A methodological approach to rapid assessment of a river flood in coastal waters. First test in the Po River delta

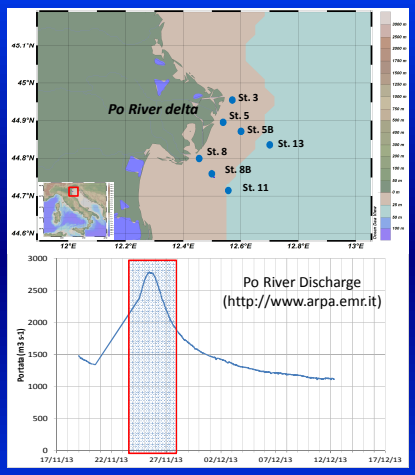
Alessandra Campanelli[1], Debora Bellafiore[2], Manuel Bensi[3], Francesco Bignami [4], Giuseppe Caccamo [1], Mauro Celussi[3], Paola Del Negro[3], Christian Ferrarin[2], Mauro Marini[1], Elio Paschini[1] and Luca Zaggia[2]

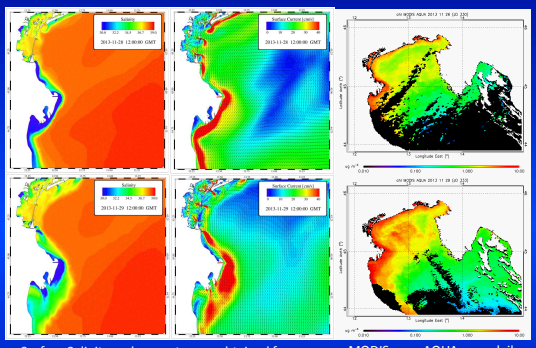
1 CNR-ISMAR, Largo Fiera della Pesca 2, 60125 Ancona, Italy , 2 CNR-ISMAR, Arsenale, Tesa 104, Castello 2737/F, Venezia, Italy, 3 OGS, Borgo Grotta Gigante 42/C, 34010 Sgonico TS, Italy, 4 CNR-ISAC, Via Fosso del Cavaliere 100, 00133, Rome, Italy

Corresponding author: a.campanelli@ismar.cnr.it

Introduction

As part of the actions of the flagship project RITMARE (Ricerca ITaliana per il MARE) a daily oceanographic survey was performed on 29th November 2013 in front of the Po River delta (Northern Adriatic Sea). The Po river affects a large part of the Northern Adriatic Sea with strong implications on the circulation and functionality of the basin. Physical-chemical and biological properties of coastal waters were investigated after a moderate flood occurred around 25th-27th November. The cruise activities, carried out using a small research boat, were mainly focused on the test of a methodological approach to investigate the environment variability after a flood event in the framework of rapid assessment. The effects of the flood on the coastal waters, have been evaluated in the field using operational forecasts and real-time satellite imagery to assist field measurements and samplings.





Surface Salinity and current maps obtained from numerical model

MODIS AQUA daily chlorophyll maps with 1 km spatial resolution)

Methods

Surface satellite chlorophyll maps and surface salinity and current maps obtained from a numerical model forced by meteorological forecast and river data were analyzed to better identify the Po plume dispersion during and after the event in order to better locate offshore monitoring stations at the sea. The model that is applied in this work is SHYFEM (Shallow water Hydrodynamic Finite Element Model; https://sites.google.com/site/shyfem/), a 3D finite element hydrodynamic model, designed and developed for transitional environment and coastal sea implementations at ISMAR-CNR. The model solves the primitive equations, in the shallow water approximation.

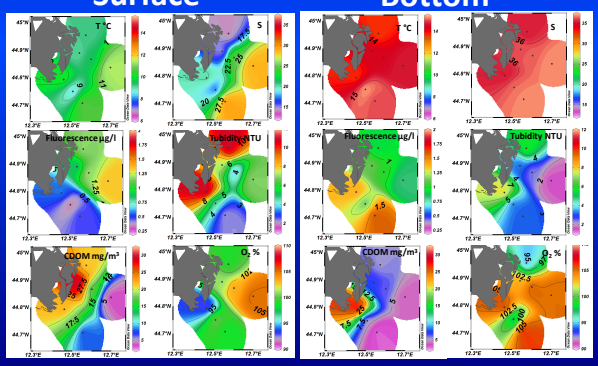
Profiles of Temperature, Salinity, Turbidity, Fluorescence and Colored Dissolved Organic Matter (CDOM) along the water column were collected at 7 stations in front of the Po River delta.

