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Rijksinstituut voor Kust en Zee/RIKZ

INDICATORS for CHARACTERISATION and MANAGEMENT of COASTAL ZONES in EUROPE

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Preface

The EEA has been charged by the European Commission to develop indicators for the Coastal environment. The indicator development within the European Topic Centre on Marine and Coastal Environment (ETC/MCE) started in 1996 by task leaders RIKZ (National Institute for Coastal and Marine Management) in the Netherlands and LNEC (Laboratorio Nacional de Engenharia Civil) in Portugal. Workshops are held on indicator definition with the other ETC partners NIVA (Norwegian Institute for Water Research) Norway, LNEC Portugal, IFREMER (France), Nacional Centre for Marine Research (NCMR) Greece.

The first ETC/MCE indicator definition study, has been focusing on the selection of the most appropriate framework and the most relevant environmental issues (RIKZ/LNEC, 1996).
The methodology for the testing of indicators was developed and reported in the first half of 1997 by RIKZ. For the testing ready available data for the proposed indicators from different countries were tried to be gathered by means of a questionnaire .However the testing had to be done only with Dutch data due to scarce and incomplete response on the questionnaire.
The draft report was delivered in June 1997. The questionnaire non-responses were discussed in November 1997 of the EIONET meeting of the ETC/MCE with the Primary contact Points (PCP's) /National Reference Centres (NFP's). The low responses from other questionnaires sent out by the various Topic Centres in the period 1996-1997 were also discussed within the EEA . Since then working procedures related to the set up of questionnaires in general and towards the PCP's have been ameliorated.
This indicator report has accommodated the comments on the draft report 1997 made by some National Reference Centres and the DGXI in November 1997 and May 1998.

The ETC/MCE has been preparing in 1998 a second indicator questionnaire to retrieve data, which has been sent out to the EEA member countries in February 1999.
The aim of that 1999 ETC/MCE Indicator Questionnaire was to develop the ETC/MCE data base on the characterisation of the coastal zone and to further test the availability in order to define the requirements and end-use characteristics of possible indicators.The response on this second ETC/MCE questionnaire improved considerable. The data retrieval resulted in the set up of an ETC/MCE database .
The results of the further testing executed under the 1998 ETC/MCE workprogram has been described in EEA, 2000.

This updated and revised second ETC/MCE indicator report on the use of indicators for the characterisation and management of the coastal zone adds recent insights in the set up of indicators in general. This revised report reflects on some experiences with the testing of indicators on the available international data bases executed in 1999. The conceptual relationship of indicators with models has been investigated in a seperate study executed under the ETC/MCE 1997 workprogramme and was commented by the PCP's in 1998.
For an overview on the presents state of the art on the development and use of indicators for policy assessment and management of the coastal zones all three ETC/MCE indicator reports developped in 1997, 1998 and 1999 have to be taken into account .

Summary of conclusions and recommendations

Indicators development is a continuous process
Looking at the themes relevant in EU policy assessment related to Marine and Coastal Environment there is at present a limited set of key indicators in use within the EEA reporting. Pressure and state Indicators for Coastal Eutrophication have been developed in the context of the EEA 1999 Yearly indicator Report.
Integrating the DPSIR approach with the issues of coastal zones makes a systematic approach possible for indicator development. It is an ambitious task as so many issues are at stake.

Collaboration on data collection and data processing
The case studies and further data gathering show clearly that an optimisation of the proposed methodology asks for the co-ordination of a systematic data collection in close co-operation with existing international data collection.. Aggregation of data to information needs further discussion between the EEA and the Marine Regional Conventions.

Width of the coastal zone
Present insights for the boundaries of the coastal zone no longer stick to the original chosen 10 km sea wards and land wards. For the ETC/MCE 1999 Indicator Questionnaire a 20km sea ward stretch has been chosen. Within this zone there is in areas under pressure measurable antropogenic influence from the land side. It is recommended to look for broader boundaries of the coastal zone at the land side considering subjects as biodiversity and spatial development in the context of the discussion on a European Strategy for Integrated Coastal Zone Management launched by DG environment in 1999.

Intensify communication on indicators and supporting variables
The agreement on the use of indicators will be facilitated by a consistent approach in indicator development. The EEA adopted the DPSIR system which is nowadays widely agreed.
The operationalisation however faces the gap between scientific integrity and the information needs for politics. For the linkage of pressure and state indicators, the inclusion of explaining variables and models are on the longer term indispensable. The notion that politics could already be served with mere state signals which show some linkage with pressure indicators asks continuous and intensive communication with the scientific community. The working groups of the European Marine Conventions and within ICES could play a role. More and more NGO organisations are also able to contribute substantially to data gathering and fact finding.

Involve all relevant stake holders.
Relevant stakeholders for European Indicators for Marine and Coastal Management are not only the EU and the EEA but also Conventions and even the national level could benefit from clear working procedures for defined indicators. That no duplicating efforts for work done under the Marine Conventions is required will result in making more efficient use of the same basic data. This process is now coming into an operational phase.

1. INTRODUCTION

1.1 Background

The need to develop indicators for the characterisation and management of the coastal zone is expressed in task 5 of the 1995/1996 Subventions by the European Topic Centre/ETC on Marine and Coastal Environment/MCE (ENEA/LNEC, 1996). The aim is to develop a system of indicators which can be used to assess the state of the European coastal zones and pressures on them. Operationalisation should take into account the availability of information.

The term indicators has been subject to different interpretations about the level of abstraction. However there is no misunderstanding about the use of indicators in policy assessment and management. They tell the general public and politics what is the change in the environment related to autonomous developments, policy efforts and measures. This helps to identify urgent common pressures, to assess the effectiveness of alternative policy options and to communicate with the public.

Since the presentation of the draft report in 1997, other studies have contributed to the framing, the development and use of indicators for the environment in general as well as to coastal zones. Partly parallel with the framing and identification of indicators by the ETC/MCE, EUROSTAT started with a large project on European Environmental Pressure Indices (1998). The 'top' 60 Indicators, were identified for ten European themes (each with 6 indicators). One of these themes was the Marine and Coastal Environment. Besides Pressure indicators corresponding State indicators were considered as well.*(http://www.telecom.es/tau/enviroindicators.htm)*

The importance of a common set of indicators was stressed at the European Conference of Ministers (Aarhus, June1998) : " *Indicators can play a vital part in focusing and illuminating the significance of environmental change and the progress of sustainability.*
Providing the data and information to support widely agreed key indicator sets in a consistent and timely way should be one main objective of the reform of monitoring and data gathering".
The need for timely and consistent information reflects the experience of the past years concerning data availability and data gathering within the EEA. The process to come up with widely agreed key-indicators is taking profit of more clearly elaborated working procedures and communication. Good examples are the indicators for sustainable development from the UK Ministry of the Environment.

In the EEA report *Europe's Envrionment : The Second Assessment*,1998, the state of the marine and coastal environment has been described following widely agreed themes for concern: (1) eutrophication, (2) contamination, (3) over-fishing and (4) degradation of coastal zones. Further areas of concern like (5) coastal erosion, (6) effects of exploitation of coastal mineral resources and (7) disturbance by offshore activities were perceived as causing localised problems and were not discussed further.

The EEA report *Environment in the European Union at the turn of the century,* 1999 provided an assessment of the development of environment quality in the near future ,i.e. 2010.
The main findings considering the marine and coastal environment are summerised in table 1.

Table 1. Challenges and problems in the different EU maritime regions (EEA,1999)

The **bold** themes and sectors are presently within the ETC/MCE subject to data retrieval for indicator development and Integrated Environmental Assessment. The *cursif ones* are nominated for future work .The identification of sensitive areas is requiring both information on pressures from land and sea as well as natural sensitive zones.

Atlantic	**North Sea**	**Baltic**	**Western Mediterranean**
Dichotomy of under-exploitation of abandoned areas and over-exploitation and rising population of areas under development. Risks linked to natural conditions (insufficient amount of drinking water, erosion, fires, flooding). Maintain coastal ecosystems threatened by coastal erosion, regression of beaches and scarcity of water resources in humid southern zones. Seasonal pressure of tourism, especially in southern Brittany. Qualitative degradation of river and sea water (industrial dumping and abandoned mining sites) Apparition of extreme situations in agriculture: over-exploitation of certain zones, abandonment of other zones. Growing urban pressure, especially around 'capitals' and coastal cities, and diffuse and uncontrolled urbanisation in interior zones.	Strong consensus for **integrated management of coastal areas.** *Improve quality and availability of operational information for spatial planning.* Encourage renewable forms of energy. Coastal erosion. **Reduce level of marine pollution.** *Concern to protect natural areas still untouched by economic development.*	Increase in **eutrophication** leading to the proliferation of algae. Origin of major problems: nitrogen due to combustion of fossil fuels, agriculture and landfills; added phosphorus **(agriculture and landfills).** Numerous of hot-spots **(direct industrial discharges)**. Global vulnerability of the Baltic Sea due to less saline water and its nature as a closed sea (narrow exchange corridors with the North Sea)	Conscious of rich natural heritage which is threatened and is at risk (natural risks, agriculture, tourism, transport, urbanisation in coastal areas). *Prospects for fragile or low-density areas in all aspects.* *Control of tourism development.* **Manage and protect** inland and **marine waters**; specific problems in semi-arid zones; regulating debit and quality of water, provision of water and risks linked to natural conditions (erosion, desertification, saline intrusions in groundwater).

1.2 Scope of the report

The aim of task 5 in the ETC/MCE annual workprogramme 1996 was to establish *"a methodology to develop and apply (a framework of) indicators which can be used with regard to the European coastal zones"*.(ENEA&LNEC, 1996).The most appropriate framework and the relevant environmental issues were identified in the working document RIKZ and LNEC, 1996.

This report redefines these first steps of framing the indicators by applying the common accepted methodology DPSIR for integrated assessments. The resulting method looked further for available background and reference values in order to be able to compare the status of different coastal areas. Case-studies of data on the coastal zones in the Netherlands have been executed to illustrate the methodology.

The development of indicators within the DPSIR context for the coastal zone, which relates to all relevant European themes that influence the coastal zones, its water quality, its habitats, the coastal protection and the like, can only be done by a clear focus on the scope.
The scope of the 1996/97 study is limited to the development of pressure and state indicators for environmental issues. Indicators related to driving forces, impact and responses have not been elaborated. Also social and economic aspects and human functions are beyond the scope of this study. Data and information were used in as far they were available within the time span of the yearly ETC/MCE workprogramme.

1.3 Framework and methodology

The task to develop and apply -a framework of- indicators which can be used with regard to the European coastal zones" should contribute to the identification of :
- a structure for organising and reporting on monitoring data;
- a tool for communication with policy-makers in particular, but also with the general public.
- an information and assessment tool for the identification of environmental problems;
- a tool to set priorities for environmental problems in the European coastal zone.

Indicators summarise information or, more specifically, the raw data concerning a selected issue or problem. An indicator is (OECD, 1993) :
"*a parameter or a value derived from parameters, which points to / provides information about / describes the state of a phenomenon / environment / area and has further implications for the environment*".
The EEA describes the indicators more related to policy assessment: the indicators should answer or should come close to answering a policy questions that are central in current EU policies.
Where clear quantitative targets for policy achievements have been set, the variables of the indicators are chosen according to the targets, f.i the input of harmful substances to the sea, allowing a distance to target analysis..
When policy targets are more general f.i. the ecosystem approach in fisheries, the variables for the indicators are less clear. In any case, the indicators should show a development over time. "Where current data is available for the beginning of an important time series only, a snapshot can be presented." (EEA, 1999c).
The framework of indicators for the coastal zone had to be consistent with the aims of the EEA methodology for the multi-annual reports or, as they are called now the State and Outlook of the Environment (SOER) reports and the Yearly-indicator-based reports. These reports aim to describe and explain changes and effects caused by human activities, to provide a comprehensive picture of the state of Europe's environment, to assist decision-making and to help raise public awareness about environmental problems (Stanners & Bourdeau, 1995).

The EEA is using the "DPSIR" analytical conceptual model derived from the OECD PSR model See box 1.1. The Dobris report of 1995 and the EEA 2[e] Assessment Report adopted the DPSIR model asking the following questions:

1. What is happening to the state of the European environment?
2. What is causing it to be like this?
3. What are the sources of these pressures?
4. What conspicuous problems can be identified in the European environment, and what is being done to tackle them?

The "DPSIR" framework can be combined with an environmental issue/thematic approach (Adriaanse, 1993) in order to identify environmental problems. This approach organises and structures environmental indicators by theme or environmental issue, resulting in a matrix illustrated in Table 1.1.

Table 1.1 The DPSIR framework related to coastal zone issues.

Theme	Driving forces	Pressure	State	Impact	Response
Pollution					
Depletion of resources					
Climate change					
etc.					

