CASE STUDY STATUS REPORT

SCHELDT RIVER BASIN,

(Deliverable D26)

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Institute for Environmental Studies (IVM), Netherlands

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Case study report Scheldt

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SIXTH FRAMEWORK PROGRAMME

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Content

Summary

CASE STUDY FACT SHEET

INTERNATIONAL SCHELDT BASIN

1. Name(s) partner(s)
Flemish Institute for Technological Research (VITO)
Institute for Environmental Studies (IVM)

2. General case study characteristics

2a. Geographical characteristics

International Scheldt district (37000 km2) includes fresh and brackish water (tidal) rivers Scheldt, Somme, Ijzer and salt Scheldt estuary, covering France (50%), Belgium (43%) and the Netherlands (7%). Lowland watercourse, wide valleys, medium to light slopes. Main cities Ghent, Brussels, Antwerp, Vlissingen, Middelburg. Case study area will be limited to the Dutch and Flemish part of the Scheldt district.

2b. Land use characteristics

Agriculture dominant land use (61%), mainly livestock and arable farming, but also highly urbanized (13%) with 12.8 million inhabitants (353 inhabitants/km2). Main industrial areas include Brussels, ports of Ghent, Terneuzen, Antwerp and Vlissingen. In coastal areas tourism plays an import role. Less than 10 percent of the land is covered with forests.

3. Pressure and impact analysis

3a. Main pressure(s) and/or pollutant(s)

Main sources of pollution are households, agriculture, industry and commercial shipping.
Agriculture: most important contributor to emissions of nutrients (N,P) and pesticides
Households: important issue for Flanders is that only 58% is connected to sewerage treatment system

3b. Impact(s)

Status water quality improving, but not good in a majority of the surface water bodies in the international basin. WFD good chemical and ecological status objectives have not been established yet. Environmental damage categories include eutrophication and high metal content of surface water, especially zinc, cupper and lead. Bad bathing water quality in some coastal areas. Morphological alterations of certain river stretches have taken place to improve transport efficiency. This reduces the expected absorption capacity of the river system of excess floodwater and nutrients.

4. Definition goods and services provided by aquatic ecosystem

Most important goods and services provided by the aquatic ecosystem include drinking water, transportation, recreation, irrigation water, cooling water and water used for other industrial processes such as food processing and paper industry.

5. Beneficiaries/stakeholders involved

Households (drinking water, recreation), industry (cooling, process water), agriculture (irrigation), shipping (transport)

6. Definition environmental and resource costs and benefits

Environmental costs are the costs of not reaching good ecological status by 2015 throughout the entire Scheldt district.

7. Main objective monetary valuation environmental and resource costs and benefits

Estimation of environmental and resource benefits of reaching good ecological status with a focus on recreation and non use values.

8. Economic valuation method

Stated preference methods (probably choice experiment) to assess the use and non-use values associated with reaching good ecological status now and in the future. Concerning use values focus will be on recreation.

9. Key methodological issues

Linking economic values to pressure and/or biological impact indicators.
Aggregation/upscaling economic values from individual water body to basin level.
Dealing with transboundary impacts.
Benefits transfer across sub-basins, taking into account spatial (upstream-downstream) interrelationships and possible substitution effects (e.g. recreation)

10. Available data, information sources and stakeholder involvement

International Scheldt Article 5 report
International comparison cost-effectiveness analysis programme of measures Scheldt sub-districts
Contingent Valuation survey carried out in 4 of the 5 official Scheldt sub-districts (France, Netherlands, Flanders, Brussels)
Secretary-general International Scheldt Commission in Advisory Board & Scaldit (INTERREG III project)

2. General case study characteristics

2.1 Location of the case study area

The Scheldt river basin district extends from northwestern France, via the western half of Belgium to the Netherlands. The total area of the district of the Scheldt is 36 416 km²: therefore, the district is one of the smaller international River basin districts in Europe. The Scheldt with a river basin of 22 116 km² is the largest part of the district. Other important river basins included in the district are the Somme river basin (6 548 km²) and the Ijzer basin (1 750 km²). The major part of the area of the Scheldt district lies in France and in the Flemish region (50% resp. 33%). The Walloon Region and the Netherlands cover 10% and 6%. The Brussels Capital Region comprises 0.44% of the Scheldt district. (ISC, 2005)

This case study will focus on the Flemish and Dutch part of the Scheldt basin.

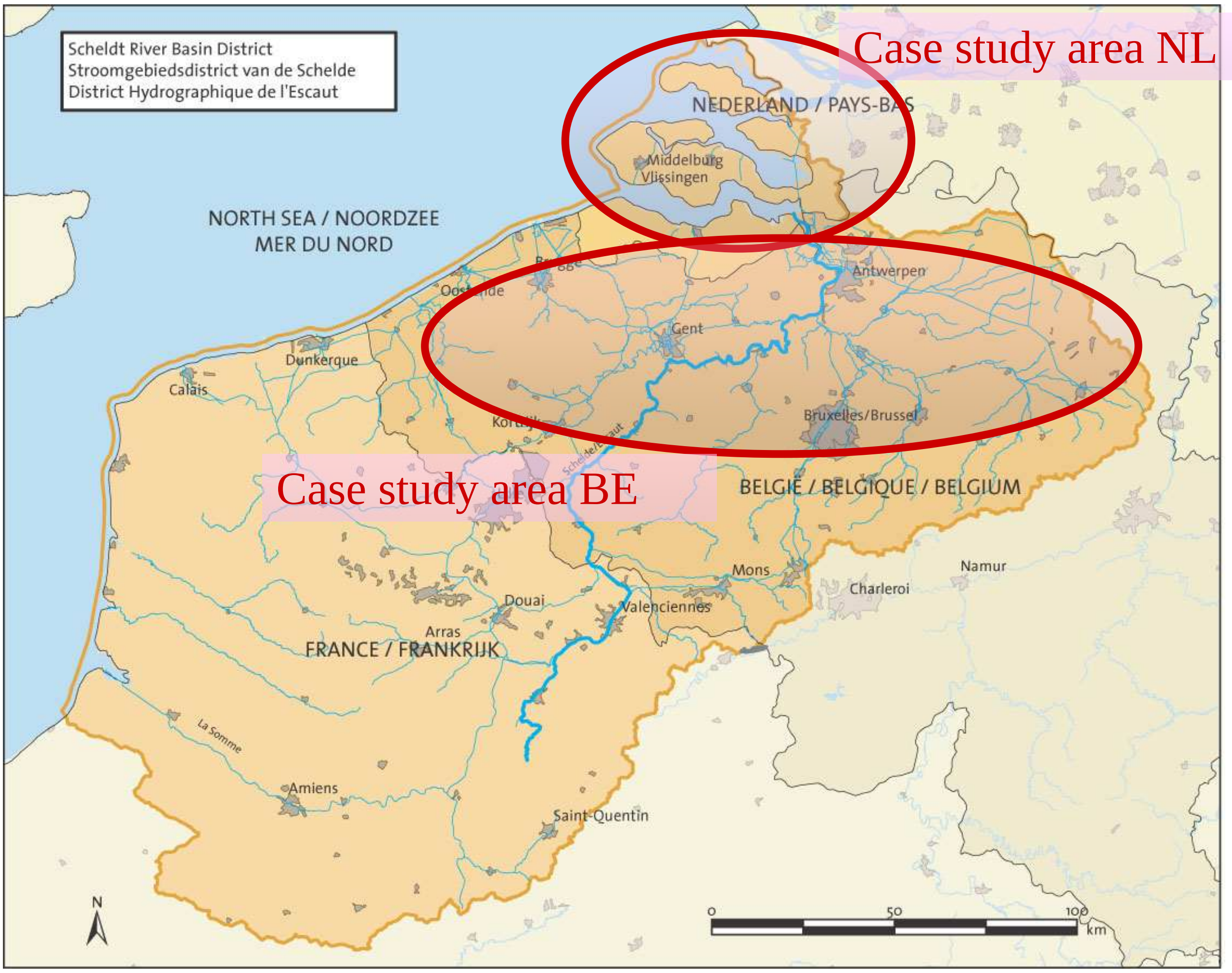


Figure 1 International Scheldt river basin district (ISC, 2005)

2.2 Geographical characteristics

2.2.1 Physical geography, climate, river length, basin area, altitude

The Scheldt originates in Northern France and then flows through Wallonia, Flanders, the Netherlands and finally discharges into the North Sea. The relief is little hilly. The rivers are real lowland watercourses, characterized by wide river valleys and medium to light slopes. The Flemish part of the Scheldt is mainly flat. The highest altitude is 157m above sea level. The lowest altitudes are nearby the coast and the Scheldt region around Antwerp. The Dutch part comprises primarily low-lying, flat polders. Differences in altitude are only a few meters in relation with sea level.

