Modelling eutrophication along the land-ocean continuum of the NEA

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Introduction

A major challenge in EU marine governance is to reach the "good environmental status" (GES) in the North-East Atlantic (NEA). There is a link between human nutrient emissions to the rivers and high marine chlorophyll *a* concentrations (Chl; Fig 1). Nutrient emissions at the level of the watersheds can result in eutrophication problems in the coastal zones. It is necessary to evaluate the possibilities of nutrient reductions by adapting human activities in the river watersheds.

Which scenario of inland nutrient reduction will allow achieving the GES at sea?

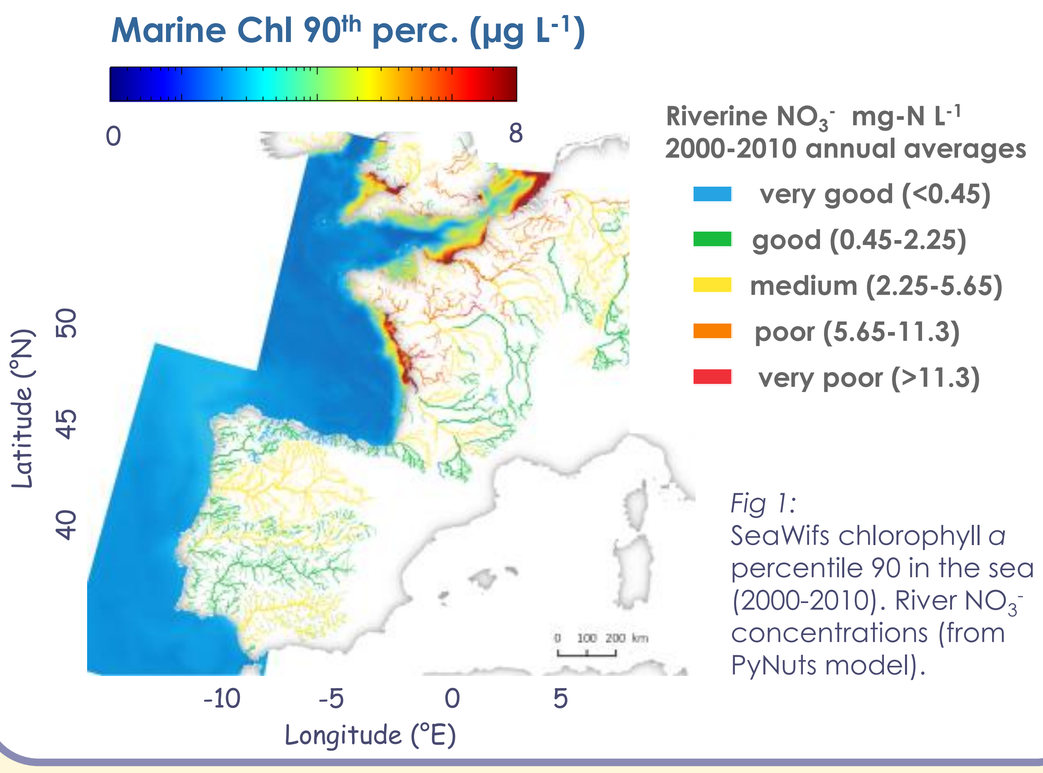

Fig 1: SeaWifs chlorophyll *a* percentile 90 in the sea (2000-2010). River NO_3^- concentrations (from PyNuts model).

Objectives

1/ Evaluate current eutrophication vs. pristine conditions

2/ Identify future "realistic" scenarios of nutrient reduction in the river watersheds of NEA

3/ Assess the impact of the scenarios in the sea

Methods

Model domains

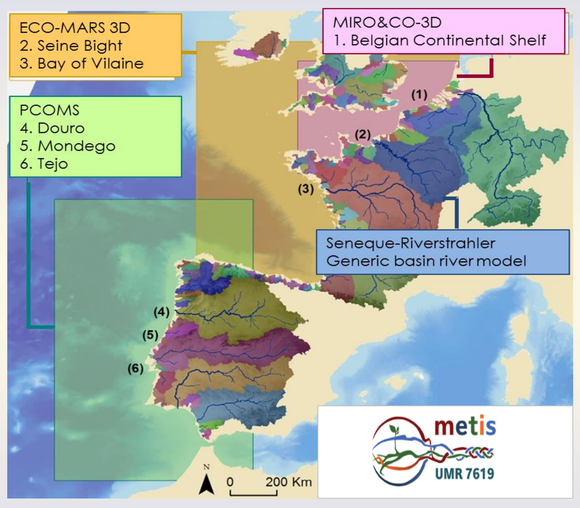

Fig 2: Domains of the watershed-river model and the three marine ecosystem models.

Three marine ecosystem models [1],[2],[3] are combined to one generic river model [4],[5] applied to the NEA watersheds (Fig2). It calculates terrestrial nutrient exports to the sea under different scenarios:

i. A past "pristine-like" scenario, where natural nutrient exports are estimated in the absence of any human influence.

ii. The current situation

iii. A series of future "realistic" scenarios, where different urban wastewater treatments and agricultural practices are combined.

Results

The effects of nutrient reduction scenarios have been calculated in the sea. In Fig 3, the pristine situation (PRI) shows low levels of winter dissolved inorganic nitrogen, DIN, compared to the current situation (NOW), which scales anthropogenic eutrophication with an absolute natural level. **The most promising future scenario combines Local production, Organic farming and Demitarian diet (LOD).** It implies deep changes in human practices and shows a significant DIN decrease in the rivers and in the sea while maintaining food security.

