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MID-TERM POLICY BRIEF

Work Package 5
Synthesis, Overall Communication & Outreach

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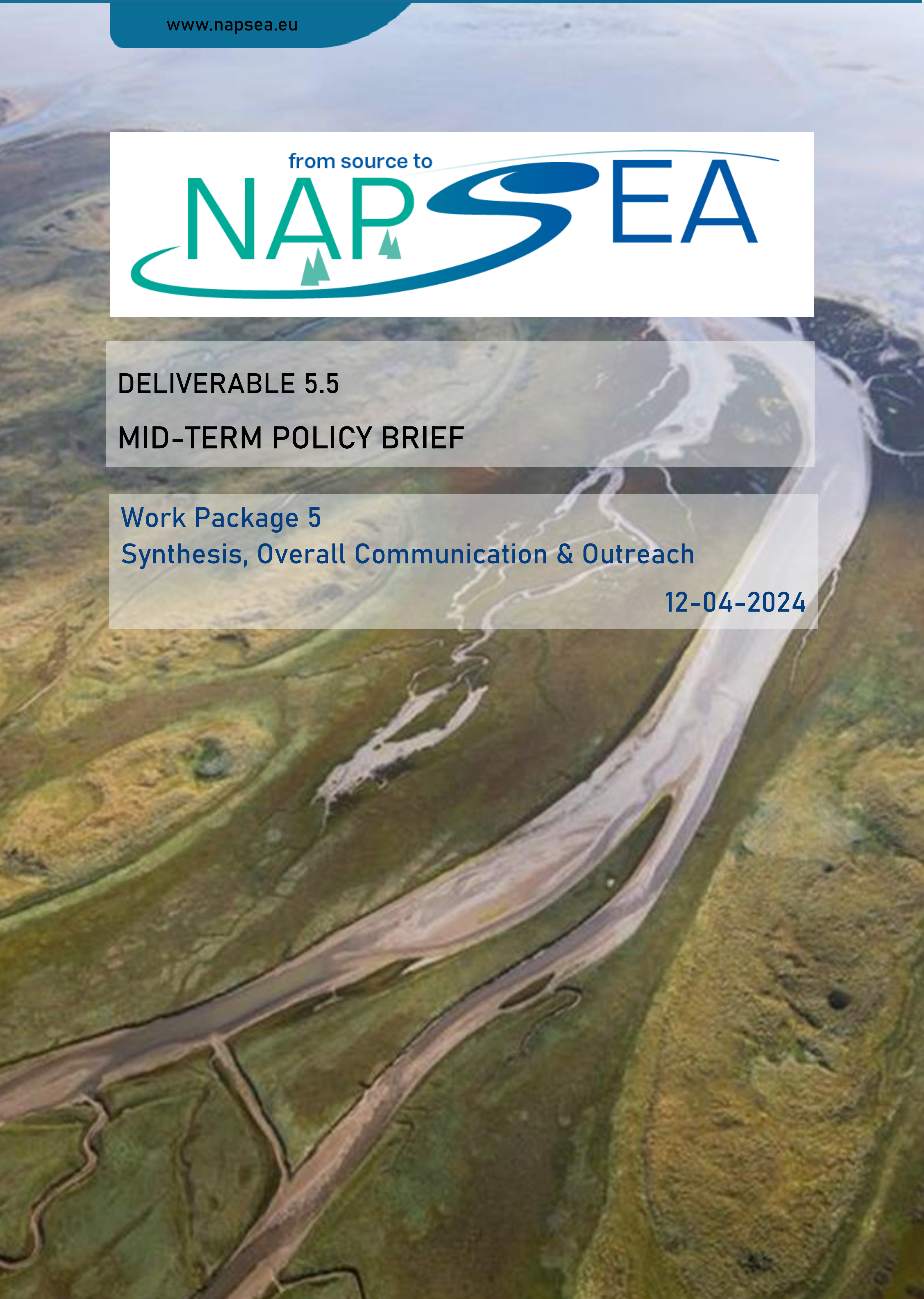

