

# Teaching and learning materials on Biodiversity and ecosystem services (University of Ljubljana)

## Biodiversity and ecosystem services: Natural Science Backpack

### SUMMARY

This article discusses a self-learning kit for primary school students aged 6-14 that uses an inquiry-based approach and formative evaluation process. The kit includes everyday objects and scientific consumables to provide a "real science" experience while promoting imagination and creativity. It is designed for group use with only one toolkit available for circulation among students, and each child records their observations in a diary, presents their findings to peers, and passes the kit on to the next child. The project aims to promote knowledge and environmental awareness, with plans to expand the kit by adding more materials, instruments, and tools.

### INTRODUCTION TO THE TOPIC

Biodiversity loss is one of the most pressing problems (Johnson et al., 2017), and we are facing a sixth mass extinction (Barnosky et al., 2011). The planetary boundary of biosphere integrity has already been crossed, especially at the level of genetic diversity (Steffen et al., 2015). The direct drivers of global diversity loss include land and ocean use change, natural resource exploitation, pollution, climate change, and invasive alien species (Jaureguiberry et al., 2022). Indirect causes include sociocultural drivers, such as values, norms, beliefs, or education (Pörtner et al., 2021). The alarming decline in biodiversity has prompted scientists to raise awareness of the services provided by ecosystems. Ecosystem services have been defined as the full range of benefits that humans obtain directly or indirectly from ecosystem processes (Costanza, 1997). In 2012, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was established to "strengthen the knowledge base for better policy through science, conservation and sustainable use of biodiversity, long-term human well-being, and sustainable development." Educating students about forest ecosystem services could be an effective means of communicating the importance of different ecosystems and the dependence on ecological life support systems. In this way, students can learn about and appreciate ecosystems and better value human interactions with them (Torkar & Krašovec, 2019). Education can be an important strategy to reduce threats to biodiversity and, especially raise biodiversity literacy.

### PRESENTATION OF THE MATERIALS

#### Overview

The materials presented here are designed primarily for primary school students between the ages of 6 and 14. Our team collaborated with researchers from various fields, including early childhood education and forest pedagogy, as well as teachers and students themselves, to create these materials. We utilized an inquiry-based approach and a formative evaluation process to optimize the materials, which serve as a self-learning kit.

Our kit includes a range of everyday objects and professional scientific consumables that aim to motivate children and provide them with a "real science" experience while still encouraging their imagination and creativity. The kit is designed for use by a group of children, such as a classroom, with only one toolkit available for circulation among the students. Each child uses the kit for a week, recording their observations in the included diary, presenting their findings to their peers, and then passing the toolkit on to the next child in line. This process allows children to share their enthusiasm with their classmates, parents, and other family members, acting as multipliers of knowledge and environmental awareness.

As we continue to develop the project, we plan to expand the kit by adding more materials, instruments, and tools to increase the range of possibilities and applications.

**Information**

Age	Primary school (6-14 years old)	
Topic	Biodiversity and ecosystem services	
Country	Slovenia	
Duration		Less than 1 hour
	X	Between 1-2 hours
	X	Between 2-5 hours
		Between 5-10 hours
		More than 10 hours
Stakeholders involved in the implementation	X	Teachers
	X	Families
		Researchers
		Experts form industry
	X	Informal and non-formal education professionals
		Professionals from the Media
		Policy Makers
		Civil society
Open Schooling Scaffoldings	X	Reflection activities
	X	Jigsaw groups / debates
		Meet with the experts
		Learn in the lab
	X	Going outside
	X	Other: Experience themselves, creative science
Other Tags	X	Modelling
	X	Inquiry
	X	Argumentation
	X	Social Justice
		Gender
		CLIL (Content and Language Integrated Learning)
	X	Problem-based learning
	X	Project-based learning
	X	Formative Evaluation
		Flipped Classroom
	X	Contextualization
	X	Design Thinking
		Case study
		Gamification
		Making
	X	STEAM perspective
		Technological process
		ICT
		Tinkering
	X	Evaluation Rubric
	Cooperative work	
Technical Resources	magnifying glass, binoculars, Vernier calliper, strainer, scissors, battery flashlight, measuring tape, scale, microscope, binoculars	
Webpage materials	<ul style="list-style-type: none"> <li>- English version:</li> <li>- <a href="#">Slovenian version (original)</a></li> </ul>	



