Study on Integrating an Ecosystem-based Approach into Maritime Spatial Planning

Netherlands Case Study:

Assessing the economic and the ecological impacts, costs and benefits of spatial plans for the North Sea

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Geographical context

The Greater North Sea, situated on the continental shelf of north-west Europe, is one of the world's busiest maritime areas. It opens into the Atlantic Ocean to the north and, via the English Channel to the south-west, and into the Baltic Sea to the east. The Greater North Sea (including its estuaries and fjords) has a surface of about 750 000 km^2 and a volume of about 94 000 km^3, with depths not exceeding 700m. The seabed is mainly composed of mud, sandy mud, sand and gravel. The variety of marine landscapes, i.e. fjords, estuaries, sandbanks, bays, or intertidal mudflats, is important for biodiversity which, in turn, can sustain the social system including economic activities.

The Greater North Sea is surrounded by densely populated, highly industrialised countries. Major activities in the North Sea include fishing, the extraction of sand and gravel, and offshore activities for the exploitation of oil and gas reserves, including the laying of pipelines. One newly emerging activity is renewable energy, mostly from offshore windfarms. In terms of shipping, the North Sea is also one of the most frequently traversed sea areas of the world, and the coastal zone of the Greater North Sea is heavily influenced by recreation and also by run-off from land-based activities, including agriculture.

Biological systems in the Greater North Sea are rich and complex. Approximately 230 species of fish are known to inhabit the area. Some 10 million seabirds are present at most times of the year and several marine mammal species occur regularly over large parts of the North Sea.

This case study considers the marine spatial planning (MSP) process applied in the Dutch Exclusive Economic Zone (EEZ), which covers 57 000 km^2, almost 8% of the Greater North Sea. A key issue for the Dutch MSP process is the siting of offshore wind facilities and their impacts. The case study describes part of the process to guide the planning of offshore windfarms while balancing the demands for space from renewable energy with those for sustainable food (primarily fisheries) and nature conservation (N2000 areas).

Cross-cutting issues addressed in the case study

Here it is important to distinguish between (1) the overall Dutch MSP process which was primarily about cross-sectoral participation and (2) the focal point of this case study involving the application of specific tools as part of the science-policy interface in this process. The latter took place in the period from February to June 2020, when the government requested scientific bodies covering the socio-economic and natural sciences to perform a first assessment of different scenarios for the spatial plans of the North Sea that emerged from the overall process.

Methods and tools addressed

This case study outlines the overall MSP process in the Netherlands, but its focus is on the science-policy interface and more specifically work that (as part of the overall stakeholder participation process) was intended to evaluate the socio-economic and environmental consequences of the various MSP scenarios through a "Trial Integrated Assessment" (called hereinafter the "Trial IA"), which involved the application of three specific tools: a *Mental model*, *Cumulative Impact Assessment (CIA)* and *Cost-benefit analysis (CBA)*. The results of the project were intended to show how MSP could support the achievement of Dutch policy objectives for the North Sea including increased energy from renewables, i.e. offshore wind, while considering trade-offs with food production, i.e. fisheries, and environmental conservation, also in light of the requirement to achieve and maintain good environmental status (GES) set by the EU's Marine Strategy Framework Directive.

Key conclusions and recommendations

With the overall MSP process the Dutch government succeeded in bringing together parties that usually do not actively cooperate with each other, like fisheries organizations, environmental NGOs and windfarm developers. The Trial IA brought-in scientific knowledge and analysis, albeit at a later stage with the North Sea Agreement stakeholder participation process already well underway.

The government's initial request was for a Trial IA to give a first indication of the potential socio-economic and environmental consequences of alternative options for the long-term spatial planning of the Dutch part of the North Sea – in particular, alternatives for the siting of wind power – and the requirements for the knowledge base for further analysis. It was hoped that this would help to identify best spatial planning solutions. Due to gaps in data and methods this was not possible and, therefore, the study was complemented by a separate expert analysis for a spatially explicit assessment of the potential ecological impacts of alternative options. This fairly crude expert analysis confirmed the findings of the CIA: differences in the economic and ecological impacts between the various alternative options were not sufficiently distinctive to be able at present to identify a preferred spatial planning scenario for the North Sea.

The Trial IA was part of an adaptive planning cycle where the Trial IA should be considered as a preliminary *assessing* step which, as part of the stakeholder participation process, generated an input into what can then be considered the next cycle. In particular, the outcome helped to identify the knowledge base requirements that need to be further developed. The Trial IA succeeded in revealing the shortcomings of the current CIA. It is assumed that these can be (partly) circumvented once the best information that is currently available is incorporated in the CIA.

The government (has) put great effort in bringing sectoral and NGO stakeholders to the table at an early stage of the process, with the science sector present as well. However, the MSP process was conducted under great time stress resulting in, according to the scientists involved, only preliminary results which need to be reconsidered at a later stage of the process. The latter is also foreseen in later phases of the process, such as when the actual locations for new windfarms will have to be decided upon.

Probably the main lesson learned from this case study is that the application of the 5-step MSP process to clarify between both parties (i.e. the client/policy and science) where and how this Trial IA fitted in the overall MSP process could have avoided several misunderstandings between the science and policy partners and hence benefitted the process. From the application of the Trial IA in a preliminary *assessing* step it has become clear what knowledge needs to become available in a future *developing* step to ascertain (or at least improve the chances) that the CIA could have distinguished between the alternatives for siting wind power and hence provided guidance for the MSP.

The recommendation is therefore to make sure all parties are aware of the process and how specific meetings/analyses/projects fit into this process. Pertaining to the analytical tools, this case study has shown the dependency of the assessment tools, such as CIA and CBA, on adequate information in the knowledge base. The mental model proved useful to clarify with the client which sectoral activities could be considered in the assessment: on this basis, key activities were included for analysis in the Trial IA.

1 INTRODUCTION

This case study was carried out as part of the *Study on integrating an ecosystem-based approach into maritime spatial planning*, a project for the European Commission (DG MARE and EASME)[1]. The case study is part of the marine spatial planning (MSP) process applied in the Dutch Exclusive Economic Zone (EEZ) and the territorial sea to guide the planning of several activities, with a focus on offshore windfarm developments. The case study outlines the overall process, mostly a cross-sectoral participation process, and then focuses on the involvement of science, in particular through a project that employed several analytical tools that can support the ecosystem-based approach (EBA).

The case study describes and evaluates the extent to which ecosystem-based approaches (EBA) were applied and it draws lessons to be learned from this case study that can guide future EBA-MSP initiatives. The case study relates to the key elements of the practical approach used in the overall study, including the five key steps for an EBA-MSP and several of the methods/tools that are proposed as part of this approach.

At the core of this case study is the Trial Integrated Assessment (IA), conducted via the "*Kentallen analyse"* project (Roebeling et al., 2021a), which took place in the first half of 2020: the Trial IA aimed to provide insight into the economic and ecological effects of four future spatial scenarios on the North Sea usage functions. This project was part of a larger process (see Chapter 2 and in particular Figure 3), including parallel studies, expert workshops, webinars and meetings: where needed and possible, this case study report refers to the larger process. The case study describes the lessons learned in terms of process and notably the applications of the following tools: *mental model*, *cumulative impact assessment (CIA)* and *cost-benefit analysis (CBA)*. (These and other terms are briefly explained in the glossary, Annex I.) It also describes the cross-cutting processes of stakeholder participation.

Links with other projects and processes

The Trial IA has a direct link with a separate Dutch project on the cost-benefit analysis of further development of offshore wind in the Dutch sector of the North Sea. In parallel, Statistics Netherlands (CBS) has been investigating whether and how natural capital accounts can be prepared for the Dutch continental shelf (DCS). In 2019, CBS prepared a report on *Natural capital accounts for the North Sea: The physical SEEA EEA accounts* (CBS, 2019), to test the development of the physical System of Environmental Economic Accounting (SEEA) – Experimental Ecosystem Accounting (EEA) for the Dutch part of the North Sea.

Steps and timeline

The work for this case study consisted primarily of desk research, a review of relevant sources of information, and of interviews to collect key information from national policy makers two representatives of the Ministry of Infrastructure and Water Management, specifically in *Rijkswaterstaat*, an executive agency of the Ministry in charge of water management and water safety.

[1] The project was contracted by the Executive Agency for Small and Medium-sized Enterprises (EASME), which in 2021 became The European Climate, Infrastructure and Environment Executive Agency (CINEA)

The case study authors

The authors of this case study report also worked on the Trial IA. This report presents the views of the authors alone. It has been revised following comments from officials of the European Commission (DG MARE) and of the Dutch MSP authorities.

2 DUTCH MSP PROCESS

2.1 Dutch Policy Framework for the North Sea

The Dutch EEZ of the North Sea is part of the southern North Sea. It is intensely used. In the future, higher demand for offshore renewable energy and for sand to strengthen the coast is foreseen. In order to avoid conflicts with the environment and between users, in 2005 the Dutch government introduced a new spatial planning framework for the coordination of these developments. Maritime Spatial Plans have been developed since 2009, and at a regular interval of 6 years these plans are revised based on new knowledge and experience acquired, as well as to address new societal demands. Section 2.2 provides an overview of legislation that is currently in place.

As the underlying legislation has to be renewed – notably, the existing Water Act of the Netherlands is to be replaced by and subsumed into a new Environmental and Planning Act – a North Sea Programme is current underway. This includes formulation of future visions for the North Sea (North Sea 2050 Spatial Agenda) and the preparation of the Marine Spatial Plan for the period 2022-2027. Stakeholders are strongly involved. A review of the developments in the last two decades as well as the aims for the future marine spatial planning in the Dutch part of the North Sea is given by de Vrees (2019).

The North Sea Programme is described in more detail in Section 2.3. The Trial IA project was part of the North Sea Programme and the overall Dutch MSP process. Background information on Trial IA is given in section 3.2.

2.2 Key legislation

2.2.1 European legislation

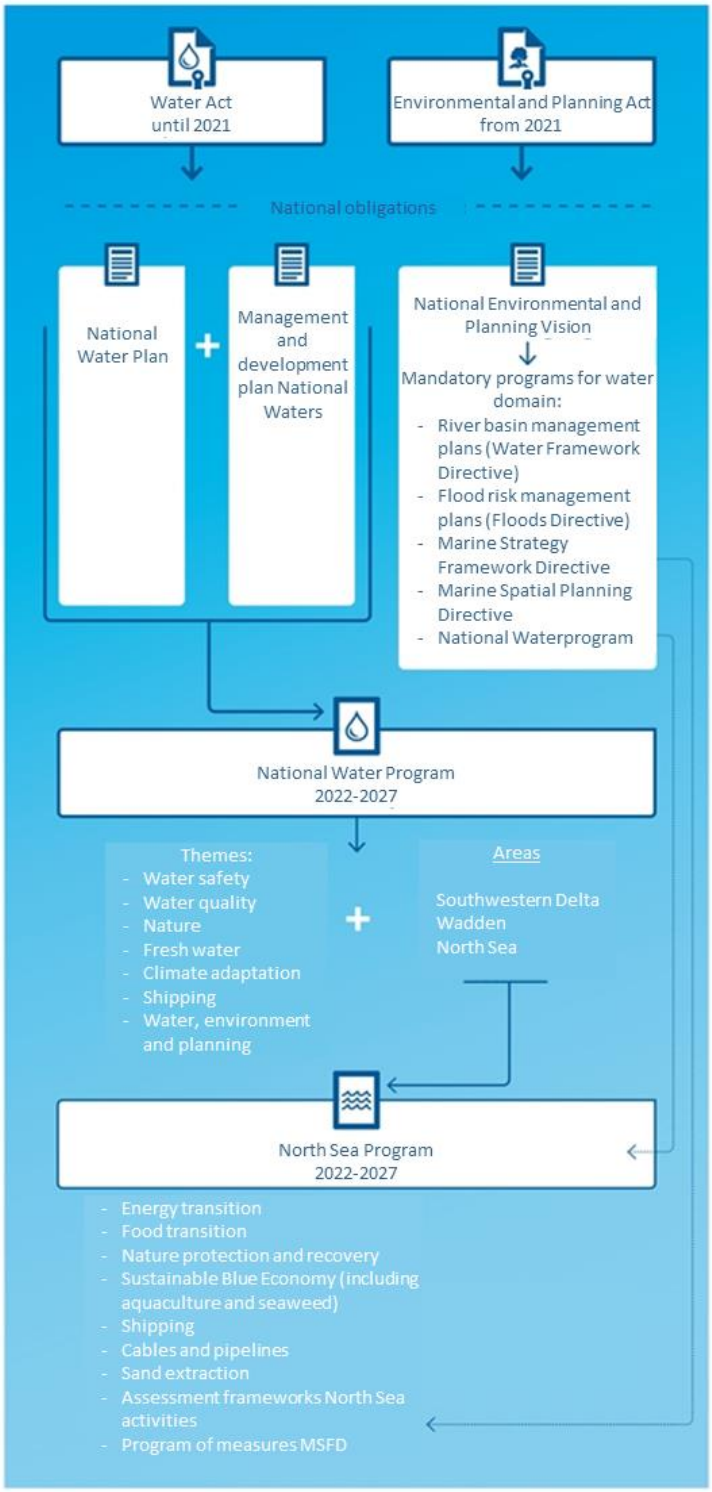
Several EU Directives would appear to apply directly: obviously the MSP Directive, and this refers to synergies with other EU legislation such as Strategic Environmental Assessment (SEA) Directive (2001/42/EC); the Marine Strategy Framework Directive (MSFD) (2008/56/EC); the "Nature Directives", i.e the Birds Directive (BD) (79/147/EC) and the Habitats Directives (HD) (92/43/EEC); the Water Framework Directive (WFD) (2000/60/EC). A key policy document, the EU 2020 Biodiversity Strategy (COM(2011) 244) and its follow-on, the EU Biodiversity Strategy for 2030 (COM/2020/380) are also important.