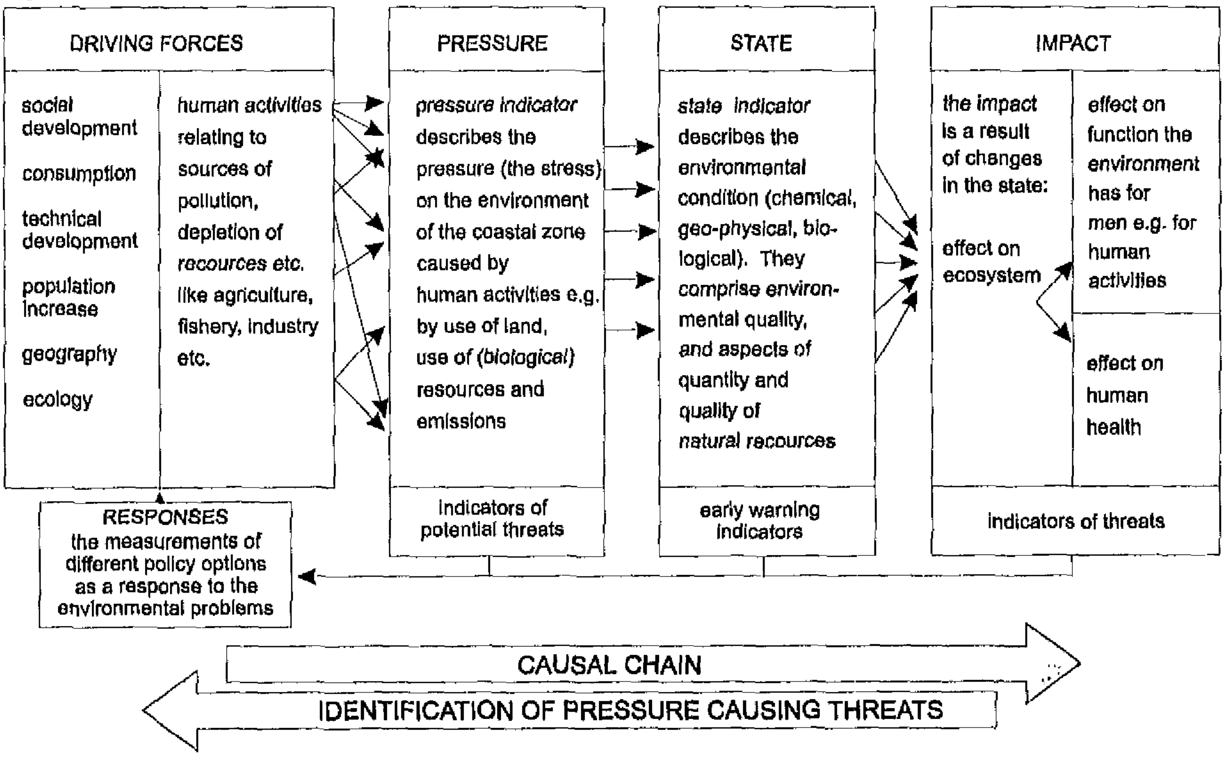
This integrated approach creates a structure that focuses on environmental problems and links human activities (sectors) in a logical way to environmental issues in the coastal environment.
The logical chain goes in two directions: possible pressures produce a change in a state which might or might not result in an impact of the pressure and existing problems or impacts can be related to the contribution of human activities in an identifiable way.
To complete the full DPSIR system for a certain theme for the Marine and Coastal Environment on the European level, appears yet not feasible. Commitment and agreement between countries are required in order to cope with the inconsistency of available data sets and the different levels of integration and aggregation.

Box 1.1 The DPSIR model

Many different frameworks and sets of indicators have been reported in industrialised countries (Bakkes et al., 1994). The most thoroughly discussed system is the "*pressure-state-response*" (PSR) framework of the OECD (1993). This framework is chosen as a starting point because of its simplicity and wide acceptance, and the fact that it can be applied on any scale. Modifications of the OECD PSR framework have resulted in alternative frameworks, e.g. the PSR/*Effects* (DPS/E) model of the EPA in the US (EPA, 1994), the PS/Impact/R model of the UNEP (Swart et al., 1995) and the *Driving forces*/PS/*Impact*/R (DPSIR) model introduced by the RIVM in 1995 and used by EEA (Wieringa, 1996). The PSR framework and alternatives connect pressures caused by human activity with changes in the state of the environment and responses aimed at improving the state of the environment by reducing the pressure. The framework adopts a causal approach and identifies the causal chain.

In line with the frameworks mentioned above a framework for the European coastal zone was elaborated. This is shown in Figure 1.1. Two directions of approaching the environmental problems can be seen: the approach via the causal chain, from driving forces to impact, and the approach of identification of sources causing the threats, from impact to pressure and driving forces.

Figure 1.1 DPSIR



The *impact* box contains changes in the ecosystem, resources and human health. Due to the resilience of the ecosystem changes in the environmental pressures do not always result in changes to the ecosystem. Moreover, changes in the state of the environment are so gradual
that changes in the system are difficult to identify and often there is a time lag before changes become visible.
The *state* box contains environmental (geo-physical, chemical and biological) variables which describe characteristics and conditions of coastal zones.
The *pressure* box contains stresses on the environment such as emissions to water, total input of substances to the coastal zone,
The *driving forces* box contains the human activities and economic sectors responsible for the pressures. If the contribution of the different driving forces to an environmental problem can be shown, more understanding of the coastal system and presumably, more adequate measures, the *response*, are the result.

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2. METHODOLOGY

2.1 Selection of environmental issues relevant for the European coastal zone

A list of possible issues was developed during the ETC/MCE workshop in Lisbon in 1996 (RIKZ / LNEC, 1996). This list has been used as a starting point for the first selection of relevant issues for the coastal zone (table 2.1). The workshop also produced a list of pressure and state indicators belonging to these issues and a list of criteria that the indicators should meet (appendix 4.1). This chapter describes the first selection of issues and a review of possible indicators for these issues. This is followed by a description of the process of indicator development.

Table 2.1 Selection of environmental issues relevant for the European coastal zone.

CRITERIA → ISSUE↓	general European coastal issue	multiple source	trans-boundary impact	relevant issues	data availability	selection for the pilot study
eutrophication/ saprobiation	+	+	+	+	+,1	+
heavy metal pollution	+	+	+	+	+,1	+
antibiotics	-	-	-	-	-	-
(persistent) organic compound pollution	+	+	+	+	-	-
oil pollution	+	+	+	+	-	-
introduction of foreign species		+	+	+	-	-
loss and degradation of habitats:	+	-	+	+	+,5	+
- thermal pollution	+	-	-	-	-	-
- resource extraction groundwater	+	-	-	+	+,3	+
- resource extraction gravel	-	-	-	+	-	-
- coastal erosion	+	-	(+)	+	-	-
- physical disturbance of coastal waters	-	-	-	-	-	-
- climate change	+	+	+	+	+,4	+
waste	+	+	-	+	-	-
fishing	+	+	+	+	+,2	+
loss of biodiversity and genetic resources	+	+	+	+	-	-

+: yes; - : no ( ) : potentially 1:HELCOM, MAP, OSPARCOM, AMAP,ICES; 2: ICES, FAO, DG XIV 3: UNESCO; 4: ETC/CC;5: WWF, ETC/LC, ETC/NC, EUCC

The following criteria are used to identify a number of issues considered relevant in this context:

- The occurrence of an environmental issue on a European scale, as the issues should be relevant for an adequate number of European countries.
- The source of the problem, is it localised or the sum of a number of activities in different countries? The latter is considered more relevant for further European assessment.
- Does the issue have a "transboundary" character, meaning that a pressure in a certain area/country can lead to a change in state in another area.

Furthermore, given the time constraints, it was also taken into account whether data could be made available on short notice. This has been proven crucial for the choice of issues which are used in this report to illustrate the proposed methodology. The result was a list of six issues, that, even though it is not extensive, is considered to be a representative basis for further elaboration:

- Pollution by Heavy Metals
- Eutrophication/saprobiation
- Over-fishing
- Loss and degradation of habitats
- Groundwater extraction
- Climate change

A description of these issues can be found in Appendix 1.

Since then European politics has been evolving further. The draft Water Framework Directive, the evaluation of the Integrated Coastal Zone Management demonstration program the policy making for European Spatial Development and a priority for biodiversity on the political agenda are reasons to come up with an adapted list of relevant issues for coastal zones which cover these main issues and include the above mentioned topics as well.
The following old themes will remain for the coming five years reasons for concern and assessment and key indicators for should therefore be developed with high priority :

- Ecosystem quality :
  - Eutrophication
  - Harmful substances (Heavy metals, Persistant Organic Pollutants, Oil
- Fisheries and mariculture

In order to have a full set of indicators for the Marine and coastal environment, the following policy issues should also be covered:

- Biodiversity,
- Integrated Coastal Zone Management and
- Spatial development.
- Climate change

This shows that the work of the 1996/97 study is covering a part of the proritised issues.
For five of the six selected issues a pilot study was done in 1997, based on a data-set that does not cover the whole of the European coastal zone, but only refers to Dutch data. The results of the pilot nevertheless give an exemple on how to apply the methodology to a data-set on the European scale. The comments on the draft report of July 1997, asked for a more broader testing.
To accommodate this as far as possible, the EEA 2^{e} assessment report has been analysed on its use of indicators (EEA,1999b). It became clear that again data availability is a key issue in this whole process. Eutrophication got relatively more attention than other themes. However only data from the Conventions could be gathered in time. Also in the process of this 2^{e} assessment it appeared not feasible to produce comparable data in a way that it was really reflecting the present status.
The ETC/MCE further testing on indicators , executed under task 6 of the 1998 annual workprogramme (EEA, 2000) delivered a first test report on indicators using comparable data from the international Oceanographic Database of ICES. It covers the themes Eutrophication and Integrated Coastal Zone Management.

2.2 Indicators for policy and management

The purpose and level of indicators determine the amount of detail in which they are described. Experiences in the EEA , the Topic Centres and the UK Ministry of the Environment make clear that:

- Indicators relate to policy-objectives
- A key indicator set represents a hierarchical structure and it depends on the level of policy making what is called an indicator.

Even though there is no approved methodology yet, these experiences and approaches lead to a characterisation of an indicator system using a pyramid or objective-criteria hierarchy (Figure 2). In such hierarchy:

- the top layer contains Headline - indicators that are used for European policy,
- the middle layer represent the elaboration of these at system-level or national level, focusing on translation of European policy to these levels.
- the bottom layer represents local management and the operationalisation to monitoring activities, availability and organisation of data-sets etc.

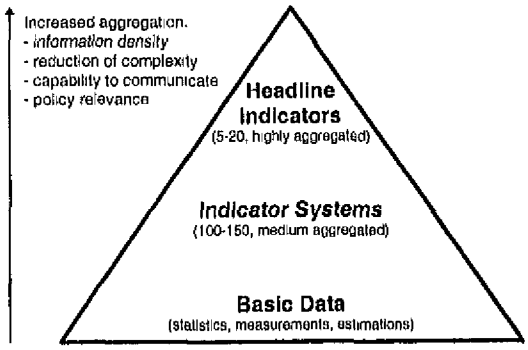

Figure 2 Pyramid of indicators

2.3 Development of pressure and state indicators

Out of the previous sections can be learned that the development of a set of indicators can be approached from, roughly, three directions:

a. The policy-objectives for indicators for sustainability on the (inter) national level.
This can be translated to local or (sub)system level identifying indicators that best represent a sustainable situation. A good understanding of the functioning of the system and the physical, biological, chemical, economical, social aspects is necessary, as well as an adequate communication and information network for the operationalisation.

b. The assessments from available data.
As harmonisation of reporting is aimed at and duplication of work is to be avoided intensified collaboration with the Regional commissions/Action Plans is preferred .

c. An integration of the DPSIR-framework with the issues-approach
To better understand the dynamic of the system and the influence of measures.

Whether general or detailed information is requiered, depends on the use of the indicators. For the identification of priority areas for policy making and to illustrate trends etc.it may well be sufficient to assess trends or local differences in one of the available indicators (being either state, pressure etc.) At this moment the use of indicators in the European context is mainly like this.
For the study of the interrelations between the ecosystem and the human use as is the focus of Integrated Environmental Assessments the further and more detailed operalisation of the DPSIR /themes system is required also from the viewpoint of producing transparant and reproducible information.

Development of an indicator system is an iterative process. The pilot projects (Appendix 1) illustrate how preliminary results, using real data, give new insights to take into account.
The main steps in the iterative process are:

- selection of issue,
- choosing the indicator
- several steps to elaborate further on the indicator concerning:
  - available data,
  - classification and
  - assessment methodologies.
- Specification of coastal units, as well as identifying representative values.
- Identification of appropriate assessment methodologies to interpret the indicator values, in order to identify major pressures and threats

2.4 Selection of issues and indicators for testing

For the selected issues suggestions for indicators are available in the report "Indicators for the coastal zone management and characterisation "(RIKZ/LNEC, 1996). The tables 2.2-a-2.2-f, present indicators for pressure and state for the selected issues. These indicators are used in the pilot study (appendix 4.5).

