OSPAR COMMISSION

Assessment of the environmental impact of dredging for navigational purposes

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

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

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Executive Summary

Dredging activities are carried out to maintain navigation in ports, harbours and navigation channels as well as for the development of such facilities. This activity seems sufficiently managed by national regulations of OSPAR Contracting Parties. However, the environmental effects of dredging activities on species and habitats and ecosystem processes are still poorly understood and require further monitoring and assessment.

Most of the material that is dredged in harbours, estuaries and at sea is dumped at sea and only minor amounts of this dredged material are used beneficially, e.g. for construction purposes, or disposed on land. This assessment focuses only on the environmental impact of dredging activities. The dumping into sea of dredged material is covered by a separate assessment, the JAMP Assessment of environmental impacts of dumping of wastes (OSPAR, 2009a).

The pressure on the marine ecosystem from dredging is increasing

Dredging activities often have adverse impacts on marine species, habitats and ecosystem processes. Dredging activities lead to direct substrate removal and thus to the destruction of species and habitats. Other problems arise from the alteration of the bottom topography and hydrography as well as sediment compositions. This can lead to physical stress on species and changes of habitats such as the decline of individual densities and species abundances or biomass in benthic communities. Re-suspension of sediments and increase of turbidity can lead to the spreading of sediments with associated contaminants, release of nutrients (eutrophication), reduced transparency of the water and reduced oxygen contents. The extent of the impact depends on the size, characteristics and sensitivity of the dredged area as well as the dredging technique.

Most dredging activities are carried out in the southern part of the OSPAR Region II (Greater North Sea), especially in the vicinity of ports, *e.g.* Antwerp (Scheldt estuary), Rotterdam (Rhine and Meuse estuary), Hull (Humber estuary), Le Havre (Seine estuary) and Hamburg (Elbe estuary), but larger dredging sites are also found in the OSPAR Region III (Celtic Seas) and in OSPAR Region IV (Bay of Biscay and Iberian Coast). About 90% of all sediments disposed of at sea are dredged by only five OSPAR Contracting Parties: Belgium, France, Germany, the Netherlands and the United Kingdom. A slight increase in the overall amounts can be observed from 1990-2005. It is likely that the need for dredging will remain high or even further increase in some areas due to the projected increase in world trade and shipping and the deeper draughts of ships, *e.g.* of large container vessels, or the development of new port projects.

Impacts of dredging activities are appropriately regulated by national and international measures

The OSPAR Guidelines for the Management of Dredged Material aim at reducing the adverse effects of dredging and dumping operations on the marine ecosystem (OSPAR, 2004a). They specifically address the disposal of dredged material by dumping in the maritime area. Contracting Parties are also encouraged to exercise control over dredging operations in order to minimise the quantity of the material to be dredged and the impact of the dredging activities as well as to apply Best Environmental Practices (BEPs). Dredging operations are also regulated through EU legislation and national regulations of OSPAR Contracting Parties, including the requirement for Environmental Impact Assessments in some Contracting Parties. At present it can be assumed that in most cases the existing national regulations of OSPAR Contracting Parties, together with EU legislation, is sufficient to minimise adverse effects of dredging on marine species and habitats.

Dredging activities have negative impacts on the marine environment

Only limited information is available on the overall effects of dredging activities on species, habitats and ecosystem processes in the OSPAR Maritime Area. The removal of sediments, greater turbidity or enhanced erosion, due to dredging activities, can have adverse impacts on habitats such as estuaries, sandbanks, mud flats and salt marshes. Dredging activities influence the often diverse fauna and flora of these habitats, including threatened and or declining species or species that are of particular economic interest. Dredging activities may also lead to a re-suspension of sediments and associated harmful contaminants such as trace metals and there is a potential that these contaminants may be taken up in the food chain. Deposit of sediments on the seabed may bury benthos organisms and lead to changes in habitat and biological communities. Dredging activities also contribute to the cumulative impacts of human activities on the marine environment.

More efforts are needed to monitor and assess the effects on the marine ecosystems

This assessment indicates that further efforts are needed to better understand the actual effects of dredging on the marine ecosystems of the OSPAR Maritime area. OSPAR should therefore consider options for monitoring and assessment of dredging activities that would allow a clearer analysis of the effects on species, habitats and ecosystems processes as well as an evaluation of the effectiveness of existing regulations, including the application of BEP. OSPAR Contracting Parties are encouraged to develop appropriate dredging strategies, in particular with regard to MPAs and other sensitive areas. However, before developing additional OSPAR measures to exercise specific control on the effects of dredging operations on marine species and habitats, existing regulations, including EU legislation, should first be fully implemented and evaluated.

Récapitulatif

Les activités de dragage sont entreprises afin d'entretenir la navigation dans les ports et les chenaux de navigation ainsi que pour les développer. Cette activité semble être assez bien gérée par les règlementations nationales des Parties contractantes OSPAR, cependant les effets environnementaux des activités de dragage sur les espèces et les habitats et les fonctionnements des écosystèmes sont encore mal compris et doivent faire l'objet de surveillances et d'évaluations supplémentaires.

La plupart des matériaux dragués dans les ports, les estuaires et en mer sont immergés en mer et seule une quantité faible de ces matériaux est valorisée, par exemple dans la construction ou éliminée à terre. La présente évaluation se concentre uniquement sur l'impact environnemental des activités de dragage. L'immersion en mer des matériaux de dragage est couverte par une évaluation distincte, l'évaluation JAMP de l'impact environnemental de l'immersion des déchets (OSPAR, 2009a).

