Changes in the long-term properties of the Danube river flow induced by damming

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We have studied scaling properties of the Danube river discharge process in the vicinity of two dams in Serbia, using the detrended fluctuation analysis (DFA) and the wavelet transform (WT). The dams were built in 1970 and 1982, respectively, along the Djerdap canyon of the Danube river, and are 80 km apart. We compared the scaling of the time series of daily Danube discharges in three periods (before damming, after the construction of the first dam, and after the construction of the second dam) and in the three measuring stations in the Djerdap canyon region. We have then compared our results, for all three periods of interest, with the scaling we obtained for the corresponding time series of discharges of Danube affluents in Belgrade, 200 km upstream from the region.

The comparison of the WT spectra and the DFA slopes for the three recording stations on the river Danube reveals dam(s)-induced changes in the scaling. Changes in scaling emerge after the damming in a) the small scales region, for time periods smaller or equal to one week, for the recording stations that are positioned downstream from the dam(s), and b) in the large scales region that encompasses periods longer than one week, for the measuring stations upstream from the dam(s). In both cases the scaling exponents became significantly smaller. We were also able to see the effect of lowering of the scaling exponents on the longer time scales even for river flows in Belgrade, 200 km upstream from the region, which could indicate the range and the nature of damming influence.

While the obtained change in scaling in the very small scales region, downstream from the dams, can be attributed to the alteration of the flow velocity, our findings reveal human-made lowering of the river discharge long-term persistence in the areas upstream the intervention. We discuss how these results should be further assessed in view of the possibility that the observed change in the long-term river flow persistence influences local climate, and significance of external trends.

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