Table 2.2-a Eutrophication/saprobiation

Pressure indicators	State indicators
• total loads N + P / year entering the sea; river, dredged material, point sources, atmospheric deposition [1,2,3,5,8,10] • total BOD loads entering sea (% untreated sewage entering sea, if loads are not available) [1,8] • total tonnes untreated sewage sludge dumped into sea [8] • discharge & dumping of faecal material in tonnes Coliforms / year [8]	• total concentration P, N in water in winter season versus reference [1,2,3,4,9,10,11] • DO saturation versus reference [1,8,11] • concentration chlorophyll a [1,4] • transparency [1,4]

Table 2.2-b: Heavy metal pollution

Pressure indicators	State indicators
• total of heavy metals (Pb, Cd, Hg) (river, coastal zone point sources, atmospheric deposition) / year entering coastal zone [1,2,3,5]	• concentration of heavy metals (Pb, Cd, Hg) in sediment and/or biota versus reference [1,2,3,4,9]

Table 2.2-c Fishing

Pressure indicators	State indicators
• fishing mortality • power of fishing boats [1] • fish landed (12 miles) / year [1] • fish catches [2,3,10,11] • annual shellfish production [1] • tonnes of shellfish/fish harvested / year by area [8] • catch/year quota & non-quota species by sea area [9] • trawling intensity (biomass benthic species/year) [1] • demand for fish as food [3]	• spawning stock biomass (a demersal, a pelagic versus biological limits and an industrial fish species) • stock of marine species [2,3] • size of spawning stock [10,11] • age distribution ration [2] • stock of target and non-target species (demersal, pelagic & benthic) [1] • overfished areas [10,11]

Table 2.2-d Habitat loss

Pressure indicators	State indicators
• land use change in coastal zone [1] • density of activities (exploration wells, dredge, dumping and extraction sites) in sea area [1] • trawling intensity (ha trawling/year, season);- number and total size (ha) of fish farms [8] • number of exploitation wells & oil/gas extraction/year [8]	• loss of priority habitat versus reference • % physical disturbance of sediment [1] • area compacted, dredged and dug up or raked by fishing per year in km2 [8] • - loss of total natural green space in area versus baseline [8] • wetland drained versus baseline [8]

Table 2.2-e Depletion of groundwater

Pressure indicators	State indicators
• ground water extraction rate [1,2,3,10] • fresh water abstracted in the coastal zone per year [1] • use intensity [2,3,10] • demand [2]	• ratio abstraction rate versus supply of groundwater [2] • abstraction of available groundwater resources [4] • groundwater resources [4] • groundwater availability [4] • frequency, duration and extant of water shortages [4] • Cl-concentration [4] • drained area of total area [4] • % drained wetland [4] • classification of antropogenic influences on wetland [4] • accessibility to population [3] • demand/supply ratio [2] • quality [2]

Table 2.2-f Climate change

Pressure indicators	State indicators
• accelerated sea level rise [1] • relative sea level rise • absolute sea level rise • emission of greenhouse and ozone depleting gases: • CO2 & CH4 and CFCs & HCFCs [2,3,7,10]	• accelerated sea level rise [2,6] • flooding of coastal land, frequency as ha. flooded/year [8] • expected loss of coastal wetlands assuming 1 meter sea level rise • concentrations of greenhouse gases [2,3]

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11. RIZA, 1996

2.5 Coastal units

To be operational, indicators should be collected in order to illustrate the issues for the various coastal morphological features and ecotopes. A certain level of aggregation at country level or at regional level, implying definition of coastal units for which indicators are applied, is necessary. At the European level units based on the various marine systems are used. In the 2nd Assessment such basis is used, although the identification of the separate systems is not exactly the same for all issues, the following distinction in 6 systems seems to be the main basis:

1. Arctic Sea
2. Baltic Sea
3. North West Atlantic
4. North Sea
5. Mediterranean Sea
6. Black Sea

However the type of data and report will influence the classification system
In the 3e ETC/MCE indicator report *'Testing of Indicators for the Marine and Coastal Environment in* Europe' (EEA,2000) the identification of coastal units is both related to the regional divisions which are used within the OSPAR and HELCOM Conventions and to the nations. For the Eutrophication indicators in total 20 European Coastal units were identified, which is more or less a maximum number to reflect the North-west European Seas.

Indicators at this system-level are necessary for overall European assessments. At a lower, more detailed, level coastal units can be defined in various ways, depending of the objective. Also it seems that every theme might prefere its own scale for geographical units. Possibilities are:

a) Local level (specification of habitats and ecotopes or at physiographic units like estuaries and lagoons)
b) *Administrative units in sub-national level* (provincies etc)
c) National level (specification of the national coastline)
d) Focus on hot spots on the one side (major pressures) and pristine areas on the other side.

2.6 Towards a representative value

The processing of the raw data to a representative value for the identified spatial unit is an essential step in the aggregation. For this step methodologies have to be identified. The choice depends on the purpose of the indicators, the amount of data, and the type of issue. In Table 2.3
an overview of the identified methodologies for the selected issues is presented. In the pilot-studies (Appendix 1) the subject is more elaborated, methodologies are explained and a preliminary choice is made. The representative value can be determined by background or reference values or other quality criteria, in order to obtain a dimensionless value. As in most of the cases, reference values or quality criteria for pressure indicators are not available, the use of trends proposed.

Table 2.3 Spatial and temporal aggregation methodologies (fat) for the elaborated indicators.

Issue	Pressure Indicator	State Indicator
Eutrophication	• **(trend in) total** of (estimated) emissions and discharges of total N and ortho P parameters entering a marine coastal zone unit by riverines, atmosphere, point and diffuse sources, and dumping of dredged material;	• **median** of total N and ortho P concentration (mg/l) in a given winter season, in marine coastal zone unit versus reference; • **90 percentile** of nutrient concentration (mg/l)in a given year winter season in marine coastal zone unit versus reference; • N/P-**ratio of median or 90 percentile** concentration in a given year;
Heavy metal pollution	• **(trend in) total** of (estimated) emissions and discharges of Cd, Pb and Hg entering a marine coastal zone unit by rivers, atmosphere, point and diffuse sources, and dumping of dredged material;	• **median** of Cd, Pb and Hg concentration in sediment and biota, in marine coastal zone unit versus reference or ecotoxicological criteria in a given year; • **90 percentile** of Cd, Pb and Hg *concentration in sediment and* biota, in marine coastal zone unit versus reference or ecotoxicological criteria in a given year;
Climate change	• accelerated **(relative)** sea level rise (cm) coming 100 year in a marine coastal area (estimation by models); • **total** sea level rise (cm) coming 100 year in a marine coastal unit (estimation by models);	• expected potential **total** loss of wetlands (km2) assuming 1 meter of sea level rise in a country versus the amount of total wetlands in Europe;
Groundwater depletion	• **(trend in) total** extraction of groundwater in terrestrial coastal unit in a given year;	not available

classification
If coastal units, data, and methodologies for representative values are available, a value for the indicator can be calculated. Interpretation can be simplified by classifying the value in three categories: negligible, moderate and serious or downward trend, no trend and upward trend. When pressure or state is described with more than one indicator one might want to base the classification on the most critical indicator value.
Classification is vey much dependent on the aggregation level amd the type of indicator. It is elaborated in the pilot studies (Appendix 1) A classification system for the whole Europe (for an issue) can be based on "reference" criteria that differ between countries or regions.

2.7 Assessment methodology

One of the main purposes of a "methodology to develop and apply (a framework of) indicators which can be used with regard to the European coastal zones" was to develop an information and assessment tool to identify environmental problems.
To identify which problems are the most severe and most important to address, the identification of "major threats" is necessary. Below a methodology for this is proposed based on the fact that such assessment should be based on combining information on state and pressure.

State indicator
The state indicator provides information on the existing situation. It is a starting point for the assessment: is the situation acceptable (negligible), doubtful (moderate) or showing serious signs of deterioration (serious). A distinction in three categories seems feasible. The three categories can be visualised (e.g. in maps) with colours (green, yellow, red).

Pressure indicator
The pressure indicator provides information on causes of the problem. Here is proposed to look at trends in pressure, rather than the absolute value. A reference value is often problematic to find, as information on "critical" or threshold" pressure-levels is lacking, making it difficult to assess the absolute level of pressure. It is, however, possible to see if a change in pressure can be identified. Furthermore, the trend in pressure provides a better link to the development of the state. The trend in pressure can also be classified in three categories: downward, no trend, or upward. Also this can be presented using colours, as long as is realised that colors does not represent absolute judgement, but indicate where problems may or may not arise in the future.

Combining both indicators
The combination of information on trend in pressures and state gives most added value. It can be used to provide a concise picture of the situation and can be a basis to identify priorities. The general concept of such assessment is presented in the example of Table 2.4.

Table 2.4. Example of an overall assessment scheme, based on information on the state and trend in pressure for a certain issue in a given coastal unit.

Pressure	(Change in) State		
	Negligible	Moderate	serious
downward trend	A = o.k	C = further evaluation	C = further evaluation
no trend	A = o.k	D = priorities	D = priorities
upward trend	B = keep under review	D = priorities	D = priorities

In the example is shown how, depending on the combinations, different conclusions can be drawn:
A. The state indicator is within the reference limits and the pressure-trend is either constant or downward. This indicates that the situation is o.k., not requiring actions. Of course, monitoring should be continued.

B. The state indicator is within the reference limits and the pressure-trend is upward. This situation can have several explanations. A further analysis of the causal chain linking pressure, state and response should be made. Monitoring of state and pressure should be continued.

C. The state indicator is above reference values and the pressure-trend is downward. This situation can also have several explanations. Further analysis of the causal chain might be necessary, possibly leading to setting priorities for issues in areas under consideration.

D. The state indicator is above reference limits and pressure-trend that is zero or upward. This situation leads to consideration of measures at as short notice as possible to decrease the pressure. Setting priorities might require further analysis.

Implementing the methodology
The methodology set out above requires four steps:
Step 1. Identification of reference values
Step 2. Classification of indicator values
Step 3. Assessment of the indicator values
Step 4. Presentation of the results

Step 1. Identification of reference values
In most cases indicators are judged in relation to a reference value, providing a yardstick to compare the current with a natural or desired situation. In general, reference values are hard to determine and values in literature can vary considerably. They are not available for a pan-European context for the selected issues, but it is questionable whether this is feasible and wished for. Indicators at an European level are normally translated to local situations, having its own reference situations. For instance: some pristine areas have much more strict reference values.

Step 2 Classification of indicator values
In the presented methodology the classification is based on three categories. State indicators are classified as "comparable or better than the reference", "moderately deviating" and "severely deviating". Pressure indicators were related to trends in three classes. The classification itself is done in this study on the basis of literature, and/or expert judgement.

Step 3 Assessment of the indicator values
The assessment is based on the combination of the classification of state and trend in pressure. If for either state or pressure or both more than one indicator can be defined and is considered appropriate, the values must be summarised in two categories. It seems logical that the most critical value in the set of indicators will be the most influential for the ultimate assessment (or: if one of the factors contributing is "red", the ultimate assessment will be "red").
Step 4 Presentation of the results
Best visualisation of (summarised) results seems to be a presentation using maps (per issue, with separate maps for pressure and state.

This assessment scheme should not be applied in a rigorous way. In the OECD report on environmental indicators (OECD, 1993) makes some remarks on the use of the indicators proposed in their study. Repeating this here is beneficial, as it is also appropriate for what is proposed in this study:

- Indicators provide one of the tools in the process of performance evaluation and need to be supplemented by other qualitative and scientific information.
- Indicators have the advantage of being concise and having a meaning beyond the simple parameter value. However, there is a danger of misinterpretation if indicators are presented without appropriate supplementary information.
- For the assessment (called performance evaluation in the OECD report), indicators must be reported and interpreted in the appropriate context, taking into account the ecological, geographical, social, economic and structural features of countries.

2.8 Comparison with recent studies

The indicators and methodology suggested has been compared to what is actually used in the EEA reports: "Europe's Environment: Second Assessment" (EEA1998) and the Mediterranean Sea: Environmental State and Pressures (EEA/Unep-Map (in press). The analysis is done per issue.

General
Both reports do not work clearly according the combined DPSIR and issues framework. The 2nd Assessment focuses on issues (themes), but gives only occasionally attention to two type of indicators per theme (both pressure and state). This is probably due to the fact that an "issue" relates to either primarily a state (like heavy metals in the system) or a pressure (like oil spills). The Mediterranean report is based on a separate discussion of state and pressure, which are both discussed further with own themes (being either sectors or environmental issues).

For both reports it is clear that it was not possible yet to make an assessment that is clearly based on the combined information between both type of indicators. Neither seems that there is an agreed methodology for assessment using both type of information . Data and information -availability seems to be a problem for almost all issues, especially for the more Southern areas.

Eutrophication /saprobation
The use of concentrations N and P (or NO2, NO3 and PO4) as state indicator is widely used. The 2nd Assessment manages to reproduce values for most European marine systems. The Mediterranean report also uses chlorophyll concentrations, but is, because eutrophication is more a local problem in

this system, more focused on local situations. The latter shows that also on a more local level the same indicators are used. Loads of N and P are used in both reports as pressure indicator, though not available for all type of sources for various systems. Trends in these pressure indicators are discussed when possible.
It can be concluded that the development and agreement on indicators for eutrophication is well on its way, are all within the list of suggested indicators (Table 2.2-a) and that most attention is needed on the pressure side, due to the various sources.

Pollution by Heavy Metals
In an European context "heavy metals" is one of the elements of the issue "contamination", also covering "persistent organic pollutants" (POP's, with a type of PCB as most used indicator) and "oil". Use of Hg, Cd and Pb in sediments and biota (mussel, fish) as state indicator is common.
The use of loads as pressure may be agreed on, but these are not discussed, probably made difficult by lack of data.
It can be concluded that the development and agreement on indicators for heavy metals is well on its way, are all within the list of suggested indicators (Table 2.2-b) on the state-side and that considerable effort is still needed on the pressure side.

Fishing
Both reports use landings and aquaculture production as indicator (pressure). The use of spawning stock biomass as state indicator leads to results for all areas. Data are available per country. The assessment is done per area, due to different species on which focus is needed, which are normally commercial species.
It can be concluded that the development and agreement on indicators for fishing is on its way, but probably needs more elaboration to tackle differences between systems. Used indicators are included in the list of Table 2.2-c.

Loss and degradation of habitats
This issue is not covered as such in either of the reports. One of the four main issues described in the 2nd Assessment is "degradation of coastal zones", covering the loss and degradation of habitats in the coastal zone. There are no clear indicators used yet for "degradation of coastal zones". Influences per sector are discussed, as well as a general judgement on the state.
It can be concluded that indicators for "loss and degradation of habitats" are either not developed, not agreed on or perceived irrelevant and that considerable effort is still needed within this issue.

Groundwater extraction
This issue is not covered as such in either of the reports. No conclusions can be drawn.

Climate change
The issue of sea level rise is only discussed by the Mediterranean report. The basis of discussion is however, not related to data on indicators. No conclusions can be drawn.

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3. CONCLUSIONS AND RECOMMENDATIONS

3.1 General conclusions

The aim of task 5/6 from the ETC/MCE yearly workprogramme is to produce information relevant to European coastal zone policy and the development a system of indicators which can be used to assess the state of the coastal zones and pressures. Because required data are not yet available, in this report the proposed methodology for the indicator system in the coastal zone is only tested in pilot studies. Conclusions of the pilot-studies are therefore focused to the development of the methodology.

