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Feedback of benthic Nutrient Recycling to Ecosystem Decline and Recovery in the northwestern Black Sea

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The broad and shallow western Black Sea shelf suffered from pollution, eutrophication and overfishing from the 1960's to the early 1990's and experienced severe changes in the ecosystem structure and functioning as a result. Eutrophication has been imposed on the western shelf largely by nutrient loads from external point sources, particularly the major inflowing rivers Danube, Dniestro and Dnipro, Recurrent widespread seasonal bottom water hypoxia caused deterioration of the benthic system over a time period of over 20 years. Riverine nutrient discharges declined following the collapse of the centrally planned industries and agriculture in the eastern European countries in the early 1990's and the ecosystem is now responding to the decrease in anthropogenic pressures. It is not known however, how resistant the benthic and pelagic ecosystems are to further stress and what the thresholds for collapse are. There are indications that temperature rise from climate change introduces further stress to the shelf ecosystem and will bring changes in the freshwater supply from the rivers.

An important internal source for eutrophication is recycling of nutrients from organic matter deposited on the seafloor. In-situ observations from 1995, 1997, 1998 and 2006 suggest that benthic nutrient fluxes did not decrease over the past decade. Release of nutrients from the sediments along with a tight benthic-pelagic coupling on the shallow shelf continues to fuel benthic and pelagic productivity decades after outside pressures on the shelf ecosystem in the form of river nutrient input have decreased. This underlines the importance of the benthic system as the memory of past eutrophication. Significant differences in benthic nutrient fluxes and bottom water concentrations be-

tween the cold and warm seasons point to a sensitivity of benthic nutrient release to climate change. We observe a two to four year time lag between nutrient pulses from the Danube River and the occurrence of large-scale bottom water hypoxia, which indicates a resilience of the benthic ecosystem over such a period of time before it collapses. Our recent surveys shows that the state of the benthic system along the Romanian and Ukrainian Black Sea coast is improving, as seasonal bottom water hypoxia is much less prevalent than a decade ago. Benthic flux experiments in a large red algal field showed that sediment with macrobenthos releases less organic and inorganic nutrients to the sediment overlaying water than a disturbed system without these plants and animals. Our experiments further indicate that the opportunistic species characterising current partially recovered benthic systems allow ecosystem functionality with respect to benthic fluxes that is comparable to an undisturbed system. It remains to be seen whether the opportunistic species provide enough functional redundancy to ensure stability of the benthic ecosystem system in a changing environment.