OSPAR
COMMISSION

Assessment of the impact of coastal defence structures

Biodiversity Series

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OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l’Espagne

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Executive summary

Coastal defence structures can shape the shoreline

Coastal defence structures have a strong influence on the configuration of the shoreline. Artificial structures can influence sediment transport, reduce the ability of the shoreline to respond to natural forcing factors and fragment the coastal space. This can result in loss of habitats and lead to noise and visual disturbance of birds. On the positive side, coastal defence structures can increase shipping and tourism and increase or restore natural habitats in certain cases. A new concept of sediment management is needed to maintain sediment balance and fight coastal erosion. The principles of Integrated Coastal Zone Management (ICZM) and use of Environmental Impact Assessments are important instruments in achieving this.

Increasing erosion affects all coasts

The need for more coastal defence structures arises directly from the increasing coastal erosion that affects many coasts. The majority of these coastal erosion problems are induced by human activities. In the future, the impact of global warming and climate change (sea level rise, storm surges, coastal floods) will become more important. People are increasingly occupying low-lying areas that are exposed to flooding, thus exacerbating their vulnerability to extreme events. The importance and scale of coastal defence structures will increase accordingly, potentially generating greater environmental impacts.

In the OSPAR area approximately 5% of the coastline is protected. An evaluation of the present use of coastal defence techniques shows that in general, countries with short coastlines and sandy beaches tend to protect the majority of their coastline with both soft and hard defence techniques. Countries with long coastlines, including cliffs and rocks, protect only a small portion of the coastline. This protection is generally restricted to hard defence techniques near harbours and cities. Hard defence techniques, such as building sea walls, have been used since the 1800s while soft defence techniques have been used since the 1900s. Beach nourishment, underwater sand nourishment and beach scraping were first used in the 1960s and their use is increasing.

The environmental impacts of coastal defence structures are closely related to the different techniques used

A distinction has to be made between hard and soft coastal defence structures and between short-term (construction, maintenance) and long-term impacts (operation). The expected short-term ecological impacts of coastal defence structures are generally negative and include disturbance of birds and destruction of marine coastal habitats with their associated flora and fauna. Longer-term impacts of hard coastal defence structures, such as the creation of hard substrate habitats can be seen as a minor beneficial effect in some cases. Other long-term impacts can be seen as negative, including damage to benthic communities and the possible invasion of non-indigenous species. The longer-term impacts of soft coastal defence structures are case-specific and can be positive for some beach ecosystem components or habitats but negative for others.

Most coastal defense structures are located in The Greater North Sea (OSPAR Region II). The southern and eastern North Sea coastal zones are almost continuously protected, leading to extensive habitat fragmentation.

An Environmental Impact Assessment is the main instrument for environmental compliance in coastal defence schemes

Technical and environmental regulations are issued and controlled by different administrative entities (state, region, municipality) and departments (ministries, institutions) in many OSPAR countries. The national laws of the Contracting Parties indicate the authorities responsible for coastal defence, the actions that they can take, and often the safety level that should be reached in coastal protection. Often these laws stipulate that natural and soft techniques should be prioritised and this principle is often repeated in environmental regulations. An Environmental Impact Assessment (EIA) is the main instrument to ensure that environmental regulations are complied with in coastal defence schemes. When urgent, coastal defence works are implemented without the EIA procedure.

In recent decades it has become recognised that the coastal defence needs to be implemented in a way that takes due regard of the overall natural processes operating on the coast. There has been a shift towards designs following the principles of Integrated Coastal Zone Management and sustainability. Modern methods of 'soft' coastal engineering (dunes, salt marshes) that reinforce natural buffers against the rising tides, will help maintain coastal sediment balance and the stability of coastal systems.

No further action needed by OSPAR

Based on an extensive literature review of different coastal defence techniques and information collected from Contracting Parties, it can be concluded that coastal defence issues are sufficiently covered in both international and national regulations and requirements. Additional comprehensive work within OSPAR is unlikely to significantly increase knowledge in this field. Therefore, it is recommended that no further action should be taken by OSPAR on this issue until new information indicates that such action is needed.

Récapitulatif

Les structures de défense côtière peuvent modeler le littoral

Les structures de défense côtière ont une grande influence sur la configuration du littoral. Les structures artificielles peuvent influencer le transport des sédiments, réduire l'aptitude du littoral à réagir aux facteurs de contrôle naturels et fragmenter l'espace côtier. Ceci peut entraîner la perte d'habitats et une perturbation acoustique et visuelle pour les oiseaux. Les structures de défense côtière présentent cependant des avantages car elles peuvent stimuler la navigation et le tourisme et agrandir ou restaurer des habitats naturels dans certains cas. Un nouveau concept de gestion des sédiments est nécessaire afin de conserver l'équilibre des sédiments et de lutter contre l'érosion côtière. Les principes de la gestion intégrée des zones côtières et l'utilisation d'évaluations de l'impact environnemental représentent des instruments importants permettant d'y parvenir.

L'érosion croissante affecte toutes les côtes

Un nombre plus important de structures de défense côtière sont nécessaires car l'érosion côtière croissante affecte de nombreuses côtes. La majorité de ces problèmes d'érosion côtière sont provoqués par des activités humaines. L'impact du réchauffement climatique et du changement climatique (montée du niveau de la mer, ondes de tempête, inondations côtières) va devenir plus important à l'avenir. Les zones de basse altitude, exposées aux inondations, sont de plus en plus peuplées ce qui exacerbe leur vulnérabilité quant aux évènements extrêmes. L'importance et l'ampleur des structures de défense côtière vont augmenter en conséquence, entraînant potentiellement des impacts environnementaux plus importants.

Dans la zone OSPAR, environ 5% du littoral est protégé. Une évaluation de l'application actuelle de techniques de défense côtière révèle que dans l'ensemble les pays possédant un littoral peu étendu et des plages sablonneuses ont tendance à protéger la majorité de leur littoral grâce à des techniques de défense aussi bien lourdes que légères. Les pays possédant un littoral étendu, comportant notamment des falaises et des rochers, ne protègent qu'une petite partie de leur littoral. Cette protection se restreint généralement à des techniques de défense lourdes à proximité des ports et des villes. Les techniques de défense lourdes, telles que la construction de digues, sont utilisées depuis le XIXème siècle alors que les techniques de défense légères sont utilisées depuis le XXème siècle. Le réapprovisionnement des plages et du sable sous-marin ainsi que le raclage des plages sont des techniques qui furent utilisées pour la première fois dans les années 1960 et qui sont de plus en plus exploitées.

Les impacts environnementaux des structures de défense côtière sont étroitement liés aux diverses techniques utilisées

Il convient d'établir une distinction entre les structures de défense côtière lourdes et légères et entre les impacts à court terme (construction, entretien) et à long terme (exploitation). Les impacts écologiques des structures de défense côtière, prévus à court-terme, sont dans l'ensemble négatifs. Il s'agit notamment de la perturbation des oiseaux et de la destruction des habitats côtiers marins ainsi que de leur flore et faune correspondantes. Les impacts à long terme des structures de défense côtière lourdes, telles que la création d'habitats de substrat dur, peuvent être considérés comme des effets positifs dans certains cas. D'autres impacts à long-terme peuvent être considérés comme négatifs. Il s'agit notamment de la dégradation des communautés benthiques et de l'invasion éventuelle d'espèces non indigènes. Les impacts à long terme des structures de défense côtière légères varient selon les cas et peuvent être positifs pour certaines caractéristiques d'écosystème et habitats de plage mais négatifs pour d'autres.

