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Sand and gravel extraction

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Van Lancker, V., Vandenreyken, H., Lauwaert, B., De Backer, A., Devriese, L. (2018). Sand and gravel extraction. In: Devriese, L., Dauwe, S., Verleye, T., Pirlet, H., Mees, J. (Eds.) Knowledge Guide Coast and Sea. 2018 - Compendium for Coast and Sea. p. 79-89.



Between 75 and 95 million m³ of marine sediment was extracted annually in the OSPAR region (North-East Atlantic and North Sea) during the years 2012-2015 (*ICES WGEXT Report 2016*). Mainly sand and gravel are mined for the construction industry and beach nourishments. Furthermore, marl is extracted to improve farmland and to filter water (*OSPAR QSR 2010*). Most of the marine sediment is extracted in the North Sea by countries such as the Netherlands (26.1 million m³ in 2015; 15.7 million m³ in 2016), the United Kingdom (19.5 million m³ in 2015; 11.3 million m³ in 2016), France (2.9 million m³ in 2015; 3.0 million m³ in 2016) and Denmark (4.9 million m³ in 2015; 6.4 million m³ in 2016) (*ICES WGEXT Report 2016*, *ICES WGEXT Report 2017*). In the Belgian part of the North Sea (BNS), most of the extracted sediment is sand with an annual volume that fluctuated in the last ten years between 2 and 4 million m³. In 2014, this volume was significantly higher at almost 6 million m³, 60% of which was used for beach nourishment. In 2017, approximately 4 million m³ was mined. At that time, almost 40% was used for coastal protection (Source: *FPS Economy*, Continental Shelf Service, 2018). Gravel is not extracted in the BNS due to low quantities in extraction areas, the small grain size and the heterogeneity of the material in the permitted areas (*Brochure Continental Shelf service 2014*).

5.1 Policy context

The sand and gravel extraction in the BNS is a federal competence that belongs to the FPS Economy, SMEs, Self-Employed and Energy and is regulated by the law of 13 June 1969 (see also *Reglementering Zand- en Grindwinning in het BNZ 2014*). The coordination of the parties involved in the management of the exploration and exploitation on the continental shelf (CS) and in the territorial sea is executed by an Advisory Committee (RD of 12 August 2000).

5.2 Spatial use

The various zones for sand and gravel extraction are legally demarcated in the marine spatial plan (MSP, RD of 20 March 2014, see also *Van de Velde et al. 2014* and theme *Integrated ocean policy*). In addition, reference zones may be established where sand and gravel extraction is prohibited in order to monitor the environmental impact in an area similar to the sand extraction areas in terms of sediment and habitat composition. In the current MSP, this zone is situated on the Thornton Bank (see THBREF zone in figure 1) and also serves as a reference area for wind turbine activities.

The geographic demarcation and accessibility of the control zones¹ for which the exploitation and exploration of mineral and other non-living resources in the territorial sea and the CS have been registered in the RD of 1 September 2004 relating to the allocation procedure (table 1 and figure 1, amended by the RD of 19 April 2014) (see also the *Sand and Gravel Regulation in the BNS 2014*). Prior to this delimitation, a study on the possible concession zones for sand extraction was conducted (*Schotte 1999*). In total, three control zones were demarcated in 2004 and divided into sectors for which concessions can be obtained. A fourth control zone was defined in 2010, in which 4 new sectors were demarcated based on new exploration data. For Belgium, the extracted region (= the effectively extracted area) amounted to about 32% of the legal concession zone in 2015, and only 12% in 2016 (*ICES WGEXT Report 2016*, *ICES WGEXT Report 2017*). If a negative seabed evolution occurs due to extraction that does not meet the legal requirements (max. 5 m relative to a reference level), certain sections of the zones can be closed. For example, the areas of KBMA in the central part and KBMB in the northern part of the Kwintebank were closed on 15 February 2003 and 1 October 2010 respectively; and one area in the central part of the Buiten Ratel (BRMC) has been closed for exploitation since 1 January 2015 (*Degrendele and Vandenreyken 2017*, figure 1)

Since the demand for sand and gravel is expected to increase further (e.g. the needs for coastal protection, the demand for construction sand and gravel on land), space is reserved for sand and gravel extraction in the new MSP (2020), which manages the use of space in our part of the North Sea until 2026. The pre-draft MSP 2020-2026 was approved by the Council of Ministers in April 2018 and in the summer months of 2018 there was a public consultation (*MSP 2020-2026, public consultation 2018*). This draft MSP offers a new sand extraction area on the Blijbank. As the draft MSP is not yet final, changes may still occur (*MSP 2020-2026, public consultation 2018*).

The offshore extraction of sand and gravel requires a concession permit (figure 2). In order to obtain a permit, an application form has to be submitted to the director of the General Direction Quality and Safety of the FPS Economy, according to the procedure stipulated in the RD of 1 September 2004 concerning the granting procedure. Furthermore, the RD of 1 September 2004 about the environmental impact assessment (EIA) defines that an EIA-report has to be submitted to the Management Unit of the North Sea Mathematical Models of the Royal Institute of Natural Sciences (*RBINS-MUMM*) (*MER voor de extractie van mariene aggregaten op het BNZ 2006*, *MER voor*

¹ A control zone is an area stipulated by law where sand extraction is permitted (delimitation stipulated in the MSP – RD of 20 March 2014).

