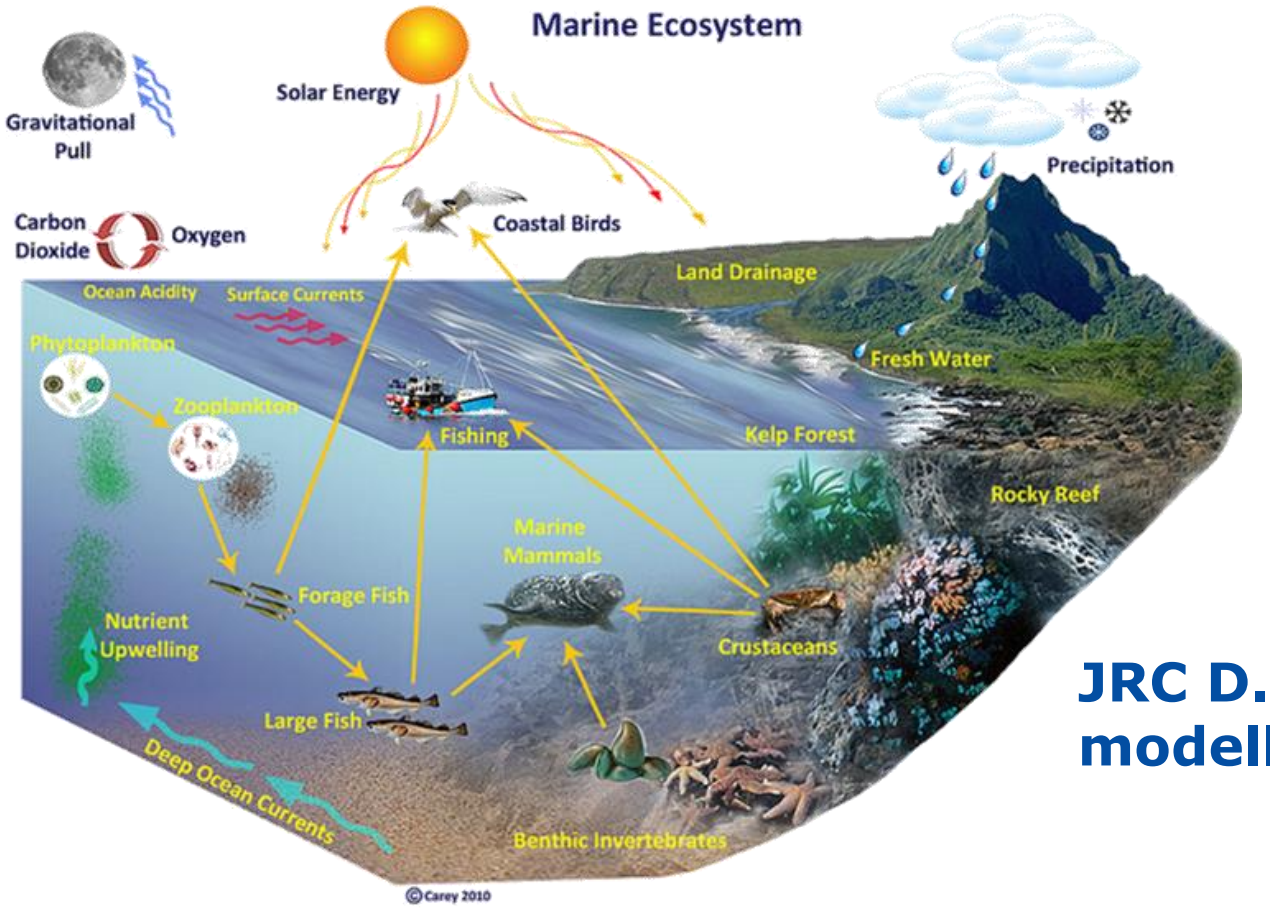
Blue2: Modelling of MSFD descriptors in support of the MSFD review



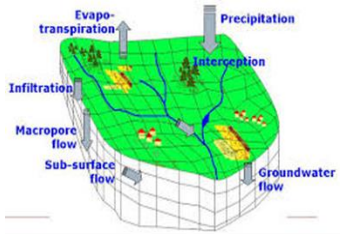
JRC D.2 Freshwater and marine modelling groups

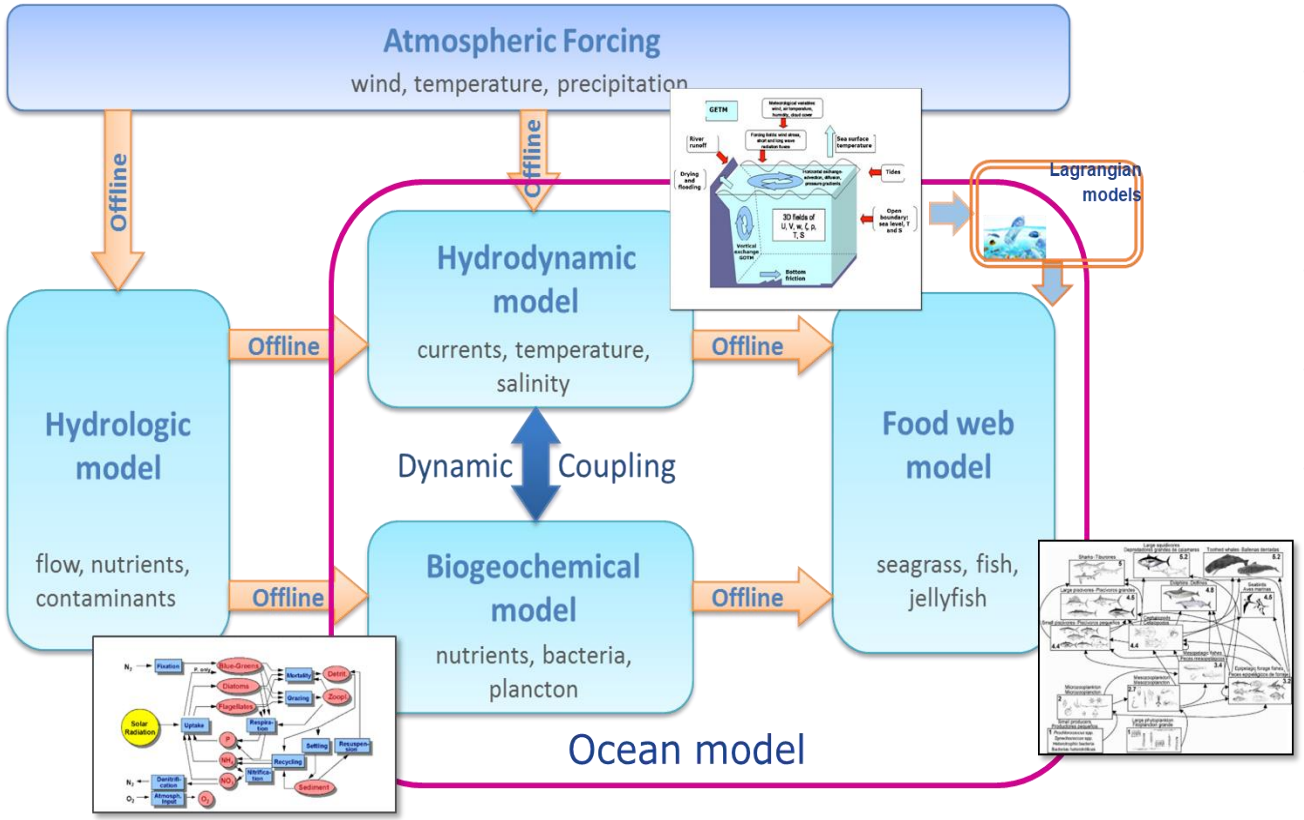
European Commission

Model development and operation in the context of the Blue2 project

- DG ENV C took the strategic decision of supporting the developing of a **Commission in house modelling capacity** for **coupled freshwater and marine ecosystems**.
- This shall be used to oversee the **evaluation**, **implementation**, and **review** of the EU water and marine related legislations (MSFD, WFD, UWWTD, ND, F2F, ZP, CFP, CAP …)
- Therefore JRC-D2 is currently **developing** the requested modelling capacity.
- Could be used to better identify **cost effective** actions at different levels

A digital twin of the hydrosphere to evaluate policy options





Integrated modelling tool to simulate the impact of management options on the environmental status of EU water/marine ecosystems:

- land use and water use
- diffuse and point source of pollution
- atmospheric forcing
- hydrologic models
- marine hydrodynamic-biogeochemical and food-web models

European Commission

Blue2.2 AA (Apr 2021- Apr 2023) main objectives

Tasks	
Task 1 – Development and continuous revision of policy scenarios	Task 7 – Mediterranean Sea food web model and preparatory work for the implementation of additional food web models
Task 2 – Freshwater modelling work	Task 8 - Continue and extend MSFD related networking activities
Task 3 – Coupled biogeochemical and lower trophic models for the Baltic Sea	Task 9 - Refined European wide ensemble scenario modelling exercise
Task 4 – Coupled biogeochemical and lower trophic level models for the Greater North Sea and Celtic Seas	Task 10 - Model simulations for estimating total allowable nutrient loads
Task 5 – Coupled biogeochemical and lower trophic level models for the Bay of Biscay and the Iberian Coast	Task 11 – Reporting
Task 6 - Black Sea litter/contaminants transport/dispersion model	