La plupart des structures de défense côtière se trouvent dans la mer du Nord au sens large (Région OSPAR II). Les zones côtières méridionales et orientales de la mer du Nord sont protégées presque continuellement, ce qui entraîne une fragmentation importante des habitats.

Une évaluation de l'impact environnemental est l'instrument principal permettant d'obtenir une conformité environnementale des systèmes de défense côtière

Des réglementations techniques et environnementales sont publiées et contrôlées par les diverses administrations (au niveau d'un état, d'une région, d'une municipalité) et services (ministères, institutions) dans de nombreux pays OSPAR. Les législations nationales des Parties contractantes indiquent les autorités responsables de la défense côtière, les mesures qu'elles peuvent prendre et souvent le niveau de sécurité auquel il convient de parvenir en matière de protection côtière. Ces législations stipulent souvent qu'il convient de donner la priorité aux techniques naturelles et légères, principe qui est souvent repris dans les règlementations environnementales. Une évaluation de l'impact environnemental (EIA) représente le principal instrument permettant de s'assurer que les systèmes de défense côtière sont conformes aux réglementations environnementales. Lorsque des travaux de défense côtière sont urgents, ils ont mis en œuvre sans appliquer la procédure EIA.

Au cours des récentes décennies, on a reconnu que la méthode de mise en oeuvre de la défense côtière doit tenir compte de l'ensemble des processus naturels opérant sur la côte. On a observé un glissement vers des conceptions suivant les principes de la gestion intégrée des zones côtières et la durabilité. Les méthodes modernes appliquées aux structures légères de défense côtière (dunes, marais salés) qui renforcent les butoirs naturels contre les marées montantes, permettront de conserver l'équilibre des sédiments côtiers et la stabilité des systèmes côtiers.

Il n'y a pas lieu pour OSPAR de prendre des mesures supplémentaires

On peut conclure, en se fondant sur la revue bibliographique approfondie des diverses techniques de défense côtière et sur les informations recueillies par les Parties contractantes, que les questions de défense côtière sont suffisamment couvertes par les réglementations et exigences nationales et internationales. Il est peu probable que des travaux exhaustifs supplémentaires au sein d'OSPAR permettent d'améliorer les connaissances dans ce domaine. On recommande donc qu'OSPAR ne prenne pas de mesures supplémentaires dans ce domaine à moins que de nouvelles informations n'indiquent le contraire.

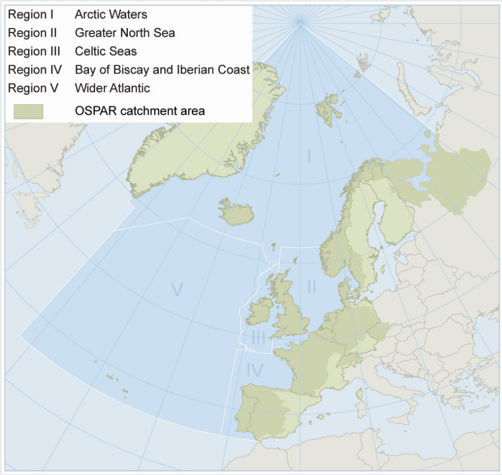
1 Introduction

1.1 Framework

The OSPAR Strategy for the Joint Assessment and Monitoring Programme (OSPAR, 2003a) provides for a series of assessments of human activities as required by the OSPAR Strategy on Biodiversity and Ecosystems (OSPAR, 2003b). Coastal defence is one of these human activities. The assessments have been prepared as contribution to the Quality Status Report (QSR) 2010 and form a basis for drawing conclusions on need for any OSPAR action. This report only covers coastal defence structures in the OSPAR Maritime Area of the coastal OSPAR countries (see box). Impacts of activities ancillary to coastal defence are addressed in other QSR assessments (see box).

Electronic navigator to complementary QSR assessments

- Sand and gravel extraction (OSPAR, 2009a)
- Land reclamation (OSPAR, 2008a)
- Construction and placement of structures (OSPAR, 2008b)
- Climate change mitigation and adaptation (OSPAR, 2009b)



Map: OSPAR maritime area and its five Regions

1.2 Aim and methodology

Belgium as lead country has conducted a background study aimed at mapping the present situation regarding OSPAR Contracting Parties' legislation, experiences and regulatory needs in relation to the environmental impacts of coastal defence structures. The outcome of this study is included in this report.

This background information was collected through an inventory of Contracting Parties' current regulations, experiences and views regarding the environmental impacts of coastal defence structures carried out in 2004 – 2006. In 2008 an additional questionnaire was sent out to gather data on the types and extents of coastal defence structures and on environmental impacts of these structures. An overview of the data collected can be seen in Annex 1.

The assessment of impacts of the installed coastal defence structures presented in section 3 is based upon the information gathered from Contracting Parties and supplied with studies of available literature.

1.3 Categories of coastal defence structures considered in this report

The categories of structures considered in the background study are listed in Table 1 below. They are slightly modified from the EUROSION Shoreline Management Guide (European commission and Directorate General Environment, 2004, release January 2004, Annex 2). In particular, the category "Dike" is absent from Annex 2 of the Shoreline Management Guide but was correctly added by some respondents and is now included in Table 1 below.

The categories "harbours", "quays", "jetties", "piers" are not considered in this assessment.

Table 1. *Categories of structures and techniques considered in the background study.*

Categories of structures	CODE	Description
Hard Techniques		
Breakwater	BW	Protective structures placed offshore, generally made of hard materials such as concrete or rock, which aim to absorb wave energy before the waves reach the shore.
Dikes	DK	Longitudinal artificially raised shore, consisting of a soft (sand, loam, *etc*.) core topped with a layer of for example grass or r asphalt. Some dikes are covered by artificial sand dunes.
Gabions	GB	Metal wire cages filled with rocks, about 1 metre by 1 metre square. Gabions are stacked to form simple walls.
Geotextile	GT	Permeable fabrics which are able to hold back materials while water flows through. Geosynthetic tubes are large tubes consisting of a woven geotextile material filled with a slurry-mix. The mix usually consists of dredged material (for example sand) from the nearby area but can also be a mortar or concrete mix.
Groyne	GF	Structures that extend perpendicularly from the shore. Usually constructed in groups called “groyne fields”. Their purpose is to trap and retain sand by interrupting longshore drift, nourishing the beach compartments between them. Groynes may be made of wood or rock.
Revetment	RV	Sloping feature which breaks up or absorbs the energy of the waves but may let water and sediment pass through. The older wooden revetment consists of posts fixed into the beach with wooden slats between. Modern revetments have concrete or shaped blocks of stone laid on top of a layer of finer material. Rock armour or riprap consists of layers of very hard rock with the largest, often weighing several tonnes, on the top. Riprap has the advantage of good permeability and looks more natural.
Seawall	SW	Bulkheads and seawalls completely separate land from water. Bulkheads act as retaining walls, keeping the earth or sand behind them from crumbling or slumping. Seawalls are primarily used to resist wave action. Design considerations for these types of structures are similar. Seawalls may be topped with a promenade.
Soft Techniques		
Artificial reef creation	AR	An artificial reef which absorbs the wave energy (thus providing coastal defence), while providing a natural habitat for marine organisms and opportunities for recreational activities.
Beach drainage	BD	Beach drainage decreases the volume of surface water during backwash by allowing water to percolate into the beach, thus reducing the seaward movement of sediment. Beach drainage also leads to drier and “gold” coloured sand, more appreciated for recreational activities.
Beach nourishment	BN	Artificial increase of sand volumes in the foreshore via the supply of exogenous sand.
Beach scraping	BS	Artificial re-profiling of the beach when sediment losses are not severe enough to warrant the importation of large volumes of sediments. Re-profiling is achieved using existing beach sediment.
Cliff drainage	CD	Reduction of pore pressure by piping water out of the cliff and therefore preventing accumulation of water at rock boundaries.
Cliff profiling	CP	Change of cliff face angle to increase cliff stability. The angle at which

