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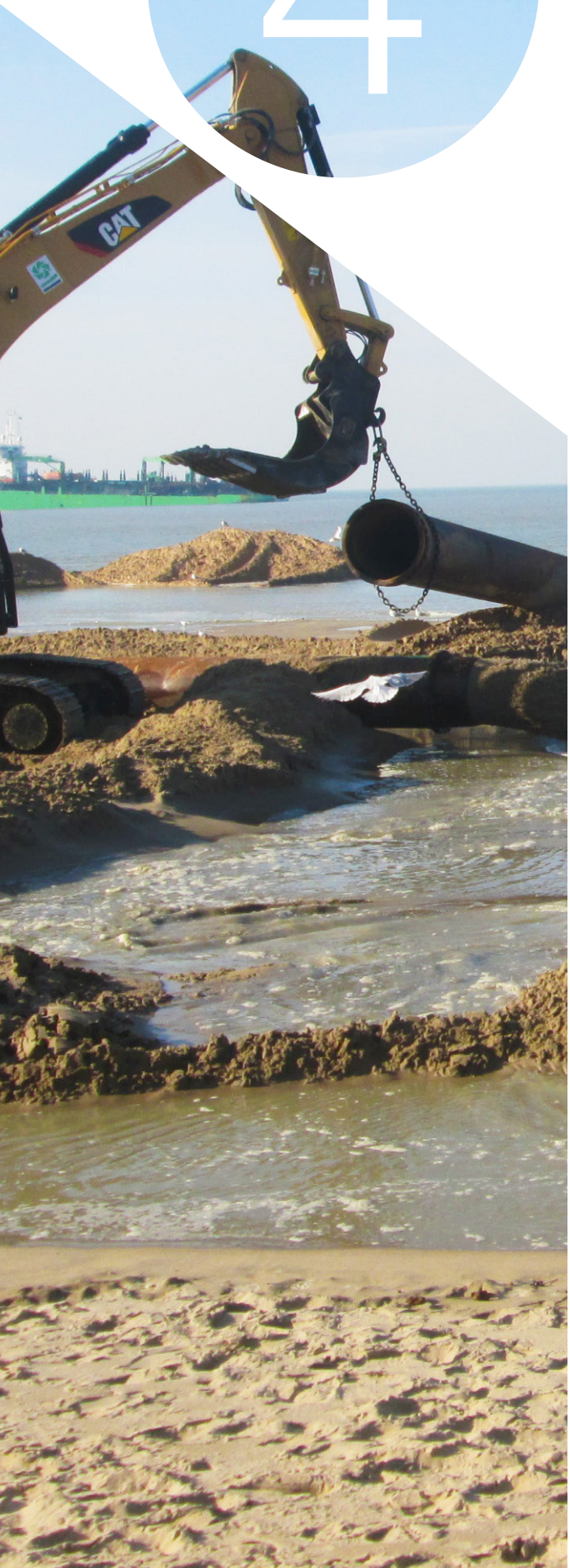

Dredging and dumping

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Dredging comprises all activities required to remove sand, silt and other layers of the bottom of waterbodies for the maintenance of shipping channels and harbours, but also for land reclamation and nature development. This theme text deals in more detail with the dredging and dumping of sediment for the purpose of maintaining and deepening the maritime access channels and harbours. The main focus is on dredging and dumping activities in the Belgian part of the North Sea (BNS). The Scheldt Estuary is not only an important ecosystem, but also provides space for a number of activities such as shipping, which require dredging (see also *ScheldeMonitor* and the *VNSC* website). A different context applies to the dredging works in the Scheldt Estuary, which are discussed in the theme text about the **Scheldt Estuary**.

In the case of dredging, a distinction must be made between capital dredging and maintenance dredging. Capital dredging is a dredging operation for the creation of new waterways and docks or the deepening of the existing ones. Maintenance dredging is a dredging operation in which the deposed sediment in shipping channels and harbour basins is removed without deepening or broadening the waterway or harbour basins beyond its original size.

