European Commission

NATURE-BASED SOLUTIONS LEARNING SCENARIO

Transform your school/town: design a constructed wetland

Research and Innovation

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European Commission

Directorate-General for Research and Innovation

Healthy Planet – C3 - Climate and Planetary Boundaries

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NATURE-BASED SOLUTIONS LEARNING SCENARIO

Transform your school/town: design a constructed wetland

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ABSTRACT

All over Europe, it is often possible to observe water resources being wasted while watering gardens. At the same time, many countries, especially in Southern Europe, face a lack of water during warm summertime periods and they cannot water green areas. These and other places could benefit from recycling water, or just from restoring their degraded ecosystems. Through this lesson, students will learn about nature-based solutions (NBS) in general and specifically about NBS for wastewater treatment, which can not only purify water from pollutants but provide numerous co-benefits. Through a project-based learning (PBL) approach, students will build a prototype of a constructed wetland.

Keywords

wetlands, phyto-depuration, water management, nature-based-solutions, ecosystem, sustainability.

1. Introduction

> *"Nature-based solutions (NBS) are solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services."*
> *https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en*

To use this Learning Scenario more effectively, teachers are encouraged to:

- Check out the list of recent EU publications on Nature-Based solutions
- Read about Nature-based solutions: Transforming cities, enhancing well-being (also available as a PDF)
- Contact local NBS practitioners or scientists working in their area (they can be found through Oppla).
- Use the "Ask Oppla" service to request help in case of any technical/scientific question on NBS.

2. Overview

Overview	
Subject	Biology; Chemistry; Ecology; Engineering; Earth sciences; Agriculture; Coding; Design and Technology, ICT
NBS topic	Water management
Recommended age of students	14–15 Can be adapted to middle school students (11–14) if the chemistry tests are excluded
Preparation time	120 minutes (includes preparing the laboratory; finding/preparing materials for the prototype)
Teaching time	Face to face: 400 minutes (8 lessons)

Overview	
	Online (via Google Meets or other online tool): 500 minutes (10 lessons of 50 minutes each)
Online teaching material[1]	• Water Footprint calculator: http://aquapath-project.eu/calculator/calculator.html[2] • Water Quality Testing Manual For Middle Schools and High Schools: http://www.mwra.state.ma.us/publications/waterqualitytesting/waterqualitymanual.htm • pH scale (virtual lab): https://phet.colorado.edu/en/simulation/ph-scale • Virtual lab on water analysis "When is water safe to drink?" http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT04/CT04.html • Hacking STEM lesson plan (How are ocean currents formed?): https://education.microsoft.com/en-us/hackingStem/lesson/1fe8a218 • What is an ecosystem? (video): https://youtu.be/eGG7hyx_HlA • Key ecology terms (video): https://youtu.be/E6WAQpRulhA • Water distribution on Earth: https://slideplayer.com/slide/12829083/ Platforms and tools: • Canva (online presentation/posters): https://www.canva.com/ • Padlet (digital wall): https://padlet.com/ • SketchUp (3D modeling): https://www.sketchup.com/plans-and-pricing/sketchup-free • Minecraft (online creative game): https://www.minecraft.net/en-us/ • CoRubrics (Google Chrome add-on): https://gsuite.google.com/marketplace/app/corubrics/969519855495
Offline teaching material	Materials for the prototype: • One plastic box 50 litres • One plastic box 80 litres • One watering rod • One bag of gravel • One bag of ground • 3–4 plants (with their perforated basket): *Carex riparia, Iris pseudacorus, Mentha aquatica, Tipha latifolai*, etc. Materials for testing salinity through Micro:bit (to test salinity and code your apparatus)/for each team: • 1 Micro:bit • 10 mm LED • 2 AA Batteries

[1] The LS can be easily implemented to remote teaching by sharing contents and tasks through online classroom/clouds. Students can build their own prototypes at home, both using online tools (such as TinkerCad, Sketchup and Minecraft) or simple materials. For an example, please see: https://youtu.be/zYmf3BmgoyQ

