

Update environmental impact report for the extraction of marine aggregates in control zones 1, 2 and 3 in the Belgian part of the North Sea

Durinck Riet^{*1}, Casteleyn Kris¹

^{*}Presenting author: riet.durinck@arcadis.com

¹Arcadis Belgium SA, Koningsstraat 80, 1000 Brussels, Belgium

Introduction

ARCADIS has been chosen to draft a new environmental impact report (EIR) concerning the effects of the extraction of marine aggregates in control zones 1, 2 and 3 in the Belgian part of the North Sea. The reason is a letter from FPS Economy (dating from 12/11/2014) asking for an actualization of the EIR – dating from 2006 – for the following reasons:

- The EIR of 2006 had become too extensive because of the growing number of appendices (such as all articles of past study days);
- Several chapters were dated (such as legal and policy constraints, description of the activities);
- The lack of an appropriate assessment.

The new environmental impact report has been drafted in 2016. Following main aspects have been incorporated:

- Marine Spatial Plan: Description of all changes relevant to the sand extraction activities, due to the implementation of the Marine Spatial Plan;
- Marine Strategy Framework Directive: Additional assessment towards the relevant descriptors/targets defined for the Belgian part of the North Sea;
- Data from study days: Acquired knowledge (mainly from monitoring) that has been presented on past study days (2008, 2011 and 2014) has been incorporated in the description of the reference situation and in the impact assessment;
- Appropriate assessment: An appropriate assessment has been added to assess the impact of the extraction activities on the Special protection area 'Vlaamse Banken' (Flemish Banks).

In following chapters the non-technical summary of the EIR of 2016 is presented.

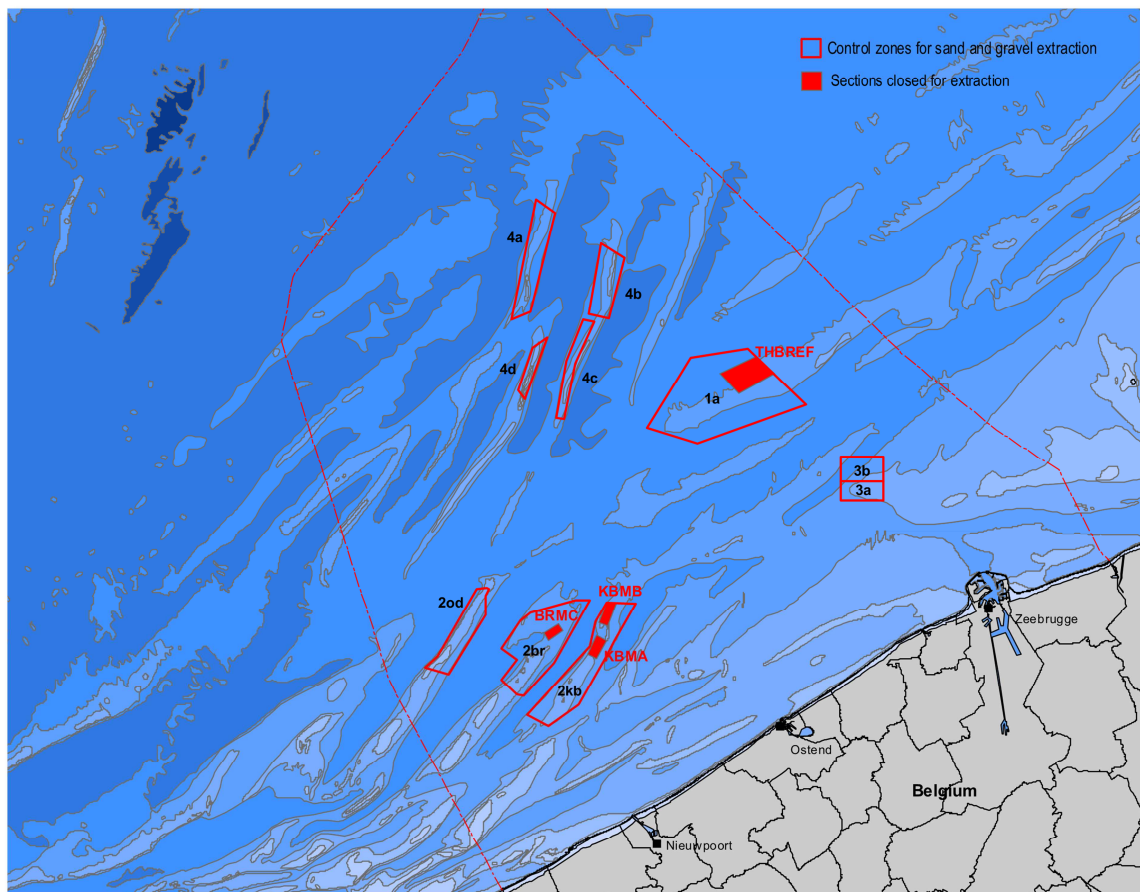
Project description

The environmental impact report has been prepared for the sand and gravel extraction carried out in **control zones 1, 2 and 3** within the Belgian part of the North Sea (BNS). This study assesses the combined effect of the extraction activities that the initiators (Zeegra, Flemish government – Coastal division and Flemish government – Maritime Access division) will develop in control zones 1, 2 and 3.

The extraction activities are carried out using trailing suction hopper dredgers. The requested extraction volume is 15 million m³ per successive period of 5 years (3 million m³/year as a rolling average over 5 years).