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Abstract	This policy brief describes the intermediate results of the NAPSEA project: Nitrogen (N) and Phosphorus (P) source to sea during the first half of the 3-year project. The NAPSEA project aims to support national and local authorities in selecting effective nutrient load reduction measures and to gain political support for their implementation.
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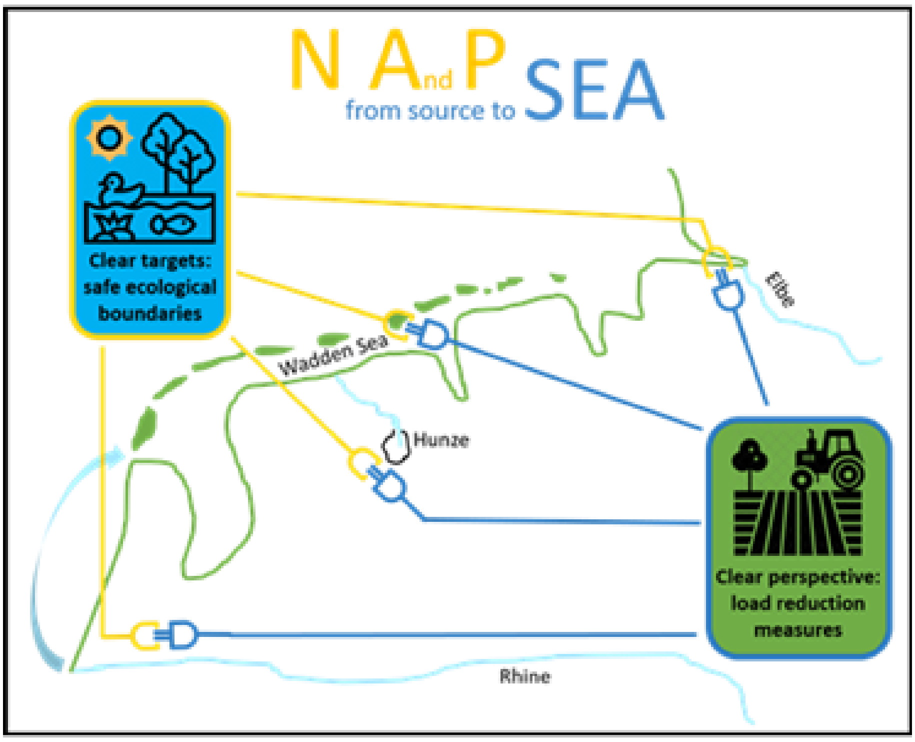

MID-TERM POLICY BRIEF

This policy brief describes the intermediate results of the NAPSEA project: Nitrogen (N) and Phosphorus (P) source to sea during the first half of the 3-year project. The NAPSEA project aims to support national and local authorities in selecting effective nutrient load reduction measures and to gain political support for their implementation. The project's geographical scope covers the catchment of the Wadden Sea, with case studies for the Rhine, Elbe and Hunze catchments and the Wadden Sea itself. NAPSEA will showcase best practices on the implementation of socially acceptable, sustainable and effective measures for these case studies. Effects of climate change and co-benefits of measures for reducing greenhouse gas emissions are taken into account.

THE EUTROPHICATION PROBLEM IN THE WADDEN SEA

The Wadden Sea is a UNESCO heritage site of great natural value that is shared by the Netherlands, Germany and Denmark. It is a tidal flats system along the coast separated from the North Sea coastal waters by a series of barrier islands. It receives freshwater input from several rivers. The nutrients in these rivers support the diverse food web of the Wadden Sea. The Wadden Sea is an important feeding area for migrating birds and nesting birds, a nursery ground for many species of fish and a habitat for shellfish and marine mammals. Seal populations on the tidal flats are a popular tourist attraction. Overall, the Wadden Sea is an attractive tourist destination and fishing area.

Nutrients support the food web, but the current nutrient loads are also a potential threat to the Wadden Sea ecosystem: the area suffers from an excess of nutrients and does not comply with Water Framework Directive objectives for eutrophication. Efforts to restore seagrass meadows are so far unsuccessful in large parts of the Wadden Sea. Therefore, we need to understand better how nutrient inputs to the Wadden Sea affect ecological conditions and to what extent nutrient reduction measures can improve ecosystem health.

