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Climate change adaptation strategies and practical experiences in integrated coastal zone management and planning (ICZM)

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1 Climate Change Adaptation in Coastal Zone Planning

The UN Intergovernmental Panel on Climate Change (IPCC) indicates that our climate will change. Science tells us that the planet will see more extreme weather events in the form of drought, flooding, storm surges, hurricanes and rising sea levels due to melting glaciers. Responsible politicians must take account of this now at the start of the 21st century.

We must try to adapt to climate change by planning on the basis of existing scientific knowledge of the potential future impacts of a changing climate. For even a binding international agreement came into force in 2012, significant climate changes will inevitably continue for decades. It is first and foremost these climate changes that national adaptation strategies must counter.

Throughout its history, humans has adapted to local climate and other conditions. We have dressed according to the weather and built houses using our knowledge of local climates. We have gathered increasing climate knowledge that has contributed to making our societies robust. We are not only capable of surviving, but also of looking ahead and planning our future. With national adaptation strategies, governments can ensure that humans take a further step and begin to incorporate our knowledge about the future climate in today's planning and initiatives; we know these will have an impact for many years to come. The goal is naturally a society that will continue to be environmentally, economically and socially sustainable.

Since climate change is expected to have wide-ranging impacts, all sectors of society need to take up the challenge. This means individual citizens, businesses and public authorities, all of whom are climate-sensitive to one degree or another. When roads suddenly disappear, when floodwater appears without warning in the basement, or when farmers experience crop damage due to waterlogged fields, we notice our vulnerability.

" Mankind has spread to all corners of the world, surviving under harsh conditions. Customs and traditions are handed down from generation to generation, which enabled men and women to survive in these extreme places. But recently, in the time span of just a few generations and sometimes even faster than that, the climate is changing everywhere. The knowledge of our ancestors is becoming obsolete. If we hold on to our old ways, we'll become more and more vulnerable.

We have three opportunities to respond: mitigate (trying to reduce climate change), adapt (accept the climate change and adjust our way of living accordingly) and suffer (normally the result of not actively responding to the climate change and hoping the results will be manageable). It should be clear that these three possibilities are closely linked.

It is of the utmost importance to try and avoid the climate changing, but even our best efforts will never lead to an unchanged climate, so, if we don't want to 'suffer', we should also adapt to the inevitable changes.

Studies have shown that coastal areas, areas prone to river flood and urban areas (such as cities) are amongst those considered to be especially vulnerable to climate change." This excerpt is from the Belgian National Climate Change Adaptation Strategy of December 2010.

The coastline comprises active coastal cliffs where the sea erodes material, as well as beach-ridge complexes where material is deposited in the lee of prevailing winds. About 80% of the Danish population lives in urban areas near the coast and a total of about 1800km of coastline is protected by dykes or other types of coastal protection.

Low-lying areas are especially at risk, as they are both exposed to increases in sea level and are under pressure from increasing surface runoff from land areas. In particular, many of the coastal towns near larger river estuaries or at the bottom of fjords may face complex problems. Merely building higher dykes, for instance, is not a long-term solution, as the problem of backwater flooding will just become greater as a result of river water being unable to flow freely into the sea. A long-term solution requires the involvement of river valleys further inland - and an involvement of spatial planners and stakeholders.

1.1 Impacts and Scenarios

One of the leading institutions regarding climate change is the IPCC: the International Panel on Climate Change. The IPCC was founded in 1988 by the United Nations Environment Programme and the World Meteorological Organization. IPCC is renowned for its climate change scenarios. These scenarios provide some indication of the effects climate change could have on planet Earth. In figure 1, taken from the 2007 Climate Change Synthesis Report of the IPCC, the effects are clearly displayed. As can be seen, climate change both depends on and affects many factors of human life, indicated in the orange and green colored textboxes (at the bottom and right hand side of the figure).

The IPCC creates several scenarios in which they vary the input data (e.g. development and speed of economic growth, demographic variables, use of fossil sources, etc.). According to the IPCC global temperature could increase anywhere between +0.3°C and 6.4°C (Belgian Adaptation Strategy, 2010; IPCC 2007).

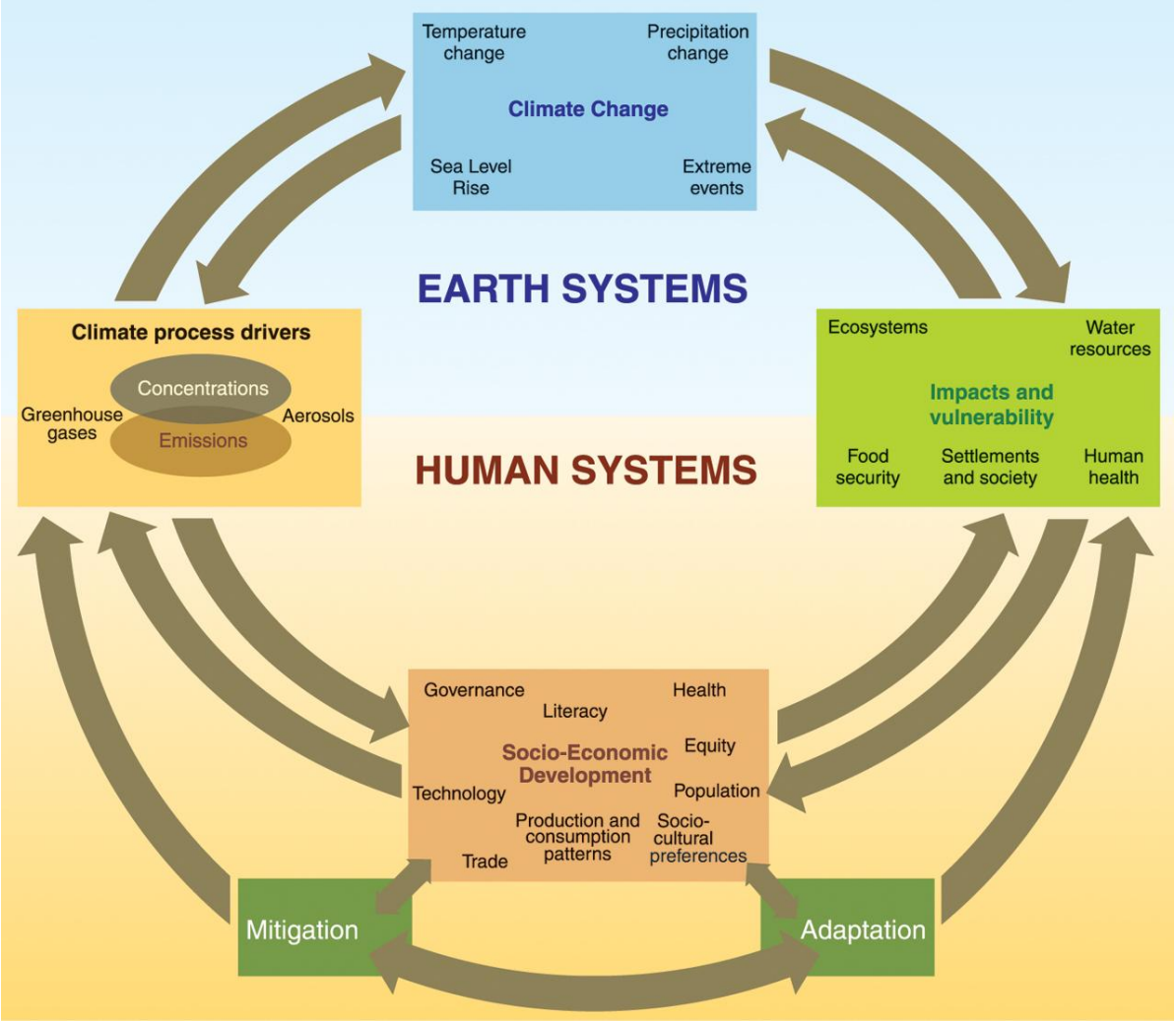

Figure 1 Schematic framework representing anthropogenic drivers, impacts of and responses to climate change, and their linkages. Source: IPCC (2007- pp26).

2 Practical Experience in Climate Change Adaption in Danish Coastal Zone Planning

2.1 Best practice in coastal area

In Denmark the central government addresses challenges related to ICZM, but the responsibility to enact ICZM in general is to a high extent situated at the local municipalities. Furthermore, it is the site owner's own choice to protect themselves from damage from flooding or erosion.

To begin with, the aspect of adjustment to and prevention of the climate changes was not formulated as a demand from the central government. The Danish Ministry of Environment states that adjustment to and prevention of climate changes is not a choice be-

tween two alternatives. It needs to bee looked at as an integrated process, because it will put societies to long-range expenses, if it is not part of the municipalities' daily work.

In 2004 the Danish Ministry of Environment worked out material to encourage and inspire the municipalities to incorporate adjustment to and prevention of the climate changes in their everyday flow of work.

Today, the matter has slightly changed. Demands have to some extent been formulated from the central government, for instance in relation to the implementation of EU's Floods Directive.

The Flood Directive, though, differs from general ICZM in that its core area is extreme floods. Denmark has in this relation worked out the Notice of Assessment and Risk Management of Flooding from the Sea, Estuaries or other parts of the Territorial Sea.

The Danish Coastal Authority points out the risk areas or where a significant flood is very likely, and which are assessed to be able to cause significant adverse effects on health, environment, heritage or economy. Again, the responsibility to implement and enact it is situated at the municipalities.

The decentralization of the assignment means that the approaches to ICZM in Denmark vary. This is reinforced by the different challenges that the more than 7.000 km of uneven Danish coastal line bring about.