Une pression croissante du dragage sur l'écosystème marin

Les activités de dragage ont souvent des effets préjudiciables sur les espèces, les habitats et le fonctionnement des écosystèmes marins. Les activités de dragage entraînent le prélèvement direct du substrat et donc la destruction des espèces et habitats. D'autres problèmes découlent de la modification de la topographie et de l'hydrographie du fond ainsi que de la composition des sédiments. Ceci peut entraîner des pressions physiques sur les espèces et des modifications d'habitats. Il s'agit en particulier du déclin des densités individuelles et de l'abondance des espèces ou de la biomasse chez les communautés benthiques. La remise en suspension des sédiments et l'augmentation de la turbidité peuvent entraîner une dispersion des sédiments et des contaminants correspondant, un apport de nutriments (eutrophisation), une réduction de la transparence de l'eau et une réduction de la teneur en oxygène. L'importance de l'impact dépend de la taille, des caractéristiques et de la sensibilité de la zone draguée ainsi que de la technique de dragage.

La plupart des activités de dragage ont lieu dans la partie méridionale de la Région II OSPAR (mer du Nord au sens large), en particulier à proximité des ports, par exemple Anvers (estuaire de l'Escaut), Rotterdam (estuaires du Rhin et de la Meuse), Hull (estuaire de Humber), Le Havre (estuaire de la Seine) et Hambourg (estuaire de l'Elbe), mais il existe également des sites de dragage plus grands dans la Région III OSPAR (mers celtiques) et la Région IV OSPAR (golfe de Gascogne et côtes ibériques). Environ 90% des sédiments immergés sont dragués par cinq Parties contractantes OSPAR uniquement: Allemagne, Belgique, France, Pays-Bas et Royaume-Uni. Les quantités totales ont légèrement augmenté entre 1990 et 2005. Il est fort probable que la nécessité de draguer reste élevée voire même augmente dans certaines zones du fait de l'accroissement prévu du commerce et de la navigation dans le monde, de l'augmentation des tirants d'eau des navires, par exemple des grands portes-conteneurs, ou du développement de nouveaux projets portuaires.

Des impacts des activités de dragage correctement régulés par les mesures nationales et internationales

Les lignes directrices OSPAR pour la gestion des matériaux de dragage visent à réduire les effets préjudiciables des opérations de dragage et d'immersion sur l'écosystème marin (OSPAR, 2004a). Elles abordent spécifiquement l'élimination des matériaux de dragage par immersion dans la zone maritime. Les parties contractantes sont également encouragées à contrôler les opérations de dragage afin de minimiser la quantité de matériaux à draguer et l'impact des activités de dragage ainsi qu'à appliquer les meilleures pratiques environnementales (BEP). Les opérations de dragage sont également réglementées par la législation de l'UE et par les réglementations nationales des Parties contractantes OSPAR, en particulier l'obligation de mener une évaluation de l'impact environnemental chez certaines Parties contractantes. On peut présumer, pour l'heure, que dans la plupart des cas, les réglementations nationales existantes des

Parties contractantes OSPAR, ainsi que la législation de l'UE, suffisent à minimiser les effets préjudiciables du dragage sur les espèces et habitats marins.

Impacts négatifs des activités de dragage sur le milieu marin

Seules des informations limitées sont disponibles sur les effets globaux des activités de dragage sur les espèces, les habitats et le fonctionnement des écosystèmes dans la zone maritime OSPAR. Le prélèvement de sédiments, l'accroissement de la turbidité ou l'augmentation de l'érosion dus aux activités de dragage, peuvent avoir des impacts préjudiciables sur les habitats tels que les estuaires, les bancs de sable, les vasières et les marais salés. Les activités de dragage ont une influence sur la faune et la flore souvent diverses de ces habitats, notamment les espèces menacées et ou en déclin ou les espèces qui présentent un intérêt économique particulier. Les activités de dragage risquent également de conduire à une resuspension de sédiments et de contaminants dangereux tels que les métaux trace. Ces contaminants peuvent potentiellement être absorbés dans la chaîne alimentaire. Les dépôts de sédiment sur le fond marin risquent d'enfouir des organismes benthiques et d'entraîner des modifications des habitats et des communautés biologiques. Les activités de dragage contribuent également aux impacts cumulés des activités humaines sur le milieu marin.

Des efforts supplémentaires nécessaires pour surveiller et évaluer les effets sur les écosystèmes marins

La présente évaluation indique que de nouveaux efforts sont nécessaires pour mieux comprendre les effets actuels du dragage sur les écosystèmes marins dans la zone maritime OSPAR. OSPAR devra donc envisager des options pour la surveillance et l'évaluation des activités de dragage qui permettraient de réaliser une analyse plus claire des effets sur les espèces et habitats et les fonctionnements des écosystème ainsi qu'une évaluation de l'efficacité des réglementations existantes, notamment l'application de BEP. Les Parties contractantes OSPAR sont encouragées à développer des stratégies de dragage pertinentes, en particulier en ce qui concerne les AMP ou autres zones sensibles. Cependant, les réglementations existantes, législation européenne incluse, doivent être mise en œuvre et évaluées avant de développer des mesures OSPAR supplémentaires permettant de contrôler spécifiquement les effets des opérations de dragage sur les espèces et les habitats marins.

1. Introduction

1.1 Background

This assessment is a contribution to the series of assessments of human activities, as listed in the Strategy for a Joint Assessment and Monitoring Programme (JAMP) Appendix 3 and focuses on the impacts on the marine environment of dredging for navigational purposes.

