River morphological changes detection from drone and radar satellite data

INTRODUCTION

The evaluation of morphological changes occurring in the river channel over space and time is essential to understand rivers’ behaviour and support sustainable river management.

Today, a wide range of remote sensing techniques and established methodology are available to quantify channel dynamics. However, due to the costs and logistic complexity that these river surveys have often limited in space and time.

Here, we investigate the potential of radar satellite data to retrieve an indication of the processes occurring within the river channel (such as erosion or deposition) that may occur on a big river (channel width > 20 m) after an important event that caused significant changes. Space-borne synthetic aperture radar (SAR) has been widely used to monitor changes on the earth’s surface, promising to be a powerful tool to map geomorphic processes. We exploit radar data collected from Sentinel-1 mission, freely available with a return time of about 5 days in our study area.

Our first attempts show good potential to map morphological changes of the river bar at event vs. seasonal scales, by exploiting time series of coherence estimates between SAR images and backscattering intensity of the radar signal.

STUDY AREA

The site under study was selected along the Po river, in northern Italy. It is characterized by an active and large exposed sediment bar, close to Isola Sant’Antonio hydrological station. Here, we collected UAV images in September 2017 and September 2018.

METHODS

In March 2018 a big flood caused an avulsion and a new secondary channel was opened. Through the year the bar was periodically inundated and then dried up in the later season.

Identification of three distinct areas:
- Erosional area: elevation change < -0.5 m;
- Depositional area: elevation change > 0.5 m;
- Stable area: elevation change between 0 and ±0.4

Overall decrease in the pixels intensity values of the bar in the post-event dates, in comparison to the pre-event dates. The monthly variation in pixel intensity is lower than the the variation in a year. However, several factors can modify the backscattered signal.

So far:
- We exclude that the intensity decrease is due to soil moisture linked to previous precipitation, because the Sentinel 1 images were selected avoiding days following rainy times;
- We exclude an important contribution of the vegetation growth in the modification of the intensity values.

By comparing the orthophotos it is evident that the vegetation coverage on the bar is almost the same at a distance of a year.

CONCLUSION

The high revisit time and the low cost of the Sentinel-1 satellite data open up the possibility to observe not only intra-annual and seasonal differences during a given year but also morphological activity over multiple years. This approach is promising to develop proxies of river morphological processes that can support the understanding of their distribution and drivers through space and time. Further analyses are needed, by exploiting both the coherence and the intensity data of the radar signal, to discriminate the different contributions to the radar signal and confirm the connection with morphological changes.

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[Image of study area and SAR coherence analysis]

[Graph showing intensity analysis and coherence maps]