Categories of structures	CODE	Description
		cliff become stable is a function of rock type, geologic structure and water content.
Cliff toe protection	CT	Protection of the cliff base by placing blocks at the foot of a potential failure surface.
Dune regeneration	DR	Wind blown accumulation of drifted sand located in the supra-tidal zone. Wind velocity is reduced by way of porous fences made of wood, geotextile, plants, which encourage sand deposition.
Marsh creation	MC	Planting of mudflats with pioneer marsh species, such as *Spartina sp*. Marsh vegetation increases the stability of sediment due to the binding effects of the roots, increasing shear strength and decreasing likelihood of erosion. Marshes also provides cost-effective protection against flooding by absorbing wave energy.
Mudflat recharge	MR	Supply of existing mudflats with cohesive sediments. This is achieved via trickle charging, rainbow charging, and polders.
Rock pinning	RP	Prevention of slippage in seawards dipping rocks by bolting layers together to increase cohesion and stability.
Sand by-passing	SB	Reactivation of sediment transport processes by re-introducing material intercepted by a coastal structure and down-drift of it. A variant of sand by-passing is to use materials dredged for navigational purposes to reactivate the sediment transport.
Underwater sand nourishment	UN	Artificial increase of sand volumes in the near-shore area via the supply of exogenous sand.
Vegetation planting and/or stabilisation	VG	Colonisation of coastal soils by vegetation whose roots bind sediment, making it more resistant to wind erosion. Vegetation also interrupts wind flow thus enhancing dune growth. As for cliffs, vegetation increases cohesion of surface soils on cliff slopes to prevent downhill slumping and sliding.

2 Overview of coastal defence structures and techniques

2.1 Present situation

This section gives an overview of the OSPAR coasts protected by coastal defence structures and the type of protection currently installed. The relative importance of different types of structures is reflected in the length of the protected coast. When different types of structures are present at the same location, their length is counted separately.

Table 2. *Overview of coastal defence categories and their relative importance expressed in terms of kilometres of defended coast for the Contracting Parties. The codes for the categories of structures are explained in Table 1.*

Country		Total coastal length in OSPAR area km	No defence techniques Km	Hard techniques								Soft techniques								
				BW	DK	GB	GT	GF	RV	SW	Undefined	BN	BS	CP	CT	DR	MC	RP	UN	VG
Belgium	BE	67	10					40		35		20	20			20				
Denmark	DE	7300	900	68				1242	750			61	110			110				110
France	FR	5500	a	*			*	**		**		*	*		*	*		*		**
Germany	DE	1168	158		608			162	9	434		48				148			2	
Iceland	IS	4988	a	23					110											
Ireland	IE	5850						No information								No information				
Norway	NO	83281	75000								8300									
Portugal	PT	1793						No information								No information				
Spain	ES	4800	4600	4				10		89		24	1			1	9			1
Sweden	SE	3214	a			0.7	*	0.2	11.6	1.0		0.7	*			*				8.0
The Netherlands	NL	1276	38		766			766				253					51		253	
United Kingdom	UK	10350	a	35		11		119	370	992	300	15	30	89						

* Occurs in some points

**Occurs in a substantial portion of the coast

a Unprotected length not passed on

Soft defence techniques AR, CD, MR and SB are not indicated in the table since they are not applied within the OSPAR area

The overview map in Figure 1 shows the location of hard and soft coastal defences for the whole OSPAR Maritime Area.

***Figure 1**:* *Coastal defence techniques used along the coastline of the OSPAR Maritime Area.*

Note: There is no information available where there is no colour indicator.

The coastline of small countries with sandy beaches is generally extensively protected with both soft and hard defences. Countries with long coastlines with rocks and cliffs leave notable parts of their coastline unprotected, with defences being used primarily around harbour areas and near cities. This is illustrated in Figure 2. Belgium, The Netherlands and Germany have short coastlines and mostly sandy beaches. Only a very small percentage of their coastline is unprotected. Very often both hard and soft defence techniques are used along the same strip of coastline, as indicated in Figure 3. Denmark, the United Kingdom, Spain and Norway, have long coastlines with stretches of cliffs and have high percentages of unprotected coastline. Figure 4 shows the coastline of the north of Spain where long stretches of coastline are unprotected. It must be stated that unprotected does not mean unsafe. The zones of coastline that are left unprotected generally do not represent any acute danger.

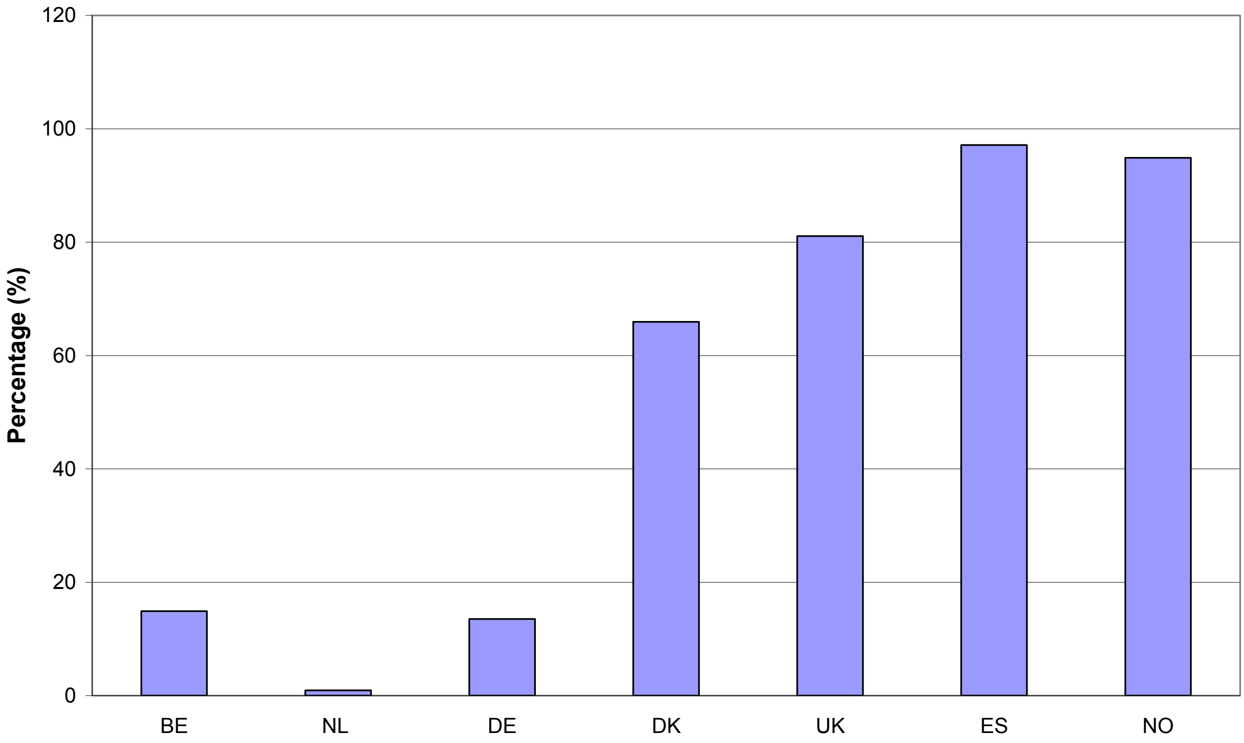


***Figure 2**: Percentage of unprotected coastline in Belgium, the Netherlands, Germany, the United Kingdom, Denmark, Spain and Norway*

