3 Dredging and dumping

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Dredging comprises all activities required to remove sand, silt and other bottom layers of waterbodies for the maintenance of shipping channels and harbours, but also for land reclamation and nature development. For more information on the extraction of raw materials from the sea, for example for the construction industry, reference is made to the thematic chapter **Sand and gravel extraction**. With respect to dredging, a distinction should be made between capital dredging and maintenance dredging. Capital dredging is dredging for the creation of new or the widening of existing waterways, docks and locks. Maintenance dredging is dredging in which the sediment in waterways and port basins is removed without enlarging the waterway or the port basin beyond their original dimensions[1] (Verslag van het Rekenhof 2016).

This thematic chapter elaborates on the dredging for and dumping of sediment to maintain and deepen maritime access routes. This includes the access routes to the seaports of Ostend, Zeebrugge, Ghent and Antwerp. The current text specifically focuses on the dredging and dumping activities in the Belgian part of the North Sea (BNS). The Scheldt estuary is not only an important ecosystem, it also forms the operating area of a number of functions, such as shipping, for which dredging is required (see also ScheldeMonitor and the VNSC website). A different context applies to the dredging works in the Scheldt estuary, and as such we refer to the thematic chapter **Scheldt estuary** for this topic.

Between 2008 and 2014, more than 1,000 million tonnes (dry weight) of sediment were deposited in the OSPAR[2]-region (North East Atlantic and North Sea) (OSPAR IA 2017). A large portion of this sediment is dredged and disposed of in the southern part of the North Sea, mainly due to the maintenance of the shipping channels to major seaports such as Hull, Zeebrugge, Rotterdam, Bremen, Emden, Hamburg, Esbjerg, etc. (OSPAR QSR 2010). In the Belgian part of the North Sea, 10.9 million tonnes (dry weight) of dredged material were dumped at sea in 2017 (Lauwaert et al. 2019). The evolution of the amount of dredged material in the BNS has been monitored by the Scientific Service Management Unit of the Mathematical Model of the North Sea (RBINS-MUMM) since 1991 (figure 1). It is possible that more sediment will be dredged and dumped in the future due to the increasing size of ships and the associated widening and deepening of the navigation and port channels (OSPAR QSR 2010). At the same time, large-scale hydraulic engineering works offer opportunities for the sustainable reuse of sediment in, for example, coastal defence projects. A current example of this approach is the foreshore nourishment between 2020 and 2023 in Knokke, with material from the dredging works for the New Lock Terneuzen.

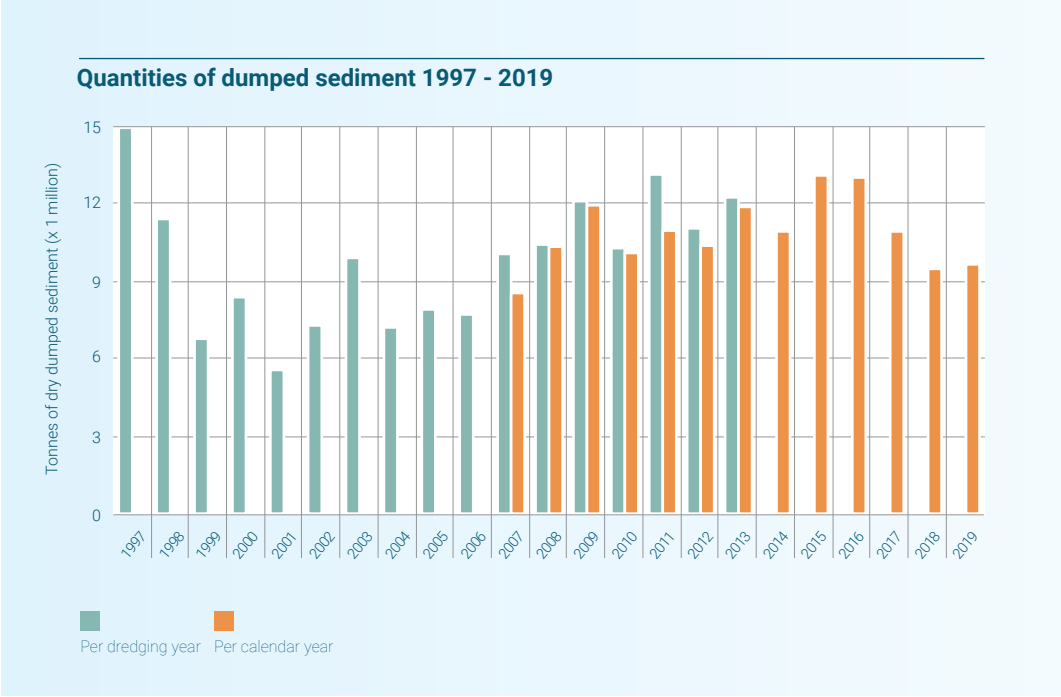

Figure 1. Quantities of sediment dumped in the BNS, expressed in tonnes of dry matter (Source: RBINS-MUMM). A dredging year in the figure above is defined as the period between 1 April and 31 March of the following year; from 2015 onwards, dredging years run concurrently with the calendar years.

