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.

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, 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.

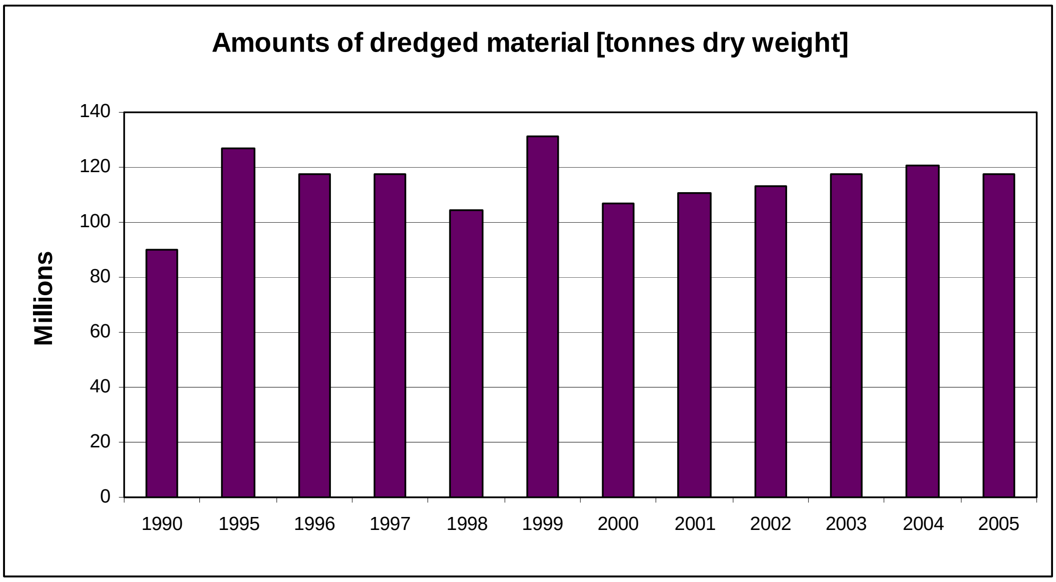

Figure 2.1 Amount of dredged material disposed of from 1990 – 2005 within the OSPAR area indicating trends in dredging activities. Source: OSPAR, 2009a.

[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 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 m^2			**10 000–100 000 m^2**			**> 100 000 m^2**		
		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.

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.

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.

➥*Go to full QSR assessment report on the environmental impact of dredging for navigational purposes (publication number 366/2008)*