The extracted marine aggregates are an important source of construction materials where, depending on the quality and the grain size, the sand is used as filler or as a raw material in asphalt production or in the mortar or concrete industry. On the other hand, the extracted sediments are used for coastal protection (sand replenishments) and other marine constructions such as offshore windmills.

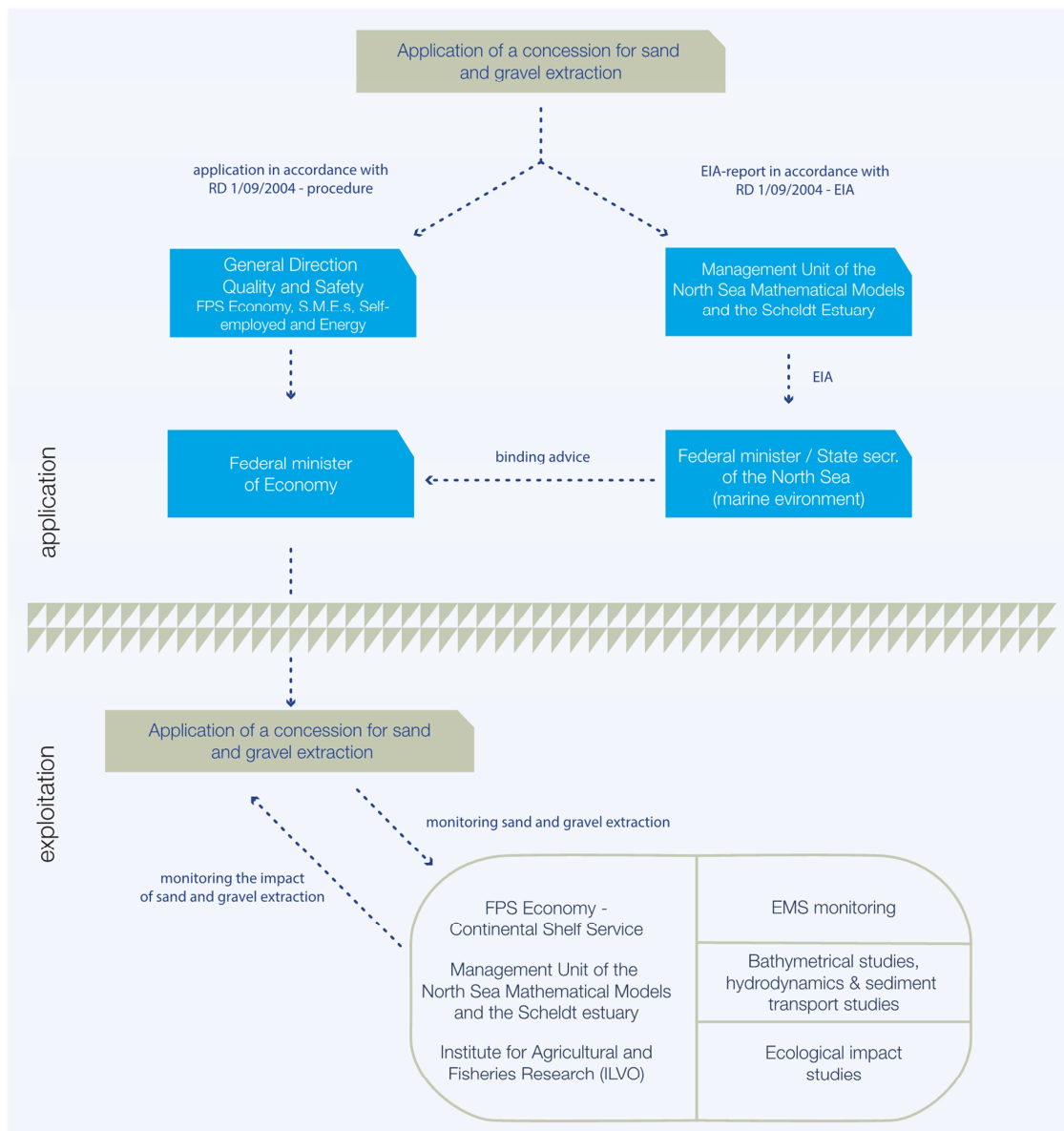
Figure 1: Control zones for sand and gravel extraction in the Belgian Part of the North Sea



Procedure

The offshore extraction of sand and gravel requires a **concession permit**. 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 royal decree of 1 September 2004 concerning the granting procedure. Furthermore, the royal decree of 1 September 2004 about the environmental impact assessment (EIA) defines that an environmental impact report must be submitted to the Management Unit of the North Sea Mathematical Models (MUMM) (RBINS). The EIA by MUMM is subsequently transferred to the minister/state secretary competent for the marine environment, who in turn formulates a binding recommendation to the federal minister competent for economy.

