The current cost of avoiding degradation of the Dutch North Sea environment

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Summary

S.1 Introduction

This report is commissioned by Rijkswaterstaat-Waterdienst Centre for Water Management on behalf of the Ministry of Infrastructure and the Environment. The report is part of several investigations initiated to establish the 'economic and social analysis' as mentioned as a requirement for the Initial Assessment of the Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC, article 5(2)). This requirement is to produce an analysis of the 'cost of degradation of the marine environment'. This report fulfills that requirement.

This purpose of this report is to provide an overview of the current yearly cost of *avoiding* environmental degradation in the Dutch North Sea. This result can be used to determine a lower bound for the *actual* cost of degradation. Next to that, this report provides insight into which measures are in place and who bears the costs of the measures. The results of this report can be useful as a basis for a cost-effectiveness study and when discussing affordability and/or the disproportionality of the costs of additional measures for the MSFD.

Costs are related to specific measures. These measures occur on land or sea. Therefore the data in this report is split up into sea-based measures and land-based measures. The reason that land-based measures are included is because measures taken regarding inland water quality also affect the North Sea environment, such as measures to prevent pollution and eutrophication.

S.2 Main results

Given the assumptions used, and bearing in mind the measures for which no data is available, the total cost of avoiding degradation to the Dutch North Sea environment has been calculated to be €1.58bn. This is also a *lower bound* for the *actual* cost of degradation. Sea based measures account for approximately €132m. Land-based water quality measures account for approximately €1.45bn a year. The land-based costs make up the main share. The total cost of land-based water quality measures are not taken into account since they do not solely have an effect on the North Sea environment. Therefore, depending on the degree to which the measures affect the Dutch North Sea environment, percentages of the costs are calculated. Information on who bears the costs is detailed in the report.

Besides the actual calculation of the costs, one of the main results of this report comes from the list of measures. In addition to the land-based and sea-based distinction, a wide range of activities and their associated measures has been considered. At sea these measures are related to fisheries, shipping, oil and gas production, wind farms, land reclamation, sand and shell mining, dredging and the government. On land, efforts to improve water quality involve measures related to agriculture, industry and inland shipping as well as waste water treatment, sewers and the improvement of river- and lake beds.

Table S.1 shows the distribution of the annual costs to every cost category. The data in this table is split up into sea-based measures and land-based measures.

Tabel S.1	**Annual cost of measures of avoiding degradation of the Dutch North Sea environment**
Cost category	**Annual costs: €000**
Sea-based costs	
Sand and shell mining: - restrictions on site locations.	2,500
Oil and gas production: - measures regarding discharges of polluted production water.	12,500
Fisheries and aquaculture: - more sustainable fishing methods (i.e. gear change), - ban on dumping of marine debris from aquaculture, - limitations on cockle fisheries.	8,121
Shipping: - insurance costs, - contributions to the International Oil Pollution Compensation (IOPC) Fund, - TBT-free anti-fouling materials, - ballast water treatment facilities, - port receptions facilities for waste, - beach cleaning.	17,234
Recreation: - Beach Cleaning.	8,940
Wind farms: - Environmental Impact Assessments (EIA).	3,666
Ministry of Defense (Royal Dutch Navy): - research into underwater noise, - technical measures on board ships.	412
Dredging: - restrictions on sea based dumping of dredged material.	30,000
Land reclamation: Maasvlakte II: - EIA reporting, - habitat compensation, - monitoring of environmental effects, - restricted fishing areas, - enforcing and management of these measures.	20,595
Government: - policy work, - management, - monitoring of the North Sea environment and economic activities, - improvement of the knowledge about the North Sea environment.	35,400
Subtotal sea-based costs	*139,268*
Land-based costs	
Waste water treatment plants	402,094
Sewers	458,154
Agriculture	364,037
Industry	188,026
River and lake beds	33,324
Other measures	250
Inland shipping	3,700
Subtotal land-based costs	*1,449,585*
Total	*1,588,853*

Samenvatting

S.1 Inleiding

Dit rapport is geschreven in opdracht van Rijkswaterstaat-Waterdienst voor het ministerie van Verkeer en Waterstaat. Het rapport maakt deel uit van verschillende onderzoeken die uitgevoerd worden in het kader van de Initiële Beoordeling. De Initiële Beoordeling is één van de eerste juridische verplichtingen van de Kaderrichtlijn Mariene Strategie (KRM) (Directive 2008/56/EC, artikel 8). Een onderdeel hiervan is een analyse te maken van de 'aan de aantasting van het mariene milieu verbonden kosten'. Dit rapport geeft invulling aan deze verplichting.

Het doel van dit rapport is een overzicht te geven van de kosten die jaarlijks worden uitgegeven om de aantasting van het milieu in het Nederlandse deel van de Noordzee *te voorkomen*. Dit overzicht kan worden gebruikt als indicatie voor de *ondergrens* van de *werkelijke* aan de aantasting van het mariene milieu verbonden kosten. Daarnaast geeft dit rapport inzicht in het type maatregelen en wie de kosten hiervan dragen. De uitkomsten van dit rapport kunnen zowel dienen als basis voor een kosteneffectiviteitsstudie, als voor het bepalen van de betaalbaarheid en/of de disproportionaliteit van kosten voor toekomstige KRM-maatregelen.

Kosten zijn in dit rapport gerelateerd aan maatregelen die op zee en op het vasteland worden genomen. In dit rapport worden deze twee typen maatregelen apart behandeld. Maatregelen gerelateerd aan waterkwaliteit(sverbetering) aan landzijde worden meegenomen omdat deze effect kunnen hebben op de kwaliteit van het Noordzeewater (denk aan maatregelen om vervuiling door chemische stoffen en eutrofiering te voorkomen).

S.2 Belangrijkste resultaten

Met inachtneming van de aannames die in dit rapport gedaan zijn en het feit dat gegevens over de kosten van enkele maatregelen ontbreken, zijn de jaarlijkse totale kosten om aantasting van het Nederlandse Noordzeemilieu te voorkomen berekend op ruim €1,58 mld. Dit bedrag is een ondergrens van de werkelijke kosten van aantasting. Maatregelen op zee bedragen hiervan jaarlijks €132m. Waterkwaliteitsmaatregelen aan landzijde vormen het grootste gedeelte van deze kosten: ruim € 1,45 mld. Hierbij wordt rekening gehouden met het feit dat niet alle waterkwaliteitsmaatregelen die op land genomen worden een direct effect hebben op het Noordzeemilieu. Daarom wordt, afhankelijk van het effect op het Nederlandse Noordzeemilieu, per maatregel een deel van deze kosten meegenomen in de berekening. In dit rapport wordt aangegeven wie de kosten dragen.

Naast het berekenen van de kosten van maatregelen is het bepalen van het type maatregelen een ander belangrijk resultaat van dit rapport. Hierbij is een analyse gemaakt van de maatregelen die zowel op zee- als aan landzijde genomen worden. Deze maatregelen hebben betrekking op onder andere de visserij, scheepvaart, olie- en gasproductie, windparken op zee, landaanwinning, zand- en schelpenwinning, baggerwerkzaamheden en bij de overheid. Op land gaat het om maatregelen die tot doel hebben de waterkwaliteit te beïnvloeden en hebben betrekking op de landbouw, industrie, binnenvaart, riolering, rioolwaterzuivering en het verbeteren van oevers en waterbodems.

In tabel S.2 staat het totaaloverzicht van de jaarlijkse kosten per kostensoort. De data in deze tabel zijn verdeeld in maatregelen die op zee en op het vasteland genomen worden.

Tabel S.1	Jaarlijkse kosten van maatregelen om aantasting van het Nederlandse Noordzeemilieu te voorkomen
Kostensoort	**Kosten: €000 per jaar**
Zee-gerelateerde maatregelen	
Zand- en schelpenwinning: - restricties in de locaties.	2,500
Olie en gasproductie: - maatregelen gerelateerd aan productiewater.	12,500
Visserij en aquacultuur: - verduurzaming van de visserij (o.a. aanpassingen techniek), - verbod op het introduceren van invasieve exoten in het mariene milieu, (schelpdierindustrie), - sluiten van gebieden op de Noordzee (kokkelvisserij).	8,121
Scheepvaart: - verzekeringskosten, - contributies voor het International Oil Pollution Compensation (IOPC) Fund, - TBT-vrije anti-fouling verf, - ballastwater behandelingsinstallaties, - haven ontvangst installaties, - schoonmaken van stranden.	17,234
Recreatie: - schoonmaken van stranden.	8,940
Windparken op zee: - Milieu Effect Rapportages (MER).	3,666
Ministerie van Defensie (Koninklijke Marine): - onderzoek naar het effect van onderwatergeluid, - technische maatregelen aan boord van schepen.	412
Baggeren: - opslaan van verontreinigde zoute bagger op land i.p.v. het verspreiden hiervan op zee.	30,000
Landaanwinning: Maasvlakte II: - MER-rapportages, - natuurcompensatie, - monitoring van de effecten op het Noordzeemilieu, - uitsluiten van visserij in het Maasvlakte II en natuurcompensatiegebied, - uitvoeren en handhaven van bovenstaande maatregelen.	20,595
Overheid: - beleidsvoorbereiding en coördinatie, - beheeractiviteiten, - monitoring, - kennisontwikkeling.	35,400
Subtotaal kosten zee-gerelateerde maatregelen	139,268
Land-gerelateerde maatregelen	
RWZI's	402,094
Riolering	458,154
Landbouw	364,037
Industrie	188,026
Waterbodems	33,324
Overig	250
Binnenvaart	3,700
Subtotaal kosten land-gerelateerde maatregelen	1,449,585
Totaal	*1,588,853*

1 Introduction

1.1 Aim of the report

This report has been commissioned by Rijkswaterstaat-Waterdienst Centre for Water Management on behalf of the Ministry of Infrastructure and the Environment. The aim of this report is to provide an overview of the current yearly cost of avoiding marine environmental degradation in the Dutch North Sea. By presenting an overview of the current costs involved in avoiding degradation to the marine environment, it is not only possible to say how much society values the Dutch marine environment but it also provides an insight into who bears which (share of the) costs and how these costs are financed.

