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Joint Research Centre

European Commission

Colloque anniversaire du PIREN-Seine

Pressures, Ecological Status and Ecosystem Services in EU waters

Grizzetti B., Udias A., Vigiak O., Aloe A., Zanni M., Bouraoui F., Pistocchi A., Dorati C., De Roo A. (JRC)

11th December 2019, Sorbonne University, Paris

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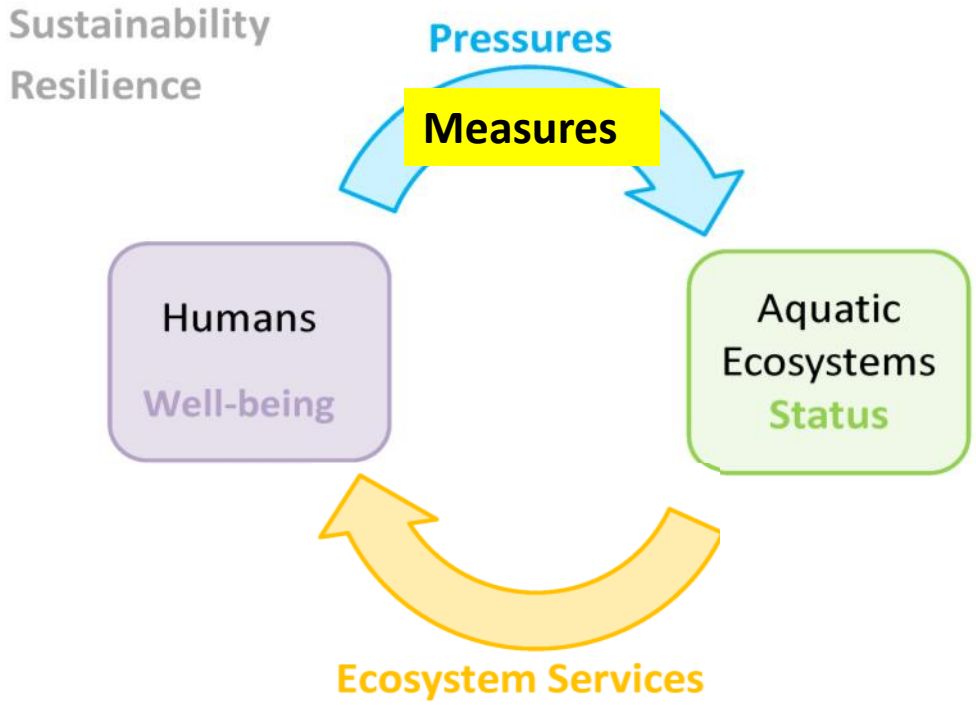
Content

1. Relationship between multiple **pressures** and ecological **status** in EU freshwaters

2. Link between ecological status and water **ecosystem services**

3. **Measures** to reduce nutrient pollution and water scarcity in EU freshwater and coastal waters (**scenarios analysis**)



Objective

Evaluate the effectiveness of the EU water policies at the European scale.

Provide independent scientific support to EU policy:

- Water Framework Directive → River Basin Management Plans, including Programme of Measures, first cycle (2009-2015), second cycle (2015-2021), third cycle (2021-2027)
- Urban Waste Water Directive
- Nitrates Directive

Mission of the Joint Research Centre**: The Joint Research Centre is the Commission's science and knowledge service. The JRC employs scientists to carry out research in order to **provide independent scientific advice and support to EU policy

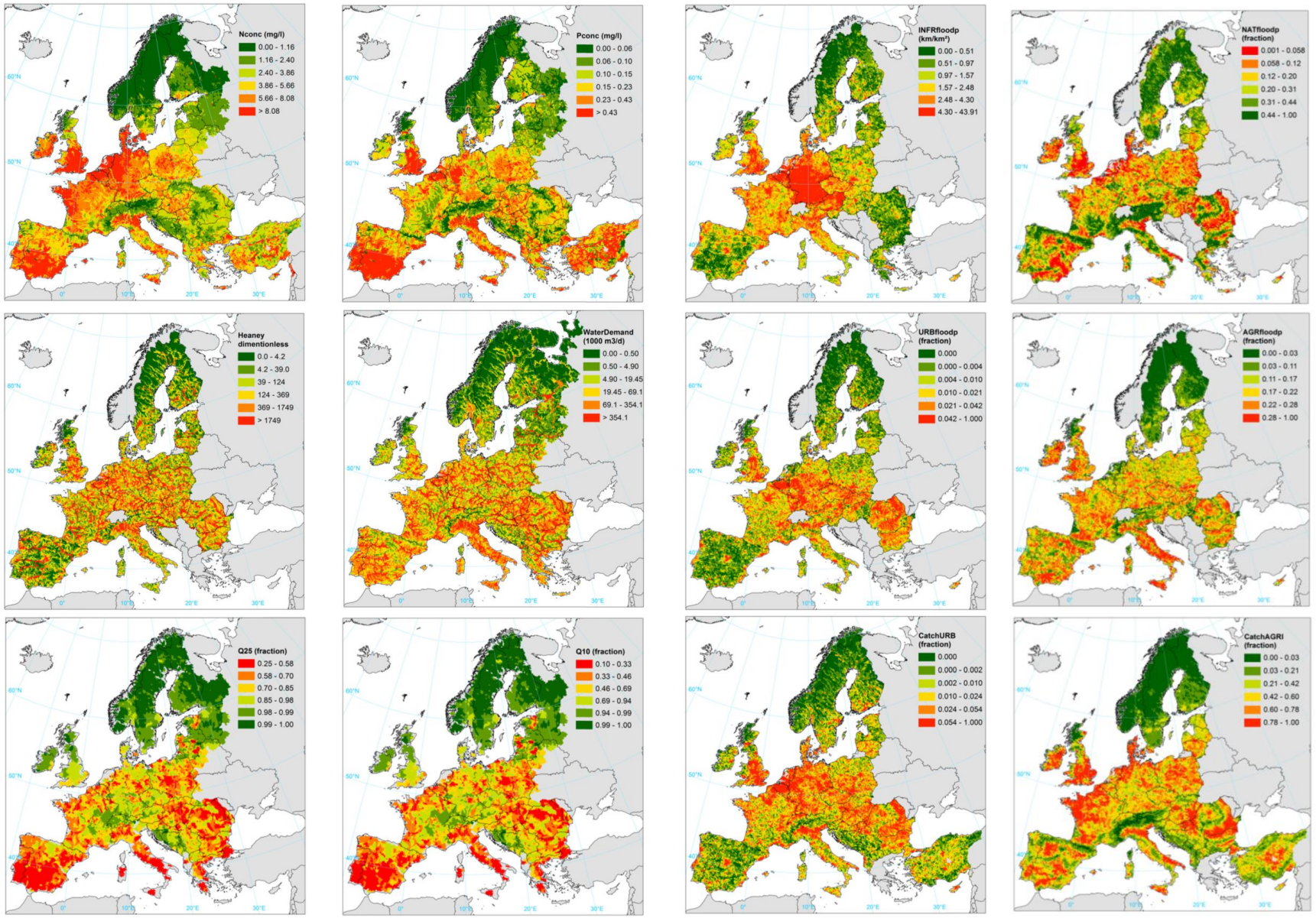
1. Multiple Pressures and Ecological Status

Assessment of pressures

Pressure	Proposed Indicator	Acronym
Pollution	Nitrogen concentrations in rivers	Nconc
	Phosphorus concentrations in rivers	Pconc
	Diffuse pollution from urban runoff	Heaney
Hydrological alterations	Total water abstractions	WatDemand
	Flow alteration (25%ile)	Q25
	Flow alteration (10%ile)	Q10
Hydromorphological alterations	Density of infrastructures in floodplains	INFRfloodp
	Ratio of riparian vegetation width on floodplain width	NATfloodp
	Artificial Land cover in floodplains	URBfloodp
	Agricultural Land cover in floodplains	AGRfloodp
Integrated	Artificial Land cover in catchment area	catchURB
	Agricultural Land cover in catchment area	catchAGRI