THE NAPSEA APPROACH

NAPSEA will use an integrated approach to address nutrient pollution from source to sea, combining three complementary perspectives: governance, nutrient pathways & measures and ecosystem health, as illustrated in Figure 1:

1. The **governance** perspective evaluates the consistency and overall effectiveness of the relevant policy frameworks at different geographical scales (local, national, European).
2. The perspective of **ecosystem health** quantifies safe ecological boundaries of nutrient concentrations that will allow for a healthy ecosystem development.
3. The perspective of **pathways and measures** quantifies nutrient emission sources and their pathways to the Wadden Sea with models, to assess how nutrient loads are affected by nutrient reduction measures and climate change.

As expected outcomes of the project we aim to provide an evaluation of the effectiveness of the current implementation of relevant policies to reduce eutrophication impacts in the Wadden Sea and the upstream freshwater systems in the catchment, to not only comply with WFD eutrophication objectives but also contribute to the improvement of other ecological indicators and climate adaptation. Furthermore, we will provide recommendations for more socially acceptable nutrient reduction strategies and a more consistent and integrated policy implementation.

In this brief, we present for each perspective what it entails, describe some first results and look ahead to the second half of the project.

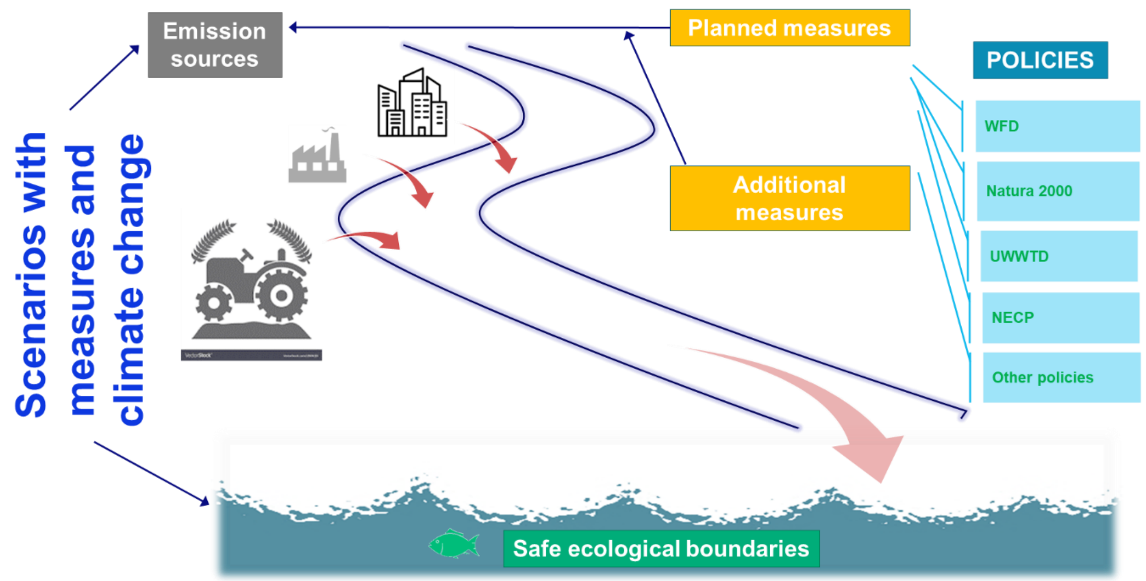

Figure 1: Schematic overview of interconnected activities in the NAPSEA project

Governance perspective

The overall effectiveness of the current policy frameworks and its implementation in the Wadden Sea and its catchment areas is evaluated by a fitness check of the policies. The fitness check is in progress[1].

