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Contradictory effect of flood events and vegetation succession on the dynamics of gravel bars

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Since river regulations extensively changed the natural course and regime of many European gravel-bed rivers, most gravel bars tend to lose some of their natural dynamics. Gravel bars are often overgrown by vegetation when there is a lack of high flows for a long time. In many areas, they are objects of protection, as they are in some cases related to preserved parts of naturally braided rivers, and they represent a unique habitat for rare species of vegetation and fauna.

In our research, we analysed spatio-temporal gravel bar dynamics, with a focus on vegetation succession progress, in two rivers of the Outer Western Carpathians for twenty years (2000–2020): the Czech part of the Olše River (73 km) and the part of the Ostravice river downstream the valley dam (46 km). We used nine archive orthophotos (2000–2020) and hydrological data to analyse the effects of flood events, vegetation succession and river regulations on the gravel bar dynamics. The orthophotos were processed in ArcGIS Pro to analyse the coverage of vegetation and unvegetated area on gravel bars where the reference banks lines from the first two studied orthophotos (2000, 2003) were used to determine the edges of bars.

Two major floods in 1997 and 2010 greatly affected the vegetation cover of gravel bars in both rivers. After the 1997 and 1999 moderate floods, the total vegetated area on gravel bars in 2000 was the lowest in all studied years in the Olše (42 %) and the second lowest in the Ostravice (54 %). Following years, trends showed slow but progressive succession until the next major flood in 2010 and moderate floods in 2014. The total area of bar vegetation in the Olše decreased by 19,2 % in 2012 compared to the last studied year of 2009 (81,8 %), and by another 9 % in 2014 probably due to the time proximity of the flood event. Similarly, the total vegetated bar area in the Ostravice decreased by 24 % in 2012 (from 92 % in 2009) and by another 13,7 % in 2014. However, only two years later, the vegetated bar area significantly increased in both rivers: compared to the year 2014, it increased by 39,8 % in the Olše and by 42,1 % in the Ostravice. The remaining studied years showed a similarly high percentage of vegetation cover (2018=87,1–93,6 %, 2020=84,5–91 %). Although the Ostravice is regulated by a valley dam, the floods had a very similar effect on both rivers. The main difference is in the rate of vegetation coverage in the years not affected by floods. In the Ostravice almost all the bars were vegetated completely or for the most part, while in the Olše, there was more variability in vegetation coverage on gravel bars including only partially vegetated or unvegetated bars. Our results suggest an ongoing succession of vegetation on most gravel bars in the last twenty years and show a significant effect of major flood events and river regulations on their morphodynamics.