Grizzetti et al, 2017 Scientific Reports

Assessment of pressures



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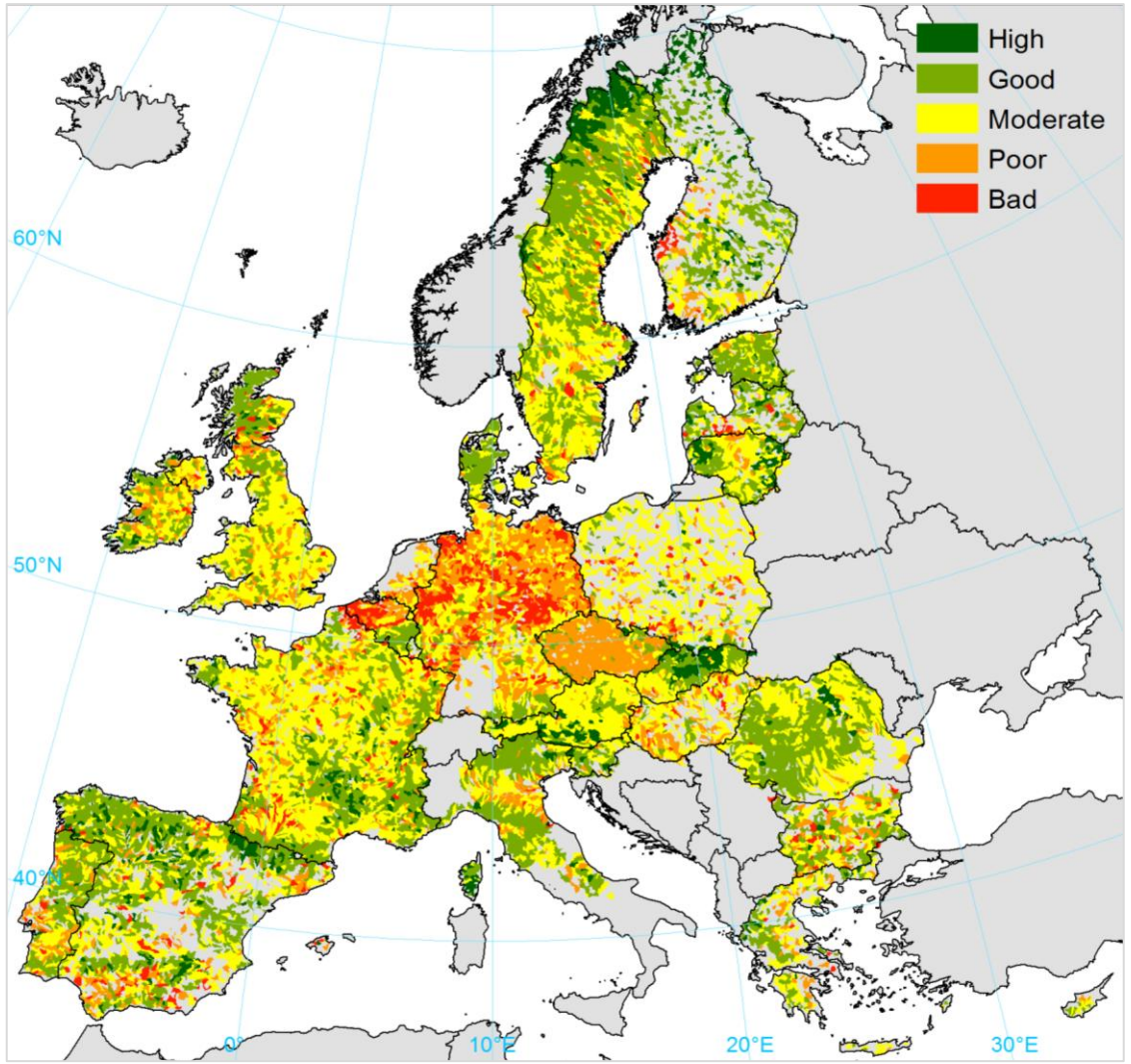
Proxy of Ecological Status of rivers



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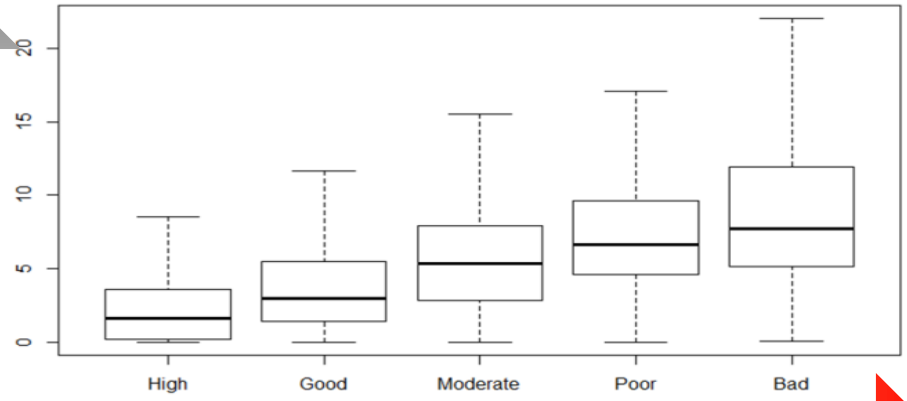
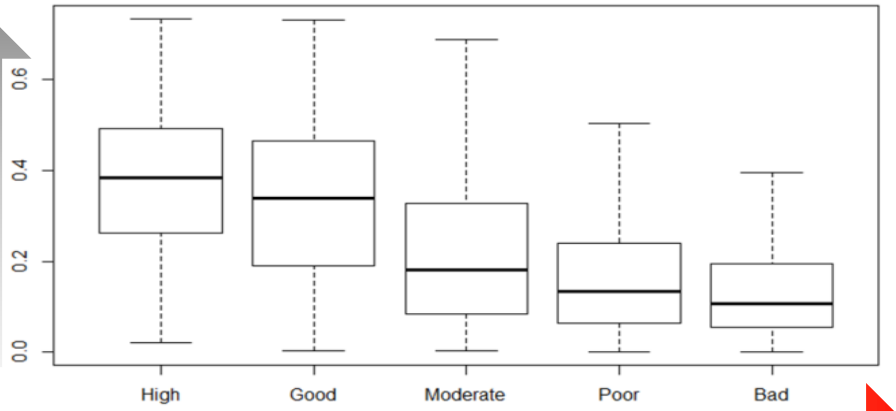
Relationship between single pressures & Ecological Status of rivers

Nitrogen concentration



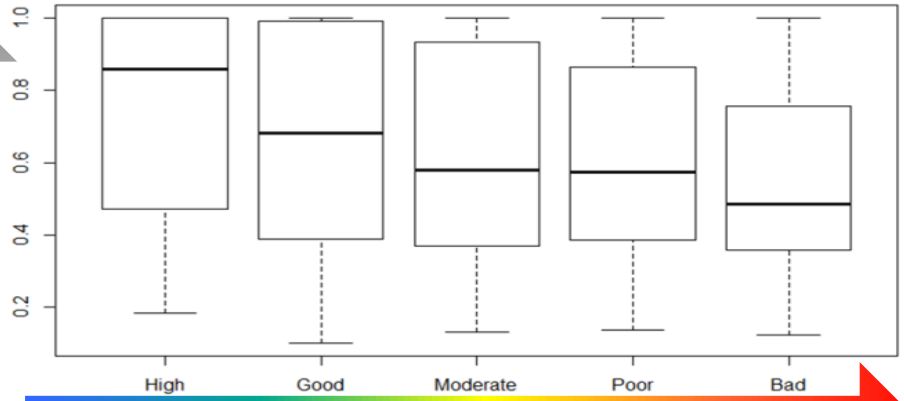
Ecosystem degradation

Fraction natural areas in floodplain



Ecosystem degradation

Naturalness of (low 10%) water flow



Ecosystem degradation

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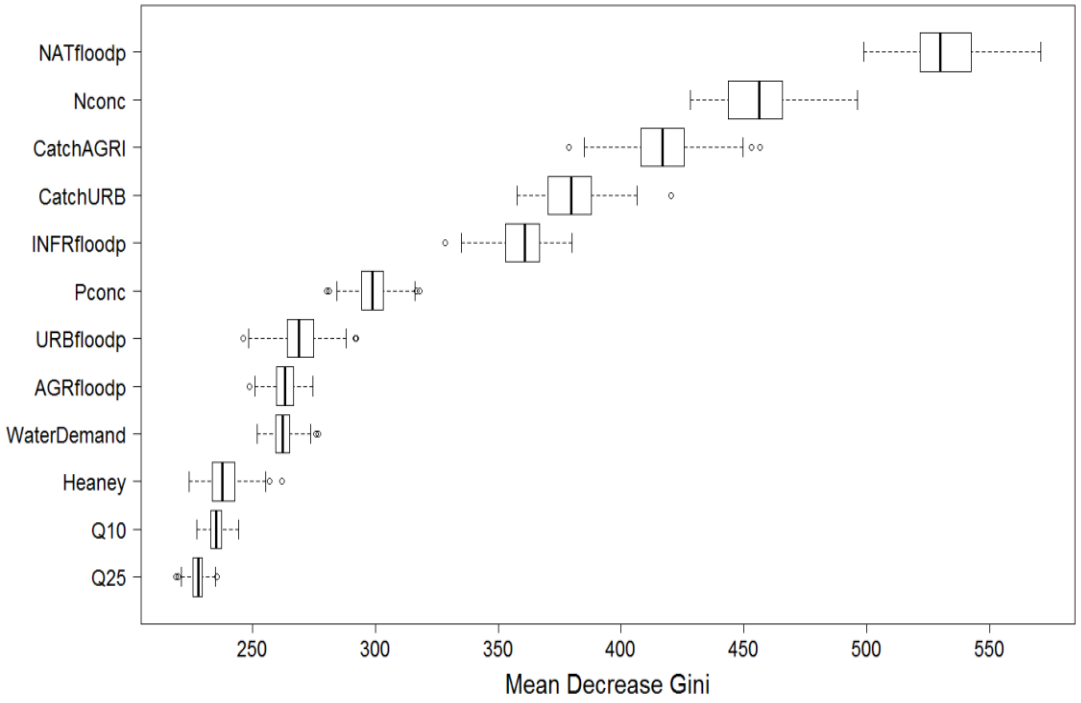
Relationship between multiple pressures & Ecological Status of rivers



The good ecological status of rivers is explained by a combination of pressures. The most important predictors are:

- the presence of **natural areas in floodplains**
- **nutrient concentration** (especially nitrogen)
- **infrastructures in floodplains**
- **urbanisation and agriculture** in the drained catchment

