How much water is left for nature? – The search for the appropriate environmental flow

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In many rivers, only a small amount of streamflow remains for nature after water is diverted for hydropower production. In light of climate change and biodiversity loss, this is having increasingly serious consequences. Researchers from WSL, UZH and Eawag have compiles an interdisciplinary overview and highlight areas where knowledge gaps exist.

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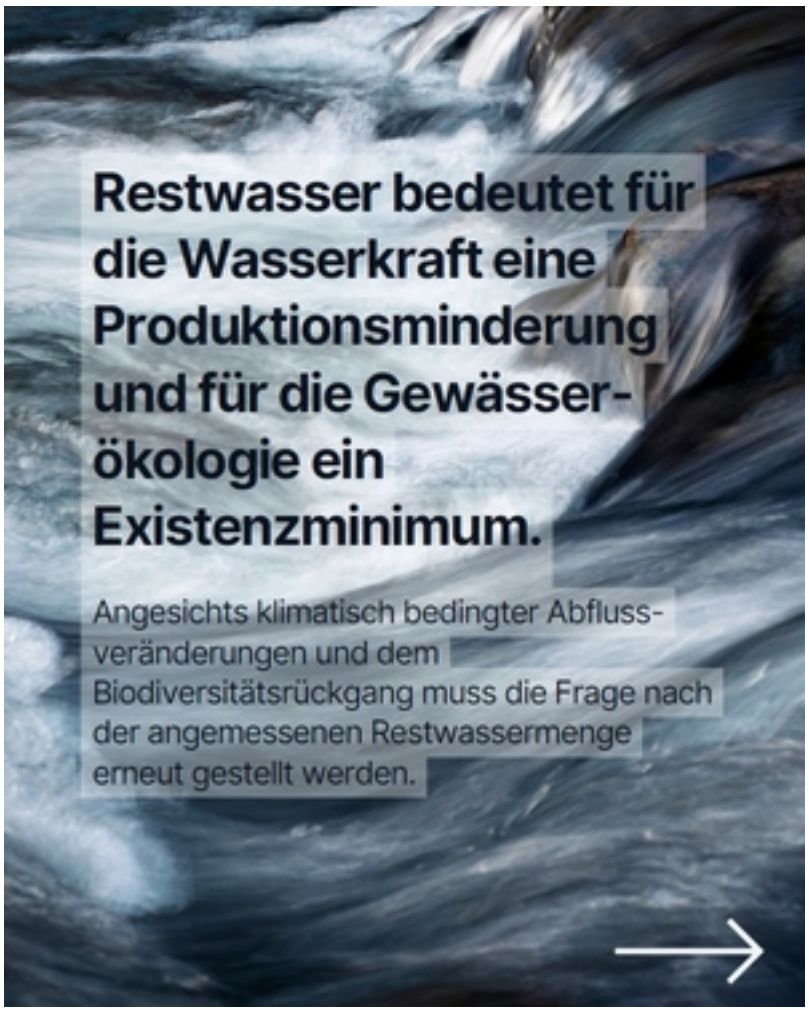

The most important findings of the article in PDF format (link in the image, in German only) (source: Speed2Zero)

In many rivers, little streamflow remains because of anthropogenic water diversions for purposes such as energy production or agricultural irrigation. A legally required minimum flow, known as environmental flow, is intended to ensure the biological function of rivers. In the article “Environmental flow. The search for the adequate amount” in the magazine Aqua & Gas, Tobias Wechsler from the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) describes why determining adequate environmental flows is so complex. “Environmental flow means a reduction in hydropower production, but a minimum subsistence level for aquatic ecology,” explains the hydrologist.

Since 1975, Switzerland's constitution requires that “adequate environmental flows” be maintained after hydropower production. However, “when the environmental flow provisions were enshrined in the Water Protection Act in 1991, an approach prevailed that resulted in lower minimum environmental flows than recommended by ecological studies,” the authors write in their report.