This report is part of one of the first legal requirements of the MSFD (Directive 2008/56/EC, article 5(2)), which is to produce an Initial Assessment. The MSFD aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. Each Member State is required to develop strategies for their marine waters. These strategies must contain a detailed assessment of their marine waters, as mentioned in article 8 of the directive. One of the requirements of Article 8 is an analysis of the 'cost of degradation of the marine environment' (European Parliament, Council, 2008). This report is meant to fulfil this requirement

1.2 The Marine Strategy Framework Directive

As mentioned, this project is very closely related to the MSFD. As such, a short introduction to the Directive is presented here.

In June 2008, the European Union's Marine Strategy Framework Directive was adopted. Its aim is to more effectively protect the marine environment across Europe. It aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. GES means that the overall state of the environment in marine waters provides ecologically diverse and dynamic oceans and seas which are healthy and productive. There are eleven descriptors of GES. These descriptors are discussed in appendix 1 with respect to the costs which are considered in this report.

The MSFD requires that the use of the marine environment must be kept at a sustainable level that safeguards potential uses and activities by current and future generations. This means the structure, functions and processes of marine ecosystems have to be fully considered, marine species and habitats must be protected and human-induced decline of biodiversity prevented (European Parliament, Council, 2008).

The MSFD establishes European Marine Regions on the basis of geographical and environmental criteria. Each Member State - cooperating with other Member States and non-EU countries within a marine region - is required to develop strategies for their marine waters. The marine strategies to be developed by each Member State must contain a detailed assessment of the state of the environment, a definition of 'good environmental status' at regional level and the establishment of clear environmental targets and monitoring programs (European Parliament, Council, 2008).

Each Member State must draw up a programme of cost-effective measures. Prior to any new measure an impact assessment which contains a cost-benefit analysis of the proposed measures is required (European Parliament, Council, 2008).

1.3 Contents

The report begins with the methodology for data collection in section 2. Section 3 contains the results of this study which are explained in detail. In section 4 the results are evaluated and conclusions are drawn.

1.4 Dataset production

In this report, qualitative information on the purpose and costs of the measures and the assumptions made to calculate these costs will be detailed in addition to the quantitative data which is supplied in Excel form. The sources of all data used are available in the report. The data is split up by sector and then to further disaggregation as far as is meaningful and potentially useful. As such, accessing the first layers of data is simple but all background and disaggregated data is also easily available. Future costs will be presented in parallel to the above elements.

2 Method

2.1 Introduction

In this section the theoretical concepts and approaches to calculate the cost of marine environmental degradation are discussed. The approach used in this report is to calculate the cost of *avoiding* degradation and to use this number as a lower bound for the *actual* cost of degradation. There are two key aspects of the methodology which need to be understood in order to properly understand how costs of *avoiding* degradation relate to the *actual* cost of degradation. The first relates to the fact that degradation is only considered when it has already been addressed by measures. The second is that the cost of *avoiding* degradation must be interpreted as a lower bound for the *actual* cost of avoiding degradation. This approach was stipulated by the commissioner of the work and is explained in more detail below.

2.2 Approach to the cost of degradation

The economic definition of the cost of degradation is the welfare forgone, reflecting the reduction in the value of ecosystem services provided compared with another (less degraded) state. Ecosystem services refers to all the benefits which society gets from a resource. In the case of the North Sea, these benefits include the profit of industries (fishing, oil, transport) as well as the value that people place on having a clean, well-managed, sustainable and biologically diverse North Sea. These are referred to as 'environmental value'. The cost of degradation in the North Sea is therefore the loss of environmental value and the loss of profit which have resulted from the damage to the marine environment.

The method which is adopted in this report does not estimate the losses in profit and environmental value directly. Instead, it considers the cost of *avoiding* degradation to the marine environment and uses these to make inferences about how much the degradation to the marine environment is costing society. This highlights the first key aspect of the methodology which needs to be understood in order to properly understand how cost of *avoiding* degradation relate to the *actual* cost of degradation. This is, namely, that only the degradation which is being dealt with under the existing measures is considered. This is the case because despite the efforts to avoid degradation, some degradation may still exist. Degradation may still exist because existing measures may only deal with a proportion of the degradation which takes place. In addition, a particular type of degradation may not have been addressed through current regulation. Therefore, this method can only calculate the cost of degradation to the extent that society currently bears the cost of doing so. For this reason, the calculation of the cost of *avoiding* degradation must be interpreted as a lower bound for the actual cost of degradation.

In addition to the first aspect (that only degradation which is currently being addressed is considered), the second aspect must be considered. This implies that the cost *avoiding* degradation must be interpreted as a lower bound for the *actual* cost of degradation. This rests on the principle that policy makers consider the costs and benefits of a policy and that the policy will only be enacted if the benefits are greater than the costs. This means that the benefits of a policy must be at least as big as the costs. In other words, through the decision making process, society (assuming decision makers accurately represent society) reveals part of the value which it places on the marine environment.

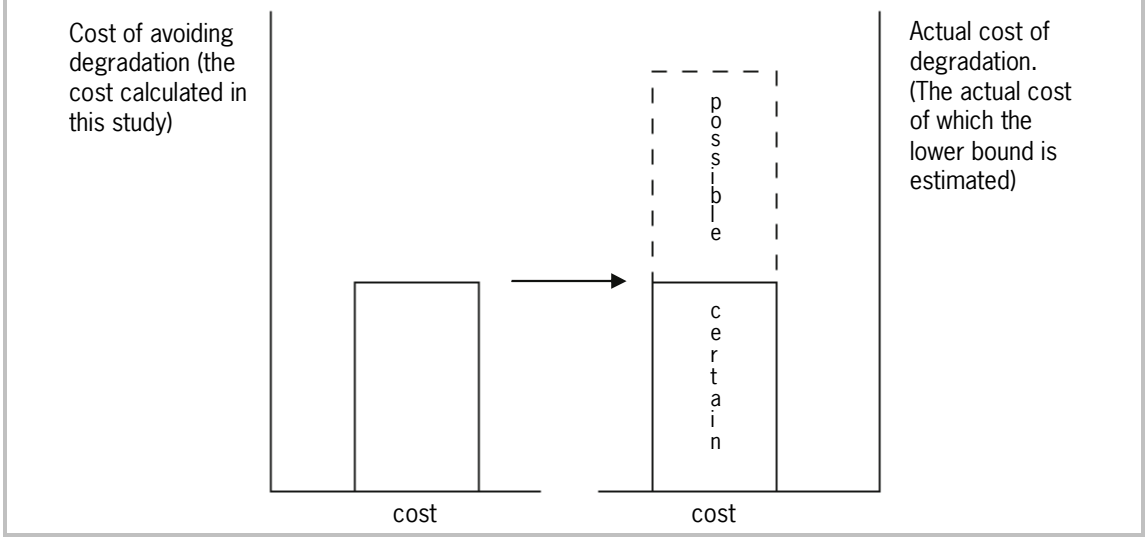
In this way, this method can be seen as a 'revealed preference' approach. Revealed preference is a sub-field of environmental valuation, which studies the actions of people to derive their values and preferences. The other subfield is 'stated preference'. These studies use questionnaires to derive values and preferences. There are arguments that revealed preferences calculations are more reliable than stated preference calculations. This point is often based around the fact that looking at what people actually do is more meaningful than asking them hypothetical questions. Regardless of which method is, in reality, 'the

best', revealed preference studies are certainly strong according to this argument and are perceived, by some, to usually produce more reliable estimates.

This method will now be applied directly to the issue at hand. The government regulates the use of the North Sea in order to protect it. In doing so, the government incurs costs upon itself. It also incurs costs on the private sector whose operations affect the North Sea. The government considers all these costs to decide if the benefits for the marine environment are worth the costs. The marine environment will benefit from these regulations. The benefits must be greater than costs for the expenditure to be worthwhile. Therefore, if the cost of *avoiding* degradation is known, then it is known what the minimum cost of degradation is (benefits lost). The benefit is the cost of degradation (loss of benefit) which has been avoided. Therefore, this investigation produces numbers which can be used to indicate the lower bound of the yearly cost of environmental degradation (benefit lost). The theory behind the method for calculating the cost of avoiding degradation has been explained. It has also been explained how this applies to the marine environment and this study.

Figure 1 shows these relationships. The left hand side shows the costs which are estimated in this report. The lower section of the right hand side ('certain') is the same size as the left hand side column. This shows that the cost of avoiding degradation (that which is calculated in this report) represents the 'certain' amount of the actual cost of degradation. The 'possible' area is a schematic representation of what the actual cost of degradation could be. This is purely diagrammatic as it is not possible to know what the size of the 'possible' area is. The 'possible' area suggests, figuratively, a representation of the actual cost of degradation which is not reflected by the current cost of *avoiding* degradation.

Figure 2.1 **A schematic diagram showing the relationship between cost of avoiding degradation and actual cost of degradation**



2.3 Examples of other studies which calculate cost

In the next section, the practical applications of the above approach are discussed. Before this, it is useful to consider how costs have been calculated in other, related studies. This can help with some of the practical issues which will be dealt with in the following section.

Calculating costs produces very useful information for policy makers. One particular area that is of contemporary and global relevance are Marine Protected Areas (MPAs). An understanding of the costs of creating these areas is vital for planning, justification and determining the feasibility of these projects.

There are several studies concerning the costs of MPAs which provide a useful background for this project and an insight into the theory behind 'costs', their categorisation and their calculation in practice.

McCrea-Strub et al. (2010) consider the costs of establishing marine protected areas. These are the monetary costs of setting up an MPA and of running it once it has been established. These are therefore the financial costs of the short term investments to create the MPA followed by the administration, monitoring and management costs. This shows the importance of considering both initial investments as well as long run costs and this will be mirrored in this report.

Parallel to these financial costs is the concept of opportunity cost. In the case of MPAs, this concept concerns the loss to fisheries of restrictions in the MPA. Adams et al (2010) carried out such an analysis in the Pacific Ocean. This analysis considers an appropriately broad array of opportunity costs. The losses of not being able to fish in the protected areas are considered. In addition these losses are offset by the ability to transfer fishing to areas which are not currently fished. This will decrease the losses to the fishing industry but will not offset them entirely. Another offsetting element is the effect on fish populations outside the MPAs. This study has two key insights for this study. First, costs are more than just the costs financial costs and can also consider the effects on industries. Second, industries can adapt to change and minimise their losses.

