EGU General Assemgly 2011 Vienna | Austria | 03 – 08 April 2011

Modelling nutrient loads to northern Adriatic


Goran Volf [a], 
Nataša Atanasova [b], 
Boris Kompare [c], 
Nevenka Ožanić [a]

[a]Faculty of Civil Engineering, Department of Hydraulic Engineering, University of Rijeka, Viktora Cara Emina 5, 51000 Rijeka, Croatia. e-mail: goran.volf@gradri.hr
[b] Centre for Marine and Environmental Research - CIMA, University of Algarve; International Centre for Coastal Ecohydrology - ICCE, Portugal
[c]Faculty of Civil and Geodetic Engineering, Institute of Sanitary Engineering, University of Ljubljana, Slovenia.

a) 

b) 

b) 

c) 

1.Introduction:

Agricultural fertilisation, wastewater discharge and other human activities have resulted in increased nutrient concentrations in groundwater, rivers, lakes, and coastal seas all over Europe (de Wit and Bendoricchio, 2001), causing numerous undesirable effects, most of which are related to the increased algal blooms and their consequences.

The northern Adriatic (NA) is the shallowest area of the Adriatic Sea, while its northwestern part one of the most productive in the Adriatic, as well as in the Mediterranean Sea (Sournia, 1973, Mozetič et al., 2009). Numerous rivers and streams discharge nutrient rich freshwaters into the northern Adriatic shallow waters (Raicich, 1996), being the potential drivers for long-term changes in the marine ecosystem.

This study provides a quantitative assessment of the freshwater and associated nutrients fluxes to the NA. For this assessment the GIS based model **AVGWLF** (Evans et al., 2002) was applied to the entire NA watershed to simulate the nutrient loads during the period of 9 years (1999-2007).

2. Case study area and data description:

NA basin measures approximately **110,600 km^2** and is spread over three neighboring countries, Italy, Slovenia and Croatia. It is consisted of several basins: Po River basin, Adige River basin, Piave River basin Livenza River basin, Tagliamento River basin, Isonzo River basin, Dragonja river basin, Mirna River basin, Brenta-Bacchiglione basin, tributary to lagune Marona-Grando, SW Istrian tributary and other smaller basins. In text bellow are describet mayor basins in NA.

Data used for modeling nutrient loads:

- **Major rivers and their basins layer**
- **Elevation layer**
- **Land use/cover layer**
- **Number of inhabitants**
- **Soil layer**
- **Urban systems - WWTP**
- **Precipitation and air temperature data**

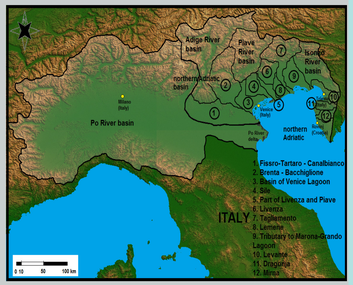
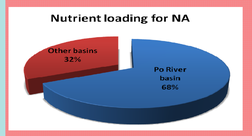


Fig. 1. Case study area - NA basin

3. Results and disscusion:



Po River contributes with major part - around 68%, while other basins contribute with around 32% of the total nutrients loading.

Fig 2. Percentage ratio of nutrient loadings

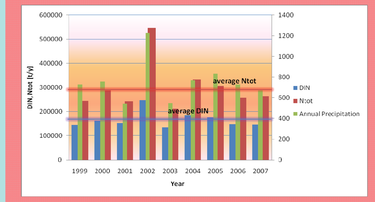


Fig 3. Dissolved inorganic nitrogen (DIN), total nitrogen (N_{tot}) in t/y and annual precipitation in basin in mm

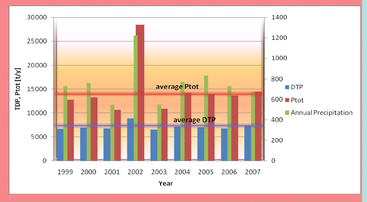


Fig 4. Dissolved total phosphorus (DTP), total phosphorus (P_{tot}) in t/y and annual precipitation in basin in mm