Larger differences occur in dune areas and on the Brabant embankment. There is more relief under water. Tidal gullies, tens of meters deep, cut through the delta and the coastal zone.

The climate is a temperate maritime climate, characterized by relatively fresh summers and mild winters. January is the coldest month (2.5°C), July the hottest (17.2°C). In coastal areas the proximity of the sea provides lower temperatures in the summer and higher temperatures in the winter. Because of its limited territory, the climate within the basin varies very little. In the period 1990-2001, the average annual rainfall was 820 mm, distributed quite homogenously over the different seasons.

The Scheldt and a number of its tributaries are subject to the tides. Tides have an influence up until 160 kilometers from the mouth of the river (the city of Ghent). The tidal range reaches a maximum of 5 metres at Antwerp. The tides cause seawater to enter the estuary. As a result the Scheldt has areas with briny, brackish and fresh water. The tides also cause important flood risks. Especially in the Dutch part and also in some parts of the Flemish region, a lot of efforts are set up to reduce flood risks.

Climate change is expected to cause increases in temperature and precipitation. Summers are expected to be, on average, drier and warmer. Even so, the risk of local flooding in summer is expected to increase, because precipitation will occur in short, but heavy, showers. Saline intrusion is expected to increase as a result of sea level rise. This can have effects on drinking water supply, agriculture and nature. Coastal erosion will probably increase, and drainage of water from polders will become more difficult. (ISC, 2005) (www.kaderrichtlijnwater.nl)

2.2.2 Land use

The Scheldt is a highly urbanised and heavily built-up area. On average 13% of the Scheldt district is covered by urban area. It has a total population of 12.8 million inhabitants and a population density of 353 inhabitants/km². The Flemish region houses 40% of the population and the Dutch part only 4%. Largest cities are Brussels, Lille, Antwerp and Ghent.

There are also a number of major industrial areas and ports. The ports of Zeebrugge, Ghent, Antwerp, Vlissingen, Terneuzen, Calais and Dunkerque are all located within the Scheldt district.

Agriculture covers 61% of the area. Livestock farming is the main activity in the northern part. The Flemish and Dutch polders are a narrow strip of wet clay, which are difficult to work but very fertile and therefore mainly used for crop farming.

The whole coastal strip of the Scheldt district is important for tourism. The Flemish coastal part has changed considerably due to the construction of tourist facilities. In the Netherlands the natural character of the coastal area has been better preserved.

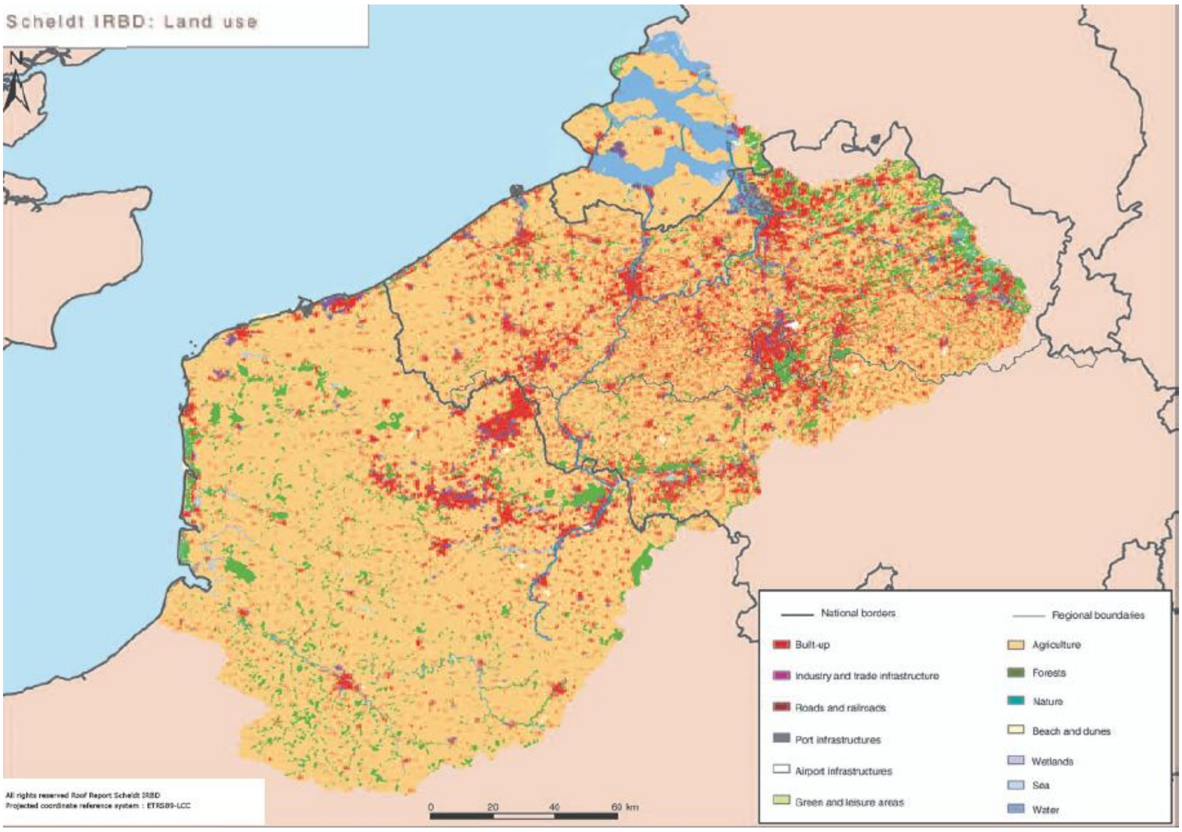


Figure 2 Land use in the International Scheldt river basin district (ISC, 2005)

2.2.3 Biotic framework

The estuary of the river Scheldt extends from the mouth at Vlissingen to Ghent (km 160), where sluices impair the tidal wave. The Dutch part of the Scheldt river basin, The Westerschelde is an estuary, where freshwater from the Scheldt mixes with salt water from the North Sea. The habitat area in the estuary (36.922 ha) is characterised by *schorren*, mud and sand flats and marshes (13.500 ha), channels and shallow waters (7500 ha) The Dutch part of the estuary, called the Westerschelde (58 km), is a well mixed region characterized by a complex morphology with flood and ebb channels surrounding several large intertidal flats and salt marshes. Information about ecotopes is available at www.ecotopenkaarten.nl. Most if not all of the functions as mentioned in the guidelines table (see annex) are present. More information on the specific ecosystems and its components and functions will have to be gathered for the case study scenario development. (Meire et al., jaar)

Biodiversity
The Scheldt estuary is one of the most important estuaries along the NW-European migration route for water birds, maximum numbers reaching up to 230,000 individuals. For 21 water bird species, the Scheldt has international importance. Charismatic mammal species such as the seal and the porpoise can be found in the Ooster- and Westerschelde. Bad water quality severely impacted benthic invertebrates and fish. Diversity in estuaries is lowest in the brackish part, due to the large variation of salinity. Different phytoplankton communities can be distinguished in the estuary.

2.3 Water system characteristics[1]

2.3.1 Renewable and non-renewable resources

Annual renewable water resources, non-renewable water resources, use of non-conventional resources (desalination, wastewater reuse). So far not relevant, information might be included later.

[1] *AG: Karakterisering stroomgebied Schelde* http://www.kaderrichtlijnwater.nl/

2.3.2 Water bodies, types and reference conditions

Flanders

So far, 180 surface water bodies have been identified for the Flemish part of the Scheldt estuary. A large majority of these water bodies have been characterised as heavily modified.

	Natural	Heavily modified	Artificial
River	15	115	25
Lake	0	0	13
Transitional water body	0	8	3
Coastal water body	1	0	0
Total	16	123	41

Netherlands

The Netherlands has provisionally identified 71 surface water bodies in the Scheldt catchment (see map below).

