is to "provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities" (11.7). This relates to the fact that the urban setting is where city resident's experience nature on the daily basis, today, as cities expand, the natural areas decreases. "Regreening" cities can integrate nature in the city, bridging between nature and urban, creating areas for ecosystems to exist and potentially flourish, increasing biodiversity through creation of habitats and food sources in the city. Designing nature into cities can help meet both the ecological and social sustainability principles, by: increasing social interaction, and social-nature interaction, as well as providing opportunities for physical activities in common spaces, lowering air and noise pollution, moderating local temperature etc. These benefits directly and indirectly support human well-being and improve mental and physical health by stress relief, decrease in respiratory disease, etc. (Kolokotsa et al. 2020; Standish, Hobbs, and Miller 2013). But to increase nature integration within urban planning, it is necessary to "increase our understanding of how people perceive and value landscapes" (Standish, Hobbs, and Miller 2013, 1), this will support urban planners to create a mutual beneficial urban environment as an efficient accommodation, balancing between population density and accessibility to nature, moving toward strategic sustainable development (Standish, Hobbs, and Miller 2013; Van den Berg, Hartig, and Staats 2007; Wu 2010).

1.3. Biodiversity and urban sustainability

As human activities, including urban sprawl increase, ecological land is systemically degraded by physical means (SP3). Loss of ecological land reduces biodiversity, biosphere integrity is a "core" planetary boundaries being crossed (Steffen et al. 2015). "Around 1 million species already face extinction, many within decades, unless action is taken to reduce the intensity of drivers of biodiversity loss" (IPBES,2019, XVI). Cities only cover a small percentage of the Earth's land area, but because most people live in cities, urban nature is an important in factor for elevating exposure to biodiversity and increasing public perception and interaction with nature (Standish, Hobbs & Miller, 2013). By efficient use of compact space, cities can integrate nature and meet social, economic and environmental needs with probably less impact on intact habitats for native species loss (van den Berg et al. 2007; Wu 2010). Today, most cities still miss out on opportunities to nurture biodiversity and human well-being in the urban environment while focusing solely on expanding economic pillars (IPBES,2019).

Furthermore, "the lack of biodiversity data may result in weaker protection and poorer quality of mitigation than could otherwise be achieved" (Underwood, Taylor, and Tucker 2018, 16). This effects the ability to plan more strategically for sustainable cities. There is an urgent need for improving biodiversity evaluation to strengthen the knowledge available, to be able to protect and revive biodiversity. Considering the urban context "Every local initiative matters, since the benefits of many small, local biodiversity measures accumulate at the global level" (Pörtner, Hans-Otto et al. 2021, 20). This need is emphasized in our research, which aims to support better understanding of ecosystem and biodiversity conditions at the local level, to allow more informed, strategic action towards sustainability within cities.

1.4. Social sustainability challenges

Seeing cities as the "habitat of humankind" (Kirabo Kacyira 2012), in the arena of global societal challenges, we focus on quality of life as an overview term. Reviewing the literature, quality of life and well-being are two commonly used terms. Identifying the connection between the two, through a model of quality of life, Felce and Perry (1995) identify well-being as a domain that strongly effects quality of life (Felce and Perry 1995). Definitions of well-being, include both subjective and objective elements from the human experience, e.g., "the basic materials for a good life, freedom of choice and action, health, good social relationships, a sense of cultural identity, and a sense of security" (Díaz et al. 2006, 2 At the base of well-being, stands the "sustained delivery of fundamental ecosystem services, such as the production of food, fuel, and shelter, the regulation of the quality and quantity of water supply, the control of natural hazards, etc.". (Díaz et al. 2006, 2) . With that in mind, how well cities incorporate nature is hugely influential on resident's well-being as it is related to social and environmental elements; it is also very context depended, related to culture, geographic and history. (Díaz et al. 2006; "Measurement of and Target-Setting for Well-Being: An Initiative by the WHO Regional Office for Europe" n.d.).

Beside the ecosystem services nature supplies to society, there are additional benefits of nature to human well-being. Wilson's "Biophilia hypothesis" argues that "humans possess an innate need to

affiliate with other living things" this research was conducted to explore the relation of nature and well-being (Nisbet, Zelenski, and Murphy 2011). Identified benefits associated with biophilic spaces include reduced stress, increased happiness and creativity, improved health and connectedness of people to nature. Connectedness to nature relates to people's feeling of being part of something bigger, supporting personal growth and shaping self-identity (Triguero-Mas et al. 2017; Capaldi, Dopko, and Zelenski 2014; Kuo 2015; Howell et al. 2011; Chawla 2004; Atchley, Strayer, and Atchley 2012). As this connectedness to nature grows it can deliver from mutual benefits -research indicates that as the human experience in and of nature increases, this can strengthen their perceived value of nature, promoting environmental awareness and even action. (Hinds and Sparks 2011; Whitburn, Linklater, and Abrahamse 2020; Martin et al. 2020)

Considering the predictions that human population and urbanization will continue to increase, to halt uncontrolled urban sprawl and minimize the adverse impacts there is a need for change in the way we plan and use cities. This includes better integrated nature and the creation of multi-beneficial urban areas, through a strategic sustainable approach, supporting both the social and the ecological systems (Seto, Guneralp, and Hutyra 2012, UN Habitat 2018). The mutually beneficial approaches of urban nature are often referred to as "Nature based Solutions".

1.5. Nature Based Solutions (NbS)

1.5.1. NbS Definition

The concept of nature-based solutions (NbS) was firstly introduced in 2008 and in the recent years, there has been a rising interest and awareness around the concept. A popular definition from the International Union for Conservation of Nature (IUCN) defined NbS as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al. 2016, 5)

The definitions of NbS vary depending on context and the use. There is no one agreed definition of NbS that is universally accepted (Pörtner, Hans-Otto et al. 2021). However, at the core of NbS are a multi-function solutions that integrate nature to generates multiple co-benefits to address ecological and social challenges (European Commission 2015; Pörtner, Hans-Otto et al. 2021).

Focusing on NbS projects in urban areas, there are eight main NbS types based on the Urban Nature Atlas categories (Dora Almassy et al. 2018, 22);

- "Building greens, such as green roofs and green walls
- Urban green areas connected to grey infrastructure, e.g., alley and street trees, railroad bank, house gardens, green playground/ school grounds
- Parks and (semi) natural urban green areas, including urban forests
- Allotments and community gardens
- Green indoor areas
- Blue areas, such as rivers, lakes, seacoasts, wetlands
- Green areas for water management, e.g., rain gardens or sustainable urban drainage systems

- Derelict areas, abandoned spaces with patches of wilderness”

1.5.2. NbS and strategic sustainable development

As mentioned, everything in the biosphere is interconnected as a complex system, it requires a system thinking approach to address the problems strategically and systematically. *“By working with nature, rather than against it, communities can develop and implement solutions that pave the way towards a resilient, resource-efficient and green economy”* (Sowińska-Świerkosz and García 2021, 2), NbS can be used to support that transition and strengthen resilience especially within cities, if implemented in a contextually appropriate way (European Commission 2015; Seddon et al. 2020; Lafortezza et al. 2018; Kabisch, Frantzeskaki, and Hansen 2022). NbS can be an element to avoid hitting the funnel walls. NbS can help transform conditions for the socio-ecosystems to revive biodiversity and human well-being while strengthening human awareness about the value of nature.

However, considering NbS "for reaching deeper leverage points in systemic transitions … they cannot only be regarded as physical infrastructure but need to be embedded in a societal process" (Kabisch, Frantzeskaki, and Hansen 2022, 1390). For example, NbS planning need to consider different spatial scales as land ownership in order to steer decisions for multi beneficial NbS (Goddard, Dougill, and Benton 2010).

Moreover, the assessment of any city’s current situation is a critical process to better understand opportunities to incorporate NbS into the urban system, by integrating nature into the existing infrastructure to becomes possible to tackle existing social and environmental issue. This potential has led to European Union (EU) investment in NbS with the aim for Europe to become a leader in NbS Research and Innovation (R&I) (European Commission 2015; Maes and Jacobs 2017; Lafortezza et al. 2018).

1.5.3. NbS Challenges

To scale NbS globally there is a need for clear policies. In recent years, NbS has been embedded into global and EU policies for sustainable development (European Environment Agency. 2021) to support the movement of policies shifting from “ecosystem-based to nature-based solutions (NbS)” (Raymond et al. 2017, 1). Having a shared mental model and clear vision about NbS can facilitate moving toward envisioned sustainable futures. But still, the main gaps are in practicalities, there is a need for agreed standards for NbS projects to be planned, implemented and evaluated (European Environment Agency. 2021; Davis et al. 2018). There is also a gap in coordinating legality and financial support within EU for NbS projects, which slows the uptake of NbS in practice (Davis et al. 2018).
In addition, another key issue for scaling NbS is that the concept has not been rigorously assessed. There are concerns about the outcomes which leads to uncertainty relating to cost-efficiency and reliability when compared with conventional engineered solutions (Seddon et al. 2020). For example, the difficulty of assessing the biodiversity of green roofs, is related to the human resources, expertise, and continuity to monitor the key benefits. This comes with the additional investment in maintenance cost. There are also limited indicators for NbS evaluation.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), as one of the leading bodies on the topic is working on developing an assessment tool; "assessing diverse conceptualizations of multiple values of nature and its benefits, including biodiversity, ecosystem functions, and services." (Ahn et al. 2015, 3). Because NbS addresses context specific complex challenges, there is a need for a holistic, multi-beneficial assessment to conclude its contribution and effectiveness (Raymond et al. 2017). Assessment should consider elements relevant to environmental and social aspects (Pascual et al. 2017; Colaninno, Neonato, and Tomasinelli 2021) while being aware of the risk of tradeoffs in NbS projects (Pörtner, Hans-Otto et al. 2021; Seddon et al. 2020).

Focusing on the urban level, there are specific challenges for urban NbS implementation due to geological conditions, population density, complex social connections, etc. The following challenges are summarized from (Kabisch, Frantzeskaki, and Hansen 2022, 1);

1. **"Spatial conflicts with urban system nestedness"-** Cities are dense and complex systems. Natural, residential, commercial, transportation, and infrastructure areas are all interlinked. This requires an understanding of systemic overview and strategic planning.
2. **"Specific urban biodiversity, fragmentation, and altered environments"-** Biodiversity are scattered around in small space in urban areas because of a lack of land and ecological connectivity. This can prevent the propagation of the ecosystem.
3. **"Value plurality, multi-actor interdependencies, and environmental injustices"-** The unequal usages of spaces, services, and benefits in cities impact diverse residents. Some people have access to good environmental conditions, but some are living in threatened areas. To avoid unexpected negative outcomes, allowing participation for environmental rights, especially for urban public spaces, is the critical step.
4. **"Path-dependencies with cultural and planning legacies"-** Each city has different challenges as it was built upon previous infrastructure. The areas have unique characteristic and social values. One size does not fit all, so local context should be considered.
5. **"A potential misconception of cities as being artificial landscapes disconnected from nature"** -Due to urbanization, cities are mostly perceived as technological or industrial lands separated part from nature. Creating a shared vision for new transformational cities towards sustainability needs strategic communication.

1.5.4. Principles for Urban Nature-based solutions

There is a need to tackle the challenges of design and implementation of NbS in urban areas in a strategic and systematic way. To overcome the challenges identified in the previous section, Kabisch, Frantzeskaki, and Hansen (2022) identifying the 5 Principles for Urban NbS that aim to provide a holistic view of spatial translation, participatory planning, and good governance to support NbS transitions in cities (Kabisch, Frantzeskaki, and Hansen 2022). The 5 Principles of Urban NbS are illustrated in figure 1.3, and are listed below;

1. Systemic understanding
2. Contribute to benefiting people and biodiversity
3. Contribute to inclusive solutions for the long-term
4. Consider context conditions
5. Foster communication and learning.

For our research, we have adopted the 5 principles outlined by Kabisch, Frantzeskaki, and Hansen (2022) to support scaling of urban NbS and to support a strategic shift towards sustainable development within cities. These science base principles focus on the specific challenges related to urban NbS. and are therefore an excellent conceptual framework to support this research project. We have chosen to utilize these 5 urban NbS principles as core guidelines for dealing with the complexity of the urban system, using system thinking and supporting the mapping and understanding of the system to find leverage points for a strategic sustainable development transition. The 5 urban NbS principles cover social and ecological considerations, representing the two main systems in the urban setting and their interconnectedness. The 5 urban NbS principles directly and indirectly support the 8 SPs with a focus on urban NbS planning that can support cities transitioning towards sustainability.

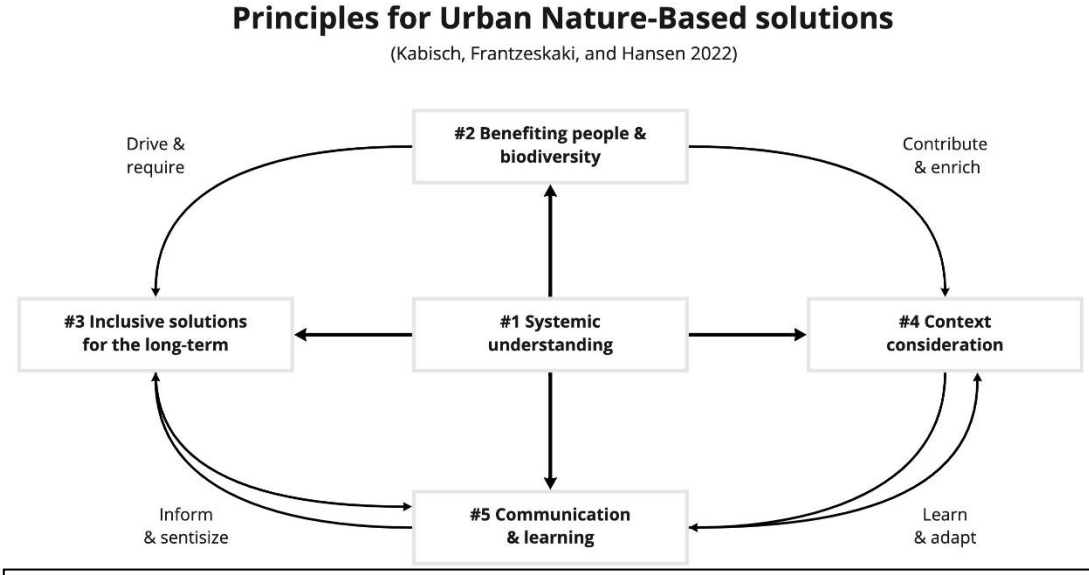


Figure 1.2: The five principles for Urban NbS
(Kabisch, Frantzeskaki, and Hansen 2022, 1391)

1.6. Residents' participation in NbS and urban planning

When planning NbS solutions specifically and urban environments in general, there is a paradox/ challenge; "The main actors in urban planning are city inhabitants, but unfortunately, they are not usually included in urban development planning until the end of the process." (González-Méndez et al. 2021, 9). Furthermore, while considering minorities, marginal and vulnerable groups within cities, those have even less accessibility to information and participation in decision-making processes. In our research we focus on youth and young adults.

Focusing on young participants, youths and young adults, groups that don't have the right to vote and/ or are not yet in key positions to feel as if they can make a difference. Participant-led process can allow them to speak out, get their voice heard in a common language and on their terms. They can define their own environment and share how they use, and capture the places that adults created. Urban environments influence youth development, health, and identity which emphasizes

the importance of participatory methods for engaging youth and communities in an interactive participant-led process (Dennis et al. 2009; Teixeira and Gardner 2017). Increasing the accessibility of quality information on participants' surroundings supports decision-making planning (Bennett and Lantz 2014). Therefore, mapping and understanding the urban environment through the eyes of residents and specifically youth can potentially influence and integrate their needs into the urban development processes and to help shape the cities they want to live in. (Teixeira and Gardner 2017; Smith et al. 2015; Sprague Martinez et al. 2018).

Participatory research shifts the way data is collected; from participant to by participants, basing the research on the perspective and knowledge available within them (Cornwall and Jewkes 1995), this approach has the "potential for bridging gaps between research and practice, addressing social and environmental justice" (Cargo and Mercer 2008, 325). In the literature, there is still little research about stakeholder involvement through different stages of a project (Wamsler 2017). Which leads to concerns within different professionals, especially urban planners, of being unaware of the outcome's perception (Anna Maria Orru 2014). In our research used a participatory method; a version of Participatory Photo Mapping (PPM) that will be introduced in detail in method section.

1.7. Research Purpose

This is a design and action research project integrating the 5 principles for urban NbS (Kabisch, Frantzeskaki, and Hansen 2022) as a conceptual framework to transcend governance gaps in young resident's participation and stimulate discussion around social and environmental aspects for effective urban NbS planning, as an approach supporting transition towards strategic sustainable development. As urban planning uses limited resources the decisions must be strategic and based on current reality while aspiring for a better future. Our research aims to develop and prototype a communication and urban evaluation tool (proof of concept), that integrates residents perceived quality of life with an ecological indicator to investigate the impact of urban biodiversity on resident's perceived quality of life.

1.8. Research question

Aiming to develop and prototype our communication-urban evaluation tool, for proof of concept we focused on the following research question: *What might a tool that can enhance resident's participation for NbS and urban planning evaluation look like?*

1.9. Scope

1.9.1. Case studies

In our research we choose to focus on the city level, in two cities in southern Sweden; Malmö and Karlskrona. The reasons for focusing on these two cities is based on their similarities and differences that could support us in answering our research question;

- NbS policies; Karlskrona does not have any official NbS projects in the city, nor official NbS policies in urban planning. In comparison, Malmö has actively incorporates NbS projects in the city and is part of NATURVATION and other NbS networks.
- Population and urban area size; Malmö is the third largest city in Sweden and a main center city, while Karlskrona is smaller city.
- Convenience, physically close; Karlskrona is our home city in Sweden. We wish to contribute and develop sustainability research and practices in the area we live and learn in. And Malmö is physically close, less than 4 hours in direct train.
- University city- both cities have universities, relevant population for our research.

Within the cities we are focusing on residents, not tourists and short time visitors we aimed at people who live in one of the cities for at least six months, increasing the chances they are permanent residents of the city. The benefit of residents mainly as people pass their daily life in the cities, experiencing the city through different lenses, seasons, timings, etc. In addition, we assume that people who live in a specific place for a while, maybe plan to settle in, they are more likely to care enough to participate and try to influence improving their city.

NbS in Sweden

The Swedish Environmental Protection Agency released in March 2021 an NbS report, a first of a kind, the Swedish national NbS guide was developed to share knowledge, information and guidelines for NbS planning, implementation and evaluation. The report defines NbS as *"Nature-based solutions are multifunctional and cost-effective measures to address various societal challenges by protecting, developing or creating ecosystems while promoting biodiversity and human well-being"* (unofficial translation- Weibull and Persson 2021, 12). Important to note that NbS considered as an umbrella concept for Green infrastructure (GI) and Ecosystem services (ES);

- ES- "Ecosystem services are all products and services that nature provides to humans and that contribute to our welfare and quality of life. Pollination, natural water regulation and nature experiences are some examples."
- GI- "Green infrastructure is a network of nature that contributes to functioning habitats for plants and animals and to human well-being." (unofficial translation-Naturvårdsverke 2019, 2; Weibull and Persson 2021)

This report might improve NbS policies and practices clarity in Sweden. Currently, at the municipalities level NbS does not appear in policies, even if practiced (i.e. Malmö) it is addressed by other terms (i.e. ES, GI) and through environmental policies in urban planning (Barton 2016).

