ATMOSPHERIC NITROGEN INPUT INTO THE NORTH SEA: INORGANIC AND ORGANIC NUTRIENT FLUXES

Duration of the project: 15/12/2003 – 30/04/2006
Budget: € 179.970
Keywords: Nutrients, Eutrophication, (In)Organic Nitrogen, North Sea

CONTEXT

The North Sea is threatened by eutrophication. Excess supply of nutrients, especially nitrogen compounds, causes proliferation of algae, leading to pernicious oxygen depletion. The nitrogen supply is not only due to rivers, but to the atmosphere as well. Especially in summer, when nutrients are scarce and the river supply is reduced, the atmospheric contribution can become predominant. The relevant atmospheric nitrogen is emitted as nitrogen oxides (by traffic and industry) and as ammonia (by agriculture). Organic nitrogen compounds might be important but their deposition fluxes are unknown.
Measurements of the concentrations of the various inorganic and organic nitrogen components and of their deposition, with rain and in the dry phase, will allow evaluating the contribution of the atmosphere to eutrophication processes, using adequate mathematical models.

PROJECT DESCRIPTION

Objectives
The input of nutrients, in particular the ones containing nitrogen, causes a proliferation of harmful algal blooms and other eutrophication phenomena, affecting fisheries and tourism. The contribution of atmospheric input to coastal eutrophication triggers increasing interest but is not well characterised yet. Specifically, the description of atmospheric fluxes in terms of inorganic and organic nitrogen and their distribution between the gaseous and particulate phases have not been examined systematically, apart from a few studies concerning the Baltic Sea and the seas around Japan. This project aims at the first comprehensive identification and quantification of the individual inorganic and organic compounds that contribute significantly to the nitrogen loading of the air above the Southern North Sea, as a function of the season and wind direction.

Methodology
The samplings will take place at a short distance from the beach, at a roof location between Den Haan and Wenduine, without any local pollution sources. Additional sample collections will possibly be carried out on board the R/V Belgica and Zeeleeuw. The gas phase is sampled with special denuders; aerosols are taken with filters in a high volume setup and with impactors that allow size differentiation, and rainwater is collected with an automated unit. The classical inorganic analyses (with ion chromatography and electron microprobe analysis) will be complemented with new methodologies to be elaborated for the characterisation of the organic components contributing to the nitrogen nutrient fluxes. This combination of frontier methods will allow a yet unseen degree of speciation to be achieved. In contrast to the inorganic analysis, the characterisation of organic nutrients is practically a blank field. Extensive chemical pre-separation in combination with powerful chromatographic methods and highly specific detection ("electron capture" and mass spectrometry detection) will be used to achieve the first inventory of the organic nitrogen nutrients in the gas phase and aerosol. The calculation of the "wet" deposition flux (via the rain water) is rather trivial; for the dry deposition of particles, existing models will be applied that predict the deposition velocity near the sea surface as a function of the particle size; for the dry deposition of gases, existing models will also be applied. The obtained atmospheric fluxes will be compared with the supply of nitrates via the rivers, to evaluate their relative importance, for different seasons and different meteorological conditions.

Expected results and/or products
The extended sampling and analysis program for the gaseous and particulate phase and the rain water will allow to assess the nitrogen deposition fluxes for the Belgian part of the North Sea with a better reliability than has been achieved so far. The complementary use of inorganic and organic analysis will be a major step to the understanding of the atmospheric input to the marine ecosystem, for instance the correlation of alkyl nitrates with the volatile hydrocarbons and NOx.

Using all this information, a comparison will be made of summer and winter data, with selected air mass trajectories, to study the temporal variation of the atmospheric nitrogen impact on the marine ecosystem in relation to the natural processes.

The results will provide direct input to the mathematical models that are developed to maintain the marine ecosystem.

The improved understanding of the nitrogen fluxes in the atmosphere will be used to define a simple, fast and robust method for routine sampling and analysis of target compounds that may serve as representative indices for the nitrogen loading. This will in turn significantly help to outline an appropriate method for the large scale monitoring needed for the sustainable use and management of the Southern North Sea.

The project could create a unique knowledge centre in Belgium with expertise concerning the role of atmospheric pollution in eutrophication and related problems. The innovative nature of the project with respect to the organic nutrients will trigger significant interest from the international scientific community.

The results will be disseminated via the classical channels (international scientific journals and conferences), a dedicated website, etc.

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A publication of the Belgian Science policy
Wetenschapsstraat 8 Rue de la Science - B - 1000 Brussels
TEL.: + 32 2 238 34 11 - FAX: + 32 2 230 59 12 - http://www.belspo.be
September 2004