frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 04 January 2023
DOI 10.3389/fenvs.2022.1118157

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Editorial: Hydropower: From ecology to policy

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KEYWORDS

regulated rivers, diversity, ecosystem processes, impact, mitigation, management, modelling

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Freshwater Science,
a section of the journal
Frontiers in Environmental Science

RECEIVED 07 December 2022
ACCEPTED 12 December 2022
PUBLISHED 04 January 2023

CITATION
Quadroni S, Doretto A, Fornaroli R and White JC (2023), Editorial: Hydropower: From ecology to policy.
Front. Environ. Sci. 10:1118157.
doi: 10.3389/fenvs.2022.1118157

Editorial on the Research Topic
Hydropower: From Ecology to Policy

Hydropower generation through river exploitation is widely considered to be a renewable and clean energy source because of the absence, or negligible level, of greenhouse gas emissions into the atmosphere. However, previous studies have demonstrated that hydropower plants and related structures often affect river ecosystems and their biota in several ways (Kondolf et al., 2014; Grill et al., 2019). These ecological effects can occur during all the phases associated with hydropower facilities, from construction to operation, and are primarily driven by changes in the physical habitat (e.g., water temperature, sediment grain size, water depth and velocity, discharge fluctuations, and dewatering). Quantifying the magnitude of the impact of such shifts on biodiversity and river processes is usually difficult, and outcomes may vary depending on the operational strategy of the hydropower plant and site-specific conditions.

In this Research Topic, Pérez-Calpe et al. evaluated the synergic effects of water diversion for hydropower generation and pollution on coarse particulate organic matter (CPOM) processing and CO_2 fluxes in four rivers in the Northern Iberian Peninsula, controlling for season and type of channel (i.e., wet or dry). Focusing on other ecosystem components and adopting a different spatio–temporal scale, Scotti and collaborators conducted a multi-year study on a glacier-fed stream (Saldur Stream, Northern Italy), assessing the impact of a small hydropower plant on both the taxonomic (Scotti et al.) and the functional (Scotti et al.) diversity and composition of benthic macroinvertebrate communities. Overall, these studies stress the importance of considering concomitant pressures and the specific environmental setting when examining the direct and indirect outcomes associated with hydropower production.

Increased environmental awareness has prompted widespread research into new management strategies aimed at mitigating the impact of hydropower on riverine ecosystems. This consideration has assumed pivotal importance, especially under the current circumstances with respect to global climate change, which imposes an urgent need for energy from renewable sources, as declared in the 2030 Agenda for Sustainable Development published by the United Nations (Goal 7; Colglazier, 2015). This has fuelled the proliferation of small to medium hydropower plants in the mountainous areas of Europe during recent decades, and their number is expected to increase worldwide in the near future (Zarfl et al., 2015). In the light of this, quantification of the impact of hydropower can serve as a basis for the adoption of science-based criteria and management solutions to improve the sustainability of hydropower plants and their operations. Several of the articles published in this Research Topic support this goal.

Pander et al. investigated the effects on fish mortality and fish communities of dewatering of a side channel and associated riverbank habitats occurring as a result of the periodic maintenance operations of a weir in the Inn River (Germany). Based on the results obtained, the authors propose suggestions and guidelines for the reduction of the impact of these routine operations on the fish fauna of this habitat. In a mesocosm experiment, Führer et al. tested the individual and combined effects of down-ramping rate, slope of the riverbank, and timing of down-ramping (daytime or nighttime) on the stranding of various larval stages of common nase (*Chondrostoma nasus*). This is one of the first studies evaluating the response of a Cyprinid species to habitat changes induced by water level fluctuations due to hydropeaking. Thus, it provides useful information on potential ways to make such operations less ecologically harmful by limiting the effects on target fish species. Similarly, Alfredsen et al. developed a 2D hydraulic model to evaluate the areas most affected by hydropeaking operations, in terms of ramping rate and water level fluctuations, in the River Nidelva (Norway), and the related impact on juvenile Atlantic salmon (*Salmon salar*). On the basis of their results, the authors propose a potential mitigation strategy that involves increasing the duration of the stop of the hydropower plant to ensure low dewatering rates and releasing a higher volume of water at each shutdown.

Finally, to enable the implementation of effective management strategies and solutions to mitigate the impact of hydropower on river ecosystems, a comprehensive evaluation should consider not only the environmental impact but also the social and economic consequences. To this end, Opperman et al. examined possible trade-offs between the need for hydropower plants and their social, economic, and environmental benefits by considering the best solutions at different scales, ranging from individual projects to basin and regional levels. By comparing case studies from different countries, the authors provide useful insights into ways of maximizing the benefits of such projects from a sustainability perspective.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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