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Thermopeaking in Alpine streams: field observations and model predictions

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In Alpine regions, intermittent hydropower generation has high economical relevance in comparison with other power generation sources. This, however, is often counter-balanced by a strong impact on the ecological integrity of aquatic ecosystems. This is mainly due by rapidly varying water level fluctuations (hydropeaking), due to the way water is released into the river from the power plant.

Hydropeaking is often associated with sharp variations of stream temperature (thermopeaking), that is often a major cause of riverine habitat degradation impacting the existing aquatic communities and species composition.

Assessment of actual impacts and of the feasible mitigation strategies requires:

1) to quantify the thermal fluctuations from field observations, and

2) to predict the effects of different release scenarios.

In this work we first attempt at quantifying thermopeaking effects in Alpine streams through wavelet analysis of water temperature records. We compare water temperature regimes between thermopeaking-impacted and unimpacted rivers with the aim to distinguish daily natural cycles from thermopeaking fluctuations. The advantages of wavelet analysis is the ability to examine all temporal scales simultaneously and independently.

Furthermore we developed a predictive tool based on a 1D model which solves the coupling of hydrodynamics and the heat transport. For capturing the rapid variations

of both temperature and discharge, the convection-diffusion problem has been splitted in a convective problem and a diffusion problem. The former has been solved using the WAF finite volume shock capturing method, while the latter has been solved using the implicit Crank-Nicolson method.

Application to the Adige River (Northern Italy) of this framework demonstrates that the coupling of the wavelet analyses for field observations and the 1D model is an effective tool for designing thermopeaking mitigation procedures.