The MSP Directive specifically refers to the need to follow the SEA Directive for plans that are likely to have significant effects on the environment. It calls for an ecosystems-based approach and contains provisions on public participation. The SEA Directive sets out a stepwise process – including screening, scoping and the preparation of an environmental report. It should be noted that, while the Directive sets certain requirements for these steps, it does not set out the process in details. For example, the SEA Directive does not formally define the scoping process – its organisation is at Member States' discretion – and the only obligation is that authorities with specific environmental responsibilities and that are likely to be concerned by the environmental effects of implementation plans and programmes are consulted on the scope of the environmental Report. While the SEA Directive does not specifically refer to other EU legislation, 2013 guidance published by the European Commission highlights the role that SEA can play in supporting the implementation of biodiversity legislation as well as policies such as the Biodiversity Strategy[2]. The SEA Directive also has a clear link to the Directive on Environmental Impact

[2] See: https://ec.europa.eu/environment/eia/pdf/SEA%20Guidance.pdf

Assessment (EIA) (which in turn is cited under the MSP Directive). When a plan is approved, projects identified or allowed under the plan will be prepared. For example, new offshore wind farms can be proposed for designated areas. For many types of projects, including wind farms, an EIA needs to be conducted to analyse the potential consequences and to find alternatives if necessary.

Figure 1: Dutch policy framework for the North Sea



Source: https://www.noordzeeloket.nl/beleid/interdepartementaal/idon-nieuwsbrief/nr-33/ruimtelijke- programmering-waterdomein/

The MSFD was adopted with the objective to protect and preserve the marine environment, prevent its deterioration and restore the environment in areas where it has been adversely affected. Both the MSP Directive and MSFD identify policy goals related to ecosystems that need to be considered in maritime spatial plans, including good environmental status under the MSFD as well as the goals of other EU environmental legislation and policies. The EU adopted the BD in April 1979 with the objective to commit to the protection of all wild bird species naturally occurring within the EU. The HD was adopted in May 1992 with the objective to conserve natural habitats and wild fauna and flora in the European territory of the Member States to which the treaty applies. The EU BD and HD require the Member States to implement two main sets of provisions. The first set of measures requires Member States to establish a strict protection regime for all wild European bird species, plus other endangered species listed in Annex IV of the HD, both inside and outside protected sites. The second set requires the designation of core sites for the protection of species and habitat types listed in Annex I and II of the HD and Annex I of the BD, as well as for migratory birds. Together, these designated sites form part of a coherent ecological network of nature areas, known as the European Natura 2000 Network.

2.2.2 National legislation

In the Netherlands, MSP is included in the Water Act (Figure 1). Under the Water Act, the policy framework is elaborated in the *National Water Plan* and *the Management and Development Plan for the National Waters*, including the *Policy Document for the North Sea* as an independently readable appendix. The *Policy Document for the North Sea* includes the Netherlands' Maritime Spatial Plan and reflects the Dutch Government's policy choices for the North Sea (Figure 1). The Dutch National Government acted in accordance with the requirements of the MSP Directive when formulating the *North Sea Policy Document* (Platjouw, 2018). The spatial policy is development oriented, leaving room for changes and adaption, but with an agenda made by the national government to fulfil the agreed objectives, such as the urgency to find space for renewable energy at sea (de Vrees, 2019).

Every six years, the *National Water Plan* and related documents are revised. The first *National Water Plan* was published in 2009 and the second, for the period 2016–2021, was adopted in December 2015, including the *Policy Document for the North Sea*[3]. Despite intensive consultation processes, not all stakeholders are always satisfied with the result. The biggest challenge for the near future is to find solutions for the societal demands that also can be supported by the fishing sector (de Vrees, 2019).

The Dutch Water Act will be replaced by the Environment and Planning Act (hereafter EPA). The EPA will not only replace the Water Act, but many other existing legislative acts concerned with environmental law. Although the EPA has already been adopted (Staatsblad, 2016, 156), it will not enter into force before all necessary implementing legislation is adopted (expected in 2022 (Oude Elferink, 2020)). The *National Water Programme 2020-2027* (NWP), and as part of it the revised *Policy Document on the North Sea*, is being prepared under the legal regime of the Water Act. The NWP 2022-2027 is the successor to the *National Water Plan 2016-2021* and the *Management and Development Plan for National Waters 2016-2021*, thereby merging these two plans and anticipating to the new EPA that includes the NWP as one of its instruments.

The NWP 2022-2027 provides the integral framework for central government water policy. It describes the main outlines of the national water policy and management for the period 2022-2027 (including North Sea policy) and provides a perspective to 2050. The transitional provisions in the EPA provide for the NWP 2022-2027 to be divided into a

[3] The Dutch Ministry of Infrastructure and the Economy and The Dutch Ministry of Environmental Affairs, 2015

number of mandatory programmes, including the *Programme of Measures* of the *Marine Strategy* (under the MSFD) and the *maritime spatial plan* (under the MSP Directive).

The *Policy Document on the North Sea*, part of the NWP, see (Figure 1) is part of the Dutch implementation of the Paris Climate Agreement plus national accords included in the Dutch Climate Agreement. The Document also implements the EU's MSFD and international frameworks for the marine environment such as the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention'). The *Policy Plan on the North Sea* is a spatial plan in accordance with the requirements of the MSP Directive, and it also contains the Programme of Measures under the MSFD.

A broad range of sectoral and national maritime interests are affected by the *Policy Document on the North Sea*:

- Mobility system / shipping;
- National security and military activities;
- Energy supply;
- Water safety and climate resilience;
- Food and agro production;
- Cultural heritage, landscape and nature;
- Nature and biodiversity;
- Fishing.

The key legal Acts that govern these interests and activities are listed in Table 1.

Table 1: Dutch legislation affecting the North Sea

Dutch legislation applicable for the North Sea (English)	Dutch titles of the legislation
Shipping Traffic Act	Scheepvaartverkeerswet
Prevention of Pollution from Ships Act	Wet voorkoming verontreiniging door schepen
Water Act	Waterwet
Environment and Planning Act (EPA)*	Omgevingswet
Soil Protection Act	Wet bodembescherming
Mining Act	Mijnbouwwet
Mining Decree	Mijnbouwbesluit
Basic Registration of Subsurface Act	Wet basisregistratie ondergrond
Earth Removal Act	Ontgrondingenwet
Spatial Planning Act	Wet ruimtelijke ordening
Laws of environmental Conservation	Wet milieubeheer
Environmental Impact Assessment Decree	Besluit milieueffectrapportage
Environmental Law General Provisions Act	Wet algemene bepalingen omgevingsrecht
Nature Conservation Act	Wet natuurbescherming
Fisheries Act	Visserijwet
Heritage Act	Erfgoedwet
North Sea Installations Act	Wet installaties Noordzee
Offshore Wind Energy Act	Wet windenergie op zee
Wreck Act	Wrakkenwet

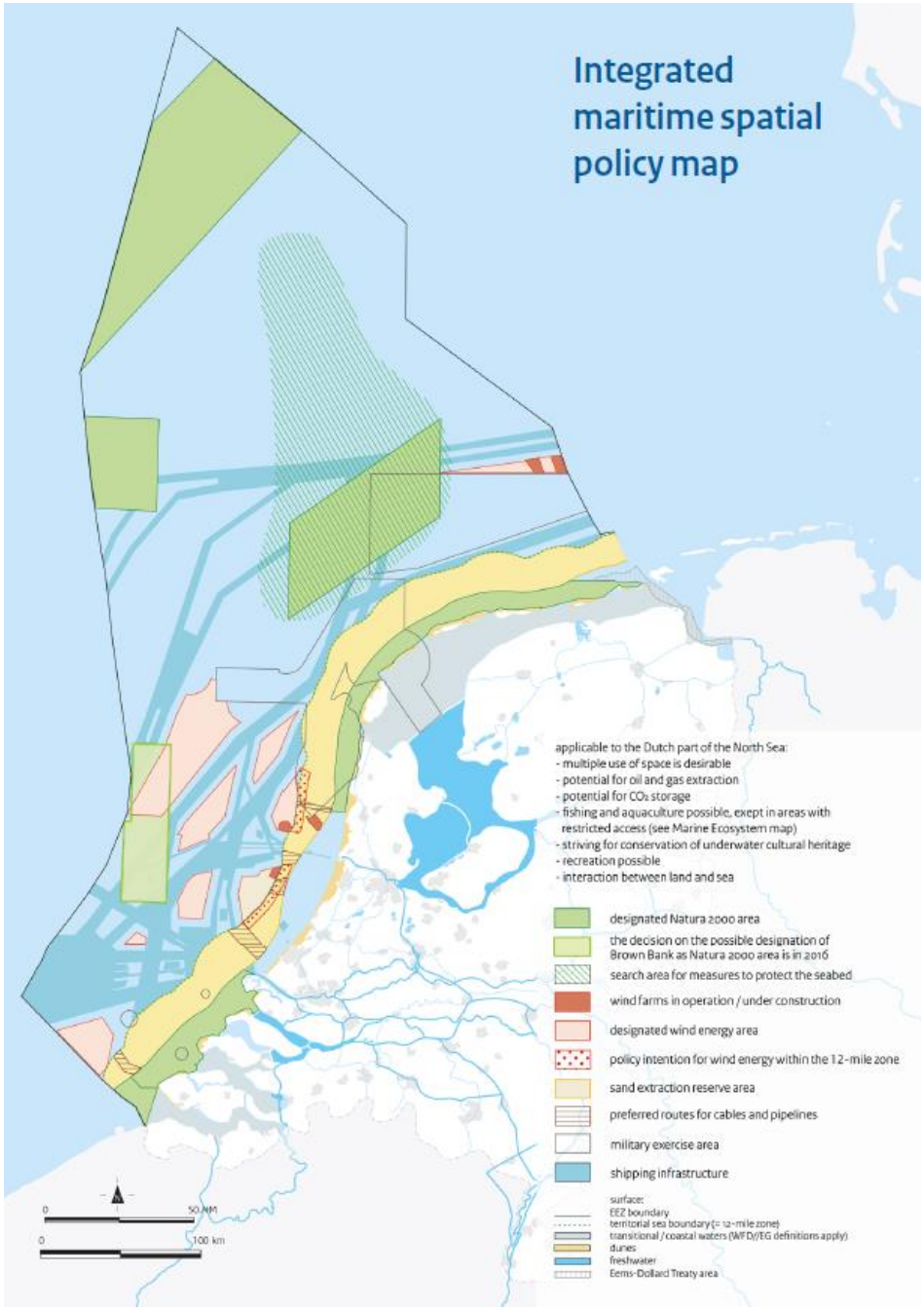
Dutch legislation applicable for the North Sea (English)	Dutch titles of the legislation
Maritime Accidents Control Act	Wet bestrijding maritieme ongevallen
Statutory Act establishing an exclusive economic zone	Rijkswet instelling exclusieve economische zone

Source : Oude Elferink, 2020

* The EPA was adopted in 2016 and is expected to enter into force in 2022. The EPA will replace (parts of) other laws, i.e. Water law, Earth Removal Act, Nature Conservation Act, Environmental Law General Provisions Act, Public Works Management Act, Soil Protection Act, Laws of environmental Conservation, Spatial Planning Act, Wreck Act, Heritage Act and Mining Act.