A large share of the sediments dumped each year is dredged and dumped in the southern part of the North Sea, largely due to the maintenance of the fairways to big ports such as Hull, Zeebrugge, Rotterdam, Bremen, Emden, Hamburg, Esbjerg, etc. (*OSPAR QSR 2010*). Between 2008 and 2014, more than a thousand million tonnes (dry weight) of material were deposited in the OSPAR[1] region (North-East Atlantic and North Sea) (*OSPAR IA 2017*, *OSPAR 2017*). Belgium and Germany were at the forefront in the OSPAR[1] region for the dumping of sediment at sea with respectively 267.2 million tonnes and 228.7 million tonnes (dry weight) in the period 2008-2014, followed by France, the Netherlands and the United Kingdom with respectively 174.0, 158.4 and 103.2 million tonnes (dry weight) (*OSPAR IA 2017*, *OSPAR 2017*). In Belgium, 13.2 million tonnes (dry weight) were deposited in 2015 (*Lauwaert et al. 2016*). The evolution of the amount of dredged material in the BNS has been monitored by the Management Unit of the North Sea Mathematical Models of the Royal Institute of Natural Sciences (*RBINS-MUMM*) since 1991 (figure 1). In the future, the amount of dredged and dumped sediments might increase due to the growing vessel size and the associated widening and deepening of the shipping and port channels (*OSPAR QSR 2010*, see also implementation of the *Coastal Safety Masterplan* and the *Complex Project Coastal Vision* in theme **Safety against flooding**). The most common dredging and dumping techniques and the type of the dredged sediment in the BNS are described in more detail in section **4.4 Impact**.

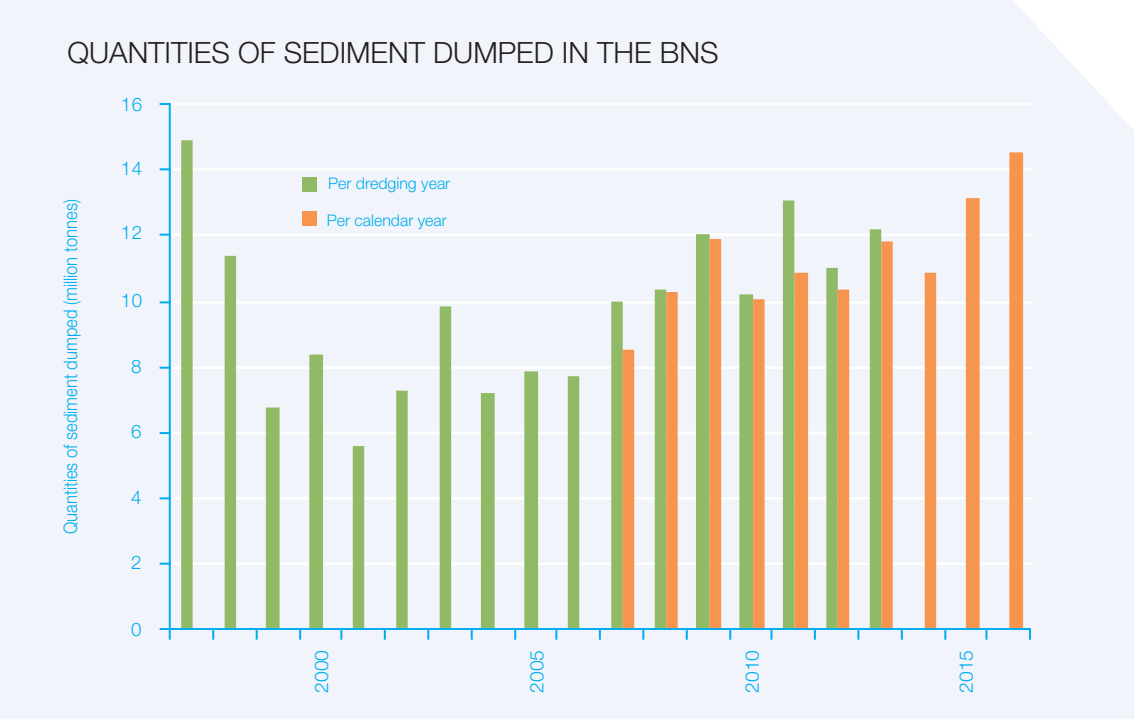

Figure 1. Quantities of sediment dumped in the Belgian part of the North Sea, expressed in million tonnes of dry matter (Source: RBINS-MUMM). A dredging year is defined as the period between 1 April and 31 March of the subsequent year.

[1] OSPAR Convention for the protection of the marine environment of the North-East Atlantic.