The inputs of nutrients to surface waters are addressed by a wide range of national and European policy frameworks and initiatives. The combination of measures from all these policies determines the overall reduction of nutrient inputs to the Wadden Sea. The policy instruments are formed by different authorities, concern multiple economic sectors and apply to a variety of natural systems in the catchment areas, from rivers and lakes to coastal waters. Therefore, policies are not always consistent and/ or vary in how nutrient reduction is addressed. Some policies are source-oriented, such as the Urban Waste Water Treatment Directive (UWWTD), the National Emission reduction Commitments (NEC) Directive (affecting atmospheric deposition of N), the Nitrates directive (ND) and the zero-pollution action plan. Other policies target the ecosystem health of aquatic ecosystems, such as the Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD).

Lack of consistency between assessment frameworks for policies

We looked at the consistency of policies with an ecosystem approach by looking at the narratives behind environmental objectives and associated indicators and thresholds used in assessments A review of the assessment frameworks of WFD and MSFD highlighted the inconsistency of these policies[5]. A large set of indicators for the assessment of eutrophication status and the status of pelagic or benthic habitats is available across the legal assessment frameworks WFD and MSFD. But, due to different choices and definitions of objectives and indicators, only a limited selection is comparable across these frameworks and across the German-Dutch border. For example, indicators apply to different seasons or use different metrics. One of the few parameters that is comparable between policies is chlorophyll a, although it is not used as WFD indicator in Dutch river water bodies. The narratives behind the threshold values also vary, with different definitions of natural reference conditions and acceptable deviations. Therefore, a consistent gradient of threshold values for indicators, from land and freshwater to sea, is lacking.

Ecosystem Health perspective

Currently, WFD and MSFD use only a limited set of eutrophication indicators, such as: chlorophyll-a, nutrients and oxygen. NAPSEA aims to identify additional, more tangible, ecological indicators to express the broader impacts of eutrophication on ecosystem health[5]. Our review of currently used ecological indicators in WFD and MSFD identified the following ecological indicators that may be impacted by eutrophication: phytoplankton composition (e.g. blue-green algae), macrofauna species composition and abundance, and macroalgae and angiosperms. For these indicators the feasibility of defining safe ecological nutrient concentrations will be explored in the case studies. For some of these indicators earlier attempts to find straightforward correlations with nutrients have not succeeded. Therefore, we will explore more complex models, including other ecosystem characteristics than nutrients as well. These will be merged into a coherent set of indicators for safe ecological boundaries in the river-sea continuum.

First results on the relation between seagrass cover and eutrophication status show that seagrass recovery was more successful in areas with low chlorophyll concentrations along the coast of Schleswig-Holstein and Denmark (NFWS and DWS in Figure 2) than in other areas of the Wadden Sea, pointing to a potential impact of eutrophication[7,8].