The 2015 maritime spatial plan allocated a large share of the Dutch EEZ to these different activities (see Figure 2 below). The upcoming and revised MSP, however, will – as already indicated – have to accommodate further sectoral policy needs, and in particular those related to renewable energy: consequently, the plan will need to find additional space for offshore windfarms.

Figure 2: Integrated maritime spatial policy map



Source: The Dutch Ministry of Infrastructure and Economy and The Dutch Ministry of Environmental Affairs, 2015

Responsible authorities

In the Netherlands, the Dutch Ministry of Infrastructure and Water Management is responsible for MSP by managing and coordinating the Integrated North Sea Policy (European MSP Platform, 2020). The Interdepartmental Directors' Consultative Body North Sea supports the Minister when it comes to elaborating the Integrated North Sea Policy and is considered to be the lead planning agency. Other ministries represented in this body include the Ministry of Economic Affairs and Climate; the Ministry of Agriculture, Nature and Food Quality; Ministry of Internal Affairs; Ministry of Defence; Ministry of Education, Culture and Science; and the Ministry for Finance.

The box below summarises the authorities and the planning documents for MSP in the Netherlands.

MSP authorities and legislation in the Netherlands

Planning at national level

- The Central Government's North Sea Policy sets out a framework for the spatial use of the North Sea in relation to the marine ecosystem (as part of the governance structure for integrated maritime policy).
- The North Sea Policy document applies to the Dutch EEZ and the non-administratively classified Territorial Sea.
- The National Water Plan explicitly mentions land-sea interaction.

National MSP authority

- Interdepartmental Directors' Consultative Body North Sea led by the Ministry of Infrastructure and Water Management.

Source: European MSP Platform, 2020

2.3 North Sea Programme

The *North Sea Programme 2022-2027*, commissioned by the Interdepartmental Directors Committee for the North Sea (*Interdepartementaal Directeuren Overleg Noordzee*, IDON), is developed by the Minister of Infrastructure and Water Management (I&W) in collaboration with the Ministers of Agriculture, Nature and Food Quality (LNV), Interior and Kingdom Relations (BZK) and Economic Affairs and Climate (EZK) as far as the policy areas of these departments are concerned (see Table 2). By matching relevant subjects to departmental expertise areas, working groups were defined for the following topics:

- Strengthening marine ecosystems (lead LNV and I&W),
- Sustainable use of the North Sea (lead I&W);
- Transition towards sustainable energy (lead EZK);
- Transition to sustainable food supply (lead LNV):
- Sustainable blue economy (lead LNV): and
- Spatial planning (lead I&W and BZK).

Relevant stakeholders were invited to participate in these working groups. New in this Programme is the integration of the management plans (often implemented by *Rijkswaterstaat*) with the policy plans.

Table 2: Organisation of the North Sea Programme 2022-2027

Organisation	Role
Interdepartmental Directors North Sea Consultative Body (IDON)	Coordinates North Sea policy making. Commissioner who requested a North Sea Programme 2022-2027
Minister of Infrastructure and Water Management (I&W)	Coordinator North Sea Programme 2022-2027
Ministers of: • Agriculture, Nature and Food Quality (LNV) • Interior and Kingdom Relations (BZK) • Economic Affairs and Climate (EZK)	Working group leaders: • Strengthening marine ecosystems • Sustainable use of the North Sea • Transition towards sustainable energy • Transition to sustainable food supply • Sustainable blue economy • - Spatial planning
Stakeholders: • energy sectors (oil&gas; wind energy; etc.) • sand extraction • shipping and ports • fisheries and aquaculture • recreation sectors (coastal) • nature and environmental organizations	Participants

Development of *North Sea Programme 2022–2027*

The Interdepartmental Directors North Sea Consultative Body (IDON) stated in their Plan for development of a *North Sea Programme 2022-2027* (In Dutch: *Plan van aanpak Programma Noordzee 2022-2027*) that it aimed to offer insight and clarity to all stakeholders for the North Sea, and that it would be developed in cooperation with the stakeholders as well as via consultation of a broader audience (IDON, 2019).

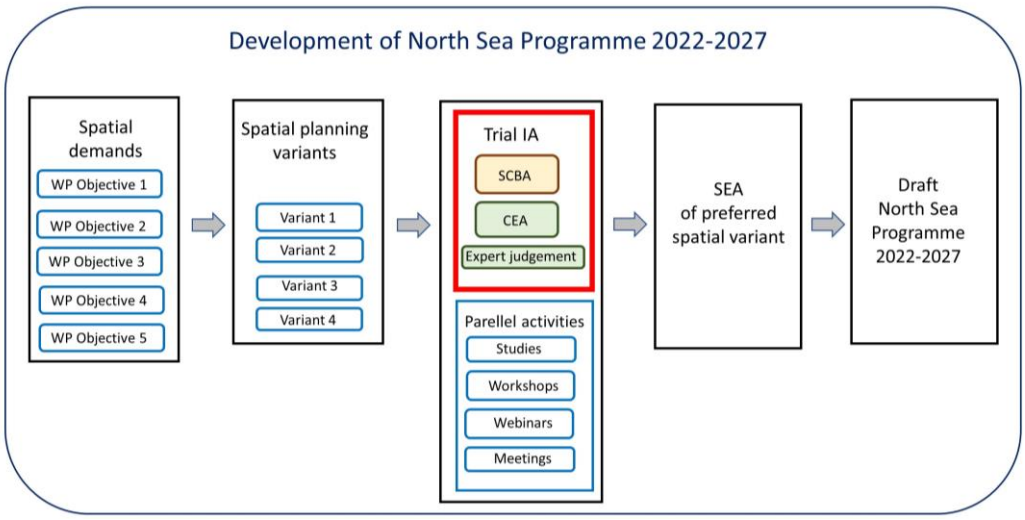
The following steps were planned in a time frame in the process of the development of the North Sea programme 2022-2027 (see 3):

- For each work package, the spatial demand is compiled in cooperation with relevant stakeholders. These work packages comprise (in Dutch): Reinforce the marine environment (*Versterking Marien Ecosysteem*), Sustainable Use (*Duurzaam gebruik van de Noordzee*), Transition to renewable energy (*Transitie naar duurzame energie*), Transition to sustainable food (*Transitie naar duurzame voedselvoorziening*), and Sustainable Blue Growth (*Duurzame Blauwe Economie*).
- This information is fed into work package "Spatial Planning" (RO). Logical variants are combined in cooperation with the stakeholders involved in the before mentioned individual work packages. These variants are tested, and then possible new variants may be composed. Work package "Spatial planning" (werkpakket RO) produces 3 to 4 variants.
- These 3 to 4 variants are then assessed in the Trial IA for their consequences. There is interaction with NZO/stakeholders allowing intermediate adjustments of parts of the variants.

- The information of these variants will be supplied to a SEA (in Dutch: *PlanMER*) in which the variant emerging as the preferred variant will be subjected to a more detailed CBA and CEA[4] than in the Trial IA.

The Trial IA, the focus of this case study, is outlined in red in Figure 3.

Figure 3: Scheme for the development of the North Sea Programme 2022-2027



Source: Based on information from IDON (2019).

[4] The terms CEA (cumulative effect assessment) and CIA (cumulative impact assessment) are often used interchangeably within the literature and the same applies to this report. However the use of CIA could be preferred as the ultimate aim is to assess impact (i.e. as the change in state of the receptor, sensu Piet et al. (2021)

3 KEY ACTORS

3.1 Societal background

To understand the background of the Trial IA, and its position in policy making at large, a brief historical sketch of the development of policies for offshore wind energy is needed. In 2013, the Dutch Energy Agreement for Sustainable Growth ("*Energieakkoord*"; SER, 2013) was approved by more than forty organisations – including central, regional and local government, employers and unions, nature conservation and environmental organisations, and other civil-society organisations and financial institutions. The Energy Agreement contained four quantitative long-term objectives:

- a savings in final energy consumption averaging 1.5% annually, meaning a 100-petajoule (PJ) saving in energy by 2020;
- an increase in the proportion of energy generated from renewable sources from 4% (2013) to 14% by 2020;
- a further increase in that proportion to 16% by 2023; and
- the creation of 15,000 jobs.

Note that in the Energy Agreement, offshore wind energy is not explicitly mentioned.

In later reports and policy documents, including the "*Energierapport*"[5] (2016), the "*Energieagenda*"[6] (2016) the "*Routekaart Windenergie op Zee*"[7] (2018) and the "*Integraal Nationaal Energie- en Klimaatplan 2021-2030*"[8], the foundations for a long-term energy policy up to 2050, including the development of offshore wind energy, were laid-out. The "*Routekaart Windenergie op Zee 2030*" quantifies how offshore wind energy should develop until 2030:

- Approximately 1GW was already installed at the time of writing
- An additional capacity of 3.5 GW was already planned in the period up to 2023
- Between 2024 and 2030, an additional capacity of 7GW should be installed.

This large-scale deployment of offshore wind energy needs to be embedded in the overall regulatory context, including spatial and environmental policies. The 2030 *North Sea Strategy* was developed and it required, in line with the intentions of the new "*Omgevingswet*" (Environment and Planning Act), a broadly supported, participatory process. In the original planning, the *2030 North Sea Strategy* would have been ready in the summer of 2018, outlining the strategic challenges (including timing, areas of tension and opportunities) with the related key options for national (and international) investment, knowledge and cooperation agendas. However, the negotiations on a North Sea Agreement overtook this strategy.

Over the period 2018-2020, a fierce debate on the future on the North Sea, and the role, responsibilities and rights of its current and future users, took place in the Netherlands.

[5] https://energieakkoord.ser.nl/Uploaded_files/Documenten/283-energierapport-transitie-naar-duurzaam18januari2016ID284.pdf

[6] https://www.tweedekamer.nl/kamerstukken/brieven_regering/detail?id=2016Z23255&did=2016D47582

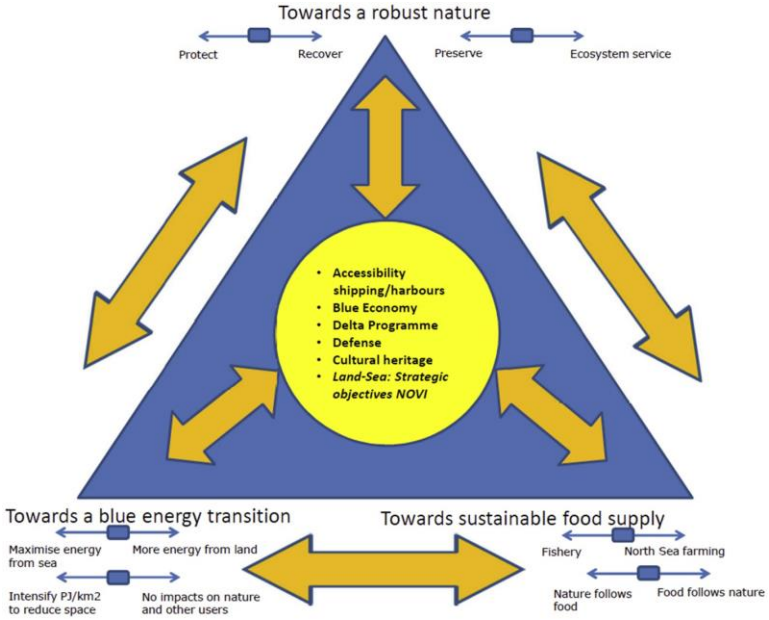
[7] https://www.rijksoverheid.nl/documenten/kamerstukken/2018/03/27/kamerbrief-routekaart-windenergie-op-zee-2030

[8] https://www.rijksoverheid.nl/documenten/rapporten/2019/11/01/integraal-nationaal-energie-en-klimaatplan

Whereas before this period, the further development of offshore wind was mostly seen as a technological and financial challenge, the debate showed that it would have an impact on other users of the sea and also that the ecosystem effects of its large-scale deployment required further attention.

The tensions between these different interests and the underlying societal functions – and in particular those among energy, food and nature – are visualised in Figure 4, taken from de Vrees (2019).