D5, eutrophication

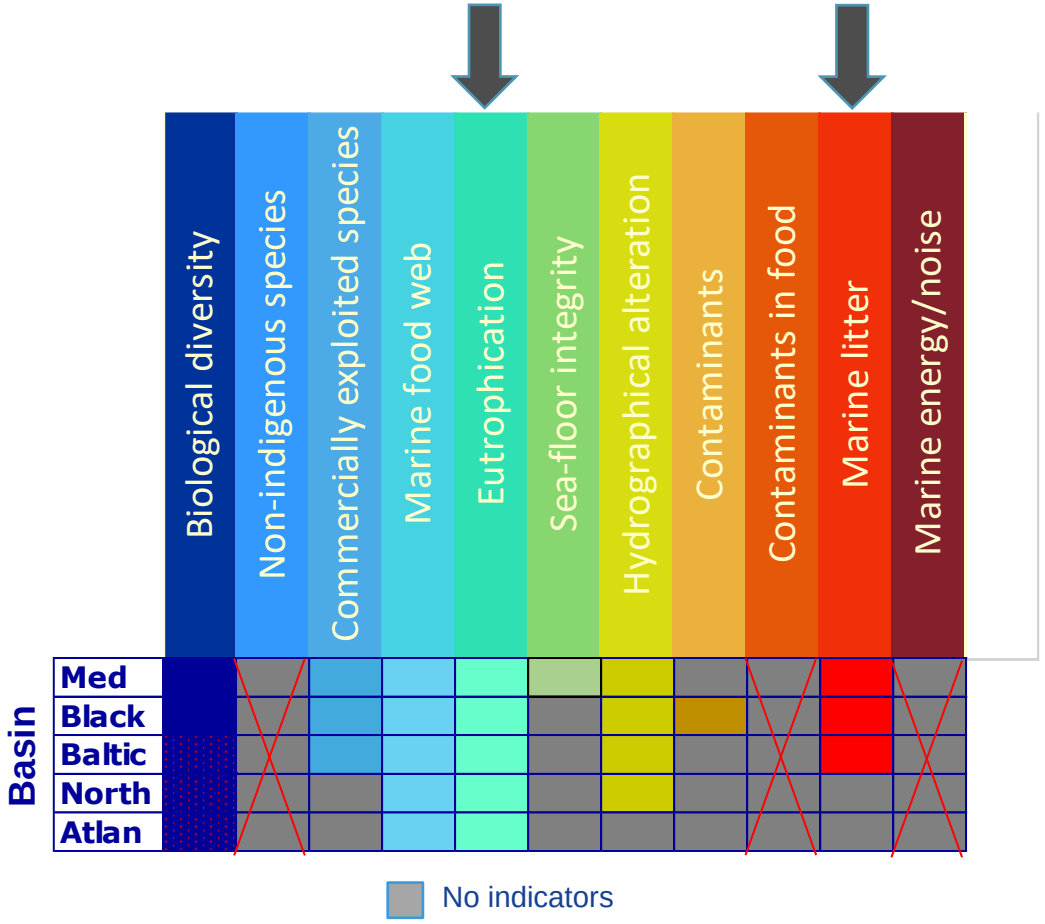
D10, litter

D1, D3, D4 (food webs)

Policy scenario definition (mostly for D5)

European Commission

JRC Modelling Framework and MSFD relevant descriptors



Coloured squares indicate Descriptors and basins for which the MMF models could provide useful information

MMF models are more suited to address ‘pressure’ descriptors

MSFD Descriptor D5: Eutrophication

D5 is the more mature descriptor in modelling terms

MSFD Descriptor D10: Marine litter

European Commission

JRC Modelling framework: D5 assessment

Freshwaters

Water quantity (LISFLOOD)

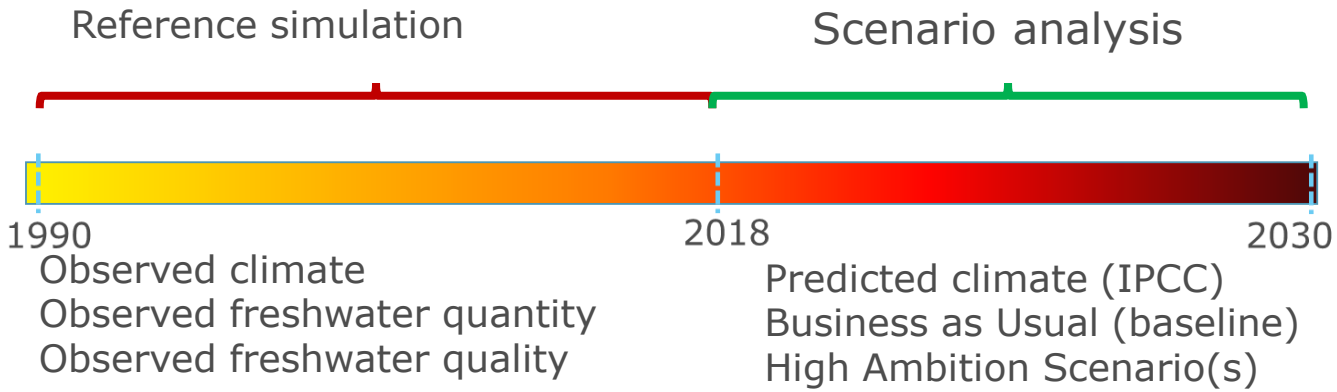
Water quantity & nutrients (SWAT)

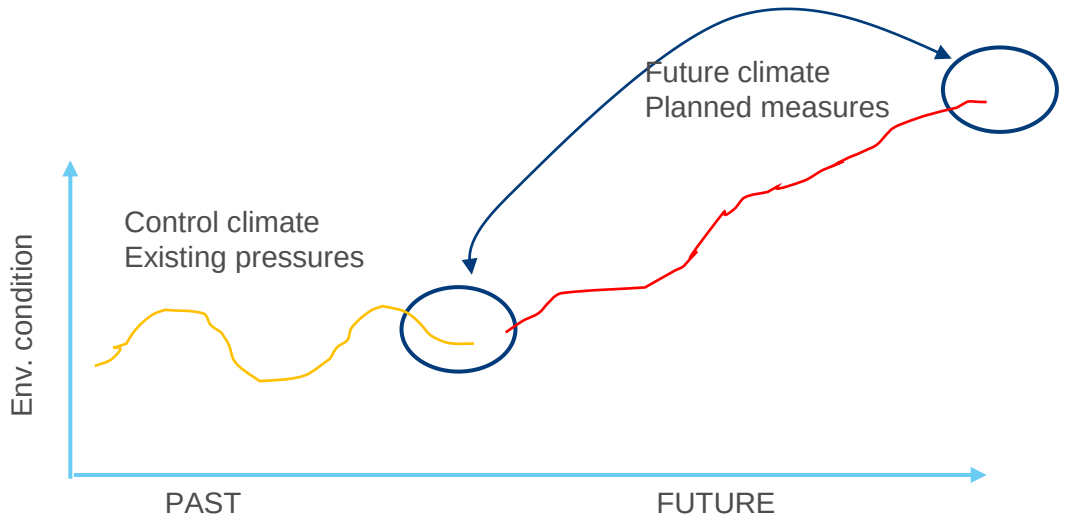
Nutrients (GREEN)

Seas

Hydrodynamic-biogeochemical marine models (Mediterranean Sea, Black sea, Baltic Sea, North Sea)

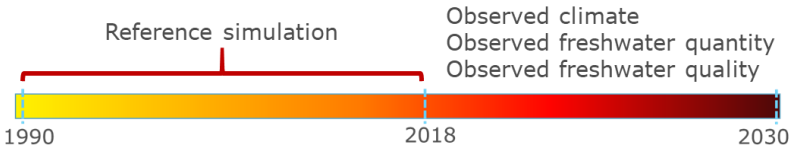
High tropic marine models (Mediterranean Sea, Black Sea)





European Commission

JRC Modelling framework: D5 assessment

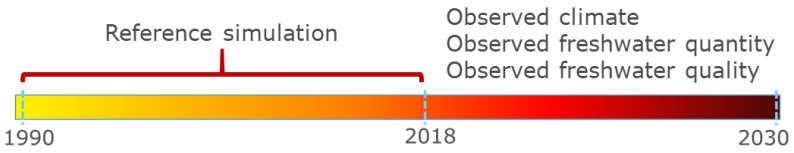


WATER QUANTITY

The **reference situation (REF)** is based on **observed climate (1990-2018)**. In this simulation, the **current water saving measures** are included **without** additional measures

Water saving measure	Current state (REF)
Irrigation efficiency	Current irrigated areas (Eurostat)
Urban water use efficiency / leakage reduction	Current losses from 5% in NL up to 40-50% in Malta (Benitez Sanz et al., 2018)
Water reuse for agriculture	Only in Spain (reported)
Cooling water in the energy sector	Cooling scenario of 2015 (Global Energy Climate Outlook (GECO))
Desalination	Not applied

