

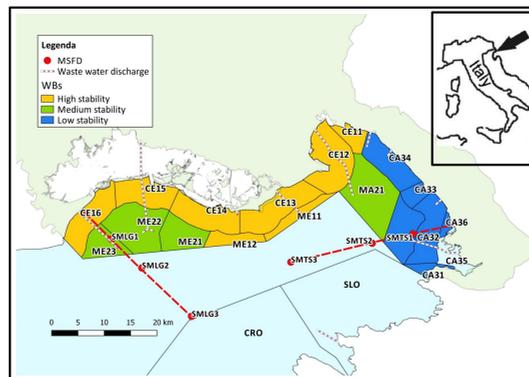
Descriptor five (eutrophication) within the Marine Strategy Framework Directive in the Gulf of Trieste: A preliminary assessment

Introduction and aim of the work

One of the main issues affecting the coastal environment is represented by eutrophication. This is a process driven by enrichment of water in terms of nutrients, especially compounds of nitrogen and/or phosphorus, leading to a general quality degradation of the environment. Pressures include agriculture, energy production, industrial activities, transport, tourism, fishing and fish farming. High levels of Chl_a, excessive growth of seaweeds, decrease in water transparency and, sometimes, the appearance of toxic algal blooms are the most common observed impacts. Several research focused on understanding of biogeochemical problems related to eutrophication and to quantify eutrophic trends. However, environmental policy and research findings cannot be easily incorporated in order to implement the management strategies. In the last decade, coastal water monitoring has been intensified towards the EU Water Framework Directive 2000/60 (WFD) and the Marine Strategy Framework Directive (MSFD). In this work the derived dataset consisting of 7 monitoring years was treated by applying specific indices in order to preliminary assess the trophic state of the area.

Study area

The Gulf of Trieste (northern Adriatic Sea) is a shallow (<25 m of depth) semi-enclosed basin characterised by high variability in its oceanographic properties. The Isonzo River represents the major source of land-borne nutrients in the eastern sector, whereas the inputs originating from the Marano and Grado Lagoon catchment cannot be underestimated. In addition, both urban and industrial sewages insist especially in the more populated area.



Samplig operations and laboratory activities

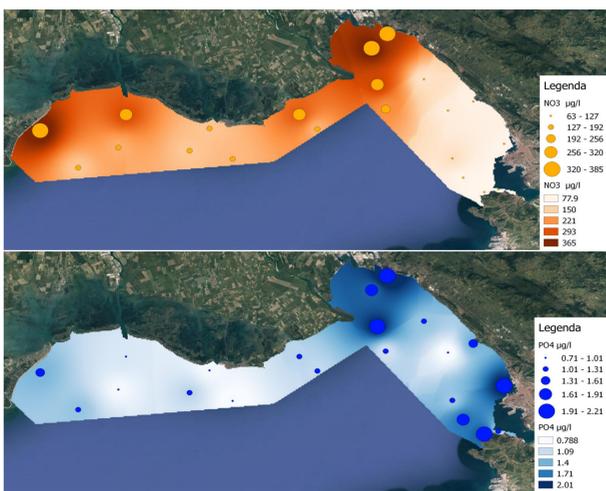
- Water samples were collected monthly at 21 water bodies and at 6 sites along two transects for the WFD and MSFD, respectively, from 2010 to 2017;
- T, S, pH, dissolved oxygen and Chl_a were measured *in situ* using a CTD multiprobe (Hydronaut 316 plus);
- Dissolved nutrients were determined by means of segmented flow analyzer technique (Bran+Luebbe Quattro) following standard methods (1);
- Phytoplankton was determined following standard guidelines (2);
- Statistical analysis was performed with the free software PAST 3.0

RESULTS AND DISCUSSION

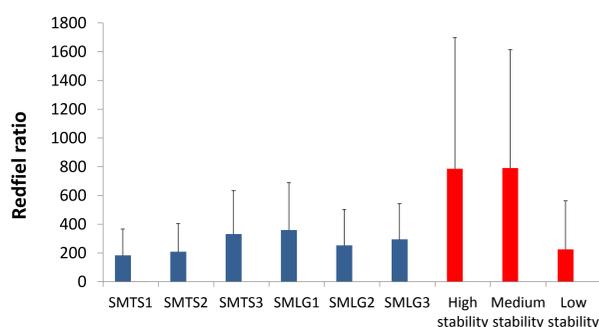
Nutrients distribution at the basin scale

More than 21,000 data were acquired in the WFD monitoring context. The spatial distribution of NO₃⁻, which is the prevalent N form (~80%), highlights the importance of Isonzo riverine inputs. Some degree of accumulation is also present close to the Marano and Grado Lagoon tidal inlets as a consequence of the export from this transitional environment highly enriched by the agricultural catchments at the Friulian plain. PO₄³⁻ prevails close to the urban area of Trieste and Monfalcone, however levels are very low if compared to other coastal systems.

Values of P90 for Chl_a averaged 1.13 μg l⁻¹.



