1. CONTEXT

For centuries, the Scheldt and its tributaries have ensured a well-watered country bursting with dynamism. But tidal rivers may also bring a great deal of water-based misery. Protecting Flanders more effectively against flooding by the Scheldt and its tributaries is the main objective of the Sigma Plan. All at once, the wonderful nature of the Scheldt will be restored in numerous places. Thousands of walkers and cyclists can then enjoy it to the fullest. The Sigma Plan also has an eye on the economic role of the Scheldt as one of Europe's busiest rivers.

In this chapter, you will find out all about the work in Bergenmeersen, a subsector of the Kalkense Meersen Cluster Sigma Project. You will discover how the Sigma Plan originated and how that progressive plan evolved into a smart project for the future that goes far beyond flood management.

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1.1 Leading figure in the Sigma Plan: the Scheldt

1.1.1 The Scheldt and its tidal area

The Scheldt originates in northern France, on the Saint Quentin plateau. It is a small spring, which first forms a brook and is fed by other brooks and tributaries. All these brooks and rivers that flow into the Scheldt together form the Scheldt basin, along with the main river itself.

Up to Ghent, it is known as the Upper Scheldt; after Ghent its name changes to the Sea Scheldt. From this point on, the river is in fact already part sea. After all, unhindered by any barrage or dam, the tides can be felt 160 km inland as far as Ghent. Past Antwerp, the Scheldt flows into the Netherlands; there it is known as the Western Scheldt. At Bath, the river arcs in a large bend before emptying into the North Sea at Vlissingen. The effect of the tides can also be felt in the Durme, Rupel, Senne, Dyle, Kleine Nete and Grote Nete rivers. Together with the Sea Scheldt and the Western Scheldt, these tributaries of the Sea Scheldt form the Scheldt estuary, the tidal area of the Scheldt.

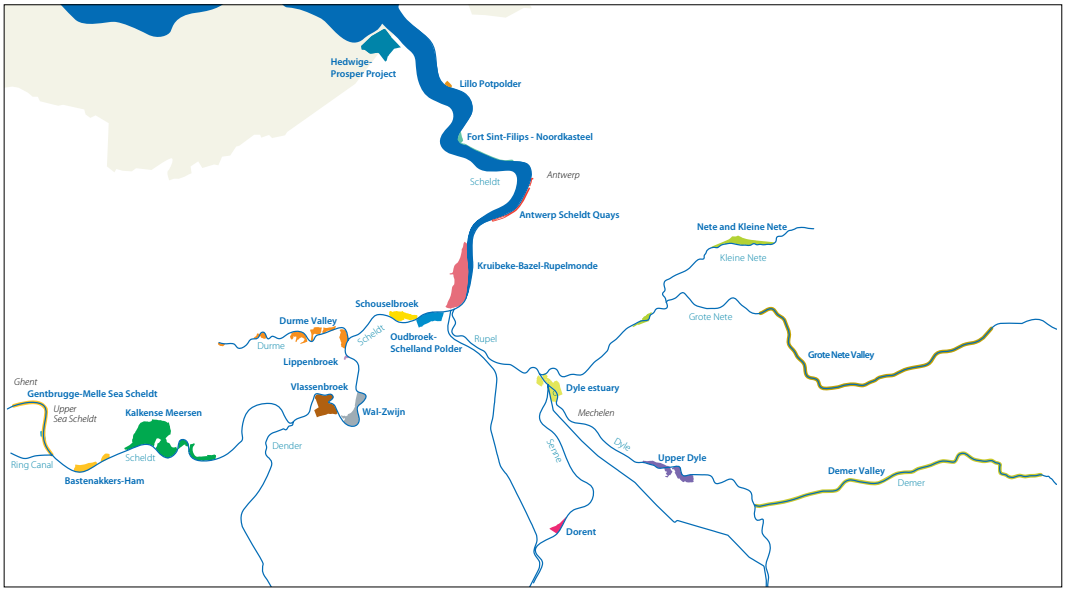

Figure 1.1. Map of the Sigma Plan project areas

1.1.2 The Scheldt as an economic artery

As one of Europe's busiest rivers, the Scheldt plays a prominent economic role. The river is a major shipping route, which carries millions of tonnes of cargo to and from the ports of Antwerp, Vlissingen, Terneuzen, Ghent and even Brussels each year. Via the Leie and the Upper Scheldt, the Scheldt links Flanders and the Netherlands with France. Past Antwerp, ships can join the Albert Canal eastwards, towards the Meuse river basin and beyond. Countless businesses are based in the ports and on the banks of the Scheldt. These employ tens of thousands of people and have a decisive impact on the economy of the whole of Flanders.

Figure 1.2. Inland navigation on the Scheldt

FLANDERS IN EUROPE

The Belgian federated entity, including Flanders, can act internationally with regard to their respective competences. They are active on international and European forums and can conclude treaties. That substantial right to conclude treaties is unique, as is the central position in Europe.

The European Union is a major influence on Flemish policy. After all, Flanders is also responsible for approving European treaties (such as the Treaty of Lisbon) and implementing European directives that concern Flemish powers. Flanders' foreign relations are also far-reaching. For example, Flanders enjoys bilateral relations with neighbouring countries and regions and signs treaties. Flanders also cooperates with multilateral organisations such as UNESCO, the OECD, the Council of Europe, UNAIDS, the International Labour Organisation and the World Health Organisation.

The central position and accessibility of Flanders are also extremely important. The port of Antwerp on the Sea Scheldt, for example, is one of the largest sea ports in the world. Brussels Airport is one of Europe's main airports for the transport of cargo and passengers. Flanders also has a dense network of railways, motorways and waterways. The various transport options make Flanders the ideal gateway to Europe.