JRC Modelling framework: D5 assessment

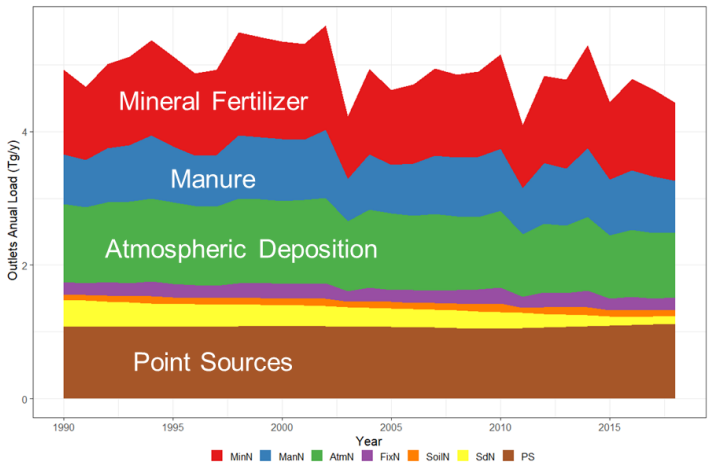


WATER QUALITY

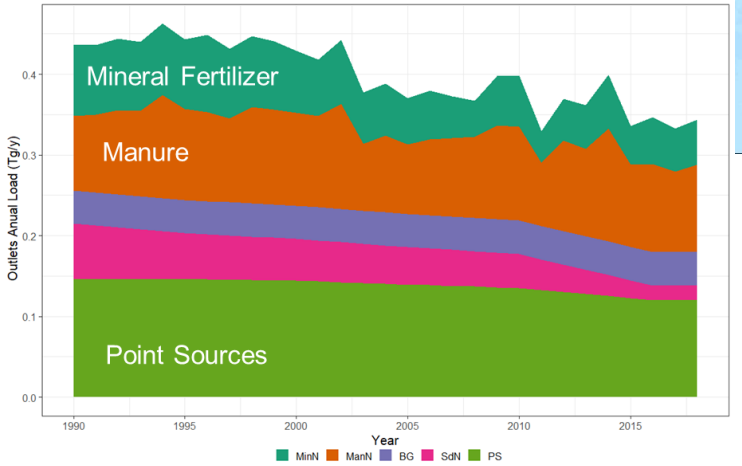
Reconstruction Nitrogen and Phosphorus diffuse and point inputs to European river basins 1990-2018

- Atmospheric deposition (only for N)
- Mineral and manure fertilizer application, crop fixation (only for N)
- Urban Waste Water Treatment plant discharges, industrial discharges
- Scattered dwellings (i.e. isolated houses and small agglomerations not connected to sewerage systems)

Nitrogen

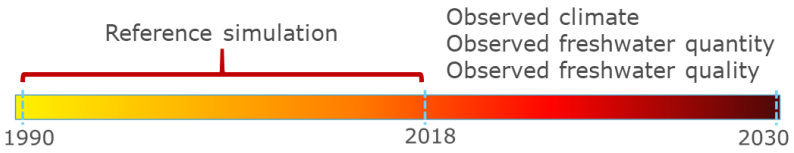


Phosphorus



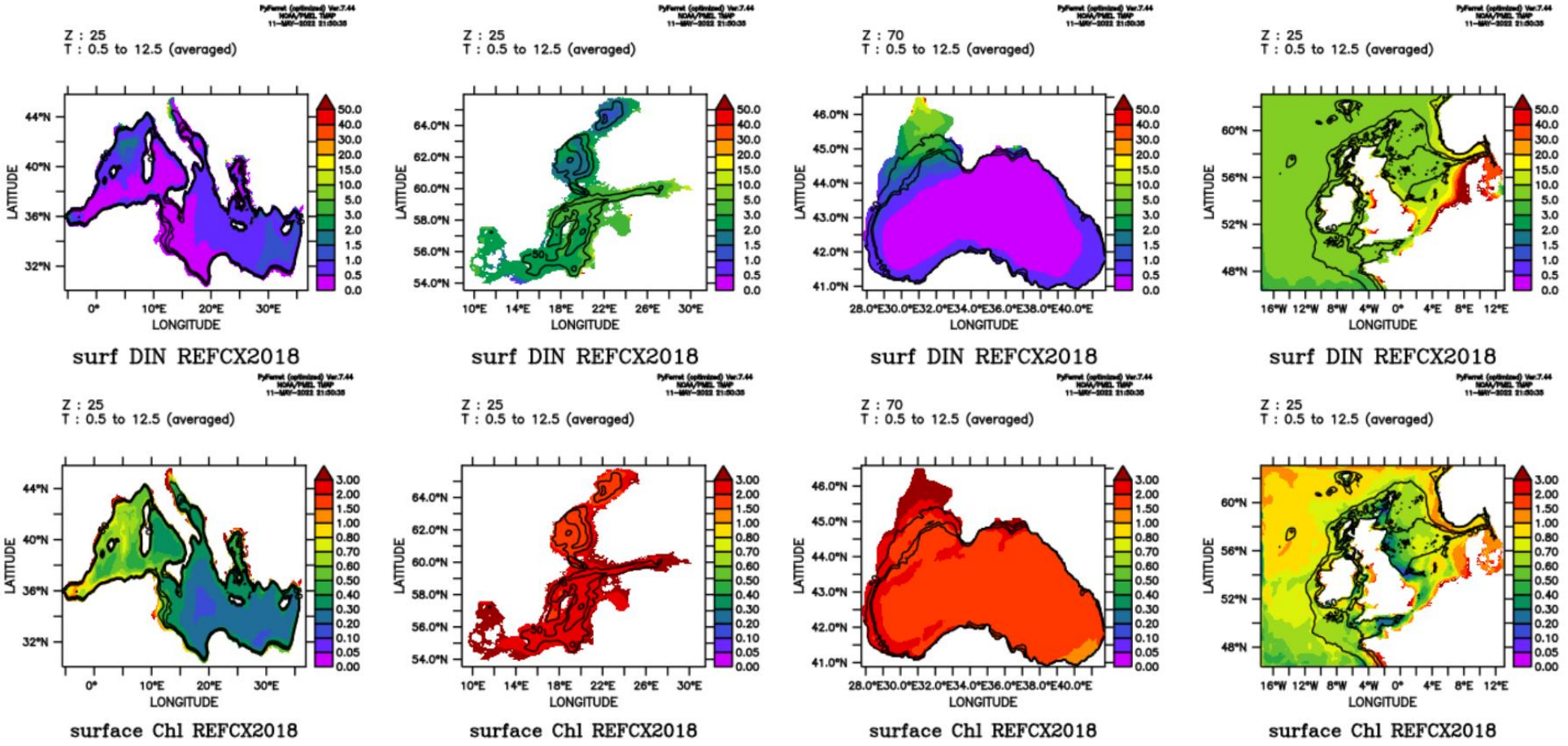
European Commission

JRC Modelling framework: D5 assessment



MARINE STATUS

Nutrients and water loads → to marine models to recreate eutrophication conditions in EU basins



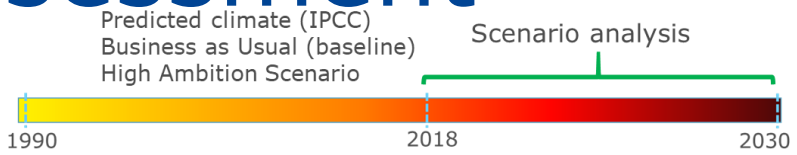
D5C1

D5C2

European Commission

JRC Modelling framework: D5 assessment

WATER QUANTITY

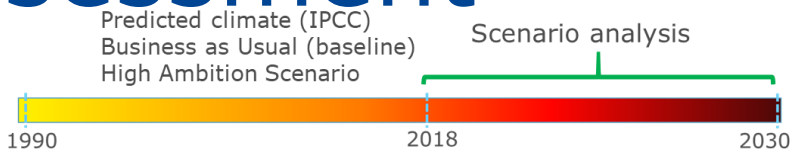


Water saving measure	BAU (reported MS planned measures)	HAS (all individual measures)
Irrigation efficiency	REF + additional investments as planned by MS (Benitez Sanz et al., 2018)	BAU + additional investments (Benitez Sanz et al., 2018)
Urban water use efficiency / leakage reduction	REF + investment plans (Benitez Sanz et al., 2018)	In all MS to 5% (NL target)
Water reuse for agriculture	Only in Spain (reported)	Costs not exceeding a threshold of 0.50 €/m³ (Pistocchi et al., 2017)
Cooling water in the energy sector	Cooling scenario of 2030 (Global Energy Climate Outlook (GECO))	Cooling scenario of 2050 (Global Energy Climate Outlook (GECO))
Desalination	Not applied	Cost not exceeding the 2 €/m³ (Pistocchi et al., 2017)

Both the BAU and HAS scenario simulations are based on the meteorological forcing (2005-2030) from the MPI-ESM-LR model downscaled with the COSMO-CLM model for the RCP4.5 emission scenario.

JRC Modelling framework: D5 assessment

WATER QUALITY



Source	Scenarios description
Domestic wastewaters	Revision of the UWWT Directive (Pistocchi et al. in preparation): • **PS1** - full compliance with the measures established in the UWWTD • **PS2, PS3, PS4, PS5** - combination of additional measures for increasing the efficiency of the level of treatment and the extent of the Sensitive Areas (where more stringent treatments are necessary)
Agriculture	CAPRI model (Barreiro Hurle et al. 2021): • **capriBau** - the current CAP (business as usual scenario) • **capriHAS** - the implementation of the new CAP legislative proposal plus measures to achieve the Green Deal targets also using New Generation EU Funds
Atmospheric deposition (N)	EMEP model (INMAP project): • **ATM** - measures adopted by the Commission to reduce atmospheric emissions by 2030 in the Fit For 55 package

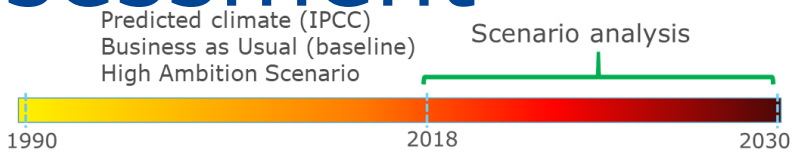
Blue2.2 nutrient reduction scenarios for marine models:

