



ENABLS

Education and NBS -
bending the curve for biodiversity

Teacher Training Guide for NBS

2026



Funded by
the European Union

Table of Contents

1. Teacher Training Guide.....	5
1.1. Introduction to the Teacher Training Guide.....	5
1.2. Pedagogical Principles.....	6
1.3. Target Group.....	12
Part I: Basics.....	13
Chapter I: Biodiversity & Ecology.....	13
Chapter II: Nature-based Solutions.....	19
Part II: NBS in Practice.....	26
Chapter III: Environmental Risks.....	27
Chapter IV: Food Production.....	35
Chapter V: Water Management.....	43
Chapter VI: Urban Development.....	49
Conclusions.....	56
Glossary of Key Terms.....	57
2. NBS Basics Module.....	60
Station 1: Biodiversity: “Who lives here and why?”.....	62
Station 2: Water and soil: “What happens below our feet?”.....	63
Station 3: People and Climate: “Why this matters for humans”.....	63
Station 4: Experimental zone: “Testing NBS in real life”.....	63
3. NBS Municipal Development & Planning Module.....	67
About ENABLS.....	73
Annex 1: Supplementary Document Module 1.....	74
Annex 2: Supplementary Document Module 2.....	80

List of Figures

Figure 1: Example of Living Micro-Ecosystem Lab Activity Setup	16
Figure 2: Definitions of Nature-based Solutions	19
Figure 3: Goals of Nature-based Solutions	20
Figure 4: Example of Setup for Testing how NBS work	23
Figure 5: Before and After Peatland Restoration	28
Figure 6: Controlling Invasive Species	29
Figure 7: Example of an Ecosystem Resilience Testing Activity	32
Figure 8: Examples of Non-productive Grasslands Margins	36
Figure 9: Different Types of Small-scale Composters	37
Figure 10: Water and Soil Experiment	63
Figure 11: Presentation Structure	65
Figure 12: Climate Walk Stop Example	71

List of Tables

Table 1: Accessibility Tools	11
Table 2: Examples of Regenerative Farming	36
Table 3: Comparison of In situ and Ex situ Conservation	37

Table of Abbreviations

Abbreviation	Description
CO ₂	Carbon dioxide
CVET	Continuous Vocational Education and Training
CWR	Crop Wild Relatives
eNABLS	Education and Nature-Based Solutions: Bending the Curve for Biodiversity
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
GreenComp	European Sustainability Competence Framework
IVET	Initial Vocational Education and Training
Min	Minutes
NBS	Nature-based Solutions
TVET	Technical and Vocational Education and Training
TTG	Teacher Training Guide
UDL	Universal Design for Learning
VET	Vocational Education and Training

1. Teacher Training Guide

1.1. Introduction to the Teacher Training Guide

Current global sustainability challenges highlight the need to develop the skills required to support the transition to a greener economy. Learners in technical and vocational education and training (TVET), as well as adult learners, therefore need to be familiarised with urgent environmental issues, as well as local sustainability challenges, such as biodiversity loss, their impacts and potential mitigation strategies. These include principles of Nature-based solutions (NBS) and the related relevant innovative socio-technical solutions.

The current Teacher Training Guide (TTG) is designed to explore the topic of NBS, biodiversity and ecology, focusing on supporting teachers and trainers in VET and adult education. It aims to empower, encourage and equip them to give engaging courses for their future learners.

The guide is divided into two parts. The first part, **‘Basics’**, addresses the broader background topics such as biodiversity and ecology, leading to a common understanding of NBS. The second part, **‘NBS in Practice’**, explores the more practical and technical aspects of NBS, including environmental risks, food production and water management, as well as urban development.

This Teacher Training Guide outlines key topics and themes to be explored in connection with curricula across different subjects. These may include biology, geography, agriculture, construction-related subjects, urban planning, or environmental sciences, among others. In this way, NBS for biodiversity can be integrated into both TVET and adult education, especially also into existing modules or subjects.

Chapter I and II comprise Part I ‘Basics’ of the guide, whereas the remaining chapters (III – VI) make up Part II ‘NBS in Practice’. All chapters (I – VI) contain a brief summary overview of the respective topic, which teachers may choose to explore in greater depth. This is followed by discussion questions designed to stimulate debate among students. The questions may be posed when introducing each topic, but also at any point before, during or after activities take place (e.g. as a concluding exercise of an activity; between stops of a walk). The teacher may use the discussion questions in a plenary setting, inviting students to speak up within a group, or they may be explored by students 1-on-1. In each chapter, the discussion questions are followed by the proposed interactive student activities, which always constitute three types of activities: walking, challenge-based, and tactile activities, based on the pedagogical principles described in the section below.

At the end of the document, you will find a glossary explaining the central terms used throughout the text.

1.2. Pedagogical Principles

The underlying pedagogical principles for this Teacher Training Guide are based in experiential learning. Nature-based learning often combines direct experience, observation, reflection, and dialogue. Teachers are therefore encouraged not only to facilitate knowledge acquisition, but also to create opportunities for students to explore environmental challenges through experience and to critically reflect on their own observations and perspectives. Students should be supported in developing their own informed viewpoints rather than being guided towards predetermined conclusions.¹

Experiential activities are most effective when structured as a sequence of introduction, experience, and reflection. Thus, teachers are encouraged to explain the purpose of an activity beforehand, allow students to engage directly with the experience, and subsequently facilitate reflection to help students connect their observations with broader environmental, social, and economic themes. Reflection may take place through peer exchange and discussion, as well as through guided questioning. For the latter, teachers may resort to the proposed discussion questions on each chapter.

Every chapter of this Teacher Training Guide proposes three types of activities: walking, challenge-based, and tactile activities. Teachers are encouraged to adapt their choice of activity to the learning objectives, student profile, and available resources. Although the activities can and are to be used independently, teachers may wish to introduce them progressively, for example by beginning with tactile activities before moving to walking or challenge-based activities, particularly when learners have limited prior experience in the covered topics.

First, **walking pedagogy** activities, which involve learning through movement and exploration. This form of pedagogy is used in order to promote inclusion² and connection among students, with the environment, and with communities³, and argued to be a flexible and transformative way to get students thinking deeply about the context of the places in which they are working and living⁴. NBS must be understood within their spatial and ecological context. On-site learning allows for direct observation of vegetation, soil, water, land use, existing measures, and land-use conflicts. This particularly supports a systemic and site-specific understanding of NBS.

Outdoor (walking) activities should be adapted specifically for the outdoor context rather than simply relocating a traditional classroom lecture outside. Teachers are encouraged to consider practical aspects such as the time available, group size, accessibility, safety requirements, and the suitability of the location for the planned activity. Sufficient time should be allocated not only for the activity itself,

¹ Kasper, L, Van der Stok, L. (forthcoming)

² Depending on the specific setting – the approach may promote participation and connection if designed free of barriers for groups with certain disabilities.

³ Friedman, S., Morrison, S. A., & Rickards, A. (2025). Moving towards inclusion and connection: practitioners' conceptualisations of walking pedagogy. *Children's Geographies*, 23(2), 157-171.
<https://doi.org/10.1080/14733285.2025.2476427>

⁴ Qualmann, C., & Morris, B. (2025). Encountering Olympic landscapes: walking as a pedagogic tool in Stratford, London. *Research in Drama Education: The Journal of Applied Theatre and Performance*, 30(4), 718-738.
<https://doi.org/10.1080/13569783.2025.2557841>

but also for introducing the exercise and facilitating reflection afterwards, as these stages are essential for supporting learning.

Teachers should also consider how easily students can move through and engage with the selected environment, as well as how the group will be managed once participants are dispersed across a larger area. Depending on institutional requirements, additional safety measures or supervision may be necessary when activities take place outdoors.

At times, it might not always be possible to go outdoors. In such cases, indoor relational methods, such as the following challenge and tactile activities, can provide considerable depth and touch upon a sense of nature-connectedness. In addition, there are learning objectives for which students benefit from a calm indoor environment. Thus, teachers are encouraged to adapt and select activities according to their learning objectives, students' needs but also available resources. Where access to outdoor spaces or specialised equipment is limited, many activities can be modified using indoor settings and/or simple, readily available materials.

Second, **challenge-based activities**, such as problem-solving tasks⁵, design exercises, or other practical applications. NBS react to concrete societal challenges such as heat, flooding, loss of biodiversity or soil degradation. As there is often more than 'the one perfect solution', and different interests and trade-offs need to be considered, problem-oriented learning is especially well suited to develop, evaluate and assess NBS.

And third, **tactile learning** activities, which require hands-on and multisensorial engagement⁶, such as experiments and/or interaction with relevant objects and tools. NBS are based on ecological processes and their practical application. Through building, experimenting, planting or modelling, learners may directly see how they function and understand the connection between the concept and the practical implementation.

Such activities work particularly well for learners with visual impairments or sensory processing differences, as they center direct physical engagement rather than reading or listening⁷. Teachers should check that materials and workstations are accessible for all learners, including those with limited mobility. The types of activities were selected based on those implemented within the eNABLS project across partner institutions, of which some were implemented with visually impaired participants.

Additionally, some students may initially find experiential activities, such as outdoor (walking), challenge and tactile activities unfamiliar. Teachers are encouraged to clearly communicate the purpose of activities, as reflecting on their value may help students participate more willingly, as well as

⁵ Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42(2), 99–107. <https://doi.org/10.1080/00461520701263368>

⁶ Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. *Trends in Cognitive Sciences*, 12(11), 411–417. <https://doi.org/10.1016/j.tics.2008.07.006>

⁷ Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bolling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for children and adolescents: A systematic review and quality assessment of the evidence. *Health and Place*, 58. <https://doi.org/10.1016/j.healthplace.2019.05.014>

acknowledge that different students' reactions and interpretations are valid, and create an environment where students feel comfortable exploring new perspectives.

The three types of activities are based on the assumption, found in existing research on NBS education, that site-specific (walking pedagogy), experiential, problem- or challenge-based, and practically oriented (tactile) learning is particularly important, as more practical experience supports learners in achieving the desired learning outcomes.⁸

Walking pedagogy enables direct engagement with the spatial and ecological context of NBS, challenge-based learning allows for addressing real socio-ecological challenges, and tactile learning allows for the practical testing and understanding of processes and measures.

This is especially true for learning outcomes referring to the GreenComp Competences⁹, ESCO green skills¹⁰, and the ESCO Transversal Skills¹¹.

The GreenComp is a reference framework for sustainability competences, as it provides a common ground to learners and guidance to teachers and trainers, which advances a consensual definition of what sustainability as a competence entails¹². Additionally, the ESCO Green skills respond to a call to action to achieving climate neutrality by 2050 defined as "the knowledge, abilities, values and attitudes needed to live in, develop and support a society which reduces the impact of human activity on the environment"¹³. Lastly, the ESCO Transversal skills constitute basic or soft skills contributing to one's personal development. Additionally, these are the building blocks for the development of "hard" skills and competences required to succeed on the labour market¹⁴.

For each proposed activity a brief description is provided, along with the expected duration and recommended group size. Additionally, each activity clearly identifies the possible learning outcomes

⁸ Keryan, T., Uhlhorn B., et al. (2025) Exploring the understanding and integration of nature-based solutions into higher education and TVET: Insights from 7 EU countries

⁹ Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). GreenComp: The European sustainability competence framework. *Publications Office of the European Union*. <https://doi.org/10.2760/13286>

¹⁰ European Commission (2022). Green Skills and Knowledge Concepts: Labelling the ESCO classification. Technical Report. <https://esco.ec.europa.eu/system/files/2025-01/Green%20Skills%20and%20Knowledge%20-%20Labelling%20ESCO.pdf>

¹¹ European Commission & Cedefop (2021). Towards a structured and consistent terminology on transversal skills and competences. *ESCO Publications*. <https://esco.ec.europa.eu/system/files/2022-05/MSWG%2014-04%20Report%20of%20the%20expert%20group%20on%20transversal%20skills%20and%20competences.pdf>

¹² European Commission (n.d.). GreenComp: the European sustainability competence framework. https://joint-research-centre.ec.europa.eu/greencomp-european-sustainability-competence-framework_en

¹³ Cedefop (2012). Green skills and environmental awareness in vocational education and training. *Publications Office of the European Union*. https://www.cedefop.europa.eu/files/5524_en.pdf

¹⁴ European Commission (n.d.). Transversal knowledge, skills and competences. <https://esco.ec.europa.eu/en/about-esco/escopedia/escopedia/transversal-knowledge-skills-and-competences>

that can be attained. Lastly, every chapter concludes with a list of references. The references relate to the summary overview section of each chapter and should be used for more in-depth understanding of the topics covered.

Although the topics referring to each chapter are presented in a logical sequence, each chapter can be used independently, depending on the needs of the teacher and students. The aim of this Teacher Training Guide is to create opportunities for integrating NBS for biodiversity into education, while raising awareness of urgent environmental issues among students, adult learners and society more broadly.

Teachers are encouraged to use formative assessment strategies throughout the activities. For hands-on and collaborative tasks, observation rubrics can be used to monitor participation, problem-solving, and teamwork. Peer evaluation can additionally support feedback and communication skills during group work. For challenge activities, students may maintain a design portfolio to document their ideas, drafts, and final outcomes. Reflection journals can be used after activities to encourage students to reflect on their learning, challenges, and progress.

The *Inclusive Practice Notes* throughout this guide, as well as the following *Accessibility Tools table* provide guidance on adapting the activities in this guide to support inclusive practice and the participation of learners with disabilities. Thus, accessibility tools and techniques to the three activity types for teachers are provided below.

Inclusive Practice Note

Nature-based learning environments benefit all learners, but their potential for people with disabilities has not yet been fully explored in TVET and adult education. Research shows that hands-on, multisensory and experiential approaches are particularly effective for learners with physical, sensory, cognitive and psychosocial disabilities, as they reduce cognitive load and open multiple ways into learning¹⁵. Good inclusive practice starts at the planning stage: activities need to be designed with accessibility in mind from the beginning, not adjusted afterwards¹⁶. This means applying Universal Design for Learning (UDL) principles¹⁷ across all three activity types in this guide, so that every learner can engage with NBS content regardless of ability. Studies on TVET specifically show that most trainers do not adapt their lesson plans for disabled students, and most are not aware of the relevant policy frameworks¹⁸. It is also worth noting that people with disabilities are among those most affected by environmental crises and urban flooding, and their perspectives need to be part of sustainability education, not treated as an optional extra¹⁹.

¹⁵ Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bolling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for children and adolescents: A systematic review and quality assessment of the evidence. *Health and Place*, 58, 102136. <https://doi.org/10.1016/j.healthplace.2019.05.014>; Stahlhut, M., Amholt, T. T., Barfod, K. S., Mikkelsen, S., Mall, C., Elsborg, P., Aadahl, M., & Bolling, M. (2025). Education outside the classroom for children with neurodevelopmental disorders in special needs education settings: A scoping review. *International Journal of Educational Research*, 132. <https://doi.org/10.1016/j.ijer.2025.102649>

¹⁶ CAST (2018). Universal Design for Learning Guidelines version 2.2. CAST. <https://udlguidelines.cast.org>

¹⁷ Rose, D. H., & Meyer, A. (2002). Teaching every student in the digital age: Universal Design for Learning. *Association for Supervision and Curriculum Development*. ISBN: 978-0-87120-599-5

¹⁸ ILO (2013). Inclusion of people with disabilities in vocational training: A practical guide. *International Labour Office, Gender, Equality and Diversity Branch*. <https://www.ilo.org/publications/inclusion-people-disabilities-vocational-training-practical-guide>; Malle, A. Y., Pirttimaa, R., & Saloviita, T. (2015). Inclusion of students with disabilities in formal vocational education programs in Ethiopia. *International Journal of Special Education*, 30(2), 57-67. <https://eric.ed.gov/?id=EJ1094820>; Ebuonyi, I. D., Rottenburg, E. S., Bunders-Aelen, J. F. G., & Regeer, B. J. (2020). Challenges of inclusion: A qualitative study exploring barriers and pathways to inclusion of persons with mental disabilities in technical and vocational education and training programmes in East Africa. *Disability and Rehabilitation*, 42(4), 536-544. <https://doi.org/10.1080/09638288.2018.1503729>

¹⁹ Stough, L. M., & Mayhorn, C. B. (2013). Population segments with disabilities. *International Journal of Mass Emergencies and Disasters*, 31(3), 384-402. <https://doi.org/10.1177/028072701303100306>; Fox, M. H., White, G. W., Rooney, C., & Rowland, J. L. (2007). Disaster preparedness and response for persons with mobility impairments: Results from the University of Kansas Nobody Left Behind Study. *Journal of Disability Policy Studies*, 17(4), 196-205. <https://doi.org/10.1177/10442073070170040201>

Table 1: Accessibility Tools

Activity Type	Accessibility Tool or Technique	Which Learners Benefit
Walking	Virtual field trips using Google Earth, iNaturalist or Google Street View	Learners with mobility impairments or chronic illness
Walking	Audio description of environments for learners who cannot observe visually	Learners with visual impairments
Walking	Pre-route accessibility check and alternative indoor pathway	Wheelchair users and learners with mobility aids
Challenge	Plain language briefs with sentence starters and structured templates	Learners with cognitive disabilities or low literacy
Challenge	Assigned group roles (researcher, illustrator, presenter) to distribute participation	Learners with psychosocial disabilities or communication differences
Challenge	Extended time and flexible submission formats (verbal, visual, written)	Learners with processing or physical disabilities
Tactile	Workstations adapted to accessible height for seated learners	Wheelchair users
Tactile	Gloves and tools as alternatives to direct hand contact with materials	Learners with sensory sensitivities or limited hand mobility
Tactile	Multisensory engagement: touch, sound and smell alongside visual observation	Learners with visual impairments
All Activity Types	UDL offer multiple means of engagement, representation and expression	All learners, proactively
All Activity Types	Crisis communication thread: how NBS-related emergencies are communicated accessibly	Learners with sensory or cognitive disabilities
All Activity Types	Needs assessment at the start of the programme to identify access requirements and communication preferences	All disabled learners and trainers

1.3. Target Group

This Teacher Training Guide is primarily designed for **teachers and trainers in TVET and adult education** but also suitable for teachers and trainers in general education and youth work. It supports a wide range of learners, without restricting content to a specific age or, particularly in Part I, where no prior knowledge is necessary. The topics and proposed activities are carefully designed to be adaptable, enabling teachers to tailor them to diverse learner profiles and educational contexts. Additionally, the group size of the proposed activities is designed for typical TVET and adult education class/group sizes and can be adapted to different teaching contexts. Where appropriate, students are encouraged to work individually, in pairs, or in small groups. In this way, the guide makes NBS, biodiversity, and ecology concepts accessible and engaging for all students, while still providing, especially in Part II, greater depth and rigor for those with a specific interest or curricular focus in these areas.