4.1 Policy context

The maintenance and deepening of the maritime access channels to ports and the maintenance of the depth in the ports is governed at the Flemish level. The Department of Mobility and Public Works (MOW), *Maritime Access Division*, is responsible for the fairways as well as the engineering structures and properties located along the maritime access channels to the Flemish harbours, such as Zeebrugge; while the Agency for Maritime and Coastal Services (MDK) - *Coastal Division* is responsible for the maintenance of the Flemish marinas of Ostend, Blankenberge, Zeebrugge and Nieuwpoort. However, the competence with regard to the dumping of dredged materials at sea is a federal matter. Hence, the management of dredged materials in Belgium is a shared competence, for which a cooperation agreement was signed on 12 June 1990 between the Flemish Region and the federal state. This agreement was updated by the cooperation agreement of 6 September 2000. The conditions for the re-use of dredged material from watercourses or water bodies (including fairways, harbours and docks) as soil or building material are included in the Code of Practice for dredging and disposal dredged material and implemented in Article 5.3.4.3. of the decree of the Government of Flanders, establishing the Flemish regulation on sustainable management of material cycles and waste materials (*VLAREMA*) and were also included in the MD of 5 November 2015.

The procedure for obtaining a permit to dump dredged materials 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 material and the location of the dredging and dumping sites of the permits that have been granted to the Maritime Access Division and to the MDK Agency since 2004, can be found in several ministerial decrees (see *Belgisch Staatsblad*).

4.2 Spatial use

In the marine spatial plan (MSP, RD of 20 March 2014, see also *Van de Velde et al. 2014* and theme **Integrated ocean policy**), five sites for sediment dumping have been demarcated: Bruggen en Wegen Zeebrugge Oost (ZBO), Ostend (OST), Nieuwpoort (NWP), S1 and S2 (see figure 2) (*Lauwaert et al. 2014*, *Lauwaert et al. 2016*). In the MSP, an area west of the port of Zeebrugge is reserved as a 'search area' for an alternative dumping site to reduce the reflux of dredged sediments. In the process of the new MSP (2020-2026), dumping sites are being revised for various reasons such as dumping capacity and nature protection (*MSP 2020-2026, public consultation 2018*). For example, the site at Nieuwpoort will be relocated to a location outside the Flemish banks, and a solution for the site S1 will be provided in terms of capacity.

On request of the Maritime Access Division, a field test was carried out between October and November 2013 to investigate the alternative dumping site west of Zeebrugge (*Fettweis et al. 2016*, *Lauwaert et al. 2016*). Research into the implementation of this alternative dumping site and the environmental impact is being continued, and will serve as input for considering the different options. In *Van Hoey et al. (2014a)*, the impact of a possible new dumping site west of Zeebrugge on shrimp fishing has already been studied.

An alternative dumping method, using a fixed pressure pipeline close to the coast, has been proposed for the marinas of Nieuwpoort and Blankenberge (*Lauwaert et al. 2016*). A fixed point discharge method would require a revision of the MMM law (20 January 1999). It is currently expected that this method will have a greater impact on the environment, but in order to follow up this method intensively, a scientific study is being launched and a pilot project is recommended (*Lauwaert et al. 2016*). A prospective study with the alternative Water Injection Dredging (WID) technique was carried out by *Van Oyen et al. (2016)*. The silted-up sediment is relocated by using natural forces in accordance with the principle of gravity driven density flows. By fluidising the sediment, it can flow out of the port under specific conditions.

4.3 Societal interest

The Flemish ports are important economic gateways (see theme **Maritime transport, shipping and ports**). Because of the increase of the scale of the vessels, it is necessary to continuously maintain the port's shipping lanes, as well as to deepen and widen these fairways. In 2017, the Government of Flanders invested about 255 million euro to safeguard the accessibility of the ports (including the Scheldt Estuary, see figure 3, *Merckx 2018*). The accessibility of the Flemish ports of Ostend, Zeebrugge, Ghent and Antwerp is guaranteed by the *Maritime Access Division* of the MOW Department. The tasks of this department include e.g. maintenance dredging works, wreck salvage, deepening of the channels and silt processing (also see decision of the Government of Flanders of 13 July 2001).

