14 Scheldt Estuary

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The Sea Scheldt and its tidal tributaries (Durme, Rupel with the Zenne, Dijle and Netes), the Western Scheldt and the mouth of the Scheldt together constitute the Scheldt Estuary. The water bodies and flood plains are subject to the tides from the North Sea. Hence, a strong interaction exists between the Scheldt Estuary and the North Sea (exchange of water masses, dissolved substances, sediments, fauna & flora etc.). Given the importance of the relationship between the user functions of both areas (fisheries, shipping, dredging and dumping, recreation, etc.), the Compendium for Coast and Sea also covers the Scheldt Estuary. The current text is largely based on the contents of *ScheldeMonitor*. This is a Flemish-Dutch knowledge and information portal for research and monitoring in the Scheldt Estuary, which offers information (expertise, literature, projects, etc.), data (datasets, measurements, etc.) and data products (maps, graphs, indicators, etc.).

Besides the Scheldt Estuary, a number of other important estuaries are situated in the North Sea area. These include the estuaries of the Seine (France), the Oder (Germany and Poland), the Elbe (Germany), the Weser (Germany), the Humber (United Kingdom), the Ems - Dollard (Germany and Holland) and the Thames - Essex (United Kingdom) (*Debergh et al. 2009*, *TIDE project*). The estuaries have a great ecological value and parts of them are designated as *natura 2000 areas* (see also theme **Nature and environment**). On the other hand, these estuaries provide space for important economic activities such as harbour developments. Furthermore, the estuaries face common challenges such as increasing flood risks, issues with regard to sediment management and the preservation of ecosystem functions. Because of the common challenges of these areas, European collaboration projects concerning estuarine research and management have been conducted. Depending on the project and the project partners, these projects focus on one or several challenges (e.g. *FLOODSCAPE*, *FRaME*, *HARBASINS*, *TIDE*, *SEDNET*, *SCALDWIN*, *EMOVE*, etc., see also *list of projects* in ScheldeMonitor). The Scheldt Estuary is unique in northwestern Europe because a tidal regime is preserved along the entire fresh-salt water gradient in the river with the typical tidal habitats and communities (*Directie Zeeland & AWZ 2001*).

14.1 Policy context

The policy and management of the Scheldt Estuary is a cross-border matter that involves both Flanders and the Netherlands. Between both countries, several treaties and memoranda of understanding on the Scheldt Estuary have been concluded (see table 1 and *website VNSC*). Furthermore, ministerial declarations and treaties have been made in the context of integrated water management in the Scheldt Basin, which not only involve Flanders and the Netherlands, but also the Walloon Region, the Brussels-Capital Region and France (see table 1 and *website International Scheldt commission*). An overview of historical treaties and agreements is available in *van Langenhuysen & van Langenhuysen (1919)* and *Baekelandt (2002)*.

To ensure the coordination between the Flemish and Dutch authorities, a number of specific cross-border organisations for the Scheldt Estuary have been created. In 1948, on the occasion of the foundation of the Benelux Customs Union, the Technical Scheldt Commission (TSC) was established. This commission was composed of Dutch and Belgian/Flemish officials and was responsible for studies about the Scheldt (e.g. the Deltaplan, the Scheldt-Rhine connection, Long Term Vision (LTV) and the Development sketch 2010 for the Scheldt Estuary). After 2008, the TSC was succeeded by the Flemish-Dutch Scheldt Commission (*VNSC*), as stipulated in the Scheldt Treaties that were concluded on 21 December 2005 in Middelburg. The VNSC consists of a political and an official college and promotes the collaboration between Flanders and the Netherlands in the field of the policy and management of the Scheldt Estuary (the preparation and establishment of plans, programmes and projects, the establishment and guidance of a common programme for monitoring and research, etc.). Depending on the policy and management questions, the official college can establish a permanent or temporary working group to perform specific tasks. The two permanent working groups are ‘Research and monitoring’ and ‘Communication’. In 2015, four temporary working groups were active: ‘Development sketch 2010 for the Scheldt Estuary’, ‘The new sluice of Terneuzen’, ‘Inland navigation in the Scheldt Area’, and ‘Policy and management evaluation’.