**Activity 1. Biodiversity and ecosystem services self-exploration.**

The objective of this activity is to inspire students, their family, and friends to discover their local environment and increase awareness about the significance of biodiversity, ecosystems, and the services they offer to humans. By engaging in this activity, we hope to foster collaboration between generations and across various subject areas. Additionally, this initiative seeks to tackle the issue of biodiversity blindness, as many individuals fail to acknowledge the cohabiting organisms that play a crucial role in our existence. Our goal is to encourage individuals to appreciate and preserve the natural world for future generations.

**Keywords:** Outdoor education, ecology, intergenerational education

**Students' resources**

Students can use Natural Science Backpack with all included resources and materials for their individual or collaborative research of local environment.

Natural Science Backpack includes following materials and resources:

N	MATERIAL	DESCRIPTION	QUANTITY
1	magnifying glass	6x magnification	1
2	magnifying glass	10x mgnification	1
3	a collection of activity cards		1
4	binoculars	20x mgnification	1
5	sorting tray		1
6	a larger tub with a lid		1
7	a small tub with a lid		1
8	rope	5 m	1
9	pencil sharpener		1
10	rubber		1
11	measuring cylinder	250 ml	1
12	mesh		1
13	measuring cup with lid	100 ml	3
14	cup with lid	100 ml	5
15	cup with lid	25 ml	5
16	funnel		1
17	centrifuge tube	25 ml	5
18	centrifuge tube	12 ml	5
19	big spoon		1
20	small spoon		1
21	knife		1
22	fork		1
23	pencile		1
24	Vernier caliper		1
25	small shovel		1
26	strainer		1
27	larger ziplock bag		30
28	smaller ziplock bag		30

<b>29</b>	natural sciences diary		1
<b>30</b>	large dropper		1
<b>31</b>	small dropper		3
<b>32</b>	protective glasses		1
<b>33</b>	safety gloves		6
<b>34</b>	scissors		1
<b>35</b>	battery flashlight		1
<b>36</b>	measuring tape	1,5 m	1

## Teachers' resources

To support teachers in their efforts to raise awareness about the importance of biodiversity and ecosystem services, we have prepared a comprehensive booklet. This resource provides detailed instructions for hands-on workshops that can be easily implemented in the classroom. Our selection of activities covers a wide range of ecosystem services and biodiversity exploration on all levels, including microbiological, plant, fungal, and animal ecosystems, as well as water and land ecosystems in general. The activities have been designed to be flexible and adaptable to different environmental conditions, so teachers can easily choose an activity that suits their specific situation. The booklet is presented in a user-friendly format that makes it easy for teachers to use and adapt to their specific needs.

- In the English version (not yet available)
- In the Original version (Slovenian language):  
[KONČANA popravljena knjižica za tisk.pdf](#)

## Additional resources

You can find more information about the activity and its evaluation in the following research papers:

- Klofutar, Š., Jerman, J., & Torkar, G. (2022). Direct versus vicarious experiences for developing children's skills of observation in early science education. *International Journal of Early Years Education*, 30(4), 863-880.
- Klofutar, Š. (2022). Pomen neposrednih izkušenj z gozdnimi organizmi v zgodnjem naravoslovnem izobraževanju (Doctoral dissertation, Univerza v Ljubljani, Pedagoška fakulteta).  
[http://pefprints.pef.uni-lj.si/6569/1/Praprotnik\\_Krnel\\_Torkar\\_Naravoslovni.pdf](http://pefprints.pef.uni-lj.si/6569/1/Praprotnik_Krnel_Torkar_Naravoslovni.pdf)
- [Klofutar, Š. \(2022\). Pomen neposrednih izkušenj z gozdnimi organizmi v zgodnjem naravoslovnem izobraževanju \(Doctoral dissertation, Univerza v Ljubljani, Pedagoška fakulteta\). https://repositorij.uni-lj.si/IzpisGradiva.php?id=136589](https://repositorij.uni-lj.si/IzpisGradiva.php?id=136589)