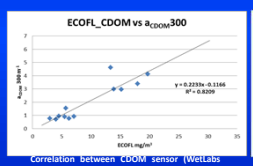
Sea surface water samples were also collected for the analysis of nutrients (N-NO_2, N-NO_3, N-NH_4, P-PO_4, H_4SiO_4), Dissolved Organic Carbon (DOC), Particulate Organic Carbon (POC), Particulate Organic Nitrogen (PON) and CDOM absorption ($a_{CDOM}(\lambda)$); surface and bottom). The CDOM regulates the penetration of UV light throughout the water column and mediates photochemical reactions, playing an important role in many marine biogeochemical processes.

Results

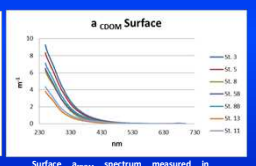
Satellite images showed a strong color front that separates the higher-chlorophyll coastal water from the more oligotrophic mid-basin and eastern boundary Adriatic waters. In front of the river mouth, the surface layer was characterized by low salinity (14-15), high turbidity (8-11 NTU) and high CDOM (20-22 mg m^{-3}) values. These parameters showed a strong gradient from coast to offshore and from surface to the bottom. The fluorescence values were more variable since the phytoplankton growth is not quickly correlated with the load of riverborne materials. The highest fluorescence values (1.8-2 µg l^{-1}) were, in fact, detected offshore and at bottom. A good correlation between salinity versus CDOM (R^2=0.84, p=0.01) and salinity versus Spectral slope of a_{CDOM} (S_{CDOM}275-295; R^2=0.86, p=0.01) were found. These features reveal the role of CDOM as tracer of the freshwater inputs and it is also evident from different absorbance values between surface and bottom.

Chemical analysis of surface waters affected by the river plume display high concentration of organic carbon (DOC: 100-160 µmol l^{-1}; POC: 20-35 µmol l^{-1}) and nutrients (nitrate and silicate) strengthening this zone as one of the most eutrophic area of the Mediterranean Sea (Campanelli et al. 2011, Marini et al. 2008). The lower values are detected in the offshore stations as expected.

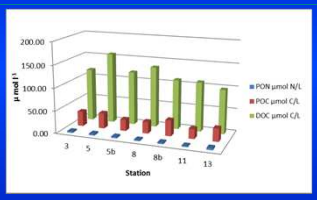




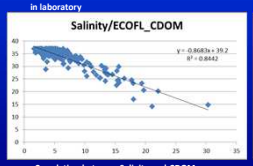
Correlation between CDOM sensor (WetLabs ECOFL CDOM) and CDOM absorbance measured in laboratory



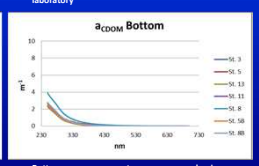
Surface a_{CDOM} spectrum measured in laboratory



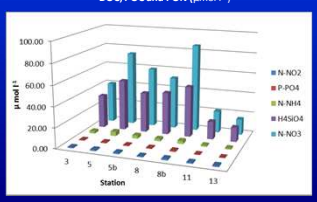
DOC, POC and PON (µmol l^{-1})



Correlation between Salinity and CDOM sensor (WetLabs ECOFL CDOM)



Bottom a_{CDOM} spectrum measured in laboratory



Dissolved Nutrients (N-NO_2, N-NO_3, N-NH_4, P-PO_4, H_4SiO_4 µmol l^{-1})

Conclusions

- The goal of the action has been to better intercept, detect and characterize the plume area in a few days.
- The synergy of actions applied in the test has proved useful to better analyze the variability of coastal water characteristics after a river flood.
- A similar methodological approach could be reasonably applied to the rapid assessment of different events (i.e. harmful phytoplankton growth, chemical spills) which can occur in this area or in areas with similar features.
- The definition of methodologies for rapid assessment of marine processes can be useful for the future integrated management of coastal zone.

References

Campanelli, A., F. Grilli, E. Paschini, M. Marini, 2011. The influence of an exceptional Po River flood on the physical and chemical oceanographic properties of the Adriatic Sea. Dynam. Atmos. Oceans, 52: 284-297.

Marini, M., B.H. Jones, A. Campanelli, F. Grilli & C.M. Lee. 2008. Seasonal variability and Po River plume influence on biochemical properties along western Adriatic coast. J. Geophys. Res., 113: C05S90, doi:10.1029/2007JC004370.

European Geosciences Union-General Assembly 2014
Vienna, Austria, 27th April – 02nd May 2014