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Geoethics in water management – Resources for higher education (GOAL Project framework)

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Universität für Bodenkultur Wien, Austria.

The recognition of the Human Right to Water and Sanitation by the United Nations General Assembly in 2010 marks a major symbolic and legal milestone. The United Nation's Sustainable Development Goals (UN SDGs) incorporate the different interests of society. In combination with limited resources conflicts of interests are inevitable. Competing interests of different stakeholders concerning water and land-use management are particularly big drivers of conflicts in this field. Also the personal daily behaviours of its individuals influences the water and energy consumption of whole society.

An essential baseline to achieve societal goals related with water might be the implementation of coherent environmental policies. Transnational implications of e.g. large water-infrastructure projects bring additional complexity to decision making processes. The Implications of climate change on water management add another layer of uncertainty.

Professionals with a higher education in geosciences are at the heart of humankind’s attempts to deal with all of this issues. They are not only supposed to hold technical expertise, but also understand their responsibilities. A modern education of the students in geosciences therefor has to account for this challenges. Geoethics is capable of providing the theoretical background on this challenges.

The GOAL project (Geoethics Outcomes and Awareness Learning) aims in general at improving the concepts and practices of Geoethics and specifically to provide educational material (a syllabus and complementary educational resources) to be used in higher education. From the wide range of geoethical issues related to water management, two cases were chosen to introduce students to the concepts of Geoethics. The water supply system of Austria´s capital Vienna serves as a starting point to deal with questions like utilization pressure on water and land. An historic dam that is now used for production of "green" electric energy via hydropower, sets the frame for the discussion about the impacts of hydropower on the riverine ecosystem.

Acknowledgment

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Geoethics in water management

Resources for higher education

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Declared Aims and goals of humanity
(in water management)

- Human right to Water and Sanitation 10th Anniversary (UN – General Assembly 2010)

- 5 years of Sustainable development goals (UN Sustainable Development Summit 2015)

Realization of these goals

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- The Sustainable Development Goals incorporate the different and contrasting interests of society
- Resources are limited

conflicts of interests are inevitable

- Implications from climate change research add to complexity and uncertainty

The people working on this realization

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Professionals with a higher education in geosciences:

- are at the heart of the processes to achieve these goals (Engineers, scientists, consultants and advisers, … people affected)
- will face dilemmas and issues during their (work)life
- should also get training on how to deal with them
- Geoethics provides a theoretical background on this challenges
- The GOAL-Project provides education material for students

The GOAL Project

www.goal-erasmus.eu

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Geoethics Outcomes and Awareness Learning

- Cofunded by the ERASMUS+ Programme
- Six partners from universities in Portugal, Austria, Israel, Italy, Lithuenia and Spain

- developed a geoethics sylabus
- offers suggestions for 11 Educational Ressources
- E(hand)book

GOAL – Educational Recources

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- Introduction to Geoethics
- Geoethics and geological risks
- Geoethical aspects of georisks within field trips
- Geoethical values in a UNESCO Global Geopark
- Geoethical aspects of geoheritage within field trips
- Geoethical aspects of Georesources
- Aspects of georesources within field trips
- A geoethical conflict in fossil sites
- Geoethical aspects of hydropower plants
- Earth system nexus human interaction: a geoethical perspective
- Geoethical aspects of water supply

Geoethical aspects of hydropower plants

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- Hydropower is widely considered green energy
- But numerous impacts on river ecosystem by the necessary infrastructure

Students will:

- Learn effects of hydropower plants on river ecosystems by studying of scientific papers (Flow Alteration, Hydropeaking, River connectivity Habitat fragmentation,…)
- Learn about geoethical values (ethical, social, cultural) and the principle of responsibility

Geoethical aspects of hydropower plants

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Questions the students will work on:

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?
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 presented case 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?