Figure 2: Procedure for a concession permit and the exploitation of sand and gravel extraction in the Belgian part of the North Sea (Van Lancker et al., 2015)



Alternatives

For this environmental impact report, two scenarios are developed that are assessed for their impact. In **scenario 1 'Business as usual'** the current situation is used, as far as possible. In **scenario 2 'Maximum dispersion'**, it is assumed that there will be a maximum geographical dispersion of the extraction activities over the different concession zones (not just the maximum dispersion over the different control zones and sectors, but also over the whole area within a specific sector). For this, the total maximum quantity of aggregates to be extracted is homogeneously distributed over the sand banks of the various sectors. In this scenario it is important to note that a truly homogeneous distribution of the extraction activities is an ideal situation that in reality is not feasible since it cannot be assumed that there is a homogeneous distribution of the various types of aggregate over the various zones and sectors. It can also not be assumed that it is simply practicably feasible to effectively achieve a homogeneous extraction. Scenario 2 will rather be a reflection of a 'best case scenario', since a maximal geographic dispersion is assumed and the impact per m² is therefore minimal.

SCENARIO 1: BUSINESS AS USUAL (BAU) IN CONTROL ZONES 1, 2 & 3					
Extraction volumes per successive period of 5 years per sector					
Sector 1a	Sector 2kb	Sector 2br	Sector 2od	Sector 3a	Sector 3b
6 940 000 m ³	2 015 000 m ³	4 030 000 m ³	2 015 000 m ³	0 m ³	0 m ³
6 940 000 m ³	2015 1 646 000 m ³ 2016 1 629 000 m ³ 2017 1 612 000 m ³ 2018 1 595 000 m ³ 2019 1 578 000 m ³ total over 5 years: 8 060 000 m³			0 m ³	
15 million m³					

SCENARIO 2: MAXIMUM DISPERSAL IN CONTROL ZONES 1, 2 & 3					
Extraction volumes per successive period of 5 years per sector					
Sector 1a	Sector 2kb	Sector 2br	Sector 2od	Sector 3a	Sector 3b
5 577 264 m ³	2 789 409 m ³	3 631 437 m ³	1 639 148 m ³	605 752 m ³	756 989 m ³
5.577.264 m ³	2015 1 646 000 m ³ 2016 1 629 000 m ³ 2017 1 612 000 m ³ 2018 1 595 000 m ³ 2019 1 578 000 m ³ total over 5 years: 8 060 000 m³			1 362 740 m ³	
15 million m³					

In fact, a quantity of sand may also be extracted in control zone 4. This control zone is however not part of this project, but will be discussed in the chapter on the 'Cumulative impacts'.

Impact description and assessment

Soil / Seabed

Bathymetry – The removal of marine aggregates in the BNS has a permanent effect on the bathymetry of the seabed. The effect is however local and not cumulative. The effect of the removal of marine aggregates and altering the bathymetry of the seabed is considered to have a moderate negative impact (--) in both scenarios. The difference in the lowering of the seabed in both scenarios is limited, namely 0.40 m (scenario 1) and 0.12 m (scenario 2) over a successive period of 5 years.

Seabed morphology – The emergence of dredge tracks has a temporary and local effect on the seabed morphology. The change in the heights of sand dunes, on the other hand, is a permanent effect. Since this is a local effect, the effect of marine aggregate extraction on the morphology of the seabed is assessed as moderately negative (--). This assessment applies to both scenarios.

Sedimentological changes – For scenario 1 (business as usual) it is more likely that sedimentological changes (shift of grain sizes) will occur in one or more zones, given the extraction activities will be more concentrated than in scenario 2, where there will be maximal dispersion of the extraction. The effect in scenario 2 is considered to be negligible (virtually no effect) (0), while the effect is judged to be slightly negative in scenario 1 (-).

Water

Hydrodynamics and sediment transport – It is assumed that scenario 1 (business as usual) will potentially trigger a greater effect on the flow and sediment transport than scenario 2 (maximum dispersion) because the chances of a larger lowering of the local seabed structure in scenario 1 is larger, and so the chances of a significant effect on the water flow and geographical erosion/deposition pattern is greater. The effect of scenario 2 is therefore considered to be slightly negative (-), while the effect of scenario 1 is rated as moderately negative (--). The impact on the safety against flooding (coastal defense) is negligible (0).

Turbidity – The increase in turbidity as a result of the sand extraction is very temporary and limited in extent. In addition, the increased turbidity is at most of the same order of magnitude as the natural turbidity during a storm. Therefore, the effect of the increase in turbidity is considered to be negligible (virtually no effect) (0) in both scenarios.

Sedimentation from the turbidity plume – Sedimentation of the turbidity plume is not negligible. Monitoring results show that there is a risk that fine material from the overflow has far-field effects. Given the potential consequences for the seabed functions and thus the seabed integrity, the effect of the sedimentation of the turbidity plume is considered to be moderately negative (--) for scenario 1 (business as usual) and slightly negative (-) for scenario 2 (maximum dispersion). The extraction activities in scenario 1 are indeed more geographically concentrated and the sedimentation of fine material will be more concentrated, so that the probability of there being effects on the seabed functions and the seabed integrity is greater than in scenario 2.

Water quality – The effect of sand extraction on the water quality is considered to be negligible (virtually no effect) (0), for both scenarios.

Fauna & Flora

MACROBENTHOS

Habitat loss – In both scenarios, a major local habitat loss occurs due to the removal of the top layer of the seabed. In scenario 2, the habitat loss occurs over a larger area (more widely spread out), while the habitat loss in scenario 1 is more concentrated. Given that the extraction area in both scenarios, however, is limited in comparison with the total area of the BNS, the impact of the habitat loss for both scenarios is assessed as slightly negative (-).