For instance, the coastal line at Hjørring municipality in the northern part of Jutland is exposed to immense erosion whereas at Lolland municipality there is a high risk of flooding due to low coastal areas. The municipalities therefore face different ICZM challenges.

On this basis a best practice of the Danish municipalities approach to ICZM is outlined below. The best practice is based on information from a number of coastal municipalities.

2.1.1 Vertical integration between local, regional and central authorities

In Denmark, there is a tradition of cooperation between the three levels of authority; the local, the regional and the central authority.

Even though the responsibility to enact the ICZM is situated at the municipalities, it is often dealt with in projects encompassing a number of municipalities, the central government, and stakeholders in the private sector and the civil society in different setups.

At the present moment, the municipalities cooperate with the Danish Coastal Authority in various situations and ICZM projects, for instance the Onsevig Project, which encompasses the Danish Coastal Authority and the municipality of Slagelse.

They also participate in regional ICZM Projects, for example the SOSUD project, which encompasses Region Zealand and the municipalities of Lolland, Slagelse and Odsherred.

The municipalities also at present work intensively with the implementation of the Flood Directive. They are to have worked out a risk management plan by 2013. One principal due to this assignment is that the Flood Directive overrules the Planning Act.
The area therefore has a high level of political attention, which supports the environmental staffs focus upon it.

Political support and attention plays a major role in incorporating adjustment to and prevention of the climate changes in the environmental staff's everyday flow of work.
In situations where the public are interested in climate proofing their local coast, it is not unusual that the municipalities experience difficulties to find common ground with other levels of authority. Some of the consulted municipalities have experienced internal disagreements, when they want to support the public demands concerning ICZM, for instance when public demands are in conflict with a principal municipal development direction.

In addition, the municipalities underline their economic limits.

Too often the municipalities do not have the economic capacity to be responsive to the public demands and to act and adjust their ICZM in their everyday workflow, which according to the National Climate Strategy is expected from them. Nor do they have the economic capacity to work out long-term strategies to the development of the coastal area.

2.1.2 Horizontal integration across sectors

As outlined earlier the ICZM in Denmark is split up between different sectors. The fact that the responsibility to a high extend is situated in the municipalities implies an additional fragmentation of the area.

The advantage is that a local embedding of the assignment means a very present approach; it is enforces where it happens.

Furthermore, the municipalities often are characterized by having small administrative units with a high level of cross-sector work relations and cross sector projects. The different areas, to which the municipalities have the responsibility, are often highly integrated.

For instance, the municipality of Hedensted always tries to organize their work, so that the relevant stakeholders and actors contribute to the solution of the ICZM tasks.

The municipality of Gribskov often deals with complex cases in ad hoc project groups, consisting of people from different sectors.

The municipality of Slagelse has an internal network, which focus on climate and coast. The network consists of people from different sectors within the municipality. Despite the municipalities' high level of cross-sector work relations and cross sector project, there does not exist much inter-municipal cooperation, when it comes to ICZM.

Though, the Minister of Transportation has the authority to decide that a matter, which is significant to a coastal area concerning more than one municipality, is to be treated in the municipal council.

2.1.3 Public Participation

The ICZM has a relatively high level of public participation at the local level. This is due to the fact that planning of the coastlines is included in the Planning Act, which obligates the municipalities to involve the public in a hearing.

Furthermore, the municipalities are due to the Coastal Protection Act also obligated to involve the citizens, whom are imposed maintenance obligation.
The municipalities can impose maintenance obligation to citizens, whom achieves protection by the measure or in other ways benefits there from.
The public is therefore at the local level guaranteed a minimum level of participation related to the ICZM.

The coastal municipalities make use of various ways of involving the public. The most common is public meetings. But some municipalities expanse the concept and arrange climate festivals or the opportunity to vote for or against a project.

For instance, the municipality of Greve arranged a public meeting in relation to their preparation of a master of Hundige coastal line.

The municipality of Slagelse also has arranged a public meeting in relation to their climate protection plan. They also communicated it to the relevant site owners along the coast. Elements from the climate protection plan furthermore formed the basis for a climate festival.

The municipality of Lolland is currently working on an assignment concerning planning, management and administration of securing Nakskov Harbor. The result will be submitted for dialogue with businesses concerned, trade associations, and probably also citizens and site owners.

Prior to the municipality of Lolland's climate adaptation plan they held in 2008 a major conference involving a wide group of stakeholders. At the SOSCOD project at the southern part of Lolland's coast stakeholders are also involved.

For the municipality of Gribskov's part, their beach nourishing project also met the criteria of public participation. Furthermore, the site owners got the opportunity to vote pro or con to the project.

The municipality of Hedensted put climate adaptation on the agenda. They deliver analysis and knowledge to the concerning site owners, to support them in finding good local solutions, support them in realizing common climate solutions, and they involve the site owners in the decision making process.

The requirements of public involvement incorporated in the Planning Act and the Coastal Protection Act mean that some municipalities find the decision-making process unnecessarily protracted and complicated.

For instance, the hearing procedure gives the public the opportunity to submit complaints frequently during the many steps of the decision-making process.
One of the coastal municipalities also point out that the imposed maintenance obligation based in The Coastal Protection Law imposes a challenge to the ICZM. The citizens have difficulties to accept the fact that the expenses related to the ICZM also fall on them.

The municipalities therefore call for other ways of involving the public, which supports the ICZM processes at the local level instead of counteracting them.

2.1.4 References

http://www.klimatilpasning.dk/da-DK/Kyst/Sider/forside.aspx
The municipality of Greve, Hjørring, Hedensted, Gribskov, Lolland, Odsherred and Slagelse
The Floods Directive

2.2 Integrated Coastal Zone Planning in the Municipality of Hjørring (DK)

Coastal zone planning is an integrated part of the general spatial planning – municipal planning –, which is carried out by all Danish municipalities. The planning is legally mandated in the Danish Planning Act. This is a planning procedure runs in cycles of 4 years. The first round of planning was carried out in the wake of the Structural Reform of 2007 and the respective municipalities typically adopted the plans during 2009.

The first round was marked in particular by the need for consolidating and coordinating the plans of the municipalities merged by the structural reform. Moreover the planning of rural zones, previously managed by the counties, was now to be addressed by the municipalities. Resources were too scarce for thorough discussion and in depth processing of more than a minor number of particular themes. As for the municipality of Hjørring, the consequences of climate change have primarily been addressed in the environmental

impact assessment of the municipal plan. The next round of planning has been initiated and is to be concluded in 2013.

Subsequently a ”Climate Task Force” was established and it has prepared a strategy for climate and sustainability for the municipality of Hjørring, which, however, does not include the impacts on the coastal zone. The environmental impacts of the municipal sector plans are assessed. For the waste water issue, assessments of impact from the climate change are now available.

Hence this account will include processed excerpts from the Municipal Plan 2009 covering the coastal zone along with excerpts from the accompanying Environmental Impact Assessment and excerpts from the assessments of the waste water theme.

The EU-flooding directive is implemented in Denmark. There are no designated risk areas in the municipality of Hjørring. The coastal area as a result of the climate change is more or less limited to an increase in erosion.

2.2.1 The Coast and the Coast Land

The near-coast areas are defined by the coastal zone, in principle including the areas within a distance of 3 km from the coastline (the Planning Act). These areas are subject to a variety of particular protective interests, which are partly originating by the general goal of keeping the Danish coastal lines open and accessible to the public, and partly by the protective measures for landscapes and nature brought about by e.g. The EU-directives.

The 51 km long coastline of the municipality is characterised by the sea and wide beaches, often framed by the dramatic landscape of the dunes for example at locations like Lønstrup Klint and Rubjerg Knude, along with the dynamics of the duned landscapes that can be experienced between the towns of Hirtshals and Tversted.

Due to their landscape, nature and beaches, the coast and the coastland make a unique and special asset to the municipality of Hjørring. The coastal zone covers a total of 12.680 ha/ 31.332,13 acres. These magnificent surroundings provide room for a diversity of holiday and leisure activities, a variety of locations utilised for resorts and leisure facilities as well as major summer cottage and residential areas, fisheries and urban occupations in coastal cities, and agriculture. Moreover, urban areas are found along the coast in five coastal towns:

- Hirtshals with an active fishing and traffic harbour
- Løkken
- Lønstrup
- Tversted, and
- Nr. Lyngby (borrough)