Resident's participation in urban planning, Sweden

Residents' participation in urban planning and shaping their city setting is different between nations, regions and municipalities and also changes through time. In Sweden a national law "Planning and Building Act (2010:900)" integrates stakeholders' feedback in the planning process, requiring municipalities to share their plans with the public and different stakeholders, through different channels, one of which is a plan exhibition. Then the collected feedback, being considered and needed modifications are conducted in the plan, those then shared with all stakeholders. Only after that the plan can be agreed upon and implemented. (Boverket 2021; "Legislation Planning and Building Act (2010:900) Planning and Building Ordinance (2011:338)" 2018).

Karlskrona

Karlskrona is located in south-east Sweden, in Blekinge county. The city gained the UNESCO world heritage status through its unique architecture and the UNESCO biosphere reserve status, for the natural archipelago, as figure 1.4 shows the city is integrated in nature, outside the urban settlement is much forest cover, a UN world biosphere archipelago, and some agricultural land. Everywhere in Karlskrona, people are close to nature. The municipality's population increased during 2021 and at the end of the year stood at 66,708 people. From that 6.2% between the ages of 16-20, 4.9% between 21-24 and 24.6% between 25-44. The proportion of 13–24-year-olds is greater in Karlskrona municipality than in the national average. Looking at immigration rates, during 2021, there was a total net migration to Karlskrona (Kronengen 2022).

Karlskrona does not have any official NbS policies, the common term in use is GI, the comprehensive environmental is considered as needed of update, being written in 2010 ("Översiktsplan 2050 Karlskrona Kommun, Blekinge Län" 2021). As for sustainable development, it is part of the city's vision for 2050; "a sustainable development in Karlskrona municipality by enabling 500 dwellings a year and creating a good supply of land reserved for business related activities. The ambition is to create conditions for a population growth and a more sustainable municipality." ("Utställningshandling För Översiktsplan 2050" 2022, pt. English summary), in action, Karlskrona "Expo25" as a milestone, focusing on five areas for development: sustainability, recent technology, urban planning and development, social services and quality of life ("About Expo Karlskrona" n.d.). The event aims to create multi stakeholders' collaboration. In addition, Karlskrona is a member of Sweden Eco-Municipalities, a network to support cities in transferring towards sustainability. One of the steps to join the network is that "the local authority must adopt a strategic plan for achieving local sustainability that is in line with the four sustainability principles developed by the Natural Step Framework." ("Sveriges Ekokommuner - In English" n.d.)

Malmö

Malmö, the third biggest city in Sweden located on the south-west coast, as shown in figure 1.4, land cover is mostly urban settlements surrounded by agriculture. It is the first city in Sweden that announced the commitment towards UN SDGs. Malmö is one of the fastest growing metropolises including a variety of people from 183 different countries and an overall population of 351,749 (updated 31 December 2021). From that 21% under the age of 18 and 19% between the ages of 25-34 ("Malmö Stad Population" 2021).

Malmö actively incorporates NbS approach, both through different interventions and through eleven NbS projects as part of NATURVATION. Still, on the policy and urban planning level, the main official use is variety including Green infrastructure (GI) or Ecosystem services (ES). For example, because of the geographical condition and fast-growing urbanization in Malmö, the city has been facing various challenges such us stormwater flooding and social issues in industrial areas. Through the city's approach, Augustenborg Eco-city pilot project was created as a multi beneficial project; stormwater management, botanical green roofs, and community engagement. The neighborhood focusses on creating conditions for biodiversity and received the World Habitats awards in 2010 (Barton 2016; Månsson et al. 2021).

Looking at Malmö's Environmental Program for the City of 2021–2030 it seems that sustainability is in the center of their goals; "A Malmö with the lowest possible climate impact, A Malmö with a good urban environment, and A Malmö with rich biodiversity and healthy ecosystems" (Chrisander and Sohrabi 2021, 7) in addition, there is an emphasize on the importance of collaboration, engagement, regulations and policies for succeeding in achieving those goals. Throughout the program there is a focus on improving human well-being through reduction of hazardous exposure, increase in access to green and blue areas, etc. improve local environmental aspects, focusing on climate and biodiversity. (Chrisander and Sohrabi 2021).

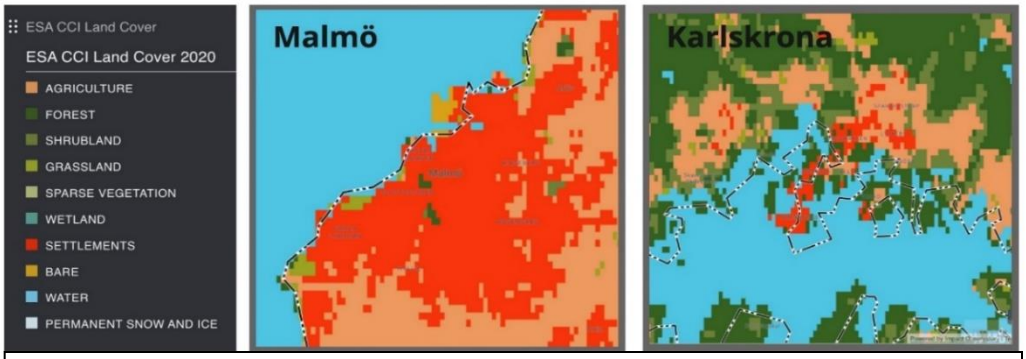


Figure 1.3: City and surroundings land cover; Karlskrona and Malmö (Source- UN Biodiversity Lab)

1.9.2. Research participants; Youths

Through our research we choose to focus on the youths and young adults population in each city, ages from 15 to 35 years old and living in one of the cities for at least six months. Our aim in working with these groups is allowing their voice to be heard, focusing on youths that cannot vote and are usually not given the power to influence their city setting. Both youths and young adults are the future, they will be choosing where to study and settle down. Focusing on their point of view, how they experience the world can create a clearer picture to city planners and allow planning that considers their needs and wishes. This can promote continued communication between citizens and municipality, to generate civic engagement with the possibility to influence. This can directly relate to decrease in immigration out of the cities and potentially increase immigration in, supporting the strategic sustainable development of the city. It is worth noting our choice to work with youths from 15 and overcame an ethical consideration according to the academic, research, and GDPR ethical ground rules involving people under 15 years makes the process more difficult to get ethical clearance to work, which seems out of our scope for the research time frame.

For this research, we focus on Sweden and youths, but this tool can be implemented by variety of users in different contexts.

1.10. Audience

This research aims to assist few main groups, professionals, decision makers and the public. Mostly, though creating a communication tool with the goal to strengthen and broaden the

communication between residents to city's urban planners and decision makers. Residents' participation promotes their civic engagement, strengthen their democratic rights while simultaneously supporting the professionals, practitioners and decision makers- politics in the development process. This communication can improve the city development, implementation and results for the benefits of those resident's, mirroring their needs and wishes while improving the local ecosystem. This can influence at the local level and has the potential to affect the regional, national and even international level. The research can generate conversation between the environmental department and urban planners to work collaboratively towards NbS.

1.11. Limitations

Research limitations include;

1. Resources: duration of time to conduct this research, capacity, knowledge and experience of the research team in conducting research, no financial support for development of the tool and marketing for the survey, restricted to online-open source database,
2. Technical; the research team had little prior knowledge in using platforms and software for developing the research tool and using online data sources.
3. Language: we conducted our research, retrieved documents, interviews and survey in English, in a native Swedish speaking country.
4. Reliability of data; biodiversity, through our online survey we have put our trust in participants to share true data about themselves and about the places they describe.

Full disclosure: Through our research data collection we have reached out to survey participants including friends, family members, colleges, etc.

The data gathering phase of this research experienced other limitations as;

- Technical; participants experienced different challenges in completing the survey. Google map's representation for multiple pins for the same location.
- Expectation: some participants took longer than expected to complete the survey
- Accuracy of data; participants mismatch between- answers and type of place (a place that improves/ hinder their quality of life), pin of location with description of place/ photo. In addition, some participants reply to the survey with written answers only.
- Time: we were able to continue the survey and feedback data collecting for only a month, which we believe more time would have allowed us collect more reports.

Full disclosure post data collecting;

- Respondents including notes about violence, minorities etc. were not represented in the map. Those responds were considered part of the relevant value analysis (e.g., "Safety" or "accessibility")
- We have approached survey participants in person, through the interaction some participants filled the survey in presence of one of the researchers. In addition, few responders filled the survey through the researcher's devices (i.e. phone/ computer) and shared parts of the results through WhatsApp (i.e. photos).

2. Research methods

Our research, as mapped in the adjacent figure included four main phases; (1) Conceptual framework and project scoping, (2) Development of the tool, (3) Data collection, and (4) Validation. The first step aims to gather insights and needs from literature and practitioners to develop the tool's concept. The second step was designed to support the tool development through literature review and interviews about participatory research and planning. Step three was designed for collecting data by the PPM survey and from the GBIF open-source database (biodiversity occurrences data). The fourth step was to focus on validation of the tool through research participant's feedback.

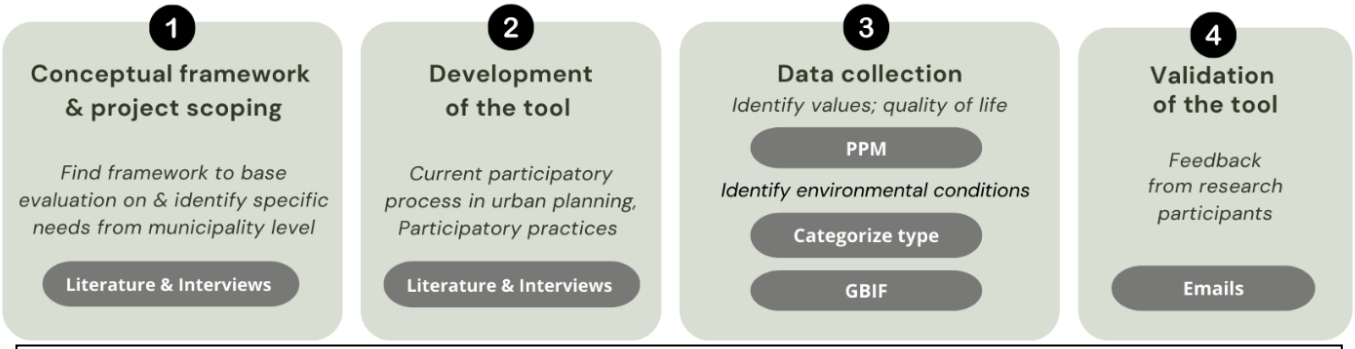


Figure 2.1: Research process

Through our research process, we collected data from different sources and used different methods. To handle the data and clarify the results for the conclusion. We have conducted a multi-step analysis, used the inductive approach and addressing the data through the lens of our research question; what data is repetitive, and what are the common themes and motifs that can be identified from the data. Throughout each step of our analysis had a responsible researcher of the analysis, after creating a way to approach the data, the rest of the research team was reviewing the process and results, this was to minimize biases and maximize the benefits of multiple points of view. We have conducted a separate process for each city and then created a comparison between the data of each city, to see overall trends, similarities and differences.

2.1. Conceptual framework and project scoping

We designed our research around the 5 principles for urban NbS (Kabisch, Frantzeskaki, and Hansen 2022), and the main challenges in urban planning as identified in our literature review, specifically those challenges related to the integration of NbS projects. We decided to focus on developing a tool aimed to promote residents- municipality communication and evaluation for urban NbS projects.

The tool concept is of an interactive multi-layered map, as a platform for conversation between residents and municipality about the urban places, presenting two main elements; resident's perception of the urban areas and a biodiversity indicator. Those three main elements of the tool;

participatory, communicative, multi layered with human and ecosystems well-being, are inspired by 3 of the 5 principles for urban NbS, i.e., Inclusive solutions for the long term (3), Communication and learning (5), Benefiting people and biodiversity (2).

To refine the tool based on this concept, and to meet the needs of both main audiences, we conducted a literature review and semi-structured interviews. Both data gathering methods focused on the main topics rather than a narrowly defined list of specific questions. This allowed us to understand the needs and challenges in our specific context and scope, with a focus on evaluation of urban planning and NbS and participatory methods and participation in urban planning. Example interview questions are provided in appendix 7.1.

This process included retrieving documents, online open-sourced data, and in-person interviews. We have conducted nine semi-structured interviews and conversations in total; respondents included eight participants from Karlskrona municipality and one from Malmö municipality. Interviewees included members from several relevant departments; urban planning, environmental, education, etc. (list of interviewees appendix 7.2). In addition to two different professionals outside of the municipalities. Interviewee responses, and official document and policy maps of the different city layers; explained the city's urban setting and guidelines for sustainability and future planning. One of our main challenges was finding official municipality information in English, therefore material sourced in Swedish was translated using Google translate.

2.1.1. Creating the framework for multi-layered NbS map

Building on the tool concept, we modified the idea based on the data collected through literature and interviews and develop the scope of the map layers (figure 2.2). Mapping different elements in the urban setting and presenting it as a multi-layered map allows for a more holistic assessment of NbS in various locations in the city. This also allows local areas to be developed and evaluated in systemic and strategic sustainability. Moreover, presenting varied data organized by separated layers can be analyzed and considered distinctly or jointly with the current city's plan map. The layers of the conceptual map should present data of different indicators from relevant sources;

- 1th and 2nd layers (Karlskrona, Malmö); research participants identify locations that improve their quality of life and the natural environment. Including participants' photos and example quote.
- 3rd and 4th layers (Karlskrona, Malmö); research participants identify locations that hinder their quality of life and the natural environment. Including participants photos and example quote.
    - Collectively the four layers represent the perceived residential city experience, considering the social benefits of NbS in the urban environment through residents' eyes. This data was collected through Participatory Photo Mapping (PPM).
- 5th and 6th layers (Karlskrona, Malmö); biodiversity occurrence for each pinned location.
    - Those layers represent the ecological indicator that should be considered in NbS planning as multi-beneficial areas. The biodiversity occurrence was identified for each

location reported by residents in previous layers and extracted from GBIF open-source database. Biodiversity occurrences help understand local biodiversity better which means assist to better prepare to protect it. This is to reduce the gap of biodiversity data and standardize data for environmental development.

- 7th layer; existing NbS projects in Malmö.
    - This layer allows specific evaluation of NbS projects in the cities, considering their multi-beneficial impact represented by the previous layers (social and ecological). The data was extracted from UNA database of NbS projects. This layer is essential as it set up NbS standard, example to inspire learning for other new projects for NbS in other areas.

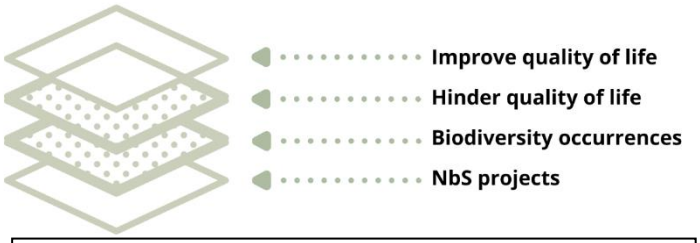


Figure 2.2: Multi-layered map

2.2. Development of the tool

Methodologically, this step was similar to the first step "Conceptual framework and project scoping", the steps were conducted simultaneously, the data collection was through literature review and the semi-structured interviews. Focusing on participation we needed to understand the 'current reality' of participatory methods and processes and identifying guidelines for improving participation in our tool, and in urban planning, considering it essential for NbS projects.

For improving our understanding of residents' engagement in general, and specifically of youth in urban planning, we conducted a literature review about participation in urban planning, participatory research, and the involvement of youth in those fields, globally and in Sweden. In addition, we asked the interviewees about "Decision-making process for urban planning" focusing on community participation in general and of youth specifically (examples of interview questions are included in appendix 7.1, and a list of interviewees in appendix 7.2). In addition, to creating a participatory tool, we conducted a literature review about guidelines for participation, focusing on online surveys.

The analysis of this data was implemented into our tool design, to make it user friendly. To evaluate the participant's experience of the tool, the actual "user's experience", and to see if our tool can enhance participation in urban and NbS planning, we collected feedback from research participants. Feedback on PPM survey participation through the survey itself (under "Anything you would like to add?" section) and in conversation with survey participants. Feedback on the complete tool (online interactive map) we collected through email to research participants who agreed to share their email for further updates and feedback (feedback questions in appendix 7.3)

2.2.1. Participatory Photo Mapping

PPM is a method based on other participatory methodologies (i.e. participatory photography, public participation GIS and community based participatory research) and on the premise "that 'lived experience' itself cannot be reduced to only one aspect" (Dennis et al. 2009, 467). In practice it can be done in different ways, usually including photography, mapping and interviews (Teixeira 2015) either directly with the participants or through online digital tools (Dennis et al. 2009). Using this method should be while considering challenges both in collecting the data and integrating it through an analyzing process. In sharing the participatory protocol there might be technical and practical issues experienced by participants and ethical questions about the process and the collected information. Through analyzing there are issues of misinterpretation of data and integration of the varied data (Dennis et al. 2009; Billger, Thuvander, and Wästberg 2017). On the other hand, choosing this method has clear benefits, mainly in engaging community members, including youth (Dennis et al. 2009; Teixeira and Gardner 2017) and increasing the accessible information on the participants' surroundings to support decision making in planning (Bennett and Lantz 2014). In addition, this allows the creation of a shared and more accessible language between the participants, researchers and other stakeholders (Dennis et al. 2009). The tool may provide a new platform for the community to raise their voices with freedom of speech which supports social sustainability principles of influence and meaning making.

Conducting PPM in research allows participants to engage as "co-researchers", as they are the experts for their life. The PPM method is simple and collects multi-elements information that requires participants to be active and share their personal perception of their environment, encouraging them to question and analyze their current reality. This creates a closer relationship between the participants and the researchers and can empower participants and promote leadership through the involvement in the process. (Teixeira and Gardner 2017; Burke, Greene, and McKenna 2017; Smith et al. 2015; Sprague Martinez et al. 2018).

Overall, compared to data collecting methods, and specifically participatory tools, PPM's main advantage is that it allows us as researchers to collect multi-layered data, location, written answers and photos. Beyond the known saying that "A picture is worth a thousand words" this supports the participant's ability to express their thoughts and ideas in different ways: written and as a visual photo. Focusing on the younger generation that is highly used to visual capture as communication tool through different channels (e.g., Instagram, TikTok, etc.).

2.3. Tool testing, data collection

After creating the scope for the tool, we collected data for residents using PPM online survey, biodiversity occurrences from GBIF open database, and NbS project's locations through UNA online map. This was collected and analyzed for both cities as described in the following sections.

2.3.1. What do people value in urban NbS within their city's environment?

Data collection- Residents' perception survey (PPM)

The method we used is a modified version of PPM collecting participants photos, locations and text through online tool (Teixeira and Gardner 2017; Dennis et al. 2009). This allowed us to get rich data about resident's perception of their city experience. PPM was as an online survey, to map "places that improve/hinder residents' quality of life and the natural environment".