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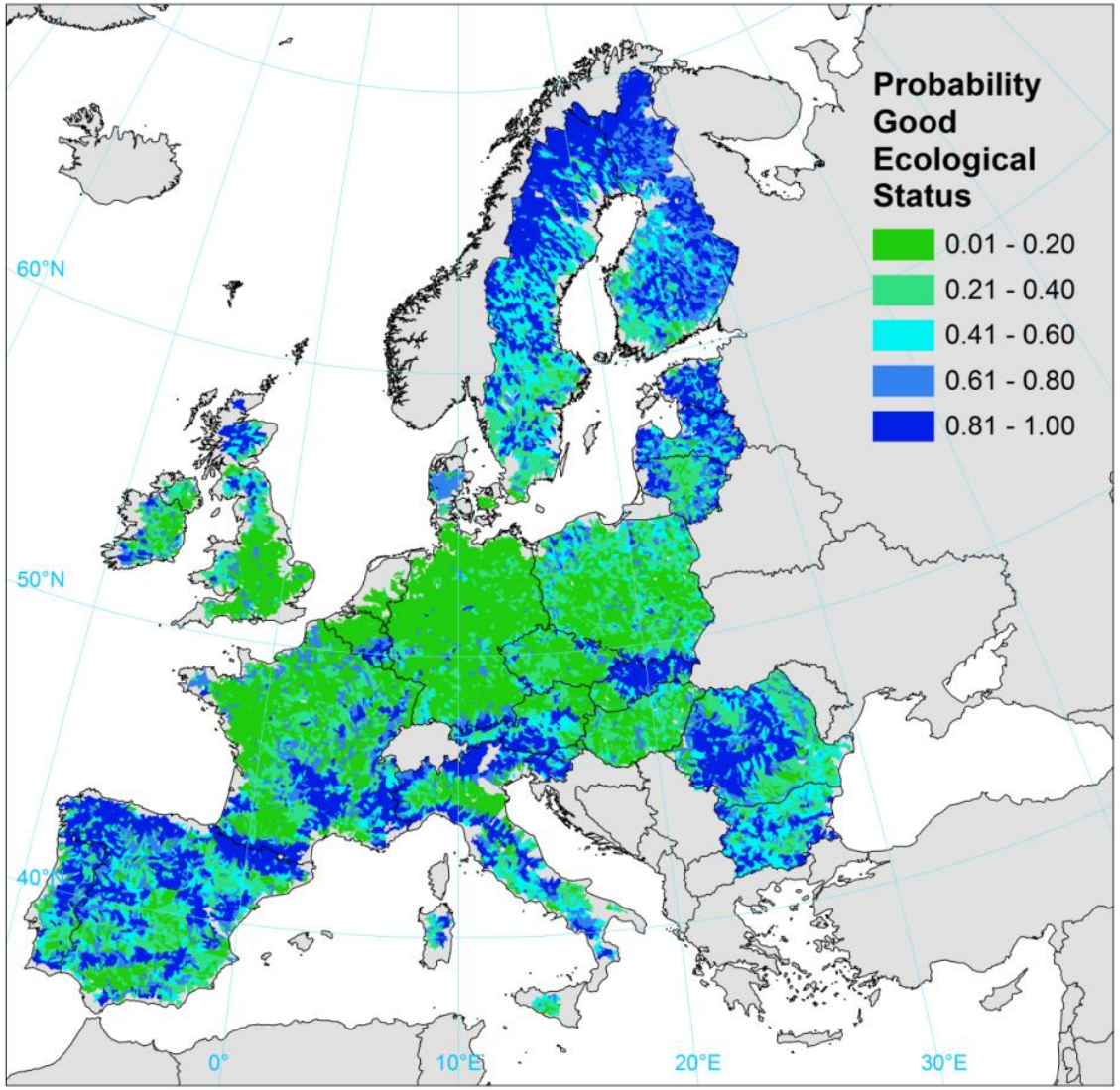
Probability of good ecological status in European rivers, based on multiple pressures



- The proportion of the **EU surface where rivers meet the water policy target** of good ecological status, with a probability of at least 70%, is **32%**

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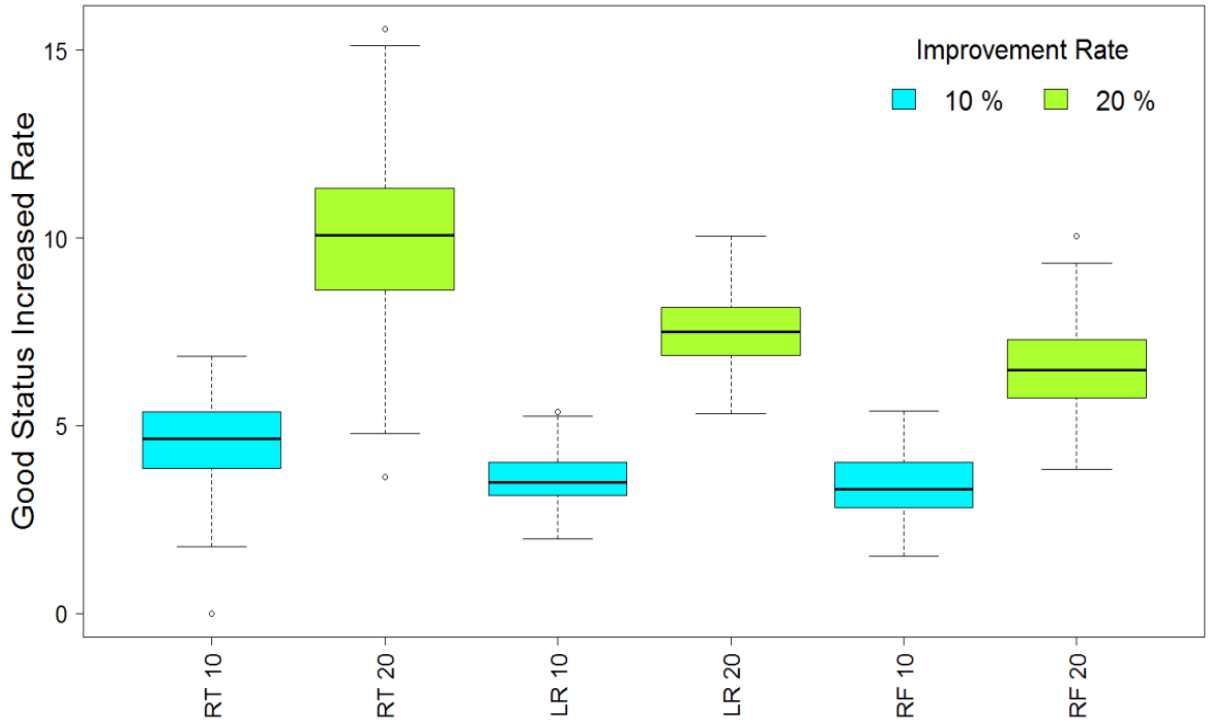
Effects of scenarios of improvements of pressures



- The predicted increase in good ecological status by simultaneously reducing nitrogen concentration in rivers and enhancing natural areas in floodplains is slightly higher than the sum of the predicted increase by changing the two pressures independently, showing a **synergistic effect**

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2. Ecosystem Condition and Ecosystem Services

Mapping and assessment of ecosystem services of rivers, lakes and coastal waters

Table 2
Proxies/indicators to quantify ecosystem services at the European scale adopted in this study.

Ecosystem services	Natural capacity	Service flow	Sustainability or efficiency
Water provisioning (for drinking and non-drinking)	• Total renewable water	• Water demand	• Water Exploitation Index (sustainability)
Water purification	• Natural areas in floodplains	• Nitrogen retention	• Ratio of nitrogen retained vs. total input to water body (efficiency)
Erosion prevention	• Density of vegetated riparian land	• Sediment retention in riparian land	• Ratio sediment retention in riparian land vs. total input to water body (efficiency)
Flood protection	• Natural areas in floodplains	• Water volume retained for a flood with 200 years return time	
Coastal protection	• Protection capacity of natural systems	• Protection supply	
Recreation and tourism	• Recreation potential	• Recreation opportunity spectrum	

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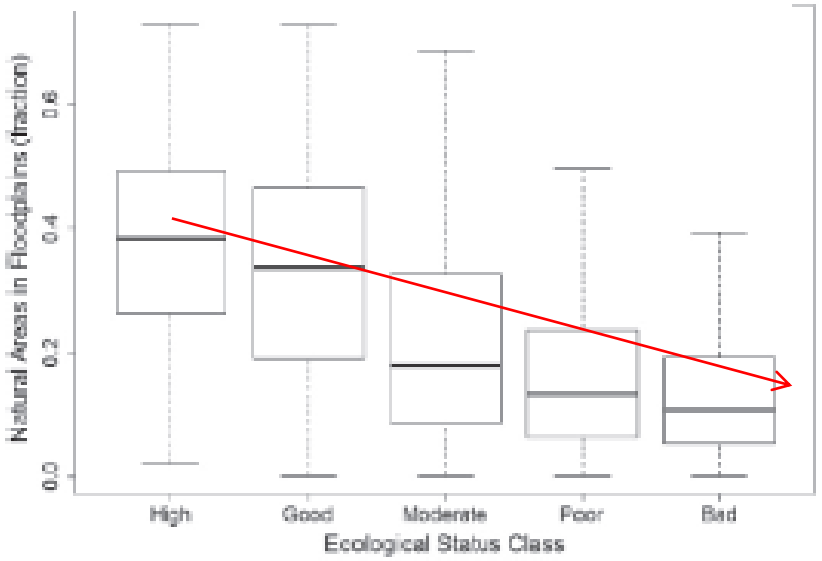
Relationship between ecosystem services and conditions (ecological status)

d. Water purification - Natural capacity

(Kruskal-Wallis test p<0.05; Jonckheere-Terpstra test *decreasing* p<0.05)