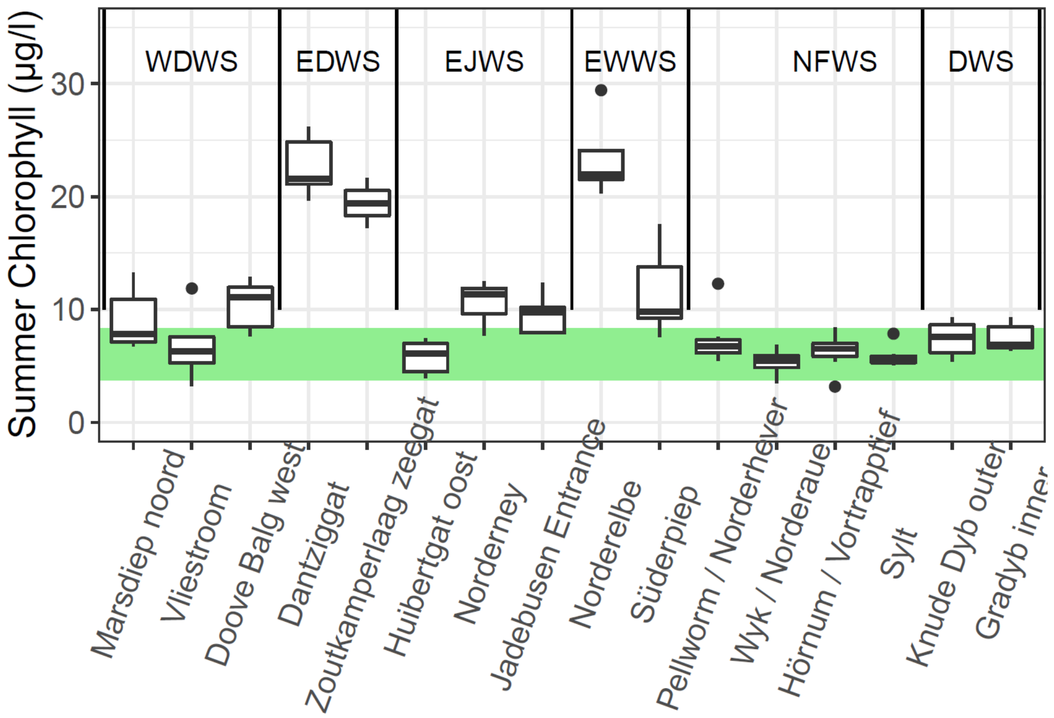

Figure 2: Ranges of chlorophyll-a concentrations observed at monitoring sites along a gradient from west to east in the Wadden Sea. The green bar indicates chlorophyll levels corresponding to ranges observed the northern Wadden Sea (NFWS and DWS) with successful seagrass recovery[7].

Figure 3: Picture of seagrass overgrown by macro-algae in the Wadden Sea[8]

Pathways and measures perspective

From the pathways and measures perspective, we are quantifying the main sources of nutrients in the Wadden Sea and the effects of reduction measures on improving ecosystem state.

Main riverine nutrient sources to the Wadden Sea

The contribution from different rivers to nutrient concentrations in the Wadden Sea[6] (Figure 4) show that Rhine and Elbe rivers are the main sources of nutrients, although other rivers are also important. The Rhine river has two main outflow locations in the Dutch delta near Rotterdam (grouped under cluster NL_south together with the Meuse outflow) and a smaller river branch flowing directly into the Wadden Sea through Lake IJssel (NL_north). River water discharged near Rotterdam flows northward along the coast to reach the Wadden Sea. Other riverine inputs (such as the Seine river) are also transported with this coastal current and contribute through exchange between the Wadden Sea and coastal waters. In addition, direct atmospheric deposition is a considerable nitrogen source in the Wadden Sea.

