Assessment of water quality for European water bodies

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CERTH-JRCTechnical Thessaloniki, Greece 21 October 2014

Water Resources Unit

European Commission

Water and chemicals

The JRC assesses and monitors the impact of pollutants and chemicals in aquatic ecosystems at regional and pan-European levels. To facilitate this, the JRC developed the Environmental Quality Standards (EQS) that set limits on allowable concentrations of aquatic pollutants.

Ecological water quality

In the early nineties, the increasing contamination levels of freshwaters led the European Commission to adopt a series of directives to reduce water pollution. The general objective of these directives is to achieve 'good status' for all surface waters by 2015.

Preserving ecosystems

The JRC supports EU nature and water policies by mapping ecosystem services, developing robust modelling approaches to simulate future ecosystem scenarios, and assessing the costs and benefits of conservation actions

Water Quantity and Efficiency

It has developed an integrated modelling framework that links land-use, hydrological and resource-efficiency models in order to evaluate different scenarios and policy options in terms of efficiency and cost-effectiveness

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Danube Water Nexus Unit

JRC contribution to build the evidence base of the Water-Agriculture-Energy-Ecosystems Nexus

Agriculture

Energy

Environment

Industry

Tourism

Drinking water

- Evaluate **availability and demand** of water in terms of competing objectives of the different sectors
- Look at the implications for **water resources allocation** and water security
- **Agriculture and energy** as the priority sectors in which water saving and efficiency should be improved in order to avoid scarcity

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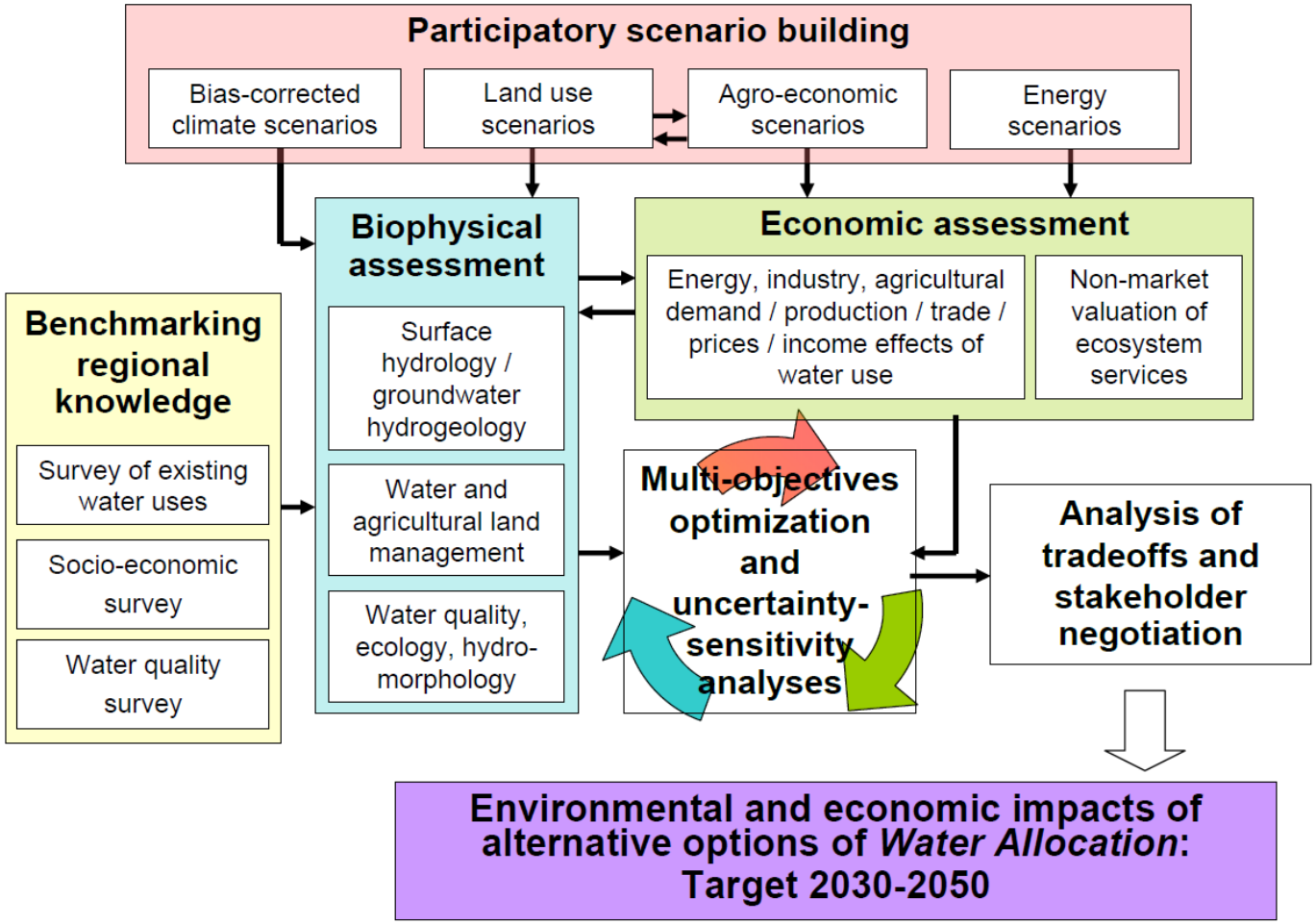
A proposal of methodological framework