SPATIAL USE - SAND AND GRAVEL EXTRACTION

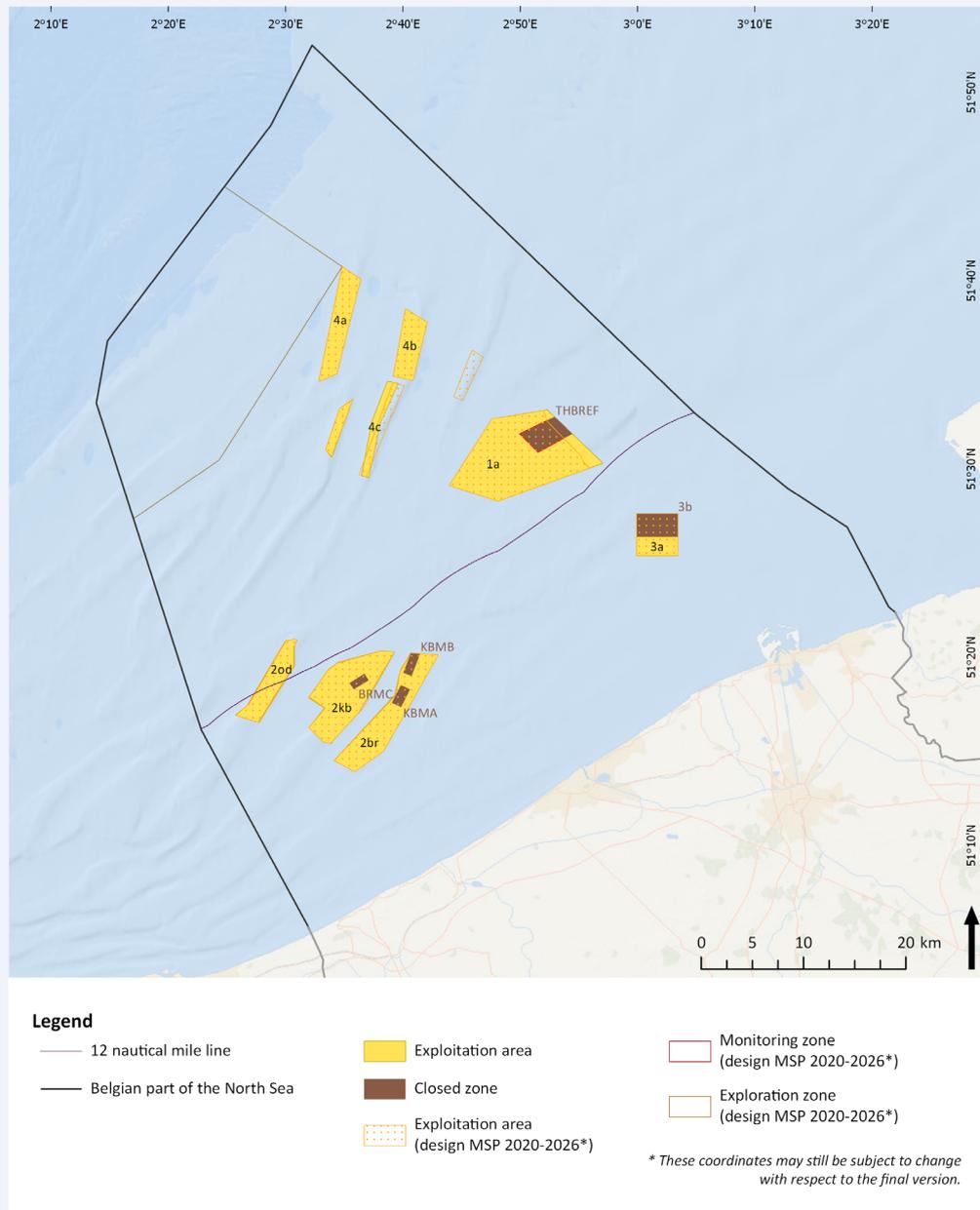


Figure 1. The demarcation of the control zones for sand extraction in the BNS (Source: [website FPS Economy, Continental Shelf Service](#), RBINS, [marineatlas.be](#) (based on RD of 20 March 2014), *MSP 2020-2026*, *public consultation 2018*).

de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016). The EIA-report by MUMM is subsequently transferred to the minister/secretary of state competent for the marine environment, who in turn formulates a binding recommendation to the federal minister competent for economy (Source: *Reglementering Zand- en Grindwinning in het BNZ 2014*).

The concessions that have been granted for the exploration and exploitation of the mineral and other non-living resources in the BNS are to be found in the ministerial decrees in the Belgian Official Gazette (*Belgisch staatsblad*) (table 2). Each concessionaire pays a fee in line with the volume he has extracted, with an annual minimum of EUR 18,592.02 euro (Source: FPS Economy, Continental Shelf Service). The amounts of the allowance are adjusted annually and vary according to the type of material: sand from control zones 1, 2 and 4: 0.72 euro/m³ in 2018; sand from control zone 3 (lower quality): 0.46 euro/m³ in 2018; and gravel: 1.51 euro/m³ in 2018. A new concessionaire may

exploit a maximum of 100,000 m³ in the first year. Each year, an Advisory Committee advises the minister competent for Economy on the quantities that each concessionaire may mine in the following year.

Table 1. An overview of the different control zones for sand extraction in the BNS with their location and accessibility.