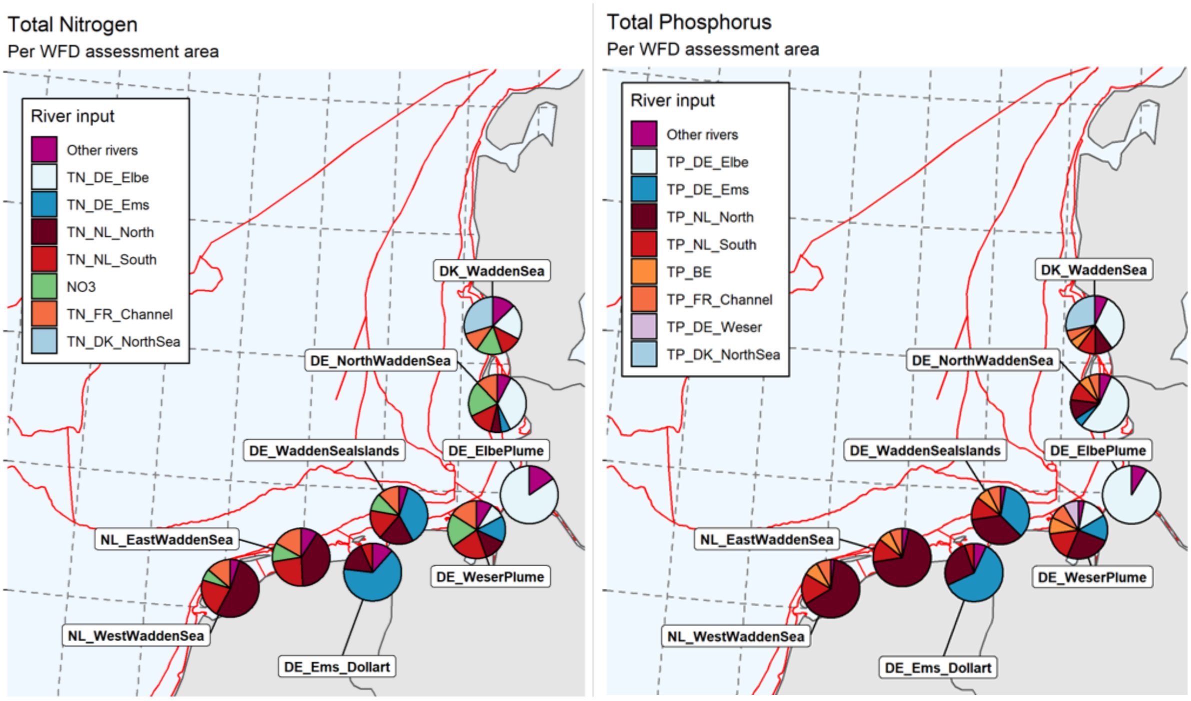

Figure 4: Contribution (%) of rivers and atmospheric deposition to total anthropogenic nutrient inputs to the WFD assessment areas of the Wadden Sea. The contribution from the Atlantic Ocean is excluded from these figures and amounts to approximately 20% for total nitrogen and 50% for total phosphorus

Main emission sources to the Elbe and Rhine

We compiled the contribution of the main emission sources in both the Netherlands and Germany to the nitrogen and phosphorus loads of the largest rivers (Rhine and Elbe), based on a review of available reports and databases[2] (Figure 5). The results show that agriculture is the main source for both nitrogen and phosphorus. Urban wastewater is an important source, particularly for phosphorus. Atmospheric deposition on freshwater contributes only a small part of total nitrogen loads from the Rhine and Elbe.

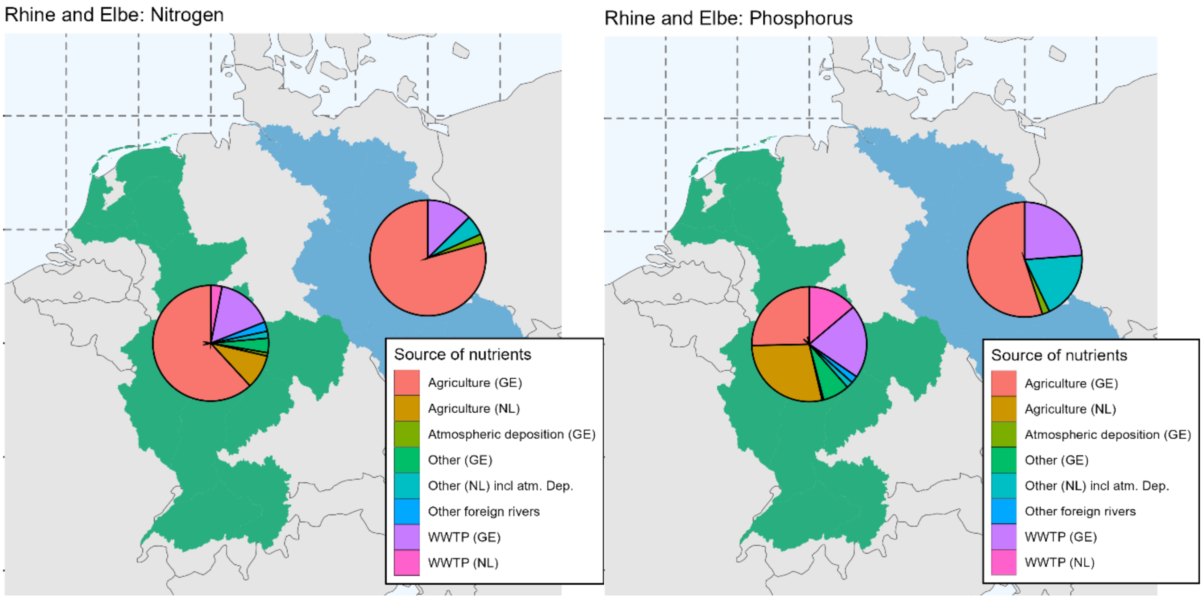

Figure 5: Estimated contribution (%) of sources from Germany and the Netherlands in the total nitrogen and phosphorus loads of the Rhine and Elbe rivers.