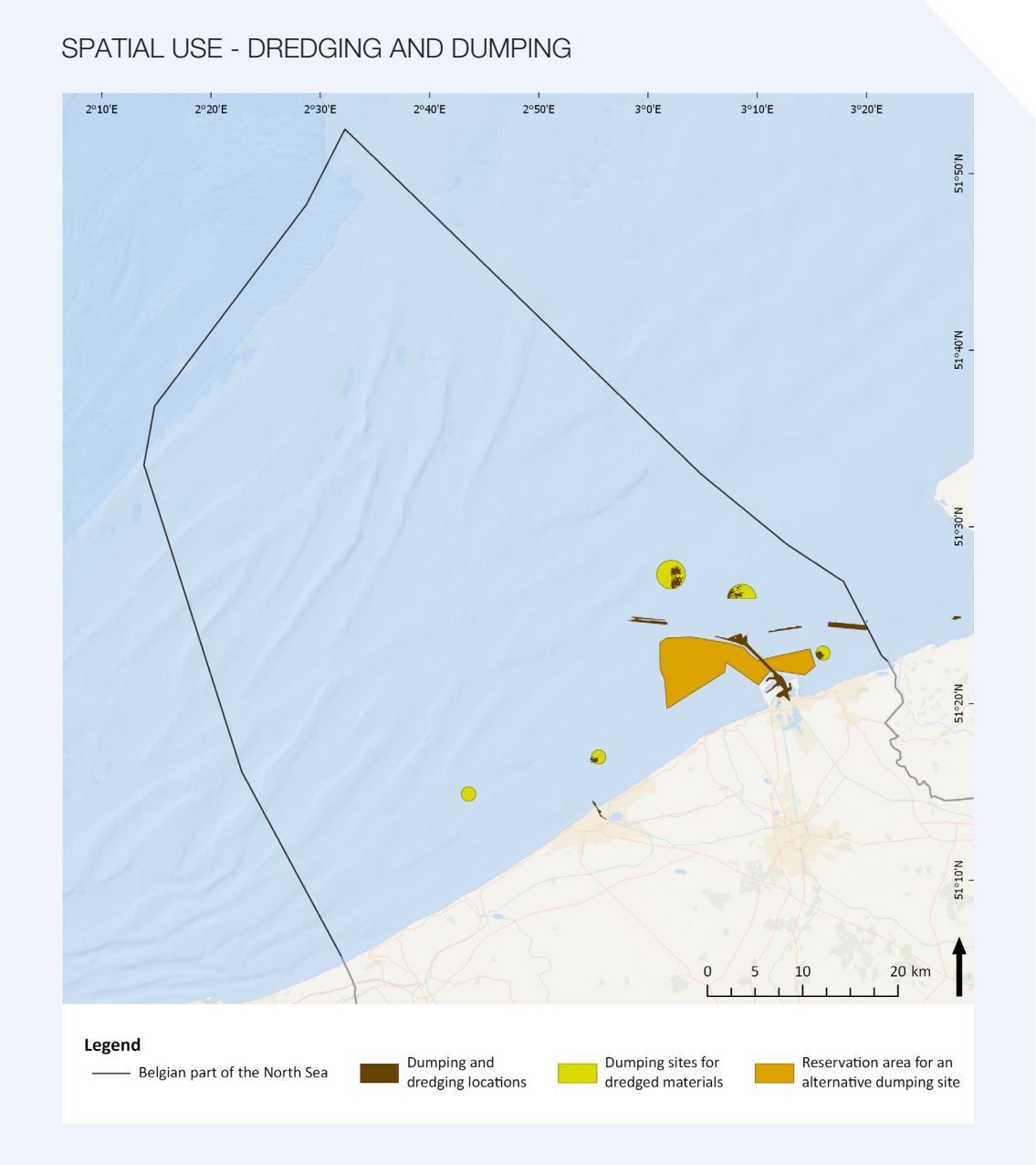

Figure 2. The location of dredging and dumping sites in the BNS for the year 2016 (Source: RBINS, *marineatlas.be* (based on the RD of 20 March 2014), Maritime Access Division).

The ministerial decrees of 22 December 2016 granted four permits for the dumping of 26.450 million tonnes of dry weight at four dumping sites in the BNS to the Maritime Access Division, on an annual basis from 1 January 2017 until 31 of December 2021. In addition, the Agency for Maritime and Coastal Services (MDK) was granted four permits for the dumping of a total of 700,000 tonnes of dry weight annually during this period (also see MD of 22 December 2016). The Maritime Access Division also has disposal permits from the provinces of East Flanders and Antwerp (Sea Scheldt) for the disposal of dredged materials from the maintenance of the Sea Scheldt and Western Scheldt, as well as the necessary extraction and dumping permits from the competent Dutch authorities (Western Scheldt) (see also the theme **Scheldt Estuary**).