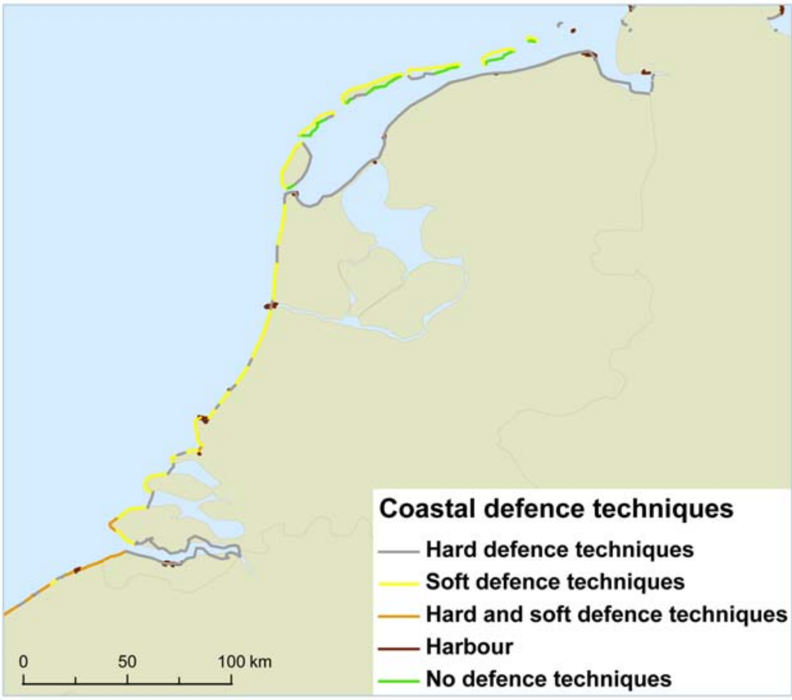


***Figure 3**:* *Coastal defence techniques applied in Belgium and the Netherlands*.

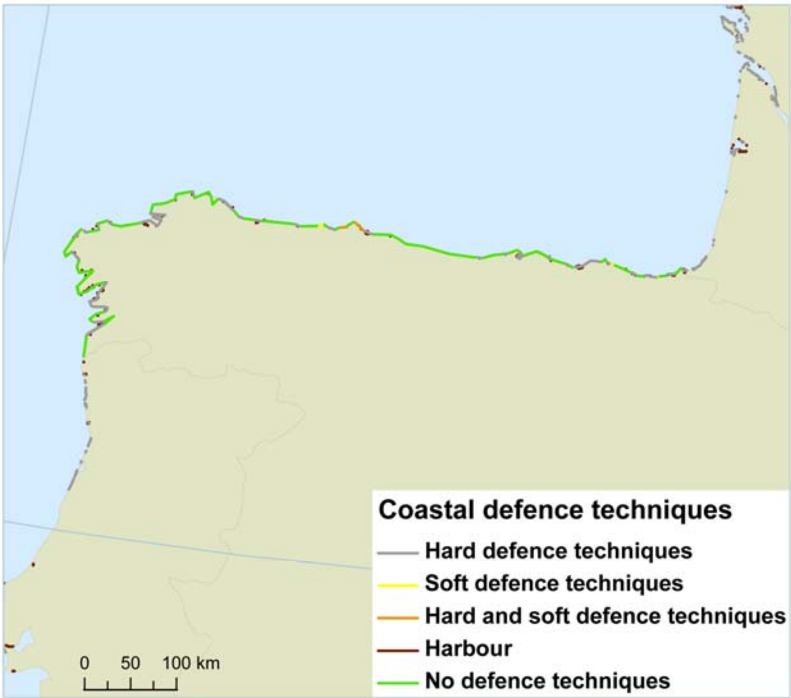


***Figure 4**:* *Coastal defence techniques applied in the North of Spain*

2.2 Temporal changes

The construction of hard defences started in the 1800s. These techniques continue to be used today. The use of hard defence techniques has followed the trend of intensified land use along the coastline. Older works are refurbished and extended to increase the level of protection as necessary.

The use of soft coastal defence techniques is a more recent approach. However, a distinction must be made between the soft defence techniques that, once installed, have a long term effect, like dune regeneration and marsh creation, and the techniques that have a short term effect and have to be repeated frequently like beach nourishment, underwater sand nourishment and beach scraping.

The former group of techniques has been applied since the early 20th century. These techniques, once in place, only require maintenance but are only suitable for certain types of coastline. Hence their use is not expanding notably.

Beach nourishment, underwater sand nourishment and beach scraping, by contrast, are used increasingly. These techniques where first applied in the 1960s. Since the effects are relatively short term, the procedure may need to be repeated. Beach nourishment and underwater sand nourishment are repeated every four to five years at certain locations in the Netherlands.

2.3 Case study: Wadden Sea – The Netherlands

The Wadden Sea is a coastal sea stretching over 450 km along the coast of the Netherlands, Germany and Denmark and is one of the world's largest wetland systems.

A network of tidal channels, sandbars, mudflats, salt marshes and islands creates a transition zone between land and sea, characterized by the tidal regime and highly variable salinity, light, oxygen and temperature. This has resulted in a complex system which provides a unique habitat for a rich flora and fauna.

The Dutch Wadden Sea islands generally have broad beaches and dunes. These present the most important element of coastal protection on the North Sea coast of these islands. The Dutch coastal defence policy is based on the principle of dynamic maintenance, *i.e.* using sand nourishment to maintain the coastline. The building of hard, man-made structures (for example groynes) is allowed in exceptional cases only. Hard structures are present along six of the 155 km of the sandy coast of the inhabited islands.

***Figure 5**: Broad beach, dunes and groynes at the coastline of the Dutch Wadden Sea island Vlieland. Source: Rijkswaterstaat - www.kustfoto.nl. Copyright Rijkswaterstaat, 2007.*

In the period 1991 – 2000, 23 million m³ of sand was supplied to over 95.5 km of coastline. A large part of this nourishment is shoreface nourishment (applied below the low water line). This is, in terms of costs, more successful than beach nourishment. The first subtidal channel wall nourishment was carried out in 2003 in the Molengat tidal channel near the island of Texel.

The salt marsh area has remained stable since 1999. The existing protection along the mainland marshes prevents them from being eroded. Protection is being maintained in the most environmentally friendly way possible. Sediment deposition is allowed and sometimes encouraged on these marshes by wind-driven transport or wash-over. This could help in maintaining the island when sea level rise accelerates. (Essink *et al.*, 2005)

3 Assessment of the impacts of coastal defence structures

3.1 What are the problems? Are they the same in all OSPAR regions?

Some form of coastal protection has been needed ever since humans have lived in areas at risk of flooding. The use of coastal defence structures has spread particularly in estuaries and along the southern and eastern coast of the North Sea. The scale and extent of coastal defence structures has increased along with increasing income and living standards and increasing development in the coastal zone (European Environment Agency, 2006).