But Flanders is more than a gateway to Europe. It is an economic engine with the world as its market. Around 75% of Belgian exports, or more than 150 billion euros, come from Flanders. Most of these exports are destined for the European market. What is striking is the sharp increase in exports to the new EU Member States, the BRIC countries (Brazil, Russia, India and China) and various other emerging economies. The chemical, pharmaceutical and automobile sectors traditionally account for a major share of Flanders' total exports.

The large volume of economic activity around the Scheldt seems irreconcilable with a rich and valuable inter-tide policy. However, through close cooperation between port companies, waterway managers and the environmental sector, Flanders is playing a pioneering role in estuary management. In various European projects, this Flemish expertise is being exchanged with actors involved in the integral management of estuaries in the rest of Europe.

1.1.3 Floods: also part of the Scheldt

The Scheldt Valley is no stranger to floods. They are the result of heavy storm surges in the North Sea, which send massive tidal bores up the river. As early as the Middle Ages, villages and estates along the Scheldt were permanently wiped from the map by severe storm surges. For older residents, the floods of 1953 and 1976 are still fresh in the memory. During the last floods, an area of 800 ha in Flanders lay under water. The municipality of Ruisbroek was particularly badly affected.

Figure 1.3. Ruisbroek in 1976

1.2 The Sigma Plan: an integral plan for a versatile Scheldt

Following the catastrophe in villages such as Ruisbroek, the Belgian authorities launched the Sigma Plan in 1977. This plan was intended to offer Flanders better protection against floods from the Scheldt. The 1977 Sigma Plan focuses purely on safety, by creating taller, stronger dykes (also known as Sigma dykes or dykes at Sigma height) and flood control areas.

Since then, around 500 km of dykes have been brought up to Sigma height, the agreed height of dykes along the Scheldt. Twelve flood control areas (FCAs) have now been proving their worth for years. These temporarily catch the water if a storm surge rushes up the Scheldt. The flood control area of Kruibeke-Bazel-Rupelmonde, the last flood area from the original Sigma Plan, will be operational by 2014. The strategic location and large capacity of that flood area make the Sea Scheldt basin considerably safer all at once. Meanwhile, the entire network of dykes is gradually constructed.

Figure 1.4. Scheldt water flooding over the overflow dyke in the Paardeweide FCA

The areas of Bergenmeersen and Paardeweide were laid out as flood control areas within the Kalkense Meersen Cluster in the 1980s, as part of the original Sigma Plan.

The Sigma Plan was updated in 2005. The update was needed to shore up the Sigma Plan against any future consequences of

climate change, increases in sea levels, increasing tidal intrusion and heavier rainfall. Meanwhile, insight into the estuary's many functions has deepened and the vision of the water manager has developed to encompass a more integrated approach. Insofar as is possible, planned measures now take into account all aspects of the workings of the estuary.

A river needs room to flow and flood, but also to allow its ecosystem to function healthily. Safety measures can go hand in hand with the development of the nature that is needed for this purpose. These principles are now specifically defined in the updated Sigma Plan. After all, over the past 150 years a great deal of valuable nature has been lost along the Scheldt. Measures are being taken in the Sigma areas to restore this special nature. Firstly, tidal nature is being developed by moving dykes landward (de-poldering) and creating flood areas with controlled reduced tides (CRT), as in Bergenmeersen. Secondly, wetlands are being developed in the natural flood areas, some of them in FCAs that also absorb storm surges and reduce the impact of the rising water. European habitats are being developed in these wetlands, such as valuable grasslands, marshy areas and alder carrs, which provide a habitat for numerous species.

You can also enjoy the wonderful Scheldt landscape. The new cycle paths and trails, bird-watching hides and viewpoints being created by the Sigma Plan will make visiting the Scheldt an even more intense experience.

The Sigma Plan also takes into consideration the farmers who have suffered from the creation of flood areas. The Flemish Government developed a programme of mitigating measures for these farmers.

Figure 1.5. Recreation on the Scheldt dyke

The updated Sigma Plan is being implemented in several phases. The promoters want to have completed the update by 2030.

1.3 Arrangements with the Netherlands: framework for the Sigma Plan

The updating of the Sigma Plan also fits in with the Scheldt Estuary Long-Term Vision (LTV) (see box, p. 17). Both processes, the Sigma Plan and the LTV, influence each other and exchange information with each other. Various preliminary investigations and supporting studies have given shape to the Sigma Plan in recent years. These preliminary studies have provided vital information to draw up and evaluate workable alternative plans.

The environmental impact assessment plan (EIA plan) and the social cost/benefit analysis (SCBA) of the updated Sigma Plan were carried out parallel to and interacting with similar studies for the 2010 Development Outline (OS 2010) (see box, p. 17).

THE SIGMA PLAN: WHO IS WHO?

The Sigma Plan is the initiative of Waterways and Sea Canal (Waterwegen en Zeekanaal, W&Z), which manages the navigable waterways in western and central Flanders. Flood protection is one of this agency's main objectives. The Agency for Nature and Forest (Agentschap voor Natuur en Bos, ANB) is a key partner of the Sigma Plan. This government agency is responsible for the development of nature within the Sigma Plan.

The implementation of the Sigma Plan is centred on a multifunctional approach. W&Z and the ANB are therefore utilising a large number of partners. Flemish administrations and the Flemish Land Company (Vlaamse Landmaatschappij, VLM) and the Department of Spatial Planning, Housing Policy and Immovable Heritage (Ruimtelijke Ordening, Woonbeleid en Onroerend Erfgoed), as well as local authorities, agricultural organisations, environmental associations, hunters, fishers, and the tourism and hotel and catering sectors are actively involved in implementing the plans. Research institutions such as Flanders Hydraulics Research (Waterbouwkundig Laboratorium, WL), the University of Antwerp (UA), the Research Institute for Nature and Forest (Instituut voor Natuur- en Bosonderzoek, INBO) and the Flemish Institute for Technological Research (Vlaamse Instelling voor Technologisch Onderzoek, VITO), consultant firms such as IMDC, Tractebel Engineering, Antea, and hydraulic engineering contractors have all worked on that ambitious, innovative plan.

