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Data-fusion of satellite and ground sensors for river hydro-morphodynamics monitoring

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Changes in fluvial morphology, such as the migration of channels and sandbars, are driven by many factors e.g. water, woody debris and sediment discharges, vegetation and management practice. Nowadays, increased anthropic pressure and climate change are accelerating the natural morphologic dynamics. Therefore, the monitoring of river changes and the assessment of future trends are necessary for the identification of the optimal management practices, aiming at the improvement of river ecological status and the mitigation of hydraulic risk. Satellite data can provide an effective and cost-effective tool for the monitoring of river morphology and its temporal evolution.

The main idea of this work is to understand which remote sensed data, and particularly which space and time resolutions, are more adapt for the observation of sandbars evolution in relatively large rivers. To this purpose, multispectral and Synthetic Aperture Radar (SAR) archive data, with different spatial resolution, were used. Preference was given to satellite data freely available. Moreover, the observations extracted by the satellite data were compared with ground data recorded by a fixed camera.

The study case is a sandy bar (area about 0.4 km^2 and maximum width about 350 m) in a lowland reach of the Po River (Italy), characterized by frequent and relevant morphological changes. The bar shoreline changes were captured by a fixed video camera, installed on a bridge and operating for almost two years (July 2017 - November 2018). To this purpose, we used: Sentinel-2 multispectral images with a spatial resolution of 10 m, Sentinel-1 SAR images with a resolution of 5 x 20 m and CosmoSkyMed SAR images with a resolution of 5 m. It is worth noting that the Sentinel data of the Copernicus Programme are freely available while the CosmoSkyMed data of the Italian Space Agency (ASI) are freely distributed for scientific purpose after the successful participation to an open call. In order to validate the results provided by Sentinel and CosmoSkyMed data, we used very high resolution multispectral images (about 50 cm).

Multispectral images are easily interpreted, but are affected by the presence of cloud cover. For

instance, in this analysis, the expendable multispectral images were equal to about 50% of the total archive. On the other hand, the SAR images provide information also in the presence of clouds and at night-time, but they have the drawback of more complex processing and interpretation. The shorelines extracted from the satellite images were compared with those extracted from photographic images, taken on the same day of the satellite acquisition. Other comparisons were made between different satellite images acquired with a temporal mismatch of maximum two days.

The results of the comparisons showed that the Sentinel-1 and Sentinel-2 data were both adequate for the shoreline changes observation. Due to the higher resolution, the CosmoSkyMed data provided better results. SAR data and multispectral data allowed for automatic extraction of the bar shoreline, with different degree of processing burden. The fusion of data from different satellites gave the opportunity of highly increase the sampling rate.