In line with the UDL principles, this guide also addresses the needs of learners and educators with physical, sensory, cognitive and psychosocial disabilities. As noted, it is the skills training staff working at community level who bring policies to life so that people with disabilities can fully participate. The Inclusive Practice Note in the Pedagogical Principles section and the Accessibility Tools table provide practical guidance on adapting activities for diverse learner profiles.

Part I: Basics

Part I of this Teacher Training Guide provides the basic concepts about the topics of biodiversity, ecology and NBS. It is designed to be adaptable across a wide range of subjects and levels of specificity, allowing students without a specialised focus on these topics to engage with and benefit from foundational concepts. Through an integrative and hands-on pedagogical approach, students develop an understanding of the complexity of current environmental challenges while identifying innovative and collaborative solutions.

For a more detailed example of how these basic concepts can be applied in a course format, please refer to the NBS Basics module, *Fundamentals of NBS for VET*, designed for Initial Vocational Education and Training (IVET), as part of the ENABLS project, in section E.2 of this document.

Chapter I: Biodiversity & Ecology

Summary Overview

Biodiversity refers to the variety of life on Earth at three interconnected levels: the diversity of ecosystems and habitats, the diversity of species, and the genetic diversity within species. All three levels contribute to the functionality and adaptability of ecosystems and form the basis for vital processes such as **pollination, nutrient cycling, and climate regulation**. Protecting individual species alone is therefore insufficient: species require suitable and **interconnected habitats**, while genetic diversity strengthens their adaptability to diseases and changing environmental conditions. The loss of biodiversity is evident in everyday life, for example, in the decline of wild pollinators (and the insects on windshields), and it threatens not only species and ecosystems but also food security, water availability, and the resilience of human societies. Nevertheless, public awareness and understanding of the different levels of biodiversity remain limited; its loss is often perceived as an abstract problem detached from everyday life.

Ecology is the study of the relationships between living organisms, including humans, and their physical environment; it seeks to understand the vital **connections between plants and animals and the world around them**. Ecological insights help us understand how ecosystems function, respond to changes, and provide services for humans and nature. This knowledge forms an important basis for the sustainable management of natural resources and for the development of nature-based solutions that address societal challenges while simultaneously preserving or enhancing biodiversity and ecosystem functions.

Ecology provides information about ecosystems and thus shows us how we can use Earth's resources in ways that meet our current needs while at the same time leaving the environment healthy or restoring it for future generations (this is where NBS come in).

Debate: Discussion about the Interconnectivity of Systems' Elements

The following discussion questions focus on the interconnectivity of systems' elements such as soil, air, plants or animals. They can be used by the moderator to guide students in collaborative debates and reflections on the needs, difficulties, and ongoing interaction between systems' elements.

- What might happen if one element in an ecosystem (e.g. a pollinator species or a water source) is removed or significantly reduced?

- How do human activities influence ecological systems, and how do these systems, in turn, affect human well-being?
- Can you think of an example from your local environment where a change in one part of the system led to unexpected consequences elsewhere?
- How might climate change impact the relationships between species and their environment?
- What responsibilities do individuals and communities have in maintaining or restoring these interconnected systems?
- How can biodiversity conservation contribute to local community well-being?
- Should species and ecosystems also be protected when there is no immediate advantage for humans? Why or why not?

Proposed Activities

Walking Pedagogy Activity – “Ecosystem and Biodiversity Mapping”

Description: This activity aims to help students understand how biodiversity is embedded in socio-ecological systems and how it is influenced by interactions between species, habitats, environmental conditions and human uses.

Students go on an excursion to a local green space (e.g. park, wetland, urban green area) with a focus on identifying and understanding interconnections between elements of biodiversity. Individually or in small groups, they identify and record species (e.g. trees, plants, insects) using observation sheets or digital tools (e.g. mobile phone apps such as ObsIdentify, Google Lens), and categorize habitats and ecosystem elements (soil, water, vegetation). In addition, students can observe and document interactions (e.g. pollination, shading, food chains), as well as identify signs of human influence (e.g. land use, maintenance practices, pollution). During this ecosystem mapping exercise, learners may explore how different stakeholder groups (e.g. residents, land managers, conservationists, farmers, or visitors) interact with and value the ecosystem. They may also reflect on potential trade-offs between biodiversity conservation, recreation, land use, and economic activities. This helps students understand ecosystems as socio-ecological systems and strengthens systems thinking and critical thinking competences. To deepen sensory engagement, students can engage in a “texture hunting” activity by recording different tree textures. This can be done using a kneadable eraser or non-toxic clay pressed onto tree surfaces, then inked with a portable ink pad and stamped onto paper. At the end of the walk, students create a simple ecosystem map highlighting their main recordings (key species and their interconnections).

At the end of the activity, teachers facilitate a guided reflection in which students discuss what they observed, how ecological and social system elements interact, and how their observations influenced their understanding of biodiversity conservation.

Suggested Duration: 85 minutes

- Introduction and instructions: 10 min
- Walk and ecosystem mapping: 50 min
- Ecosystem map creation: 10 min
- Group discussion and reflection: 15 min

Recommended Group Size: 10–25 students, working individually or in small groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Promoting Nature (1.3); Systems Thinking (2.1); Critical Thinking (2.2); Problem Framing (2.3); Exploratory Thinking (3.3); Individual Initiative (4.3).

ESCO Green Skills – conduct research on flora; understand ecological relationships between species and habitats; identify ecosystem species and interconnections; adopt ways to foster biodiversity and animal welfare; safeguard biodiversity; inspire enthusiasm for nature; educate people about nature.

ESCO Transversal Skills – demonstrate curiosity; think analytically; process spatial information; apply knowledge of science, technology and engineering; organise information, objects and resources; attend to detail; express yourself creatively; think creatively; think holistically; work in teams; use equipment, tools or technology with precision; report facts; identify problems; evaluate environmental impact of personal behaviour; maintain concentration for long periods; solve problems; keep an open mind.

Challenge-based Activity – “Ecosystem Restoration Task”

Description: This activity aims to help students analyse biodiversity loss as a systems problem and design possible restoration responses for different types of ecosystems.

Students are presented with one of three scenarios: a keystone species (e.g. wolf, beaver) or a functionally important species (e.g. pollinators such as bees, or soil organism such as worms) has declined or disappeared from a local ecosystem. The chosen ecosystem may be an urban/municipal, an agricultural or a forest space. In groups, they must identify causes of decline, analyse consequences for the ecosystem, and design an intervention to restore conditions. This activity focuses on conceptual planning and design only, not implementation.

The activity concludes with a comparison of the proposed restoration strategies, encouraging students to reflect on the ecological, practical, and social trade-offs involved in ecosystem restoration.

Suggested Duration: 85 minutes

- Introduction and scenario presentation: 10 min
- Group analysis of causes and ecosystem consequences: 20 min
- Group design of restoration intervention: 25 min
- Presentations: 15 min
- Discussion and reflection: 15 min

Recommended Group Size: 10–25 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking (3.3).

ESCO Green Skills – understand ecosystem management; design habitat restoration; assess environmental impact; analyse environmental data; understand climate change impact; develop environmental remediation strategies; safeguard biodiversity.

ESCO Transversal Skills – identify problems; think critically; think analytically; solve problems; apply knowledge of science, technology and engineering; think holistically; evaluate environmental impact of personal behaviour; make decisions; plan; work in teams; build team spirit; express yourself creatively; think innovatively; demonstrate curiosity; keep an open mind; approach challenges positively; organise information, objects and resources.

Tactile Activity – “Living Micro-Ecosystem Lab”

Description: This activity aims to help students understand ecological interactions, feedback loops, and ecosystem resilience by constructing and observing a small living system.

In groups, students construct a closed or semi-closed micro-ecosystem (e.g. terrarium, soil ecosystem box, or small plant-based system) using natural materials. The system is designed to allow observation of ecological interactions over time, such as, moisture cycles, plant growth and decay, species interactions (if small invertebrates are ethically and safely included). Once established, students introduce controlled environmental variations, for example, reduced light exposure (simulated shading), changes in water availability, temperature variation (safe indoor range). They observe how the system adapts and document changes over time (example setup below).

Follow-up reflections should invite students to discuss how the micro-ecosystem changed over time, what this reveals about balance and resilience, and how human actions can influence ecosystem stability.

Figure 1: Example of Living Micro-Ecosystem Lab Activity Setup²⁰



Suggested Duration: 50 minutes, plus follow-up observations over several days or weeks

- Introduction and explanation: 15 min
- Construction of the micro-ecosystem: 20 min
- Introduction of controlled environmental variations and initial observations: 10 min

²⁰ Illustration modelled with GPT 5.5 (June 2026)

- Discussion and reflection: 5 min

Recommended Group Size: 10–25 students, working in pairs or groups of 2–4.

Possible Learning Outcomes:

GreenComp Competences – Promoting Nature (1.3); Systems Thinking (2.1); Adaptability (3.2); Exploratory Thinking (3.3).

ESCO Green Skills – understand the functions of ecosystems; understand the concept of ecology; analyse ecological data; conduct ecological research; assess environmental impact; safeguard biodiversity; biology.

ESCO Transversal Skills – apply knowledge of science, technology and engineering; think analytically; think holistically; solve problems; identify problems; plan; work in teams; work independently; demonstrate curiosity; use equipment, tools or technology with precision; organise information, objects and resources; report facts; evaluate environmental impact of personal behaviour; think critically; manage quality; maintain concentration for long periods.

References

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A. & Kinzig, A. P. (2012). Biodiversity loss and its impact on humanity. *Nature*, 486(7401), 59–67. <https://doi.org/10.1038/nature11148>

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., Balvanera, P., Brauman, K. A., Butchart, S. H. M., Chan, K. M. A., Garibaldi, L. A., Liu, K. Ichii J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Polasky, S. (...) Zayas, C. N. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. <https://doi.org/10.5281/zenodo.3553458>

Ecological Society of America (n.d.). What is Ecology? <https://esa.org/about/what-does-ecology-have-to-do-with-me/>

Friedman, S., Morrison, S. A., & Rickards, A. (2025). Moving towards inclusion and connection: practitioners' conceptualisations of walking pedagogy. *Children's Geographies*, 23(2), 157–171. <https://doi.org/10.1080/14733285.2025.2476427>

Häckel, E. (1866). *Generelle Morphologie der Organismen: Allgemeine grundzüge der organischen formen-wissenschaft, mechanisch begründet durch die von Charles Darwin reformirte descendenztheorie* (2nd vol.). Georg Reime

O'Neill, M., O'Donovan, D., Barimo, J., Mullally, G., Sharifi Isaloo, A., Keohane, K., Spalding, T., Swirak, K., Boland, T., & Griffin, R. (2025). *Walking as Critical Pedagogy*. Routledge. <https://doi.org/10.4324/9781003569671>

Renshaw, P., & Tooth, R. (2017). *Diverse Pedagogies of Place*. Routledge. <https://doi.org/10.4324/9781315695389#>

Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human–nature interactions. *Frontiers in Ecology and the Environment*, 14(2), 94–101. <https://doi.org/10.1002/fee.1225>

Chapter II: Nature-based Solutions

Summary Overview: What are NBS?

While there is not one uniform definition for Nature-based solutions, there are several established definitions, setting different priorities. Here are some of the most commonly cited, which also present the ENABLS understanding of NBS:

“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.”²¹

“Actions inspired by, supported by or copied from nature and which aim to help societies address variety of environmental, social and economic challenges in sustainable ways.”²²

“Innovative and strategic approaches and actions to tackle societal and environmental challenges including food and water security, human health, climate change mitigation and adaptation, biodiversity conservation, economic and social development, and disaster risk reduction. They aim to protect, restore, and sustainably use natural and human-modified ecosystems in a cost-effective, resource-efficient way adapted to local conditions.”²³

In response to increasing ecological crises, NBS have established themselves as an integrated approach that utilises the functions and processes of ecosystems to address societal challenges such as flooding, food insecurity, and urban heat. Unlike purely technical or monofunctional solutions, NBS aim to **address societal challenges while simultaneously making positive contributions to biodiversity, ecosystem functioning, and human well-being**. NBS can be implemented independently or in combination with technical and other measures.

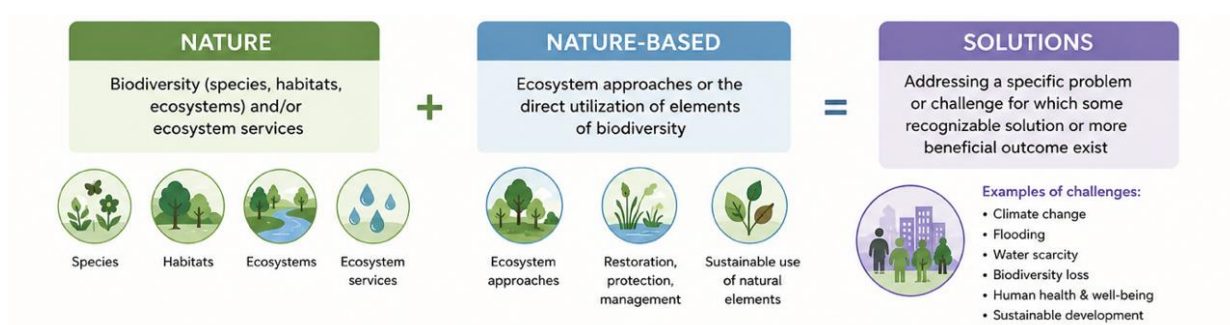
Therefore, the crucial aspect of understanding NBS is not simply the use of natural elements or processes. NBS are based on the protection, sustainable management, or restoration of natural or modified ecosystems and pursue an integrated approach that considers ecological and societal goals in combination. A measure is not automatically an NBS simply because it is ‘natural’ or environmentally friendly; rather, it must address a societal challenge while simultaneously contributing to the conservation or improvement of biodiversity and ecosystem functions, as well as human well-being.

²¹ IUCN (2020). *Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS*. International Union for Conservation of Nature.
<https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf>

²² European Commission: Directorate-General for Research and Innovation (2015). *Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities – Final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' – (full version)*. Publications Office.
<https://data.europa.eu/doi/10.2777/765301>

²³ Jones, M., Keryan, T., de Wit, M., Fender, A., & Klawitter, J. (2024). *A Comprehensive Overview of Nature-Based Solutions: Harnessing Nature for Environmental and Social Benefits*. EU Open Research Repository.
<https://zenodo.org/records/15975043>

Figure 2: Definitions of Nature-based Solutions²⁴



Using NBS, the goals of the European Research and Innovation Agenda, including enhancing sustainable urbanisation, restoring degraded ecosystems, developing climate change adaptation and mitigation, and improving risk management and resilience, can be reached.

Figure 3: European Research & Innovation Agenda on Nature-based Solutions

Research & Innovation Agenda on Nature-Based Solutions and Re-Naturing Cities	
Goals	Research & Innovation Actions
Enhancing sustainable urbanisation	- Urban regeneration through nature-based solutions - Nature-based solutions for improving well-being in urban areas
Restoring degraded ecosystems	- Establishing nature-based solutions for coastal resilience - Multi-functional nature-based watershed management and ecosystem restoration
Developing climate change adaptation and mitigation	Nature-based solutions for increasing the sustainable use of matter and energy
Improving risk management and resilience	- Nature-based solutions for enhancing the insurance value of ecosystems - Increasing carbon sequestration through nature-based solutions

Source: European Commission (2015)²⁵

Examples of NBS encompass measures for **ecosystem restoration**, such as reforestation, wetland restoration, and coral reef regeneration, in case they simultaneously address a societal challenge and have a positive impact on biodiversity, ecosystem functions and human wellbeing; measures for **ecosystem protection** through conservation and the establishment of protected areas; and **the use of**

²⁴ Illustration modelled with GPT 5.5 (June 2026)

²⁵ European Commission: Directorate-General for Research and Innovation (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities – *Final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' – (full version)*. Publications Office.
<https://data.europa.eu/doi/10.2777/765301>

green and blue infrastructure in urban design, including green roofs, permeable surfaces, and green spaces, if they address a societal challenge. NBS also incorporate **ecosystem-based approaches to climate adaptation**, such as agroecological methods that restore and maintain soil health and protect water resources, and mangrove forest restoration. Additionally, NBS support **ecosystem disaster risk reduction**, for example, through restoration of coastal wetlands to mitigate coastal erosion and provide flood protection, as well as restoration and adapted management of ecosystems, which may help to reduce risks such as erosion, landslides or certain impacts of wildfires. In vocational contexts, applications of these may involve installing green roofs and permeable surfaces, applying sustainable farming practices, managing urban green infrastructure, restoring local habitats, or participating in community-based restoration and biodiversity initiatives.

While NBS offer significant environmental and societal benefits, they are not universally applicable and may involve trade-offs, uncertainties, and implementation challenges. Their effectiveness depends on local ecological, social, economic, and governance conditions. As a result, learners need opportunities to explore not only ecological processes but also the social, cultural, economic, and governance dimensions of environmental challenges. Educational activities should therefore encourage students to examine multiple stakeholder perspectives, identify trade-offs and potential conflicts, and understand NBS and the environmental challenges addressed by them as part of interconnected socio-ecological systems. Such approaches help develop systems thinking, critical thinking, and problem-framing competences that are essential for the planning, implementation, and evaluation of NBS.

Debate: Discussion About Using NBS to Mitigate Environmental Concerns

The following discussion questions focus on the use of NBS to address environmental challenges. They can be used by the moderator to guide students in collaborative debates and reflections on the potential of NBS and the urgency of climate change mitigation efforts.

- How do NBS differ from other interventions, for example, conventional engineering approaches in addressing environmental challenges, and what are the advantages or limitations of each?
- How can NBS contribute simultaneously to human well-being and biodiversity conservation? Are there trade-offs between these goals?
- Which examples of NBS might be most effective in your local context, and why?
- What limitations, trade-offs, or unintended consequences might arise from NBS, and how can they be addressed?

Proposed Activities

Walking Pedagogy Activity – “When Less is More”

Description: This activity aims to help students examine how different levels of human management influence biodiversity, ecosystem functions, and the potential of low-intervention practices such as NBS.

Students explore public green spaces (e.g. park, urban meadow, forest) to compare areas with different levels of human management and maintenance. During the walk, they observe and document differences in vegetation, biodiversity, soil conditions, and ecosystem functions between highly managed spaces and less intensively managed or semi-natural areas.

