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Analysis of flow regime alteration in the Adige river: standard and novel approaches

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We analyze flow regime alteration of the Adige river, the second longest Italian river, in the framework of an interdisciplinary research project funded by the Adige River Authority with the objective of assessing the ecological impact of hydropower systems on riverine ecosystems, including the analysis of possible short- and long-term mitigation measures.

The watershed, which in Trento is of 10,000 km^2, contains 29 large dams for a total storage volume of 364 10^6 m^3, which counts for 5.5% of the total mean annual streamflow. Most of this volume (i.e. 74%) has been created in the decade 1950-1960 for hydropower generation.

In the present work we have coupled statistical descriptors of flow regime alteration, typically utilized in ecological studies, with signal processing analysis of streamflow time series based on the wavelet transform (WT) approach, which proved to be a very effective tool in analyzing non-stationary time series. The analysis has been performed on two time series collected at the streamgauge of Ponte San Lorenzo in the city of Trento: the long-term (1923 – 2005) daily streamflow time series and the 6 years long streamflow time series collected between 2000 and 2005 with 30 minutes time step.

Alteration of the natural flow regime can be seen in regularly distributed, high frequency flow pulses at weekly and daily time scales, a feature not observed before 1950, i.e. before the contruction of most of hydropower systems today active. On the

other hand, statistical analysis showed that the typical natural alpine annual hydrograph, with two peaks in late spring and autumn and a minimum in winter, that characterized the hydrological behavior of the Adige River in the pre-impacted period, has been gradually modified reducing the late spring/summer peak and increasing the winter minimum. In addition, both statistical and WT analyses showed signs of possible changes in the way hydroelectric production has been managed in the last 5 years. WT analysis applied to the short-term detailed time series showed the predominance of a daily time scale variation coupled with a weekly variation, which were absent in the pre-impacted period. We conclude that integrating information from the two methods shows good opportunities to capture global as well as local information embedded in streamflow time series displaying multiple modes of alteration at different time scales.

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