The need for coastal defences arises directly from increasing coastal erosion that affects all coasts. The EC's EUROSION project (European Commission and Directorate General Environment, 2004) found that the majority of current coastal erosion problems are induced by human activities and artificially stabilised seafronts are progressively encroaching on sedimentary coastlines and cliffs. Dynamic ecosystems and their undeveloped coastal landscapes are gradually disappearing due to a lack of sediment. In many places the process of 'coastal squeeze' is responsible for this phenomenon. The geographic impact of coastal defence structures is very pronounced in lowland coastal states. As such, the southern and eastern North Sea coasts are virtually completely defended (Figure 1). Very important coastal defence schemes are also present in the other Contracting Parties' lowland coastal stretches and near river mouths. The number of inhabitants and the value of property and assets they protect are considerable. The number and length of coastal defence structures along hard rock and cliff coasts are less clear from the questionnaire's replies. Although the defence structures along these coasts are scattered, each and every one has its local importance.

The southern and eastern North Sea coastal states have a long tradition in coastal protection. In fact, their shores show a quasi continuous line of coastal protection works. Mostly hard structures have been used, such as dikes, groyne fields and seawalls. However, the length of soft defences, such as beach nourishment schemes, increases each year and already significant parts of the Belgian, Dutch and Danish North Sea shores are defended using this technique. Beach nourishment is often accompanied by dune regeneration programmes. With regard to other soft defence techniques, beach scraping is important in Belgium and Denmark, while marsh creation is applied on a considerable scale in the Netherlands.

Although substantial in length, the parts of the Irish, Northern Irish, Scottish, Spanish and French coasts that are protected, represent only a fraction of those countries' total coastline. Here too hard defences prevail while recent years have seen a shift to the use of soft defence techniques.

The most often selected environmental topics of concern by respondents listed in the questionnaire were "Migration, roosting and feeding areas for birds", "International conservation areas", "National conservation areas" and "Coastal processes (sediment transport, erosion, sedimentation, hydrodynamics)".

Looking to the future, the impact of global warming and climate change will become increasingly important. It is expected that rising sea levels, an increased probability of storm surges and associated coastal floods will result. Increasing human vulnerability rather than physical magnitude or frequency of the events themselves is the prime concern. People are increasingly occupying low-lying areas that are exposed to flooding, thus exacerbating their vulnerability to extreme events. The importance and scale of coastal defences will thus increase, with potentially commensurate environmental impacts.

3.1.1 Environmental impacts of coastal defence structures

The environmental impacts of coastal defences are closely related to the different techniques used. To describe the environmental impacts a distinction has to be made between hard and soft defences and between short-term (during construction and maintenance phase) and long-term impacts (during operational phase).

Hard coastal defence structures

There is no specific information available for each OSPAR country on the ecological impact of the different types of hard coastal defence structures. The only relevant research was done within the framework of the EU-funded DELOS Project (Environmental Design of Low Crested Coastal Defence Structures - LCSs[1]), where existing LCSs in Europe were inventoried and six sites in the United Kingdom, Denmark, Italy and Spain were selected at which continuous multidisciplinary monitoring was carried out. This recent research is published in several DELOS Special Issue papers (Airoldi *et al*., 2005; Lamberti *et al*., 2005; Martin *et al*., 2005; Moschella *et al*., 2005). Other relevant studies on hard coastal defence structures were carried out along the Belgian coast (Engledow *et al.,* 2001; Volckaert *et al*., 2003; Volckaert *et al*., 2004).

Despite the fact that the DELOS studies were conducted in very different coastal systems (different seas, different tidal range, different wave and current regimes, different types of beaches) many of the results obtained have been consistent (Martin *et al*., 2005). The DELOS project specifically focused on LCSs. From an ecological point of view, however, LCSs function similarly to other types of hard defence structures and most of the ecological impacts are broadly applicable to any type of hard or rock armoured artificial structures (Airoldi *et al*., 2005). Therefore the DELOS Special Issue papers and additional published studies have been used for the description of the potentially ecological impacts of hard coastal structures that can occur in the OSPAR regions.

Figure 6*:* *Breakwaters in front of a public beach.*
Source: EUCC - The Coastal Union. Copyright Stefanie Maack, 2002.

[1] Low Crested Structures (LCSs) are offshore breakwaters, parallel to the shore that can be submerged or regularly overtopped by waves (Lamberti *et al*., 2005).

Short-term impacts

Construction phase

The type and magnitude of the changes induced by hard coastal defence structures can vary considerably depending on the environmental setting where the structures are built. However, the construction of hard defence structures always results in a local loss and disturbance of natural sedimentary habitats, including the associated assemblages of animals and plants (soft substrate benthos), and can also disrupt surrounding soft seabed environments. Further, urban hard coastal defence structures can introduce new artificial hard substrata that are extensively and rapidly colonised by algae and marine animals (see further long-term impacts) (Bacchiocchi and Airoldi, 2003; Martin *et al*., 2005, Airoldi *et al*., 2005; Moschella *et al*., 2005).

There can be some local, temporal disturbance to birds and fishes, particularly from noise and vibration associated with construction of the hard defence structures and for birds there can also be visual disturbance.

In conclusion, the disturbance during the construction phase of hard defence structures is a negative but temporary effect. The loss of soft-bottom assemblages is a negative and permanent effect. Their replacement by hard bottom assemblages can be seen as either positive or negative.

Maintenance phase

During the maintenance phase there can be a temporary disturbance of the sessile fauna, algae and mobile fauna that has colonised the artificial hard structures. The ecological effects during the maintenance phase are presumably similar to those in the construction phase.

The disturbance during the maintenance phase is thus a negative but temporary effect.

Long-term impacts

Any hard defence structures will have consequences for the coastal landscape and for the structure and functioning of coastal ecosystems. These consequences can occur locally, but also scale up to surrounding areas and ultimately can affect coastal ecosystems on a regional scale. The variability of ecological systems makes it difficult to predict the ecological impacts of hard coastal defence structures in a specific area quantitatively, but there are some qualitative general impacts, as described below (Airoldi *et al*, 2005).

Impacts at local scale

At a local scale hard coastal defence structures introduce new artificial hard substrata into areas that are often characterised by scarce natural rocky reefs. They can be extensively and rapidly colonised by algae and epibenthic fauna and can cause an increase in diversity locally. However, the diversity of species is lower than on natural rocky shores and epibiota are generally dominated by species with a large dispersal range. Further more, the populations mainly consist of juvenile stages and individuals usually no older than 2 years. Therefore, it appears that the hard coastal defence structures do not provide appropriate habitats for stable communities of adult animals (Airoldi *et al*., 2005; Bacchiocchi and Airoldi, 2003; Bulleri, 2005; De Wolf, 2001; Engledow *et al*., 2001; Martin *et al*., 2005; Moschella *et al*., 2005; Volckaert *et al*., 2003).

The presence of hard defence structures tends to cause an accumulation of sediments, mainly on the side where the current (and net transport) comes from. This causes a significant reduction in the abundance of benthic invertebrates (Martin *et al*., 2005).

Hard coastal defence structures can be used by birds for foraging, waiting for the tide and as a resting place (De Wolf, 2001; Engledow *et al*., 2001; Volckaert *et al*., 2003).

***Figure 7**:* *Groynes to protect the beach*

Source: EUCC - The Coastal Union. Copyright EUCC-Deutschland.

