INFLUENCE OF WIND STRESS AND THE ISONZO/SOCA RIVER OUTFLOW ON SURFACE CURRENTS IN THE GULF OF TRIESTE

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Abstract
Between October and November 2023, heavy rainfall in the Isonzo/Soca River catchment area led to two major runoff peaks with significant discharges into the Gulf of Trieste (GoT, northern Adriatic Sea). These events are an ideal case-study to investigate how the Isonzo/Soca outflow and associated winds affect ocean currents. Through an integrated multi-platform analysis of hydrometric, meteorological and oceanographic data, the mechanisms governing the interaction between river runoff and ocean currents in the GoT were analyzed and the importance of prevailing winds such as Bora and Sirocco in modulating current dynamics was addressed. It was also observed that intense Isonzo/Soca runoff, triggered by heavy rainfall, can prevail over wind effects, leading to a dominance of river-induced circulation patterns in the GoT.

Keywords: Adriatic Sea, Currents, Wind, River input, Circulation

Introduction
In the period between October and November 2023, the Isonzo/Soca river catchment area experienced particularly heavy rainfalls. Remarkable surges in river discharge were recorded, exceeding all previous records for the year and leading to significant outflows into the GoT. Concurrently, sea level rise and coastal inundation were observed. The event at the beginning of November is of particular significance as it was also accompanied by strong storm surge and waves that caused severe damage to the coast. The aim of this study is to investigate how an exceptionally strong Isonzo outflow, together with the wind patterns associated with the meteorological event, influenced the ocean currents in the surrounding coastal region.

Data
Through an integrated analysis of hydrometric, meteorological and oceanographic data, we want to study the mechanisms and processes that regulate the interaction between fluvial discharges and ocean currents in the GoT. The river discharge data were provided by The Regional Agency for the Protection of the Environment (ARPA FVG); the wind data come from the Weather Research and Forecasting (WRF) model (available at the link https://www.mmm.ucar.edu/models/wrf), version 4.2.1; the data on surface ocean currents originate from the combination of four WERA-type [1] HF radar stations operating in the GoT. The description of the system and the data are available at the European HFR node website: https://www.hfrnode.eu/networks/hfr-nadr-2/ [2].

Results
The prevailing winds in the GoT come from the north-eastern (Bora wind) and southern sectors (Sirocco and Libeccio winds). During Bora events, the surface currents normally leave the GoT, while during Sirocco events the surface currents enter the GoT [3]. It was observed that in the days before a precipitation event, a wind with a strength of more than 3 m/s from the S-SE direction almost always affected the area. The strong precipitations acting on the hydrographic basin at the end of October and beginning of November led to exceptional increases in the Isonzo/Soca runoff into the GoT (October 27 and November 3). This is also clearly seen in the Sentinel-2 satellite images for November 4 (Figure 1).

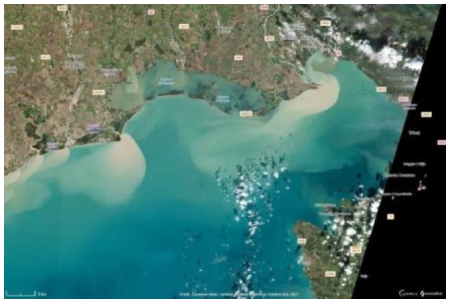

Fig. 1. Image Sentinel-2 04th November 2023 10:11 UTC, from https://link.dataspace.copernicus.eu/l3n1.

HFR sea surface current data confirmed that wind-induced Ekman transport appears to dominate the surface current dynamics in the GoT (Figure 2). Nevertheless, exceptionally intense outflows from the Isonzo/Soca, triggered by heavy precipitation and accompanied by S-SE winds, can overlay the effects of wind-driven transport, leading to the dominance of river-induced circulation patterns in the GoT.

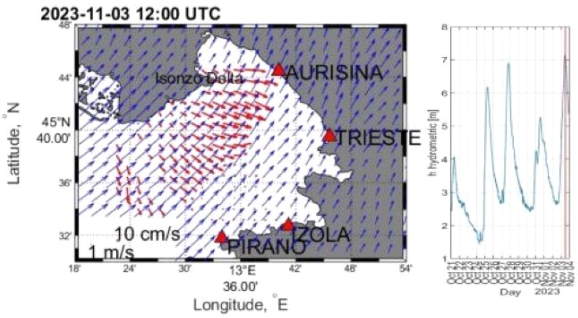

Fig. 2. Left: surface currents from HFR data (red),wind data from WRF data (blue) for November 3, 2023, 12:00 UTC; the red triangles represent WERA HF stations. Right: the hydrometric height of the Isonzo/Soca river.

References
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