[1] The minimum dimensions or clearance profile required for ships of a certain size to navigate a waterway.
[2] OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic.

3.1 Policy context

The maintenance and deepening of the maritime access channels to ports and the maintenance of the depth in the ports is a Flemish competence. The Department of Mobility and Public Works (MOW), Maritime Access division, is responsible for the fairways, as well as for the engineering structures and properties located along the maritime access routes to the Flemish ports, including Zeebrugge and Ostend. The Agency for Maritime Services and Coast (MDK), Coastal division, is charged with the maintenance of the Flemish marinas of Ostend, Blankenberge, Zeebrugge and Nieuwpoort. The management of dredging works is a mixed competence in Belgium for which a cooperation agreement was made between the Flemish Region and the federal state on 12 June 1990, as amended by the Cooperation Agreement of 6 September 2000. The competence for dumping dredged material at sea lies with the federal Government. The conditions for the re-use of dredged material from waterways or water bodies (including fairways, harbours and docks) as soils or building material are included in the Code of Good Practice for Dredging and Clearing Material (Government of Flanders s.d.). These also implement Article 5.3.4.3. of the Decision of the Government of Flanders, establishing the Flemish regulation on the sustainable management of material cycles and waste materials (Decision of 17 February 2012) and were also included in the Ministerial Decision of 5 November 2015.

The procedure for obtaining a permit to dump dredged material at sea, necessary for carrying out the tasks of the Government of Flanders, has been stipulated by the RD of 12 March 2000. The maximum amount of dredged sediment and the location of the dredging and disposal sites that have been granted to the Maritime Access division and the Agency for Maritime Services and Coast since 2004, can be found in various Ministerial Decrees published in the Belgian official journal.

3.2 Spatial use

In the marine spatial plan (MSP 2020-2026, RD of 22 May 2019 see also Verhalle and Van de Velde 2020), five zones for the disposal of dredged material were delimited: *Bruggen en Wegen (Br&W) Zeebrugge Oost* (ZBO), *Br&W* Ostend (OST), *Br&W* Nieuwpoort (NWP), S1 and S2 (figure 2). In addition, the MSP also defines a number of exploration zones for the dumping of dredged material, which can be used to relocate or optimise the existing dumping zones S1, *Br&W* Ostend, *Br&W* Nieuwpoort and *Br&W Zeebrugge Oost*. The designation of new zones for dumping is linked in the MSP to site-specific conditions, such as the impact on fisheries and shipping (MSP 2020-2026).

Dumping at a location to the west of Zeebrugge was prompted by the results of research conducted in the 2009-2016 period, which looked into the optimisation of dredging operations (Lauwaert et al. 2019). On behalf of the Maritime Access division, a pilot was carried out between October and November 2013 to further investigate an alternative dumping site west of Zeebrugge (Fettweis et al. 2016, Lauwaert et al. 2016). From 2017 onwards, a study about the practical implementation was started and, considering the environmental aspects, co-use and practicality, a number of possible scenarios were defined. The next step is to set up a long-term pilot, which will allow the scenarios to be thoroughly tested before finalisation (Lauwaert et al. 2019). For the dredging works in the port of Blankenberge, the use of a dumping zone to the west of Zeebrugge also provides an efficiency gain.

In addition to the existing zone for dumping in the vicinty of the Port of Zeebrugge, the MSP also includes reservation zones for the S1 dumping site. This site is located on the Sierra Ventana, however the accretion of this zone in a NW direction and the proximity of the offshore wind farm zone may limit the space for navigation. The remaining capacity of the dumping site, which has been at the present location since 2000, is also limited. A study programme will be initiated to examine the possible relocation of the site (Lauwaert et al. 2019).