## REFERENCES

- Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O., Swartz, B., Quental, T. B., ... & Ferrer, E. A. (2011). Has the Earth's sixth mass extinction already arrived?. *Nature*, 471(7336), 51-57.
- Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., ... & Van Den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387(6630), 253-260.
- IPBES, 2018. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Available at: <https://www.ipbes.net/>
- Jaureguiberry, P., Titeux, N., Wiemers, M., Bowler, D. E., Coscieme, L., Golden, A. S., ... & Purvis, A. (2022). The direct drivers of recent global anthropogenic biodiversity loss. *Science Advances*, 8(45), eabm9982.

## MUL+IPLIERS

- Johnson, C. N., Balmford, A., Brook, B. W., Buettel, J. C., Galetti, M., Guangchun, L., & Wilmshurst, J. M. (2017). Biodiversity losses and conservation responses in the Anthropocene. *Science*, 356(6335), 270-275.
- Pörtner, H. O., Scholes, R. J., Agard, J., Archer, E., Arneth, A., Bai, X., ... & Ngo, H. (2021). Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). <https://zenodo.org/record/5101125>
- Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review*, 2(1), 81-98.
- Torkar, G., & Krašovec, U. (2019). Students' attitudes toward forest ecosystem services, knowledge about ecology, and direct experience with forests. *Ecosystem services*, 37, 100916.



## Biodiversity and ecosystem services: Water and wind erosion

### SUMMARY

The article presents an activity designed for primary school students aged 6-14 that explores the natural processes of water and wind erosion, as well as the impact of human activities on erosion. Slovenia is home to many stunning geological formations created by these processes, including gorges and canyons. The activity aims to raise awareness about the importance of forests and their ecosystem services in protecting land from erosion caused by human activities like land use and deforestation. By participating in the activity, students can learn about the erosion process and the role of plants in preventing soil erosion.

### INTRODUCTION TO THE TOPIC

Biodiversity loss is one of the most pressing problems (Johnson et al., 2017), and we are facing a sixth mass extinction (Barnosky et al., 2011). The planetary boundary of biosphere integrity has already been crossed, especially at the level of genetic diversity (Steffen et al., 2015). The direct drivers of global diversity loss include land and ocean use change, natural resource exploitation, pollution, climate change, and invasive alien species (Jaureguiberry et al., 2022). Indirect causes include sociocultural drivers, such as values, norms, beliefs, or education (Pörtner et al., 2021). The alarming decline in biodiversity has prompted scientists to raise awareness of the services provided by ecosystems. Ecosystem services have been defined as the full range of benefits that humans obtain directly or indirectly from ecosystem processes (Costanza, 1997). In 2012, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was established to "strengthen the knowledge base for better policy through science, conservation and sustainable use of biodiversity, long-term human well-being, and sustainable development." Educating students about forest ecosystem services could be an effective means of communicating the importance of different ecosystems and the dependence on ecological life support systems. In this way, students can learn about and appreciate ecosystems and better value human interactions with them (Torkar & Krašovec, 2019). Education can be an important strategy to reduce threats to biodiversity and, especially raise biodiversity literacy.