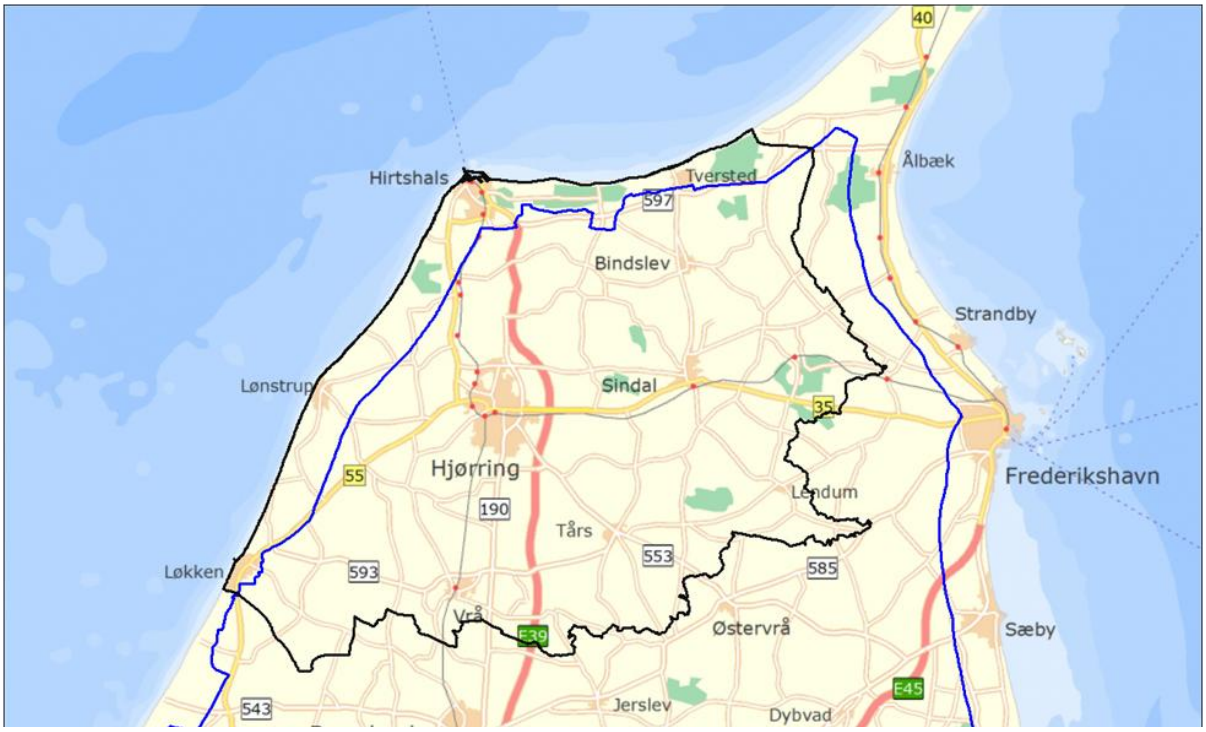

Fig. 2: The Coastland. The Coastalzoneline = blue is as the starting point 3 km from the coastline

The cultural heritage is closely related to the history of coastal erosion and sand drift. This is the story of the human struggle against the forces of nature that sets its mark in the many plantations in the coast land and in the location of coastal towns like Lønstrup in shelter of the tall cliffs. Also the coastal towns bear witness of the story of small ship trading and fishing as well as the development of tourism.

The challenge in this region is to obtain a balance in consideration of both the protective interests in the coastal landscape and the interests in utilising the areas for agricultural purposes, coastal urban development as well as holiday industry and leisure interests.

In a BLAST context, it is important to draw attention to the fact that the Danish Planning Act outlines particular protection requirements for the coastal zone. The background for this is Denmark featuring a long coastline and a limited population. In other words, we can ”afford to protect rather than utilise”. In this the Danish planning differs significantly from the condition in Belgium, for example, where the trend seems to be one of securing citizens’ rights to utilize the limited coastal resources. It would hardly be possible to maintain a major variety of coastal protection interests. In short, this might be described as less intensive utilisation and more intensive protection in Denmark as opposed to more intensive utilisation and less intensive protection in Belgium.

So the municipal planning must begin with the protective interests related to the coastal area.

2.2.2 Objectives for the Coast

The Municipal Plan 2009 outlines the following objectives for planning in the coastal zone:

- to protect the coastal landscape from irrelevant building developments
- to enhance public access to the coast and maintain the clean status of the beaches
- to facilitate the use of the coast and the coastal areas for urban, holiday and leisure purposes as well as for technical plant and facilities, provided that such activities and facilities are deemed relevant and compatible in terms of planning or functionality, and that interests in coastal landscape protection are considered in the motivation for any specific proposals of projects and facilities
- to make sure that the developing of the coastal zone is based on long term visions and that the large number of considerations and interests are balanced in an integrated planning and management of the coastal zone and the near-coast parts of the marine territory
- to enable the course of natural processes in the coastal areas without intervention with the exception, however, of the coastal protection at the borough of Lønstrup

These objectives are defined by the intention of taking up the challenges in preserving and using the near-coastal areas. Moreover the objectives have been transformed into strategies for the efforts over the coming years.

2.2.3 Strategy for the Coast

The overall strategy for the coastal zone is to balance the interests of protection and utilisation off against each other in order to protect natural and recreational assets while making room for any desired development that can be motivated in terms of planning and functionality.

The coastal landscape is a scarce resource in high demand and planning must be performed on this assumption. For this reason every assessment of the impact of any technical facility urban development, holiday or leisure resort or any major technical plant or facility is closely scrutinised in this context.

As a general rule, urban development should be located away from the coast and behind an existing town. However, the coastal cities are often ”squeezed” by the sea on side and major roads, forests or natural areas to the other side. So it is an important task to locate areas suitable for development and new activities and building projects while respecting the protective interests of the coastal zone. New developing areas are to be designated in parts where the location will not be conflicting with any particularly valuable area interests including the national and international natural preservation interests.

The urban developing interests should be balanced with and assessed in consideration of the partitioning of the coastal zone into the A, B, and C areas (to be discussed later), and in consideration of the following protective interests in the coastal zone:

- Landscape
- Nature
- Cultural History
- Recreation
- Preservation of wildlife, flora and fauna and their habitats
- Characteristic coastal landscapes and urban areas
- Areas of geological interest
- Valuable cultural environments etc.
- Urban development in the coastal zone

The overall planning is the strategic and operative tool to facilitate interaction between cultural heritage, nature and landscape and daily life in the coastal cities. This is the sustainable framework of the development for the years to come. The focus should be aimed at tailoring just the right profile and balance suitable for each town.

Using an overall plan the basic elements can be laid out for this general planning but it must be followed up by specific total planning of the urban development within the coastal zone. This means that moving forward a need may arise to conduct planning for urban development within or at the perimeter of the coastal zone next to the following coastal cities: Hirtshals, Løkken and Lønstrup.

2.2.4 Activities in the Coastal Areas and Coastal Protection

Activities at the beaches, the coast or the near-coastal parts of the marine territory in the way of tourist activities, coastal protection plant or marine wind turbines can be of significant impact to the coastal landscape. So it is the strategy of the municipality to consider and assess such activities in relation to the general objectives, the aim of which is to ensure the balance between protection and usage of the near-coastal parts of the municipal area.

2.2.4.1 Business and Port Activities at the coast

The port of Hirtshals is a dynamic industrial and traffic harbour with continuously developing activities within maritime industry and research and the ferry port. The port is a natural element at the coast and the potential for development should also be ensured for the future.
Disposal sites have been established near the port of Hirtshals for dredging sludge from the harbour basins, and a number of solitary wind turbines have been established along with two wind farms (5 wind turbines at Møllebakvej, Lønstrup, and 3 wind turbines between Sdr. Ringvej and Hornevej to the South of Hirtshals). For the wind turbines this is

motivated by the coastal areas belonging to the most attractive locations in terms of wind.

2.2.4.2 Clean beaches

With an increasing maritime transport along the coast, the risk of pollution from this traffic has increased heavily. In case of accidents with spillage of oil or chemicals, large stretches of coast will be very exposed to pollution due to their location close to the shipping routes, current conditions, conditions of the seabed etc. The coastal stretches of the municipality are of very high scenic and recreational value and hence extremely vulnerable to pollution. The municipality is cleaning the beaches on a continuous basis due to the recreational value of the beaches.

2.2.5 Coastal protection and erosion

Based on the objectives for the coast adopted by the town council, room should be ensured for the course of nature to rule along the coast in order to maintain the natural conditions in the coastal areas to the widest extent possible and hence ensure a varied coastal landscape and a diversified flora and fauna. This entails that in the point of origin, the municipality will be against the establishing of new permanent coastal protection facilities with the exception of what is deemed necessary for protecting the borough of Loenstrup although the erosion is significant.

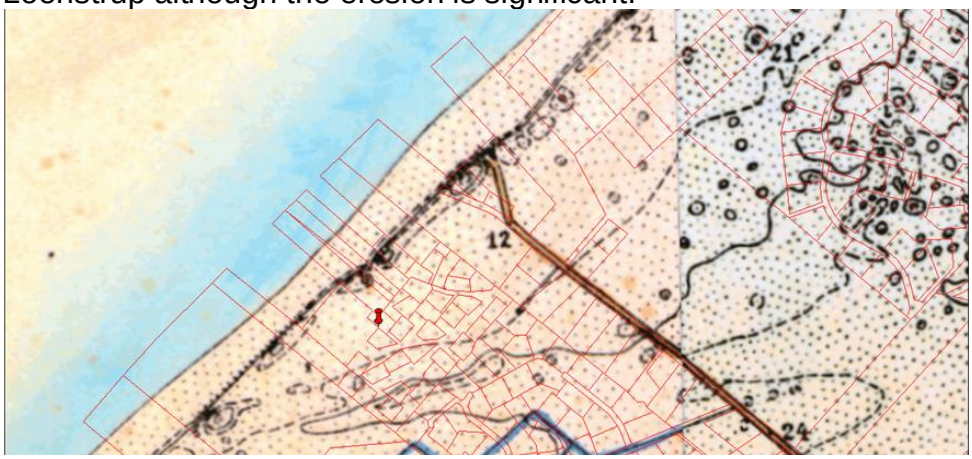

Fig. 3 Map produced 1842-1899. Distance from the red pin to the sand cliffs approx 75 m. The red pin is situated where three properties' boundaries meet.