Figure 4: Tension between energy, food and nature



Source: de Vrees, 2019

The debate culminated in the signing of the North Sea Agreement (on June 19, 2020; OFL, 2020) by most of the stakeholders concerned. This North Sea Agreement describes agreements between government and stakeholders on the future activities on the North Sea over the period up to 2030 and thereafter. The list of signatories to the North Sea Agreement is provided below (see Table 3). Two fisheries organisations participated in the negotiations: the Dutch Fishermen's Union (*Nederlandse Vissersbond*) and "*VISNed*" (representing the Dutch cutter fisheres). After consulting its members on the draft text, the "*Nederlandse Vissersbond*" concluded they could not support the agreement. "*VISNed*" indicated that they support the agreement but, given the disunity in the sector, they chose not to sign either.

Table 3: Signatories to the North Sea Agreement

Category	Organization
National government	Minister of Infrastructure and Water Management (I&W)
	Minister of Agriculture, Nature and Food Quality (LNV)
	Minister of Economic Affairs and Climate (EZK)
Energy sector	Netherlands Wind Energy Association (NWEA)
	Netherlands Oil and Gas Exploration and Production Association (NOGEPA)
	Energie Beheer Nederland (EBN)
	TenneT

Category	Organization
Non-governmental organisations	Stichting de Noordzee
	WWF Nederland
	Greenpeace
	Natuur & Milieu
	Vogelbescherming Nederland
	Natuurmonumenten
Sea ports	Havenbedrijf Rotterdam N.V.

Source : OLF, 2020

3.2 Background to the project

The *Trial IA* project was commissioned in the context of the *North Sea Programme 2022-2027*, which describes current uses and future developments in the North Sea as well as the relationship with the marine ecosystem. In the development of the *North Sea Programme 2022-2027*, an extensive participatory process was set in motion to define a set of agreements for the spatial plan of the North Sea over the long term (a 2040-2050 time horizon). The *North Sea Programme 2022-2027* aimed to provide insight and clarity to all stakeholders concerned with the North Sea, and it was intended to be drawn-up in collaboration with these stakeholders (see Table 2) as well in consultation with the wider public. During the period from February to June 2020, a government initiated interactive process of joint fact-finding with stakeholders took place, in which different scenarios for the spatial plans of the North Sea were created, assessed and evaluated in an iterative fashion.

In order to support these discussions, there was a need to obtain insight into the expected advantages and disadvantages of these scenarios for the various stakeholders. Given the short turn-around time of these iterations, the Trial IA project aimed to provide an indication of the economic and ecological costs and benefits of spatial plans for the North Sea, to support the iterative and interactive marine spatial planning process (see Roebeling et al., 2021a).

The future scenario for spatial planning of human activities in the Dutch part of the North Sea is characterised by (see Table 4) a large extension of windfarms from 1 GW to 11,5 GW in 2030 and subsequently about 40 GW in 2040/2050, an almost complete decrease in oil and gas extraction, a 39% increase in shipping, an extension of aquaculture/mariculture to 400 km^2 (co-use in windfarms), a 60% increase in sand extraction, an extension of nature areas according the North Sea Agreement (version April 2020) and a change in fishing areas depending on the developments in other use functions.

Table 4: Global characteristics of the future scenario and its planning variants

	2017	2040/2050
Windfarms	1.0 GW	39.5-40.5 GW
Oil and Gas extraction	161 platforms	5 platforms
Shipping		+39%
Aquaculture/mariculture	1 km^2	400 km^2
Sand extraction	25 million m^3	40 million m^3
Nature & biodiversity	Current nature areas	According to North Sea Agreement

	2017	2040/2050
Fishery	Fishing area dependent on development of other use functions	

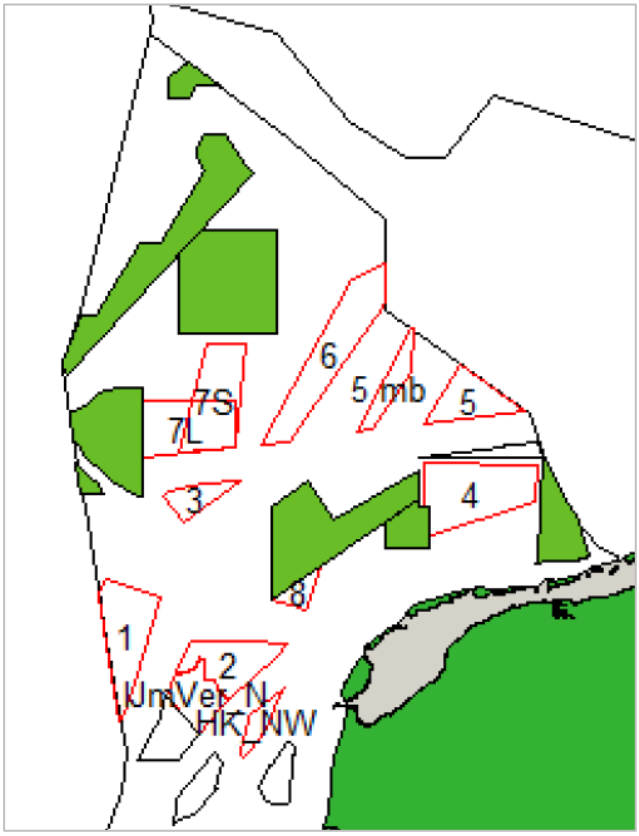
There are four spatial planning variants for the future scenario based on the choice for windfarm locations and concomitant capacity to include (see Table 5). In work sessions with stakeholders and representatives of the government identified eight new offshore windfarm locations (see Figure 5). These locations also differ in surface area (extent) and intended installed capacity for wind energy generation. Only part of these windfarm locations are required to deliver the additional 28-29 MW (after 2030) in order to meet the target of approx. 40 GW in 2040/2050. Four different spatial planning variants were identified that differ in their positioning in the Dutch EEZ, i.e. primarily south (Variant 1), a mixture of both south and north (Variant 2), primarily north (Variant 3) and primarily coastal (Variant 4). Further details can be found in Roebeling et al. (2021a).

Table 5: Characteristics of the four MSP variants (GW estimate based on 10 MW/km2). For the offshore windfarm locations, see Figure 5.

Offshore windfarm location	GW	Variant 1	Variant 2	Variant 3	Variant 4
1	9	9	9		
2	7 (+3)	7 + 3	10		7+3
3	3	3			
4 a)	13				13
5	6	6	6	6	6
6	20		4	13	
7	10			10	
8 b)	1,5				
Total	55 + 3 + 13 (if a) + 1,5 (if b)	28	29	29	29

a) Location 4 is only a realistic option if there is an alternative for the military exercise area;
b) Location 8 cannot be combined with location 2.

Figure 5: The different scenarios for the location of offshore windfarms that were assessed by the Trial IA. Green areas are designated (planned or agreed) N2000 areas



Source: Deetman et al. (2020)

To assess the socio-economic consequences, a Cost-Benefit Analysis (CBA) was applied (following Strietman et al., 2019), that included the following sectors: oil and gas, maritime transport, windmill construction, windmill exploitation, fisheries, aquaculture and sand extraction. To assess the ecological costs and benefits, Cumulative Impact Assessment (CIA) was used (following Jongbloed et al., 2019), considering the ecosystem components birds, sea mammals, fish and benthic.

Results from the Trial IA showed large economic and environmental impacts when moving from the current situation (2017) to all four future scenarios (2040/2050), due to the significant changes in sectoral activities (strong growth in wind energy vs. strong decrease in oil & gas and fisheries) and corresponding environmental pressures (see Roebeling et al., 2021a). However, small differences in economic and environmental impacts between future scenarios (2040/2050) were observed, due to the relatively small differences between scenarios (i.e., mainly differences in the location of windfarms).

Given these small differences in results between future scenarios for 2040/2050, separate follow-up studies on the impacts of a wide range of alternative future scenarios for this timeframe were commissioned during the period September to November 2020. Differences between scenarios were determined by the location of wind farm areas and, thus, not by the total capacity (GW) of wind farms.

Follow-up studies included a Levelized Cost of Energy (LCoE) study for new wind farm areas after Roadmap 2030 (BLIX, 2020b), a study on the socio-economic values of fisheries in these new wind farm areas (Deetman et al., 2020) and a cost-benefit study on off-shore hydrogen production (NSE, 2020). These results were, amongst others, used in a separate project (Roebeling et al., 2021b) which assessed the economic impacts of these alternative future scenarios (2040/2050) on a limited number of sectors (windmill construction,

windmill exploitation, fisheries and maritime transport) and excluded an assessment of the environmental impacts. While that separate project is not the focus of this particular case study, it shows how the planning process developed after the Trial IA.

3.3 Feedback from policy-makers

The role and usefulness of the Trial IA (conducted via the '*Kentallen analyse*' study) in the overall Dutch MSP process was the topic of an interview with two key national policy-makers (coordinator of the spatial planning process on the North Sea; Trial IA North Sea project leader). This interview included questions about the larger North Sea spatial planning process, the role of the Trial IA in relation to other/parallel studies and activities, the usefulness of the insights obtained from the Trial IA, the usefulness of the Trial IA for stakeholder information/engagement and, finally, the opportunities for improvement. The information from this discussion is provided in the following tables, with the answers to the five questions that were the main topics shown in blue.

1. The Trial IA was part of a larger process, including parallel studies, expert workshops, webinars and meetings. Please indicate the studies and activities that were developed in parallel during the marine spatial planning process for the North Sea that took place in the first semester of 2020.

Studies	• De economische en ecologische effecten van inrichtingsvarianten voor de Noordzee tot 2040/2050 (WEcR, 2020) • Study into Levelized Cost of Energy of seven new wind zones and IJmuiden Ver (BLIX, 2020a) • Expert inschatting van nieuwe windparkzoekgebieden op de Noordzee voor verschillende soortgroepen (WMR, 2020)
Workshops	• Expert workshop 'Natuur en windenergie' (04-02-2020) • Expert workshop 'Windenergie' (19-02-2020)
Webinars	• Webinar 'Kentallenanalyse Programma Noordzee' (11-06-2020)
Meetings	• Noordzeeoverleg (including discussion results Trial IA; monthly) • Interdepartementaal Directeuren Overleg Noordzee (IDON; monthly)

2. What insights did (expected/additional obtained) and didn't you (expected/desired but not obtained) derive from the Trial IA?

Expected or additional obtained insights	Expected or desired but not obtained insights	Recommendations
• Expected to obtain insight in the ecological and economic consequences (advantages and disadvantages) of different spatial planning scenarios for the North Sea	• Ecological analysis was not spatially explicit and economic analysis required the inclusion of additional cost items (e.g. related to shipping safety and landing costs). Hence, it turned out that the differences in ecological and economic impacts were relatively small across spatial planning	• Additional research needed to i) assess the spatially explicit ecological impacts of spatial planning scenarios for the North Sea and ii) assess the economic impacts of the inclusion of additional costs items for the spatial planning scenarios for the North Sea

Expected or additional obtained insights	Expected or desired but not obtained insights	Recommendations
	scenarios for the North Sea	
• Expected that, based on these insights, a preferred spatial planning scenario for the North Sea could be identified	• Hence, differences in impact were not sufficiently distinctive to identify a preferred spatial planning scenario for the North Sea	• Need for an integrated assessment framework that can provide an optimal spatial planning scenario – i.e., one that balances ecological, economic and social values

3. How useful was the Trial IA for informing the iterative and interactive marine spatial planning process for the North Sea?

Advantages	Disadvantages	Recommendations
• Gave insight in the ecological and economic impacts of different spatial planning scenarios for the North Sea • This provided stakeholders a good basis for discussion on results and trade-offs • This resulted in the definition of i) alternative spatial planning scenarios for the North Sea and ii) the identification of research gaps and future research avenues	• Ecological impacts were difficult to assess and compare • The ecological analysis showed that each scenario had its advantages and disadvantages • The study analysed relative differences, whereas some stakeholders expected absolute values	• Improve presentation of results to better communicate with stakeholders • Need for framework that allows to assess the overall ecological impacts • • Present results in absolute and relative terms, so that stakeholders can better understand the results

4. In the marine spatial planning process and Trial IA for the North Sea, what worked well (drivers) and what did not work so well (obstacles)?