### PRESENTATION OF THE MATERIALS

#### Overview

The materials presented here are designed primarily for primary school students between the ages of 6 and 14. Our team collaborated with researchers from various fields, including early childhood education and forest pedagogy, as well as teachers and students themselves, to design this activity. Water and wind erosion are natural processes that have been shaping the Earth's surface for millions of years. These processes have created some of the most awe-inspiring natural wonders on the planet, such as the magnificent Grand Canyon in the United States. Slovenia is also home to numerous stunning geological formations, including gorges like the Dolžanova gorge, riverbeds such as the Great Soča Gorge, and canyons like the Kokra River Canyon, all of which are slowly and steadily being formed by water. One particularly unique type of gorge is the glacial gorge, where the erosion is caused by the movement of glacial ice. Wind erosion is also responsible for creating remarkable natural landscapes, such as the captivating sand dunes found in deserts around the world. However, water and wind erosion are not always beneficial. Human activities such as land use and deforestation have increasingly become the main causes of extensive water and wind erosion. This can result in a reduction in soil amounts and surface fertility. It is therefore important to raise awareness about the importance of forests and their ecosystem services in protecting land from extensive water and wind erosion. To achieve this, we have developed an activity that allows students to explore the erosion process and learn how plants can help prevent soil erosion.

Information

Age	Primary school (6-14 years sold)	
Topic	Water and Wind Erosion	
Country	Slovenia	
Duration (select those which apply):	<input type="checkbox"/>	Less than 1 hour
	<input checked="" type="checkbox"/>	Between 1-2 hours
	<input type="checkbox"/>	Between 2-5 hours
	<input type="checkbox"/>	Between 5-10 hours
	<input type="checkbox"/>	More than 10 hours
Stakeholders involved in the implementation (select those which apply)	<input checked="" type="checkbox"/>	Teachers
	<input checked="" type="checkbox"/>	Families
	<input type="checkbox"/>	Researchers
	<input type="checkbox"/>	Experts form industry
	<input checked="" type="checkbox"/>	Informal and non-formal education professionals
	<input type="checkbox"/>	Professionals from the Media
	<input type="checkbox"/>	Policy Makers
Open Schooling Keywords (select those which apply):	<input checked="" type="checkbox"/>	Reflection activities
	<input checked="" type="checkbox"/>	Jigsaw groups / debates
	<input type="checkbox"/>	Meet with the experts
	<input type="checkbox"/>	Learn in the lab
	<input checked="" type="checkbox"/>	Going outside
	<input checked="" type="checkbox"/>	Other (add all Open Schooling Keywords you consider relevant for your activity/TLS): experience themselves, creative science
Other Tags	<input checked="" type="checkbox"/>	Modelling
	<input checked="" type="checkbox"/>	Inquiry
	<input checked="" type="checkbox"/>	Argumentation
	<input checked="" type="checkbox"/>	Social Justice
	<input type="checkbox"/>	Gender
	<input type="checkbox"/>	CLIL (Content and Language Integrated Learning)
	<input checked="" type="checkbox"/>	Problem-based learning
	<input checked="" type="checkbox"/>	Project-based learning
	<input type="checkbox"/>	Formative Evaluation
	<input type="checkbox"/>	Flipped Classroom
	<input checked="" type="checkbox"/>	Contextualization
	<input checked="" type="checkbox"/>	Design Thinking
	<input checked="" type="checkbox"/>	Case study
	<input type="checkbox"/>	Gamification
	<input checked="" type="checkbox"/>	Making
	<input type="checkbox"/>	STEAM perspective
	<input type="checkbox"/>	Technological process
	<input type="checkbox"/>	ICT
	<input type="checkbox"/>	Tinkering
	<input type="checkbox"/>	Evaluation Rubric
<input checked="" type="checkbox"/>	Cooperative work	
	Add all keywords that you consider relevant to describe your activity/TLS	
Technical Resources	<b>Lab version:</b> styrofoam, sand (or soil), spruce (and/or other) twigs, small tub, sprayer or watering can, water and hair dryer	



	<b>Field version:</b> water, watering can or jug
Webpage materials	- English version (not yet available) - Original version (Slovene language): <a href="#">Erozija_popravljena_2022-03-18_15_45_17.pdf</a>