Increase in turbidity – The increase in turbidity as a result of the sand extraction is very temporary and limited in extent. In addition, the maximum increased turbidity is of the same order of magnitude as the natural turbidity during a storm. Since the benthos of the subtidal sand banks is adapted to these natural dynamics, the impact of the increase in turbidity as a result of the extraction activities is considered to be negligible (virtually no effect) (0), in both scenarios.

Sedimentation of the turbidity plume – Taking into account the (possible) direct and indirect effects, the sedimentation of the turbidity plume is not negligible. Monitoring results show that there is a risk that fine material from the overflow has far-field effects. Given the potential consequences for the seabed functions and ecosystem efficiency, the impact of sedimentation of the turbidity plume is considered to be moderately negative (--) for scenario 1 (business as usual) and slightly negative (-) for scenario 2 (maximum dispersion). The extraction activities in scenario 1 are indeed more concentrated geographically and the sedimentation of fine material will be more concentrated, so that the probability of occurrence of effects on the seabed features and the seabed integrity is greater than in scenario 2.

Changes in structural and functional characteristics of the benthic ecosystem - As long as marine aggregate extraction takes place at low intensities (such as so far at Oostdyck, Thorntonbank, the southern central part of the Buiten Ratel) or at high, but infrequent intensities (Oosthinder, control zone 4), it can be assumed that the current sandy benthic ecosystem of the BNS is resilient enough to buffer the biological impact of extraction, both structurally and functionally. On the other hand, when the extraction pressure is high and focuses on a limited area, which is frequently visited and where large volumes are extracted, changes in the sediment composition are expected to lead to biological changes. Since these biological changes are, however, relatively limited and do not give rise to measurable changes in ecosystem functioning, no significant adverse effects are to be expected.

In addition, there appears to be a real chance that fine material from the overflow has far-field effects, with possible consequences for the benthic communities. Such effects are most likely to occur with intensive extraction that is localized within a limited area (whether or not frequently visited).

In scenario 1 (business as usual) the extraction activities are more geographically concentrated than in scenario 2 (maximum dispersion), thus the chance of the occurrence of changes in sediment composition in scenario 1 is larger, and the sedimentation of fine material will therefore be more concentrated. Therefore, the effect of marine aggregate extraction on the structural and functional characteristics of the benthic ecosystem is considered to be moderately negative (--) for scenario 1 and slightly negative (-) for scenario 2.

Ecotoxicological impacts – Ecotoxicological effects on benthos as a result of marine aggregate extraction are considered to be negligible (virtually no effect) (0) for both scenarios.

EPIBENTHOS & FISH COMMUNITIES

The effect of **habitat loss and habitat change, increased turbidity** and **mortality** on the epibenthos and the fish communities is considered to be slightly negative (-) for both scenarios.

Ecotoxicological impacts on the epibenthos and the fish communities as a result of marine aggregate extraction are considered to be negligible (virtually no effect) (0) for both scenarios.

AVIFAUNA & MARINE MAMMALS

Food availability – It is expected that a reduced availability of benthos as a food source may occur only in the intensively mined zones, with potential direct and/or indirect effects on seabirds and marine mammals. The area of the zones to be intensively mined, however, is very limited in comparison to the total area of the BNS.

At the moment there is no clear general impact of aggregate extraction on the demersal fish communities. In addition, there is no knowledge of high sensitivity (mortality) in relation to marine aggregate extraction of specific species that are of great importance in the diet of the common seabird and marine mammal species in the BNS.

On the other hand, marine aggregate extraction can also cause a temporary facilitation of food availability.

Consequently, it is assumed that both for seabirds and marine mammals almost no changes will occur in the food availability as a result of marine aggregate extraction in the BNS. The impact is considered to be negligible (virtually no effect) (0) for both scenarios.

Increased turbidity – Given that the increased turbidity occurs only temporarily and, moreover, is at most of the same order of magnitude as the natural turbidity during a storm, the impact of the increase in turbidity as a result of the extraction activities on seabirds and marine mammals is considered to be negligible (virtually no effect) (0) for both scenarios.

Disruption – Disruption as a result of marine aggregate extraction is temporary in nature and will take place in restricted zones in the BNS. The number of ship movements is limited compared to the existing shipping traffic in the Belgian part of the North Sea. Seabirds and marine mammals are mobile species that, if desired, can avoid the zones of disturbance. The loading and unloading activity in the coastal ports is part of the currently prevailing port activities to which the present avifauna is accustomed, and does not take place in the vicinity of the resting places of seals. Consequently, the effect of disruption (including noise) as a result of marine aggregate extraction is considered to be slightly negative (-).

APPROPRIATE ASSESSMENT

Control zone 2 is located inside the Special protection area 'Vlaamse Banken' (Flemish Banks). On the basis of the European Habitats Directive (art. 6) an appropriate assessment must be made for the sand and gravel extraction activities within this zone as these activities may potentially have a significant impact on the protected habitats.

Habitat type 1110 'Sandbanks which are slightly covered by sea water all the time' – The physical habitat is affected only very locally in the intensively mined areas within control zone 2. The sandbank-gullies ecosystem as a whole is not affected. Moreover, a gradual decrease in the extractable volume is enforced in control zone 2 resulting in a gradual decrease in the degree of disturbance of the habitat type 1110 within the Special protection area.