Finally, they reflect on the conditions under which different management approaches or reduced interventions can be considered NBS. They examine which societal challenges are addressed, which

ecological processes and ecosystem functions are strengthened, and what impacts arise for biodiversity and human well-being. Furthermore, they discuss potential conflicts of objectives as well as ecological, social and management-related framework conditions.

Suggested Duration: 85 minutes

- Introduction and observation focus: 10 min
- Walk and comparison of managed and less-managed areas: 50 min
- Documentation of differences: 10 min
- Group reflection and discussion: 15 min

Recommended Group Size: 10 - 30 students, working individually, in pairs, or in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Promoting nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Adaptability (3.2); Exploratory Thinking (3.3).

ESCO Green Skills – monitor nature conservation; assess environmental impact; analyse ecological data; understand ecosystem management; adopt ways to foster biodiversity and animal welfare; safeguard biodiversity; discuss urban sustainability.

ESCO Transversal Skills – observe critically; think critically; think analytically; process spatial information; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; think holistically; identify problems; solve problems; demonstrate curiosity; attend to detail; express yourself creatively; participate actively in civic life; keep an open mind; make decisions; work in teams; report facts.

Challenge-based Activity – “Design an NBS Solution”

Description: This activity aims to help students apply NBS principles to a real or realistic local environmental challenge while considering ecological interconnections, feasibility, and stakeholder trade-offs.

Students are given a real or realistic local environmental challenge (e.g. biodiversity loss in green spaces, urban flooding). In small groups, learners develop an NBS proposal for the respective challenge. In doing so, they consider which societal challenge is being addressed, which ecological processes or ecosystem functions are being used or strengthened, what positive effects can arise for biodiversity or ecosystems and human well-being, and what conflicting goals, stakeholder interests and implementation conditions need to be taken into account. Groups then present their NBS solutions, which may be done visually by presenting sketches, maps, concept posters or digital tools. This activity focuses on conceptual planning and design only, not implementation.

After the presentations, students compare the proposed solutions and reflect in which ways they fulfil the central criteria for NBS, which options seem most feasible, which stakeholders may benefit or be affected, and what limitations or trade-offs remain.

Suggested Duration: 100 minutes

- Introduction to the challenge and stakeholder context: 15 min

- Group problem analysis: 20 min
- Design of the NBS proposal: 35 min
- Visual preparation of proposal: 10 min
- Presentations and reflection: 20 min

Recommended Group Size: 10–25 students, working in groups of 3–5.

Possible Learning Outcomes (depending on the concrete design of the activity):

GreenComp Competences – Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking (3.3); Political Agency (4.1); Collective Action (4.2).

ESCO Green Skills – understand ecosystem management; support urban sustainability; assess environmental impact; discuss sustainable technologies; develop environmental policy; promote sustainability; conserve natural resources.

ESCO Transversal Skills – identify problems; think critically; think analytically; solve problems; plan; think holistically; evaluate environmental impact of personal behaviour; make decisions; apply knowledge of science, technology and engineering; work in teams; build team spirit; express yourself creatively; think innovatively; demonstrate curiosity; keep an open mind; address an audience; moderate a discussion; participate actively in civic life.

Tactile Activity - “Testing How NBS Work”

Description: This activity aims to help students understand which biophysical and ecological processes are used by various NBS, by experimenting with NBS functions such as infiltration, runoff reduction, cooling, and erosion control.

Students conduct a hands-on simulation of NBS functions to understand how natural systems regulate environmental processes. Working in groups, they test simple comparative setups such as, comparing runoff on sealed vs. permeable surfaces (e.g. sand, soil); comparing temperature under vegetation cover vs. exposed surface; comparing erosion in vegetated vs. bare soil samples. Students observe and record differences in a written form, and carry out calculations. Afterwards, students apply their observations on real NBS applications and discuss how the examined processes may be used for green roofs, wetlands, urban trees or rain gardens.

The activity concludes with a discussion linking the experimental results to real-world NBS applications such as green roofs, wetlands, urban trees, rain gardens, and permeable surfaces.

Figure 4: Example of Setup for Testing how NBS work²⁶



Suggested Duration: 75 minutes

- Introduction and setup explanation: 10 min
- Preparation of comparative test stations: 15 min
- Hands-on testing and data recording: 30 min
- Comparison of results: 10 min
- Reflection and link to real NBS applications: 10 min

Recommended Group Size: 10–24 students, working in groups of 2–4.

Possible Learning Outcomes:

GreenComp Competences – Systems Thinking (2.1); Problem Framing (2.3); Exploratory Thinking (3.3).

ESCO Green Skills – interpret scientific data; analyse environmental data; understand ecosystem functions; understand the concept of ecology; assess environmental impact; discuss sustainable technologies.

ESCO Transversal Skills – apply knowledge of science, technology and engineering; think analytically; solve problems; identify problems; process spatial information; think critically; think holistically; carry out calculations; interpret mathematical information; organise information, objects and resources; attend to detail; work in teams; demonstrate curiosity; keep an open mind; report facts; use equipment, tools or technology with precision; manage quality.

²⁶ Illustration modelled with GPT 5.5 (June 2026)

References

- Eisenber, B., & Polcher, V. (2019). Nature Based Solutions -Technical Handbook. *Personal Communication*, 2020-02.
- European Commission: Directorate-General for Research and Innovation (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities – *Final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' – (full version)*. Publications Office. <https://data.europa.eu/doi/10.2777/765301>
- Ibrahim, A., Marshall, K., Carmen, E., Blackstock, K. L., & Waylen, K. A. (2025). Raising standards for stakeholder engagement in Nature-based Solutions: Navigating the why, when, who and how. *Environmental Science & Policy*, 163, 103971. <https://doi.org/10.1016/j.envsci.2024.103971>
- IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. International Union for Conservation of Nature. <https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf>
- Jones, M., Keryan, T., de Wit, M., & Klawitter, J. (2024). Comprehensive Overview of Nature-Based Solutions: Harnessing Nature for Environmental and Social Benefits. ENABLS Project Consortium. https://enabls.eu/wp-content/uploads/2025/07/eNaBLS_A_comprehensive_overview_to_NBS_v1.0.pdf
- Keryan, T., Uhlhorn, B., Wals, A., Jones, M., & Radinger-Peer, V. (2025). Exploring the understanding and integration of nature-based solutions into higher education and TVET: Insights from 7 EU countries. *Urban Forestry & Urban Greening*, 114, 129163. <https://doi.org/10.1016/j.ufug.2025.129163>
- Sowińska-Świerkosz, B., & García, J. (2022). What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. *Nature-Based Solutions*, 2(100009). <https://doi.org/10.1016/j.nbsj.2022.100009>

Part II: NBS in Practice

Building on the foundational knowledge introduced in Part I, Part II of this Teacher Training Guide explores the more applied and technical dimensions of NBS. It provides comprehensive chapters addressing key areas such as environmental risks, food production, water management, and urban development.

These chapters are designed to support a deeper understanding of how NBS can be implemented in practice, highlighting both their potential benefits and the complexities involved in their application across different contexts. While Part II is designed to provide a more in-depth perspective, especially for learners with a stronger curricular focus on NBS-related aspects, it remains adaptable and accessible to a broad range of subjects and learner profiles, including those without a specialised focus.

Through a combination of integrative and hands-on approaches, students are encouraged to critically engage with real-world challenges, assess trade-offs, and explore integrated solutions that connect environmental, social, and economic dimensions. In this way, Part II supports the development of advanced competences relevant to the transition towards more sustainable and resilient systems.

For a more detailed example of how NBS can be applied in practice, please refer to the Municipal Development and Planning module, *NBS in Practice*, designed for Continuous Vocational Education and Training (CVET), as part of the ENABLS project, in section E.3 of this document.

Chapter III: Environmental Risks

Summary Overview

Environmental risks represent significant threats – from natural hazards (e.g. earthquakes, floods) or human activities (e.g. pollution, climate change) – to ecosystems and human health. Understanding these risks and knowing how to mitigate them is essential.

To this end, the current chapter explores distinct environmental risks and shows how NBS can be used to overcome them, and to contribute to climate protection and climate change mitigation.

Climate Mitigation by Peatland Restoration

Peatlands are water-saturated ecosystems where organic material accumulates as peat, forming thick soil layers that store large amounts of carbon. They develop in areas with excess moisture, and although they may sometimes appear dry on the surface, the underlying peat is always saturated. Their formation depends on interactions between water, vegetation, and climate, and they play an important role in storing water, regulating flow across landscapes, and continuously sequestering carbon due to slow decomposition under low-oxygen conditions.

When peatlands are drained for forestry, which lowers the water level and disrupts these natural functions, there is an increased peat decomposition, releasing CO₂ and weakening ecosystem services while reducing biodiversity.

An example of an NBS is **peatlands' hydrological restoration**, which aims to restore near-natural hydrological conditions, particularly by raising the water level. This can be achieved by blocking drainage ditches and, depending on the location and restoration goals, removing woody vegetation. Rewetting can reduce further peat degradation and associated CO₂ emissions, as well as restore typical peatland ecological processes, habitats, and functions. Thus, peatland restoration can contribute to climate protection while simultaneously having positive effects on biodiversity and other ecosystem functions, even if a complete return to the original state is not always possible.

Figure 5: Before and After Peatland Restoration²⁷



Note. In a drained peatland (left) the lowered water level allows oxygen to penetrate the peat and accelerates its microbial decomposition. Ten years after rewetting (right), sphagnum mosses have re-established themselves, and new peat is beginning to form on the surface (arrow). The increased water level creates oxygen-depleted conditions in the underlying peat, slowing its further decomposition. At the same time, this renewed peat formation can contribute to carbon sequestration in the long term.

Resistant Seedling Materials for Healthy Forest Ecosystems and Climate Change Mitigation

Forest ecosystems play a critical multifunctional role by acting as carbon sinks, regulating climate, water, and nutrient cycles, supporting biodiversity, and providing raw materials and social benefits.

However, climate change is increasingly threatening these systems, with rising temperatures expected to cause forest dieback, reduced growth, and shifts in species composition. Many dominant tree species are becoming more vulnerable, highlighting the urgent need for more resilient forest systems and planting materials that can withstand changing environmental conditions.

Restoring and managing resilient forest ecosystems in a climate-adapted way can represent a nature-based solution to climate change adaptation. Selecting and using climate-resilient planting material can be a supporting forestry measure. Advanced tree breeding programs can help provide planting material that is better adapted to stresses such as drought, pests, and temperature changes. In vocational contexts, this topic is particularly relevant to professions such as forestry, horticulture, environmental management, and landscape management, where selecting climate-resilient seedlings, supporting reforestation projects, monitoring tree health, and implementing sustainable forest management practices contribute directly to climate adaptation and biodiversity conservation.

Controlling Invasive Alien Species

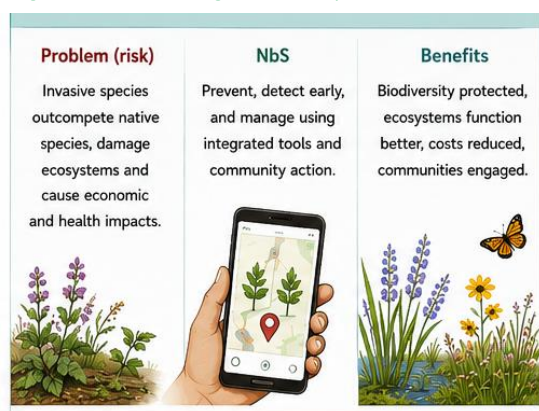
Invasive alien species are species introduced through human activities outside their natural range, where they establish themselves and spread, potentially having negative impacts on biodiversity, ecosystems, and human well-being. Their introduction can be both intentional and unintentional, and their numbers are increasing worldwide. The impacts of invasive alien species vary depending on the species and context. However, they are considered one of the main drivers of global biodiversity loss and can significantly impair ecosystems and their functions. Furthermore, they can cause economic,

²⁷ Source: University of Eastern Finland

health, and social consequences and, in certain cases, facilitate the transmission of diseases. Current strategies and control measures are insufficient to completely contain their spread.

Prevention is considered the most effective strategy for dealing with invasive alien species. Depending on the species, stage of spread, and context, measures for early detection, eradication, containment, or control are also employed. Measures to protect and restore ecosystems can be supported by innovative monitoring technologies and the involvement of diverse stakeholders. Citizen science projects can, for example, contribute to the early detection and monitoring of invasive alien species and thus support effective biodiversity and ecosystem management. An example of this approach are mobile apps, such as the Finnish app *Crowdsorsa*, which enables citizens, schools, and local communities to report and monitor invasive alien species. By supporting early detection and collecting location-based observations, it contributes to biodiversity conservation while raising public awareness and encouraging community participation.

Figure 6: Controlling Invasive Species²⁸



Debate: Discussion About NBS for Managing Environmental Risks

The following discussion questions focus on the use of NBS to manage environmental risks. They can be used by the moderator to guide students in collaborative debates and reflections on the potential of NBS as mitigation efforts for specific environmental risks.

- What are the contributions of peatland restoration to climate protection, climate mitigation and biodiversity, and in what ways is this considered an NBS?
- How can the selection or the breeding of climate resistant seedlings contribute to both climate mitigation and biodiversity conservation in forests? Why is this not necessarily an NBS?
- How can local communities effectively participate in managing invasive alien species?
- Which criteria should be applied in order to decide whether an invasive alien species should be prevented, controlled or eradicated? What role should ecological impacts, possible unintended consequences, social aspects, feasibility and available (time/budgetary/...) resources play?

²⁸ Illustration modelled with GPT 5.5 (June 2026)

Proposed Activities

Walking Pedagogy Activity – “Ecological impairment and possible Environmental Risk Assessment”

Description: This activity aims to help students identify and assess ecological impairment and possible environmental risks in real landscapes (which are often hard to detect directly) and consider how NBS can reduce ecological disturbance and strengthen ecosystem resilience.

Learners explore a selected landscape and take part in a practice-oriented learning activity that aims to observe, document and critically evaluate local environmental risks. During inspections in selected environments (e.g. moors, urban green spaces, natural areas) and examine which ecological impairments can be identified on site. In doing so, they document observable characteristics, e.g. the learners identify indicators of ecological disturbances such as the effects of drainage structures and changed vegetation in moors, sealed areas and limited infiltration opportunities in urban areas or impaired or fragmented habitats or the destruction of habitats or the occurrence of invasive species.

They then analyze possible causes and consequences of the observed changes and discuss which ecological processes and ecosystem functions are affected.

Building on this, they examine whether and how NBS can contribute to reducing the identified impairments or restoring ecosystem functions and which additional measures may be necessary.

Where appropriate and under supervision, the activity may be extended to include introductory restoration actions, such as supporting peatland recovery efforts or assisting in the controlled removal of invasive species, following established safety and ecological guidelines.

The activity concludes with a discussion of the observed ecological impacts and environmental risks, the ecosystem functions affected, and whether and how NBS could contribute to mitigating these impacts or restoring impaired ecosystem functions. Potential conflicts of objectives, socio-ecological contexts, and any necessary complementary measures are also considered.

Suggested Duration: 85 minutes

- Introduction (and safety briefing): 10 min
- Walk and field observation: 50 min
- Documentation of ecological disturbance indicators: 10 min
- Group reflection and discussion: 15 min

Recommended Group Size: 10 - 25 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking (3.3); Collective Action (4.2); Individual Initiative (4.3).

ESCO Green Skills – conduct environmental surveys; assess contamination; monitor nature conservation; perform environmental investigations; support ecosystem management; safeguard biodiversity; execute habitat restoration.

ESCO Transversal Skills – identify problems; think critically; think analytically; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; process spatial information; report facts; attend to detail; work in teams; demonstrate curiosity; keep an open mind; solve problems; react to physical changes or hazards; demonstrate awareness of health risks; use equipment, tools or technology with precision; participate actively in civic life; manage quality; organise information, objects and resources.

Challenge-based Activity – “Tackling Environmental Challenges”

Description: This activity aims to help students analyse environmental challenge scenarios and design NBS strategies that improve ecosystem resilience and reduce long-term impacts.

Students analyse a real or hypothetical environmental challenge scenario, such as degraded peatlands, climate-vulnerable forests, invasive alien species spread, or biodiversity decline. Based on their analysis, in groups, students develop a strategy to address the respective environmental challenge and examine the potential contribution of NBS. They investigate which societal challenge is being addressed, which ecological processes and ecosystem functions are being utilized or enhanced, what impacts on biodiversity and human well-being are expected, and what conflicting objectives or uncertainties exist. Furthermore, they assess whether complementary management or technical measures are necessary. Based on the identified risks, the learners in groups design an NBS strategy aimed at improving ecosystem resilience and reducing long-term environmental impacts. Finally, learners can present their NBS strategy and explain the role of NBS and any complementary measures within it, for example, using maps, posters, or concept plans. This activity focuses exclusively on conceptual planning and development, not implementation.

After presenting their strategies, the learners reflect on the extent to which the proposed NBS fulfill the previously introduced NBS characteristics, what contribution they can make to addressing the respective environmental challenge, what supplementary measures might be necessary, and what uncertainties and conflicting objectives remain. In doing so, they consider ecological, social, and economic framework conditions, how different NBS options address risks, what uncertainties remain, and how ecological, economic, and social factors influence decision-making.

Suggested Duration: 110 minutes

- Introduction and scenario briefing: 10 min
- Group analysis of the risk and affected ecosystem: 20 min
- NBS strategy design: 30 min
- Preparation of map, poster, or concept plan: 30 min
- Presentations and reflection: 20 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking (3.3); Political Agency (4.1); Collective Action (4.2).

ESCO Green Skills – assess environmental impact; develop environmental remediation strategies; support ecosystem management; interpret climate change impact; implement biodiversity action plans; support urban sustainability; promote sustainability.

ESCO Transversal Skills – identify problems; think critically; think analytically; think holistically; solve problems; plan; make decisions; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; work in teams; build team spirit; demonstrate curiosity; think innovatively; express yourself creatively; keep an open mind; organise information, objects and resources; report facts; address an audience; participate actively in civic life.