2.4 Practical applications of the approach to cost of degradation

Under the approach outlined above, there are many different types of costs of different magnitudes, that occur over different time scales, which need to be considered. At the most basic level, the costs need to be considered in terms of:

1. whether they relate to sea or on land,
2. whether they are borne by the private sector or,
3. whether they are borne by the public sector and
4. the time scales over which they are borne.

2.5 Sea-based or land-based costs

This report covers both land-based and sea-based costs. The sea-based costs require consideration of the variety of sectors that operate on the North Sea. These include fishing, oil and gas extraction, sand mining, shipping and wind farms. Such sea based activities are concerned with the costs of complying with regulations for shipping such as non-toxic anti-fouling paint, marine litter and safe and clean shipping. The costs of Environmental Impact Assessment (EIA) for activities such as wind farming can be significant, as can be the costs of closing sand abstraction areas for environmental protection.

Land-based costs are important because they can have significant effects on the Dutch North Sea environment. As such, costs of ongoing measures to maintain good inland water quality as well as the improvements occurring under the Water Framework Directive (WFD) are considered. Other activities which occur inland include the activities in ports, agriculture, aquaculture and land reclamation.

2.6 Costs to the private sector

Costs borne by the private sector need to be carefully considered. Costs to businesses are, in theory, represented as changes in profits (surplus) because this figure effectively represents the real costs to society (i.e. a loss in profit is a cost and an increase in profit is a benefit). While this is theoretically preferable, a shortage of data means that other figures are sometimes used. For example, gear restrictions may increase a firm's cost but the changes in fishing gear may also (positively or negatively) affect the yield

(revenue). As such, the effect on profit is the best way to accurately show the costs which marine environmental protection involves.[1] It is assumed that increases in costs lead to reductions in profit and are not compensated by, for example, decreasing wages paid to workers. While this may be the case, the result is the same in terms of welfare and profit is more applicable to a wide variety of situations (i.e. where wages are fixed). During the data collection process, flexibility was required since changes in profit were not always easily available. Flexibility was maintained in order to acquire the most data to reasonable levels of accuracy while understanding the limitations of the data.

The complications of private sector costs stem from the multinational use of the Dutch North Sea and other areas of the oceans. They are also related to the multinational nature of businesses which use the North Sea. These facts complicate the process of isolating the costs which are incurred on the Netherlands. As such, assumptions are required to make this process manageable.

Costs to the private sector have a spatial element. In this study, the key spatial element is the Dutch North Sea. A problem is that the Dutch North Sea is used by companies based all over the world and by ships registered all over the world. Dutch vessels also operate both in the Dutch North Sea and across the rest of the world's oceans. Careful thought is required to decide how to deal with this fact. Ideally, percentages can be used to calculate the proportion of costs which can be allocated to the Dutch part of the North Sea. This relates to measures regarding shipping and fisheries. Clearly the proportions are different for these two industries. The derivation of a percentage for fishing is shown in the section 3.4. For, shipping a percentage of 10% of the costs is used. This comes from Ecorys (2007) and is considered to be suitable estimate for use in this report.

In addition to the spatial issues regarding allocating costs to the Dutch North Sea, we must also consider where companies are based and who owns them. Ideally, only Dutch companies operating in the Dutch North Sea will be counted because this will reflect the cost to the Netherlands. Shortages of data mean that this is not always possible. However, this is acceptable because of the need to obtain a broad range of simple and meaningful numbers. The implications of including non-Dutch companies in the calculations are made clear so that the effect on the results can be evaluated.

In parallel to the issue of ownership, it is worth to remember that many companies operating on the Dutch North Sea have international ownership. Consider an oil rig run by a Dutch company in the Dutch North Sea. The extra costs of environmental regulation are incurred on a Dutch company and as such there is a loss of profit for a Dutch company operating in the Dutch North Sea. Shareholders own the business and are the ultimate recipients of profits. The shareholders of the Dutch company may well be based all around the globe. It is therefore not certain that the Netherlands will suffer from losses in profit due to the regulation. It is probably the case that the Dutch government will lose out on the tax on profits levied on the company. It is also likely that companies which have a significant headquarters function in the Netherlands are likely to also have a significant shareholder base in that country. It is not the place of this report to analyse the ownership of companies to determine the degree to which they are actually 'Dutch'. In the case of Dutch companies operating in the North Sea, results will be obtained by counting all of the losses in profits which they incur due to environmental legislation.

Again continuing with the example of oil rigs, will now consider the problem with other areas of the North Sea. Dutch companies operating outside of the Dutch North Sea will incur costs from the legislation imposed by other countries. This will have an impact on the profits of the Dutch companies. However, the key point is that it is not Dutch legislation which causes the effect on profit, so it cannot be considered here.

Finally, there is also the problem of non-Dutch companies operating in the Dutch North Sea. Through incurring costs on non-Dutch companies operating in Dutch waters, the Netherlands is, in a theoretical sense, showing how much cost the Netherlands is willing to bear to avoid degradation of the marine envi-

[1] Profit is equal to revenue minus cost. It is the money left over from the sales of a business after they have paid all their costs. Profit is what really matters for the health of business. Revenues for a business can be extremely high, but if costs are even higher, the business can still be very unhealthy. Sometimes, when costs increase, revenues will stay the same. In this way, a change in costs will be exactly reflected in a change in profits. However, in many cases, when costs change, revenues will change too. Consider for example the costs of hiring better workers. They cost more but they will produce more output so revenue will change too. Changing costs does not mean a proportionate change in profit so it is best to consider profit where possible.

ronment in the North Sea. However, the problem is that the costs are not being incurred on Dutch companies. This again raises the question of how 'non-Dutch' a non-Dutch company actually is. In the end, these problems are solved by considering what data is available and the best way to use this data to get simple and meaningful results.

All of these methodological points are considered for the individual industries and measures which are included in this report. The ideal situation has been outlined. In producing the dataset, it has been attempted to stay as close to the ideal situation as possible. Deviations are justified through the need to acquire simple and meaningful numbers. The implications of deviations from the ideal situation are explained in order that results can be properly evaluated.

2.7 Costs to the public sector

The costs to the public sector come in several forms. There are the costs of subsidies to avoid degradation from fishing, i.e. to encourage the adoption of new gear with less environmental impact, as well as the implementing land-based policies such as the WFD.

A very significant element of costs is simply the cost of running the sections of the government which are concerned with the North Sea environment. Several sectors of government are involved. A useful unit to quantify this is the cost of a Full Time Employee (FTE). In this report the cost of an FTE includes the cost of facilities and equipment as well as the salary for the employee. This report uses the assumption that an FTE costs €100,000 per year (Ecorys, 2007).

2.8 Costs over time

In this report, current yearly costs are the relevant numbers. In many cases, ongoing projects may not actually be incurring any costs in 2010. For example a wind farm can take up to 7 years to get through the planning process. As such, costs are averaged over 7 years. Throughout the report different case specific assumptions are made about the best way to deal with the time element. The basic principle is that current costs do not have to be borne in 2010 per se, but must be borne within a definable and relevant period which includes 2010.

Discounting is not used in this report. Discounting takes streams of year-on-year values and turns them into a single number. This number is called a 'present value of the stream of values' or normally just 'present value'. If the 'definable and relevant period' is used to discount the yearly costs over that period, then the present value shows the impact of the whole stream of values in the present time. This does not reflect the burden in the year in question. In addition, the advantage of discounting is that it facilitates the comparison of streams of values over time by representing them as one single number. In this report, and due to the first point in this paragraph, comparison is achieved through the use of average values and as such this advantage of discounting is negated.

2.9 Methods used in data collection

Data for this report was collected through literature research, contact with experts, and through various websites. Existing literature was located within the organization (LEI), from other research institutes and also from other organisations involved in the North Sea environment or industry. Experts were consulted for further sources of information which were not available through the internet and available literature, as well as their expert opinion regarding assumptions which were made to calculate costs. A list of consulted experts is available in appendix 3. Internet searches were used to collect data from various websites re-

lated to the Dutch and EU Government as well as other organisations which are related to industry and the environment of the Dutch North Sea.

3 Current cost of avoiding degradation

3.1 Introduction

In this chapter the cost of avoiding degradation in the Dutch North Sea are discussed. The total cost of avoiding degradation is calculated to be approximately €1.58bn a year. A greatest share of this number (approximately 90%, or €1.45bn) is related to the costs of improving water quality on land, which affects water quality and ecology of the North Sea.

All of the costs are related to mitigation measures which are in place to avoid degradation to the marine environment or are related to policy making or management. The costs of these measures and the costs of policy work and management to regulate these activities are covered in this chapter. Each of the measures involved will be discussed, including land-based sources. During the production of the figures in this chapter, the focus was on providing a wide range of simple of meaningful numbers. This means that as many aspects of the relevant costs have been covered as possible. This has been treated as more important that dealing with the fine detail of the individual measures.

No suitable measures with available data were found which relate to recreation and tourism, the laying of cables and pipes and seismic surveys.

3.2 Sand and shell mining

Mining of sand and shells are the only two kinds of surface mining occurring in the Dutch area of the North Sea. Of these two, sand extraction is the most important. In 2005, around 26m m^3 of sand was extracted from several specified mining locations. Due to environmental concerns, the government only issues permits to certain specified locations. Since these are not all located at the economically most optimal locations there is a cost involved. The sector estimates that it spends approximately 5% more than in an 'ideal' situation where it is allowed to mine for sand and shells in every suitable location. In 2005, the total turnover was €48.7m. Therefore, the extra costs of avoiding degradation is estimated to be around €2.5m (Ecorys, 2007).

Another measure which relates to sand and shell mining relates to avoiding turbidity. Turbidity refers to the suspension of material from the sea bed in the water due to the process of mining. Higher levels of suspended material interfere with aquatic species metabolism and can interfere with spawning. Certain types of dredging equipment reduce the turbidity but may be more costly. Unfortunately, this report was unable to identify these costs.