	What worked well?	What didn't work so well
Marine spatial planning process	• Intensive discussions with stakeholder groups in meetings, workshops and webinars	• Stakeholders that expected not to benefit from the spatial planning scenarios for the North Sea, looked for arguments to frustrate the process • COVID-19 complicated the stakeholder engagement process
Trial IA	• Provided information on the multiple ecological and economic impacts of	• The Trial IA was not sufficiently detailed (economic impacts) or spatially explicit (ecological

	What worked well?	What didn't work so well
	different spatial planning scenarios for the North Sea • Resulted in discussion amongst stakeholders and subsequent definition of alternative spatial planning scenarios for the North Sea • Resulted in the definition and execution of (short-term) follow-up studies	impacts), due to data and knowledge gaps, to identify a preferred spatial planning scenario for the North Sea • COVID-19 complicated the stakeholder engagement process
	• Provoked and initiated a lively political discussion ...	• ... that, however, partly coincided with the dynamics and politics surrounding the definition of the North Sea Agreement

5. For future marine spatial planning processes and Trial IAs for the North Sea, what would you recommend next time?

Marine spatial planning process	• More intensive than what was done is not possible, with such strong differences in opinions and interests among stakeholders. In the end it is a policy driven process where consensus cannot be reached and the government will have to decide.
Trial IA	• To analyse and assess not only relative changes but, in order to create believe and recognition, also analyse and assess absolute changes • To be able to assess in a more detailed and spatially explicit fashion the ecological and economic impacts of marine spatial planning scenarios • To have an integrated assessment framework that provides a ranking and guides the selection of spatial planning scenarios

4 EBA PRINCIPLES, METHODS, TOOLS AND CROSS-CUTTING ELEMENTS

4.1 To what extent was EBA integrated in MSP

This section provides a brief review how the EBA steps and principles were addressed in the Dutch MSP process and in particular in the Trial IA. It draws on the steps and principles elaborated in the context of the overall *Study on integrating an ecosystem-based approach into maritime spatial planning* (the identification of five EBA steps in turn draws on Schmidtbauer Crona (2017), and that of EBA principles draws on Long et al. (2015).

There is no reference to specific steps in the design of either the overall Dutch MSP process, but several can be recognized in how the process was conducted so far. Moreover, although the Trial IA did not explicitly consider the EBA principles, several of them were clearly addressed in the overall MSP design and planning.

Table 6 shows how EBA principles were addressed in the Trial IA. It also shows briefly how the principles were addressed in the overall process and in cross-cutting steps: for this, it draws on de Vrees (2019), which clearly shows that the MSP process started with a *defining step* firmly embedded in a stakeholder involvement process. The Trial IA exercise can be considered a somewhat premature *assessing step* with the purpose of feeding into the stakeholder process in order to obtain feedback that then shapes the *developing step* so that a more robust *assessing step* can be conducted in a next cycle of the MSP process. If this interpretation is correct, several smaller sub-cycles resulting in a gradual improvement of the knowledge base and the science capacity to inform decision-making took place before moving to a final decision and to the *implementation step*.

Table 6: How can the overall Dutch MSP process and specifically in the Trial IA be fitted to the stepwise MSP process? Note this was not in the design of the Dutch MSP process.

MSP steps and transversal processes	EBA principles	How this was tackled in the North Sea case study
Overall Dutch MSP process		
Defining	Decisions reflect Societal Choice	Policy objectives drive the Dutch MSP process. Adaptation is required when policy objectives change.
	Appropriate Spatial and Temporal Scales	The temporal scale is determined by the requirement to focus the assessments on the period 2040/2050. This is realistic as this reflects the time before the current plans for offshore windfarms materialize. The spatial scale is determined by the detail of the information on the future locations of sea-based sectoral activities (such as for offshore wind).
	Distinct boundaries	The boundary of the North Sea case study is defined, i.e. Dutch EEZ and the territorial sea, but only covering the offshore areas not coastal zone and the estuaries. From a jurisdictional perspective it makes sense to only cover the Dutch EEZ. From the ecological impact assessment within the Trial IA, it appears that the coastal zone with 1Nm and the estuaries were excluded as only the relevance for the MSFD was considered.
The Trial IA		
Developing	Ecological integrity and	Addressed via the use of a Mental model and Cumulative

MSP steps and transversal processes	EBA principles	How this was tackled in the North Sea case study
	biodiversity	Effects/Impacts Assessment (CEA/CIA).
	Appropriate Spatial and Temporal Scales	When developing the knowledge base for the ecological assessments, it became clear that much of the ecological information was not available at the spatial scale required.
	Consider ecosystem connections	Addressed via the use of a Mental model and Cumulative Effects/Impacts Assessment.
	Account for dynamic nature of ecosystems	Not addressed.
	Recognise coupled SES	Although both the social and ecological system were covered with, respectively, the CBA and the CEA/CIA (see subsequent models & tools sections), this did not truly represent a coupled social economic system (SES) where feedbacks between the two would exist: in the Trial IA's analysis, sea-based sectoral activities impact the marine ecosystem, though ecosystem functioning and quality do not impact sectoral activity.
	Consider cumulative impacts	Cumulative ecological impacts of the activities via pressures on ecological components and biodiversity on the North Sea were assessed with an existing CEA tool covering a broad scope but not were spatially explicit. This served the developing process as well as the preliminary assessment process. The outcome of the CEA has revealed important knowledge gaps and provided focus on more refined defining and assessing, including spatially explicit information on new offshore wind areas and sensitive ecological components. Cumulative economic impacts in the CBA approach were assessed through aggregation of sectoral impacts, considering sea-based sectoral activities and land-based sectoral activities that supply goods and services to these sea-based sectoral activities.
Assessing	Inter-disciplinarity	With the application of the CBA and the CEA/CIA (see subsequent models & tools sections), both the socio-economic and natural sciences were covered.
	Sustainability	All dimensions of sustainability were addressed with the environmental (healthy sea), social (safe sea) and economic (profitable sea) societal goals, as set out in the national *Integrated Management Plan for the North Sea 2015*.
	Recognise coupled SES	Although both the social and ecological system were covered with respectively the CBA and the CEA/CIA (see subsequent models & tools sections), this did not truly represent a coupled SES. Extension of the applied CEA/CIA to also include ecosystem services together with some valuation of their contribution to human wellbeing could have addressed this.
	Consider cumulative impacts	See above. Assessment of cumulative economic impacts as well as ecological impacts were carried out, but only on an exploratory level. This can be repeated after alterations and improvements in the definition and developing steps. So there are possibilities to cover this with CEA/CIA.

MSP steps and transversal processes	EBA principles	How this was tackled in the North Sea case study
Future steps		
Implementing	Acknowledge uncertainty	As implementation has not occurred yet, these steps cannot be evaluated. However, the MSP process is explicitly designed to be adaptive because this is required by legislation, and the evaluation of performance of the system or the implementation of the actions and policy is planned. Moreover, the MSP should be adjusted in the case of of a new government direction with new policy objectives or changes in developments from outside (de Vrees, 2019). To these ends, continuous monitoring and regular evaluation are embedded in the process.
	Apply the Precautionary Approach	
	Appropriate Monitoring	
	Adaptive Management	
Follow-up	Appropriate Monitoring	
	Adaptive Management	
Cross-cutting elements		
Stakeholder mobilisation	Stakeholder involvement	This is explicitly considered and discussed. The Trial IA formed part of the North Sea Programme 2022-2027, to be drawn-up in collaboration with these stakeholders as well in consultation with the wider public.
Governance and institutional set-up	Use of Scientific Knowledge	Clearly, scientific knowledge is embedded in the process. As it is only at the start of the process, it is too early to determine the uptake of scientific conclusions and recommendations.

It should be noticed that the CBA in the Trial IA-study was situated somewhere in between in the process for the North Sea Programme 2022-2027. Therefore the CBA was dependent on the choices made in the preceding phase.

4.2 Tools and cross-cutting elements

This section describes which tools were applied in the Trial IA and highlights how the information available determined their application. Also, their role in the transversal process of stakeholder involvement was specifically considered.

4.2.1 Mental model

Mental models represent the way in which people understand the world around them. Cumulative Effects Assessment (CEA) (see section 4.2.3) require a mental model (or sometimes referred to as linkage framework) which connects the different categories of human/economic activities-pressures and ecosystem components through impact chains. This is carried out in the CEA tool that was applied in the Trial IA study.

Sectors involved in the CEA as part of the Trial IA

It should be realised that a mental model can always be **applied** and the comprehensiveness depends on its complexity in terms of the level of detail of the sectors and their activities, or of the ecosystem, or of the extent to which ecosystem services or the full social-ecological system are considered. A first selection of at least 10 types of

activity from the many involved in the Dutch North Sea was made in the NSP process preceding the conduct of the Trial IA study.

At the start, the Trial IA focused on the inclusion of these sectors. However, the carbon capture and storage (CCS) sector and the tourism and recreation sector were omitted from the mental model because of insufficient data access. This was discussed and agreed with RWS. Several types of fisheries are present, and they vary considerably in both economic value and ecologic impact. Three categories were distinguished and used in the CEA: bottom fishery, pelagic fishery and gillnet fishery. The resulting set of activities which were included in the CEA is listed in Table 7. Pressures and ecological components are also part of a mental model and listed in the same table. However, the selection of pressures and ecologic components was not discussed among RWS/I&W, stakeholders and Wageningen Research (WR). The selection of the relevant pressures and ecological components was only made by WR and used in the CEA. This is described in section 4.2.4).

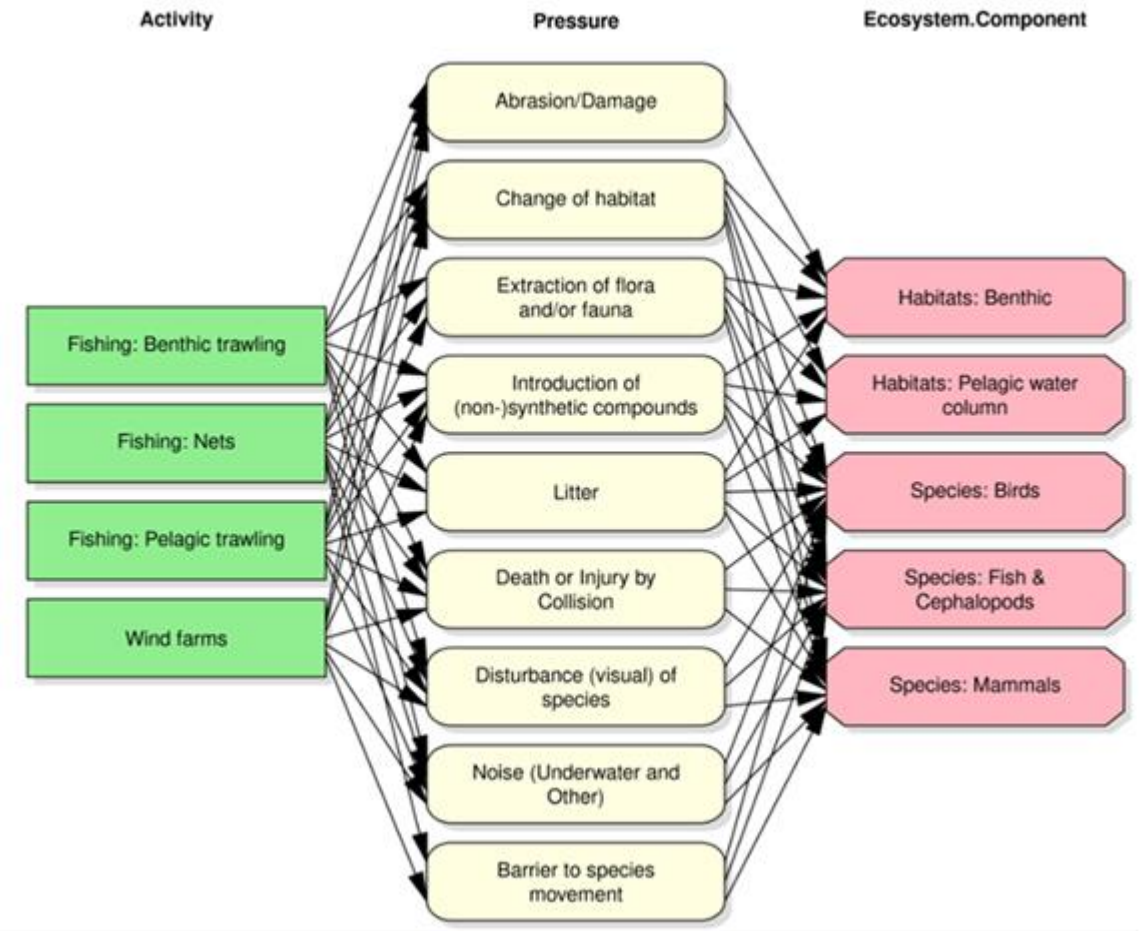
Table 7: Activities, pressures and ecological components including the mental model and the CEA for the North Sea case study

Activities
Aquaculture
Fishing: Benthic trawling
Fishing: Nets
Fishing: Pelagic trawls
Oil and Gas
Sand extraction
Shipping
Telecoms and Electricity
Wind farms
Ecological components
Birds
Fish
Mammals
Habitat Pelagic water column
Habitat Sublittoral sediment
Habitat Littoral sediment
Habitat Circalittoral rock and other hard substrata
Pressures
Abrasion/Damage
Artificialisation of habitat
Barrier to species movement
Change of habitat structure/morphology
Changes in input of organic matter
Changes in Siltation
Death or Injury by Collision
Disturbance (visual) of species

Electromagnetic changes
Extraction of flora and/or fauna
Input of light
Introduction of genetically modified species
Introduction of Microbial pathogens
Introduction of non-indigenous species
Introduction of Non-synthetic compounds
Introduction of Radionuclides
Introduction of Synthetic compounds
Litter
N&P Enrichment
Noise (Underwater and Other)
pH changes
Selective Extraction of non-living resources: substrate
Smothering
Total Habitat Loss
Translocations of species (native or non-native)
Water abstraction
Water flow rate changes

Figure 6 visualises the output of the mental model for the Trial IA; for clarity, the sectoral activities are limited to fishing and wind farms and only their main pressures and potential impact on ecosystem components are presented.