[2]The AQUAPATH Erasmus+ Project: http://aquapath-project.eu/ aimed to raise awareness on water. On the website there are interesting resources, besides the footprint calculator (http://aquapath-project.eu/calculator/calculator.html), like the booklet https://waterfootprint.org/media/downloads/WFN_presentation_schools.pdf

Overview	
	• 2XAA Battery Holder • 3 Double ended alligator clip • 20 cm clips of copper tape • Coffee stir sticks • Baking soda • 2 glasses
NBS resources used	• Constructed wetlands as multipurpose green infrastructures in Gorla Maggiore, Italy https://oppla.eu/casestudy/17252 • Sustainable water management – Treatment Wetlands design: https://oppla.eu/product/2029 • Vacaresti Nature Park: https://naturvation.eu/nbs/bucuresti/vacaresti-nature-park • Nitrogen pollution and climate change reduce carbon storage and biodiversity of peatlands: https://oppla.eu/product/19524 • IRIDRA – Fitodepurazione classica: http://www.iridra.eu/it/fitodepurazione/fitodepurazione-classica.html • UNESCO coursebook – Nature-based solutions for water: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/EN_training_course2019.pdf • Main messages from the UN World Water Development Report 2018 (video): https://www.youtube.com/watch?v=o-b20tOibHM • The dragonfly zone (video): https://vimeo.com/308533615 • *Zone Libellule*: a nature-based wastewater treatment technique leveraging the self-purification capacity of wetlands https://wedocs.unep.org/bitstream/handle/20.500.11822/28804/suez.pdf?sequence=1&isAllowed=y • Vacaresti Nature Park: https://naturvation.eu/nbs/bucuresti/vacaresti-nature-park • Nitrogen pollution and climate change reduce carbon storage and biodiversity of peatlands: https://oppla.eu/product/19524 • Constructed wetland: https://www.naturvation.eu/nbs/dublin/constructed-wetland • European Commission – Environment: https://ec.europa.eu/environment/water/index_en.htm • European Commission – Definition of NBS https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en • Naturvation – Urban Atlas of NBS for water management https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en

3. Integration into the curriculum

Through a multidisciplinary approach, this learning scenario can contribute to the development of several scientific competences and learning objectives:

- Biology: plant nutrition, organisms and their environment, ecosystems (human influence and nature-based solutions)

- Chemistry: experimental techniques, chemical reactions, air and water.
- Ecology: environmental sustainability, tropisms, water blueprint, nature-based solutions

This LS also offers the opportunity for a holistic approach to increase the awareness on water and water management. Therefore, the English teacher could work on CLIL, to explore multilanguage materials; the Geography/History teacher could make students reflecting on the global need of fresh water in the world (as water can be considered the blue gold) and what responsible actions to take in account to prevent scarcity or waste. The Economics teacher could make students reflecting on the opportunity of considering Nature-Based Solutions for water management, as they are more sustainable and affordable, compared with other solutions.

4. Aim of the lesson.

The aim of this learning scenario is to help students to become more confident in working with information and ideas, to become more innovative and equipped for future environmental challenges. The learning scenario aims to help them understand the importance of preserving nature, addressing climate change, and developing sustainable uses of natural resources. Furthermore, the learning scenario will be the way to introduce them to the topic of nature-based solutions and their applicability of wastewater treatment, in order to learn the importance of finding alternatives for a more sustainable approach towards solving water pollution challenges.

5. Outcome of the lesson

The ideal product could be the construction of a constructed wetland, if the school is in the countryside, or if there is a source of water to collect from. In other cases, it will be a **prototype** of a constructed wetland, built using two rectangular plastic boxes to be set in the school's garden, with a water source to fill it. One box will simulate the phyto-depuration basin, the other one the constructed wetland (filled with some soil and adapted aquatic plants).

6. Trends

- Project-based learning
- Collaborative learning
- STEM Learning: increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum
- Learning materials: textbooks, web resources and open source books
- Outdoor education

7. 21st century skills

Global Awareness: students will be driven to consider that water is a precious resource. They will be asked to conduct research linked to waste water issues in different regions of their country/different countries.

Environmental Literacy: students will be involved in hands-on activities in the classroom, in the laboratory and outdoors, to learn about ecology, sustainability and the management of resources (even on an economics basis), to become able to take responsible actions towards nature and the environment.

