Assessment of the Cumulative Effect of Activities in the Maritime Area

Overview of relevant legislation and proposal for a harmonised approach

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Executive Summary

Introduction

Despite all efforts to publish guidance documents on cumulative effects assessment, a common understanding of cumulative effects assessment (CEA) is still lacking, hampering the development of a transparent and widely (globally) accepted approach. In the meantime, environmental impact assessments of projects or plans often attempt to address the issue of cumulative effects but mainly at a highly qualitative level and incomparable to other environmental impact assessments. The objective of the study reported in this document is

- to prepare an overview on how cumulative effects assessment is implemented in international regulation (OSPAR ICG-CUM, Task 2);
- to identify adequate coverage of maritime activities by these regulations (OSPAR ICG-CUM, Task 1) and
- to develop a check-list of factors which should be considered in relation to cumulative impacts (OSPAR ICG-CUM, Task 3), leading to preliminary recommendations for a harmonised, effective and –preferably- pragmatic approach to CEA

The first step into a common understanding and approach to the assessment of cumulative effects is to arrive at a uniform and commonly accepted definition. Based on a discussion on all relevant aspects of (cumulative) effects assessment, the following definition of cumulative effects assessment is proposed:

"All effects on the environment which result from the impacts of a plan or project in combination with those overlapping effects from other past, existing and (reasonably foreseeable) future projects and activities"

Task 2: implementation of CEA in international regulation

When performing an environmental impact assessment for a project or for a plan or programme, the assessment of cumulative effects is considered essential for many countries and mandatory for EU countries. This is even stronger in those cases where accumulation of effects occurs across boundaries and the effects within the jurisdictional boundaries on itself do not justify a separate EIA.

Relevant international regulation was evaluated to identify whether the assessment of cumulative effects is required, whether guidelines are provided to carry out such assessments and how international cooperation is stimulated. From this evaluation, it was concluded that the European Seas have a clear legal basis to require CEA for new projects, plans and programmes through the Espoo Convention (incl.. Kiev protocol), the EU-EIA-and SEA Directives and the EU-Habitats Directive, further strengthened by the ecosystem approach that is followed in the Water Framework Directive and the Marine Strategy Directive.
The OSPAR Area as a whole is incompletely covered, as for non-European waters there is no direct legislative basis to require a CEA to be carried out. This might also lead to problems with transboundary effects at the border of European and non-European waters.

It is recommended:

- that OSPAR considers how to adopt in its programmes and measures a requirement for assessment of cumulative effects of human activities.

Task 1: coverage of maritime activities by international regulation

For legislative purposes it is important to have a complete overview of activities that should (or could) be subject to a cumulative effects assessment. An extensive overview of activities is provided in the EU-EIA and -SEA Directives, taken over in the Kiev Protocol to the Espoo Convention (see Appendix B of the report for an overview of activities referred to in international regulation).

International regulation has varying levels of enforcing power. Of those regulations evaluated in this study, the EU EIA and SEA directives have the highest level of enforcing power with the possibility of sanctioning authorities that are not in compliance. OSPAR, ESPOO and London Convention (and protocols) are next in row using recommendations and agreements, but lacking the possibility of sanctioning. The UNCLOS acts as a backstop, having little enforcing power.

The strength of regulation of activities in the marine environment is therefore dependent on the enforcing power of those regulations dealing with the activity. An overview of the strength of regulation has therefore been prepared (see figure 1). 16 of the 30 identified activities are regulated with the highest level of enforcing power (EU EIA/SEA). 5 activities are not regulated by the EU EIA/SEA directives, but are regulated by OSPAR (artificial islands, artifical reefs, cables, CO2 storage and shipping) and 1 by the LC (generic dumping). UNCLOS catches 4 of the remaining activities (bioprospecting, defence activities, marine biofuel production and scientific research). Finally, 4 activities are not covered by any of these international regulations (desalination plants, extensive mariculture, atmospheric deposition and landbased inputs).

Activity	Strength of regulation
archeology	1 (3, 5)
artificial islands	2 (5)
artificial reefs	2 (4)
atmospheric deposition	-
bioprospecting	5
cables	2 (5)
CO2 storage	2 (4, 5)
coastal reconstruction	1 (3,)
cooling water	1 (3)
defense activities	5
desalination	-
dredging (harbors, waterways)	1 (2, 3)
dumping of (dredged) sludge	1 (3, 4, 5)
dumping, other	4
mariculture, extensive	-
mariculture, intensive	1 (2, 3, 5)
fisheries	1 (3)
hydro energy	1 (3)
land reclamation	1 (3, 5)
land-based input (rivers, runoff)	-
marine biofuel production (eg., algae, weed)	5
offshore oil and gas	1 (2, 3, 5)
pipelines	1 (2, 3, 5)
ports	1 (3, 5)
scientific research	5
shipping	2 (5)
aggregate extraction	1 (2, 3, 5)
tourism	1 (2)
wastewater treatment plant	1 (2)
wind parks	1 (2, 3, 5)

Figure 1. Analysis of the strength of regulation (enforcing power) of the various maritime activities, decreasing from 1 to 5. 1: EU EIA/SEA; 2: OSPAR; 3: ESPOO; 4: LC; 5: UNCLOS.

It was further identified that CEA studies might benefit from inclusion of diffuse sources (i.e., atmospheric deposition and land based inputs). International regulation provides no means to require an effects assessment to be carried out for land based activities that might affect the marine environment. It was further identified that some activities in the maritime area have a diffuse nature and currently do not require an environmental effects assessment to be carried out (e.g., shipping, tourism, fisheries). Although covered by international regulation, there is a poor basis for requiring an effects assessment of these activities.
It is recommended:

- to establish criteria for human activities currently not covered by international regulation, such as desalination plants and extensive mariculture, that determine when an EIA and/or a SEA (including cumulative effects assessment) is required;
- to study the necessity of, and criteria for, international regulation to require an effects assessment to be carried out for land based activities that might affect the marine environment.

Task 3: recommendations for methods for CEA

Cumulative effects assessment must be considered a full environmental effects assessment (and should thus be part of any EIA and SEA), where the combined effect on the environment of all impacts of multiple activities is evaluated. Although the complexity of the assessment increases when introducing the cumulative aspect in effects assessment, the basic elements stay the same: activities cause impacts that may lead to adverse effects on the ecosystem.

Several guidance documents have been published, each evaluating a (rather comparable) suite of methods and tools that can be used for CEA The methods and tools generally fall into two groups:

- *Scoping and impact identification*:
  Methods to assist in the identification of how and where a cumulative effect would occur.
- *Evaluation*:
  Methods to quantify and predict the magnitude and significance of effects, based on their context and intensity.

During a CEA, multiple techniques may be used, either in combination or in different stages of the process.

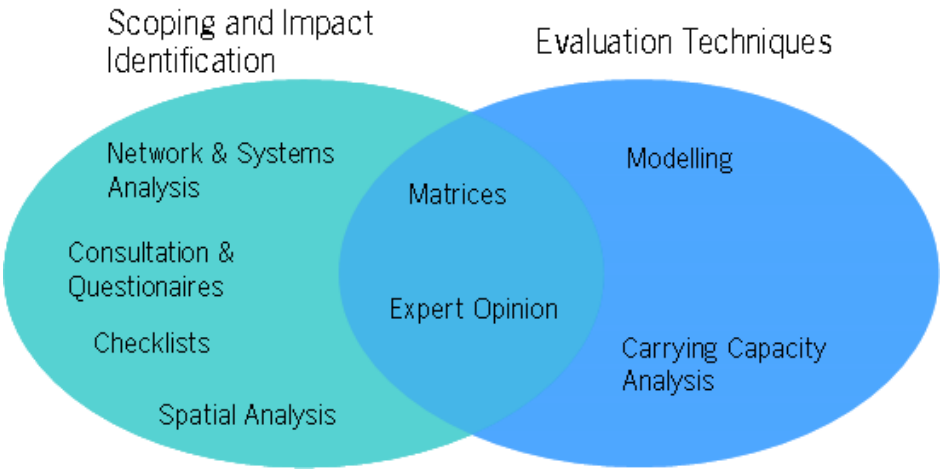

Figure 2. Methods and tools that can be used in cumulative effects assessment (source: EU, 1999)

Case studies

In the report we summarised a number of case studies; CEA's that have been performed by, or under the legislation of, OSPAR Contracting Parties:

- CEA on roosting birds in relation to offshore windparks (Germany)
- Land reclamation ' Maasvlakte 2' (Netherlands)
- Offshore wind parks (Netherlands)
- Regional Environmental Assessment (REA, UK)
- CUMULEO (Netherlands)
- Multiple aggregate extraction (UK)

From these case studies we learned that cumulative effects assessments are generally well performed, although mainly by sector. When multi-sector assessments are performed, these are fairly simple. Some case studies were lacking a good definition of the ecosystem to be protected and a consistent approach to choose the ecosystem components (indicators or receptors) to be used in the assessment. The lack of a common structure or approach to the CEA, yields incomparable processes with incomparable results. Verification of the performance of the CEA is seriously hampered since each study follows its own approach.

Evaluation of significance and acceptability cannot be performed on the basis of the results produced, and there was no use of threshold values or criteria to evaluate the significance or acceptability. Many of the results of the assessments lacked quantification, as a result of the method or as a result of a lack of data. The lack of data (on other activities) is considered a serious problem in cumulative effects assessment.

It is recommended:

- to further develop the proposed framework for cumulative effects assessment (to be primarily addressed within the context of Strategic Environmental Assessments, where appropriate), potentially in the form of OSPAR guidance;
- to share collected data (including EIA/SEA on specific monitoring projects) among contracting parties and make this data available to initiators of projects for which a CEA needs to be performed;
- to inform QSR2010 by undertaking selected pilot projects. These examples could help to determine a practical and harmonised approach to CEA, and aim to take account of the EU-Marine Strategy Framework Directive. Collecting such relevant data and information and gaining experience will increase Contracting Parties capabilities for CEA.

Glossary of terms

- Action
  Any project or activity of human origin.
- Activity
  Any action that is not a physical work. Activities do not involve the construction of an object and may lead to an environmental effect (e.g., a highway is a physical work, but traffic on the highway is an activity).
- Additive effect
  An additive effect is the overall consequence which is the result of two stressors acting together and which is the simple sum of the effects of the stressors acting independently.
- Aggregate
  Aggregate is the component of a composite material used to resist compressive stress, for example sand or gravel.
- Antagonistic effect
  A biologic response to exposure to multiple stressors that is less than would be expected if the known effects of the individual stressors were added together.
- Assessment framework
  A description of a process that organizes actions and ideas, usually in a step-by-step fashion. Frameworks help to guide practitioners in carrying out an assessment.
- Baseline data
  A description of existing environmental, social and economic conditions at and surrounding an action.
- Biodiversity
  Refers to the variety of life on earth: the number of plants and animals and other organisms that exist on our planet and the variety within these species and the ecosystems they inhabit.
- Bioprospecting
  Bioprospecting describes the search for previously unknown compounds in organisms that have never been used in traditional medicine.
- Blue Book
  On 10 October 2007, the European Commission presented its vision for a Integrated Maritime Policy for the European Union. The vision document – also called the Blue book – was accompanied by a detailed Action Plan and a report on the results of the broad stakeholder consultation.
- Boundary
  A limitation conferred by space, time, or ecology was well as political, social and economic factors.
- Carrying capacity
  The carrying capacity is the supportable population of an organism, given the food, habitat, water and other necessities available within an ecosystem for that organism.
- Cause and effect relationship
  The connection between an action's disturbance (cause) and its effect on the environment.
- Combined effect
  The effect caused by various components of the same action.
- CO_2 storage
  Carbon dioxide (CO_2) capture and storage (CCS) is a process consisting of the separation of CO_2 from industrial and energy-related sources, transport to a storage location and long-term isolation from the

atmosphere. A possible CCS technique is the placement of CO_2 in sub-seabed geological formations (CS-SSGS).

- Cumulative effects

  "All effects on the environment which result from the impacts of a plan or project in combination with those overlapping effects from other past, existing and (reasonably foreseeable) future projects and activities" (as defined in this report).

- Cumulative Effects Assessment (CEA)

  Assessment of cumulative effects.

- Direct effect

  An effect in which the cause-effect relationship has no intermediary effects, i.e. which follows as a direct cause-effect consequence of a project activity.

- Ecosystem

  A community of interdependent plants, animals and other living organisms (including humans) together with the environment with supports them and with which they interact.

- Ecosystem approach

  The phrase 'Ecosystem Approach' was first coined in the early 80s, but found formal acceptance at the Earth Summit in Rio in 1992 where it became an underpinning concept of the Convention on Biological Diversity, and was later described as: "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". The EU has implemented the ecosystem approach in the proposed Marine Strategy Directive.

- Ecosystem indicators (i.e. receptors)

  An indicator measures or describes a current condition in relation to a predetermined reference or set of references and, when observed over time, demonstrates trends. The EU uses the term "environmental indicator" and defines this as "A parameter or a value derived from parameters that describe the state of the environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the responses steering that system. An indicator has gone through a selection and/or aggregation process to enable it to steer action."

- Effect

  Any response by an environmental or social component to an action's impact.

  Under the Canadian Environmental Assessment Act (CEAA), "environmental effect" means, in respect of a project, "(a) any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance and (b) any change to the project that may be caused by the environment, whether any such change occurs within or outside of Canada".