Natural areas in floodplains

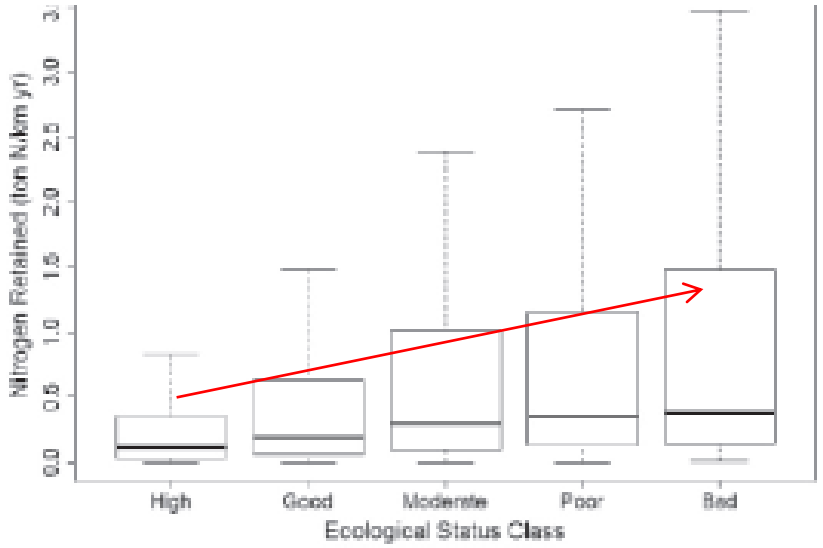


(Ecological Status of rivers)

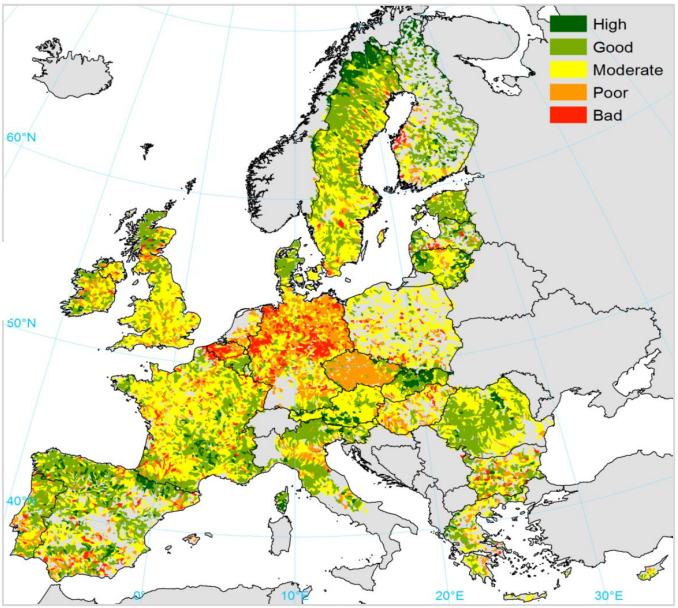
e. Water purification - Service flow

(Kruskal-Wallis test p<0.05; Jonckheere-Terpstra test *increasing* p<0.05)

Nitrogen retention in rivers



(Ecological Status of rivers)



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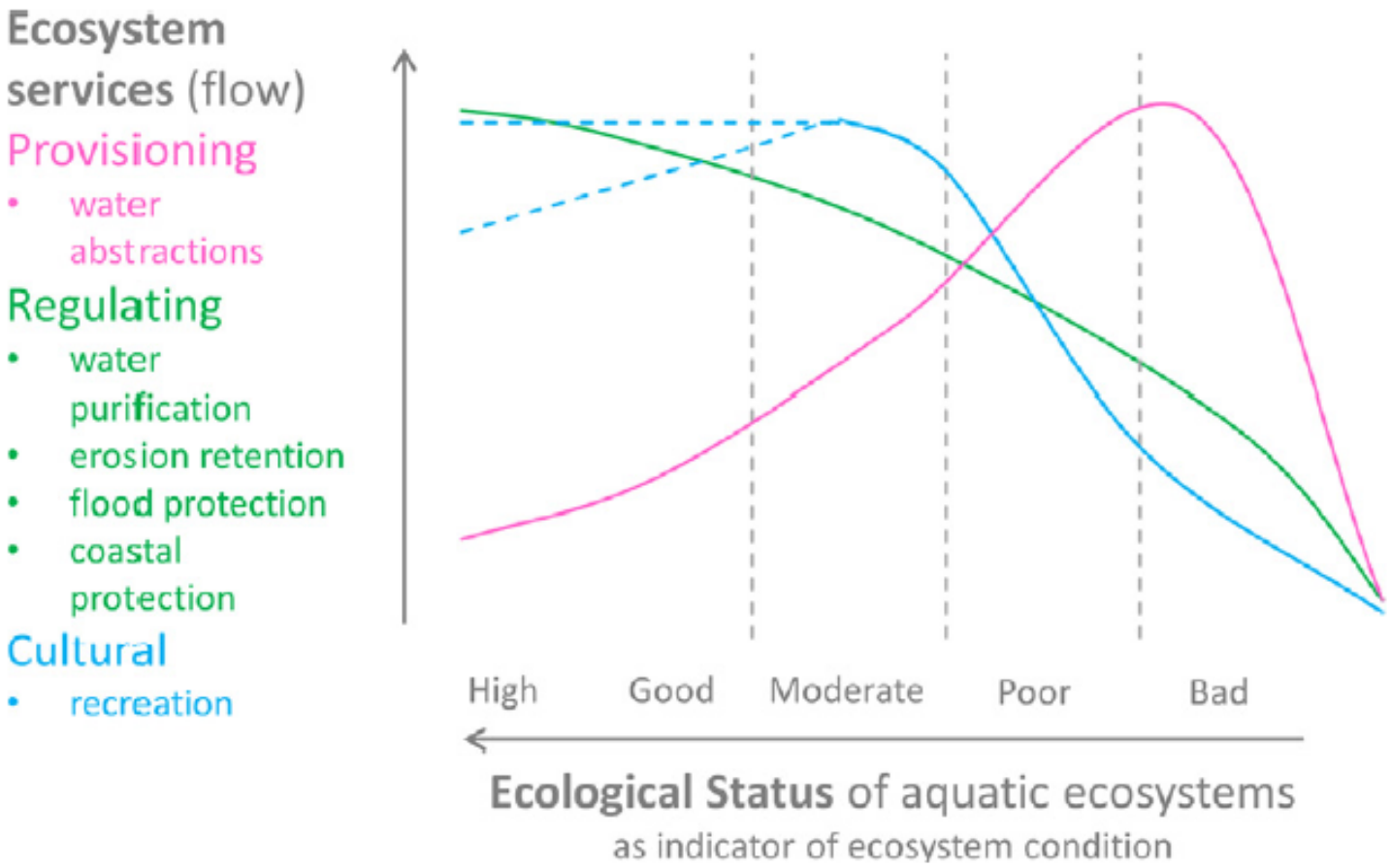
Key messages



- Higher ecosystem service delivery is mostly correlated to better ecological status
- Relevance of protecting and restoring aquatic ecosystems

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3. Measures to reduce nutrient pollution (scenarios analysis)

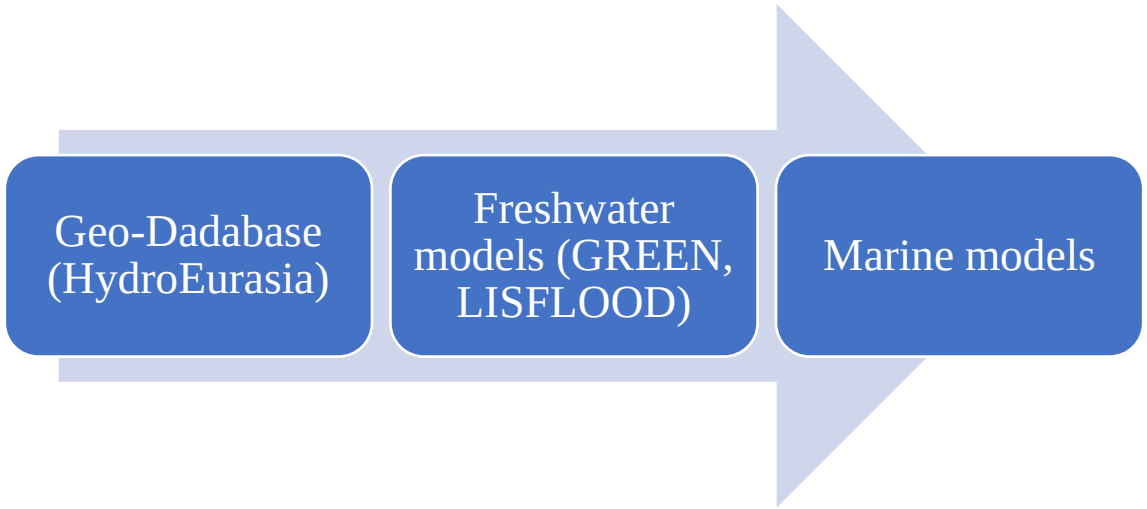
Aim

- Quantify **nutrients loads** and concentrations to freshwater and coastal waters
- Identify the **major sources** (point and diffuse) of nutrient pollution and their location
- Evaluate the **effectiveness of measures** to reduce nutrients pollution from different sources
- Assess the impact of **policy scenarios** on nutrient water quality

