



Indicators for the Scheldt estuary

Soil interfering activities



The annual volumes of dredged and disposed material reached maximum values of 17 million m³ during the first and second expansion of the Scheldt estuary (Westerschelde and Beneden-Zeeschelde). After the second expansion an average of 9.2 million m³ was dredged annually. In the whole period (1931 - 2008), 116 million m³ was dredged more than what was disposed of. Until 1970, much of the dredged material was used for the construction of new port and industrial sites. Since 1956 also 154 million m³ of sand was extracted from the Scheldt estuary. Sand extraction in the Westerschelde has been capped at 2.6 million m³ since 1993 and will presumably be stopped from 2014 onwards. In the period 1981 - 2008, an average of 1.1 million m³ of sand was extracted from the Beneden-Zeeschelde. The costs of maintenance dredging in the Scheldt estuary are minimal compared to the added value achieved through the Scheldt ports.

Why monitor this indicator?

The Long-term Vision for the Scheldt estuary (LTV, [1]) states that an optimal accessibility is of fundamental importance for the economic development of the Scheldt ports. Expanding or maintaining the waterway is inextricably linked with this development. providing a sufficiently broad and deep navigation channel, offers guarantees for the (current) shipping to and from the Scheldt ports. To keep free access to the Flemish and Dutch ports of Vlissingen, Terneuzen, Gent and Antwerpen, dredging activities are commissioned by the Flemish government. The Mobility and Public Works Department - Maritime Access Division is hereby responsible for maintaining the navigation channel. Every week a plan is drawn to determine where to dredge and with what vessels. Each ship then sails to its designated dredging location and starts the dredging and disposal cycle. The cycle runs until the desired depth is reached. Dredged material (released during the expansion or capital and maintenance dredging of the waterways in the estuary or ports, respectively, capital and maintenance dredged material) consists of a mixture of sand and silt in various proportions. In the Westerschelde mainly sand is dredged, in the Zeeschelde this is sand and silt. Dredging and disposal activities require permits (see also technical fact sheet of the measurement).

Dredging and disposal activities as well as sand extraction can, in addition to other human and natural issues, affect the multichannel system of the estuary and the characteristic gradual transitions between sand flats, mud flats, salt marshes and shallow water. This channel system has a significant relationship with shipping (separation of traffic flows), the diversity of ecotopes or habitats, the penetration of the tide, the sediment dynamics and turbidity, and the ecological functioning of the estuary. The target 2030 of the LTV therefore requires maintenance of this multichannel system and the disposal of dredged material, preferably within the estuary, in an acceptable and sustainable manner. The elaboration and monitoring of a dredging-disposal strategy and the associated permitted volumes of dredged and disposed soil material in the Scheldt estuary by location, thus constitute some of the principles of management and policy for the Scheldt estuary in a long-term vision.

Sand extraction policy in the Westerschelde came into force in 1993 [2] focusing on the conservation of sand dynamics by compensation of extracted sand through 'natural' supply in the estuary. Currently policy for sand extraction in the Westerschelde [3, 4] is subjected to a critical analysis. It appears that this will result in a reduction of sand extraction up to and including 2013 (Al, J., pers. comm.), to reduce the impact on the large-scale sand balance of the Westerschelde. The future regulation of sand extraction in



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the Zeeschelde will be granted within the framework of public commissions. Through the environmental permit, exploitation will be linked to the Environmental Impact Assessment (EIA [5]).

What does the indicator show?

Flanders performs dredging and disposal activities in the Scheldt estuary since approximately 1885. The reporting of dredging and disposal activities does not differentiate between capital and maintenance dredging material. The quantities of material associated with expansion activities and maintenance of the navigation channel are therefore aggregated in the statistics.

Part 1 aggregates the total quantities of dredged material, disposed material and extracted sand from the Westerschelde and Beneden-Zeeschelde mainly for the purpose of accessibility to the Scheldt ports. In addition, there are other soil interfering activities in the Scheldt estuary e.g. to create access to the locks, the Zeekanaal, for shipping to the port of Gent and the berths of ferries. Data concerning these activities are not included in the indicator. This [link](#) gives an overview of the current dredging and disposal sites. For a map of the current locations of sand extraction, we refer to the technical fact sheet of the measurement [6]. All these dredging, disposal and sand extraction locations in the Westerschelde (up to the Drempeel van Vlissingen) and the Beneden-Zeeschelde together cover a Total area of over 14,300 hectares.