The proposed framework in chapter 1 (Figure 1.1), relating the DPSIR approach to themes, works for the issues elaborated in the pilot studies. According to the task in this study, indicators for pressure and state have been elaborated. It is recommended to elaborate indicators for driving-forces and impact in an analogous way, in order to complete the framework providing information directed towards environmental policy.

The combination of the issue approach and the DPSIR model works well. However, for the application of the indicators system on the coastal zone a certain amount of precision in defining the issues is necessary to describe the coastal zone adequately. For example, heavy metal pollution, eutrophication, oil pollution are defined and not "pollution" in general.

The selection of issues for the coastal zone is based on three criteria: European wide coastal issue, international sources and transboundary impact. The selected issues are:
eutrophication/ saprobiation, heavy metal pollution, (persistent) organic compound pollution, oil pollution, introduction of foreign species, loss and degradation of habitats: (- groundwater depletion, - extraction of gravel, - coastal erosion, - climate change), waste, fishing, loss of biodiversity and genetic resources.

The selection of issues for the pilot-studies is based on data-availability and are heavy metal pollution, eutrophication, fishing, groundwater depletion and climate change.

The development of the methodology of the indicator system is an iterative process. In the pilot-study, for heavy metals, all steps in the iterative process were taken and problems could be solved for the Dutch situation.

To describe the state of the selected issues, indicators were identified and could be defined as a dimension less term. However, the pressure indicators could not be identified in a dimension less way. For this reason the trends in the pressure are used as indicators.

Although in the literature many suggestions for all type of indicators are found, very few examples of elaborated and actually used indicators are available. This study provides a first implementation step in actually processing real, quantitative data in an indicator framework.

An overview of reference values for all types of environmental issues will facilitate the further development and use of indicators. Action to collect reference values has been started by the EEA.

The assessment of a certain environmental issue is based on information on the trend in the pressure and on the state indicator(s). The purpose of this assessment methodology is to identify the major problems within the issues in European coastal zone. In the pilot-studies this approach results in a adequate picture.

To reach the aims of the indicator system, concise information for European coastal policy, a simple presentation is required. For this reason the results of the indicator system for the coastal units are presented in maps according to a division in three categories, depending on the results for that particular issue. This allows for a simple presentation, despite the complex underlying method of data processing.

Next to this simple presentation, the accompanying text obviously needs to provide both an explanation of the assessment procedure and an interpretation and explanation of the results, e.g. in terms of cause-effect relations.

3.2 Technical conclusions

Even if, the coastal zone has been defined with a landward and seaward boundary, spatial units within this zone need to be defined to which the indicators values refer. These units could be different for the various issues. The following aspects should be taken into account:
- the morphological and hydrological characteristics of the coastal zone; by a certain catchment area.
- the type of issue (pollution, habitat loss);
- the category of the issue (pressure or state);
- the data availability.

The size of these units needs to be optimised in order to be detailed enough to provide useful information, and large enough to provide an overview at the European scale.

Heavy metal pollution
On the basis of these first results for the coastal zones of the Netherlands , the selected indicators and the proposed categories seem to differentiate reasonably but might present a relatively pessimistic picture.
Furthermore the following observations can be made, some of which might lead to further refinement of the proposed indicators and categories:

- for diffuse sources, the loads of heavy metals might not be available for a number of European countries, although modelling results might be useful.

- for mercury, no data were available to apply the proposed indicators. Mercury is hard to measure in marine sediment, but European data on methyl mercury in biota are available.
  In future, mercury in biota should be used in a trial as well, using the proposed reference values in this pilot study as a starting point;

- the categories for trend in pressure are now based on a change of 10 percent over five years, it is possible that for certain data sets such a trend could not be distinguished from the natural fluctuations. This should be investigated in a future study using data from more countries;

- the values for the ecotoxicological assessment criteria (EACs) are already accepted by OSPAR, which might provide a good basis to apply these indeed.

- the proposed categories for the state indicators for elevated concentrations of heavy metals are arbitrary and therefore open for discussion. The results for the Dutch Coast can be considered as an overestimation, but the proposed categories should be first applied to a larger European data set in the future before a final decision on the categories can be made.

Eutrophication/saprobiation
On the basis of these first results for the Dutch coastal zone, the selected indicators and the proposed categories appear to differentiate reasonably and provide a realistic picture.
Furthermore the following observations can be made, some of which might lead to further refinement of the proposed indicators and categories:
- the categories for trend in pressure are now based on a change of 10 percent over five years, it is possible that for certain data sets such a trend could not be distinguished from the natural fluctuations. This should be investigated in a future study using data from more countries;

- the reference values for the state indicators for elevated nutrient concentrations are already accepted in OSPAR, which will provide a good basis to apply them;

- the proposed categories for the state indicators for elevated concentrations of nutrients are arbitrary end therefore open for discussion. The results for the Dutch Coast are considered representative, but the proposed categories should be applied to a larger European data set in the future before a final decision on the categories can be made;

- the N/P ratio is an elegant indicator for undesirable eutrophication effects, because of its direct links to ecosystem effects. Information on the critical ratio values are lacking, the proposed classes for the indicator values are arbitrary and open for discussion.

Fishing
The aim of the fishing issue was to identify coastal areas threatened by overexploitation of fishing. However, for most fish species the coastal zone does not form the right spatial scale to asses pressures and states. Much larger sea-areas would be appropriate. In this context a preliminary example for the North Sea was elaborated. Definition of pressure and state indicators on this large scale appear to be well possible and valuable results can be obtained. For some localised specific fisheries (e.g. on shrimps) assessment for coastal units might be developed.

The fishing issue requires a larger scale than the coastal zone to be properly addressed, with the exception of localised specific fisheries. Suitable indicators are available.

Groundwater depletion
The extraction rate seems a feasible pressure indicator for groundwater depletion. The coastal units, however, should be defined according to the manner in which data are organised and to their availability. Note that groundwater extraction can only be used as long as groundwater will be used. Policy can strongly influence the results.

The proposed state indicator, groundwater extraction rate versus supply, does not give an adequate picture of groundwater situation, since the effects of groundwater extraction also occur in fully developed areas, apart from overdeveloped areas. Another indicator is suggested to elaborated e.g. % drained wetland. This suggested indicator, however, can show overlap with indicators of habitat loss. Indicators for the state should therefore be defined in close relationship with habitat loss.

Climate Change
Indicators for Climate Change relate to a potential problem, in contrast to already existing environmental problems indicated by the other environmental issues. The definition of the pressure indicator (sea level rise) should be sufficient, but only if more detailed information is available to about subsidence and ongoing sea level rise, regionally differentiated results can be presented. Then, for the pressure indicator discriminating results can be obtained.

Estimated potential wetland loss appears to be a valuable and discriminating indicator on the scale of Europe. Updating of the used data on wetland surfaces in the actual situation is required.

The relative classification system chosen here clearly focuses on the European scale. Losses which could be substantial on local or even national level might come out a relative unimportant problem at the European level.

In some cases, the coastal units should be defined in more detail, since one country can adjacent to two or more regional seas, like France for instance. It is recommended to define the coastal units per sea per country. However, this refinement is only possible if more detailed information becomes about expected potential wetland loss and accelerated sea level rise becomes available.

3.3 Data requirements

In Figure 3.3.1 the main steps in the data flow are summarised. During this project, it was noted that a lot of data is available, however, it is difficult to get the data due to both technical problems, and complication concerning the permission to use the data.

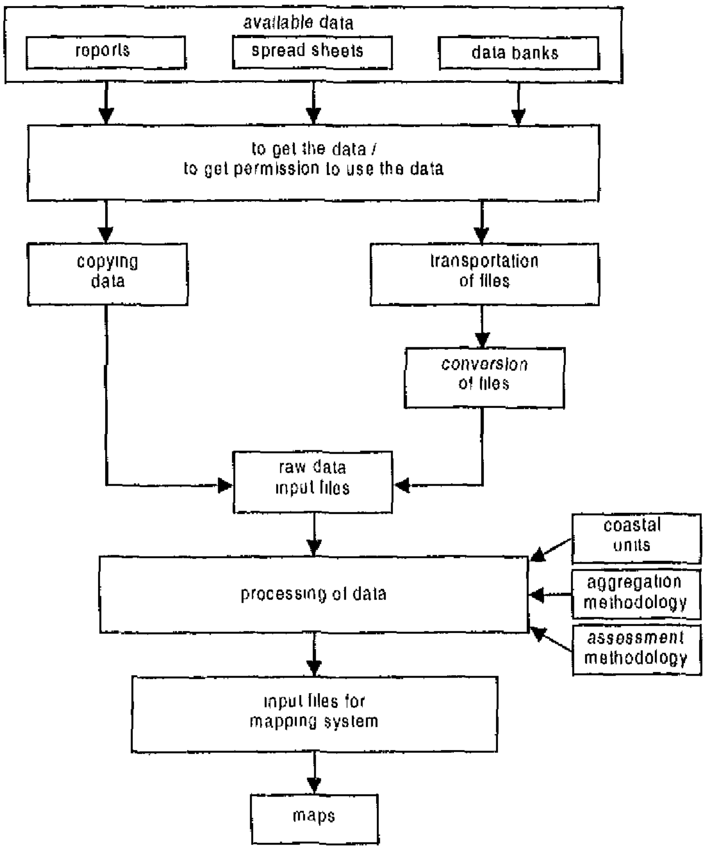

Figure 3.3.1 Steps in the chain data identification-information presentation

For the application of the framework of indicators also information concerning coastal units is required, and the agreement about the aggregation and assessment methodology.
It is recommended to enhance the involvement of coastal countries and conventions in the ETC/MCE in order to facilitate and improve the data and information -flow to apply the indicator system at European scale.

3.4 Final conclusions

- The strength of the indicator approach is a clear presentation, based on the processing of factual, measured quantitative data.
- The framework of indicators will only work if available data become organised, and if the methodology is discussed, and in general is adapted by the involved countries.
- For further implementation on a European scale, acceptance of the methodology as well as a proper organisation of data collection are crucial.
- The relevance of the framework of indicators can be increased even further by use of mathematical models which describe the links within the framework.

Appendix 1 Case study for the Coastal zones of the Netherlands

1. Criteria for the indicators (according to RIKZ & LNEC, 1996)

Criteria have been formulated for the selection of indicators relevant to the coastal zone. These criteria will be used to select and further develop the indicators. Based on an existing list of criteria (OECD, 1993; Hammand, 1995; Swart et al., 1995; OECD& Eurostat, 1996 and Workshop on State *Indicators for the Environment, 1996)* a revised list of criteria for the selection of indicators for the characterisation of the coastal zone is presented below.

Table 1.1 Criteria for selection of Indicators

Relevant to the coastal zone

- indicators should be responsive to changes in environmental conditions (biological, geo-physical and/or chemical) in the coastal zone related to human activity
- they should relate to functional concepts (ecosystem: foodweb relations; human risk: safety);
- the total list of indicators should be representative of the characteristics of the coastal zone; the indicators should not overlap the state, pressure and impact categories

Relevant to European policy

- indicators should show response elasticity (how easily could a decision-maker respond/reduce a particular pressure to improve the state and/or reduce the impact);
- they should concern transboundary aspects (relating to human activities, pressures, states or impacts) within Europe;
- they should provide a basis for international comparisons on a European level;
- *they should be simple and easy to interpret*

Measurability / data availability

- the data required to support the indicator should be measurable and should be readily available or potentially so at a reasonable cost/benefit level;
- the data required to support the indicator should be adequately documented and of known quality;
- the data required to support the indicator should be updated at regular intervals in accordance with reliable (and comparable) procedures;
- they should be capable of revealing trends over time (in the past and in the future);

Correction for natural fluctuations

- there should be a threshold or reference value against which indicators can be compared so that users are able to assess the significance of values associated with them;

Spatial aggregation

- it should be possible to aggregate an indicator over space and time

General

- indicators should be well-founded in technical and scientific theory;
- they should lend themselves to linkage with economic models, forecasting and information models in a general way.

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2. Description of the coastal zone

The World Coast Conference gives the following general definition of coastal zone:
"....the band of dry land and adjacent ocean space (water and submerged land) in which territorial processes and land uses directly affect oceanic processes and uses, and vice versa". Many similar formulations can be found in the literature.

General characteristics of a coastal zone are that (LNEC/CEDEX/RIKZ, 1995):

- it is a dynamic area with frequently changing biological, chemical, and geological attributes;
- the presence of steep physical gradients results in much greater biodiversity than in terrestrial systems
- it includes highly productive and biological diverse systems that offer crucial nursery habitats for many species;
- it has features such as coral reefs, mangrove forests and beach and dune systems which serve as crucial natural defenses against storms, flooding and erosion;
- the coastal waters and seas act as a sink for the disposal of pollution originating from land;
- it attracts major human settlements due to its proximity to oceans biological and other resources and marine transport routes, as well as its potential for recreation and tourism.

For the work of ETC/MCE the following operational definition of the coastal zone was adopted (LNEC, 1996):

- 12 miles seaward of the coastline (the territorial waters);
  10 km landward of the landside of coastal structures or areas, or (if coastal structures or areas are not present) 10 km landward of the coastline;
- coastal structures include coastal water bodies like estuaries and lagoons up to salt intrusion and terrestrial structures like dunes;
- coastal areas include the area below sea level.

The 12 mile seaward boundary and 10 km landward boundary are compatible with the OECD questionnaire (OECD &EUROSTAT, 1996).

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3. Brief characterisation of the issues selected for the pilot study

Pollution (Heavy Metals)
Since most contaminants enter the marine environment by outflows and run-off from the surrounding land, in particular via the rivers, the highest concentrations are often found in estuaries and coastal areas and thus the effects on the ecosystem can be expected to be the strongest there. Additional inputs can be expected from sources at sea (e.g. shipping) and atmospheric deposition. The potential hazard of metals stem from both their direct toxic effects and, depending on the properties of the metal, their capacity for bio-accumulation.