Control zone	Sector	Location	Accessibility
Zone 1	1a	Thorntonbank	Open, except for the area THBREF
Zone 2	2kb	Kwintebank	Open, except for KBMA and KBMB
	2br	Buiten Ratel	Open, except for the area BRMC
	2od	Oostdyck	Open
Zone 3	3a	Sierra Ventana	Open
	3b	Sierra Ventana	Closed as long as this sector is used as a dumping site for dredged material
Zone 4	4a	Noordhinder	Open
	4b	Oosthinder	Open
	4c	Oosthinder	Open
	4d	Westhinder	Open

Table 2. An overview of the concessionaires for sand extraction in the BNS with the maximum volume awarded for 2018 (Source: FPS Economy, Continental Shelf Service).

Concessionaire	Maximum volume of extraction awarded for 2018
Charles Kesteleyn NV	100,000 m ³
Dranaco NV	100,000 m ³
SATIC NV	150,000 m ³
TV Zeezand Exploitatie NV	100,000 m ³
Alzagri NV	200,000 m ³
Van Oord België	100,000 m ³
Belmagri NV	200,000 m ³
CBR - Sagrex	600,000 m ³
De Hoop Bouwgrondstoffen BV c.o. SATIC NV	100,000 m ³
DEME Building Materials NV	1,000,000 m ³
Government of Flanders - Coastal Division	1,200,000 m ³
Government of Flanders – Maritime Access division	350,000 m ³
DC Industrial NV	800,000 m ³
NHM NV	550,000 m ³
Betoncentrale Van den Braembussche	200,000 m ³

5.3 Societal interest

The extraction of sand and gravel in the BNS has strongly increased over the past few years (figure 3). In 1976, a sediment volume of 29,000 m³ was extracted; which amounted to 4 million m³ in 2017 (Source: FPS Economy, Continental Shelf Service). Between 1976 and 2016, 65 million m³ of sea sand was extracted. Since 2003, three phases can be distinguished in the evolution of sand extraction on the BNS (Roche et al. 2017). Between 2003 and 2010, more than 75% of the sediment was extracted in zone 2, especially on the Kwintebank (2kb). After closing two regions on the Kwintebank (2kb), a shift took place since 2007 to zone 2br (Buiten Ratel) until the central part of the Buiten Ratel was closed for extraction in 2015. From 2014 onwards, extraction shifted to three sectors: Thorntonbank (1a), Sierra Ventana (3a) and the Oosthinder (4c). Currently, a maximum of 15 million m³ of sediment can be extracted in the control zones over a period of five years (not taking into account exceptional projects such as coastal protection). Half of this sediment was landed in Flanders in 2016. The other half was unloaded in Dutch, French and UK ports (Source: FPS Economy, Continental Shelf Service).

In cooperation with Zeegra vzw, the professional association of importers and producers of sea aggregates, the Continental Shelf Service has attempted to assess the direct economic impact of the sea aggregates sector. Of course, there is also a major indirect impact, such as the economic growth of port activities, the Belgian construction