Dredging activities are carried out for several reasons. They are essential to maintain navigation in ports, harbours and navigation channels as well as for the development of such facilities. Two main types of dredging can be distinguished: maintenance and capital dredging. Maintenance dredging is the periodic removal of material deposited through river flow, tidal currents or wave action to ensure that channels, berths or construction works are maintained at their designed dimensions. Capital dredging is carried out for navigation, to enlarge or deepen existing channels and port areas or to create new ones, but can also include excavation for civil engineering works. Clean-up dredging is the deliberate removal of contaminated sediment from the marine environment for human health and environmental protection purposes. In general there are two main options for the destination of dredged material. The sediments can either be kept within the estuary system or removed for disposal at sea (OSPAR, 2009a) or on land. Sediments are also dredged for purposes like beach nourishment or land reclamation and as material for construction or building purposes, which is sometimes defined as sand mining or extraction (aggregate dredging in the UK). These activities are addressed by the Assessment of the environmental impact of land reclamation (OSPAR, 2008a) and the Assessment of the environmental impacts of sand and gravel extraction (OSPAR, 2009b).

1.2 Methodological approach

The assessment of the environmental impact of dredging activities is based on the responses received from Contracting Parties to two questionnaires and on information contained in the background document on Environmental impacts on marine species and habitats of dredging for navigational purposes (OSPAR, 2004b). The background document includes a concise summary of the available knowledge on dredging techniques paying particular attention to their environmental impacts and a brief description of the most important of these. The background document was prepared partly on the basis of the responses to the first questionnaire circulated in 2002. In this first questionnaire information was collected on the dredging and disposal techniques used, investigations undertaken into the environmental impacts of dredging and disposal operations on existing regulations and on the need for further investigations, assessment techniques and regulations. Seven Contracting Parties (Belgium, France, Germany, the Netherlands, Portugal, Spain and the United Kingdom) and the non-governmental observer organization CEDA (Central Dredging Association) responded to this questionnaire. In the second questionnaire, which was circulated in 2006, general information from Contracting Parties was collected on the size and characteristics of the dredging sites, the intensity and duration of maintenance and capital dredging activities and the extent of beneficial use of dredged material and disposal options other than aquatic disposal. Eight Contracting Parties (Belgium, France, Germany, Ireland, the Netherlands, Spain, Sweden and the United Kingdom) responded to the second questionnaire. No responses were received from Denmark, Iceland, Norway and Portugal.

2. What are the problems?

The removal of sediments can have adverse impacts on marine species and habitats. The impact may be due to physical or chemical changes in the environment at or near the dredging site. The extent of the impact depends on the size, characteristics and sensitivity of the dredged area and the dredging technique.

2.1 Trends in dredging activities

Most of the material dredged in harbours, estuaries and at sea is dumped at sea and only minor amounts of this dredged material are beneficially used *e.g.* for construction purposes or disposed on land. It can therefore be assumed that amounts and trends in dumping activities directly correlate to those of dredging activities. The yearly OSPAR Reports on the Dumping of Wastes at Sea and the assessments of these yearly reports (OSPAR, 2002, 2003, 2004c, 2007) therefore give an indication of the extent of and trends in dredging activities[1]. Figure 2.1 shows the total amount of dredged material from maintenance and capital dredging activities that was dumped at sea from 1990–2005 The overall amount of material disposed of at sea varies significantly from approximately 80–131 million tonnes in dry weight from 1990 – 2005. A slight increase in the overall amounts of dredged and dumped material can be observed. About 90% of the dredged material reported to OSPAR is dumped by only five Contracting Parties (Belgium, France, Germany,

[1] For a comprehensive analysis for the environmental impacts of dumping of dredged material please refer to the JAMP Assessment of the environmental impacts of dumping of wastes and other material (OSPAR, 2009a).

the Netherlands and the United Kingdom). Only minor dredging activities are carried out by Iceland, Norway and Portugal. Trends in the amounts dumped are difficult to predict as the amount of material to be dredged is strongly influenced by natural conditions, dumping strategies, sediment disposal criteria and episodic capital dredging activities, which occasionally contribute large quantities to the total amount of dredged material disposed of at sea. However, due to the projected increase in world trade and shipping, it is likely that the need for dredging will remain high or even further increase in some areas due to the deeper draughts of ships, *e.g.* of large container vessels, or the development of new port projects.

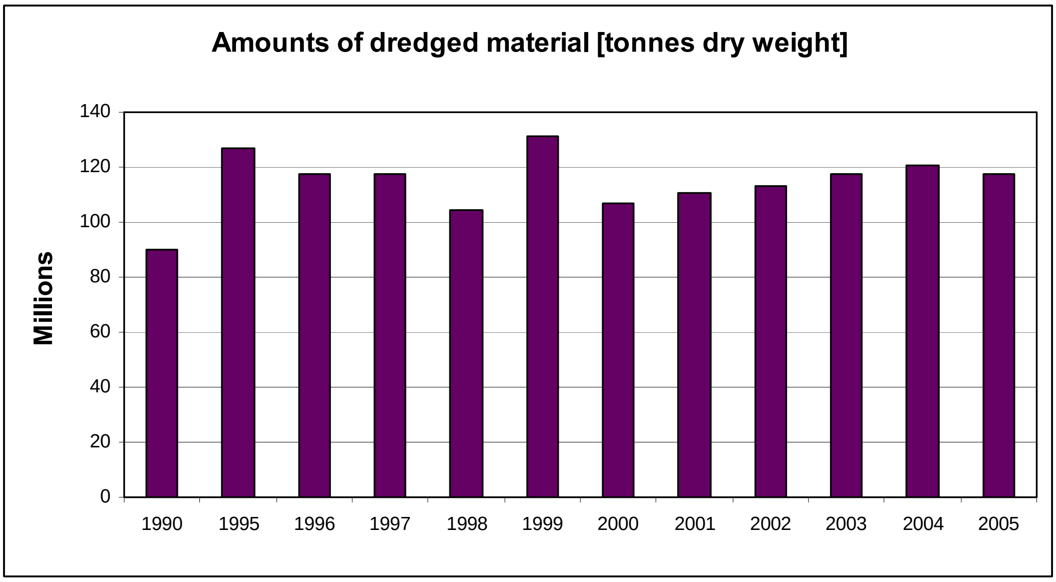

Figure 2.1 Amount of dredged material disposed of from 1990 – 2005 within the OSPAR area indicating trends in dredging activities. Source: OSPAR, 2009a.