In Part 2, the data from part 1 are disaggregated by location of dredging, disposal and sand mining. This spatial division is relevant for more focused questions e.g. regarding the impact of soil interfering activities on the different ecotopes or habitats in the Scheldt estuary.

Part 3 contains information about the cost of maintenance dredging in the Scheldt estuary compared to the added value of the Scheldt ports.

Part 1: Annual dredging, disposal and sand extraction volumes

In the Westerschelde and Beneden-Zeeschelde for the purpose of accessibility of the Scheldt ports

For interventions in the navigation channel in the Westerschelde data on the volumes are available from 1955. For the Beneden-Zeeschelde this is from 1931. Data on the amount of sand extracted in the Scheldt estuary by the Flemish and Dutch governments and private companies, are available from 1956 for the Westerschelde and from 1981 for the Beneden-Zeeschelde. Nevertheless, an effort was made in this fact sheet to visualize the data on the annual volume of dredged material, disposed material and extracted sand from the Westerschelde and Beneden-Zeeschelde together (see figure 1).

In the period of expansion works in the Westerschelde, displayed with a red frame in the figure, peak volumes were **dredged** in the Scheldt Estuary: 16.0 million m³ (of which 13.4 in the Westerschelde) in 1975 during the first expansion and 17.0 million m³ in 1998 during the second expansion (of which 14.2 in the Westerschelde). Between the first and second deepening, an average of 12.3 million m³ material was dredged per year and after the second expansion this was on average 9.7 million m³.

The increased dredging activity in the Beneden-Zeeschelde in 1970 and 1971 was linked to the construction of the Zandvliet lock and the corresponding access channel. In these two years a volume of respectively 5.8 and 7.9 million m³ was dredged. In recent years (2004 - 2008) increased dredging activity can also be observed in the Beneden-Zeeschelde, probably linked to the construction of the Deurganckdok and the expansion of the Drempeel van Frederik (Planck, Y., pers. comm.).

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Disposal volumes in the Westerschelde follow the pattern of dredging activities, although usually less material was returned than there was dredged. Until 1970, an important part of the dredged material was also (re)used in the Beneden-Zeeschelde, in this case for the leveling of port and industrial sites. From the seventies onwards, the volume of dredged material increased there.

Sand extraction in the Westerschelde fluctuated between 200,000 and 5.4 million m³ during the period 1956 - 2008 and is capped at 2.6 million m³ since 1993 (see below). Over the entire period of available data (1981 - 2008) an average of 1.1 million m³ of sand was extracted from the Beneden-Zeeschelde.

