A satellite-based analysis of the geomorphological efficiency of river plumes

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Abstract In this study, the geomorphological efficiency of Po River (Italy) is investigated. To this end, a statistical analysis of Sentinel-2 (S2) turbidity maps was performed to evaluate the spatio-temporal variability of river plume morphologies for the period June 2015 – April 2018. River plume dynamic, indeed, strongly affects its capability to efficiently contribute to sediment supply in the surrounding coastal area. Plume morphologies captured by S2 images were furthermore linked to the main environmental forcings affecting their dispersal in northern Adriatic Sea (i.e. wind and river discharge) to evaluate how they affect their overall structure.

Keywords: River plumes, Remote sensing, Coastal geomorphology, Coastal dynamics.

Method

Image collection

Level-1C S2 images were collected from ***Copernicus Open Access Hub***

- Cloud free images
- Visible river plumes
- Negligible wind and wave re-suspension

Hydro-meteorological Data

Hourly **wind** speed and direction data - Acqua Alta Oceanographic Tower (AAOT)

Hourly **discharge** data - Pontelagoscuro gauging station (ARPA-ER)

Atmospehric correction

(Vanhellemont and Ruddick, 2015)

Turbidity maps

(Dogliotti et al., 2015)

ACOLITE processor

Data referred to a **temporal window of 72 hours before satellite acquisition** were considered (Braga et al., 2017)

River plume delimitation

Turbidity values were compared to a threshold value corresponding to the Adriatic Sea background turbidity, 5-6 FNU (Brando et al., 2015).

Assessment of hydrometeorological forcings influence on river plume structure

Geomorphological efficiency

Evaluated considering the frequency of river plume dispersal in the alongshore direction. (Falcini et al., 2012)

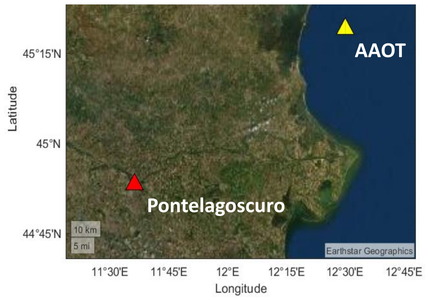

Figure 1. Location of AAOT meteorological station and Pontelagoscuro hydrologic station

Results

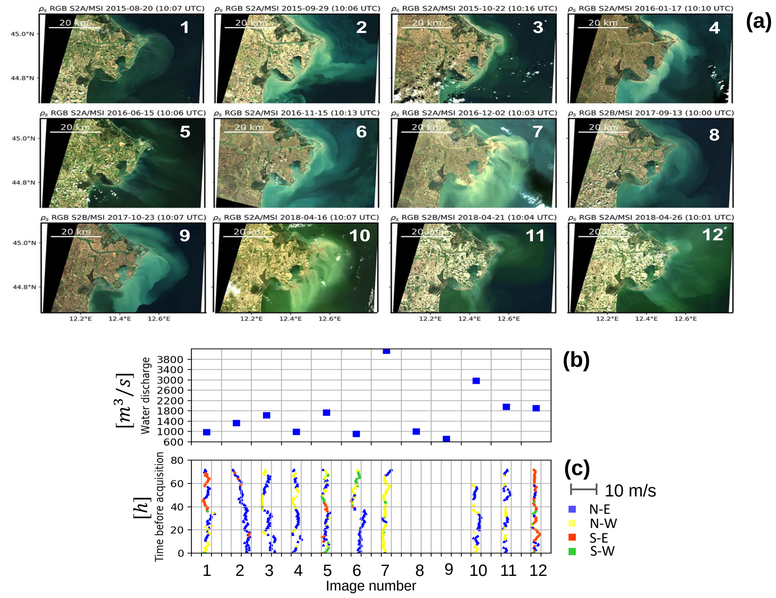

Figure 2. True color river plume images (a) with river discharge (b) and wind data (c) show that the interplay of meteo-oceanpgraphic conditions is fundamental in modulating spatial pattern of the along- and cross-shore suspended sediment dispersal, with a predominant wind influence during low-discharge events.

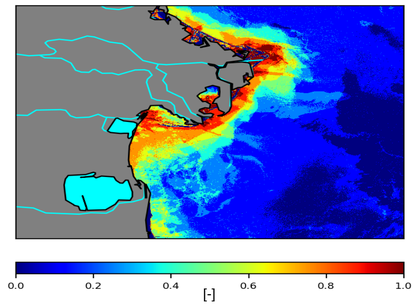

Figure 3. Relative frequency map of turbidity values captures plume patterns variability of fig.2, revealing that high suspend sediment dispersal is strictly confined nearby the river mouth, as expected, while lower frequency values are observed in the farther coastal area, as a consequence of hydro-meteorological forcing influences.

Conclusions

The analysis showed plume morphologies with moderate spatio-temporal variability and confirmed the major role of river discharge and wind in affecting their overall structure:

- Long-lasting northerly winds (downwelling winds) compress plumes against the coast hampering bulge formation and consequently increasing freshwater and sediment transport of the geostrophic coastal current;
- Long-lasting southerly winds (upwelling winds) determine sediment delivery far offshore, undesired condition from a geomorphological point of view;
- High river discharge seems to limit wind influence on plume structure which exhibits a prototypical morphology.

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