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CHARM

WASSERNETZWERK BADEN-WÜRTTEMBERG

CHAllenges of Reservoir Management: Societal implications

Sediments

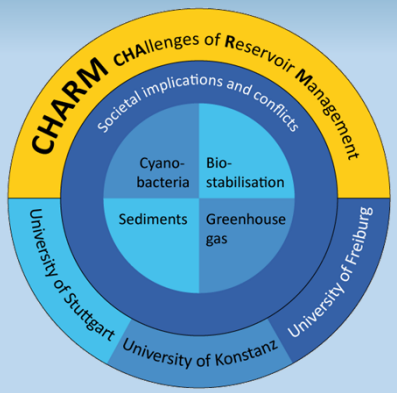
Reservoir sedimentation represents a huge challenge in reservoir management. Depositions not only reduce the available storage volume, but might result in a loss of flood control or in worst case, block intakes and outlets.

Within CHARM the sediment stability and the erosional behaviour of fine sediments will be investigated in both, the laboratory and the field. In a second step algorithms will be developed and implemented in numerical models. These models are the basis for predictions and as consequence the basis for a sustainable reservoir management.

Biostabilisation

Microbial organisms inhabiting fine sediment secrete polymers that bind the grains together and can significantly influence the erosional resistance of sediment (known as 'biostabilisation').

Within the CHARM project the role of biostabilisation on fine sediment behaviour will be investigated using both field observations as well as manipulative experiments to examine the influence of abiotic conditions such as hydrodynamics, temperature, light and nutrients.



Cyanobacteria

Many reservoirs experience high nutrient input which can favour harmful cyanobacteria blooms leading ultimately to a decreased water quality and a potential impact on the environment.

Within CHARM the objective is to explore the physicochemical and biological factors triggering bloom formation in order to establish future monitoring and management strategies. Main focus is the toxin production of cyanobacteria, water level fluctuations, mixing events due to reservoir management and climatic influences.

Greenhouse gas

Reservoirs store sediments and the organic material within sediments is decomposed by bacteria leading to an accumulation of the greenhouse gases carbon dioxide (CO_2) and methane (CH_4). These gases may eventually be released from sediments.

Within CHARM the objective is to measure the dynamics and distribution patterns of CO_2 and CH_4 in reservoirs and quantify the emissions of these gases to the atmosphere. A specific focus is to assess the influences of reservoir management on production and storage, and on emissions and emissions pathways of CO_2 and CH_4.

Societal implications of reservoir management

Social contextualisation

Introduction

Reservoirs are complex systems which can be traced back to 5000 B.C. The historic examples were mostly built for irrigation purposes in arid regions as well as drinking water supply. With the ongoing electrification efforts, the production of hydropower became another important motive for dam construction. Today, reservoirs present themselves as highly complex systems, inter-linking added functions like flood control and recreational uses with the spatial-social environment.

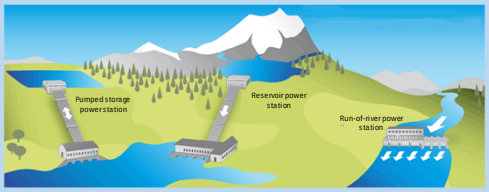


Fig. 1: Types of hydropower stations [1]

Large dams in particular, being categorised as at least 15m high (ICOLD), have a major impact on the surrounding landscape and ecology, the hydrological system downstream as well as on the societal contexts compassing it.

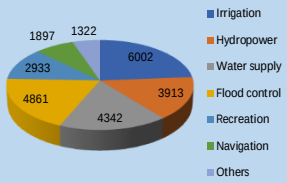


Fig. 2: Large dams worldwide categorised after their use [2]

There is a long list of implications extending to a wide range of research dimensions and approaches.

Time dimension: as reservoirs have a service life of many decades, their role within the system changes over time.

Stakeholder dimension: Each reservoir will have an impact on a number of interests present (in the immediate vicinity of the water body as well as upstream and downstream).

Spatial dimension: the location of the reservoir is oftentimes a crucial issue.

Governance dimension: The type of governance influences the reservoir system most profoundly.

Social discourses: the way a society discusses and communicates values and key-interests influences the perception of reservoirs in turn. It is therefore linked to the perception of risk amongst stakeholders and the general public.
To understand the discourse dynamics is key to developing a comprehensive management framework.

Methodology

Methodological approach

In order to do justice to the complex and inter-linked systems under research, the methodology has to be just as diverse and adaptable. One of our main goals within CHARM is the identification of effect chains with regard to specific aspects under discussion. The evaluation follows a hypothesis based research approach.

Media and discourse analysis

At the beginning of each evaluation, a review of relevant sources provides insight into the specific project and its challenges.