In national water, there are 11 surface water bodies, which fall under the management of R*ijkswaterstaat.*.Seven (Grevelingenmeer, Oosterschelde, Veerse Meer, Zoommeer-Eendracht, Westerschelde, Zwin, Zeeuwse kust) have the status heavily modified and all are designated as protected areas on the basis of European directives. The four canals (Spuikanaal, Kanaal door Zuid Beveland, Antwerps kanaalpand en Kanaal Gent-Terneuzen) have the status artificial. The Canal through Zuid Beveland falls in the category coastal water.

In regional water, a total of 60, mostly small water bodies have been designated. Of these, 53 are the result of excavation and so have the status artificial. A total of 16 regional water bodies are protected. All regional water bodies needs to be assessed as to whether the objectives of the WFD can be achieved. It is not required to report on all small water bodies separately, but to aggregate them.

Thirteen surface water bodies border on similar water bodies in Belgium or Flanders. Five are national waters, and either are regional. The Netherlands needs to coordinate its objectives, measures and monitoring with the Belgische Federale Staat (for the Zeeuwse coastal waters) and with the Vlaamse Gewest (for the other water bodies). Scaldit provides a combined description of the characteristics and problems of surface water bodies near the national borders.

3. Pressure, impact and risk analysis

3.1 Significant pressures impacting on water status of groundwater and surface water[2]

3.1.1 Contaminants

The WFD identifies the following sources of pressures on surface water bodies that needs to be described and elaborated:

- Point source pollution;
- Diffuse source pollution;
- Water abstraction;
- Regulation of water flow;
- Morphological modifications;
- Other human influences; and
- Land use.

Flanders

As mentioned before is the Scheldt basin heavily urbanised and industrialised. A lot of point source pollution is present within the area. Considering population 86% of the population was connected to a sewage system. However, only 58% of the household emissions are treated with a collective treatment plant. This is one of the major issues concerning surface water quality.

The Flemish industry is characterised by a large amount of small and medium sized enterprises (SME's). The emissions of approximately 1000 companies are annually analysed by the Flemish Environment Agency. Approximately half of these enterprises are connected to a collective treatment station. The other enterprises have their own treatment. The chemical and the food processing industry are the main contributors to emissions. They account for more than half of the industrial pressure. Other important sectors are the textile and metal industry.

The diffuse emissions coming from agriculture account for more than half of the total Nt-emissions and approximately one third of total Pt-emissions. Especially intensive livestock farming causes excessive manure production.

An overview of the most important contributors for several pollutants is given in the table below.

[2] *Karakterisering stroomgebied Schelde* http://www.kaderrichtlijnwater.nl/

Contribution	< 5%	5 - 20%	20 - 50%	> 50%

Pollutant	Total emissions (ton/year)	Population	Industry	Agriculture	Other sources
BOD	43000	Untreated wastewater		Fertilizer	
COD	150000	Untreated wastewater	Textile, food and chemical sector	Fertilizer	
Nt	38000	Untreated wastewater + outflow WWTP	Chemical sector	Fertilizer	
Pt	3500	Untreated wastewater + outflow WWTP	Food and chemical sector	Fertilizer	
As	4		Metal sector	Erosion	Wood conservation
Cd	0,28		Metal sector	Erosion	Atmospheric deposition
Cr	7,6		Textile sector	Erosion	
Cu	32	Building material		Erosion	Paint on sea vessels, wood conservation
Hg	0,2	Dentists	Chemical sector	Erosion	
Ni	9,8		Metal sector	Erosion	
Pb	8,6	Building material	Metal sector	Erosion	Fishing / Hunting
Zn	102	Building material	Metal and chemical sector	Erosion	Traffic - atmospheric deposition

Netherlands

There are 23 wastewater treatment plants (WWTPs) that, combined, treat 1 million resident-equivalents in wastewater; 98% of households are connected to sewerage reticulation; the objectives of the Urban Wastewater Directive are amply met. Five WWTPs discharge directly into national waters and two via drains. The remainder discharge into regional surface waters. Sewers also collect from diffuse sources, including atmospheric deposition and drainage of urban areas. As a result, a wide range of substances enters regional waters via WWTPs, such as nutrients, zinc and copper, and PAHs. Pesticides such as diuron, propoxur, aldicarb, maneb/zineb, carbendazim en simazine are also encountered is sewage effluents.

Industry does not always discharge into sewerage systems. Many industries in this area discharge directly into surface waters after treatment. Water used by humans is usually connected to the sewerage of there is biological treatment on-site. Remaining wastewaters are not usually treatable using biological methods and so undergo physic-chemical treatment. All industries have a permit via the Pollution of Surface Water Law (WVO) for discharge to surface waters. Most emissions occur in the Westerschelde. Large companies report on their emissions in their annual environmental reports. A wide variety of substances may be emitted, including nutrients, heavy metals and many organic compounds such as PAH and chlorinated hydrocarbons. Emissions from industry and WWTPs also include substances for which no data is yet available, such as fire inhibitors, softeners, and hormones or their derivatives.

All other emissions are diffuse. Diffuse sources are usually greater than point sources. Overflows are also treated as diffuse because of their frequency and wide distribution. Heavy rain can exceed the capacity of sewers, which leads to problems with hypoxia and loads of heavy metals, PAHs and pesticides. Zinc and copper enter sewers directly from urban drainage. Agriculture, seepage of brackish water, and historical loads in soils are the main source of nutrients, heavy metals and pesticides in regional waters. These substances enter the water after drainage from agricultural lands. Pesticides also reach surface waters via the wind during application. Brackish seepage, inevitable in polders under sea level, carries P and, to a lesser extent N (as ammonium) from ground- to surface waters. Atmospheric deposition of N, heavy metals, pesticides and PAHs occurs in regional as well as national waters.

The sources of these substances include industry, shipping, agriculture and traffic. Polder drainage means that national waters receive contaminants from regional waters, primarily nutrients. Commercial and recreational shipping cater for diffuse sources of heavy metals, PAHs and an increasing amount of TPT and copper to national waters. Sediments of the Gent-Terneuzen Canal and the Canal through Walcheren are, locally, heavily polluted. In the former, sediments are mainly contaminated with PAHs and zinc, and locally by mineral oil and the heavy metals mercury, arsenic and cadmium. Mainly copper contaminates the Canal through Walcheren. Further research has shown that the water quality in this canal is heavily influenced by its sediments.

The water entering the catchment is contaminated. The total load of nutrients, heavy metals and PAHs from outside the Netherlands is more than twice the total Dutch load. Transboundary loads enter water bodies upstream from the Dutch Scheldt, and particularly from the Westerschelde, Canal from Gent to Terneuzen, and the Zoom. Transboundary loads are a major source of contaminants for the coasts of both Zeeland and Belgium.

3.1.2 Water abstraction

Flanders

A large uncertainty exists when estimating the total amount of water abstraction and its division among different sectors. Figures presented are believed to be underestimations.

The total amount of drinking water production is estimated to be 342 million m³. Approximately half of this water is groundwater and the other half comes from surface water. About 20% of the drinking water is imported from the Walloon region.

The total water used by households is estimated to be 250 million m³ or 37% of total water usage in the Flemish Scheldt basin. The total water usage for industry without incorporating cooling water is estimated at 298 million m³ or 42% of total water usage. Agriculture only accounts for 5% of the total water usage.

Netherlands

Household used 24 million m^3 of water from municipal supply in 1996, and produced nearly 600 thousand resident-equivalents of wastewater (including tourists). Industry uses about 1.5 m^3 of water (2001). The chemical industry uses 40% of this. Only 4% comes from municipal supply. The rest is extracted by industries themselves. About 55% comes from fresh surface waters and about 39% from brackish surface waters. Little use is made of fresh groundwater. The main purpose of the water is cooling. After use, warmed water is returned to surface waters. In 2001, industry produced 300 thousand resident-equivalents of wastewater. Trade and services are responsible for 45% of industrial wastewater, catering industries for 25%, and chemical industry for 15%. The environmental services sector treats more than 80% of the wastewater from industry and households.

Water use by agriculture is strongly dependent on weather. In 2001, this sector used approximately 0.4 million m^3 of freshwater for irrigation.

The Netherlands assume that a substantial pressure is placed on water bodies as a result of water abstraction when total abstraction is less than 1-% of the average drainage. Agriculture abstracts water for regional surface waters on a very limited scale, largely because it is too brackish. Abstraction is not monitored, but because it is linked to strict conditions, it is reasonable to assume that it has a limited impact. Industry abstracts larger volumes of surface water from national waters, notably the Westerschelde. Relative to total flows in national waters, these abstraction are insignificant.