Figure 6: Illustration of the mental model for the Trial Integrated Assessment confined to four of the nine selected sectoral activities: fishing and wind farms, their main pressures and their potential impact on the ecosystem components



Prior and during the Trial IA, RWS and the ministries of I&W and LNV explored the pros and cons of the **scenario variants** with the stakeholders in a joint fact-finding process. The scenario variants consist of combination of activities which vary in the intensity, total spatial extent and spatial allocation of some of these activities at the North Sea. In 2040/2050. It was foreseen that this stakeholder process may lead to the adjustment of the scenario variants that would be analysed in the Trial IA study.

The mental model is suitable to compare multiple variants within the same framework. The result of the Trial IA was used in discussions with stakeholders in order to select a number of variants that were presented for the strategic environmental assessment (SEA) (In Dutch: *Plan MER*) for the *National Water Programme*. During the execution of this SEA, the aim will be to decide on a preferred variant. For this preferred variant another and more comprehensive SEA will be carried out. This is at a later stage than the Trial IA that is described in this North Sea case study report. The mental model should be applied during various stages in the North Sea Programme process.

In the Trial IA, there were limited discussions on the mental model (the societal base/SES) and the knowledge base. Presumably these discussions already took place in the preceding stage of the NSP process: Wageningen Research was not included in the preceding phase of the NSP; it can be recommended to link the execution of the MSP steps and treat this as an integrated process.

The applied CEA-tool does not have the possibility to conduct spatially specific impacts. The tool does not work with spatial distribution of activities, pressures and ecological components on the North Sea. Furthermore, this information will not be available for the complete spectrum of activities, pressures and ecological components. A solution to both problems was found in commissioning an extra study. This was an expert opinion assessment of new offshore wind farms on species groups in the Dutch North Sea (also mentioned in section 3.3). This study served the aim of distinguishing between impacts of the spatial variants of new offshore wind farm areas. However, it is clear that important knowledge gaps exist and these are identified in both reports: the Trial IA report and the Expert opinion report. In addition, it can be concluded that there is a strong need for a spatially specific and quantitative CEA method that can be applied for the North Sea. When that is developed, it could be incorporated in **a tool for MSP**. Which would allow to evaluate scenarios for MSP based on CEA and other EBA principles.

For spatial tools, data availability might be limiting implementation. See also CEA in section 4.3. In the Trial IA, this was not considered by all parties beforehand, and there was too little opportunity to apply this while conducting the study due to the tight NSP time frame. There may still be opportunities to improve parts of mental model and other parts of MSP and tools and apply in the remaining phases.

Participation of stakeholders

The Trial IA for the North Sea was a part of the process that will end in a new North Sea Programme. The Dutch authorities designed the sequence with all steps, intermediate products and final products, connected stakeholders, tools, etc. (see section 2.3). That implies that EBA-principles could have been or will be applied at different stages in the process. WR was not involved in some of the stages preceding the Trial IA. So, here this analysis cannot be complete: this case study is limited to the Trial IA and information that will be provided by the persons that are interviewed for the North Sea case study report (see sections 3.3). In the webinar with the stakeholders some remarks were made by stakeholders with respect to the mental model choices that were made (see section 4.2.3).

Relevant ecological components involved?

In the CEA four ecological component groups were included: seabirds, fish, marine mammals and habitats (see Table 7).

In the Expert opinion study, a somewhat different set of ecological components was considered: seabirds, seals, harbour porpoise, bats, fish and reef-building benthos species. This was based on the potentially high vulnerability of certain species and habitats for offshore wind farms – or in the case of the reef-building benthos species – more opportunity for development, due to protection against bottom trawling fishery. In the webinar it was suggested to add the group of migratory birds to this selection.

The CEA tool is suitable to include more species groups and more habitats. For instance, for the Dutch North Sea pelagic and demersal fish species can be discriminated and linked to different fishery groups. As habitat types, sublittoral sediment, littoral sediment, circalittoral rock, other hard substrate and the pelagic water column can be chosen.

For the Trial IA, the researchers of WR chose to aggregate all habitats defined in the CEA into one group of seabed habitats. That aggregation is easier to understand for stakeholders. This aggregation, and the reasons behind it, were discussed and agreed with the steering group. During the consultation meeting/webinar with the stakeholders, a question was raised about the aggregation of habitats in only one group (see section 4.3). It is believed that the person who raised this question wished to distinguish among some habitat types. That is possible with the CEA-tool as described before.

Future scenarios

In the Programme North Sea preparation process, shortly before and during the period that the Trial IA study took place, the government organised an interactive process of joint fact-finding with stakeholders to design and evaluate different variants for the spatial planning of human use in the North Sea. Four variants for 2040/2050 were distinguished based on global locations of the potential wind farm areas with areas in the south (*Combinatie Zuid*), a mixture of energy clusters in south and north (*Mix Energiehubs*), areas mainly in the north (*Combinatie Noord*) and areas with smaller distance to the coast (*Dichtbij Energievraag*).

During the Trial IA, there was a shift in the focus of the project to the long-term. At the start, future scenarios were focused on two years: 2030 and 2040/2050 without application of (spatial) variants for those years. WR conducted an economic and ecologic analysis for those years and presented intermediate results. Soon after, RWS requested an analysis of the four variants for 2040/2050, whereas analysis for 2030 was of less interest. The results for the Trial IA reported in Roebeling et al. (2021a) only comprise the reference situation (2017) and the future situation (2040/2050) with its four variants. For 2030, some data are provided for developments in some sectors, but an assessment was not carried out for the situation in 2030.

EBA-principles involved

The following observations, beyond the information in Section 4.1, can be made:

- **Ecological integrity and biodiversity**: this was not explicitly considered in the analysis and the process, except for the approach that the spectrum of ecological components was included in the mental model (framework) and the CEA was chosen to cover ecological integrity and biodiversity.
- **Consider ecosystem connections**: this was partly considered in the analysis, namely only in the expert opinion for some species. However, it did not receive attention in the process.

WR experience overall

The fine tuning has not taken place in the Trial IA, but may have been taken into account in the SEA with an extensive social cost-benefit analysis (SCBA) and CEA scheduled in the following phases of the North Sea Programme 2022-2027 (NSP). From the Trial IA and the discussions with the steering group and the stakeholders in the webinar, WR concludes that there is a need to fill in the major knowledge gaps as well as a need for the development of a practical tool for MSP including a CEA tool and spatial detail. The latter would be very helpful to structure presentations and discussions.

4.2.2 Cost-Benefit Analysis

As outlined in Section 0, the Trial IA aimed to provide an indication of the economic and the ecological costs and benefits of spatial plans for the North Sea (see Roebeling et al., 2021a). The CBA described in this section focused on the costs and benefits for economic sectors, without a consideration of environmental costs and benefits.

To assess the economic costs and benefits of the current situation (2017) and the future scenarios (2040/2050) for the North Sea, the Economic Impact Assessment (CBA) approach was used (following Strietman et al., 2019). The economic impact is assessed by i) determining the economic size of the relevant sectors in the current situation (2017), ii) estimating the expected growth of the sectors for each of the future scenarios (2040/2050) and, finally, iii) determining the economic size of the sectors in the future scenarios. The

economic size per sector was calculated for sea-based sectoral activities as well as for related land-based sectoral activities that supply goods and services to these sea-based sectoral activities. Sectors considered comprised: oil and gas, maritime transport, wind turbines construction, wind farms exploitation, fisheries, aquaculture and sand extraction. Economic indicators included gross production value, value added and employment.

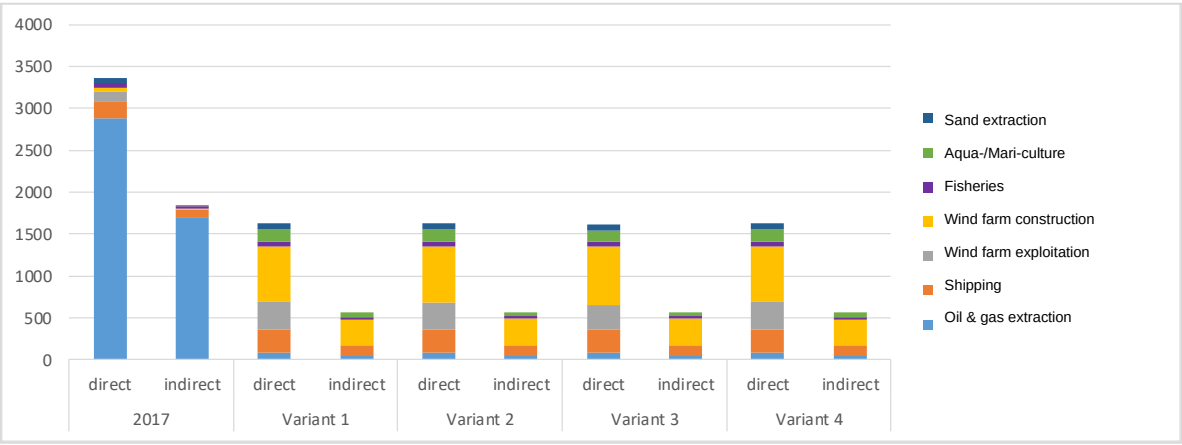
The temporal scale comprises a comparative static analysis of the current situation (2017) and the future scenarios (2040/2050). The spatial scale coincides with the Dutch part of the North Sea (Dutch EEZ), considering sea-based sectoral activities as well as land-based sectoral activities that supply goods and services to these sea-based sectoral activities. Land-based sectoral activities that process goods and services from these sea-based sectoral activities were not considered.

Coupled social economic system (SES) perspectives were considered through sea-based sectoral activities that impact the marine ecosystem, based on their size (area), pressure and spread of pressure. There was, however, no feedback from the ecological system to the social system – i.e. the functioning and quality of the marine ecosystem and corresponding supply of marine ecosystem services and values are considered constant in the CBA (only dependent on size).

Cumulative economic impacts in the CBA approach were assessed through aggregation of sectoral impacts, considering sea-based sectoral activities and land-based sectoral activities that supply goods and services to these sea-based sectoral activities. However, land-based sectoral activities that process goods and services from these sea-based sectoral activities were not considered. Also, various macro-economic aspects were not considered in the CBA. In particular, these included the uncertain impacts of the Brexit, the development of sectoral activities in other parts of the North Sea and, as already mentioned above, the uncertain impacts on the land-based sectoral activities that process goods and services from these sea-based sectoral activities. Follow-up studies have been developed since, such as in relation to fisheries (Deetman et al., 2020) and wind parks (BLIX, 2020; Roebeling et al., 2021b).

The outcome of the CBA revealed that future variants show a major shift in the relative economic importance of the various uses between 2017 and 2040/2050 (Figure 7). Wind farm operation, wind farm construction and aqua/mariculture would become uses with a relatively high economic importance, shipping and sand extraction retain their economic importance, fisheries show a decline in economic importance, and oil and gas extraction would become uses with no significant economic value. With regard to employment, there is a diversified picture emerging in the variants, in which multiple user functions contribute substantially to employment on the North Sea.

