FUTURE SCENARIOS OF RIVER DISCHARGES OF WATER AND NUTRIENTS TO THE MEDITERRANEAN AND BLACK SEA

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Abstract
The purpose of this paper is the development of future scenarios on the riverine inputs of water and nutrients to the Mediterranean and Black Sea. Based on detailed reconstructions of the river fluxes during the last 40-50 years, we identified their major controlling factors which were then used to project the budgets from the recent past into the near future. The modelling framework is given by the IMAGE model and its spatially explicit parameterisations of potential drivers, such as population growth, socio -economic development, land use changes and climatic boundary conditions. The future scenarios are based on the four scenarios for the years 2030 and 2050 developed within the Millenium Ecosystem Assessment.
Keywords: River Input, Global Change, Nutrients

Anticipation of future environmental changes is one of the major scientific challenges in Earth sciences. Two major drivers, commonly regrouped under the term of global change, are crucial for future ecosystem changes. The first is climate change, strongly acting through modification of the water cycle on Earth and its temporal variability. The second driver is demographic and socio-economic development, frequently accompanied by negative feedback on ecosystems services, e.g. through the massive release of pollutants and/ or the reduction of biodiversity. River discharges of water and associated elements are highly sensitive to both drivers, making them good indicators for global change in general. Moreover, as the fluxes represent a major link between the terrestrial and marine domains, they can be considered active players in the future evolution of the coastal ecosystems that closely depend upon river inputs.

The Mediterranean is one of the regions on Earth where global change is expected to cause considerable environmental impacts. The region has been identified as a "hot spot" for climate change. Many observation and modelling studies indicate that there is an ongoing trend towards warmer and dryer conditions, which is likely to continue in the future. On the other hand, the Mediterranean lies on the border of three continents, with different cultural, economical and political characteristics. This contrast is further enhanced when including the drainage basin of the Black Sea, because of the abrupt economical changes on the former USSR countries in the early 1990s. As a consequence, future demographic and economic development is expected to occur heterogeneously in this region, which may alter the spatial distribution of the actual environmental conditions. Exploitation of the coastal resources represents a major income for local populations, traditionally through fisheries and agriculture, and, as the Mediterranean has become the greatest tourist destination in the world, increasingly also via tourism. Therefore regional scenarios on the future evolution of river discharges to the sea are important to assess the potential impact of global change in the Mediterranean region, both in coastal waters and within the surrounding drainage basins.

The development of these scenarios is the purpose of our paper. Based on detailed reconstructions of the river fluxes during the last 40-50 years, we identified their major controlling factors which were then used to project the budgets from the recent past into the near future ([1], [2]). The quantitative framework of both the hindcasting and forecasting modelling scenarios is given by the IMAGE model and its spatially explicit parameterisations of potential drivers for the river fluxes, such as population growth, socio-economic development, land use changes and climatic boundary conditions. The future scenarios are consequently based on the four scenarios for the years 2030 and 2050 that were developed within the Millenium Ecosystem Assessment (MEA), and for which IMAGE produced the corresponding data layers.

We focussed on two contrasting parameters or parameter groups within the river fluxes. These are the fluxes of freshwater and the fluxes of nutrients, represented by nitrate and phosphate. Our results predict a significant trend of decreasing freshwater fluxes for the future, which already started in the past. Regional hot spots for this decrease are the drainage basins of the Alboran Sea and, when including the demographic evolutions, also the drainage basins of the Aegean and North-Levantine seas (Fig. 1). The predicted total nutrient fluxes to the Mediterranean and Black Sea remain in the envelope of the observed variability during the last 40 years. At regional scales, however, the budgets may considerably change. In the Mediterranean drainage basins of the North, such as the North-Western Basin and the Adriatic Sea, they uniformly tend to decrease. But in the basins of the South- and North-Levantine seas, where populations will grow rapidly, they may strongly increase. In the past, nutrient inputs from these two drainage basins were almost negligible in the total budgets, but they might become major components in the future.

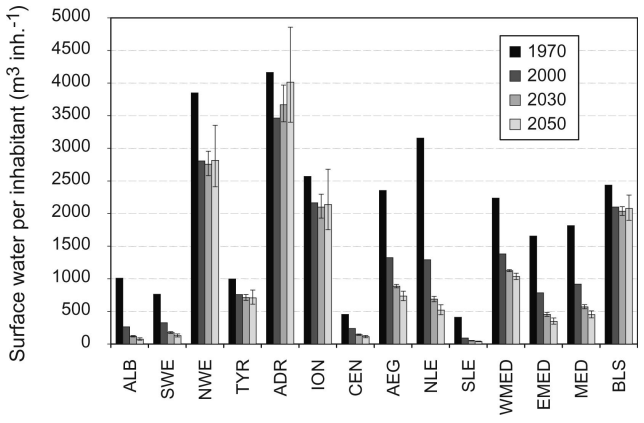

Fig. 1. Evolution of the population specific water resources in the drainage basin of Mediterranean and Black Sea. Standard deviation corresponds to the differences between the four future scenarios. The distinguished sub-basins are the Alboran (ALB), North-Western (NWE), South-Western (SWE), Tyrrhenian (TYR), Adriatic (ADR), Ionian (ION), Central (CEN), Aegean (AEG), North-Levantine (NLE), and South-Levantine (SLE) seas. WMED, EMED, MED corresponds to the Western, Eastern and entire Mediterranean Sea, and BLS represents the entire Black Sea

References
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