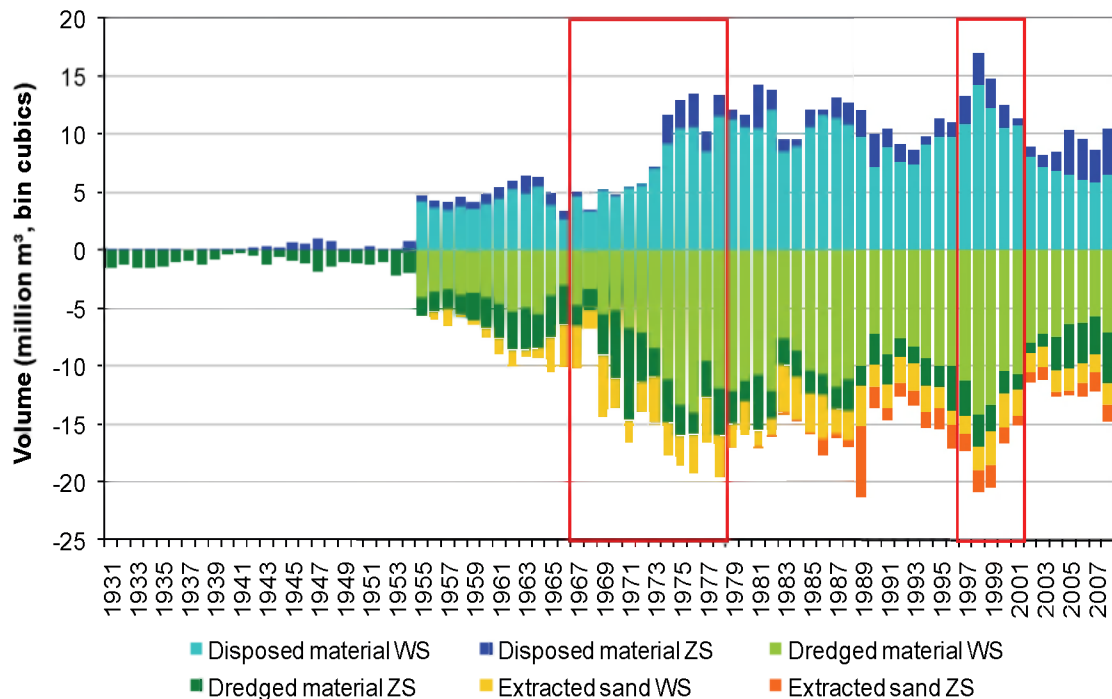


Figure 1: Annual volume of disposed material (blue), dredged material (green) and extracted sand (yellow-orange) from the Westerschelde (WS, light colors) and Beneden-Zeeschelde (ZS, dark colors). Expressed in 'beunkuubs' (bin cubics), this means that no account is taken of the density of the material: for more information, see the technical fact sheets [6, 7]. The periods of expansion works in the Westerschelde are displayed in a red frame. Available time series for sand extraction in the Westerschelde and Beneden-Zeeschelde start from 1956 and 1981 respectively. Time series for dredging and disposal in Westerschelde and Beneden-Zeeschelde start from 1955 and 1931 respectively. Source: Maritime Access Division (AMT), Directorate General for Public Works and Water Management (RWS) and Haecon, 2006 [8].

Part 2: Annual dredging, disposal and sand extraction volumes per location

In the Westerschelde and Beneden-Zeeschelde for the purpose of accessibility of the Scheldt ports

Strategy for Flexible Disposal

Within the framework of the LTV, the 'cell concept' was developed specifically for the evaluation and reporting of dredging and disposal activities in the Westerschelde. The system of channels and sand flats in the Westerschelde is hereby represented by morphological units or 'macro cells' (see figure 2, left or for more information see technical fact sheet [7]). 'Disposal capacity volumes' are being established, using the cell concept and the observed morphological developments, determining the volume of material that can be disposed of every year in the main and secondary channels of a given area or 'macro cell' without jeopardizing the multichannel system of the Westerschelde. The cell concept is not applicable to the disposal activities on the sand flat edges in the framework of the current 'Flexible Disposal'

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strategy (2009, [9]) and disposal capacity volumes for the sand flat edges in a macro cell are established through expert judgement (Planck, Y., pers. comm.). Disposal capacity volumes can be found in the technical fact sheet of the measurement [6]. With the Flexible Disposal strategy, the disposal of dredged material can be adjusted without the need for a new permit. On the one hand this strategy takes into account the previously determined maximum disposal capacity volumes and on the other hand a number of quality parameters are monitored to avoid adverse effects on the natural values of the Westerschelde.

In the absence of a multichannel system, the method of the cell concept and accompanying disposal capacity volumes is not relevant for the Zeeschelde. Here, management can rely on i.a. the specific dredging and disposal sites that are periodically determined through provincial environmental permits. The permits also provide quality criteria for the material to comply with before disposal [10.11].

For the Westerschelde dredging, disposal and sand extraction volumes are available per macro cell. In the Beneden-Zeeschelde dredging and disposal amounts were reported by 'sections' (see figure 2, right). From 2004 onwards for the Beneden-Zeeschelde and 2005 onwards for the Westerschelde, the division of data into macro cells or sections is not available yet.