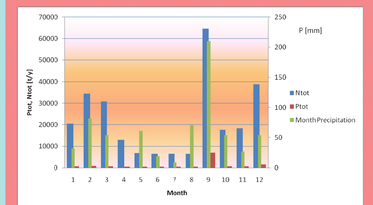


Fig 5. Monthly loads of total nitrogen and total phosphorus in t/month and monthly precipitations in mm

- The diffrence between DIN and N_{tot} is approximately 55% and DTP and P_{tot} 48%.
- Total average load of phosphorous is 15 t/y (min. 11 t/y and max. 28 t/y) and largely depends on flood events, while the total average load of nitrogen is 299 t/y (min. 212 t/y and max. 546 t/y) and does not depend on flood events but directly on the discharged water volume .

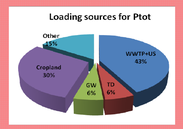


Fig 6. Major loading sources for total P

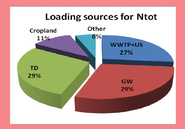


Fig. 7. Major loading sources for total N

Major sources of nitrogen are WWTP plus urban systems (27%) and agricultural activities (58%), while for phosphorus mayor sources are WWTP plus urban systems (43%) and cropland surfaces (30%).

4. Conclusions

In this paper we present a model that simulates the nutrient loadings from the NA basin taking into account point and dispersed sources. Expectedly, the major sources come from the PO river basin, however the rest of the smaller basins contribute around 30% of the total loading and should not be neglected.

In spite of the latest research (Mozetič et al., 2009), indicating that the northern Adriatic can no longer be considered as a very eutrophic basin, episodes of algal blooms and moreover mucilage events are still frequent and require measures in the entire basin.

According to the model ' s results agricultural activities contribute bigger part of the nutrients loading, however urban areas also represent a fairly big source and thus, proper management of these areas, such as introducing suitable wastewater treatment, shall reduce the nutrient loadings to northern Adriatic.

Further work will be focused to integrate these results with an ecological model for estimating the trophic state in NA as well as to use the integrated model for controlling and managing the activities in the contributing areas particularly for determining the proper wastewater treatment level according to marine ecosystem status.

Acknowledgements:

The authors thank to all who contributed to the data collection used for the modelling and to dr. Francesco Tornatore for valuable informations and studies related to the Po River. We are grateful to Barry M. Evans for valuable comments and for his proffesional help with AVGWLF application. This work is part of Ph.D. Thesis: „Assessing the proper wastewater treatment level according to marine ecosystem status“ and project „Hydrology of sensitive water resources in karst“ (114-0982709-2549) funded by the Ministry of Science, Education and Sports of the Republic of Croatia.

References:

de Wit, M. and Bendoricchio. G., 2001, Nutrient fluxes in the Po basin, Science of the Total Environment, 273, 147–161.

Evans, B.M., 2002. Development of an Automated GIS-Based Modeling Approach to Support Regional Watershed Assessments. Ph.D. Dissertation in Soil Science, The Pennsylvania State University, 231 pp.

Mozetič, P., Solidoro, C., Cossarini, G., Socal, G., Precali, R., et al., 2009, Recent Trends Towards Oligotrophication of the Northern Adriatic: Evidence from Chlorophyll *a* Time Series, Estuaries and Coasts, 33, 362–375.

OECD. Eutrophication of Waters: Monitoring, Assessment and Control. Paris: OECD, 1982.

Raicich, F., 1996, On the fresh water balance of the Adriatic Sea. J. Mar. Syst. 9, 305 - 319.

Sournia, A., 1973, La production primaire planctonique en Méditerranée. Bull. Étude Commun. Medit., 5, 128.

Session HS9.8: EGU2011-6136