This meant the Sigma Plan, which is aimed at protecting Flanders from floods from the Scheldt, was optimised at an early stage. The general principles of this – in essence the maximum application of the "Room for the River" concept – were therefore carried over into the 2010 Development Outline produced by the project organisation ProSes.

However, the 2010 Development Outline goes further, integrating the pillars of "safety", "natural quality" and "accessibility" of the Scheldt Estuary LTV. The first two are closely linked in Flanders because the river needs room for both, a scarce commodity in a densely populated region. Therefore, the same areas are often eligible for safety measures and nature development. The Flemish Government therefore decided to incorporate the "natural quality" pillar of the 2010 Development Outline into the updated Sigma Plan. This gave the plan two similar objectives: safety and natural quality.

Figure 1.6. Het Verdronken Land van Saeftinghe (the Drowned Land of Saeftinghe) nature reserve (the Netherlands)

1.4 From safety plan to integral project

In 1977, the Sigma Plan was defined as a reaction to the heavy floods of the previous year. For a long time, the plan was aimed solely at providing adequate safety against flooding as a result of storm surges from the North Sea. "Hard" infrastructure, such as dykes, flood control areas and a storm surge barrier, were pushed to the fore as solutions.

In the meantime, however, a deeper insight developed into the estuary's many functions, and the concept of integral water management emerged. The safety issue remains prominent, but there has been a noticeable shift towards a more sustainable approach. The essence: respect the various functions of the water system, avoid negative consequences for the environment and seek added value and synergies. This philosophy is expressed in concrete terms in the safety concept "Room for the River": provide better protection against flooding by giving the river more room to breathe.

INCREASINGLY INTENSIVE FLEMISH-DUTCH COOPERATION IN RELATION TO THE SCHELDT ESTUARY

Cooperation between the Netherlands and Flanders in relation to the Scheldt estuary has come a long way in past decades. Even though interests do not always converge, this cooperation has become increasingly intensive.

The Joint Scheldt Policy and Management were accelerated by the development of the Scheldt Estuary Long-Term Vision at the end of the last century. The LTV – drawn up by the Technical Scheldt Committee (Technische Scheldecommissie) – outlines an integral vision for, on the one hand, the safety, natural quality and accessibility of the estuary, and on the other hand the cooperation between the Netherlands and Flanders on policy in the estuary.

To achieve these ambitious targets by 2030, the "2010 Development Outline for the Scheldt estuary" was produced between 2002 and 2004. This development outline indicates at a strategic level what projects and measures must be implemented to make the Scheldt safe, accessible and natural by 2030. The Flemish-Dutch Project Management for the Scheldt Estuary Development Outline (ProSes) prepared the outline.

Setting up the successor to the Technical Scheldt Committee, the Flemish-Dutch Scheldt Committee (Vlaams-Nederlandse Scheldecommissie, VNSC), was a key step in the communication and cooperation between Flanders and the Netherlands. The VNSC is focused on developing the Scheldt estuary as "a multifunctional estuarine water system that is used sustainably for man's needs". The joint objectives are protection against flooding, optimum maritime access to the Scheldt ports, maintaining a healthy and dynamic ecosystem and establishing common scientific research.

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1.4.1 The preferred scenario for safety

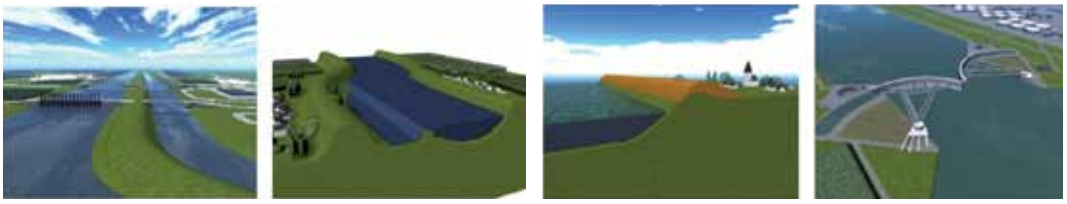
The General Methodology was applied to estimate and predict extreme watercourse conditions. This was developed by the University of Leuven (KU Leuven) in collaboration with Flanders Hydraulics Research. Based on flow-duration-frequency relations (FDF), high water-duration-frequency relations (HDF) and wind intensity-duration-frequency relations (IDF), so-called composite hydrographs, limnigraphs (water level recordings) and windstorms are produced. Standard composite edges were produced for a total of 12 recurrence intervals (in years): 1, 2, 5, 10, 25, 50, 100, 500, 1000, 2500, 4000 and 10,000. Using hydrodynamic simulations with the one-dimensional water movement model Mike11, the water level associated with the recurrence intervals studied was then able to be estimated at each location in the Sigma area.

The (Flemish) risk methodology: input for the social cost/benefit analysis

The goal of the updated Sigma Plan is no longer protection against excessive water levels. The focus is now on limiting possible damage in a risk approach in which risk = probability X consequence. The updated Sigma Plan aims for an "acceptable" flood risk along the Scheldt and its tributaries. The acceptable flood risk was determined by a social cost/benefit analysis (SCBA). Creating even more flood control areas could contribute significantly towards protecting the entire Sea Scheldt basin. This emerged in 2002 from calculations with the hydraulic model (Mike11) for the Sea Scheldt basin,

Figure 1.7. The Western Scheldt (the Netherlands)

Figure 1.8. Some alternative plans



Overschelde (linking channel) *FCA* *Taller dykes* *Storm surge barrier*

performed as part of the update study for the Sigma Plan by the University of Ghent and Flanders Hydraulics Research. These calculations substantiated whether these areas could be reserved and organised for that purpose. These studies revealed 182 potential flood areas (PFAs) covering a total area of 15,700 ha.