  The EU defines effects as: "Any change in the physical, natural or cultural environment brought about by a development project. Effect and impact are used interchangeably."

- Environmental Assessment (EA)/Environmental Impact Assessment (EIA)

  The systematic, reproducible and interdisciplinary identification, prediction and evaluation, mitigation and management of effects from a proposed development and its reasonable alternatives (as defined by the CEAA). The term EIA is used by the EC to describe the procedure which fulfils the assessment requirements of Directive 97/11/EC and is defined as: "process by which the consequences of proposed projects or programs are evaluated as an integral part of planning the project, alternatives are analysed, and the general public has ample opportunity to comment".

- Evaluation
  The determination of the significance of effects. Evaluation involves making judgements as to the value of what is being affected and the risk that the effect will occur and be unacceptable.
- Impact
  Any aspect of an action that may cause an effect; for example, land clearing during construction is an impact, while a possible effect is loss and fragmentation of wildlife habitat.
  Note that the EU uses 'impact' and 'effect' interchangeably.
- Indicators
  Anything that is used to measure the condition of something of interest. Indicators are often used as variables in the modelling of changes in complex environmental systems.
- Indirect effect
  An effect in which the cause-effect relationship (e.g., between the project's impacts and the ultimate effect on a ecosystem indicator) has intermediary effects, i.e. at least one step removed from a project activity in terms of cause-effect linkages. As an interaction with another action's effects is required to have a cumulative effect (hence, creating intermediary effects), cumulative effects may be considered as indirect.
- Induced action
  An action that occurs as a consequence of another action. The induced action is not an intended component of the initiating action.
- Likelihood
  The degree of certainty of an event occurring. Likelihood can be stated as a probability.
- Magnitude
  A measure of how adverse or beneficial an effect may be.
- Matrix
  A two-dimensional listing, row listing and vertical listing constitutes impact interaction between each elements of characteristics and conditions of the environment and proposed actions that may affect the environment.
- Meta-populations
  A meta-population consists of a group of spatially separated populations of the same species which interact at some level.
- Mitigation
  A means of reducing the significance of adverse effects. Under CEAA, mitigation is "the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means".
- Monitoring
  A continuing assessment of conditions at and surrounding the action. This determines if effects occur as predicted or if operations remain within acceptable limits, and if mitigation measures are as effective as predicted.
- Project
  Any action or activity requiring the design, construction and operation of structures or equipment. Projects are usually defined with a specific name, function and description. Under the CEAA, a "project" means (s. 2(1)): "(a) in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work, or (b) any proposed physical activity not relating to a physical work that is prescribed or is within a class of physical activities that is prescribed pursuant to regulations made under paragraph 59 (b)."
  The EU defines "project" as: "The execution of construction works or of other installations or schemes

and other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources."

- Qualitative approach
  Subjective (i.e., based on best professional judgment).
- Quantitative approach
  Use of environmental variables represented by numbers or ranges, often accomplished by numerical modeling or statistical analysis.
- Receptor
  See ecosystem indicator.
- Reclamation
  The alteration of a landscape, as purpose of a project or as mitigation for an action, to re-create conditions prior to the project.
- Recovery
  The return of environmental conditions to the state they were prior to the action.
- Region
  Any area in which it is suspected or known that effects due to the action under review may interact with effects from other actions. This area typically extends beyond the local study area; however, how far it extends will vary greatly depending on the nature of the cause-effect relationships involved.
- Residual Effects
  Effects that remain after mitigation has been applied.
- Scenario
  A description of environmental and development conditions at a certain time to allow comparisons of change (e.g., pre-development, current, and reasonably foreseeable).
- Scoping
  A consultative process for identifying and possibly reducing the number of items to be examined until only the most important items remain for detailed assessment (as defined by the CEAA). Scoping ensures that assessment effort will not be expended in the examination of trivial effects. The EC defines "scoping" as: "The process of identifying the content and extent of the Environmental Information to be submitted to the Competent Authority under the EIA procedure."
- Significance
  A measure of how adverse or beneficial an effect may be, i.e. the relative importance of an issue, concern or environmental effect, as measured by prevailing standards, regulatory requirements and social values.
- Strategic Environmental Assessment (SEA)
  A similar technique to environmental impact assessment (EIA) but normally applied to policies, plans, programmes and groups of projects. Strategic environmental assessment (SEA) provides the potential opportunity to avoid the preparation and implementation of inappropriate plants, programs and projects and assists in the identification and evaluation of project alternatives and identification of cumulative effects. SEA comprises two main types: sectoral SEA (applied when many new projects fall within one sector) and regional SEA (applied when broad economic development is planned within one region).
- Study area
  The geographic limits within which an impact to a ecosystem indicator is assessed.
- Synergistic effect
  When the combined effect of several forces operating is greater than the sum of the separate effects of the forces.

– Threshold

  A limit of tolerance of an ecosystem indicator to an effect, that if exceeded, results in an adverse response by that ecosystem indicator.

Contents

1 Introduction

1.1 Background

The sea is, although apparently empty when watched from the beach, an intensively used area with a high economic value. Besides its economic value, the oceans and seas are also an area with a special ecological value. Without careful use and management, economic exploitation will lead to significant and possible irreversible damage to this ecologically valuable area. This was, *inter alia*, recognised by the European Commission (DG Maritime Affairs), which expressed its concern in the recently published Blue Book [EC, 2007]:

"On the one hand technology and know-how allow us to extract ever more value from the sea, and more and more people flow to Europe's coasts to benefit from that value. On the other hand, the cumulated effect of all this activity is leading to conflicts of use and to the deterioration of the marine environment that everything else depends on."

With this statement, the European Commission emphasizes the fact that our attention needs to be broader; so as well as assessing effects of individual activities and projects, we need to assess the effects of the plurality and density of current (and expected future) use of the sea.

In 2005 the European Commission presented a thematic strategy with the objective of protection and conservation of the marine environment. In order to achieve that objective, the European Commission proposed the Marine Strategy Directive, designed to achieve good environmental status in the marine environment, and to ensure the continued protection and preservation of that environment and the prevention of deterioration. The focus in this directive is on the integrated, ecosystem based approach.

In the Netherlands the discussion on cumulative effects started in the mid-eighties when concern over various activities in the Wadden Sea was reason for a study on cumulative effects (Dijkema *et al.*). However, it was the sudden interest for offshore wind energy that really brought into focus the need for better management for marine space and cumulative effects, becoming even more pertinent with the current drafting of marine management plans.

Minutes of many meetings under the OSPAR convention (e.g., BDC and MASMA) give evidence that the issue of the cumulative effect of all activities taking place in the OSPAR maritime area is cause for concern over the past few years. The context of such discussions in OSPAR is within spatial planning of the maritime area. On the basis of the outcome of a workshop on Spatial Planning in the North Sea (SPINS 05/5/1) and follow-up discussions in 2005 and 2006 (MASMA) it was concluded, a.o., that the focus on marine spatial planning for OSPAR should continue to be on transboundary issues and especially on cumulative impacts. Furthermore, an approach is needed to deal with cumulative effects in the coming Quality Status Report of 2010 (QSR 2010).

At the OSPAR/MASMA meeting of October 1, 2007, it was agreed to establish a Intersessional Correspondence Group on Cumulative Effects (ICG-CUM) to carry out the following tasks:

1. To review potential impacts of human activities in the maritime area not covered by Espoo Convention the EC Environmental Impact Assessment (EIA) Directive or the Strategic Environmental Assessment (SEA) that might cause transboundary and/or cumulative effects

2. consideration of whether the arrangements under the Espoo Convention and EU EIOA and SEA Directives adequately cover cumulative effects of human activities in the maritime area
3. in the light of task 2: to develop a check-list of factors which should be considered in relation to cumulative impacts of activities in the maritime area
4. consideration of whether existing arrangements adequately cover transboundary and cumulative impacts other than environmental impacts.

It was agreed that the Netherlands would lead the ICG-CUM. The Group's first task would be to analyse and comment a report to be prepared by a Consultant dealing with tasks 1, 2 and, partially, 3. This report is the product of that process.

1.2 Transparent approach

The relevance of cumulative effects is recognized not only in Europe and the OSPAR region, but globally policy makers and experts are engaged in studies to increase the understanding on this complex issue. Guidance documents have been published by various authors and authorities (e.g., CEAA, 1998, 1999; Court *et al.*, 1994; European Commission, 1999, 2000; ODPM, 2005a, 2005b; Scottish Executive, 2006; Therivel & Ross, 2007; USCEQ, 1997). However, despite these efforts, a common understanding of cumulative effects assessment (CEA) still lacking, hampering the development of a transparent and widely (globally) accepted approach. In the meantime, environmental impact assessments of projects or plans often attempt to address the issue of cumulative effects but mainly at a highly qualitative level and incomparable to other environmental impact assessments. This in itself justifies the development of common understanding and harmonized methods for the assessment of cumulative effects.

1.3 Objective of the study

The objective of the study reported in this document is to prepare an overview on how cumulative effects assessment is implemented in international regulation (OSPAR ICG-CUM, Task 2); to identify adequate coverage of maritime activities by these regulations (OSPAR ICG-CUM, Task 1) and to develop a check-list of factors which should be considered in relation to cumulative impacts (OSPAR ICG-CUM, Task 3), leading to preliminary recommendations for a harmonised, effective and –preferably- pragmatic approach to CEA

The focus in this document is on environmental issues in the OSPAR Area. Where relevant, economic and safety issues will be addressed as well.

1.4 Reading guide

We start this report with an elaboration on definitions used for cumulative effects assessment in Europe, United States and Canada; in order to propose a common definition (chapter 2). This is followed by an evaluation of cumulative effects assessment in international regulation (chapter 3) and the coverage of all maritime activities (to be used in CEA) by the same international regulation (chapter 4). Chapter 5 focuses on the actual assessment of accumulated effects by elaborating on the concept of CEA (paragraph 5.1); defining the requirements for CEA as a function of its use (paragraph 5.2) and provides a description of the most commonly used tools (paragraph 5.3). That is followed by some examples of CEA studies carried out by OSPAR Contracting Parties, concluded with some observations on these studies (paragraph 5.4). Based on that, we present some initial thoughts on a

framework (paragraph 5.5) that could be further developed into a common and harmonised approach to cumulative effects assessment within the OSPAR Convention (and its contracting parties).

2 Definition of Cumulative Effects

The first step into a common understanding and approach to the assessment of cumulative effects is to arrive at a uniform and commonly accepted definition. Table 1 shows some examples of the definition of cumulative effects that are used in the various documents used in this study. In the following paragraphs we will discuss the most relevant aspects to CEA in order to arrive at a proposal for a common definition.

Table 1. Definition of cumulative effects used in various documents

Definition	**Source**
Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.	Guidelines for the Assessment of indirect and cumulative impacts as well as impact interactions (EU, 1999)
Effects of activities need to be assessed in combination with other existing or expected projects or activities.	RWS 'uitvoeringskader N2000 Beheerplannen' (NL, 2007)
The effects of the activity under study on the (environmental) objectives of an area in combination with the effects of other activities	Nature Conservation Act (NL,1998)
The joint effects on the environment of all activities in the Waddensea	Dijkema *et al.* (NL, 1985)
In a transboundary context: where there is no direct effect on the environment under the jurisdiction of another State, but where the development concerned, when taken together with all the other existing developments, may have an adverse effect on the ecosystem as a whole.	OSPAR (SPINS 05/2/1)
The effect on the environment which results from effects of a project when combined with those of other past, existing and imminent projects and activities. These may occur over a certain period of time and distance.	Canadian Environmental Assessment Agency (2004)
Broadly, cumulative impacts refer to the accumulation of human induced changes in valued environmental components over time and across space in an additive or interactive manner. Cumulative impacts, cumulative effects and cumulative environmental changes are generally interchangeable terms	Spaling H. (1994)

2.1 Relevant aspects of cumulative effects

2.1.1 Impact vs Effect

An obvious difference among definitions can be found in the terminology used: cumulative impacts or cumulative effects. Among the various documents, and sometimes even within, the terms impact and effect are used alternately. The meaning of both terms is, however, different. An elaboration on this difference (in the context of Life Cycle Assessment) is provided by the International Organisation for Standardisation (ISO) and the Society for Environmental Toxicology and Chemistry (SETAC); published by Jensen *et al.* (1997) in a Guide to LCA.

The term 'impact' should be used to represent the exposure of the ecosystem to certain stressors. The term 'effect' should be used to refer to the specific changes in the ecosystem as a result of the impact. For example, fish may be exposed to chemical substances (impact), leading to the reduced egg production (effect).

Although cumulative effects and cumulative impacts are generally considered interchangeable terms (Spaling, 1994), we will use the term Cumulative Effects, as it is the objective to assess the specific effects on the ecosystem.

2.1.2 Transboundary effects

Transboundary effects can be considered a 'normal' effect in a special situation. Transboundary effects refer to effects in the area of jurisdiction of one state, while the cause is found in the area of jurisdiction of another state. It is important to define transboundary effects, especially when it comes to the (formal) cooperation between neighbouring countries (cf. Espoo Convention, see also Appendix A). Transboundary project (i.e., the project is physically taking place across state borders, e.g., cables and pipelines), not only require transboundary consultation, but preferably a cooperative or shared responsibility with respect to the assessment of environmental effects.