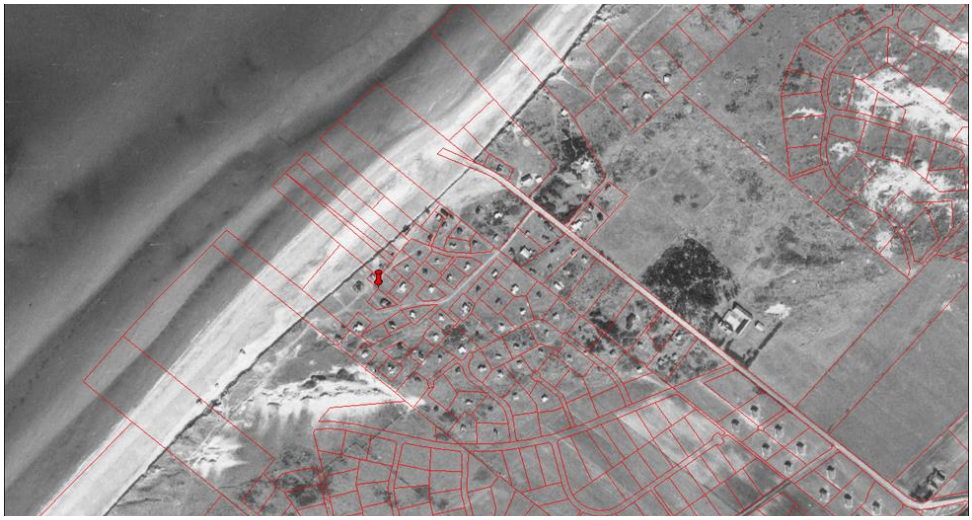

Fig.4 Ortofoto 1960-1964. Distance from the red pin to the sand cliffs approx 35 m

*Fig. 5: Ortofoto 2010. Distance from the **red pin** to the sand cliffs approx 1,5 m*

The coastal areas are in high demand for residential and leisure purposes and they are attractive areas for certain types of industries, port facilities as a natural activity related to the coast and also for the establishing of wind turbines. So these and other interests with an important role to play have left their significant stamp on the coastal landscape of the municipality. Among other things this means that more than 22% of the coastal landscape has been utilised, or is planned to be utilised for urban development, and facilities for the holiday and leisure industry, technical plant etc.

2.2.6 Main Structure

The coastal zone including all areas within 3 km of the coastline is divided into three types of area:

Coastal Landscapes of Particular Value - Zone A are undeveloped coastal areas, which are in principle kept clear of buildings and installations.

Coastal Landscapes Covered by Planning - Zone B are coastal areas where urban development, holiday industry, leisure and technical facilities can be established in accordance with current and present planning.

Coastal Landscapes - Zone C are coastal areas of no significant interest in terms of landscape and nature and normally with no visual contact to the coastline, thereby allowing for a motivated utilisation in accordance with the general guidelines of the municipal plan for utilisation and protection of the open land.

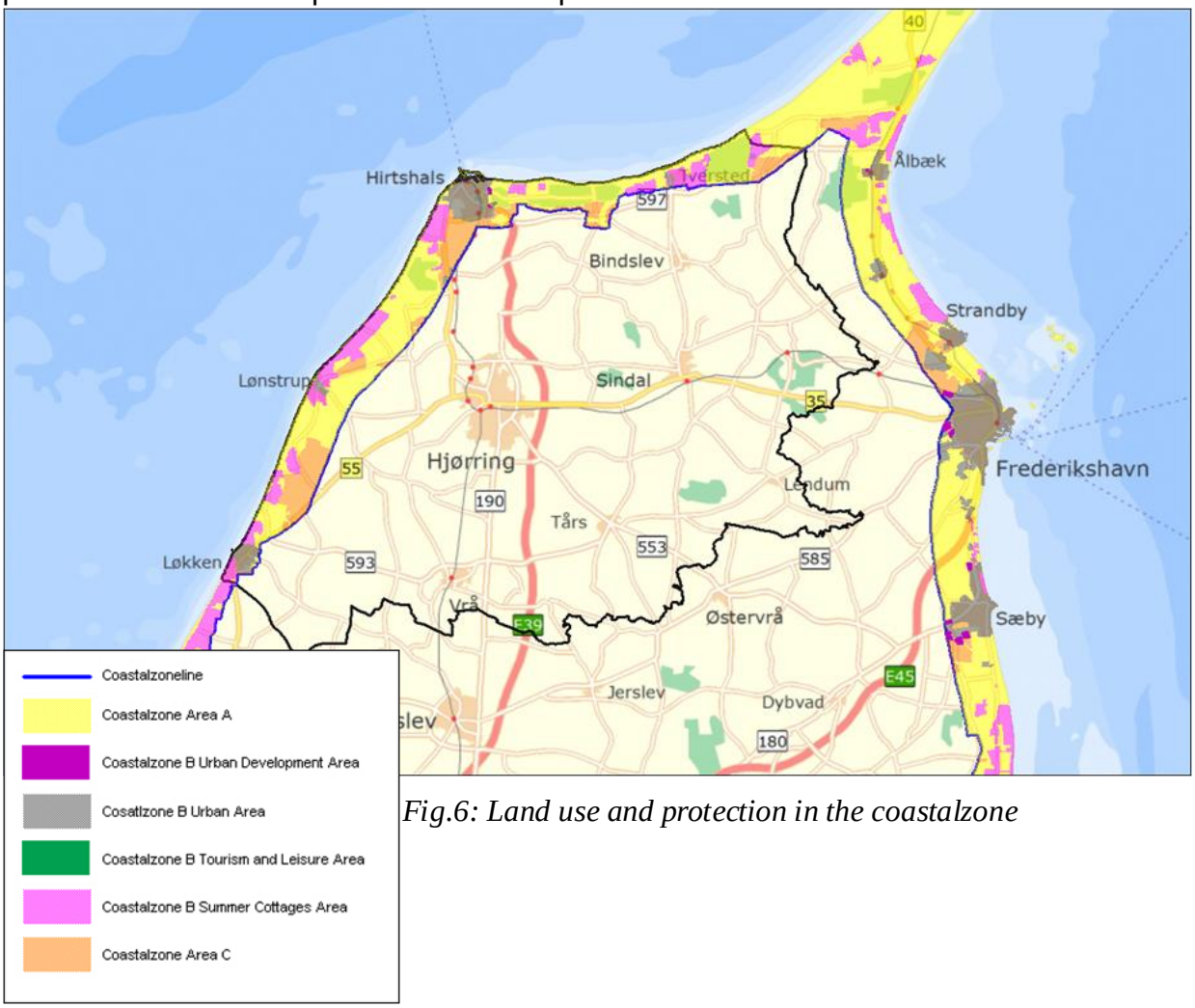

Fig.6: Land use and protection in the coastalzone

2.2.7 The Coastal Areas and the Coastal Waters

The quality of the coastal waters is of decisive importance to the industries of fishery and tourism and for the recreational interests in the coastal zone

Quite often activities in the coastal zone have a significant impact on the coastal waters. Thus the quality of the coastal waters is to a large extent sensitive to the impacts from the open land via the watercourses and to a certain extent it is sensitive to activities at sea. The increasing shipping activity is also increasing the risk of pollution accidents in the way of oil and chemical spillage etc. This is an increasing threat to the vulnerable coastal flora and fauna and in obvious conflict with the interests of tourism and recreation.

Hence the coast and the sea should be protected against land-based activities where the attention at an earlier stage was concentrated on the coastal protection.

2.2.8 Natural Interests in Coastal Areas

The municipality features a number of large and quite vulnerable natural areas and landscapes in a national as well as international context. This goes for four Natura 2000 classified areas between the beach location named Nørlev Strand and the dune plantation of Tornby on the west coast, between Kjul and Tversted on the coast facing to the North, two maritime locations to the West of Hirtshals, and a major area situated to the West of the beach of Skallerup Strand/Sdr. Lyngby.

The total coastal zone covers 12.680 ha/31.332,13 acres. Coastal zone A covers almost 60% of the total coastal zone.

The regulation of the interests of protection and utilisation in the open range of the coastal zone is performed in accordance with certain guidelines. However, the urban areas and developing areas are regulated in general via the framework of detailed local plans.

Further information, however in Danish only, is available at:
http://hjoerringplan.odeum.com/

2.2.9 The Environmental Impact Assessment on Climate

The municipal plan 2009 has been subject to an Environmental Impact Assessment. This part includes excerpts of the Environmental Impact Assessment of Municipal Plan 2009.

The municipality of Hjørring is facing a challenge in relation to the climate change. The challenge is partly to ensure the reduction of the greenhouse gas emission, and partly to ensure an adaption to the current and potential future climate changes.

The following assumptions have been made:

The projections (2008) of the Meteorological Institute of Denmark, the DMI predict the following climate changes in Denmark:

- A rise in temperatures
- An increase in winter precipitation and presumably a decrease in summer precipitation
- More cases of heavy precipitation, particularly during autumns
- Longer periods without precipitation during the growing season
- A rise in sea levels at the West Coast
- A rise in storm activity
- An increased evaporation and a decreasing soil moisture.

Since the actual climate change and its impact on the municipality of Hjørring are hard to predict, including the increase in sea level to be anticipated, the 0 alternative for climate change is uncertain and gives only indications of impacts.

The developing trend in the municipality of Hjørring with an increased traffic (the municipality of Hjørring, 2006) will cause corresponding CO2 emissions. Moreover, an increased generation of electricity will be experienced.

Today the municipality of Hjørring is facing the consequences of climate change including heavier incidents of precipitation, which in turn means heavier peak loads on the sewage system and a risk of larger amounts of overflow to the recipients. Additional challenges to the water supply and the sewage system are anticipated. (The water supply of Hjørring 2008).

2.2.9.1 0-The Alternative

The proposed plan of the municipality of Hjørring does not contain any directions for the reduction of greenhouse gas emissions. Hence there is no difference between the plan proposal and 0-alternative. The trend of greenhouse gas emissions in the municipality of Hjørring is estimated to be decreasing in spite of an increasing automotive traffic owing to the long-term expectation that energy production and engine combustion will become more environmental with less emission of CO2.

