

Operation of complex hydropower schemes and its impact on the flow regime in the downstream river system

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Context

The problem of hydropeaking depends on hydraulic, morphological and ecological parameters. An interdisciplinary approach is necessary to address all issues in order to improve the environmental conditions downstream of hydropower plants (HPP) (EPFL, EAWAG and industrial partners).

- **Hydropeaking**
- Degradation of river ecosystem

Approach

High-head storage hydropower plants in Alpine areas are able to complement the irregular production of renewable energy sources (wind power) in the European power supply system. Sudden opening and closing of the turbines produces highly unsteady flow conditions in the river downstream of the powerhouse outlet resulting in:

- **Mitigation measures**
- Improvement of river ecosystem

Modeling

A semi-distributed conceptual model has been developed, calibrated and tested. In the hydrological forecasting tool three-dimensional rainfall, temperature and evapotranspiration distributions are taken into account for producing the dominant hydrological processes GSM-SCOONT (Schäfli 2005):

- Snowpack constitution / melt
- Snowmelt
- Glacier melt
- Soil infiltration
- Runoff

Routing System (Jordan 2007):

- Integration of routing in rivers
- Hydraulic works (water intakes, reservoirs, spillways and plants)

Parameter study

Today

Tomorrow

Climate

Implementation of climate change scenarios, influencing the inflow parameters (temperature and precipitation)

Hydrology

Changes of hydrological characteristics of the Alpine catchment area by glacier model (glacier melt, evapotranspiration)

HPP operation

Simulation/Optimization of HPP operation (heuristic) for economic, climatic, ecological and flood scenarios

Flow Regime

Simulation of flow regime (hourly values) Impact of use of the water resources in the river system by hydraulic indicators

Mitigation measures

Development of hydropeaking mitigation measures (Turbine restriction, basin, tunnel, cavern, distributed system)

Fish habitat suitability

Ecological response by Fuzzy-logic approach with biological data from field measurements (EAWAG)

- **Economic and ecological rating of hydropeaking mitigation measures**
- Operative and constructive measures

Case study

Economic-ecological diagnostic and intervention method applied to the upper Aare River catchment in Switzerland