The intention was obviously not to convert the entire 15,700 ha into FCA. The PFAs were evaluated using an environmental criteria analysis (ECA). Together with all the other components that lead to greater safety, they were then incorporated into a new hydraulic model of the Sea Scheldt basin. With the help of that model, various scenarios were studied, with different combinations of PFAs and lower/higher dykes. Storm surge barriers and an "Overschelde", a channel between the Western and Eastern Scheldt, were also considered.

The result was approximately fifteen different alternative solutions to the flood problem, or put simply, alternative plans. Each of these alternative plans consists of one or more components and leads to greater safety up to a certain level (among others, 1/1000, 1/2500, 1/4000 and 1/10,000 years).

The advantages of these alternatives were compared with each other in an environmental impact assessment (EIA plan) and an SCBA.

The SCBA for the updating of the Sigma Plan estimates investment costs, avoided flood risks and costs and benefits relating to the impact of the alternative plans on, among other things, agriculture, the environment and recreation. Using these figures, the costs and benefits of the various alternative plans were able to be weighed up for the situations in 2000 and 2100, a process that also produces that so-called "optimal safety level". This is the level of safety against flooding that offers the most favourable ratio between social costs and benefits.

The risks of flooding will increase significantly over the next century as a result of rising sea levels. The safety benefits of the various alternative plans will therefore be great enough to earn back these investments. The alternative plans do not all have the same cost/benefit ratio, or the same environmental impact. Both the "taller dykes" and the "room for the river" alternative plans have a better cost/benefit ratio than the "storm surge barrier" and "Overschelde" alternative plans.

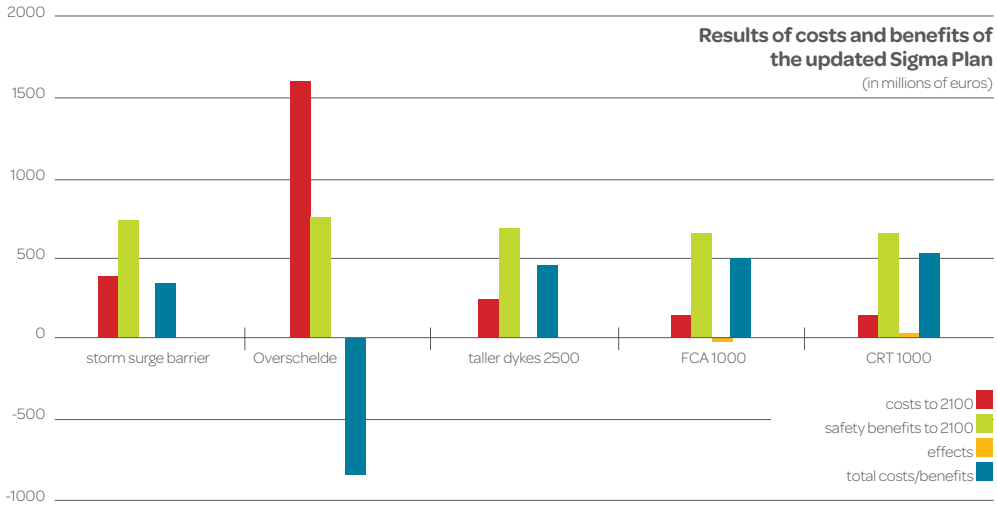


Figure 1.9. The alternative plans were compared with each other in an SCBA.

A large part of the avoided risk of flooding that is achieved by a storm surge barrier is obtained through the combination of local taller dykes and extra flood control areas, all at a much lower cost (investment + maintenance). The optimum solution therefore consists of a combination of local taller dykes and extra flood control areas.

The "storm surge barrier" and "Overschelde" alternative plans therefore no longer appeared to be part of the solution to the problem regarding protection against flooding in the Sea Scheldt basin, either in the short or medium term.

Optimising "safety" using the SCBA method

The best possible solution, "taller dykes and room for the river", was now known. The social costs and benefits of the many possible variants were gradually and systematically compared.

To this end, the study area of the Sigma Plan was divided into five zones, each characterised by its own flooding problem. The optimum solution is being sought for each zone, starting with the zone situated further downstream.

- Zone 1: the Sea Scheldt from the Belgian-Dutch border to the mouth of the Rupel
- Zone 2: the Sea Scheldt from the mouth of the Rupel to Dendermonde, the Rupel and Durme
- Zone 3: the Dyle between the Rupel and Mechelen
- Zone 4: the Sea Scheldt from Dendermonde to Ghent, which also includes Bergenmeersen
- Zone 5: the rest of the study area (Kleine Nete and Grote Nete, Dyle and Senne)

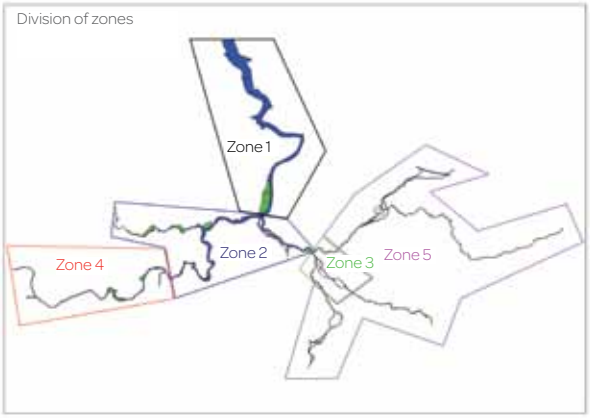


Figure 1.10. The study area of the Sigma Plan is divided into five zones, each characterised by its own flooding problem.

