Preface to special section on Past and Future Trends in Nutrient Export From Global Watersheds and Impacts on Water Quality and Eutrophication

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[1] Coastal eutrophication is a worldwide problem [*Diaz and Rosenberg*, 2008; *Selman et al.*, 2008]. It is largely caused by increased river transport of nutrients such as nitrogen (N), phosphorus (P), and carbon (C). Further distortion of coastal marine ecosystems is related to changing element ratios as a result of increasing N and P loading and decreasing river export of silica (Si). The main causes of increased river nutrient loading are the increasing livestock and crop production and fertilizer use, and increasing wastewater flows. There have been considerable gains in knowledge of current amounts and sources of N and P entering the terrestrial biosphere, and biogeophysical factors that control the amount of N and P ultimately exported by rivers to coastal ecosystems. Considerably less work has addressed how various socioeconomic factors and approaches to nutrient management affect N and P inputs to the terrestrial biosphere and subsequent impacts on river nutrient export.

[2] This special section of Global Biogeochemical Cycles focuses on Past and Future Trends in Nutrient Export from Global Watersheds and Impacts on Water Quality and Eutrophication. It summarizes the recent work of the Global Nutrient Export from Watersheds (NEWS) work group, using an integrated modeling approach connecting socioeconomic, nutrient management and biogeophysical factors to river export.

[3] We present the second generation of the Global NEWS model [*Mayorga et al.*, 2010; *Seitzinger et al.*, 2010]. The first generation of the NEWS model was published in a 2005 Special Section of Global Biogeochemical Cycles [*Beusen et al.*, 2005; *Dumont et al.*, 2005; *Harrison et al.*, 2005a; *Harrison et al.*, 2005b; *Seitzinger et al.*, 2005]. The NEWS model calculates river export of different forms of N, P, C and Si as a function of hydrology, morphology, land use and human activities in the river basin. More than 6000 river basins are included in the model.

[4] Since 2005, three important developments took place on which we report in this special section: (1) several submodels for individual nutrient forms were updated [*Beusen et al.*, 2009; *Harrison et al.*, 2010; *Mayorga et al.*, 2010; *Seitzinger et al.*, 2010], such as including detergent sources of P in the DIP submodel [*Harrison et al.* 2010], and development of a submodel for river export of dissolved silica [*Beusen et al.*, 2009]; (2) the models for different nutrient species were integrated into one modeling interface [*Mayorga et al.*, 2010]; and (3) the model was used to analyze past trends (1970–2000) and four future scenarios (up to 2050). The future scenarios were based on the Millennium Ecosystem Assessment (MEA) [*Alcamo et al.*, 2006]. We interpreted these scenarios to develop spatially explicit model inputs for diffuse sources of nutrients from agriculture and natural ecosystems [*Bouwman et al.*, 2009] and sewage [*Van Drecht et al.*, 2009], and hydrology [*Fekete et al.*, 2010] consistent with the range of social, economic, policy, and ecological considerations in the four MEA scenarios.

[5] Past and future trends in river nutrient export to coastal waters calculated from the NEWS model were used to analyze global trends [*Seitzinger et al.*, 2010] as well as changes at the continental scale for South America and Africa [*van der Struijk and Kroeze*, 2010; *Yasin et al.*, 2010] or at the scale of individual river basins in Europe [*Thieu et al.*, 2010; *Yan et al.*, 2010], and a time series comparison of measured and modeled DIN export by the Changjiang River (1970–2003) [*Yan et al.*, 2010]. We also developed a global perspective on indicators for nutrient inputs to land, and for changing nutrient ratios which could favor increases in nondiatom algal blooms [*Billen et al.*, 2010; *Garnier et al.*, 2010].

[6] Our results indicate that since 1970, river export of nutrients has been increasing considerably in many world regions. During the coming decades, DIN and DIP loads were projected to continue to increase in many world regions; however, particulate loads were projected to decrease. Perhaps the most surprising result of our analyses was that for large world areas, at least in one scenario, we calculate lower nutrient export rates in the future than in 2000, despite in-

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creases in population, economic activity and agricultural production in those areas. These decreasing trends are the net effect of changes in hydrology (as a result of climate change, dam construction for hydropower, and consumptive water use) and changes in environmental and agricultural management. In the future (period 2000–2050), the potential risk that nondiatom algal growth may lead to harmful algal blooms in coastal marine ecosystems is indicated to continue to increase in all four scenarios, although there are considerable regional differences [*Garnier et al.*, 2010].

[7] This special collection of Global NEWS articles is the first to assess global, spatially explicit trends in multiple-nutrient river loadings to coastal waters across a range of scenarios. The Global NEWS model serves as a basis for setting priorities for future research and informing environmental policy at the regional scale. Clearly, there is a need for more experimental studies on river nutrient loading and coastal eutrophication, especially in tropical regions. The Global NEWS model has proven to be particularly useful for analysis of the causes of nutrient pollution in world regions where coastal eutrophication is a problem, but where experimental studies are scarce [*van der Struijk and Kroeze*, 2010; *Yasin et al.*, 2010].

[8] **Acknowledgments.** Global Nutrient Export from Watersheds (NEWS) (http://www.marine.rutgers.edu/globalnews) is an international work group of UNESCO's Intergovernmental Oceanographic Commission, and an endorsed activity under the Land-Ocean Interactions in the Coastal Zone (LOICZ) project of the International Geosphere-Biosphere Programme and the International Human Dimensions Programme. We thank the entire Global NEWS workgroup for their contributions to the further development and scenario analyses of the NEWS model upon which the papers in this special section are based.

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