When considered from an ecosystem perspective, however, state borders do not exist. In that case it is not the transboundary context of effects, but the actual (geographic) extent that is relevant. Therefore, when assessing cumulative effects, state borders should be disregarded and environmental pressure or sensitive ecosystem components from neighbouring countries need to be included in the assessment. This is important for pressures that may have effects over long distances (such as persistent chemicals) as well as for mobile species (cetaceans, birds and fish) where effects on meta-populations need to be taken into account.

2.1.3 Indirect (or secondary) effects

The EU Guidelines indicate that indirect effects should be considered in cumulative effects assessment. Indirect effects refer to effects on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway. Although indirect effects need to be considered, these merely represent a possible chain of effects (e.g., toxicants may impair the reproduction of zooplankton, which reduces the food availability and therewith the stock of commercial fish) and not necessarily accumulation of effects.

Since the chain of (indirect) effects is as important as the direct effects occurring during or shortly after the activity, these should be inherent to any effects assessment. In this report, therefore, no explicit reference will be made to indirect effects.

2.1.4 Effect interactions

In general, cumulative effects can be divided into three types of accumulation:

1. Effects of multiple instances of the same activity (e.g., relevant when assessing the cumulative effects of multiple wind parks in a coastal area);
2. Effects of more than one activity, leading to the same disturbance (e.g., accumulation of the effects of noise emissions caused by shipping, exploration drilling and construction of windparks);
3. Effects of more than one activity, leading to multiple disturbances (e.g., accumulation of the effects of noise of windpark construction and the effects of fisheries).

The last, most common, type (3) is sometimes regarded as effect interaction (e.g., European CEA Guidelines; EU, 1999), being a special case of cumulative effects. In most studies, however, it is this type that is considered of most interest in CEA. For the definition of CEA in this study, all three types of cumulative effects are included. Cumulative effects further comprise additive, synergistic and antagonistic effects.

2.1.5 Time and space

Cumulative Effects Assessment should also consider the dimensions time and space:

- *Time*
  Other activities that need to be considered in a cumulative effect assessment do not necessarily occur parallel to the activity under study. Effects of activities that have occurred, or were initiated, in the past also need to be considered. Similarly, a cumulative effect assessment needs to consider effects of activities that will start or last into the foreseeable future. This is especially relevant for disturbances or effects that are persistent over time. It should be noted that there is, for as yet not a clear definition of what to consider as 'foreseeable'.
- *Space*
  Comparable to the time dimension, activities in other areas may lead to effects that are cumulative with the effect of the activity under study. For example, land reclamation along the coast may lead to a (temporary or permanent) change in the feeding area for birds. As such, the bird density in the area of the activity under study may increase, leading to possible higher effects of the activity on this bird species. The spatial component of cumulation of effects is most obvious when (the effects of) activities overlap.

2.1.6 Selection of ecosystem indicators

In paragraph 2.1.1 it was explained that this study will focus on the accumulation of effects (rather than the accumulation of impacts) which are consequences of impacts of human activities. In any CEA it is therefore important that the receptors for the effects assessment are carefully chosen.

An effects assessment is expected to provide insight into the way an ecosystem is affected. As detailed models describing the complete marine ecosystem are not available, one should base an effects assessment on a selection of receptors that represent the structure and functioning of the environment. The final set of receptors (also: ecosystem indicators) should be agreed upon by the states that have jurisdiction in the area concerned, and preferably also agreed by the relevant stakeholders at a regional seas level.

More on the selection of ecosystem indicators (receptors) can be found in paragraph 5.5.1.

2.2 Proposal for a common definition

Based on the discussion in the paragraphs above, it is proposed to use the following definition of cumulative effects:

"All effects on the environment which result from the impacts of a plan or project in combination with those overlapping effects from other past, existing and (reasonably foreseeable) future projects and activities"

As such, cumulative effects assessment:

- considers effects on (a set of) relevant receptors representing the environment due to interactions with effects of other activities and not just the effects of the single plan, project or activity under review;
- evaluates magnitude and significance, giving consideration to all effects (including other than just local, direct effects).

- includes other past, existing and future (e.g., reasonably foreseeable) projects or activities, over a larger (i.e., "regional") area that may cross jurisdictional boundaries.

3 Cumulative effects in international regulation

When performing an environmental impact assessment for a project or for a plan or programme the assessment of cumulative effects is considered essential for many countries and mandatory for EU countries. This is even stronger in those cases where accumulation of effects occurs across boundaries and the effects within the jurisdictional boundaries on itself do not justify a separate EIA. Although in the first instance it is important to have the assessment of cumulative effects required under national regulation, for the latter is also important to have international regulation which sets the scope for harmonisation of regulation and stimulates international cooperation in these issues.

This chapter identifies whether the assessment of cumulative effects is required, whether guidelines are provided to carry out such assessments and how international cooperation is stimulated. The final aim is to identify whether the arrangements under these instruments allow adequately for situations in which (transboundary) accumulative effects may occur.

Regulations considered in this chapter are:

- United Nations Convention on the Law of the Sea (UNCLOS)
- London Protocol Convention (LC)
- EU Environmental Impact Assessment Directives (EIA/SEA)
- Espoo Convention (incl. Kiev Protocol)
- OSPAR Strategies

3.1 General overview

Maritime areas are governed by a suite of national, regional and global laws, agreements and conventions. National legislation often involves the implementation of the international agreements. International regulation may sometimes overlap. This paragraph provides a brief synthesis of the international regulation. A description of the international regulation is provided in Appendix A.

The UN Convention on the Law of the Sea (UNCLOS) focuses on pollution of the marine environment, where pollution is defined as the introduction of substances or energy which likely results in deleterious effects (article 1.4). Although UNCLOS provides a list of projects that should be considered in the light of the convention; its definition of pollution includes virtually all maritime activities. UNCLOS can therefore be considered as rather precautionary, providing a backdrop for all other regulations.

Some of the regulations are based on the principle of protection and/or restoration of ecosystem quality in general or of specific species and habitats (i.e., EU Habitats Directive, EU Water Framework Directive, EU Marine Strategy Directive, OSPAR Biodiversity and Ecosystems Strategy). Regulation focuses on (conservation- and restoration-) objectives for ecosystem management, posing specific requirements upon maritime activities in order to realise those objectives.

Other regulations are aiming at a reduction of the environmental impact of activities, requiring a full assessment of the effects of plans, projects and activities on the ecosystem as a whole (i.e., EU EIA/SEA Directives, Espoo Convention, London Convention, OSPAR Strategies on Offshore oil and gas, Hazardous Substances and

Radioactive Substances). These regulations often provide the legislative context from which assessments, including EIA and SEA, are required.

The London Protocol Convention takes a special place in this list as it focuses, unlike the others, on dumping activities where introduction of substances or material into the sea is the objective and not an (unwanted) consequence. Effects assessments within the scope of the London Convention are therefore not aiming at the definition of mitigating measures, but to determine (or test) the criteria set for dumping.

Environmental threats do not respect national borders. Governments have realized that to avert this danger they must notify and consult each other on all major projects under consideration that might have adverse environmental impact across borders. The UN ECE Espoo Convention on Environmental Assessment is a key step to bringing together all stakeholders to prevent environmental damage before it occurs. The Convention entered into force in 1997. It requires Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

Cumulative effects are not directly considered. However, in the evaluation of the environmental effects of activities not listed in the Convention text (Appendix I), it is prescribed (as general criterion) to consider those activities causing additional loading which cannot be sustained by the carrying capacity of the environment. From this criterion one could conclude that the Espoo Convention does require the assessment of cumulative effects.

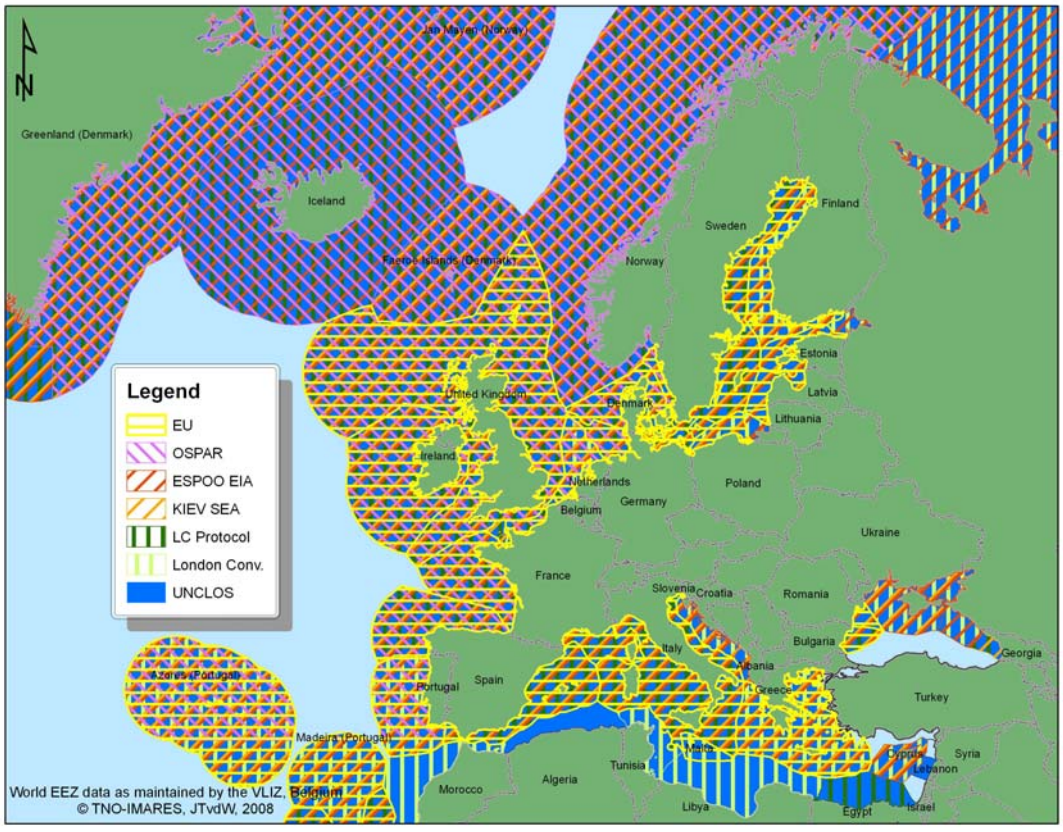

Figure 3. Geographic presentation of international legislation in the maritime area (not including the high seas)

3.2 Cumulative Effects Assessment

Not all international regulations require a CEA for projects or plans. London Convention and UNCLOS focus on the individual activities and do no require an assessment of effects from interaction with other activities. Although hidden in the text, UNCLOS may leave some room for interpretation that CEA could be required ('obligation to protect and preserve the marine environment', article 192; and 'grounds to believe that activities lead to significant and harmful changes require an effects assessment', article 206). If accumulation of effects leads to significant adverse effects, these articles would require an assessment of those effects.

More obvious requirements for cumulative effects assessment (although not explicitly stated) can be found in the Espoo Convention, the EU Marine Strategy Directive (EU-MSD) and the EU Water Framework Directive (EU-WFD). The Water Framework Directive uses the ecological status of water systems (including the coastal zone) as a starting point, while the proposed Marine Strategy Directive follows the ecosystem approach. Focussing on integrated ecosystem objectives, both Directives would benefit from an assessment of cumulative effects. Espoo prescribes that activities causing additional loading which cannot be sustained by the carrying capacity of the environment, should be subject to an effects assessment, which should then be considered an assessment of cumulative effects. Although the OSPAR Strategies do not explicitly require CEA's to be carried out, various working groups under the Biodiversity Committee now discuss the possible approaches that can be followed for assessment of cumulative effects under the OSPAR Convention. This report provides input to that discussion.

Explicit reference to CEA is made in the EU EIA/SEA Directives, as well as in the EU Habitats Directive (EU-HD). In each of these Directives, CEA is mentioned as a requirement for the environmental impact assessment to be carried out.

Table 2. Reference to CEA in the relevant international regulations.

Reference to CEA?	**Regulations**
No	UNCLOS, LC
Implicit	EU-WFD, EU-MSD, Espoo, OSPAR Strategies
Yes	EU-EIA/SEA, EU-HD

3.3 Conclusions and recommendations

It can be concluded that the European Seas have a clear legal basis to require CEA for new projects, plans and programmes through the Espoo Convention (incl.. Kiev protocol), the EU-EIA-and SEA Directives and the EU-Habitats Directive, further strengthened by the ecosystem approach that is followed in the Water Framework Directive and the Marine Strategy Directive.

The OSPAR Area as a whole is incompletely covered, as for non-European waters there is no direct legislative basis to require a CEA to be carried out. This might also lead to problems with transboundary effects at the border of European and non-European waters. It is therefore recommended that OSPAR considers how to adopt in its programmes and measures a requirement for assessment of cumulative effects of human activities. The possible role of OSPAR in the implementation of the EU-MSD could provide a good opportunity. The inclusion of cumulative effects in the QSR2010 would be a good basis for the implementation, provided that it is based on an agreed and harmonised approach. The latter would enable data collected for the QSR to be used by those performing a CEA for plans or projects.

4 Activities to consider in Cumulative Effects Assessment

For legislative purposes it is important to have a good overview of activities that should (or could) be subject to a cumulative effects assessment. An extensive overview of activities is provided in the EU-EIA and -SEA Directives, taken over in the Kiev Protocol to the Espoo Convention (see Appendix B for an overview of activities referred to in international regulation). Over time, the economic interest in the maritime area has increased and an update of this list might be relevant.