In each case, the optimum solution for a particular zone was included in the optimisation of the next zone upstream. The optimum Sigma Plan equates to the combination of optimum solutions from the five separate zones. This optimum solution was then subjected to a sensitivity analysis, which examined how robust the results of the optimum solution are in relation to other assumptions of crucial parameters (e.g. rising sea level, economic growth, etc.) and in relation to methodological choices (modelling of the formation of breaches).

The risks in each zone must be limited and spread as uniformly as possible. This involved seeking out the most profitable cost/benefit ratio, which in practice means reducing the risks in the so-called damage centres in particular. Damage centres are municipalities, towns or areas where there are major risks in the zero alternative, in which no additional safety measures are taken. In principle, many safety benefits (major risks avoided) can be achieved in these damage centres. Greater investments in safety are therefore justified. To put it in another way: from a cost/benefit standpoint, it is logical to first try and protect the damage centres as much as possible.

The optimised "safety" Sigma Plan developed on the basis of the method described above consists of:

- The zero alternative (Sigma Plan from 1977) is completed.
- The 24 km of additional taller dykes in the vicinity of Antwerp is completed: the flood barrier in Antwerp is raised to 9 m, the rest of the dykes between Oosterweel and the flood control area of Kruibeke-Bazel-Rupelmonde (KBR) (on both the left and right banks) to 9.25 m and the section on the right bank between the northern border of KBR and Hemiksem to 8.75 m.
- 1,325 ha of additional flood areas are created.

1.4.2 "Natural quality" in the Sigma Plan

The Flemish Government approved the 2010 Development Outline and the main objectives of the updated Sigma Plan at its meeting on 17 December 2004.

However, in an evaluation by the University of Antwerp (UA) and the Research Institute for Nature and Forest (INBO), the measures proposed for the "natural quality" component in the 2010 Development Outline were deemed inadequate to help achieve the objectives of the Scheldt Estuary Long-Term Vision. On the Flemish side, it was felt

that this negative assessment could change if the updated Sigma Plan can also contribute optimally to the ecological recovery of the Sea Scheldt. This can be achieved by efficiently integrating the measures for protection against flooding and for ecological recovery, for example when organising the flood areas.

On 17 December 2004, the Flemish Government therefore decided that the "natural quality" component of the Scheldt Estuary Long-Term Vision on Flemish territory would also become an intrinsic part of the updated Sigma Plan. This also means that the nature development projects that have to be implemented in accordance with the 2010 Development Outline in the Kalkense Meersen, the Durme Valley and the Prosper Polder are part of the updated Sigma Plan. Investigations were also carried out to see which added nature development would best reach the natural quality objectives of the Scheldt Estuary Long-Term Vision. Building on the Scheldt Estuarine Nature Development Plan that was produced for the 2010 Development Outline (NOPSE), the Sea Scheldt nature recovery plan, the EIA plan, the SCBA, the agricultural impact assessments (AIAs) and other studies, the UA and the INBO are carrying out an ecological multi-trail investigation.