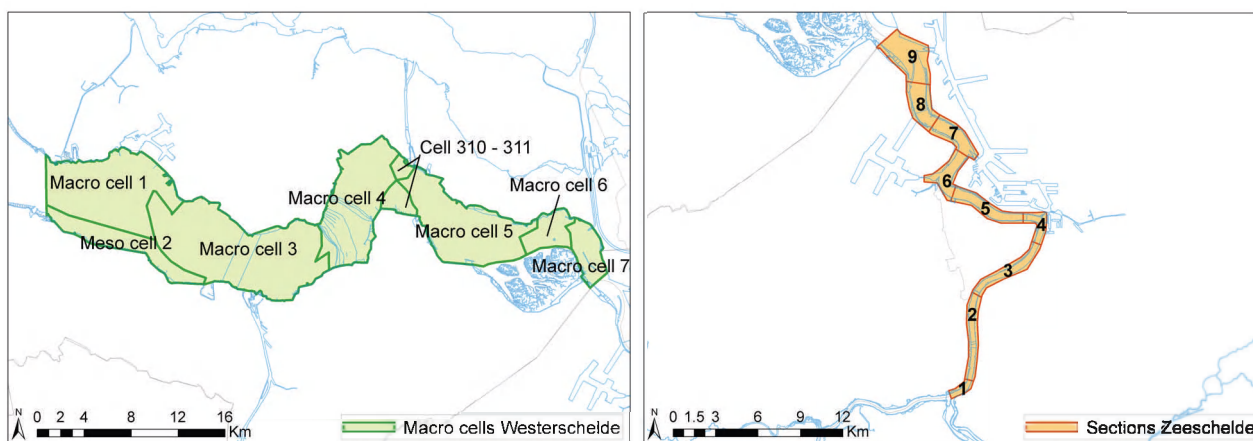
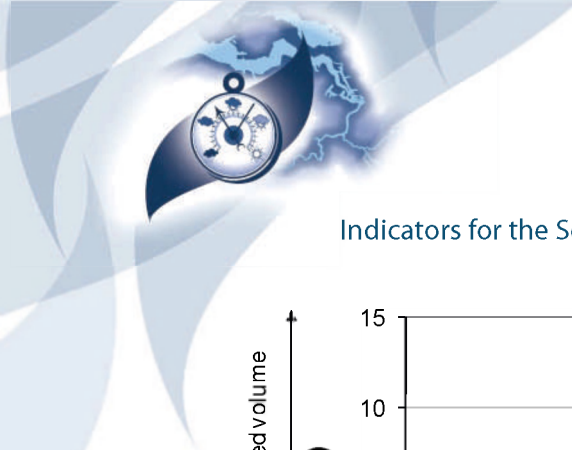


Figure 2: Left: Westerschelde and subdivision in 6 macro cells, meso cell 2 and cell 310 – 311. Right: Beneden-Zeeschelde and subdivision in 9 sections. After: Haecon, 2006 [8].

Dredging and disposal: Westerschelde

In the initial period of available dredging data for the Westerschelde (1955 - 1968) dredging only occurred in the macro cells 5, 6 and 7, in the eastern part between Hansweert and the Belgian-Dutch border (see figure 3). From the first expansion of the navigation channel, in the late 60s - early 70s, other macro cells in the central and western part of the Westerschelde were also covered. On average however, 84% of the annual dredged material came from the macro cells 5, 6 and 7.

Before the second expansion of the shipping lane, mainly the central and eastern part of the Westerschelde (macro cells 4, 5, 6 and 7) were used for disposal. Since 1997, at the beginning of the second expansion, the disposal activities shifted to the western part of the Westerschelde. Next to macro cell 4, much material was disposed of in macro cells 3 and 1. In macro cells 1, 3, 4 and 5 there was more net disposal than dredging over the entire period 1955 - 2004, while the opposite was true for macro cells 6 and 7.



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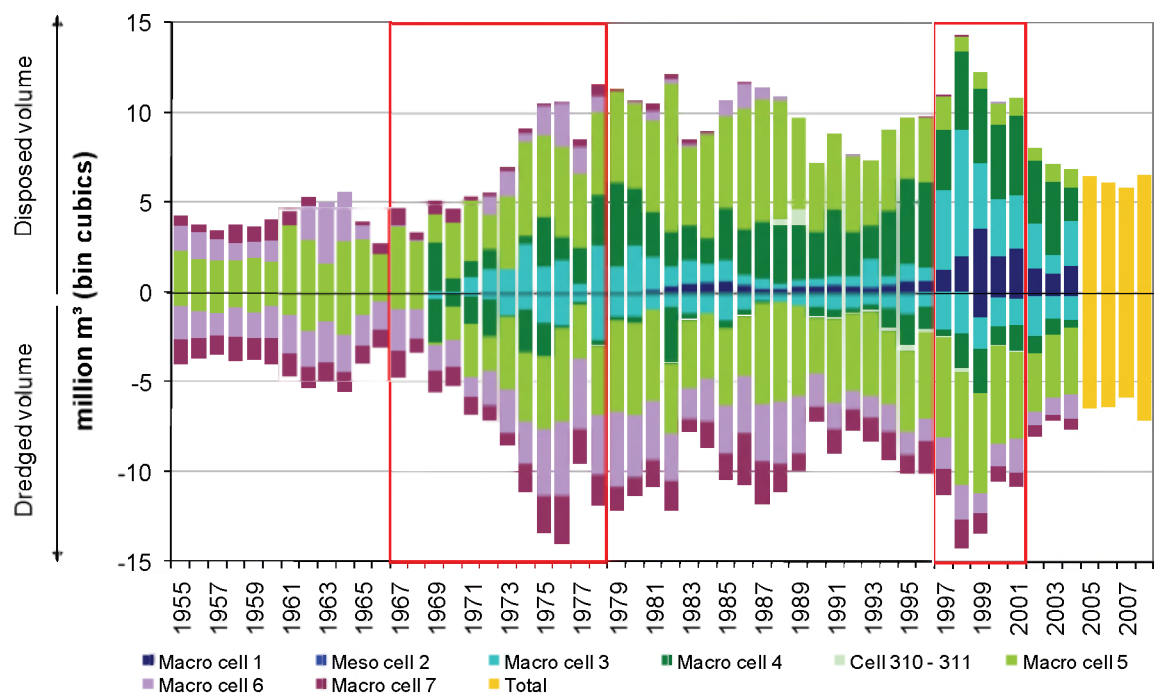


