Hydropeaking mitigation in Switzerland: collaborative learning between research and practice

Assainissement des éclusées en Suisse : apprentissage collaboratif entre recherche et pratique

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RÉSUMÉ

La Loi Suisse sur la Protection des Eaux, modifiée en 2011, exige l'assainissement des atteintes écologiques dues aux éclusées d'ici 2030 à l'aide de nouvelles infrastructures (par ex. bassin de rétention). Les détenteurs de centrales hydroélectriques sont responsables de la planification, de la réalisation, du suivi et de l'évaluation des effets des mesures prises. Les coûts sont entièrement pris en charge par la Confédération Suisse. Pour appliquer le mandat légal de manière efficace et dans le délai imparti, une approche coordonnée à l'échelle nationale est nécessaire. Celle-ci nécessite (i) un apprentissage collaboratif et systématique des premiers projets mis en œuvre ; (ii) une évaluation critique des directives existantes de monitoring et d'évaluation des mesures prises pour réduire les atteintes dues aux éclusées ; (iii) des comparaisons entre projets pour identifier les facteurs qui influencent la trajectoire d'atténuation des atteintes dues aux éclusées. Nous présentons ici les premières étapes pour guider le processus d'apprentissage pour le développement d'un programme suisse de suivi et d'évaluation. Ce programme vise à standardiser la méthode de suivi et d'évaluation des mesures prises pour réduire les atteintes dues aux éclusées à l'échelle du projet, mais aussi permettant une comparaison entre les projets à l'échelle nationale.

ABSTRACT

The Swiss Water Protection Act, amended in 2011, requires the mitigation of the negative ecological effects of hydropeaking by 2030 by means of constructional measures (e.g. retention basin). The hydropower operators are responsible for the planning, realization, monitoring and evaluation, with the costs being fully covered by the Swiss Confederation. To implement the legal mandate in the most effective way and within the set short time frame, a coordinated approach at the national scale is needed including (i) collaborative and systematic learning from the first implemented projects; (ii) a critical evaluation of the existing guidelines for monitoring and evaluation; (iii) cross-project comparisons to identify factors that influence the recovery trajectory after hydropeaking mitigation. Here we present first steps to guide the learning process for the development of a Swiss monitoring and evaluation program for hydropeaking mitigation aiming at a standardized project assessment but also allowing for cross-project comparison at the national scale.

KEYWORDS

Bio-physical complexity, cross-project comparison, ecological indicators, programmatic monitoring and evaluation, transdisciplinary stakeholders

1 HYDROPEAKING MITIGATION IN SWITZERLAND

In Switzerland 29% of the total national electricity supply is produced via high-head storage power schemes that provide on-demand electricity during times of high consumption. The frequent fluctuations in water level downstream of the turbine outlet ('hydropeaking') are estimated to seriously affect the natural functioning of ca. 1'000 river kilometres.

To prevent these negative tendencies, the Swiss Water Protection Act (WPA 2011), similar to the European Water Framework Directive (WFD 2000), demands the mitigation of hydropeaking by constructional measures. The implementation of the law consists of two steps - a strategic planning at the cantonal level by December 2014 and the planning, realisation and monitoring and evaluation (M&E) of the mitigation measures by the power plant operators until 2030. For both steps, there is a guideline provided by the FOEN, the Federal Office for the Environment (Baumann, et al., 2012; Tonolla, et al., 2017).

In the strategic planning the cantonal authorities identified all hydropower power plants where hydropeaking mitigation was considered a priority. These power plants were defined as i) having a peak flow 1,5 times higher than base flow and ii) exerting adverse effects on the abundance, composition and diversity of the river type-specific plant and animal assemblages. Across Switzerland, 102 power plants met these criteria.

Based on the strategic planning, the power plant operators have to plan, realise and evaluate appropriate constructional measures (e.g. retention basin) to mitigate the negative ecological effects of hydropeaking (Tonolla, et al., 2017). The costs will be fully covered by the FOEN. The budget from the federal government is 50 Mio CHF/yr (≈ 42,5 Mio €) for hydropower mitigation (including mitigation of interruption of fish passage and sediment deficit). Anyway, because of the recent guideline adoption, only little practical experience with a standardised approach exists yet.

2 LEARNING FROM IMPLEMENTATION

The Swiss hydropeaking mitigation represents a worldwide unique multi-billion Swiss-franc investment to improve the ecological status of rivers and the various services they provide. To achieve the political goals and effectively invest the available resources within the short time horizon, a close collaboration and iterative learning process across all stakeholder groups – authorities, industry, NGOs, research – is needed.

In 2017, the FOEN and the research institute Eawag launched a 4-year research project to develop and initiate a national M&E program for hydropeaking mitigation. The project aims at (i) scientifically supporting the first implemented projects, (ii) a critical evaluation of the existing M&E guidelines and (iii) cross-project comparisons to identify factors that influence the recovery trajectory after hydropeaking mitigation. Following the general framework proposed by Weber, et al. (2017), four goals need to be fulfilled for a monitoring and evaluation program: The program needs to **1)** account for complexity, uncertainty and changes in time (e.g. climate change, future electricity market, social perception); **2)** promote a collaborative learning process across projects, stakeholder groups and disciplines **3)** verify to what extent mitigation was achieved; and **4)** identify why the observed effects were present, thereby improving our mechanist understanding of river functioning.

3 A CONCEPTUAL MODEL TO GUIDE THE LEARNING PROCESS

Collaborative learning does not happen on its own, but requires careful planning and a sound knowledge base (Weber et al. 2017). A conceptual model illustrating both the current state of knowledge and knowledge gaps can be helpful for guiding the transdisciplinary learning process. We started mapping semi mechanistically the complexity of hydropeaking causes and effects. The resulting conceptual model provides a solid support for goal 1 above ('account for uncertainty') by defining the complex impacts of hydropeaking on biological, physical and chemical processes in rivers and its feedbacks. The conceptual model may also allow to better grasp causes of change and uncertainty related, for instance, to the evolving electricity market (energy transition) or to climate change which affects water storage volumes of dams (catchment ice cover and sediment mobility).

The conceptual model also provides the basis for goal 2 ('collaborative learning'). A structured

representation of hydropeaking and its interrelated effects offers a useful starting point to guide transdisciplinary discussions with a wide diversity of stakeholder groups (e.g. federal and cantonal authorities, power plant operators, consultants, researchers) from various disciplines (e.g. ecology, engineering, geomorphology). Iterative discussions of lessons learned allow a state-of-the-art and practice-oriented cyclical adaptation of the implementation guidelines. Mapping the complex effects of hydropeaking also allows to identify a series of contextual variables that can affect the site specific trajectory following hydropeaking mitigation (i.e. effect of tributaries, embankment, and river type).

In relation to goals 3 ('verify achievement') and 4 ('identify why'), the conceptual model provides a framework for the definition of a set of key indicators for a consistent national M&E program. A particular focus is placed on defining measurable indicators allowing a quantitative evaluation of the achievements at the project scale, but also enabling a cross-project assessment at the national scale.

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