Creativity and Innovation: after researching on a white list of online resources (please refer to the suggested links listed above), students will be asked to design innovative solutions for a constructed wetland prototype for the school garden or the laboratory, in order to understand purifying processes for water quality recovery through a designed wetland.

Critical Thinking and Problem Solving: to develop critical thinking and problem solving skills, the whole module will be developed using a PBL approach, where we can assume that the school or the municipality is the real client, who asks for a solution to have clean water via the planning and design of a constructed wetland. The realisation of a prototype (eventually chosen between different models designed by students) will be the outcome.

Collaboration: dividing students in groups is not enough to make them work collaboratively, so it will be necessary to give each student one definite role in the group (such as leader, presenter, digital expert and documenter). After every lesson, one wrap-up moment will be set, when each group will present and share with the class their findings, asking for feedback from peers. In this way, collaborative work will be encouraged, and each team will learn from one another about the advantages of different proposed solutions.

Information Literacy: students will be guided, when searching information on the web or leaflets, to distinguish trustworthy sources from less convincing ones. They will be guided also to consider copyrights and to use proper and reliable materials.

ICT (Information, Communications, and Technology) Literacy: in developing the lesson plan, students and teachers will interact through GSuite tools and use other educational tools (such as Canva and Padlet) in order to be able to access, manage, integrate or communicate information or outcomes.

Initiative and Self-Direction: students will work in a team in all the different phases of the development of the activity, and they will work independently (apart from some activity in the lab that will be driven by the teacher). There will be several moments where they will share their findings and outcomes to the class, while the teacher will be a coach that will give them directions or suggestions. In this way, learning becomes the result of a process that students construct themselves by elaborating and reflecting on the tasks, rather than just following instructions.

Citizenships skills: in order to develop these skills, students will be guided, also through some brainstorming sessions, to become more responsible towards the environment and water, inquiring the effects of daily actions, considering nature-based solutions and moving towards more sustainable behaviours.

8. Activities

Activity	Procedure	Time
Introduction: Water (Chem/Bio) + laboratory	Introduction to water (chemical and biological characteristics, biotic indexes), by the teacher (e.g. using the slides provided here), followed by simple tests on water samples (temperature, pH, turbidity, salinity with Micro:bit, O_2, NO3)	120 min
Water (Earth sciences)[3]	The teacher introduces the following topics to students: • What is an ecosystem? • Water distribution on Earth (Earth Science): rivers, seas, oceans, glaciers, lakes, wetlands, etc. • Water pollution – examples, consequences, challenges and opportunities Slides to present this, can also be found in the accompanying slides to this learning scenario, accessible from here.	30 min[4]
Water blueprint	Students are required to take the test to calculate their water Blueprint (http://aquapath-project.eu/calculator/calculator.html), followed by the analysis (in teams of 3-4) of the EU Commission resources about water. (https://ec.europa.eu/environment/water/index_en.htm). Each team is responsible for looking for information about the different topics related to water (river management, flood risk, water	60 min

[3] Teachers can evaluate the opportunity to organise a visit to the city's water treatment plant and the purification plant.
[4] If students have not learned about water distribution on Earth in previous science or geography subjects, this activity could be expanded to 60 minutes.

