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Towards a better understanding of river dynamics in semi-urbanised areas: a machine learning analysis on time-series satellite images

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River channels and floodplains have been highly modified over the last 70 years to mitigate flood risk and to gain lands for agricultural activities, settlements and soft infrastructures (e.g., cycle paths). River engineering measures simplified the geomorphologic complexity of river system, usually from braided or wandering channels to highly-confined single-thread channel. Meanwhile, rivers naturally adjust and self-organise the geomorphologic function as response of all the disturbances (e.g., flood events, river-bed degradation, narrowing, control works) altering sediment and water transfer, exacerbating bank erosion processes and streambank failures, and exposing bare sediment that can be subsequently colonized by pioneer species. In this context, river management has to address river dynamics planning sustainable practices with the aim to combine hydraulic safety, river functionality, and ecological/environmental quality. These actions require the detection of river processes by monitoring the geomorphological changes over time, both over the active riverbank and the close floodplains. Thus, remote sensing technology combined with machine learning algorithms offers a viable decision-making instrument (Piégay et al., 2020).

This study proposes a procedure that consists in applying image segmentation and classification algorithms (i.e., Random Forest and dendrogram-based method) over time-series high resolution RGB-NIR satellite-images, to identify the fluvial forms (bars and islands), the vegetation patches and the active riverbed. The study focuses on three different reaches of Oglio River (Valcamonica, North Italy), representative of the most common geomorphic changes in Alpine rivers.

The results clearly show the temporal evolution/dynamics of vegetated and non-vegetated bars and islands, as consequence of human and natural disturbances (flood events, riparian vegetation clear-cutting, and bank-protection works). Moreover, the procedure allows to distinguish two stages of riparian vegetation (i.e., pioneer and mature vegetated areas) and to quantify the timing of colonization and growth. Finally, the study proposes a practical application of the described methodology for river managers indicating which river management activity (including timing, intensity and economic costs) is more appropriate and sustainable for each studied reach.

References: Piégay, H., Arnaud, F., Belletti, B., Bertrand, M., Bizzi, S., Carbonneau, P., Dufour, S., Liébault, F., Ruiz□Villanueva, V. and Slater, L.: Remotely sensed rivers in the Anthropocene: state of the art and prospects, Earth Surf. Process. Landf., 45(1), 157–188, https://doi.org/10.1002/esp.4787, 2020.