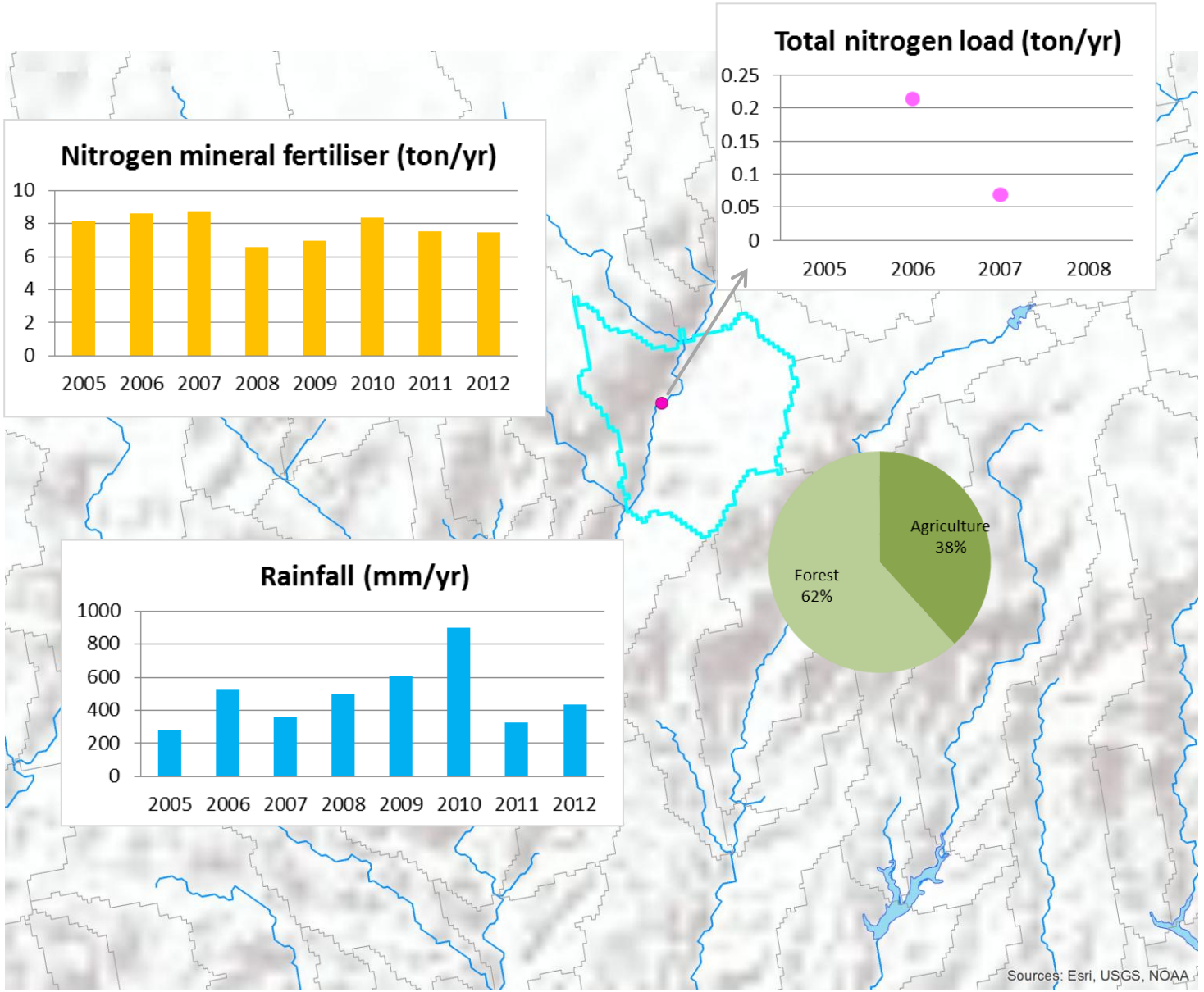
Structure

Simulations (GREEN model, LISFLOOD model):

- Current conditions (REF)
- Business as Usual (BAU)
- Enhanced reduction of nutrients (NUTR)
- High Technical Feasibility Reduction (MTFR)

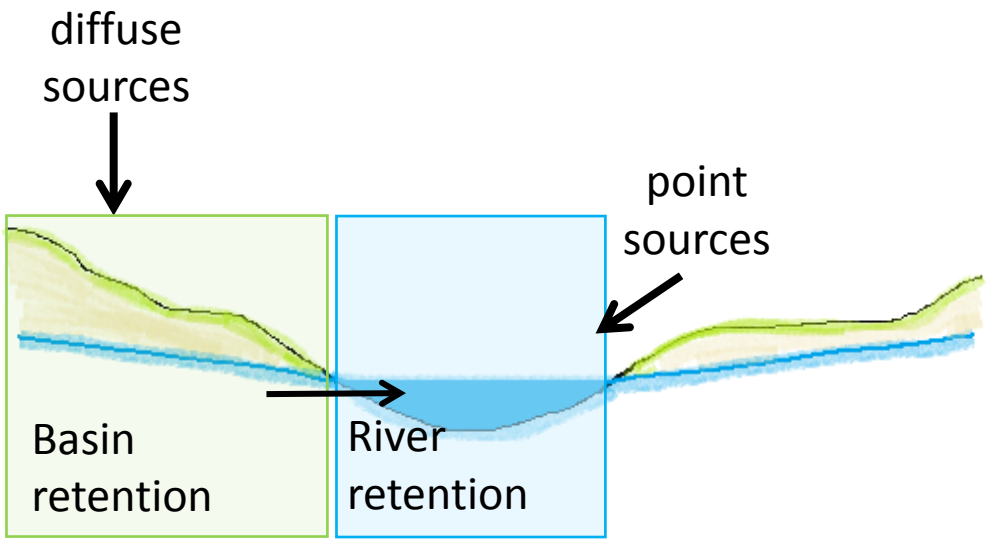


Geo-database



	GREEN v2.1
Geo-database	**HydroEurasiaV1** Average catchment size 7 km2. High spatial resolution of rivers (CCM) and lakes (Ecrin) delineation
Water quality	2005-2012 Measurements of nutrient concentrations reported by Member States to EEA (WaterBase v14) (inconsistency) Annual water flow from the model Lisflood
Diffuse sources	Land use and fertiliser maps developed based on Corine land cover (location agricultural area) and CAPRI model (fertiliser input, utilised agricultural area) for 2005-2012
Point sources	Point sources reported by EU Member States under the UWWT Directive and E-PRTR. Outside EU28 and Norway values are estimated based on population, level of collection and treatment by country reported in EUROSTAT and other sources

GREEN model



- Conceptual statistical regression model
- Sub-catchments (7 km^2 average size)
- Annual nitrogen (N) and phosphorus (P) load
- Application at the European scale
- Represent basic measures of nutrient reduction form point and diffuse sources

GREEN model inputs & links to other models

Inputs per catchment:

Climate
- Precipitations

Hydrology
- Stream network & catchments (CCM2, HydroEurasiaV1)
- Lakes (Ecrins)
- Discharge (from LISFLOOD)

Land use
- Corine Land Cover (2006-2012)

Anthropogenic pressures
- Mineral and manure fertilisers applications and nitrogen crop fixation (CAPRI model spatialised using CLC)
- N atmospheric deposition (EMEP model). P background losses estimated
- Discharges from domestic sources (UWWTD database combined with JRC gap filling). Discharges from industrial plants (E-PRTR)
- Water consumption for irrigation (from LISFLOOD)

GREEN model parameters are calibrated using observed data of nitrogen and phosphorus concentrations in surface waters (from EEA WaterBase)

GREEN model

Outputs per catchment and at the sea outlets:

- N and P loads (ton/y)
- N and P sources contribution to load (%)
- N and P budget per river basin (kg/ha)
- N and P concentrations estimated combining nutrient loads and the water flow from LISFLOOD model (mg/l)

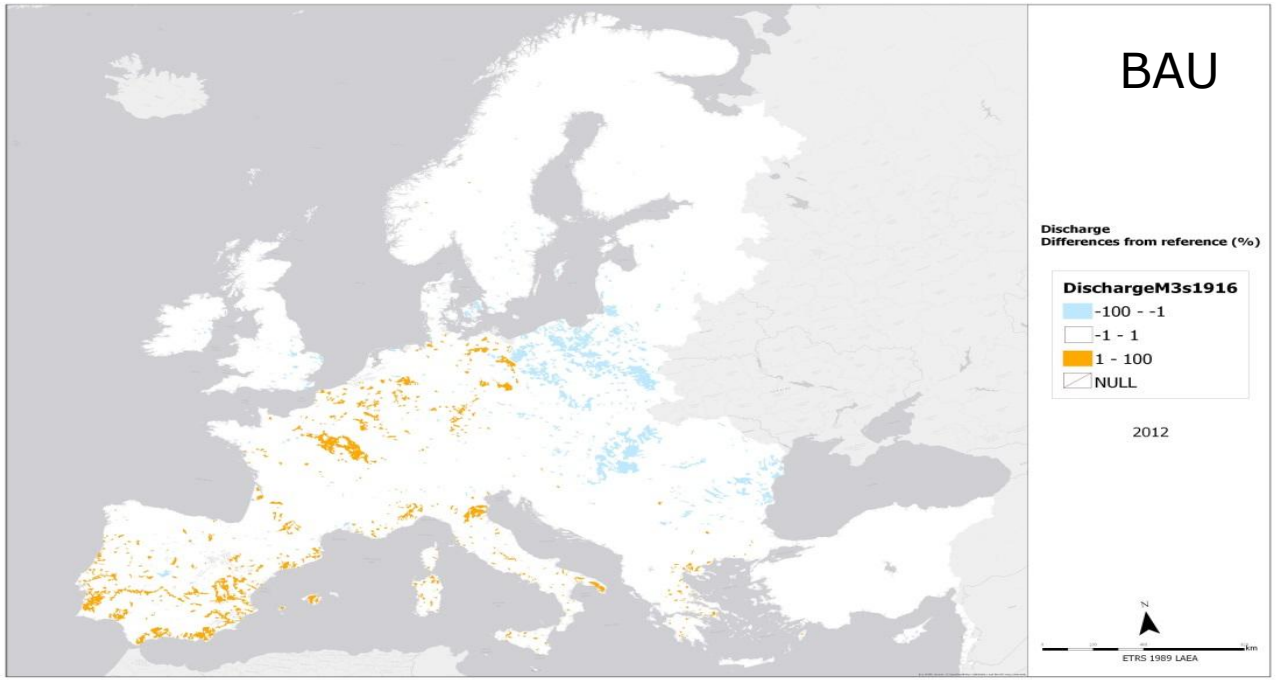
GREEN model output can be use as input to JRC marine models