In evaluating this result, care must be taken about basing the estimate on turnover. Ideally, the 5% figure would be applied to profit and not to turnover. Turnover was used because it was the only data available. Since turnover should be greater than cost, the results are, in this respect an overestimate. However, given that sand and shell mining has a small impact on the final result, this is not a significant problem, especially given that the result is an underestimate due to the turbidity measures.

Who bears the cost?

For these measures (both less than ideal locations and reductions in turbidity), the costs are borne for through increased costs to the sand and shell mining businesses. The costs of licensing sand and shell mining are borne by the Ministry of Infrastructure and Environment. These are counted under the government section 3.10.

3.3 Oil and gas production

Most of the costs of measures in the oil and gas industry are related to produced water. Produced water comes from the process of lifting oil and gas from water-bearing formations. These waters usually contain oil, heavy metals and Polycyclic aromatic hydrocarbons (PAHs). Because of this, they must be treated prior to being discharged overboard. As with drilling muds, following treatment, they must be tested for toxicity and cannot exceed set discharge rates. At the end of the separation process, the treated water is discharged into the sea.

The investment cost of treatment plants on oil and gas platforms in Dutch waters are estimated to be €6m. This total figures consists of two separate elements. The cost of running the treatment plants are estimated to be €5.8m per year. In addition to the day to day costs of treatment, research is also carried out into the process at a cost of €0.7m per year. This number comes from Ecorys (2007). In addition, Tacoma (2010) has confirmed that the figures are still valid as of 2010. These costs are summarised in table 3.1.

Table 3.1	**Average annual costs related to oil and gas production (€,000)**
Type of cost	**Average annual cost a)**
Investment	6,000
Operational	5,800
Research	700
Total	*12,500*
Source: a) Tacoma (2010) and Ecorys (2007).	

These costs are estimated for all platforms operating in the Dutch North Sea. It has not been possible to separate out any non-Dutch companies which are operating in the Dutch North Sea. As such, these results should be considered as an overestimate.

Who bears the cost?
These costs represent the effect on profit for the oil producers. As such, they bear the burden of the regulation.

3.4 Fisheries and aquaculture

In this section, the costs involved in Dutch fisheries management, research, innovation and restrictions because of Natura 2000 are discussed.

Within the last 150 years, the fisheries sector underwent an enormous change. Advancements in technology made it possible to find and catch fish in circumstances and quantities that were unthinkable of more than one hundred years ago. The sector underwent the most significant change after the Second World War, with the advent of beam trawling. Since then, fisheries gradually went from small-scale to large-scale. Over the years, concerns about overfishing and the ecological impact of fisheries resulted in management restrictions such as quota and coming restriction fishing areas under Natura 2000. Next to that, the fisheries sector is currently supported by the Netherlands and the EU in the form of subsidies to stimulate innovation in more sustainable fisheries techniques (gear change, etcetera).

In the current situation, the fisheries sector is legally restricted by and is subsidized through the EU and the Netherlands. The main management tool is the EFF (European Fisheries Fund). Several of the subsidies can be classed as being spent to prevent degradation of the marine environment. All of the relevant subsidies require some funding from the private sector. In some cases these costs can be counted as real costs to society. In some cases they cannot. This is because the costs can be considered as an investment which the private sector makes in order to increase its revenues. The private sector will only make

this investment if the revenues are greater than the costs. In this way, the costs are not 'real costs' (Taal, 2010). When the private sector can be assumed to be able to offset increases in costs with increases in revenues, these costs are 'not counted' in the final column of table 3.2. In one case (subsidy 2: collective actions in the fisheries chain) a proportion of the costs to the sector are real costs because it is not expected that the private sector will be able to recover all of its costs through increases in revenues. In this case expert opinion (Taal, 2010) was used to decide that 30% of the costs were 'real'.

Table 3.2 shows the relevant subsidies and their magnitudes. The figures are mean costs per subsidy over the 6 year period of the subsidies (2008 to 2013).

Table 3.2	**Average annual subsidy and related private sector costs for fisheries in the Dutch North Sea for the period 2008-2013 (€,000)**		
Name	**Description**	**Treatment of private sector costs**	**Average annual cost (€,000)**
Certification of the fisheries chain	Certification of fisheries	Counted	€1,250
Collective action in the fisheries chain	Improving management of fish stocks, sustainable techniques, cooperation within the sector	30% of costs counted	€3,760
Investing in fishing vessels - alternatives for trawling	Reducing impact on benthos by beam trawling, stimulating selective fishing methods	Not counted	€2,000
Investing in fishing vessels	Stimulating use of pulse fishing, reducing impact on benthos by beam trawling	Not counted	€880
Investing in ex round fish vessels	Recovery of cod stocks, selective fishing methods	Not counted	€480
Innovation in the fisheries chain	Selective fishing methods, environmental management plans, introduction of MPAs, reducing discards & environmental impact	Not counted	€3,500
		Average Total	*€11,870*
Source: Ministry of Economic Affairs, Agriculture and Innovation (2010).			

The final step related to subsidies is to adjust for the fact that the benefits of subsidies will not just be felt in the Dutch North Sea but also in any area of the where Dutch fishing vessels operate. The percentage of sea days that Dutch fishing vessels fished in the Dutch North Sea has been calculated using official log book databases for 2009. This is equal to 62% (Bartelings, 2010). Sea days is considered to be the most relevant figure because they relate more closely to the environmental effects of fishing than the value of the catch. As such the final value is €7,361.

When considering this data it is important to bear in mind that not all available finance will not necessarily be utilised. This is because of failed projects. Subsidies are paid on a per project basis and the private sector must finance the initial expenditure. If the project is a success then the organisations involved qualify to have the money reimbursed through the subsidy. The risk that some projects will fail has not been accounted for. This is because it does not matter, for the purpose of this report, whether a project fails. Failure or success does not change the fact that society is willing to incur the cost of preventing degradation of the marine environment. This in turn provides insights into the lower bound for the cost of degradation.

The full table on subsidies is available in appendix 2. This shows all subsidies (including those which are uncounted), their distribution over time and their values.

Within the following years, due to the implementation of Natura 2000 areas within the North Sea itself, fisheries will be further affected (i.e. beam trawlers might have to avoid those areas). The yearly future

costs to the fisheries sector (due to loss in benefit) are estimated to be less[1] than €11,500,000 (Oostenbrugge et al., 2010). However, these are future costs and as such cannot be included in the totals of this report.

Within the Dutch North Sea, some fisheries are not allowed in certain areas due to environmental protection. An example of such a fishery is the cockle fishery, which is not allowed in the Voordelta. The yearly loss in profit to cockle fishery is estimated to be around €0.5m (Holstein, 2010). Unavailability of data precludes the inclusion of other fisheries, thus it is best to consider this cost as an underestimate.

To prevent the introduction of non-indigenous species in the North Sea waters, the aquaculture sector is obliged to take measures when importing shellfish from abroad. Originally, these shells were imported, cleaned of marine debris and sold. The marine debris was then dumped into the Oosterschelde, along with the debris from the Dutch shells. Since some of the debris from imported shellfish includes non-indigenous species which posed a hazard to the marine environment, it was decided by (Natura 2000) law to forbid it. The total costs related to measures to prevent the introduction of non-indigenous marine plants and animals from entering the Oosterschelde and North Sea are estimated to be around €260,000 a year. These costs include monitoring, legal advice, permit application and quarantine measures (Holstein, 2010).

Some fisheries (i.e. cockle fisheries) are obliged to apply for permits (Nature Conservation Act/Natuurbeschermingswet). These costs are not included in the calculations because the overall figure was negligible.

Table 3.3	**Average annual costs related to fisheries and aquaculture (€,000)**
Type of cost	**Average annual cost**
EFF Subsidies	7361 b)
Marine debris	260 c)
Cockle Fisheries	500 d)
Total	*8,121*
Natura 2000 a)	11,500

a) This is not a current cost and therefore it is not counted in the total.
Source: b) Ministry of Economic Affairs, Agriculture and Innovation (2010) c) Oostenbrugge et al (2010) d) Holstein (2010).

Who bears the cost?

EFF subsidies are funded by the EU, the Dutch Government and by the fishing industry. Natura 2000 costs as calculated in this report, are borne by the fisheries industry through limitations on the areas which they can fish. The costs of alternative disposal of marine debris and of restrictions on cockle fisheries will be borne by the aquaculture sector.

3.5 Shipping

In 2009, approximately 840 of ships were under a Dutch flag (KVNR, 2010). Regarding the measures in the Dutch shipping industry to avoid degradation to the North Sea environment, five types of measures are classified; insurance, anti-fouling, emissions to air, ballast water treatment and marine litter. In the following section each type of measure and their costs are discussed. The Dutch shipping sector is also investing in other measures such as research regarding underwater noise, operational measures like education of crew and weather routing, fuel efficiency measures, environmental friendly tube oil, optimalisation of lube oil systems, transport chain optimalisation, testing and collecting of data and dual fuel systems, disposal of sludge and black and grey water (Altena, 2010). Due to the limited scope of this research, data

[1] The costs presented here is the value of fisheries within the proposed Natura 2000 areas. Note: a large part of the fishing effort will most likely relocate, therefore the total loss of income will be less than the value of fisheries within Natura 2000 areas. This number includes foreign fishermen fishing in Dutch waters and Dutch fisheries under foreign flag.

on these measures are unavailable and as such, are not taken into account. This section uses the Ecorys (2007) assumption that 10% of Dutch shipping occurs in the North Sea.

Insurance

Insurance measures refer to both the insurance costs to cover the impact of disasters at sea (i.e. oil spills due to collisions) and the costs of contributing to the International Oil Pollution Compensation Funds (IOPC Funds). The insurance costs of an average Dutch ship are between €125,000 and €150,000 for a 10,000 GT (gross tonnage) ship (Ecorys, 2007). This figure is used because 10,000 GT is approximately the average size of a ship under a Dutch flag. It is important to note that only a proportion of the total insurance amount can be attributed to avoiding degradation of the marine environment. It is assumed, based on expert opinion, that this proportion is 25% (Ecorys, 2007). Based on the number of ships in 2009, the figure is €26-32m. This figure must then be adjusted to account for the fact that the fund covers all oceans not just the North Sea. In order to do this, the 10% assumption is used. As such the final yearly average is between €2.6-3.2m.