Figure 3: Annual volume of dredged (below) and disposed material (above) from the Westerschelde per macro cell. Expressed in ‘beunkuubs’ (bin cubics), this means that no account is taken of the density of the material: for more information, see the technical fact sheets [7]. The periods of expansion works are displayed in a red frame. Source: Maritime Access Division and Haecon, 2006 [8].

Dredging and disposal: Beneden-Zeeschelde

Figure 4 shows that, during the period 1931 to 2003, dredging in the Beneden-Zeeschelde primarily takes place in sections 6 to 9, downstream from the port of Antwerpen to the border between Belgium and the Netherlands. Disposal activities mainly took place in the most downstream part of the Beneden-Zeeschelde: section 9. Over the entire period more dredging than disposal of material occurred in all sections.

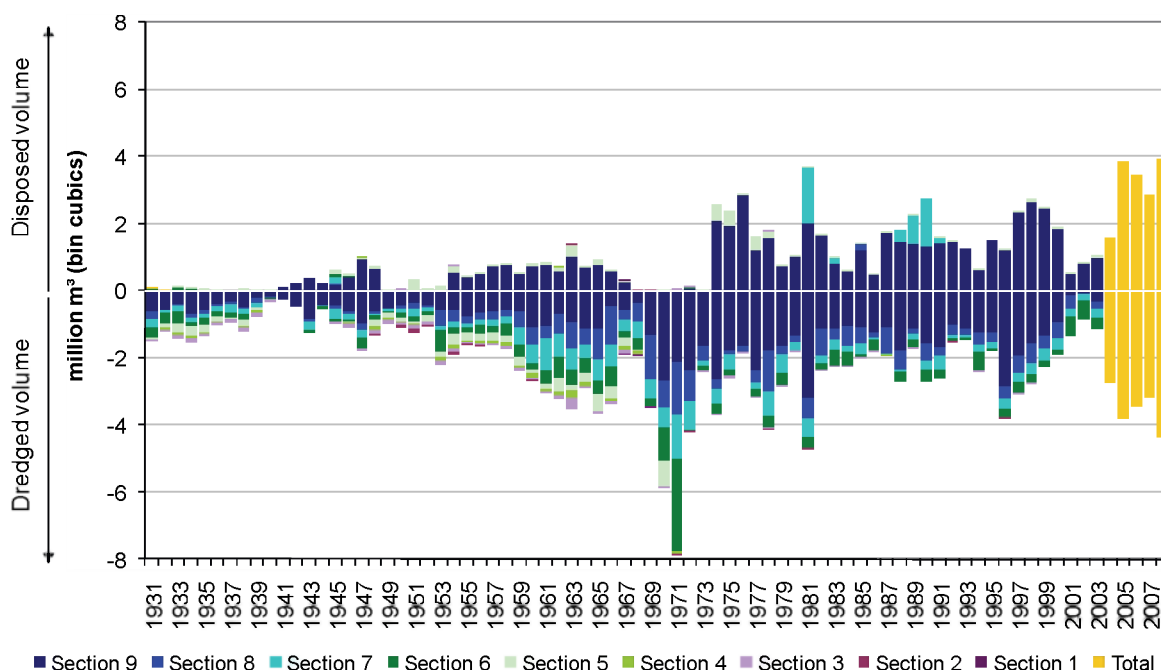
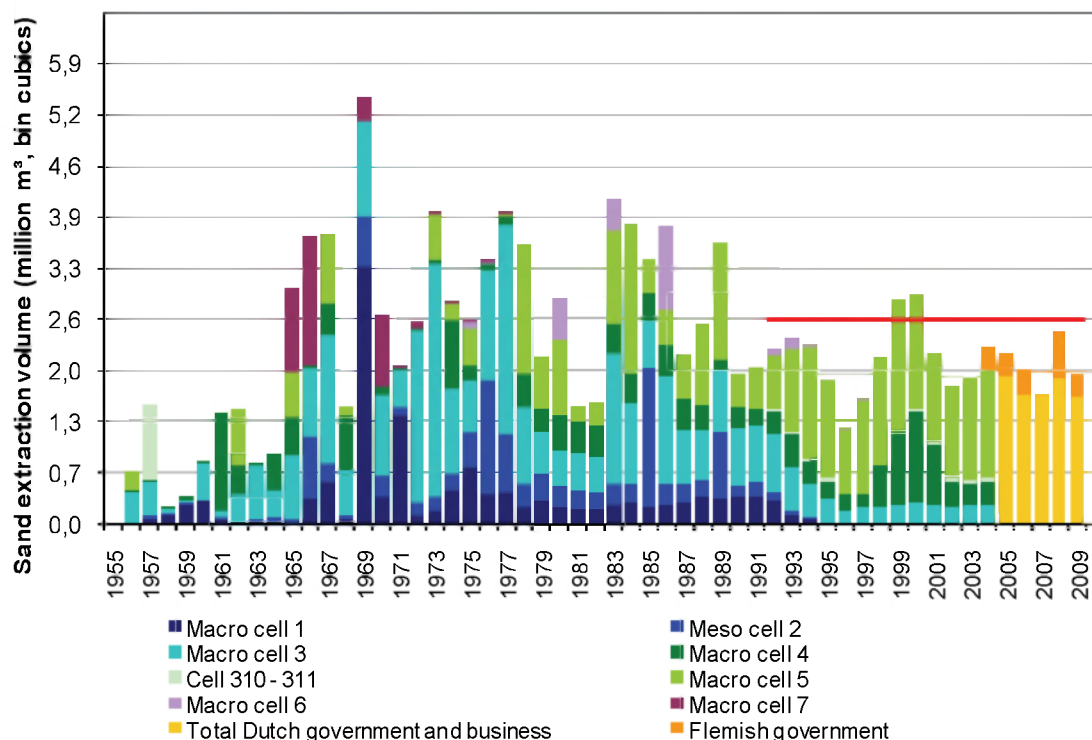


Figure 4: Annual volume of dredged (below) and disposed material (above) from the Beneden-Zeeschelde per section. Expressed in 'beunkuubs' (bin cubics), this means that no account is taken of the density of the material: for more information, see the technical fact sheets [7]. The periods of expansion works are displayed in a red frame. Source: Maritime Access Division and Haecon, 2006 [8].

Sand extraction: Westerschelde and Beneden-Zeeschelde

Sand extraction in the Westerschelde previously took place especially in the western part: meso cell 2, macro cells 1 and 3 (see figure 5). From the mid 90s until 2004, the latest year with detailed data per macro cell, the focus of sand extractions was in macro cells 4 and 5 (middle and eastern part of the Westerschelde). The maximum amount of sand that can be extracted (2.6 million m³, indicated by the red line in the figure) was exceeded in 1999 and 2000. This excess probably lies in the fact that sometimes an amount of sand, granted to the governments, is transferred to a subsequent year if e.g. a large infra-structural work requires a lot of sand in a short time (Lieke, G.-J., pers. comm.). It now appears that sand extraction in the Westerschelde will be fully cut before 2014. As of 2014 sand extraction would no longer take place in the Westerschelde.