Habitat type 1170: 'Reefs – Gravel beds' – Because of redefinition of the sectors of control zone 2 and the introduction of a ban on gravel extraction in control zone 2 by introduction of the Marine Spatial Plan in 2014, the direct impact of marine aggregate extraction on gravel beds within the Special protection area 'Vlaamse Banken' is reduced to a minimum.

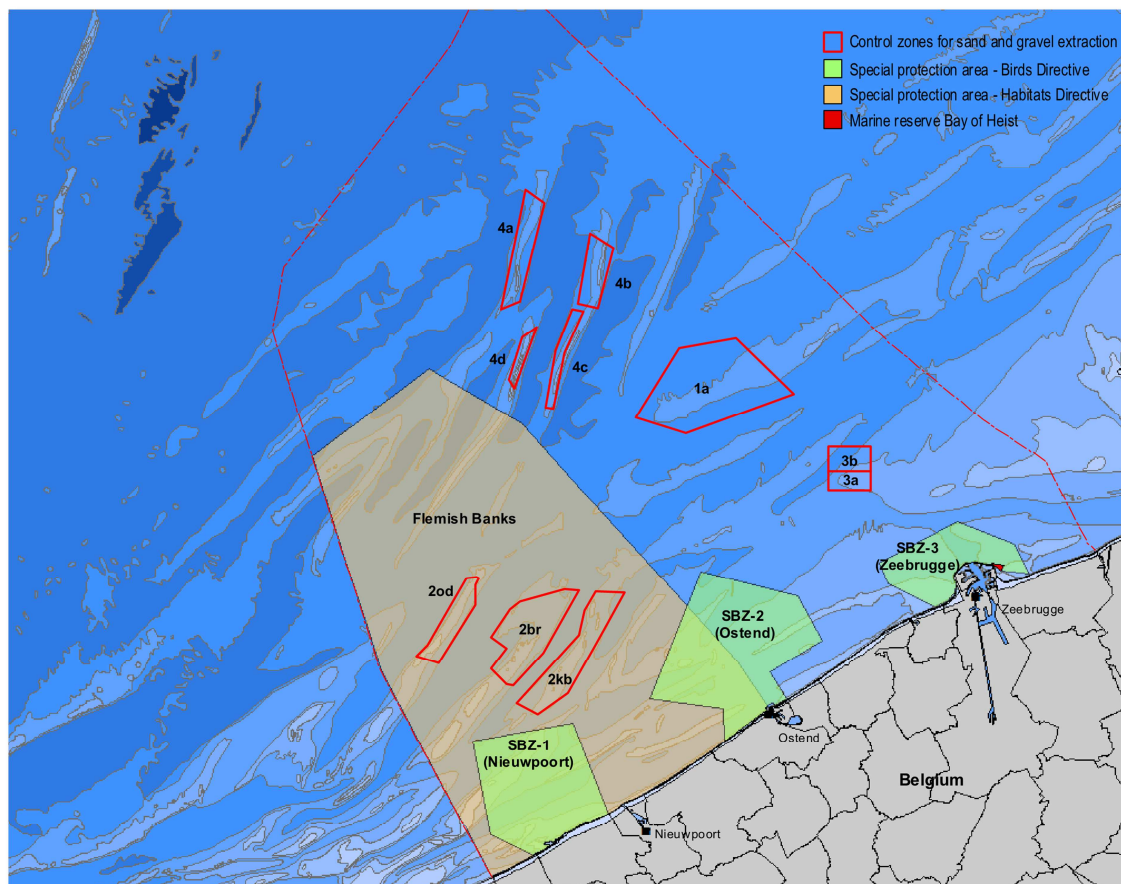
On the other hand, it appears there is a real chance that fine material from the overflow has indirect effects on gravel beds. However, no direct relationship has been established yet between the enrichment with fine material and the extraction activities.

Habitat type 1170 'Reefs – *Lanice* aggregations' – The *Lanice conchilega* aggregations within the Special protection area 'Vlaamse Banken' are mainly located near the shore, while control zone 2 is in deeper water.

Harbour porpoises – No changes are expected in the availability of food for harbour porpoises resulting from marine aggregate extraction in the BNS. The noise disturbance caused by marine aggregate extraction is temporary in nature and takes place in the restricted zones in the BNS. Moreover, harbour porpoises are mobile animals that can avoid the disruption zones if necessary.

Conclusion appropriate assessment – No significant adverse effects are expected on the Special protection area ‘Vlaamse Banken’ and the harbour porpoise. Any indirect effects on gravel beds as a result of enrichment of the seafloor matrix with fine sediments (possibly from overflow) however do form a gap in knowledge and should be investigated further.

Figure 3: Marine protected areas in the Belgian part of the North Sea



Air & Climate

The proportion of emissions from marine aggregate extraction in control zones 1, 2 and 3 relative to the total emissions from inland shipping is limited for both scenarios. Given, in addition, that the amount of material to be extracted in control zones 1, 2 and 3 (in total) remains virtually unchanged compared to the present situation and given the continuing decline in emissions of air pollutants (by systematic implementation of various standards and fleet renewal), it can be assumed that the impact of the marine aggregate extraction in control zones 1, 2 and 3 on the air quality will rather decrease with respect to the current situation or at least will remain the same. The effect of marine aggregate extraction in control zones 1, 2 and 3 on the air quality is therefore considered to be slightly negative (-).