On a local scale, artificial hard coastal defence structures create new habitats for rocky shore fauna and flora, and feeding, foraging and resting habitats for birds. However, in comparison with natural rocky shore habitats, the diversity is poor and the biota is dominated by opportunistic species. This ecological impact can be seen as a minor beneficial effect in some cases. The reduction of benthic invertebrates on the lee side of the hard coastal defence structure, due to the accumulation of sediments, can be seen as a negative effect.

Impacts at regional scale

On a regional scale, a high number of artificial hard coastal structures in proximity can act as “stepping stones”, disrupting natural barriers to species distribution and providing new dispersal routes that permit the invasion of non-indigenous species, including pests (Airoldi *et al*., 2005; Bulleri and Airoldi, 2005; Glasby *et al*., 2007; Palumbi, 2003). This is generally a negative impact.

Soft coastal defence structures

Soft coastal defence structures work in sympathy with the natural processes of sediment erosion, storage and transport. This results in a low maintenance coastal system which is able to respond to external forcing factors such as storms and sea level rise.

There is no specific information available for each OSPAR state on the ecological impact of the different types of soft coastal defence structures. Only the ecological impact of beach nourishment is extensively studied and described in the literature (Speybroeck *et al*., 2005; Speybroeck *et al*., 2006; Speybroeck *et al*., 2004; Speybroeck, 2007; Van Ginderdeuren *et al*., 2007).

Short-term impacts

Construction phase

During the construction phase of soft coastal defence structures, both visual and auditory disturbance of foraging birds and nesting, breeding shorebirds can occur. Conversely, some species such as gulls can be attracted by the supplied sediment if this contains food.

The use of bulldozers may destroy the primary dune vegetation and increases the degree of compaction of the beach sediment. This can affect vascular plants (and their associated terrestrial fauna, predominantly arthropods), living on the dry parts of the beach.

In the cases of beach nourishment, under water sand nourishment and mudflat recharge there are impacts both at the borrow site (the sediment source) and the target site. At the borrow site removal of sediments causes damage and mortality to the benthos (Slim and Löffler, 2007). At the target site, burial and smothering occur. This causes mortality to any benthos not able to move through the covering sediments. These effects will be more pronounced when the nourishment zone extends further into the sea (for example underwater sand nourishment), because the deeper coastal zone is a more stable environment than the zone near or on the beach, and the benthos is less adapted to changing environmental conditions. Changes in the habitat after nourishment will influence the rate of recovery of the areas natural communities (see below).

Disturbance of birds during the construction phase of soft defences is a negative but temporary effect. The destruction of fauna and flora during the construction phase is a negative and permanent effect.

***Figure 8**:* *Foreshore nourishment.*
Source: Ecomare. Copyright Sytske Dijksen.

Maintenance phase

Some soft coastal defences have to be maintained. For instance, in the case of beach nourishment the beach needs to replenish every few years. The ecological effects during the maintenance phase are similar to those in the construction phase (*i.e.* disturbance and destruction), and are generally negative.

Other soft coastal defence structures like mudflat recharge or salt marsh creation are self-sustaining, therefore no maintenance is needed.

Long-term impacts

A long-term impact of soft coastal defences is habitat modification or the creation of new habitats, which can provide suitable sites for a variety of associated plants and animals. However, this mostly results in a (partial) loss of habitat, which may be of higher ecological value than the newly created ones.

Mudflat recharge and marsh creation

The creation of mudflats can be a precursor to the establishment of salt marshes. Given the appropriate elevation, mudflats can be colonised by pioneer saltmarsh plants. Mudflats, that are too low for the development of saltmarsh, can be colonised by intertidal invertebrates providing additional feeding areas for wading birds. Marshes can also be created by planting a pioneer species like *Spartina* grass, but this species is potentially invasive and may spread rapidly. It should be noted that artificial mudflats and saltmarshes rarely re-create the exact conditions and communities found in natural or semi-natural systems (Garbutt, 2005).

Dune regeneration and stabilisation

Transplanting marram grass *(Ammophila arenaria)* to the face of eroded dunes will enhance their natural development above the limit of direct wave attack. Sand couchgrass (*Elytrigia juncea*) and lyme grass (*Leymus arenarius*) encourage the growth of new foredunes along the toe of existing dunes. Dune grass planting will have no damaging impact on the natural environment of the receiving area, but can be harmful to the borrow area. Over harvesting of transplants from any area can give rise to increased local erosion. Care should be taken not to introduce non-indigenous shoots that may change the composition of the dune flora. Fencing to protect specific sites may encourage people to make their own routes through the dunes leading to damage elsewhere in the dune system (Wallingford *et al*., 2000).

Beach nourishment

The use of beach nourishment is a fairly recent phenomenon. Beach nourishment is widely considered as a better alternative than the construction of hard structures to protect against detrimental erosion. Even though beach nourishment is generally considered as an environmentally benign option for coastal protection and beach restoration, significant impacts (both negative and positive) on several ecosystem components (microphytobenthos, vascular plants, terrestrial arthropods, marine zoobenthos and avifauna) have been described in the literature (Speybroeck *et al*., 2006).

The long-term impacts of beach nourishment are apparent at the borrow site (the sediment source), the target site and at adjacent sites impacted indirectly through sediment transport (longshore and aeolian transport) (Speybroeck *et al*., 2004).

At the borrow and at target sites there is a loss of the resident fauna and flora during the construction phase, which is a negative impact (see above). The rate of re-colonization depends on species-specific dispersal and migration capacities and on species-specific habitat demands and tolerances, including physical and biological elements (Speybroeck *et al*., 2006).

***Figure 9**:* *Dune regeneration using wooden fences*
Source: Coastal Division Agency for Maritime and Coastal Services (MD&K). Copyright MD&K.

The long-term impacts of beach nourishment are predominantly case-specific and it is difficult to draw general conclusions. The ecological effects of beach nourishment are related to the nature and the quantity of the nourishment sediments. For instance, if the fill sediment contains a high proportion of shell fragments this can slow down or even prevent the recovery of some invertebrates or can slow down the natural succession of the vegetation and is a negative effect. On the other hand a certain percentage of shells can create favourable nesting conditions on the dry beach for some birds, which can be seen as a positive effect. Prolonged nourishment or erosion of the fill sediment can indirectly influence turbidity-sensitive plants and animals. These effects can be negative or positive: turbid water can offer protection for animals against visual predators, it can limit the penetration of light through the water and therefore decreasing phytoplankton and benthic algal productivity, it can hamper the feeding and breathing of polychaetes and bivalves, it can result in a slow recovery of macrobenthic organisms. Furthermore, grain-size and the morphology of beaches can influence the structure and functioning of the ecosystem (for example benthic communities). The size of the ecological effects is also influenced by place, time and size of the nourishment project and the chosen nourishment technique and strategy (Speybroeck *et al*., 2006).

Regardless of the disturbance of avifauna (birds) during the construction phase (as described above), the main impact of beach nourishment on avifauna is the decrease of food availability as a result of the mortality of benthic organisms, the increase of turbidity, the slow recovery of impacted habitats and possible permanent shifts in the ecological community structure. This can decrease the number of foraging birds in that area. Birds will re-colonise the newly nourished beach after the construction phase, when disturbance has ceased and/or food supply is restored (Speybroeck *et al*., 2004).