The greatest dredging activities are carried out in the southern part of the OSPAR Region II (Greater North Sea), especially in and around the harbours of Le Havre (Seine estuary), Dunkerque, Zeebrugge, Antwerp (Scheldt estuary), Rotterdam (Rhine and Meuse estuary), IJmuiden, Felixstowe, Hull (Humber estuary), Esbjerg and Göteborg, Wilhelmshaven (Jade bay), Hamburg (Elbe estuary) and in the Ems estuary. Larger dredging sites are also found in the OSPAR Region III (Celtic Seas) *e.g.* in the estuary of the Mersey and OSPAR Region IV (Bay of Biscay and Iberian Coast). The main dredging sites at the Bay of Biscay are found in France in the harbours and estuaries of Loire (Nantes), Gironde (Bordeaux) and Adour (Bayonne), and on the Iberian Coast they are found in Spain (Avilés, Vilagarcía and Huelva) (OSPAR, 2002, 2003, 2004c, 2007).

To complement the information on amounts of and trends in dredging activities derived from the annual OSPAR dumping reports, further information was collected through the questionnaires. Table 2.1 contains this information on the sizes of the areas dredged in maintenance dredging activities during the period 2003 – 2005, as reported by the Contracting Parties. France reported differently on the amount dredged per dredging site: in 2003 on six sites more than 1 million m^3 and on 38 sites less than 1 million m^3. Most Contracting Parties reported only a few sites on which capital dredging activities took place in each year (2003, 2004 or 2005). The sites and sizes of the sites for capital dredging vary strongly from year to year, but the total area yearly dredged for capital dredging is much smaller than for maintenance dredging activities.

Table 2.1 Number of maintenance dredging sites per size category, as reported by the Contracting Parties, in the period 2003 – 2005.

OSPAR Region	**Contracting Party (total number of sites)**	**Number of maintenance dredging sites per size category**								
		< 10 000 m²			**10 000–100 000 m²**			**> 100 000 m²**		
		Harbour	**Estuary**	**Sea**	**Harbour**	**Estuary**	**Sea**	**Harbour**	**Estuary**	**Sea**
Greater North Sea	Belgium (9)	0	0	0	2	0	0	3	1	3
Greater North Sea	Germany (20)	4	0	1	2	0	2	4	7	0
Greater North Sea	Netherlands (28)	0	0	0	12	0	0	16	0	0
Greater North Sea	Sweden (4)	1	0	1	0	0	0	2	0	0
Greater North Sea and Celtic Seas	United Kingdom (102)	41	5	3	25	5	2	9	9	3
Celtic Seas	Ireland (8)	1	1	0	1	5	0	0	0	0
Bay of Biscay and Iberian Coast	Spain (15)	1	2	0	0	9	0	0	3	0

The average amount of reported material dredged annually in maintenance dredging activities is about 20 million tonnes dry weight in France, Belgium and Germany and about 10 million tonnes dry weight in the Netherlands and in the United Kingdom over the period 1998 – 2005 (OSPAR, 2009a). Less material was dredged in maintenance dredging activities in Spain (1 million tonnes) and Ireland (0.5 million tonnes) and in Sweden (0.4 million tonnes).

In Belgium 14% of the material dredged in maintenance dredging activities was used beneficially, as material for embankment and for plate restoration. In Germany, sand, amounting to about 10% of the dredged material, was used for construction purposes. In France about 3% of the dredged material in maintenance dredging activities was used for construction and beach nourishment and about 2% of clean mud from maintenance dredging activities was used for agricultural purposes. In the United Kingdom a small percentage (2%) was used for beneficial placement. The Netherlands, Germany and France reported the disposal of dredged material from maintenance dredging on land. In the Netherlands about 1 million tonnes dry weight of contaminated material dredged for navigational purposes was disposed annually in a confined area next to the sea. In France about 0.5 million m^3 was disposed in a confined basin at sea in 2003. Germany reported that 0.7 million tonnes was disposed in 2005 in a lake left behind from a former sand mine.

In France over 12 million m^3 of sand was used for the construction of a platform in Le Havre (Port–2000) in 2003. In the United Kingdom, most of the silt, clay, sand, gravel and rock dredged in capital dredging activities were used for beach nourishment, land reclamation or environmental enhancement. In Sweden dredged blasted rock of marine origin was used for artificial reefs and breakwaters. In the Netherlands, apart from maintenance or capital dredging activities, 12 million m^3 of sand is dredged yearly for beach nourishment. Spain reported that the total amount of sand and silty sand that was used beneficially for beach nourishment, land reclamation and agricultural purposes was 3.3 million tonnes and that 1.2 million tonnes disposed on land.

The frequency of the maintenance dredging activities and duration of the maintenance and capital dredging activities differ greatly depending on the size of the site. Maintenance dredging activities at the smallest sites (<1000 m^2) are carried out occasionally or yearly and last less than one month. At the intermediate sites (1000 – 100 000 m^2) maintenance dredging activities last from one week to several months and are predominantly carried out occasionally or yearly. At the largest sites (>100 000 m^2), the maintenance dredging activities are predominantly carried out more or less continuously. Capital dredging activities at the largest sites can last from one month to more than one year. Between the Contracting Parties there are no major differences in the frequency and duration of the dredging activities.