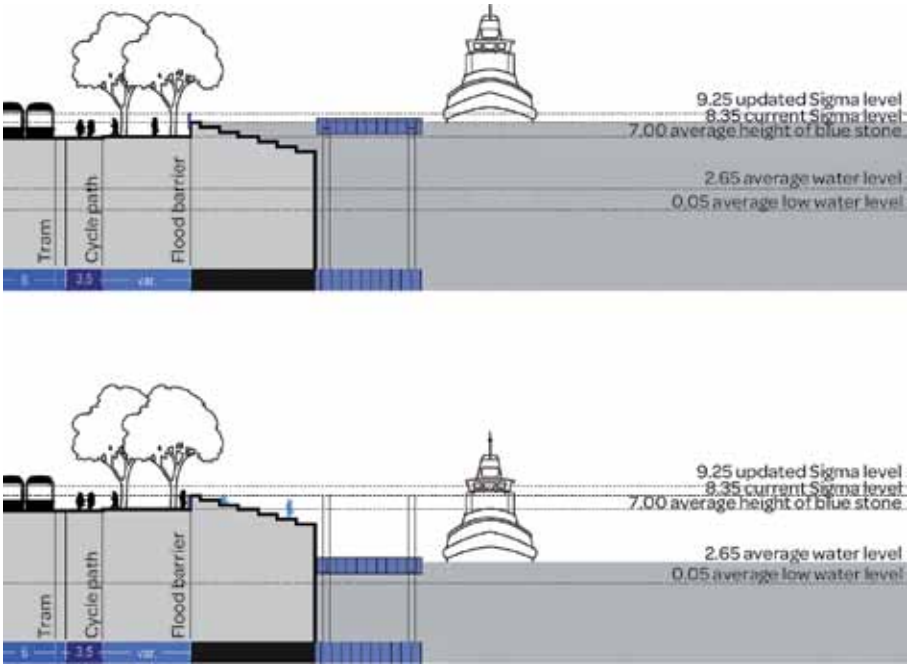


Figure 1.11. Flood barrier on the Scheldt quays in the city of Antwerp

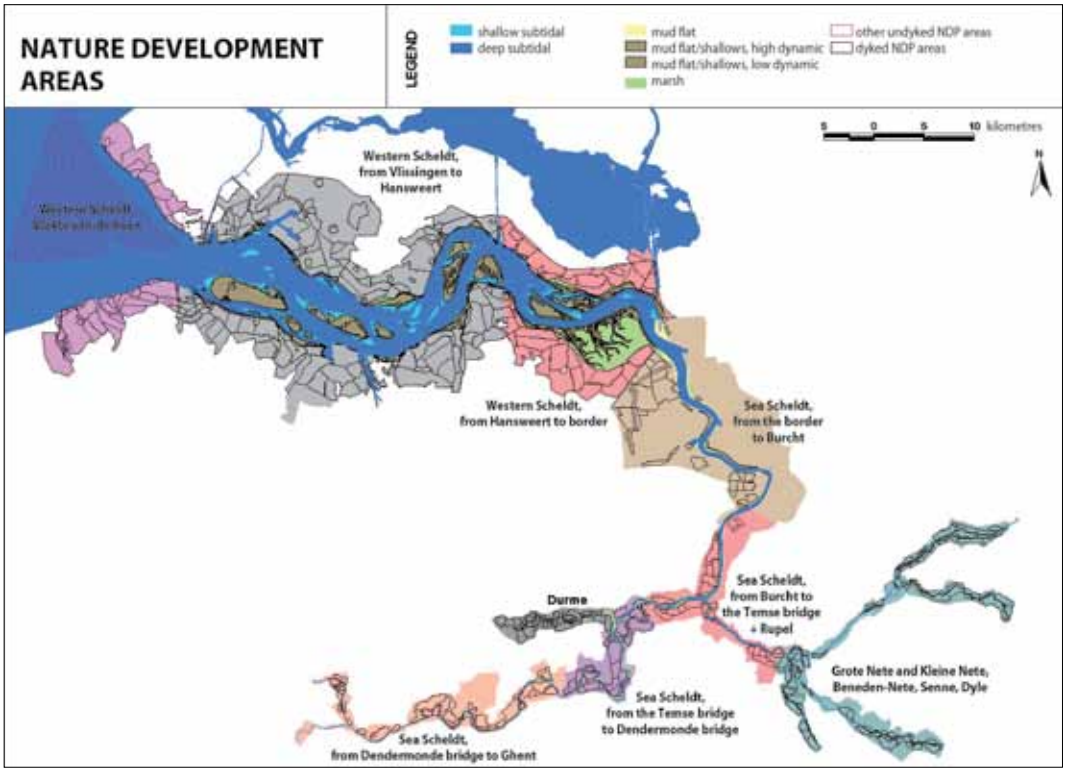


Figure 1.12. The zones of the nature development plan

The starting point was the functional objectives for the estuary, as proposed in the NOPSE: remedial measures for the chemical, physical and biological weaknesses in the functioning of the estuary. These are a conditio sine qua non for a robust ecosystem and for achieving a sound ecological position for the EU Water Framework Directive. In addition, those Natura 2000 and regionally important habitats were selected for which the Sea Scheldt is important. The possibility of achieving European conservation objectives (COs) for these biotopes was explored. An inventory was drawn up of the current natural values of the valley areas and it was determined where these could best be strengthened. At the same time, ecological models were used to investigate where, based on abiotic site characteristics, potential existed for what type of nature and what needs there were for nature connections. Finally, specific configuration requirements were also added to create a suitable habitat for the protected (bird) species for which the Sea Scheldt is important. This process was also based on the expertise in the field and visions of the Agency for Nature and Forest (ANB) and other land managers in relation to the areas managed by them.

Selection of project areas and their organisation

The areas defined by the Flemish Government Decree of 17 December 2004 were first examined to select project areas for nature development. These are the nature development projects in the 2010 Development Outline of the Scheldt Estuary Long-Term Vision, supplemented by the flood areas and reservation areas as defined in the optimum "safety" Sigma Plan defined in the SCBA. The existing flood control areas were added to these before the list was finally completed with the additional nature development projects required.

To select the most desirable type of organisation for each project area (removal of polders, FCA-CRT or wetland), a habitat analysis was carried out by combining various approaches and instruments. The aim of this approach: to uniformly assess, in addition to the estuarine ecological functions, the dyked and undyked natural values and potentials, with due regard for international and national nature policy. Public support for the proposed measures was also taken into consideration.

The results of the various approaches were brought together in a total analysis and weighed up against each other. The final result is a list of projects, with a proposal for organisation and habitat target type(s) for each project area and an overall picture for the entire study area that takes the different approaches into account as much as possible. Habitat requirements for specific species were not included in the provisional analysis, but were added to the scenario that was finally put forward at a later stage.

No.	Objective code	Objective	01 VRaa	02 VHan	03 HanGr	04 GrBur	05 BurTm	06 TmDem	07 DemGt	08 Durme	09 ZeDNe	10 stSc
D1.1	buff_afv	maximise upstream drainage buffer	0	0	0	0	+	+	++	+	++	++
D1.2	disp_E	maximise tidal energy dissipation	+	++	++	++	++	+	+	+	+	0
D1.3	meerg	expand multi-channel system	0	++	++	0	0	0	0	0	0	0
D1.4	nat_hab	optimise natural habitat processes	++	++	++	++	++	++	++	++	++	0
D1.5	turb	minimise turbidity	0	+	+	++	++	++	+	++	+	0
D2.1	C	optimise carbon management	0	0	0	0	0	0	0	0	0	++
D2.2	N	optimise nitrogen management	0	0	+	+	+	++	++	++	++	++
D2.3	O2	optimise oxygen management	0	0	0	+	++	++	+	++	+	++
D2.4	P	optimise phosphorus management	0	0	0	0	0	0	+	+	+	++
D2.5	Si	optimise silicon management	+					++	++	++		0
D3.1	prim_prod	optimise primary production	0	+	+	++	++	++	+	++	+	0
D3.2	zoöpl	optimise conditions for zooplankton	0	+	+	+	++	++	++	++	++	0
D3.3	benthos	optimise conditions for benthos	+	++	++	++	++	++	++	++	++	0
D3.4	vis	optimise fish migration	0	+	+	+	+	+	++	++	++	++
D4.1	ond_H2O	expand area of shallow low-dynamic water	+	++	++	++	++	++	++	++	++	0
D4.2	slikuit	expand area of mud flats	+	++	++	++	++	++	++	++	++	0
D4.3	slikdyn	reduce dynamic mud flats	0	++	++	0	0	0	0	0	0	0
D4.4	schoruit	expand area of marsh	+	++	+	+	++	+	++	+	++	0
D4.5	schorverj	rejuvenate marsh	+	++	++	++	++	++	++	0	0	0
D4.6	wetland	expand area of wetland	0	0	0	+	+	+	++	+	++	0