Ecological relevance of environmental flow

Streamflow diversions can increase water temperatures in summer and reduce them in winter. (Graphic: Mende & Sieber 2022)

Thirty years later, the ecology of our water bodies has not fared well. Aquatic organisms are overrepresented on Switzerland's red lists of endangered species, with 65% of fish and cyclostomes and 47% of invertebrates listed. These groups provide a simplified way of assessing the ecological status of water bodies. Reduced water volumes can slow down streamflow velocity, promote algae growth, and cause greater fluctuations in water temperatures – conditions that are unsuitable for specialised species.

However, even organisms living in dry habitats in the riparian zone, such as on riverbanks, are affected, for example species of dragonflies and shore plants as well as birds such as the little ringed plover. “River organisms can cope with disturbances such as high or low water levels, but not with very small amounts of environmental flow or daily fluctuations, such as those caused by hydropower production,” says WSL ecologist Sabine Fink. She is studying the ecological impacts of hydropeaking - the rapid fluctuations in streamflow caused by hydropower operations. Parts of the rivers almost dry up, while following sudden surges erode the stream bed and carve deep channels into it. Both have consequences for the organisms living in the riparian zones and on islands. “In the Alpine rivers we have been observing over the last 10 years, that the species composition has changed and now corresponds to that found in classic dry habitats.”

It is becoming increasingly clear that climate change must also be taken into account. It affects stream flows and has a direct impact on water management, but also on biodiversity in rivers. At the same time, there is political will to expand hydropower generation. “These changes raise the question of what constitutes an adequate amount of environmental flow,” emphasises Wechsler. This is because the demands of nature and other water uses, such as for cooling water or irrigation, are also increasing. “Environmental flow and streamflow fluctuations from individual power plants affect the survival of species and habitats in entire catchment areas,” says ecologist Fink, “which is why solutions are needed for entire river systems.”

Water rights should become more flexible

What could be the next steps? Wechsler sees these in particular in the design of water rights concessions. The right to use water, a public good, is currently granted for up to 80 years (see box) and allows little scope for adjustments during the term of the concession. “Adaptive management can help to respond better to changes such as climate change or hydropeaking – without losing planning security,” says Andri Bryner, Wechslers hydrologist colleague from Eawag.

To better reconcile the various demands placed on rivers and go forward into a sustainable water resources management, transparent data is needed. Currently, there is no independent data on the impact of environmental flow requirements on hydropower production. However, “In the past, this influence has been overestimated,” write the authors of the study in Aqua & Gas.

Limited flexibility in water concessions

For hydropower plants granted concessions before 1992, the environmental flow requirements (Art. 31–33 GSchG) only come into effect after new concessioning. This has led to long deadlines: as concessions were often granted for the maximum permissible period of 80 years, in some places almost a century can pass between the inclusion of adequate environmental flows in the constitution (1975), the entry into force of the water protection act ‘GSchG’ (1992) and the actual implementation.

Research programmes

SPEED2ZERO is a joint initiative of ETH Zurich, WSL, EPFL, Eawag, PSI, Empa and SDSC. It aims to develop Switzerland sustainably towards a net-zero society, with greenhouse gas emissions halved by 2030. The project addresses the areas of net-zero emissions, energy, biodiversity and climate change, and develops interactive visualisations, scenarios, toolboxes and action plans to enable sustainable transformation. speed2zero.ethz.ch

Hydraulic Engineering and Ecology is an interdisciplinary research programme that provides scientific foundations for the sustainable management of our watercourses. It is supported by the Federal Office for the Environment and the research institutions Eawag, Plateforme de Constructions Hydrauliques EPFL, VAW ETH Zurich and WSL. Its aim is to develop scientific principles for current issues in watercourse management and to prepare them for implementation. rivermanagement.ch

Cover image: Alpine hydroelectric power plant on the Blinne river in the canton of Valais: when streamflow is are low, temperatures fluctuate quickly, which can be a problem for cold-adapted species. (Image: Jonathan Molina)

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