Activity	Procedure	Time
	scarcity and droughts, drinking water, bathing water, water reuse, etc.). Every team must make a pitch, presenting results through Canva or other sharing tools. It is recommended for teachers to distribute the students in groups as heterogeneous as possible and to leave them free to distribute the roles in the group. Following the recommendations of the Project-Based Learning methodology, each group should choose a group leader, a documenter, and a presenter. However, each member of the group is responsible both for his role and for the whole process.	
Video Water NBS	The students watch the UNESCO video on Nature Based Solution for water, (https://www.youtube.com/watch?v=o-b20tOibHM) to introduce them to the topic of NBS.	10 min
Collecting evidence of waste of water in swimming pools, gardens	The teacher asks students to conduct research/take photos of examples of excessive use of water or contaminated water in urban streams, channels, lakes, then gardens and green areas and swimming pools. Students upload pictures on a public wall (a Padlet or other sharing tools) and they are asked to imagine how to find a solution to waste of water/bad quality of water (visibly polluted). A final wrap-up will lead to looking for a solution in teams. At this point it is important to introduce the definition of NBS that is given by the Commission. Also, the teacher can share examples of NBS from the Naturvation atlas. It is advised to focus on Solutions that tackle challenges like water management.	30 min
Video Wetlands	Watching video "Dragonfly zone" (https://vimeo.com/308533615) to learn about wetlands. Learning about wetlands and their vegetation. Plants for phyto-depuration.	30 min
Prototyping	Designing and construct a wetland constructed wetland as shown in Annex 1	120 min
Optional Activity	Using the NASA education website about the water resources, students can research and discuss how astronauts get clean water when they are in the Space. Students may use the following sites: https://appliedsciences.nasa.gov/what-we-do/water-resources https://earthdata.nasa.gov/learn/pathfinders/water-quality-data-pathfinder	

9. Assessment

The NBS-constructed wetland prototype can be either assessed by the teacher (using the rubric suggested in Annex 2), or through self-assessment also using the same rubric, for example with the Co-Rubrics adds-on for Google Sheets which can help with the creation, use and sharing of the rubric. See https://youtu.be/9hAPkbdm29Q for a Co-Rubrics tutorial to produce easily something like as shown in Figure **1**. This rubric spreadsheet template can be used to start with the process explained in the tutorial.

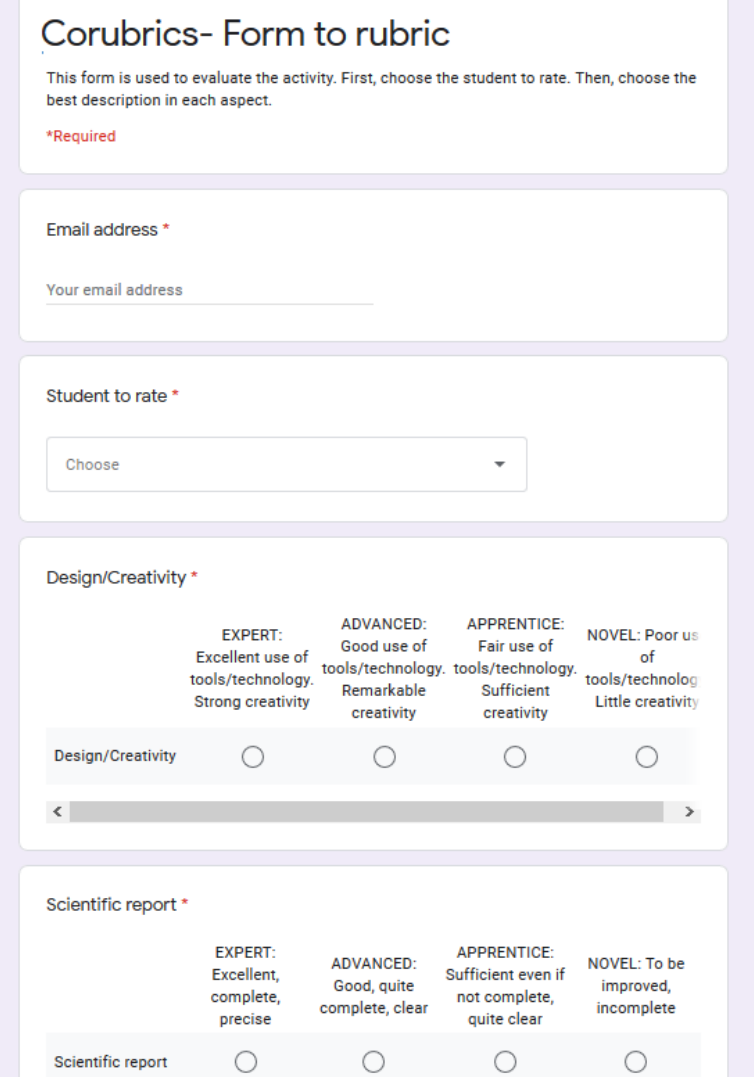

Figure 1: Rubric form created in Google spreadsheets by Co-rubrics

Annex 1: Example of a constructed wetland prototype

Constructed wetlands: "Transform your school/town: construct a bio-lake" by Tullia Urschitz

