1. BELGIUM

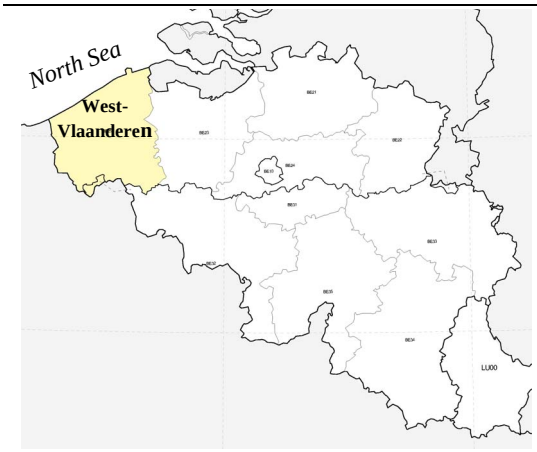
This country fiche provides a comprehensive overview and assessment of climate change adaptation in Belgium. After detailing the vulnerability of Belgium's coastal zones, the responsibility and financing for coastal protection is explained. Next, the fiche presents the relevant research activities, the coastal defence, risk reduction and adaptation plans available in Belgium as well as the current and future protection and adaptation expenditure. The persons contacted and sources of information used are listed at the end.

1.1. VULNERABILITY OF BELGIUM'S COASTAL ZONES TO CLIMATE CHANGE

Belgium has a coastline of 98 km bordering the south-eastern part of the North Sea. The entire coastline is situated within one province, *West-Vlaanderen,* as visualised in *Figure 1-1*. Additionally, the Western Scheldt, the Scheldt estuary up to Antwerp is exposed to the North Sea tidal range and potential storm surges. Even though most of this estuary lies on Dutch territory, the influence of the North Sea is observed in some important Belgian cities like Ghent and Antwerp. It has therefore been an important area of interest for flood protection.

A summary of the most important physical and socio-economic indicators of the Belgian coastal zone together with a map of the coastal provinces is presented in *Figure 1-1*.

Figure 1-1: The Belgian coastal zones and their main physical and socio-economic indicators



Physical and socio-economic indicators	*North sea*
Sea Level Rise	High
Coastline length	98 km
10 km coastal zone below 5 metres elevation	> 85%
Coastline subject to erosion	25 km (25%)
GDP in 50 km zone (€ million)	95 722 (34%)
Population in 50 km zone	3 846 676 (37%)

Source: Policy Research based on EEA, 2006, The changing faces of Europe's coastal areas (for Sea Level Rise and 10 km coastal zone below 5 metres elevation); European Commission (Eurosion study), 2004, Living with coastal erosion in Europe: Sediment and space for sustainability (for coastline length and coastline subject to erosion); Eurostat 2004 (for GDP and population in 50 km zone)

The following paragraphs discuss the main climate change risks for the coastal zones of Belgium. Although the Belgian coastline is relatively short, observed Sea Level Rise (SLR) and populated low-lying areas make the Belgian coastal zone vulnerable to coastal flooding and erosion.

a/ Flooding and erosion

Coastal lowlands are considered the most vulnerable to Sea Level Rise and related inundations. In this respect, Belgium, together with the Netherlands, where more than 85% of the coastal zone is located below 5 metres elevation, is highly vulnerable. Moreover, SLR and the increased likelihood of severe storm surges are projected to be the highest in the tidal North Sea region. These climate change effects may also aggravate coastal erosion, a problem which already affects a large part of the Belgian coastline.

In addition to these morphological aspects, the socio-economic characteristics of the Belgian coastal zone make the area vulnerable to flooding due to the increasing numbers of people and economic assets near the coast.

b/ Freshwater shortage

The high water consumption in Flanders, amounting to 745 million m^3 per year, puts increasing pressure on the available freshwater resources. Projected Sea Level Rise, increasing the risk of saltwater intrusion into the groundwater supply, may cause further strains on the water supply.

Saltwater intrusion can however also be caused by other activities such as over-extraction of groundwater as was recently the case in Nieuwpoort.
In Belgium, the management of the groundwater system is the responsibility of the Flemish Environment Agency (VMM) of the Flemish Ministry of Environment, Nature and Energy. To date, the VMM uses a 1973-map of the saltwater intrusion situation in the Belgian coastal zones which, as recent studies have indicated, is still representative. The VMM plans to study the impact of climate change on saltwater intrusion in coastal zones in the near future in order to identify whether specific adaptation measures are needed. Currently the Research Unit Groundwater Modelling of the Department Geology and Soil Science at Ghent University is investigating a pilot area at the western part of the Belgian coast (Westhoek Nature Reserve).

c/ Loss of coastal eco-systems

A large part of the Belgian coastline consists of beaches and dunes which are often the natural biotopes for coastal eco-systems and species. Erosion, SLR as well as coastal protection measures against flooding may indirectly threaten the ecological value of these biotopes.