On a sectoral level, Flanders and the Netherlands collaborate as well. Both countries ensure the organisation of smooth and safe shipping from and to the Scheldt ports by means of the Common Nautical Management (*CNM*). The *permanent committee of supervision on Scheldt navigation*, that was founded pursuant to article 9 of *the treaty of 19 April 1839* concerning the separation between the Netherlands and Belgium, is the highest body in the organisation of the CNM. The Common Nautical Authority (*CNA*) ensures the daily nautical management, supervised by the permanent committee. The CNA provides information about radar systems and shipping guidance by the Vessel Traffic Services (VTS), as well as information about regulations and procedures. The monitoring of shipping on the Scheldt is mainly performed by the Scheldt Radar Chain (SRC), a shipping guidance system used by the Flemish and Dutch governments. The operational, functional and technical management of the systems of the SRC is executed by the *management and exploration team*.

Table 1. Overview of transborder treaties and memoranda for the Scheldt Estuary (*website VNSC*, *website International Scheldt Commission*).

FLANDERS – THE NETHERLANDS (FROM 1960)	
Scheldt treaties	Memoranda of Understanding (MoU)
Pilot rates (*Loodsgeldtarieven*) (2005)	MoU The Hague (*MvO Den Haag*) (2005)
Common nautical management (*Gemeenschappelijk Nautisch Beheer*) (2005)	First MoU Vlissingen (*Eerste MvO Vlissingen*) (2002) Second MoU Vlissingen (*Tweede MvO Vlissingen*) (2002)
Common policy and management (*Gemeenschappelijk beleid en beheer*) (2005)	MoU Kallo (*MvO Kallo*) (2001)
Development sketch 2010 for the Scheldt Estuary (*Ontwikkelingsschets 2010 Schelde-estuarium*) (2005)	
Scheldt Treaty (*Scheldeverdrag*) (2002)	
Widening of the channel 48/43/38 feet (*Verruiming vaargeul 48/43/38 voet*) (1995)	
Improvement of the waterway at Walsoorden (*Verbetering vaarweg te Walsoorden*) (1970)	
Scheldt-Rhine connection (*Schelde-Rijnverbinding*) (1963)	
Canal Ghent-Terneuzen (*Kanaal Gent-Terneuzen*) (1960) • Protocol Canal Ghent-Terneuzen (*Protocol Kanaal Gent-Terneuzen*) (1985)	

BELGIUM – FRANCE – THE NETHERLANDS	
Treaties	Ministerial declarations
Treaty of Ghent (2002)	*Ministerial declaration of Liège* (2001)
Treaty of Charleville-Mézières (1994)	*Ministerial conference in Middelburg* (1998)

The objective of the International Scheldt Commission (*ISC*) is to improve the cooperation between riparian states (France, Belgium and the Netherlands) and regions of the Scheldt, in order to achieve a sustainable and integrated water management of the international Scheldt river basin district. Since 2000, attention has also been paid to the common aspects of the river basin management plan for the Scheldt Basin (report 2016-2021, in preparation) in the context of the goals of the Water Framework Directive (WFD).

In the current policy concerning the Scheldt Estuary, particular attention is being paid to the Long Term Vision for the Scheldt Estuary (LTV, *Directie Zeeland & AWZ 2001*). This vision was established in 2001 by the Netherlands and Flanders, and approved by the governments and parliaments of both countries. The LTV constitutes the basis for the development of a trans-border and integrated policy for the estuary. The vision was conceived from the idea that the different functions of the Scheldt Estuary (within the three main themes of safety, nature and accessibility as well as other functions such as fisheries, tourism and recreation) have to be taken into account, in a sustainable way in the future. In the LTV, a 'Target 2030' has been formulated, listing the goals to be achieved by 2030. The *Development sketch 2010 for the Scheldt Estuary (Proses 2005)* indicates which measures and policy efforts are needed in order to achieve the objectives of 'Target 2030'. The challenges for policy makers and managers with regard to the Scheldt Estuary are nowadays included in the *Agenda for the Future*. In 2014, a research programme was established in the context of this agenda.