Eutrophication/saprobiation
The build-up of nutrients and organic matter in coastal zones, caused by inputs of waste water and inputs stemming from agricultural activities leads to an increase in the level of production specifically in coastal areas and can induce extensive plankton blooms, algal scum, changes in the benthic fauna and sometimes a massive growth of submersed and floating macrophytes. Visible effects of eutrophication and its side-effects are discoloration of waters, reduced transparency, and disturbance to bathers thus impairing recreation.

Fishing
Fishing mortality rate combined with poor recruitment of young fish has for certain species in certain areas in Europe resulted in unacceptably low levels of stocks. Fishing activities are occurring in the coastal waters as well as offshore. The geographical distribution of fish is depending on the species and some fish species migrate between different areas. In general, the shallow coastal margins can be considered an important nursery area for juveniles of many fish species. This justifies the development of a specific indicator for fisheries in relation to the coastal zone.

Loss and degradation of habitats
Human activities in the coastal zone lead to loss of and damage to natural habitats. Construction of infrastructure inevitably affects ecological processes and leads to elimination of breeding areas, destruction of habitats and loss of biotopes. Recreational activities and military activities can also cause major disturbances in the coastal zone. Groundwater extraction can lead to a change in the hydrological conditions of certain habitats. Climate change can lead to a loss of wetlands along the whole of the European coast.

Groundwater extraction
Though groundwater extraction is not a problem that is restricted to the coastal zone, the effects of overdevelopment of groundwater reserves can cause specific problems in this area. Typical examples are draught of wetlands and salt intrusion. As an indicator of the pressure in a coastal unit, the total amount of extracted groundwater will be presented, as an indicator of the state the decline in groundwater level will be shown. The coastal units for which the available data should be aggregated to one indicator value should be defined as areas for which the change in groundwater level can be mainly attributed to certain known sources of groundwater extraction.

Climate change
Using the results of a global study on the effects of climate change, a first overview has been produced of the pressure, defined as the expected mean sea level rise for different areas, and the state, defined as the surface area of wetlands that will be lost because of the sea level rise.

4. Specification of coastal units

The specification of coastal units is linked to the definition of the spatial units within the coastal zone for which the indicators are presented. Within the work carried out by the European Topic Center/ETC on Marine and Coastal Environment/MCE on indicators (ENEA/LNEC, 1996), more specific work is going on concerning the delimitation of coastal units (task 4, subvention 1996). The following aspects should be taken into account when defining coastal units for the different issues:

- the morphological and hydrological characteristics of the coastal zone;
  for most issues the boundaries of the coastal units will be strongly related to the natural coastal characteristics, e.g. coastal units for pollution might be defined as an area most heavily influenced by a certain catchment area;

- the type of issue (pollution, habitat loss);
  the issue can be of influence on the size of the coastal units, depending on the scale which is considered appropriate for an assessment of the problem. The size should be big enough to provide information of relevance to the European scale, and not so big that problem areas might be lost within a given coastal unit. For some issues, like pollution and eutrophication, it might be necessary to focus especially on certain areas like estuaries, for other issues the pressure and the effects can be spread evenly over the coastal zone which might result in bigger coastal units. The ultimate goal is to define for each issue the smallest number of more or less homogeneous units;

- the category of the issue (pressure or state);
  the relation between pressure and state indicator; the results of a pressure indicator should have a relation with results in the state indicator in the same coastal unit. Though in most cases the coastal units for pressure and state for one issue will be similar, it is possible that the pressure or state are more localised and therefore demand more detailed coastal units;

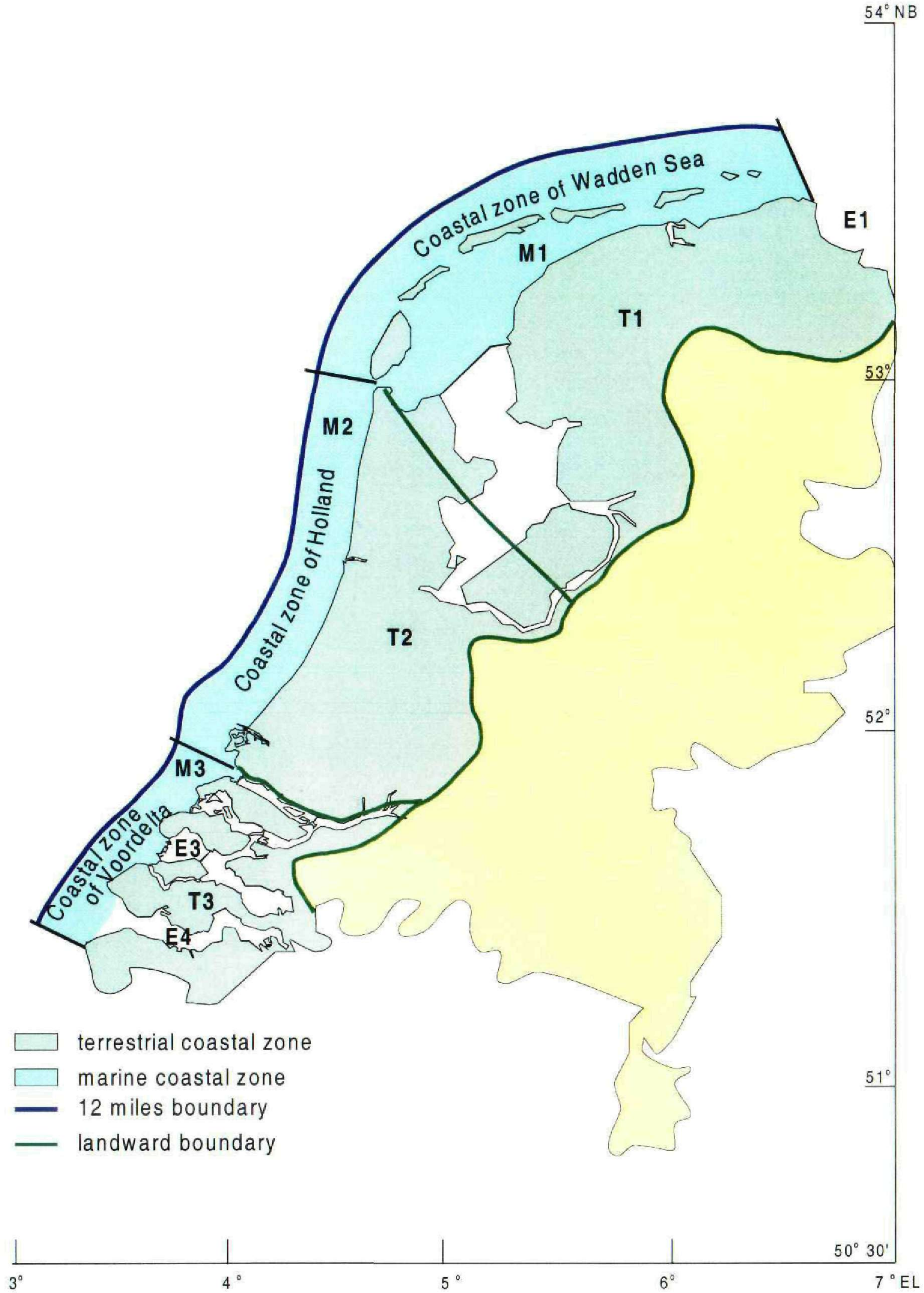
- the data availability;
  the coastal units should as far as possible and appropriate be compatible with data collected in current monitoring programs and existing social-economical units.

Possible spatial units for the Netherlands are described in Table 4.1. and presented in map 4.1

Table 4.1 Preliminary suggestion of spatial units in coastal zone of the Netherlands

Spatial units	Characteristics and uses
Wadden Sea coastal zone	
Wadden Sea (M1)	- wetland, islands with dune structures, beaches and polder - shipping, fishery (shrimps, shellfish), mining (sand, gravel, oil, gas, shells), energy, tourism & recreation, nature area
North eastern part (T1)	- agriculture, tourism & recreation - polder
Eems-Dollard (estuary) (E1)	- wetland - shipping, fishery (shrimps), mining (sand, gravel, oil, gas, shells), energy, industry
Coastal zone of Holland	
Coast of Holland (M2)	- sandy sediment, net silt transport into north east direction, adjacent to beaches and dune structures - fishery and shell fishery, mining (sand, gravel, oil, gas, shells), energy, tourism & recreation
Western part (T2)	- urbanisation, industry, agriculture, harbour activities, tourism & recreation - dune structures, polder
Voordelta coastal zone	
Voordelta (M3)	- sand transport into delta area, adjacent to beaches and dune structures - fishery and shell fishery, tourism & recreation, nature area
South western part (T1)	- agriculture, tourism & recreation - dune structures, polder
Eastern Scheldt (estuary)(E3)	- tidal brackish lake, open diked arm of Scheldt estuary, wetland - fishery (shells, shrimps), tourism & recreation
Western Scheldt (estuary) (E4)	- wetland - shipping, energy, tourism & recreation, industry, open connection to Port of Antwerp

M: marine; T: terrestrial; E: estuary or open connection to sea;



Map 4.1 Coastal units in the Netherlands.

5. Pilot studies

5.1 Heavy metals

Introduction

It is known that at elevated concentrations heavy metals can cause serious toxic effects. Three metals have been selected to illustrate heavy metal pollution: cadmium and mercury, which are known to pose a risk for top-predators, and lead, which can affect predators of shellfish at high concentrations. The most important driving forces, pressures, state and impacts of heavy metal pollution are summarised in table 5.1.

Table 5.1 .1 Indicator system : heavy metals

Driving Forces/ Sectors	**Pressure**
in watercatchment area: • industry, urbanisation • harbour activities, • shipping, • atmospheric deposition	**loads of heavy metals** • river, • coastal zone point sources, • atmospheric deposition
Impact	**State**
• impact on primary production • impact on lower trophic levels • loss of habitats • loss of biodiversity	• concentration heavy metals in sediment/biota versus reference

Data and coastal units

Only Dutch data was supplied within the time restraints of the project. Input data over the period 1989-1993 and data on concentrations for 1993 were used. These data sets are the most recent data sets which can be used for a complete coverage of the Dutch Coastal zone (Wulffraat et al., in prep.). Coastal units are chosen according to the marine units proposed in Appendix 1.4. Sample points on or close to the seaward boundary were excluded because the strong gradient.

Pressure indicator

Possible indicators

In the literature, different type of pressure indicators for pollution are suggested but the (estimated) loads of the pollutants into the coastal zone are generally considered to be the most appropriate (Hammond et al. (1995), Swart et al. (1995), OECD &EUROSTAT (1996), Cie of EC, DG XI, XII (1996)). The pressure indicator for heavy metals can be formulated as the "annual total load of heavy metals from rivers, dredging activities, diffuse emissions and point emissions into a coastal unit".

In the pilot study different ways of calculation are used for the various loads:

Riverine loads
The "direct method" (de Vries & Klavers, 1994) is used, also used by the Oslo and Paris Commission. To calculate the pressure in a uniform way, it might be advisable to include the estuary in the coastal unit. This is in line with the method recommended by OSPAR to calculate inputs.

Direct sources
In the estimated loads for dredged material a correction is made for double counting. Loads by point sources and shipping are as much as possible estimated by the direct method.

Diffuse sources
Annual averaged emissions have been estimated for each country from activity statistics for 1990 and emission factors. The model used for the transport and the deposition is the EUTREND model. The results for 1990 are used without modification.

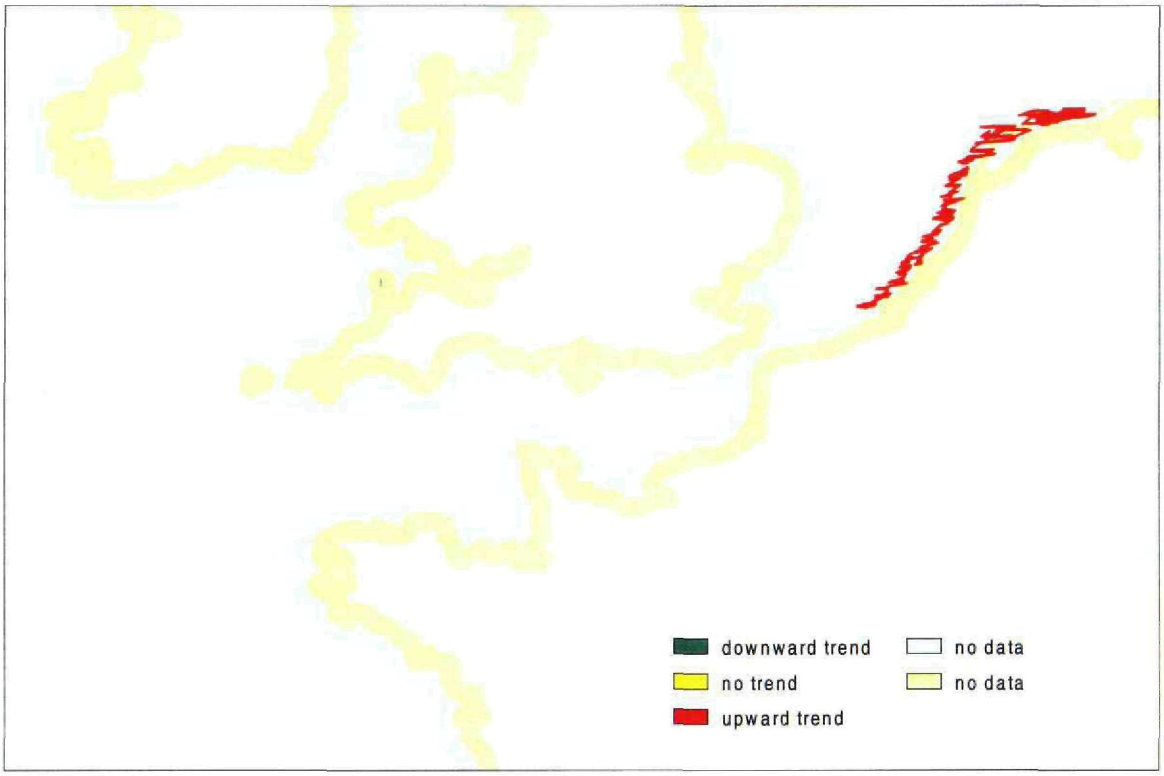
Classification of Indicator values
For pollution, a change in inputs of at least ten percent over a period of five years is proposed as a reasonable period and change to be reflected. Dutch data on trend in inputs have been considered over the period 1999-1993. Trend analysis been carried out based on the system:

Red	Increase in input of ten percent or more over five years	upward trend
Yellow	Increase or decrease of less than 10 percent over five years	no trend
Green	Decrease in input of ten percent or more over five years	downward trend

Trends have not been tested on their statistical significance. The results are presented in table 5.1.2. and map 5.1

Table 5.1.2 Trends in loads of heavy metals into the Dutch coastal zone in the period 1989-1993 (Wulffraat et al 1996, Baart et al., 1995)

	Cadmium	Mercury	Lead
Voordelta	downward	upward	upward
Coast of Holland	downward	no trend	upward
Wadden Sea Coast	no trend	no trend	upward



Map 5.1.1 Trend in pressure *(loads in metals 1989 - 1993)*

Assessment

The most critical indicator value in a coastal unit will account for the overall assessment of the trend in pressures, as a result all Dutch coastal units show an upward trend.