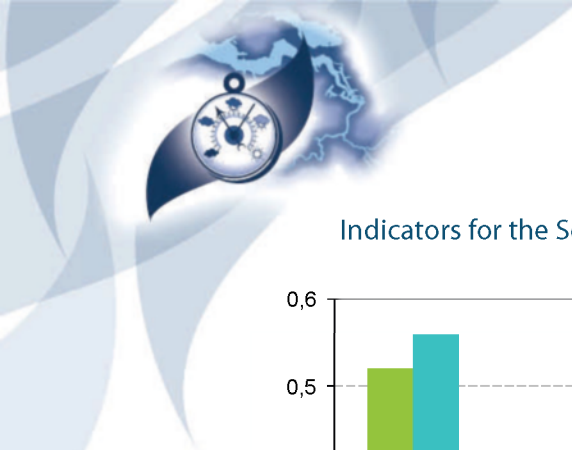


Figuur 5: Annual volume of extracted sand from the Westerschelde per macro cell. Expressed in 'beunkuubs' (bin cubics), this means that no account is taken of the density of the material: for more information, see the technical fact sheets [6]. The red line shows the maximum amount of sand that is allowed to be extracted annually since 1993. Source: Directorate General for Public Works and Water Management (RWS) Zeeland and Haecon, 2006 [8].

Sand extraction in the Beneden-Zeeschelde, in the period 1981 - 2003, is mainly concentrated in the most downstream area: section 9. The data for the Zeeschelde are therefore not presented here in a disaggregated way. In 1989, 1990 and 1991 sand was extracted exceptionally in section 8.

Part 3: Costs of maintenance dredging works

Dredging has a price tag. Figure 6 gives an idea of the relative costs of maintenance dredging as a percentage of direct and indirect added value realized through the Scheldt ports (see indicator 'socio-economic importance of the ports' [12]). This percentage decreased in the period 2002 - 2007 from respectively 0.52% and 0.55% to 0.28% and 0.30%. The economic costs of maintenance dredging are minimal compared to the realized added value. Ensuring optimal accessibility to the Scheldt ports generates of course other costs such as the one-time cost of capital dredging and non-monetary costs associated with e.g. the disturbance of the environment.



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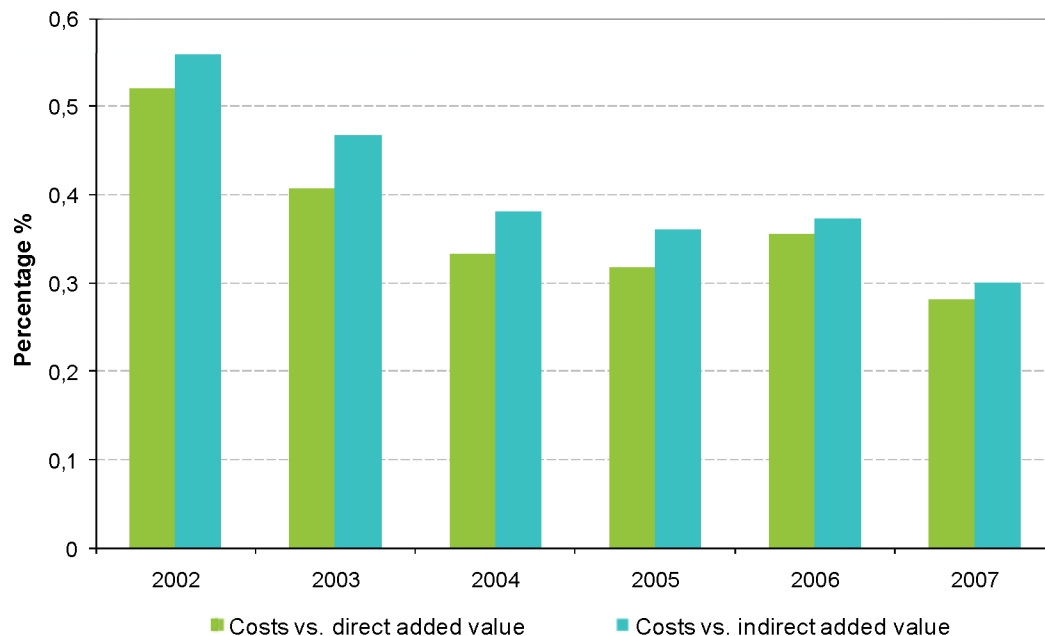


Figure 6: The annual cost of maintenance dredging in the Scheldt estuary as a percentage of direct and indirect added value generated through the Scheldt ports*. Source: Maritime Access Division. *The methods for determining added value differ in Flanders and the Netherlands (see indicator 'socio-economic importance of ports' [12]). Here, data for Flemish and Dutch Scheldt ports are aggregated to get an idea of the magnitude of the ratio between the costs of maintenance dredging and the added value.

Where do the data come from?