3.1.3 Hydromorphological modifications

Flanders

Hydromorphological modifications in the Flemish Scheldt basin consist mainly of the realignment of rivers, fortification of river banks and the construction of locks for water management and shipping purposes. Also because of the high urbanisation and industrialisation a lot of rivers were relocated or covered.

Dredging of watercourses is also an important issue. Because of the realignment of rivers the sedimentation processes of rivers are heavily disturbed. Also, because of a change in agriculture cultivation techniques, erosion processes have been intensified. This causes an excessive amount of sediments which are in addition in most cases polluted. Because of the high cost of sediment removal and the lack of capacity to process or store this sludge, an historical dredging backlog exists of approximately 17 times the annual growth of sediments.

Netherlands

Modifications in national waters range from drainage regulation and management of water levels to flood mitigation, to water supply, to shipping. Barriers, dykes and artificially managed water levels have led to extreme hydromorphological changes. In order to protect the land against storm floods from the North Sea all dikes along the estuary (more than 700 km) have been heightened and strengthened. Therefore, the base of the dikes needed to be widened, which was mostly done on the marshes and not on the landside of the dike. In many parts of the Scheldt estuary, intertidal habitat is lost due to dike building. By now, over more than 50% of the total length of the estuary lacks tidal marshes in front of the dike. Dykes have fragments corridors between large and smaller waters. Barriers have restricted and disrupted connections among the sea, the estuary and freshwaters. In Grevelingen, Lake Veerse, and Zoom Lake, barricades have caused an unnatural development of water levels. Bank stabilisation in Lake Grevelingen and continuous dredging in the Westerschelde also contribute to hydromorphological pressures. Regional waters usually have an artificial level controlled by weirs and pumps, as well as artificial banks. Management and maintenance are directed towards sufficient drainage of water and sufficient water depth. To guarantee the safe access to the ports along the estuary, but mainly to the port of Antwerp, for ever larger ships, large scale dredging of the maritime access routes in the Westerschelde and in the lower Zeeschelde is required. Most dredging takes place at the bars where ebb and flood channels merge and at the port sluices. Some bars have been deepened more than 5 m and a further deepening is required. Although some sand is extracted from the estuary, most dredged material is relocated within the estuary at some specified dumping locations. In natural areas, management is more directed towards natural conditions. Measures in polders are directed towards making the land usable for agricultural, urban development or nature. The many ditches and waterways that criss-cross the polders are artificial, but sometimes follow the course of old creeks. In the Pleistocene sand areas, streams have been straightened and several ditches have been created for agriculture. The fens and old creeks are under pressure from dehydration as a result of water level management in the surrounding agricultural areas. The Markeizaat and the Binnenschelde are strongly modified as a result of dam construction.

3.1.4 Other sources of pressure

Netherlands

Physical disturbance by shipping, fisheries, recreation and tourism, cooling water discharges and sand extraction affect the ecological state of surface waters. In regional waters and in the Zwin, these sources have no significant influence on the ecological state of the water. The greatest influences are in the Oosterschelde, Westerschelde, Grevelingen, Veerse Lake and the coast of Zeeland. Ballast water from ships, as a source of introduced species, could also form a problem in these areas. The extent is not known. Introduction of the Japanese oyster has been a large problem in the Oosterschelde. Shipping is a major source of pressure in Lake Zoom/Eendracht and the canals. Recreation is of importance on in Lake Veerse. Cooling water is discharged into the Canal from Gent to Terneuzen.

3.2 Water bodies at risk: diagnosis of water quality and ecological issues [3]

3.2.1 Methodology

Flanders

Flanders uses results of a water quality model (Pegase) to assess wether or not water bodies will be at risk in 2015. Steps are:

- Assessment state in 2000

[3] *Karakterisering stroomgebied Schelde* *http://www.kaderrichtlijnwater.nl/*

- Construction of a business as usual scenario 2015 including increase in collective treatment, more stringent emission targets for industry and manure targets for agriculture. It is assumed that loads in upstream regions as France and the Walloon region will not decline.
- Comparison of simulation results with concentration targets for 2000 and 2015. A worst case approach was applied, meaning that targets have to be reached on all locations of the water body.

Existing concentration targets are used to assess whether or not a water status can be evaluated as good or bad.

Pollutant	Quality	mg/l	Pollutant	Quality	mg/l	Pollutant	Quality	mg/l
BOD	very good	0 - 3	Kj-N	very good	0 - 1,5	PO4- - P	very good	0 - 0,05
	good	3 - 6		good	1,5 - 3		good	0,05 - 3
	average	6 - 9		average	3 - 6		average	0,3 - 0,5
	bad	9 - 12		bad	6 - 15		bad	0,5 - 1
	very bad	> 12		very bad	> 15		very bad	> 1
COD	very good	0 - 15	NH4+ - N	very good	0 - 1	Pt	very good	0 - 0,25
	good	15 - 30		good	1 - 2,5		good	0,25 - 1
	average	30 - 45		average	2,5 - 5		average	1 - 2
	bad	45 - 60		bad	5 - 10		bad	2 - 3
	very bad	> 12		very bad	> 10		very bad	> 3
DO	very good	> 8	NO3- - N	very good	0 - 2			
	good	6 - 8		good	2 - 4			
	average	4 - 6		average	4 - 10			
	bad	3 - 4		bad	10 - 20			
	very bad	0 - 3		very bad	> 20			

No evaluation was made in the article 5 reports on ecological quality.

Netherlands

The Netherlands assesses states on the basis of the following:

- The ecological state of artificial and heavily modified water bodies is assessed using objectives for natural waters that are most similar (GES), with a view to identifying the most important constraints for achievement of objectives.
- Stand still is assessed via state in 2000.
- Only measures certain to be implemented before 2015 are considered.
- The effectiveness of measures is careful assessed based on effects that have been measured in the past.
- It is assumed that loads from outside the Netherlands will not markedly decline before 2015.
- The analysis uses available data and expert judgement, and so serves to highlight knowledge constraints.

The state of surface waters is expressed in chemical and ecological states. The Netherlands uses the principle of one-out-all- out in its risk analysis, as directed by the WFD.

3.2.2 Current chemical state

Flanders

As can be seen in the figure below, is the global chemical state in 2000 mostly bad or very bad. For 78% of all water bodies the global physico-chemical quality is bad to very bad. Not a single water body has a global good to very good quality. Main problems are the organic compounds and phosphorus loads.

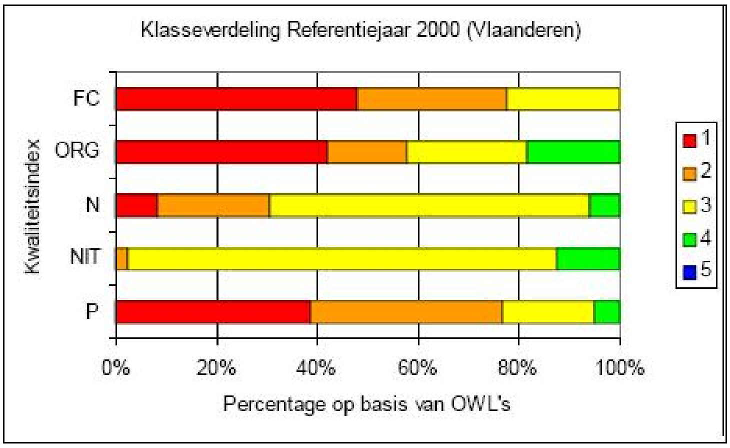


Figure 3: Chemical status water bodies Scheldt basin Flanders in 2000 (1 = very bad, 2 = bad, 3 = average, 4= good, 5 = very good)(FC = global physico-chemical status, ORG = organic compounds)

Netherlands

Priority substances are monitored in the Westerschelde. More than 60% meet standards. In the other water bodies, only substances expected to exceed standards are measured (see map 23), viz. heavy metals, pesticides and PAHs. No water body has a good chemical state.