An alternative disposal method, using a fixed pressure pipeline close to the coast, was proposed for the marinas of Nieuwpoort and Blankenberge (Lauwaert et al. 2016). Because the use of a possible dumping zone west of Zeebrugge (see above) already provides an efficiency gain for the port of Blankenberge, the research into alternative dumping methods for the port of Blankenberge was discontinued (Lauwaert et al. 2019). For the marina of Nieuwpoort, research has shown that the preconditions and the limited expected profitability do not justify the use of alternative methods. For Nieuwpoort, the alternative dumping site defined in the MSP 2020-2026 will be further investigated (Lauwaert et al. 2019).

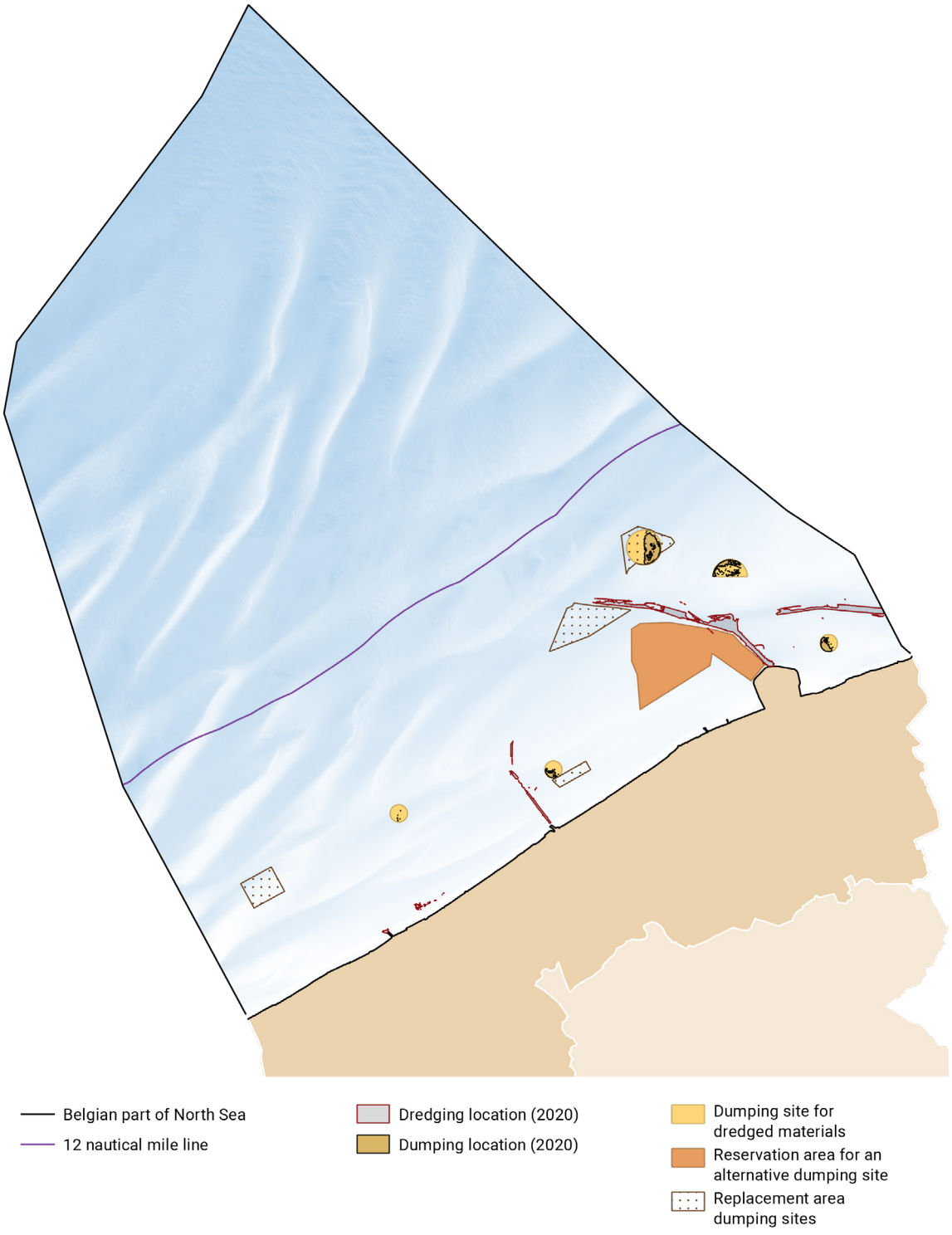

Figure 2. The location of the dredging and dumping sites at the BNS (source: RBINS, MarineAtlas.be (based on the RD of 22 May 2019 (MSP 2020-2026), Coastal Portal).