Noise

The **underwater noise caused by marine aggregate extraction** (the dredging itself) is, in favorable weather conditions, significantly louder than the background noise up to a few kilometers from the source. The sound of the trailing hopper suction dredger(s) above the water can be observed up to at a distance of 1 to 2 km from the source. In view of the fact that the activity considered constitutes a continuation of the existing activity, there is no question of an increase of the ambient noise environment but the situation with respect to the current situation remains substantially unchanged. The effect of marine aggregate extraction (activity within the control zones) below and above water on the sound climate is considered to be slightly negative (-).

The influence of the **passing trailing suction hopper dredgers on the current overall ambient noise above and below water** is limited compared to the current shipping. The noise emissions during the loading and unloading of ships are relatively low and take place in an environment with an already highly disturbed noise environment (port area). In view of the fact that the activity considered constitutes a continuation of the existing activity, there is no question of an increase in the ambient noise environment but the situation with respect to the current situation remains substantially unchanged. The effect of ship movements for marine aggregate extraction and from the unloading of the extracted marine aggregates on the noise environment is considered to be negligible (0).

Sea view & Cultural heritage

There is no question of an increase in the **disruption of the sea view** by the marine aggregate extraction in control zones 1, 2 and 3 since it is a continuation of the already existing activity. The ship movements are not noticeable in the prevailing busy shipping traffic, which is part of the experience of the seascape. Consequently, the effect of marine aggregate extraction on the sea view is considered to be negligible (0).

Marine aggregate extraction means a possible loss of, or damage to **maritime cultural heritage**. Provided that the practical recommendations are respected and maximum use is made of the practical guide from the SeArch project, the effect is considered to be slightly negative (-).

Compatibility with other activities

Fishing – The direct effect (temporal incompatibility) of marine aggregate extraction on the fisheries is limited given the fact that benthic fisheries focus more on the flanks and gullies between the sandbanks, and the fact that shrimp fishing takes place mainly outside the zones where the most intensive extraction will take place. In addition, there is no change with respect to the current situation. The possible indirect effect is also limited since in the BNS to date no clear overall impact has been observed from aggregate extraction on the demersal fish communities. Consequently, the effect of marine aggregate extraction on the fisheries is considered to be slightly negative (-).

Marine aquaculture – Marine aggregate extraction has possible ecotoxicological effects on the (potentially future) farmed organisms in aquaculture zones by the potential release of toxic substances during the extraction activity. Due to the strong current of the sea water, however, such a rapid dilution occurs that the effect of marine aggregate extraction in the BNS on aquaculture is considered to be negligible (0).

Shipping / maritime transport – The control zones for sand and gravel extraction do not show any overlap with the main shipping routes and traffic flows that are necessary for shipping to approach the Belgian and Scheldt ports.

Shipping traffic can occur anywhere within the extraction zones. This shared space use brings a risk of collisions between ships. A discussion and assessment of the risk of collisions is given in the paragraph 'Safety aspects'.

Dredging and dumping – No geographical conflicts are observed between marine aggregate extraction and dredging activities (including the dumping of dredged materials). The effect is considered to be negligible (0).

Energy – Current knowledge indicates only local (significant) changes in current patterns and erosion/sedimentation patterns at very intensively mined zones. It can therefore be assumed that such significant changes to current patterns will not extend beyond the limits of the control zones. Therefore, no effect (0) on the stability of the wind turbines and any future energy atolls is expected.

Marine aggregate extraction has a negligible effect (0) on cables and pipelines, provided that the applicable regulations and safety perimeters are respected.

Safety against flooding – Marine aggregate extraction has a possible direct impact (increased wave impact during a storm) and indirect impact (coastal erosion) on the safety against flooding (coastal defense). Both effects are considered to be negligible (0), essentially as a result of the relatively large distance from the sand extraction to the coast and the presence of other sandbanks that weaken the wave energy.

Military use – Marine aggregate extraction has a negligible effect (0) on military activities, provided that the prohibition on access to the relevant military zones during notified military exercises and other activities is respected.

Tourism and recreation – Marine aggregate extraction has no impact on the tourist-recreational activities in the coastal area. Provided that the shipping regulations are respected, the chance of collision of an extraction ship with recreational navigation is also considered to be very small. The effect of marine aggregate extraction is considered to be negligible (0).

Safety aspects

Maritime safety – Building on the conclusions of the environmental impact reports of 2006 and 2010 for marine aggregate extraction, it can be assumed that the probability of the occurrence of an accident at the marine aggregate extraction in control zones 1, 2 and 3 is small. The increase in the risk of shipping accidents compared to the current situation due to the increasing importance of control zone 1 is negligible. The effect of marine aggregate extraction in control zones 1, 2 and 3 on maritime safety is therefore considered to be slightly negative (-).

Risk of oil pollution – The chance of oil pollution is considered to be very low. The biggest danger on the stranding of an oil spill comes from a discharge in areas 3a and 2kb (at high wind friction (5%)). The precautionary principle should be applied where, in the first place, a shipping accident must be avoided as much as possible and, if this turns out to be impossible, a discharge must be avoided or limited as quickly as possible. The avifauna in particular, and possibly also marine mammals, will mainly experience the major short term effects of oil pollution. However, it is often not easy to distinguish the effect of an oil spill from natural fluctuations in a population.

The effect of marine aggregate extraction on the probability of the occurrence of oil pollution is considered to be slightly negative (-).