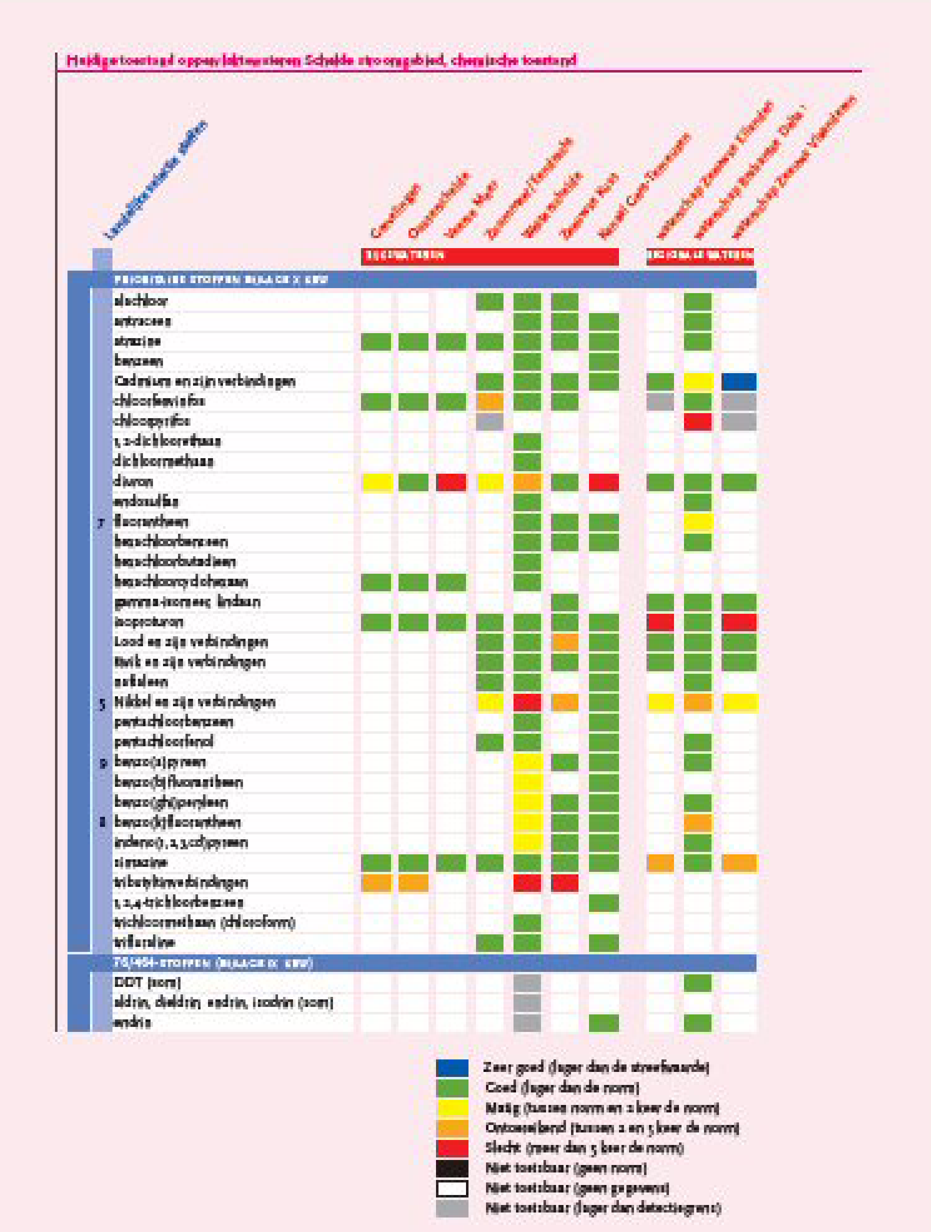
Regional waters on the Brabant embankment and in a number of Zeeland polders exceed standards for nickel. Several water bodies exceed EU standards for pesticides, viz: chloorpyrifos, chloorfenvinvos, diuron, simzine and isproturon. The problems with pesticides in regional waters come from agriculture: drainage from agricultural land and wind transport during application.

All national waters exceed standards for many priority substances. Problem substance and source differ per water body. Exceedance of nickel standards is caused mainly by agriculture and, to a small extent, by atmospheric deposition (probably originating from industry). High levels of PAHs are cause by shipping and atmospheric deposition (again, probably originating from industry, but also traffic). Agriculture causes standards for pesticides chloorfenvinvos and diuron to be exceeded in select water bodies. The banned anti-fouling TBT, originating from shipping, still exceeds standards in the Westerschelde, Lake Veerse, the Oosterschelde and the canals. The sediments of the Canal from Gent to Terneuzen exceed standards for various PAHs; mineral oil and heavy metals (mercury, arsenic and cadmium) exceed norms in several places. Given the large surface area of contaminated sediments, it is reasonable to assume that they have a strong influence on water quality.

Chemical states in the Westerschelde and the Canal from Gent to Terneuzen are strongly influenced by transboundary pollution. More than 90% of nickel loads come from Flanders. In the Westerschelde, 80% of the PAH benzo(a)pyrene derives from Flanders.

Current chemical state is summarised in the table below.

Table 1 Current chemical status of surface water in the Scheldt river basin



3.2.3 Chemical state in 2015

Flanders

When predicting the chemical state in 2015 in a business as usual scenario, implementing already foreseen measures, a slight improvement occurs in the general physico-chemical quality. 59% of all water bodies still have a bad to very bad global status. However, only 1 water body will achieve a good status in 2015. Additional measures are certainly required to achieve good status.

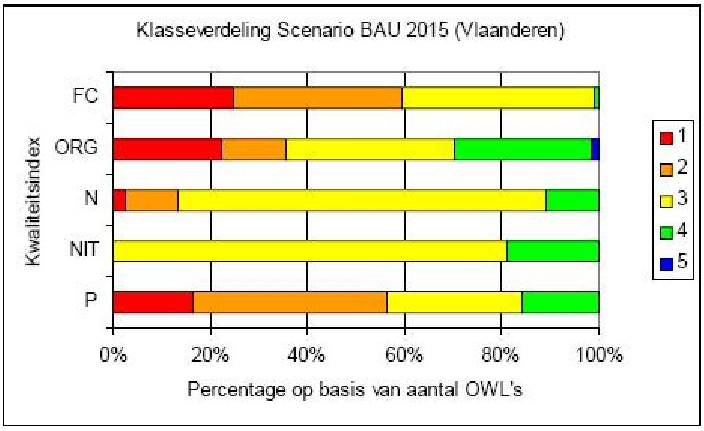


Figure 4: Predicted chemical status water bodies Scheldt basin Flanders in a BAU-scenario 2015 (1 = very bad, 2 = bad, 3 = average, 4= good, 5 = very good)(FC = global physico-chemical status, ORG = organic compounds)

Netherlands

State in 2015 is determined via a baseline scenario in which economic and autonomic trends are translated into emissions. Consequent levels per substance are then compared with standard to give and overview of which substances are likely to compromise a good chemical state in 2015. The analysis is extended to assess which substances per water body cause problems. These conclusions are combined with available knowledge on expected developments within individual water bodies, leading to a score cards indicating which substances will not meet standards in 2015.

The analysis shows that all water bodies will be at risk in 2015, although some improvement relative to the current situation will occur as a result of current policy. The same substances and the same sources that compromise current states cater for the greatest problems in 2015.

National regulation will lead to stricter controls on pesticides. The Covenant on Crop Pesticides will lead to reduced use of these substances. Heavy metal loads from land drainage will decline as a result of policies on manure. Consequently, fewer pesticides and heavy metals will exceed standards in 2015. Several pesticides that are only poorly soluble will remain longer in water sediments. It is possible that use of new pesticides will increase.

Agreements regarding sustainable buildings will also lead to a decrease in heavy metal loads from urban areas. Use of TBT is banned from 2008. Release of TBT and heavy metals from sediments will continue to be an important source of these substances, such that standards will be exceeded. The Sediments Purification Programme, National Waters, will effect reduced release from contaminated sediments in national waters. Purification of the Canal through Walcheren begins after 2006. Consultation with Flanders regarding cleaning of the Canal from Gent to Terneuzen will occurs in coming years, and preliminary research into this water body will begin in 2008. However, no real improvement in water quality in this canal can be expected before 2015. Economic developments, primarily in traffic and households, will probably increase loads. More cars will mean more PAH, lead and nickel emissions. Loads from WWTP will increase as the number of households increases. Implementation of cleaner technologies will not keep up with these trends.

A stand still of the chemical state in 2015 is possible, but conditional on all measures being rigidly implemented. Extra measures will be needed to achieve a good chemical state.

3.2.4 Current ecological state

Flanders

To have an idea on the ecological state of the rivers, Flanders has indices based on the presence of fish and macroinvertebrates. The Belgian biotic index (BBI) looks at the presence of invertebrates in rivers and brooks. The fish index does the same for fish. Very few data are available on phytoplankton and water plants.