As for climate change, the impacts for Hjørring listed above are anticipated to be shared with the remaining Denmark. A particular issue for the municipality of Hjørring, however, will be the rising sea level at the West coast- Moreover, the 0-alternative is expected to include a continued rise in sea level, which may cause flooding of low areas.

The 0-alternative for climate change appears on the table below and is based on ”The Government’s Strategy for Adaption to Climate Change in Denmark” and the Danish Ministry of Environment’s ”Climate Change” with a focus on assessing the impact on the aquamarine environment.

2.2.9.2 INTERESTS AFFECTED

Coastal Management, dikes, ports and coastal urban development

- An increased risk of flooding
- An increased risk of erosion

2.2.9.2.1 Buildings and facilities

- A security risk, in particular to older buildings, owing to heavier storms
- An increased risk of water penetration

2.2.9.2.2 Roads and railways

- Water build-up at and along roads with the risk of a reduced load supporting capacity and security owing to e.g. rising ground water and storm felling
- Risk of land slides

2.2.9.2.3 Sewage

- An increased risk of flooded terrain and basements

2.2.9.2.4 Water

- An increased risk of deoxygenation owing to the washing out of nutrients from agricultural areas, which is accelerated by the increasing winter precipitation.
- Deteriorating water quality owing to the discharge from wastewater treatment plant and sewage overflow enabled by rain

2.2.9.2.5 Water supply

- Changes in the formation of ground water

2.2.9.2.6 Energy supply

- Reduced need of heating during winters
- Increased need for cooling over summer

2.2.9.2.7 Agriculture

- Larger production potential owing to the rise in temperature and CO2 content
- A changed /increasing need for crop protection
- An increased need for fertilisation with the risk of an increased washout of nutrients
- Increasingly difficult farming conditions in certain areas caused by flooding and a high groundwater level
- An increased need of irrigation of sandy farmland

2.2.9.2.8 Forestry

- Unstable forest and deforestation resulting in loss of production and the loss of natural and recreational assets

2.2.9.2.9 Fishery

- Risk of threatened species and populations

2.2.9.2.10 Nature

- An increased biological population owing to the rise in temperature and an extended season of growth
- Increased growing over and deoxygenation
- Increased erosion and flooding of shallow coasts, littoral meadows and river valleys

2.2.9.3 Area Utilisation

- Increasing difficulties in draining the low level areas including those within the coastal zone
- Landslides with an impact on the infrastructure
- An increased risk of flooding in low level areas with an impact on buildings, plant and facilities

2.2.9.4 Health

- More heat waves with the risk of sickness, particularly in children and senior citizens
- Changes in pollen patterns with an increased risk of allergy
- Increased growth of toxic algae and certain marine bacteria posing a threat to the beach water quality
- More moisture damage and mould in buildings

2.2.9.5 Rescue Centres

- A growing need for more resource intensive rescue operations and assistance from the rescue centres.

2.2.10 Excerpt of Assessments of Climate Change in Relation to the Wastewater Issue

In relation to the Waste Water issue, Climate Change is primarily of relevance to two conditions:

- Changes of sea level
- Changes in precipitation intensity

In consequence of the global warming, the DMI estimates that over the next 100 years sea levels will rise in the bracket of 18 to 59 cm. Considering that the rise in land level for North Denmark over the last 100 years amounts to 20 cm, and that very few of the areas in the municipality of Hjørring are really low level, the rise of sea level is not expected to be of any impact within the municipality.

The changes in precipitation intensity can have an impact in three different ways:

- More frequent extreme rain in the summer - long duration
- More frequent extreme rain in the summer - short duration
- A rise in precipitation per annum, increasing winter precipitation and decreasing summer precipitation

The impacts of long and extreme rain incidents will be the following:

- Flooding of land areas where watercourses are unable to drain off the volumes of water as fast as they generate. Flooding typically occurs when the ground is drenched from extended precipitation and the rainwater flows off on the ground instead of seeping into the ground.
- Towns located along water courses or in areas of low topography will encounter flooding
- Sewage systems (common as well as separate) will normally not be overloaded from this type of rain incidents. However, overflow basins and basins in rainwater systems will suffer from more frequent overloads with large volumes of contamination discharged to the recipients.
- According to the DMI, future rain incidents of a relatively short maximum duration of approx. 1 hour will occur with an increase in intensity of approx. 20 - 60 %.

The impacts of short and extreme rain incidents will be the following:

- Local sewage overloads resulting in flooding of cellars (common systems) and terrain (common and separate systems).

- Land flooding will build up in local hollows in the urban areas. This type of flooding is well known today, their frequency will just be increasing significantly.

- Independent of the topography, cellar and basement flooding will occur wherever the sewage is under-engineered.

The increasing winter precipitation is an impact factor to the risk of flooding in urban and rural areas resulting from watercourses going over their banks due to the increased level of soil drenching.

The decreasing summer precipitation will have no impact on the risk of flooding in urban and rural areas, at least not in a negative direction.

However, the change in seasonal precipitation may have an impact on the potential of enabling the watercourses to meet the quality goals set forth in the water planning.

With an increasing winter precipitation, the discharge of water and the nutrient washout will increase if adequate action is not taken. Moreover an increased discharge of ground

water to the watercourses is anticipated, which with the increasing precipitation will result in an increasing tendency of soil drenching. This can be of a particular negative impact to the physical conditions of the watercourses, which are crucial to the fauna of the water streams and in turn to the environmental quality.

From the agricultural interests we must anticipate a stronger wish for efficient drainage of the farmland to make the most of the extended growing season brought about by the climate changes. In the spring this should enable the earliest possible start of growing and in the autumn it would help to avoid wet and cold soil resulting in a reduced growth of crop and facilitate a harvest of good quality.

Rising prices on land, increasing volumes of rain and increased influence of the field production on the financial yield (due to the change in the EU agricultural support policies) are all anticipated to be further incentives for draining.

A more comprehensive draining of the fields and the increased building intensity in the countryside will also increase the discharge to the watercourses. This should be balanced against the reduced risk of water streaming away on the surface when the soil is drained more efficiently since the soil is less liable to drench during rain.

Taking in consideration the physical state of the watercourses as well as nutrients being carried into the lakes and the sea, it would be desirable to "keep the water ashore" as long as possible. One solution could be making sure to provide buffer zones between (all) fields, drainage installations and watercourses. This should keep the water – and the nutrients - as close to the source as possible.

So care must be taken to allow for the impacts of the climate change in the handling of wastewater.

3 Norwegian Coastal Zone Planning Policies

Following the initial report on Norwegian Coastal Zone Planning Policies, this report is a review of how climate change adaptation is a part of the general planning policies in the coastal zone. However ICZM also include planning to make a lesser human impact on climate to reduce the predicted changes, this is only to some degree discussed in this document.

Norwegian Coastal Administration and Kristiansand municipality are used as best practice examples because of high focus on coastal zone management and adaptation to climate change. The goal in the harbour- and fairway act given in § 1 says: "*The law shall provide for good accessibility, safe access and proper use and management of waters in accordance with the public interest and concern to fisheries and other industries*", giving both the municipalities and the Coastal Administration a responsibility to act on climate change in ICZM.

Cross-sectoral national guidelines on climate change policies are given from the Department of the Environment (MD). MD is also responsible for the Planning and Building Act (PBA) which are basis for coastal zone planning in municipalities where land use is decided, and climate change must be taken into account, with predicted increase in temperature, precipitation and sea level rise in the coming decades.

3.1 Climate change adaptation

IPCC have in their major report 2007 given factual basis on a global level, showing the need to mitigate the change in climate globally, most possibly caused by human activity, and the need for adaptation to changes to come.

The Stern Report – shows also the political necessity to act on this.

The previous report from Blast WP6 on Norwegian policies in ICZM show examples of the main relevant climate changes for ICZM[1]. Here we go more in detail on the different climate factors of relevance in ICZM

3.2 Climate predictions in southern Norway and the North Sea

3.2.1 Climate in Norway (Klima i Norge) 2100

As factual basis for climate change adaptation in ICZM the government have published a NOU (Norwegian official investigations) called *Klima i Norge 2100* (Hanssen-Bauer *et al.*, 2009) which gives the main climate change scenarios for Norway and Norwegian municipalities. The NOU gives a scenario on a short trend for situation in 2030, and scenarios on a longer term to prepare for predicted situation in 2050 and 2100.

Hanssen-Bauer *et al.* (2009) is based on the Intergovernmental Panel on Climate Change (IPCC)'s report from 2007 on global warming. Major work has been done to downscale global scenarios to relevant information for Norway, and the different parts of Norway. Hanssen-Bauer *et al.* (2009) include a lot of relevant climate variables for coastal zone management of municipalities of Norway. The regional projections of global climate are based on 1) scenarios of anthropogenic emissions of greenhouse gases and particles, 2) global calculations of the climate system's response to these, and 3) methods to regionalize these calculations with greater geographic detail.

3.2.2 Integrated management plan for the North Sea

The Climate and Pollution Agency (KLIF) is coordinating the integrated management plan for the North Sea. Knowledge reports have just recently been presented 15. September 2011 as basis for the plan, including a report on climate scenarios for the North Sea (KLIF, 2011).

[1] *Norwegian policies in ICZM and requirements for data and methods, adapting to climate change*, chapter 4.2.1 (BLAST report work package 6, 31.8.2011)

3.2.3 Relevant climate change for ICZM

Discussions on adaptation to the predicted climate changes have a high focus on increase in global and regional air temperature. However many other climate factors are important to be aware of in ICZM, i.e temperature, precipitation, wind, rising sea level, extreme weather, flooding, avalanches and slides (www.klimatilpasning.no[3]).