Table 1.1. Prioritisation of objectives per subsector. At the top are the zone codes for the entire Scheldt estuary. Bergenmeersen is situated in zone 7 (zone between Dendermonde and Ghent).

++ = very important
+ = important
0 = less important
blank = unknown

The *functional approach* is based on the ecological functioning of the estuary and indicates for each project area what organisational form would best contribute to all the estuarine processes. To do this, use was made of the ecological functions from the NOPSE and their relative importance per zone (Table 1.1). For each area, the table shows the elevation in the tide window and the associated flood pattern, as well as the location along the longitudinal axis of the Scheldt, with the associated location in the concentration profiles of relevant parameters.

The distribution of tidal energy and drainage energy along the longitudinal axis was also taken into consideration. This information indicates where the emphasis must be placed on estuarine or non-tidal nature, based on the energy distribution. For each project area, each function was given a score (0, 1 or 2) per organisational form (removal of polders, FCA-CRT or wetland). In each case, the organisation must make the greatest possible contribution to the most priority functions for a specific zone.

The determination of potential for the development of dyked nature types was estimated using a threefold approach:

- Current habitats: the area of Natura 2000 habitats and regionally important biotopes (RIBs) was calculated for Flanders, the project area (PFAs), the whole of the NDP zones and the habitat guideline area within.
- Habitat quality: based on the existing plant varieties, maps were drawn up that show the level of development per ecotope type for the kilometre grid cells investigated.
- Potential habitats: the areas were characterised abiotically using the POTNAT model of the INBO. The potentials for developing Natura 2000 habitats and RIBs were evaluated for each area.

Prioritisation of habitat types: based on the area available, an analysis was carried out to determine how important a habitat guideline area is for the habitat types for which it was reported: relative to Flanders and, where known, also on a European scale.

Connectivity in the NDP zones: fragmentation of natural habitats is one of the major threats to biodiversity worldwide. The formation of networks in which smaller core areas are linked by a system of connecting elements (corridors, stepping stones, etc.) is one alternative for preserving large habitat entities. The structural connectivity of a number of general habitats was visualised and analysed to estimate the scope of potential connectivity problems.

Four major habitat units or core areas are distinguished: (1) the salty grassland area in zone 4, (2) the core area of carr in zone 5, (3) the freshwater tidal habitat in zone 5-6-8, and (4) the tall oat-grass/marsh marigold grasslands in zones 7 and 8. The connecting network is supported by smaller habitat elements, mixed and spread out along the river. On the one hand, a buffer analysis shows that most places within the four habitat types are less than 1 to 2 km from each other. On the other hand, there is at least one interruption of 5 km or more for each type. The buffer maps provide a spatial picture of the main interruptions.

Management vision: in areas where nature will be strengthened, land managers are active who previously drew up nature targets and management visions for their area. A "manager vision" path was therefore developed with these managers. This examines where and to what extent the existing independent visions agree with or differ from the vision of the Sigma Plan.

Main objectives of the Sigma Plan "natural quality"

From the border to Burcht, the focus is on energy dissipation and filling in the gaps in the estuarine habitat as far as possible along the steep salinity gradient. The removal of polders and the recovery of undyked waste dumps are the main measures in achieving this. The zone around Antwerp will require permanent attention to improve connectivity. The increasing use of dyked area on the right bank threatens the overtide options for waterfowl.

Between Burcht and Temse and on the Rupel, additional estuarine habitat is required for energy dissipation, aeration and the silicon cycle. However, the polders around Hingene also hold the most important core of alder carrs (91E0) for the Scheldt Valley, a priority Natura 2000 habitat. Organisational measures focus on optimising both aspects. Upstream from the old lock at Wintam, the continuity of mud flats and marshes is a point of interest for the entire Rupel basin.

Between Temse and Dendermonde, the main areas of focus remain aeration and the silicon cycle. It is also the core zone for freshwater tidal areas in the Sea Scheldt. The potentials for developing land-based habitats are currently small.

From Dendermonde to Ghent, the main focus must be on buffering upper flow rates to reduce wash-out of pelagic populations. It is important to limit flooding of a regionally important core quaking bog (7140) behind the dykes in Weymeers as much as possible, and there are good potentials for forming cores for tall oat-grass/marsh marigold grasslands (RIB, 6150). The lack of continuity in the undyked habitat is also an area that requires attention.

The potentials for the Durme and its valley are considerable for optimising estuarine processes, for developing marsh marigold grasslands and low-lying meadows and for creating gradient situations. Sticking points are the lack of surface drainage and the sedimentation in the river. To optimise estuarine processes, it is important that estuarine habitat is expanded through appropriate phasing: from the mouth to Lokeren, not vice versa.