**TEACHING AND LEARNING MATERIALS**

**Visual abstract**

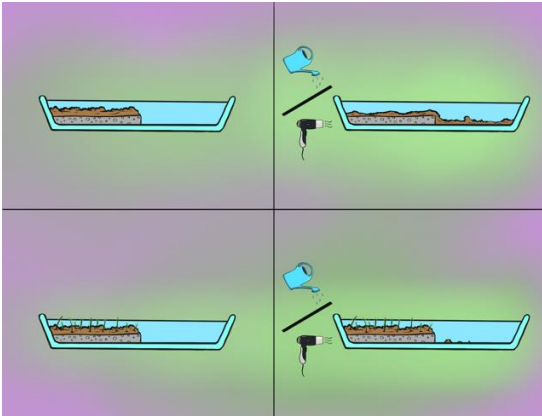


Figure 9. Booklet illustration of »inside« controlled version of water and wind erosion experiment.

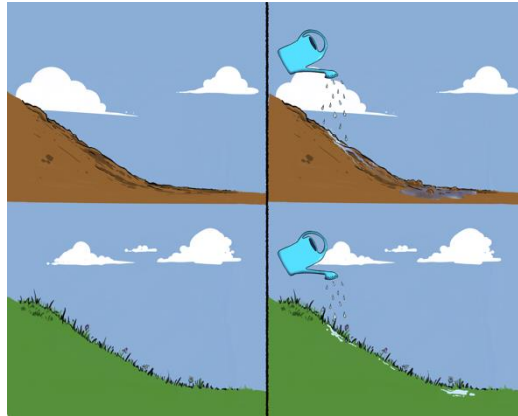


Figure 10. Booklet illustration of field version of water erosion experiment.



Figure 11. Photo of »inside« controlled version of water erosion experiment performance.



Figure 12. Photo of field version of water erosion experiment performance.

**ACTIVITIES**

The following activity aims to encourage children and their families to explore their local environments and gain a hands-on understanding of the erosion process and the role of plants in preventing it. We have designed two versions of a similar experiment. The first version is a controlled lab experiment that investigates water and wind erosion. The second version is a field-based experiment where students can directly observe the effects of water erosion in nature and their local environment. Down below, you can find the link that contains a full version, downloadable, ready to print “Activity Instructions”, we included within the booklet:

- English version (not yet available)
- Original version (Slovene language):  
[Erozija\\_popravljena\\_2022-03-18\\_15\\_45\\_17.pdf](#)

## Activity 1. Water and wind erosion exploration.

To achieve these objectives, we have designed two versions of the experiment. The first version is a controlled lab-based activity that investigates water and wind erosion. In this version, students will create a mini-landscape with different types of soil and vegetation. They will then simulate wind and water erosion by using a hairdryer and a spray bottle. Students will observe the effects of wind and water erosion on the different soil types and vegetation and make comparisons between the different types of soil and vegetation.

The second version is a field-based activity that allows students to explore the effects of water erosion in their local environment. Students will choose a location near a body of water, such as a river or a stream, and conduct a survey of the plant species present. They will then observe and document the impact of water erosion on the local environment, such as changes in the riverbed or loss of vegetation. By conducting this experiment, students will have a better understanding of the critical role of plants in protecting soil and preventing erosion.

Through these activities, students will learn about the importance of protecting our natural resources and how they can play a significant role in protecting the environment. They will also develop critical thinking and problem-solving skills that they can apply to other areas of their lives. We hope that by increasing their awareness and appreciation of the plants around them, students will also become advocates for protecting the natural world and its resources.

**Keywords:** Outdoor education, ecology, wind erosion, water erosion.

### Students' resources

Students will require materials listed in the table below. We have designed the activity to require only everyday and readily available materials, minimizing the need for complex or expensive equipment. Our aim is to make the experiment accessible to as many students as possible while keeping the cost and preparation time low.