ICES (WGECO) outlined the steps necessary to undertake a full Integrated Ecosystem Assessment of the marine environment, and highlighted the importance of developing a formal framework to link manageable human activities with the pressures they cause in the marine ecosystem (ICES, 2005b, 2006). A two-table matrix was developed to link individual ecosystem components with specific pressures, and associated those pressures with the activities which are responsible for them (Choi et al., 2005; DFO, 2005). In OSPAR, the UK presented a framework for identifying assessment and monitoring needs (EIHA 07/5/1), containing a set of human activities. The set of activities was derived by identification of those activities causing specified impacts (which were in turn derived from the EU-MSD and OSPAR MPA –Marine Protected Areas– guidelines).

In parallel to the approach followed in OSPAR and by the ICES working group, we chose to build a set of activities from a list of impacts. Again, the impacts are based on the EU-MSD, but complemented with additional impacts that were considered missing.

4.1.1 Impacts

As indicated above, the inventory of activities starts with an inventory of effects to consider in the cumulative effects assessment. Such a list was drawn up for the Marine Strategy Directive (Annex II, Table 2) and presented below in Table 3. For the purpose of this study an additional number of impacts should be considered as well, presented in the same table, indicated with an asterix (*).

*Table 3. Non exhaustive list of impacts as presented in the Marine Strategy Directive (Annex II), completed with additional impacts (marked with an *) by the authors of this report*

Impacts	**Effects**
Physical loss	Smothering Sealing
Physical damage	Siltation Abrasion Selective extraction * Non-selective extraction
Other physical disturbance	Noise Visual * Migration barrier * Electromagnetic radiance * Water/tidal flow changes Marine litter

Impacts	Effects
Interference with hydrological processes	Changes in thermal regime Changes in salinity
Contamination by hazardous substances	Introduction of synthetic compounds Introduction of non-synthetic compounds Introduction of radio nuclides
Nutrient and organic matter enrichment0	Nutrient enrichment Organic enrichment Changes in thermal regime Changes in turbidity Changes in salinity * Changes in pH #
Biological disturbance	Introduction of microbial pathogens Introduction of non-indigenous species and translocations Selective extraction of species, including bycatch
Other disturbances	Visual Changes in turbidity * Changes in pH #

4.2 Activities causing impact

To derive a set of activities that are potentially relevant for CEA, an inventory of activities was drawn up from each impact that is specified in Table 3. A complete overview of activities causing these impacts can be found in Appendix C of this report. Some activities cause only 1 or few impacts (e.g., fisheries), while other activities cause multiple impacts (e.g., offshore oil and gas). It should be noted that the number of impacts caused by an activity is not an indication of the severity nor the extent of the overall impact caused by the activity.

4.3 Coverage of activities in international regulation

In order to provide for a legal basis for requiring a cumulative effects assessment for specific activities, these activities should be covered by relevant international regulation.

International regulation has varying levels of enforcing power. Of those regulations evaluated in this study, the EU EIA and SEA directives have the highest level of enforcing power with the possibility of sanctioning authorities that are not in compliance. OSPAR, ESPOO and London Convention (and protocols) are next in row using recommendations and agreements, but lacking the possibility of sanctioning. The UNCLOS acts as a backstop, having little enforcing power.

The strength of regulation of activities in the marine environment is therefore dependent on the enforcing power of those regulations dealing with the activity. An overview of the strength of regulation has therefore been prepared (see Table 4). 16 of the 30 identified activities are regulated with the highest level of enforcing power (EU EIA/SEA). 5 activities are not (directly) regulated by the EU EIA/SEA directives, but are regulated by OSPAR (artificial islands, artifical reefs, cables, CO_2 storage and shipping) and 1 by the LC (generic dumping). UNCLOS

catches 4 of the remaining activities (bioprospecting, defence activities, marine biofuel production and scientific research). Finally, 4 activities are not covered by any of these international regulations (desalination plants, extensive mariculture, atmospheric deposition and landbased inputs).

Table 4. Analysis of the strength of regulation (enforcing power) of the various maritime activities, decreasing from 1 to 5. 1: EU EIA/SEA; 2: OSPAR; 3: ESPOO; 4: LC; 5: UNCLOS.

Activity	Strength of regulation
archeology	1 (3, 5)
artificial islands	2 (5)
artificial reefs	2 (4)
atmospheric deposition	-
bioprospecting	5
cables	2 (5)
CO2 storage	2 (4, 5)
coastal reconstruction	1 (3,)
cooling water	1 (3)
defense activities	5
desalination	-
dredging (harbors, waterways)	1 (2, 3)
dumping of (dredged) sludge	1 (3, 4, 5)
dumping, other	4
mariculture, extensive	-
mariculture, intensive	1 (2, 3, 5)
fisheries	1 (3)
hydro energy	1 (3)
land reclamation	1 (3, 5)
land-based input (rivers, runoff)	-
marine biofuel production (eg., algae, weed)	5
offshore oil and gas	1 (2, 3, 5)
pipelines	1 (2, 3, 5)
ports	1 (3, 5)
scientific research	5
shipping	2 (5)
aggregate extraction	1 (2, 3, 5)
tourism	1 (2)
wastewater treatment plant	1 (2)
wind parks	1 (2, 3, 5)

It must be noted that for regulation under some of the mentioned international regulatory instruments, a minimal size limit applies. In this study these size limits are not taken into consideration, as for CEA the inclusion of many smaller activities might be as relevant as the inclusion of one larger activity. This should be considered an issue for future discussion in the context of CEA.

4.4 Activities not covered by international regulation

The following activities, which are relevant for current, economic use of the sea, are not covered by international regulation:

- *Extensive mariculture*
  Extensive mariculture involves little or no input from the producer and relies on the natural production of a water body. Environmental effects relate to the potential introduction of alien species, extraction of species and reduction of biodiversity. The impact is considered low to medium, at a local scale.

- *Desalination*
  Desalination of seawater to produce fresh water for drinking or irrigation, leads to an effluent of high salinity, containing various process chemicals, that is often discharged into the marine environment. Intake of water for desalination usually results in a loss of marine species due to impingement (i.e., collision with screens at the intake) or entrainment.

Furthermore, when assessing cumulative effects of activities at sea, diffuse inputs might need to be considered as well.

- Atmospheric deposition
- Land-based input (rivers, runoff)

Although it is difficult to identify measures to reduce such inputs (from the perspective of the management of the sea); the presence of these inputs might affect the capability of the ecosystem to deal with additional inputs from activities in the maritime area (i.e., reducing the carrying capacity).

4.5 Conclusions/recommendations

From the analysis in this chapter, we can conclude that the majority of the relevant activities that may take place in the maritime area are covered by international regulation.

Only two activities are considered not –or only partially- covered: desalination plants and extensive mariculture. It is recommended to establish criteria for activities currently not covered by international legislation that determine when an EIA (including cumulative effects assessment) is required.

It was further identified that CEA studies might benefit from inclusion of diffuse sources (i.e., atmospheric deposition and land based inputs), especially (but not exclusively) when the activity involves the discharge or emission of nutrients and/or chemical substances. International regulation provides no means to require an effects assessment to be carried out for land based activities that might affect the marine environment. It is recommended to study the necessity of and criteria for such requirements.

Finally, it must be mentioned that some activities in the maritime area have a diffuse nature and do not require an environmental effects assessment to be carried out (e.g., shipping, tourism, fisheries[1]). Although covered by international regulation, there is a poor basis for requiring an effects assessment of these activities.

[1] Effects assessment of fishing activities usually focuses at the effect on (commercial) fish stocks

5 Methods to determine Cumulative Effects

This chapter provides an elaboration on the assessment of cumulative effects, provides an overview on tools or methods that might be used for CEA and, finally, provides some initial thoughts on how to improve and harmonise CEA within the OSPAR area. This chapter has no intention to propose a single method or tool for CEA.

5.1 What is Cumulative Effects Assessment?

In Chapter 2 of this report we have proposed a common definition of cumulative effects *"All effects on the environment which result from the impacts of a plan or project in combination with those overlapping effects from other past, existing and (reasonably foreseeable) future projects and activities"*) and put that in the context of the assessment of such effects.

Regular effects assessments usually evaluate the effect on the ecosystem as a result of a specified impact of one activity (see Figure 4a). The size of the effect on the ecosystem is dependent on the sensitivity of the ecosystem for the specific impact and the intensity of that impact, which is a characteristic of the activity.

When a full environmental impact assessment is performed (e.g., as a legislative requirement) for a project or activity, the effect on the ecosystem of all impacts of this (single) activity are evaluated (see Figure 4b). It is obvious that different impacts lead to an effect on different components of the ecosystem. These are therefore usually dealt with separately, under the assumption that the total set of ecosystem components (indicators or receptors) represent the overall ecosystem (or at least those parts thereof that might be affected by the activity)(See Figure 4c).

Cumulative effects assessment must be considered a full environmental effects assessment (and should thus be part of any EIA and SEA), where the combined effect on the environment of all impacts of multiple activities is evaluated (see Figure 4d).

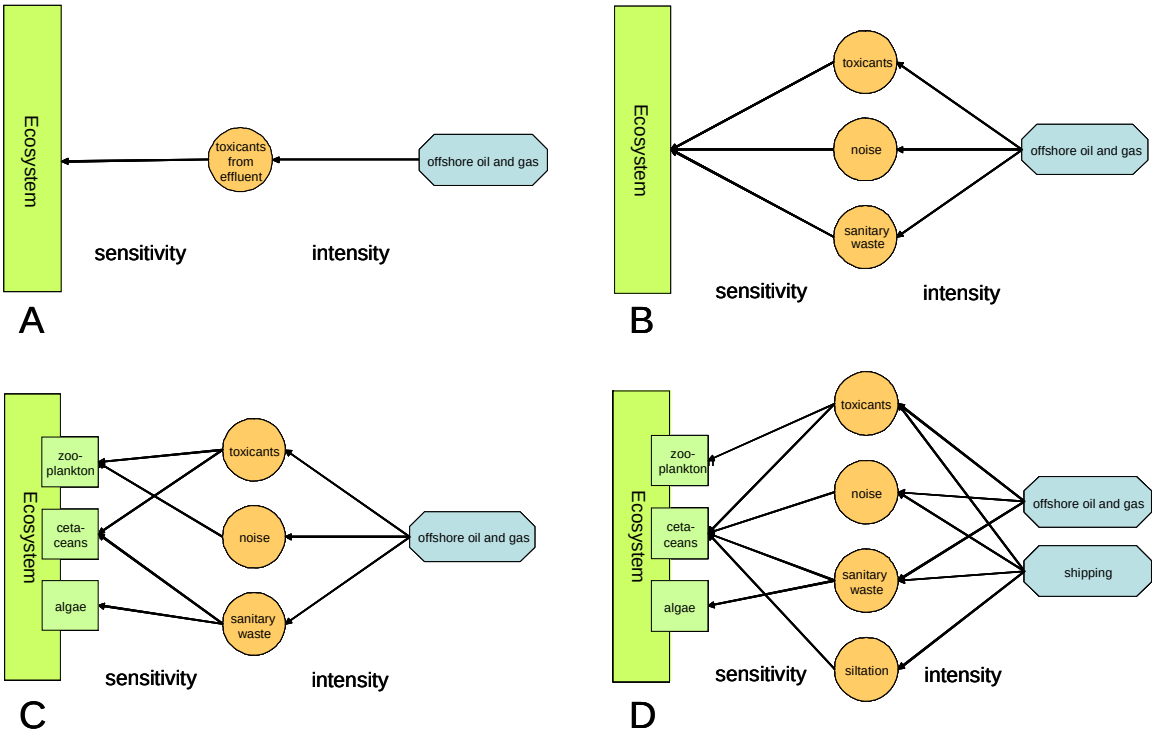

Figure 4. Schematic representation of the relation in (cumulative) effects assessment, using the oil and gas industry as an example (a: effects of a single impact of a single activity; b: effects of multiple impacts of a single activity; c: introduction of ecosystem components; d: effects of multiple impacts of multiple activities).

Although the complexity of the assessment increases when introducing the cumulative aspect in effects assessment, the basic elements stay the same: activities cause impacts that may lead to adverse effects on the ecosystem. The severity of the effects is dependent on the sensitivity of the affected ecosystem component and the intensity, duration and scale of the impact. This is schematically presented in Figure 5.

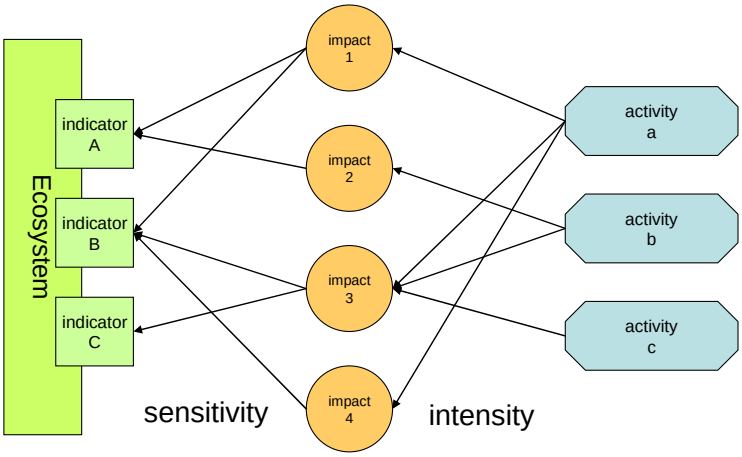

Figure 5. Schematic representation of cumulative effects assessment

In a recent review Therivel & Ross (2007) concluded that in general the main steps of CEA are:

1. identify the affected receptors—also described as valued ecosystem components, receivers or resources (scoping);

2. determine what past, present and future human activities have affected or will affect these receptors, and what has led to these activities (context);
3. predict the effects on the receptors of the project/plan in combination with the effects of other human activities, and determine the significance of the effects;
4. suggest how to manage the cumulative effects.