Survey tool: Residents' perception was collected through an online survey. For the survey we used Google Form, the advantages were the accessibility for users, the survey's features, simplicity in creating, filling and viewing data collected (to see survey interface, appendix 7.4). Especially when focusing on our audience- young population that is highly familiar with online tools and specifically Google's services. The disadvantages were related to ethical questions raised about Google Form being an unsafe tool for data protection, and the fact that through photo uploads of participants we automatically collected their Google username. Those issues were handled with clarification in the consent form and through the data handling.

Survey marketing: Reaching out to our survey audience was done through a few main approaches; "pass the word" between friends, colleagues, family and pioneer participants- mostly interviewees. The other approach was publishing informative poster (see appendix 7.5) on Facebook's students' groups in Malmö and Karlskrona. Same poster was passed out and hung around the city center Karlskrona, BTH university, Malmö central library and throughout the city center. In addition, the survey was offered to high schools to be used as part of a lesson plan about civic engagement/ practicing English.

Survey questions: The survey was structured with five sections; explanation and consent form, general and demographic questions, options to share about a place that improve your quality of life and the natural environment, options to share about a place that hinder your quality of life and the natural environment and a closing-thank you section. The two main sections were with the set of questions where participants could share about a place in their city that improve/ hinder. Each participant could complete a survey respond with up to three places for each type, and up to five pictures per place. For reviewing the full survey, see appendix 7.6.

In using the online survey tool, we were aware of the challenges of unclear data caused by participants misunderstanding of the questions, technical challenges with the tool, lack of focus, etc. Dealing with those was done in a systematic approach; mismatch between photo/ description of place and location went to the favor of the photo, "correcting" the location if known. Another challenge with online surveys and specifically PPM, is from the researchers side, the issue of misinterpretation of data and integration of the varied data (Dennis et al. 2009; Billger, Thuvander, and Wästberg 2017), this was addressed by collecting different types of data; photo, location and few written answers. This together with multi steps and lenses of data analysis allowed us to capture better the participants intention.

Data analyze- participants perception of a place's influence on their quality of life

To analyze what people value in their urban setting, participants were asked to answer the survey, able to report a place that improves/ hinder their quality of life and the natural environment. through those reports we created a value analysis; directly ("positive perception") through pictures

and explanations of why participants enjoy the places that improve their quality of life, and by the offers how to improve places that hinder their quality of life. Indirectly ("negative perception") analysis by crossing answers between the two main sections of the survey, using pictures and explanations of what is the problem participants in places that hinder their quality of life and by things they mentioned as issues that interrupt them from enjoying places that do improve their quality of life, as can be seen in table 2.1

This approach was taken as validation, not just mapping what improves resident's quality of life, but also what they consider as hindering, this to identify the common themes and the core values.

Table 2.1; Structure of the analysis process for residents' value

	What place in your city improve / hinder your quality of life and the natural environment?	
	Improve	Hinder
Section's value related questions	• What is special about those? • What do you like about it? • What do you do there?	• What are the problems with it? • What interrupts you from enjoying it?
	• Are there any problems with it? • What interrupts you from enjoying it?	• In your opinion what can be done to improve it?

*Value through negative perception *Value through positive perception

Analysis steps for each city separately;

1. Participants answer questions about places that improve their quality of life and the natural environment, and provide ideas for improving places that hinder quality of life and natural environment; Identify similar and repetitive images/ themes in;
    a. Photos shared from places that improve quality of life and the natural environment.
    b. Written answers of "What is special about those? Can include; What do you like about it? What do you do there?" from places that improve quality of life and the natural environment.
    c. Written answers from places that hinder resident's quality of life and the natural environment - "In your opinion what can be done to improve it?"

Note, analysis was done by each participant, not by each location.

2. Participants answer questions about places that hinder their quality of life and the natural environment and issues that interrupt them from enjoying these places; Identify similar and repetitive images/ themes in;
    a. Photos shared from places that hinder quality of life and the natural environment.
    b. Written answers of "What are the problems with it? What interrupts you from enjoying it?" from places that hinder quality of life and the natural environment.

c. Written answers from places that improve resident's quality of life and the natural environment - "Are there any problems with it? What interrupt you from enjoying it?"

From the themes identified we created clusters and sub clusters to describe the themes that are shared by each step of analysis and in between steps. Detailed example in table 2.2

Table 2.2; Example of value analysis

Survey answers			
Participant Number	**Written answer "What is special about those? Can include; What do you like about it? What do you do there?"**	**Photos shared**	
4	"It's in nature. It's soothing, calms me down, is inspiring and heals me.		
Steps of value analysis			
1. Elements in photos	**2. Elements in written answer**	**3. Sub cluster**	**4. Cluster**
Nature, view, tree, water, rocks, ice, bonfire	In nature, soothing, calms, inspiring, heals	• Serene atmosphere\ freedom, Inspiration • Embedded in nature	• Mood & Aesthetic • Environment Setting; Natural

Example based on a respond of a place that improves quality of life and natural environment in Karlskrona, but was done similarly for all responds

2.3.2. What are the environmental conditions of the places that people value?

Categories - type of place

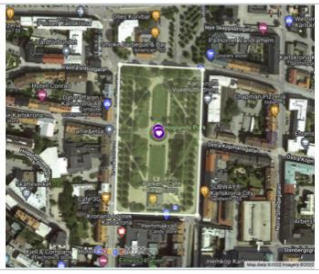
To further analyze the places reported in the PPM survey, we decided to create a categorization for the places based on the land cover and function of the place. This to gather similarities and find "type" of places that people value. This was done based on three main definitions.

- **Nature:** location with high level of natural areas (over 90%+ natural land cover), the sea, forest or natural reserves without human infrastructure interruption.
- **Urban-Nature:** location with medium-level of nature in urban areas (20-90% natural land cover), NbS, trees in streets or nearby buildings, natural park that built by human, etc. This includes piers in natural settings.
- **Urban:** location with low-to-non level of nature (less than 20% natural land cover), such as only buildings, concrete, street, road, etc.

Those categories can simply clarify urban planners what is in the place, what conditions and elements are in place. Relating it to the value residents perceived support more informed decision making for future planning.

The process to classify the places was done by identifying elements in the participants' photos, then considering their responses to the question "Please describe what is the place" for confirming the category. For validation cross-checked the geographical map. This is to be able to suit each location to a specific type's definition. The process and different types are described in detail in table 2.3

Table 2.3; Analysis steps for location's type

Type of place		
Step 1: See the photos from participants and description to identify type of place. The following photos are the examples of how to categorize data.		
Urban	**Urban-nature**	**Nature**
		
Step 2: Draw a boundary line on the google map at the location participant selected to confirm the type of place based on geographical photos.		
		
Low-level of nature • Concrete road • Construction zone • Buildings, infrastructure, etc.	**Medium-level of nature** • Human-made park in the city • Trees one street and buildings • Canal etc.	**High-level of nature** • Nature reserves • Natural areas, forest park • Sea, beach, etc.

Dealing with data limitations:

1. If there was no photo from the participant, we used only the description of the location to analyze.
2. If participants pin and describe the place as a whole district area, we scope the whole district to analyze.

Mapping NbS locations

For identifying NbS locations, identifying if they were reported by participants and identify their human perceived value and environmental conditions. We have used the Urban Nature Atlas (UNA) database, as a leading profiling tool for NbS projects in Europe. UNA mapped 11 NbS projects in Malmö, each location reported in Malmö was compared to the UNA project list, if they matched, the location received an additional sub-category as "NbS."

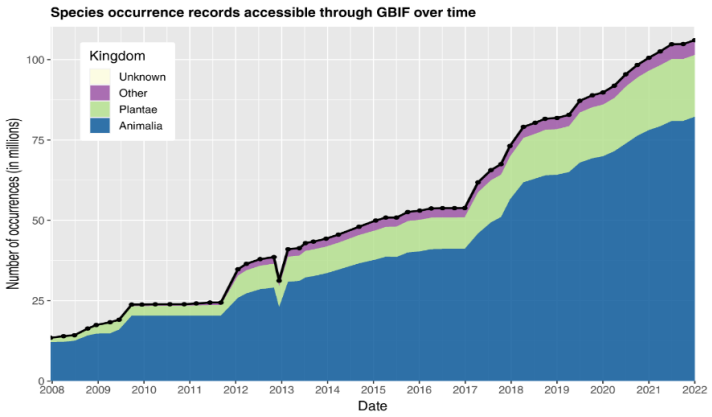
Environmental conditions of the places that people value

Biodiversity indicator:
To better understand the environmental conditions of the places that people value we chose to include a biodiversity indicator in the tool. Biodiversity is a major element in NbS projects as mentioned in definition, part of the second principle of urban NbS (Kabisch, Frantzeskaki, and Hansen 2022), therefore we researched biodiversity indicators. Having said that biodiversity is a broad and complex subject, we were investigating online free open sources through the literature (Underwood, Taylor, and Tucker 2018; Petersen et al. 2021) looking for existing databases that can fit our scope of mapping, showing biodiversity levels / density / rate in different areas at the detailed local level- within the specific cities and urban environment.

Being a subject that is commonly researched and mapped, there are a lot of online, open sourced, free to use databases for biodiversity, with a different focus on specific species, data collecting methods, etc. For instance, the biodiversity databases that we looked up were such as Artportalen from SLU University, Swedish Biodiversity Data Infrastructure (SBDI), iNaturalist, UN biodiversity Lab, GBIF, etc. To be able to answer our research question we needed an indicator for biodiversity, we didn't look for absolute number, but we wished to be able to show a trend, look for relation between biodiversity, urban planning and residents perceived well-being, we needed a relative number to represent biodiversity in the different mapped location.

Our research focus led us to use a database from the Global Biodiversity Information Facility (GBIF), the largest open-access database for biodiversity, funded by over 30 countries internationally who are part of GBIF voting participants. This database is suitable in scope, accessibility, the relevance of date, variety of species, and diverse information sources. This participatory international database allows us to check species' occurrences on specific sites.

Defined by GBIF, occurrence data is "the evidence of the occurrence of a species at a particular place on a specified date". Our research focuses on the occurrence data in the places that survey participants selected and mapped as improving/ hindering their quality of life and the natural environment. This without any species filtration and scoping as the default time range between the year 1000-and 2022.



Number of records published by institutions in Sweden, categorized by kingdom

Figure 2.3; GBIF activity report in Sweden generated January 2021 (source; GBIF)

GBIF data in Sweden includes datasets contributed by Artopolen (Swedish Species Observation System), Bird Ringing Centre in Sweden (NRM), Swedish University of Agricultural Sciences (SLU); Aqua Institute of Freshwater Research, National register of survey test-fishing (NORS), eBird Observation Dataset (EOD) and Swedish Bird Survey, etc. Data is collected by organizations, history museums, volunteers, citizen scientists, or researchers who aim to provide information about life on earth. ("Sweden A GBIF Voting Participant from Europe and Central Asia" n.d.)

The more data gathered the higher the validation of the data. As seen in figure 2.3, the number of records published in Sweden is increasing through the years. An example of the potential utilization of GBIF occurrence data is to prioritize areas and species for conservation purposes (Shirey et al. 2019).

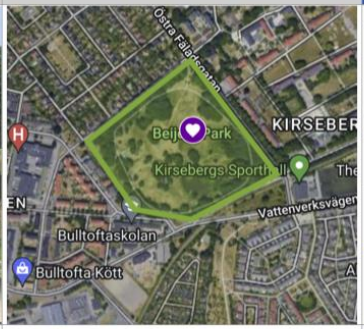
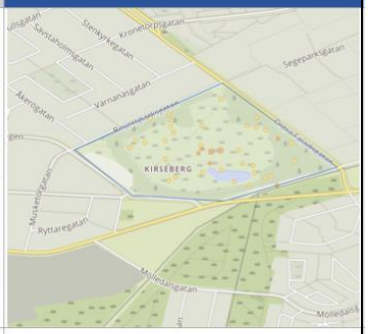
The limitation of data collection via GBIF:
Some errors could appear if the data set is too large in the selected area. Therefore, we decided to map out specific areas instead of downloading the complete data for Sweden. Moreover, the data may provide only general locality information. Naturalists may favor some locations, while some areas might not yet be explored. The occurrence number presented does not mean the exact number of whole species detected in the zones. It shows where certain species are recorded at specific dates and times. There are also chances of repetitive data collection. Considering how data is collected there is also important of seasonal data, visibility of species, etc. In view of our mapping of biodiversity we should also consider limitations as size of placed measured and land change through the years considered. GBIF allows us to identify high biodiversity areas at a general level. However, it is important to keep in mind that the areas that are most threatened at the present time, are not updated or presented. For the city base map, we have used Google's online open source map, adding missing information from the city's and other sources open-source-online maps;

- Karlskrona's official detailed plancity map
- Malmö's official city map- Malmö kartor- digital atlas
- Official NbS through Malmö- The Urban Nature Atlas

Analyzing the environmental condition of places:
To identify the relationship between reported places and their environmental conditions we choose to focus on two elements for analysis;

- Residents' perception of the place, does it improve/ hinders quality of life and nature environment. this to try and connect the human perceived influence of a place on their

Table 2.4; Analysis steps for biodiversity occurrences

Photos+description	Google Map	Biodiversity map
		
Check photos, description and location pin from participants.	Use vector tool on google map to mark location boundary.	Zoom in the map of GBIF.org to the location and scope boundary to check biodiversity occurrence. *Example: Occurrence data: 979* GBIF.org (01 May 2022) GBIF Occurrence Download https://doi.org/10.15468/dl.25vy7h

quality of life with the environmental conditions. Trying to identify trends of strong connection, to strengthen the understanding that the social and ecological systems are connected. (i.e., Wilson's "Biophilia hypothesis")

- "Type" of place, is it Urban, Urban- Nature or Nature. This tries to connect land cover with environmental conditions, strengthen the understanding of land cover over biodiversity and support integration of nature into urban environment.

For the detailed steps of extracting location's biodiversity occurrences see appendix 7.7

2.4. Tool evaluation and validation

2.4.1. Post analysis- research participant feedback

To gain feedback and validation of results we conducted additional step of data validation. We have shared the analyzed data, presented in the online Google map, with research participants, both interviews and survey participants from Malmö and Karlskrona. Participants that shared their email address and agreed to get a research update, got an email with an explanation and link to the online map followed with five questions related to data validation, this allowed them to agree/disagree with the pinned places, to provide their opinion on the biodiversity data, and if they were interested to use this tool later (see feedback questions in appendix 7.3). This can potentially support our understanding of the results, as well as validate the data we collected and gain some insights about participants (residents and municipality workers) intention to use the tool.

2.5. Research ethics

This research was reviewed and approves by our thesis advisor and BTH Data Protection Officer. It is considered as low risk research; the main considerations are around youth participation and data collection and handling. To minimize the ethical risk, we have chosen to work with youths above 15 years old, as the acceptable age for participation in research without special clearance and research practices. For the data collecting and handling, we have used Google Form as our survey tool, the consideration was of it being an unsafe tool for data protection, and the fact that through photo uploads of participants we automatically collected their Google username. Those issues were handled with clarification in the consent form and through the data handling. Considering our interviews, those were all with consent for participation, signing a consent form and receiving an interview summary for feedback and needed adjustments. To minimize data leak´s risks, we have stored all our data in OneDrive storage, supplied to us by BTH.

3. Results and discussion

3.1. Results- Conceptual framework and project scoping

To address the first step 'conceptual framework and project scoping' we started by identifying the necessary requirements for our conceptual tool based upon the literature and approaching both municipalities for feedback and insights. From literature, as mentioned in the introduction, we identified the need in NbS evaluation (Raymond et al. 2017; Ahn et al. 2015; Pascual et al. 2017; Colaninno, Neonato, and Tomasinelli 2021) and participatory processes for urban planning (Raymond et al. 2017; Li and Nassauer 2021; Mok et al. 2021; Wang et al. 2019; González-Méndez et al. 2021; Kabisch, Frantzeskaki, and Hansen 2022). For NbS evaluation we choose to focus on the 5 principles for urban NbS as guidelines for elements to evaluate; (1) Systemic understanding, (2) Benefiting people and biodiversity, (3) Inclusive solutions for the long term, (4) Context conditions, and (5) Communication and learning. (Kabisch, Frantzeskaki, and Hansen 2022). For participation we have focused on a participatory research method approach in creating the survey and tool, specifically PPM (Dennis et al. 2009; Teixeira and Gardner 2017; Smith et al. 2015; Sprague Martinez et al. 2018), as guidelines for shifting from collecting data from participants to by participants as the knowledge holders. (Further development for enhancing participation in section 7.2)

In addition to the literature review we have conducted interviews with municipality workers and other professionals. Through those interviews we wanted to map the existing tools and methods in use for participatory urban planning and evaluating, understand the challenges and strengths of those processes and identify if our tool concept is needed and what adjustment needs to be made to make it suitable for municipalities use.

Interviews resulting in all municipalities' interviewees showing interest in such a tool, mentioning that there is a difficulty to engage residents in municipality processes, in addition to a gap in urban ecosystem evaluation, specifically biodiversity. Detailed quotes considered in our tool development presented in Figure 3.1 and 3.2. From the different interviews and conversations, and through the presented quotes we identified few main shared themes; residents' participation specifically for urban planning is a challenge municipality are dealing with, mostly in getting residents to engage. In addition, the common participatory process in Sweden is perceived as long and slow and generates frustration within participants. Considering youth, municipalities note the difficulty in reaching this group. Addressing information mapped for urban evaluation, there is a lack in biodiversity/ environmental data and evaluation procedures- there is still a gap in creating a clear full mapping of those.

In addition, one of the professional interviewees said, in considering the urban environment "Some people still think urban areas are for people and nature is out there for animals. Still does not seem that they know about the multi-functional benefits. There is a growing need for what to do with the land in cities because the land is so expensive."