The silting up process of the nature reserve 'Het Zwin' illustrates this potential risk. 'Het Zwin', a nature reserve of 158 hectares, stretches along both the Flemish and the Dutch coast for about 2.3 km. The area is subject to the North Sea tidal range and is the natural habitat of many plants, fishes and birds. 'Het Zwin' has always been at risk of silting up. Sand replenishments to protect nearby beaches against flooding and erosion aggravate this problem. The area is locked in between the sea and the protective dikes which makes the movement of the wetland inlands impossible. In the long run, the area might also be exposed directly to the problem of SLR and the risk of permanent flooding. At present, measures are undertaken to protect the natural value of this reserve.

Furthermore, a study is being carried out by the University of Ghent, assigned by *the Agency for Maritime and Coastal Services (IVA-MDK),* to investigate the ecologic impact of beach nourishments.

1.2. RESPONSIBILITY AND FINANCING FOR COASTAL PROTECTION AND CLIMATE ADAPTATION

In Belgium coastal defence is the exclusive responsibility of the Flemish region. The responsible administration is the *coastal division of the Agency for Maritime and Coastal Services (IVA-MDK)* subordinated to the *Flemish Ministry of Transport and Public Works*. The federal government is responsible for national contingency plans in case of national calamities. In addition, research into climate change is supported at the federal level.

The actual task of the *coastal division IVA-MDK* is to protect the people and the natural heritage of the coastal area against the flooding by the sea which is realised by:

- Monitoring the evolution of the foreshore, the backshore (or the beach) and the bordering dunes;
- Managing a storm tide monitoring system and studying coastal safety and protection measures;
- Inspecting and maintaining coastal infrastructure on a regular basis;
- Improving the coastal protection whenever necessary.

The Western Scheldt is embedded in a study that investigates proper measures against flooding in order to upgrade the safety level for the entire Scheldt estuary, the so-called SIGMA-plan and falls under the responsibility of the agency '*Waterwegen en Zeekanaal NV'*. The agency is connected to the Ministry of Mobility and Public Works.

1.3. RESEARCH TO BELGIUM'S VULNERABILITY TO CLIMATE CHANGE AND CLIMATE CHANGE SCENARIOS

In Belgium, the main research institute currently involved in climate change research is the *Management Unit of the North Sea Mathematical Models and the Scheldt estuary* (MUMM)[1], a department of the *Royal Belgian Institute of Natural Sciences* (RBINS). Their climate research activities are mainly financed by the federal research programme 'Science for a Sustainable Development'. Also the *Royal Meteorological Institute* in Belgium (KMI) is involved in climate research under the same programme. Furthermore, the *coastal division of the Agency for Maritime and Coastal Services (IVA-MDK)* operates the Flemish Banks Monitoring Network which includes weather forecasting centres on the shore. Data collected is used to make future predictions of climate change.

MUMM studies the eco-systems of the North Sea, gives advice when an environmental assessment is required and makes coastal forecasts concerning the wind, tides, waves and sea level. MUMM is currently involved in the CLIMAR-project. This project has brought together five partners (MUMM, Arcadis-Belgium, Flanders Hydraulics Research, ILVO-Fisheries and the Maritime Institute of the University of Gent) to develop an evaluation framework for adaptation scenarios and measures as a response to climate induced impacts for the Belgian part of the North Sea. The project is financed by the research programme 'Science for a Sustainable Development' of the Belgian Federal Science Policy Office in 2 project phases (2007-2008 and 2009-2010). During the first project phase, MUMM was responsible for the analysis of the sea level, wind and waves changes over time. A literature study of the physical and ecological impacts of climate change was also undertaken. These studies, together

[1] Beheerseenheid van het Mathematisch Model van de Noordzee (BMM).

with the Dutch KNMI scenarios[2] have been used to draw five climate change scenarios for the Belgian coast by 2040 and 2100. These scenarios will be used to determine the actions to be taken to protect the Belgian coastal zone.
Under the same research programme, the CCI-HYDR[3] project is supported with the aim to assess the impact of possible climate changes on the occurrence of floods and low-flows in Belgium. In a first project phase, climate scenarios have been set-up for Belgium based on the results of the EU project 'PRUDENCE'. Currently a sensitivity analysis to land-use and climate change scenarios is being performed. CCI-HYDR is carried out by the KMI (Royal Meteorological Institute of Belgium) and the University of Leuven. The project will last for 4 years (2006-2009) and has a total budget of € 500 000.