The responses to the 2002 questionnaire revealed that in Belgium, France, Germany, the Netherlands and Spain the most dredged material is removed with the hydraulic (trailing) suction hopper dredgers with and without cutterhead (these terms are explained in OSPAR, 2004b). Most Contracting Parties apply several conventional techniques (mechanical, hydraulic and hydraulic/mechanical). There is some preference for mechanical techniques in areas like ports, docks and quays. In navigation channels and access channels to harbours, both mechanical and hydraulic techniques are used. Mechanical techniques such as clamshell or crane dredger, backhoe dredger or a cutterhead are preferred when rocks or clay need to be removed. Other commonly used techniques are the mechanical bucket ladder dredger and the dipper/backhoe dredger. In Germany, the Netherlands and the United Kingdom ploughing (seabed leveling) is another technique that is sometimes used. In addition, in Belgium, Germany, the Netherlands and the United Kingdom hydrodynamic techniques such as water injection (Germany, the Netherlands, the United Kingdom) and agitation are used. In the United Kingdom, sidecast dredging is applied as well. In Belgium, hydrodynamic techniques in 2002 were used only for dredging in the river Scheldt. In Germany the estimated amount of material removed with water injection dredging was less than 5% of the total amount dredged in 2002.

2.2 Different types of dredging techniques

The impacts of different types of dredging methods on species and their habitats are summarised in the OSPAR background document on the impacts of dredging activities (OSPAR, 2004b). Most dredging methods were developed for capital dredging and maintenance dredging of channels and harbours. Remediation of contaminated beds imposes different requirements on the dredging techniques, such as the complete removal of sediment layers which are often thin, without increasing the turbidity of the water.

Dredging methods can be assessed and ranked with regard to their environmental effectiveness (Van der Veen, 1993). Purely mechanical approaches such as grab cranes and digger buckets have the lowest ranking of the existing methods. The highest scores can be assigned to the combined mechanical/hydraulic techniques and these can be considered to be the most effective in dredging contaminated soils. Combined mechanical/hydraulic techniques are recommended for the removal of relatively thin layers of sediment. However, the cutter dredger and the chain silt slicer cause relatively high spillage and dispersal of sediments and thus are less appropriate. The ranking of techniques according to their environmental effectiveness may offer indications for the selection of an appropriate dredging technique for contaminated sediments.

For the maintenance of some harbours and sedimentation areas lying parallel to the navigation channel, silty sediments are removed by a hydrodynamic dredging technique such as water injection dredging. Sediments are re-suspended by the injection of water with low pressure and subsequently are transported as a density flow or by natural currents occurring at the dredging site. Mechanical agitation dredging is only applied in small harbour areas or other small sedimentation areas that are difficult to access.

Hydrodynamic dredging can only be undertaken under suitable circumstances. First, the material to be removed needs to be receptive to transport by the water column. Second, the water needs to flow in the direction where the transported material is intended to go and where it does not interfere with other interests. Promising areas for application may be: (1) areas with high natural sediment concentrations; (2) areas with erodable material; (3) areas with a potentially high current velocity, either natural or artificial; (4) areas in the vicinity of deep troughs; (5) areas with material of low level contamination. An overview of knowledge on hydrodynamic dredging techniques is given in the annexes to the background document (OSPAR, 2004b).

Hydrodynamic dredging results in a stronger increase of turbidity than other dredging techniques. In water injection dredging, the increase of turbidity usually has its maximum close to the bottom. Depending on the material dredged, oxygen depletion may occur. However, it is generally limited to the area directly surrounding the dredging site and to tidal waters, and no enduring impact has been observed. If sediments are contaminated, remobilisation of contaminants can occur and associated contaminants can spread with limited control. The application of the water injection procedure is restricted to areas where no harmful oxygen depletion and remobilisation of contaminants is expected.

2.3 Pressures and impacts

Dredging operations will almost always re-suspend sediments, but the level of re-suspension and associated impacts depend on the physical and chemical characteristics of the sediment, as well as the site conditions, type of equipment and dredging method. The impacts of dredging activities are strongly influenced by the contamination of the sediment and local factors like water depth, rate of flow, tidal currents, wave action, type of seabed and sediment concentration of the water under natural circumstances, as well as the dredging method.

The main impacts of dredging activities on marine habitats and species can be summarised as follows (OSPAR, 2004 b):

- Substrate removal and thus habitat and species removal (recolonisation or recovery of disturbed areas may be possible);
- alteration of the bottom topography and hydrography, and thus destruction of local habitats and the risk of direct physical/mechanical stress to species;
- alteration of the sediment composition, *i.e*. of substrate characteristics in the surrounding of the dredging site, resulting in a change of nature and diversity of benthic communities, *e.g.* decline of individual density, species abundances or biomass;
- re-suspension of sediments and increase of turbidity. The potential impacts include spreading of sediments and associated contaminants in the surroundings, remobilisation of contaminants in the water phase enhancing the bioavailability and ecotoxicological risk, release of nutrients resulting in increase in eutrophication and direct impact on organisms due to reduced transparency and consumption of oxygen (the increase in turbidity due to re-suspension of sediments caused by dredging, *e.g.* together with chemical quality and biological characteristics of the sediments, may be regarded as an indicator for potential ecological effects in the surroundings of the dredging sites).

Short-term impacts include the increase of the turbidity due to excavation works and sediment disposal. Medium and long-term impacts include habitat removal and impacts due to changes in flow and sediment budgets especially affecting the tidal propagation and changes to the geometry of channels,.