In addition to the costs related to insurance, the Dutch oil industry contributes to the International Oil Pollution Compensation Funds (IOPC Funds). These funds are part of an international regime for liability and compensation for oil pollution damage caused by oil spills from tankers. Under the regime, the owner of a tanker is liable to pay compensation up to a certain limit for oil pollution damage following a leak. If that amount does not cover all the admissible claims, further compensation is available from the 1992 Fund if the damage occurs in a state which is a member of that fund. Additional compensation may also be available from the Supplementary Fund if the state is a member of that fund as well. The IOPC Funds are financed by levies on certain types of oil carried by sea. The Dutch contribute 7% of the value of the 1992 fund and 15% of the supplementary fund (IOPC, 2009).

The contributions of the IOPC members varies depending on the amount which the fund needs to pay out. Accordingly, the average of the costs for the Netherlands is taken over 3 years - 2007 and 2008 data from the IOPC report (2009) and the data from the Ecorys (2007) which was calculated for 2006. In these years, 7% of the 1992 fund plus 15% of the supplementary fund is approximately €440,000 for 2007 and €3,670,000 for 2008. The 2006 figure is €8,000,000. The average over the 3 years are adjusted to account for the fact that the fund covers all oceans not just the North Sea. Again, the 10% assumption is used and as such the final yearly average is €403,830.

Anti-fouling

In order to minimise the impacts of marine species attaching themselves to ships, many ships are protected by antifouling coatings. Many types of coatings, however, have been found to be toxic to marine organisms. For example, extremely low concentrations of tributyltin moiety (TBT), which was the most commonly used anti-fouling agent, caused defective shell growth and development of male characteristics in female dog whelks. Concerns about the environmental and health effects of these paints have led to the ban of these compounds in marine coatings by the International Maritime Organization (IMO). The International Convention on the Control of Harmful Anti-fouling Systems on Ships was adopted in 2001 and came into force in 2008 (IMO, 2010). The yearly costs of measures related to TBT-free anti-fouling material taken by the Dutch shipping industry are €59m (CBS, 2010). The 10% assumption is used and as such the final yearly average is €5.9m.

Reduction of SOx and NOx emissions

A further measure relates to on SOx and NOx emissions from ship exhausts. Some of the potential environmental impacts associated with a reduction in shipping emissions include reductions in sulphur and nitrogen deposition and reductions in acidification and eutrophication. This relates to the MARPOL Annex VI Regulations which entered into force on 1 July 2010. These regulations require a reduction in emissions through changing fuel use or installation of scrubbers or any other technical measure. Accordingly, the costs of these measures will be the increase in costs to the shipping industry. Due to the recent nature of

these regulations, it is not possible to present data on the costs. This is partly due to a lack of knowledge about whether ships will adopt more expensive fuels or choose to adopt scrubbers or any other technical measure. Uncertainties about the future cost of low sulphur fuels also complicates the analysis. Moreover, the use of technical measures could lead to acidification and eutrophication of seawater, especially in estuary-like areas such as harbors and the Baltic Sea. Legislation to avoid this still needs to be developed. Further information on this topic can be found in ENTEC (2010).

Marine Litter

Marine litter[1] poses numerous threats to the marine environment and economy. The economic effects of marine litter are impacts on habitat destruction and effects on wildlife as well as aesthetics and tourism, human health and safety (UNEP, 2005). Within the 12-mile zone ships are not permitted to dispose of any kind of litter at sea. Outside of the 12-mile zone it is only permitted to dispose of degradable domestic and human waste. All Dutch ports have reception facilities where ships can dispose of their litter. Based on the year 2009, the costs to the Dutch shipping industry to use these facilities are €17.3m a year (Prinssen, 2010). Using the assumption that 10% of these costs are accountable to the Dutch North Sea, the final yearly average is €1.73m.

Ballast water

Ballast water treatment facilities are required under IMO legislation. In 2016 all large ships are obliged to have ballast water treatment systems on board. The costs of these facilities are estimated to be around €0,5-3,0m for an average Dutch ship (€1,5m for a large ship) (Altena, 2010). The total yearly costs of these facilities for all ships under Dutch flag are €42-84m per year. A central estimate is therefore taken of €63m. Of these costs, 10% can be allocated to the North Sea. As such the final yearly average is €6.3m.

Table 3.4 shows the final result of approximately €17m per year.

Table 3.4 **Average annual costs for the shipping industry (€,000,000)**

Measure	Sub-Measures	Lower Estimate per sub-measure a)	Central Estimate per sub-measure	Upper Estimate per sub-measure a)	Total per measure
Insurance	Insurance b)	2.6	2.9	3.2	3.304
	IOPC c)	0.404	0.404	0.404	
Anti-fouling d)		5.9	5.9	5.9	5.9
Marine Litter e)		1.73	1.73	1.73	2.99
Ballast Water f)		4.2	6.3	8.4	6.3
	Totals	*14.834*	*17.234*	*19.634*	*17.234*

a) Where available. Where not, the central estimate is used;
Sources; b) Ecorys, 2007; c) IOPC, 2009; d) CBS, 2010; e) Prinssen, 2010; f) Altena, 2010.

Who bears the cost?

All the costs of the measures in this section are borne by private industry. There are two exceptions. Beach cleaning is paid for by municipalities and the Dutch government also pays a contribution to the IOPC fund. The ratio of the IOPC fund which is paid for by the Dutch government is not available from the IOPC.

[1] Marine litter is defined as 'any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, waste water, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores.' (UNEP 2005: 3)

3.6 Recreation

Beach litter comes from many sources including fisheries, shipping and inland sources, but the most significant source of litter is the recreational use of beaches. As such the costs could be split between other sections of this report, however, data on the proportion of litter coming from different sources is unavailable. As such municipalities throughout the Northeast Atlantic region face relatively high costs associated with the removal of beach litter. Removing beach litter costs municipalities in the Netherlands approximately €8.84m per year.[1] For most municipalities, the potential economic impact of marine litter on tourism provides the principal motivation for removing beach litter. The city of The Hague, for example, spends around €1.266.000 annually on its beach cleansing program (Mouat et al., 2010). Volunteer organisations also remove a significant amount of litter from beaches, which suggests that the total cost of voluntary action to remove marine litter could add a considerable number to the cost of beach cleans.

3.7 Offshore wind farms

Currently, two offshore wind farms are in operation in the Dutch area of the North Sea: Noordzeewind (108 megawatt, located in front of Egmond aan Zee) and the Princess Amaliawindpark (120 megawatt, located in front of IJmuiden). In the near future, several others will be constructed. Wind farms may be required to be positioned in less than optimal locations due to environmental concerns. This could involve significant costs to the high costs of high voltage power cables (greater distance implies higher costs of expensive cables), but no data on this was available. Another potential measure involves using bubble curtains to limit the noise pollution from hammering monopole foundations into the seabed. These are not currently a measure in the Dutch North Sea because waters are too deep at current sites for bubble curtains to work. As such, the only source of data available for this report relates to the production of EIAs (Environmental Impact Assessments).

It can take between 5 and 7 years to get through the process of getting permission to build a wind farm in the North Sea. As such the costs of EIAs can be considered as being spread across this period. Currently there are 12 wind farms which are going through the planning process. These are shown in Table 3.5.

In order to calculate the costs of EIAs several assumptions are made. The first is that the cost of turbines at the Prinses Amalia Park are representative of the costs of wind turbines in the Dutch North Sea. This allows the total costs of the wind farms to be calculated according to how many turbines are going to be or are being built. Since no information was available on the cost of EIA, another assumption involves the percentage of costs which can be allocated to the EIA. Percentages were available from The Ministry of Infrastructure and Environment (2010). These referred to the percentage of total costs attributable to EIAs for land-based wind turbines. These range from 0.001% to 1% of total costs depending on the size of the wind farm. These land-based figures they can only be used as a very rough guide. Given that EIAs require substantial effort to produce and also given the indications of costs of land-based wind farms, 0.5% was decided upon. This percentage fits within the range of land-based percentages. It also produces results which seem to be reasonable given the demands of EIAs.

Table 3.5 shows the final result of approximately €3.7m per year.

[1] The total cost of beach cleans in the Netherlands and Belgium combined is €10,4m annually. If the Dutch coast is considered to represent around 85% of this figure, the Dutch costs of beach cleans is €8.84m per year (Mouat et al., 2010).

Table 3.5	Average annual EIA costs of turbines in the Dutch North Sea over a 7-year period (€,000)			
Wind Park Name	**Number of turbines**	**Cost per turbine a)**	**Total cost**	**Costs of EIA b)**
Q4-WP	26	€6,383	€166,000	€830
Q10	51	€6,383	€326,000	€1,628
EP Offshore NL1	55	€6,383	€351,000	€1,755
Tromp Binnen	59	€6,383	€377,000	€1,883
Schevingen Buiten	59	€6,383	€377,000	€1,883
BARD Offshore NL1	60	€6,383	€383,000	€1,915
GWS Offshore NL1	60	€6,383	€383,000	€1,915
West Rijn	72	€6,383	€460,000	€2,298
Den Helder I	78	€6,383	€498,000	€2,489
Beaufort	93	€6,383	€594,000	€2,968
Brown Ridge Oost	94	€6,383	€600,000	€3,000
Breeveertien II	97	€6,383	€619,000	€3,096
			Average Tota c)	*€3,666*

a) Average cost of a turbine based on Prinses Amalia Park; b) Assuming 0.5% of total cost is spent on EER; c) Averaged over 7 years.
Source: Rijkswaterstaat (2010) (for wind park names and turbine numbers).

Who bears the cost?
In this case, all the costs of producing EIAs are borne by the private companies who are running the wind farm projects.