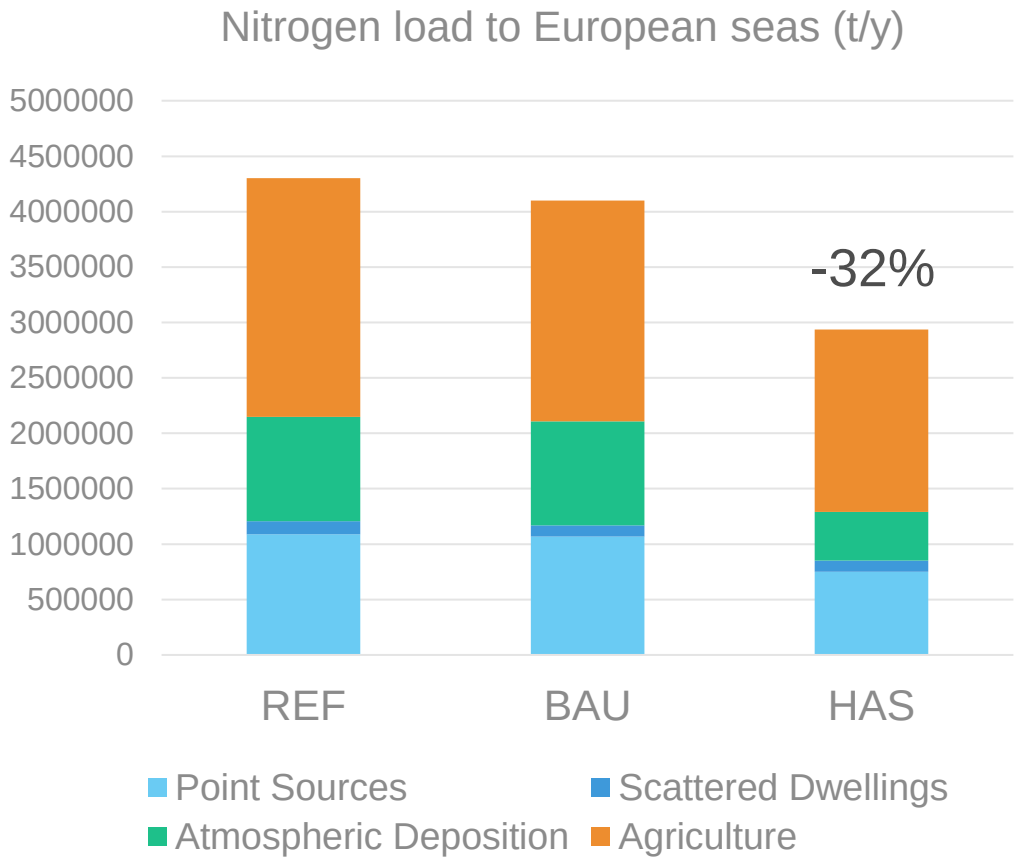
Business As Usual: **PS1+BAU**

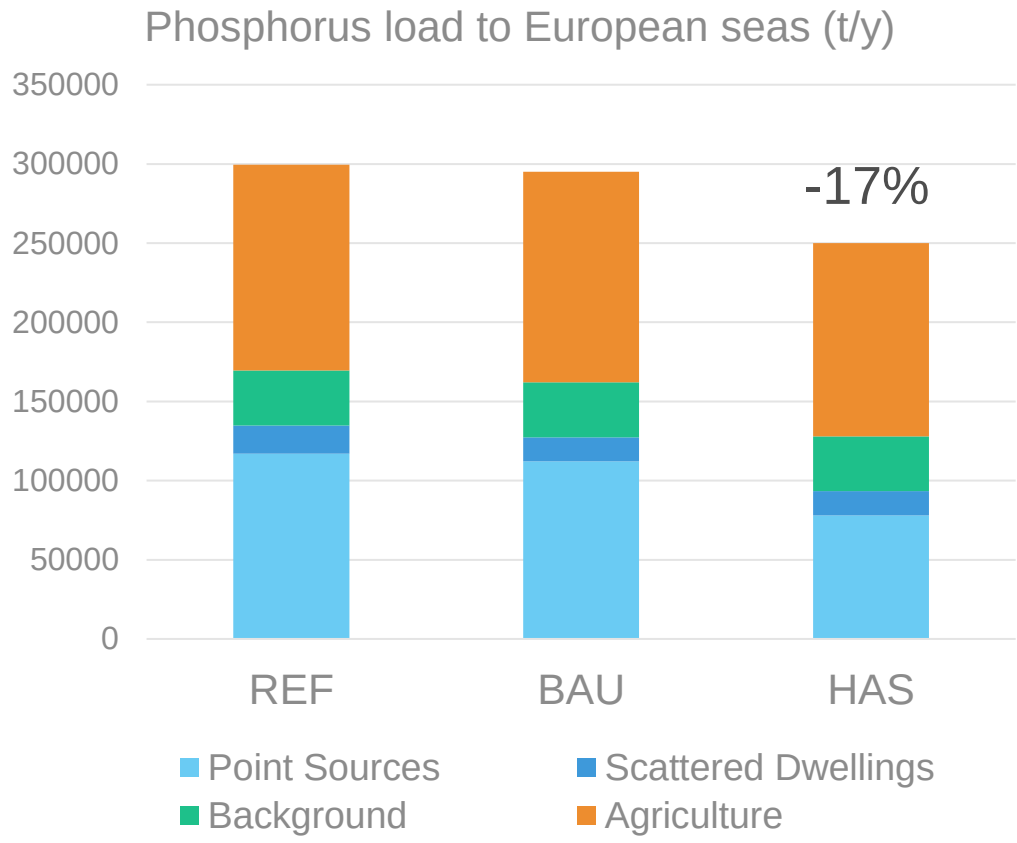
High Ambition Scenario: **PS5+ATM+HAS**

European Commission

JRC Modelling framework: D5 assessment







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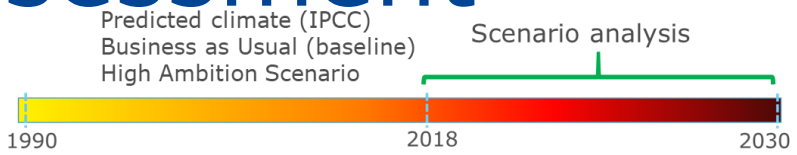
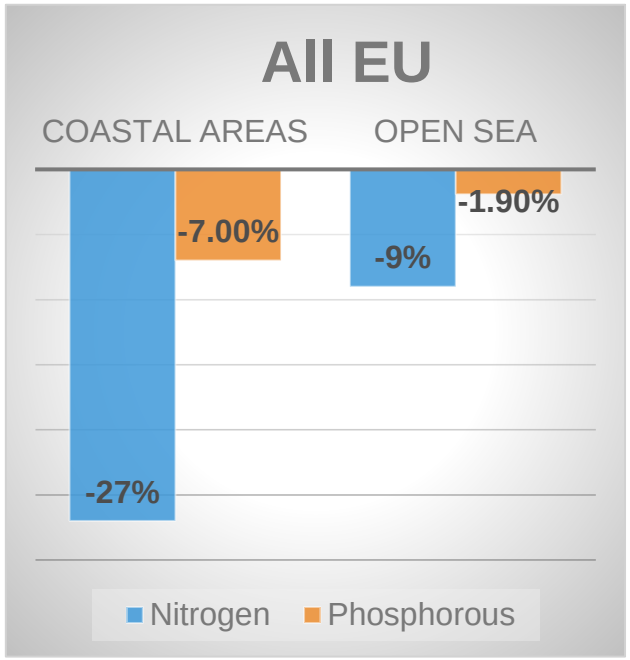
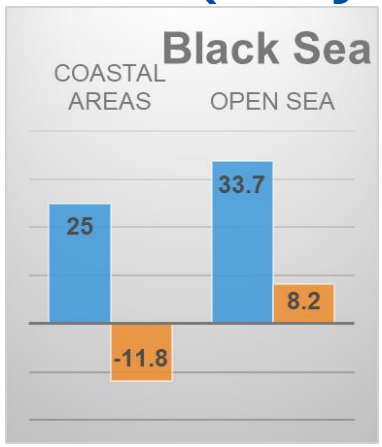
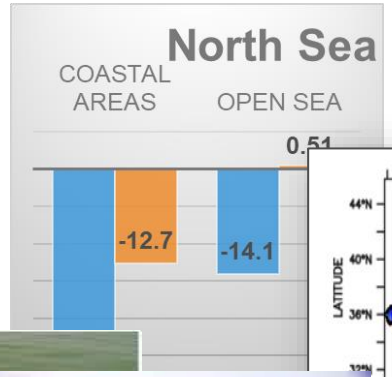
JRC Modelling framework: D5 assessment



MARINE STATUS (only HAS)



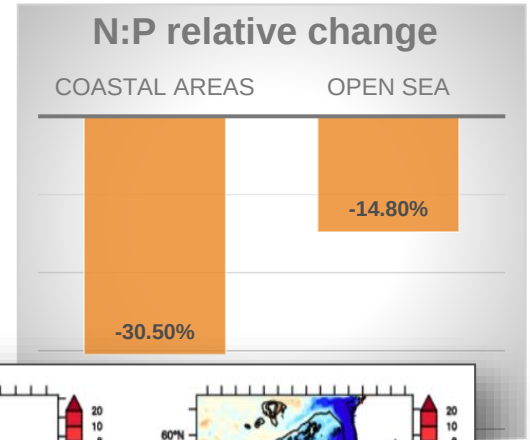


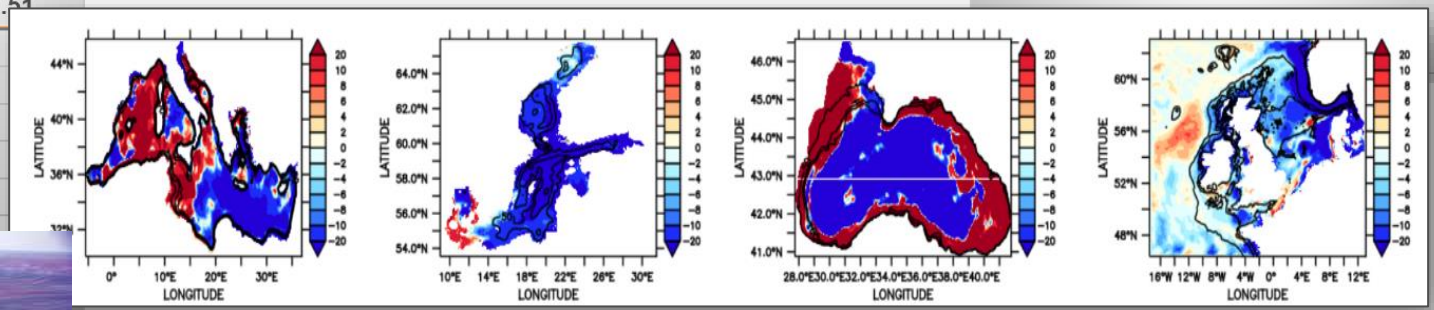


Impact of measures much higher in coastal regions

HAS scenario can worsen nutrients conditions for certain areas/criteria

Increase of the risk of harmful algae blooms!