Dredging works in Flanders have a considerable budgetary interest. Over the period 2009-2014, the cost of the dredging works in the fairways of the North Sea, the Western Scheldt and the Flemish navigable inland waterways, including the processing of contaminated dredged material, amounted to an average of 204.5 million euro annually, varying between 150.1 and 243.7 million euro. If the dredging works, financed by the Flemish Region, in the port of Antwerp are included, this amount increases to an average of 210.5 million euro annually (Court of Audit - Flemish Parliament, 37-C (2015-2016) - No. 1).

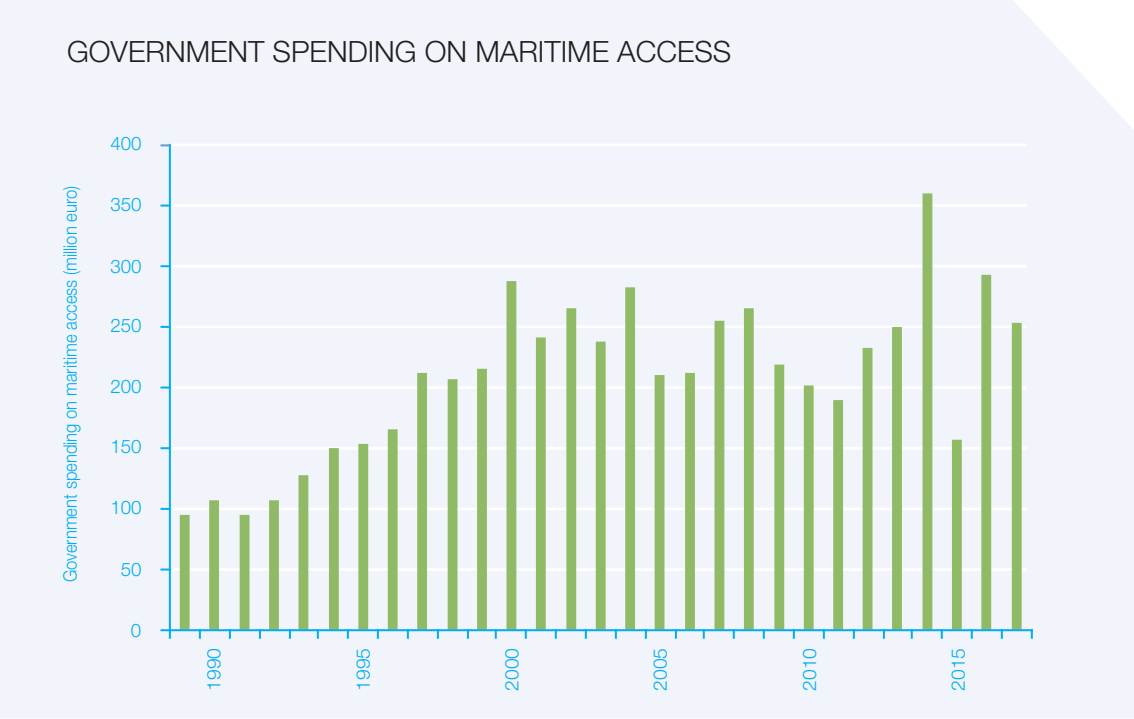

Figure 3. The government spending on maritime access by the Flemish Community in millions of euro for the period 1989-2017 (*Merckx 2018*).

4.4 Impact

The most common type of dredging ship which is used for the maintenance dredging works is the trailing suction hopper dredger. This ship is equipped with one (exceptionally two) suction pipe(s) and a large dredge head that functions as an enormous hoover, sucking the sediment out of the channels. This type of ship has the advantage of being very mobile, hence on the one hand it does not hinder shipping and on the other hand it can transport the dredged materials over longer distances. In this process, the sediment is removed until the minimum guaranteed nautical depth is achieved, including a small margin to anticipate future sedimentation. The sediment ends up in the hopper of the ship and can be dumped at the licensed dumping sites by means of a system of bottom doors or sliders located downwards in the hopper. In certain cases, it can be opted to mix the dredged material on board of the ship with water and then hydraulically pump it through a bow coupling and a system of floating and onshore pipelines and bring it ashore.