3.3 Societal interest

The Flemish ports are important economic gateways (see thematic chapter **Maritime transport, shipping and ports**). Due to the increase in scale of the ships, it is necessary to maintain the channels to these ports continuously and to widen them on certain occasions. In 2019, the Government of Flanders invested 219.9 million

euro to ensure the accessibility of the Flemish ports (including the Scheldt estuary, figure 3). Starting in 2016, an annual amount of 59.5 million euro is included for the financial contribution from Flanders to the Netherlands on behalf of the new lock in Terneuzen (Merckx 2020).

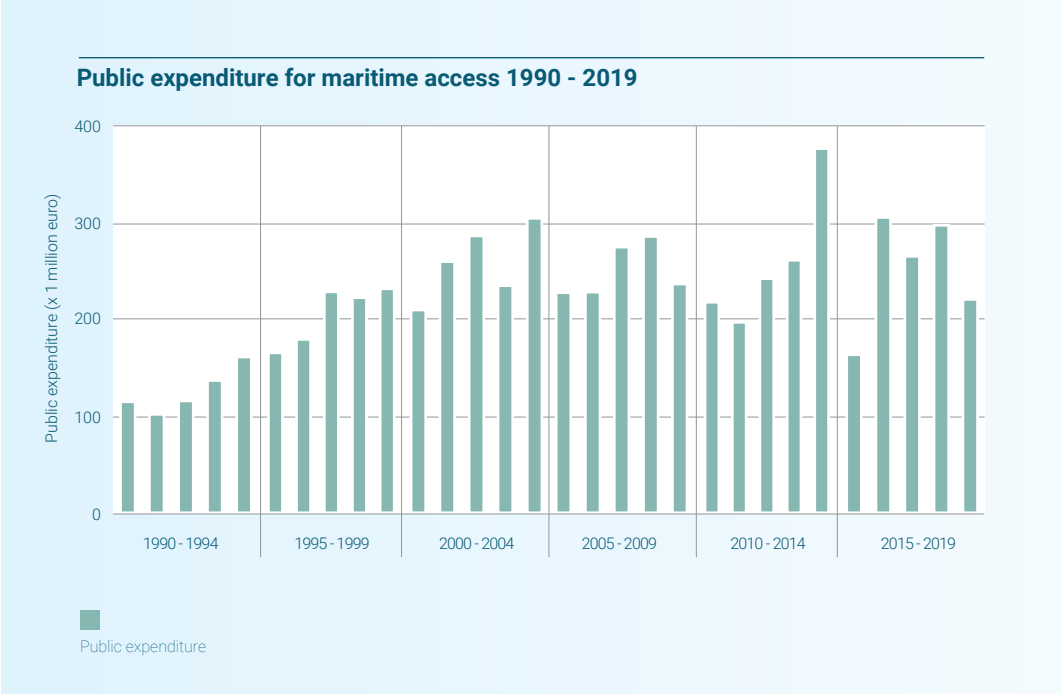

Figure 3. Public expenditure for maritime access by the Flemish Community in million euro for the period 1989-2019, in 2019 prices, Merckx 2020).

The Ministerial Decisions of 22 December 2016 determined that from 1 January 2017 until 31 December 2021, the Maritime Access division had a total of four permits, allowing to dump a total maximum of 26,450,000 tonnes of dry matter at four sites in the BNS (on an annual basis). In addition, the Agency for Maritime Services and Coast also had four permits allowing it to dump a total maximum of 700,000 tonnes of dry matter per year (Ministerial Decisions of 22 December 2016) from 1 January 2017 to 31 December 2021. For the disposal of dredged material from the maintenance of the Sea Scheldt and the Western Scheldt, the Maritime Access division also has permits from the provinces of East Flanders and Antwerp (Sea Scheldt) and the necessary removal and disposal permits from the competent Dutch authorities (Western Scheldt) (see also the thematic chapter **Scheldt estuary**).

3.4 Impact

The most common type of vessel used for maintenance dredging is the trailing suction hopper dredger. This dredger is equipped with one suction tube (exceptionally two) and a large suction nozzle (the 'drag head') that act like a huge hoover hose to remove sediment from the channels. This type of vessel has the advantage that it is very mobile, so that it does not hinder navigation, while it is still able to transport the dredged sediment over longer distances. In these maintenance dredging operations, the sediment is removed until the minimum guaranteed depth is achieved, including a small margin to anticipate future sedimentation. Once the sediment has been loaded and the vessel has arrived at the designated dump site, the dredged material can be unloaded by means of a system of bottom doors or slides. In certain cases, it is also possible to mix the dredged material with water in order to pump it hydraulically via a bow coupling and a system of (floating) pipelines to land.