Thereby it is possible to identify:

- land uses in the area with possible connections to the reservoir system (e.g. agriculture, forestry, recreational activities...).
- stakeholders and their interests and/or requirements regarding the characteristics of the water body.
- potential dissent and conflicted issues.
- past/ current discussion trends.

Based on this evaluation, the next phase is to identify the participating stakeholders within the context of the particular project and prepare a questionnaire according to the gathered information. Additional aspects of interest and clarification on topics already pegged by media analysis will then be collected during succeeding expert interviews.

Constellation analysis

In order to highlight certain aspects, relations, dissent and collaboration, the so called constellation analysis is applied. This method can be understood as a tool to visualise complex social and physical relations and initially provides a comprehensive overview.

Composite programming

To get a comparable idea of local contexts, another innovative approach is the method of composite programming.

- Composite programming is a multi criteria analysis method that uses a system of relevant indicators to describe situations.
- It is stakeholder-based and can transform qualitative social indicators into quantitative values to describe to what degree a stakeholder approves of a specific aspect of the situation in question. It also illustrates differences between stakeholders.
- The overall goal is to gather qualitative data and transfer this data into a numerical frame to provide immediate comparability of the individual stakeholder standpoints. The calculated values will range between 0 and 1, depending on the chosen nuances. 0 corresponds with total rejection of the project, while 1 stands for complete acceptance.

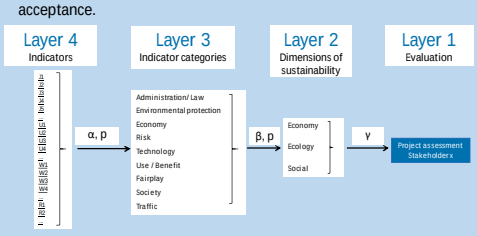


Fig. 3: Showcase of a Composite Programming approach

Case studies

Cyanobacteria blooms

Cyanobacteria are the only photosynthetic bacteria that mostly live in fresh- or seawater, but occur also in the terrestrial environment. They are visible as cloudlike accumulations of blue - greenish color within water bodies (so called blooms) or as biofilms upon stones or sediment

Fig. 4: Cyanobacteria bloom [3]

Some species of cyanobacteria produce toxins that can be harmful for human and wildlife if ingested. Effects range from nausea and dizziness to more severe conditions like liver failure, neurological symptoms and in some cases even death.

Usage of toxins as well as environmental triggers are not yet fully understood.
CHARM investigates some of these open questions connected to cyanobacteria in respect to artificial lakes and their management.
Cyanobacterial blooms depend in natural water systems on environmental parameters like temperature light and nutrients. Artificial reservoirs underlie in addition to that management related factors.

Fig. 5: Warning sign at a lake [4]

Therefore, the effect chains in respect to these factors are of great interest.

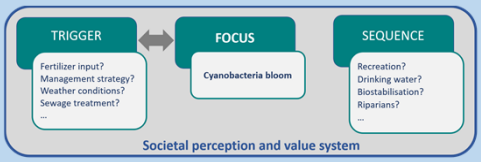


Fig. 6: Hypothesis-based effect chain: cyanobacteria bloom

Schluchsee water level conflict

In 2017, the operating permit for the Schluchsee reservoir needed to be renewed, leading to some adjustments. So far, the operators have voluntarily agreed to keep a certain water level during the summer months, so the hydropower production would not impede tourism, thereby gaining a certain degree of acceptance and support from the adjacent residents. In future, the Schluchseewerk AG would like to fluctuate the water level by one additional meter in summer and even more during wintertime.

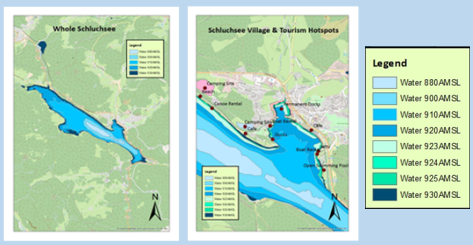


Fig. 7: Schluchsee water level scenarios

The municipality of Schluchsee is economically highly dependent on tourism and recreation and fears declining numbers of visitors. If the water level is reduced, unattractive and possibly malodorous watersides will be exposed. Furthermore, the functionality of existing recreational facilities may be impeded.

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Sources:
[1] http://www.wasserkraft-deutschland.de/fileadmin/user_upload/wasserkraftarten.png
[2] http://www.icold-cigb.net/GB/world_register/general_synthesis.asp
[3] Foto Barbara Weisbrod
[4] Zimmerhof, M. (2015): Hohnsen bleibt gesperrt. In: Hildesheimer Allgemeine Zeitung (26.10.2015).

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