Impact on the Good Environmental Status and Environmental Targets

Marine aggregate extraction has a potential impact on the Good Environmental Status and on the achievement of the Environmental Targets of Belgium as defined within the context of the Marine Strategy Framework Directive 2008/56/EC.

D1/D4/D6 (biological diversity / marine food chains / seafloor integrity) – Because of the redefinition of the sectors of control zone 2, the introduction of a ban on gravel extraction in control zone 2 and the gradual decrease in the extraction volume in control zone 2, a positive trend compared to the initial status (2012) is expected for various indicators that demonstrate the achievement of the Good Environmental Status for descriptors D1, D4 and D6 (at least with respect to marine aggregate extraction). Marine aggregate extraction does not therefore hypothecate the achievement of the Environmental Targets in the BNS for these descriptors.

The possible indirect effects as a result of enrichment of the seabed matrix with fine sediments (possibly from overflow) form a gap in knowledge and should be monitored further.

D6 (seafloor integrity) – For descriptor D6 (seafloor integrity) the assessment is nuanced:

- It is assumed that the actual removal of substrate and changes in topography due to aggregate extraction do not have a significant impact on the integrity of the seafloor and the connectivity of the habitats.
- In the near-field (in the intensively mined areas), sedimentological changes may occur; this results in a more heterogeneous habitat. There is however no question of significant unilateral refinement of the sediments. For this aspect there is likewise no significant impact expected on the Good Environmental Status of D6.
- In the far-field, no 'smothering' (suffocation) of the gravel beds was observed as a result of the turbidity plume. On the other hand, there is a risk that fine material from the overflow has far-field effects by captation and buffering of these fines in the soil matrix, with possible consequences for the seabed functions. For this aspect, a significant impact on the sea floor integrity and the achievement of the Good Environmental Status for D6 cannot be excluded.

Given the currently prevailing gaps in knowledge concerning this effect, further research and monitoring is initially appropriate. If it appears from this that the integrity of the seabed is indeed compromised, mitigating measures should be sought.

D2 (non-native species) – Marine aggregate extraction does not give rise to the introduction of new non-native species. Hence no impact is expected on the achievement of the Good Environmental Status for descriptor D2.

D7 (hydrographic properties) – On the basis of the discussions of the effects within the disciplines of 'Soil/Seabed', 'Water' and 'Fauna and Flora', it is decided that no significant impact is expected as a result of marine aggregate extraction on the achievement of the Good Environmental Status and Environmental Targets for descriptor D7 (hydrographic conditions).

D8 (contamination) – The risk of the occurrence of an accident during marine aggregate extraction in control zones 1, 2 and 3 is small. The risk of the occurrence of oil pollution is also very low. Careful compliance with the current legislation on maritime safety as a strict constraint applies at all stages of the marine aggregate extraction process. In addition, the precautionary principle must be applied where, in the first place, a shipping accident must be avoided as much as possible and, if this turns out to be impossible, a discharge must be avoided or limited as quickly as possible. These aspects taken into consideration, it can be decided that marine aggregate extraction does not therefore hypothecate the achievement of the environmental targets in the BNS for descriptor D8.

D11 (underwater noise) – In general, it is decided that marine aggregate extraction in control zones 1, 2 and 3 will not cause a positive trend in the annual average environmental noise levels since it can be considered as being a continuation of an existing activity. Marine aggregate extraction does not therefore hypothecate the achievement of the environmental targets in the BNS for descriptor D11.

Cumulative impacts

The marine aggregate extraction in control zones 1, 2 and 3 can, in combination with the marine aggregate extraction in control zone 4, lead to an accumulation of effects. In addition, cumulative effects may also occur as a result of marine aggregate extraction in combination with other human activities at sea which (partly) cause similar effects:

The construction and operation of wind farms in the BNS;
 The laying of the HVDC interconnector between the UK and Belgium; the Nemo Link;
Dredging and dumping of dredged material in the BNS;
Fishing, in particular trawling fisheries.

In many cases, the cumulative effect is **equal to the sum of the effects** of the individual activities (1+1=2). In some cases, the cumulative effect is **less than the sum of the effects** of the individual activities (1+1>1). Finally, there are various aspects in which the cumulative effect is (potentially) **greater than the sum of the effects** of the individual activities (1+1<1).

Cumulative effect of marine aggregate extraction in control zone 1, 2 and 3 combined with	Marine aggregate extraction in control zone 4	Windfarms	Nemo Link	Dredging and dumping of dredged material	Fishing
Soil / Seabed	S	S	S	S <S	>S ?
Water	S <S S or >S ?	S	S	S	S
Fauna & Flora: macrobenthos	>S				
Fauna & Flora: epibenthos & fish fauna	>S				
Fauna & Flora: marine mammals	>S				
Air	S				
Noise	>S				
Cultural heritage	S				
Compatibility with other activities	<i>See maritime safety</i>				
Maritime safety	>S				

In the assessment of the cumulative effects, it is important to note that the activity for which this environmental impact report is produced, namely marine aggregate extraction in control zones 1, 2 and 3, is a continuation of an already existing activity. The cumulative effects discussed are already present and will, as a result of the continuation of the marine aggregate extraction in control zones 1, 2 and 3 (in much the same way, apart from some shifts in the importance of certain sectors in response to legal conditions and the economic needs) change little or not at all in the future. So there is no question of an increase in the various cumulative effects compared with the current situation (taking into account the autonomous development), regardless of the fact that the cumulative effect is the same, less than or greater than the sum of the effects of the individual activities.