The degree of the impacts of dredging depends on the extent of the areas dredged (in terms of area and depth), the frequency and duration of dredging activities, the characteristics and the sensitivity of the areas dredged and their surroundings (in terms of distribution and importance of habitats and species), the dredging techniques applied as well as relationships with other uses and users of the system (cumulative aspects). Hydrodynamic and sidecast techniques raise the turbidity on the dredging sites potentially more than conventional dredging techniques. These techniques use the principle of deliberate re-suspension of the fine fraction of sediment from the riverbed or seabed with the aim of removing this material from the dredging area using natural processes for transportation. When using these techniques the material dredged is relocated at the dredging site rather than disposed at a disposal site. Potential impacts of hydrodynamic and sidecast techniques include:

- re-mobilisation of contaminants can occur and contaminants associated with the fine fraction can be spread with limited control of the transport if sediments are contaminated;
- substances which consume oxygen, nutrients and harmful materials, bonded to the sediments, can be released into the water relatively easily and thus reduce its oxygen content or cause an increase in the concentration of nutrients or harmful materials;
- a relative enrichment of the coarse fraction (‘armouring’) will occur in the dredged area, which will make the area less susceptible to erosion, also making future hydrodynamic dredging operations more difficult;
- the sometimes occurring visual effect of clouding or colouring of the surface water by hydrodynamic dredging, especially when raising material to the water surface, is not always allowed or desired. This clouding does not necessarily lead to environmental damages.

3. What has been done? Did it work?

In order to reduce the adverse effects of dredging and dumping operations on the marine ecosystem OSPAR has developed Guidelines for the Management of Dredged Material (Reference Number 1998-20; revised version 2004–08) that specifically address the disposal of dredged material by dumping in the maritime area (OSPAR, 2004a). Contracting Parties are encouraged to exercise control over dredging operations, including sidecast and agitation dredging practices, in order to minimise the quantity of the material that has to be dredged and the impact of the dredging activities. The technical Annex III to the guidelines contains Best Environmental Practices (BEPs) for minimizing the effects of dredging operations on the environment.

The BEPs describe how the volume of dredged material can be minimised, how the dredging process can be improved and how the impacts of dredging can be minimised. Minimizing the volume includes minimizing the need for dredging and optimizing the management of dredging operations by using accurate survey systems and by evaluating the process. Improving the dredging process means the use of the best suited techniques (dredging techniques, degassing installations, *etc.),* the use of selective dredging techniques and controlling the dredging process *e.g.* by measurements. Minimizing the impacts of dredging consists of minimizing the increase in turbidity and in oxygen depletion.

Potential negative effects of dredging operations are also reduced through the implementation of EU legislation. The Council Directive (97/11/EC) requires environmental impact assessments in case of capital dredging operations. The Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC) require measures in case of negative impacts of human activities on species and habitats listed in these directives. Where dredging activities are carried out in or adjacent to Natura 2000 sites (*i.e.* protected areas that are established under the Birds and Habitats Directives and part of the Natura 2000 network), EU legislation on the conservation of natural habitats and wild flora and fauna may protect the sites sufficiently. Decisions relating to dredging activities need to be taken in accordance with the procedures laid out in the EU Directives.

All Contracting Parties that responded to the 2002 questionnaire regulate dredging operations by national laws and recommendations. Most Contracting Parties carry out Environmental Impact Assessments (EIAs) before dredging operations start, however to different extents. Only Spain, France and the Netherlands reported that an EIA is generally required. Generally, impact assessments are carried out in special cases with a high risk of environmental impacts, *e.g.* in sensitive or highly contaminated areas. In almost all Contracting Parties, regulatory authorities or agencies impose restrictions in cases where negative environmental impacts due to dredging were observed or are expected. Restrictions include *e.g.* use of protective or mitigating measures in order to minimise effects of dredging, such as silt screens or sealed grabs. Furthermore, temporal or seasonal restrictions for dredging are imposed ("dredging windows").

The protection of the environment depends upon the appropriate and effective application of existing regulations. However, at present the effectiveness of existing regulations and BEPs in minimising the volumes dredged, improving the dredging process and minimising the impacts of dredging activities in species and habitats and ecosystem processes cannot be judged on the basis of currently available information.

4. How does this work affect the overall quality status?

Dredging activities can have negative effects on the diverse fauna of estuaries and other marine habitats. Species that are affected include species with a direct economic value like grey shrimps, plaice, bass, eel, or that are particular sensitive and listed on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2008b) or in the Birds and Habitats Directives, *e.g.* Sea lamprey (*Petromyzon marinus*); River lamprey (*Lampetra fluviatilis*); Twaite shad (Alosa *fallax*); Grey seal (*Halichoerus grypus*) and sea bird species.

Only limited information is available on the actual overall effects of dredging activities on species, habitats and ecosystem processes in the OSPAR Maritime Area. Some valuable information on the environmental effects of dredging and disposal activities is provided by the Dutch New Delta Project (2007). The project used the experience from dredging activities in different types of estuaries to investigate the relation of pressures and impacts of dredging and disposal activities. In this project a general framework for the assessment of cause-effect relationships of dredging activities within estuaries was developed that identifies a range of environmental effects. These effects include *e.g.* habitat changes from hydromorphological regimes changes and effects on fish or fish eating bird species from increased turbidity as well as related effects on estuary functions, such as changes in biodiversity or reduction of spawning areas (see Figure 2.2).

