DEL045 - Improving sediment management in river systems with reservoirs

Japan

Gates operation

Nepal

Dams cascading

USA

Dam removal

Re

Motivation

Sediment management in hydropower dams is of crucial importance, both for economic and environmental reasons. Sedimentation in reservoirs may lead to loss of active storage and blockage of the inlets and consequently loss of economic value. For the ecological value (e.g. fish habitat) a proper mix and timing of sediment flushing to the downstream is important. Many hydropower authorities around the world are therefore interested in improving the sediment management of the reservoirs. J-Power, the largest power company in Japan, is actively seeking to jointly develop knowledge and techniques to improve their gate operation for better management of the sediment trapped in the reservoirs and spread of sediment downstream.

This project is a follow-up of the previous TKI project with J-Power (DEL026). In addition, J-Power wants to assist to address the sediment related issues in hydropower dams in Nepal (mainly Run-of-the-River) by involving Deltares and enhancing the cooperation with local institutions and companies that are active in this field.

Goal

The aim of this project is to further deepen and broaden our knowledge on how dynamic (time varying control) gate operation can contribute to the optimization of sediment management around hydropower dams to 1) efficiently flush the reservoirs (to increase lifetime), 2) reduce erosion problems downstream, 3) increase the sediment supply downstream of a dam and 3) create a good habitat/ ecosystem downstream by minimizing environmental and ecological impacts. For this we propose to carry out the following activities:

• Extend the Real Time Control (RTC) module, such that more complex regulations can be modelled using Delft3D.
• Investigate to which extend Delft3D can properly model complex flow patterns downstream of a hydropower dam (This knowledge is also relevant for other projects dealing with flow velocities in scour holes or other depressions in the riverbeds.)
• Determine and assess relevant indicators for ecology/fish habitat from the model results.
• Simulate cascading dam systems considering sediment management strategy.

Research tasks

1. Literature survey on sediment management in reservoirs, and data collection.
2. Further improvement of Delft3D and RTC tools to be able to apply the PID controller to control the reservoir water level(s) for much more flexible operation rules.
3. Funagira Reservoir in the Tenryuu River (Japan) and Kabeli hydropower reservoir in Tamur River (Nepal) is studied to simulate different sets of reservoir conditions and gate operations. Then perform a proper analysis to the data to come up with useful conclusion to be used in reservoirs and dams which have similar challenging conditions. Furthermore,
4. Explore the possibility of Delft3D to simulate complex flow behavior like the jets and hydraulic jumps downstream of the dam.
5. Assess the impact of the new sets of reservoir operation on the ecosystem (modelling indicators for ecology/fish habitat).
6. Modelling of cascading system of dams using 2D morphodynamic modelling to perform combined sediment management techniques to series of dams, planned in Koshi basin, Nepal.

Research results

In this research a literature review has been conducted to explore the state of art in sediment management related to dam operation. The RTC toolbox has been developed to apply PID controller to provide the automatic gate operation according to the user-defined reservoir water level, when it is coupled with Delft3D4 software. Consequently;

- The modelling approach has been developed successfully.
- Two 2D-models and pilot studies have been developed for Funagira Reservoir (existing reservoir in Japan) and Kabeli reservoir (Planned reservoir in Nepal).
- Based on the literature review and modelling activities two papers (Funagira reservoir and Kabeli reservoir) have been published in the ICOLD (International commission of large Dams) in Prague (3-7 July, 2017).
- MSc study related to river restoration and habitat recovery following dam decommissioning in USA is being conducted as a joint collaboration between Deltares and UNESCO-IHE.
- Preliminary evaluation of fish habitat upstream and downstream Funagira reservoir is conducted. This study presents a quick scan of several sediment flushing scenarios for the Funagira dam in Japan on the habitat suitability of the fish species Ayu (*Plecoglossus altivelis*). To prevent erosion of the Tenryuu River downstream of the Funagira dam, several sediment flushing scenarios have been proposed. Results from these scenarios were used to assess the effect on the habitat suitability of feeding and spawning of the Ayu fish based on relative changes in water depth and flow velocity. Results show that most flushing scenarios increase the habitat suitability upstream of the dam and decrease the habitat suitability downstream of the dam compared to the current dam operating regime. Higher discharges increase the amount of suitable shallow zones upstream, but create higher flow velocities downstream that counterbalance this effect downstream of the dam. Due to the limited amount of parameters and the small temporal resolution of the flushing scenarios, results should only be viewed as relative indications and not as an absolute prediction of suitable habitats.

Recent space activity

Madelief Doeleman
DEL146 - Broeikasgasemissies bij nat grondverzet updated yesterday at 17:55 view change

Erik Hendriks
DEL162 - PRISMA 3 - Programma Innovatief Sediment Management voor Havens updated yesterday at 15:02 view change

Lidian Lenssinck
DEL177 - DigiShape Open Source Platform (D-OSP) created yesterday at 09:02

Marien Harkes
DEL153 - Fast Low cost Installation of Pipelines updated 27-03-2024 view change

Erwin Meijers
Tutorial created 26-03-2024

Space contributors

- Amgad Omer (1382 days ago)
- Lidian Lenssinck (2697 days ago)