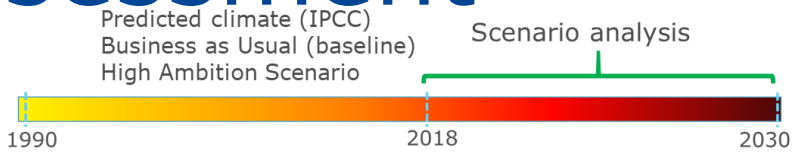


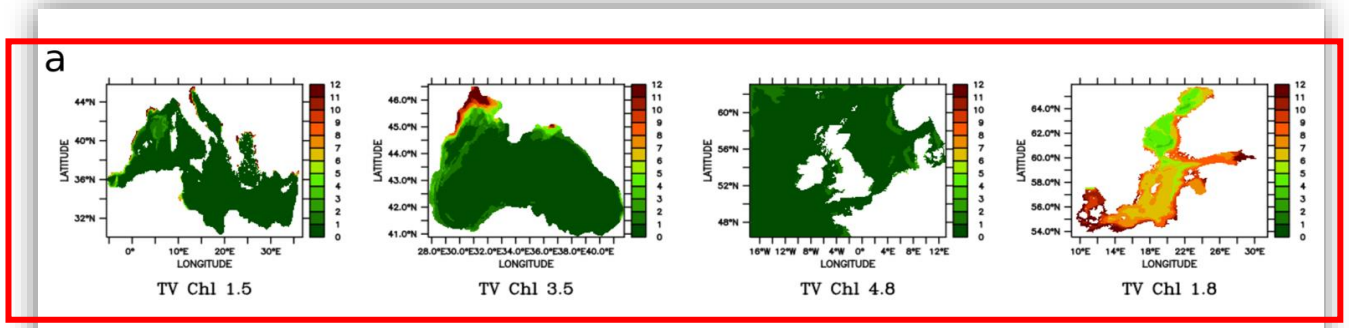


'Smart' nutrient reduction strategies are needed!

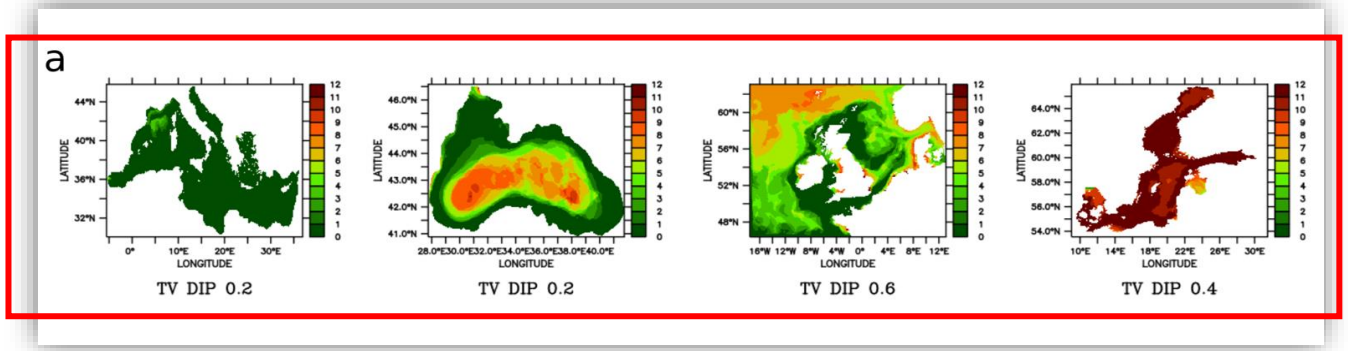
European Commission

JRC Modelling framework: D5 assessment



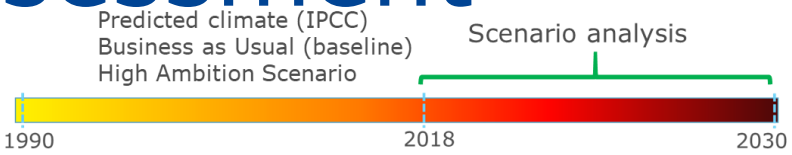


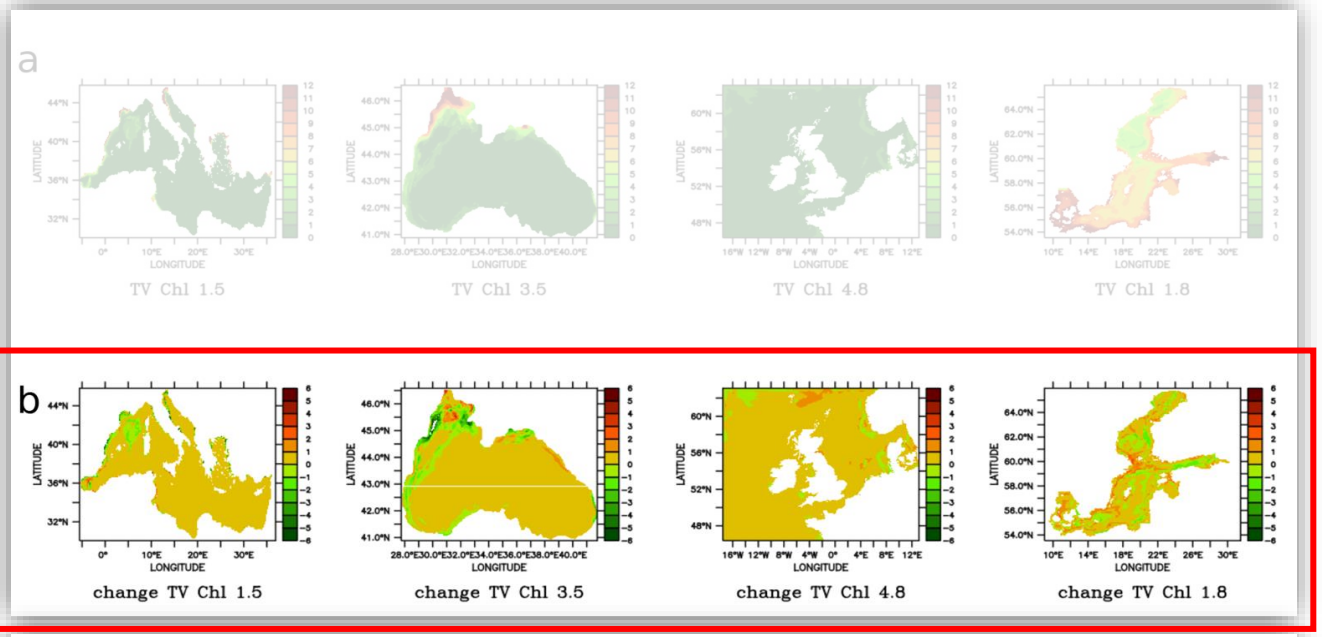
Comparison modelled variables vs. threshold values proposed by MS