1.4.3 Three synthesis proposals for greater safety and natural quality

A synthesis proposal was able to be drawn up based on the existing preferred "safety" scenario and the knowledge of the areas and their organisation from a "natural quality" perspective. At the request of the agricultural sector, not one but three synthesis proposals were developed. This would leave several choices and the sector could pass comment based on balancing its interests.

Each of the three synthesis proposals satisfied the following conditions:

- In terms of net safety benefits, they are comparable with the optimum safety alternative.

- They each meet expectations in terms of "natural quality" (i.e. offer a guarantee of robust nature in the estuary and meet European nature targets for the estuary), albeit in different ways.

Each of the alternative plans obtained through this systematic approach is a cohesive whole that is difficult to split up. The alternative plans must therefore be viewed as one single project (consisting of sub-projects). For technical reasons, decisions about projects automatically also involved largely defining the other sub-projects. It was, however, clearly possible – and indeed the intention – to indicate in the memo to the Flemish Government of 1 July 2005 which sub-projects would be implemented on the ground first.

The characteristic features of each of the three synthesis proposals are briefly summarised below:

- **Scenario 1:** as regards nature, this alternative plan assumes the greatest possible separation of the nature function on the one hand and the functions of agriculture and recreation on the other. In this approach, the necessary area for nature was kept as small as possible and localised in optimally organised nature cores, preferably around existing recognised nature reserves or natural areas on the regional plan. Other zones were avoided, especially areas with a high agricultural and/or recreational value. From a nature point of view, this approach is strong, since it avoids disruption, for example through fragmentation, as much as possible, and because larger nature cores also lead to greater biodiversity.
- **Scenario 2:** this alternative plan opts for estuarine nature of lower quality, but over a greater area. Among other things, this translates into the creation of more FCA-CRTs instead of removing polders.
- **Scenario 3:** this alternative plan is also known as the interweaving scenario. In it, the interweaving can be both functional (e.g. basic waterlogging is organised that still allows marginal or suboptimal agriculture) and spatial (e.g. three quarters of the area become natural, one quarter remains agriculture). This alternative plan involves a larger area, which also includes all the priority areas for agriculture.

For each of the three synthesis proposals, three tests were performed: a nature test, a safety test and an agriculture test. These tests were carried out by experts in each of the three sectors and boiled down to ranking the three synthesis proposals according to relative preference.

The tests revealed that both the agriculture sector and the nature sector preferred scenario 1 because of the separation of functions, the higher quality for both agriculture and nature and the fact that, in net terms, less farmland had to be taken up. Where possible, additional comments from the agricultural sector regarding the choice of individual areas were also taken into consideration when producing the final Most Desirable Alternative (MDA). This MDA forms a derivative of the original scenario 1. The conversion of Bergenmeersen from FCA to FCA-CRT is a direct consequence of the choice for scenario 1.

1.4.4 The Most Desirable Alternative

The following is a map of the most desirable alternative plan finally proposed, which was produced using the method outlined above.

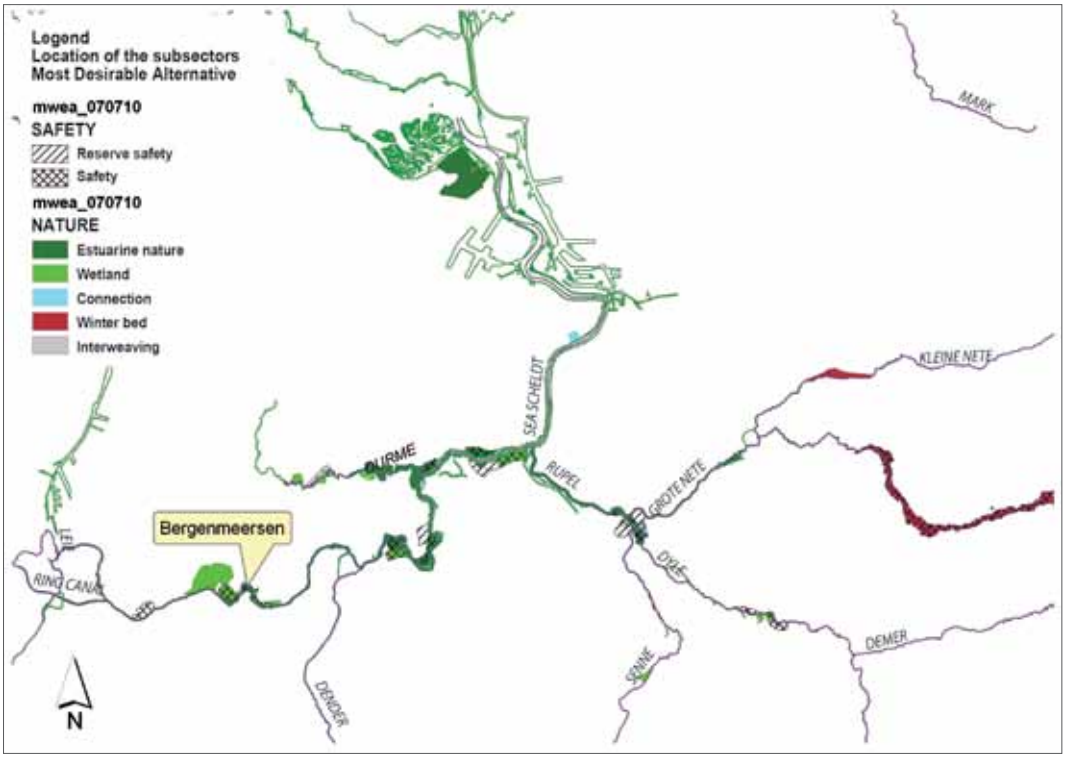


Figure 1.13. Map of the Most Desirable Alternative for the Sigma Plan, showing the areas that satisfy the safety and nature objectives

1.5 References

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