The Belgian biotic index has different classes ranging from 0 (very bad quality) to 10 (very good quality). To reach a good ecological quality, class 7 has to be reached. In 2005 30% of all measured locations, reached this good status. 46% had an average quality, and 14% had a bad biological quality. 10% even had a very bad quality. These figures account for the entire Flemish region. However, the vast majority belongs to the Scheldt basin. An evolution of this index over the last 15 years shows biological quality is improving, but still remains unsufficient.

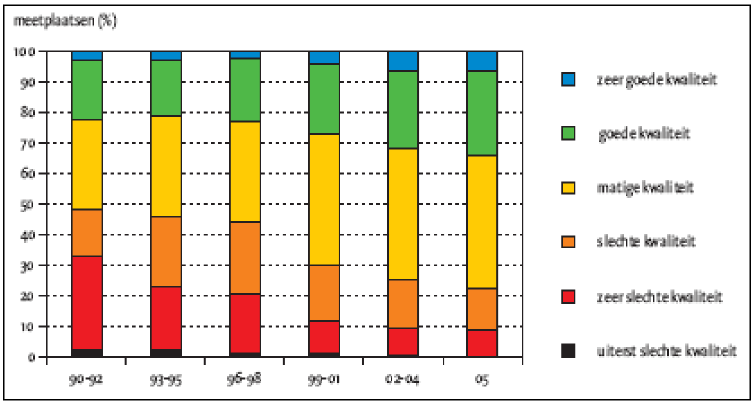


Figure 5: Evolution of Belgian Biotic Index in Flanders (ranges from black-extremely bad to blue-extremely good)(VMM, 2006)

Looking at the results for the fish index shows that also here a vast majority has a bad quality. 64% of all examined locations has a bad or unsufficient fish population. The number of locations with a good score is only 5%.

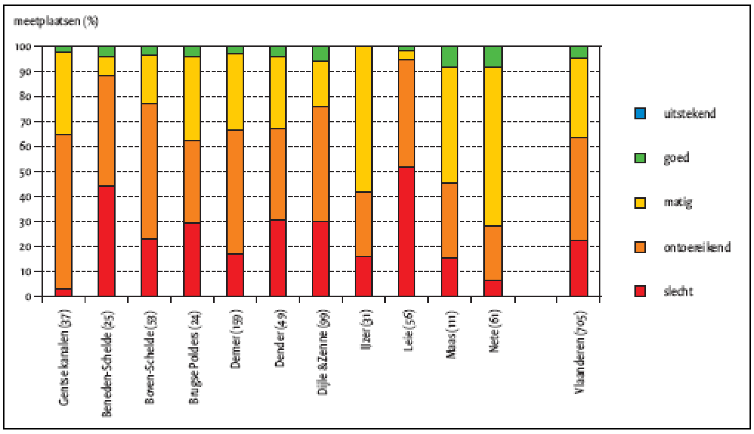


Figure 6: Fish index in Flanders in 2001-2006 for all subbasins (ranges from red-bad to blue - very good)(VMM, 2006)

Netherlands

Ecological state is determined via physico-chemical parameters and biological and hydromorphological quality. The former comprises such characteristics as temperature, transparency, dissolved oxygen, acidity and concentrations of a number of chemical substances. The last comprises substances that have an influence on the ecosystem: nutrients (N and P) as well as a number of heavy metals and pesticides. Member states set standards for these substances in catchment management plans. The risk analysis is based on standards from national policy based on maximum acceptable risk, and standards from the EU directive to reduce pollution to surface waters (76/464). One out, all out applies.

Standards for biological and hydromorphological quality will also be set by member state, based on descriptions of a reference state. The reference state, aka very good ecological state, describes the ecological state that a water body can achieve if there is no or very little human influence. The GES is derived from this reference state. A reference state is not feasible for artificial and strongly modified water bodies. Here the WFD identifies a Maximum Ecological Potential (MEP) as reference.

Biological quality stems from four species groups that comprise food webs: algae, water plants, benthic organisms and fish. A good state implies sufficient diversity of these species, and their sufficient abundance to guarantee ecosystem function. For regional water, existing guidelines from STOWA have been applied. For national waters, expert judgement has been used. For coastal and connecting water, the OSPAR framework has been partly applied.

All surface water bodies exceed standards for the physic-chemical parameters (maps 16-20, 24). N levels are more than twice the standard in almost all water bodies; P levels are more than five times the standard. Eutrophication of surface waters is an important problem that constrains achievement of good ecological quality. This is primarily the effect of agricultural drainage, brackish seepage and, locally, effluent discharges from WWTPs in regional waters. Drainage from agriculture, effluent discharge from WWTPs, and pumped drainage of polders are the main sources of nutrients in national waters. Industry is also a source of P. N also derives from atmospheric deposition, with agriculture, traffic and industry the main sources.

Copper and zinc also exceed standards in most surface water bodies. In regional waters, agricultural drainage is the main source of heavy metals and, to a lesser extent, traffic, WWTPs and corrosion of building materials. The major source of copper in the Canal through Walcheren is its contaminated sediments. In national waters, shipping and atmospheric deposition (industry) are the main sources of copper. The major source of zinc in the Canal from Gent to Terneuzen is its contaminated sediments.

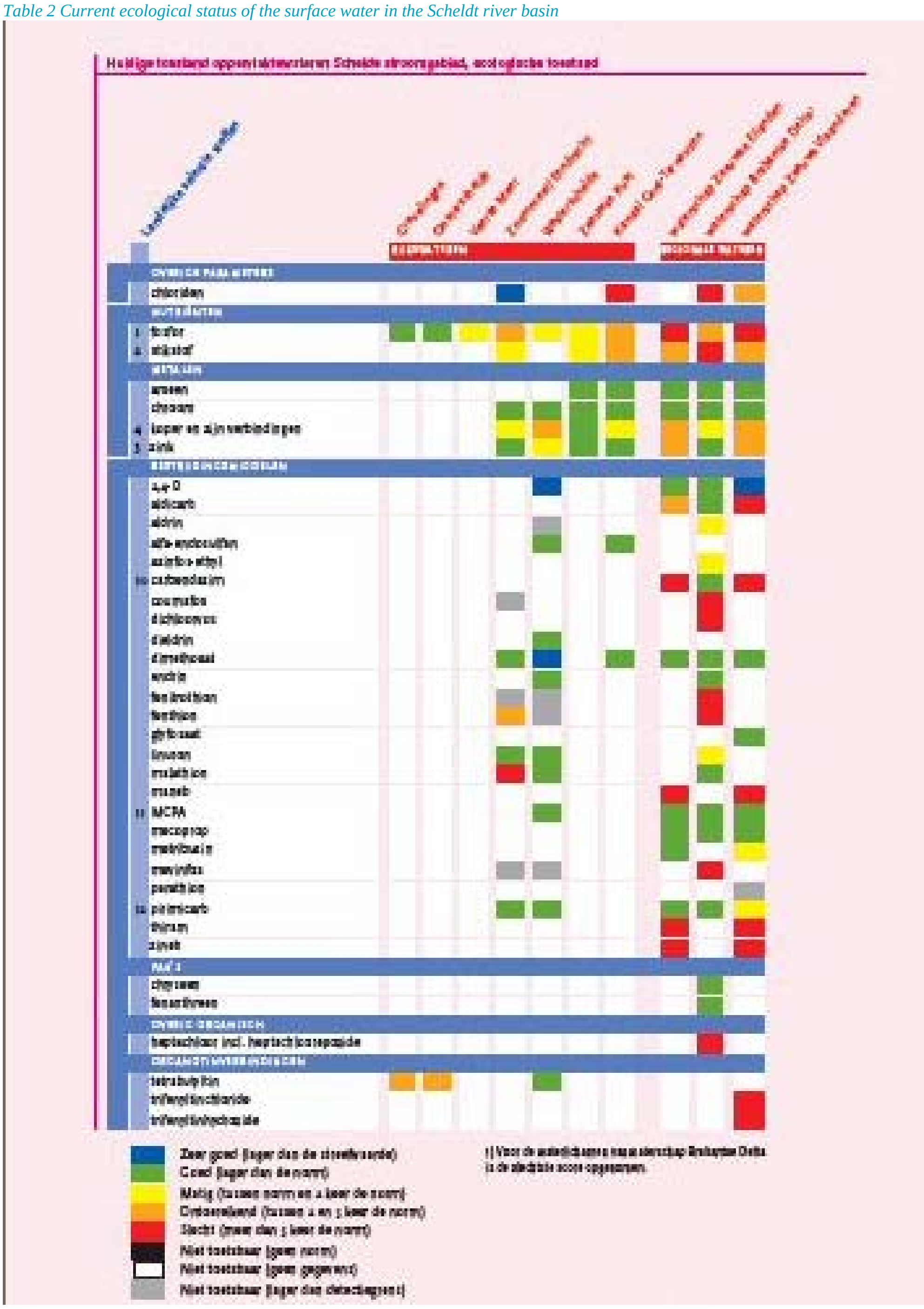
Regional waters exceed standards for the pesticides aldicarb, carbendzaim and maneb/zineb. These derive from agriculture.

