



Nitrogen cycling from rivers to ocean in a hypothetical scenario of integrated agriculture

Vincent Thieu (1,2), Gilles Billen (2), Josette Garnier (2), Christiane Lancelot (3), and Nathalie Gypens (3)

(1) IES JRC, Rural Water and Ecosystem Resources Unit, Ispra (VA), Italy, (2) UMR 7619 Sisyphe CNRS/UPMC, Paris, France, (3) ULB ESA, Brussels, Belgium

Located in the North-Western Europe the terrestrial continuum that includes the Seine, Somme, and Scheldt River basins offers an interesting example of a transborder territory (France, Belgium, and Netherlands) with high-intensity anthropogenic pressures. It well-illustrates the rapid development of modern agriculture in industrialised countries and the resulting severe alteration of water resources and jeopardising the capacity of rural territories to produce drinking water. The corresponding nutrient loads delivered then into the Southern Bight of the North Sea, strongly affect the ecological functioning of the coastal zone.

An integrated 'river-ocean' assessment, coupling two deterministic models – the SENEQUE RIVESTRAHLER model simulating nutrient dynamic in the drainage network and the MIRO model describing the ecological functioning coastal ecosystem – points out the relevance of current policy based measures (improvement of waste water treatment) to mitigate phosphorous emissions, while the nitrogen pollution related to agriculture will remain critical despite the implementation of classical management measure (good agricultural practices).

Therefore and irrespectively of the current political agenda, a more radical alternative is established, consisting of a generalised shift to an integrated agriculture of all agricultural areas in the three basins, excluding the use of synthetically compounded fertilisers and the importation of livestock feed. Such scenario aims at evaluating whether agriculture, by essence, can conciliate (i) the demand for food and feed by local populations, (ii) a good ecological functioning of aquatic ecosystems and (iii) a balanced nutrient status for the adjacent coastal area.

This scenario involves an increased livestock density in the Seine and Somme and a decrease in livestock in the Scheldt basin. It leads to a significant reduction of agricultural production that finally brings the three basins closer to autotrophy/heterotrophy equilibrium, while a persisting requirement of long-distance importation of meat and milk clearly emphasises the unsustainability of the increasing share of animal proteins in the modern human diet. In the more optimistic hypothesis, nitrate concentrations in most of the drainage network would drop below the threshold of 2.25 mgN/l (10 mgNO₃/L) which is often considered a threshold for a good ecological status. The excess of nitrogen over silica (with respect to the requirements of marine diatoms) delivered into the coastal zones would be decreased by a factor from 2 to 5, thus strongly reducing, but not entirely eliminating the potential for marine eutrophication.

Despite a lack a short-term realism, this alternative could appears – in the line of the 'adapting mosaic' defined by the Millenium Ecosystem Assessement - as an end-point situation to be compared when building future nutrient reduction policies and incentive agricultural measures.