

# THE INFLUENCE OF SUBMARINE WASTEWATER SYSTEM ON CHEMICAL AND BIOLOGICAL PARAMETERS IN THE WATER COLUMN AND SEDIMENT AT THE MIDDLE ADRIATIC (CROATIA)

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## Abstract

To eliminate the inadequate disposal of wastewaters in the middle Adriatic area, which created negative impacts and long-term changes of chemical and biological parameters during the second half of the last century, Republic of Croatia provided collection of wastewaters and discharge through submarine outlets. This paper presents results of investigations of oxygen, nutrients, chl *a* concentrations, microzooplankton, bacterioplankton and fecal bacteria in the water column, sediment redox potential, organic matter, organic carbon content and granulometric composition in the submarine wastewater outlet located in the Brac Channel, near town of Split.

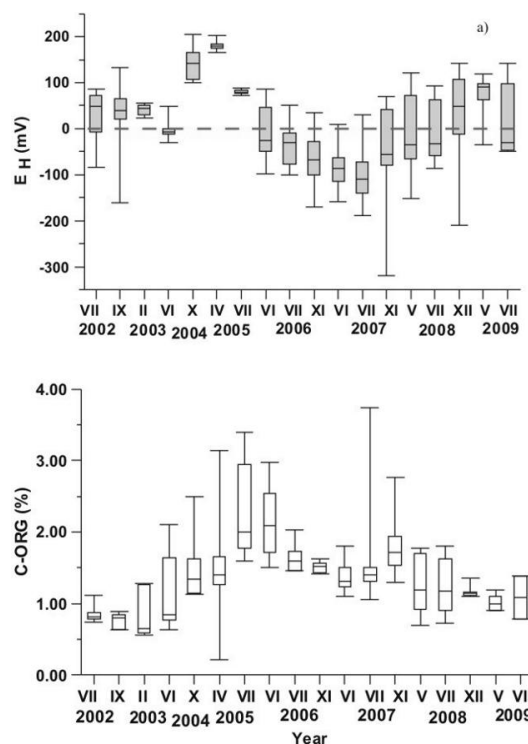
**Keywords:** *Adriatic Sea, Coastal Waters, Nutrients, Organic Matter*

## Material and Methods

Samplings and measurements were obtained at 11 stations located along the submarine wastewater outlet in the Brac Channel during the period prior to (2002-2004) and after the activation of the discharge (2004-2009). Dissolved oxygen in seawater samples was determined by Winkler titration, while inorganic and organic nutrients were determined colorimetrically [1]. Chlorophyll *a* (Chl *a*) concentrations were determined fluorometrically [2], number of heterotrophic and fecal bacteria was identified using flow cytometry and membrane filtration culture method, respectively. Sediment samples were collected by gravity corer and redox-potential was measured “*in situ*” by vertical penetration of a Pt electrode with Ag/AgCl reference electrode. Organic matter content in sediments was determined gravimetrically, while organic carbon content was determined using a Carlo Erba CHNS-O analyzer. Granulometric composition of the sediment samples was determined by sieving and the hydrometric method.

## Results and Discussion

Oxygen saturation in the water column during the entire investigated period (2002-2009) at all stations ranged from 76% to 120% and it did not show significant difference depending on the outlet activation time, but rather followed seasonal cycle of oxygen at the middle Adriatic coastal area. Vertical and temporal distribution of total inorganic nitrogen concentration (range: 0.2-8.9 mmol m<sup>-3</sup>) were in accordance with values determined prior to activation of discharge and natural seasonal oscillations of nitrogen with ammonia as prevailing inorganic species. Distribution of orthophosphate concentrations (range: 0-0.77 mmol m<sup>-3</sup>) showed occasionally enhanced values, particularly at station nearest to the outlet which can be attributed to the input of wastewater in the area. While number of heterotrophic bacteria showed significant decrease in relation to period prior to activation, biomass of phytoplankton expressed as chl *a* concentration (range: 0.07-1.07 mg m<sup>-3</sup>) showed continually increase after the launching of the discharge. More obvious influence of the submarine wastewater input of organic matter was on sediment redox potential (Eh) and organic carbon content (C-ORG) in the surface layer (0-2 cm) (Fig. 1a,b). Prior to the outlet's activation, Eh at all investigated stations was mostly positive with short period of slightly negative values in 2003, which is probably part of the natural Eh oscillation as was reported for the middle Adriatic [3]. After the wastewater system's activation, from 2005 to 2009, medians of redox potential in the surface sediment layer of the entire investigated area were more negative (Fig. 1a), particularly at the stations nearest to the outlet (not shown on Fig.). C-ORG content at the all stations increased in relation to the period prior to activation (Fig. 1b) due to organic matter input and its accumulation in sediment. The observed changes in sediments are direct consequence of wastewater outlet and, considering the mechanical filtration of the effluents prior to discharge, the main impact to this marine environment occurs through dissolved inorganic and organic matter which can explain the observed delay in sediment response to anthropogenic input.



**Fig. 1.** Box-whisker plots of redox potential (a) and organic carbon content (b) in the sediment surface layer at investigated stations during 2002-2009

## References

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