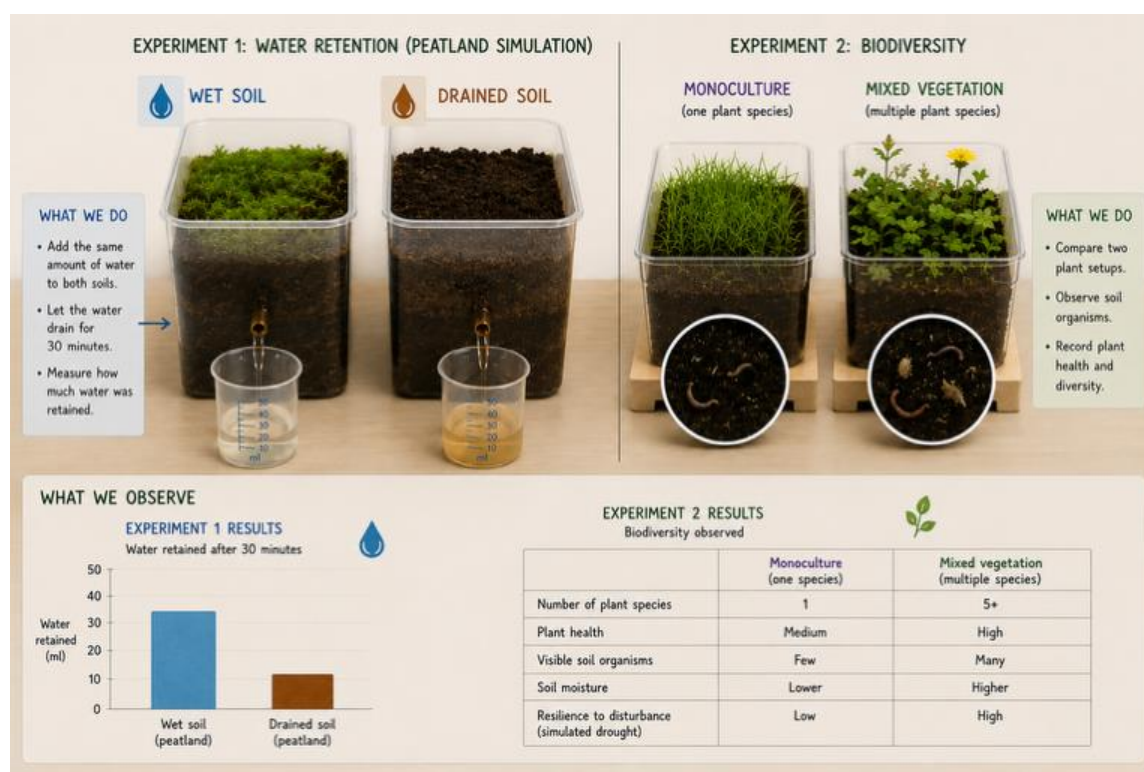
Tactile Activity – “Testing Ecosystem Resilience”

Description: This activity aims to help students explore how ecosystems respond to disturbance and how restoration or measures for more biodiversity can support recovery and resilience of these systems.

Students conduct small-scale laboratory experiment using simple hands-on simulations to explore how ecosystems respond to environmental disturbances and how NBS can support recovery and resilience. Working with controlled experimental setups, students compare variables such as water retention in wet vs. drained soil (peatland simulation) or biodiversity in monoculture vs. mixed vegetation setups. They observe system responses and analyse feedback loops.

The activity concludes with a discussion of which system appeared more resilient, what feedback loops were observed, and how ecosystem restoration or adaptive management can reduce environmental risks.

Figure 7: Example of an Ecosystem Resilience Testing Activity²⁹



²⁹ Illustration modelled with GPT 5.5 (June 2026)

Suggested Duration: 80-100 minutes

- Introduction to resilience and experimental variables: 10 min
- Setup of experimental comparisons: 20 min
- Observation and measurement: 25 min
- Recording and comparison of results: 10 min
- Reflection on restoration and adaptive management: 15 min

Recommended Group Size: 10–24 students, working in groups of 2–4.

Possible Learning Outcomes:

GreenComp Competences – Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking (3.3).

ESCO Green Skills – observe ecosystem functions; understand the concept of ecology; analyse ecological data; assess environmental impact; discuss sustainable technologies; interpret climate change impact.

ESCO Transversal Skills – apply knowledge of science, technology and engineering; think analytically; solve problems; identify problems; think critically; think holistically; carry out calculations; interpret mathematical information; process spatial information; evaluate environmental impact of personal behaviour; organise information, objects and resources; attend to detail; use equipment, tools or technology with precision; work in teams; demonstrate curiosity; keep an open mind; manage quality; report facts; work independently.

References

- Frolking, S., Roulet, N., & Fuglestedt, J. (2006). How northern peatlands influence the Earth's radiative budget: Sustained methane emission versus sustained carbon sequestration. *Journal of Geophysical Research*, 111, G01008. <https://doi.org/10.1029/2005JG000091>
- Gauthier, S., Bernier, P., Kuuluvainen, T., Shvidenko, A. Z., & Schepaschenko, D. G. (2015). Boreal forest health and global change. *Science*, 349(6250), 819-822. <https://doi.org/10.1126/science.aaa9092>
- IPBES (2023). Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Secretariat. <https://doi.org/10.5281/zenodo.7430692>
- Laine, A. M., Ojanen, P., Lindroos, T., Koponen, K., Maanavilja, L., Lampela, M., Turunen, J., Minkkinen, K., & Tolvanen, A. (2024). Climate change mitigation potential of restoration of boreal peatlands drained for forestry can be adjusted by site selection and restoration measures. *Restoration Ecology*, 32, e14213. <https://doi.org/10.1111/rec.14213>
- Leifeld, J., & Menichetti, L. (2018). The underappreciated potential of peatlands in global climate change mitigation strategies. *Nature Communications*, 9(1071). <https://doi.org/10.1038/s41467-018-03406-6>
- Oksanen, E. (2021). Birch as model system for acclimation and adaptation of northern forest ecosystem to changing environment. *Frontiers in Forests and Global Change*, 10. <http://dx.doi.org/10.3389/ffgc.2021.682512>
- Reich, P. B., Bermudez, R., Montgomery, R. A., Rich, R. L., Rice, K. E., Hobbie, S. E., & Stefanski, A. (2022). Even modest climate change may lead to major transitions in boreal forests. *Nature*, 608(7923), 540-545. <https://doi.org/10.1038/s41586-022-05076-3>
- Salemaa, M., Hotanen, J-P., Oksanen, J., Tonteri, T., & Merilä, P. (2023). Broadleaved trees enhance biodiversity of the understorey vegetation in boreal forests. *Forest Ecology and Management*, 546(121357). <https://doi.org/10.1016/j.foreco.2023.121357>
- Salojärvi, J., Smolander, O-P., Nieminen, K., Rajaraman, S., Safronov, O., Safdari, P., Lamminmäki, A., Immanen, J., Lan, T., Tanskanen, J., Rastas, P., Amiryousefi, A., Jayaprakash, B., Kammonen, J. I., Hagqvist, R., Eswaran, G., Ahonen, V. H., Serra, J. A., Asiegbu, F. O. (...), Kangasjärvi, J. (2017). Genome Sequencing and Population Genomic Analyses Provide Insights into the Adaptive Landscape of Silver Birch. *Nature Genetics*, 49, 904-912. <https://doi.org/10.1038/ng.3862>

Chapter IV: Food Production

Summary Overview

Agriculture is one of the leading causes of biodiversity loss worldwide. While agricultural practices in Europe differ greatly across regions in scale, methods and ecological consequences, the intensification of modern farming has largely contributed to declining biodiversity everywhere. The key ecological challenges associated with modern agricultural practices that compromise ecosystems' ability to provide essential services, ensuring food security and environmental health - apart from climate change – are: soil degradation, habitat loss and habitat fragmentation, pollution and changes in water management, and with them, a loss of biodiversity, including of pollinators (e.g. wild bees).

Transforming agriculture to support biodiversity is essential for sustaining ecosystems and securing global food systems. Solutions such as **agroecology**, which is the application of ecological principles to design and manage sustainable agroecosystems, as well as policy-driven incentives and **rewilding**, a restoration approach with minimal human intervention (e.g. low-intensity grazing with habitat restoration, balancing biodiversity goals with limited productivity), demonstrate that a restored balance is achievable. In vocational contexts, these approaches are reflected in everyday agricultural and horticultural practices that promote soil health, biodiversity conservation, and sustainable food production. Examples are **managing grasslands**, **regenerative farming practices**, **conservation of crop wild relatives (CWR)** and **food waste management** (such as composting).

Grasslands for Biodiversity

Permanent agricultural grasslands are known to support a higher level of biodiversity than arable land. The lowest levels of biodiversity tend to be on grasslands with particularly high fertilizer inputs, grazing pressure or frequent mowing operations and temporary grasslands (leys). Temporary grasslands are regularly re-seeded with one or more species of grass or grass-legume mixtures. These are relatively common in dairy production and are part of organic arable farming. Due to a long history of evolutionary co-adaptation between native herbivores and other species, grazing by domesticated livestock is generally associated with higher pastoral biodiversity and is also widely used as a conservation tool. Increasing management pressure along any of the above aspects is likely to adversely affect biodiversity.

Biodiversity can also be enhanced in intensively managed grasslands by **leaving non-productive margins**. It works as a refuge for numerous organisms, such as bumblebees, beetles and spiders, and along watercourses, they can operate as buffer zones for water protection. Restoration of semi-natural grassland commonly involves sowing a seed mixture and direct seeding by transferring hay from a freshly mowed biodiversity-rich donor grassland, while livestock can be used to spread seeds of native species when letting them move across large areas. The optimal idea is to create a spatio-temporal mosaic of highly productive areas, extensively managed parcels and native vegetation.

Figure 8: Examples of Non-productive Grasslands Margins



Note. Example of a mowing refuge in a grassland (left; photo by Jean-Yves Humbert) and a partially fenced grassland margin along a stream supporting biodiversity (right; photo by Irina Herzon).

Regenerative Farming

Regenerative agriculture harnesses natural processes and mimics natural cycles, focusing on photosynthesis and carbon sequestration, nutrient and water cycles, and pollination. Farming becomes a self-renewing process. This paradigm shift towards improving soil health, restoring ecosystems and addressing the global challenges of climate change and biodiversity loss, provides a sustainable pathway for future food production. It requires collaboration between farmers, researchers and policymakers to implement and scale these practices.

Table 2: Examples of Regenerative Farming

Regenerative Farming Practice
Keep fields covered by plants year-round (catch and undersown crop, grasses, winter cereals)
Minimize and appropriate time tillage
Use organic fertilisers and preventive crop protection methods (by using preventive crop protection methods)
Maintain diverse crop rotations (greater diversity of plant species is beneficial)
Increase the share of perennial plants
Incorporate agroforestry practices to enhance carbon sequestration and biodiversity (e.g. windbreaks in fields can support pollinators and natural pest control)
Add biochar to fields
Adopt carbon farming practices on peatlands (by promoting perennial grasses)

Conservation of Crop Wild Relatives

Crop wild relatives (CWR) are wild plant species that are closely related to crops, forming a pool of genetic diversity with superior adaptive traits. They may contain superior adaptive traits against environmental stresses, pests and pathogens. Modern agriculture, however, relies on a limited number of high-yielding crop varieties, which has led to significant genetic erosion. Traditional landraces adapted to diverse and harsh conditions have largely been replaced, resulting in crops that are more vulnerable to climate change, extreme weather, soil degradation, and biotic stresses.

The **conservation of CWR** has become a global priority, and requires close cooperation between stakeholders, researchers, policy makers, economics and many other members of society. Conservation can occur *in situ* (protecting species in their natural habitats) and *ex situ* (i.e. seed banks and botanical gardens). For *in situ* conservation, a proper strategy for habitat management must be created. For example, protective slopes to cool winds are sometimes necessary for the wind-sensitive plants, or increasing topographic heterogeneity and ecological niches is favourable for many plant species. Woody debris often have beneficial effects on soil ecosystems and stabilize near-surface temperature and moisture, while removal of invasive species is increasingly important in warming climates, and connectivity between habitats ensures genetic flow and maintenance of genetic diversity. For *ex situ* conservation, seed banks and botanical gardens are most common.

Table 3: Comparison of In situ and Ex situ Conservation

Comparison Aspects	<i>In situ</i> conservation	<i>Ex situ</i> conservation
Where?	In natural habitats	Outside natural habitats
Purpose	Protect species and their ecosystems	Preserve genetic material
Examples	Habitat management, ecological corridors, invasive species control	Seed banks, botanical gardens
Main advantage	Maintains natural ecological processes and genetic adaptation	Provides long-term genetic storage and supports research and breeding

Food Waste Management

Food production is essential for human well-being, but food waste and overproduction have become a major global challenge. Approximately one-third of all food produced worldwide is lost or wasted, leading to significant economic losses and unnecessary environmental impacts, including greenhouse gas emissions and inefficient use of natural resources. At the same time, food waste represents a lost opportunity for nutrient recycling, particularly for key elements such as nitrogen and phosphorus, which are already under pressure within the Earth's planetary boundaries. In many countries, food waste is still partly incinerated in mixed waste streams, which leads to the loss of valuable nutrients that could otherwise be returned to the soil.

Sustainable food waste management focuses on reducing waste and recovering resources through circular approaches such as **composting** and **anaerobic digestion**. These methods are closely linked to the concept of NBS, as they rely on natural decomposition processes to transform organic waste into useful products. Composting converts food waste into nutrient-rich soil amendments, while anaerobic digestion produces biogas for renewable energy and digestate that can be used as fertiliser. Together, these systems support nutrient recycling, reduce greenhouse gas emissions, and decrease dependency

on synthetic fertilisers. By closing nutrient loops between consumption and food production, food waste management becomes a key element of a more sustainable and resilient food system.

Figure 9: Different Types of Small-scale Composters³⁰



Note. Examples of small-scale composting systems suitable for households, schools, and community gardens. Such systems illustrate how organic waste can be locally transformed into nutrient-rich compost.

Debate: Discussion About Sustainable Food Production Practices

The following discussion questions focus on sustainable food production practices. They can be used by the moderator to guide students in collaborative debates and reflections on several examples of ways to transform agriculture to support biodiversity and the environment.

- How can agricultural grasslands be managed to balance food production with biodiversity conservation?
- Are the discussed measures always NBS? What are the criteria?
- How do regenerative farming practices contribute to ecosystem services such as carbon storage, soil health, and pollination?
- Why is genetic diversity in crops important, and how can the conservation of crop wild relatives help address future agricultural challenges?
- How can food waste management systems (e.g. composting and anaerobic digestion) close nutrient cycles, and what role should individuals, municipalities, and governments play in this process?

³⁰ Top left: <https://foodcycler.com/>; Top right: <https://www.familyhandyman.com/article/what-i-wish-i-knew-before-starting-a-compost-bin/>; Bottom left: <https://www.blackanddecker.com/products/bdstga9701>; Bottom right: <https://www.compostmagazine.com/three-bin-composting-system/>

Proposed Activities

Walking Pedagogy Activity – “Exploring Agroecosystems”

Description: This activity aims to help students observe how food production landscapes can support or limit biodiversity, ecosystem functions, and climate resilience.

Students visit a farm, grassland, (urban) community garden, or other food production landscape to observe how agricultural management practices influence biodiversity and ecosystem functions. During the walk, students identify features such as pollinator habitats, field margins, crop diversity, soil cover, grazing systems, etc. Students reflect on how agricultural systems can balance food production with biodiversity conservation and climate resilience. Where collaboration with farms or agricultural landscapes is limited, teachers may use school gardens, public parks, community gardens, allotments, or virtual field visits to explore similar concepts.

The activity concludes with a reflection on how agricultural systems can balance productivity, biodiversity conservation, climate resilience, and the needs of farmers and local communities.

Suggested Duration: 85 minutes

- Introduction and observation focus: 10 min
- Field visit or site exploration: 50 min
- Documentation of agroecological features: 10 min
- Group reflection and discussion: 15 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Supporting Fairness (1.2); Promoting Nature (1.3); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking (3.3); Political Agency (4.1); Collective Action (4.2).

ESCO Green Skills – understand the concept of agroecology; discuss climate smart agriculture; compare ecological principles; identify crop production principles; describe sustainable agricultural production principles; adopt ways to foster biodiversity and animal welfare; conserve natural resources.

ESCO Transversal Skills – observe critically; think critically; think analytically; process spatial information; apply knowledge of science, technology and engineering; evaluate environmental impact of personal behaviour; identify problems; report facts; attend to detail; demonstrate curiosity; keep an open mind; think holistically; participate actively in civic life; express yourself creatively; organise information, objects and resources; work in teams; make decisions.

Challenge-based Activity – “Designing a Biodiversity-Friendly Food System”

Description: This activity aims to help students apply agroecology and regenerative agriculture principles to redesign a food production area or local food system.

Students work in groups to redesign a farm, food production area, or local food system using principles of regenerative agriculture and agroecology. Their proposals may include measures such as crop

diversification, pollinator support, food waste reduction, etc. Students may present their designs through maps, posters or diagrams. This activity focuses on conceptual planning and design only, not implementation.

After presenting their designs, students reflect on how different strategies contribute to biodiversity, food production, waste reduction, and long-term sustainability, while considering possible trade-offs.

Suggested Duration: 110 minutes

- Introduction to the design challenge: 10 min
- Group analysis of the existing food system or site: 20 min
- Development of biodiversity-friendly strategies: 30 min
- Preparation of map, poster, or diagram: 30 min
- Presentations and reflection: 20 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Supporting Fairness (1.2); Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Adaptability (3.2); Exploratory Thinking. (3.3); Political Agency (4.1).

ESCO Green Skills – understand the concept of agroecology; discuss climate smart agriculture; understand food ethics; ensure responsible sourcing in food supply chains; promote ethical eating; adopt ways to reduce negative impact of consumption; describe sustainable agricultural production principles.

ESCO Transversal Skills – identify problems; think critically; think analytically; think holistically; solve problems; plan; make decisions; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; express yourself creatively; think innovatively; demonstrate curiosity; keep an open mind; work in teams; build team spirit; address an audience; moderate a discussion; participate actively in civic life; organise information, objects and resources.

Tactile Activity – “Exploring Crop Diversity and Seed Conservation”

Description: This activity aims to help students understand the role of crop diversity, crop wild relatives, and seed conservation in supporting future food security and climate adaptation.

Students explore the importance of crop diversity and conservation through virtual learning activities. Using resources such as the Svalbard Global Seed Vault virtual tour, the world's largest seed storage (<https://seedvaultvirtualtour.com>), or Kew Gardens virtual tour (<https://www.youtube.com/watch?v=yyOrRpKZtKY>), a botanical garden famous for genetic diversity of plants, students investigate the role of crop wild relatives, seed banks, and genetic diversity in future food security and climate adaptation. In order to support structured learning, virtual tours may be complemented by reflective worksheets or by the discussion questions provided in this guide. Additional hands-on experiments, such as seed germination tests, could also be further implemented.

The activity concludes with a reflection on why genetic diversity matters for future food systems and how seed banks, botanical gardens, farmers, and communities can contribute to conservation, and how these measures can be considered NBS.