1.4. COASTAL DEFENCE, RISK REDUCTION AND ADAPTATION PLANS IN RELATION TO CLIMATE CHANGE

To date, Belgium has no law or directive regulating the protection of the coast against flooding by the sea. In practice however, the Flemish Region maintains the following safety level for the entire coastline: the whole coastline should be able to withstand a storm with a return period of 1 000 years. This safety level is also being used in the Integrated Master Plan which will be developed by 2010 to overcome all weak links in the Flemish coastal defences.

In the meantime, the Belgian coastline is monitored on a yearly basis and every five years the entire coastal defence system is submitted to a safety check. Currently, some parts of the Belgian coastline do not achieve the required safety level and provide a minimum protection against storms with a return period of 100 years.

Coastal protection measures such as beach nourishments and the maintenance of coastal defence infrastructures are carried out every year. The general tendency in the coastal defence policy in Belgium is to use soft measures, mainly beach nourishments, to safeguard the natural dynamics of the coast. Between 2004 and 2007, the Belgian coast was replenished with 2.7 million m^3 of sand to secure a safety level of at least 100 years.

Next to the Integrated Master Plan, the Coastal Division is developing separate coastal protection plans for the city of Ostend and the nature reserve 'Het Zwin'. *Table 1-1* presents an overview of the Belgian coastal protection plans in relation to climate change.

As for the protection of the Western Scheldt, the SIGMA-plan, developed in 1977, outlines measures which consist of flood controlled areas and flood defences. The total cost up to 2030 is estimated at

[2] KNMI, 2006, *Klimaat in de 21e eeuw: vier scenario's voor Nederland*, Drukkerij van de Ridder, Nijkerk.

€ 30 million (including both the 1977 and 2005 SIGMA-plan) with an additional € 49 million for supporting measures[4].

Table 1-1: Overview of the Belgian coastal defence plans in relation to climate change

	Integrated Master Plan for Future Coastal Safety	*Improvement of the Coastal Protection at Ostend*	*Coastal Protection of the Flemish Part of the Zwin area*
Responsibility level	Regional (Flanders)	Regional (Flanders)	Regional (Flanders)
Planning period	2010 – 2015	2007 - 2012	2009 - 2011
Protection level	1:1000	1:1000	1:1000
Scenarios used	SLR: 60 cm/100 year	SLR: 60 cm/100 year	SLR: 60 cm/100 year
Protection against	Flooding and erosion	Flooding and erosion	Flooding
Cost	*n.a.*[5]	€ 55 million	€ 10.9 million[6]

Source: Policy Research

a/ Integrated Master Plan

In March 2007, the IVA-MDK started a study for the development of an Integrated Master plan for coastal protection and safety in Flanders. On the basis of this coastal protection plan, priorities will be defined and the flood-risk will be minimised by means of long-term programmes. Climate change impacts such as SLR and more frequent and intense storms will be taken into account.

The study will investigate the potential ecological effects of different coastal protection and climate adaptation solutions through an environmental impact assessment. In addition, a cost-benefit analysis taking into account all main and secondary effects of flooding (e.g. how many people are living in the flood-prone areas, how much assets are located in the flood-prone areas, what will be the potential effects on agriculture) will be performed.

The 3-years preparatory study is ongoing and the Master Plan is expected to be ready by 2010.

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3 Climate change impact on hydrological extremes along rivers and urban drainage systems in Belgium.

4 In 1998, the Netherlands and Flanders decided to develop a joint long term vision by 2010 for the Scheldt estuary and its functions of flood safety, port accessibility and important natural eco-system; to provide safety against flooding, the implementation of the updated SIGMA-plan in Flanders was chosen as the most appropriate measure.

5 A budget of € 1.4 million is foreseen for the development of the Integrated Master Plan, the cost of capital measures are not available yet.