This general approach will be elaborated upon later in this chapter. Please not that it provides only a generic approach to cumulative impact assessment. For the purpose of environmental assessment, such as under the EIA and SEA Directives, the relevant impacts and receptors need to be determined in conformity with the Directives and stretch beyond ecosystem elements.

5.2 Requirements for cumulative effects assessment?

The reasons for performing a cumulative effects assessment can roughly be divided into two groups, each requiring a different approach to the actual assessment. The two main reasons to perform (or require) a CEA are:

- *Requesting permission for a plan or project (permit application)*
  In this case a CEA is requested from the initiator of the project (or plan) to provide insight in the environmental effects, considering the fact that other activities already have an impact on the environment to which the proposed project will add. The initiator needs to demonstrate that no critical thresholds (agreed upon or, preferably, established by the competent authority) are exceeded by adding a new activity.
- *Management or monitoring of the maritime area*
  The manager of a maritime area needs to define programmes and measures to protect the ecosystem or to improve the ecological quality. Usually, key ecosystem components are identified (receptors, ecosystem indicators) to represent the ecosystem as a whole. In this case CEA helps identifying the impacts and activities that affect the ecosystem components. If it is the objective to improve the status of an ecosystem component, the programmes and measures should focus on the impacts and activities with the highest contribution to the effect. Marine spatial planning is an emerging an popular instrument (and a keu element of the EU maritime policy) for management of the maritime area and –as such- a useful instrument for CEA.

The requirements for a cumulative effects assessment are different for the two types of assessments. Table 5 presents the requirements specified for CEA used for application of a permit for a plan or project, and for CEA use for management of a maritime region.

Table 5. Requirements for cumulative effects assessment, to be used for either plans/projects or management purposes.

	Plan or project	**Management**
Approach	Pragmatic	Scientific
Tools	Ready to use	Development
Time for assessment	1-2 years	2-4 years
Spatial scale	Determined by special scale of effects	Management area
Objective	Acceptance	Comparison
Data	Data should be available	Stakeholders should be available
Acceptance criteria	Yes	No
Output	Quantitative	Qualitative or (semi-)quantitative

5.3 Methods and tools for cumulative effects assessment

Several guidance documents have been published, each evaluating a suite of methods and tools that can be used for CEA (e.g., CEAA, 1998, 1999; Court *et al.*, 1994; European Commission, 1999, 2000; ODPM, 2005a, 2005b; Scottish Executive, 2006; Therivel & Ross, 2007; USCEQ, 1997). The suite of methods is quite comparable among the various guidance documents. The methods and tools generally fall into two groups (cf. EU Guidance document for CEA):

- *Scoping and impact identification*:
  Methods to assist in the identification of how and where a cumulative effect would occur.

- *Evaluation*:
  Methods to quantify and predict the magnitude and significance of effects, based on their context and intensity.

During a CEA, multiple techniques may be used, either in combination or in different stages of the process.

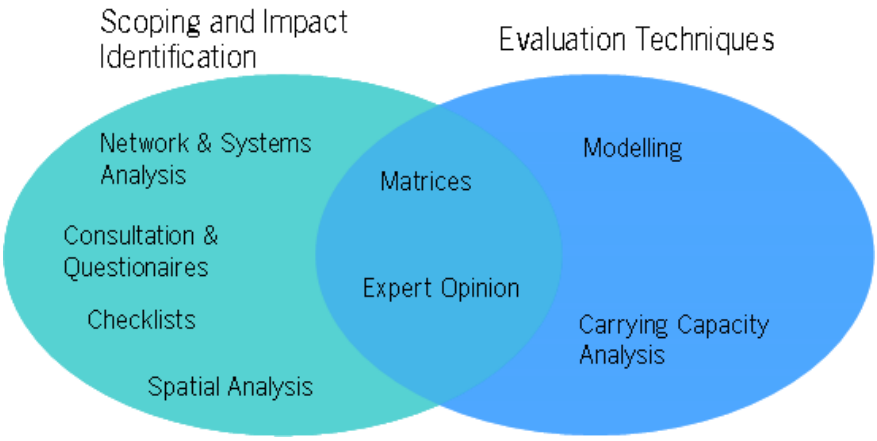

Figure 6. Methods and tools that can be used in cumulative effects assessment (source: EU, 1999)

A short description, advantages and disadvantages is provided in Table 6 for the 8 methods that are presented in Figure 6.

Table 6. Short description, advantages and disadvantages of the most relevant tools for cumulative effects assessment (from EU, 1999), to be used in combination or in different satagesof the CEA.

Method or tool	Description	Advantage	Disadvantage
Expert opinion	A means of both identifying and assessing cumulative effects. Expert Panels can be formed to facilitate exchange of information of different aspects of the impacts of a project.	• Can consider such effects as an integral part of the assessment	• Some specialists or experts may be remote from the main project team
Consultations and Questionnaires	A means of gathering information about a wide range of actions, including those in the past, present and future which may influence the effects of a project.	• Flexible • Considers potential impacts early on. • Can be focused to obtain specific information.	• Prone to errors of subjectivity • Questionnaire can be time consuming, and risk of poor response.
Checklists	Provide a systematic way of ensuring that all likely events resulting from a project are considered. Information presented in a tabular format.	• Systematic method • Can develop 'standard' checklist for similar projects.	• Can allow oversight of important effects • Nature of cause-and effect relationships not specified.
Spatial analysis	Uses Geographical Information Systems (GIS) and overlay maps to identify where the cumulative effects of a number of different actions may occur. Can also superimpose a project's effect on selected receptors or resources to establish areas where effects would be most significant.	• GIS flexible & easy to up date. • Can consider multiple projects and past, present & future actions. • Allows clear, visual presentation	• GIS can be expensive & time consuming. • Difficult to quantify effects. • Problems in updating overlays.
Network and systems analysis	Based on the concept that there are links and interaction pathways between individual elements of the environment, and that when one element is specifically affected this will also have an effect on those elements which interact with it.	• Mechanism of cause and effect made explicit. • Use of flow diagrams can assist with understanding of effects.	• No spatial or temporal scale. • Diagrams can become too complex.
Matrices	A more complex form of checklist. Can be used quantitatively and can evaluate effects to some degree. Can be extended to consider the cumulative effects of multiple actions on a resource.	• Provides a good visual summary of effects. • Can be adapted to identify and evaluate to some degree cumulative effects. • Matrices can be weighted and effects ranked to assist in evaluation.	• Can be complex and cumbersome to use.
Carrying capacity analysis	Based on the recognition that thresholds exist in the environment. Projects can be assessed in relation to the carrying capacity or threshold determined, together with additional activities.	• Addresses accumulation of impacts against thresholds. • Considers trends in the environment	• Limited to data available. • Not always able to establish the threshold or carrying capacity for a particular resource or receptor.
Modelling	An analytical tool which enables the quantification of cause-and-effect relationships by simulating environmental conditions. This can range from air quality or noise modelling, to use of a model representing a complex natural system.	• Quantifies cumulative effects • Geographical and time-frame boundaries are usually explicit • Addresses specific cause and-effect relationships	• Often requires large investment of time and resources • Can be difficult to adapt some models to a particular project. • Depends on baseline data available.

5.4 Practical experience

5.4.1 Practical experience - guidance for Cumulative Effects Assessment

Most OSPAR Contracting Parties do not have national guidance documents available to carry out CEA. The competent authorities act according to the EU-EIA and SEA Directives when requiring a CEA to be carried out. In general, cumulative impacts are considered on a case-by-case basis using expert judgement. Examples of cumulative effect assessments carried out on this basis are windfarms (Germany, Netherlands), aquaculture carrying capacity studies and offshore oil and gas SEA's (Ireland) and offshore oil and gas and windfarm SEA's (UK).

In the Netherlands no guidance is available at the moment, although the Dutch commission for EIA is working on a framework for Natura 2000 with special attention for cumulative effects assessment.

In the UK specific guidance for cumulative effects assessment is provided in various guidance documents available for (strategic) environmental assessment, prepared by the Environment Agency (2003) and English Nature (2004). Also, the UK are investigating approaches to integrated assessments of multiple human activities on the marine environment (Eastwood *et al.,* 2007)

None of the contracting parties indicated that they use the EU Guidelines for CEA.

5.4.2 Practical experience - case studies

In this paragraph we summarised a number of case studies; CEA's that have been performed by, or under the legislation of, OSPAR Contracting Parties:

- CEA on roosting birds in relation to offshore windparks (Germany)
- Land reclamation ' Maasvlakte 2' (Netherlands)
- Offshore wind parks (Netherlands)
- Regional Environmental Assessment (REA, UK)
- CUMULEO (Netherlands)
- Multiple aggregate extraction (UK)

<u>CEA on roosting birds in relation to offshore windparks (Germany)</u>
In Germany an approach has been developed for the quantification of cumulative impacts on roosting birds which has been used in the approval procedure for offshore wind-farms in Germany and in the process of designation of preferred areas for offshore wind-farms in the framework of the development of the Spatial Plan for the German EEZ. In the decision making process, the overall significance of impacts is estimated on the basis of both potential loss of reference habitat and potential loss of reference population (Dahlke, 2006, OSPAR (20-0&) EIHA 07/3/13-E (L). Germany also provided information to MASMA on this approach to deal with cumulative effects of offshore wind farms on birds (action requested from Contracting Parties MASMA 2007). These methods comprise modelling of population dynamics (Fox *et al.*, 2006; Dieschke *et al.*, 2006) and assessing the sensitivity of bird species (Garthe & Hüppop, 2004) in combination with habitat quality and quantity reduction. This is briefly summarised. Changes in the reproduction success and reduced survival are supposed to have impacts on the population level of bird species and should therefore be considered when dealing with cumulative impacts in areas with common biogeographical or flyway populations (Fox *et al.*, 2006). Garthe and Hüppop (2004) developed the so called Species Sensitivity Index (SSI) in order to quantify the vulnerability of different seabird

species to offshore wind farms. The SSI is based on nine factors, representing flight behaviour, general behaviour and status, and thought to be relevant in terms of disturbance and collision risk. Each factor was scored on a 5-point scale from 1 (low vulnerability) to 5 (high vulnerability). Based on the species-specific SSI and the density of given species a so called Wind Farm Sensitivity Index (WSI) was developed. Threshold WSI levels were proposed for various levels of concern, thus indicating parts of the German North Sea that seem to be rather sensitive to disturbance from wind farms. In addition Dierschke *et al.* (2006) suggested that effects of offshore wind farms on seabirds may impact their population dynamics as soon as either their reproduction or mortality rate are affected to a degree that induces changes on the population level. However, due to complex interactions it will not be possible to detect direct connections between effects of wind turbines and population changes.

In Garthe & Hüppop (2004) the SSI score is listed for 26 sea bird species and ranges from 5.8 to 44.0. The spatial distribution of the WSI for all sea bird species combined can be shown for different periods throughout the year. We consider this approach semi-quantitative because 4 of the 9 sensitivity factors are subjective considerations.

Land reclamation ' Maasvlakte 2' (Netherlands)

Directly to the west of the current Rotterdam port and industrial area, a new location for port activities and industry is to be created in the North Sea. This Maasvlakte 2 will shortly cover 1000 hectares net of industrial sites, located directly on deep water. The reclaimed land will emerge after the construction of a combination of hard and soft sea defences in the North Sea. Beach and dunes form the soft part of the sea defence, rubble or concrete blocks the hard sea wall. Inside these defences, the sites will subsequently be sprayed on. The sand for this will come from selected locations at sea, but will also become available when the port itself is deepened. The land reclamation will measure around 2000 hectares in total. Half of this will consist of infrastructure, such as sea defences, fairways, railways, roads and port basins. The other 1000 hectares will provide the space for industrial sites.

For the construction of the Maasvlakte 2 an EIA study is requested, for which specific guidelines have been drawn up by the Dutch commission for EIA studies. These guidelines only briefly indicated the need to assess the accumulation of effects with few other, nearby, projects. In the EIA report, however, a more extensive assessment of cumulative effects has been presented. This is to conform with the Habitats Directive, implemented in the Dutch Nature Conservation Act.

Conservation objectives of Natura 2000 areas have been chosen as the receptors for the effects assessment. Considering these objectives, a long list of activities potentially affecting the conservation objectives was made; including autonomous development of the existing Maasvlakte, new tidal regime in the Haringvliet, sand extraction, coastal reconstructions, fisheries, shipping, wind parks, recreation and defense activities. Both the spatial and temporal aspect of possible accumulation of effects was considered.

A predominantly qualitative assessment of cumulative effects was carried out on the basis of Expert opinion, evaluating the potential accumulation for each of the relevant Natura 2000 areas close the Maasvlakte 2 (i.e., Voornes Duin and Voordelta). It was concluded that accumulation of effects is to be expected on various bird species as a result of additional recreational activities and sand extraction.