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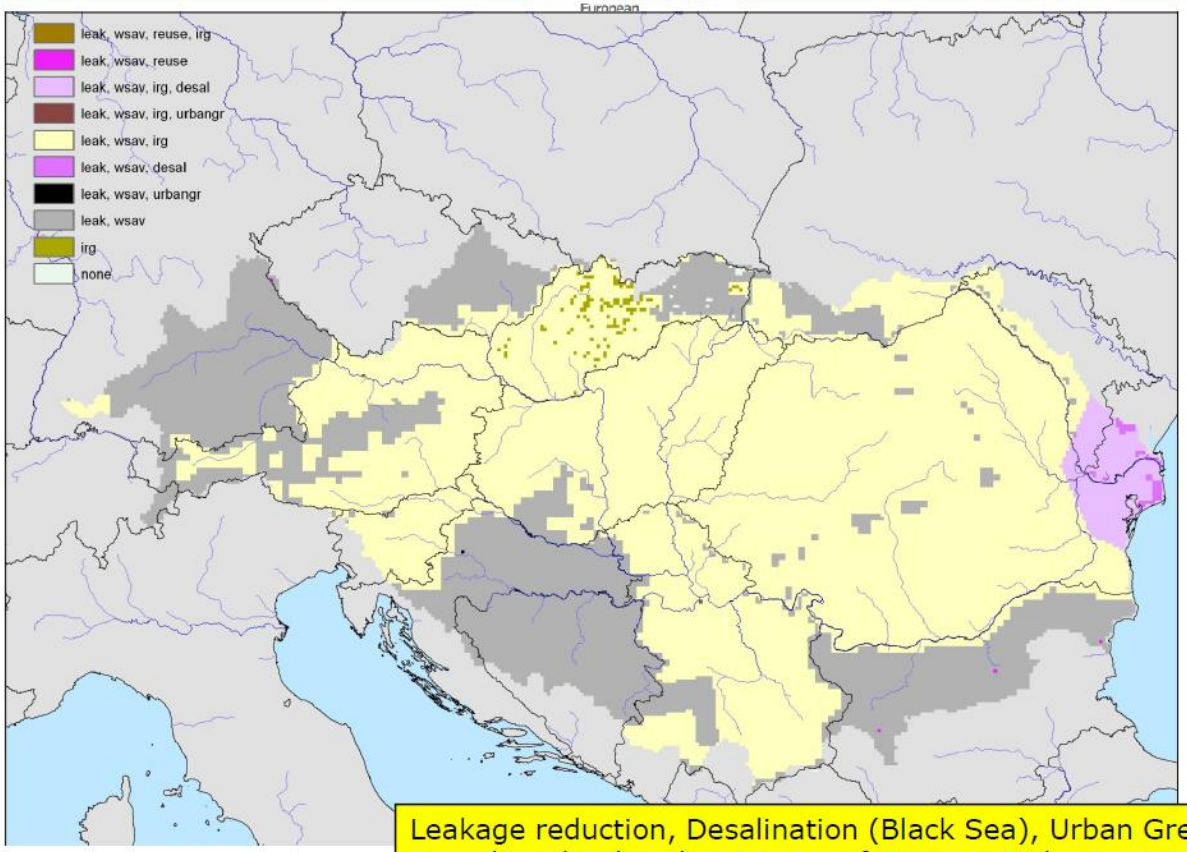
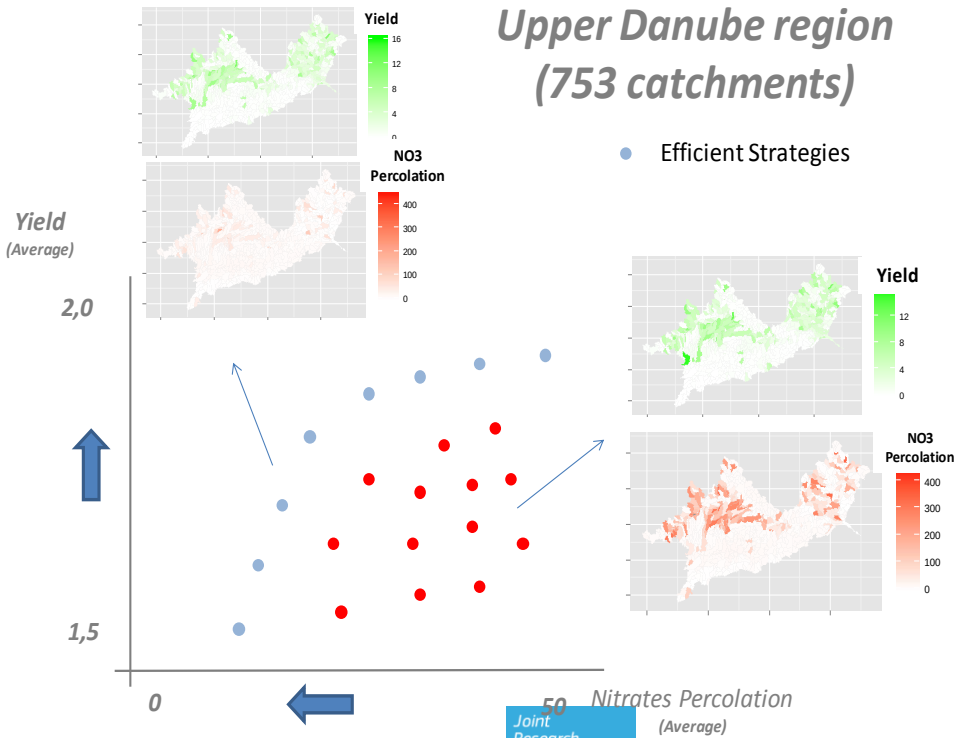
Danube: scenario-combination C47



Leakage reduction, Desalination (Black Sea), Urban Greening in Zagreb and Belgrade, Re-Use of Water in Industry in Bulgaria, irrigation water use efficiency, and water savings in households

Multi-criteria hydro-economic optimisation of water resources in Europe

Fertilizer optimization: SWAT model

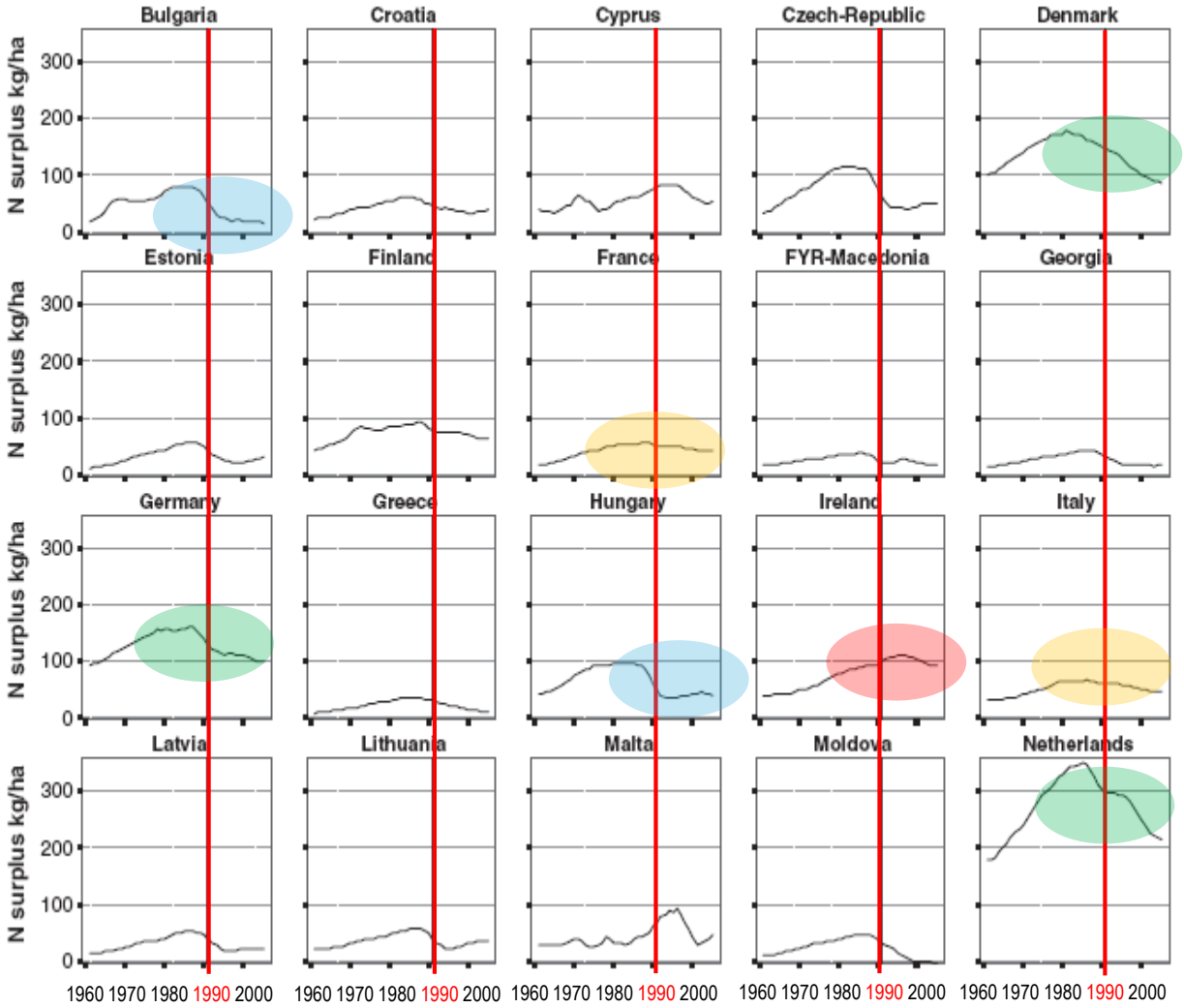


Environmental Directives

- The **Nitrates Directive (1991)**, to control nitrate pollution from agricultural activities (diffuse sources) (Directive 91/676/EEC)
- The **Urban Waste Water Treatment Directive (1991)**, to reduce pollution from waste water treatment plants (point sources) (Directive 91/271/EEC)
- The **Water Framework Directive (2000)**, with the aim of achieving good ecological and chemical status for all water bodies by 2015 by implementing Programmes of Measures included in River Basin Management Plans. (Directive 2000/60/EC)

→Policies good and effective?
→What about future scenarios?