Nearby beaches (including their coastal dunes, foreshore and groynes), but also adjacent wetlands, can be influenced by nourishment through longshore transport (by water) and aeolian transport of sand (Speybroeck *et al*., 2006).

In conclusion, the expected long-term impacts of soft coastal defences are case-specific and can be positive for some beach ecosystem components or habitats but negative for others. Habitat creation can be seen as a positive effect, for example. On the other hand, habitat creation results in a loss of the present habitat which may have a high ecological value and therefore can be seen as a negative effect. Beach nourishment, for example, has both negative and positive impacts on fauna and flora. The ecological impacts are related to the quality and the quantity of the fill sediment, the place, time and size of the nourishment project and the chosen nourishment technique and strategy.

***Figure 10**: Beach nourishment on the Dutch Wadden Sea island Texel.*
Source: Ecomare. Copyright Sytske Dijksen.

3.2 What has been done?

Technical and environmental regulation of coastal defence projects is controlled by different administrative entities or institutions in different Contracting Parties.

3.2.1 Administrative arrangements and legislation

The authorities responsible for design, construction and maintenance of coastal defence structures can belong to different administrations or institutions, such as: ministries of public works, ministries of the environment (often, both are united in the same ministry or department), often in cooperation with local authorities and research institutes. The involvement of local authorities is stressed by all respondents.

There are some differences in administrative arrangements between OSPAR Contracting Parties. In France and in the United Kingdom for example, the responsibilities for coastal defence are shared between national and regional authorities on the one hand and land owners on the other hand. In Ireland, the role of local authorities is paramount though national funding is accompanied by some control of the national authority. In France, local partnerships are responsible for coastal defence schemes, but they are funded by the central state when they follow the national regulations

National laws or guidance on coastal defence are applied in all the countries south and east of the North Sea in the OSPAR maritime area, and in Spain. References to relevant regulations *etc.* adopted by different Contracting Parties are given in the questionnaire replies available from the OSPAR Secretariat.

The different national laws of the Contracting Parties identify the authorities responsible for coastal defence, the actions that they can take, and often the safety level that should be reached in coastal protection. These laws frequently stipulate that natural and soft techniques should be prioritised, and this principle is often repeated in environmental regulations. For example the French "Loi du littoral" (1986) provides a national framework for coastal land use and development compatible with the principles of sustainable development. It contains no safety levels or norms. No overall law specifies the level of protection to be adopted in Britain, although appraisal techniques are set out by the Department for Environment, Food and Rural Affairs.

3.2.2 Current environmental regulations

The responsibilities for environmental and ecosystem issues relating to coastal defence schemes are generally widely shared. In most of the Contracting Parties responding, a central environmental administration is assisted by local administrations, sometimes municipal authorities and research institutes. The replies to the questionnaire contain a clear inventory of the relevant authorities.

Based on the responses given by Contracting Parties on their five most recently implemented coastal defence schemes, the implementation of environmental regulations for coastal defence works is relatively recent and only a few actual examples of where this has been done can be cited.

EU countries refer to the national or regional implementation of EC regulations such as the Environmental Impact Assessment (EIA) Directive (Directive 85/337/EEC), Birds Directive (79/409/EEC) and Habitats Directive (92/43/EEC), and general ecological management principles that have systematically been incorporated in national laws.

Criteria or critical limits used in permitting coastal defence structures are rarely specified in the replies; some reference is made to specific studies. Public consultation has taken place in all cases where EIAs have been carried out.

Mitigation and compensation measures can be imposed in all responding countries except in Spain. Only a limited number of examples can be given, however, as the EIA obligation is recent for all countries. They all involve the creation of nature preservation areas.

In a few replies, including the Spanish, reference is made to specific environmental studies. The British reply included an environmental action plan adopted in the Dymchurch coastal defence scheme.

In the Netherlands, the predicted increases in sea water levels, as well as the predicted increase in storm frequencies and wave loads, are driving forces in coastal defence policy particularly with respect to flooding. In planning and constructing coastal defence measures, the EU recommendations on Integrated Coastal Zone management are taken into account. Beach supplementation is an important technique, applied in the Netherlands. In planning and constructing coastal defence, morphological and ecological coherence is taken into account (Ministerie van verkeer en waterstaat, 2003).

The use of EIAs to assess the impacts of coastal defence schemes seems more current in the United Kingdom and in Spain, though the more recent dates of the replies may partly explain this observation.

3.3 Did/does it work?

All respondents refer to EIA as the main instrument to ensure compliance with environmental regulations. EIA is applied to new schemes or significant changes to existing ones. EIAs are widely, even if only recently, used to map possible impacts of coastal defence schemes. National legislation has incorporated European Community regulations in EU countries. In general, the application of EIAs is recent and no relevant statistical data on the practical organisation or the effectiveness of such EIAs is available. There are only a few examples of EIAs carried out for existing coastal defence schemes. When urgent, coastal defence works can be implemented without the EIA procedure. Some coastal protection measures are considered as urgent and as such escape the EIA obligation. This is the case for numerous beach nourishment schemes in the Netherlands.

In the examples available, the cost of the EIA procedure typically amounted to 0.5 – 1% of the total cost of the coastal defence scheme and in the Cantabria Region of Spain to 1 – 1.5%.

Efforts regarding the follow-up of environmental issues related to coastal defence schemes appear to be limited. This observation may also be connected to the recent nature of EIA obligations.

3.4 How does this affect the overall quality status?

The shoreline is a dynamic system where equilibrium is maintained despite the continued movement of waves, tides, wind and sediment. The present configuration of the shoreline is affected by the various coastal defence works put in place over the last two centuries. These defence structures have had (and still have) an important influence on the transport of sediments and have also reduced the ability of the shoreline to respond to natural forcing factors.

Due to these coastal defence structures, many coasts in the OSPAR region have been, to some extent, converted into artificial surfaces. Together with urban sprawl, the construction of coastal defence structures is an important factor in the fragmentation of coastal space. This can result in loss of habitats (for example natural and semi-natural areas, wetlands, *etc*.) with important implications for biodiversity.

Indirect effects of coastal defence schemes include increased shipping activities (defence structures related to harbour construction) with attendant environmental impacts, (such as emissions, the introduction of invasive alien species, *etc*.), and an increase in tourism in defended coastal zones (with a consequent increase in wastes).

Over the last decade it has become recognised that coastal defence needs to be implemented in a way that takes due regard for the overall natural processes operating on the coast. Badly planned coastal defences on one part of the coast can have knock-on effects elsewhere.

The value of natural defences, such as sand dunes and salt marsh, has become more widely recognised. Application of new, soft defence techniques can in some cases result in an increase in or restoration of natural habitats or environments. In some cases such techniques can also reduce the negative effects related to hard defence structures. However, these soft structures have a dynamic response to coastal processes and are often more fragile than a hard defence.

The expected short-term ecological impacts of coastal defence schemes are auditive and visual disturbance of birds and destruction of habitats with their associated marine animals and plants. These effects can be seen as negative. The expected long-term impact of hard coastal defence structures like the creation of artificial new hard-bottom habitats and their associated biota can be seen as a minor beneficial effect. Other expected long-term impacts like reduction of benthic invertebrates and the possible invasion of non-indigenous species can be seen as a negative effect. The expected long-term impacts of soft coastal defence structures are case-specific and can be positive for some beach ecosystem components or habitats but negative for others.