In addition to the trailing suction hopper dredger, a cutter suction dredger or cutter head dredger is also often used for capital or construction dredging work. This is a stationary dredging vessel that uses a rotating cutter head to loosen material from the bottom. The hydraulic pumping system on board ensures suction of the sediment mixture and its hydraulic transport. Nowadays, feasibility studies and demonstration projects are also conducted to evaluate alternative methods (e.g. fixed pressure pipelines) (Lauwaert et al. 2016). An exploratory study using the alternative technique of Water Injection Dredging (WID) was carried out by Van Oyen et al. (2016). This involves moving the sediment by applying natural forces according to the principle of gravity-driven density flows. Fluidising the sediment allows it to flow out of the harbour under certain conditions.

The nature of the dredged sediment varies depending on the location along the coast. The composition of the dumped material may influence the sediment composition of the dump sites (e.g. lumps of silt in the sediment). In addition, the natural sediment composition on the various deposit sites also varies. For example, the Nieuwpoort site is characterised by a large fraction of sand and a small fraction of silt. The Br&W Ostend and Br&W Zeebrugge sites have the lowest average grain size (<200 µm) and the highest concentration of silt (Van Hoey et al. 2012, Lauwaert et al. 2016).

The impact of dredging and dumping activities on the marine environment is monitored and studied in terms of physical, chemical and biological aspects (Lauwaert et al. 2019, Belgian State 2018; table 1 and figure 4, the latter outlining the general framework, not specific to the BNS). For the period 2013-2016, research was conducted about the occurrence of marine litter at the dredged material dump sites (Lauwaert et al. 2016, De Witte et al. 2021). Further research will focus on the origin and baseline of this marine litter also in the context of the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) (Lauwaert et al. 2019). The impact of dredging and dumping on other users is addressed in studies such as, Verfaillie et al. (2005) (GAUFRE project BELSPO) and Van Hoey et al. (2014a).

Table 1. An overview of the effects of dredging and dumping activities on the environment.

Environmental impact	Literature
Physico-chemical impact: changes in soil morphology and composition (grain size) and sedimentological effects (sediment plumes, turbidity, pollutant release, etc.)	Verfaillie et al. 2005 (BELSPO GAUFRE project), Fettweis et al. 2007b (BELSPO MOCHA project), Goffin et al. 2007, Du Four and Van Lancker 2008, Van Hoey et al. 2009, André et al. 2010, Fettweis et al. 2011, Lauwaert et al. 2011, Lauwaert et al. 2014, Vanhellemont and Ruddick 2015, Fettweis et al. 2016, De Witte et al. 2016, Lauwaert et al. 2016, Decrop et al. 2018, Vanlede et al 2019, Lauwaert et al. 2019
Biological impact: effects on fauna and flora (disturbance of benthos, influence of released pollutants, etc.)	Verfaillie et al. 2005 (BELSPO GAUFRE project), André et al. 2010, Lauwaert et al. 2011, Lauwaert et al. 2014, De Backer et al. 2014, Lauwaert et al. 2016, Lauwaert et al. 2019, Mestdagh et al. 2020

3.5 Sustainable use

In order to address the impact of the dumping of dredged material on the marine environment, the activity is globally governed by the London Convention (1972) and the London Protocol (1996), which address the pollution caused by the dumping of material at sea. At regional level, the OSPAR Convention (1992), which aims to protect the marine environment of the North-East Atlantic (including the North Sea), provides a relevant regulatory framework. OSPAR also issued guidelines for the sustainable management of dredged material (OSPAR Commission 2014). Currently there is no obligation under the OSPAR Convention to monitor the environmental impacts of the dumping of dredged material, but many OSPAR countries have national monitoring programmes in place which also take this topic into account (OSPAR IA 2017).