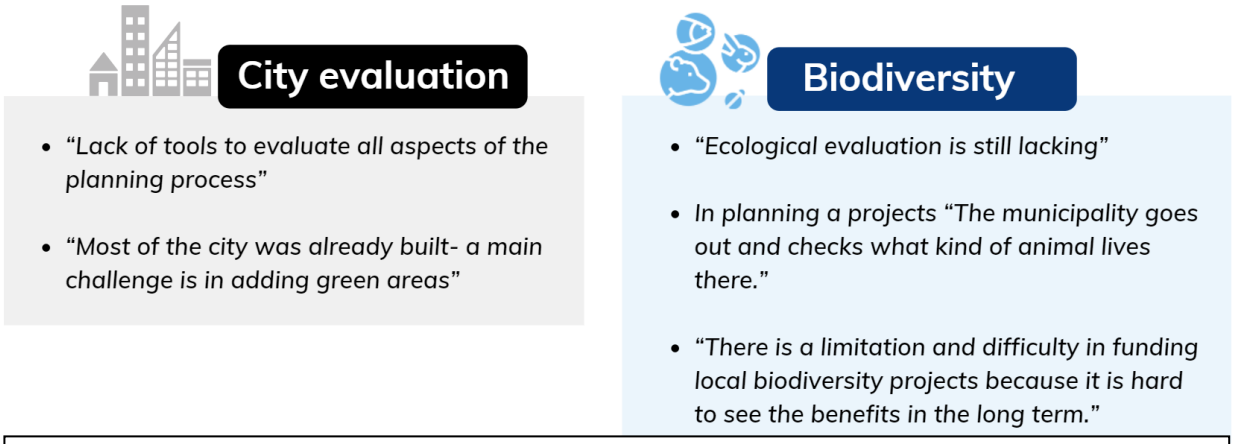


Figure 3.1; Interviews quotes on city evaluation and biodiversity

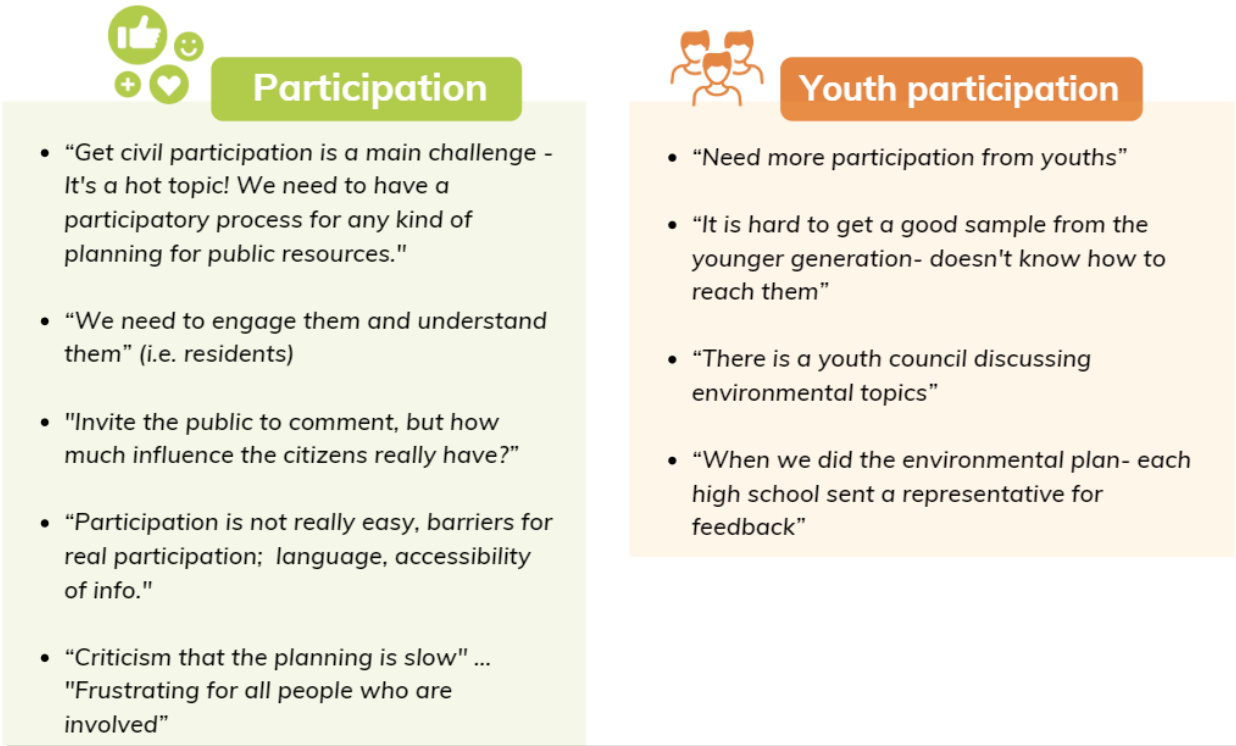


Figure 3.2; Interviews quotes on participation and youth

3.2. Results- Development of the tool

Focusing on participation for the tool development, we have identified the importance and challenges in participatory processes in both cities. When asked about participatory processes, specifically with youth, both cities considered the efficacy of participatory processes and collecting the voices of the young generation as major challenges and a priority to address. Both the literature and our respondents emphasized the difficulty of effective participation approaches.

From interviews (see figure 3.2 above) it was clearly identifying that both cities are following the Swedish resident's participation in planning law, mentioning that they are making extra effort to engage people, for example by rotation of exhibition and "feedback box". Increase participation is in interest, and a main challenge. Focusing on youths the challenge is bigger, municipalities try to reach out, unsure how and mainly through schools, in Karlskrona there was an attempt to reach feedback from youths by app, reaching out within school's lessons, it was considered as a success for the specific project. But have not implemented as continues data collection.

When considering participation in online surveys (as our PPM and tool) the literature maps varied of drivers for participation that should be considered while creating, marketing, and reminding of the survey. Listed elements to consider; "survey length, interest in the topic, desire to voice one's opinion, curiosity, enjoyment, the desire to help, recognition and a feeling of obligation to complete the survey, personalized invitations to complete a survey, the number of reminders, other design features of the survey invitation, trust or the relationship with the organization conducting the survey and questionnaire design." (Brosnan, Kemperman, and Dolnicar 2021)

Beside the overall elements, we have found a model of response motivators, Brüggen et al. (2011) developed the Survey Participation Inventory. The model categories people by the type of motivators that can increase their chances of responding a survey (completing the survey) those based on means of motivation - interest, enjoyment, curiosity, give opinion, helping, incentives, need for recognition, obligation. Identifying three main groups.

1. Voicing assistants: motivated mainly by intrinsic (i.e., giving an opinion and helping).
2. Reward seekers: motivated mainly by incentives that they receive for their participation.
3. Intrinsic: motivated by multiple intrinsic motives (i.e., enjoyment and giving an opinion).

Interesting to note that the Reward seekers were represented by the youngest group of the participants in the survey, but still above our age scope (Brüggen et al. 2011; Brosnan, Kemperman, and Dolnicar 2021)

3.3. Discussion– Conceptual framework and tool development

"What might a tool that can enhance resident's participation for NbS and urban planning evaluation look like?" having this question in mind, we developed our research and tool based on the 5 principles for urban NbS (Kabisch, Frantzeskaki, and Hansen 2022).

Through our literature review, we understood the importance and gap of NbS evaluation (Seddon et al. 2020; Ahn et al. 2015; Raymond et al. 2017; Pascual et al. 2017; Colaninno, Neonato, and Tomasinelli 2021; Pörtner, Hans-Otto et al. 2021) and the resident's participation in urban planning, *"The main actors in urban planning are city inhabitants, but unfortunately, they are not usually included in urban development planning until the end of the process*" (González-Méndez et al. 2021, 9; Raymond et al. 2017; Li and Nassauer 2021; Mok et al. 2021; Wang et al. 2019; Kabisch, Frantzeskaki, and Hansen 2022). In addition, understanding the reality of participatory processes today, Sweden emphasizes the importance of citizen participation. Participatory processes are incorporated by law to gain public opinion upon the city's comprehensive plan erket 2021; "Legislation Planning and Building Act (2010:900) Planning and Building Ordinance

(2011:338)" 2018. This is done in a top-down manner; the plan is made by professionals and afterword residents are asked to give feedback through different channels (e.g., email, online form). Through our interviews, we came across two main criticisms of this approach; the barriers to "real" participation are language and lack of accessibility to information. In addition, the Swedish law procedure for residents' participation is considered "slow" which makes participants frustrated (Figure 3.1, 3.2).

Strengthening this notion, municipality members emphasized the city's effort to enhance participation, going beyond the requirements of Swedish law. They presented a challenge to increase residents' participation (i.e., "get civil participation is the main challenge") and specifically youth participation. For example, interviewing Karlskrona municipality members, it was described as difficult to reach the younger generation for their opinion about the developed new city plan. In addition, the Deputy Mayor of Malmö, Simon Chrisander agrees that "getting inclusion is a structural challenge". He mentioned the challenge of approaching youth and that, in his opinion, youth involvement requires education on how the city and municipality systems work.

From this main gap, we chose the concept of the tool, based upon the participatory research method, to allow residents as knowledge holders and those who experience the city daily to share their understanding between themselves with practitioners and decision-makers in the municipality (Cornwall and Jewkes 1995). They can communicate per location that they perceive as improving or hindering their well-being and the natural environment. Through this, it is possible to identify trends of location types and elements that influence residents' well-being and meaningful values.

Our research focuses on including the voices of young residents who are crucial for the city's development but often underrepresented in the city's decision-making as mentioned in the literature (Teixeira and Gardner 2017; Burke, Greene, and McKenna 2017; Smith et al. 2015; Sprague Martinez et al. 2018). The research and tool were developed based on literature to consider improving participation rates in creating an online tool (section 7.2. Development of the tool) and the overall review on participatory research and PPM (Dennis et al. 2009; Teixeira and Gardner 2017). We found the online interactive tool is mostly accessible, especially to young people.

The application of the PPM approach has the potential to collect rich data in a simple way that anyone can share their perspectives through photos with the freedom of voice. This can promote inclusive and participatory processes while helping urban planners gather context-specific information relevant to the city to integrate NbS according to the visioned future appropriately. As a continuous communication and evaluation platform, the tool can allow participants to join and express their opinions or needs at any point of time from any place. As identified in the literature, the simple language used in the PPM survey can make participation more accessible. The online interactive platform is suitable especially for youth who are used to communicating through images and by their phone. (Teixeira and Gardner 2017; Burke, Greene, and McKenna 2017; Smith et al. 2015; Sprague Martinez et al. 2018). Considering residents' insights will encourage residents to participate, feel capable of influencing, and support the answer to our research question: how to enhance participation.

Potentially, this can bridge the gap between policymakers and citizens, allowing the integration of voices, opinions, and ideas from various stakeholders to reduce the silo system, which can support

facing the second challenge in urban planning, specifically for NbS, “Value plurality, multi-actor interdependencies, and environmental injustices” (Kabisch, Frantzeskaki, and Hansen 2022).

We aim for NbS and urban planning evaluation because cities are often viewed as disconnected from nature and artificial landscapes for humankind (Kabisch, Frantzeskaki, and Hansen 2022). Although Malmö and Karlskrona have different geographical conditions, the two cities share a vision of sustainable development and identify the needs to strengthen the socio-ecological system. However, from interviews, the gaps identified “lack of tools to evaluate all aspects of the planning process” and “ecological evaluation is still lacking.” Specifically considering the ecosystem, although both cities emphasized that the biodiversity issue is critical, “There is a limitation and difficulty in funding local biodiversity projects because it is hard to see the benefits in the long term,” mentioned interviewees. Being able to explicitly show the importance of the relationship between biodiversity and social benefits will steer the conversation to consider and prioritize both ecosystem and society in the city’s development. Thus, we decided to tackle these cities’ challenges with a systemic approach and include ecological indicators in our tool.

In addition, the tool's holistic view can enable residents to learn about urban NbS and explore their local environment and biodiversity, which can help promote a shift in values and foster environmental protection. This can generate a positive feedback loop to adapt NbS transformations towards sustainability.

Overall, at the core, this tool was created to promote communication between residents and municipalities to support the evaluation of urban planning and promote the integration of NbS. This tool-map is a simplified-visualize version of the processed data from residents' participation in the PPM survey, including indicators of the ecological conditions in those locations, supporting the need for accessible data for better strategic urban planning (Bennett and Lantz 2014). (Bennett and Lantz 2014). Municipalities can use this tool to analyze the resident's perceptions and the environmental conditions, focusing on the interconnectedness of the social and ecological systems in their specific local context to plan the integration of NbS for strategic sustainable development.

3.3.1. Steps of development of the tool

Through this process, we looked for a free, open-source platform as a prototype to integrate essential data that is needed in the city’s planning and represent both social and environmental aspects altogether while generating accessible information for all users.

Base map: There are several base maps that we researched such as Arc GIS, Atlist, Google earth, Google my map, etc. Looking for accessible, online, open-sources, easy to use, modifiable map we trialed those options and decided to use Google my map that is customizable, able to add layers, and free open source for prototyping the evaluation tool. Moreover, Google my map uses the similar location links from Google map that participants shared location/ address. This makes data be synced easier. However, we found two main gaps with this; adding reported places can be done only by permitting participants, and not open for all google users automatically. Additionally, the map does not represent visually well if a place was mentioned multiple time. As potential strength, Google base map, can be shifted into city’s urban planners GIS base map to combine with other existing data for practical municipality use.

PPM online survey: There are several online surveys service providers such as TypeForm, 1KA, Survey monkeys, Google form, etc. We decided to use Google form as it is free, adjustable, have a verity of question types, as participants ability to upload various images at once, it can be designed and it is widely used, making it more known and ease participants use. For enhancing participation, we integrated in the survey graphics for better instructions explanation and engage participations.

Environmental conditions:

- **Type of place:** there are different ways to categories land cover from macro (i.e., urban\ nature) to micro (park, residential area, industrial area, natural reserve, etc.). For our research we have chosen the macro approach, aiming on identifying type of place with characteristics that can support urban planners, emphasizing of integration of nature elements in cities.
- **Biodiversity indicator:** There are several biodiversity indicators as mentioned in the biodiversity section (2.3.2.), however, some data providers focus on general global view. We decided to use GBIF as online free, open source that collected data worldwide including Swedish mega data providers, that can supply data in the focus of specific local areas. Having data at micro-scale level will allow local authorities to see clearer pictures and act at their capacity level.

NbS locations: There are different databases for NbS mapping globally and specifically in Europe. We have chosen to use the Urban Nature Atlas (UNA) database, as a leading profiling tool for NbS projects in Europe. UNA mapped 11 NbS projects in Malmö.

Integration of the data onto one map: The previous steps created our map layers (Map legend figure 3.3);

- **Base map**- Google map, geographic base where users can select and see additional layers separately or altogether.
- **NbS projects**-
  - Collect the location of NbS projects that pinned on UNA database
  - Searched the location on the Google my map (Malmö)
  - Pinned location with selected code- 'tree' icon
  - Added description on the map about NbS intervention based on UNA data
- **PPM online survey**- residents reported locations that improve / hinder their quality of life and natural environment through photos, location, and description.
  - Pin location provided by survey participants (Google link/ address) on Google map;
    - The place that improves quality of life as ‘heart' icon
    - The place that hinder quality of life as ‘!’ icon
  - Added photos and description from participant’s report on the pinned location
- **Type of place**- categories by land cover for locations reported by PPM participants. Represented on map by color codes;
  - Scoped the area with a vector tool around each pinned location with a vector tool.
  - ‘Nature’ type use ‘green’ color code on the pinned icon
  - ‘Urban-nature' used ‘purple’ color code on the pinned icon
  - ‘Urban’ used ‘grey’ color on the pinned icon
- **Biodiversity**- GBIF occurrence data for locations reported by PPM participants.

- Scoped areas with a vector tool on Google map and then scoped at GBIF map at the same boundaries to check biodiversity occurrence in the area.
- Screen shot and saved data from GBIF
- Uploaded screen shots on Google map in specific boundaries
- Typed caption of the number and provided citation link for those who are interested in download occurrences / species data from GBIF
- Color coded based on occurrence number range (logarithm) to differentiate the amount of biodiversity of occurrence;
    - Red: 0-10
    - Orange: 10-100
    - Yellow: 100-1,000
    - Light Green: 1,000-10,000
    - Dark Green: over 10,000

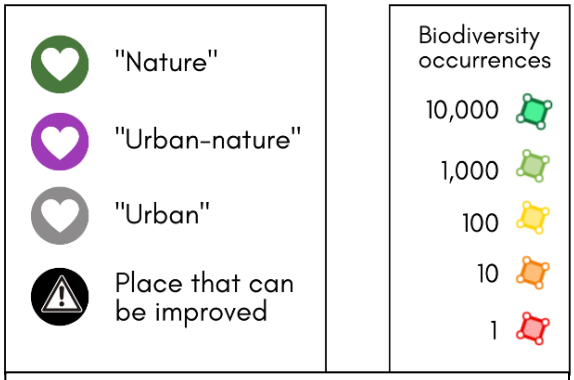


Figure 3.3; Map legend

To note, all processes have been done manually due to technical and time limitation. There are possibilities to develop data collection automatically or separate district map based on municipal current GIS map from city's plan.

3.4. Results- Tool testing, data collection

3.4.1. What do people value in their city's environment?

To test the tool's functioning, we mapped residents' perceptions of how urban places improve or hinder their quality of life. The participatory survey was collecting data during April 2022, through this time period we collected overall 35 responses, from those three participants who were out of our defined age scope. The in-scope collected data included 18 participants from Karlskrona and 14 participants from Malmö. Within those, we have received responses considering places that improve or hinder residents' quality of life and the natural environment, overall, we have collected 58 responses that represent locations, from the majority reported as places that improve residents' quality of life and the natural environment (48 responses) and few of places that hinder (10). The proportion of kind of place shared by participants in Karlskrona's and Malmö's is shown in figure 3.4. To see participant demographics, see appendix 7.8

From the responses, we identified core values that people shared in both cities; "Natural environment, Aesthetics, Activities, Accessibility, Facilities" Additional values unique to Karlskrona or Malmö included- Karlskrona: mood. Malmö: Safety. Detailed mapped values with examples of responders shared quotes and images in Figure 3.5. The value figure present main examples of varied of quates and photos that were included in the main theme identified. Each figure includes two sections "Positive value" that represents analyzed data from the crossed data from places that improve residents quality of life and recommendations how to improve places that hinder their quality of life. The "negative" section includes the same elements, but from answers about places that hinder their quality of life and issues residents have in places that usually

improve their quality of life (detailed analysis explained in table 2.1; structure of the analysis process for resident's value).