PROCEDURE FOR A CONCESSION PERMIT AND THE EXPLOITATION OF SAND AND GRAVEL EXTRACTION IN THE BNS

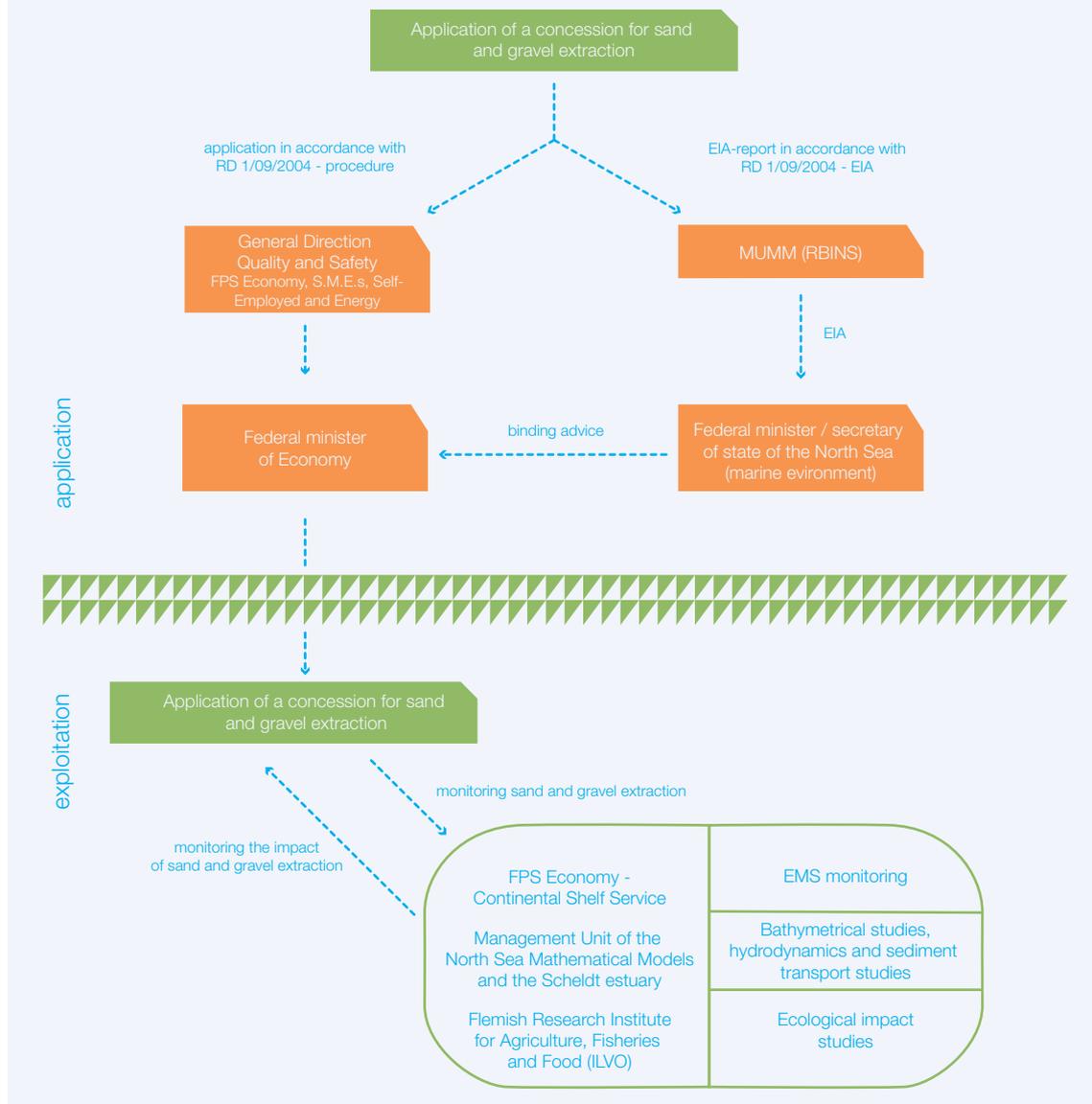


Figure 2. Flowchart of the procedure for a concession permit and the exploitation of sand and gravel extraction in the BNS (law of 13 June 1969 and implementing decrees).

industry, road transport, suppliers, etc. Some relevant facts and figures are listed here:

- 13 private companies with a concession permit employ 130 people in Belgium and 138 in the rest of Europe. These employees are mainly active in the extraction of marine sand;
- The annual turnover from the sale of sea sand and sea gravel in Belgium (in 2016) amounted to more than 70 million euro;
- The concessionaires do not only mine on the BNS, but also extract or buy sand in neighbouring countries (table 3). In 2016, both the sand extracted in Belgium as well as the sand extracted or purchased in the Netherlands amounted to approximately 3 million m³. In the United Kingdom and Germany, almost 1 million m³ and about 40,000 m³ of sand were extracted or purchased respectively. In the United Kingdom, in addition to sand, gravel is also extracted;
- Sea sand has many applications (figure 4). Most of the extracted sea sand is medium-grade sand for use in ready-mixed concrete (54%), precast concrete (18%) and other concrete products (10%). In addition, sea sand is used for the production of asphalt, as sand filling used for e.g. drainage, foundation and beach works;
- In addition to the use of sea sand in the construction sector, sea sand is also used for coastal protection (see theme **Safety against flooding**);

Table 3. Volumes (m³) of sand extracted or purchased in Belgium and neighbouring countries in 2016.

Country	Volumes extracted or purchased in 2016
Belgium	3.031.410 m ³
The Netherlands	2.953.469 m ³
United Kingdom	922.450 m ³
Germany	37.015 m ³

- The implementation of beach nourishment (rainbowing) is currently the most important coastal protection measure. Beach nourishment ensures that the beaches are sufficiently wide and high to protect the coast against flooding in the event of very heavy storm surges. For beach nourishment, sand with a median grain size of 250-350 µm is used, while this is ± 200 µm for pre-shore nourishment. Since 2010, new concession zones have been defined in the Hinderbanks region (e.g. [Van Lancker et al. 2015](#), [Van Lancker et al. 2016](#), [Roche et al. 2017](#), [Van Lancker et al. 2017](#)). It is planned to extract 35 million m³ of sediment over 10 years, mainly in the context of the [Masterplan Coastal Safety](#) and the ‘public works’ OW-plan Ostend (plan for the protection against the sea and the maritime accessibility of Ostend) ([MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010](#), [Mathys et al. 2011](#), [Rumes et al. 2011](#));
- The indirect impact of the sand extraction sector is more difficult to quantify. In addition to the purchase of marine granulates, more than 40 million euro was spent in the private sector in Belgium during 2016 on the required infrastructure and 20 million euro in the rest of Europe. Investments were also made in the public sector, such as ports and pilotage, explicitly almost 4 million euro in Belgium and more than 7 million euro in the rest of Europe.

It can be stated that the extraction of sea aggregates is not only of strategic importance, but has undoubtedly become an economic activity with high added value that generates growth and prosperity for Belgian construction companies (Source: FPS Economy, Continental Shelf Service).