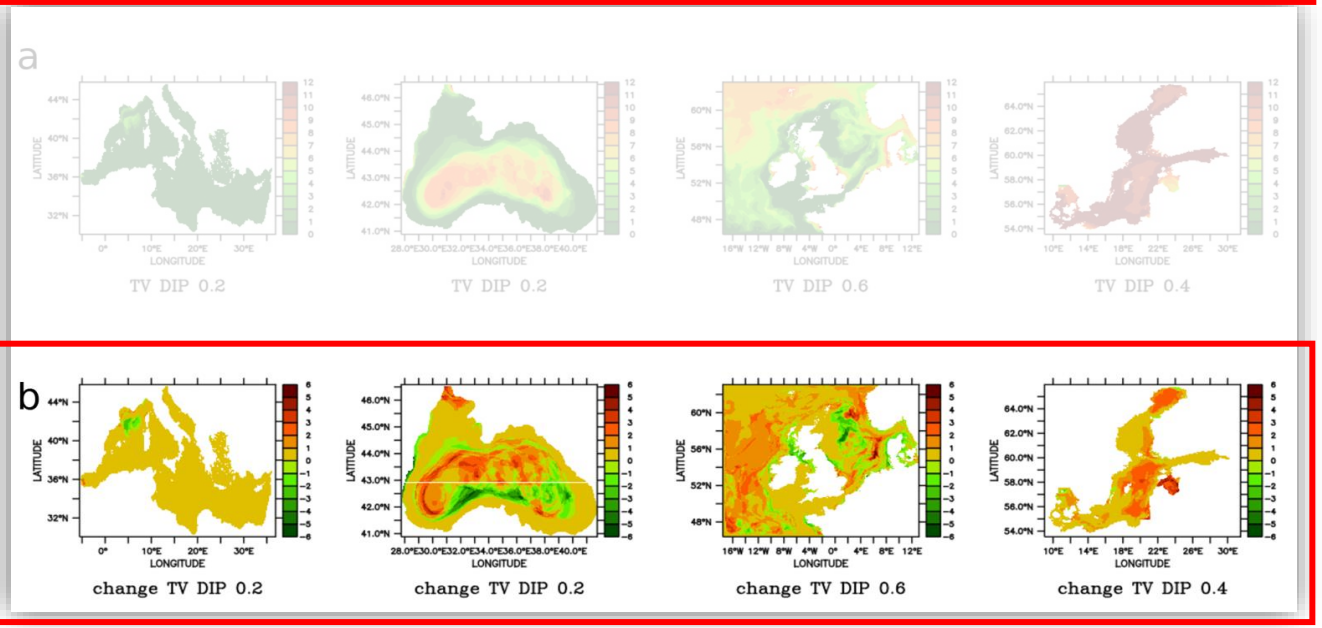


European Commission

JRC Modelling framework: D5 assessment







Comparison modelled variables vs. threshold values proposed by MS

In general the HAS scenario improves the eutrophication condition

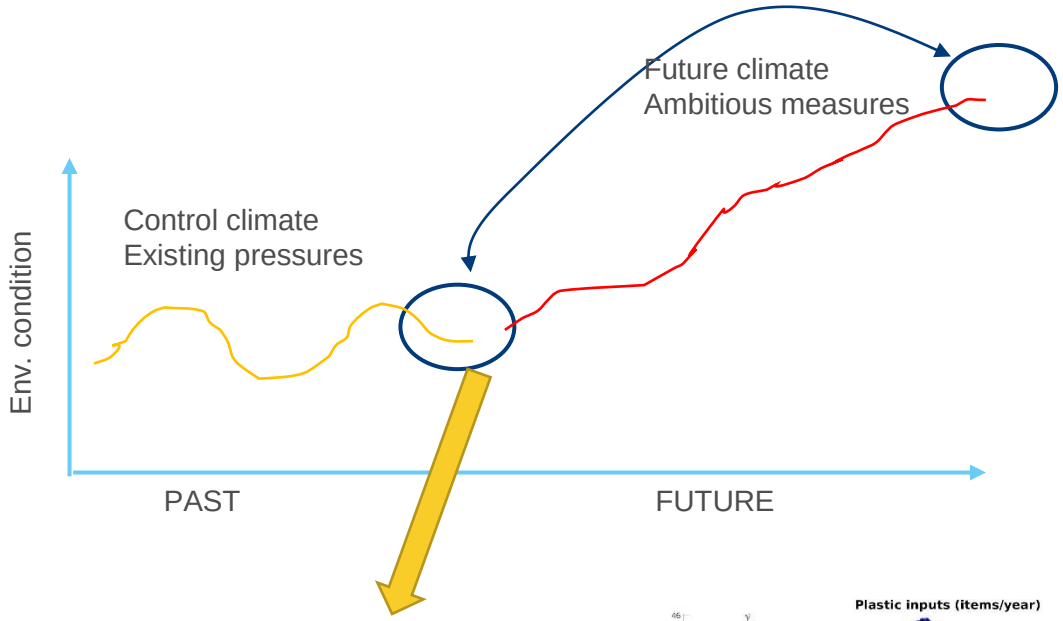
In certain regions and for some criteria the situation could worsen

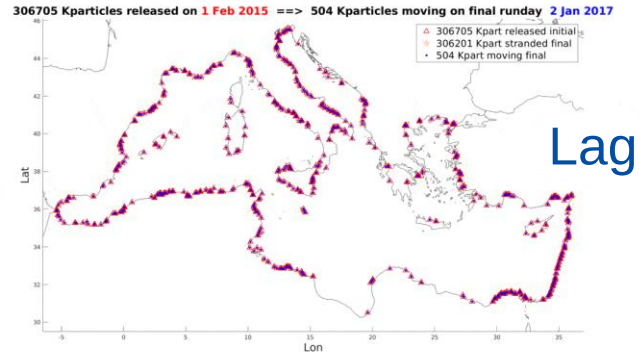
- **Climate change**
- **N:P imbalance**

European Commission

JRC Modelling framework: D10 marine litter

A similar approach has been followed with D10 (litter) but only for the Mediterranean Sea



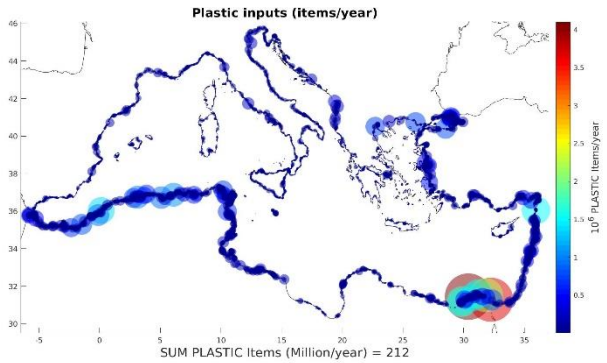


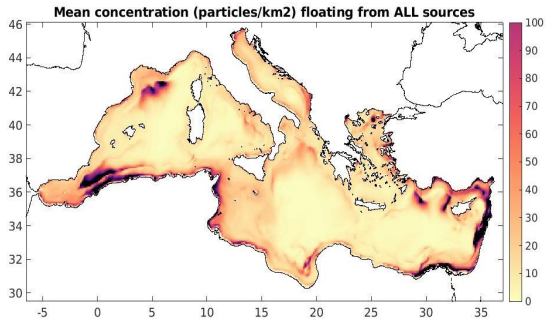
Lagrangian model

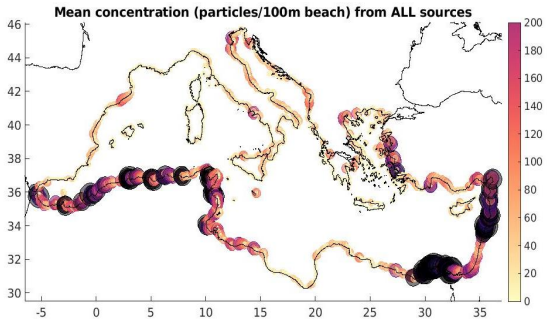
Macro-plastic inputs are largely unknown (but we can estimate them)

(Gonzalez et al., 2021 Nature Communications)

Population; waste production, % of mismanaged waste (**EEA/EUROSTAT**) + riverine observations (**RIMMEL project**)







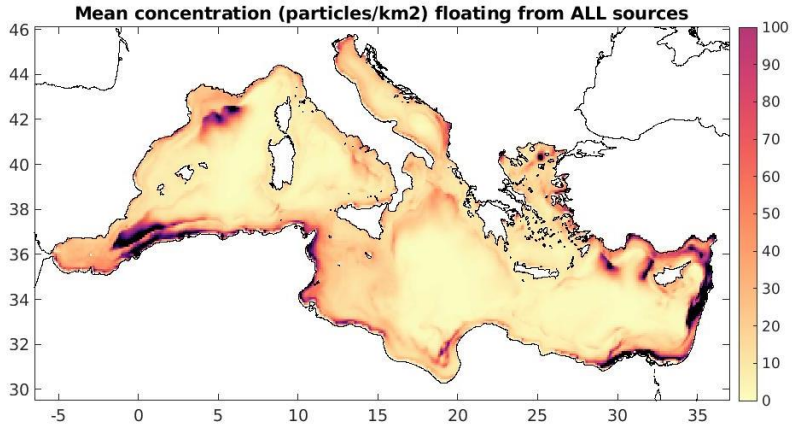
Reference (2016 – 2018)

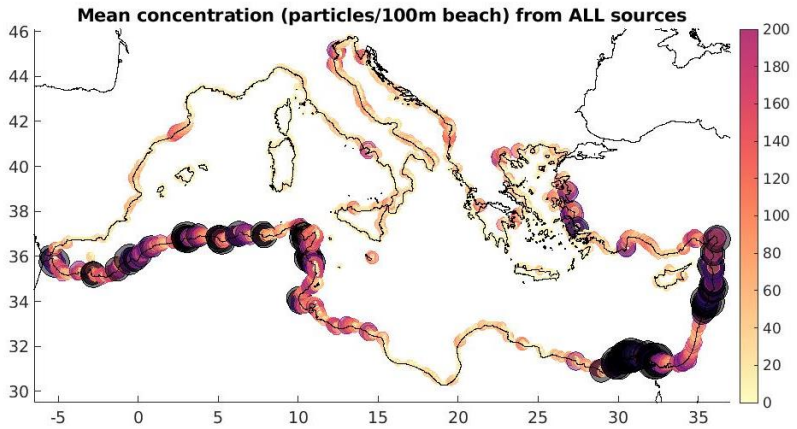
European Commission

JRC Modelling framework: D10 marine litter

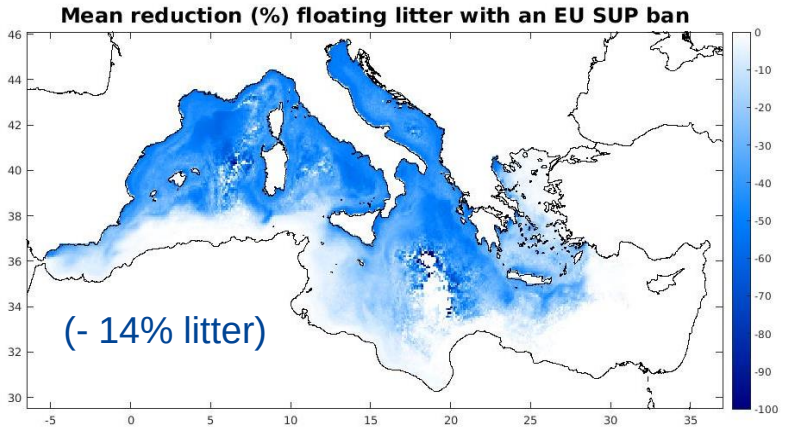
Scenario analysis: (impacts of measures)

