MODELLING HYDRAULIC PREFERENCES OF ALPINE INVERTEBRATES

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Author Speaker
BECQUET Juliette
Affiliation
IRSTEA, 5 rue de la Doua CS 20244, 69625 Villeurbanne Cedex
Co-authors

CAUVY-FRAUNIE Sophie, (IRSTEA)LAMOUROUX Nicolas, (IRSTEA)FORCELLINI Maxence, (IRSTEA)CONDOM Thomas, (Institut des géosciences de l'environnement)

Abstract

Worldwide, river ecosystems are highly threatened by hydrological alterations, particularly in the Alps where water demand steadily increases with the proliferation of high-altitude small hydropower plants and the rise of artificial snow production. Flow alteration impacts can be mitigated by applying environmental flow (e-flow), which describes the quantity, timing and quality of water flows required to sustain the river ecosystems. Among existing tools, hydraulic-habitat models allow assessing e-flow, by linking hydraulic and biological models. While hydraulic models predict the frequency distributions of local hydraulic conditions (e.g. water depth, flow velocity, near-bed shear stress) of a stream reach according to discharge, biological models relate the hydraulic preferences of aquatic organisms by linking their abundance with the hydraulic conditions at the microhabitat scale. Initially developed for fish, biological models have not been adapted to high-altitude, often fishless, streams. Therefore, it is urgent to develop new biological models on alpine organisms to estimate the impact of flow alteration on alpine aquatic communities. In this study, we first aim to develop biological models for benthic invertebrates, dominant in alpine streams (e.g. Baetis alpinus, Diamesinae). Second, we will combine these new biological models with existing hydraulic models to assess the effect of flow alteration on the availability of suitable hydraulic habitats for alpine invertebrates.To develop alpine biological models, we sampled macroinvertebrates (using Surber) and measured water depth, flow velocity and near-bed shear stress (using FST hemispheres) in 30 microhabitats within seven stream reaches located in the French Alps. We then examined the effect of each hydraulic variable on invertebrate abundance based on generalized mixed models, assuming a Negative Binomial distribution of microhabitat abundance. To estimate changes in hydraulic conditions with flow, we measured, at the seven stream reaches, mean width and a minimum of 100 punctual water depth and substrate size along ten transects, at two different discharges. We expect to observe a dominance of species highly sensitive to high flow velocity (rheophilic), linked to the morphology of mountain rivers. We assume that flow reduction will result in a global homogenization of hydraulic conditions at stream reach scale, associated with a global loss of sustainable hydraulic habitats for rheophilic species.This study will thus improve our knowledge on invertebrate hydraulic preferences and allow assessing new tools for alpine stream management to mitigate the effects of hydrological alterations on aquatic ecosystems.

Keywords
Hydraulic-habitat model, Alpine stream, Macroinvertebrate, Shear stress, Flow alteration