State indicator

Possible indicators

In line with the pressure indicators for pollution, the state indicators for pollution generally suggested in the literature are the concentrations of pollutants in the coastal zone in relation to a reference value. (Hammond et al. (1995), Swart et al. (1995), OECD & EUROSTAT (1996), Cie of EC, DG XI, XII (1996)).

The reference values are :

- background concentrations as presented in table 5.1.3 .These are established for the North Sea area and can therefore be used to be compared to the Dutch data.
- Ecotoxicological assessment criteria (EACs) for heavy metals and some organic substances (OSPAR, 1996) established by the Oslo and Paris Commission.

Table 5.1.3 Values for heavy metal concentrations in sediment and blue mussel

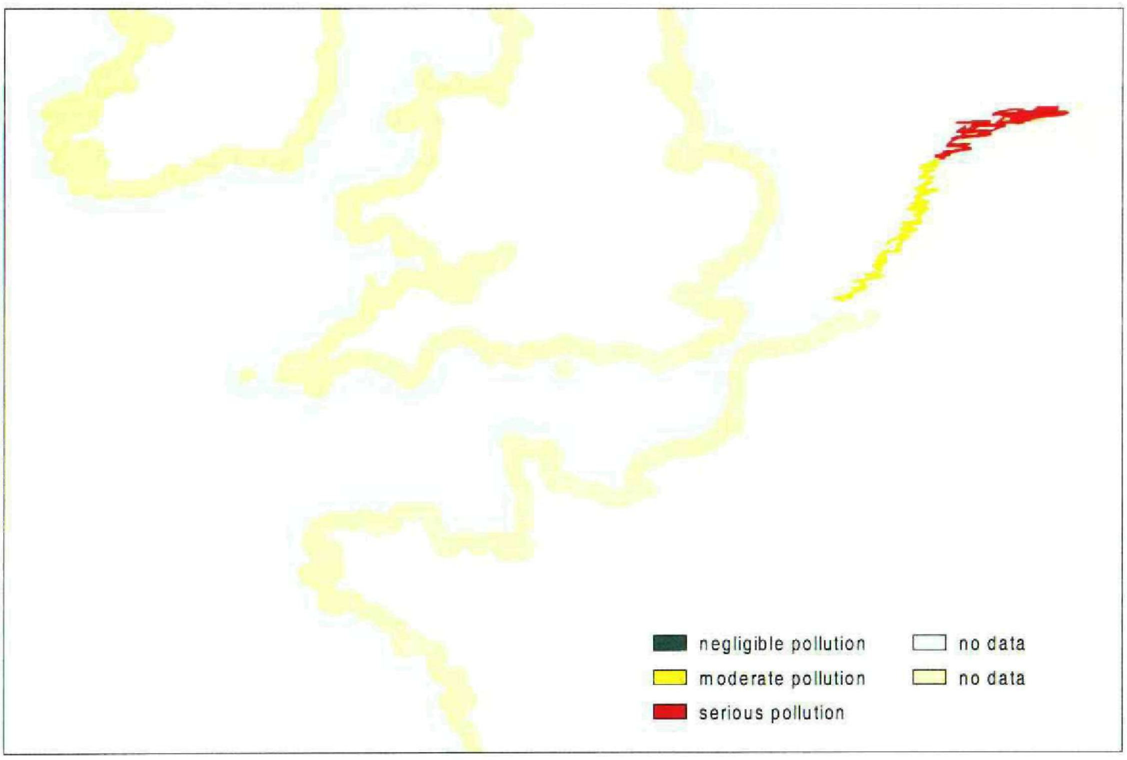
Heavy metal	**sediment** (mg/kg dry weight)		**biota** (blue mussel, mg/kg dry weight)	
	background *)	EAC**)	background *)	EAC **)
Cadmium	0.5 ± 0.01	0.1-1	< 2	n.a.
Mercury	0.067 ± 0.009	0.05-0.5	< 0.2	n.a.
Lead	37 ± 2.9	5-50	< 5	n.a.

*) Laane (ed), 1992
**) report of third OSPAR workshop on Ecotoxicological Assessment Criteria, 1996.

Classification of Indicator values

In table 5.1.4 and 5.1.5 concentrations of heavy metals and indicator values for heavy metal concentrations in relation to reference values are presented. The median concentration and the 90% of the measured concentrations are given. Three classes for the indicator values for background concentrations for Cd, Hg, or Pb are proposed:

"Red " Concentrations elevated by more than a factor 5
"Yellow" Concentrations are elevated by a factor 3-5
"Green" Concentrations are elevated by less than a factor 3



Map 5.1.2 State *(ratio concentrations metals versus reference 1993)*

Table 5.1.4 Ninety percentile and median concentrations of heavy metals in sediment in the Dutch coastal zone in the year 1993 and the associated state indicator values concerning heavy metal pollution

Coastal unit	sediment conc <63μm (mg/kg)			conc/bg		conc/EAC	
	Cd	**Hg**	**Pb**	**Cd**	**Pb**	**Cd**	**Pb**
VD 90%	1.6	n.a.	71.39	3.3	2	1.7	
VD median	0.72	n.a.	52.51				
CoH 90%	2.18	n.a.	120.28	5	3.3	2	2.5
CoH median	0.88	n.a.	85.84				
WSC 90%	3.46	n.a.	119.70	10	3.3	3.3	2.5
WSC median	0.62	n.a.	59.77				

bg = background concentrations (Laane (ed), 1992); EAC= ecotoxicological assessment criteria (report of third OSPAR workshop on Ecotoxicological Assessment Criteria, 1996.); n.a = not available; VD: Voordelta; CoH: Coast of Holland; WSC: Wadden Sea Coast; < 63 μm: analysed in the fraction less than 63μm.

Table 5.1.5 Ninety percentile and median concentrations of heavy metals in biota in the Dutch coastal zone in the year 1993 and the associated state indicator values concerning heavy metal pollution

Coastal unit	mussel conc. (mg/kg dw)			conc/bg		
	Cd	**Hg**	**Pb**	**Cd**	**Hg**	**Pb**
VD 90%	4.39	0.24	2.75	2.5	1.3	0.6
VD median	3.62	0.22	2.39	1.7	1.1	0.5
CoH 90%	n.a.	n.a.	n.a			
CoH median	n.a.	n.a.	n.a.			
WSC 90%	0.79	0.31	2.14	0.4	1.7	0.8
WSC median	0.66	0.29	1.75	0.3	1.4	0.4

bg = background concentrations (Laane (ed), 1992); n.a = not available; VD: Voordelta; CoH: Coast of Holland; WSC: Wadden Sea Coast

Assessment

In this pilot study the 90% value is used for the comparison, to focus on the "worst case" values within a given coastal unit. Results are:

- Voordelta, cadmium in sediment in comparison to the natural background is "yellow",
- Coast of Holland, cadmium as well as lead in sediment in comparison to the natural background are yellow,
- Wadden Sea Coast, lead and cadmium in sediment in comparison to the natural background are yellow and cadmium in comparison to the ecotoxicological assessment criterion is also yellow.

All the other indicator values are green. It is remarkable that all the mussel values are green. This might be caused by the fact that the background concentrations are already relatively high.

Because the most critical indicator value in a coastal unit determines for the total assessment of the state, the Voordelta and the coast of Holland are presented as "Yellow" and the Wadden Sea Coast as "Red".

Conclusions and discussion

The following observations can be made, some of which might lead to further refinement of the proposed indicators and categories:

For diffuse sources, the loads of heavy metals might not be available for a number of European countries, although modelling results might be usable.

For mercury, no data were available to apply the proposed indicators. Mercury is hard to measure in marine sediment, but European data on methyl mercury in biota should be available.
In future, mercury in biota should be used in a trial as well, using the proposed reference values in this pilot study as a starting point.

The categories for trend in pressure are now based on a change of 10 percent over five years, it is possible that for certain data sets such a trend could not be distinguished from the natural fluctuations. This should be investigated in a future study using data from more countries.

The values for the ecotoxicological assessment criteria (EACs) are already accepted by OSPAR, which might provide a good basis to apply these indeed.

The proposed categories for the state indicators for elevated concentrations of heavy metals are arbitrary and therefore open for discussion. The results for the Dutch Coast can be considered as an overestimation, but the proposed categories should be first applied to a larger European data set in the future before a final decision on the categories can be made.

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5.2 Eutrophication/saprobiation

Introduction

Eutrophication in its most generic definition, which applies to both fresh and marine waters, is *the process of enrichment of waters with plant nutrients like nitrogen and phosphorus, that stimulates aquatic primary production* (Volleweider et al., 1996). The most important driving forces, pressures, state and impacts of eutrophication are summarised in Table 3.21.

Table 5.2.1 Indicator system: Eutrophication/ Saprobiation

Driving Forces/ Sectors	Pressure
in watercathment area • agriculture, • urbanisation, • fishery & shell fisheries, mariculture, • certain industries (e.g. artificial fertilisers	**Loads** of **nitrogen** and **phosphorus** entering sea river, • dredged material, • coastal zone point sources • atmospheric depostition
Impact	**State**
• Algal proliferation • Toxic algae bloom (qualitative) • Oxygen depletion • Disturbance of foodwebs • Decrease in fish yields • Loss of habitat • Loss of biodiversity	• Concentration P, N in water (winter) versus reference • N/P ratio versus reference see also table 2.1 a

Data and coastal units

Only Dutch data was supplied within the time restraints of the project. Input data over the period 1989-1993 and data on concentrations for 1993 were used. These data sets are the most recent data sets which can be used for a complete coverage of the Dutch Coastal zone (Wulffraat et al., in prep.). Coastal units are chosen according to the marine units proposed in Appendix 1.4. Sample points as on or close to the seaward boundary were excluded because the strong gradient.

Pressure Indicators

Possible indicators

In the literature, different types of pressure indicators for eutrophication and saprobiation are suggested but the (estimated) loads of respectively nutrients and BOD into the coastal zone are generally considered to be the most appropriate (Hammond et al.,1995, Swart et al., 1995, OECD & EUROSTAT, 1996).

In this pilot the pressure is defined as the load of nutrients, estimated analogous to the load of heavy metals. As an example, in table 5.2.2 an overview of the total loads into the coastal units of the Netherlands is given for the year 1993. The coastal units are identical to those used for heavy metals.