The *Research and Monitoring* working group is a permanent working group of the Flemish and Dutch Scheldt Commission (VNSC), established in the context of the LTV for the Scheldt Estuary. The Research and Monitoring working group coordinates a long-term monitoring and research programme (MONEOS, *Meire & Maris 2008*) to support the policy and management of the Scheldt Estuary. In this context, an evaluation of the Scheldt Estuary is conducted every six years (evaluation methodology: *Holzhauer et al. 2011*, T2009 report: *Depreiter et al. 2014*) (see **Indicators for a sustainable management**).

In 2003, *ScheldeMonitor* was launched in the context of VNSC as an information system with regard to research and monitoring in the Scheldt Estuary. In addition to the disclosure of information, data and data products related to

the Scheldt Estuary have also been included since 2010. Special attention is paid to the disclosure and archiving of datasets from the MONEOS programme.

In Flanders, two of the themes which are covered by the LTV - safety and nature - are commonly implemented by means of the *updated Sigmaplan (2005)*. Hence, the measures set in this plan serve both the safety and nature function of the estuary. The objectives of the LTV with regard to nature in the Sea Scheldt have been further refined in the context of the updated Sigmaplan (*Adriaensen et al. 2005*). Furthermore, a series of measures has been proposed to realise these goals. Three types of measures are important in this regard: the development of mud flats and salt marshes by allowing controlled reduced tides in a controlled floodplain (CFP), the renewal of dikes or depolderisation, and the development of wetlands in the valley, whether or not as a CFP. The goals and measures are part of the *updated Sigmaplan (2005)*, as approved by the Flemish government (22 July 2005).

The policy and management with regard to the Scheldt Estuary are largely driven by international and European legislation such as the Birds and Habitats Directives, the Water Framework Directive (WFD), the Floods Directive (see also *http://www.scheldemonitor.be/nl/monitoring-en-beleidskader*) and the national and regional policy instruments that have to ensure the local implementation of these measures (see also theme **Nature and environment**) by means of concrete goals such as the good ecological and chemical condition (WFD) and the conservation objectives of the natura 2000 areas in and around the estuary. An overview of the policy framework for the Scheldt Estuary is given in *Debergh et al. (2009)* and on the following webpage: *http://www.scheldemonitor.be/nl/monitoring-en-beleidskader*

14.2 Spatial demarcation

By definition, an estuary contains the part of a river which is subject to tidal influence (*Fairbridge 1980*). In the case of the Scheldt Estuary, this is the area from the mouth of the river to the locks in Ghent (Merelbeke), including the Durme, Rupel, Zenne, Dijle and Netes up to where tidal influence can be recorded. Furthermore, the upper limit of the highest high water is regarded as a border (figure 1).

The LTV (*Directie Zeeland & AWZ 2001*) applies to a specific geographical area. However, a trans-border perspective is used when this is required for certain aspects. The upstream border was set at the locks in Ghent (Merelbeke) and the mouths of the tributaries. The downstream border of the estuary contains the Scheldt and its estuaries, including *Vlakte van de Raan* and other shallow water areas. The channels are taken into account up to the limit of the nautical management (indicative border: the piloting intersections west of *het Scheur*). The port of Zeebrugge and