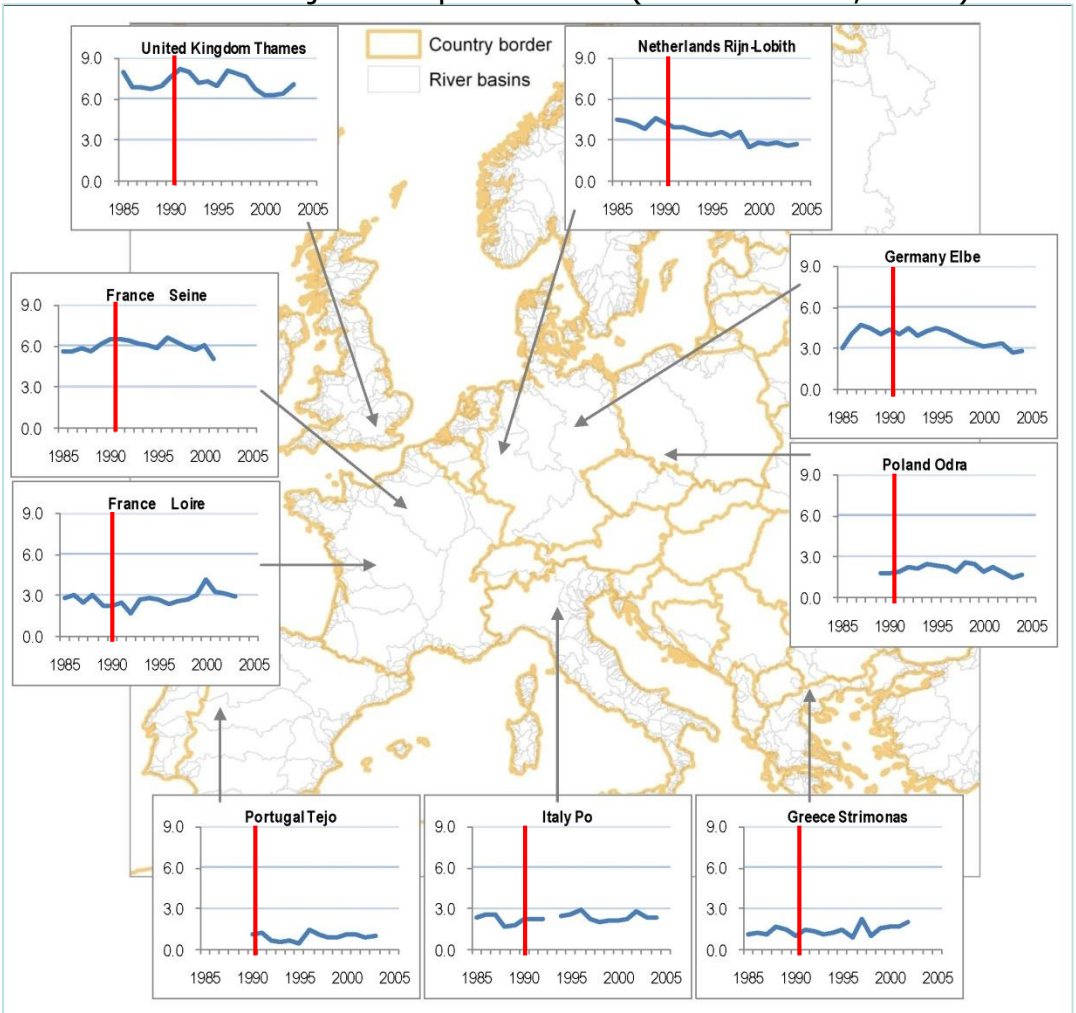
Nitrogen surplus



Bouraoui and Grizzetti, 2011. Science of the Total Environment

Nitrogen in rivers

Annual nitrate concentrations (in **mgN/L**) in surface water at the mouth of some major European rivers (source OECD, 2008)



- NO_3 concentrations in European rivers, lakes and coastal waters are high in many regions
- Groundwater NO_3 concentrations have remained stable and high in some regions
- Lag time of groundwater response to changes in fertiliser application

Grizzetti et al., 2011.
in The European Nitrogen Assessment

Bouraoui and Grizzetti, 2011.
Science of the Total Environment

Activities of the Water Resources Unit on nutrients in European waters

- identifying "**hot spots**", spatial **trends** and general **pathways** of nutrients (and pollutants) at the European scale

- estimating the **contribution of sources** (diffuse/punctual) to inland and coastal waters

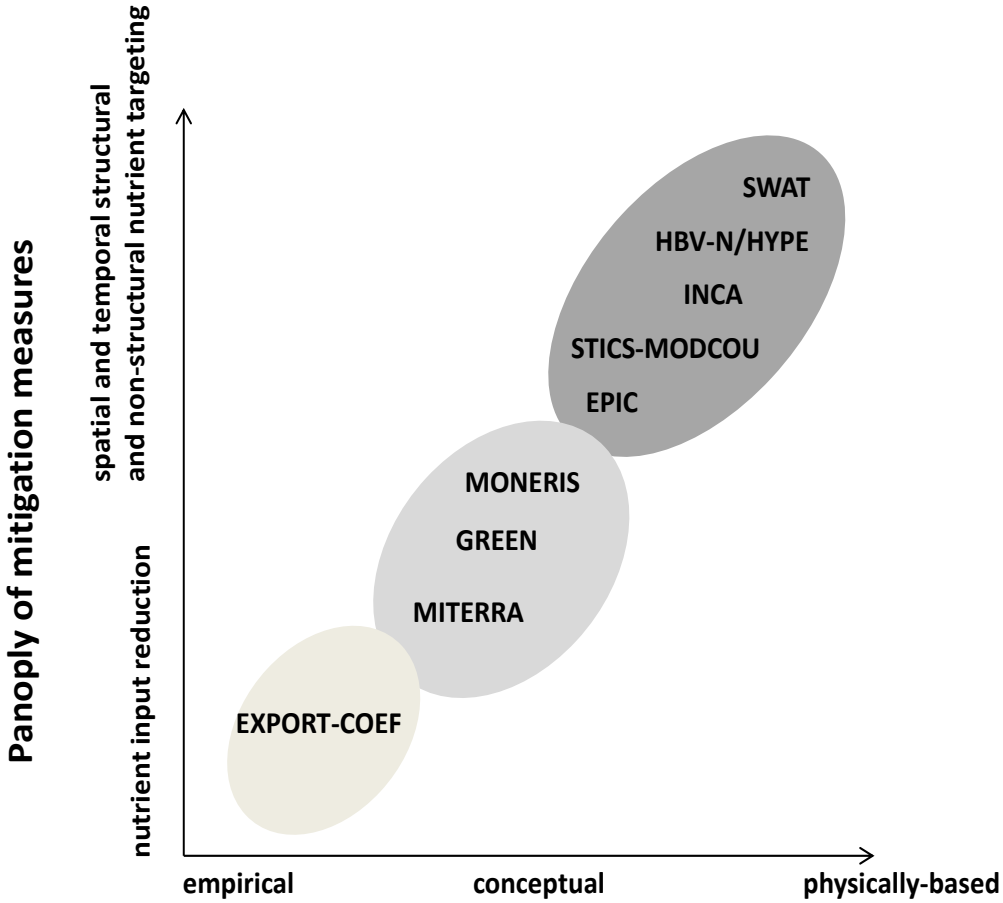
- evaluating the **impacts of management strategies** on water quality and the time needed to see improvement in water quality

→ modeling and data analysis

Modelling nutrient loads and fate

Modelling tools:

- GREEN-HYDRO model
  statistical approach
- EPIC model (1-D)
  physically-based approach
- SWAT model (3-D)
  physically-based approach



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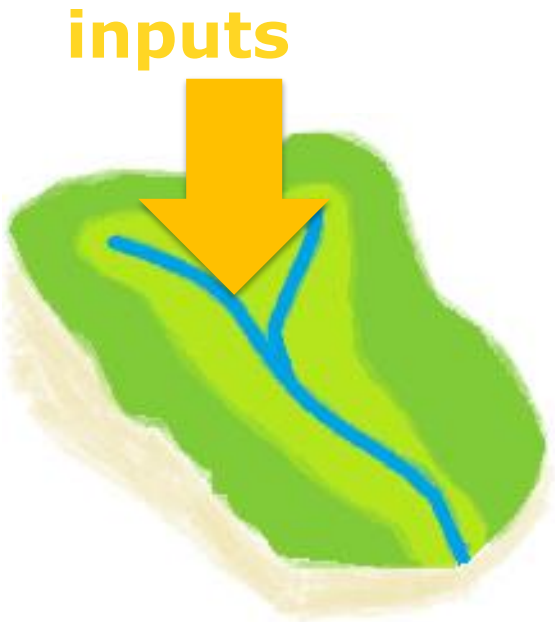
1. Nitrogen pressures

2. Nitrogen fate in river basins

3. Analysis of scenarios



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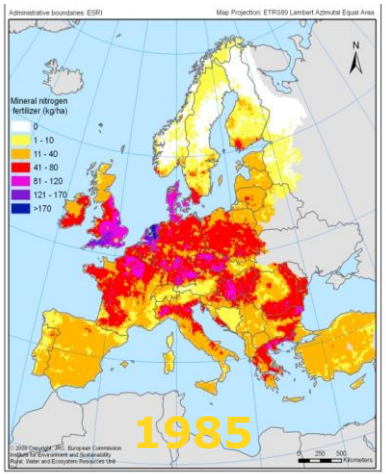
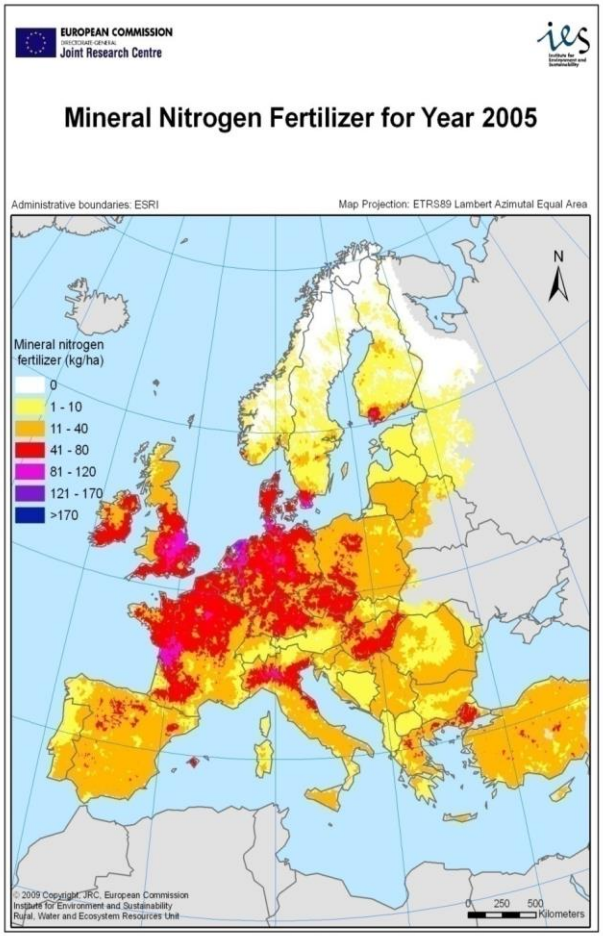
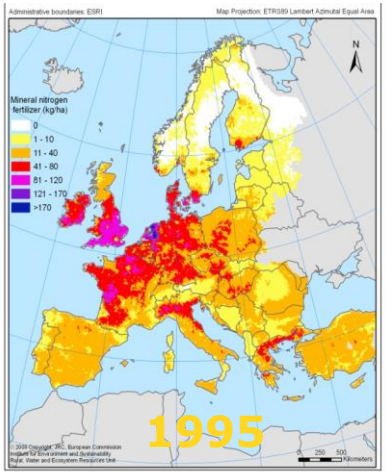
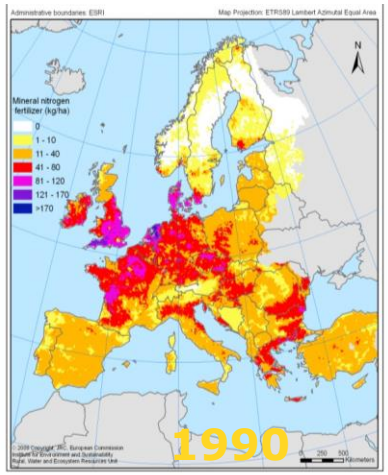
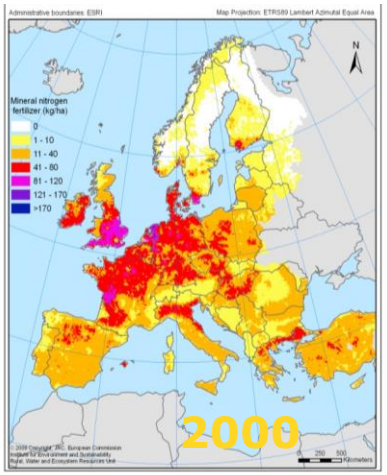
Mineral Nitrogen Application











