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GOAL Educational Resource

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TITLE OF THE CASE	Geoethical aspects of hydropower plants.
SHORT CASE DESCRIPTION	Hydropower is a renewable source of energy that is considered widely as "green" energy. However, the infrastructure required to produce hydropower (e.g. dams) has numerous impacts on the river ecosystem. Geoethical conflicts and dilemmas shall be discussed based on the case of a small hydropower plant along the Salza river.
KEYWORDS	Hydropower, geoethical aspects, riverine ecosystems, water management.
PRIOR KNOWLEDGE	Water management, riverine ecosystems, basic ethics.
AIM	Critically reflect and discuss the impact of using perceived "green energy" sources in an ecosystem context-based on the geoethical conflicts and dilemmas that arise when using hydropower.
OBJECTIVES	• To analyse the effects of hydropower plants on riverine ecosystems and the environment. • To understand the effects of hydropower on ecosystems conservation. • To know about the involved stakeholders in the decision-making process. • To become aware of geoethical conflicts and dilemmas related to hydropower. • To evaluate the importance of water as a non-renewable natural resource. • To predict how geosciences can help society in facing water demands in less favoured countries.
CASE	Hydropower is a renewable source of energy that is considered widely as a source for "green" energy. However, the infrastructure (dams) required to produce hydropower has a big impact on the river system.

Figure 1: The Salza river is known for the beautiful landscape and water sports

The Salza river (also Mariazeller Salza) is an eastern tributary of the Enns river. It originates in Lower Austria and flows South of Mariazell through the Styrian nature preserve of Wildalpener Salzatal and meets the Enns after 90 km. The Salza is known as a pristine river and a popular spot for water sports (rafting, kayaking, etc.; Figure 1). Most water sport activities start downstream of the Prescenyklause. The Prescenyklause (Figure 2) was constructed with a weir (a small dam) for a saw mill in 1848. Today the water of the reservoir is used to power a small electric power plant.

Figure 2: The Prescenyklause 1931 (left) and today (right).

However, already for centuries, the Salza valley and neibouring valleys have been used as source for the enormous demand for wood of the metal industry on the Enns river. The wood has been transported on the rivers, firstly documented for the Salza river in 1373. The use of "Klausen" (lock for log floating) for rafting of wood has been a common practice in rivers with strong current. The Prescenyklause is the only structure remaining of the once large-scale water transport facilities in Enns, Salza and Mürzgebiet. As a monument of forestry services from the first half of the 19th century, it has been a listed as building of cultural heritage since 1974. Today, the Prescenyklause is in its original form resulting from careful repair.

Extensive renovations had been carried out in the years 1926 to 1928, and in 1951. In 1954, the rafting at the Prescenyklause stopped. Due to the massive construction of the Klause, it was possible to use it as a forest engineering building for more than 100 years. From 1985 to 1987 the Klause has been re-adapted to a power plant. Therefore, the existing dam has been renovated and reinforced and a tunnel has been struck into the rock next to the Klause. Now, the water flows through this tunnel and drives two turbines that produce electricity. The entire power plant is underground and therefore it's not visible. The cavern power plant is controlled by the headquarters in Mariazell. By this construction, it was possible to preserve the original Klause, and to secure its continued use at the same time (all the other old forestry hydraulic structures in Austria are expired and largely disappeared). The power plant has a power of about 1.5 MW.

A group of students from Vienna travelled to the Salza river for rafting and kayaking for a weekend. They enjoyed the nice scenery of the Salza river. However, when they had been transported to the starting point of the their first kayak tour downstream from the Prescenyklause (Figure 3), they could see the massive contruction and questions of the impact of the Klause on the Salza river raised.

Figure 3: The starting point of kayaking tours downstream the Prescenyklause.