THE AREA OF THE SCHELDT ESTUARY

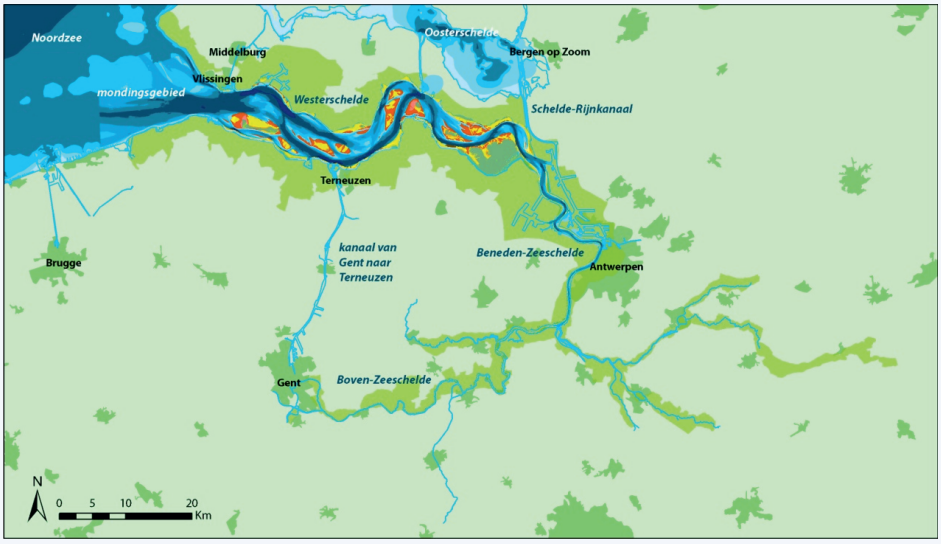

Figure 1. The area of the Scheldt Estuary, with an indication of the estuary, the Western Scheldt, the Lower Sea Scheldt and the Upper Sea Scheldt (Source: VNSC Communication).

its waterway *Pas van het Zand* are not included in the area demarcated for the LTV. The LTV also covers the banks up to the principal weirs.

The spatial division which is presented in the evaluation methodology for the Scheldt Estuary (*Holzhauer et al. 2011*) is based on the division in OMES/MOSES compartments which are related to the salinity and residence times (figure 2). These zones can be subdivided or combined depending on the desired detail. Four different scales can be distinguished:

- Level 1: Estuary
- Level 2: Western Scheldt – Sea Scheldt - Tributaries
- Level 3: Mouth zone – Polyhaline zone – Mesohaline zone – Zone with strong salinity gradient – Oligohaline zone – Freshwater zone with long residence time – Freshwater zone with short residence time - Tributaries
- Level 4: OMES/MOSES compartment

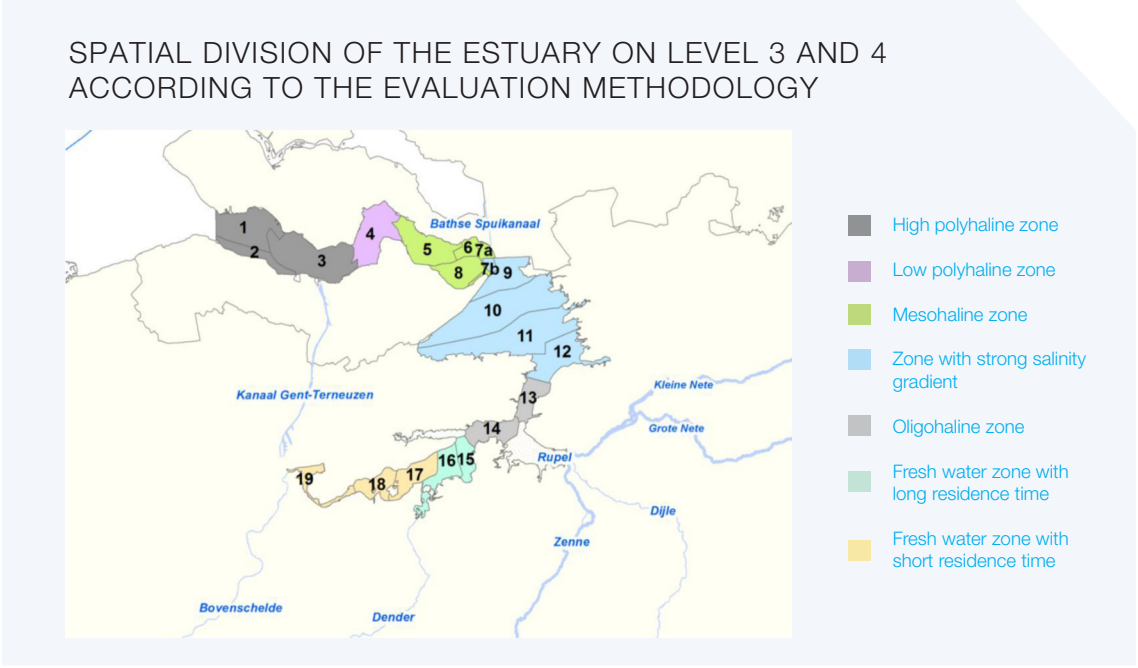

Figure 2. The spatial division of the Scheldt Estuary on level 3 and 4 according to the evaluation methodology (Source: *Maris et al. 2014*).