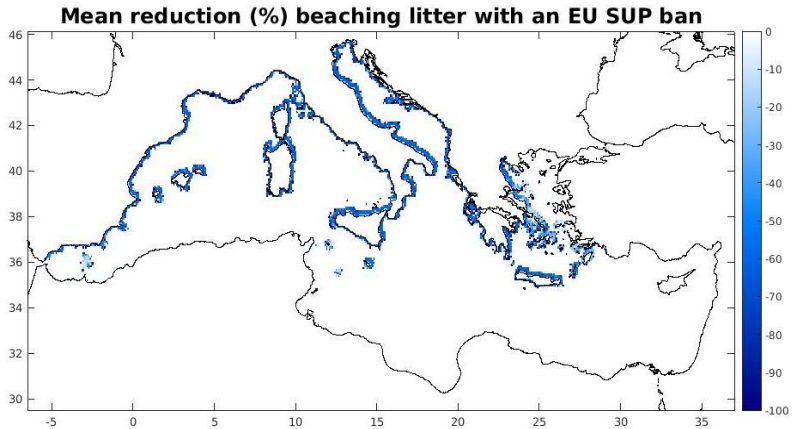
On shared basins international cooperation is needed if more ambitious targets are sought (ZPA)



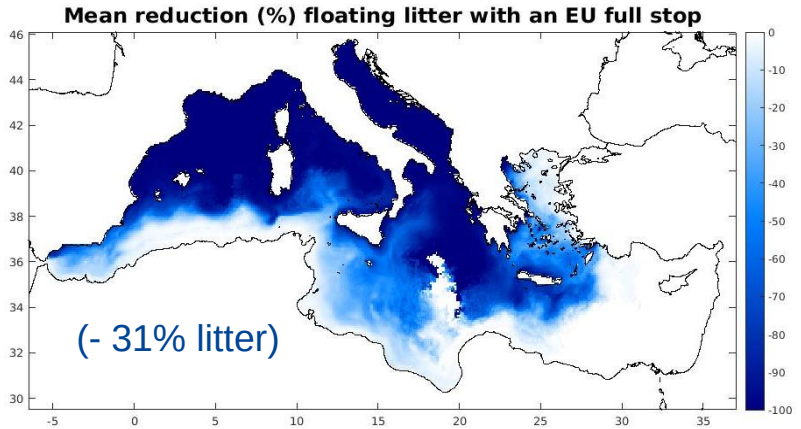


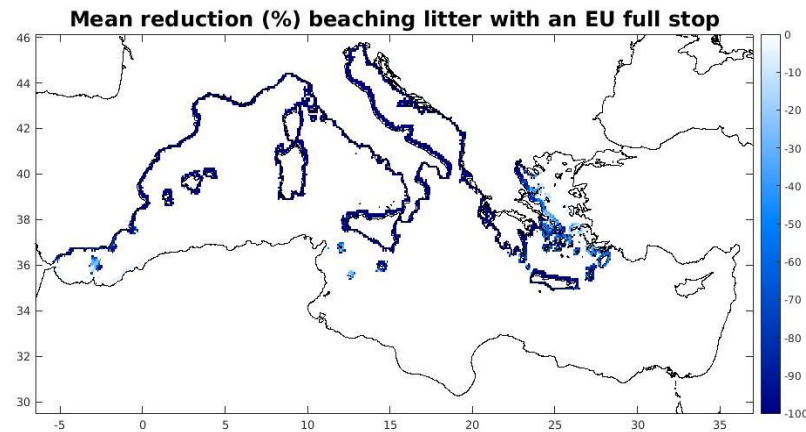
Reference (2016 – 2018)





SUP ban in EU (2016 – 2018)



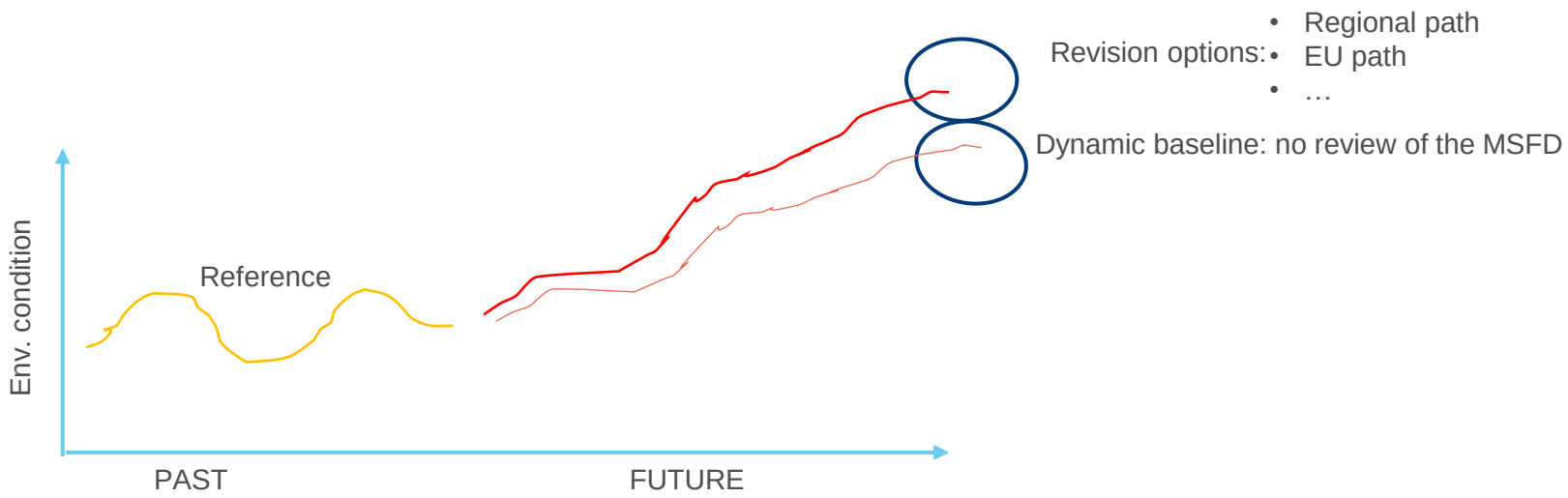


No litter @ EU (2016 – 2018)

European Commission

JRC Modelling framework: future work

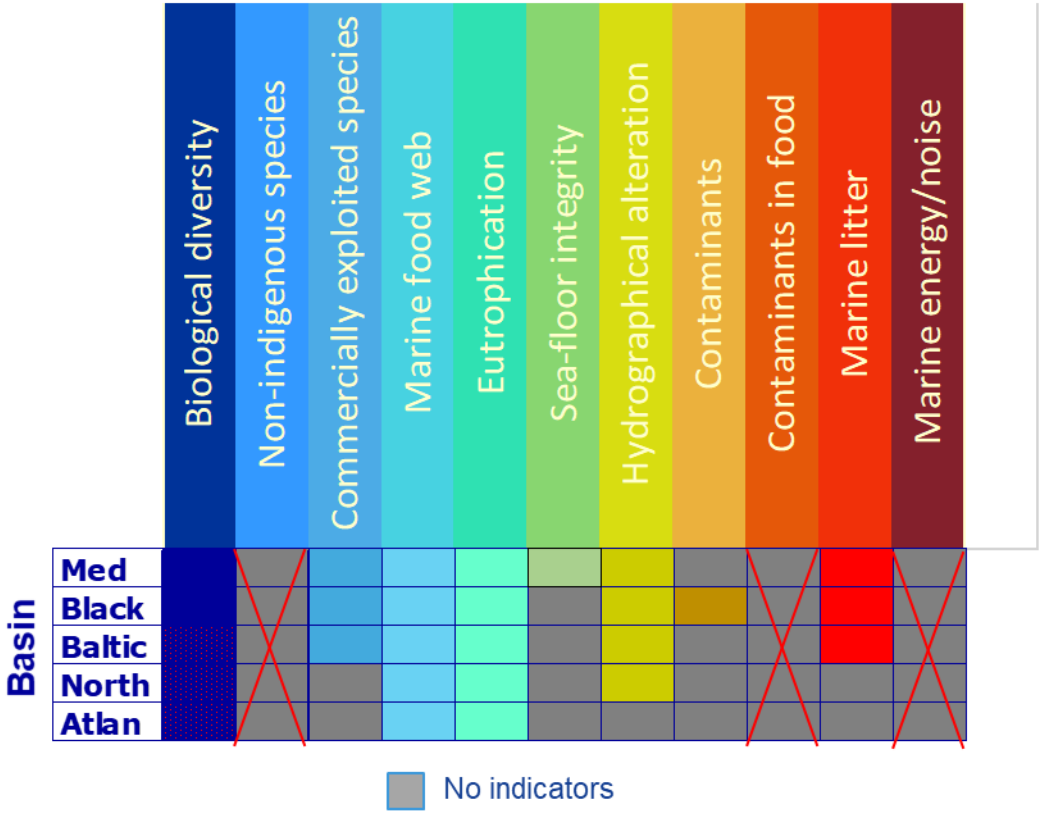
- Apply the same scenario analysis method to more MSFD descriptors → Evaluation, IA and Revision of the directive



- Clear definition of all scenarios (reference & dynamic baselines)
- Clear definition of revision options (and translation in model parameters)
- Extension of the MMF to cover more descriptors/criteria in more basins

JRC Modelling framework: future work

- Apply the same scenario analysis method to more MSFD descriptors → Evaluation, IA and Review of the directive
- Extension of the MMF modelling capacities