3.8 Defense

The Royal Netherlands Navy accounts for an appreciable amount of ship movements in the Dutch North Sea and takes measures to limit its impact on the marine environment. The Royal Netherlands Navy is currently engaged in a 6-year (2009 up to and including 2014) €114m programme of investing in ship building. Of this ship building programme, expert opinion (De Rooij, 2010) estimates that 1% of the costs of this program are related to avoiding degradation of the marine environment through technical measures built into the ships. As such, the costs are €1.14m, which averaged over the 5 years equals €190,000.

In addition to the extra costs involved in ship building, the Ministry of Defense also carries out research into, and the mitigation of, underwater noise. This is part of an 8 year programme (2006 up to and including 2014) which costs approximately €2m. The average over the 9 period equals €222,000. The total is calculated in table 3.6.

The Hydrographical Service (which is part of the Ministry of Defense) is not counted here, but is counted under the governance section 3.10.

Table 3.6 shows the final result of approximately €412,000 per year.

Table 3.6	Annual costs related to defense for the period 2009-2014 (€,000)
Type of cost	**Annual cost**
Ship building a)	190
Research a)	222
Total	*412*

Source: a) De Rooij (2010).

Who bears the cost?
The Ministry of Defense is funded by the Dutch Government. As such they bear the costs of the avoiding degradation in the marine environment in this case.

3.9 Dredged material

Most of the larger Dutch ports are situated on the North Sea and the Rhine and Meuse estuaries. Deposition of marine and fluvial sediment occurs at these locations. This is most apparent is the port of Rotterdam. Marine sediments accumulate through tidal action mainly in the western port areas, whereas the eastern port areas are mainly influenced by fluvial sediments, transported by the Rhine (Vellinga and Eisma, 2005).

These sediments, if left undisturbed, pose a hazard to sea traffic and the accessibility of the ports. Therefore, about 30m m^3 of material is dredged every year from all Dutch seaports and seaways. In the port of Rotterdam alone, some 20m m^3 of sediment is dredged each year (Vellinga and Eisma, 2005). Most of the sediments to be dredged derive from the marine environment and only around half of the river sediment settles in the port. Heavy metals such as zinc and copper are commonly found in port sediments as well as Polycyclic Aromatic Hydrocarbons (PAHs) and Tributyltin (the toxic part of anti-foul paints which was previously applied to ship hulls).

The relocation of this dredged material to the North Sea, the preferred disposal option, is regulated by a set of chemical criteria. About 2m m^3 of dredged material exceeding certain limits of heavy metals has to be disposed of in confined (land-based) sites (in the case of Rotterdam: the Slufter). However, most of the dredged material (about 28m m^3) is returned to the North Sea. The costs of processing the contaminated dredged material is estimated to be around €20 per m^3. The costs of relocating dredged material at sea are estimated to be around €5 per m^3 (Eisma,2010). The extra costs for the 2m m^3 are therefore around €30m a year.

Who bears the cost?
The dredging is commissioned by the parties responsible for managing the port area and the river: The Port Authorities and the Ministry of Infrastructure and Environment. The sediments in the river system are mainly clean, which can be relocated at sea. The contaminated dredged material is mostly dredged by Port Authorities in port areas. As such, they bear the burden of this regulation.

3.10 Land reclamation: Maasvlakte II

With the creation of Maasvlakte 2, the Port of Rotterdam is adding 1,000 hectares of new business premises on newly reclaimed land in the North Sea, next to the present Maasvlakte. Nature will be lost with the construction of Maasvlakte 2. In order to limit the impact on the environment as much as possible, compensatory measures are and will be taken. This will be done in accordance with Dutch and European provisions. The Birds and Habitats Directive is paramount here. In this directive, the European Union states which areas must be protected so that the habitats of specific flora and fauna are conserved.

The current phase in the Maasvlakte 2 project runs over 2006-2013. This encompasses several elements of the project including planning and construction of the port extension itself as well as the EIA reporting and the implementation of associated environmental projects. Not all of these activities were carried out for every year in 2006-2013. Some have already been carried out (before 2010) and some will be carried out in the future (after 2010). Yearly costs are calculated over this 8 year period.

As part of the Maasvlakte 2 project, a number of studies and reports were carried out to analyze the natural values that will be lost. Two EIAs were carried out to evaluate the environmental impact. The costs of these studies are estimated to be around €30m, paid for by the Port of Rotterdam (Vellinga, 2010). Over the 8 year period, this equals, €3.75m.

To compensate for the loss in (North Sea and coastal) nature, a nature compensation scheme was setup. The compensation for nature consists of the creation of a sea bed protection area and the extension of the dunes. The sea bed protection area used to be called a marine reserve. The focus of this area is on protecting the sea bed and providing rest areas for protected bird species. The sea bed protection area will cover an area of 31,250 hectares at the most. A maximum of 100 hectares will be earmarked for extra dunes near Delfland and there will be a further 23 hectares at the most for the foredune at the Brouwersdam and/or on the reclaimed land. The costs of these compensation measures are estimated to be around €90m and are borne by the Dutch government (Vellinga, 2010). Over the 8-year period, this equals, €11.25m.

The total monitoring programme to measure the environmental effects during the construction of Maasvlakte 2 carries a price tag of approximately €10 million, paid for by the Port of Rotterdam. Next to that, the effectiveness of the nature compensation scheme will be monitored. The cost estimate of this effectiveness study is around €30m (Vellinga, 2010). As such the total costs of monitoring are approximately €40m. Over 8 years, this is equal to €5m.

At the Port of Rotterdam, approximately 5 FTE are working on the topics mentioned above, which adds another €0,5m (Vellinga, 2010) if the assumption of one FTE (Full Time Employee) costing €100,000 per year is followed.

Oostenbrugge et al (2008) produced estimates of the losses that will result from the closing of the areas for beam, shrimp and otter trawling fishing. Losses are estimated under 2 scenarios; termination of operations and relocation of operations. It is considerably more likely that fishing operations will move to other areas rather than stopping entirely. As such, the second scenario is used. The effect is measured as change in gross value added. This is defined as the return from invested capital and labour (I.e. profit) and this is considered as a good measures of the losses suffered by the entrepreneur (Oostenbrugge et al., 2008). The loss in yearly gross value from relocating fisheries for beam trawling is estimated to be €29,000 and €66,000 to shrimp and otter trawling. Ergo, the total yearly cost to the industry is €95,000 per year.

The total environmental costs of the Maasvlakte 2 to be around €165,5m. This is then averaged over the 8 year period (2006 to 2013) and as such the final value is €20,595,000. The costs to the Port of Rotterdam (EIA, FTEs and compensation measures) may financed through loans. This suggests that the costs may be higher because of interest payments. Information on whether the relevant environmental aspects of the Maasvlakte 2 were funded through loans was not available. If the costs were in fact, funded through loans, interest is a costs of borrowing money, not a cost of avoiding environmental degradation. This is an argument not to include the cost of loans.

Table 3.7 shows the final result of approximately €20.6m per year.

Table 3.7	Average annual costs related to the Maasvlakte II for the period 2006-2013 c) (€,000)
Type of cost	**Average annual cost**
EIA a)	3,750
Compensation Measures a)	11,250
Monitoring a)	5,000
FTEs a)	500
Fishing losses b)	95
Total	*20,595*

Source: a) Vellinga, 2010; b) Oostenbrugge et al., 2008.
c) Averages over this period are not used for fishing losses or FTEs.

Who bears the cost?
The Port of Rotterdam has financed the EIAs, FTEs and the monitoring program. As such, their current yearly costs are €9.25m. The compensation measures are funded by the Dutch Government and the fishing industry will bear the losses resulting from the closed areas.

3.11 Government

The Dutch government is directly involved in policy work, management, monitoring of the North Sea environment and economic activities, improvement of the knowledge about and further understanding of the North Sea environment. The costs involved in these include policy preparation and coordination, subsidies to research institutes and NGOs, permit licensing, coastguard and inspection.

Ecorys (2007) estimate the governance costs according to the number of FTEs (full-time employees) who are involved with MSFD-related topics. This was estimated for 2005 and is shown in table 3.8.

Table 3.8	Number of FTEs involved in MSFD related work	
Government Body (total FTEs)	**Sub-body**	**FTEs**
Ministry of Infrastructure and Environment (160)	Directorate-General Transport	7
	Directorate-General Water	5
	Inspectorate for Transport, Public Works and Water Management	3
	North Sea Agency (RWS North Sea Directorate)	72
	Specialist Services (i.e. RWS Waterdienst Centre for Water Management)	66
	Other Services	7
Ministry of Economic Affairs, Agriculture and Innovation (15)	Directorate Fisheries	6
	Directorate Nature	2
	Directorate Energy production	1
	State supervision of mines	6
Research institutes related to Ministry of Economic Affairs, Agriculture and Innovation (112)	LEI	12
	IMARES	90
	Deltares	10
Ministry of Education, Culture and Science (39)	Netherlands Geological Survey	12
	Netherlands Institute for Ocean Research	25
	Netherlands Institute for Cultural Heritage	2
Ministry of Defence	Hydrographical service	10
Coast Guard		18
	Total	*354*

Source: Updated from Ecorys 2007.

An FTE is assumed to cost €100,000 per year. This number includes salary and other costs such as overhead, housing, etc. As a result the final costs is €35,400,000. This is based on data which could now be updated to provide a better result. It would also be wise to vary the FTE cost per department. It is currently still a reasonable estimate.

This table has been updated in terms of the names and organisation of the relevant ministries but the content remains the same. As such, it may not be wise to put too much emphasis on the rows of the table. The total figure however, is still expected to represent the number of FTEs in government concerned with marine environmental degradation. It is reasonable to assume that over the last 5 years, while allocation may have changed, the total number has remained reasonably similar.

Who bears the cost?
Clearly, in this case, the costs of running the government with respect to avoiding degradation of the marine environment is borne by the government themselves.

3.12 Land-based sources and activities

Inland water drains into the sea and directly affects pollution and eutrophication levels in the North Sea. Sources of pollution include agriculture and urban development (i.e. nitrate, phosphor and pesticides), inland shipping and industry (toxic substances). The types of pollutants and their sources are (Driesprong-Zoeteman, 2004):

- Nutrients: leaching, industry and waste water treatment plants;
- Heavy metals: leaching and waste water treatment plants;
- Zinc: lack of data;
- Copper: leaching, waste water treatment plants and shipping;
- Polycyclic Aromatic Hydrocarbons (PAHs): atmospheric deposition, shipping, waste water treatment facilities;
- PCBs: atmospheric deposition.