Besides the trailing suction hopper dredger, the cutter suction dredger is also commonly used for capital and deepening works. This is a stationary or autonomous vehicle that disaggregates, sucks up and hydraulically transports material from the seabed by using a rotating cutting head. Currently, feasibility studies and demonstration projects to evaluate alternative methods (e.g. Water Injection Dredging, or fixed pressure pipelines) are being carried out (*Lauwaert et al. 2016*, *Van Oyen et al. 2016*).

The nature of the dredged sediment varies according to the location along the coast. The composition of the dumped material may affect the sediment composition of the dumping sites (e.g. silt fractions in the sediment). In addition, the natural sediment composition on the different dumping sites also varies. The dumping site in Nieuwpoort is characterised by a large fraction of sand and a small fraction of silt. The site Bruggen en Wegen Ostend and Bruggen en Wegen Zeebrugge have the lowest average grain size (< 200 µm) and the highest concentration of silt (30-40%) (*Van Hoey et al. 2012*, *Lauwaert et al. 2016*).

The impact of the dredging and dumping activities on the marine environment is monitored and investigated in terms of physical, chemical and biological aspects (*Lauwaert et al. 2014*, *Lauwaert et al. 2016*, table 1, and figure 4 outlines the general framework, not specific to BNS). For the period 2013-2016, research was carried out to the occurrence of marine litter at the dumping sites (*Lauwaert et al. 2016*). The impact of dredging and dumping on other users is discussed in *Verfaillie et al. (2005)* (*GAUFRE project BELSPO*) and *Van Hoey et al. (2014a)*.