Offshore wind parks (Netherlands)

In the legislative procedures for the construction of offshore wind parks on the Dutch Continental Shelf the issue of accumulation of effects is very prominent, due to the fact in total for over 60 windparks permission for construction has been requested. Although it is not likely that all these windparks will be realized, the Dutch

authorities assume that close to each wind park at least 1000 MW of wind park power will be installed. In the guidelines for preparation of an EIA for offshore wind parks, the initiators are requested to assess the accumulation of effects with the permitted wind parks, existing maritime activities, as well as a potential of 1000 MW power in wind parks to be installed in the (near) future. Several scenarios for these 1000 MW are provided for inclusion in the EIA study (e.g., clustered, scattered)

In the EIA for Breeveertien II (initiator: Airtricity) an extensive assessment of cumulative effects is presented, focussing mainly on the combination with other (existing and to be expected) wind parks. Although a matrix was used to identify how other activities may accumulate with the effects of the wind park, little attention was given to these activities as their impact interaction was considered insignificant. Besides accumulation of environmental effects, also the accumulation of safety effects (navigation) was studied.

For each ecosystem indicator (i.e, birds, mammals, fish and benthos) the potential accumulation of effects was described; mainly on the basis of Expert opinion, assisted by an effect matrix and GIS-analysis (for geographic layout options). It was concluded that no significant accumulation of effects would occur, with the exception of bird collisions with the turbines.

Offshore Energy SEA (UK)

The Department for Business, Enterprise and Regulatory Reform (BERR), as the principal regulator of the offshore oil and gas industry, has taken a proactive stance on the use of Strategic Environmental Assessment (SEA) as a means of striking a balance between promoting economic development of the UK's offshore energy resources and effective environmental protection. The European Strategic Environmental Assessment Directive (Directive 2001/42/EC) was only required to be transposed into UK law by 2004. The earliest of the SEAs was carried before the text of the Directive was agreed and drew on international best practice. BERR began a sequence of sectoral SEAs of the implications of further licensing of the UK Continental Shelf (UKCS) for oil and gas exploration and production in 1999. For this purpose the UKCS was subdivided into 8 areas. Since 2003 BERR has also been applied the SEA process to UK offshore wind farm leasing rounds. SEA is the process of appraisal through which environmental protection and sustainable development may be considered, and factored into national and local decisions regarding Government (and other) plans and programmes – such as oil and gas licensing rounds. As these SEAs have been carried out, the process has evolved and been improved. The evolution and refinement of the process is expected to continue. The current approach to cumulative impact assessment used in the latest Environmental Report (SEA 7) includes a structured consideration of secondary, incremental and cumulative effects. A required part of SEA is consultation with the public, environmental authorities and other bodies, together with such neighbouring states as may be potentially affected. In conducting the SEA process, BERR is guided by an SEA Steering Group, composed of departmental representatives, conservation and other agencies, NGOs, industry representatives and independent experts. Details on the SEA can be found at www.offshore-sea.org.uk and the data at www.ukdeal.co.uk).

CUMULEO (model development, the Netherlands)

In the framework of the We@Sea programme an effect model called CUMULEO (acronym for CUMULative Effects of Offshore windfarms) has been developed (van der Wal *et al.*, 2006). This model is based on GIS because of the strong spatial character of disturbance and the values to be protected. CUMULEO v1.0 consists of a number of operations carried out with GIS maps from a Site-atlas; a database of maps with relevant information for CEA related to offshore wind parks. Calculation rules are applied on a fictive scenario consisting of the cumulative effect of 10 small offshore wind farms (100 MW each) located at the Dutch North Sea coast. Data requirements for calculation rules and basic information are identified, for further development. The CUMULEO 1.0 version was based only on the effects of Offshore wind farms (type 1 CEA). In a follow-up study, other use functions of the

North Sea were integrated in the model, leading to CUMULEO 2.0. Cumulative effects in CUMULEO are determined on 4 different ecosystem components: birds, sea mammals and fish, seafloor fauna and landscape and human experience (???). For each ecosystem component, an algorithm was developed, based on a number of (documented) assumptions. The use functions that are taken into consideration are: offshore wind farms, shipping, oil and gas exploration, fishery, recreation, military use, sand extraction, cable and pipes, Bird and Habitat Directives areas, dredge dump areas.

Impacts of a multiple aggregate extraction on seabed macro-invertebrate communities (UK)
Accumulations of licensed marine aggregate areas are a feature of a number of areas off the coast of the United Kingdom. The purpose of this study was to determine whether there was any evidence of a large-scale cumulative impact on benthic macro-invertebrate communities as a result of the multiple extraction licenses located off Great Yarmouth in the western North Sea. Analysis of the precise location of dredging revealed a cumulative increase in the area of seabed dredged over the period 1993-2001. A broad-scale spatial survey, with sampling sites within and beyond the extraction area, was designed to characterise the sediments and benthic communities across the region and to look for evidence of any large-scale cumulative impact. A subset of these stations was also sampled for a further three years and confirmed that results from the broad scale survey were stable over time. Results showed the study area to be characterised by sands, in the northern half of the survey area, and sandy gravels in the south. The low diversity communities found across much of the survey area are typical of mobile sandy sediments and the naturally disturbed conditions, characteristic of this area, result from a combination of the exposed coast, shallow water, strong tides and sandy sediments. The extent to which aggregate extraction activities may have contributed to the distribution of communities is discussed (Cooper *et al.*, 2007).

5.4.3 Practical experience - Observations

A preliminary analysis of the case studies performed by Contracting Parties, as presented in the previous paragraph, leads to a number of observations:

- Assessments are generally well performed, although mainly sectoral. Focus is on multiplication of the same activity in the region, which is expected to lead to cumulative effects (type 2 cumulative effect, see paragraph 2.1.4);
- When multisectoral assessments are performed, these are fairly simple (expert opinion, semi-quantitative scoring). Evaluation of significance and acceptability cannot be performed on the basis of the results produced;
- Some case studies were lacking a good definition of the ecosystem to be protected and a consistent approach to choose the ecosystem components (indicators or receptors) to be used in the assessment;
- No use of threshold values or criteria to evaluate the significance or acceptability. Many of the results of the assessments lacked quantification, as a result of the method or as a result of a lack of data;
- Lack of information may limit the assessment
- No common structure or approach to the CEA, yielding incomparable processes with incomparable results. Verification of the performance of the CEA is seriously hampered since each study follows its own approach.

On the basis of these observations, a suggestion on possible ways to further improve CEA is presented in following paragraphs. The purpose of these suggestions is to promote further discussion with OSPAR on the development of approaches to CEA with the OSPAR area.

5.5 Initial thoughts on further improvement of CEA in the OSPAR area

It could be more effective and efficient for cumulative effects assessment, if it was carried out using a common framework. A useful framework is provided by the Canadian Environmental Assessment Agency (CEAA) in their reference guide and practitioners guide for CEA (published in 2004 and 2003 respectively). The common framework proposed in this chapter uses the CEAA framework as a basis, modified for the use on both project and management level and presented in Table 7. The paragraphs following the table provide an elaboration on the basic steps in cumulative effects assessment.

Table 7. Proposed common assessment framework for CEA

Basic CEA steps	**Tasks to complete for a plan or project CEA**	**Tasks to complete for a management CEA**
Scoping	❖ Identify regional issues of concern ❖ Select appropriate regional receptors • Identify spatial and temporal boundaries • Identify other actions that may affect the same receptors ❖ Identify potential impacts due to actions and possible effects on receptors	• Identify regional issues of concern • Select appropriate regional receptors • Identify spatial and temporal boundaries • Identify potential impacts due to actions and possible effects on receptors
Analysis of Effects	❖ Complete the collection of regional baseline data ❖ Assess effects of proposed action on selected receptors ❖ Assess effects of all selected activities on selected receptors	• Complete the collection of regional baseline data • Assess effects of all activities on selected receptors
Identification of mitigation	• Recommend mitigation measures	• Recommend management scenarios
Evaluation of significance	• Evaluate the significance of residual effects • Compare results against thresholds	• Evaluate the significance of residual effects • Compare results against land (??) use objectives and trends
Follow-up	• Recommend regional monitoring and effect management	• Recommend regional monitoring and effect management

Tasks indicated with an ❖ may benefit from a management CEA carried out for the region, before the project CEA is performed.

5.5.1 Scoping

Scoping is the first step in the performance of a cumulative effects assessment and is used to determine the range and extent required for a proper CEA. A major task in the scoping process is the identification of key issues of concern and ecosystem indicators (receptors). Apart from indicators of an environmental nature, indicators could as well involve health, safety or economic issues.

Indicators have a prominent and legitimate role in monitoring, assessing, and understanding ecosystem status, impacts of human activities and effectiveness of management measures in achieving objectives. Given all these roles, the suites of indicators intended to fulfil them must be chosen with care. Rice and Rochet (2005) presented a framework for selecting a suite of indicators from the long list of diverse, potential indicators (see Appendix D).

Although intended for fisheries management, the framework has a wider applicability and can be used for selection of indicators for ecosystem management.

The framework presented by Rice and Rochet has been included in Appendix D

Within OSPAR, much effort has been put in the development of a set of environmental indicators, referred to as EcoQO's (Ecological Quality Objectives). This set is a mixture of effect and impact indicators, and might therefore not all be useful in the context of a cumulative effects assessment.

For a management CEA the next step is the identification of all impacts of all activities. A project CEA requires the identification of the impacts (and their effects) of the activity under study, as well as the impacts of activities that affect the same receptors.

Because each indicator implies monitoring, evaluation and reporting costs, redundant indicators should be avoided. To be cost effective and to provide clear management guidance suites of indicators should be kept as small as possible while still fulfilling the needs of all users. For a project CEA it has no need to develop a set of ecosystem indicators that actually represent the full ecosystem. For project CEA's it is sufficient to select only those ecosystem indicators that are actually expected to be affected by the project. Only those activities need to be included in the CEA that affect the same indicators.

In order to identify the activities to include in the CEA, it is important to have information on the spatial scale at which the ecosystem is expected to be affected (activities within this area should be considered for inclusion). Comparable information should be available on a temporal scale, to identify activities that have occurred in the past or occur in the foreseeable future.

A well performed scoping process should lead to information that can be represented schematically according to Figure 5. The basic elements (ecosystem indicators, impacts and activities) are now identified and related to each other (see Figure 7). No information is provided in the scoping process with regard to the intensity of the impacts or with regard to the sensitivity of the indicators for the selected impacts.

Most often used instruments in the scoping process (conform the classification provided in Figure 6) are Consultations and Questionnaires, Matrices, Spatial analysis and Expert opinion)

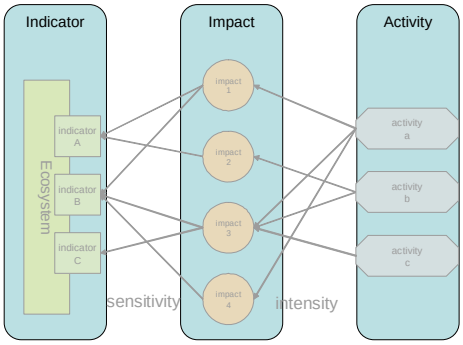

Figure 7. The scoping process allows for the identification of the basic elements for Cumulative Effects Assessment: (ecosystem) indicators, activities and impacts.

5.5.2 Analysis of Effects

The objective of the analysis is to identify the environmental effects of a project and determine the significance of these effects. It is only when the effects are known and understood that it is possible to determine and implement effective mitigation measures (or management scenarios).

The analysis of effects comprise the collection of additional information about the ecosystem indicators, for example on the geographical distribution (for as far not collected in the scoping phase) and the sensitivity for the various impacts caused by the activities. This sensitivity should be specific for the type of effect that is considered of interest for the assessment (e.g., mortality, reduced feeding efficiency or evasive behaviour). This quantifies the relations between impact and ecosystem indicators, as can be seen in Figure 8. Although usually available in a project CEA, information on the activities should be collected for management CEA's in order to quantify the intensity of the impacts caused by the activities. Once both the intensity of impacts and the sensitivity of the ecosystem indicators (receptors) are known, the actual effects analysis can be carried out.

As with environmental assessments in general, there is not one approach or methodology for all assessments of cumulative environmental effects. Different circumstances, such as location of project and type of potential environmental effects will dictate appropriate methodologies. Modelling, expert systems and geographic information systems are being increasingly used. However, where information is lacking, qualitative approaches and best professional judgement are used. It is obvious that the qualitative methods provide results for which it is more difficult to evaluate the significance and acceptability.

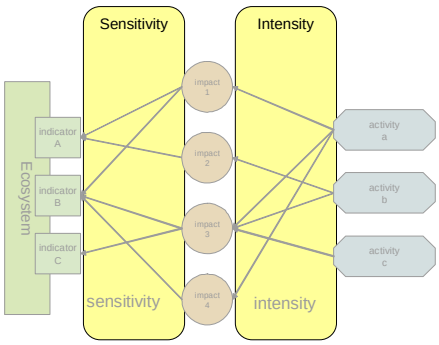

Figure 8. For effects assessment the relations between the basic elements (indicator sensitivity and impact intensity) need to be quantified.

5.5.3 Identification of mitigation

Prior to determining the significance of any cumulative environmental effects, technically and economically feasible mitigation measures, that could reduce or eliminate the effects, should be identified and analysed. In CEAs that are carried out for management purposes, alternative management scenarios should be considered as the mitigation measures.