Suggested Duration: 75 minutes for the virtual activity; optional seed germination extension over several days

- Introduction to crop diversity and seed conservation: 10 min
- Virtual tour or guided resource exploration: 30 min
- Worksheet or guided reflection questions: 15 min
- Group discussion: 20 min
- Optional seed germination setup: additional 20–30 min, with follow-up observations over several days

Recommended Group Size: 10–30 students, working individually, in pairs, or in small groups of 3–4.

Possible Learning Outcomes:

GreenComp Competences – Supporting Fairness (1.2); Systems Thinking (2.1); Futures Literacy (3.1); Exploratory Thinking (3.3).

ESCO Green Skills – name plant species; interpret botany; understand the concept of agroecology; conserve natural resources; safeguard biodiversity.

ESCO Transversal Skills – apply knowledge of science, technology and engineering; think critically; think analytically; think holistically; identify problems; solve problems; evaluate environmental impact of personal behaviour; demonstrate curiosity; keep an open mind; organise information, objects and resources; attend to detail.

References

- Ayilara, M., Olanrewaju, O., Babalola, O., & Odeyemi, O. (2020). Waste Management through Composting: Challenges and Potentials. *Sustainability*, 12(11). <https://doi.org/10.3390/su12114456>
- Carver, S., Convery, I., Hawkins, S., Beyers, R., Eagle, A., Kun, Z., Van Maanen, E., Cao, Y., Fisher, M., Edwards, S. R., Nelson, C., Gann, G. D., Shurter, S., Aguilar, K., Andrade, A., Ripple, W. J., Davis, J., Sinclair, A., Bekoff, M., (...), Soul'e, M. (2021). Guiding principles for rewilding. *Conservation Biology*, 35, 1882–1893. <https://doi.org/10.1111/cobi.13730>
- Gliessman, S. R., Engles, E., & Krieger, R. (1998). Agroecology: ecological processes in sustainable agriculture. CRC press.
- Iriondo, J. M., Magos Brehm, J., Dulloo, M. E., Maxted, N. (eds.). (2021). Crop Wild Relative Population Management Guidelines. Networking, partnerships and tools to enhance in situ conservation of European plant genetic resources. *Farmer's Pride*. <http://www.farmerspride.eu/>
- Khoury, C. K., Brush, S., Costich, D. E., Curry, H. A., de Haan, S., Engels, J. M. M., Guarino, L., Hoban, S., Mercer, K. L., Miller, A. J., Nabhan, G. P., Perales, H. R., Richards, C., Riggins, C. & Thormann, I. (2022). Crop genetic erosion: understanding and responding to loss of crop diversity. *New Phytologist*, 233, 84-118. <https://doi.org/10.1111/nph.17733>
- Pereira, L. S. (2017). Water, agriculture and food: Challenges and issues. *Water Resources Management*, 31, 2985–2999. <https://doi.org/10.1007/s11269-017-1664-z>
- Rehman M., Iqbal A., Chang C., Li W., & Ju M. (2019). Anaerobic digestion. *Water Environment Research*, 91(10). <https://doi.org/10.1002/wer.1219>
- Schils, R. L. M., Bufo, C., Rhymer, C. M., René L. M., Francksen, R. M, Klaus V. H., Abdalla, M., Milazzo, F., Lellei-Kovács, E., ten Berge, H., Bertora, C., Chodkiewicz, A., Dămătîrcă, C., Feigenwinter, I., Fernández-Rebollo, P., Ghiasi, S., Hejduk, S., Hiron, M., Janicka, M. (...). (2022). Permanent grasslands in Europe: Land use change and intensification decrease their multifunctionality. *Agriculture, Ecosystems & Environment*, 330. <https://doi.org/10.1016/j.agee.2022.107891>
- Sädeharju, S., Malin, E., & Jääskeläinen, J. (2021). The E-college for Regenerative Farming. Chapter 1: Regenerative Farming & Chapter 2: Soil. *Baltic Sea Action Group*. <https://www.bsag.fi/en/the-e-college-for-regenerative-farming/>

Chapter V: Water Management

Summary Overview

Water is a critical resource for ecosystems, human health, and economic activities, yet its quality and availability are increasingly under pressure. Over 70% of surface waters and nearly 25% of groundwaters are not in good chemical status, which results in biodiversity loss and degraded quality of drinking and bathing water. At the same time, rising temperatures and changing precipitation patterns affect water quality and availability across Europe. Regions in Southern Europe face frequent droughts, while Northern Europe experiences seasonal flooding, requiring adaptive strategies. Additionally, melting glaciers and altered river flows disrupt ecosystems, highlighting the urgent need for sustainable water solutions. Beyond their technical and ecological functions, water management solutions are also shaped by governance processes, stakeholder interests, and decisions regarding resource allocation, maintenance, and long-term planning.

Biological treatment of wastewater and stormwater is a NBS that mimics natural ecosystems to treat polluted water, addressing challenges posed by urbanization, industrialization, and climate change. This cost-effective process of removing organic matter from water using microorganisms to achieve optimal bacterial growth and substrate removal for purification of wastewater and stormwater plays a vital role in sustainable water management by improving water quality while minimizing environmental impact and saving biodiversity. Additionally, **drinking water treatment processes** are essential because even natural water sources often carry impurities that pose significant risks to health and safety. This NBS harness natural processes to filter, purify, and manage water.

NBS of Biological Treatment of Wastewater and Stormwater

One of the most effective NBS of Biological treatment of wastewater and stormwater is **constructed wetlands**, which use vegetation, soil, and microorganisms to remove nutrients, sediments, and pathogens. Other widely used urban solutions include **rain gardens**, which capture and filter runoff while reducing flooding and supporting biodiversity, and **biofiltration systems**, which use porous media colonised by microorganisms to break down pollutants from roads and paved surfaces.

Additional NBS include **verge soakers**, which infiltrate and filter road runoff through vegetated trenches, **permeable (thirsty) pavements**, which allow water to pass through surfaces and recharge groundwater, and **street tree inlets**, which direct stormwater to tree roots for absorption and natural filtration. Together, these systems reduce pollution, mitigate flooding, improve water quality, and enhance urban biodiversity while providing cost-effective and climate-resilient water management solutions. However, they are not always directly and strongly promoting biodiversity, for example when we think of sown grass monocultures; nevertheless, they indirectly promote biodiversity through their cleansing effect.

NBS of Drinking Water Treatment

NBS of Drinking Water Treatment include **natural coagulants** such as plant-based substances (e.g. Moringa seeds, cactus mucilage, and tamarind seed powder) are used to remove suspended particles, bacteria, and other contaminants as biodegradable and low-cost alternatives to synthetic chemicals. Solar-based methods, including **solar disinfection** and **solar water distillation**, use sunlight and heat to inactivate pathogens or evaporate and condense water, producing safer drinking water with minimal infrastructure.

Other solutions rely on natural filtration and ecosystem functions. **Constructed wetlands** use vegetation, soil, and microorganisms to remove nutrients, pathogens, and organic matter from water. **Riparian buffers** and **vegetated filter strips** are planted areas along or near water bodies that slow runoff and trap sediments and pollutants before they reach drinking water sources. **Biofiltration systems** use sand, gravel, or other porous media to support microorganisms that break down contaminants. **Artificial groundwater recharge** improves water quality by allowing surface water to infiltrate and be naturally filtered through soil and rock layers. Lastly, **floating treatment wetlands** use plant roots suspended in water to support microbial activity and remove nutrients and pollutants.

Debate: Discussion About NBS in Water Management

The following discussion questions focus on NBS in water management. They can be used by the moderator to guide students in collaborative debates and reflections on several examples of NBS in water management.

- How do NBS such as constructed wetlands, rain gardens, and biofiltration systems improve water quality and reduce flooding?
- How can urban design (e.g. permeable pavements, street tree inlets) contribute to sustainable water management in cities?
- To what extent can NBS address future water challenges related to climate change, and when might technological solutions still be necessary?
- Who should be responsible for planning, financing, implementing, and maintaining NBS for water management, and how should competing stakeholder interests be balanced?

Proposed Activities

Walking Pedagogy Activity – “Tracing Water”

Description: This activity aims to help students understand how water moves through public spaces and how NBS can retain, infiltrate, slow down, or redirect rainfall.

Students explore a public environment (e.g. school surroundings, neighbourhood streets, parks) to trace how water moves through the landscape. They observe how rainfall is managed in different surfaces and structures, and elements which can be considered NBS, such as rain gardens, green roofs, permeable pavements etc. Students compare areas with high runoff (sealed surfaces) and areas where water is retained, infiltrated, or slowed down by nature-based features. Where possible, they observe visible signs of water stress (e.g. flooding marks, dry soils, erosion) and discuss how design influences water flow. Documentation is done through photos, sketches, and simple mapping.

The activity concludes with a reflection on how urban design shapes water flow and how NBS can reduce runoff, flooding, erosion, and other water-related risks.

Students may work in small groups to present their findings through posters, short videos recorded during the walk, or simple visual diagrams illustrating how water moves through the landscape and how NBS contribute to water retention, infiltration, and flood mitigation.

Suggested Duration: 85 minutes (additional 60 minutes if students prepare and present visual outputs)

- Introduction and route briefing: 10 min
- Walk and observation of water movement: 50 min
- Documentation through photos, sketches, or mapping: 10 min
- Reflection and discussion: 15 min
- Group preparation and presentation of visual outputs: 60 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5 for the preparation and presentation of visual outputs.

Possible Learning Outcomes:

GreenComp Competences – Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Exploratory Thinking (3.3); Collective Action (4.2).

ESCO Green Skills – assess environmental impact; discuss urban sustainability practices; identify ecosystem elements.

ESCO Transversal Skills – process spatial information; think critically; think analytically; observe critically; identify problems; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; think holistically; solve problems; demonstrate curiosity; attend to detail; organise information, objects and resources; report facts; express yourself creatively; work in teams; keep an open mind; participate actively in civic life.

Challenge-based Activity – “Redesigning Water Systems”

Description: This activity aims to help students redesign a local site to improve existing water management by comparing nature-based and engineered solutions and subsequently develop an NBS.

Students work in small groups to redesign a local site (e.g. schoolyard, parking area, street, or neighbourhood) to improve water management using NBS. Based on a given scenario (e.g. urban flooding, stormwater overload, poor infiltration), they identify key problems in water flow and propose spatial interventions such as rain gardens, permeable pavements, green roofs, or street trees. They compare multiple design options and present their choices in terms of effectiveness, resilience, and trade-offs between nature-based and engineered solutions. This activity focuses on conceptual planning and design only, not implementation.

After presenting their designs, students reflect on which interventions are most feasible, how they improve water retention or infiltration, and what trade-offs exist between NBS, engineered infrastructure, cost, accessibility, and maintenance.

Suggested Duration: 100 minutes

- Introduction to the scenario and site: 10 min
- Problem identification and water-flow analysis: 20 min
- Group design of NBS interventions: 35 min
- Comparison of design options and trade-offs: 15 min
- Presentations and reflection: 20 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Supporting Fairness (1.2); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Exploratory Thinking (3.3); Political Agency (4.1); Collective Action (4.2).

ESCO Green Skills – develop flood remediation strategies; support urban sustainability; discuss ecosystem management; assess environmental impact; support sustainable technologies; conserve water resource; recognize environmental engineering; promote innovative infrastructure design.

ESCO Transversal Skills – identify problems; think critically; think analytically; think holistically; solve problems; plan; make decisions; evaluate environmental impact of personal behaviour; process spatial information; apply knowledge of science, technology and engineering; express yourself creatively; think innovatively; work in teams; build team spirit; address an audience; moderate a discussion; organise information, objects and resources; keep an open mind.

Tactile Activity – “Water Retention Lab”

Description: This activity aims to help students test how different surfaces and NBS components influence water absorption, runoff speed, filtration, and water clarity.

Students explore how different surfaces and NBS influence water retention, filtration, and runoff reduction through a hands-on experimental setup. Working in groups, they simulate rainfall on different materials (e.g. soil, gravel, grass, sand, impermeable surfaces) and compare water absorption, runoff speed, and water clarity. This activity can be extended with simple NBS models such as small vegetated trays, or layered soil systems to demonstrate how plants, soil, and microorganisms improve water quality and regulate flow. Students record observations and compare results.

The activity concludes with a reflection on how the experimental outcomes relate to real-world NBS such as rain gardens, permeable pavements, vegetated trays, constructed wetlands, and urban water resilience.

Suggested Duration: 75 minutes

- Introduction and explanation of variables: 10 min
- Setup of materials and rainfall simulation stations: 15 min
- Hands-on testing and observation: 25 min
- Recording and comparison of results: 10 min
- Reflection linking results to real NBS: 15 min

Recommended Group Size: 10–24 students, working in groups of 2–4.

Possible Learning Outcomes:

GreenComp Competences – Promoting Nature (1.3); Futures Literacy (3.1); Exploratory Thinking (3.3); Collective Action (4.2).

ESCO Green Skills – interpret scientific data to assess water quality; monitor water quality; analyse environmental data; identify ecosystem interconnections; discuss sustainable technologies; operate environmental engineering.

ESCO Transversal Skills – apply knowledge of science, technology and engineering; think analytically; solve problems; identify problems; think critically; think holistically; carry out calculations; interpret mathematical information; process spatial information; evaluate environmental impact of personal behaviour; use equipment, tools or technology with precision; organise information, objects and resources; attend to detail; work in teams; demonstrate curiosity; manage quality; report facts.

Inclusive Practice Note

Urban water management and flood risk affect disabled communities in particular, since people with disabilities are disproportionately vulnerable during environmental emergencies³¹. The *Redesigning Water Systems* activity is a good opportunity to ask groups to include at least one accessibility criterion in their proposals, for example making sure that rain gardens and permeable pathways are safe for wheelchair users and people with visual impairments. For the *Tracing Water* walk, trainers should check the route for accessibility in advance and prepare a satellite imagery alternative for learners who cannot access outdoor spaces³². The question of how water-related emergencies are communicated to people with sensory or cognitive disabilities can also be introduced as a thread running through the discussion in all three activities in this chapter.

³¹ Stough, L. M., & Mayhorn, C. B. (2013). Population segments with disabilities. *International Journal of Mass Emergencies and Disasters*, 31(3), 384-402. <https://doi.org/10.1177/028072701303100306>; Fox, M. H., White, G. W., Rooney, C., & Rowland, J. L. (2007). Disaster preparedness and response for persons with mobility impairments: Results from the University of Kansas Nobody Left Behind Study. *Journal of Disability Policy Studies*, 17(4), 196-205. <https://doi.org/10.1177/10442073070170040201>

³² ILO (2013). Inclusion of people with disabilities in vocational training: A practical guide. *International Labour Office, Gender, Equality and Diversity Branch*. <https://www.ilo.org/publications/inclusion-people-disabilities-vocational-training-practical-guide>;

References

- Boelee, E., Janse, J., Le Gal, A., Kok, M., Alkemade, R., & Ligtoet, W. (2017). Overcoming water challenges through nature-based solutions. *Water Policy*, 19(5), 820-836. <https://doi.org/10.2166/wp.2017.105>
- Feng, W., Liu, Y., & Gao, L. (2022). Stormwater treatment for reuse: Current practice and future development—A review. *Journal of Environmental Management*, 301, 113830. <https://doi.org/10.1016/j.jenvman.2021.113830>
- Oral, H. V., Carvalho, P., Gajewska, M., Ursino, N., Masi, F., Hullebusch, E. D. V., Kazak, J., Expósito, A., Cipolletta, G., Andersen, T., Finger, D., Simperler, L., Regelsberger, M., Rous, V., Radinja, M., Buttiglieri, G., Krzeminski, P., Rizzo, A., Dehghanian, K., (...), Zimmermann, M. (2020). A review of nature-based solutions for urban water management in European circular cities: a critical assessment based on case studies and literature. *Blue-Green Systems*, 2(1), 112-136. <https://doi.org/10.2166/bgs.2020.932>
- Vymazal, Jan. (2011). Constructed wetlands for wastewater treatment: five decades of experience. *Environmental science & technology*, 45(1), 61-69. <https://doi.org/10.1021/es101403q>

Chapter VI: Urban Development

Summary Overview

By 2050, 68% of the world's population is expected to live in cities. This rapid trend, known as urbanization, presents both environmental challenges and opportunities. On the one hand, cities can be more resource-efficient per capita than rural areas. For example, infrastructure such as plumbing and district heating systems typically require fewer resources per person in densely populated areas. In addition, urban areas often provide efficient public transportation, reducing reliance on private cars and lowering per capita carbon emissions.

On the other hand, cities are rarely rich in natural ecosystems and are often dominated by concrete, asphalt, and other “lifeless” surfaces, which can restrict natural ecosystems and their functions. Even though these typical urban structures are efficient, they pose environment and human health problems. Challenges such as stormwater runoff and flooding, urban heat islands, poor air quality, and reduced biodiversity highlight the need for effective urban management, where NBS can play a crucial role.

In urban areas, NBS are often planned and implemented as part of green or green-blue infrastructure. Green infrastructure encompasses strategically planned and interconnected green spaces and open areas, while green-blue infrastructure additionally includes water-related elements and processes. Such infrastructures can connect different NBS and help address multiple ecological and societal challenges simultaneously.

Urban NBS can include, for example, specifically designed **urban green spaces**, which contribute to improved air quality, temperature regulation, stormwater management, and both mental and physical well-being. For them to be considered an NBS it is crucial, that they are used specifically to address societal challenges while simultaneously providing ecological benefits. **Green roofs**, for instance, support stormwater retention, enhance energy efficiency, mitigate urban heat island effects, improve air quality, promote biodiversity, and reduce noise levels. Similarly, naturally designed **retention basins (stormwater retention)** or **wet ponds** help reduce flood risk, improve water quality, and create habitats that support biodiversity. Diverse and pollinator-friendly vegetation such as **insect-pollinated vascular plants** can be an important component of urban greening. By strategically integrating suitable flowering plants into green spaces, green roofs or other green infrastructure, habitats and food resources for pollinators can be created, promoting urban biodiversity and supporting ecosystem services for the urban population. Urban green initiatives can thus offer significant ecological and social benefits. However, these are not always distributed evenly and equitably. In some cases, improvements in environmental quality and attractiveness may contribute to rising property values and living costs, potentially limiting access to benefits for vulnerable groups or contributing to processes of ‘green gentrification’. Gentrification describes a displacement effect that accompanies the upgrading and consequent increase in the cost of living in a neighborhood. This price increase can force former residents to relocate to less green areas, as they become unable to afford rising rents. Ensuring equitable access and considering environmental justice principles are therefore important aspects of urban NBS planning and implementation.