At European level, the Water Framework Directive (WFD, Directive 2000/60/EC) and the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) identify human-induced changes in the concentration of sediment in the water column as one of the major pressures on the marine environment. The MSFD also defines a number of descriptors for a good environmental status which are relevant for dredging and dumping (Lauwaert et al. 2016, OSPAR IA 2017, Lauwaert et al. 2019): the condition of benthic habitats, soft substrate (descriptor 6, Seafloor integrity, Rice et al. 2010), concentrations of contaminants (descriptor 8, Contaminants and pollution effects, Law et al. 2010), marine litter (descriptor 10, Marine litter, Galgani et al. 2010), and the permanent alteration of hydrographical characteristics (descriptor 7, Hydrographical conditions, EC website). In addition, descriptors 1 (Biological diversity, Cochrane et al. 2010) and 4 (Marine food webs, Rogers et al. 2010) are (indirectly) affected by the disposal of dredged material. In the MSFD, the change in silt deposition due to dredging and dumping activities is no longer directly included in the list of anthropogenic impacts on the marine environment (Directives 2008/56/EC and 2017/845/EC). Since the 2017 revision, dredging and dumping of materials has been included as 'uses and human activities in or affecting the marine environment' under the theme of 'physical restructuring of rivers, coast or seabed'. In the revision of the initial assessment for the Belgian marine waters (Belgian State 2018), the impact in the context of the dumping of dredged material is evaluated with respect to MSFD descriptors 1, 6, 10 & 11. The implementation of the MSFD in Belgian legislation is done by the RD of 23 June 2010 (see thematic chapter **Nature and environment**). The possible application of the MSFD evaluation scheme in the assessment of the activity 'dumping of dredged material' was elaborated in Lauwaert et al. (2016). Hereby, ten relevant MSFD environmental targets were selected. In addition, the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC) are also an important framework to address the impact of dredging and dumping activities. In Van Hoey et al. (2014b), a Benthic Ecosystem Quality Index (BEQI) was developed in the framework of the WFD, MSFD