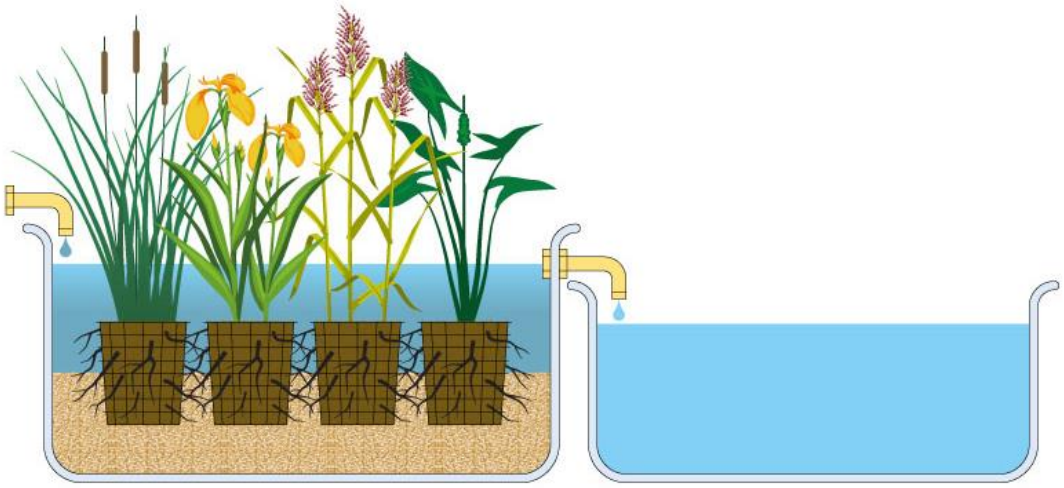

Figure 2: POSSIBLE DESIGN OF THE BIOLAKE PROTOTYPE (credits: @utullia CC-BY)

Annex 2: NBS Prototype rubric

	EXPERT	ADVANCED	APPRENTICE	NOVEL	WEIGHT
	4	3	2	1	
Design / Creativity	Excellent use of tools/technology. Strong creativity	Good use of tools/technology. Remarkable creativity	Fair use of tools/technology. Sufficient creativity	Poor use of tools/technology. Little creativity	30%
Scientific report	Excellent, complete, precise	Good, quite complete, clear	Sufficient even if not complete, quite clear	To be improved, incomplete	25%
Engineering / NBS solutions	Excellent understanding of how a constructed wetland works	Advanced understanding of how a constructed wetland works	Good understanding of how a constructed wetland works	Understanding of how a constructed wetland works to be improved	25%
Presentation / pitch	Presentation excellent, concise, effective	Very good, concrete, quite effective presentation	Simple, but clear presentation	Presentation to be improved, not completely convincing	20%

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About the NBS project

The NBS project is initiated and funded by the European Commission Directorate-General for Research and Innovation and coordinated by PPMI, in collaboration with European Schoolnet (EUN). PPMI (www.ppmi.lt/en) is a leading European research and policy analysis centre, aiming to help public sector and civil society leaders from around the world, presenting evidence in a way that is simple, clear and ready to use. European Schoolnet (www.eun.org) is the network of 34 European Ministries of Education, based in Brussels. EUN aims to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners. Find out more about nature-based solutions: https://ec.europa.eu/research/environment/index.cfm?pg=nbs and all the NBS Learning Scenarios created in this project as well as the overall reports can be found at http://www.scientix.eu/pilots/nbs-project

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All over Europe, it is often possible to observe water resources being wasted while watering gardens. At the same time, many countries, especially in Southern Europe, face a lack of water during warm summertime periods and they cannot water green areas. These and other places could benefit from recycling water, or just from restoring their degraded ecosystems. Through this lesson, students will learn about nature-based solutions (NBS) in general and specifically about NBS for wastewater treatment, which can not only purify water from pollutants but provide numerous co-benefits. Through a project-based learning (PBL) approach, students will build a prototype of a constructed wetland.

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