The climate change predictions imply very different changes in the different parts of Norway, and therefore adaptation to changes in ICZM must differ very much depending on local predictions, and the local situation.

An increase in CO_2 in the atmosphere is predicted to have effect on many climate factors relevant for ICZM, like sea temperature, sea salinity and sea circulation and ecological changes (se figure 1).

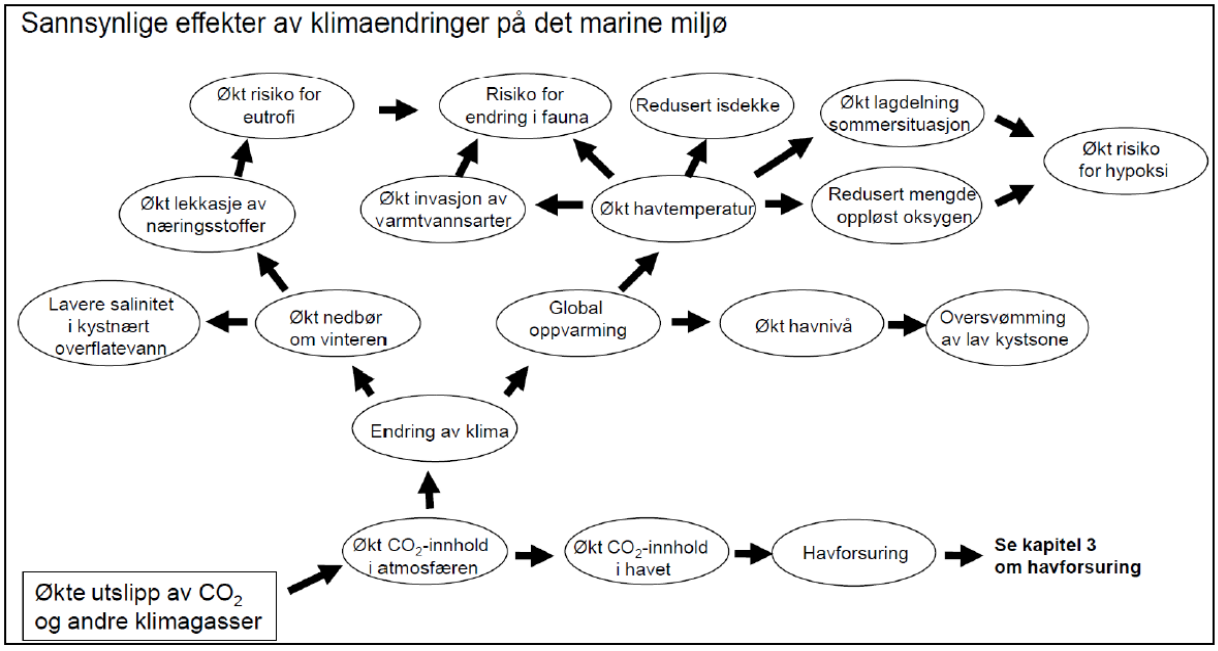

Fig. 7 Predicted effects of increase in CO2 in atmosphere on the marine environment in the North Sea (KLIF, 2011).

Rising sea level

[2] http://www.regjeringen.no/en/dep/md/kampanjer/engelsk-forside-for-klimatilpasning/climate-challenges.html?id=540002, Directorate for Civil Protection and Emergency Planning (read 21.12.2011)
[3] http://www.regjeringen.no/en/dep/md/kampanjer/engelsk-forside-for-klimatilpasning/climate-challenges.html?id=540002, Directorate for Civil Protection and Emergency Planning (read 21.12.2011)

Hanssen-Bauer *et al.* (2009) gives estimated increase of sea level, and estimated 100-year return storm surge of all 279 coastal municipalities in Norway based on the "business as usual" (A2) scenario from IPCC 2007. The estimates are also based on models from Rahmstorfs (2007), since estimates from IPCC 20007 are not recommended for use for planning according to sea level rise (Hanssen-Bauer *et al.* 2009).

In short; sea levels along the Norwegian coast is expected to rise by about 70 cm along the southern and western coast, about 60 cm in northern Norway and about 40 cm in Oslofjorden and Trondheimsfjorden within this century (year 2100). Due to uncertainties related to the various contributions to future sea level rise, sea-level rise can be from 20 cm below to 35 cm higher than the values provided. Predicted storm surge in 2100 (100 year storm) differ from 192 mm to 344 mm over medium water level (NN1954) in the municipalities.

Fremtidig havnivåstigning i norske kystkommuner								
Kommunenummer	Kommune	Målepunkt	År 2050 relativt år 2000			År 2100 relativt år 2000		
			Landheving (cm)	Havstigning (cm)	100-års returnivå * (relativt NN1954)	Landheving (cm)	Havstigning (cm)	100-års returnivå * (relativt NN1954)
			Usikkerhet: –8 til +14 cm			Usikkerhet: –20 til +35 cm		
Vest-Agder								
1004	Flekkefjord	Flekkefjord	4	27	137	9	81	196
1037	Kvinesdal	Øye	5	26	137	9	81	197
1003	Farsund	Farsund	5	26	140	10	80	199
1032	Lyngdal	Lyngdal	6	25	139	11	79	198
1029	Lindesnes	Åvik	6	25	142	12	78	200
1002	Mandal	Mandal	6	25	144	13	77	201
1018	Søgne	Høllen	7	24	149	14	76	205
1001	Kristiansand	Kristiansand	8	23	152	16	74	208
Aust-Agder								
0926	Lillesand	Lillesand	10	21	160	20	70	214
0904	Grimstad	Grimstad	11	20	163	22	68	216
0906	Arendal	Arendal	12	19	158	24	66	209
0914	Tvedestrand	Tvedestrand	12	19	164	25	65	216
0901	Risør	Risør	13	18	170	26	64	221

Fig. 8 Predicted sea level rise for Norwegian municipalities in 2050 and 2100. Because the Scandinavian half island is still rising after the ice-ages this gives a land rise of 8 cm until 2050, and 16 cm until 2100 in Kristiansand. The expected rise in sea level

Together with the given expected sea level, and predicted storm surge, Hanssen-Bauer *et al.* (2009) says attention should be given to the uncertainties, and to the local areas given exposure for high waves, when planning use of areas in the coastal zone. Later results for instance presentation from

Recent research and a presentation of the new Norwegian climate model NorESM in December 2011 (Furevik and Jansen, 2011) predict a higher increase in temperature than IPCC's 2007, and future predictions of sea level rise might be higher than those we use today (DSB, 2009, DSB 2011).

3.2.3.1 Changes in precipitation

Changes in precipitation are also predicted according to the three projections (medium, low, and high) from Hanssen-Bauer *et al.* (2009). An increase of yearly precipitation between 5 and 40 % is expected over all. Precipitation is expected to increase in all seasons in all parts of Norway, except Sørlandet and Eastern Norway with expected lower summer precipitation.

Region	Sesong	1961–90 til 2021–50: Endring (%) i nedbørsum			1961–90 til 2071–00: Endring (%) i nedbørsum		
		M	L	H	M	L	H
Norge	År	9,6	2,4	14,0	18,3	5,4	30,9
	Vinter DJF	11,1	3,8	18,4	21,4	8,5	39,9
	Vår MAM	10,0	3,7	20,0	19,4	7,2	41,5
	Sommer JJA	5,0	–1,6	9,7	9,2	–3,2	17,4
	Høst SON	12,2	2,1	16,1	23,3	4,6	33,4
NR-3 Sørlandet	År	4,6	-0,8	9,3	8,5	–1,5	17,0
	Vinter DJF	12,4	3,8	28,0	22,7	7,0	51,4
	Vår MAM	6,3	-0,4	16,6	11,6	–0,8	30,4
	Sommer JJA	–4,6	–15,4	5,0	–8,5	–28,2	9,2
	Høst SON	3,3	–4,8	8,7	6,0	–8,8	16,0

Fig. 9 Predicted changes in yearly precipitation and seasonal precipitation for Norwegian regions in 2100. The medium estimate of change in yearly precipitation in Norway is +18,3 %, with +5,4% and +30,9% as 10 and 90 percentiles respectively. For Sørlandet and

Changes in precipitation will influence coastal zone management in many different ways, i.e. by need of surface water drainage in urban areas, and management of changed frequencies and dimensions of flooding, landslides and avalanches.