Mitigation measures could include:

- avoiding sensitive areas such as fish spawning areas or areas known to contain rare or endangered species;

- adjusting work schedules to minimise disturbance;
- pollution control devices, such as scrubbers and electrostatic precipitators; and
- changes in manufacturing, process, technology, use, or waste management practices, such as substituting a hazardous chemical with a non-hazardous one, or the re-cycling or re-use of waste materials.

5.5.4 Evaluation of significance

Determining the significance of residual effects (i.e., effects after mitigation) is probably the most important and challenging step in EIA. The determination of significance for CEAs is fundamentally the same; however, it may be more complex due to the broader nature of what is being examined. A cumulative effects approach requires determining how much further effects can be sustained by an ecosystem indicator before suffering changes in condition or state of ecosystem indicators.

The following questions could be asked to determine significance of effects:

- Are the environmental effects adverse?
- Are the adverse environmental effects significant?
- Are the significant adverse affects likely?

A cumulative effect on an ecosystem indicator may be significant even though each individual project-specific assessment of that same indicator concludes that the effects are insignificant. This is a fundamental principle in the understanding of cumulative effects. Project-specific assessments, that focus on the incremental contribution of the project being assessed, can assist in making such conclusions as they must consider the implications of other actions also affecting the ecosystem indicators (receptors). However, this inclusion (and sometimes the analytical approach used) requires the consideration of various factors that may influence the determination of significance (some which have not always been an issue in earlier assessments without a cumulative effects component). These factors include the:

- exceedance of a threshold;
- effectiveness of mitigation;
- size of study area;
- incremental contribution of effects from action under review;
- relative contribution of effects of other actions;
- relative rarity of species;
- significance of local effects;
- magnitude of change relative to natural background variability;
- creation of induced actions; and
- degree of existing disturbance.

5.5.5 Follow-up

The purpose of follow-up is to verify the accuracy of environmental assessments and determine the effectiveness of mitigation measures. Follow-up in practice is normally recognized as monitoring and the establishment of environmental management measures. The situations in which a follow-up is required include those where (Davies, 1996):

- there is some uncertainty about the environmental effects of other actions;
- the assessment of the action's cumulative effects is based on a new or innovative method or approach;
- there is some uncertainty about the effectiveness of the mitigation measures for cumulative effects.

6 Conclusions and Recommendations

The objective of the study presented in this report was to:

1. evaluate the implementation of cumulative effects assessment (CEA) in international regulation with special focus on the ESPOO convention (incl. KIEV protocol) and the EU EIA/SEA Directives;
2. evaluate the coverage of all maritime activities by international regulation and
3. to develop a check-list of factors which should be considered in relation to cumulative impacts, leading to preliminary recommendations for a harmonised, effective and –preferably- pragmatic approach to CEA

Ad. 1, implementation of CEA in international regulation

It was concluded that the European Seas have a clear legal basis to require CEA for new projects, plans and programmes through the Espoo Convention (incl.. Kiev protocol), the EU-EIA-and SEA Directives and the EU-Habitats Directive, further strengthened by the ecosystem approach that is followed in the Water Framework Directive and the proposed Marine Strategy Directive.

The OSPAR Area as a whole is incompletely covered, as for non-European waters there is no direct legislative basis to require a CEA to be carried out. This might also lead to problems with transboundary effects at the border of European and non-European waters.

It is recommended:

- that OSPAR considers how to adopt in its programmes and measures a requirement for assessment of cumulative effects of human activities.

Ad. 2, coverage of maritime activities by international regulation

The majority of the relevant activities that may take place in the maritime area are covered by international regulation, with the exception of two activities that are considered to be not –or only partially– covered: desalination plants and extensive mariculture.

It was identified that CEA studies might benefit from inclusion of diffuse sources (i.e., atmospheric deposition and land based inputs). International regulation provides no means to require an effects assessment to be carried out for land based activities that might affect the marine environment. It was further identified that some activities in the maritime area have a diffuse nature and currently do not require an environmental effects assessment to be carried out (e.g., shipping, tourism, fisheries). Although covered by international regulation, there is a poor basis for requiring an effects assessment of these activities.

It is recommended:

- to establish criteria for desalination plants and extensive mariculture that determine when an EIA and/or a SEA (including cumulative effects assessment) is required;
- to study the necessity of, and criteria for, international regulation to require an effects assessment to be carried out for land based activities that might affect the marine environment.

Ad 3, recommendation for a harmonized, effective and pragmatic approach to CEA

Cumulative effects assessments are generally well performed, although mainly by sector. When multi-sector assessments are performed, these are fairly simple. Some case studies were lacking a good definition of the ecosystem to be protected and a consistent approach to choose the ecosystem components (indicators or receptors) to be used in the assessment. The lack of a common structure or approach to the CEA, yields incomparable processes with incomparable results. Verification of the performance of the CEA is seriously hampered since each study follows its own approach.

Evaluation of significance and acceptability cannot be performed on the basis of the results produced, and there was no use of threshold values or criteria to evaluate the significance or acceptability. Many of the results of the assessments lacked quantification, as a result of the method or as a result of a lack of data. The lack of data (on other activities) is considered a serious problem in cumulative effects assessment.

It is recommended:

- to further develop the proposed framework for cumulative effects assessment (to be primarily addressed within the context of Strategic Environmental Assessments, where appropriate), potentially in the form of OSPAR guidance;
- to share collected data (including EIA/SEA on specific monitoring projects) among contracting parties and make this data available to initiators of projects for which a CEA needs to be performed;
- to inform QSR2010 by undertaking selected pilot projects. These examples could help to determine a practical and harmonised approach to CEA, and aim to take account of the EU-Marine Strategy Framework Directive. Collecting such relevant data and information and gaining experience will increase Contracting Parties capabilities for CEA.

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8 Referees

Report C018/08
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This report has been professionally prepared by Wageningen IMARES. The scientific validity of this report has been internally tested and verified by another researcher and evaluated by the Scientific Team at Wageningen IMARES.

Approved: Dr. R.H. Jongbloed
Senior Scientist

Signature:

Date: March 14, 2008

Approved: Drs. J.H.M. Schobben
Head of Department Environment

Signature:

Date: March 14, 2008

9 Quality assurance

IMARES utilises an ISO 9001:2000 certified quality management system (certificate number: 08602-2004-AQ-ROT-RvA). This certificate is valid until 15 December 2009. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. The last certification inspection was held the 16-22 of May 2007. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2000 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2009 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation, with the last inspection being held on the 12th of June 2007.

Appendix A. Summary of relevant international regulation

United Nations Convention on the Law of the Sea (UNCLOS)

The United Nations Convention on the Law of the Sea (UNCLOS) is an international treaty governing the use and exploitation of the world's oceans. Nations around the world met 30 years ago in an intense, ten-year round of international negotiations which culminated in the 1982 Convention. On November 16, 1994, after attaining the requisite 60 signatures, the Law of the Sea Treaty entered into force and became international law. The Law of the Sea Treaty is a true constitution of the sea, establishing a coherent, uniform and global rule of law governing the use of the oceans, including the skies above and the seabed below.

Although the treaty is almost as vast as the oceans themselves, its major principles include:

- Navigational Freedom.
- Exclusive Economic Zones.
- Environmental Protection.
- Marine Scientific Research.
- Dispute Settlement Provisions.

Environmental Assessment

With respect to environmental protection, the focus of UNCLOS is on pollution of the marine environment, defined as the introduction of substances or energy which likely results in deleterious effects (Art 1.4). When interpreted broadly, this definition allows for the coverage of the environmental pressure of most human activities.

Cumulative Effect Assessment

However, the latter part of its definition: "which likely results in deleterious effects" leaves room to allow all pollution that does not cause any effect. At this moment the question should be asked whether an activity should be considered on itself or in combination with other activities. UNCLOS prescribes that when states have reasonable grounds to believe that activities lead to substantial pollution or significant and harmful changes to the environment, the effects of such activities should be assessed (Art. 206) and provides in an obligation to protect and preserve the marine environment (Art. 192).

As such, UNCLOS gives room to the assessment of cumulative effects, but does not explicitly require such assessments. A recent study of NILOS (in prep) confirmed that UNCLOS fails to provide any practical means for the protection of vulnerable marine ecosystems, nor modern conservations norms and tools such as the ecosystem approach or strategic environmental assessments.

Transboundary co-operation

Section 2 of the Convention deals with regional and global co-operation. It is stated that States shall cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international/regional organizations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features.

The Convention further prescribes that joint contingency plans shall be prepared and that States will endeavour to participate actively in regional and global programmes to acquire knowledge for the assessment of the nature and extent of pollution, exposure to it, and its pathways, risks and remedies.

London Convention (LC)

The "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972", the "London Convention" for short, is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. Currently, 82 States are Parties to this Convention.

In 1996, the "London Protocol" was agreed to further modernize the Convention and, eventually, replace it. Under the Protocol all dumping is prohibited, except for possibly acceptable wastes on the so-called "reverse list". The Protocol entered in to force on 24 March 2006 and there are currently 32 Parties to the Protocol.

Environmental Assessment

The focus of the London Convention is on regulating the dumping of all waste that is on the reverse list (or waste that is candidate for inclusion in the reverse list). Dumping in this matter is defined as any deliberate disposal or storage at sea of waters or other matter from vessels, aircraft, platforms or other man-made structures at sea, or these structures themselves (Art. III.1). Dumping is only allowed after a permit is issued, following a thorough assessment of the intended dumping, including:

- characterisation of the waste to be dumped,
- characterisation of the dumping site
- assessment of effects on the environment and all other legitimate uses of the sea.

In order to facilitate the process of assessing the planned dumping activity, the LC provides in 'Waste Assessment Guidelines' (WAG), based on the contents of Annex 2 of the Protocol. A specific WAG is available for all intended dumping, although for most waste on the reverse list a specific waste assessment guidelines has been drawn up.

Cumulative Effects Assessment

Although these document provide some guidance on the elements of an assessment required to issue a permit, they do not provide detailed directions on how to perform an assessment. It further focuses mainly on the dumping activity itself and does, as such, not consider accumulation of effects as a result of other activities in the same region.

Transboundary co-operation

With the aim of implementing the regulations of the Convention, Article 12 of the Protocol (as Article VIII of the Convention) deals with regional co-operation. It is stated, amongst others, that Contracting Parties shall seek to co-operate with the parties to regional agreements in order to develop harmonized procedures to be followed by Contracting Parties to the different conventions concerned.

European Union

The European Union has several Directives and Recommendations to provide for the assessment of effects of human activities. Each of those directives (if relevant for the marine environment) is briefly described below.

Environmental Assessment

European regulation that is relevant with respect to effects assessment is:

- EIA Directive (85/337/EEC) of 27 June 1985 as amended by Directive 97/11/EC on the assessment of the effects of certain public and private projects on the environment ('the Environmental Impact Assessment (EIA) Directive') applies to the assessment of the environmental effects of those public and private projects which are likely to have significant effects on the environment. The objectives of this Directive are achieved through the legislative process. The contents of the Directive are mainly of a procedural nature, but provides a minimum requirement for environmental reporting (Art. 5.1, referring to Annex IV).
    - *Cumulative effects:* A footnote in this Annex elaborates on the term effects assessment: "these effects should include secondary, cumulative synergistic, short, medium and long- term permanent and temporary, positive and negative effects". The accumulation of effects with other projects is also mentioned as a criterion for selection of projects subjects to an EIA in Annex III (referred to in Art. 4.3).

- SEA Directive (2001/42/EC) of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment ('the SEA Directive') deals with environmental assessment at a higher, more strategic, level than that of projects (which are dealt with in the Environmental Impact Assessment (or EIA) Directive)). The SEA Directive obliges public authorities to consider systematically whether they need to carry out an environmental assessment of the plans and programmes they prepare in accordance with the procedures laid down in the Directive.
    - *Cumulative effects:* As the SEA Directive deals with plans and programmes, the assessment of cumulative effects of individual projects (within such plans or programmes) is implicitly addressed. This is demonstrated in the objective of the Directive (Art. 1) stating that it is intended to contribute to the integration of environmental considerations. Comparable to the EIA Directive, accumulation of effects is explicitly mentioned in the elaboration of effects assessment in Annexes I and II.
- Habitats Directive (92/43/EEC): The main aim of the EC Habitats Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species at a favourable conservation status, introducing robust protection for those habitats and species including birds protected under the EU Birds Directive) of European importance.
    - *Cumulative effects:* In its requirements for effects assessment (Art. 6.3), assessment of cumulative effects is explicitly mentioned: "Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, *either individually or in combination with other plans or projects*, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives."
- Water Framework Directive (2000/60/EC): The goal of this directive is to ensure that the quality of the surface water and groundwater in Europe reaches a high standard ('good ecological status') by the year 2015. It comprises an integrated approach to water management, including an assessment of the current state of the catchment, the human and natural pressures and their impacts on the water.

    - *Cumulative effects:* Using the ecological status as a starting point, accumulation of effects is implicitly included.
- Marine Strategy Directive (2005/0211): The Marine Strategy Directive is modelled on the EU Water Framework Directive and includes target dates to achieve Good Environmental Status for Europe's marine environment by 2021. A major step in this approach is the initial assessment of the marine waters of the member states, including: a characterisation of the marine waters (physical and biologically), assessment of major pressures, identification of environmental indicators and a definition of a monitoring programme.
    - *Cumulative effects:* The ecosystem approach as followed in the marine strategy directive implicitly asks for a cumulative assessment of effects.