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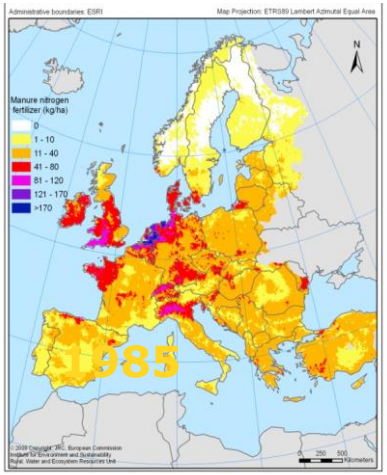
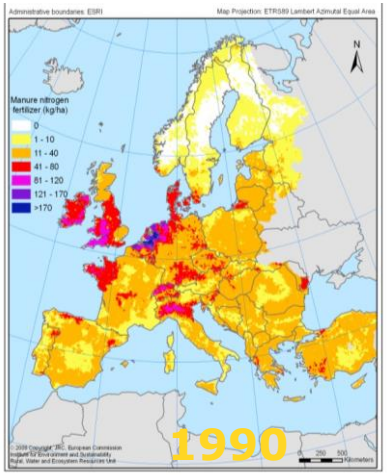
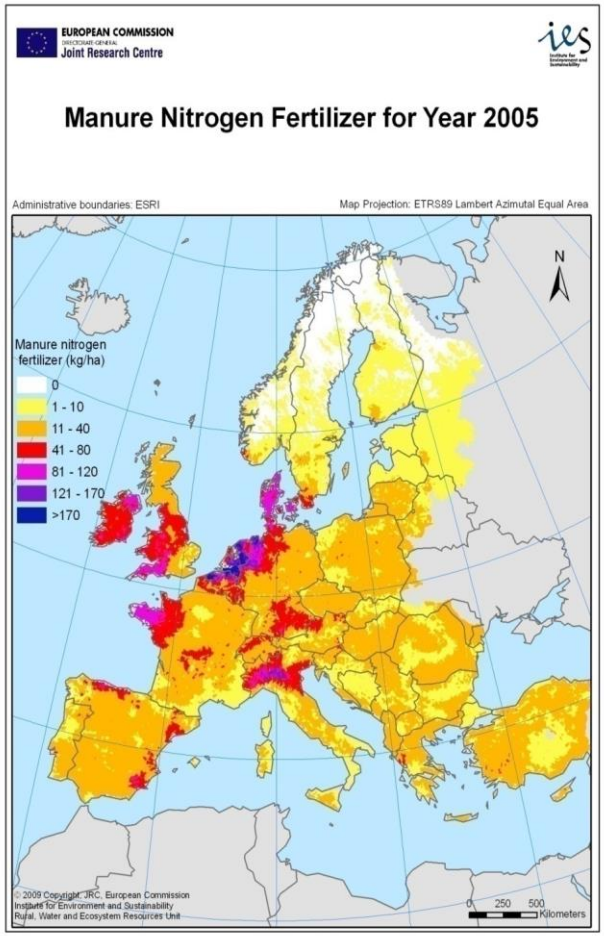
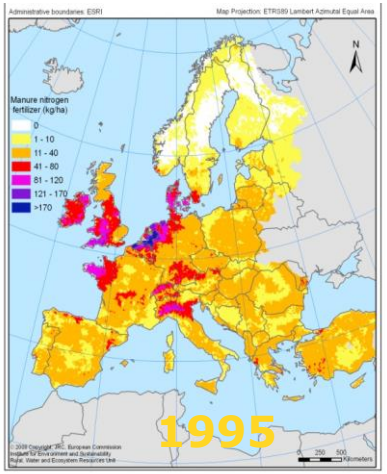
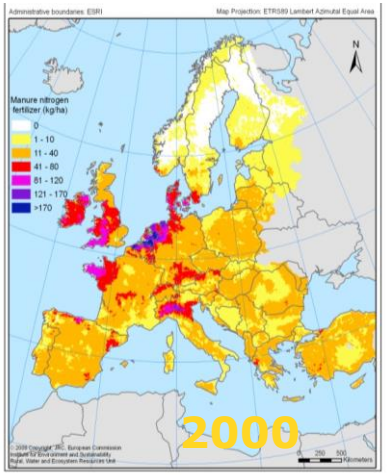
Manure Nitrogen Application











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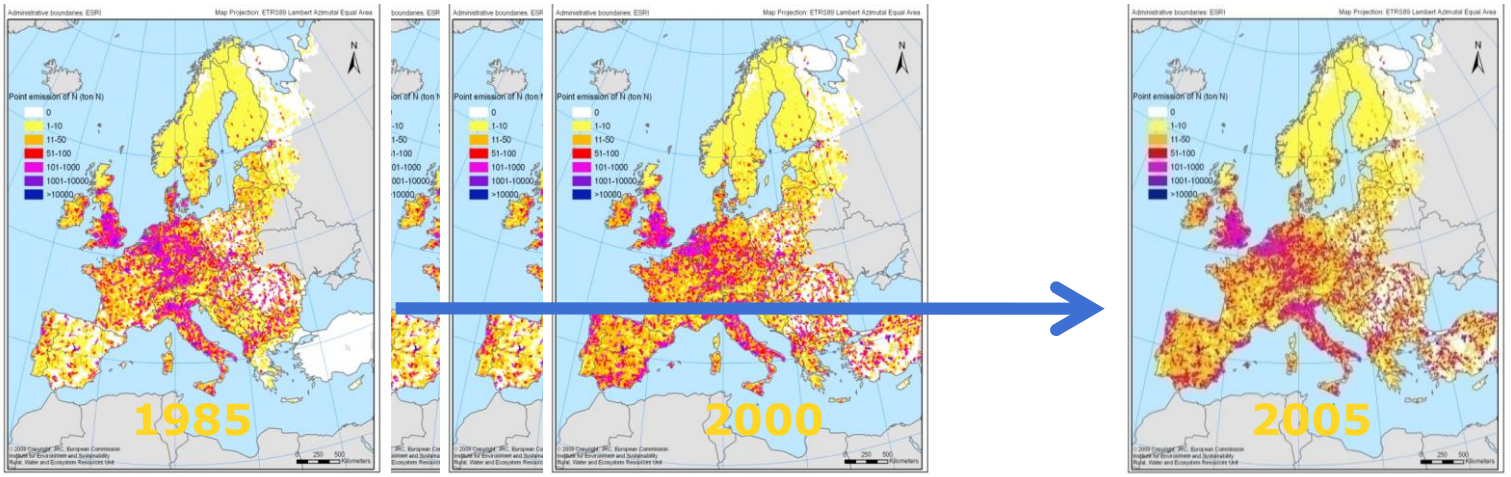
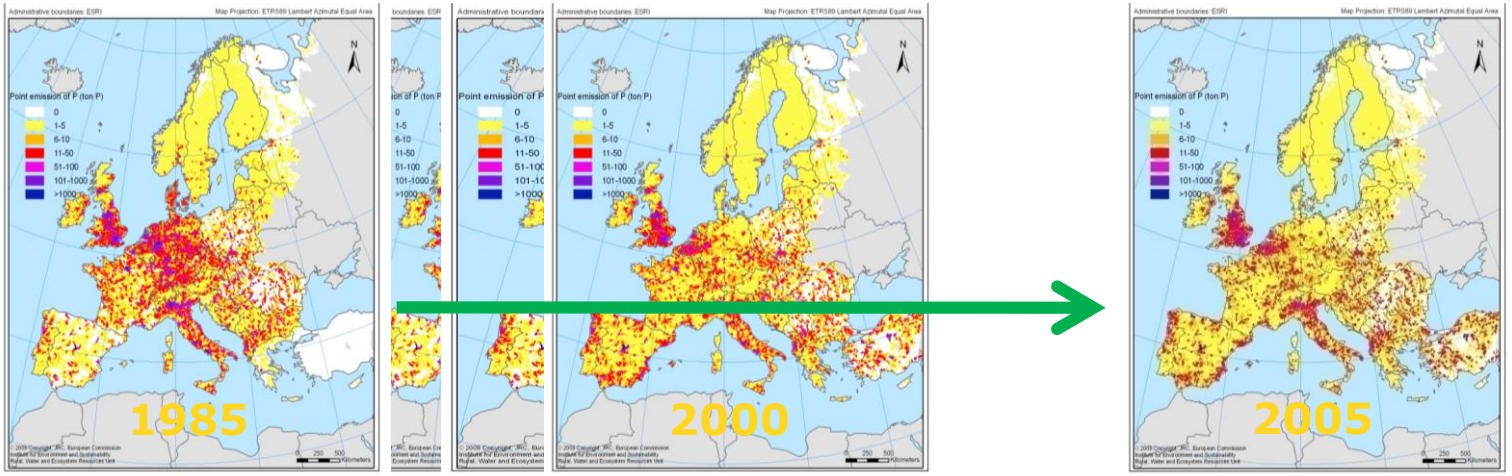
Nitrogen & Phosphorus Point Source Emissions



Nitrogen



Phosphorus

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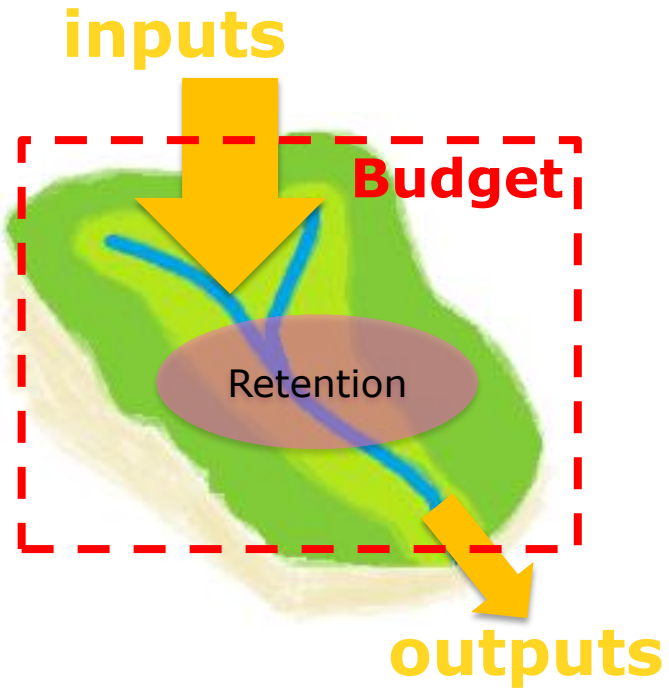