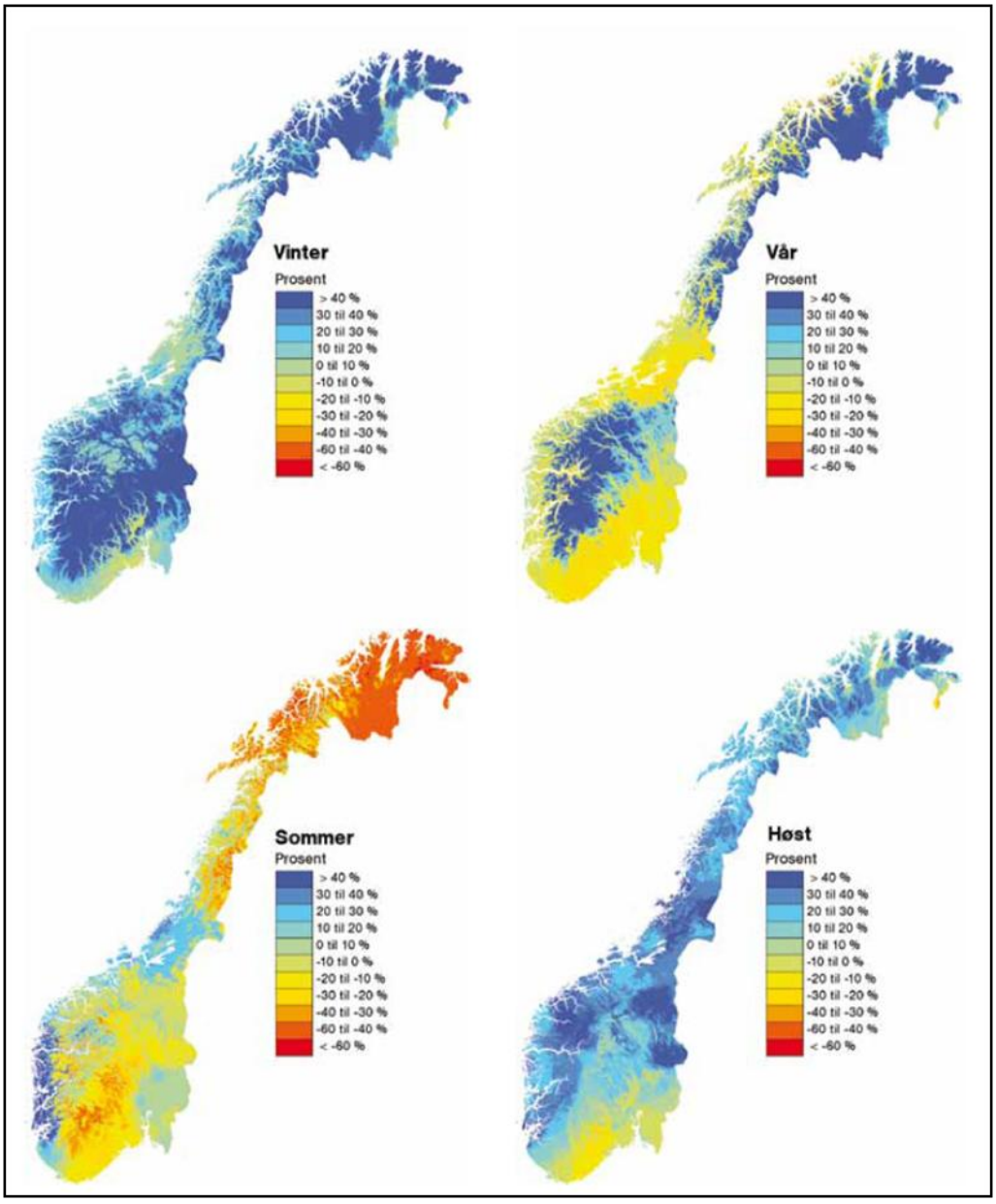

Fig. 10 Map showing predicted % change in seasonal water runoff for land areas of Norway 50 year ahead based on average from 1980-99. Increased water runoff can give higher risk of landslides, and flooding. Predicted changes in precipitation vary from + 40% to –

3.2.3.2 Extreme weather

Sea power and wave-power on coastal construction decide design and dimensions on maritime constructions.

Debernard and Røed (2008) give predictions of more extreme waves in the North Sea and Skagerak, with increase of 6 - 8% within 2100, based on IPCC scenarios A2, B2 and A1B. In the Barents Sea a certain increase is expected but with high uncertainty. For the rest of Norway small changes are expected.

Wind has not been easy to predict with today's climate models and Hanssen-Bauer *et al. (*2009) does not conclude on any estimates for 2100. However they suggest the frequency of strong winds can increase.

3.2.3.3 Sea temperature and acidity

Surface temperature in the North Sea can increase 1.7 º (year average), and the increase seems to be strongest in shallow areas south and east in the North Sea (Ådlandsvik, 2008). Together with accelerating increase in acidity in the North Sea this will obviously give changes in the maritime ecosystem.

Also relevant for management of maritime constructions, as well as the marine ecosystem is the sea acidity. KLIF (2011) predict an increased acidity with expected average pH in surface water of the North Sea to 7.95 in 2050, and 7.75 in 2100, based on IPCC's A2 scenario (IPCC, 2007).

3.2.3.4 Other changes

An increase in temperature of 2.3 – 4.6ºC is predicted for Norway on the average in 2100 (Hanssen-Bauer *et al.*, 2009). This will of course have major impact on vegetation and ecology and may also on way of living. An 1-2 months increase in growth season can be expected.

3.3 National guidelines Norway

3.3.1 National guidelines for climate change adaptation

The Ministry of the Environment is responsible for national cross-sectoral guidelines on climate change adaptation, and DSB (Directorate for Civil Protection and Emergency Planning) have published several report as guidance to climate change adaptation in ICZM and risk and vulnerability assessments as part of ICZM.

Climate change will result in higher temperatures, increased precipitation, rising sea level and more extreme weather. This will in turn have an impact on the construction, transport, health and primary industries, as well as other areas of society. There is a great need for knowledge about the effects of climate change in ICZM. Specific measures to meet the consequences are also in demand. The government has established the website "Climate change adaptation" (http://www.klimatilpasning.no) to address this need. Guidelines include recommended climate scenarios on different climate factors, and examples of best practices of climate change adaptation in given municipalities. The focus is on climate challenges, opportunities and examples of climate change adaptation measures. Adaptation to climate change must become an integral part of social

planning, in both the public and private sectors. A targeted effort in this area can save the Norwegian society large amounts of money in the future.

A high focus is on the expected sea level rise. Even though many other countries have bigger challenges than Norway with the coming sea level rise, it is very important that planning and management of coastal areas build on knowledge on the expected sea level rise. DSB have just recently (December 2011) published guidance for planning of developing land areas based on their responsibility for Civil Protection. Detailed guidance in the report *Håndtering av havnivåstigning i kommunal planlegging* (DSB, 2011) is based on predicted storm surge in DSB (2009) and Hanssen-Bauer *et al.* (2009), but have added the predicted 20, 200 and 1000-year storm surge in year 2100.

DSB (2011) recommend the use of *Zones requiring special consideration* (PBA 11-8 a) in the municipal master plan to show vulnerable areas near shore, together with regulatory provisions. Contour height of such near shore areas for the different storm surges should be calculated by:
Given 100-year storm surge in DSB 2009 (the highest prediction)
+ given value from Statens Kartverk to adjust for 20, 200 or 1000-year storm surge (DSB 2011, p. 8)
+ wave impact (must be a local assessment. Here is given an example with The Norwegian Meteorological Institute's report for Bergen municipality).

DSB (2011) give many further details on how ICZM can adapt to the sea level rise, and reference to local, regional, national and Nordic guidance on climate change adaptation in ICZM.

From this list of references we will especially refer to KLIMA-GIS working with visualising sea level rise and coastal flooding in GIS-tools in Sandnes municipality and Stavanger municipality (http://www.klimagis.no) and examples from the Kristiansand master municipality plan (se chapter 4.2).

In addition to adding the expected change in sea level, the Norwegian project Klima-GIS have simulated storm surges together with precipitation and run many simulations to determine the risk in the different areas. Klima-GIS is also working with the expected wave heights in a new climate. Expected wave heights are based on the current depth conditions at a higher water level in the future, and changes in wind and precipitation.

3.3.2 Coastal Protection measures in ICZM in Norway

Many of the countries around the North Sea have large areas with a low level above seawater, which have high risk of flooding, and they have developed different strategies for protecting their coastal areas, of especially high importance for areas, which today are under sea level i.e. in Belgium. This strategy does not have a parallel in Norway and have not been of high importance here; however the predicted increase in sea level makes this also an object in Norwegian ICZM.

Storm surge flooding have always been a safety issue in the towns and developed areas, which are located down on the shore, which most of them are. Climate change force a higher focus on the height above sea level when developing areas come even nearer the ocean, and coastal protection as a strategy will most certainly be of growing interest also in Norwegian municipalities. We can for instance refer to Kristiansand master municipality plan 2011-2022, which takes coastal protection into account in the regulatory provisions. Today we don't have any national guidance on these topics, but will most certainly look to our friends around the North Sea as the relevance of this will be growing, especially for urban areas with low altitude like parts of Kristiansand town centre.

3.4 Norwegian regional and local examples

3.4.1 Norwegian Coastal Administration

The Norwegian Coastal Administration's vision is to make our coast and waters the safest and purest in the world. The Norwegian Coastal Administration's goals are:

- Safe navigation,
- A clean environment,
- Transfer of goods from shore to sea,
- Sustainable coastal communities,
- Quality throughout all operations, and
- Always present when needed

A main part of this task is to establish and maintain maritime infrastructure with approximately 15.000 lighthouses and marks along the coast, and approximately 600 fishing harbours,

Management of coastal infrastructures like piers, quays, and lighthouses has to take into account the harsh weather on the Norwegian coast. Climate change is also relevant for this management.

Norwegian Coastal Administration is responsible for building new fishing harbours, and repairing after damages on moles and navigational installations. In both cases changes in climate are taken into account.

The 50-year storm or 100-year storm is used for dimensioning of constructions, depending on expected lifetime of construction. Climate adaption gives different responses for different constructions and different parts of the coast. Cost/benefit is also considered before choice of construction and dimensioning.

Examples:

- Repair of Lista mole recently, near Kristiansand. Construction was reinforced, and height of mole protection was increased with 50 cm because of expected climate changes in the next 50 years.
- In Andenes, in north of Norway block weight was increased to take into account increased wave heights because of climate change, and more open sea in the Arctic. However, estimates of changes in wave heights seem very uncertain, and climate models do not give obvious tendencies.
- In Oslofjorden, for instance, ice-drift is a major power on navigational installations, giving need of strong constructions. Climate changes might reduce this danger, and lower cost of constructions. However this is possible changes on a very long term.
- Good quality of estimates for expected climate changes are important to make the best decisions in all these cases, including rise of sea level and changes in wind and waves. Information must be available for the entire coast.