Lastly, the implementation of NBS requires **governance** and **planning** practices rooted in stewardship, reflexivity, dialogue, and long-term commitment. Their success in co-creating urban regeneration depends on a combination of enabling factors, including citizen involvement, political support, social inclusion, public acceptance, financial resources, as well as robust monitoring, evaluation, and upscaling mechanisms. Of particular importance are the collaboration and exchange of knowledge between different actors, including public administration, politics, civil society, science, education, and private actors. Political and planning frameworks should therefore consider institutional, legal, social, and

economic aspects throughout the entire NBS process – from the initial idea and planning through collaborative development to implementation and long-term maintenance – and should also incorporate issues of environmental justice.

For a more detailed example of how these urban development concepts can be applied in a course format, please refer to the Municipal Development and Planning module, *NBS in Practice*, designed for Continuous Vocational Education and Training (CVET), as part of the ENABLS Horizon project, in Annex 2 of this document.

Debate: Discussion About NBS in Urban Development

The following discussion questions focus on NBS for urban development. They can be used by the moderator to guide students in collaborative debates and reflections on urban challenges, the presence of NBS in urban settings, as well as the role of governance and policy-makers in NBS.

- What are the main environmental challenges that urbanization poses in urban spaces?
- How do NBS contribute to both environmental sustainability and human well-being in urban areas?
- What roles should citizens, governments, and private stakeholders play in developing NBS in cities?

Proposed Activities

Walking Pedagogy Activity – “Mapping NBS in the City”

Description: This activity aims to help students identify, analyse, and critically assess existing and potential NBS as well as elements of green and green-blue infrastructure (e.g. green roofs, rain gardens, green retention areas) in urban spaces and understand how they contribute to biodiversity, cooling, water management, and human well-being.

Students go on a walk in an urban space (e.g. neighborhood, park) to identify, analyse, and critically reflect on existing and potential NBS. During the walk, they identify NBS and elements of green/green-blue infrastructure (e.g. green roofs, permeable surfaces), their functions (e.g. cooling, water management, biodiversity support), and which societal challenges they address. They also reflect how the observed measures actually constitute NBS, which potential effects they could have and which limitations or conflicts about objectives exist. Where possible, the activity includes interaction with local stakeholders (e.g. municipal representatives, planners), who provide insights into why specific NBS were implemented and discuss potential trade-offs. Students document findings using notes, photos, or maps.

The activity concludes with a discussion comparing observed NBS measures, their functions, potential effects and limitations, and possible improvements that could make urban spaces more resilient, inclusive, and biodiversity-friendly.

Suggested Duration: 90 minutes

- Introduction and mapping focus: 15 min
- Urban walk and identification of NBS elements: 50 min
- Documentation and assessment of functions and limitations: 10 min

- Group reflection and improvement aspects: 15 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Valuing Sustainability (1.1); Supporting Fairness (1.2); Promoting Nature (1.3); Critical Thinking (2.2); Futures Literacy (3.1); Exploratory Thinking (3.3); Political Agency (4.1); Collective Action (4.2).

ESCO Green Skills – defend urban sustainability; select green space strategies; assess environmental impact; understand ecosystem management; discuss sustainable technologies; promote sustainability; engage others in environment friendly behaviours.

ESCO Transversal Skills – process spatial information; think critically; think analytically; observe critically; identify problems; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; think holistically; demonstrate curiosity; attend to detail; organise information, objects and resources; report facts; express yourself creatively; work in teams; keep an open mind; participate actively in civic life; make decisions; moderate a discussion; address an audience.

Challenge-based Activity – “Designing a Climate-Resilient Urban Space”

Description: This activity aims to help students redesign an urban space affected by environmental and climatic challenges using NBS principles that support biodiversity, climate resilience, and human well-being.

The learners work in groups to redesign an urban area affected by, for example, severe heat stress, flood risks, poor air quality, or a lack of green spaces. First, they analyse the initial situation and identify the key challenges and spatial constraints. Based on this, they develop suitable NBS and justify their selection. In doing so, they consider which challenges the proposed measures address, which ecological processes and functions are utilized or enhanced, and what contributions can be expected to biodiversity, climate resilience, and human well-being. Groups then present their proposals. This activity focuses on conceptual planning and design only, not implementation.

After presenting their proposals, learners reflect on the extent to which their designs address the identified challenges, which population groups and other stakeholders could benefit from or be affected by the proposed measures, and what conflicts of objectives, synergies and limitations may arise in the planning and long-term development of urban NBS.

Suggested Duration: 100 minutes

- Introduction to the urban challenge: 10 min
- Group analysis of the site and key problems: 20 min
- Development of NBS design proposal: 35 min
- Presentations: 20 min
- Discussion and reflection: 15 min

Recommended Group Size: 10 - 30 students, working in groups of 3–5.

Possible Learning Outcomes:

GreenComp Competences – Supporting Fairness (1.2); Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Exploratory Thinking (3.3); Collective Action (4.2).

ESCO Green Skills – support urban sustainability; design green space strategies; solve climate change impact; promote sustainability; conserve natural resources.

ESCO Transversal Skills – identify problems; think critically; think analytically; think holistically; solve problems; plan; make decisions; evaluate environmental impact of personal behaviour; apply knowledge of science, technology and engineering; process spatial information; express yourself creatively; think innovatively; work in teams; build team spirit; address an audience; moderate a discussion; organise information, objects and resources; report facts; participate actively in civic life; keep an open mind.

Tactile Activity – “NBS Prototypes in Urban Space”

Description: This activity aims to help students understand how NBS function in urban environments by designing and testing small physical prototypes.

Students design and build simple physical prototypes demonstrating how NBS can function in urban environments. Possible activities include constructing small green roof models, testing permeable pavement materials, comparing temperatures on vegetated and sealed surfaces, or designing miniature urban green infrastructure layouts. Learners investigate the natural processes and ecological functions underlying each NBS and how these can contribute to cooling, rainwater management, or the provision of habitats, for example.

The activity concludes with a reflection on which functions can actually be investigated or illustrated by the models and which effects—for example, on biodiversity or human well-being—cannot be directly assessed using a simplified prototype. Finally, they reflect on the extent to which the observed processes can be transferred to real urban spaces and what spatial, technical, ecological, and social challenges must be considered in the planning and implementation of urban NBS.

Suggested Duration: 90 minutes

- Introduction and prototype options: 10 min
- Planning and material selection: 10 min
- Building prototypes: 35 min
- Testing or observation: 20 min
- Reflection on urban implementation challenges: 15 min

Recommended Group Size: 10–25 students, working in groups of 2–5.

Possible Learning Outcomes:

GreenComp Competences – Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Exploratory Thinking (3.3)

ESCO Green Skills – understand the application of sustainable technologies; understand urban sustainability; name examples of environmental engineering; identify green building practices; promote innovative infrastructure design;

ESCO Transversal Skills – apply knowledge of science, technology and engineering; think analytically; solve problems; identify problems; think critically; think holistically; process spatial information; evaluate environmental impact of personal behaviour; use equipment, tools or technology with precision; organise information, objects and resources; attend to detail; work in teams; demonstrate curiosity; carry out calculations; interpret mathematical information; manage quality; report facts; think creatively; express yourself creatively.

References

- Anguelovski, I., Connolly, J. J. T., Cole, H., Garcia-Lamarca, M., Triguero-Mas, M., Baró, F., Martin, N., Conesa, D., Shokry, G., Del Pulgar, C. P., Ramos, L. A., Matheney, A., Gallez, E., Oscilowicz, E., Máñez, J. L., Sarzo, B., Beltrán, M. A., & Minaya, J. M. (2022). Green gentrification in European and North American cities. *Nature Communications*, 13(1), 3816. <https://doi.org/10.1038/s41467-022-31572-1>
- Hölscher, K., Frantzeskaki, N., Collier, M. J., Connop, S., Kooijman, E. D., Lodder, M., McQuaid, S., Vandergert, P., Xidous, D., Bešlagić, L., Dick, G., Dumitru, A., Dziubała, A., Fletcher, I., Adank, C. G-E., Vázquez, M. G., Madajczyk, N., Malekkidou, E., Mavroudi, M. (...), Vos, P. (2023). Strategies for mainstreaming nature-based solutions in urban governance capacities in ten European cities. *Urban Sustainability*, 3. <https://doi.org/10.1038/s42949-023-00134-9>
- Jennings, V., Larson, L., & Yun, J. (2016). Advancing Sustainability through Urban Green Space: Cultural Ecosystem Services, Equity, and Social Determinants of Health. *International Journal of Environmental Research and Public Health*, 13(2), 196. <https://doi.org/10.3390/ijerph13020196>
- Karamoutsou, L., Veliou, E., Kvernberg, E. B., & Psilovikos, A. (2024). Urban Stormwater Management: A Sustainable Approach. *Water*, 16(15). <https://doi.org/10.3390/w16152089>
- Li, Y., Zhai, W., Yang, Z., Tang, J., Li, H., & Huang, H. (2024). A review of nature-based solutions to environmental hazards through the lens of environmental justice. *SSRN*. <http://dx.doi.org/10.2139/ssrn.4724771>
- Meyer, W. B. (2013). The Environmental Advantages of Cities: Countering Commonsense. <https://doi.org/10.7551/mitpress/9513.001.0001>
- Oberndorfer, E., Lundholm, J., Bass, B., Coffman, R., Doshi, H., Dunnett, N., Gaffin, S., Köhler, M., Liu, K., & Rowe, B. (2007). Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services. *BioScience*, 57. <https://doi.org/10.1641/B571005>
- Perivoliotis, D., Arvanitis, I., Tzavali, A., Papakostas, V., Kappou, S., Andreacos, G., Fotiadi, A., Paravantis, J. A., Souliotis, M., & Mihalakakou, G. (2023). Sustainable Urban Environment through Green Roofs: A Literature Review with Case Studies. *Sustainability*, 15(22). <https://doi.org/10.3390/su152215976>
- Phelan, P., Kaloush, K., Miner, M., Golden, J., Phelan, B., Silva, H., & Taylor, R. (2015). Urban heat island: Mechanisms, implications, and possible remedies. *Annual Review of Environment and Resources*, 40. <https://doi.org/10.1146/annurev-environ-102014-021155>
- Shahmohammad, M., Hosseinzadeh, M., Dvorak, B., Bordbar, F., Shahmohammadmirab, H., & Aghamohammadi, N. (2022). Sustainable green roofs: a comprehensive review of influential factors. *Environmental Science and Pollution Research*. <https://doi.org/10.1007/s11356-022-23405-x>
- Skaldina, O., Nylund, A., & Ramula, S. (2024). Neglected puzzle pieces of urban green infrastructure: richness, cover, and composition of insect-pollinated plants in traffic-related green spaces. *Landscape Ecology*, 39. <https://doi.org/10.1007/s10980-024-01881-5>

United Nations (n.d.) 68% of the world population projected to live in urban areas by 2050, says UN. <https://www.un.org/uk/desa/68-world-population-projected-live-urban-areas-2050-says-un>

Zhang, X., Brandt, M., Tong, X., Ciais, P., Yue, Y., Xiao, X., Zhang, W., Wang, K., & Fensholt, R. (2022). A large but transient carbon sink from urbanization and rural depopulation in China. *Nature Sustainability* 5, 321–328. <https://doi.org/10.1038/s41893-021-00843-y>

Conclusions

NBS provide meaningful opportunities to address environmental challenges while supporting biodiversity, human health and well-being. This Teacher Training Guide highlights the importance of integrating NBS, biodiversity and ecology concepts into TVET and adult education. By combining foundational knowledge with an integrative and hands-on pedagogical approach – through walking pedagogy, challenge-based and problem solving learning and tactical activities – it supports teachers in communicating current environmental challenges while fostering engagement, critical thinking, and problem-solving among learners.

This guide aims to develop the skills, competences, and awareness needed to contribute to more sustainable, resilient, and environmentally responsible systems. It includes several activities to be developed with TVET students and adult education learners. To this end, various possible learning outcomes were proposed from the GreenComp Competences and ESCO Green and Transversal skills, based on the potential of each activity. Across the proposed activities, the GreenComp competences most consistently addressed are Systems Thinking (2.1), Problem Framing (2.3), Exploratory Thinking (3.3), Adaptability (3.2), Futures Literacy (3.1), and Promoting Nature (1.3). Similarly, the activities foster ESCO Green Skills related to ecosystem management, biodiversity conservation, environmental assessment, and sustainable resource management, together with ESCO Transversal Skills such as critical thinking, analytical thinking, problem-solving, teamwork, planning, and decision-making.

Lastly, implementing NBS requires navigating complexity, uncertainty, and often competing environmental, social, and economic interests. Understanding these challenges, alongside the benefits of NBS, is essential for developing systems thinking and enabling learners to critically assess, design, and implement context-specific solutions in real-world settings.

Let's enable society to bend the curve for biodiversity together!

Glossary of Key Terms

Biodiversity

The variety of life on Earth at genetic, species and ecosystem levels. Biodiversity underpins essential processes such as pollination, nutrient cycling and climate regulation, and its loss poses significant risks to human wellbeing.

Ecosystem Services

The benefits that people get from ecosystems, including food and water, climate and flood regulation, recreation and education, and soil formation and nutrient cycling.

eNABLS

Education and Nature-Based Solutions: Bending the Curve for Biodiversity. A Horizon Europe project (2024 to 2026) involving 11 partners across 7 European countries, working to bring NBS into TVET and higher education through Living Labs and curriculum development.

ESCO Green Skills

A set of competencies within the European classification of skills, competences, qualifications and occupations (ESCO) that relate to environmental sustainability. They include skills such as assessing environmental impact, protecting biodiversity and supporting ecosystem management. More details can be found in the [eNABLS-definition](#).

GreenComp

The European Sustainability Competence Framework, developed by the European Commission Joint Research Centre. It sets out 12 competences across four areas and is used throughout this guide to define learning outcomes for all activities. More details can be found in the [eNABLS-definition](#).

Nature-Based Solutions (NBS)

Actions that protect, sustainably manage or restore natural and modified ecosystems in ways that address societal challenges while also delivering benefits for biodiversity and human wellbeing. More details can be found in the [eNABLS-definition](#).

Peatland

A wetland where partially decomposed organic matter builds up over time under waterlogged conditions. Peatlands store large amounts of carbon and play an important role in regulating water and supporting biodiversity.

Resilience

The ability of a system, whether ecological, social or urban, to absorb disturbance, adapt to change and keep functioning when it is put under stress.

Systems Thinking (GreenComp Competence 2.1)

The ability to understand how the parts of a complex system are connected, and to recognise the feedback loops, trade-offs and unintended consequences that can arise from changes within it.

TVET (Technical and Vocational Education and Training)

Education and training that gives learners the knowledge, skills and competencies they need for a specific occupation or trade. TVET teachers and trainers are the main audience for this guide.

Walking Pedagogy

A way of teaching that uses movement, exploration and direct contact with the physical environment as tools for learning. It is one of the three core activity types in this guide.

Crisis Communication

The way that accurate and timely information is shared with the public before, during and after an emergency. Good crisis communication must reach everyone, including people with sensory, cognitive or physical disabilities.

Disability

According to the UN Convention on the Rights of Persons with Disabilities, disability arises from the interaction between a person's impairments and the attitudinal and environmental barriers that prevent their full and equal participation in society. It includes physical, sensory, cognitive and psychosocial dimensions.

Environmental Justice

The idea that the benefits and burdens of environmental change should be shared fairly across all communities, with particular attention to groups who are most affected and least heard, including people with disabilities.

Inclusive Education

An approach to education that makes sure all learners, including those with disabilities, can access, take part in and benefit from quality learning. It requires activities and environments to be designed accessibly from the start, rather than adapted later.

Universal Design for Learning (UDL)

A framework for designing teaching and learning that anticipates the diversity of learners from the start, offering multiple ways of engaging with content, representing information and demonstrating understanding.

Urban Resilience

The capacity of a city and its communities to prepare for, respond to and recover from environmental, social and economic shocks while keeping essential services running. NBS for water management and urban development play an important role in building urban resilience.

Walking Pedagogy for Inclusive Practice

Where full outdoor access is not possible, walking pedagogy activities can be adapted using virtual field trips, citizen science apps or satellite imagery tools. Trainers should always check routes for accessibility in advance and have an indoor or digital alternative ready.

2. NBS Basics Module

2.1. Fundamentals of NBS for VET

Course Name: A Walk Through a Green Space: Designing Habitats for Humans and Wildlife

Organisers: Initial Vocational Education and Training (IVET) Providers

Short Description:

This IVET course introduces students to nature-based solutions (NBS) through interactive, hands-on learning in a public green space setting. Students explore how trees, plants, and animals contribute to livable, biodiverse public spaces. Through experiments, interactive stations, and innovative design tasks, students apply their insights to conceptually redesign a grey area into a green, multifunctional habitat that benefits both people and wildlife.

Topics:

The course focuses on NBS in public environments, highlighting the interactions between soil, plants, water, and animals that create healthy ecosystems. Participants explore how trees, vegetation, and biodiversity work together to regulate temperature, manage stormwater, prevent erosion, and support pollinators and wildlife. Key topics include biodiversity, soil functions, water infiltration, erosion control, urban heat islands, pollination and ecosystem services. Using an interdisciplinary approach, the activity connects ecology, environmental education, and urban planning while demonstrating how green infrastructure supports both human well-being and animal life in dense urban environments.

Target audience:

IVET Students

Recommended Group Size: class-size (flexible, e.g. 10-25 students)

Prior Knowledge: basic knowledge on ecosystems and biodiversity. No advanced prior knowledge of NBS is required.

Interest in nature, ecology, public green spaces, and interactive activities

Methodology:

The educational approach combines experiential learning, role play, and inquiry-based methods tailored to adolescents and young adults. Hands-on experiments, sensory exploration, and guided reflection foster understanding of ecological and NBS concepts. Group-based activities encourage cooperation and creativity, while the walk through the public green space connects real urban spaces with learning. Walking pedagogy serves a flexible and transformative way to get students thinking deeply about the context of the places in which they are working and living, and promotes inclusion, connection with students, the environment, and communities.

Suggested Duration: Approximately 180–190 minute

Introduction to NBS and ecosystems: 20–30 min

Introduction to the walk and assignment of "System Web" roles: 10 min

Walk through the public green space: 90 min

Interactive design task: 40 min

Presentations: 20 min

Intended Learning Outcomes:

GreenComp Competences: Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Exploratory Thinking (3.3); Collective Action (4.2).

ESCO Green Skills: understand the concept of ecology; connect how soil, plants, water, and animals interact in an ecosystem; support urban sustainability; safeguard biodiversity; analyse ecological data; analyse environmental data; conduct environmental investigations; assess environmental impact; discuss climate change impact; design green space strategies; conserve water resources; compare sustainable technologies; develop environmental remediation strategies; distinguish between plant species.