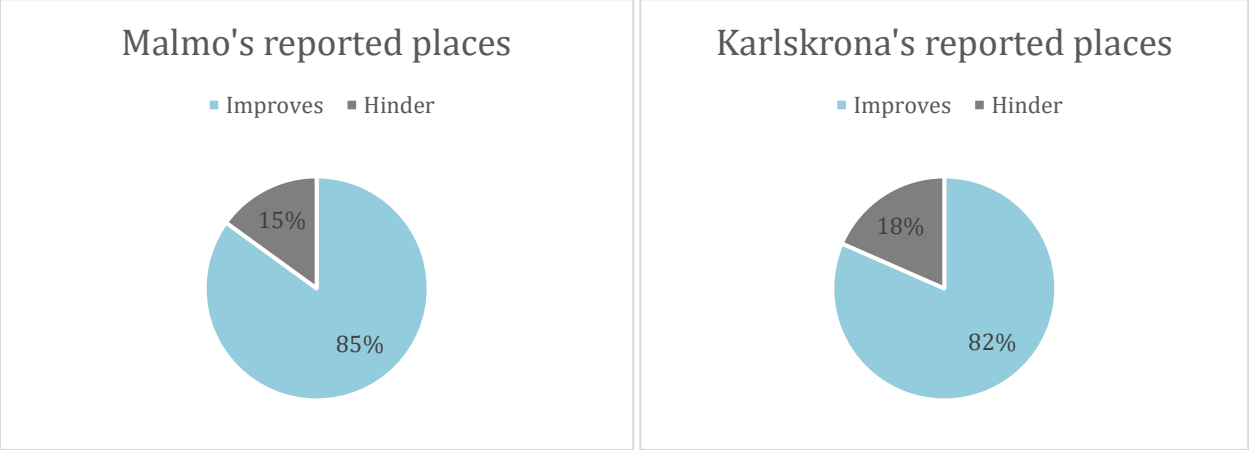


Figure 3.4; percentage of pparticipant's from each city to report of places that improve/hinder their quality of life and the natural environment

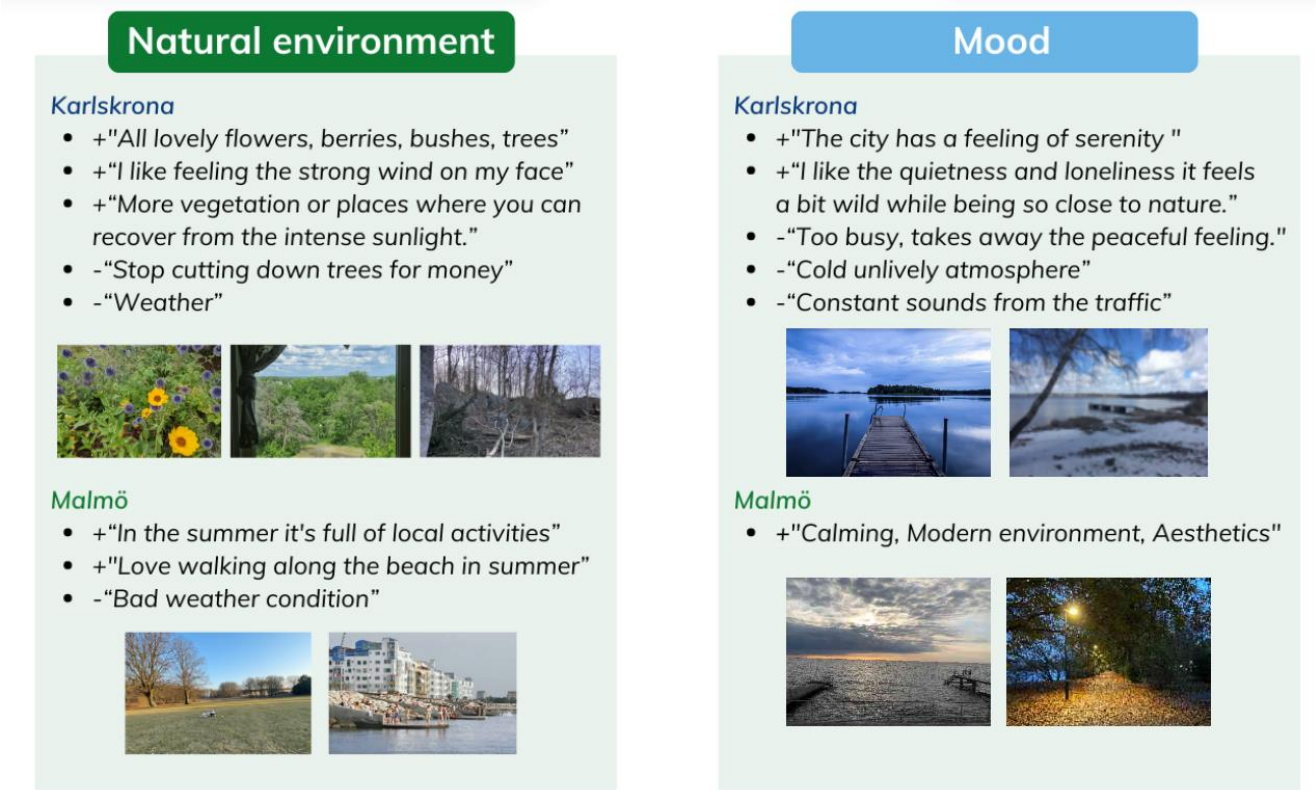


Figure 3.5; Analysed values in clusters; Natural environment, Mood, Aesthetics, Accessibility, Activity, Safety and Facilities

Aesthetic

Karlsrkona

- +"The park is a beautiful place"
- +"I like the symmetry of the three islands somehow, it's aesthetically pleasing"
- -"Lacking plants and feeling of nature"
- -"There is a lot of asphalt and stones, not clear what the space serves, cold unlively atmosphere"



Malmö

- +"Modern environment, calming, aesthetics"
- "Aesthetically pleasing"
- -"It somehow ends up being dirty"
- -"Sometimes the water's not clean with debris"
- -"Perhaps it interrupts the swans and ducks from enjoying the canal more than me. I am worried if they consume any of this trash could be harmful."



Accessibility

Karlskrona

- +"I like that it's easily accessed path"
- +"The centrality of the focal attraction"
- +"Locate them in more strategic location"
- -"Can be more accessible"
- -"I can't find information"
- -"Great distance you have to travel"
- -"Cyclists, pedestrians have been put aside, as if cars prioritized"
- -"Restrictive hours of operation"


Malmö

- "Public beach just 10 min from city center"
- +"Cool piece of engineering connecting Sweden to the rest of Europe"
- -"Segregated from Malmö"


Facilities

Karlsrkona

- +"Have a bench conveniently placed"
- "What is special.. the centrality of the focal attraction"
- "Provide seating possibilities"
- -"Isnt many places to sit"
- -"become too crowded"


Malmö

- +"Malmo has a lot of nature and parks and good education"
- "such a cool piece of engineering connecting Sweden to the rest of Europe"
- +"more initiatives centered around boating"
- -"To small space and too popular"


Figure 3.5; Analysed values in clusters; Natural environment, Mood, Aesthetics, Accessibility, Activity, Safety and Facilities

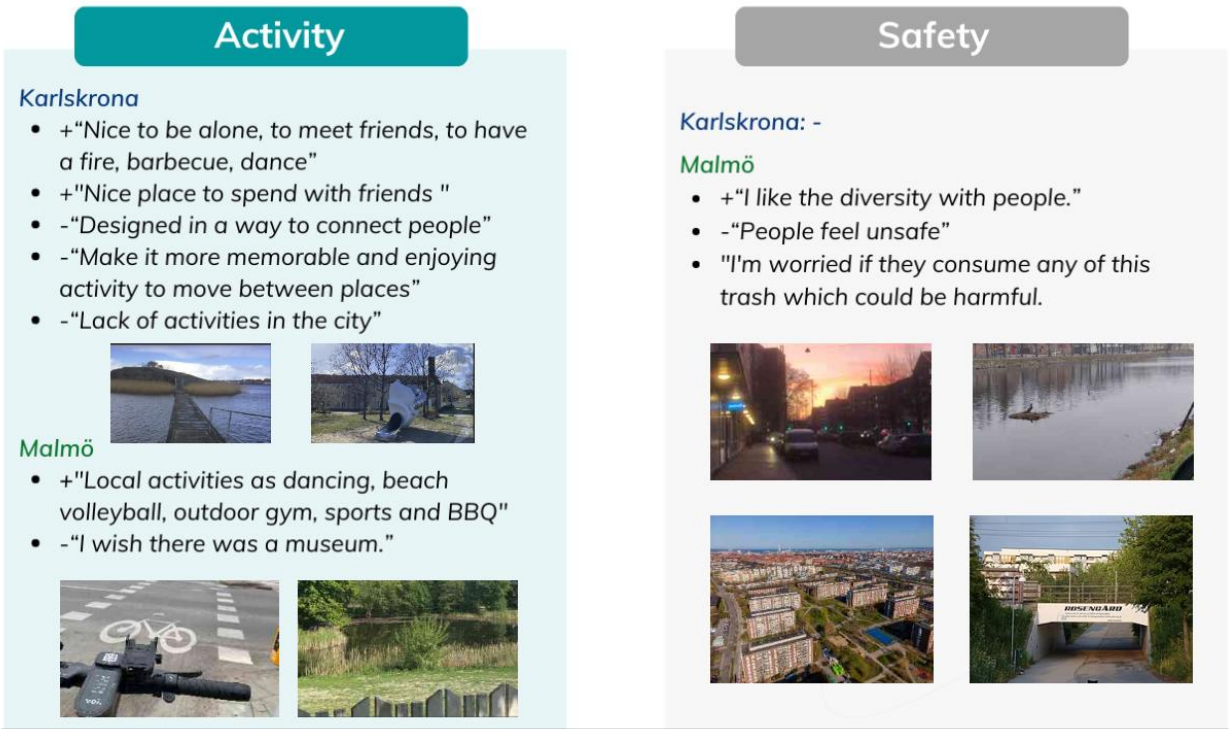


Figure 3.5; Analysed values in clusters; Natural environment, Mood, Aesthetics, Accessibility, Activity, Safety and Facilities

3.4.2. What are the environmental conditions of the places that people value

Categorized type of place

To test the tool's functioning, we analyzed the locations identified by respondents to define the type of place by land cover using the following categories; 'urban', 'urban-nature', and 'nature'. Each category based on the level of human infrastructure and natural areas and from low to high.

Identifying the relationship between the type of place and its potential to improve or hinder resident's quality of life. The majority of Karlskrona's participants reported 'nature' and 'urban-nature' as places that improve their quality of life and the environment (45%, 48%). In contrast, in Malmö, participants reported mostly 'urban-nature' (88%) In both cities, the places that typed as urban has the lowest rate in both cities (6-7%) (figure 3.6). For the places that hinder their quality of life; in Karlskrona, 'urban' areas were mostly mapped (43%), followed by 'nature' and 'urban-nature' (29%, 28%). While in Malmö only 'urban-nature' areas were reported (100%) (figure 3.7).

To test the tool's functioning, in another aspect, the following figures (3.6, 3.7) show gradient scales of geographical map of environmental conditions in both cities from 'urban' to 'nature' based on the green-blue-grey areas. The researchers observed and interpreted by surrounded condition. To note: The figure focuses on primary environmental conditions of the selected areas.

The shared or nearby pinned locations selected by participants are not presented repeatedly on the figure.

Figure 3.6; percentage of participants report as improving their quality of life and natural environment by types of place and city

Figure 3.7; percentage of participants report as hindering their quality of life and natural environment by types of place and city

In Karlskrona (figure 3.8), the environmental condition is dominated by 'nature' areas as for improving quality of life and environment. There are few human-made parks selected in Karlskrona. Participants found are residential areas integrated in nature and surrounded by trees with high density. Some 'urban' grey areas are selected and mentioned as hindering quality of life and environment **(red box)**. The **red box** also covers in all type of places; in 'urban' areas are grey zones in the city square and public space, in 'urban-nature' areas are recycling center and the road for commuting, and even in 'nature' areas, are reported some issues.

In Malmö (figure 3.9), from the top view we can see most environmental conditions in the selected areas are 'urban-nature'. Pure 'nature' condition (top right) is also selected, but as a minor. For the places in **red boxes**, hindering quality of life and environment, are also 'urban-nature' that have trees along the streets and canal. If we observed the selected parks, there are designed differently in tree density. NbS areas **(blue boxes),** are the pilot NbS projects collected data from Urban Nature Atlas. It is clearly seen that NbS integrated in the 'urban' areas have grey buildings and street. This is because to reduce land degradation and in the industrialized zone. The green roofs and trees along the street, are also seen all over the NbS selected places.

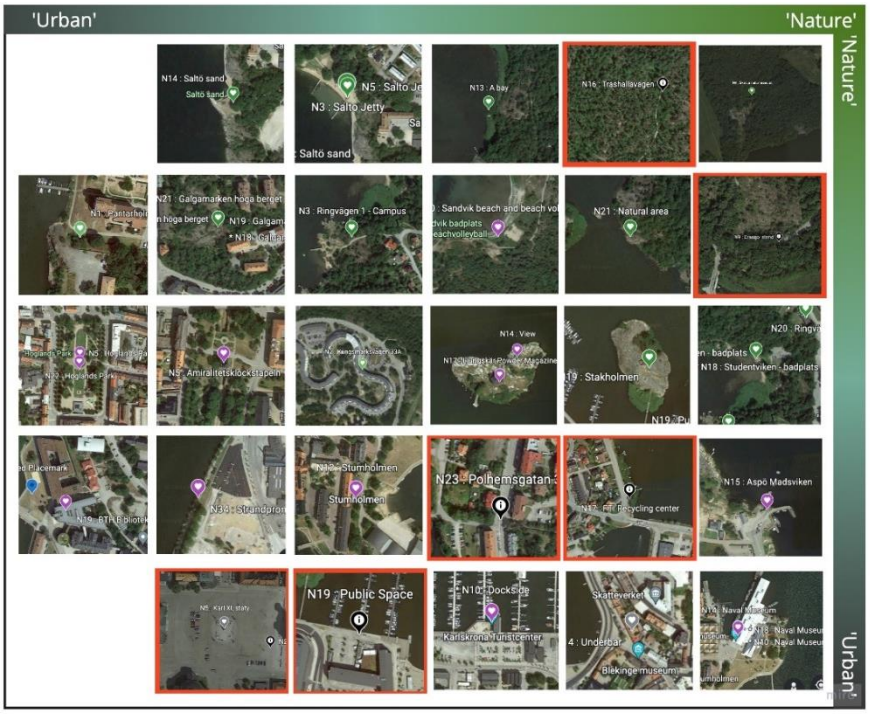


Figure 3.8; Karlskrona, gradient scales of geographical map of environmental conditions in both cities from 'urban' to 'nature'

To summarize, in Malmö, there are more 'urban-nature' space selected than natural areas. The city tries to integrate nature into the city especially 'urban area' by NbS. On the other hand, in

Figure 3.9; Malmö, gradient scales of geographical map of environmental conditions in both cities from 'urban' to 'nature'

Karlskrona, there are tree cover density surrounded by the sea. The residential areas as improving quality of life are integrated in nature. However, in Karlskrona, especially in 'urban' area, there has no NbS intervention yet or reported by UNA.

NbS environmental condition and value

The following figures (3.10,3.11,3.12) are NbS areas in Malmö that 'improve quality of life and natural environment' selected by participants. There are 3 main NbS projects that are mentioned; Västra Hamnen (Western Harbour), Biodiversity, and Hyllie climate smart district.

NbS1: The Västra Hamnen, Malmö (figure 3.10)

- **The environmental condition:** 'urban-nature'
- There are several green areas and green roofs integrated in the city's district together with water irrigation system. The location is nearby the coastal sea.
- **Value:** environmentally friendly, while concern about crowded people.

NbS2: "Biodiversity" project (figure 3.11)

- **The environmental condition:** 'urban'
- There are few trees planted along the streets and green roof on top of Malmö University.

Nature-Based solutions selected areas from participants
in Malmö based on Urban Nature Atlas (NATURVATION project)

Photos+description	NbS location	NbS intervention
		**The western Harbor (Vastra Hamnen)** The first pilot project of NbS in Malmö started in 2001. The NbS interventions were built for solving stormwater issue in industrial areas. NbS types categorized by UNA: • Nature on buildings • Green roofs • Grey infrastructure featuring greens • Alley and street greens • Parks and urban forests • Pocket parks/neighbourhood green spaces • Blue infrastructure • Rivers/streams/canals/estuaries • https://una.city/nbs/malmo/western-harbour
"Environmentally friendly and important meeting point for a lot of people in the summer." "A lot of people in Västra Hamnen in the summer. To small space and too popular."	**Scania platsen**	
		
"A lot of people come here in the summer to swim and jump in the water. There's a popular beach nearby. It's nice to take a walk along the coast.There are shops to visit along the way. Sometimes it can get too crowded"	**Bo01 Vastra Hamnen** This area is called "Västra Hamnen" The tall building is Turning Torso. Its located on the west coast of Malmö	

Figure 3.10; NbS1: The Västra Hamnen

- The areas with few greeneries tended to face the urban challenges of biodiversity fragmentation.
- **Value:** environmentally friendly transportation, but also concern about weather condition.

NbS3: Hyllie: Climate smart district (figure 3.12)
- **The environmental condition:** 'urban-nature'
- There are natural green areas integrated in the buildings; green roofs.
- **Value:** renewable energy, solar panel, and infrastructure with modern environment.

Note, there are possibilities that some photos the participants downloaded from the internet.

Environmental conditions in reported places

For each location reported by respondents we extracted biodiversity data from the GBIF database. From the results we can see two trends; 'nature' and 'urban-nature' have overall higher biodiversity occurrences, but several 'urban' locations also indicated high biodiversity rates. (figure 3.13 and 3.14) In both cities, places that were reported as 'improving' quality of life, are associated with higher biodiversity occurrences data (figure 3.13 and 3.14).

Both figure 3.13 and figure 3.14 place locations reported by survey participants, using their survey's photos to show the relation between type of place (gradient from urban to nature) to the biodiversity occurrences associated with that place. The figures separated by mapping locations reported by participants as improving their quality of life and the natural environment (heart icon on the left side of the figure) and places that hinder their quality of life and the natural environment (exclamation mark on the right side of the figure) The type of place and biodiversity occupancies was analyzed as mentioned in section 6.3.1 (table 2.3 and table 2.4 respectively)

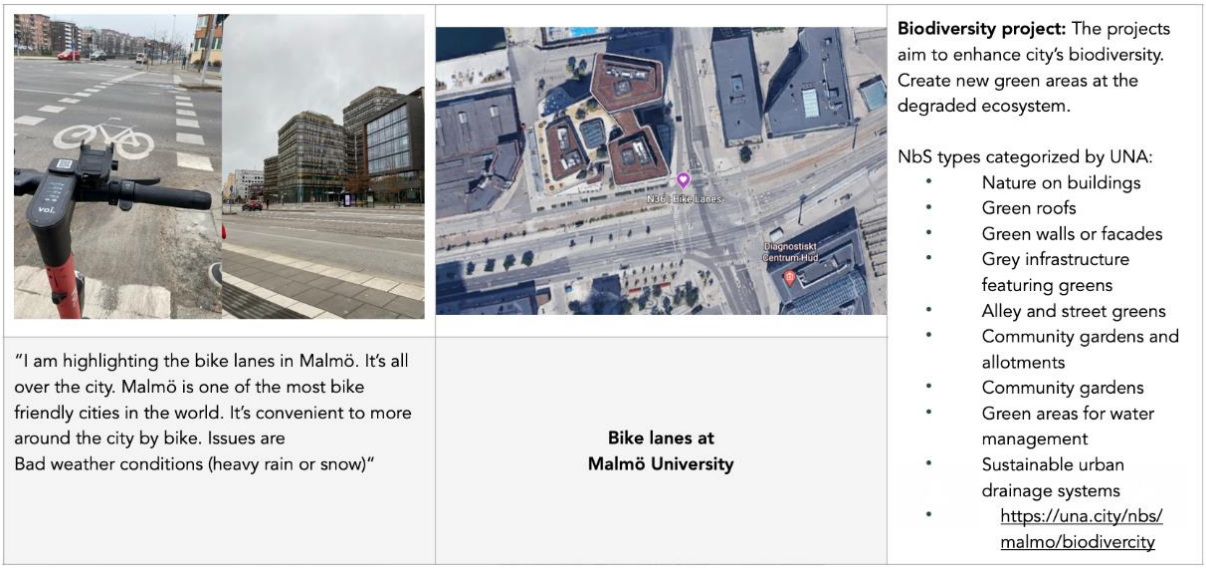


Figure 3.11; NbS2: "Biodiversity" project

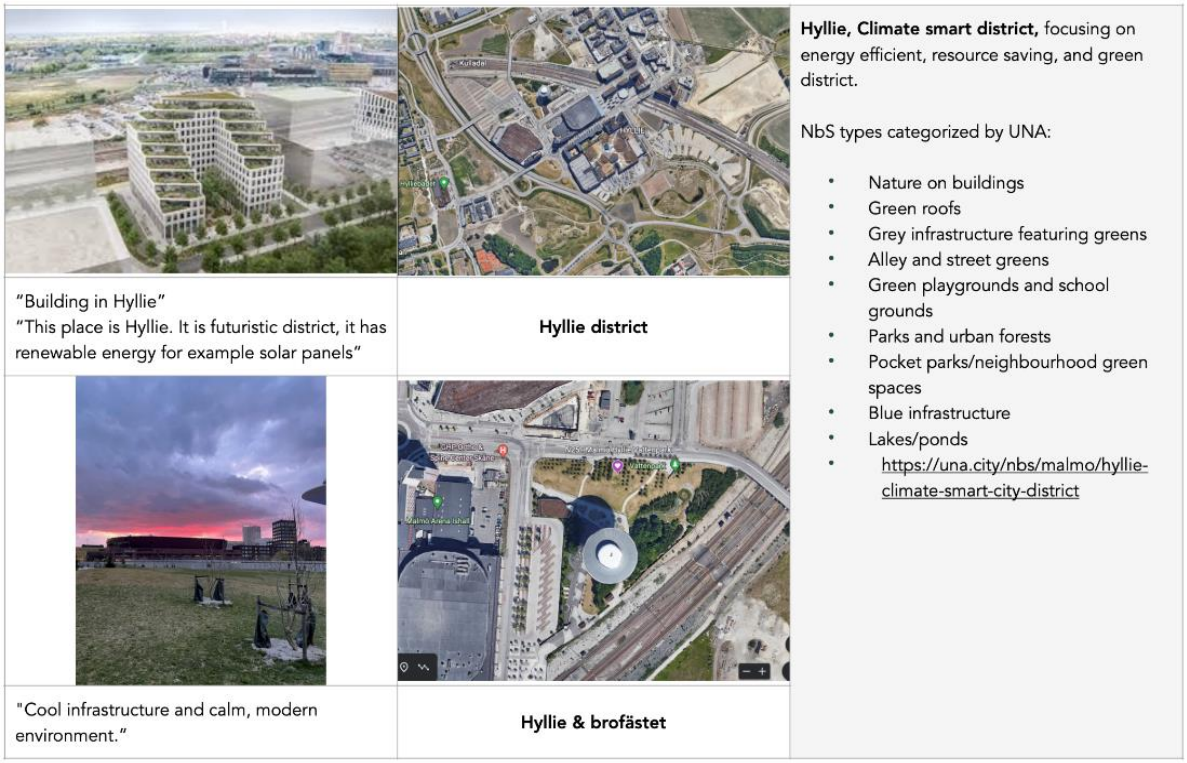


Figure 3.12; NbS3: Hyllie: Climate smart district

From figure 3.13 we can identify few main trends in the relation between type of place and the biodiversity conditions at that place, while considering if it percived as improving or hindering self well-being by the responders in Karlskrona. First, it in places that were reported as hindering quality of life, there is a lower limit of biodivarsity occurancies than in places that percived as improving quality of life. In addition, there is a clear theme from the photos of lack of natural elements or inturreptions to natural areas that assosiated with negetive perception to human well-being and lower biodiversity rates.