The most important waterway in terms of pollution by heavy metals and nutrients is the Nieuwe Waterweg, which ends up in Hoek van Holland. The Haringvliet, IJsselmeer and the Noordzeekanaal are to a lesser extent of importance in terms of pollution (Driesprong-Zoeteman, 2004). In this section the costs associated with the measures related to these pollutants are discussed.

Expenditure related to fresh water quality measures is only partially aimed at improving the marine environment. Some expenditures can be considered to be irrelevant for the marine environment. For others only a percentage of the costs are spent to avoid degradation of the marine environment. In this section, costs are estimated based on the assumption that a certain percentage of the relevant costs can be attributed to the marine environment.

There are two key sets of data for land-based sources. The first is the current costs incurred by the government, businesses and consumers of the present set of water quality objectives. This data comes from a previous Ecorys report from 2006. Cost data is also available from the Environmental Assessment Agency (2008). This data is newer and therefore would be preferred to the Ecorys data. However, the newer data is collected in relation to the Water Framework Directive (WFD). The results do not purely consider the WFD measures which are relevant for MSFD, instead they consider all WFD measures. As such, while the Ecorys (2006) data is older, it is more relevant to the question at hand and as such, it is preferred. While the Ecorys (2006) data is preferred, it is still not ideal. The data, according to Ecorys (2006) should be considered as 'very indicative' and as a 'rough estimate'.

The second set of data concerns the current costs of the WFD. This needs to be considered in addition to the Ecorys data because the WFD is a significant development in terrestrial water quality. As such, it is vital that costs are updated in this respect. Data on WFD measures as of 2008 was obtained from the Ministry

of Transport, Public Works and Water Management (2008). This refers to the entire plan for the WFD from 2000 to 2027. The measures are split into periods. The present period is 2010 to 2015. This was the only period that was counted because it is the current period. Previous periods have measures which have not yet been implemented. These were not counted in the current period because it is not possible to be sure what period they will actually be implemented in. All measures in the 2010 to 2015 period were counted.

All costs are split into the following categories; waste water treatment plants, sewers, agriculture. Industry, river and lake beds and other. 'Other' relates to specific measures which do not fit with the specific categories but definitely have an impact on the marine environment. WFD costs over 2010 to 2015 are available for circa 90% of all measures. As such the figures are a slight underestimate. WFD costs for the marine environment are an average of costs over the 6 year period. They are also adjusted for the percentage of the expenditure which affects the marine environment. These percentages are 50% for all measures except for sewers (25%). These percentages are taken from Ecorys (2007) where they were derived from expert opinion. The per year WFD costs relating to the marine environment were then added to the Ecorys (2007) figures. These represent all non-WFD current costs and are not recalculated in this report. As such a total yearly cost is derived.

Table 3.9 Land-based costs for preventing marine environmental degradation (€,000)

Type of Measures	WFD costs a)	Average WFD costs for the marine environment per year over the period 2010-2015 b)	Existing costs c)	Total
Waste water treatment plants	325,000	27,000	375,000	402,000
Sewers	196,000	8,000	450,000	458,000
Agriculture	48,000	4,000	360,000	364,000
Industry	96,000	8,000	180,000	188,000
River and lake beds	40,000	3,000	30,000	33,000
Other	3,000	250	0	250
Total	*708,000*	*51,000*	*1,395,000*	*1,446,000*

a) Costs (where data is available) for expenditures between 2010 and 2015; b) Accounting for the fact that only % of these costs relates to the marine environment (50% for all expect sewers which is 25%) and averaged over 6 years; c) The ongoing yearly costs of policies come from Ecorys (2006).

The high cost associated with land-based sources means that the results in this section need to be carefully evaluated and understood. First, the nature of the 'existing costs' is important. Ecorys define the existing costs as (translated) 'the yearly cost for the government, business and consumers for water quality policies'. While this is not broken down into any more detail explicitly, it is clear that this is a very broad definition of costs which is also appropriate for the calculations in this report. A significant water quality policy is the Nitrates Directive (91/676/EEC). The Ecorys definition therefore includes the costs to the government of running the Nitrates Directive as well as the increase costs which are incurred upon agriculture. Consumers will be included through policies which need to be implemented through the water boards who will pass the costs on to consumers.

The last element of the land-based sources is Inland shipping. Under current legislation, inland shipping is restricted in the way it can dispose of items such as litter, the use of coatings and lubricants, the treatment of bilge water and cargo remains (Centrale commissie voor de Rijnvaart, 2009); For this reason, the costs involved in the measures to meet legislation were analysed.

The yearly costs of litter collecting and waste water treatment are estimated to be around €3,7m (Tacq, 2010). This number does not refer to the other costs mentioned in the previous paragraph. As such it does not reflect all the costs to inland shipping. A percentage to account for the proportion that this measure relates to the marine environment has not been taken. This is because no indication of a suitable percentage is available and also because the cost relates only to litter collecting and waste water treatment. This means that the result is an underestimate in one respect and an overestimate in another. This leads to an acceptable estimate.

The final total for land-based sources plus inland shipping is therefore approximately €1.45bn. The derivation of this is shown in table 3.10.

Table 3.10 Average annual land-based costs (€,000)

Type of cost	Average annual cost
WFD a)	51,000
Existing Costs b)	1,395,000
Total land-based	*1,446,000*
Inland shipping c)	3,700
Total	*1,450,000*

Source: a) Ministry of Transport, Public Works and Water Management (2008); b) Ecorys (2007); c) Tacq, 2010.

Who bears the cost?

The cost to inland shipping are borne by the shipping firms. However, identifying who bears the burden of the other cost in this section is challenging. It has not been possible to precisely allocate the burden of land-based measures between sectors. The cost data on WFD and 'existing' land-based measures are totaled for the economy as a whole and not for individual sectors. Extra work outside the scope of this project would be required to analyse the very broad set of policies and measures which exist in this category in order to accurately identify the correct distribution of the burden of costs. Some general conclusions can, however, be drawn. Waste water treatment in the Netherlands is paid for through water boards and sewerage is paid for by local councils (gemeenten). These in turn affect the households. Measures concerning agriculture and industry will involve costs to businesses as well as costs to the government of implementing measures. Rivers and lake beds will probably be funded by central government.

4 Discussion

4.1 Evaluation of results

This report has taken a broad approach (covering as many issues as possible) to collecting data on the costs of avoiding marine environmental degradation in the North Sea. A wide variety of costs have been covered. There is variation in the accuracy of these figures. In parallel to this, it is also important to consider the quality of data (i.e. how up to date they are) and the validity of the assumptions that were made during calculations. Given these issues some aspects of the data will now be evaluated, where these issues may well have a significant impact on the total number for the costs of avoiding degradation.

Land-based activities account for the majority of the costs in this report. It is therefore vital to understand the assumptions made here. The most significant assumption is regarding the percentages. The percentages are used to allocate a proportion of the costs as being spent directly to avoid degradation of the marine environment. These percentages were determined by expert judgment as part of a study by Ecorys (2006). This report has not evaluated these percentages but they are the only ones which are available. It is important to remember that the percentages are subjective and that another panel of experts, may produce different outcomes. In any case, our method is consistent with previous studies and also conforms to the opinions of the original panel of experts. However, more information on this issue would be very useful and could have a significant effect on the final results.

In general, this report has adopted a preference for small overestimates rather than small underestimates. This is because the costs of avoiding marine environmental degradation are a lower bound for the costs of marine environmental degradation. Therefore, in general, the principal that it is better to overestimate a lower bound than to underestimate it has been applied. For example the percentages used in land-based measures are arguably a reasonable overestimate because the principle objective of many of the measures was inland water quality.

4.2 Wider application of the data

The applicability of the cost data which is collected on the above measures needs to be considered. For wider application, users of the data should take care in using the final, total figure because it consists of various types of costs, on-land and on sea, which are collected from various sources and refers to various types of environmental improvements.

The insight into who bears which costs to avoid marine environmental degradation can be useful when discussing affordability and/or the disproportionality of the costs of additional measures for the MSFD. The information provided on the current costs by sector can be used as the baseline to calculate the percentage change in the costs which is useful information to determine whether an increase in costs is disproportional or not. Other uses may not be practical. Using this cost data to infer benefits of new measures for use in a Social Cost Benefit Analysis (SCBA) would be difficult to justify. This is because the data does not refer to changes in costs which would result from new policies or measures and is therefore of limited use within a Social Cost Benefit Analysis.

Besides SCBA, one of the intentions of this report is to use the data for input into a Cost Effectiveness Analysis (CEA) of upcoming measures in relation to the MSFD. CEA calculates the cost per unit benefit and this facilitates a comparison of the costs of different ways to achieve a particular objective. An understanding of how useful this data is for that purposes requires an understanding on the units of costs (i.e. costs per ship or costs per m^2 of sea bed protection zone). It also requires insight into whether, at a broad first glance, the measures discussed in this report may be suitable to use as the basis for new measures under the MSFD. A preliminary and theoretical discussion on these issues will now be presented. This will be structured according to the categories used so far in the report.