N	MATERIAL	DESCRIPTION	QUANTITY
<b>LABORATORY VERSION</b>			
1	styrofoam	watter and wind	25x25 cm
2	sand (or soil)	watter and wind	2 kg
3	spruce (and/or other) twigs	watter and wind	
4	small tub	watter and wind	25x50x10 cm
5	sprayer or watering can	watter	1
6	water	watter	1,5 l
7	hair dryer	wind	1
<b>FIELD VERSION</b>			
1	water		
2	watering can or jug		5 l

### Teachers' resources

To support teachers in their efforts to raise awareness about the importance of biodiversity and ecosystem services, we have prepared a comprehensive booklet. This resource provides detailed instructions for hands-on workshops that can be easily implemented in the classroom. Our selection of activities covers a wide range of ecosystem services and biodiversity exploration on all levels, including microbiological, plant, fungal, and animal ecosystems, as well as water and land ecosystems

in general. The activities have been designed to be flexible and adaptable to different environmental conditions, so teachers can easily choose an activity that suits their specific situation. The booklet is presented in a user-friendly format that makes it easy for teachers to use and adapt to their specific needs.

The booklet also contains detailed instructions and explanations for the activity discussed here.

- In the English version (not yet available)
- In the Original version (Slovenian language):  
[Erozija popravljena 2022-03-18 15 45 17.pdf](#)

## Additional resources

You can find more information about the activity and its evaluation in the following research papers:

- Mikoš, M. (1996). Vodna erozija v slovenskem prostoru. In J. Lapajne (Ed.), Zgodovina: zbornik predavanj (pp. 27–41). Ministrstvo za okolje in prostor, Uprava Republike Slovenije za geofiziko.
- Vrščaj, B., Bergant, J., Kastelic, P., & Šinkovec, M. (2020). Erozija v Sloveniji kratka predstavitev in ocena pomembne degradacije tal. Kmetijski inštitut Slovenije.  
[https://www.kis.si/f/docs/Druge\\_publicacije/EROZIJA\\_KIS-2020.pdf](https://www.kis.si/f/docs/Druge_publicacije/EROZIJA_KIS-2020.pdf)
- Petrovec, V., Bizjak, M., Rednak Robič, B., Kopasić, M., Kramar, J., Pavlin, J., & Bajd, B. (2014). Naravoslovje in tehnika 5 e-učbenik za naravoslovje in tehniko v 5. Razredu osnovne šole (D. Krnel, Ed.). Zavod Republike Slovenije za šolstvo. Page 35.  
<https://eucbeniki.sio.si/nit5/1381/index2.html>
- <https://www.e-plaz.si>

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- Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O., Swartz, B., Quental, T. B., ... & Ferrer, E. A. (2011). Has the Earth's sixth mass extinction already arrived?. *Nature*, 471(7336), 51-57.
- Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., ... & Van Den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387(6630), 253-260.
- IPBES, 2018. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Available at: <https://www.ipbes.net/>
- Jaureguiberry, P., Titeux, N., Wiemers, M., Bowler, D. E., Coscieme, L., Golden, A. S., ... & Purvis, A. (2022). The direct drivers of recent global anthropogenic biodiversity loss. *Science Advances*, 8(45), eabm9982.
- Johnson, C. N., Balmford, A., Brook, B. W., Buettel, J. C., Galetti, M., Guangchun, L., & Wilmschurst, J. M. (2017). Biodiversity losses and conservation responses in the Anthropocene. *Science*, 356(6335), 270-275.
- Pörtner, H. O., Scholes, R. J., Agard, J., Archer, E., Arneeth, A., Bai, X., ... & Ngo, H. (2021). Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). <https://zenodo.org/record/5101125>
- Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review*, 2(1), 81-98.
- Torkar, G., & Krašovec, U. (2019). Students' attitudes toward forest ecosystem services, knowledge about ecology, and direct experience with forests. *Ecosystem services*, 37, 100916.