- Data on dredging and disposal volumes and data on costs of maintenance dredging are property of the Department of Mobility and Public Works, Maritime Access Division.
- Data on sand extraction in the Beneden-Zeeschelde are property of the Department of Mobility and Public Works, Maritime Access Division.
- Data on sand extraction in the Westerschelde are property of the Directorate General for Public Works and Water Management (RWS) Zeeland.
- Data on added value are published in the annual reports 'Havenmonitor' (port monitor) by Rebel Group Advisory and Buck Consultants International (U.S.) and 'Economic importance of the Belgian ports: Flemish maritime ports, Liège port complex and the port of Brussels' by the National Bank of Belgium (NBB).

Opportunities and threats

The Long-term Vision for the Scheldt (LTV) estuary aims for an acceptable and sustainable storage of dredged material, preferably within the estuary. In 2009, new permits were issued for dredging and disposal of soil material in the Westerschelde in the context of the third expansion and maintenance of the shipping lane [9,13]. Maximum disposal quantities or capacities were established to maintain the multi-channel character of the Westerschelde. Secondly, space was created for a 'flexible disposal strategy', by which the disposal of dredged material can be adjusted based on the meticulous monitoring of quality parameters in order to counter undesirable effects. The project group 'Flexible Disposal' of the Research and Monitoring working group is responsible for supervising the monitoring program as part of the



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flexible disposal strategy and to assess monitoring data based on the quality parameters. By disposing dredged material on the sand flat edges (in addition to the secondary and main channels), it is further intended to create ecologically valuable ecotopes. The first test disposals on the sand flat of Walsoorden were a success from the morphological point of view and generated no adverse ecological effects [14]. For the Zeeschelde, provincial environmental permits [10, 11] determine the sites where dredged material can be disposed of and the criteria to which dredged material must respond.

In the framework of the LTV a 'mud transport model' was developed, to be able to investigate both the natural development of silt dynamics and silt balance in the estuary and the effects of human activities, such as an expansion of the navigation channel, on this autonomous evolution. The link between the silt dynamics and ecology (primary production) is also examined. A first conclusion from these studies is that dredging in the ports has a relatively small effect on the silt levels in the system. Except for the port of Antwerp, human influence is noticeable compared to the natural variation [15, 16, 17].

The production of validated data on volumes of extracted sand, dredged and disposed material from the Scheldt estuary and its associated metadata is part of a good management and policy support. The data in this indicator concern total volumes of dredged material, disposed material and extracted sand in the Westerschelde and Beneden-Zeeschelde for the purpose of accessibility of the Scheldt ports. In the future, it is also relevant to obtain a quantitative overview of other soil interfering activities in the Scheldt estuary.

The different data sets on dredging, disposal and sand extraction among data sources do not always match. This year, the Maritime Access Division and RWS Zeeland are building a consistent data set to increase the reliability of older data in the time series.

The technical fact sheets from the measurements of this indicator describe the definitions, data and methodology and limitations. The sheets are available at: <http://www.scheldemonitor.org/indicatorfiche.php?id=4>

Integration with other indicators/measurements?

Dredging and disposal activities in the Scheldt estuary must secure accessibility to the Scheldt ports through the creation of a sufficiently deep and wide navigation channel. Such accessibility must, according to the Long-term Vision, translate into a safe and smooth shipping traffic to and from the Scheldt ports (see indicator 'nautical management'). In addition, this accessibility must also result in an optimization of the socio-economic development of the Scheldt ports so that they continue to have a leading position in the Hamburg - Le Havre range and also in 2030 belong to the world top (see indicator 'socio-economic importance of ports').

Soil interfering activities can influence the multichannel system of the Westerschelde. The tilt coefficient records the depth ratios between the ebb and flood channels in the Westerschelde and therefore is a measure for the preservation of the multichannel system. Dredging, disposal and sand extraction can also have an impact on the diversity of ecotopes and habitats. The monitoring of the ecotope system and in particular of the preservation of ecologically valuable low dynamic area follows up on the impact of dredging and disposal activities on the ecosystem (see indicator 'morphology and dynamics in the estuary').

Large parts of the Scheldt estuary are designated as protected area under the Habitats and Birds Directives. The possible effects of soil interfering activities on protected habitats and species within these Natura 2000 sites have been examined i.a. in the 'EIS expansion navigation channel Beneden-Zeeschelde and Westerschelde' [18]. Yet vigilance is important and possible links between soil interfering activities and the conservation status of these habitats and species (see indicator 'status of species and habitats') may not be overlooked.



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