4. Conclusions and what do we do next?

Over the last decades it has become recognised that coastal defence needs to be implemented in a way that takes due regard for the overall natural processes operating on the coast. These processes can operate over large stretches of coastline, for example eroding cliffs on one part of the coast can provide the sediment which forms beaches elsewhere. Badly planned coastal defences on one part of the coast can have knock-on effects elsewhere.

The recent decades have seen a clear shift towards designs following the principles of ICZM and sustainability. It is recognised that the main objective should be to shift from coastal defence and beach management to maintenance of sediment budget. In the light of this, a new concept of sediment management is needed. Modern methods of 'soft' coastal engineering that reinforce natural buffers against the rising tides, such as dunes and salt marshes and the protection of key sources of sediment, will help maintain coastal sediment balance and the stability of coastal systems (European Environment Agency, 2005). However, those coastal areas which are particularly exposed to and therefore threatened by strong wave action and storm tides, require more effective measures. In these areas it is crucial to install or maintain coastal defence structures, such as dykes, in order to safeguard adjacent settlements against sea level rise resulting from global warming.

The enquiry yields a comprehensive view of the coastal defence structures and schemes present along the Contracting Parties' shorelines, the laws and regulations affecting the design and the environmental issues related to coastal defence schemes, and the authorities responsible for implementing them.

It was noticed in passing that there is some need for a reference guide containing practical experience in environmental issues relating to coastal defence. Indeed, the actual implementation of coastal defence works often resides with local authorities that have no immediate access to the lessons learned in recent accomplishments in coastal defence. Also, the obligation to carry out EIAs in the EU is recent and no database on the effectiveness of such EIAs is available.

The main intention of the background enquiry and the impact assessment was to determine the need for development of any programmes or measures by OSPAR with respect to the environmental aspects of coastal defence works and to investigate the potential ecological impacts of coastal defence structures, based on an extensive literature review.

Little attention is given by Contracting Parties to the need for supra-national regulations and the need to develop standards and criteria to be used. Although a few responding Contracting Parties recognise indirectly the supra-national character of some cross-border problems related to coastal defence (for example cross-border beach erosion effects), the present cross-border cooperation seems satisfactory.

All respondents are of the opinion that the existing environmental regulations applicable to coastal defence schemes are sufficient. In the EU countries, EU environmental regulations have recently been incorporated in national regulations, especially the directive regarding EIAs. Some respondents kindly express some reluctance to the topic being broached by supra-national levels such as the OSPAR Convention. No member state expressed the need for the OSPAR Convention to coordinate national environmental regulations in the coastal defence area. The implementation of existing EU regulations seems to require some more time and experience before a need for new supra-national regulations can be identified.

No measures regarding impact on coastal defence have been developed by OSPAR at present. Based on an extensive literature review of ecological impact assessments of different coastal defence techniques and the answers given by the Contracting Parties to the questionnaire, it can be concluded that coastal defence issues are sufficiently covered in both international and national regulations and requirements. Additional comprehensive work within OSPAR would most probably not increase the knowledge significantly within this field. It is therefore recommended that no further action should be taken by OSPAR on this issue until new information indicates that such action is needed.

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Annex 1. Answers received from Contracting Parties in the 2004 – 2006 questionnaire and additional query in 2008

		DE	NO	UK	BE	DK	NL
1							
1.1	Authority that answered the questionnaire specified	Y	Y	Y	Y	Y	Y
1.2	Coastal length in km (complete length incl. bays, fjords,…)	1168	83281	10350	67	7300	1276
2							
2.1	Overview of present coastal defence structures given	Y	Y	Y	Y	Y	Y
2.2	Authority responsible for coastal defence specified	Y	-	Y	Y	Y	Y
2.3	Overview maps given	P	N	N	Y	Y	Y
3							
3.1	Coastal defence policy authority named	Y	-	Y	Y	Y	Y
3.2	Specific laws on coastal defence policy	Y	-	Y	N	N	Y
3.3	Main features or principles given	Y	-	Y	Y	Y	Y
3.4	Reference specified	Y	-	Y	N	N	Y
4							
4.1	Current environmental regulations authority	Y	-	Y	Y	Y	Y
4.2	Specific laws on current environmental regulations	Y	-	N	Y	Y	Y
4.3	Main features or principles given	Y	-	N	Y	Y	Y
4.4	Reference specified	Y	-	N	Y	Y	Y
5							
5.1	Environmental regulations imposed	Y	-	Y	Y	Y	N
5.2	Cases and environmental costs given	P	-	N	Y	Y	N
5.3	Classes of environmental topics and limits answered	Y	-	Y	Y	Y	N
5.4	Public consulted	P	-	Y	Y	Y	N
5.5	Mitigation measures imposable	Y	-	Y	Y	Y	Y
5.6	Examples given	P	-	Y	Y	N	N
5.7	Studies performed	P	-	Y	Y	Y	Y
5.8	Studies listed	N	-	N	Y	Y	Y
5.9	Specific problems recorded	N	-	N	Y	N	N
6							
6.1	Will regulations shortcomings be taken into account?	S	-		S	Y	Y
6.2	Principles of coastal defence policy under development	P	-	Y	Y	N	N
6.3	Principles of environmental regulation under development	P	-	N	Y	N	N
6.4	Need for supra-national regulation	N	-	N	N	N	N
6.5	International criteria suggested	N	-	N	N	N	N
6.6	Concluding remarks given	N	-	N	N	N	N

S = regulations are sufficient
P = parts of the country

		FR	IE	ES	IR	SE	PT
1							
1.1	Authority that answered the questionnaire specified	Y	Y	Y	Y	Y	N
1.2	Coastal length in km (complete length incl. bays, fjords,…)	5500	5850	4800	4988	3214	1793
2							
2.1	Overview of present coastal defence structures given	N	N	Y	Y	Y	N
2.2	Authority responsible for coastal defence specified	Y	Y	Y	Y	Y	-
2.3	Overview maps given	N	N	Y	N	N	N
3							
3.1	Coastal defence policy authority named	Y	Y	Y	-	Y	-
3.2	Specific laws on coastal defence policy	Y	N	Y	-	N	-
3.3	Main features or principles given	Y	Y	Y	-	Y	-
3.4	Reference specified	Y	N	Y	-	N	-
4							
4.1	Current environmental regulations authority	Y	Y	Y	-	Y	-
4.2	Specific laws on current environmental regulations	Y	Y	Y	-	N	-
4.3	Main features or principles given	N	Y	Y	-	Y	-
4.4	Reference specified	N	Y	Y	-	N	-
5							
5.1	Environmental regulations imposed	Y	Y	Y	-	Y	-
5.2	Cases and environmental costs given	Y	N	Y	-	N	-
5.3	Classes of environmental topics and limits answered	Y	N	Y	-	Y	-
5.4	Public consulted	Y	Y	Y	-	Y	-
5.5	Mitigation measures imposable	Y	Y	N	-	Y	-
5.6	Examples given	N	Y	N	-	N	-
5.7	Studies performed	Y	N	Y	-	Y	-
5.8	Studies listed	N	N	Y	-	N	-
5.9	Specific problems recorded	N	N	N	-	N	-
6							
6.1	Will regulations shortcomings be taken into account?			Y	-	S	-
6.2	Principles of coastal defence policy under development	N	N	Y	-	N	-
6.3	Principles of environmental regulation under development	N	N	N	-	N	-
6.4	Need for supra-national regulation	N	N	N	-	N	-
6.5	International criteria suggested	N	N	N	-	Y	-
6.6	Concluding remarks given	N	N	Y	-	N	-

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OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably

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