Figure 7: Direct and indirect value added (in million €) of the various uses, in 2017 and in 2040/2050 depending on the MSP variant (for explanation see section 3.2)



Source: Roebeling et al., 2021a: p.39

The differences in economic effects between the future variants 2040/2050 are relatively small (Figure 7), which is the result of the small differences between the variants – i.e. only variation in the location of windfarm areas. For the economic effects, this means that there are relatively small differences (compared to the total values of all uses) in construction costs, differences in yield and landing costs (cables) of the windfarm areas that, together, make up 28 GW.

4.2.3 Cumulative Impact Assessment

As mentioned before, the Trial IA aimed to provide an indication of the economic as well as the ecological costs and benefits of spatial plans for the North Sea (Roebeling et al., 2021a). To assess the ecological costs and benefits of the current situation (2017) and the future scenarios (2040/2050) for the North Sea, the Cumulative Impact Assessment (CIA) approach was used (following Jongbloed et al., 2019).

What was done in the CEA and what was the result of it?

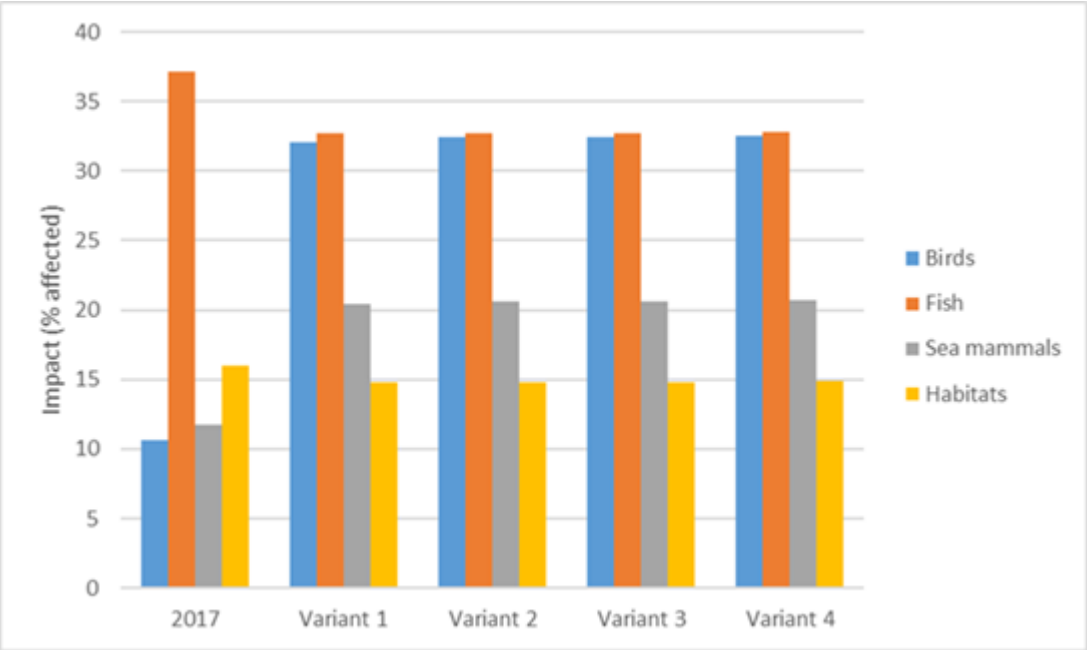
Before describing the application and the outcome of the ecological assessment within the Trial IA, the choice of environmental assessment methods should be concluded. There are four main types of environmental assessments serving different purposes with overlapping spatial and strategic scales (see Annex 2). For new and comprehensive spatial plans there is often a need to start ecological assessment on a high strategic level and to follow it across sequential decision-making levels (Partidario 2000; Tamis et al., 2016): an overarching approach covering different purposes and assessment levels would be beneficial. In the NSP, SEA and CEA are the required type of methods and indeed these are requested by IDON. For the Trial IA, only the CEA was applied.

In the Trial IA, to get an indication of the direction of the ecological effects of the considered spatial planning variants, the CEA calculated the difference in the impact of human/economic activities on ecosystem components (fish, seabirds, marine mammals and habitats) between the present situation (2017) and the (hypothetical) future situations (2040/2050). This provided insight into the influence of various policy measures and spatial planning variants on ecological and biodiversity effects.

The input information needed to feed the CEA included data on the spatial extent and intensity of human/economic activities in the Dutch EEZ of the North Sea: this was provided by the Rijkswaterstaat (RWS) / Ministry of Infrastructure and Water Management (I&W) / Ministry of Agriculture, Nature and Food Quality (LNV) and the stakeholders via the joint fact-finding work compiled in the work packages and variants (mentioned in section 2.2). In addition, information was derived from several published sources (e.g. Matthijsen et al. (2018, 2019), CBS (2016, 2019), Ecorys (2018), PWC (2018) available at Wageningen Economic Research. A reference situation (2017) and two time horizons (2030 and 2050) with variants were considered.

The outcome of the CEA revealed that the future variants increase the impact on seabirds and marine mammals due to wind energy development but decrease the impact on fish and habitats due to decreased fishery activity and the greater space dedicated to protected nature areas and wind farm areas closed for other human/economic activities (Figure 8). Differences among the future variants in effects on nature and biodiversity are small due to small differences among these variants in surface area of the human/economic activities on the NCP of the North Sea. As noted, the CEA method was based on total spatial extent but not on locations which will differ in species density and habitat presence. However, the commissioner (Ministry of Infrastructure and Water Management) was very interested in such a spatial specific assessment for new wind farms search areas and their combinations in the variants.

Figure 8: Total impact per ecosystem component (birds; fish; sea mammals; habitats) due to all uses, in 2017 and in 2040/2050 depending on the MSP variant (for explanation see section 3.2).



Source: Roebeling et al., 2021a: p.42

In order to get an indication of the possible effects on nature/biodiversity due to wind energy production in eight potential new wind farm areas, an expert opinion method was applied. WR experts in the field of seabirds, marine mammals, bats, fish and reef-builders were consulted and the results were elaborated in a synthesis report (Jongbloed et al., 2020). The results revealed that for seabirds, harbour porpoise and reef-builders, potential wind farm areas could be distinguished on the basis of their potential effects. For seals, bats and fish, distinctions among the potential wind farm areas concerning potential impacts of wind farms were not well possible. Overall, this expert opinion analysis pointed at a small preference for one of the four future variants, namely Variant 2 (*Mix Energiehubs*). There are important knowledge gaps that reduce the confidence of the assessments with the CEA and the Expert knowledge opinion. A partially spatially specific CEA could reduce these knowledge gaps and improve the confidence of assessments, but this was not possible at the time due to limited time and budget.

What was the opinion of RWS/I&W/steering group on outcome and process?

In the intermediate part of the process, the steering group did not understand the type of results produced by the CEA, and in particular the unity of the predicted impact on nature values. Therefore, WR elaborated the type of result from a relative unity for impact into % affected. That was acceptable for the steering group.

The steering group expected that the influence of spatial information (locations of human/economic activities and location specific densities of species and habitats on the North Sea) could be included in the CEA of human/economic activities, especially the wind farm areas. WR explained that that type of analysis was not offered in the tender because it would not fit into the available frame for time and budget. A solution was found to solve part of the problem by conducting an additional study. This was a consultation of WR experts to compile an assessment of the impact of potential wind farm areas in the Dutch North Sea for species groups, in which spatial information was taken into account (as mentioned in section 4.2.1). The results of these two studies provided a good basis for the webinar with stakeholders and the remainder of the NSP process. In an evaluation, RWS, I&W and Wageningen Research agreed that the problems encountered concerning expectations around the type of results and the time pressure of the Trial IA study may have been prevented by better communication.

What was the opinion of the consultation (webinar) on outcome and process?

Many and very diverse comments, questions and suggestions were made during the webinar with stakeholders and other interested organisations and persons. However, the opportunity was relatively limited, and background information was not shared.

Opinion of WR on outcome and process

The CEA tool applied in the Trial IA, as noted above, was not spatially explicit. That means that it does not use spatial distributions of the activities, pressures and ecosystem components and therefore it cannot provide maps of potential cumulative impact to guide the MSP process. Although it lacks this spatial information, it can indicate the activities and their pressures most likely to compromise achievement of environmental policy objectives. This is what was done in the Trial IA in this stage of the North Sea Programme.

For such a spatial assessment. sufficient input data have to be available for the spatial distribution of activities, pressures and ecosystem components, as well as the sensitivity of ecosystem components for pressures in the North Sea, at least the Dutch part. However, that kind of information is not currently available for part of the pressures and ecological components. In addition, that information is not compiled for the North Sea.

The ecological part of the Trial IA was carried out by a CEA based on qualitative expert judgement-based descriptors. In addition, for the offshore wind sector, a questionnaire was used as a supplementary tool to include information on the spatial distribution of potential offshore wind farms, their pressures, the ecosystem components, as well as the sensitivity of ecosystem components to these pressures.

For the ecological part of the Trial IA, use was made of an existing database for the North East Atlantic and North Sea that was developed in EU two projects – ODEMM and AQUACROSS – and a database for the Dutch North Sea in a study for PBL (Jongbloed et al., 2019), which was very time consumptive. The availability of these databases was an advantage to the Trial IA-project. In addition, for the Trial IA-project, more specific input data for the sectors in the Dutch North Sea in the baseline year and the future scenarios was used. That data resulted from joint fact finding in the Programme North Sea process.

EBA-principles involved

There are 5 EBA principles that can be considered or applied in CEA. They are briefly described below.

- *Recognise coupled SES* (developing): See the description in Table 6 in section 4.1. The conclusion is that extension of the applied CEA/CIA to also include ecosystem services together with some valuation of their contribution to human wellbeing was not addressed in this Trial IA.
- *Consider cumulative impacts*: This was analysed by application of a CEA tool and also in the expert opinion on OWP and species.
- *Inter-disciplinarity*: Most input data for the total spatial extent and intensity of sectors were found in sources that applied inter-disciplinary sources. In addition, input data were supplied by joint fact finding of I&W, RWS, LNV and sectors which preceded the Trial IA. The CEA and Expert opinion on the OWF and species were only carried out by biologists. Methodology and results were discussed with stakeholders in a consultation session (webinar).
- *Sustainability*: This is implicitly considered by assessing different future scenarios and OWF variants (4) concerning the impact on nature values in order to get insight

in the most sustainable options. This EBA is also considered in the section mental models (see above).

- *Recognise coupled SES* (assessing): As is described in Table 6, although both the social and ecological system are covered by respectively the CBA and the CEA/CIA (see subsequent models & tools sections), this does not truly represent a coupled SES. Extension of the CEA/CIA applied to also include ecosystem services together with some valuation of their contribution to human wellbeing could have addressed this. However, that was not done in this Trial IA.

4.2.4 Stakeholder involvement

As outlined in Section 0, the Trial IA was part of the North Sea Programme 2022-2027 process. As noted there, departments of several ministries coordinated working groups for relevant North Sea subjects and invited corresponding stakeholders to participate in these working groups.

During the period from February to June 2020, the government initiated an interactive process of joint fact-finding with stakeholders, in which different scenarios for the spatial plans of the North Sea were created, assessed and evaluated in an iterative fashion. To this end, several working group workshops with stakeholders were organised to discuss specific North Sea subjects; monthly meetings with ministries and research providers were held to discuss scenario outcomes and define alternative scenarios; and, finally, a public webinar was organized to consult the wider public about the outcomes of the final scenarios and outcomes.

During this process, over the period February to June 2020, the following knowledge from different scientific areas was developed and used to inform the definition of spatial plans for the North Sea:

- Expert workshop '*Natuur en windenergie*' (04-02-2020);
- Expert workshop '*Windenergie*' (19-02-2020);
- Study into the Levelized Cost of Energy (LCoE) of seven new wind farm areas and *IJmuiden Ver* on the North Sea (BLIX, 2020a);
- Expert assessment of the expected impacts of wind farm areas on species groups on the North Sea (Jongbloed et al., 2020); and
- Assessment of the economic and ecological impacts of spatial plans for the North Sea by 2040/2050 (Roebeling et al., 2021a).

These studies themselves built on relevant previous studies and knowledge.