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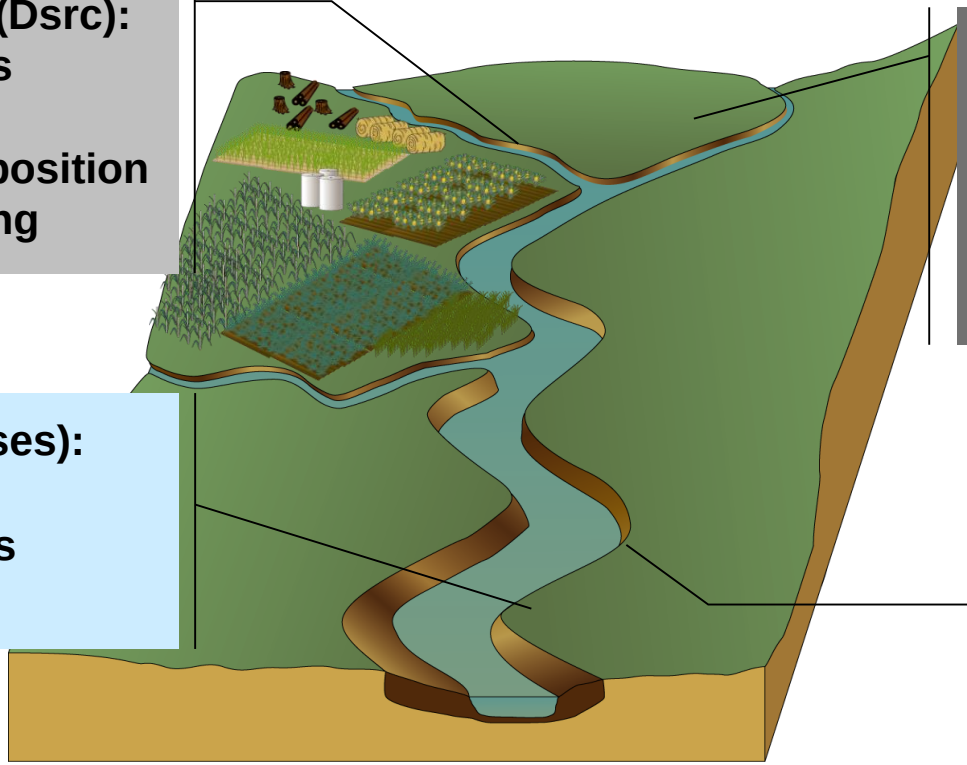
Model GREEN

Diffuse sources (Dsrc):
Mineral fertilizers
Animal manure
Atmospheric deposition
Scattered dwelling



R_{land} (Diffuse losses):
Crop uptake
Soil storage
Atmospheric losses

R_{riv} (in-stream losses):
plant growth
Atmospheric losses
Nutrient settling

Point sources (Psrc):
WW treatment plants
Industrial loads
Paved areas

- Conceptual statistical regression model
- Sub-catchments ~170 km2
- Annual nitrogen load
- Application at the European scale

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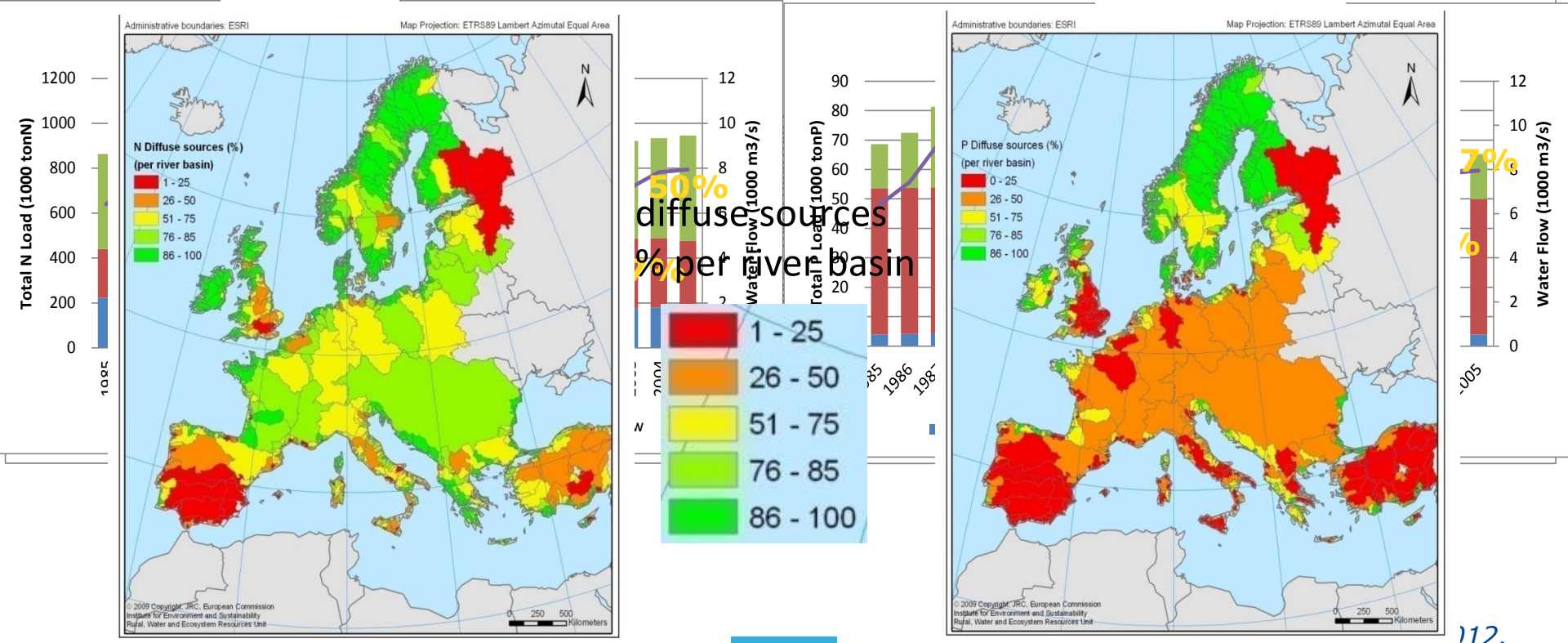
Nutrient export to European seas: source apportionment statistical model