Models can simulate the link between emissions and nutrient concentrations in water

In NAPSEA, catchment models for the Rhine and Elbe basins have been developed and calibrated to reproduce historic trends over the last decades and recent conditions (2010-2020) of nitrogen concentration and loads as well as recent phophorus concentration and loads. The models quantify terrestrial removal and retention of N as well as instream retention of N and P from point and diffuse sources. The catchment models will provide input to Wadden Sea models to simulate the source to sea pathways of nutrients.

We will use these models to evaluate the effectiveness of measures to reduce nutrient inputs from the Rhine and Elbe to the Wadden Sea. We will run model scenarios including planned measures by the relevant policies and climate change to see if these will be sufficient to meet safe ecological boundaries for nutrients in the Wadden Sea and its catchment. If not, additional measures will be evaluated. The precise definitions of the scenarios will be discussed with stakeholders in workshops in spring 2024 for the Elbe, Rhine and Hunze case study areas.

Overview of planned measures

We have completed a literature review of currently planned measures and their expected effectiveness for nutrient reduction from different sources[2]. The evaluation showed that for nitrogen intensive agriculture with its high nitrogen surplus on agricultural soils, tile drainage and subsurface flow are the dominant pathways, while for phosphorus urban sources including wastewater treatment plants as point sources are at least equally important as the agricultural input. Atmospheric nitrogen deposition on water is mostly relevant for coastal and marine waters. Effectiveness of measures affecting losses from agriculture strongly depends on where and how these are implemented. Voluntary implementation leads to broader acceptance by farmers but reduces their effectiveness. The Soil Health Law would require a substantial reduction of soil erosion to achieve a "tolerable" soil loss on arable land. Less erosion would also result in lower phosphorus input to surface waters. Based on the current trends of atmospheric emissions of ammonia from agriculture and nitrogen oxides from traffic and industry, reaching the national emission targets seems feasible.

We use the information on planned measures as input to the model scenarios on the effectiveness of planned nutrient reduction measures. The programs of measures often describe measures in an aggregated way, comprising a range of specific measures. The effectiveness of these measures will depend on the specific sites, farm type and methods applied. All this contributes to uncertainty in any assessment of measure effects at the basin scale. We will discuss with the stakeholders how to deal with these uncertainties in the definition and interpretation of model scenarios.

FIRST CONCLUSIONS AND NEXT STEPS

We have created a joint overview, for Germany and the Netherlands, of the nutrient emissions and planned nutrient reductions in the main rivers inputs to the Wadden Sea,. The planned measures still need to be elaborated in more detail which leaves uncertainty about their effectiveness but also leaves room to optimize their implementation. We developed models that can quantify the sources and pathways of nutrients from emission through the catchments and coastal waters to the Wadden Sea. The nutrient pathways between Germany and the Netherlands are strongly linked, with nutrients flowing from Germany to the Netherlands with the Rhine and returning to the German Wadden Sea with the coastal current. Although the nutrient pathways are closely linked between freshwater and marine waters, the assessment frameworks are inconsistent along the land-sea continuum and use only a limited number of indicators for eutrophication. We have started to quantify the link between nutrients and other ecological indicators, such as seagrass.

We recommend to apply an integrated transboundary approach for the selection and implementation of measures. It should clarify the impact of measures in the whole catchment of the Wadden Sea on ecological indicators that are more tangible for the public than chlorophyll-a. This would provide a transparent scientific basis for the selection of a set of measures with optimal effectiveness and social acceptability. During the remainder of the project we will further elaborate this integrated approach in close collaboration with stakeholders. Both the model scenarios, safe ecological boundaries and social acceptability of measures will be discussed with relevant stakeholders in workshops.

MORE INFORMATION

More information about the NAPSEA project can be found on the project website: napsea.eu. All project deliverables summarized in this policy brief can be downloaded from there and one can subscribe to our newsletter for updates on our progress.

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