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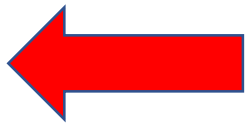

Geoethical aspects of water supply

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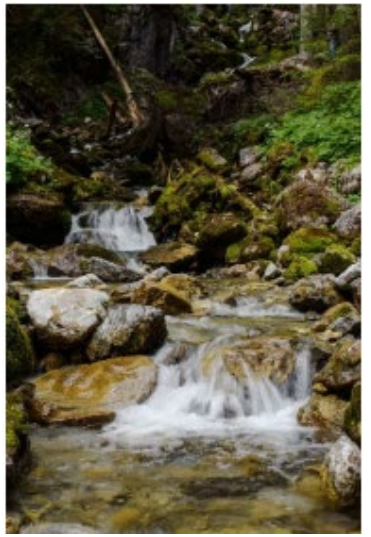

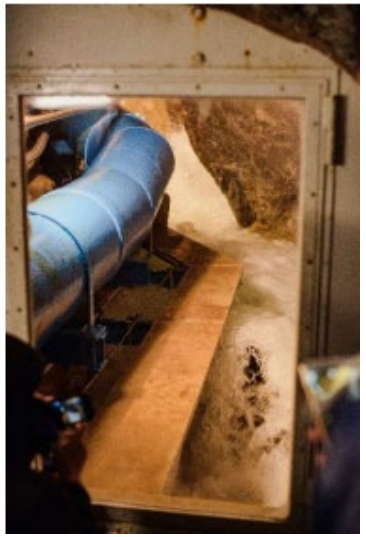

Geoethical issues and dilemmas resulting from

- utilization pressure on water and land are addressed on a local scale
- daily personal behavior and consumption are addressed on a global scale

Students will:

- Learn about the importance of natural systems for water supply
- Learn about the concepts of virtual water and waterfootprint
- Learn about geoethical values (ethical, social, cultural) and the principle of responsibility

Geoethical aspects of water supply

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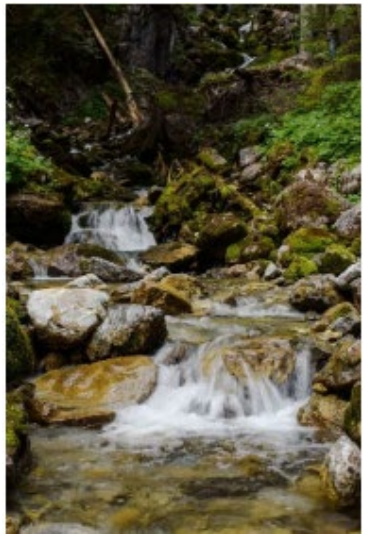

Questions the students will work on:

1. Which geoethical issues and dilemmas arise from different interests in land use?
2. How do changes in land use affect water ressources?
3. How geoethical values can be met by the operation and management of the catchment area of the springs?
4. Which geoethical values are met by the Water Footprint Network?
5. Which Sustainable Development Goals have a strong impact on water supply management and may also pose a (partly) conflict of interests to SDG-6?
6. Which geoethical issues and dilemmas are related with the achievement of the different SDGs and their linkage?
7. How can Earth Scientists be involved in the process of achieving the SDGs related to water management?
8. Explain how geoethical values support geoscientists in their role in the process of achieving the SDGs.

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GEOETHICS OUTCOMES AND AWARENESS LEARNING

All materials:

Geoethics syllabus

E(hand)book

11 Educational Ressources

are (soon) freely available at

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GOAL Educational Resource

AUTHORS	Günter Langergraber (BOKU, Austria), Sebastian Handl (BOKU, Austria), Susanne Schneider- Voß (BOKU, Austria) & Markus Fiebig (BOKU, Austria)
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	Geoethical aspects; Hydropower; Riverine ecosystems; Water management.
PRIOR KNOWLEDGE	Basic ethics; Riverine ecosystems; Water management.
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.

Fig. 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.; Fig.1). Most water sport activities start downstream of the Prescenyklause. The Prescenyklause (Fig.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.

Fig. 2 – The Prescenyklause 1931 (left) and today (right).

However, already for centuries, the Salza valley and neighbouring 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 is 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 their first kayak tour downstream from the Prescenyklause (Fig.3), they could see the massive construction and questions of the impact of the Klause on the Salza river raised.