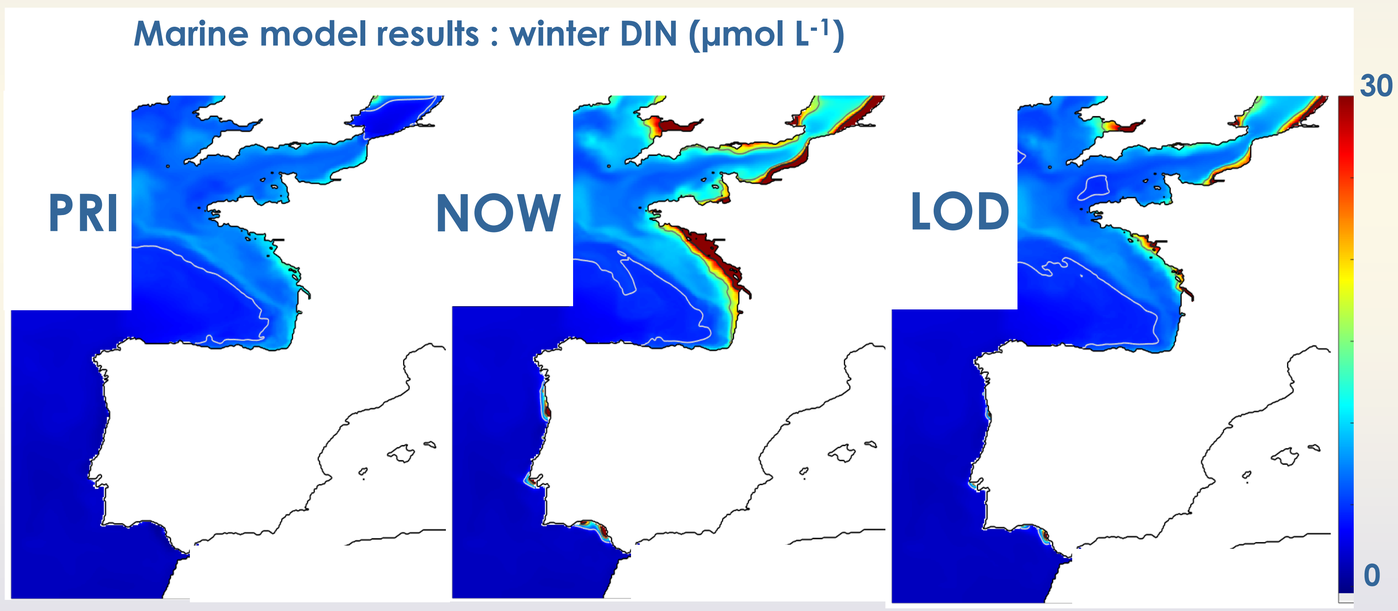

Fig 3: Comparison of modelled winter DIN between the scenarios PRI (pristine situation), NOW (current situation) and LOD (realistic future scenario) across the North East Atlantic.

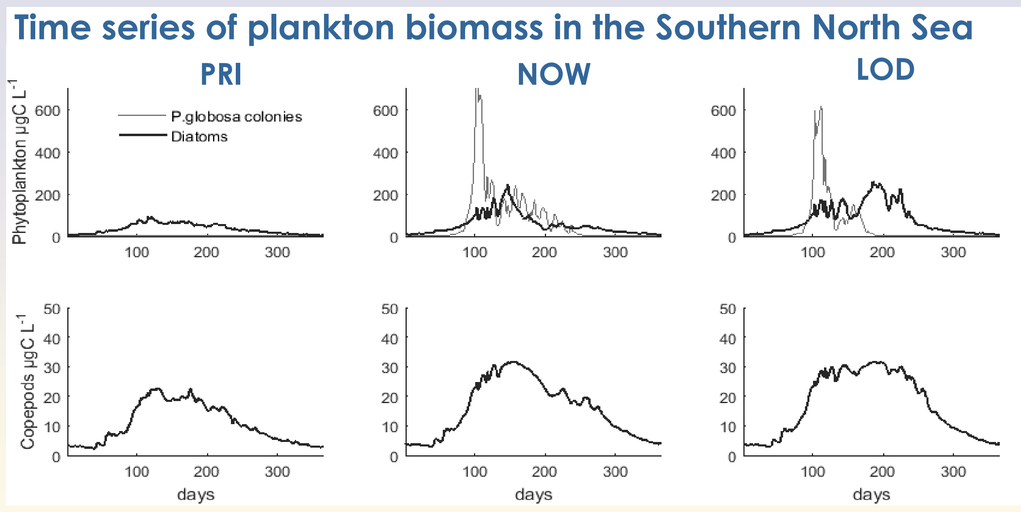

Fig 4: Multiyear mean time series (2000-2010) of modelled diatom, colonial Phaeocystis and copepod biomasses for three scenarios at station 330 (51°26.00'N, 2°48.50'E) in the southern North Sea.

Also, the plankton community responds to the scenario. Fig 4 illustrates the plankton seasonal dynamics in the North Sea.

PRI: In a natural situation, diatoms dominate the bloom.

NOW: The current eutrophication does not improve significantly the food web production, and merely enhances undesirable blooms of colonial *Phaeocystis*.

LOD: Colonial *Phaeocystis* decreases in the favor of diatoms. Copepods and trophic efficiency slightly increase.

Conclusions

- Today, coastal eutrophication remains problematic across the NEA
- The pristine situation scales the anthropogenic eutrophication in rivers and coastal zones
- The LOD future scenario gives promising ideas to reduce eutrophication
- Mitigating eutrophication may require paradigmatic changes at cultural and social levels

EMoSEM's outcome will be transferred to Member States responsible for WFD and MSFD operations.

Acknowledgements

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