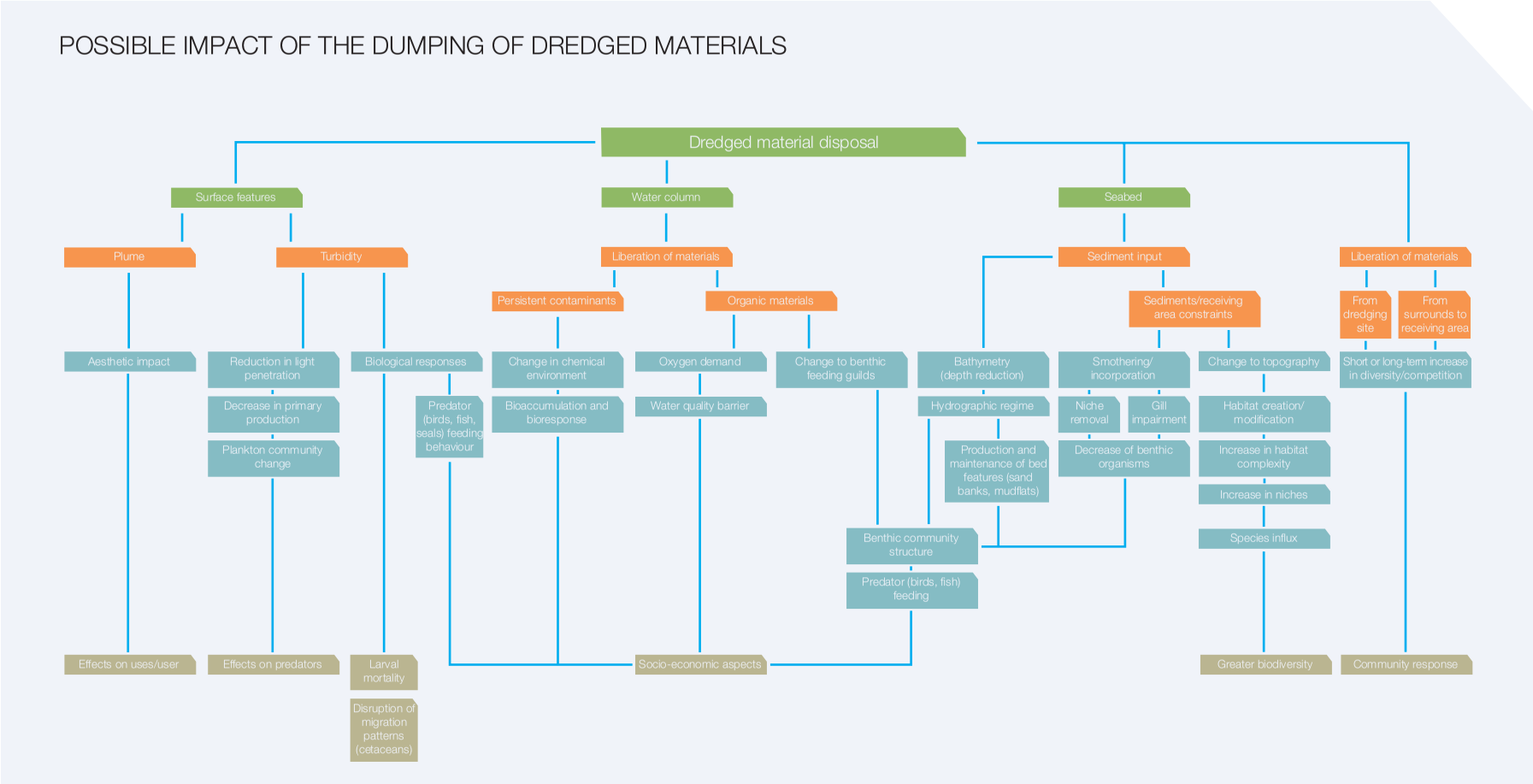

Figure 4. Conceptual diagram of the possible impact of the dumping of dredging materials (not all is applicable for BNS) (derived from *Elliot and Hemingway 2002*).

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

Environmental impact	Literature
Physico-chemical impact: changes in seabed morphology, composition (grain size) and sedimentological effects (sediment plumes, turbidity, release of contaminants, etc.)	*Verfaillie et al. 2005 (GAUFRE project BELSPO)*, *Lauwaert et al. 2006*, *Fettweis et al. 2007b (MOCHA project BELSPO)*, *Goffin et al. 2007*, *Du Four en Van Lancker 2008*, *Lauwaert et al. 2008*, *Lauwaert et al. 2009*, *Van Hoey et al. 2009*, *André et al. 2010*, *Fettweis et al. 2011*, *Lauwaert et al. 2011*, *Lauwaert et al. 2014*, *Vanhellemont en Ruddick 2015*, *Fettweis et al. 2016*, *De Witte et al. 2016*, *Lauwaert et al. 2016*
Biological impact: effects on fauna and flora (disruption of benthos, influence of released contaminants, etc.)	*Verfaillie et al. 2005 (GAUFRE project BELSPO)*, *Lauwaert et al. 2006*, *Lauwaert et al. 2008*, *Lauwaert et al. 2009*, *André et al. 2010*, *Lauwaert et al. 2011*, *Lauwaert et al. 2014*, *De Backer et al. 2014*, *Lauwaert et al. 2016*

4.5 Sustainable use

In order to address the impact of the dumping of dredged materials on the marine environment, this activity is globally governed by the *London Convention (1972)* and the London Protocol (1996) on pollution due to the dumping of materials at sea. In our region, these activities are also covered by the *OSPAR Convention (1992),* which aims to protect the marine environment in the North-Eastern part of the Atlantic Ocean (including the North Sea). OSPAR provides guidelines for the sustainable use of dredged materials (*OSPAR Guidelines for the management of dredged material at sea 2014*). There is currently no obligation under the OSPAR Convention to assess the environmental impact of dumping dredged material, but many OSPAR countries monitor these activities within the framework of national monitoring campaigns (*OSPAR IA 2017*).

On the European level, the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) identify the changing concentration of sediments in the water column due to human intervention as one of the most important pressures on the marine environment. In the MSFD, some of the descriptors for a good environmental status (GES) of the marine environment are relevant for dredging and dumping (*OSPAR IA 2017*, *Lauwaert et al. 2016*): seafloor integrity (descriptor 6, more information: *Rice et al. 2010*), introduction of energy including underwater noise (descriptor 11, more information: *Tasker et al. 2010*), concentrations of contaminants and marine litter (descriptor 8 and 10, more information: *Law et al. 2010*, *Galgani et al. 2010*) and the permanent alteration of the hydrographical conditions (descriptor 7). In addition, the descriptors biodiversity and marine food webs are also (indirectly) affected by the dumping of dredged material (descriptor 1 and 4, *Cochrane et al. 2010*, *Rogers et al. 2010*). In the MSFD, the change in silt deposition as a result of dredging and dumping activities is no longer directly included in the list of anthropogenic pressures on the marine environment (Directives *2008/56/EC* and *2017/845/EC*). Since the 2017 revision, the dredging and disposal of materials has been included as 'use 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 Belgian marine waters (*Belgian State 2018, public consultation*), the impact in the context of the dumping of dredged material is evaluated with respect to MSFD descriptors 1, 4, 6 and 10. The implementation of the MSFD in Belgian legislation is foreseen by the RD of 23 June 2010 (see theme **Nature and environment**). The potential application of the MSFD evaluation scheme in the assessment of the activity 'dumping of dredged material' was elaborated on in *Lauwaert et al. (2016)*. Ten relevant MSFD environmental targets were selected. In addition, the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC) constitute an important framework for the reduction of the impact of dredging and dumping activities. In the publication of *Van Hoey et al. (2014b)*, a Benthic Ecosystem Quality Index (BEQI) was established in the context of the WFD, MSFD and Habitats Directive for the evaluation of the state of the soft substrate fauna which can be applied to assess the dumping of dredged matter.