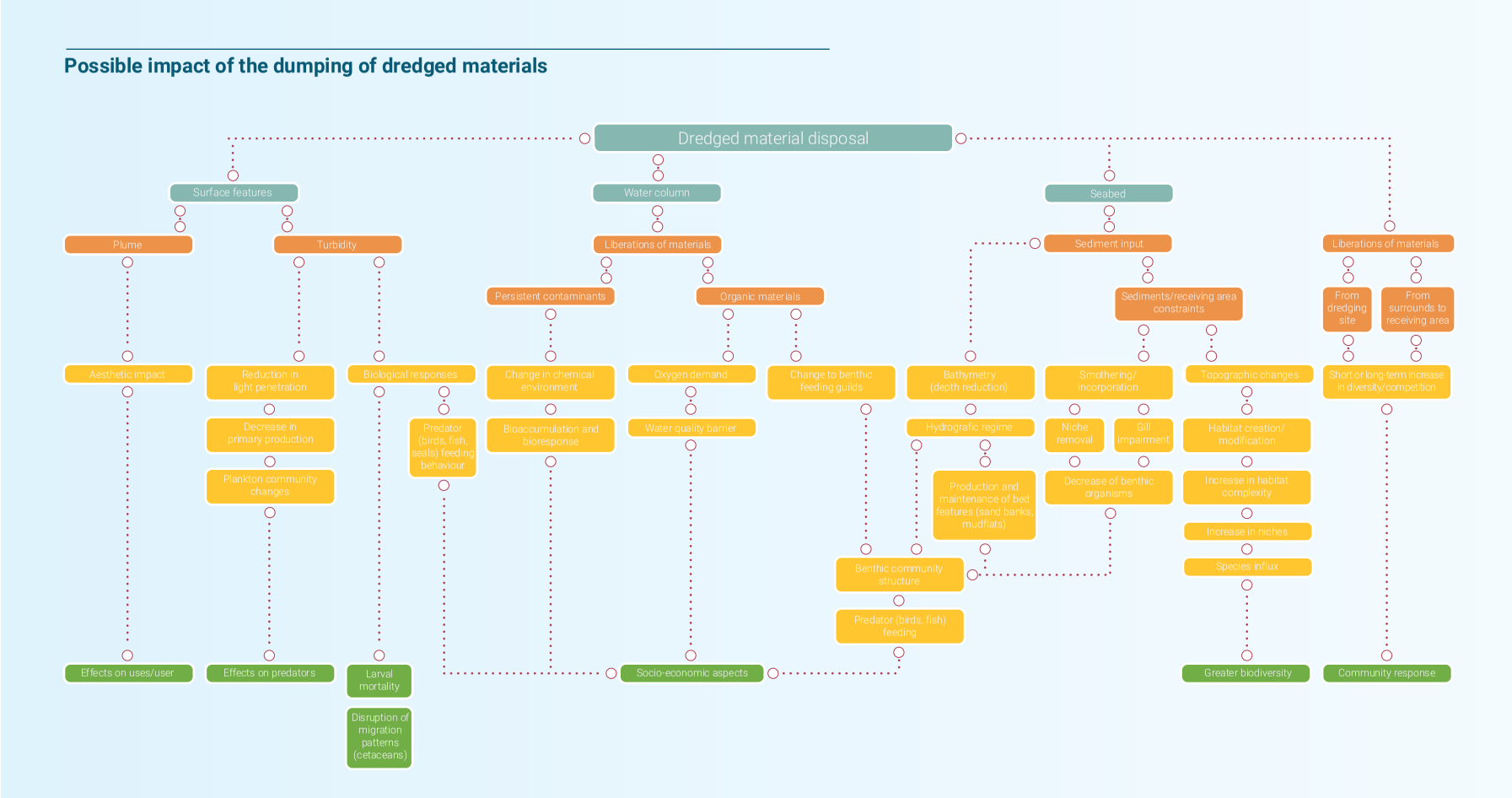

Figure 4. Conceptual diagram of the possible impact of dumping dredged material (not everything is applicable to the BNS) (derived from Elliot and Hemingway 2002).

and Habitats Directive for the assessment of the status of the soft substrate fauna. This index is applied, among others, in the monitoring of the dumping of dredged material.

In the BNS, dredging and dumping are bound by the Law of 20 January 1999. Specifically, for works carried out by the Government of Flanders, the RD of 12 March 2000 (amended by the RD of 18 October 2013) stipulates that a synthesis report must be submitted to the competent minister every five years. In these reports, the effects of the dredging and dumping activities are discussed and recommendations are made to the competent minister to underpin the environmental policy at sea (synthesis reports: Lauwaert et al. 2002, Lauwaert et al. 2004, Lauwaert et al. 2006, Lauwaert et al. 2008, Lauwaert et al. 2009, Lauwaert et al. 2011, Lauwaert et al. 2016, Lauwaert et al. 2019). Furthermore, the quality of the dredged material itself must meet certain sediment quality criteria (Goffin et al. 2007, OSPAR 2008). This quality is checked every 10 years by taking and analysing *in situ* samples at the dredging sites. In this context, a campaign was conducted in 2018 (Lauwaert et al. 2019). In addition, samples of the dredged sediment are taken from inside the hold or hopper of the dredges on a regular basis (approximately every four months) and analysed against the limit and target values stated in the granted permits.

In the framework of the permits, a monitoring and scientific programme is imposed to the Government of Flanders. In the MOMO programme, RBINS-MUMM is responsible for the monitoring and modelling of the cohesive sediment transport and the evaluation of the effects on the marine ecosystem as a result of dredging and dumping operations (see, among others, Fettweis et al. 202). The Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) studies the biological and chemical aspects at the various dump sites. In doing so, attention is paid to knowledge gaps such as the presence of marine litter, microplastics and other emerging contaminants in the dredged material, as well as to possible cumulative effects (OSPAR IA 2017, Lauwaert et al. 2016, Lauwaert et al. 2019). In addition, new monitoring technologies are used (sediment profile imaging, cf. Van Hoey et al. (2014a)). Furthermore, functional ecosystem changes are included to evaluate the biological aspects. For the implementation of plans or projects with possible significant effects on Natura2000 sites, an appropriate assessment (*passende beoordeling*) must be made (RD of 27 October 2016). For this purpose, an overarching framework for all dump sites will be elaborated (Lauwaert et al. 2019).

Steps are also being taken by the contracting authority to reduce the environmental impact of dredging. In the tenders (2019) for the nourishment of the Flemish coast, also the reduction of the environmental impact and CO_2 emissions in particular were a criterion for the granting of the contract, besides other criteria such as price and quality.

In the dredging industry there is currently a movement going - in cooperation with knowledge institutions - (i) to align and base dredging activities on natural processes, (ii) to sustainably reuse dredged material, or (iii) to deliberately create certain ecosystems (see among others the so-called Nature Based Solutions-concept, in the thematic chapter **Safety against flooding**). In addition, the feasibility of the use of dredged material is also examined for the suppletion of beaches in function of coastal safety, the creation of room for rivers to increase drainage and storage capacity, land reclamation, nature development etc. (Temmerman et al. 2013, de Vriend et al. 2015). These activities are also grouped under the term "beneficial use" (OSPAR 2014). In addition to suppletion methods, recent research is also looking into the possibilities of integrating CO_2 capture into dredging practices (Meysman and Montserrat 2017).

Legislation reference list

Overview of the relevant legislation on international ('Year A': adoption; 'Year EIF': entry into force), European, federal and Flemish level. For the consolidated European policy context see Eurlex. The national legislation can be consulted on the Belgian official journal and the Justel-database, the Flemish legislation is available on the Flemish Codex.

