Forms and seasonal variability of nutrient loading to global river networks over the 20th century

L. VILMIN[1], A. H. W. BEUSEN[1,2], J. M. MOGOLLÓN[1], A. F. BOUWMAN[1,2]

[1] Department of Earth Sciences – Geochemistry, Faculty of Geosciences, Utrecht University, P.O. Box 80021, 3508TA Utrecht, The Netherlands
l.m.vilmin@uu.nl

[2] PBL Netherlands Environmental Assessment Agency, P.O. Box 30314, 2500GH The Hague, The Netherlands

Nitrogen (N) and phosphorus (P) are key nutrients, which play a major role in the biogeochemical functioning of aquatic systems. Their natural cycles have been deeply modified by human activities. Transfers of N and P to surface freshwaters have amplified during the 20th century, mostly because of escalating fertilizer use, and increasing sewage water emissions in growing urban areas. This phenomenon has lead to widespread eutrophication problems, constituting threats to human and ecosystem health. The contribution of different sources, natural and anthropogenic, to total N and P loading to river networks has recently been estimated using the Integrated Model to Assess the Global Environment (IMAGE). However, eutrophic events (*i.e.*, development of algal blooms) generally respond to a combination of conditions, including temperature, flow, as well as nutrient form and availability that cannot be captured at low (yearly) temporal resolution.

In the present study, we define for each simulated nutrient source: i) its speciation and ii) its seasonal pattern, which depends on the source's drivers. Thereby, the updated model simulates the loads of different N and P forms (ammonium, nitrate, organic N, dissolved inorganic P, particulate inorganic P and organic P) to global river networks. We analyze the results in the context of past global changes over the 20th century. Globally, the proportion of particulate P in total P loads is rising, especially in the inorganic form, due to increased soil loss from agricultural lands. While the TN:TP ratio of the loads remains quite stable, the DIN:DIP ratio, which is likely to affect algal development the most, is increasing globally. We discuss trends for areas with different demography, land uses and levels of development (*i.e.*, connectivity to the sewage network and treatment of waste water). By assessing the form of nutrient loading to global river systems at refined spatio-temporal scales (half degree resolution, monthly time step), these results are crucial to better understand the human impacts on freshwater and coastal eutrophication.