ESCO Transversal Skills: think critically; think analytically; think holistically; solve problems; identify problems; make decisions; plan; work in teams; build team spirit; demonstrate curiosity; observe critically; process spatial information; organise information, objects and resources; report facts; attend to detail; moderate a discussion; address an audience; express yourself creatively; think creatively; think innovatively; evaluate environmental impact of personal behaviour; participate actively in civic life.

Activities with audience:

The course includes an introductory session, a walk through a public green space with four stations containing experiments and interactive discussions, and finally, an interactive design phase. Students are initially assigned "system" roles, which will help them explore each station from a certain point of view, with discussions in order to better understand other actors' points of view as well.

Students explore soil, sensory, and temperature experiments, while having a walk through a public green space. This may be, for example, a park or a forest. It is important that at least part of the area is

not regularly maintained. Activities take place outdoors and indoors. Materials include experimental setups, natural objects, thermometers, worksheets, and craft materials for the habitat creation. For a detailed description of the course, please see below.

The course is structured into three interconnected sections that progressively build students' understanding of NBS. The first section will consist of a brief introduction to NBS and a reactivation of prior knowledge on biodiversity and ecosystems. This part of the course can take place either indoors or outdoors in a suitable area of the chosen public green space (e.g. seated in an open grass area). Although this section is theoretical, concrete examples of NBS are provided to ensure that learning remains experiential, and directly connected to real-world contexts. Please find possible examples in the Supplementary Document (.pptx) in Annex 1 of this document, as well as other information needed for this section of the course. The Supplementary Document should always be adapted to the students' prior knowledge, educational contexts and learner profiles, so that the examples and activities are appropriate for the current audience. A systems-thinking exercise may also be incorporated by posing and discussing questions such as, "If we mow less often, what changes?" or "If we plant trees in a specific area, who benefits and how?". These guiding questions can help prepare students for the walk, where they will see NBS unfolding in a real setting.

The second section of the course is a walk through a public urban (green) space, with four thematic stations, each combining observation, simple experiments, and guided discussion. If not feasible, some of the stations can also be built indoors, before or after the walk. These stations were designed to cover different examples of how NBS can be used in urban spaces. Those are, for example, habitat provision, biodiversity support, water management, and heat reduction. At first, students arrive at the chosen public green space. If there is information on species' geographical origins, number of species, and the presence of smaller taxonomic units, students may be briefly introduced to it. Then, they are informed about the walk and that there will be several stations along the way.

Before starting the walk, students may initiate the **"System Web" activity**, which starts by picking a "role". This activity allows students to understand the interconnectivity of systems' elements, its needs, difficulties, and ongoing interaction. For this, there will be cards with pictures. There will be the same number of cards for every picture, such that the groups will have the same number of students (this is especially important for the last design activity). The broader roles would be: 1) Pollinators (wild bees, butterflies), 2) Soil Life (earthworms, fungi, microbes), 3) Urban Wildlife (birds, hedgehogs, bats), and 4) Humans. After choosing their card, the learner would belong to each broader role, respectively. **For this activity, in each station, they are invited to think from their role's perspective: "What do I need here?", "What helps me?", "What causes problems/is difficult?", and then one or two people of each group briefly say one or two words. This way all roles are aware of the other actor's needs, difficulties, and their interconnectivity.**

Station 1: Biodiversity: "Who lives here and why?"

In the first station, an area with diverse vegetation (e.g. different trees, shrubs, grass, meadow), students are free to observe the different plants and possible signs of animals. During 15min, each student would walk around the area and, with the support of an observation sheet or clipboard, write down the species and elements they see, as well as any signs of animals. For instance, guiding questions can be: "What kinds of plants do you see?", "What animals might use this space?", "Where could they hide, feed, nest?". This station could be further supported by potentially showing students different taxidermied animals, and discussing whether they could be found there, where would they hide, feed, nest. The idea is that diverse plant layers create multiple habitats, supporting a wider range of species. And that this constitutes an NBS for biodiversity, since no technical infrastructure is required and

ecological processes are allowed to function naturally. Before continuing the walk, the questions regarding the “System Web” activity are discussed.

Station 2: Water and soil: “What happens below our feet?”

This station will ideally be located in a place where students can see different types of soil management. For instance, grassland or meadow and unpaved road versus concrete or asphalt. It will consist of an infiltration experiment on-site. For that, there will be different water bottles with different soils inside (e.g. vegetated soil, compacted soil, rocks), and containers that will retain the water after. The goal is to observe how fast water infiltrates and how soil reacts. A visual example of the proposed experiment can be found in Figure 1. The idea is that soil acts as an infrastructure and a natural water management agent, such that it absorbs water, stores it, and supports life, in ways that floods and erosion are reduced and plants survive drought. This demonstrates how soil functions as an NBS by replacing technical drainage systems through natural infiltration and storage. Before continuing the walk, the questions regarding the “System Web” activity (described above) are discussed.

Figure 10: Water and Soil Experiment



Note. Photo by Julia Fellingner (3s) as part of the eNABLS project pilot

Station 3: People and Climate: “Why this matters for humans”

This station will be located in a place where there is a variety of surface types and vegetation structures. For example, shade areas (provided by trees, shrubs), open area (grass or meadow), human-made open area (paths, edges of built space). The goal is that there is a variety of options where students can feel temperature differences, and observe comfort, shade, noise. Students will be given 15min to explore the area and with a simple map sketch heat zones. This activity can also be supported by providing students with thermometers. For that, students could organize in groups (“System Web” activity). Additionally, students could also explore “texture hunting”, by recording different tree textures. For that, they would need a kneadable eraser or non-toxic clay pressed on tree surfaces, then inked (portable ink pad) and stamped into a piece of paper. The goal is for students to understand how trees and green spaces reduce heat stress, improve well-being, and increase the usability of urban spaces. Before continuing the walk, the questions regarding the “System Web” activity are discussed.

Station 4: Experimental zone: “Testing NBS in real life”

The last station serves a way to observe a living example of NBS: an unmanaged (e.g. unmowed) area of the public green space. Students have 15min to go around this area and observe plants and animals. They can use resources such as an observation sheet or clipboard to report what they observe. Additionally, students can use apps, such as *ObsIdentify* (or *Google Lens* etc.), to identify the species they encounter. Lastly, students could also do “texture hunting”, by recording different tree and plant

textures. The goal is to understand and discuss what happens when you do not maintain grass intensively but test plant diversity. Before finishing the walk, the questions regarding the “System Web” activity are discussed.

The final section of the course consists of an interactive design and presentation phase, which takes place indoors or outdoors, if suitable space is available. Students work in small groups (according to the “System Web” activity) and are presented with a concrete, real-life challenge: the redesign of a garden / backyard or the like, affected by biodiversity loss. Based on the observations made during the walk, the groups develop NBS by allocating space for vegetation, animals, and human use in a balanced and interconnected way. The aim is to demonstrate how NBS can simultaneously increase biodiversity, reduce flood risk or heat stress, and improve human well-being. For this activity, students are provided with visual materials (e.g. maps or photos of the site) and simple design objects to support discussion, planning, and creative thinking. Finally, each group gives a brief presentation of their model design, explaining how their proposed measures function as NBS for biodiversity while simultaneously addressing climate adaptation and human well-being. If visual support is used (e.g. PowerPoint slides), Figure 2 below shows an example of the proposed presentation structure.

Figure 11: Presentation Structure



Bibliography:

Friedman, S., Morrison, S. A., & Rickards, A. (2025). Moving towards inclusion and connection: practitioners' conceptualisations of walking pedagogy. *Children's Geographies*, 23(2), 157-171. <https://doi.org/10.1080/14733285.2025.2476427>

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42(2), 99–107. <https://doi.org/10.1080/00461520701263368>

Palmer, J. A. (1998). *Environmental Education in the 21st Century*. London: Routledge.

Qualmann, C., & Morris, B. (2025). Encountering Olympic landscapes: walking as a pedagogic tool in Stratford, London. *Research in Drama Education: The Journal of Applied Theatre and Performance*, 30(4), 718-738. <https://doi.org/10.1080/13569783.2025.2557841>

Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. *Trends in Cognitive Sciences*, 12(11), 411–417. <https://doi.org/10.1016/j.tics.2008.07.006>

3. NBS Municipal Development & Planning Module

3.1. NBS in Practice

Course Name: Climate Walks for Municipal Development and Planning

Organizers: IVET or Continuous Vocational Education and Training (CVET) Providers, adult learning organisations



Short Description:

This VET course introduces learners to municipal development and planning through a Climate Walk focused on nature-based solutions (NBS) in real municipal settings. Moving from station to station, learners engage with stakeholders to explore implemented NBS interventions addressing challenges such as climate adaptation, biodiversity loss, urban resilience, and quality of life. Through observation, discussion, and critical reflection, participants examine how planning decisions shape municipal environments and evaluate the social, environmental, and practical impacts of nature-based interventions in practice.

The course is designed as a flexible and adaptable module that can be implemented in different municipalities according to their own spatial planning context, public spaces, and local examples of NBS. Before the course takes place, the VET or adult learning provider, preferably in collaboration with the municipality, identifies suitable NBS examples, selects Climate Walk stations, and contacts relevant stakeholders. It consists of 4 possible steps: a planning, implementation, reflexion and design phase.

Where appropriate, instead of being organised by the VET provider and relevant stakeholders, the Climate Walk may be preceded by a preparatory lesson or project in which learners take an active role in designing the walk. Working individually or in small groups, learners investigate the local spatial planning context, identify existing, planned, or potential NBS examples, select possible walk stations, identify experts, prepare guiding questions, and gather relevant information about each site.

With support from the trainer, they may also contribute to contacting stakeholders or preparing short presentations for the walk. During the Climate Walk, learners can then act as guides, presenting selected stations and facilitating discussion with other participants. This option would strengthen learner ownership and support the development of organisational, communication, research, and civic participation or active citizenship skills.

Topics:

The course focuses on municipal development and planning through NBS, with themes varying according to the local context (i.e. rural, urban), implemented NBS interventions, and participating stakeholders. Participants explore how public municipal spaces respond to environmental challenges through NBS. Key topics may include, for example, urban heat reduction, stormwater and flood management, biodiversity enhancement, green infrastructure, public space design, sustainable and inclusive mobility. Additional topics may include participatory planning, stakeholder engagement, and

balancing different social, environmental and economic priorities in municipal decision-making. At each station, stakeholders provide practical insight into a specific NBS implementation, its planning processes, and long-term impacts. However, the stations are not intended only as moments of knowledge transfer: learners are also encouraged to observe the site directly, ask questions, discuss different perspectives, and reflect on how the intervention affects the surrounding environment, community, and planning context. Using an experiential learning approach, structured through introduction, direct experience, and reflection, and drawing on walking pedagogy as learning through movement and exploration, the course connects municipal planning, environmental, social, and economic education, and stakeholder engagement, highlighting how NBS support sustainable and adaptive municipal development.

Target audience:

IVET learners, CVET learners and adult learners

Recommended Group Size: class-size (flexible, e.g. 10-25 participants)

Prior Knowledge: basic knowledge of ecosystems and urban planning. No advanced prior knowledge of NBS is required.

Interest in nature, ecology, public green spaces, and interactive activities

Methodology:

The educational approach combines experiential learning, walking pedagogy, and challenged-based learning tailored to CVET learners and adult learners. Through direct engagement with real municipal spaces, stakeholder interaction and collaborative discussion, learners explore how NBS are planned, implemented, and experienced in practice.

Walking pedagogy forms a central component of the course by promoting learning through movement and exploration. This form of pedagogy is used to promote inclusion and connection with learners, the environment, and communities, and has been described as a flexible and transformative approach that encourages learners to critically reflect on the contexts and places in which they live and work. Climate Walks are an accessible way to explore different perspectives, become more attuned to the environment, and, ideally, gain a more holistic view of the implementation of NBS. Furthermore, their non-hierarchical structure provides an opportunity to foster dialogue between speakers and participants.

In addition, challenge-based and inquiry-based perspectives, are integrated through the municipal planning design task, as well as through the collaborative discussions throughout. Lastly, assessment is based on learners' active participation throughout the course, including engagement in discussions, observation and reflection aspects, contributions to the "System Web" activity, and the collaborative participation in the municipal planning design task.

Recommended Number of Stops: 4-5 stops.

Suggested Duration including all proposed steps: Approximately 210–230 minutes (3.5–4 hours)

- Introduction to NBS for municipal development and planning: 20–30 min
- Introduction to the Climate Walk and instructions: 10 min
- Climate Walk: 90 min
- "System Web" activity: 30–40 min
- Municipal planning design task: 60 min

Intended Learning Outcomes:

GreenComp Competences: Supporting Fairness (1.2); Promoting Nature (1.3); Systems Thinking (2.1); Problem Framing (2.3); Futures Literacy (3.1); Exploratory Thinking (3.3); Collective Action (4.2).

ESCO Green Skills: recognize forms of urban sustainability; discuss ecosystem management; assess environmental impact; examine green space strategies; compare sustainable technologies; understand the importance of safeguarding biodiversity; examine the implementation of biodiversity action plans; discuss the development of environmental remediation strategies; promote sustainability; recognize the various perspectives and planning priorities for environmental policy.

ESCO Transversal Skills: think critically; think holistically; identify problems; solve problems; plan; build team spirit; keep an open mind; demonstrate curiosity; process spatial information; moderate a discussion; address an audience; participate actively in civic life; evaluate environmental impact of personal behaviour; think innovatively.

Activities with audience:

The Climate Walk forms the core of the course. It is preceded by an introductory session on NBS for municipal development and planning phase, and followed by a "System Web" activity and a municipal planning design task, which support learners in actively applying their learning.

The number of stops in the Climate Walk may vary depending on the educational context and location, but it is recommended that the walk remain a manageable duration (e.g. 1 hour) in order to maintain learner engagement. In addition, it is important to maintain a walking distance between each stop to allow time for reflection on the various inputs and to give learners an opportunity to engage in discussion. An overall distance of 1 – 1.5 km is recommended. Activities take place primarily outdoors and, if selected for the introductory or concluding phases, indoors. Materials may include maps, observation sheets, photographs of the sites, clipboards, and writing materials.

The **introductory session** can take place either indoors or outdoors in a suitable area of the chosen public municipal space. If outdoors, this may function as the first station and be moderated by the trainer. Although this section is theoretical, concrete examples of NBS are provided to ensure that learning remains experiential and directly connected to real-world contexts. Please find possible

examples in the Supplementary Document (Annex 2), as well as other information needed for this section of the course. The Supplementary Document should always be adapted to the learners' prior knowledge, educational contexts and learner profiles, so that the examples and activities are appropriate for the current audience.

As an option, this phase can be followed by a **planning phase by the learners**, in which they take an active role in designing the walk. Working individually or in small groups, learners investigate the local spatial planning context, identify existing, planned or potential NBS examples, select possible walk stations, identify experts, prepare guiding questions, and gather relevant information about each site.

With support from the teacher or trainer, they may also contribute to contacting stakeholders or preparing short presentations for the walk. During the Climate Walk, learners can then act as guides, presenting selected stations or introducing experts, and facilitating discussion with other participants. This option would strengthen learner ownership.

The second, and core, part of the course consists of the **Climate Walk**, which may begin with an introduction by the trainer regarding the structure of the walk, including the number of stops, overall topics and goals, estimated duration, as well as the importance of getting to know different perspectives and talking about them with people they have not yet met. The group walks together between the selected stops, where the responsible stakeholder presents a concrete example of an implemented NBS intervention, its objectives, planning process, and long-term impacts. This input is followed by participants actively observing and analysing the site, for example by identifying visible NBS elements, considering how the space is used, discussing who benefits from the intervention, noticing possible limitations or trade-offs, or reflecting on how the intervention affects the surrounding environment, community, and planning context. After each stop, the stakeholders give participants a simple question or task to work on 1-on-1 as they make their way to the next station. This is intended to encourage the participants to exchange ideas and engage in discussion, as well as to become more aware of their surroundings and reflect on them.

Figure 12: Climate Walk Stop Example



Note. Photo by Julia Fellingner as part of the eNABLS Project

After the walk, learners take part in the experiential **“System Web” activity**, typically indoors, similarly to the NBS Basics module, *Fundamentals of NBS for VET*, in which they adopt the perspectives of different elements within the system. Depending on the focus of the Climate Walk, these perspectives may represent different species within the ecosystem or different stakeholders involved in municipal planning and development. For example, learners may take the role of local residents, municipal planners, or urban wildlife. Through guided reflection questions, learners consider how each intervention affects different actors, what benefits or challenges emerge, and how environmental, social, and practical needs interact. The activity supports systems thinking by helping learners understand the interconnectedness, needs, and potential conflicts involved in planning and implementing municipal NBS interventions.

Lastly, learners participate in a **municipal planning design task**, which typically takes place indoors. In this activity, learners work in small groups and are presented with a concrete planning challenge, connected to the municipal context explored during the Climate Walk. This may include either a site visited during the walk or another relevant area within the same municipality. Based on their observations and discussions throughout the course, as well as the different perspectives taken as part of the “System Web” activity, the groups propose a NBS intervention that responds to identified environmental and social challenges. The aim of this activity is to demonstrate how NBS can support sustainable municipal development by simultaneously addressing climate adaptation, biodiversity, and urban resilience, while also requiring the consideration of multiple stakeholder perspectives and planning priorities.

Bibliography:

Climate Walk (2022). Climate Walk By the Wanderers of Changing Worlds. <https://www.climatewalk.eu/>

Friedman, S., Morrison, S. A., & Rickards, A. (2025). Moving towards inclusion and connection: practitioners' conceptualisations of walking pedagogy. *Children's Geographies*, 23(2), 157-171. <https://doi.org/10.1080/14733285.2025.2476427>

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42(2), 99–107. <https://doi.org/10.1080/00461520701263368>

Palmer, J. A. (1998). Environmental Education in the 21st Century. London: Routledge.

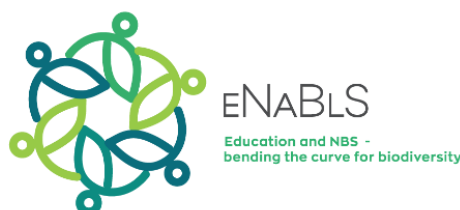
Qualmann, C., & Morris, B. (2025). Encountering Olympic landscapes: walking as a pedagogic tool in Stratford, London. *Research in Drama Education: The Journal of Applied Theatre and Performance*, 30(4), 718-738. <https://doi.org/10.1080/13569783.2025.2557841>

Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. *Trends in Cognitive Sciences*, 12(11), 411–417. <https://doi.org/10.1016/j.tics.2008.07.006>

About ENABLS

ENABLS aims to lay the foundation for networking and collaboration that promotes transdisciplinary dialogue and integrates NBS concepts and approaches across universities, TVET schools, the professional sphere, and society at large. The initiative focuses on developing and scaling relational and applied forms of teaching, learning, and capacity building, while promoting a Whole Institution Approach – where universities themselves act as Living Labs. ENABLS also prioritizes human health and well-being, social equity, and employment opportunities.