International conventions and agreements			
Acronyms	**Title**	**Year A**	**Year EIF**
London Convention	Convention on the prevention of marine pollution by dumping of wastes and other matter	1972	1975
OSPAR	Convention for the protection of the marine environment of the North-East Atlantic	1992	1998
London protocol	The Protocol to the 1972 Convention on the prevention of marine pollution by dumping of wastes and its Annexes 1, 2 and 3	1996	2006

European legislation and policy context			
Document number	**Title**	**Year**	**Number**
Directives			
Directive 92/43/EEC	Directive on the conservation of natural habitats and of wild fauna and flora (Habitat Directive)	1992	43
Directive 2000/60/EC	Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)	2000	60
Directive 2008/56/EC	Directive establishing a framework for Community action in the field of marine environmental policy (Marine Strategy Framework Directive)	2008	56
Directive 2009/147/EC	Directive on the conservation of wild birds (Birds Directive)	2009	147

Belgian and Flemish legislation		
Dates	**Title**	**File number**
Decisions of the Govt. of Flanders		
Decision of the Government of Flanders of 13 July 2001	Besluit van de Vlaamse Regering betreffende de aanduiding van de maritieme toegangswegen en de bestanddelen van de haveninfrastructuur	2001-07-13/90
Decision of the Government of Flanders of 17 February 2012	Besluit van de Vlaamse Regering tot vaststelling van het Vlaams reglement betreffende het duurzaam beheer van materiaalkringlopen en afvalstoffen	2012-05-23/464
Royal Decrees		
RD of 12 March 2000	Koninklijk besluit ter definiëring van de procedure voor machtiging van het storten in de Noordzee van bepaalde stoffen en materialen	2000-03-12/40
RD of 23 June 2010	Koninklijk besluit betreffende de mariene strategie voor de Belgische zeegebieden	2010-06-23/05
RD of 18 October 2013	Koninklijk besluit tot wijziging van het koninklijk besluit van 12 maart 2000 ter definiëring van de procedure voor machtiging van het storten in de Noordzee van bepaalde stoffen en materialen	2013-10-18/20
RD of 22 May 2019	Koninklijk besluit tot vaststelling van het marien ruimtelijk plan (2020-2026)	2019-05-22/23

Belgian and Flemish legislation (continuation)		
Dates	**Title**	**File number**
Ministerial Decrees		
MD of 7 October 1999	Ministerieel besluit betreffende het storten in zee van baggerspecie	1999-10-07/31
MD of 28 October 1999	Ministerieel besluit houdende wijziging van de ministeriële besluiten houden machtiging tot het storten in zee van baggerspecie door het Ministerie van de Vlaamse Gemeenschap, Departement Leefmilieu en Infrastructuur, Administratie Waterwegen en Zeewezen, Afdeling Waterwegen Kust met referenties BS/97/01, BS/97/02, BS/97/03 en BS/97/04 en verlengd bij ministerieel besluit van 20 maart 1999.	1999-10-28/31
MD of 28 December 2011	Machtiging tot het storten in zee van baggerspecie door de Vlaamse overheid, Departement Mobiliteit en Openbare Werken, afdeling Maritieme Toegang en voor Maritieme Dienstverlening en Kust, afdeling Kust	
MD of 28 December 2011	Machtiging voor het storten van baggerspecie bij ministeriële besluiten van 28 december 2011	
MD of 19 December 2013	Machtiging voor het storten van baggerspecie - verlenging bij ministerieel besluit van 19 december 2013	
MD of 5 November 2015	Ministerieel besluit houdende vaststelling van de algemene code van goede praktijk inzake bagger- en ruimingsspecie	2015-11-05/04
MD of 22 December 2016	Machtiging voor het storten van baggerspecie bij ministeriële besluiten van 22 december 2016	
Cooperation agreements		
Cooperation agreement of 12 June 1990	Samenwerkingsakkoord tussen de Belgische Staat en het Vlaamse Gewest ter vrijwaring van de Noordzee van nadelige milieu-effecten ingevolge bagger-specielossingen in de wateren die vallen onder de toepassing van de Conventie van Oslo	1990-06-12/38
Cooperation agreement of 6 September 2000	Samenwerkingsakkoord tot wijziging van het Samenwerkingsakkoord van 12 juni 1990 tussen de Belgische Staat en het Vlaamse Gewest ter vrijwaring van de Noordzee van nadelige milieu-effecten ingevolge bagger-specielossingen in de wateren die vallen onder de toepassing van de Conventie van Oslo	2000-09-06/31
Laws		
Law of 20 January 1999	Wet ter bescherming van het mariene milieu en ter organisatie van de mariene ruimtelijke planning in de zeegebieden onder de rechtsbevoegdheid van België	1999-01-20/33