From the places that were reported as improving quality of life we can identify a bigger range of biodiversity range, incresing as the natural elements increase in the area, as seen the type of place gradiante. In addition, it is clear to see many more natural elements in the photos in this part of the figure in compere to the right side (places that were reported as hindering quality of life).

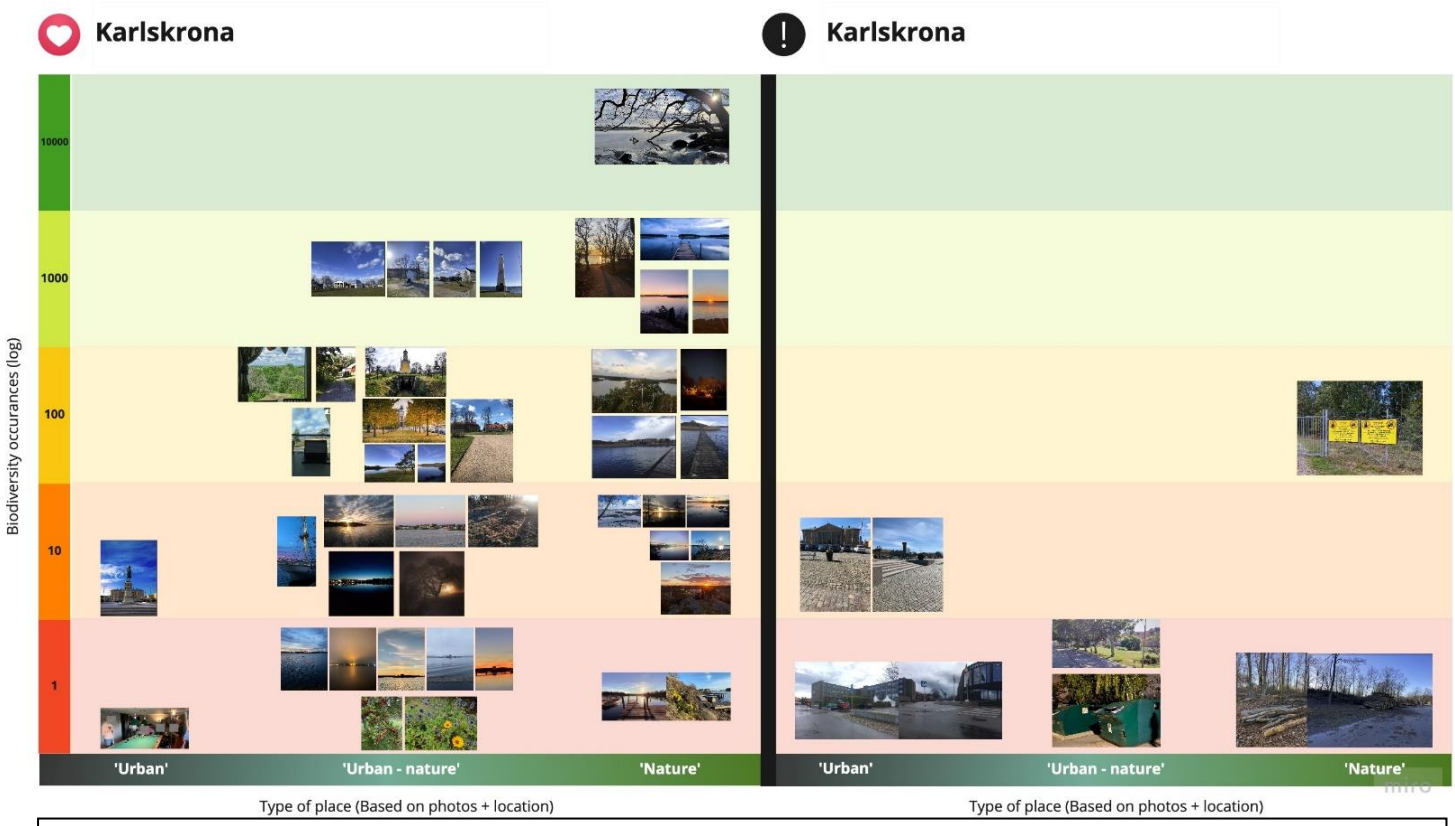


Figure 3.13; Karlskrona's gradient type of place and biodiversity occupancies (range), presented by PPM participants photos.

Additional important clarification from this mapping is of the limitation of the GBIF biodiversity occurancies, seen places with similar features showing different biodiversity ranks can be based on many other reasons than actualy having different environmantal conditions and influence on the ecosystem (limitations of GBIF mentioned, section 6.3.1, under biodiversity indicator)

From figure 3.14 we can identify few main trends in the relation between type of place and the biodiversity conditions at that place, while considering if it perceived as improving or hindering self-well-being by the responders in Malmö. The main point presented in this figure is the locations that were identified as NbS we can see range of type but still include within "urban-nature" type. Those places are associated as places that improve quality of life and nature environment and with relative medium-high levels of biodiversity. In addition, in Malmö, places that are perceived participants as hindering their quality of life are also associated with relative medium high levels of biodiversity, with no recorded of low biodiversity rate.

For overall biodiversity average between the city's considering places that improve/ hinder quality of life and nature environment, see appendix 7.9

Integrating data into the tool

Completing the analysis of survey responds we have integrated the data into “My Maps” app (Google map), the reported locations were added with participants number, name of place, the reported photos and a chosen quote from the report explaining what is appreciated in the place or what is the problem in the place). In addition, the biodiversity occurrences data was added, and represented for each reported location by survey participants. The last layer added was of NbS projects in Malmö, according to UNA 11 mapped projects. For examples from the map and instructions how to use, see appendix 7.10, link to the detailed map.

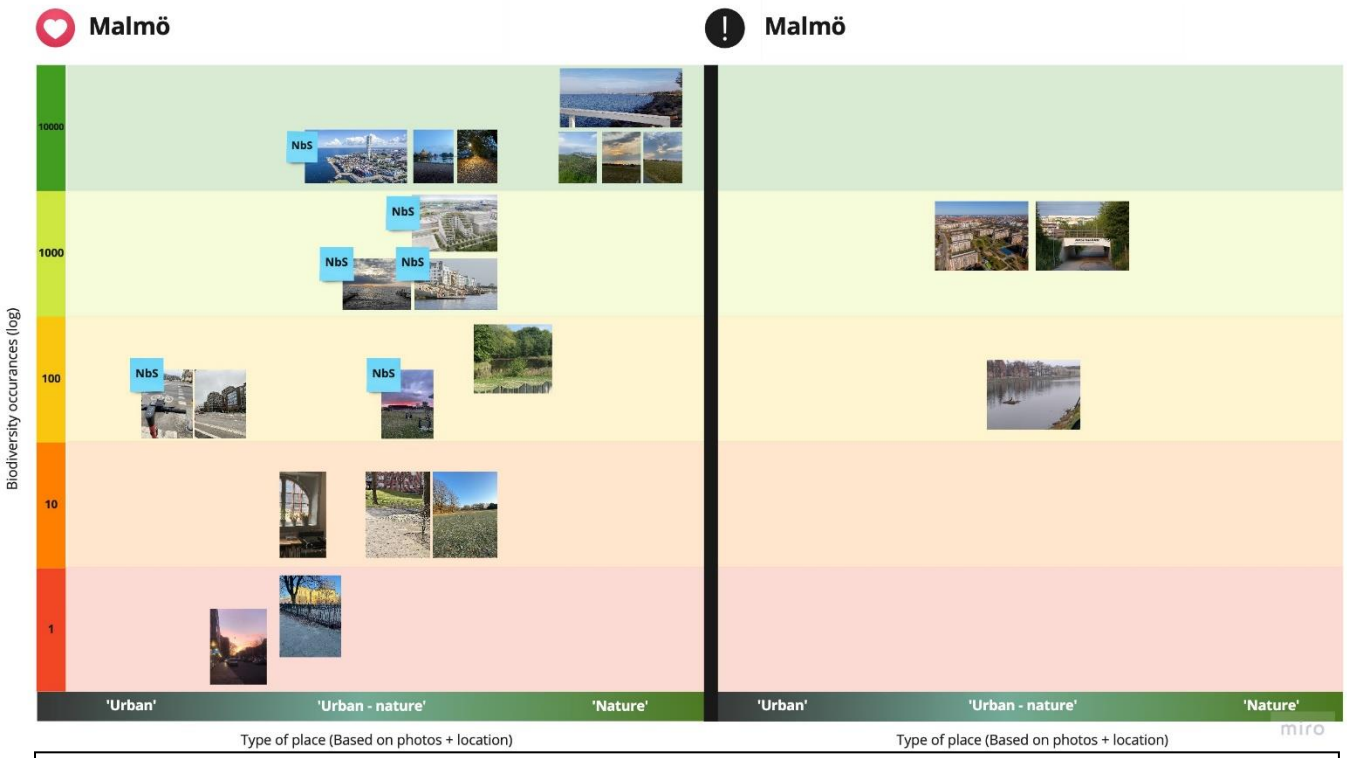


Figure 3.14; Malmö’s gradient type of place and biodiversity occupancies (range), presented by PPM participants photos.

3.5. Results- Tool evaluation and validation

Feedback for validation was asked from research participants about the prototyped tool. Currently, we have received feedback from one municipality worker from Karlskrona and one survey participant. Both confirmed the mapped locations and saw the importance of the value and biodiversity layer, saying that if this tool was online, they would use, add places, and share with friends. Asking for their impression of the tool the resident replied, “Interesting! Gives me inspiration for beautiful places to go to and raises awareness on where change is needed. Increases my understanding of the place and new perspectives to the city”. The municipality worker said: “Would be very interesting if the Municipality could continue to develop this project”.

After completing the first round of research we (the researchers) reflected upon the tool and believe that the tool has potential, but it needs further technical development. Nevertheless, in its current

form, it can be used to raise awareness about biodiversity and the social-ecological systems relation. For better engage participants, we believe it should be more fun and creative by gamification. In addition, we mapped limitations with the tool current version as mentioned below.

Limitations of the tool:

- Content limitations:
  - The map does not include all the data collected through the PPM survey, this both for focusing on the main messages of the reported place and both to not overload the map with data and keep it simple and interactive.
  - Validation of biodiversity data- the data presented can be misleading considering the limitations of the data and the over simplified representation of it in the map. If the map will be in use, we will discourage planners from considering this data as guidelines, until further improvement of the data base used in the map/ substitute for another ecological indicator. But the biodiversity occurrences can raise awareness, to create conversation about the relation of biodiversity to human quality of life and the importance of it in cities.
- Technical limitations:
  - Currently the tool does not allow comments and adding places, our process was done manually transferring from online survey to the map. Ideally reports will be added directly to the map.
  - There is no visual representation on the map of places that were mentioned multiple times. Now they represented with multiple pins, mentioned in the list of places.

3.6. Overview discussion

We discuss in depth the meanings we derived from our results, and the potential of the tool and further research based on the lens of the 5 principles for Urban NbS.

3.6.1. Systemic understanding

We developed our research and tool based on Kabisch, Frantzeskaki, and Hansen's 5 principles for urban NbS, describing cities as complex systems, where there is a need to address the "Spatial conflicts with urban system nestedness" (Kabisch, Frantzeskaki, and Hansen 2022). Our tool allows a better mapping and understanding of the interconnected social and ecological systems within urban areas. Using systems thinking approach enables open space for collaboration across sectors to help overcome siloed thinking in the city's planning and gain a holistic view to tackle sustainability challenges together with citizens. Considering the dynamic nature of a complex system, our tool adjusts to that need, collecting a continuous flow of updating data.

In our research, we address directly and indirectly a variety of leverage points to generate change in the existing unsustainable system, following four "*realms of leverage*" from Abson et al. (2017). We believe that the main leverage point in our research is in the system design, e.g., making information widely accessible through our communication and evaluation tool and strengthening the possibility of usually unheard residents to influence urban NbS solutions. In addition, we hope

that the developed tool will eventually support a shift in human values and act as an intent leverage point, changing the system's intent to choosing more strategic actions towards sustainability (Abson et al. 2017; Fischer and Riechers 2019).

Our findings implies that there is a need for strategical biodiversity assessments from scientists, citizens, or municipalities. This to allow better understanding of the ecosystem conditions. This can enable research of the interconnection between the social and ecological systems, tithing the connection between the two systems can promote system thinking and the needed shift in urban planning. Moving towards strategic sustainable development by utilizing the cities potential as efficient, multi beneficial "human habitats" to avoid hitting the funnel walls (Robèrt et al. 2019). We believe this can be done by greater participation in urban planning and integration of NbS projects in cities.

Mapping the cities challenges in evaluation and participation, we see that the application of PPM approach can help city planners to gather context specific information relevant to their specific city and appropriately integrate NbS according to the visioned future.

3.6.2. Benefiting people and biodiversity

Participants have shown 'nature' as a shared theme for improving both perceived well-being. As mentioned in literature this connection can strengthen its nature perceived value, promoting environmental awareness and even action. (Hinds and Sparks 2011; Whitburn, Linklater, and Abrahamse 2020; Martin et al. 2020) Those nature places that reported high quality of life potentially also have high biodiversity, according to GBIF occurrences data we found. This strengthened the importance of having biodiverse and urban-nature in the city can provide multi benefits as mentioned in literature, "Urban greening, including the creation of urban parks, green roofs and urban gardens, reduces urban heat island effects, enhances urban biodiversity and improves quality of life including physical and mental well-being." The higher biodiverse in ecosystem help reduce risk in the uncertain changes and keep adaptation options open. (IPBES 2019) for combating unexpected unsustainable challenges.

The tool also allows the city planners to realize resident's (and in our proof of concept, young residents') perceptions while understanding environmental conditions in the valued locations to balance the benefits. This supports urban planners to become more strategic planning based on current reality, identifying the need for multi beneficial solutions as NbS, and solving the solutions at the right spot. For example, the place that has low environmental condition but has high value may be prioritized for environmental protection. Starting with the local areas, can generate action easier than seeing the large scale that is overreached. As a result, this can increase accessibility to common spaces for nature and human, creating human connections and ecosystems networks, to improve social and ecological well-being. By this raising to the cities potential to lead humankind towards strategic sustainable development (Standish, Hobbs, and Miller 2013; Van den Berg, Hartig, and Staats 2007; Wu 2010).

However, for the biodiversity assessment there is still a gap of high quality and reliable data. The data in hand now, demonstrates the need of further research to consider and promote biodiversity and ecosystems in urban planning. This knowing that "the lack of biodiversity data may result in

weaker protection and poorer quality of mitigation than could otherwise be achieved." (Underwood, Taylor, and Tucker 2018, 16).

What do people value in urban NbS and their city's environment?

From participants' photos and written answers, we identified different elements and features that people value in the urban environment those related to, social and individual activities, mental state, accessibility, facilities, and aesthetics (figure 3.5). It is vastly perceived by participants that areas including natural elements improve quality of life and natural environment, supporting the literature claim of city's "regreening' mutual benefits (Kolokotsa et al. 2020; Standish, Hobbs, and Miller 2013). This relates to the literature narrative, including Wilson's Biophilia hypothesis that argue; "humans possess an innate need to affiliate with other living things", and the benefits of nature for human health and well-being. This understanding can support urban planners in creating a city that supports the improvement of resident's quality of life. Specific elements to consider in space design according to the reported places are mapped in appendix 7.11.

In both cities, the participant's values are similar (as seen in figure 3.5), but there are a few different elements and features highly mentioned in each city. In Malmö, there was additional focus on picnics, activities during summer and in the sun, and on the urban setting as modern and futuristic. In Karlskrona, there was added focus on individual activities, on the quietness, wildness, and inspiration that natural elements offer (e.g., Sunsets, rocks, plants, and animals), and on historical and cultural elements. We can relate those differences to the city's settings, Karlskrona being more integrated into nature and the city center includes a lot of historical elements. In comparison, Malmö as a rapid growth metropolis is more attentive to the development and integration nature of an urban environment. This supports the literature explaining that social and environmental elements affect well-being, it is highly context related (Díaz et al. 2006; "Measurement of and Target-Setting for Well-Being: An Initiative by the WHO Regional Office for Europe" n.d.)

The value mentioned for safety's theme in Malmö, although the areas surrounded by urban-nature, natural surrounding is not the main issue but the social issue. This link back to the different elements that influence well-being (Díaz et al. 2006, 2) and the challenges of urban areas in value plurality (Kabisch, Frantzeskaki, and Hansen 2022). Some people have access to good environmental conditions, but some are living in threatened areas. To avoid unexpected negative outcomes, allowing participation for social and environmental rights, especially for urban public spaces strengthen the systemic planning for urban NbS.

Focusing our review to NbS locations we cannot identify a clear difference between the values mapped from the other locations. But in the NbS selected locations, all places are mentioned as improved quality of life. Moreover, participants who selected the areas tend to have value for the environment such as "environmentally friendly" places and sustainable transportation (e.g., bike), renewable energy and solar panel, modern environment, etc. They also have concerns about overcrowding issues in the areas, and heavy rain or snow during severe weather conditions.