Nitrogen

Phosphorous



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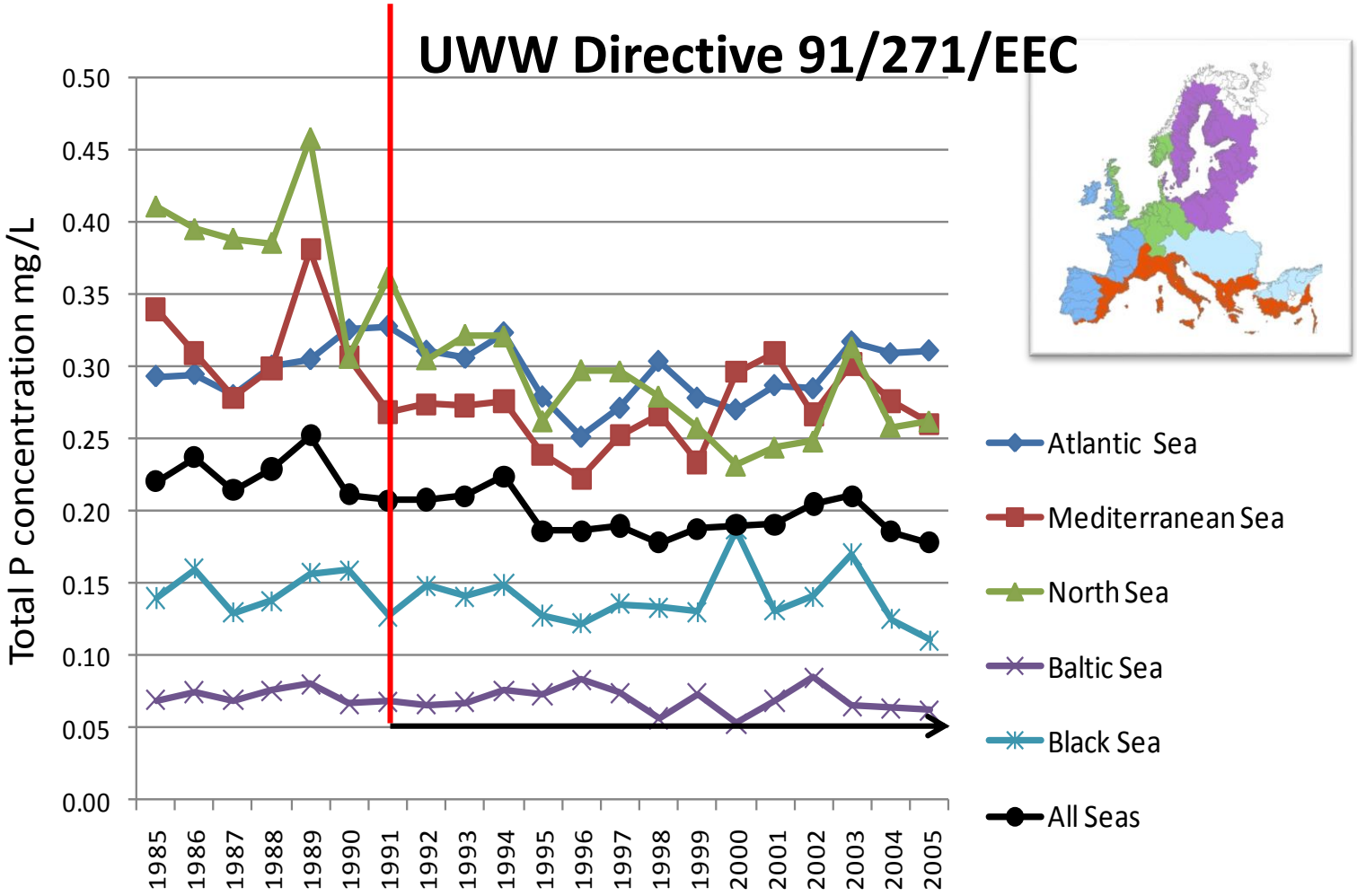
Global Change Biology

Retrospective analysis: (1985 – 2005)



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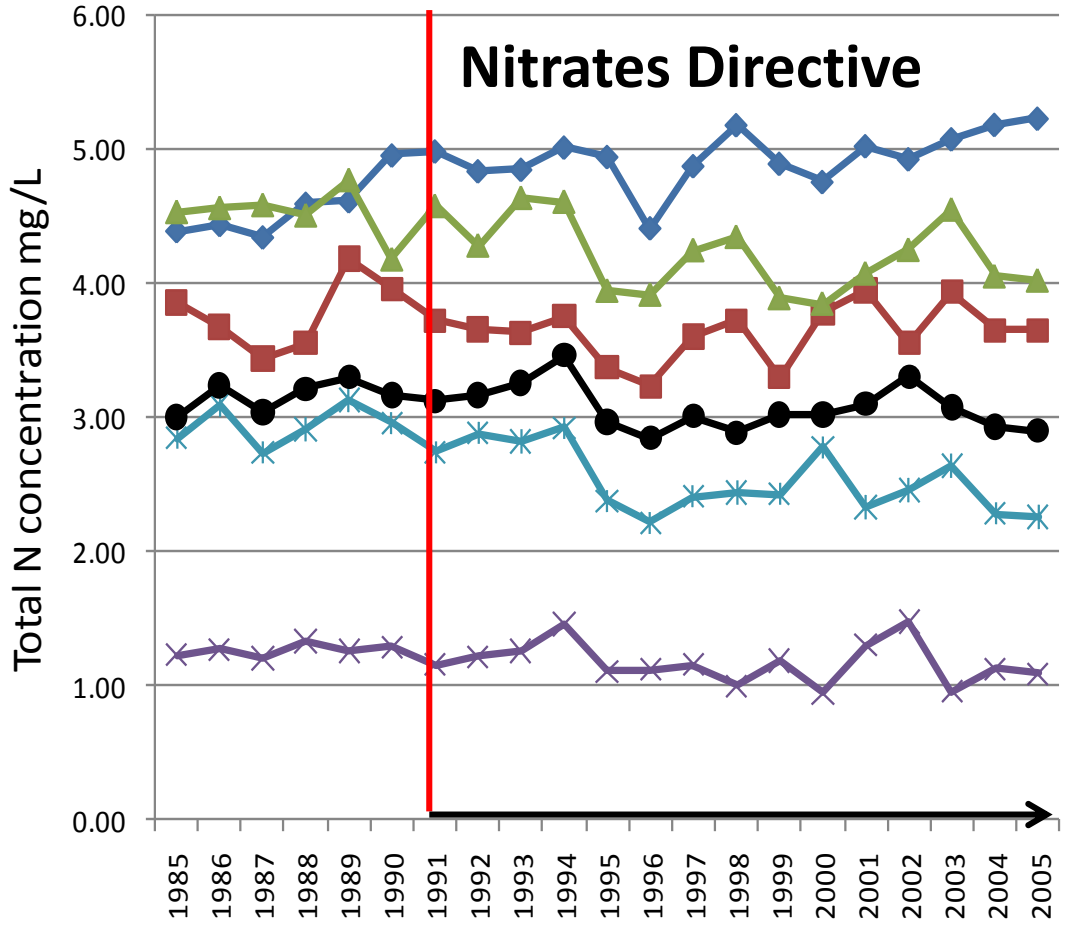

Persistence of N contamination under a overall decrease of N-surplus in EU.

Mostly explained by the delay response of groundwater.

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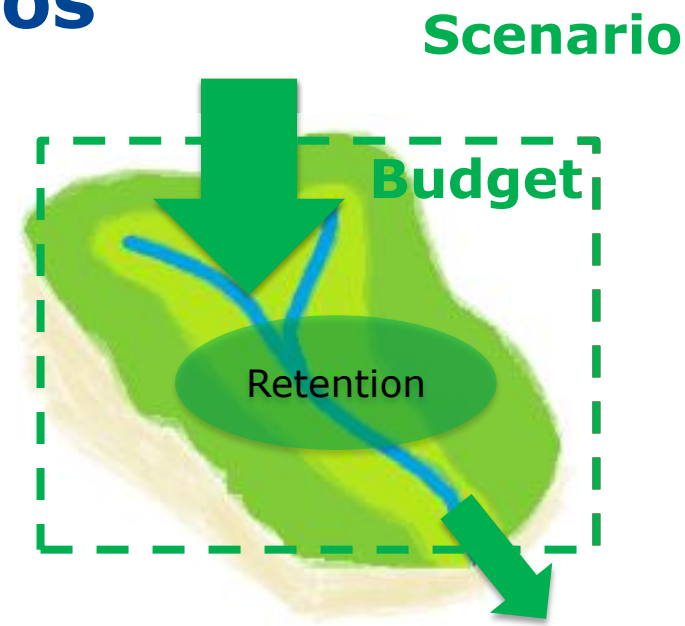