Monitoring

In accordance with the law of 13 January 1969 which states that the exploration and exploitation should be subject to an ongoing review of the impact of the activities, regular monitoring of the extraction activities in the BNS has been conducted since the end of 1999.

The possible far-field effects of sedimentation should be examined in more detail within the current monitoring program.

In addition, monitoring is recommended of the cumulative impact of marine aggregate extraction in combination with trawling, and of the cumulative impact of sedimentation of the turbidity plume resulting from sand extraction in control zone 2 and 4 on the highly valuable gravel beds.

Cross-border impacts

Considering that in this environmental impact report no significant environmental effects for the Belgian part of the North Sea were identified as a result of marine aggregate extraction, it is evident that there will also be no significant adverse cross-border environmental impacts. Significant cumulative effects from marine aggregate extraction in combination with projects abroad are not expected either.

Summary and conclusions

The main effects of marine aggregate extraction relate to the disciplines soil/seabed, water and fauna & flora (macrobenthos).

- As (intensive) extraction affects the volume of sand banks (permanent impact on the bathymetry, both local and non-cumulative) this may lead to disrupted morphology and sediment dynamics. In turn, this may lead to changes in flow patterns and abnormal erosion/sedimentation patterns.
- The physical disturbance of marine aggregate extraction can lead to changes in the structural and functional characteristics of the benthic ecosystem. When the extraction pressure is high and focuses on a limited area that is frequently visited and where large volumes are extracted, changes in the sediment composition are expected to lead to biological changes. However, the biological changes observed to date remain limited.
- With regard to sedimentation from the turbidity plume, there is a risk that fine material from the overflow has far-field effects on the ecologically highly valuable gravel beds. These potential indirect effects on gravel beds are a gap in knowledge and need to be investigated further.

These main effects are considered to be **minor (-) to moderately (--)** negative. In scenario 1 (business as usual) some effects are considered to be a degree more negative with respect to scenario 2 (maximum dispersion). In scenario 1, the extraction activities are indeed more geographically concentrated so that various effects have a greater chance of occurrence in comparison with scenario 2 where the dispersion of the extraction is maximal. In both scenario 1 and scenario 2, however, all the effects remain acceptable (maximally moderately negative).

The other effects (within these and other disciplines) are all considered to be **negligible (0) to slightly negative (-)**.

Effect	Assessment	
	Scenario 1 (business as usual)	Scenario 2 (maximum dispersal)
SOIL / SEABED		
Substrate removal – Seabed bathymetry changes	--	--
Morphological changes	--	--
Sedimentological changes	-	0
WATER		
Impact on hydrodynamics and sediment transport	--	-
<ul style="list-style-type: none"> • Increase in turbidity • Sedimentation turbidity plume 	0 --	0 -
Impact on water quality	0	0
FAUNA & FLORA – Macrobenthos		
Habitat loss	-	-
<ul style="list-style-type: none"> • Increased turbidity • Sedimentation turbidity plume 	0 --	0 -

Effect	Assessment	
	Scenario 1 (business as usual)	Scenario 2 (maximum dispersal)
Changes in structural and functional characteristics of the benthic ecosystem	--	-
Ecotoxicological effects	0	0
FAUNA & FLORA – Epibenthos & Fish communities		
Habitat loss and habitat change	-	-
Increased turbidity	-	-
Mortality	-	-
Ecotoxicological effects	0	0
FAUNA & FLORA – Avifauna & Marine mammals		
Food availability	0	0
Increased turbidity	0	0
Disturbance	-	-
AIR & CLIMATE		
Effect on air quality	-	-
NOISE		
Effect of marine aggregate extraction (activity within the control zones) on the noise climate under water	-	-
Effect of marine aggregate extraction (activity within the control zones) on the noise climate above water	-	-
Effect of ship movements for marine aggregate extraction	0	0
Effect of the dumping of the extracted marine aggregates	0	0
SEA VIEW & CULTURAL HERITAGE		
Effects on sea view	0	0
Effects on cultural heritage	-	-

Effect	Assessment	
	Scenario 1 (business as usual)	Scenario 2 (maximum dispersal)
COMPATIBILITY WITH OTHER ACTIVITIES		
Effects on fishing	-	-
Effects on aquaculture	0	0
Effects on shipping	<i>See discipline 'Safety aspects'</i>	
Effects on dredging and dumping	0	0
Effects on energy	0	0
Effects on safety against flooding	0	0
Effects on military use	0	0
Effects on tourism and recreation	0	0
SAFETY ASPECTS		
Maritime safety	-	-
Risk of oil pollution	-	-

- slightly negative effect
 -- moderately negative effect
 --- significantly negative effect

+ slightly positive effect
 ++ moderately positive effect
 +++ significantly positive effect
 0 negligible effect

References:

Van Lancker, V., Lauwaert, B., De Mol, L., Vandenreyken, H., De Backer, A., Pirlet, H., 2015. Sand and gravel extraction. In: Pirlet, H., Verleye, T., Lescrauwaet, A.K., Mees, J. (Eds.), Compendium for Coast and Sea 2015: An integrated knowledge document about the socio-economic, environmental and institutional aspects of the coast and sea in Flanders and Belgium. Ostend, Belgium, p. 105-114.

All articles of past study days for marine aggregate extraction: 2008, 2011 and 2014.