Many regional and national waters are not expected to meet standards for PCBs as these substances, to a large extent, derive from aquatic sediments. PCBs originally came from incineration plants via atmospheric deposition. PCBs are not measured in the water.

Transboundary pollution from the Meuse and from Flanders is an important source of N, P, copper and zinc in adjacent waters. It accounts for 70-90% of total loads in the Westerschelde. Here nitrogen derives from the Meuse catchment, via the WWTP Bath.

Ecological state based on substances is indicated in the table below.

Table 2 Current ecological status of the surface water in the Scheldt river basin



State with regards to biological quality is show in map 26 and in the map below. No data are available for the Zwin, the Canal through South Beveland, and the Antwerp Canal area. Remaining national water meet no standard for good state. Only phytoplankton meets standards in the Oosterschelde, Lakes Grevelingen and Veerse. The Westerschelde meet no standards on biological quality.

The state with regards biological quality of regional waters is moderate to bad. Only two small regional water bodies meet standards: Schotsman/Ruiterplaat (North Beveland) and Goese Sea/Goese Meer (South Beveland). Markiezaat and the Binnenschelde meet all standards except for phytoplankton.

The artificial character of regional waters and heavy modification of national waters means that virtually no water body can achieve a good ecological state. Hydromorphic conditions are insufficient, usually because tides are suppressed, water levels are managed, shores are hardened and artificial, and waters are dredged.

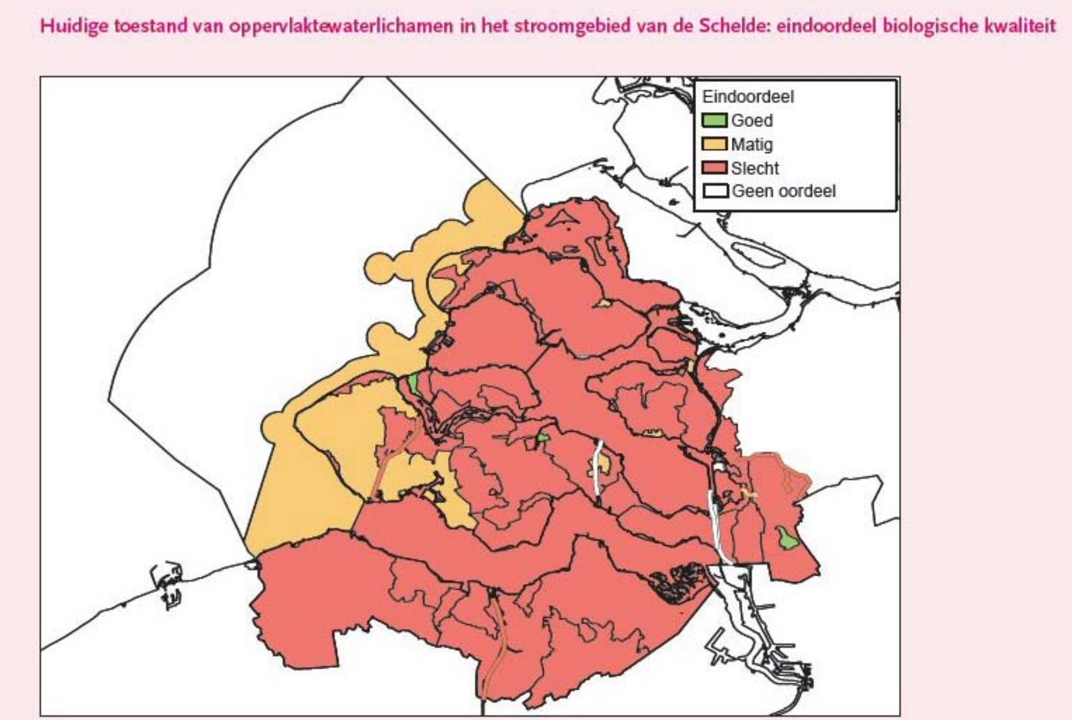


Figure 7 Current biological status of the surface water in the Scheldt river basin

3.2.5 Ecological state in 2015

Flanders

No predictions have been made on the ecological state of 2015 for the article 5 reports on the Scheldt basin. However, looking at the present ecological state and the slight improved chemical quality that is to be expected in a business as usual scenario for 2015, it is clear that without further measures the ecological state in 2015 will still be bad for a vast majority of the water bodies.

Netherlands

The analysis assessed whether human influences on biological quality would increase, remain the same, or decline. It assessed which were the most determining physico-chemical parameters and how sources would develop until 2015. Both economic and autonomic trends are included. The extent of hydromorphical changes is estimated and subsequent effects on the ecological state, with a view to their compensation or reduction.

Chemical substances are discussed above. The situation with regards biological quality is not expected to change before 2015. Only two small surface water bodies are expected to return to a good state and conform to standards for biological quality. Hydromorphological modifications remain the main constraint to a return to good ecological quality.

The analysis suggests that no surface water body will achieve a good ecological quality by 2015, based on current policy. A stand still is possible, conditional on rigorous implementation of new manure policies. Extra measures will be needed.

3.2.6 Water bodies at risk'

Flanders

An analysis of the current and future chemical and ecological state showed that quality will be bad in a vast majority of the identified water bodies in the Scheldt basin. The basic quality targets will not be reached on a single subbasin. Though it is not clearly defined in the article 5 reports, we can assume that all water bodies are at risk.

Netherlands

Current policy may achieve a stand still by 2015, but not a return to good ecological quality. Rigorous implementation of policies/covenants on manure, pesticides and sustainable management will be needed to achieve this.

Consequently, all water bodies are at risk. This holds for regional water bodies protected under the Birds or Habitats Directives, although they were not included in the analysis because standards have not yet been set. Given the expected state of surrounding water bodies, it must be concluded that these are also at risk.

Standards with regards to heavy metals, such as nickel, and a number of pesticides and PAHs form the greatest constraint for water with a good chemical quality. Good ecological quality is constrained by nutrients, heavy metals (copper and zinc) and pesticides. N and P levels exceed standards by factors of 2 or more, and cater for eutrophication. Together with the unnatural hydromorphological situation, the limited presence of species groups in the catchment is easy to explain. An important consequence of current policy is declining stocks of heavy metals, nutrients, PCBs TBT and pesticides in aquatic sediments. Given the size of current stocks, release to surface waters will continue to cause standards to be exceeded.

4. POLICY ISSUES

4.1 Water management framework and major issues

4.1.1 Institutional framework

Various authorities are responsible for water and water policy in Flanders and the Netherlands.

Most issues concerning environmental policy in Belgium are a regional responsibility. This means Flanders, the Walloon region and Brussels provide their own status reports on the water framework directive. Historically, different administrations or organisations were responsible for different water management issues. In the context of WFD implementation, the integration and planning is organised at the level of 11 sub-basins in the “so-called bekkenbeheersplannen”.

Final responsibility for Dutch water policy, and also for the Dutch Scheldt, lies with the minister of Public Works (RWS), who proposes policy for national waters and provides the framework for policy for regional waters. The ministers of environment (VROM) and for agriculture, nature and fisheries (LNV) are also responsible authorities. Provinces are responsible for groundwater policy and management, and for implementation of the policy for regional waters. The provinces of South Holland, Zeeland and North Brabant are responsible authorities. Water boards carry out management in regional waters. The Dutch Scheldt comprises four water boards: Goeree Overflakkee, Zeeuwse Eilanden, Zeeuws-Vlaanderen en Brabantse Delta. The sewerage treatment board of Hollandse Eilanden en Waarden is outside the borders of the catchment, but clearly has a relationship with it. This board is also a responsible authority.