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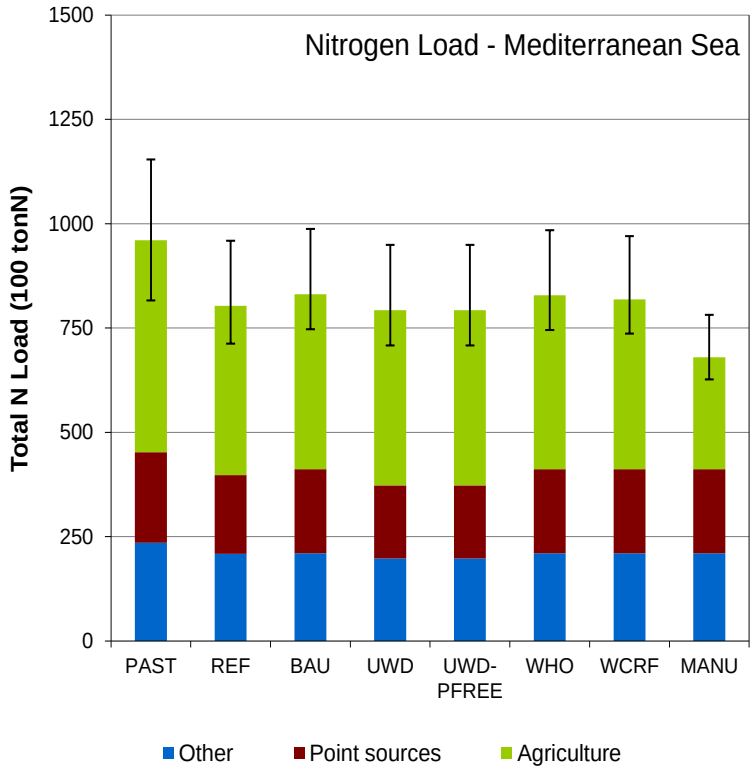
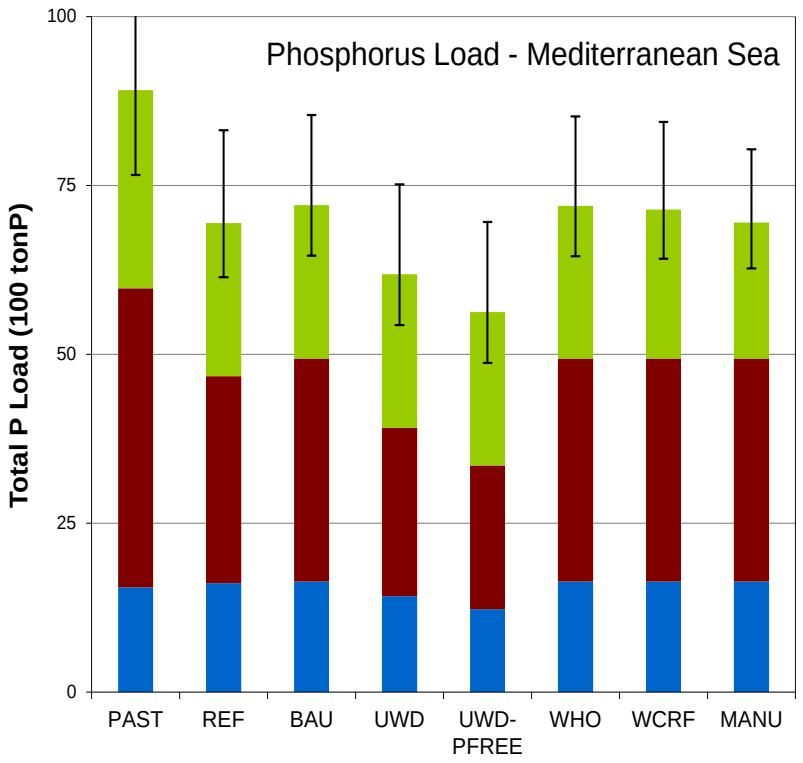
Scenario analysis: source apportionment statistical model





Bouraoui et al. (submitted)

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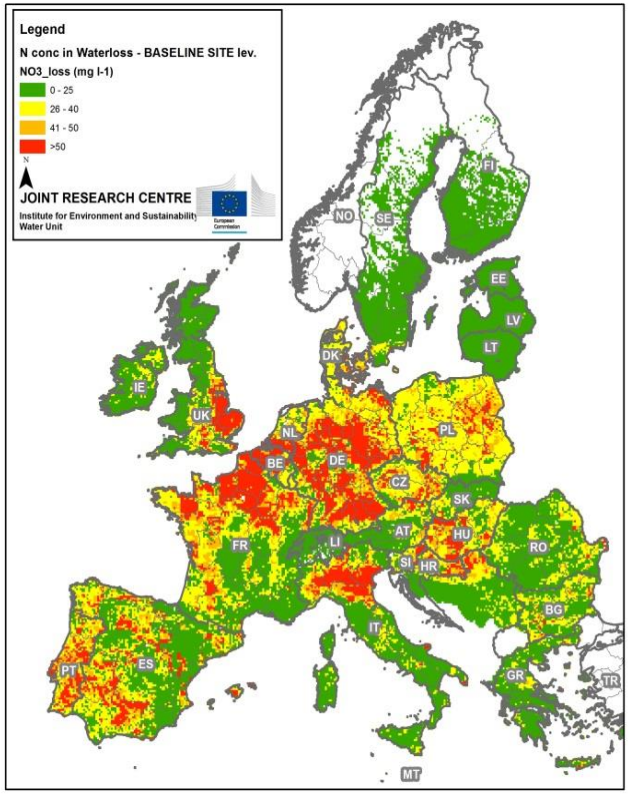
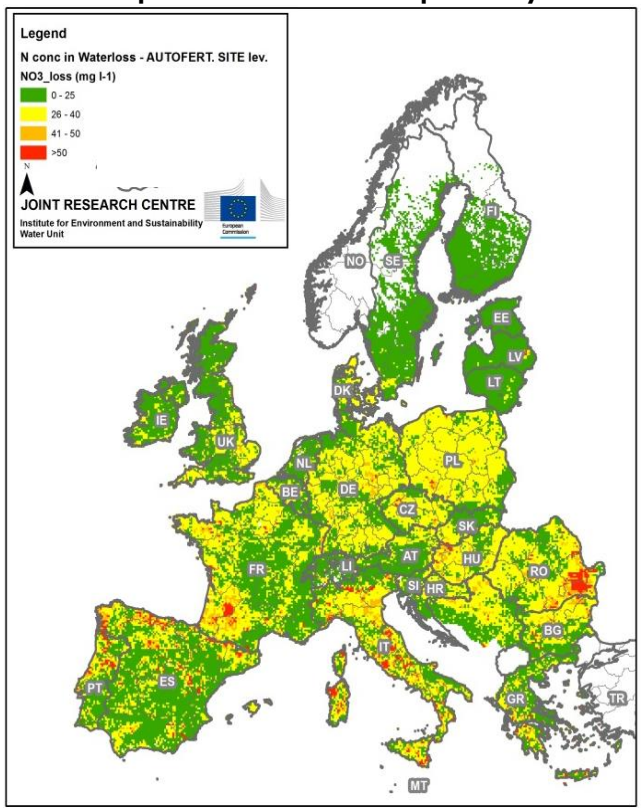
Scenario analysis: Physically based model

We can test sustainable and efficient management options to reduce nutrient loss to water, evaluate the impact of growing biofuel crops on water quality



Baseline scenario



Scenario efficient fertilisation

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Thank you for your attention!

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