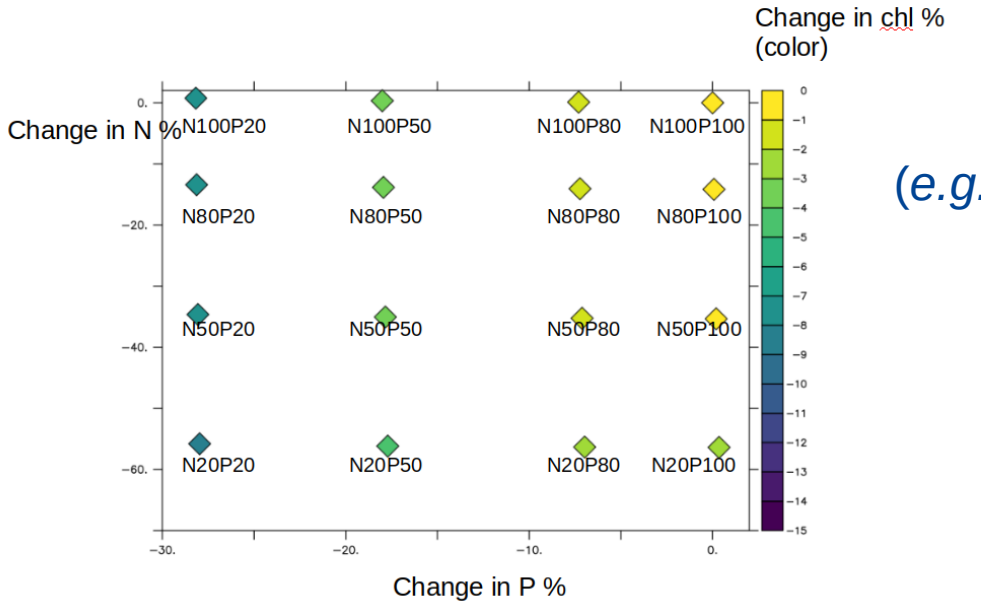


Populate the graph to the left so grey squares become coloured

Improve the interlinkages between different modelling tools and approaches: soil, air, land-use, agriculture

JRC Modelling framework: future work

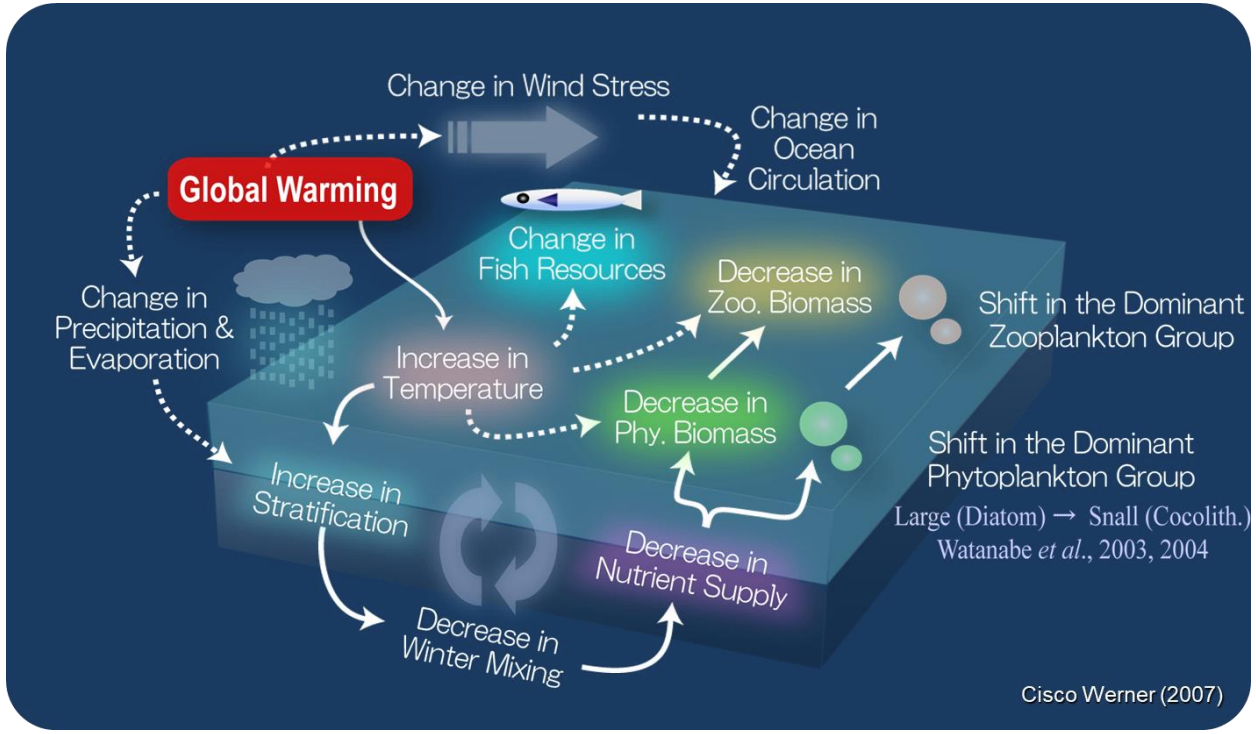
- Apply the same scenario analysis method to more MSFD descriptors → Evaluation, IA and Review of the directive
- Extension of the MMF modelling capacities
- Improve the policy-modelling connection (to evaluate the revision options)



(*e.g.,* helping assessing environmental targets)

JRC Modelling framework: future work

- Apply the same scenario analysis method to more MSFD descriptors → Evaluation, IA and Review of the directive
- Extension of the MMF modelling capacities
- Improve the policy-modelling connection (to evaluate the revision options)
- Help on the evaluation of climate change impacts



Climate change impacts multiple elements of the marine ecosystems

Non-linear interactions, negative feedbacks, complex bio-physical changes

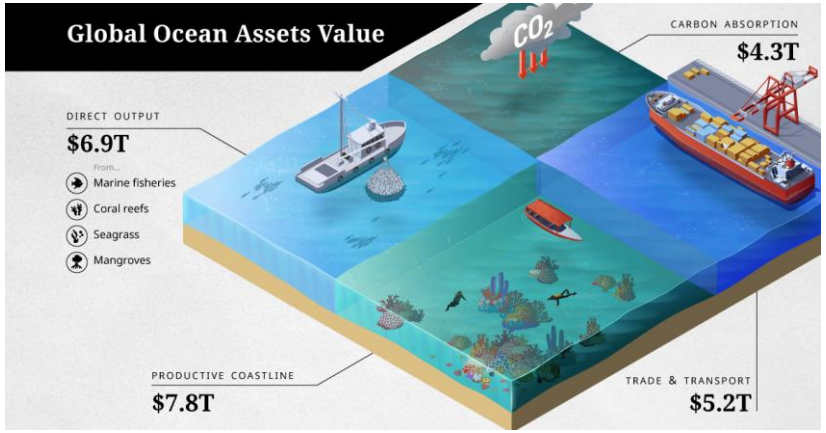
Identify:

- **D**s and **C**s of the MSFD most affected
- How deterioration of marine ecosystems impact the climate regulation role of the ocean

European Commission

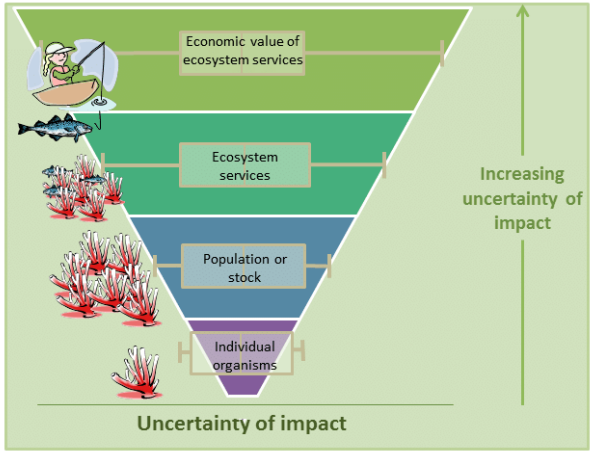
JRC Modelling framework: future work

- Apply the same scenario analysis method to more MSFD descriptors → Evaluation, IA and Review of the directive
- Extension of the MMF modelling capacities
- Improve the policy-modelling connection (to evaluate the revision options)
- Help on the evaluation of climate change impacts
- Help with the monetisation of the policy options (not only environmental impacts)



Supporting and facilitating role:

- *Contractors*
- *Network of experts*
- *Consultancy*



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JRC Modelling framework: future work

- Apply the same scenario analysis method to more MSFD descriptors → Evaluation, IA and Review of the directive
- Extension of the MMF modelling capacities
- Improve the policy-modelling connection (to evaluate the revision options)
- Help on the evaluation of climate change impacts
- Help with the monetisation of the policy options (not only environmental impacts)
- Keep on supporting overarching initiatives:

2022 → 2024

Publications:

- https://publications.jrc.ec.europa.eu/repository/handle/JRC123313
- https://publications.jrc.ec.europa.eu/repository/handle/JRC120378
- https://publications.jrc.ec.europa.eu/repository/handle/JRC126576
- https://publications.jrc.ec.europa.eu/repository/handle/JRC120213
- https://publications.jrc.ec.europa.eu/repository/handle/JRC130407
- https://publications.jrc.ec.europa.eu/repository/handle/JRC119937
- https://www.sciencedirect.com/science/article/pii/S0269749122009228?via%3Dihub
- https://publications.jrc.ec.europa.eu/repository/handle/JRC121280
- https://publications.jrc.ec.europa.eu/repository/handle/JRC117221
- https://publications.jrc.ec.europa.eu/repository/handle/JRC121731
- https://publications.jrc.ec.europa.eu/repository/handle/JRC120387
- https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4052482
- https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4052484

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