Fig. 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*" - 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 &

Sendzimir, 2018 - https://link.springer.com/book/10.1007/978-3-319-73250-3)

a) Chapter 4 (River Hydrology, Flow Alteration, and Environmental Flow)
b) Chapter 5 (Hydropeaking Impacts and Mitigation)
c) Chapter 6 (Dams: Ecological Impacts and Management)
d) 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 spontaneous 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. Summarize 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.

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Further reading on specific aspects of hydropower:

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GOAL EDUCATIONAL RESOURCE

AUTHORS	Sebastian Handl (BOKU, Austria), Günter Langergraber (BOKU, Austria), Susanne Schneider- Voß (BOKU, Austria) & Markus Fiebig (BOKU, Austria)
TITLE OF THE CASE	Water: a geoethical perspective on one of humanities most valuable resource
SHORT CASE DESCRIPTION	The water supply for the Austrian capital Vienna is used as case-study and starting point to discuss geoethical implications on several aspects involved with the use of the renewable resource water. Geoethical conflicts and dilemmas are addressed that arise from the utilization pressure on the resources water and land use.
KEYWORDS	Geoethical aspects; Holistic thinking; Natural resources; Water management; Water supply.
PRIOR KNOWLEDGE	Basics of sanitary engineering; Water management; Water supply.
AIM	Promotion of geoethics values and principles related to the human interaction with the water cycle through the reflection about water as a mayor resource of life.
OBJECTIVES	• To analyze geoethical issues and dilemmas connected with water supply on two different spatial scales (local and global). • To understand the need to preserve natural systems and its dynamics when designing interventions on the environment. • To defend the involvement of all stakeholders in the decision-making process. • To contrast the objectives of different sectors with interest in water use. • To support Geoethical values to preserve a functional environment as the fundamental basis for renewable resources as drinking water. • To value public awareness of geoscientific work.

CASE

A group of students goes on a field trip along the two water mains of the Vienna Water Works in Austria.

At their first stop at the museum in Kaiserbrunn the students learn about the history of the Vienna water mains:

The provision of spring water for Austria's capital dates back to imperial times. Vienna's First Spring Water Main was established in 1873 initialized by the emperor of Austria Franz Joseph I., who gave the first spring "Kaiserbrunn" as a present to the city of Vienna to bring a long lasting solution to the cities ongoing problems with drinking water quality that resulted in disease and epidemics. The Second Spring Water Main was opened in 1910. Since that time the whole population of Vienna (about 1.8 Mio) is supplied with spring water of excellent quality. The Water runs into the city only by the force of gravity and by implementation of drinking water hydropower plants it additionally produces green electronic energy in a quantity equivalent to supply a city of about 50.000 inhabitants.

Fig. 1 – The "Kaiserbrunn"-Spring given to the people of Vienna by the emperor Kaiser Franz Joseph I.

The guide in the museum, who is also an employee of Vienna Water Works, explains some challenges that he and his colleges are facing at their daily work.

1) For the biggest share, Vienna Water Works is in possession of the land in the catchment area of the springs. Three typical land uses are conducted in in this area. Forestry is the historic economic backbone of the region. Therefore, the employees of Vienna Water Works nowadays are also concerned with forestry to establish and maintain the land cover as a filter and important barrier against contamination. The forestry strategy follows the target of maximizing the protective nature of the land cover for the water.
2) The catchment area is also subject to tourism since it's a popular hiking area. Consequently, the Vienna Water Works established a

comprehensive strategy to deal with wastewater of mountain huts in the catchment area to minimize the risk of pollution from this source.

3) Mountain pasture is an old tradition in the region and the rights to conduct it are culturally important. Since the underground residence time of water in the karstic limestone vary strongly between the scales of days up to years, the excrements from the livestock of mountain pasture as well as from the wild animals in the forests pose a risk of pollution to the drinking water in the springs under certain meteorological and hydrological conditions. This risk is addressed on two levels. First, particularly vulnerable areas like dolinas are protected via low earth walls that keep surface runoff from entering and by fences that keep out wild animals. Secondly water quality is monitored constantly at each spring separately, so in case of a contamination they can be redirected to the river.