Table 5.2.2 Loads of nutrients into the Dutch coastal zone in 1993

	P(ortho Phosphate)	DIN (dissolved inorganic Nitrogen compounds)
Voordelta	6	103
Coast of Holland	14	206
Wadden Sea Coast	2	64

Classification of Indicator values

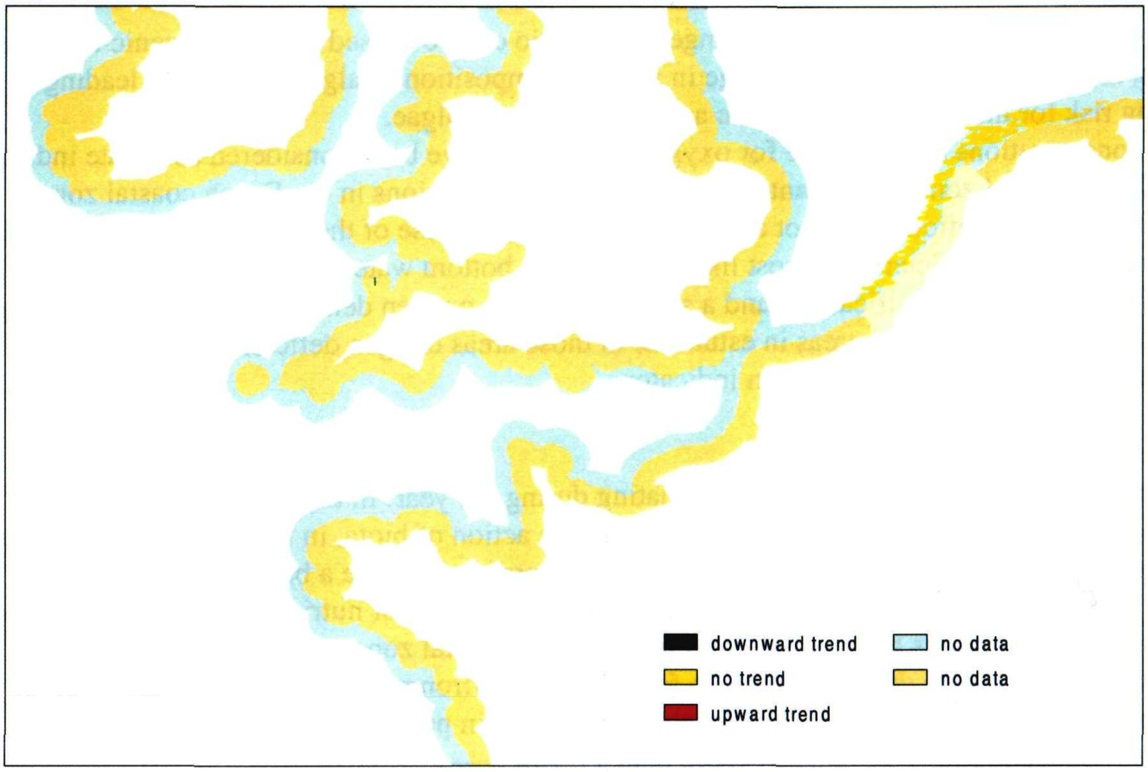
For eutrophication, a change in inputs of at least ten percent over a period of five years is proposed as a reasonable period and change to be reflected. Dutch data on trend in inputs have been considered over the period 1989-1993. Trend analysis been carried out based on the system:

Red	Increase in input of ten percent or more over five years	upward trend
Yellow	Increase or decrease of less than 10 percent over five years	no trend
Green	Decrease in input of ten percent or more over five years	downward trend

The results of the trend analysis on the Dutch data are presented in table 5.2.3. and map 5.2.1

Table 5.2.3 Trends in inputs in nutrients in the Dutch coastal zone in the period 1989-1993

	P(ortho Phosphate)	dissolved inorganic Nitrogen compounds
Voordelta	downward	no trend
Coast of Holland	downward	no trend
Wadden Sea Coast	downward	no trend



Map 5.2.1 Trend in pressure *(loads nutriënts 1989 - 1993)*

Assessment
The most critical indicator value in a coastal unit will account for the overall assessment of the trend in pressures, as a result all Dutch coastal units show no trend.

State Indicators
Possible Indicators
The working group of the Oslo and Paris Commission dealing with eutrophication and its effects have established reference values for inorganic orthophosphate end nitrogen compounds in the marine environment. The proposed reference values are:

P 0.7 FM/liter = 0.02 mg/liter (OSLO and PARIS COMMISSION, 1992)
N 10 FM/liter = 0.15 mg/liter (OSLO and PARIS COMMISSION, 1992)

These reference values are calculated for the offshore area (salinity range approximately 31-33), the actual salinity range in the Dutch coastal zone is slightly lower (28-30). Because of the negative linear correlation between the salinity and the phosphate and nitrate concentrations due to dilution, the reference values are slightly lower than they should have been for a lower salinity. Therefore, the outcome of the comparison between measurements and reference values could overestimate the elevation of the nutrient levels. However, a comparison with fresh water reference values show that the reference values for marine waters are within the range for European rivers (N 6-28 FM/liter, P 0.1 -2 FM/liter (Laane et al., 1992) which means that the reference values can be considered valid in the European coastal zone as well.
Another indicator which can be used for eutrophication symptoms is the N/P (Mol/Mol) ratio (de Vries et al., 1996). Under normal conditions, the N/P ratio in the marine environment will be

approximately 16 (Redfield, 1963). A change in this ratio can be caused by antropogenic inputs of nutrients, and is known to lead to a change in species composition of algae, especially leading to an increasing risk for the occurrence of toxic and other nuisance algae.
Oxygen concentrations as a measure for oxygen deficiency have been considered as a state indicator for the Dutch coastal zone. A first analysis of oxygen concentrations in the Dutch coastal zone showed that oxygen deficiency is not an issue in that area, because of the strong tidal currents parallel to the coast. Oxygen deficiency is most likely to occur in bottom waters in coastal areas with limited vertical mixing (due to stratification) and a sufficiently high oxygen demand, e.g. the German Bight or certain fjords and intertidal areas in estuaries. In those areas oxygen deficiencies can cause problems and might be of interest as an indicator.

Classification of Indicator values

Concentrations of nutrients are strongly fluctuating during the year. In the summer most of the nutrients are partitioned into organic matter through the action of biota, in the winter the nutrients are available in the water column. Winter concentrations therefore provide a better representation of elevated concentrations of nutrients. In table 5.2.4, concentrations of nutrients and indicator values for nutrient concentrations and the N/P ratio in the Dutch coastal zone are presented. Background values are compared with the 90% value, to focus on the environmental problems within a given coastal unit. Three classes for N or P concentrations are again proposed:
"Red " Concentrations elevated by more than a factor 5
"Yellow" Concentrations are elevated by a factor 3-5
"Green" Concentrations are elevated by less than a factor 3
As a change in the N/P ratio leads to a direct disturbance of the ecological processes, making it a rather sensitive yardstick for eutrophication effects, a separate set of classes is proposed:
"Red" N is elevated by more than a factor 3: indicator value > 48
"Yellow" N is elevated by a factor 2-3: indicator value 32-48
"Green" N is elevated by less than a factor 2: indicator value < 32

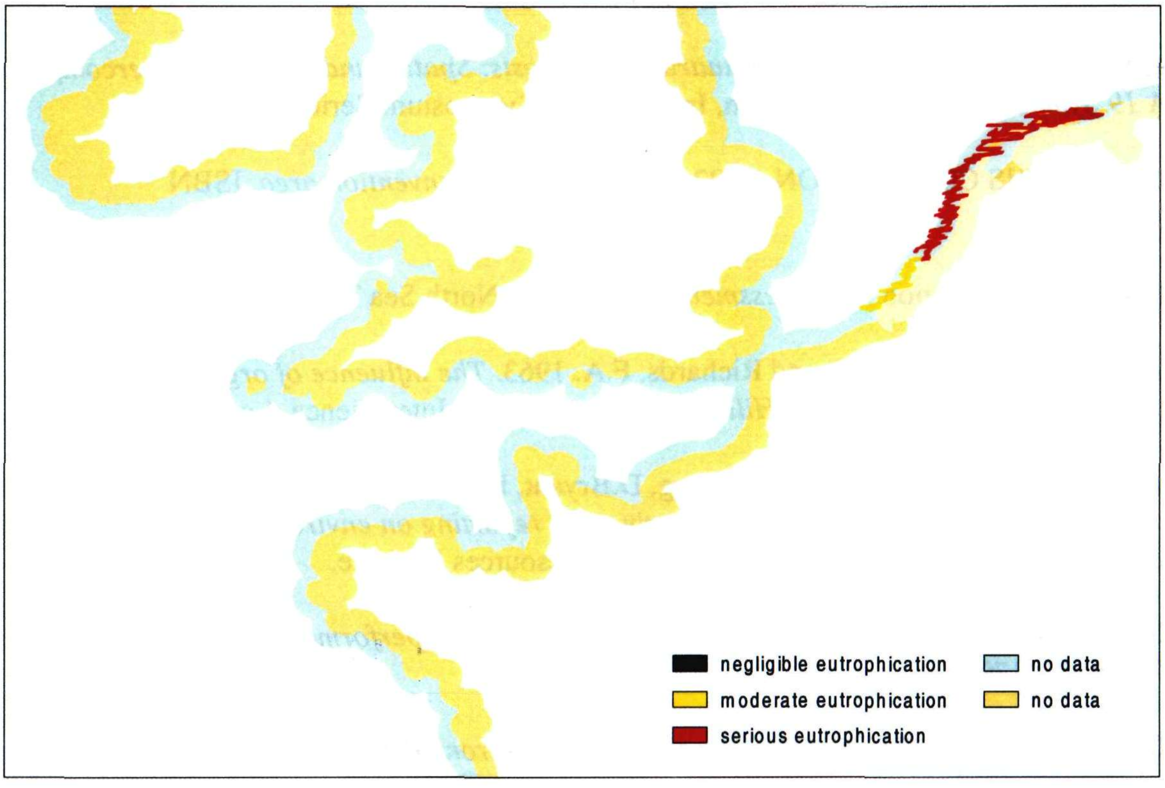
Table 5.2.4 Concentrations of nutrients in the Dutch coastal zone in the period December 1993-1 March 1994 and state indicator values concerning eutrophication

Nutrient/coastal unit	N tot mg/l	indicator value: conc/bg	P mg/l	indicator value: conc/bg	N/P ratio (M/M)
VD 90%	1.2	8	0.05	2.5	51
VD median	0.7		0.04		
CoH 90%	1.5	10	0.06	2.5	62
CoH median	1.2		0.05		
WSC 90%	2.5	17	0.05	2.5	103
WSC median	0.9		0.03		

VD: Voordelta; CoH: Coast of Holland; WSC: Wadden Sea Coast

Assessment

The graphical results of the ratio nutrient concentrations versus background / reference value is present in map 5.2.2.
As the most critical indicator value in a coastal unit accounts for the total assessment the Voordelta will be presented as "Yellow" and the Coast of Holland and the Wadden Sea Coast both as "Red".



Map 5.2.2 State *(ratio concentrations nutrïents versus reference 1993)*

Conclusions and discussion
The following observations can be made, some of which might lead to further refinement of the proposed indicators and categories.
On the basis of these first results for the Dutch coastal zone, the selected indicators and the proposed categories appear to differentiate reasonably and provide a realistic picture.
The categories for trend in pressure are now based on a change of 10 percent over five years, it is possible that for certain data sets such a trend could not be distinguished from the natural fluctuations. This should be investigated in a future study using data from more countries;
The reference values for the state indicators for elevated nutrient concentrations are already accepted in OSPAR, which will provide a good basis to apply them.
The proposed categories for the state indicators for elevated concentrations of nutrients are arbitrary end therefore open for discussion. The results for the Dutch coast are considered representative, but the proposed categories should be applied to a larger European data set in the future before a final decision on the categories can be made.

The N/P ratio is an elegant indicator for undesirable eutrophication effects, because of its direct links to ecosystem effects. Information on the critical ratio values are lacking, end the proposed classes for the indicator values are arbitrary end open for discussion.

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5.3. Fishing

Introduction

Literature concerning pressure-state and responses often classifies fishing as a pressure for biodiversity or an issue concerning renewable resources. Fishing affects the population dynamics within ecosystems and the structure and abundance of these stocks (table ....). Although substantial efforts were carried out to develop an indicator for this issue, it proved not possible to define pressure and state indicators for the coastal zone that make it possible to identify coastal areas threatened by overexploitation of fishing.

Table 5.3.1 Indicator system: Fishing

Driving Forces/ Sectors	**Pressure**
• fishery • shell fishery, • mariculture	• fishing mortality of 3 fish species chosen by countries themselves: pelagic; demersal; industrial
Impact	**State**
• loss of biodiversity • loss of habitats	• spawning stock biomass of the same species: pelagic; demersal; industrial

Data and coastal units

Various types of information were collected:
- ICES - by division: landings, recruitment, fishing mortality, stock biomass (ICES, 1996);
- ICES - by rectangles (30*30 miles^2): raw data are available at ICES. It should be possible to develop a model in order to estimate the fishing mortalities and stock biomass in the coastal zone (this analysis is not performed because it would take at least a year);
- FAO - by country: fish catches by species and area (European-wide) (Ceccarelli & Izzo, 1997);
- The Minimum Biological Acceptable Level (MBAL) is available for several species and can be used to assess the state of the stock (ICES, 1996);
- Aquaculture data (European wide) (Ceccarelli & Izzo, 1997).

As most fish stocks migrate and fisheries extend over larger sea-areas than the coastal zone, the coastal zone is not an appropriate scale to address the fisheries issue. Appropriate spatial units are systems (seas or sea regions), in line with the data available in ICES. FAO data are organised per country.

Pressure indicator

Possible pressure indicators

In literature, different type of pressure indicators for the fishing or overfishing are given. Mentioned pressure indicators for fishing are catches by area, catches by country, landings by area, fishing mortality or production of fish, see also table 2.2-c. Fishing mortality would form a good indicator because information about the stock is included in this parameter.

In this pilot it is proposed to use fishing mortality as a pressure indicator. ICES provides in an assessment of fishing mortality, based on the instantaneous fishing mortality rates for the OSPAR COM area. In these assessments, ICES estimates the total catch taken by the fishing industry. The total catch includes slipped catches, discards, landings which are not officially reported and industrial by-catches. The discards, slipped-fish, unreported landings, and industrial by-catches vary considerably between different stocks and fisheries. In some cases they are negligible but they can also constitute an important part of the total removal (ICES, 1996).

Choices are possible between dermersal, pelagic and industrial species, round and flat fish or target and non target species. The choice of species also depends on the region. For the North Sea sole, cod and plaice were selected on basis of data availability. A change in fishing mortality is proposed as an indicator to reflect a possible change of pressure.

Classification of indicator value

Proposed categories:

Red	Increase in fishing mortality of more than 20 percent over five years	upward trend
Yellow	Increase or decrease fishing mortality of less than 20 percent over five years	no trend
Green	Decrease in fishing mortality of more than 20 percent over five years	downward

Assessment

As the most critical indicator value in a coastal unit will account for the assessment the North Sea will be mapped as red, based on the upward trend in the fishing mortality for plaice (Table 5.3.2).