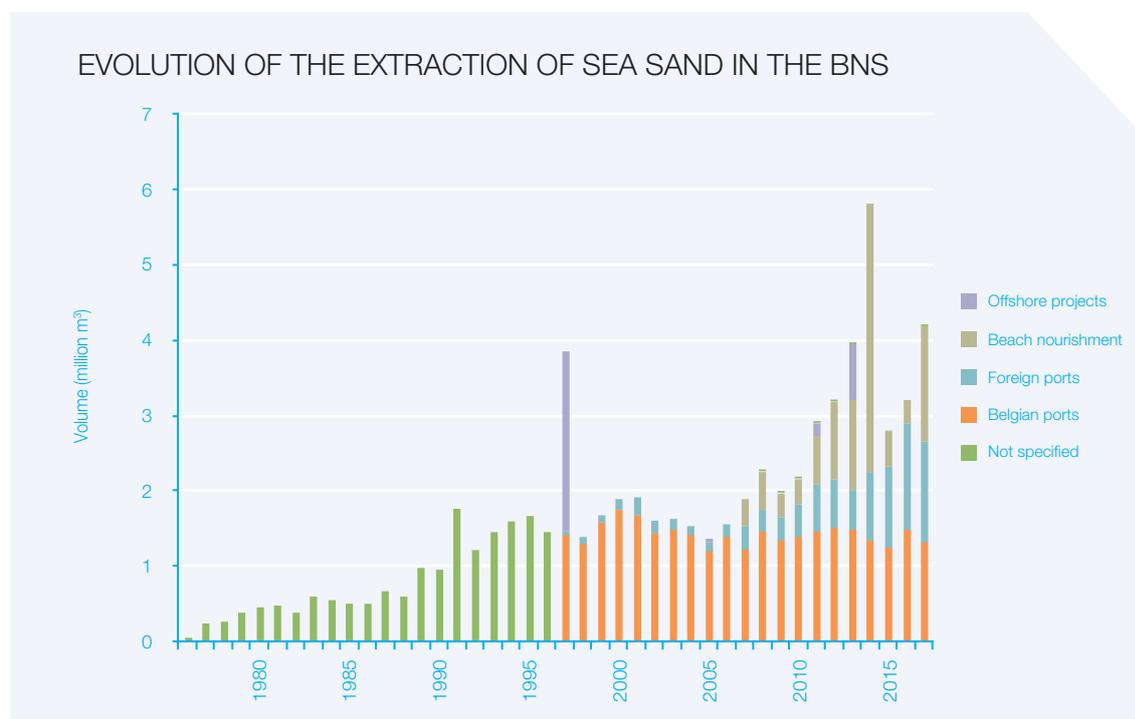


Figure 3. The evolution of the extraction of sea sand in the BNS between 1976 and 2017. Comment: construction of submarine gas pipelines in 1991 and 1997 (Source: [FPS Economy, Continental Shelf Service](#)).

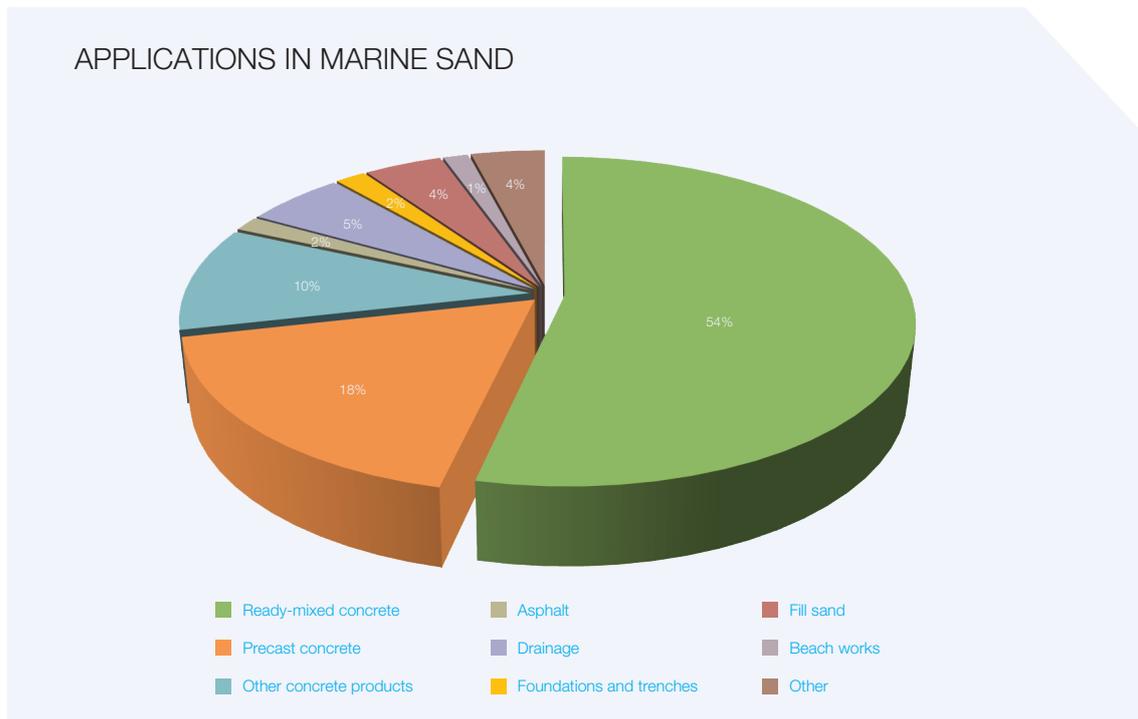


Figure 4. The different applications (with their % share) of sea sand in 2016 (private sector).

5.4 Impact

The most commonly used method for sand extraction is the trailing suction hopper dredger, that creates channels of 1-3 m wide and 0.2-0.5 m deep in the seabed ([Degrendele et al. 2010](#), [Newell and Woodcock 2013](#)). The RD of 1 September 2004 regarding the environmental impact assessment, stipulates the different effects of sand extraction on the marine environment that need to be taken into account in the environmental assessment report (tables 4 and 5). Only references relating to the BNS are listed below, supplemented with publications that are widely applicable or provide a general overview, including the Belgian part (e.g. ICES reports). Sediment extraction is also included in the Ecosystem Vision for the Flemish Coast ([Van der Biest et al. 2017b](#)) as one of the processes with the greatest negative contribution to ecosystem components and ecosystem services.