The second site visited by the students is the "Kläfferquelle". The biggest spring in the eastern alps and also a geopark site where visitors can learn about the history of the capturing of the spring and also see the impressive tunnel and the surface openings of the spring where about 1.000 l/s of water exit the Hochschab-Massif.

Fig. 2 – The "Kläfferquelle"at Wildalpen. View of the spring in the mountain (left). Sign for geopark at the entrance (right).

On the way back to Vienna, one of the students shares a link to an online video that gives an overview on the global water consumption and the concept of water food print with his/her colleges.

In the evening a lively discussion about the management of the catchment area by the Vienna Water Works in comparison to water supply facilities in other places started during dinner: Within the group the relevant questions arised.

QUESTIONS

1. Which geoethical issues and dilemmas arise from different interests in land use in this (and other) catchment area(s) of springs?
2. What would happen if the land would not be in possession of the Vienna Water Works and the landowner would decide to change the forestry strategy? (for example, towards maximization for wood production or implementing agriculture)
3. How geoethical values can be met by the operation and management of the catchment area of the springs?
4. Which geoethical values are met by the Water Footprint Network?
5. Which SDGs (Sustainable Development Goals) have a strong impact on water supply management and may also pose a (partly) conflict of interests to SDG-6 (Ensure availability and sustainable management of water and sanitation for all)?
6. Which geoethical issues and dilemmas are related with the achievement of the different SDGs and their linkage?
7. How can Earth Scientists be involved in the process of achieving the SDGs related to water management?
8. Explain how geoethical values support geoscientists in their role in the process of achieving the SDGs.

PROCEDURE

Split students in random small groups of 4 or 5 and ask them to follow the bellow procedures:

1. As an introduction to the water supply of Vienna, watch the video "Viennas Water short" (https://www.wien.gv.at/video/403/Viennas-Water-short) and the Interview with Lukas Plan (Geologist at Dep. of Geology and Paleontology, Natural History Museum Vienna, Austria) "GOAL: KLÄFFERQUELLE - SOME FACTS ABOUT THE BIG KARSTIC SPRING" (https://youtu.be/qFwfniq5J78).
2. Answer questions 1 and 2 after watching the video pill "GOAL: Geoethics issues and geoethical dilemmas" at https://www.youtube.com/watch?v=1KBFAqMMnpo.

   [Further reading for more detail: "Marone & Peppoloni, (2017)" at https://www.annalsofgeophysics.eu/index.php/annals/article/view/7445]

Plenary session were the answers of all groups are collected and discussed.

3. Answer individually question 3) after reading the article "Peppoloni & Di Capua (2016)" at https://goal-erasmus.eu/wp-content/uploads/2019/02/GEOETHICS-ETHICAL-SOCIAL-AND-CULTURAL-VALUES-IN-GEOSCIENCES-RESEARCH-AND-PRACTICE.pdf.

   [Further reading for more detail: "Bobrowsky et al., (2017)" https://goal-erasmus.eu/wp-content/uploads/2018/10/Emerging_Field_Geoethics.pdf]

4. Watch the video "Where is water?" (https://www.youtube.com/watch?v=b1f-G6v3voA) and check

the homepage of the Water Foodprint Network (https://waterfootprint.org/en/):

a) Each student estimates her/his actual and virtual water consumption of the day separately (starting from breakfast, showering, consumption of goods, etc.) by writing down her/his consumption and water uses.
b) Answer question 4 in the groups already established.

Collect and discuss the answers to questions 4 in a plenary session.

5. Read the Agenda 2030 for Sustainable Development (https://www.un.org/sustainabledevelopment/development-agenda/).

a) Each group should deal with at least 3 Goals. Each of the 17 Goals should be covered by at least one group. The groups work on answering questions 5 and 6.

[Further reading could be UN-Water-Development-Reports (https://www.unwater.org/publication_categories/world-water-development-report/)]

Plenary session where the answers of all groups are collected and discussed.

6. Go back into the groups and answer questions 7 and 8.

Plenary session where the answers of all groups are collected and discussed potentiating the appropriation of new geoethical values and principles towards a Sustainable Development.

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