14.3 The ecosystem of the Scheldt Estuary

The Scheldt Estuary is an area with unique natural values. It is one of the most important European estuaries where the tidal regime has been preserved along the entire fresh-salt water gradient with the typical tidal habitats and communities (*Directie Zeeland & AWZ 2001*).

The Scheldt Estuary is by nature a very dynamic system. Mud flats, salt marshes, sandbanks and gullies are constantly subject to tidal and salinity changes. The low-dynamic (with a low water velocity) shallow water areas, the intertidal areas (mud flats, sandbanks) and salt marshes constitute ecologically valuable habitats in the Scheldt Estuary. The mudflats and sandbanks are usually rich in benthos and constitute important feeding grounds for waders and other birds. In general, the areas with an average exposure rate (the percentage of time the mud flats are surfaced) are the most attractive areas from an ecological point of view (*MER Verruiming vaargeul Beneden-Zeeschelde en Westerschelde 2007*, *Wetsteijn et al. 2007*, *Depreiter et al. 2014*). Low-dynamic shallow water areas are essential for the reproduction and growth (nursery function) of fishes, crustaceans and molluscs. Salt marshes provide a suitable nesting area for several bird species and serve as a refuge during high water. In addition, these intertidal areas have an important regulating function as a source or sink of certain substances such as nutrients and silica (see *inter alia Struyf et al. 2006* and *Jacobs et al. 2008*).

Table 2. Overview of the available information, data and data products about the ecosystem which are present in ScheldeMonitor.

THE ECOSYSTEM OF THE SCHELDT ESTUARY	
Topic	Subtopic
Habitats diversity	
Species diversity	
Ecological functioning	
Physico-chemistry	• *Physical parameters* • *Light climate* • *Pollution* • *Bottom water quality* • *Water quality*
Hydrodynamics	• *Waves* • *Water balance* • *Water level and tide*
Morphodynamics	*Geomorphology*

Flanders and the Netherlands collaborate on an ecotope system (i.e. a (hierarchical) classification of ecotopes of habitats) for the Scheldt Estuary. This type of system is used to track changes in different habitats throughout time, to predict the impact of certain variations in the system on the present habitats and to evaluate the effects on the communities (*Arcadis 2014*).

Table 2 gives an overview of the available information (expertise, literature, projects, etc.), data (datasets, measures, etc.) and data products (maps, graphs, projects, etc.) in *ScheldeMonitor* regarding the different aspects of the ecosystem. Important information concerning the ecosystem of the Scheldt Estuary is also available in reports of the Research and Monitoring working group (see reports on the websites of *ScheldeMonitor* and *VNSC*).

14.4 The use of the Scheldt Estuary

The Scheldt Estuary is not only an important ecosystem, but also hosts several user functions such as shipping, dredging, sand extraction, recreation, protection against floods (e.g. flood control areas), fishing, etc. Table 3 gives an overview of the available information (expertise, literature, projects, etc.), data (datasets, measures, etc.) and data products (maps, graphs, indicators, etc.) in *ScheldeMonitor* concerning these user functions. Certain users functions are also discussed in reports of the Research and Monitoring working group (see reports on the websites of the *ScheldeMonitor* and *VNSC*).

Table 3. Overview of the available information, data and data products about the different user functions of the estuary which are present in ScheldeMonitor.

THE USER FUNCTIONS OF THE SCHELDT ESTUARY	
Topic	Subtopic
Morphodynamics	• *Dredging and dumping* • *Sand extraction*
Shipping	
Safety	
Fisheries	
Administration and law	
Socio-economics	

14.5 Indicators for a sustainable management

Flanders and the Netherlands have decided to conduct a common evaluation of the functioning of the Scheldt Estuary and the activities in the estuary in the framework of the Research and Monitoring working group (VNSC), every six years. This reporting aims to evaluate the three principal functions: nature, safety and accessibility by means of seven indicators for a sustainable management (see table 4). In 2011, an evaluation methodology was developed which describes how each indicator should be evaluated (*Holzhauer et al. 2011*). Every indicator has a pyramid structure which includes the relevant benchmark parameters, calculation parameters and explanatory parameters. The evaluation methodology is a dynamic document which is reviewed after each evaluation report. Hence, a first update became available in 2014: *Maris et al. 2014*. The *Evaluation and Reporting project group* coordinates the different evaluation reports (see explanation on *website ScheldeMonitor*).