In the BNS, dredging and dumping is governed 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 five-yearly synthesis report must be submitted to the competent minister. In these reports, the effects of the dredging and dumping activities are discussed, and recommendations supporting the development of a stronger environmental policy are formulated (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*). Moreover, the dredged material that is deposited needs to meet certain sediment quality criteria (*website BMM*, *Goffin et al. 2007*, *OSPAR national action levels for dredged material 2008*). This is checked every 10 years by sampling and analysing in situ samples at the dredge deposit locations. A new survey for this will be carried out in 2018. In addition, samples are taken from the ship's hold and analysed on a regular basis (approximately every four months) and evaluated based on the limit and target values set in the permits granted.

In the context of these permits, a monitoring and scientific programme is imposed to the Government of Flanders. In the MOMO programme, the MUMM is responsible for monitoring and modelling cohesive sediment transport and for evaluating the effects on the marine ecosystem of dredging and dumping activities (see, *inter alia* *Fettweis et al.*

2015 (MOMO)). The Research Institute for Agriculture, Fisheries and Food (*ILVO*) studies the biological and chemical aspects of the various dumping sites. Attention is paid to knowledge gaps such as the presence of marine litter, microplastics and other emerging contaminants in dredging material, as well as potential cumulative effects (*OSPAR IA 2017*, *Lauwaert et al. 2016*).

Currently, there is a trend in the dredging industry (in cooperation with research institutions) to adapt dredging activities to natural processes or to deliberately construct certain ecosystems (see *inter alia* the so-called 'Building with nature concept'). Furthermore, alternative suppletion approaches are developed for the construction of beaches in the context of coastal security, accommodating rivers to increase discharge and storage capacity, land reclamation, nature development, etc. (*Temmerman et al. 2013*, *de Vriend 2014*, *de Vriend et al. 2014*, *de Vriend et al. 2015*).

Legislation reference list

Overview of the relevant legislation at the international, European, federal and Flemish level. For the consolidated European legislation we refer to *Eurlex*, the national legislation can be consulted in the *Belgisch staatsblad* and the *Justel-databanken*.

International agreements, treaties, conventions, etc.

Title	Year of conclusion	Year of entering into force
Convention on the prevention of marine pollution by dumping of wastes and other matter (London Convention)	1972	1975
The Protocol to the 1972 Convention on the prevention of marine pollution by dumping of wastes and other matter and Annexes 1, 2 and 3 (London Protocol)	1996	2006
Convention for the protection of the marine environment of the North-East Atlantic (OSPAR Convention)	1992	1998

European legislation

Title	Year	Number
Directive on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)	1992	43
Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)	2000	60
Directive establishing a framework for Community action in the field of water policy (Marine Strategy Framework Directive)	2008	56
Directive on the conservation of wild birds (Birds Directive)	2009	147

Belgian and Flemish legislation

Abbreviation	Title	File number
Decision of the Government of Flanders 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
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 20 March 2014	Koninklijk besluit tot vaststelling van het marien ruimtelijk plan	2014-03-20/03
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 van 28 oktober 1999 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
Cooperation agreement of 12 June 1990	Samenwerkingsakkoord tussen de Belgische Staat en het Vlaamse Gewest ter vrijwaring van de Noordzee van nadelige milieueffecten 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 milieueffecten ingevolge bagger-specielossingen in de wateren die vallen onder de toepassing van de Conventie van Oslo	2000-09-06/31