



Human impacts on river ice regime in the Carpathian Basin

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River ice is a very important component of the cryosphere, and is especially sensitive to climatic variability. Historical records of appearance or disappearance and timing of ice phenomena are useful indicators for past climatic variations (Williams, 1970). Long-term observations of river ice freeze-up and break-up dates are available for many rivers in the temperate or cold region to detect and analyze the effects of climate change on river ice regime.

The ice regime of natural rivers is influenced by climatic, hydrological and morphological factors. Regular ice phenomena observation mostly dates back to the 19th century. During this long-term observation period, the human interventions affecting the hydrological and morphological factors have become more and more intensive (Beltaos and Prowse, 2009).

The anthropogenic effects, such as river regulation, hydropower use or water pollution causes different changes in river ice regime (Ashton, 1986). To decrease the occurrence of floods and control the water discharge, nowadays most of the rivers are regulated. River regulation changes the morphological parameters of the river bed: the aim is to create solid and equable bed size and stream gradient to prevent river ice congestion. For the satisfaction of increasing water demands hydropower is also used. River damming results a condition like a lake upstream to the barrage; the flow velocity and the turbulence are low, so this might be favourable for river ice appearance and freeze-up (Starosolsky, 1990). Water pollution affects ice regime in two ways; certain water contaminants change the physical characteristics of the water, e.g. lessens the freezing point of the water. Moreover the thermal stress effect of industrial cooling water and communal wastewater is also important; in winter these water sources are usually warmer, than the water body of the river. These interventions result different changes in the characteristic features of river ice regime.

Selected examples from the Carpathian Basin represent some of the most common human impacts (engineering regulation, hydropower usage, water pollution), disturbing natural river ice regimes of mid-latitude rivers with densely populated or dynamically growing urban areas along their courses. In addition simple tests are also introduced to detect not only the climatic, but also the effect of anthropogenic impacts on river ice regime.

As a result of river regulation on River Danube at Budapest a vanishing trend in river ice phenomena could be detected in the Danube records. The average ice-affected season shortened from 40 to 27 days, the average ice-covered season reduced greatly, from 27 to 7 days. In historical times the ice jams on the River Danube caused many times ice floods. The relative frequency of the break-up jam also decreased; moreover no ice flood occurred over the past 50 years.

The changes due to hydropower usage are different upstream and downstream to the damming along the river. On Raba River upstream of the Nick dam at Ragyogóhíd, the ice-affected and ice-covered seasons were lengthened by 4 and 9 days, in contrast, downstream of the dam, the length of the ice-covered season was shortened by 7 days, and the number of ice-affected days decreased by 8 days at Árpás.

During the observation period at Budapest on Danube River, the temperature requirements for river ice phenomena occurrence changed. Nowadays, much lower temperatures are needed to create the same ice phenomena compared to the start of the observations. For ice appearance, the mean winter air temperature requirements decreased from +2.39 °C to +1.71 °C.

This investigation focused on anthropogenic effects on river ice regime, eliminating the impact of climatic conditions. Different forms of anthropogenic effects cause in most cases, a shorter length of ice-affected seasons and decreasing frequency of ice phenomena occurrence. Rising winter temperatures result the same changes in river ice regime. Climate change and river ice regime research should also take into account these anthropogenic impacts.

Reference:

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