Municipalities translate water policy into possible uses and specify this in their development plans. Municipalities are also responsible for the construction and maintenance of sewage reticulation systems. There are 17 municipalities. The Vereniging van Nederlandse Gemeenten represents municipalities in their role as responsible authority.

4.1.2 Water right issues

Since the WFD concentrates on the polluter-pays-principle, one of the issues in the Scheldt case study is how this principle can be put in place for the Westerschelde. This estuary has such an economic importance for shipping and the harbour of Antwerp, that dredging is very important and shipping is likely to remain one of the main sources of pollution. Although an important consequence of current policy is declining stocks of heavy metals, nutrients, PCBs TBT and pesticides in aquatic sediments, given the size of current stocks, release to surface waters will continue to cause standards to be exceeded. Transboundary pollution is one of the main issues regarding water quality in national waters.

The polluter-pays-principle is also likely to influence the agricultural sector, which, together with WWTP, causes most of the problems in regional waters. Multiple changes are ongoing in this sector, which is at the same time threatened by sea level rise.

4.1.3 Flood risk issues and climate change

Climate change related sea level rise and stronger waves are likely to increase the flood risk in the Dutch part of the Scheldt but also further upstream in the Antwerp region. Seawater intrusion caused by climate change is expected to affect agriculture, tourism and drinking water supplies. The coastal zone around the city Vlissingen has been marked as one of the priority areas for coastal zone protection policies, since the current status of the protection works is well below standards.

4.1.4 Water quality issues

The main issues regarding national waters are transboundary pollution, shipping and effluents from industry and WWTP. The main issues in regional waters are agricultural and urban pollution (see also paragraph 2.1.5). Current policy may achieve a stand still by 2015, but not a return to good ecological quality. Rigorous implementation of policies/covenants on manure, pesticides and sustainable management will be needed to achieve this. Consequently, all water bodies are at risk. Standards with regards to heavy metals, such as nickel, and a number of pesticides and PAHs form the greatest constraint for water with a good chemical quality. Good ecological quality is constrained by nutrients, which causes eutrophication. Together with the unnatural hydromorphological situation, the limited presence of species groups in the catchment is easy to explain (see also paragraph 2.2.5).

4.2 Relevant water policy questions in the basin

In the light of water quality improvements, one of the main issues is the (economic) value that households and (inter)national tourists attach to good water quality for recreational use and non-uses. As the area is highly urbanised, and the waterway network is very dense, substitution possibilities are large. It is unclear how water bodies are being used and will be used when quality improvements occur. Distance decay of attached values is expected to be large. Which people attach which value to which water body will be a very difficult question to answer.

Another important issue is how transboundary pollution can be addressed within the ERCB framework, and how the polluter-pays-principle can be applied. Not only pollution from upstream areas, but also from other river basins.

4.3 Information sources and stakeholder involvement

The Scaldit report contains most information regarding the Scheldt. Monitoring information lies mostly with the responsible authorities; this information is mostly available upon request. Cartographic/GIS information is also available at these sources. Data on ecological quality seems to be limited. This could be an issue for the further development of the case study. For Flanders, data on informal recreation is very limited, although it is generally recognised as an important issue. Data on water quality is available but is only available for monitoring points. This may be hard to interpret in more relevant terms for e.g. recreational values. (e.g.. length of river suitable for angling or swimming).

The main stakeholder groups are:

- Households (causing pollution through WWTP and admospheric deposition, benefit from drinking water and recreation possibilities, and from many use and non-use values related services)
- Industry (using water for cooling and production, causing chemical and thermopollution, benefits from cleaning water ecosystem services)
- Agriculture (using water for production, causing eutrophication and chemical pollution (pesticides))
- Transport
- Tourism
- Nature

Since the focus of the study will be on households and tourism, these groups are likely to be involved in the study.

5. ERCB Analysis and methodological issues

5.1 List of main water-related goods and services, costs and benefits

Most if not all goods and services as listed in the guidelines are present in the Scheldt basin. For households, these mostly concern residential and recreational values and non-use values related to biodiversity, cultural and landscape values. These include use related ecosystem services. Further analysis has to determine which of these functions are likely to be highest in terms of quantity (not in terms of economic value) in the area.

5.2 Type of ERCB analysis to performance

Environmental costs are the costs of not reaching good ecological status in 2015. Equivalently, the environmental benefits are the benefits related to achieving this good status. The main objective of the economic valuation study is therefore: the estimation of environmental and resource benefits and costs of reaching good ecological status.

5.3 Proposed methods and tools for the valuation of ERC:

The will be on stated preferences methods (CV, choice experiments) to elicit willingness to pay among households and tourists for achieving good water quality. Recreational benefits and non-use values will be the main focus.

Secondly, by setting out comparable surveys in both countries, benefit transfer tests will be made possible.

The main tools for analysis are:

- Surveys (for the stated preference method)
- Statistical techniques (to analyse the SP data)
- GIS (to analyse spatial aspects and to present outcomes in a spatially defined way)

5.4 Methodological issues

Specific issues in the case study are:

(1) the influence of spatial characteristics of the water bodies (proximity, connections, shape, size, number, surrounding zones, relative distance), the spatial distribution of the population and their characteristics (income, education, spatial perception), and the spatial interaction between the two (relative distance towards water bodies, in-situ/ex-situ use, substitutability) on WTP for water quality improvements within the WFD framework.

In the analysis the spatial physical characteristics of the different water bodies will be explored. These characteristics influence the scale of the functions that the water bodies can deliver. They will also influence the way people are using the environment, and the way they perceive it (catchment as a whole, sub-catchment, individual water body).

Specific attention is going to be paid to the influence of spatial characteristics on use versus non-use values. Therefore, the questionnaire will focus to elicit separate values for different ecosystem goods and services. In that light, Choice Experiments are likely to offer the best possibilities.

(2) Aggregation:

- different levels (scale) of value exercise: water body, sub-catchment, river basin
- background, natural characteristics of the water system
- taking into account social system (population distribution): since many of the beneficiaries live outside the basin area (foreign tourists)

(3) Benefits transfer:

- comparable studies in Belgium and the Netherlands will be executed to test for the validity of international benefit transfer
- benefits transfer within the Dutch subcatchment can also be tested

In summary:

- Valuation objective: estimate a spatially defined WTP for achieving good water quality in 2015, broken down in WTP values for different ecosystem goods and services.
- Valuation method: Stated Preference method, most likely: choice experiment
- Target group(s): households and tourists
- Valuation scenario(s) design in relation to ERCB & WFD: comparison of current water quality with different future states (different in quality level and area).

Spatial implementation scale: for the Dutch part of the basin, the whole area will be addressed, with possibly additional focus on specific areas (nature/recreation), for the Flemish part of the basin probably two locations in two subbasins with different levels of current environmental quality and differences in substitutes.

- Methodological tests:
    - Geographical sensitivity to scope (scale of improved areas)
    - Distance-decay: different measures of distance will be tested
    - Substitution and complementarity of water bodies within the basin, taken into account their spatial relations and characteristics (proximity, hydrological connections)
    - Use and non-use values comparisons in their sensitivity to spatial characteristics
    - Benefits transfer test: within Dutch sub-basin and international (BE-NL)
    - Aggregation and use of GIS (feasibility of a GIS based value map)
- Planning of activities and their timing:
    - April-May:
        - further gathering of ecological and GIS data
        - development of possible and achievable scenarios of water quality status by involving ecologists and water experts
        - development of list of levels of water related goods and services related to water quality levels of the WFD
        - further development of analytical (statistical) model, especially regarding the inclusion of spatial characteristics
        - development of images and information to represent water quality status
    - June: development of questionnaire, by focus group discussions
    - July-August: execute survey (this period is high tourism season in Zeeland)
    - September - ??: Data input, analysis, etc
- Problems / issues / other:
    - Focus on coordination between partners.

5.5 Available studies/information on cost/benefits and expected problems of information

Graphical information on the water bodies is available and monitoring data is likely to be available or can be bought. Problems will arise in gathering ecological data and translating ecological information into effects on functions and related goods and services. Ecological monitoring data is not as easily available as chemical data.

Two earlier studies have addressed surface water quality improvements in the Zeeuwse Delta, one study used CV, the other CE (both by Brouwer, unpublished). Further specification and breaking down these values for specific areas and goods and services remains an issue.

An overview of available geo-referenced data, both on social-economic as well as on water-quality related variables, will be added to the report.

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