5.5 Sustainable use

Within the OSPAR region, all countries that extract sand and gravel on a large scale have a legislation that complies with the European Directive 85/337/EEC concerning the environmental impact assessment of specific public and private projects, as well as with the European Habitats Directive. With regard to the management of marine sediment extraction, the OSPAR Countries have agreed to apply the directives as proposed by the *International Council for the Exploration of the Sea (ICES)* (see annex 10 of the *ICES WGEXT Report 2003*). These also discuss nature conservation and spatial conflicts among users. Belgium, Denmark, Germany, France, the Netherlands and the United Kingdom demand the use of 'black box' systems which monitor the extraction in space and time. The effects of the sand and gravel extraction on the marine environment are examined by the ICES working group *WGEXT* in which Belgium is represented by *MUMM* and the Research Institute for Agriculture, Fisheries and Food (*ILVO*).

At the European level, the impact on the marine environment caused by the extraction of sediments is also included in the Water Framework Directive (WFD, 2000/60/EC), Marine Strategy Framework Directive (MSFD, 2008/56/EC, see also RD of 23 June 2010) and Habitats Directive (92/43/EEC) (see theme **Nature and environment**). Since sand extraction in the BNS does not take place within the ecological scope of the WFD, i.e. the 1-mile zone, the regulations of the MSFD and the Habitats Directive apply in the concession zones. In the MSFD, several descriptors for a good environmental status (GES) are identified (Belgian State 2012, for Belgian waters), some of which are relevant for the extraction of marine sediments ([Degraer and Vanden Berghe 2014](#)). In this respect, descriptor 6 on the integrity of the seafloor is particularly important (more information: [Rice et al. 2010](#)), but also the direct and indirect effect of

Table 4. A literature overview of the environmental impact of sand extraction.

Impact on the environment	Literature
Seabed and water (changes in the bathymetry, sedimentology, sediment plumes, turbidity, hydrodynamic regime, etc.)	<i>MER voor de extractie van mariene aggregaten op het BNZ 2006, Van Lancker et al. 2007 (MAREBASSE project BELSPO), Vanaverbeke et al. 2007 (SPEEK project BELSPO), Van Lancker et al. 2009 (QUEST4D project BELSPO), MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, Van Lancker et al. 2010, Bellec et al. 2010, Degrendele et al. 2010, Van den Eynde et al. 2010, Gareil 2010, Roche et al. 2011, De Sutter and Mathys 2011, Van Lancker et al. 2014a, Degrendele et al. 2014, Van Lancker et al. 2014b, Francken et al. 2014, Van Lancker et al. 2015, Van Lancker and Baeye 2015, Van Lancker et al. 2016, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Van den Eynde et al. 2017, Van Lancker et al. 2017, Baeye et al. 2017, Van Lancker et al. 2017b</i>
Fauna, flora and biodiversity	<i>MER voor de extractie van mariene aggregaten op het BNZ 2006, Vanaverbeke et al. 2007 (SPEEK project BELSPO), MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, De Backer et al. 2010, Bonne 2010, De Backer et al. 2011, De Sutter and Mathys 2011, De Backer et al. 2014a, De Backer et al. 2014b, De Backer and Hostens 2014, Van Lancker et al. 2014a, Van Lancker et al. 2014b, Van Lancker et al. 2015, Van Lancker et al. 2016, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, De Backer et al. 2017, Van Lancker 2017</i>
Air quality and climate	<i>MER voor de extractie van mariene aggregaten op het BNZ 2006, MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, De Sutter and Mathys 2011, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Francken et al. 2017</i>
Noise and vibrations	<i>MER voor de extractie van mariene aggregaten op het BNZ 2006, MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, De Sutter and Mathys 2011, Heinis et al. 2013, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Jones and Marten 2016, Durinck and Casteleyn 2017</i>

Table 5. An overview of the impact of sand extraction on other users.

Impact on users	Literature
Risk and safety (shipping, oil pollution, coastal protection, etc.)	<i>MER voor de extractie van mariene aggregaten op het BNZ 2006, Verwaest 2008, MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, De Sutter and Mathys 2011, Liste Muñoz et al. 2011, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Van den Eynde et al. 2017</i>
Seascape and cultural heritage	<i>MER voor de extractie van mariene aggregaten op het BNZ 2006, MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, De Sutter and Mathys 2011, Van Haelst and Pleters 2014, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Missiaen et al. 2016</i>
Interaction with other human activities (including coastal protection)	<i>Verwaest and Verelst 2006, MER voor de extractie van mariene aggregaten op het BNZ 2006, Verwaest 2008, MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, De Sutter and Mathys 2011, Vandenborre 2014, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Van Lancker et al. 2016, Van den Eynde 2017</i>
Cumulative effects (e.g. in combination with the activities in the offshore wind farms)	<i>MER voor de extractie van mariene aggregaten in de exploratiezone van het BNZ 2010, Van Lancker et al., 2010, De Sutter and Mathys 2011, Van Lancker et al. 2015, MER voor de extractie van mariene aggregaten in controlezones 1, 2 en 3 in het BNZ 2016, Walker et al. 2016, Van Lancker et al. 2016, Van Lancker et al. 2017</i>