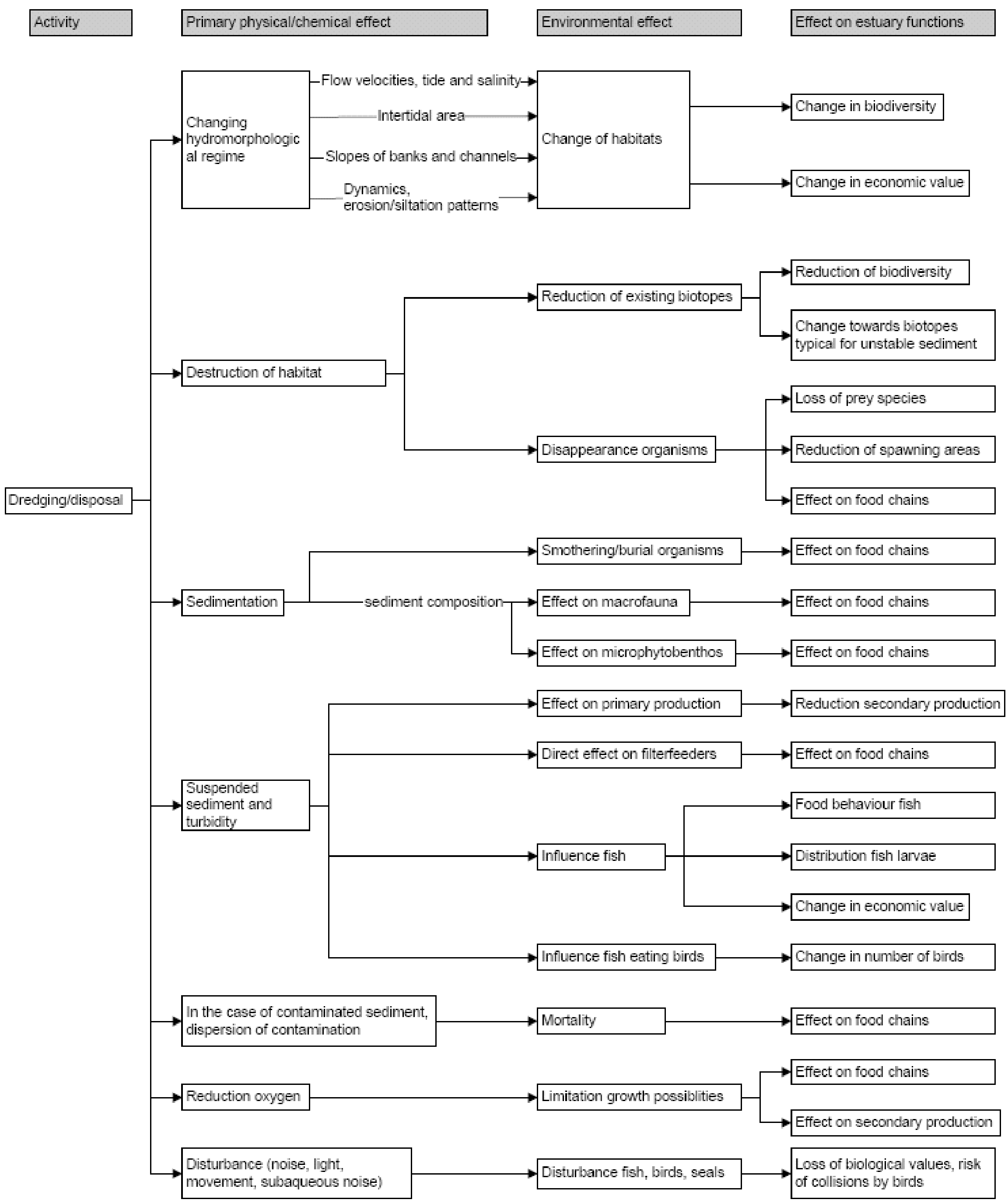

Figure 2.2: A general assessment framework for cause-effect relationships for dredging activities. Source: New Delta Project, 2007.

The New Delta project also identified habitat types that might be influenced by dredging and disposal activities:

- A group of coastal and halophytic habitats:

  Sandbanks, which are covered by sea water all the time;
  Estuaries;
  Mudflats and sand flats which are not covered by water all the time;

- A group of salt marshes:

  Salicornia and other annuals colonizing mud and sand;
  Spartina swards (*Spartinion maritimae*);
  Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*).

In a study in the Netherlands (Les & Ruijter, 2005), the spatial and temporal influence on turbidity was monitored before, during and after water injection dredging activities in an area of Rotterdam harbour. The dredged material was expelled from the harbour into the Nieuwe Waterweg, the waterway in the delta of Rhine and Meuse. The maximum turbidity measured in the Nieuwe Waterweg has fallen to the turbidity range occasionally measured under natural circumstances. The increase was restricted to a short period and to short distances. During dredging in the late afternoon a strong increase in turbidity has been observed as a sediment cloud at the bottom, but next morning this cloud had already disappeared. At low stream velocities in the waterway, the sediment cloud caused by water injection dredging has been observed at a maximum distance of 400 m in the direction of the current and of 200 m perpendicular to the current. At high stream velocities the density flow moved along the bank beyond the maximum reach of the measurements. The study confirmed results of an earlier study on water injection dredging in Germany as mentioned in the background document (Meyer-Nehls et al., 2000). In both studies an increase of turbidity in particular close to the bottom was observed only for short periods and short distances.

The turbidity under natural circumstances varies strongly within and between dredging sites according to local factors such as water depth, rate of flow, tidal currents, wave action, type of seabed and sediment load of the sea and the rivers that run into the sea. The potential environmental impact of using hydrodynamic dredging technique therefore must be evaluated in relation to the natural situation, as natural events may also result in re-suspension of sediments and increased turbidity. The total quantity of material brought into suspension should be considered in conjunction with sediment concentrations and duration of the works. The natural sediment concentrations in the water, especially under storm conditions or high (river) transport situations, are frequently similar to or even larger than that which is attained by hydrodynamic dredging. Also, natural seasonal variations could make hydrodynamic dredging (and even normal dredging) more acceptable in one season than in another. Therefore, the environmental impacts of any type of dredging works can be reduced by proper planning.