To achieve this, ENABLS established Living Labs in seven countries – Germany, the Netherlands, Finland, Austria, Lithuania, Greece, and Czechia. These Living Labs serve as multi-actor platforms that foster transdisciplinary dialogue and engage all levels of society to address biodiversity loss holistically. They support a just transition by greening the economy in a fair and inclusive way, creating meaningful work opportunities, and ensuring that no one is left behind.



Partners



Annex 1

Module 1 – Supplementary Document: Fundamentals of NBS for VET



Fundamentals of NBS for VET

NBS Basics Module

June 2026

Nature-based Solutions (NBS)

- Use ecosystems and the services they provide to address societal challenges (e.g. climate change, food security, natural disasters).
- Solutions to work with ecosystems rather than relying on conventional engineering interventions, to adapt and mitigate climate change effects.
- Can be used in conjugation with other intervention types.



Nature-based Solutions (NBS)



- 🔗 **Nature** relates to biodiversity (species, habitats, ecosystems) and/or ecosystem services.
- 🔗 **Nature-based** refers to ecosystem approaches, or direct utilization of elements of biodiversity.
- 🔗 **Solutions** refers to a specific problem or challenge for which some recognizable solution or more beneficial outcome exist.



Definitions

“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.” (IUCN, 2016)

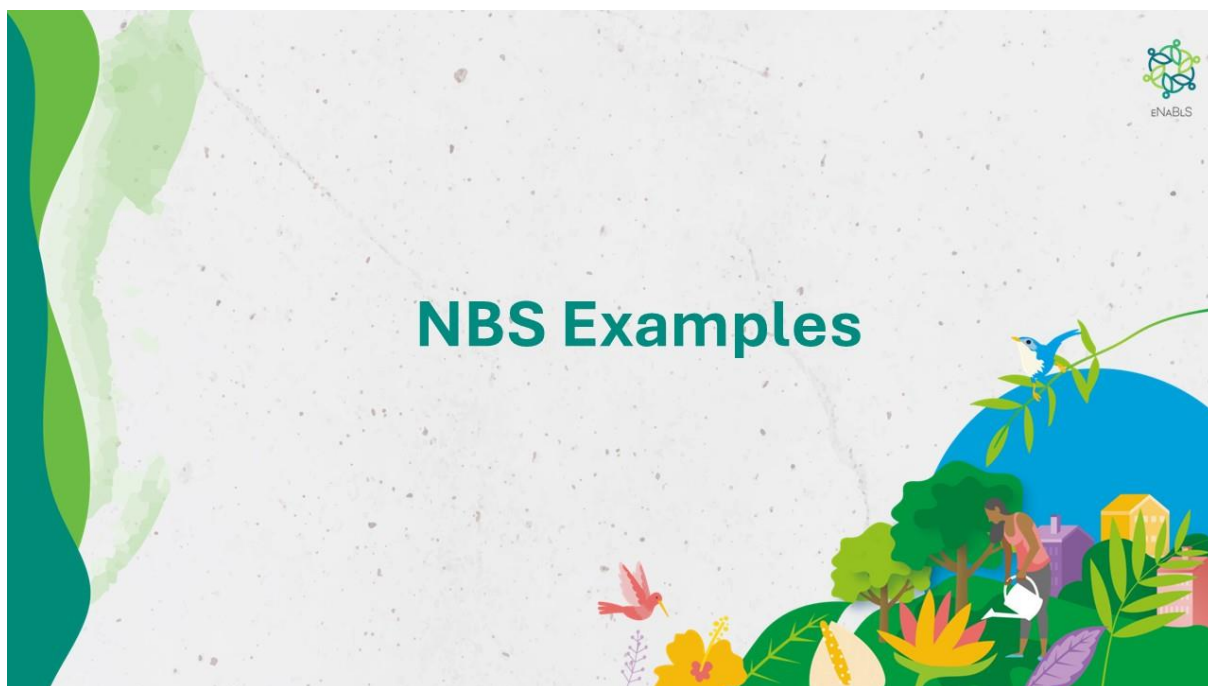
“Actions inspired by, supported by or copied from nature and which aim to help societies address variety of environmental, social and economic challenges in sustainable ways.” (European Commission, 2015)

NBS Goals



Research & Innovation Agenda on Nature-Based Solutions and Re-Naturing Cities	
Goals	Research & Innovation Actions
Enhancing sustainable urbanisation	 Urban regeneration through nature-based solutions
	 Nature-based solutions for improving well-being in urban areas
Restoring degraded ecosystems	 Establishing nature-based solutions for coastal resilience
	 Multi-functional nature-based watershed management and ecosystem restoration
Developing climate change adaptation and mitigation	 Nature-based solutions for increasing the sustainable use of matter and energy
	 Nature-based solutions for enhancing the insurance value of ecosystems
Improving risk management and resilience	 Nature-based solutions for enhancing the insurance value of ecosystems
	 Increasing carbon sequestration through nature-based solutions

European Commission, 2015



Ecosystem Restoration

- 🌿 Reforestation and replantation of native vegetation to restore degraded landscapes.
- 🌿 Restoration of wetlands to improve water quality and biodiversity.
- 🌿 Regeneration of coral reefs and revitalization of depleted fisheries.
- 🌿 Rewilding of landscapes with key species in restoring and maintaining the structure and function of ecosystems.



CC-BY Creative Commons License (left: by Michael Hunter, right: by Warren Gold)

Ecosystem Protection



- 🌿 Conservation of undisturbed semi-natural areas to maintain their ecological integrity and the services they provide.
- 🌿 Establishment of protected areas to preserve wilderness and conserve biodiversity (e.g. *Natura 2000* – EU’s network of protected sites that conserve Europe’s most valuable species and habitats).
- 🌿 Restoration of degraded peatland ecosystems to mitigate climate-related challenges.
- 🌿 Indigenous land tenure systems, empowerment of local communities in natural resource management through initiatives.



CC-BY Creative Commons License (by Nicholas A. Tonelli)

Green-blue Infra and Sustainable Urban Design



- 🌿 Design, planning and implementation of infra and systems that integrate natural elements, offering multiple benefits to humans and the environment.
- 🌿 Installation of green roofs and walls.
- 🌿 Permeable pavements to enhance water management.
- 🌿 Creating green corridors and spaces.
- 🌿 Community gardens.
- 🌿 Fostering human-nature interaction in urban settings.



CC-BY Creative Commons License
(top: by Julian Osley; down: by Ciara Ní Riain)

Ecosystem-based Approaches (EbA) & Ecosystem Disaster Risk Reduction (Eco-DDR)



- 🔗 EbA focus on climate-related hazards to slow-onset climate change impacts, such as sea level rise.
- 🔗 Agroecological methods to restore and maintain soil health and protect water resources.
- 🔗 Mangrove restoration and sustainable management of forests as climate change resilience strategies.



CC-BY Creative Commons License (by NOAA)

Ecosystem-based Approaches (EbA) & Ecosystem Disaster Risk Reduction (Eco-DDR)



- 🔗 Eco-DDR addresses both climate-related (e.g. heat waves) and non-climate hazards (e.g. earthquakes).
- 🔗 Restoration of coastal wetlands to mitigate coastal erosion and provide flood protection.
- 🔗 Maintenance of healthy ecosystems to reduce the likelihood and severity of wildfires and landslides on forested mountains and slopes (stabilizing sediments).



CC-BY Creative Commons License (by Louisiana GOHSEP)

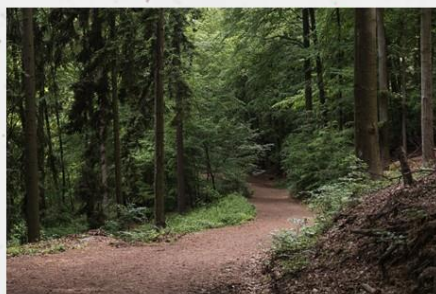
References



- 👤 Eisenber, B., & Polcher, V. (2019). Nature Based Solutions -Technical Handbook. *Personal Communication*, 2020-02.
- 👤 European Commission: Directorate-General for Research and Innovation (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities – *Final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' – (full version)*. Publications Office. <https://data.europa.eu/doi/10.2777/765301>
- 👤 IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. International Union for Conservation of Nature. <https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf>
- 👤 Jones, M., Keryan, T., de Wit, M., & Klawitter, J. (2024). Comprehensive Overview of Nature-Based Solutions: Harnessing Nature for Environmental and Social Benefits. eNaBS Project Consortium. https://enabls.eu/wp-content/uploads/2025/07/eNaBS_A_comprehensive_overview_to_NBS_v1.0.pdf
- 👤 Sowińska-Świerkosz, B., & García, J. (2022). What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. *Nature-Based Solutions*, 2(100009). <https://doi.org/10.1016/j.nbsj.2022.100009>



A Walk Through a Public Green Space...

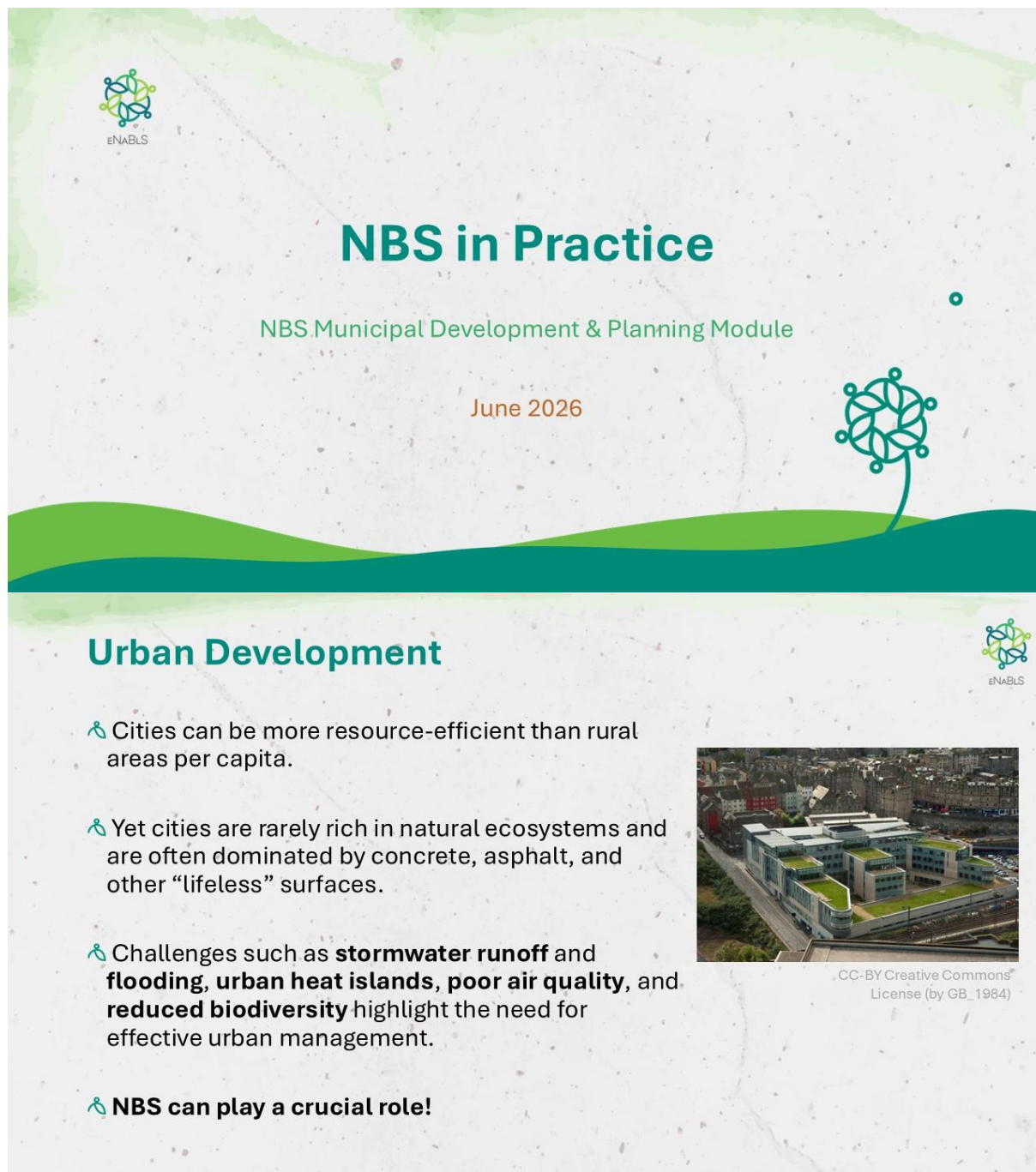


CC-BY Creative Commons License (left: by Denis Zastanceanu; right: by Alabama Extension)



Annex 2

Module 2 – Supplementary Document: NBS in Practice



NBS in Practice

NBS Municipal Development & Planning Module

June 2026

Urban Development

- 🌿 Cities can be more resource-efficient than rural areas per capita.
- 🌿 Yet cities are rarely rich in natural ecosystems and are often dominated by concrete, asphalt, and other “lifeless” surfaces.
- 🌿 Challenges such as **stormwater runoff** and **flooding, urban heat islands, poor air quality, and reduced biodiversity** highlight the need for effective urban management.
- 🌿 **NBS can play a crucial role!**

CC-BY Creative Commons License (by GB_1984)



Urban Green Spaces

- 🌿 Improve air quality;
- 🌿 Contribute to temperature regulation;
- 🌿 Help with stormwater management;
- 🌿 Contribute to both mental and physical well-being.



CC-BY Creative Commons
License (by Alabama Extension)

Green Roofs

- 🌿 Support stormwater retention;
- 🌿 Enhance energy efficiency;
- 🌿 Mitigate urban heat islands effects;
- 🌿 Improve air quality;
- 🌿 Promote biodiversity;
- 🌿 Reduce noise levels.



CC-BY Creative Commons License (by USEPA Environmental-Protection-Agency)



Retention Basins/Wet Ponds

- 🌿 Help reduce flood risk;
- 🌿 Improve water quality;
- 🌿 Create habitats that support biodiversity.



CC-BY Creative Commons License (by Drm310)



Insect-pollinated Vascular Plants



- 🦋 Enhance environmental quality;
- 🦋 Support pollinator populations;
- 🦋 Reduce pollution;
- 🦋 Provide essential ecosystem services for urban residents.



CC-BY Creative Commons License (by Ted Moravec)

Implementation of NbS: Governance & Planning



- 🦋 Nbs implementation requires **governance** and **planning** practices rooted in stewardship, reflexivity, dialogue, and long-term commitment.
- 🦋 In urban settings, key success drivers are open innovation, partnerships among stakeholders, together with education and training.
- 🦋 Policymakers should strengthen policy frameworks across the full NBS cycle while ensuring environmental justice.



References



- Hölscher, K., Frantzeskaki, N., Collier, M. J., Connop, S., Kooijman, E. D., Lodder, M., McQuaid, S., Vandergert, P., Xidous, D., Bešlagić, L., Dick, G., Dumitru, A., Dziubała, A., Fletcher, I., Adank, C. G-E., Vázquez, M. G., Madajczyk, N., Malekkidou, E., Mavroudi, M. (...), Vos, P. (2023). Strategies for mainstreaming nature-based solutions in urban governance capacities in ten European cities. *Urban Sustainability*, 3. <https://doi.org/10.1038/s42949-023-00134-9>
- Karamoutsou, L., Veliou, E., Kvernberg, E. B., & Psilovikos, A. (2024). Urban Stormwater Management: A Sustainable Approach. *Water*, 16(15). <https://doi.org/10.3390/w16152089>
- Li, Y., Zhai, W., Yang, Z., Tang, J., Li, H., & Huang, H. (2024). A review of nature-based solutions to environmental hazards through the lens of environmental justice. *SSRN*. <http://dx.doi.org/10.2139/ssrn.4724771>
- Meyer, W. B. (2013). The Environmental Advantages of Cities: Countering Commonsense. <https://doi.org/10.7551/mitpress/9513.001.0001>
- Oberndorfer, E., Lundholm, J., Bass, B., Coffman, R., Doshi, H., Dunnett, N., Gaffin, S., Köhler, M., Liu, K., & Rowe, B. (2007). Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services. *BioScience*, 57. <https://doi.org/10.1641/B571005>
- Perivoliotis, D., Arvanitis, I., Tzavali, A., Papakostas, V., Kappou, S., Andreacos, G., Fotiadi, A., Paravantis, J. A., Souliotis, M., & Mihalakakou, G. (2023). Sustainable Urban Environment through Green Roofs: A Literature Review with Case Studies. *Sustainability*, 15(22). <https://doi.org/10.3390/su152215976>

References



- Phelan, P., Kaloush, K., Miner, M., Golden, J., Phelan, B., Silva, H., & Taylor, R. (2015). Urban heat island: Mechanisms, implications, and possible remedies. *Annual Review of Environment and Resources*, 40. <https://doi.org/10.1146/annurev-environ-102014-021155>
- Shahmohammad, M., Hosseinzadeh, M., Dvorak, B., Bordbar, F., Shahmohammadmirab, H., & Aghamohammadi, N. (2022). Sustainable green roofs: a comprehensive review of influential factors. *Environmental Science and Pollution Research*. <https://doi.org/10.1007/s11356-022-23405-x>
- Skaldina, O., Nylund, A., & Ramula, S. (2024). Neglected puzzle pieces of urban green infrastructure: richness, cover, and composition of insect-pollinated plants in traffic-related green spaces. *Landscape Ecology*, 39. <https://doi.org/10.1007/s10980-024-01881-5>
- United Nations (n.d.) 68% of the world population projected to live in urban areas by 2050, says UN. <https://www.un.org/uk/desa/68-world-population-projected-live-urban-areas-2050-says-un>
- Zhang, X., Brandt, M., Tong, X., Ciais, P., Yue, Y., Xiao, X., Zhang, W., Wang, K., & Fensholt, R. (2022). A large but transient carbon sink from urbanization and rural depopulation in China. *Nature Sustainability* 5, 321–328. <https://doi.org/10.1038/s41893-021-00843-y>




A Climate Walk...




Photo by Julia Fellingner as part of the eNABLS Project





ENABLS

Education and NBS -
bending the curve for biodiversity

www.enabls.eu