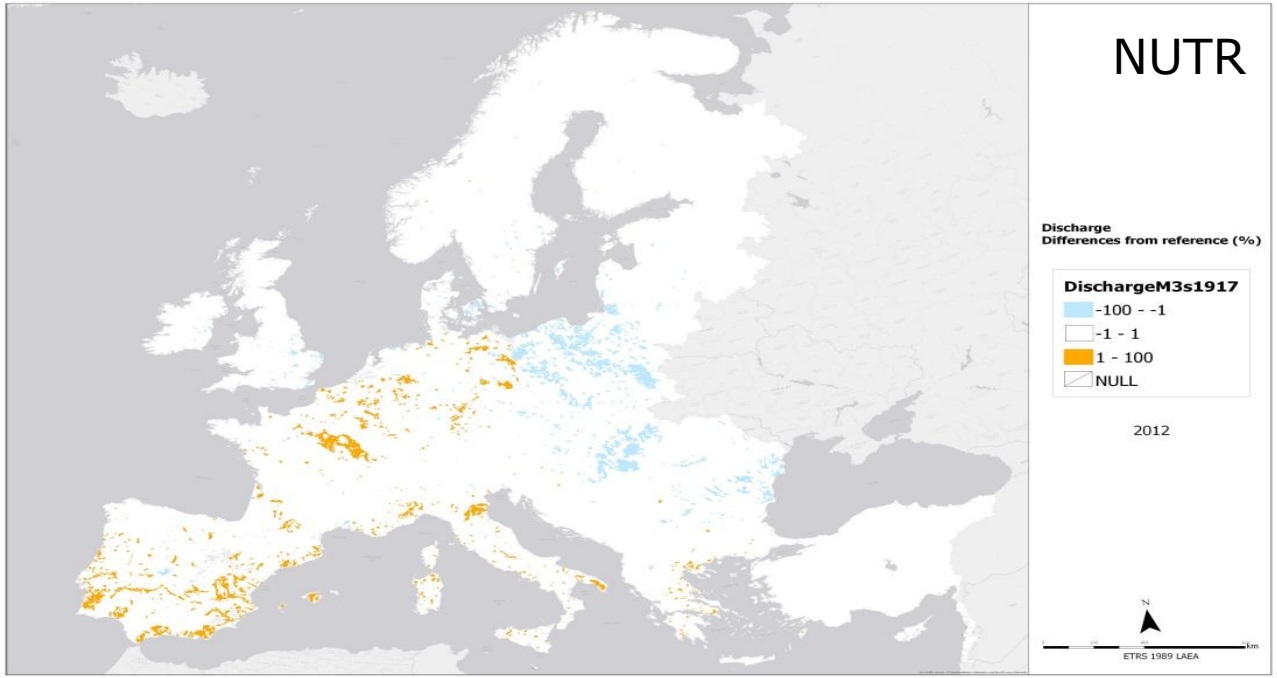
Scenarios - Nutrients

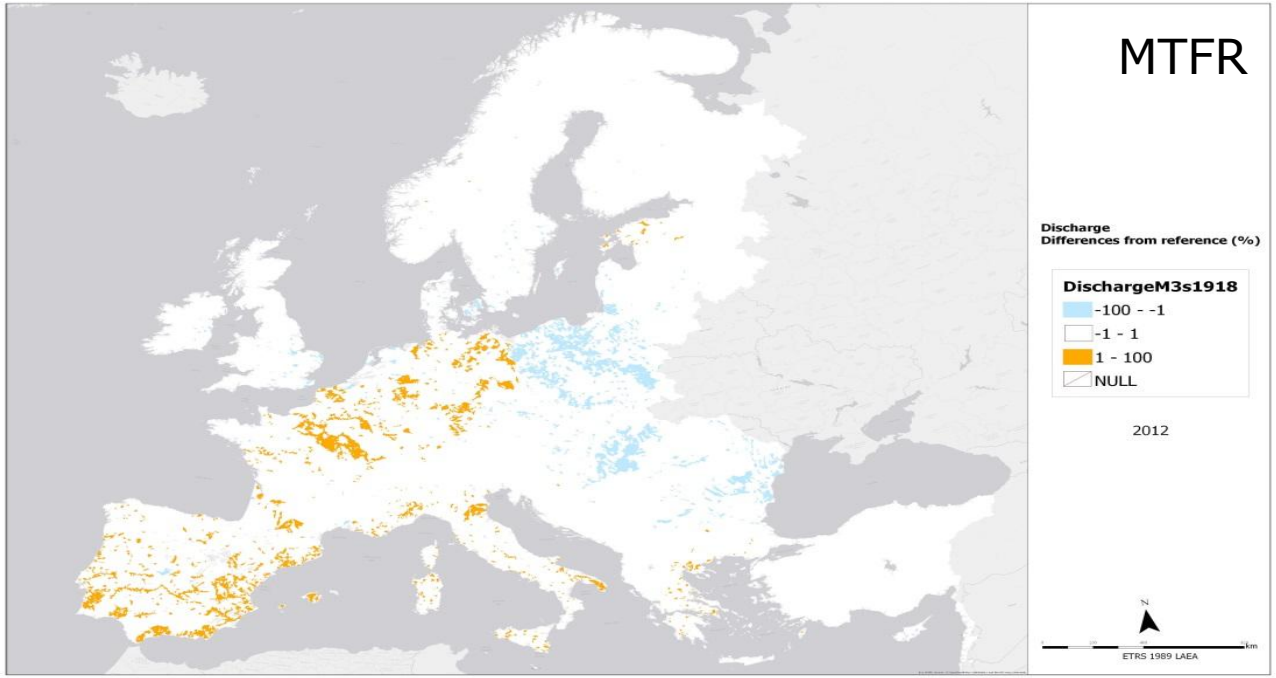
	Urban point pollution (UWWTP)	**Agriculture diffuse pollution (AGRI)**
Current Situation (REF)	Situation in 2012	Situation in 2012
Business As Usual (BAU)	Nitrogen and phosphorus reduction in UWWTPs according to the **current investments** reported by the Member States under the UWWTD data	Reduction of nitrogen and phosphorus emissions to waters considering the additional measures funded under the **Rural Development Programme 4b priority**
Nutrient (NUTR)	Nitrogen and phosphorus reduction in UWWTPs in case of **full implementation of the UWWTD** except Article 5.4	Application of maximum 170 kgN/ha of manure in all Nitrogen Vulnerable Zones according to the **Nitrates Directive** without considering areas under Derogations
High Technical Feasibility (MTFR)	Nitrogen and phosphorus reduction in case all UWWT plants are upgraded to the **highest treatment level**	Improvement of the **nitrogen surplus (set to 10%)** reducing mineral fertiliser and keeping the current agricultural production

Mean annual water flow

Differences from reference (%)