The sites where dredging activities are carried out, especially maintenance dredging are often heavily disturbed or altered by human activities. The continual dredging activities together with other activities that cause an increase of turbidity do not allow such sites to fully recover. To a large extent in OSPAR Contracting Parties dredging activities are carried out in or adjacent to marine protected areas (MPAs) or other sensitive areas. Potentially adverse environmental impacts can occur from the use of hydrodynamic or sidecast dredging techniques in or adjacent to such areas, especially in case of high contamination of the sediment. In these cases site-specific environmental assessments should be made. For the surroundings of the dredging sites, the increase in turbidity due to re-suspension of sediments caused by dredging, together with chemical quality and biological characteristics of the sediments, may be regarded as an indicator for potential ecological effects. Moreover, dredging, together with shipping, can possibly lead to erosion or enhanced sedimentation in the surrounding areas, as well as to temporal disturbance of nature.

5. What do we do next?

The environmental impacts of dredging activities with conventional and hydrodynamic techniques are not only influenced strongly by the contamination of the sediment, but also by local factors like water depth, rate of flow, tidal currents, wave action, type of seabed and sediment load of the water. This means that for each site specific assessments should be made to ensure that measures are taken to minimise impacts. A possible starting point for a revised assessment framework of dredging activities was provided by the New Delta project (2007), including an overall assessment methodology. The framework is applicable in all project phases taking into account the different project components and specific system conditions. Key factors for an assessment are the environmental sensitivity of the site and its surroundings, the natural concentrations and seasonal variations in turbidity on the site and the quantity and nature of the dredged sediment. In many cases, controlled application of available techniques may already reduce impacts sufficiently. Impacts must be placed into the correct perspective by comparing the likely magnitude of effect against the ongoing present trends and the natural variability.

As demonstrated by the responses to the 2006 questionnaire, locations and hydrodynamic conditions of dredging sites, the composition of the material dredged and dredging frequency vary widely. From the New Delta project (2007) several case studies *i.e.* Seine, Western Scheldt and Humber have shown that different types of coastal and halophytic habitats can be impacted by dredging activities. As case and site-specific impacts require a site-specific approach, general measures to control the impacts of dredging might be inadequate.

Efficient control can only be implemented if the impact of dredging methods on the environment is well understood. There is still a need for further research on the impacts under different circumstances, especially on the impact of hydrodynamic and sidecast dredging techniques. Any strategy developed has to be specific to that estuary/system since it is not possible to apply the same dredging strategy to all areas.

At present it can be assumed that in most cases, the existing national regulations of OSPAR Contracting Parties, together with EU legislation, is sufficient to minimise the adverse effects of dredging on marine species and habitats. Evaluation of the effectiveness of existing regulations, especially on protected areas, is recommended once Contracting Parties have fully implemented the existing legislation. Management plans for marine protected areas should contain guidelines for dredging activities. It is advised that a management plan for an OSPAR MPA or a Natura 2000 site contains a dredging strategy that describes how to deal with dredging activities (particularly maintenance dredging) and that covers all aspects including excavation and disposal/relocation activities. Elements in such a dredging strategy could include, but not be limited to:

- designation of areas where the dredged material will be disposed;
- methods of dredging and disposal so that adverse effects are avoided/minimised, for example no dredging during the migration period of certain vulnerable fish species or spreading of contaminated sediments;
- monitoring and evaluation programmes that allow amendment of the dredging strategy based on the results.

The EU Working Group on “Estuaries and adjacent Coastal Zones” is currently preparing a guidance document on the implementation of the EU nature legislation and the Water Framework Directive in estuaries and coastal zones, with particular attention to port-related activities and dredging. This might help to identify further actions to minimize negative effects of dredging activities.

In conclusion, OSPAR should consider options for monitoring and assessment of dredging activities that would allow a clearer analysis of the effects on species, habitats and ecosystems processes as well as an evaluation of the effectiveness of existing regulations, including the application of BEP. OSPAR Contracting Parties are encouraged to develop appropriate dredging strategies, in particular with regard to MPAs and other sensitive areas.

However, before developing additional OSPAR measures to exercise specific control on the effects of dredging operations on marine species and habitats, existing regulations, including EU legislation, should first be fully implemented and evaluated.

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[2] All OSPAR publications and measures can be downloaded from the 'publication' and 'programmes and measures' sections, respectively, of the OSPAR website http://www.ospar.org. All European Community legislation, documents can be downloaded from the Eurlex website of the European Community http://eur-lex.europa.eu/en/index.htm; EC publications can be searched at http://circa.europa.eu

Annex 1

Brief description of dredging equipments and techniques

Hydraulic (trailing) suction hopper dredgers with and without cutterhead:

The characteristics of the trailing suction hopper dredger are that it is a self-propelled sea or inland waterway vessel, equipped with a hold (hopper) and a dredge installation to load and unload itself. The cutter suction dredger is a stationary dredger equipped with a cutter device (cutter head) which excavate the soil before it is sucked up by the flow of the dredge pump(s).

Mechanical techniques such as clamshell or crane dredger:

The grab dredger is the most common used dredger in the world, especially in North America and the Far East. It is a rather simple and easy to understand stationary dredger with and without propulsion. In the latter the ship has a hold in which it stores the dredge material, otherwise barges transport the material. The dredgers can be moored by anchors or by poles (spuds).

Mechanical bucket ladder dredger and the dipper/backhoe dredger:

The bucket dredger is one of the mechanical dredgers. A bucket dredger is a stationary dredger that is equipped with a continuous chain of buckets, which are carried through a structure, the ladder. During dredging, the dredger swings round the bow anchor by taking in or paying out the winches on board. The buckets, which are filled on the underside, are emptied on the upper side by tipping their contents into a chute along which the dredged material can slide into the barges moored alongside.
A backhoe dredge is a stationary tool, anchored by three spuds: two fixed spuds at the front (starboard and portside) and a moveable spud at the back of the pontoon. Hydraulic dredgers are available in two models, the backhoe () and the dipper or front shovel. The difference between those two is the working method. The backhoe pulls the bucket to the dredger, while the front shovel pushes. The last method is only used when the water depth is insufficient for the pontoon.

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