After a day of kayaking there was a lively discussion about hydropower during dinner. The following questions were raised:

QUESTIONS

1. Which are general impacts of dams on riverine ecosystems?
2. What are the stakeholders to be involved in the planning of a hydropower plant?
3. What geoethical conflicts and dilemmas are linked to hydropower plants, e.g. in terms of sustainability, "green" thinking and environmental impact.
4. Can all conflicts be solved to satisfy all stakeholders? How?
5. Which technical measures can be implemented at sites with hydropower plants in general and at the Prescenyklause in particular to improve the riverine ecosystem?
6. How to deal with the resulting dilemmas?
7. How to sustainably preserve water so future generations can benefit from this natural resource?

PROCEDURE

Preparation

1. Read the introduction on geoethics (Peppoloni et al., 2019; http://docs.wixstatic.com/ugd/5195a5_23670a25b64a46249a971718c2fa6c9f.pdf)
2. Watch the video pill "*GOAL: Geoethics issues and geoethical dilemmas*" at https://www.youtube.com/watch?v=1KBFAqMMnpo
3. As introduction to the topic of hydropower, read the following chapters in the book "*Riverine Ecosystem Management – Science for Governing Towards a Sustainable Future*" (Schmutz and Sendzimir, 2018; https://www.springer.com/de/book/9783319732497)
    a. chapter 4 (River Hydrology, Flow Alteration, and Environmental Flow),
    b. chapter 5 (Hydropeaking Impacts and Mitigation), 6 (Dams: Ecological Impacts and Management) and
    c. chapter 9 (River Connectivity, Habitat Fragmentation and related Restoration Measures).

    [For more detailed information, you can also read chapters 2, 8, and 24]

Group work (4-5 students):

1. As a warm-up, each student should write down his/her sponateous mental connections with the "rivers" and "dams" (in keywords). Discuss in the group what kind of new ideas and concepts on the relation between humans and rivers evolved from these keywords. Summarise the results at the end of the group work.
2. Elaborate questions 1 through 6: Firstly, discuss the question in the groups. After each question the results from the groups are presented, discussed and summarized. This guarantees that each group has the same basis for discussing the next question.

REFERENCES

Main references:

Peppoloni, S., Bilham, N., Di Capua, G. (2019): Contemporary Geoethics within Geosciences. In: Bohle, M. (Ed.): *Exploring Geoethics: Ethical Implications, Societal Contexts, and Professional Obligations of the Geosciences*, Palgrave Pivot, Cham, XIV + 214, ISBN 978-3-030-12009-2, http://docs.wixstatic.com/ugd/5195a5_23670a25b64a46249a971718c2fa6c9f.pdf (Pre-print of the Open Access eBook).

Schmutz, S., & Sendzimir, J. (Eds., 2018): *Riverine Ecosystem Management – Science for Governing Towards a Sustainable Future*. Aquatic Ecology Series Volume 8, Springer Open, ISBN 978-3-319-73250-3, https://www.springer.com/de/book/9783319732497 (Open Access eBook).

Further reading on specific aspects of hydropower:

Hauer, C., Wagner, B., Aigner, J., Holzapfel, P., Flödl, P., Liedermann, M., … Habersack, H. (2018) State of the art, shortcomings and future challenges for a sustainable sediment management in hydropower: A review. *Renewable and Sustainable Energy Reviews*, 98, 40-55

Hess, C.E.E., & Fenrich, E. (2017) Socio-environmental conflicts on hydropower: The São Luiz do Tapajós project in Brazil. *Environmental Science & Policy*, 73, 20-28.

Kirchherr, J., & Ahrenshop, M.-P., Charles, K. (2019) Resettlement lies: Suggestive evidence from 29 large dam projects. *World Development*, 114, 208-219.

Schleker, T., & Fjeldstad, H.-P. (2019) Hydropower and fish – Report and messages from workshop on research and innovation in the context of the European policy framework. *Science of the Total Environment*, 647, 1368-1372.

Singh, V.K., & Singal, S.K. (2017) Operation of hydro power plants - a review. *Renewable and Sustainable Energy Reviews*, 69, 610-619.