State indicator

Possible state indicators

In line with literature, as state indicators for fishing is proposed the spawning stock biomass for a selection of fish species or in relation to a reference value (OECD, 1993; RIZA, 1996; Swart et al., 1995; Hammond et al., 1995; see also table 2.2c). The assessments of ICES for the spawning stock biomass were used as state indicator. For several species data about biomass and a reference value are available for the ICES-division. These data are already evaluated and processed. The state of the stocks can be assessed with special reference values, the MBAL (Minimum Biological Acceptable Level). As an example an overview of a complete set of data is given in (Table 3.2.2)

Classification of indicator values

Fishing stocks show large year to year fluctuations. A very preliminary and not discussed suggestion to classify the state is:

"Red " biomass versus MBAL < 0.9
"Yellow" biomass versus MBAL between 0.9 and 1.1
"Green" biomass versus MBAL > 1.1

Table 5.3.2: Trends in Species mortality and Biomass/MBAL

year	Cod		Plaice		Sole	
	Mortality	Biomass/ MBAL	Mortality	Biomass/ MBAL	Mortality	Biomass/ MBAL
90	0.715	0.42 red	0.354	1.33 green	0.42	2.65 green
91	0.927	0.41 red	0.431	1.13 green	0.47	2.3 green
92	0.857	0.4 red	0.433	1.08 yellow	0.43	2.36 green
93	0.911	0.38 red	0.435	0.95 yellow	0.51	1.66 green
94	0.847	0.39 red	0.441	0.84 red	0.5	2.35 green
Pressure indicator	no trend		upward trend		no trend	

Assessment

As the most critical indicator value in a coastal unit will account for the total assessment the North Sea would be presented as "Red" based on biomass versus MBAL for Cod in 1994.

Discussion and conclusions

The fishing issue requires a larger scale than the coastal zone to be properly addressed, with the exception of localised specific fisheries. Suitable indicators are available.

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5.4 Groundwater depletion

Introduction

Overexploitation, canalization and intensified drainage leading to lowering of groundwater levels and saltwater intrusion is a serious problem threatening the groundwater system and related ecosystems. The aim of the pressure and state indicators for groundwater depletion is to identify areas with draughts of habitats and wetlands in the coastal area due to a decline of the groundwater level caused by a relatively high groundwater extraction rate. Table 5.4.1gives an overview of the pressure and state indicators in relation to driving forces and impact.

Table 5.4.1 The indicator system: groundwater depletion-issue

Driving Forces/ Sectors	Pressure
• tourism & recreation, • urbanisation, • agriculture	• groundwater extraction rate see also table 2.2-d
Impact	**State**
• draughts of habitats • draughts of wetlands • salinization of groundwater • decline of groundwater level • shortage of water • land use • climate change • habitat loss	• draught of wetlands see also table 2.2-d

Data and coastal units

To develop indicators for pressure indicators a case study has been carried out with Dutch data on groundwater extraction (VEWIN). Information to develop state indicators is derived from a report about sustainable use of groundwater (RIZA/RIVM). Data is organized per administrative unit, which is processed per coastal provinces and taken together to represent the three units (Northern, Western and South-western).

Pressure indicators

Possible indicators

In the literature, different types of pressure indicators for (ground)water resources are suggested, but the (estimated) extraction, demand and use intensity of groundwater are generally considered the most appropriate (RIZA, 1996; Hammond et al., 1995; Swart et al., 1995; Cie of EC, DG XI, XII, 1996). In this pilot it is proposed to define the pressure as the amount of extracted groundwater per year (Table 5.4.2)

Table 5.4.2 Groundwater Exploitation in the Dutch terrestrial coastal units (Mm^3/year), source VEWIN

Coastal units	northern unit	western unit	south-western unit
1981	no data	no data	no data
1986	grw. 66.4 dunew. 0.75	grw. 20.27 dunew. 38.36	grw. 1,92 dunew. 1,28
1991	grw. 69.1 dunew. 0	grw. 36.76 dunew. 35.67	grw. 1,74 dunew. 1,62
1995	grw. 67.01 dunew. 0.65	grw. 35.48 dunew. 25,85	grw. 0 dunew. 1,64

grw: ground water; dunew.: dune water (dune ground water)

Classification of Indicator values

A trend over 10 years (period 1986-1995 is available) is proposed as a reasonable period. The trend analysis on the Dutch data has been carried out as follows: a trend is considered upward if there has been an increase of ten per cent or more over the 10 year period, is considered downwards if the there has been a decrease of ten per cent or more over the ten year period, and is considered constant in the remaining cases.

Table 5.4.3 Overview of trends in groundwater depletion in the Netherlands

Coastal unit	trend over 1986-1995
South-western unit	downward trend
Western unit	upward trend
Northern unit	no trend

Assessment

As there is only one indicator used to indicate the pressure the result for the Dutch coastal units can be directly read from Table 5.4.3.

State Indicator

Possible indicators

In contrast to the pressure indicator, many different types of state indicator are mentioned in the literature. The RIZA/RIVM study gives an overview on European scale for groundwater extraction rate versus supply. Three areas are distinguished. Areas where the extraction rate is lower than the water supply, areas where the groundwater supplies are fully developed, and areas where the groundwater supplies are overdeveloped. This system could be used to classify the indicators value in three categories.

Conclusions en discussion

The extraction rate seems a feasible pressure indicator for groundwater depletion as long as groundwater is for drinking water.

The proposed state indicator, groundwater extraction rate versus supply, does not give an adequate picture of groundwater situation. Another suggested indicator is the percentage of drained wetland. This indicator, however, can show overlap with indicators of habitat loss.

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5.5 Climate Change

Introduction

Climate change is caused by the emission of greenhouse gases such as CO2 and CH4, and CFCs and HCFCs all over the world. Relative sea level rise can be considered as main pressure for the coastal zone. Aim of the pressure and state indicators for climate change is to identify areas with potential problems related to expected wetland loss. Proposed pressure indicator is "accelerated sea level rise", "expected loss of wetlands" is identified as state indicator.
Table 5.5.1 gives an overview of the indicator system.

Table 5.5.1. The indicator system: Climate change

Driving Forces/ Sectors	Pressure
• energy conversion, • industry, • transport & shipping, urbanisation, • tourism & recreation	• accelerated sea level rise see also table 2.2-d
Impact	**State**
• people at risk • environment at risk • capital at risk • habitat loss • groundwater levels • coastal erosion • land use	• expected loss of coastal wetlands assuming 1 meter sea level rise see also table 2.2-d

Data and coastal units

A study to the global impact of sea level rise worldwide is available (DH & TWD, 1993). In this study different vulnerability assessments were carried out to estimate the flooding risks in the coastal zone. One of these assessments is the quantification of wetland loss due to 1 meter of sea level rise in 100 years. Relative sea level rise information is only available at a global scale, (one indication for Europe, IPCC, 1996). For the assessment of the relative sea level rise caused by climate change, regional information about natural sea level rise and subsidence is necessary.

According to the available information the countries along the coastline are defined as coastal units to describe the state indicator. For the pressure indicator a coastal unit can only be defined as the whole of Europe based on the available data.

Pressure indicator

Possible indicator

In the literature, different types of pressure indicators for climate change are suggested but accelerated sea level rise is considered the most appropriate pressure indicator for the coastal zone. However, accelerated sea level rise is often considerd as an impact indicator for climate change. At present (IPPC,1996) a non-linear rise in global level of 20-100cm in the coming years is projected. Regionally, the relative sea level rise can be very different from the global sea level rise.

Classification of indicator values

No suggestion has been done, since no differentiating data are available.

Assessment

Because of the lack of regional data, it is not possible to test this assessment methodology for the pressure indicator of climate change.

State indicator

Possible state indicator

The concept of loss of areas is considered most appropriate for the assessment of the vulnerability of ecosystems in the coastal zone, since it indicates the consequences of the impact with taking into account the response of the system. Especially loss of wetlands are of interest considering sea level rise due to their valuable functions and their morphological characteristics. Since it is difficult to quantify changes, e.g. with respect to biodiversity, only the change of habitat area is estimated. In Table 5.5.2 the estimation of actual surface of wetlands and the potential loss, assuming 1 meter sea level rise, without taking measures is presented. Wetlands are defined as the terrestrial part of the wetland area. The results are present in map 5.5.1.

Table 5.5.1 Total coastal wetlands at loss per country, after DH & TWD, 1993

Country	Total (**terrestrial**) area of coastal wetland (100*km2)	potential loss of wetlands assuming 1 m sea level rise (*100 km2)	Assessment ratio loss in country versus total in Europe
Albania	<	<	< (green)
Belgium	<	0	< (green)
Denmark	15	9	0,26 (red)
Finland	<	0	0 (green)
France	11	2	0,05 (green)
Germany	11	<	0,01 (green)
Greece	1	1	0,02 (green)
Iceland	7	0	0 (green)
Ireland	3	1	0,03 (green)
Italy	2	2	0,04 (green)
The Netherlands	11	11	0,29 (red)
Malta	0	0	0 (green)
Norway	1	0	0 (green)
Portugal	2	2	0,07 (yellow)
Spain	10	8	0,22 (red)
Sweden	<	0	0 (green)
United Kingdom	22	0	0 (green)
Total	96	36	

Table 5.5.1 shows that the indicated coastal wetland decline is expected to be greater than average for the coasts of the Mediterranean Sea. This is mostly due to relatively strong subsidence.

The Scandinavian countries and Iceland do not show any relative sea level rise, mainly due to an emerging coast. The increase in loss rates is closely connected with human activities such as enhanced subsidence and shoreline protection, blocking sediment sources for wetlands, and developing activities, e.g. land reclamation and aquaculture development (DH & TWD, 1993).

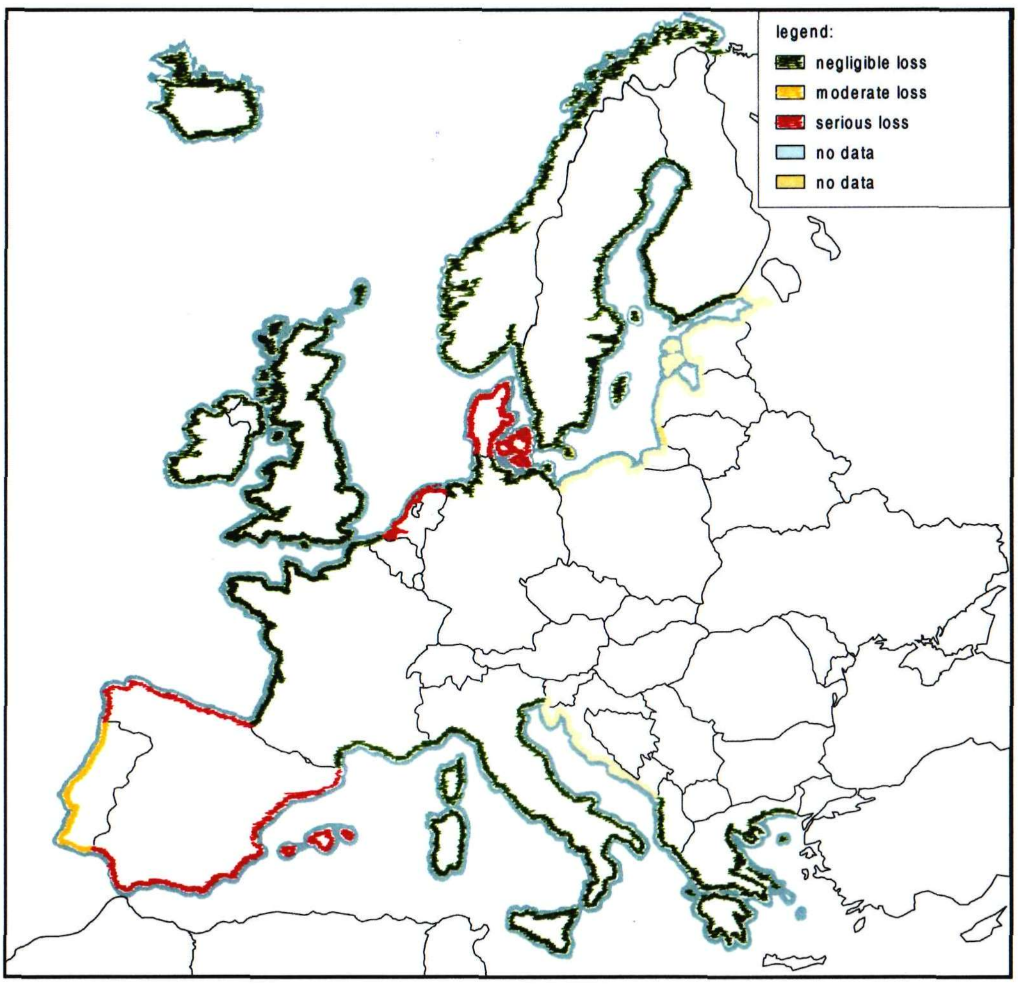
Classification of indicator value

To overcome (inter)national discussions about normalisation in absolute (classification of absolute loss) or relative terms (national loss versus national reference) on a national level, it is proposed to classify the potential wetland at loss in relation to total amount of wetland in Europe (ratio expected wetland at loss versus total area of wetland in actual situation in Europe):

"red" ratio expected potential of coastal wetlands versus total coastal wetland in actual situation bigger than 0.2 (serious loss in Europe)

"yellow" ratio expected potential of coastal wetlands versus total coastal wetland in actual situation is between 0.05-0.2 (moderate loss in Europe)

"green" ratio expected potential of coastal wetlands versus total coastal wetland in actual situation is less than 0.05 (negligible loss in Europe)



Map 5.5.1 "State" assuming one meter sea level rise *(potential expected loss of coastal wetlands)*

Assessment

There is now only one indicator identified to describe the state of climate change.

Conclusions and discussion
Indicators for Climate Change relate to a potential problem. Although a pressure indicator (sea level rise) is available and should be sufficient, more detailed information is needed about subsidence and regionally differentiation to obtain discriminating results.

Estimated potential wetland loss appears to be a valuable and discriminating indicator on the scale of Europe. Updating of the used data on wetland surfaces in the actual situation is required.

The system chosen here clearly focuses on the European scale. Losses which could be substantial on local or even national level might come out as relative unimportant at the European level.

In some cases, the coastal units should be defined in more detail, since one country can adjacent to two or more regional seas. It is recommended to define the coastal units per sea per country.

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