Need for better approaches to tackle multiple stressors in European lakes and rivers

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Sampling related to MARS experiment in a mesocosm facility in Lake Stechlin, Germany. Credit: Anne Lyche Solheim/NIVA

A newly released *Nature* paper highlights a continued management need for reduction of nutrient stress in lakes. It also shows that river management requires more complicated approaches to tackle several stressors simultaneously.

Climate change and land-use change can have serious impacts on freshwater ecosystems due to combinations of different types of pollution and physical changes of rivers and lakes. Examples of pollution include nutrients and toxic substances from agriculture and urban wastewater. Higher temperature and changes in water level or river flow and shape of the river channel and riparian zones, are examples of physical changes of rivers and lakes.

These combinations of human-induced stress, often referred to as multiple stressors, can cause degradation of water quality, ecological status, biodiversity and aquatic ecosystem services, such as fishing and recreation. In order to plan how to reduce these stressors, managers need to know how the different stressors interact.

"If one stressor aggravates the impact of another stressor, then additional measures may be needed to restore the aquatic ecosystem. However, if a stressor reduces the impact of another stressor, then fewer measures may be needed for a successful restoration. Therefore, it is vital to get more knowledge on the combined impacts of different stressor combinations on aquatic ecosystems," says Anne Lyche Solheim, senior research scientist and project manager for the MARS project at NIVA and one of the co-authors of the newly released *Nature Ecology and Evolution* publication.

Difference between rivers and lakes

The European research project MARS, finished in 2018, provided a lot of knowledge by investigating multiple stressor impacts on different

groups of aquatic biota. The project used data from mesocosm experiments (outdoor experimental system that examines the natural environment under controlled conditions), detailed empirical case studies, and large-scale spatial datasets. Rivers, lakes and estuaries across Europe were examined. A synthesis of this multiple stressor analysis, with contributions from 67 researchers in 17 countries, was published in *Nature Ecology and Evolution* the 15th of June 2020.

The paper shows that interactive effects occurred in less than one third of the lake studies, because nutrient enrichment was often the overriding stressor. Examples of stressor interactions include cyanobacterial blooms getting worse due to climate warming combined with nutrient pollution, whereas browning, due to increased inflow of humic substances can dampen the nutrient impact on such blooms probably due to reduction of underwater light.

"For rivers, we found that the amount of stressor interactions was higher compared to lakes. Although nutrient stress was the overriding stressor also in the majority of river studies concerning plants, other stressors like habitat degradation and toxic substances were more important to explain the combined impact on river animals, especially," says Jes Rasmussen, NIVA researcher scientist (formerly Aarhus University) and co-author of the paper.

"This publication highlights the importance of continuing both long-term and large-scale biological monitoring of rivers and lakes. The combination of temporal and spatial analysis can provide better understanding of ecological responses to multiple stressors," adds Jannicke Moe, senior research scientist at NIVA, who managed some of the European databases used in this meta-analysis.

More information: Sebastian Birk et al. Impacts of multiple stressors on freshwater biota across spatial scales and ecosystems, *Nature Ecology*

& Evolution (2020). DOI: 10.1038/s41559-020-1216-4