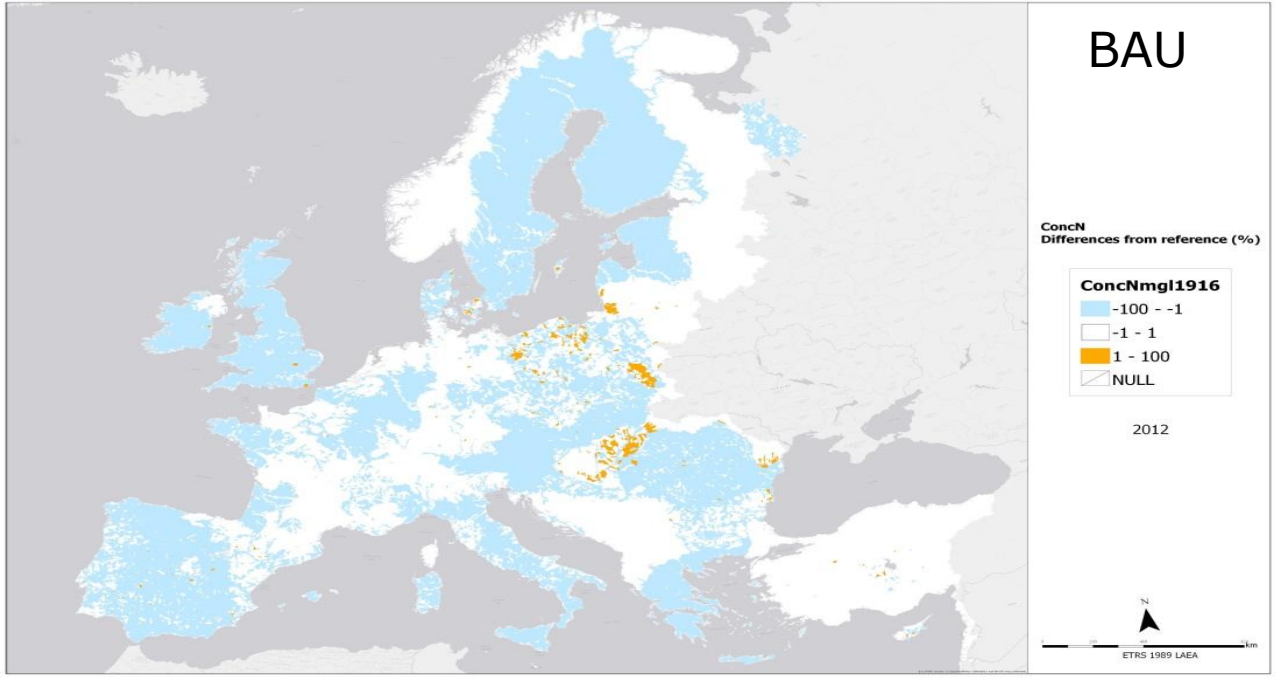


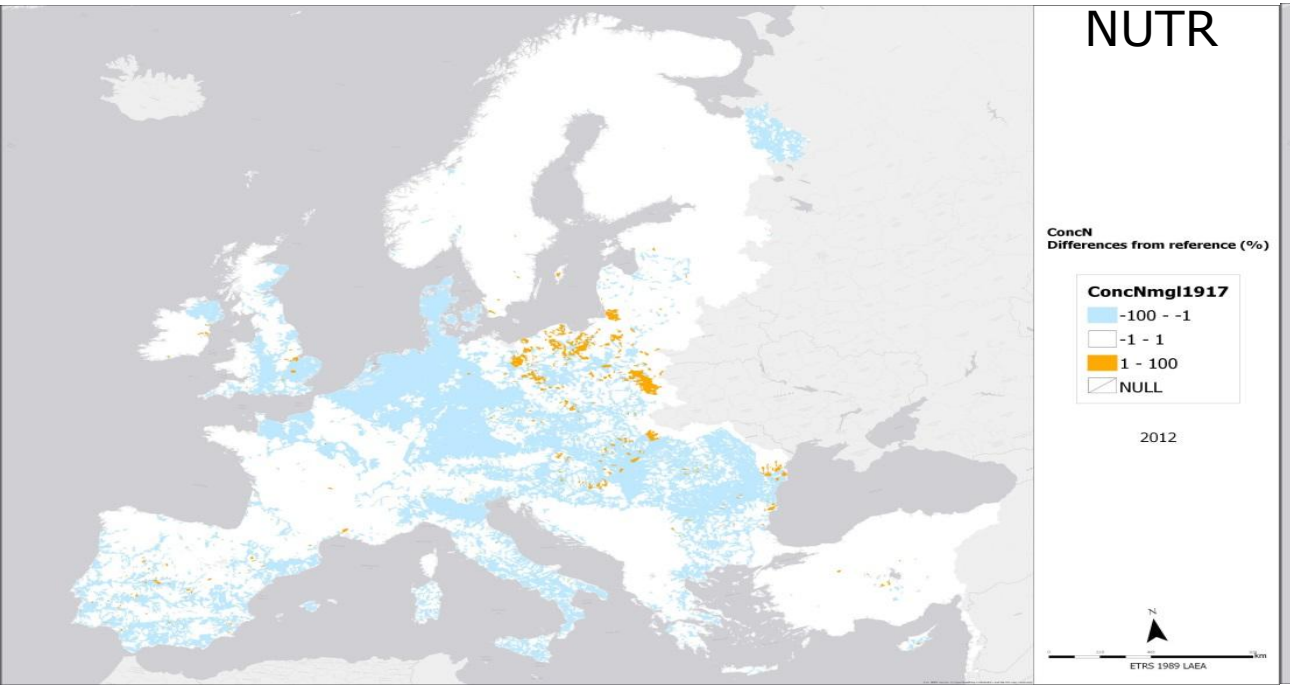




Mean annual nitrogen concentration

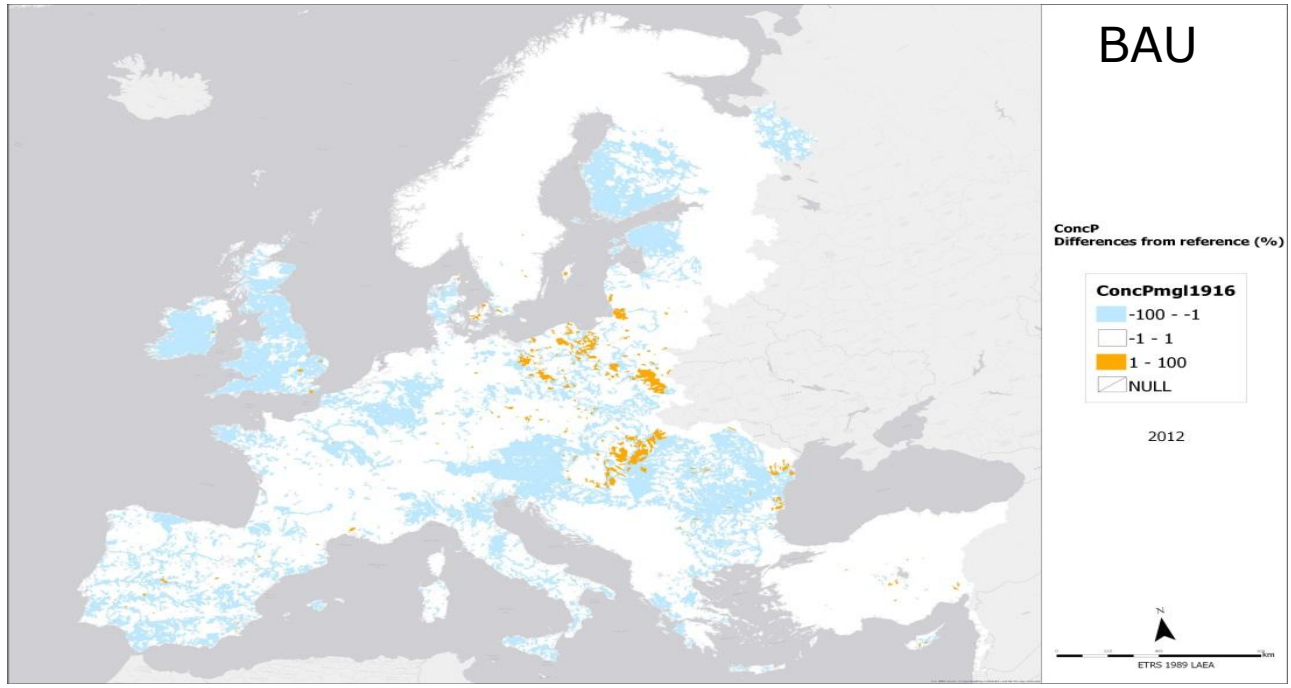
Differences from reference (%)