From the survey results and through our analysis process, we can see that the tool can allow users and municipalities to map and understand the human perceptual value of their urban environment, considering the notion that it is of high importance to "increase our understanding of how people perceive and value landscapes" (Standish, Hobbs, and Miller 2013, 1). This additionally aids the

Swedish approach and aligns with the third principle of the 5 urban NbS "Contribute to inclusive solutions for the long-term" (Kabisch, Frantzeskaki, and Hansen 2022) emphasizing the importance of residents' participation in urban planning (supporting research question). The tool allows residents to participate and have their voices heard and their needs better understood. This can support practitioners in considering the resident's experience of the city to plan contextually to their resident's needs improving urban planning, strengthening social sustainability, and creating multi-beneficial cities.

What are the environmental conditions of the places that people value

Aiming to generate a view of the city, supporting the need in a holistic, multi-beneficial assessment for NbS and urban planning (Raymond et al. 2017; Pascual et al. 2017; Colaninno, Neonato, and Tomasinelli 2021) and while considering NbS definition as "simultaneously providing human well-being and biodiversity benefits"(Cohen-Shacham et al. 2016, 5) we focused on a mapping tool including both human perceived quality of life indicator, and a biodiversity indicator. As biodiversity rates can indicate the ecosystems overall wellbeing.

Reviewing the biodiversity occurrences data collected from GBIF, we understood we cannot address it as valid data to make concrete conclusions considering biodiversity or ecological conditions. Mapping and understanding the different limitations of the database, specifically within our scope and method of data extraction. Even though we can see clear trends in related the (figures 3.13, 3.14), cconsidering the GBIF data might have led us to challenges and misinformed conclusions. For example, a reported natural area "Ljungskär", an island in the middle of Karlskrona, which function as the center of Karlskrona's Expo25, has a biodiversity occurrence rate of 1 according to GBIF database. This result has low possibility of being accurate, knowing that it is a natural area, with almost no human activity.

Focusing on NbS locations that were mapped by residents, we see from the geographical map that most NbS sites are in the 'urban' and 'urban-nature' areas. The NbS projects aim to be implemented at locations where there is land degradation or grey zone to revive the area from ecological loss and biodiversity fragmented. NbS that has low nature density are still selected as improving quality of life because participant value the accessibility (bike lane) that can be complemented by trees on streets project. Our results from analyzing NbS value and environmental conditions supports the notion that NbS are multi beneficial, both for nature and people (European Commission 2015; Pörtner, Hans-Otto et al. 2021).

This research has mapped the gap in biodiversity data and the municipalities need for biodiversity assessment. Considering the city's sustainability vision Karlskrona's environmental strategist mentioned that "There is a limitation and difficulty in funding local biodiversity projects because it is hard to see the benefits in the long term." In Malmö, the city's environmental program focusses on the value of biodiversity and urge integration of biodiversity consideration into the planning and development process. "Biodiversity is something we need to be better at" said Simon Chrisander from Malmö municipality.

We have identified a potential indictor to connect ecological and social considerations. Through the resident's perception, in the survey we have asked them to report of places that improve/ hinder quality of life and the natural environment. Analyzing the result of reported improving places, those vastly include natural elements. On the other side, grey/ urban areas were mostly mapped as

hindering quality of life. Those results are tilted by the framing of our question, but also represent the human perception of places that support both their quality of life and the natural environment, from that we can identify what places perceived as improving ecological aspects, while improving human conditions. By defining NbS as multi-beneficial approach, trying to support both ecological and social needs, our results can amplify that people will appreciate NbS.

"Every local initiative matters, since the benefits of many small, local biodiversity measures accumulate at the global level" (Pörtner, Hans-Otto et al. 2021, 20). The collected data shows contributions from people to conserve knowledge about biodiversity existence. The places that have fewer biodiversity reports / no data imply opportunities to raise more awareness for environmental protection. Engaging citizen scientists and the community at the local level can help plan for potential NbS intervention. For further development, the map could point out municipality biodiversity strategies, actions and local environmental communities to create awareness and connect citizens to act for biodiversity together.

The biodiversity data did not support our aim to map the environmental conditions of the places reported by residents, creating a gap in fully evaluate the NbS projects. Our conclusions from literature review and municipality interviews implies that there is a need for strategical biodiversity assessments from scientists, citizens, or municipalities (Underwood, Taylor, and Tucker 2018). This to create a valid database to be useful as a tool to assess ecosystems well-being and support strategic sustainable development in city planning. We have other way showed a weak connection between human perception to environmental conditions, assuming that nature and natural elements, that perceived as positive elements for human and nature in the city, are essentially supporting ecosystems, we can partly show a relation between positive human perception and environmental influence, supporting the notion for multi beneficial cities, that can be supported by NbS integration.

3.6.3. Inclusive solutions for the long term

"The main actors in urban planning are city inhabitants, but unfortunately, they are not usually included in urban development planning until the end of the process" (González-Méndez et al. 2021, 9). The tool is an online, open source, interactive platform that is accessible to the vast majority of people (e.g., excluding people with no internet connection). The tool allows residents to freely express ideas and thoughts about how they perceive the city and what can be improved. This increase inclusivity and strengthens social sustainability by giving residents the power to have influence in the system they are a part of, improving their sense of well-being (Díaz et al. 2006, 2). In considering our research question, using this tool can enhance participation in NbS and urban planning, both by increasing variety of participants and the amount.

Understanding the reality of participatory processes today in Sweden and the specific cities challenges (discussed in depts in section 3.3), we see the possibility of our tool to bridge the gap between the policymakers and citizens knowing that participatory research approach has the "potential for bridging gaps between research and practice, addressing social and environmental justice" (Cargo and Mercer 2008, 325). We found the potential of our tool to enhance residents' participation in NbS and urban planning. Nevertheless, the tool should be an additional participation platform and should be supported by other platforms appropriate for different

resident's needs (i.e., residents who experience technical challenges). In addition, creating the tool to support participation is the first step, through our testing we still experience difficulties in collecting data and encouraging residents to participate. There is a need to further research if the tool increase participation, understand the participants experience, see if the tool is adopted by practitioners and decision makers, etc. there is also adaptation needed in considering the tool context of implementation (i.e., language). Specific areas of research we found interesting are the need for incentives for increasing participation, mostly among youths. And the ability of such a tool to shift participation to civic engagement.

3.6.4. Context conditions

The urban NbS challenge of "Path-dependencies with cultural and planning legacies" (Kabisch, Frantzeskaki, and Hansen 2022, 1)- each city is unique in its environmental conditions and historical-cultural values so considering local insights can assist in planning for appropriate integration of NbS in cities (European Commission 2015; Seddon et al. 2020; Lafortezza et al. 2018). The tool helps to map and understand what is meaningful and valuable for residents in their city, considering that human well-being is also context-related, this is of high importance (Díaz et al. 2006; "Measurement of and Target-Setting for Well-Being: An Initiative by the WHO Regional Office for Europe" n.d.). For example, in Malmö, participants highlight picnics, activities in the sun, and the urban setting as modern and futuristic. In Karlskrona, participants focused on individual activities, the quietness and wilderness of nature, and historical elements. Considering the "enhance residents' participation" part of our research question this feeling of meaning can increase residents' participation, wishing to protect their valued places, or even create other meaningful places. This relates to the different city settings and supports decision-makers with information on how they can enhance NbS design that fits in the specific context.

Identifying the relationship between the type of place and its potential to improve or hinder resident's quality of life. The majority of Karlskrona's participants reported 'nature' and 'urban-nature' as places that improve their quality of life and the environment (45%, 48%). By contrast, in Malmö, participants reported mostly 'urban-nature' (88%). For the places that hinder their quality of life; in Karlskrona, 'urban' areas were mostly mapped (43%), followed by 'nature' and 'urban-nature' (29%, 28%). While in Malmö only 'urban-nature' areas were reported (100%) (figure 3.6, 3.7).

In Malmö, majority of participant's responds both for a places that improve or hinder their quality of life are typed as "urban-nature" this can be explained by the urban setting of Malmö (figure 1.4), as described by Simon Chrisander, the city's deputy mayor; Malmö having many more built areas than nature but historically "Malmö used to be known for the city with a lot of parks" even though today he adds "reality now, 36/37 from municipalities in green areas for the population size" one of the city's goals is to incorporate more nature in the urban area. This together with the NbS projects in the city (by definition those are urban-nature) can explain the high rate of urban-nature areas reported. In addition, Malmö has a strong vision and clear statement for sustainable urban development goals (see section 5.5.1. study cases, Malmö). The city implements NbS approach to address diverse needs, such as dealing with storm water and availability of land, main challenges mentioned for urban planners (according to Simon Chrisander). This pushes urban

planners to adapt to current land use, thinking about efficiency, multi-beneficial and increasing resilience (e.g., green roofs).

Karlskrona as a city located in a natural environment shows a bigger range of responses including natural areas (Figure 1.4). Being part of the Swedish eco-municipalities and UNESCO biosphere reserves, most responses from participants are positive aspects related to natural areas and human-nature infrastructure zones. The city is determined to create conditions for population growth and a more sustainable municipality. The Comprehensive plan 2050 proposal focuses on creating new neighborhoods ("Utställningshandling För Översiktsplan 2050" 2022). The main challenge for sustainable development in Karlskrona – is that most land is privately owned. Therefore, the municipality may not be able to directly force new changes for their purpose. Therefore, within the new neighborhoods and within the built areas in Karlskrona there is also the need to plan efficient and multi-beneficial urban spaces. Avoiding urban sprawl, this is an opportunity to implement NbS for the new development areas (UN Habitat 2018)

Through the tool, municipalities could gain insights based on resident's values while considering environmental lens analysis, this can allow contextual mapping and planning. The potential and concept of this tool can be scaled up limitlessly. Though different adjustments will be needed to suit different contexts (i.e., language, ecological indicator, NbS database). The concept can be taken in concern by any municipality – regional – national - global level to be used by locals to influence their surroundings, allowing development of locally appropriate urban NbS.

3.6.5. Communication and learning

The tool, at the core, is a communication tool to support the evaluation of urban planning and promote integration of NbS. It creates conversation between decision makers and residents and between residents- residents. Municipalities can learn from residents' insights as the main stakeholders of the city and about the environmental aspects to work towards strategic sustainable development.

Through our literature review, we understood the importance and gap of NbS evaluation (Seddon et al. 2020; Ahn et al. 2015; Raymond et al. 2017; Pascual et al. 2017; Colaninno, Neonato, and Tomasinelli 2021; Pörtner, Hans-Otto et al. 2021) and the resident's participation in urban planning (Raymond et al. 2017; Li and Nassauer 2021; Mok et al. 2021; Wang et al. 2019; González-Méndez et al. 2021; Kabisch, Frantzeskaki, and Hansen 2022). Our concept of the tool, based on participatory research method can support the evaluation of the urban setting and NbS projects, giving both residents and municipalities the share holds of the information, being able to choose how to act upon it. Municipalities can replan to remove the obstacles and increase enablers for improving residents' well-being. in addition, it has the potentially to increase civic engagement and transition toward strategic sustainable development.

The accessibility to the communication tool can further clarify the answer to the NbS and urban setting evaluation. It can create relationships between residents, based on their reports and values. This can strengthen communities and support residents meaning making. Potentially increasing capacity of communities to influence their environment (Teixeira and Gardner 2017; Burke, Greene, and McKenna 2017; Smith et al. 2015; Sprague Martinez et al. 2018). Additionally,

considering the ecological aspect of NbS and our research, we wish to generate a holistic conversation about development and use biodiversity data to raise awareness within residents, practitioners, and decision makers, of biodiversity conditions and its relevance to human quality of life and urban planning. Assuming that better understanding of the biodiversity and ecosystem conditions and relation to the social system, can enhance action for nature integration in cities, using NbS as leading approach for multi beneficial planning.

Potentially, the tool will shift the usual participatory process between residents and municipalities to continues conversation from residents' perception toward their city experience. This can hypothetically strengthen social sustainability through civic engagement and support practitioners and decision makers in making informed decision. The participatory process can raise public awareness of the city's urban environment and specifically ecosystem indicators as biodiversity. Furthermore, use of the tool might promote learning for future development, generate guidelines for NbS planning, locally and globally for strategic sustainable development.

This research addresses NbS for cities transitioning towards sustainability, by creating a participatory evaluation through a social and environmental lens (research title). Considering the complex system cities are, we have discussed based on the 5 principles for urban NbS how our tool acts as an intervention for system design - a leverage point in shifting towards strategic sustainable development. Focusing on information accessibility and participation, implementing of this tool can become a leading element to generate a continues conversation between residents and municipalities about human and ecological well-being. Learning and raising awareness as a first step towards value shift and adaptation of NbS approach to build efficient, multi beneficial sustainable cities.

3.6.6. Further research & development

After completing the first round of research the researchers reflected upon the tool and believe it has potential, but it needs further development. Considering the 5 principles for urban NbS, our developed tool should be further researched and developed to enhance participation and generate holistic view of cities urban environment. Further research and development should be done on three aspects of the tool: database, tool's use, and impact.

- Database: The biodiversity database could be developed with a global strategic biodiversity assessment. The tool would benefit from substituting/ additional environmental indicators for a more reliable database to represent the ecosystem's well-being. The perceptions of residents could also be automatically integrated into the tool for real-time data, to improve the convenience for data collectors, and reduced manual mistakes. Examine integration and collaboration with different database to improve ecosystem representation in the mapping, and support raise awareness of biodiversity and ecological, social systems relations (i.e., iINaturalist).
- Tool's use: There is a need to adjust the tool according to the context (i.e., language). The approach to participants should be explored, to make the tool more accessible and encourage high response rates, potentially through gamification and incentives. The tool should be accessible and promoted for greater uptake by practitioners. In addition, conducted an evaluation of the tool through the experience of the participants or the practitioners

- Tool's impact: evaluation the aimed paradigm shift in urban planning, policies and practices and identifying appropriate integration of NbS in cities is needed. Evaluation if the tool improves on existing participatory processes used in urban planning and transforming from residents' participation to engagement. The tool's potential to influence people's shift of value, considering experience from participatory research, residents' participatory evaluation of their surrounding might enlighten an understanding of what places and elements improve their quality of life and the natural environment.

In addition, it will be interesting to prototype the tool in the context of developing countries, which urgently need support to tackle urban sustainability challenges and citizen wellbeing.

4. Conclusions

While our research raised many questions, we have found potential in interactive mapping to support a much-needed shift in urban planning, toward greater integration of nature in cities through NbS. To help answer our research question, we developed and prototyped a tool to support this integration and permit civic engagement to enhance the relationship between the ecological and social systems. The tool, based on the 5 principles for Urban NbS, assists citizen participation in urban and NbS planning. Further research is needed to find a more reliable ecological indicator for mapping urban biodiversity system understanding. Nevertheless, in its current form, the tool raises awareness about biodiversity and the relationship between social-ecological systems. Furthermore, our results supported the notion that human and ecological well-being are mutually beneficial in cities. Participant responses highlighted those locations with more 'nature' were also highly valued for their well-being benefits. This acknowledgment can potentially be the first step for a value shift toward nature, specifically the integration of nature into cities. Human values are context-dependent, therefore opportunities for NbS integration should be locally identified and need to be appropriate to the existing social system – we trialed the tool in two cities and were successfully able to map residents' values to support NbS and urban planning evaluation. Our research demonstrates that the PPM tool is a useful method to better understand citizen values in any local context. (For graphical alignment of research and tool with 5 principles for urban NbS, see appendix 6.12)

Providing the answer to the enhancement of participation, feedback from municipalities and participants support the potential for the tool's implementation to improve information accessibility, communication and learning for better city planning. We hope this will create a positive feedback loop increasing social and ecological sustainability; whereby citizen input informs municipality action that reinforces citizen participation as they feel capable of influencing the future development of their city.

We believe this has the potential to support cities in their efforts to e sustainability challenges. The tool helps move cities strategically towards sustainability by knowledge building and a better understanding of the relationship between the social and ecological systems in cities; through promoting a shift in residents value and in urban planning paradigm; encourages urban planners to integrate nature in the urban environment; and using NbS as a leading approach. Collectively these meashelp transition towards multi-beneficial, resilient, and sustainable cities.

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6. Appendices

6.1. Example interview topics/ questions

Examples for questions from municipality worker in Karlskrona, same topics and related questions with minor changes were used in all interviews.

- Sustainability **practices** in Karlskrona's development
    - Focus on urban planning and sustainability guidelines
        - Term of use : NbS and/or ES/ or GI
    - Focus on biodiversity knowledge and programs; any data base?
- Development **plans**;
    - Decision making process for urban planning;
        - What is the role of residents' opinions? Is there transparency in the process?
        - City planning considering environmental aspect
    - Opportunities and challenges in planning and implementing
- **Youths**
    - Young adults immigration in/ out – programs to support positive immigration and staying
- What is their **evaluation** process for urban planning today?
    - What information do they already collect about local NbS/ urban planning?
    - Database? Results that they can share? (maybe another layer on the map)

Our thesis-

- Ask for her opinion of the research, of its relevance to Karlskrona
- Ask if she can identify any elements that are missing in our tool that would be helpful from the municipality lens; mapping, ppm, etc.