After June 2020, over the period September to November 2020, the following separate follow-up studies on the impacts of a wide range of alternative future spatial plans for the North Sea was commissioned:

- Study into the Levelized Cost of Energy (LCoE) for new wind farm areas after Roadmap 2030 (BLIX, 2020b);
- Evaluation of the socio-economic values of fisheries in these new wind farm areas (Deetman et al., 2020);
- Study on the costs and benefits of offshore hydrogen production (NSE, 2020); and
- Assessment of the economic impacts of these alternative future spatial plans for the North Sea for the sectors windmill construction, windmill exploitation, fisheries and maritime transport (Roebeling et al., 2021b).

During this process it has become clear that scientific knowledge plays an important role in informing the definition of spatial plans for the North Sea. However, some observations need to be made:

- There is a tendency to commission separate disciplinary studies to assess the environmental, social or economic impacts of spatial plans;
- Available disciplinary scientific knowledge is often not sufficiently developed to adequately inform the spatial planning process (e.g. required spatial and temporal scales; multiple direct and indirect impacts; feedbacks between the social and ecological system components);
- There is a lack of truly integrated approaches that integrally assess environmental, social and economic impacts of spatial plans across consistent spatial and temporal scales; and
- There is a lack of integrating approaches that help weighing multiple partial impacts in an overarching fashion.

5 CONCLUSIONS

The Dutch government (has) put great effort in bringing the sectoral and NGO stakeholders to the table at an early stage as part of the cross-sectoral participation process, with the science sector present as well. However, the Trial IA was conducted under great time stress starting with, according to the scientists involved, a research question that had not matured and, as a consequence, this project was underbudgeted for the question that was ultimately posed. Nevertheless, the outcome of the scientific project met the expectations of the client as it fed stakeholder discussion and identified knowledge gaps.

The Trial IA was, however, part of an adaptive planning cycle where the Trial IA should be considered as a preliminary assessing step which, as part of the stakeholder participation process, generated an input into what can then be considered the next cycle. In particular, the outcome helped to identify the knowledge base requirements that need to be further developed.

The following conclusions and observations can be drawn based on the application of some of the tools proposed for EBA-MSP.

Mental model

In the Trial IA, there were limited discussions on the mental model (the societal base/SES) and the knowledge base. The selection of what were considered relevant sectors was narrowed during the process to include seven main human/economic activities.

Cost-Benefit Analysis

The Economic Impact Assessment (CBA) with the Trial IA produced an indication of the economic costs and benefits of the current situation (2017) and the future scenarios (for 2040/2050) for the North Sea. This assessment included sea-based sectoral activities that impact the marine ecosystem, based on their size (area), pressure and spread of pressure. But the consequences of these impacts on the ecological system and the social system was lacking.

Another limitation was that the CBA was based on an aggregation of sectoral impacts considering sea-based sectoral activities and land-based sectoral activities that supply goods and services to these sea-based sectoral activities. However, land-based sectoral activities that process goods and services from these sea-based sectoral activities were not considered. Various macro-economic aspects were also not considered in the CBA.

Cumulative impacts

A Cumulative Effect Assessment (CEA) was applied to calculate the difference in impact of seven important human/economic activities on ecosystem components (fish, seabirds, marine mammals and habitats) between the present situation (2017) and the (hypothetical) future situations (2040/2050). This provided insight into the influence of various policy measures and spatial planning variants on ecological and biodiversity effects.

The CEA was based on a comprehensive existing database developed over the course of several EU projects. The availability of this database was a big advantage to the Trial IA. In addition, for the Trial IA, more specific input data for the sectors in the Dutch North Sea in the baseline year and for the future scenarios was required, which emerged from joint fact finding in the North Sea Programme process.

The following considerations are made concerning the evaluation of the quality and completeness of the CEA for MSP in this North Sea case study:

- The choice of the CEA method and the design concerning the relevant sectors, pressures, ecological components, scenarios and offshore wind scenarios was partly tuned to the aim of the study and in consultation with the stakeholders.
- The priority topics that the tools have to deal with were considered in Trial IA study.
- The desired assessments and their outputs were not defined together with the government representatives. The CEA-tool within the Trial IA produced an integrated view on environmental consequences of future scenarios with the limitation that these were relative comparisons that were not spatially specific. An ad hoc solution was found in commissioning an extra study. This was an expert opinion assessment to distinguish between ecological impacts of the spatial variants of potential new offshore wind farm areas. Important knowledge gaps were revealed as well as the need to develop a quantitative and spatially specific CEA tool for the North Sea hat can be applied to evaluate scenarios for MSP.
- The study area is transboundary and close to several borders, which were not considered in this Trial IA-study. However, this may have been considered in the overall process, before and after the Trial IA-study.
- Gathering as much relevant data as possible of relevant activities and ecological compartments was requested by government parties for the Trial IA study phase. The collection of relevant data for the activities of concern was considered in the pre-phase and will possibly also be considered in the post phase. WR used data from an extensive database connected to the CEA.
- Once the results were ready, they were shared in a consultation session (webinar) with stakeholders. However, that opportunity was relatively limited, and background information was not shared.
- Feedbacks from consultations with stakeholders and ideas for new developments can be used to adjust and improve the CEA. The commissioner/steering group may have had too little insight into the complexity and comprehensiveness of the CEA. The time schedule for the Trial IA within the overall process was very tight.

Stakeholder involvement

The Dutch government put great effort in bringing the sectoral and NGO stakeholders to the table at an early stage. Stakeholders were invited to participate in several workshop and working groups, as well as in interactive process of joint fact-finding, in which different scenarios for the spatial plans of the North Sea were created, assessed and evaluated in an iterative fashion. In addition, a public webinar was organized to consult the wider public about the outcomes of the final scenarios and outcomes. However, the exchange of information and interaction between all parties was limited and therefore the assessing step could be improved in the overall process.

Scientific knowledge

The case study also yields some important observations on the current role and status of scientific knowledge in the MSP process:

- Multi-disciplinary scientific knowledge is often not available to adequately inform the spatial planning process (e.g. required spatial and temporal scales; multiple direct and indirect impacts; feedbacks between the social and ecological system components);
- There is a tendency to commission separate studies (i.e. mono-disciplinary) to assess the environmental, social or economic impacts of spatial plans; and
- There is a lack of truly integrated approaches that assess environmental, social and economic impacts of spatial plans across consistent spatial and temporal scales and in an overarching fashion.

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ANNEX 1 GLOSSARY AND ABBREVIATIONS

Term (in English)	Abbreviation (in English)	Explanation (in English)	In Dutch
Activity		An activity, process, or physical works intended to enhance human welfare; alternative terms used are e.g., driver, sector	
Cost-benefit analysis	CBA	An economic technique applied to public decision−making that attempts to quantify the advantages (benefits) and disadvantages (costs) associated with a particular project or policy	Kosten-baten analyse (KBA)
Cumulative Effect Assessment (also Cumulative Impact Assessment)	CEA / CIA		Cumulatieve Effect Beoordeling
Ecosystem component		An attribute or set of attributes of the natural environment; alternative terms used may be valued ecosystem component, ecological component, receptor, indicator	
Environmental impact assessment	EIA		Milieu Effect Beoordeling
Environmental Risk Assessment	ERA		Milieu Risico Beoordeling
Intensity		The relation connecting pressures to activities, considering the type, duration, strength, and (spatial) extent of the pressure; alternative term used may be impact	
Interdepartmental Directors Committee for the North Sea	IDON		Interdepartementaal Directeuren Overleg Noordzee
Marine Spatial Plan	MSP		
Ministry of Agriculture, Nature and Food Quality	LNV		Ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV)
Ministry of Infrastructure and Water Management	I&W		Ministerie van Infrastructuur en Waterstaat (IenW)
North Sea Programme 2022-2027	NSP	Extensive participation stakeholder process that has to produce a set of agreements for the spatial planning of the Netherlands North Sea on the long term (2040/2050)	Programma Noordzee 2022-2027

Term (in English)	Abbreviation (in English)	Explanation (in English)	In Dutch
Numerical		Numerical figure based on experience	Kental
Offshore Wind Farms	OWF		
Pressure		A means by which one or more activities cause or contribute to a change in an ecosystem component or components; alternative terms used may be stressor, impact, effect	
Rijkswaterstaat	RWS		Rijkswaterstaat (RWS)
Sensitivity		The relation connecting ecosystem components to pressures, considering the vulnerability and recovery potential of the ecosystem component; alternative term used may be vulnerability	
Social cost benefit analysis	SCBA	A method to support the decision-making of the national, provincial and municipal governments. Cost-benefit analyses are used for infrastructural projects, and also apply to, for example, area development projects, sustainable energy development and water and nature issues	Maatschappelijke kosten-baten analyse) (MKBA)
Strategic Environmental Assessment	SEA		Plan MER
Trial Integrated Assessment	Trial IA	The SCBA and CEA applied to public decision−making that attempts to quantify the economic and ecological advantages (benefits) and disadvantages (costs) associated with the Netherlands North Sea Programme policy that was subject of this North Sea case study	
Wageningen Research	WR		Wageningen Research

ANNEX 2: ENVIRONMENTAL ASSESSMENT METHODS WITH APPLICATION DEPENDING ON THE AIM OF THE DECISION MAKING

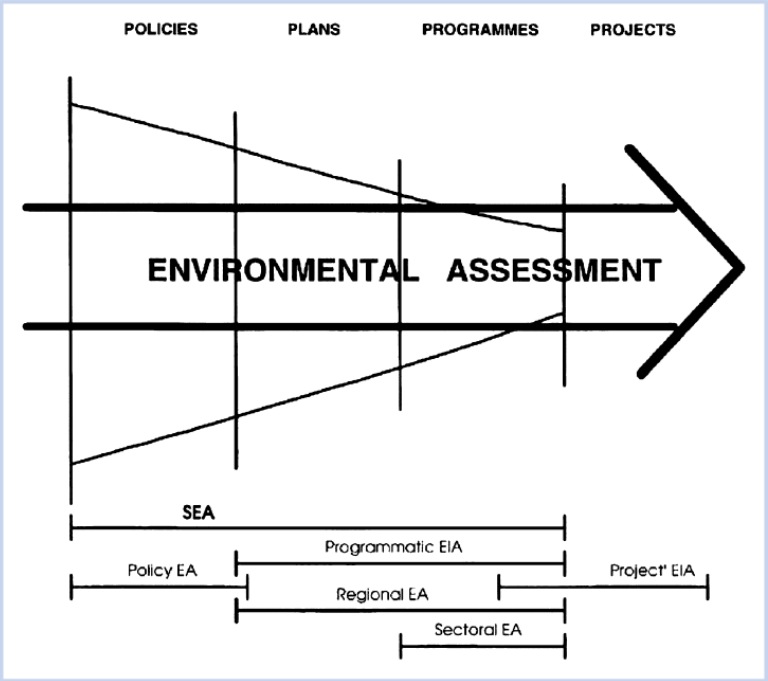

Figure 1. Focusing environmental assessments across sequential decision-making levels (Partidário 2000).

Table 1. Characteristics and options of various environmental assessments

Aspect	Environmental assessments			
	EIA	SEA	CEA	ERA
Purpose	Informing decision makers (permit application)	Informing decision makers, support consultation and governance (environmental policy and management)	Part of EIA or SEA and as stand-alone, providing insight for government and industry	Determining risk of substances (ecotoxicology) and other pressures (e.g., as methodology for CEA)
Decision-making level	Project	Plan, program	Project, plan, policy	Project, plan, policy
Need and/or requirements	Legally required in many countries	Legally required in many countries	Limited as part of EIA	Legally required for substances (ecotoxicology)
Spatial scale	Site, local	Local, regional	Variable, depending on purpose (from site to global)	Variable, depending on purpose (from site to global)
Temporal scale	Present and future	Present and future	Variable, depending on purpose	Variable, depending on purpose
Level of detail (data)	High	Low	Variable, depending on purpose	Variable, depending on purpose

CEA = cumulative effect assessment; EIA = environmental impact assessment; ERA = environmental risk assessment; SEA = strategic environmental assessment.

The figure and the table in this Annex were derived from Tamis et al. (2016)

Tamis, J.E., P. de Vries, R.H. Jongbloed, S. Lagerveld, R.G. Jak, C.C. Karman, J.T. Van der Wal, D.M.E. Slijkerman, C. Klok (2016): Towards A Harmonised Approach For Environmental Assessment Of Human Activities In The Marine Environment. Integrated Environmental Assessment and Management DOI 10.1002/ieam.1736

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