RECENT VARIATIONS OF FRESHWATER AND NUTRIENT LOADS FROM N ADRIATIC RIVERS AND DANUBE

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Abstract
The analysis of the recent (2004-2012) river water and nutrient loads in N Adriatic and NW Black Sea was made in order to assess dynamics and potential effect of the continental inputs in these coastal marine ecosystems. River data made available by national/international research projects and by institutional monitoring activities were collected and analyzed. They indicated that runoff and nutrient transport have been highly variable in these coastal systems during the recent years. These variations should be better considered, both at seasonal and interannual scales, as they can induce important changes in trophic conditions and ecosystem structures in these marine areas.

Keywords: Nutrients, Deltas, North Adriatic Sea, Black Sea

N Adriatic and NW Black Sea are coastal ecosystems strongly affected by river loads. The continental loads have significant consequences on the productivity and on the structure of this marine ecosystem [1, 2]. Danube water discharge strongly affects, together to Dniepr and Dniestr rivers, the shallow and semi-enclosed shelf of NW Black Sea. In this marine area, human-induced eutrophication has been reported as cause of extensive damages biological communities [e.g. 3].

In 2004-2012, the total flow of N Adriatic rivers (401-9162 m^3 s^{-1}) corresponded to an average of 59 km^3 yr^{-1} (Fig. 1). The drought in 2003-2007 was followed by a period of high regime in 2008-2010 and by a decrease in 2011-2012, suggesting the presence of strong oscillations of runoff mainly originated by the behavior of Po. The most important difference between the years with high (low) runoff was the presence (absence) of the peaks of flow in spring and autumn. Danube flow (2340-5190 m^3 s^{-1}) corresponded to an average of 211 km^3 yr^{-1}, a value that was similar to that in the last 50 years. For Danube, spring was usually a season characterized by high flows, whereas autumn was often dry. Contrary to N Adriatic rivers, Danube regime was high in 2005-2006 and low in 2007-2009. However, the highest flows in 2010 and the scarce flows in 2011-2012 were common to both areas.

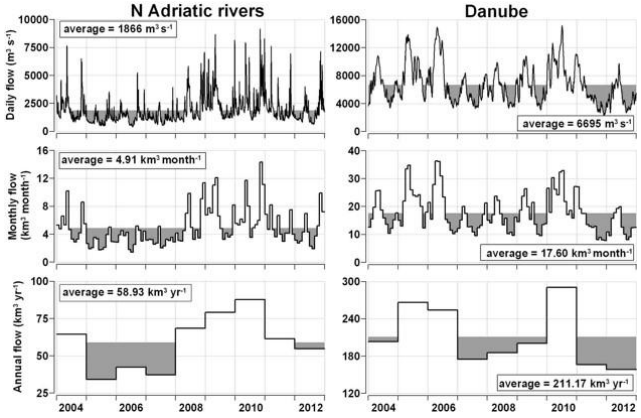

Fig. 1. Daily averaged flow, monthly and annual integrated loads of N Adriatic rivers and Danube in 2004-2012.

In N Adriatic, TN transport increased since the 1960s, whereas TP transport was stabilized in the 1980s and reduced during the following decades. In 2004-2012, TN and TP transports were in the range of 113-265 kt N yr^{-1} and 4.7-13.5 kt P yr^{-1}, respectively. Nutrient supply by N Adriatic rivers showed a high interannual variability: during the drought in 2005-2007, it was about half than that estimated during the years with a high runoff. TN emission from Danube increased in 1950-1990 and then reduced after the early 2000s. TP emission followed a similar trend, but it was an order of magnitude smaller. In 2004-2012, the total loads of TN and TP were respectively 284-616 kt N yr^{-1} and 11.8-40.6 kt P yr^{-1}, confirming that the Danube is the largest source of nutrients in Mediterranean and Black Sea. Both marine areas were subjected to overloads of nitrogen compared to phosphorus (molar ratios TN/TP = 48-221, DIN/PO4 = 31-476) and silicon (Si/DIN = 0.5-1.1).

Distinct seasonal river cycles were observed in N Adriatic and NW Black Sea, probably because of the different climatic characteristics of the drainage basins. In both areas, the overload of nitrogen compared to phosphorus and silicon mainly originates by the high concentration of NO_3 in the river waters. As a consequence, the largest pool of nitrogen is inorganic, whereas inorganic and organic pools are more equilibrated in the case of phosphorus. This unbalance of N/P ratio is the main factor that partially limits the extreme eutrophication potential of the continental loads in these marine ecosystems.

References
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