sand extraction on the conservation of biodiversity (descriptor 1, more information: [Cochrane et al. 2010](#)), and the marine food webs (descriptor 4, more information: [Rogers et al. 2010](#)). There is also an influence on descriptor 7 on the permanent alteration of hydrographical conditions ([Walker et al. 2016](#), [ICES WGEXT Report 2016](#), [ICES WGEXT Report 2017](#)) and descriptor 11 on the introduction of energy, including underwater noise (more information: [Tasker et al. 2010](#)). For each descriptor, a number of primary and secondary criteria and indicators have been proposed ([Commission Decision \(EU\) 2017/848](#)). Trends and changes are evaluated every six years. The evaluation of the first MSFD cycle (2012-2018) will be transferred to Europe in October 2018. This revision of the initial assessment for Belgian marine waters ([public consultation, Belgian State 2018](#)) assesses the impact of aggregate extraction in relation to MSFD descriptors 1, 6 and 11. The selective extraction of living and non-living resources from the seafloor has been included in the list of pressures. Furthermore, the European Habitats Directive (92/43/EEC) (see also RD of 14 October 2005) offers a framework to protect ecologically important areas such as the gravel beds in the BNS ([Degrendele et al. 2008](#), [Houziaux et al. 2008](#), [Degraer et al. 2009](#), [Raeymaekers et al. 2011](#), [De Mesel et al. 2017](#)) against pressures such as aggregate extraction activities. The most ecologically valuable natural gravel beds are located south of the extraction areas of the Hinder Banks. In the context of the two aforementioned directives, the sediment mobility in the gravel beds has thus been incorporated into the monitoring programme (Government of Flanders) related to the sand extraction ([Van Lancker et al. 2014a](#), [Van Lancker et al. 2014b](#), [Van Lancker et al. 2015](#), [Van Lancker et al. 2016](#), [Montereale-Gavazzi et al. 2017](#), [Van Lancker et al. 2017b](#)). In the marine spatial plan (RD of 20 March 2014, see also [Van de Velde et al. 2014](#)) a reference zone has been demarcated in order to monitor the impact on the environment (control zone 2). The maximum volume that can be extracted in this zone decreases annually with 1% (17,000 m³) and gravel extraction is prohibited.

The sand and gravel extraction in the BNS is monitored by the Continental Shelf service (FPS Economy), MUMM and ILVO. This research is ongoing and is financed by the fees paid by the operator in proportion to the volume mined (see 5.2 Spatial use) (Degrendele 2008, Brochure Dienst Continentaal Plat 2014, Reglementering Zand- en Grindwinning in het BNZ 2014). The results of this monitoring are presented at a three-yearly conference organised by the Continental Shelf Service (e.g. Degrendele and Vandenreyken 2017). Over the years, the European guidelines have helped to determine the monitoring approach (Van Lancker 2011).

An important part of the monitoring is the control of the extraction operations. This is done by checking the registers kept on board of the dredging vessels, and by a black-box system (Electronic Monitoring System, EMS) on the other (Brochure Continental Shelf service 2014, Reglementering Zand- en Grindwinning in het BNZ 2014, Van den Branden et al. 2017). This system was introduced in 1996, modernised in 2014 and is managed by MUMM, as commissioned by the Continental Shelf Service (Degrendele et al. 2014, Roche et al. 2017). Furthermore, the physical impact of extraction on the seabed is monitored by the Continental Shelf Service (FPS Economy) and MUMM. The sediment volumes in the control zone are followed up using the research vessels RV Belgica and RV Simon Stevin. In this regard, a maximum of 5 m of sediment may be removed compared to the original level of the seabed (Degrendele et al. 2014). Currently, the possibility for a new reference level for sand extraction is being explored which is unlike before, defined based on scientific and juridical criteria (De Mol et al. 2014, Degrendele 2016, Degrendele et al. 2017). The aim of this new reference level is to limit the impact of extraction in the most sensitive areas and to increase economic sustainability by using available volumes of quality sand. The MUMM is responsible for monitoring the hydrodynamics and the sediment transport by means of models and measurements (Van Lancker et al. 2014a, Van Lancker et al. 2014b, Francken et al. 2014, Francken et al. 2017, Van Lancker et al. 2017, Van den Eynde et al. 2017). ILVO examines the ecological impact of the extraction activities as well as the biological evolution after cessation of the activities (De Backer et al. 2014, De Backer and Hostens 2014, De Backer et al. 2017). In exploitation zone 4 (demarcated in 2010) an elaborate ‘baseline’ study has been executed to assess the impact of the current extraction activities (Mathys et al. 2011, Van Lancker et al. 2014a, Van Lancker et al. 2015, Van Lancker et al. 2016, Van Lancker et al. 2017).

