CHARACTERIZATION OF HYDROLOGICAL DISTURBANCE DUE TO HYDROPEAKING REGIMES AND DEFINITION OF AN INDICATOR

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Abstract

Hydropeaking management of hydroelectric facilities (more than 150 in France) generates sudden changes in flow on the river and can affect the composition, the abundance and the structure of fish and invertebrates populations over long distances. To assess the level of hydrological disturbance, as a risk of biological impacts, a method for characterizing hydropeaks within hydrograph and a synthetic indicator were developed and transferred to river managers and hydroelectric operators for monitoring spatial and temporal changes in hydropeaking.From the analysis of 97 stations and 1575 years of flow data, rate of change of natural flow variations have been characterized within 8 ranges between 5% and 4 times the mean inter-annual discharge. Formulas representing the "fastest variations possible naturally" and taking into account the type of change (increase or decrease), the size of the stream (via the mean inter-annual discharge) and the flow range over which the variation takes place, have been constructed and then used to discriminate hydropeaks and natural events.From the analysis of 80 stations and 491 years of flow data affected by hydropeaks, a method was developed to identify, within the hydrograph, hydropeaks whose characteristics are beyond what can occur in natural hydrology, using 3 criteria: a minimum range (>= 10% of the mean inter-annual discharge and >= 20% of the hydropeak base flow), a minimal rate of change (> to the maximum natural rate of change) and an upper limit on the maximum flow rate (to remove flood events). A large variation in hydropeaking regimes, due to the diversity of hydroelectric schemes and fluctuations in incoming flow and energy demand, was observed.A synthetic indicator differentiating 5 levels of hydrological disturbance induced by hydropeaking regimes was constructed. The level of disturbance of each of 491 years of flow data was evaluated by 3 expert operators according to knowledge of the biological impacts of hydropeaks. Linear discriminant analysis allows reproducing this classification using 5 characteristic parameters of hydropeaking regimes (87% of correct reclassification). Examples show that the indicator is sensitive to changes in hydropower plant management and allows appreciating the spatial and temporal changes in hydropeaking regimes, including the cushioning in downstream direction. The indicator can be produced per year or per period corresponding to biological phases. Its automated calculation requires only the hydrograph on the target period, the value of the mean inter-annual discharge and the maximum turbine discharge of the hydropower plant upstream.

Keywords
Hydroelectricity, Hydrologic disturbances, Flow rate of change