River management induced increased flood hazard on the Lower Tisza, Hungary

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In the last centuries various human impacts altered the European rivers. For example, floodplains were confined by artificial levees, channels were fixed by various built-in structures (i.e. revetment, groynes), and the land-use of the floodplains was changed providing habitats for invasive species. These human impacts resulted in such semi-anthropogenic processes, like accelerated floodplain aggradation, channel narrowing and incision, overbank flow pattern changes. Our aim was to evaluate the cross-sectional channel changes, overbank floodplain aggradation, riparian land cover and artificial levee height changes from the point of local flood hazard. The research was performed in a low-gradient river (Lower Tisza, Hungary), which was regulated in the late 19th century, thus the effects of century-long processes on flood hazard could be evaluated. To estimate the elevation changes of the floodplain and the channel, a LiDAR survey was applied; besides, to analyse channel changes the hydrological surveys (since 1890s) were studied along the 92 km long reach of the Lower Tisza.

According to our measurements the channel became narrower by 9%, its cross-sectional area decreased by 2% in average, however at some locations the narrowing was over 30%. These channel changes increased the flood level by 12.8 cm in average (max. 134 cm). The mean overbank floodplain accumulation was 1.2 m (max. 2.6 m), thus it increased flood levels by 112 cm in average. The mean vegetation roughness of the channel increased from 0.048 to 0.11, increasing flood levels by 42 to 139 cm (depending on different modelled scenarios). It must be noted, that the vegetation influences not just the overbank flow velocity and pattern, but also the in-channel flow conditions: the actual very dense vegetation further accelerates the channel narrowing and incision. On the other hand, artificial levees became lower by 23 cm in average (max. 75 cm). By overlapping these data, the actual flood hazard along the Lower Tisza increased by 175-272 cm (max: 350-443 cm) in average since the late 19th century river regulation works. As these processes are still active, further increase in flood hazard could be predicted. Based on our method the managers can identify those processes which contribute to peak flood level increase at a given location, thus they can plan flood hazard mitigation.