Prior to evaluation, a baseline has to be clearly defined based on the evaluation methodology (*Holzhauer et al. 2011*). 2009 is used as a reference (T2009) (*Depreiter et al. 2014*). In the aforementioned report, the baseline situation of the system of the Scheldt Estuary is described (the year 2009) as well as the trends and historic developments until 2009. The next evaluations will be conducted in 2016 and 2022.

Prior to the evaluation methodology mentioned above, a set of indicators was selected in the context of the LTV goals and aligned with the complete transboundary Scheldt Estuary in consultation with scientists and policy makers (see *Indicators for the Scheldt Estuary 2011* and *website ScheldeMonitor*).

Tabel 4. Overview of the indicators which were selected within the evaluation methodology for the evaluation of the three principal functions of the Scheldt Estuary (Source: *ScheldeMonitor*).

OVERVIEW INDICATORS EVALUATION SCHELDT ESTUARY			
Principal function	**Indicator**	**Methodology**	**Report appendix**
Safety	Water movement dynamics	*version 2011* *version 2014*	*Appendix T2009*
Accessibility	Navigability	*version 2011* *version 2014*	*Appendix T2009*
Nature	Water Quality	*version 2011* *version 2014*	*Appendix T2009*
	Flora & Fauna	*version 2011* *version 2014*	*Appendix T2009*
	Ecological functioning	*version 2011* *version 2014*	*Appendix T2009*
	Habitat	*version 2011* *version 2014*	*Appendix* & *Addendum T2009*
	Bank-gully system	*version 2011* *no pyramid 2014*	

Legislation reference list

Table with international agreements, conventions, etc.

INTERNATIONAL AGREEMENTS, CONVENTIONS, ...			
Abbreviations (if available)	Title	Year of conclusion	Year of entering into force
	Canal Ghent-Terneuzen (*Kanaal Gent-Terneuzen*) Protocol Canal Ghent-Terneuzen (*Protocol Kanaal Gent-Terneuzen*)	1960 1985	
	Scheldt-Rhine connection (*Schelde-Rijnverbinding*)	1963	
	Improvement of the fairway at Walsoorden (*Verbetering vaarweg te Walsoorden*)	1970	
RAMSAR Convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat	1971	1975
	Treaty of Charleville-Mézières (*Verdrag van Charleville-Mézières*)	1994	
	Widening of the channel 48/43/38 feet (*Verruiming vaargeul 48/43/38 voet*)	1995	
	Scheldt treaty (*Scheldeverdrag*)	2002	
	Treaty of Ghent (*Verdrag van Gent*)	2002	
	Pilot rates (*Loodsgeldtarieven*)	2005	2008
	Common nautical management (*Gemeenschappelijk Nautisch Beheer*)	2005	2008
	Common policy and management (*Gemeenschappelijk beleid en beheer*)	2005	2008
	Development sketch 2010 for the Scheldt Estuary (*Ontwikkelingsschets 2010 Schelde-estuarium*)	2005	2008
Memoranda of Understanding			
	MoU Kallo (2001)		2001
	MoU Vlissingen (2002) (2 MoUs)		2002 (2)
	MoU Den Haag (2005)	2005	2005
Ministerial Decrees			
	Ministerial conference in Middelburg (*Ministersconferentie te Middelburg*)	1998	
	Ministerial declaration of Liège (*Ministeriële Verklaring van Luik*)	2001	

Table with European legislation. The consolidated version of this legislation is available on *Eurlex*.

EUROPEAN LEGISLATION			
Abbreviations (if available)	Title	Year	Number
Directives			
Habitats Directive	Council Directive on the conservation of natural habitats and of wild fauna and flora	1992	43
Water Framework Directive	Directive 2000/60/EC establishing a framework for Community action in the field of water policy	2000	60
Floods Directive	Directive 2007/60/EC on the assessment and management of flood risks	2007	60
Birds Directive	Directive on the conservation of wild birds	2009	147