Although not included in any formal European Directive or Recommendation, an important policy development, with regard to cumulative effects assessment, is described in the Maritime Policies Blue Book (Action plan, SEC(2007)1278 provisional version). The action plan for the new maritime policy explicitly stipulates the importance of the assessment of cumulative effects (chapter 5).

Transboundary cooperation

Article 7 of both the EIA and SEA Directive deal with consultation of neighbouring countries in the case of transboundary effects. Member states are obliged to inform the neighbouring country about expected effects and should provide all available documentation for proper consultation. Neighbouring countries are allowed to make observations, which must be taken into account by the member states.

Espoo Convention

Environmental threats do not respect national borders. Governments have realized that to avert this danger they must notify and consult each other on all major projects under consideration that might have adverse environmental impact across borders. The UN ECE Espoo Convention on Environmental Assessment is a key step to bringing together all stakeholders to prevent environmental damage before it occurs. The Convention entered into force in 1997. It requires Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

The EC SEA Directive had a significant influence on the development of the UN ECE Kiev Protocol on strategic environmental assessment (SEA), which supplements the Espoo Convention. The protocol deals with similar, but not identical plans and programmes than those in the EC SEA Directive. It further contains a clause (Article 13) stating that each Party shall endeavour to ensure that environmental, including health, concerns are considered and integrated to the extent appropriate in the preparation of its proposals for policies and legislation that are likely to have significant effects on the environment, including health.

All OSPAR Contracting Parties have ratified the Espoo Convention (including for their dependencies/territories in the OSPAR area). 35 countries signed the Kiev Protocol on 21 May 2003. The EC and the OSPAR EU Member States have signed, but not ratified. The United States of America, Canada and the Russian Federation signed the Convention, but did not sign the Protocol.

Environmental Assessment

The Convention focuses on transboundary impacts, which are defined as any impact, not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another Party. The Kiev Protocol deals mainly with the SEA of plans and programmes within a state, with consideration of transboundary effects being secondary.

With respect to guidance, both the Convention and the Protocol give little direction to the preparation of effect assessment reporting. Appendix II to the convention sums up a list of elements that should be included in EIA documentation, but does not provide any guidance on how to draw up a an EIA document.

Cumulative Effect Assessment

Cumulative effects are directly considered. However, in the evaluation of the environmental effects of activities not listed in the Convention text (Appendix I), it is prescribed (as general criterion) to consider those activities causing additional loading which cannot be sustained by the carrying capacity of the environment. From this criterion one could conclude that the Espoo Convention does require the assessment of cumulative effects.

International co-operation

International co-operation in (transboundary) environmental impact assessment is the main objective of the Espoo Convention.

OSPAR Strategies

In the context of the ecosystem based approach (adopted by the joint Ministerial meeting of the Helsinki and OSPAR Commission) and the European marine Strategy, the OSPAR strategies were re-affirmed and updated in 2003 (OSPAR 03/17/1, Annex 31).

The '2003 Strategies of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic' are:

- Biological Diversity and Ecosystems
  Aiming at restoration and conservation of ecosystems and the biological diversity of the maritime area, affected as a result of human activities. To aid the objective, programmes and measures will be developed by the OSPAR Commission. The strategy is interrelated with Natura 2000 and the EU Habitats and Birds Directives.
- Eutrophication
  The objective of this strategy is to combat eutrophication in the OSPAR maritime area. Following the precautionary principle and taking preventive actions, the commission will develop and adopt common assessment criteria to characterise areas as non-problem, potential-problem or problem area.
- Hazardous Substances
  The objective is to prevent pollution by continuously reducing discharges, emissions and losses of hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for natural occurring substances and close to zero for man-made synthetic substances.
- Offshore oil and gas industry
  This strategy aims at elimination of pollution and to protect the maritime area against adverse effects by setting environmental goals and establishing improved management mechanisms for the offshore oil and gas industry.
- Radioactive substances
  It is the objective to prevent pollution of the marine environment from ionising radiation by prevention, reduction and elimination of discharges, emissions and losses of radioactive substances.

Environmental Assessment

In the context of the OSPAR strategies, environmental assessments aim on the protection and restoration of species and habitats, with a focus on a selection of human activities (see appendix X). Assessments are carried out by a Contracting Party, eventually in cooperation with other Contracting Parties, with the ultimate aim to identify programmes and measures to limit or prevent adverse effects on the ecosystem.

Cumulative Effects Assessment

The issue of CEA is not specifically mentioned in the OSPAR Strategies. The Biological Diversity and Ecosystems Strategy, however, mentions the need to develop integrated coastal zone management and to ensure proper spatial planning of the maritime area. Working groups under the Biodiversity Commission (MASMA, SPINS, EIHA) now explicitly address the assessment of cumulative effects.

Transboundary cooperation

OSPAR, being a regional convention, is based upon the cooperation of its contracting parties with the aim of protecting the OSPAR maritime area. Many decisions and recommendations require contracting Parties to report essential information on activities (new and ongoing) to the Commission, as to inform all Contracting parties to the Convention. This aids the exchange of information and enables monitoring of the progress mare with (establishment of) programmes and measures.

Appendix B. Overview of activities in International Regulation

Regulated Activities by UNCLOS

UNLCLOS specifies various activities in sections throughout the Convention text. Included activities are:

Pollution from vessels
Dumping
Laying cables or pipelines
Marine Scientific research
Constructing and operating artificial islands and installations
Military activities
Archaeology
Marine prospecting

Regulated activities by LC

Annex 1 of the Protocol provides an overview of waste or other material that may be considered for dumping. The following is included in this annex:

dredged material
sewage sludge
fish waste (or material resulting from fish processing)
vessels/platforms/man-made structures at sea
inert, inorganic geological material
organic material of natural origin
bulky items primarily comprising iron, steel, concrete and similar unharmful materials for which the concern is physical impact, if no other disposal options (e.g., for small islands)
carbon dioxide streams from carbon dioxide capture processes

Regulated activities For EIA and SEA by Espoo Convention and Kiev Protocol and EU EIA and SEA directives

The EU EIA and SEA Directives, the Espoo Convention and the Kiev Protocol all refer to projects, plans or programmes which might be subject to environmental impact assessment. The basis for these lists if formed by the EU EIA directive, which is referred to directly in the EU SEA directive. The Espoo Convention list of activities (Appendix 1) is equal to the KIEV protocol List of Activities (Annex 1), which are in turn closely related to the EIA Directive's list of projects (Annex 1). Both the EU-EIA Directive and the Espoo convention further provide a (more detailed) list of 'other' projects (Annex II of both documents). All elements of the list provided by the Espoo Convention are also included in the list of the EU-EIA Directive. The latter also includes works for transport of water resources, waste water treatment plants, installations for intensive rearing of poultry and construction of overhead power lines. No differences exist, however, in activities related to the maritime area. In general, the list of the EU-EIA Directive is more detailed and includes size related criteria.

Projects referred to in the Convention:

crude oil refineries	waste disposal installations for incineration etc.
thermal power stations and other combustion and nuclear (thermal load)	large dams and reservoirs
production or enrichment of nuclear fuels	groundwater abstraction
smelting of cast-iron and production non-ferrous metals	pulp and paper manufacturing
extraction of asbestos	major mining and processing f ores or coal
integrated chemical installations	offshore hydrocarbon production
construction of motorways, railways, etc	major hydrocarbon storage facilities
large diameter oil and gas pipelines	deforestation of large areas
trading ports, inland waterways and ports	*any not listed activity that causes concern for transboundary impacts*

Plans or programmes referred to in the protocol:

Agriculture	waste management
Forestry	telecommunications
Fisheries	tourism
energy, industry including mining	town and country planning or landuse
Transport	
regional development	

Other projects if EIA required nationally (relevant selection for the marine environment):

intensive fish farming	fish-meal and fish-oil factories
Industrial installations for the production of electricity, steam, hot water	pipelines for transport of gas or oil
Industrial installations for carrying electricity, steam, hot water	pipelines for transport of chemicals with diam > 800 mm, length > 40 km
surface storage of fossil fuels and natural gas	construction of harbours and port installations
underground storage of combustible gases	trading ports, piers for loading and unloading
installations for hydroelectric power production	canalization of flood-relief works
wind parks	construction of airports and airfields
installations related to nuclear fuel or waste	sludge deposition sites
underground mining	coastal work to combat erosion and maritime works capable of altering the coast through construction
extraction of minerals by marine or fluvial dredging	marina's
deep drillings	reclamation of land from the sea
Shipyards	

Appendix C. Matrix of relevant activities per disturbance

Smothering
- dredging
- offshore oil and gas
- dumping of sludge
- surface mining

Sealing
- wind parks
- land reclamation
- offshore oil and gas
- artificial islands
- coastal reconstruction
- pipelines

Siltation
- dredging
- land-based input (rivers, runoff)
- dumping of sludge

Abrasion
- shipping
- fisheries

Selective extraction
- dredging
- surface mining
- bioprospecting
- scientific research

Non-selective extraction
- pipelines
- cables

Noise
- dredging
- offshore oil and gas
- surface mining
- shipping
- wind parks
- ports
- fisheries
- tourism
- land reclamation
- coastal reconstruction
- artificial island
- defense activities

Visual
- wind parks
- offshore oil and gas
- artificial islands
- shipping
- tourism
- defense activities

Migration barrier
- wind parks
- land reclamation
- artificial islands
- pipelines

Electromagnetic radiance
- cables

Water/tidal flow changes
- land reclamation
- artificial islands
- pipelines
- coastal reconstruction

Introduction of synthetic compounds
- land-based input (rivers, runoff)
- offshore oil and gas
- dumping of sludge
- shipping
- fisheries
- tourism
- intensive mariculture
- atmospheric deposition
- defense activities
- wastewater treatment plant

Introduction of non-synthetic compounds
- land-based input (rivers, runoff)
- offshore oil and gas
- dumping of sludge
- shipping
- fisheries
- tourism
- atmospheric deposition
- defense activities
- wastewater treatment plant

Introduction of radio nuclides
- land-based input (rivers, runoff)
- offshore oil and gas

Nutrient enrichment
- land-based input (rivers, runoff)
- atmospheric deposition
- wastewater treatment plant

Organic enrichment
- intensive mariculture
- extensive mariculture
- dumping of sludge

Changes in thermal regime
- cooling water
- offshore oil and gas
- wastewater treatment plant

Changes in turbidity
- dredging
- offshore oil and gas
- dumping of sludge
- land-based input (rivers, runoff)
- surface mining
- wastewater treatment plant

Changes in salinity
- land-based input (rivers, runoff)
- cooling water
- offshore oil and gas
- coastal reconstruction
- wastewater treatment plant

Changes in pH
- CO2 storage

Introduction of litter
- tourism
- shipping

Introduction of microbial pathogens
- tourism
- wastewater treatment plant
- intensive mariculture
- extensive mariculture

Introduction of non-native species
- shipping
- tourism
- intensive mariculture
- extensive mariculture

Selective extraction of species
- fisheries
- bioprospecting
- scientific research

Appendix D. Framework for selection of ecosystem indicators (after Rice and Rochet, 2005)

Step	Description
1. determine user needs	In order to determine the use needs, it is important to identify the users, including both managers and stakeholders. The management objectives need to be clearly specified, to ensure that the final suite of indicators matches the concerns behind the objectives. At this initial stage, the major threats to achieving the objectives should be identified (i.e., the pressures in a DPSIR framework). This information is important when evaluating the sensitivity, specificity and responsiveness of candidate indicators.
2. develop a list of candidate indicators	The next key consideration is that candidate indicators truly measure ecosystem status relative to the objectives. Knowledge of the ecosystem, characteristics of the activities and societal values must all be considered. Where clear objectives have been set-up, this step can be as straightforward as listing reasonable ways to measure the property reflected in each of these objectives.
3. determine screening criteria	Nine relevant criteria are: *concreteness, theoretical basis, public awareness, cost, measurement, historical data, sensitivity, responsiveness, specificity*. Although all nine criteria should always be considered, they are not equally important in every case. The relative importance of the nine criteria should be established before the screening is done (which may expected to be different for the major user groups: technical experts, decision makers and managers, and general audiences).
4. score indicators against criteria	The scoring process has two components: evaluation of information content or -quality of each indicator relative to each criterion, and the strength of the evidence by which information content of quality is judged. As a full quantitative evaluation may only be possible for a few properties of a few criteria, an ordinal scoring (3-5 ranks) would seem sufficient.
5. summarize scoring results	For the final evaluation two matrices will be available: weights assigned to the criteria for each user group and the scores for each candidate indicator on each criterion. Although the results could be summarized using the sum of weighed scores, much information will be lost in this simple approach. Other methods, such as graphical radar plots, ordinal plotting or algorithms for grouping sets of indicators with similar performance would yield more valuable information for decision making.
6. decide how many indicators are needed	While it is desirable to have the fewest possible number of indicators, all key system components featuring in the objectives should be covered. This is where information on how multiple threats influence a single indicator must be taken into consideration. Decisions on the number of indicators required, are aided by effective profiling of indicator scoring on the evaluation criteria (steps 4 and 5).
7. make final selection	Selection should strive to find suites of indicators that perform well on all criteria important for expected use. If no candidate indicators perform well on all the important criteria for a given use, then the suite should try to balance strengths and weaknesses. Reasons for selection should be well documented and retained.