Our tool

- What will help them to plan better? (explain what we plan already to collect)
- Tips for participation

6.2. Interviewees list

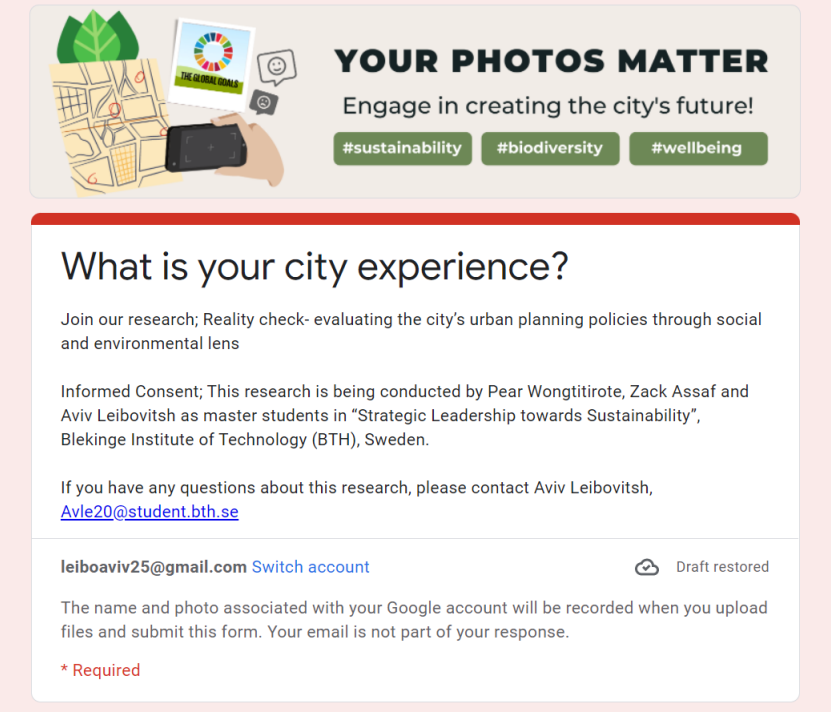
Position/ role
GIS-coordinator, Karlskrona
Environmental strategist, Karlskrona
Head of development education, Karlskrona
Development specialist, Karlskrona
Expo Karlskrona- project manager, Karlskrona
Head of the urban planning department, Karlskrona
Organizational Development Specialist, Karlskrona
Politician, Chairman of the Environmental Committee, Malmö
Researcher, SLU
Head of program for DAC, CPH by heart

6.3. Tool feedback questions

1. Are you a -city resident/ municipality worker
2. looking at the places in the map you - Agree with all places/ agree with some places/ disagree with most places/ unsure
3. looking at the biodiversity of each place you find it- important/ irrelevant/ unsure
4. What is your overall opinions or thoughts of the results?
5. if the map will be open for use, you- use it, add places and recommend friends/ only view it/ will not use it at all
6. knowing the information on the map you- want to make a change in my city/ gained important information/ think it's irrelevant/ unsure
    - if you want to make a change in your city, please share in what topic and way

6.4. PPM survey user interface

Entry Note



Example of interface in section "I want to say something nice about my city"

Please upload 2-4 photos

Try to avoid photos with people in it

Add file

Please describe what is the place *

Your answer

What is special about those? Can include; What do you like about it? What do you do there? *

Your answer

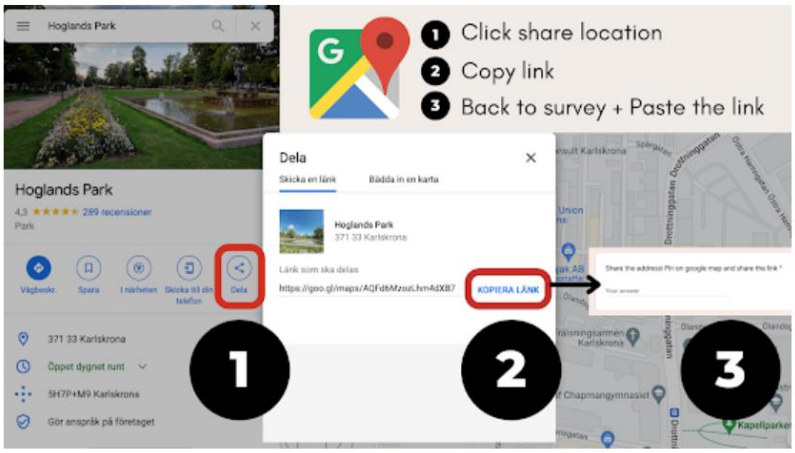
Are there any problems with it? What interrupt you from enjoying it? *

Your answer

Share the address\ Pin on google map and share the link *

Your answer

Example; How to share location on Google Map



Anything you would like to add?

Your answer

Next I want to *

- Add a nice place
- Add a place to improve
- I am done- to submit and finish the survey

Back Next Page 3 of 9 Clear form

Never submit passwords through Google Forms.

6.5. PPM survey marketing poster

6.6. PPM survey list of questions

We want to know- What is your city experience?

- Email address (NOT MANDATORY)
- Share email address if you are interested in receiving the analyzed result and be able to reflect and share feedback to influence the final conclusions of the research. There will not be any other use of the email address
- Gender: Female/ Male/ Prefer not to say/ Other
- Age; 15-18/ 18-21/ 21-25/ 25-30/ 30-35/ Other
- Which city? Karlskrona/ Malmö
- Can you see yourself still living in the city in the future? Yes/ No/ Maybe/ Other
- What would you like to share? I want to say something nice about my city/ I feel my city can do better

I want to say something nice about my city: "What place in your city improves your quality of life and the natural environment? For example, local parks, cultural areas, open areas, sports areas, innovative elements, etc."

- Please upload 2-4 photos (Try to avoid photos with people in it)
- Please describe what the place is.
- What is special about those? Can you include What do you like about it? What do you do there?

- Are there any problems with it? What interrupts you from enjoying it?
- Share the address/ Pin on google map and share the link
- Anything you would like to add?
- Next, I want to; Add a nice place/ Add a place to improve/ I am done- to submit and finish the survey

I feel my city can do better: "What place in your city hinders your quality of life and the natural environment? For example, local parks, cultural areas, open areas, sports areas, innovative elements, etc."

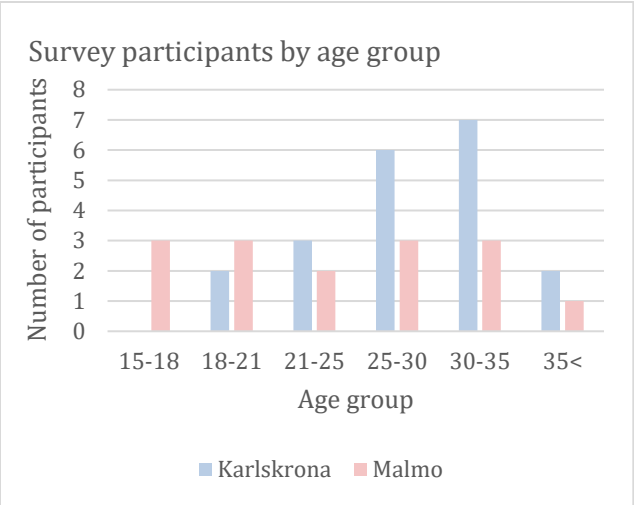
- Please upload 2-4 photos
- Please describe what the place is.
- What are the problems with it? What interrupts you from enjoying it?
- In your opinion what can be done to improve it?
- Share the address/ Pin on google map and share the link
- Anything you would like to add?

Next, I want to; Add a nice place/ Add a place to improve/ I am done- to submit and finish the survey

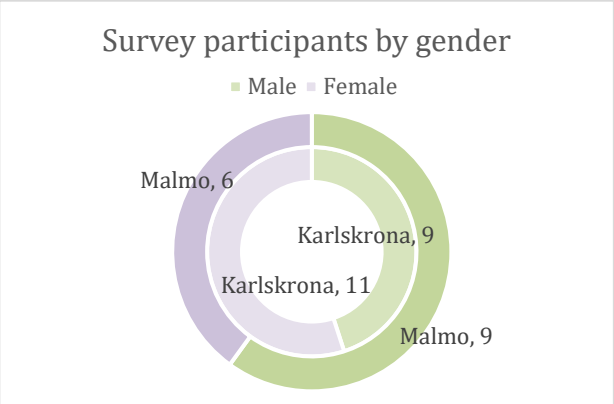
6.7. Steps for extracting location's biodiversity occurrences

1. Check photos and description of responders
2. Scope boundary on Google map based on location pin.
3. Access the GBIF website's database.
4. Click "Get access" data and then select the "Occurrences" menu.
5. Zoom in the location of case studies cities; Malmö and Karlskrona.
6. Select the area around each survey responder pinned location using the vector tool. Use google map as a guideline. The scale of each location is different.
7. Gather results of occurrence numbers shown on top of the map.
8. Add occurrence numbers to the multi layers google map
9. Click download data and create a citation for each data collection

6.8. PPM survey responder's demographics

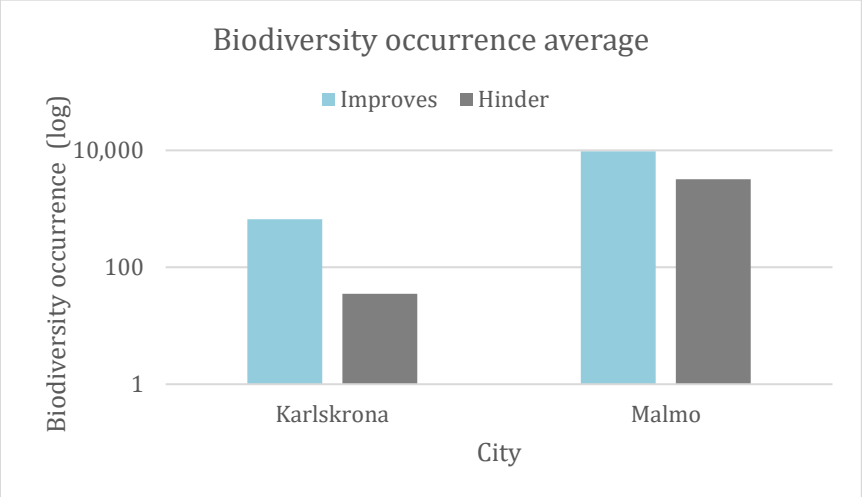


Survey participants by age group



Survey participants by gender

6.9. Biodiversity occurrence average



Biodiversity occurrence average

6.10. Tool overview- how to use the map

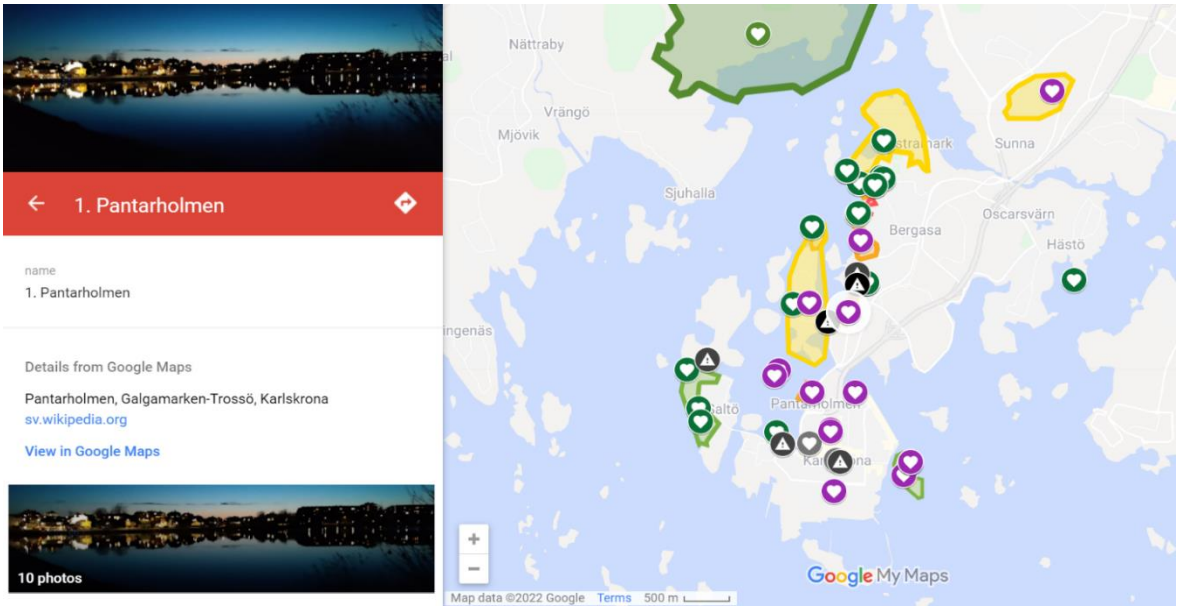
Integration of the data collected in the online Google map, representing respond's location, each pinned location include the responder's number, the name of the place, categorized by a place the improves/ hinder participants quality of life and the natural environment (separated by layers, for each category and city) and by type of place; urban, urban-nature and nature. In addition, there are layers for biodiversity occurrences, associated with places that survey participants pinned. And a layer of UNA NbS, relevant only to Malmö

To use the interactive map tool

1. Click the link: https://www.google.com/maps/d/viewer?mid=1dcmsLC8KvQQNqDusCTxg_z2CWntJpNZZ&usp=sharing
2. Select layers that want to see in each city.

- Places that improve quality of life and natural environment Karlskrona/ Malmö
- Places that hinder quality of life and natural environment Karlskrona/ Malmö
- Biodiversity occurrence for pinned locations Karlskrona/ Malmö
- Note: For Malmö, there is another additional layer "UNA NbS" which show the Nature-Based solutions projects, data collected from Urban Nature Atlas map.

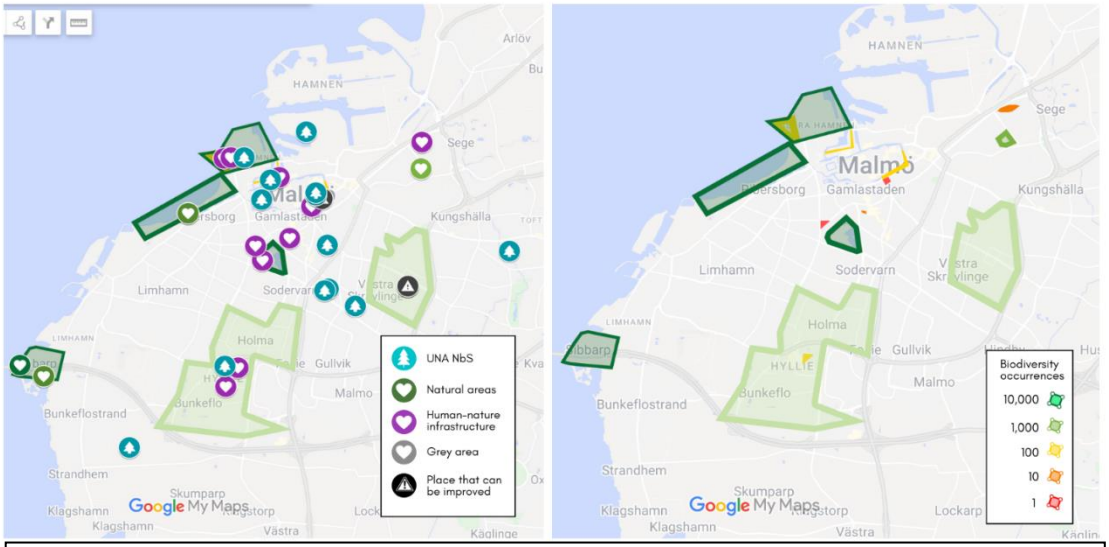
3. To see participant photos associated with the pinned location: click on the heart / exclamation mark icon of the location.
4. To download biodiversity occurrences data: click on the selected area and continue with the relevant link.



Chosen location (heart icon) associated participant number (1), name of place (Pantarholmen) location (Pantarholmen, Galgamarken-Trossö, Karlskrona) and participant shared photo.

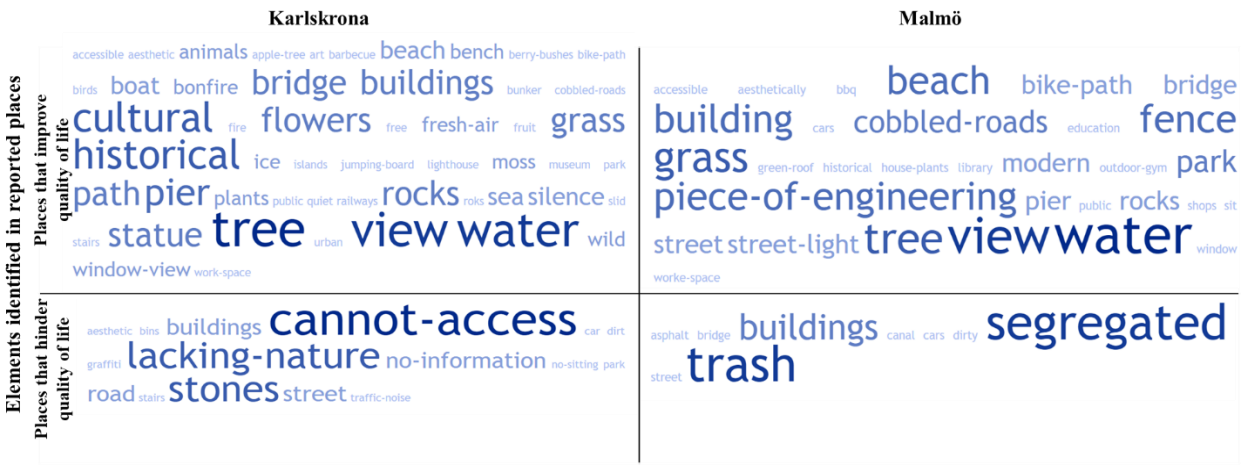
Alternative Map : Google earth result for presentation : Prototype
Karlskrona
https://earth.google.com/earth/d/140p_Vi_eVWABeys7Vn9F1yInqLeb9NYL?usp=sharing

Malmö;
https://earth.google.com/earth/d/1nw4_Ig02O3W19xglcmw6CsCzoub5x9Hd?usp=sharing

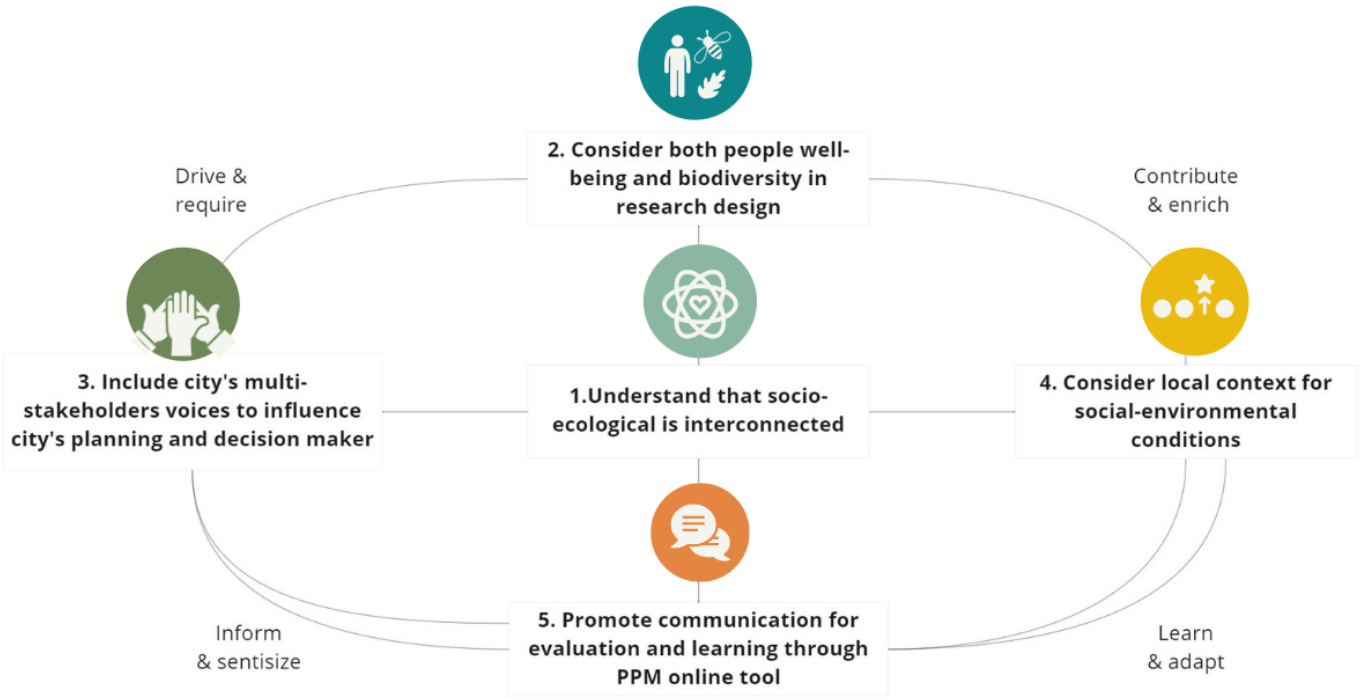


Participant's pinned locations and type of place (left), Biodiversity occurrence (right). Example from Malmö

6.11. Elements to consider in space design



6.12. Overview of the research and tool alignment with the 5 principles for Urban NbS



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