Deviations of the values in N:P ratio from the proposed Redfield (16:1) and the occurrence of an important PO₄³⁻ limitations for each of the assessment area was observed during most of the year. These large deviations were higher in coastal water (high and medium stability WBs) affected by riverine inputs and decreased moving offshore.

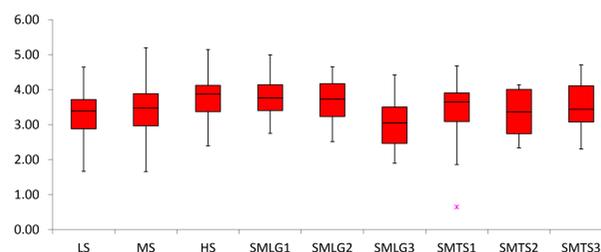


Application of trophic indices

The multimetric trophic index TRIX introduced by Vollenweider (3)

$$TRIX = [\log_{10}(DIN \cdot TP \cdot Chl_a \cdot \%O_2)] - 1.5/1.2$$

provides an integrated evaluation of indicators of eutrophication, has been widely used over the last 15 years and is compatible with the WFD 2000/60/EC.

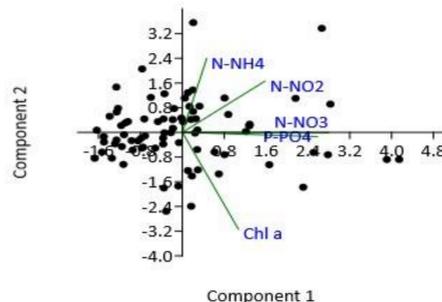


PCA as linear combination of different variables has been successfully proposed in discriminating levels of eutrophication (4). The form of this potential eutrophication index (E.I.) is as follows:

$$E.I. = aCPO_4 + bCNO_3 + cCNO_2 + dCNH_3 + eCchl_a$$

where,

C denotes the various concentrations and a, b, c, d and e the coefficients derived from the PCA analysis for the first principal component

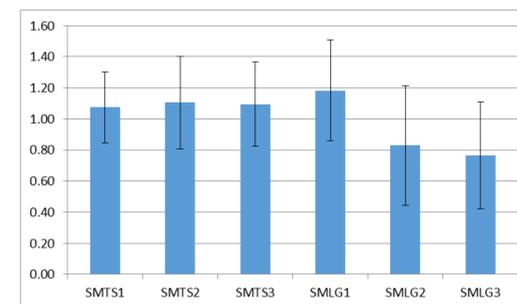


Three equations were obtained and applied to the specific WBs. For example:

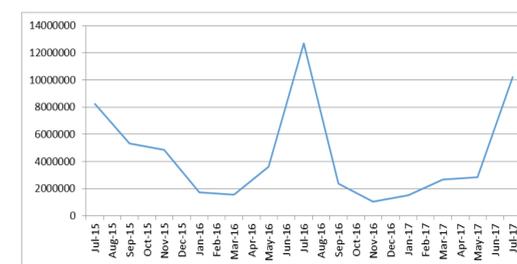
$$E.I. (high) = 0.60CPO_4 + 0.65CNO_3 + 0.37CNO_2 + 0.11CNH_3 + 0.25CChl_a$$

75th and 90th of log₁₀E.I. were calculated as limit to detect monthly criticality at WBs level in terms of possible eutrophication. A good correspondence was found in results obtained for different water body types.

The average Chl_a concentration was higher in July 2016 with 1.33±0.24 μg l⁻¹, however no clear trend was found during the whole survey. At the same time, also the distribution among site investigated did not show significant differences.



Phytoplankton abundance (average whole basin) varied from 1*10⁶ to 12*10⁶ cell l⁻¹, with the minimum in winter periods and the maximum during the summer.



Conclusions

- Riverine inputs strongly influence nutrients distribution especially in terms of N;
- Redfield ratio supports the occurrence of a diffuse P limitation;
- According to Vollenweider et al (1998), the Gulf of Trieste is in a good state of water quality;
- PCA application demonstrated to be a good tool to discriminate periodical critical situation in terms of potential eutrophication;
- Further investigations are planned to assess the eutrophication in a complete manner by individual scoring of each parameters

References

- Grasshoff K, Ehrhardt M, Kremling K, (1999) Methods of Seawater Analyses. Verlag Chemie, Weinheim, p. 419.
- ISPRA (2010) Metodologie di studio del plancton marino. Manuali e linee guida 56/2010.
- Vollenweider, R.A., Giovanardi, F., Montanari, G., Rinaldi, A., 1998. Characterization of the trophic conditions of marine coastal waters with special reference to the NW Adriatic Sea: proposal for a trophic scale, turbidity and generalized water quality index. *Environments* 9, 329-357.
- Primpas, I., Tsirtis, G., Karydis, M., Kokkoris, G.D., Principal component analysis: Development of a multivariate index for assessing eutrophication according to the European water framework directive. *Ecological Indicators* 10, 178-183.