6 The entire project relates to preserving the Zwin nature reserve as an intertidal area and creating more robust estuarine nature in the mouth of the Western Scheldt area. It also comprises the construction of new dykes. Some € 1.5 million of the total estimated cost of about € 25 million will be spent on research.

b/ Plan for the improvement of the coastal defence and maritime access to Ostend ("Zeeweringsproject")

IVA-MDK aims at improving the defence of and access to Ostend. The main measures that will be undertaken are the construction of a larger beach, two harbour embankments, reconstruction of part of the existing sea wall and an underground parking-lot in the existing dikes. Damage to valuable nature ares on the west bank of Ostend will be compensated by improving the nature reserve on the east bank of the entrance to the harbour of Nieuwpoort.

c/ Safety- and nature project "Het Zwin"

The nature reserve "Het Zwin" is in danger of loosing its unique natural value due to the silting up process that is occurring. In order to preserve this natural site, the domain will be extended. As the inter-tidal range will increase as a consequence of this extension, IVA-MDK is involved to ensure the safety during and after the project. The other partner involved is the province Zeeland of the Netherlands. At the moment the different options for preserving the Zwin nature reserve are being assessed from an environmental point of view.

1.5. PAST, PRESENT AND FUTURE EXPENDITURE

Belgium spends about € 18 million annually on coastal maintenance. In addition, specific measures to protect Ostend against flooding and erosion amounted to € 9 million in 2008. The indirect expenditure to protect against flooding and erosion amounted to € 1.3 million in the same year. Over the period 1998-2015, Belgium will have invested at least € 419 million in coastal protection and climate adaptation.

As the Integrated Master Plan is still under development, no information is available yet on the capital expenditure for specific measures stemming from this plan. However, the future expenditure can be expected to increase as the Integrated Master Plan will define the adaptation measures needed for the entire Belgian coastline.

More detailed information can be found in *Table 1-2*.

Table 1-2: Expenditure to protect against coastal flooding and erosion *(in € million)*[*]

Year	MAINTENANCE EXPENDITURE**			CAPITAL EXPENDITURE	INDIRECT EXPENDITURE				HOT-SPOT PROTECTION		TOTAL
	Hard	*Beach nourishments*	*Extra-ordinary*	*Integrated Master Plan*	*Integrated Master Plan*	*Research projects*	*Ostend*	*Zwin*	*Ostend*	*Zwin*	
1998	1.00	3.70	13.31	0			0.42				18.43
1999	1.00	3.70	13.31	0			0.42				18.43
2000	1.00	4.70	14.60	0			0.42				20.72
2001	1.00	1.50	13.70	0			0.42				16.62
2002	1.00	1.30	11.40	0			0.42				14.12
2003	1.00	1.10	9.20	0			0.42				11.72
2004	1.00	16.20	11.40	0			0.42				29.02
2005	1.00	5.00	11.00	0			0.42	0.26			17.68
2006	1.00	7.30	12.80	0		0.12	0.42	0.26			21.90
2007	1.00	5.00	12.10	0	0.10	0.40	0.42	0.26			19.28
2008	1.00	17.40	23.60	0	0.24	0.40	0.42	0.26	8.92		52.24
2009	1.00	3.70	13.31	0	0.33	0.40	0.35	0.26	2.00	9.60	30.95
2010	1.00	3.70	13.31	*n.a.*	0.33	0.28	0.13		20.33		39.08
2011	1.00	3.70	13.31	*n.a.*			0.13		16.32		34.46
2012	1.00	3.70	13.31	*n.a.*			0.13		2.30		20.44
2013	1.00	3.70	13.31	*n.a.*							18.01
2014	1.00	3.70	13.31	*n.a.*							18.01
2015	1.00	3.70	13.31	*n.a.*							18.01
TOTAL	18	93	240	*n.a.*	1.00	1.60	5.36	1.30	49.87	0.00	**419.12**
	350				9.26				49.87		

[*] *Yearly expenditure (proxy) provided by the coastal division of the Agency for Maritime and Coastal Services (IVA-MDK)*

[**] *Maintenance expenditure in 1998, 1999 and for the period after 2008 estimated by Policy Research based on the average expenditure in the period 2000-2008; for the beach nourishment expenditure the years 2004 and 2008 are not taken into account when calculating the average because in these year exceptional beach nourishments were carried out in the area of Ostend*

1.6. PERSONS CONTACTED AND SOURCES OF INFORMATION USED

1.6.1. PERSONS CONTACTED

Name	***Organisation***
Belpaeme, Kathy	Coordination Point for Sustainable Coastal Management
Claes, Wim	Disaster fund - Ministry of the Interior
Demarée, Gaston	Royal Meteorological Institute of Belgium
D'hont, Didier	Flemish Environment Agency
Maebe, Sigrid	Management Unit of the North Sea Mathematical Models
Mertens, Tina	Project Engineer, Agency for Maritime and Coastal Services – Coastal Division
Pichot, George	Management Unit of the North Sea Mathematical Models
Ponsar, Stephanie	Management Unit of the North Sea Mathematical Models
Roulin, Emmanuel	Royal Meteorological Institute of Belgium

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