Furthermore, specific studies and research projects such as BUDGET (Lanckneus et al. 2001, BUDGET project BELSPO), SPEEK (Vanaverbeke et al. 2007, SPEEK project BELSPO), MAREBASSE (Van Lancker et al. 2007, MAREBASSE project BELSPO), EUMARSAND (Van Lancker et al. 2010, EU FP6 project), RESOURCE-3D (Van Lancker et al. 2009, BELSPO), QUEST4D (Van Lancker et al. 2009, QUEST4D project BELSPO) and TILES (TILES project BELSPO) (Van Lancker et al. 2014c, Van Lancker et al. 2017c, figure 5) contribute to a better understanding of the impact and a sustainable management of the sand and gravel extraction. In the TILES project a harmonised geological knowledge-base is developed which supports natural resource management in the Belgian and Dutch part of the North Sea in the long term. The approach is explained in figure 5. First, available drillings (Kint et al. 2016) and seismic data will be combined into 3D geological models that map the quality and quantity of the exploitable geological layers (‘the raw material or resource’) (Hademenos et al. 2018). After linking the resource models with numerical impact models, parameters are calculated that can support a more sustainable exploitation strategy (Terseleer et al. 2017, Van Lancker et al. 2018). However, the ultimate minable ‘reserve’ is mainly determined by all

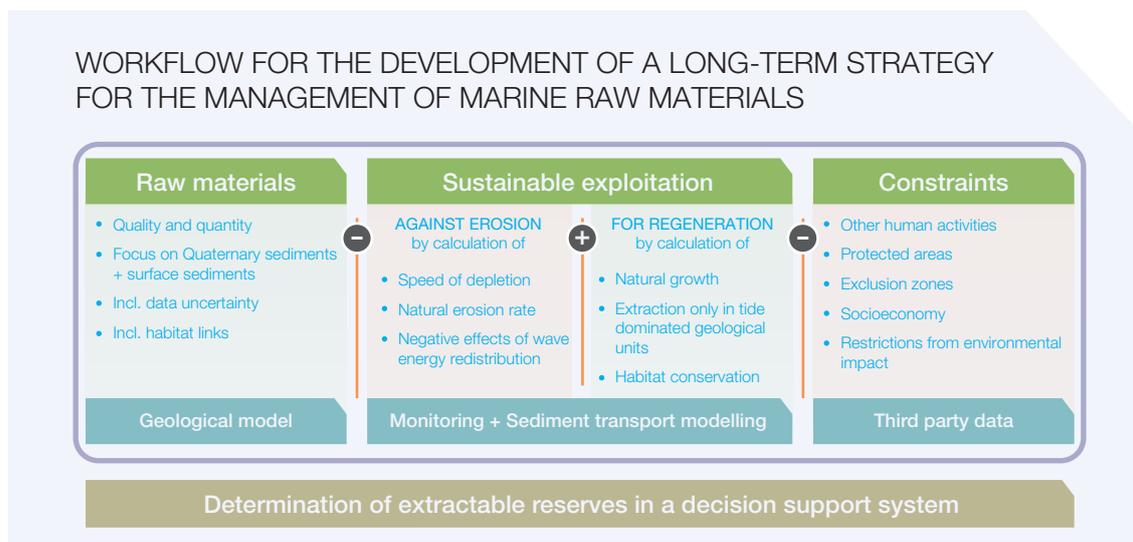


Figure 5. Conceptual workflow for the development of a long-term strategy for the management of marine raw materials at the BNS (Van Lancker et al. 2017c).

kinds of restrictions that do not permit exploitation (e.g. the use of space by other activities). Finally, the knowledge and information generated is offered in a multi-criteria decision support system in which data quality is taken into account ([Kint et al. 2018](#), [De Tré et al. 2018](#)). The information obtained from such a system contributes to a better support of the evaluation of sand extraction in the BNS.

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](#).

European legislation		
Title	Year	Number
Directive on the assessment of the effects of certain public and private projects on the environment	1985	337
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 marine environmental policy (Marine Strategy Framework Directive)	2008	56

Belgian and Flemish legislation		
Abbreviation	Title	File number
RD of 12 August 2000	Koninklijk besluit tot instelling van de raadgevende commissie belast met de coördinatie tussen de administraties die betrokken zijn bij het beheer van de exploratie en de exploitatie van het continentaal plat en van de territoriale zee en tot vaststelling van de werkingsmodaliteiten en –kosten ervan	2000-08-12/83
RD of 1 September 2004	Koninklijk besluit betreffende de voorwaarden, de geografische begrenzing en de toekenningsprocedure van concessies voor de exploratie en de exploitatie van de minerale en andere niet-levende rijkdommen in de territoriale zee en op het continentaal plat	2004-09-01/51
RD of 1 September 2004	Koninklijk besluit houdende de regels betreffende de milieu-effectenbeoordeling in toepassing van de wet van 13 juni 1969 inzake de exploratie en exploitatie van niet-levende rijkdommen van de territoriale zee en het continentaal plat	2004-09-01/50
RD of 14 October 2005	Koninklijk besluit tot instelling van speciale beschermingszones en speciale zones voor natuurbehoud in de zeegebieden onder de rechtsbevoegdheid van België	2005-10-14/35
RD of 23 June 2010	Koninklijk besluit betreffende de mariene strategie voor de Belgische zeegebieden	2010-06-23/05
RD of 20 March 2014	Koninklijk besluit tot vaststelling van het marien ruimtelijk plan	2014-03-20/03
RD of 19 April 2014	Koninklijk besluit tot wijziging van verscheidene koninklijke besluiten betreffende de exploratie en de exploitatie van de minerale en andere niet-levende rijkdommen in de territoriale zee en op het continentaal plat	2014-04-19/49
Law of 13 June 1969	Wet inzake de exploratie en exploitatie van niet-levende rijkdommen van de territoriale zee en het continentaal plat	1969-06-13/30