- *Sand and shell mining.* A measure of area (i.e. m^2) would be suitable to demonstrates costs in terms of the size of areas where sand and shell mining are prohibited.
- *Oil and gas.* A possible unit of cost would be the reduction in the concentration of pollutants in production water (i.e reduction in parts per million). The baseline would be the concentrations which would occur if there was no regulation.
- *Fisheries and aquaculture.*
  - *EFF subsidies*. Units can be suggested for some of the EFF subsidies but not for all of them. 'Certification of fisheries', 'Alternatives for trawling', 'Investing in fishing vessels' and investing in ex-round fish vessels could all be measured under the number of ships which are affected. More research is required to suggests units for 'collective action in the fisheries chain' and 'innovation in the fisheries chain'.
  - *Natura 2000*. A suitable unit in this case would be the amount of area protected. However, since the nature of protection is likely to vary between areas, this unit may need to be adjusted for the 'strictness' of protection and the specific measures that will take place.
  - *Restrictions to cockle fisheries*. Units of m^2 could be used to represent the area which cannot be used for cockle fishery
  - *Marine debris dumping.* Since dumping of these substances has been completely banned there is little scope for strengthening this measure in terms of the shell-fish industry. As such, no unit is suggested.
- Shipping.
  - *Sea traffic management.* It may be possible to reduce the risk of a collision between ships by increasing the efforts into sea traffic management. A suitable unit of measurement might be the reduction in the percentage risk, per year of a ship to ship collision.
  - *IOPC.* Changes to the IOPC fund may be hard to link to GES indicators. As such, changes to the IOPC fund are unlikely to be a suitable measure for the MSFD, thus CEA is unlikely to be required on this measure.
  - *Marine litter.* The cost of marine litter measures can use a unit of the concentrations of marine litter in standard samples.
  - *Ballast water.* If there is scope to strengthen ballast water treatment, a suitable unit of measurement may be the reduction in percentage risk that an alien species can have an impact on the local ecosystem.
- Recreation.
  - Beach cleaning could be carried out on more stretches of Dutch coast or more regularly on stretches that are currently cleaned. If a measure-effect relationship could be established between beach cleaning and marine litter standard samples then cost effectiveness could be calculated in much the same way as marine litter as accounted for in the shipping section above.
- Offshore wind farms.
  - EIA of wind farms does not seem likely to be a measure which could be analyzed using cost effectiveness. There may be other possible future measures which could be more suitable for the MSFD.
- Defense.
  - Research into underwater noise and the costs of technical measures built into ships will be hard to measure for CEA purposes because research does not have a direct impact on the marine environment.
- Dredged Material.
  - Making chemical criteria for dredged material could potentially become more strict. A potential unit to measures these costs would be the reduction in sea based dumping. Careful thought would need to be given to how much variation in the amount dumped is a response to new chemical criteria.
- Land reclamation.
  - Closed fishing areas and sea bed protection zones relating to the Maasvlakte II are the most suitable for CEA. The unit would measure the size of the closed areas.

- Land-based measures.
    - The wide variety of land-based measures precludes a meaningful discussion on suitable units for cost effectiveness measures.

In addition to the above discussion, it is important to bear in mind that the usefulness of an indicator for costs per unit of result depends however largely on the effect which is to be assessed. For example, the costs of fisheries management measures can be expressed in various ways: per kg fish, per engine hp, or per vessel. The same holds for other indicators. Thus, detailed knowledge on the effects of the measures and the links with the environmental indicators specified in the MSFD is needed to specify the units that will be useful in an CEA. In this way, the cost data and the list of measures do not present information on suitable indicators which could be used in such an analysis. However, the current database and the information sources provide a suitable *starting point* for such an exercise. For new types of MSFD measures which are not currently being implemented, other data should be gathered. In summary, given the above discussion, the results provide a basis which can be used CEA but additional work needs to be done for proper use.

4.3 Evaluation of 'who bears the cost?' and how costs are levied

This report has given insights, where possible, into who bears the cost for the various measures. There are two main categories; costs to private industry and costs to the public sector. This has been complicated by the land-based measures for which a disaggregation between costs to the government and costs to industry and households cannot be made. In addition, considering the allocation of costs between the public sector and the various parts of the private sector, insights can be gained into how the costs are levied. In this report, no costs have been analyzed which are levied through taxes or the costs of permits. Land-based measures are likely to involve a more complex set of ways to levy the costs, but again, due to the aggregation issues, they could not be identified. All costs to the private sector for sea-based measures are levied through increases in cost to meet regulations.

5 Conclusions

The final results need to be considered given the discussion above. In conclusion, this report has provided a simple and meaningful insight into the costs of avoiding degradation of the marine environment. This in turn can be used to indicate a lower bound on the costs of environmental degradation in the North Sea. Several key conclusions are now highlighted:

- Given the assumptions used, and bearing in mind the measures for which no data is available, the total cost of avoiding degradation to the Dutch North Sea environment has been calculated to be €1.58bn This is also a lower bound for the *actual* cost of degradation. Sea based measures account for approximately €132m. Land-based measures account for approximately €1,45bn a year.
- The majority of costs to avoiding degradation of the Dutch North Sea environment are incurred through land-based measures.
- The percentages which are used to allocate a share land-based costs to avoiding degradation of the marine environment are therefore key in evaluating the final results of this report.
- Issues concerning non-Dutch use of the Dutch North Sea and the international ownership of 'Dutch' companies should also be considered in evaluating the results.
- The sea-based costs are borne by various businesses and by the government. Those who bear the cost for land-based measures are more diverse due to the multitude of water quality measures which are implemented at various scales and through various institutions.
- The summary table for cost of avoiding degradation (table 6.1) is shown below:

Table 6.1 **Annual cost of avoiding degradation of the Dutch North Sea environment**

Type of cost	**Annual costs: €000**
Sea-based costs	
Sand and shell mining	2,500
Oil and gas production	12,500
Fisheries and aquaculture	8,121
Shipping	17,234
Recreation	8,840
Wind farms	3,666
Royal Dutch Navy	412
Dredging	30,000
Land reclamation: Maasvlakte II	20,595
Government	35,400
Subtotal sea-based costs	*139,268*
Land-based costs	
Sewage Treatment Plants	402,094
Sewers	458,154
Agriculture	364,037
Industry	188,026
River and lake beds	33,324
Other measures	250
Inland shipping	3,700
Subtotal land-based costs	*1,450,000*
Total	*1,589,000*

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Appendix 1

MSFD Indicators

Tabel A.1	**Relationship between the 11 MSFD descriptors of GES and the measures which are considered in this report**
Descriptor	**Relevant Measures a)**
1 - Biodiversity	3.2, 3.3, 3.4 (Relevant subsidies only), 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12
2 - Non-Indigenous Species	3.4 (dumping only), 3.5 (Ballast water only)
3 - Safe Biological Limits of Stocks	3.4 (Relevant Subsidies only), 3.5 (clean shipping and ballast water only), 3.6, 3.7, 3.8, 3.9, 3.10, 3.11
4 - Food Webs	3.2, 3.3, 3.4 (Relevant subsidies only), 3.5 (clean shipping and ballast water only), 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12
5 - Eutrophication	3.11, 3.12
6 - Sea Floor Integrity	3.2, 3.4 (Relevant subsidies only), 3.7, 3.9, 3.11
7 - Hydrological Conditions	3.7, 3.11
8 - Contaminants in Water	3.3, 3.5 (clean shipping), 3.6, 3.9, 3.11, 3.12
9 - Contaminents in Fish	3.3, 3.5 (clean shipping only and marine litter only), 3.9, 3.11, 3.12
10 - Marine Litter	3.5 (marine litter only), 3.8, 3.9,
11 - Energy	3.11
Please refer to the contents page. Each measures is referred to by its section number in the contents.	

Appendix 2

EFF Subsidies

Table A.2	All EFF Subsidies (euros)						
Subsidy and description	**Payer**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Certification in the fish chain	Government		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Description: Certification of fisheries	Sector		250,000	250,000	250,000	250,000	250,000
Collective action in the fish chain	Government	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000
Description: Improving management of fish stocks, sustainable techniques, cooperation within sector	Sector	875,000	875,000	875,000	875,000	875,000	875,000
Compensation measures for eel fisheries	Government		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Description: Protection of eel, stimulate spawning in Sargasso Sea	Sector						
Guaranteeing fisheries	Government		1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Description: Improving safety, labour conditions, product quality, energy efficiency, selective fishing	Sector						
Investing in aquaculture	Government	4,000,000			4,000,000		
Description: Reducing environmental impact of aquaculture	Sector	9,300,000			9,300,000		
Investeringen in mosselzaadinvanginstallaties	Government		1,700,000	1,700,000	1,700,000	1,700,000	1,700,000
Description: Reducing impact on benthos by musselseed fishing	Sector		4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
Investing in fishing vessels - alternatives for trawling	Government		2,000,000				
Description: Reducing impact on benthos by beam trawling, stimulating selective fishing methods	Sector		4,500,000				
Investing in fishing vessels	Government	880,000					
Description: Stimulating use of pulse fishing, reducing impact on benthos by beam trawling	Sector	1,300,000					
Investing in ex round fish vessels	Government	480,000					

Description: Recovery cod stocks, selective fishing methods	Sector	1,100,000					
Innovation in the fish chain	Government	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000
Description: Selective fishing methods, environmental management plans, introduce MPA, reduce discards & environmental impact	Sector	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000	2,300,000
Key							
Excluded because it is not relevent to the North Sea environment							
Excluded because it is not a real cost to the sector							
Only 30% of costs are real costs to the sector							
Source: www.hetInvloket.nl.							

Appendix 3

Consulted experts

Table A.3 Consulted experts

Category	Name	Organisation
Oil and gas exploration	Aart Tacoma	The Netherlands Oil and Gas Exploration en Production Association.
Fisheries and aquaculture	Frans Vroegop	Ministry of Economic Affairs, Agriculture and Innovation
	Kees taal	LEI, part of Wageningen UR
	Jaap Holstein	Producers organisation of the Dutch Cockle Fishery
	Hans van Oostenbrugge	LEI, part of Wageningen UR
	Helleen Bartelings	LEI, part of Wageningen UR
Shipping	Paul Altena	Royal Association of Netherlands Ship Owners
	Maurits Prinssen	Port Authority of Rotterdam
Defense	Ronald de Rooij	Ministry of Defense
Land reclamation	Hans van Oostenbrugge	LEI, part of Wageningen UR
	Tiedo Vellinga	Project office Maasvlakte 2
Dredging	Marc Eisma	Port Authority Rotterdam
Land-based sources and activities	Marc Peerdeman	Rijkswaterstaat - Waterdienst
	René Tacq	Stichting Afvalstoffen en Vaardocumenten Binnenvaart (SAB)
	Vincent Linderhof	LEI, part of Wageningen UR
	Rob van der Veeren	Rijkswaterstaat - Waterdienst

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