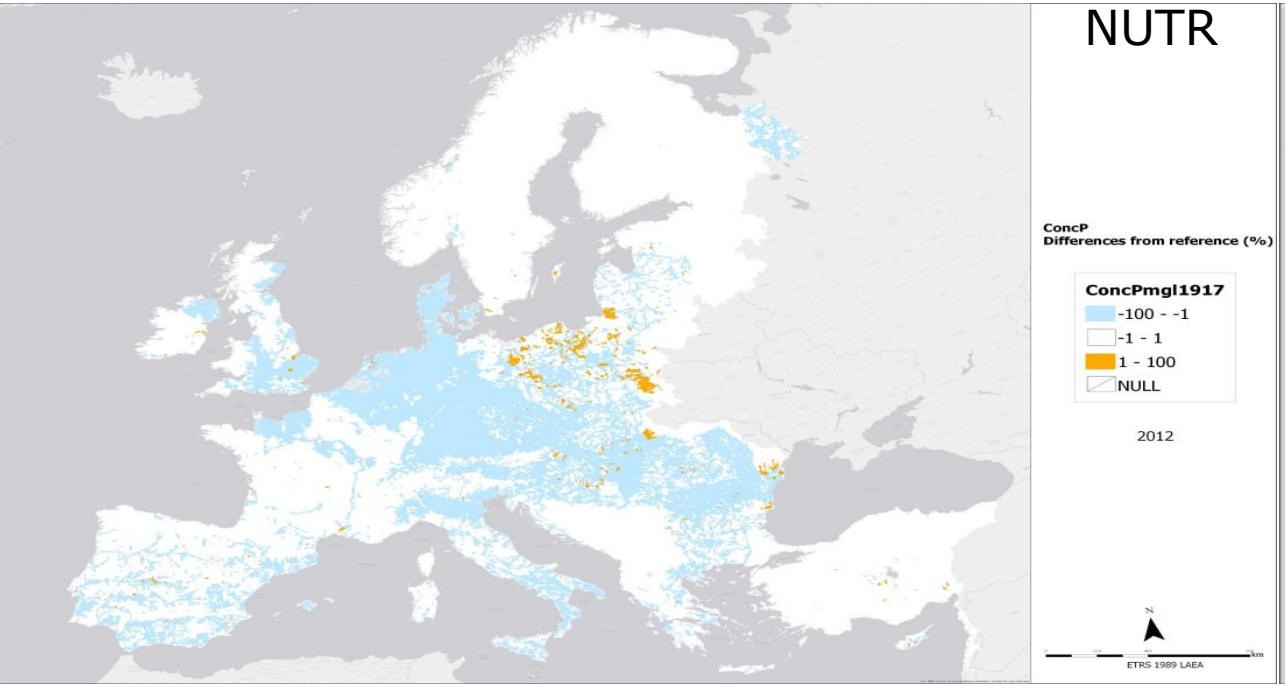




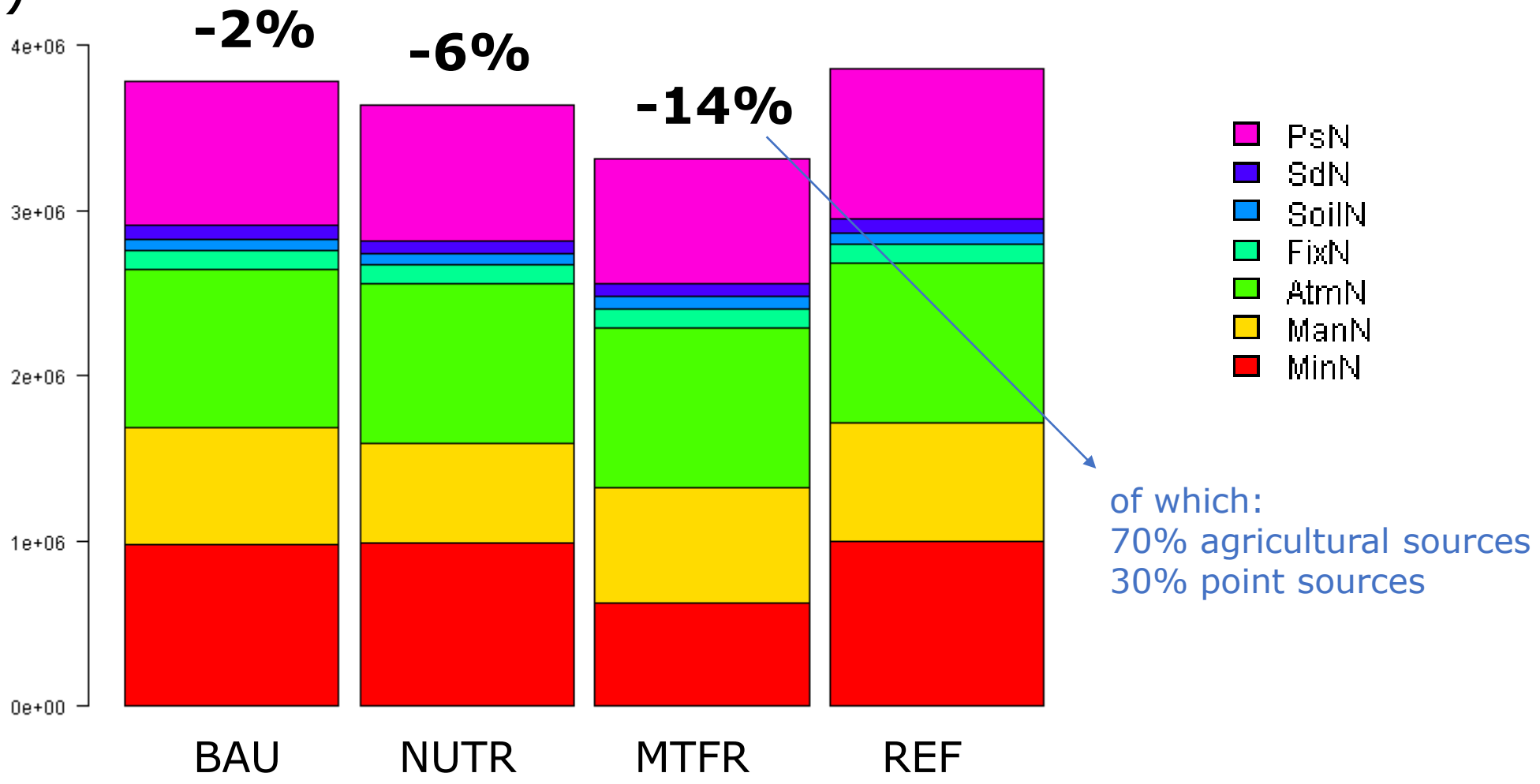
Mean annual phosphorus concentration

Differences from reference (%)

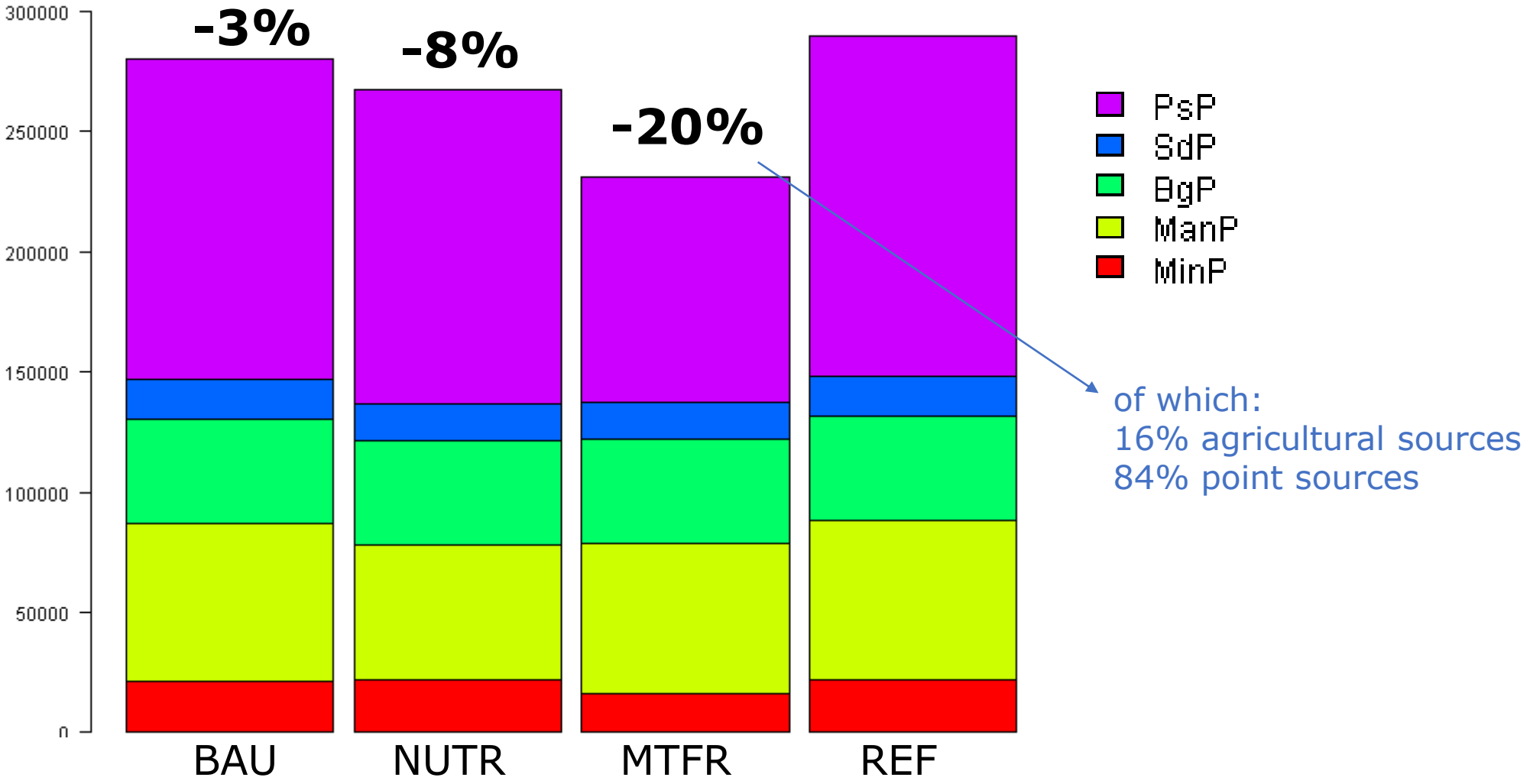




Scenarios - Nitrogen loads to European seas (tonN/yr)



Scenarios – Phosphorus loads to European seas (tonP/yr)



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Key messages

According to the scenario analysis (MTFR):

- Decrease in nitrogen (-17%) and phosphorus (-22%) mean concentration at sea outlets
- 14% reduction of nitrogen loads, and 20% reduction of phosphorus loads to European seas
- Change in N:P ratio
- Regional differences

Final remarks

EU policies implementation and evaluation

- 5th Implementation Report of the WFD (COM(2019) 95 final)
- Fitness check of the Water Framework Directive
- Evaluation of the Urban Waste Water Treatment Directive
- Evaluation of the Biodiversity Strategy to 2020 (MAES ecosystem assessment)

EU Assessments

- EEA, European waters – assessment of status and pressures 2018 (EEA) Water Information System for Europe (WISE)
- EEA, The Environment and Outlook Report 2020 (SOER 2020) https://www.eea.europa.eu/soer-2020
- **Knowledge Hub on Water and Agriculture** →Scientific knowledge to support the implementation and integration of agricultural and water policy objectives in the EU **https://water.jrc.ec.europa.eu/**

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