3.4.2 Kristiansand municipality

A process of revision of the master municipality plan of Kristiansand municipality have been going on from December 2008 to June 2011. Involvement of municipal politicians and NGOs have been highly facilitated as shown in the former BLAST report Norwegian Coastal Zone Planning Policies.

In the newly adopted master municipal plan 2011 - 2022 (adopted 22nd June 2011), Kristiansand have given three main priorities:
1) The city as a driving force, 2) The city that is good to live in, and 3) the climate city.
Kristiansand's goal on climate strategy is presented as: *"The climate city: Kristiansand is climate neutral in 2050 and has a business that is leading in renewable energy and energy efficiency"*

Kristiansand's climate strategy includes 4 priorities: 1) Area and transport, 2) Energy use in buildings, 3) Consumption and Waste, and 4) Climate change adaptation.

Within this century, predictions give the following climate changes for Kristiansand and Sørlandet, depending on level of global greenhouse gas emissions:

- Temperature rise: 2.3 -4.8 degrees
- Sea-level rise and storm surge level: Storm surge level of 2.08 m over middle water (uncertainty -0.20 m to 0.35 m)
- Precipitation: 0 - 20 per cent increase, and increased precipitation intensity.
- The consequences elsewhere in the world will be far more dramatic, and this will also affect the social development in Norway.

3.4.3 Climate change adaptation

Kristiansand municipality says climate change adaptation should be given a central role in risk assessment and emergency considerations in land use planning.

The master plan takes into account the consequences of climate change, increased risk of landslides, storm surges, sea-level rise and more by the use of “zones requiring special consideration“ (PBA § 11-8) with restrictions concerning risk and vulnerability and new restrictions on building heights above sea level.

3.4.3.1 Increased sea level rise and storm surge

According to national guidelines from DSB (2009) the prognosis for the 100-year storm surge in year 2100 is 2.43 m above middle water in Kristiansand, including uncertainty of 0.35 m. In addition to this wave effects must be taken into account where applicable.

By determining the building height above sea level one must take into account lifetime of the current buildings and whether buildings can be exposed to wave impact, and whether coastal protection can be appropriate to protect buildings against storm surges.

In Kristiansand, many areas along the fjords are exposed to waves. Only rarely will coastal protection to protect buildings against storm surges be relevant. This is because the Kristiansand fjord is wide and open, and because the two rivers that drain into the fjord will provide flow of water behind the storm surge protection. In undeveloped areas it is no problem to place buildings higher to adapt to climate change and future rise in sea level. But for developed areas, it is difficult to add buildings significantly higher than today because the adaptation to today's settlement will be difficult. This is followed up with different restrictions for developed and undeveloped areas[4].

For new buildings in developed areas floors should therefore not be lower than three meter above normal sea level (NN1954). For new buildings in undeveloped areas floors below 5 meters above normal sea level (NN1954), requires that satisfactory flood considerations is documented taken care of. Such documentation may include associated with construction of storm surge protection, small wave influences or construction of 1 floor so that it can withstand being flooded.

In this way the restrictions take into account expected sea level rise for another 200 years, i.e. to the year 2300 (DSB , 2009) in undeveloped areas, however with very high uncertainty on sea level change. Sea-level rise can be both higher and lower than is assumed.

For buildings with short lifetime within developed areas, the restriction can be reduced by 0.5 meter, and in areas with significant wave exposure, higher demands can be given.

If national restrictions for requirements for building height above sea level are adopted they will replace the municipality master plan restrictions.

[4] Restrictions of Kristiansand municipality master plan 2011 - 2022 § 7 b)

3.4.3.2 Flooding and landslides/avalanche

Restrictions are set in the Kristiansand municipality master plan for areas prone to landslides or avalanche. This is done by identifying "zones requiring special consideration" (PBA § 11-8) according to flooding and to landslides/avalanche

3.4.3.2.1 Flooding zones

According to flooding new buildings or significant expansion of existing buildings are not allowed within the 200-years flood zone at Mosby from the river Otra[5]. Buildings in other flood-prone areas must be high enough to avoid flooding damages. However scenarios for climate change is not included in the flooding-analysis of Mosby from The Norwegian Water Resources and Energy Directorate (Væringstad, 2005).

Predicted climate change in Kristiansand is around 20% increase of precipitation. This will eventually also contribute to a higher risk of flooding along rivers, and should thud been taken into account in later flooding-analysis.

3.4.3.3 Coastal protection

Restrictions in the Kristiansand master municipality plan refer to that coastal protection with walls or other constructions can reduce the minimum level over sea of new buildings near shore.

3.5 Use of the Coastal zone for climate change mitigation

Both the Kristiansand master municipality plan and the Plans of Norwegian Coastal Administration (Handlingsprogrammet / NTP?) include both climate change adaptation and climate change mitigation.

Therefore one of the indicators established is on use of the coastal zone for Renewable Energy Production, especially the ocean areas.
Fossil energy use is one of the main contributors to Climate gas emissions. Therefore a change over to renewable Energy production is one of the major strategies to mitigate climate change.

Another use of the ocean areas are deposition of CO2 under sub sea geological formations. A new report from Petroleumstilsynet have here recently estimated a potential of billions tons of CO2 in the Norwegian part of the North Sea and a big effort is put into development of such technology in Norway, however is not taken into account in here.

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4 Climate Change Adaptation Strategies – The Belgian approach

Climate change is affecting nations worldwide. Whether due to the influence of mankind, or due to natural causes, climate change is a serious threat and should be treated accordingly. One way to work with climate change is to change policies for land-use, spatial planning, water management etc. This is not as straightforward as it might sound. The difficulty with climate change is the uncertainty that goes along with it. To what height and at what rate will the sea level rise? Will my climate become wetter or will it suffer from drought? Will the seasons become more intense? How about rain showers?

For policy makers today it is difficult to deal with the issue of climate change. Not only due to levels of uncertainty concerning the possible effects. Decisions are made now, by people working and living today. Decisions influenced by politicians who want to get re-elected tomorrow, scientist who yet have to find out the exact "why, what and when" and a majority of men and women who just don't see the risk at this point in time.

As the Belgian National Climate Change Adaptation Strategy (NAS) clearly states: we have three choices: to mitigate, to adapt, or to suffer. This report will explore how climate change and adaptation is dealt with in Belgian policies.

5 Policies on Adaptation, Climate Change and Spatial Planning

There are several areas that are prone to the adverse effects of climate change, think of coastal areas, areas prone to river floods and urban areas. Belgium has got all three. Therefore adaptation to climate change is an important pillar in Belgian policies dealing with climate change (NAS, 2010).

5.1 EU Policies

In Belgium the United Nations Framework Convention on Climate Change (UNFCCC, 1992) was ratified by Belgium in the spring of 2002. This framework refers to adaptation as follows:

"Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods". (FACCE-JPI, 2011, p2).

In April 2009 the EU White Paper on Adaptation was published. The aim of this White Paper was to encourage member states to develop national adaptation plans by 2012, and the adaptation of an EU comprehensive adaptation strategy by 2013.

For Belgium this served as an incentive to start developing their own National Adaptation Strategy, as Belgium was completely missing in several important reports and surveys on adaptation strategies (NAS, 2010; PEER, 2009).

Since European policies on climate change are seemingly scattered the Joint Programming Initiative on Agriculture, Food Security and Climate Change was installed. Their first meeting was held in June of 2011. Their aim:

"The Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) brings together 20 countries and aims to improve the collaboration in research policies and research effort of its member countries to tackle these global challenges for Europe by aligning research programmes among Member States." (NAS, 2010, p7).

It is important to acknowledge that this is just one of the initiatives focussing on climate change. Other joint programmes worth mentioning:

- **Joint Programming Initiative "Climate"** which aims to: "contribute to a highly coordinated knowledge development by not only improving the scientific expertise on climate change risks and adaptation options, but also by connecting that knowledge with decision-making on safety and major investments in climate-vulnerable sectors in Europe." (source: http://www.jpi-climate.eu/)
- **Climate Knowledge and Innovation Community (Climate-KIC):** *(aims to)* "to be at the forefront of this "green revolution", providing the innovations, entrepreneurship, education and expert guidance needed to shape Europe's climate change agenda. Climate-KIC was launched as an initiative of the European Institute of Innovation and Technology (EIT)" (source: http://www.climate-kic.org/about/)

5.2 Belgian Policy Levels

Belgium is a difficult country to understand when it comes to rules and regulations. In Belgium, there are several different political levels – each with their own jurisdiction. To clarify, the political situation is roughly drafted in the textbox below:

FEDERAL:
The federal level comprises Belgium as a whole.
REGIONAL:
Belgium consists of three regions: Wallonia, Brussels and Flanders. Each of these regions has her own government and departments.
PROVINCIAL:
Each region consists of several provinces, except for the region of Brussels. These provinces have their own departments and policy areas.
LOCAL:
Each province consists of several municipalities who have their own city councils and policy areas (this also counts for Brussels, which is a region and a province in one).

The BLAST projects focuses on the coast. All policy level mentioned above have their own jurisdictions and responsibilities. As explained in a previous BLAST report "ICZM policy report for Flanders" on the Belgian political landscape: coastal zone management on land falls under federal and regional jurisdiction. The federal government (barring a few exceptions) is responsible for taking management measures at sea. The dividing line between land and sea is formed by the provincial frontier of the province of West-Flanders, which is bound on the seaward side by the baseline or mean low-water line along the coast. Execution of activities and works in the Belgian part of the North Sea that are necessary for the exercise of regional powers (i.e. waterways, harbours, coastal protection, pilot services, rescue and towing services at sea, fisheries) falls under the jurisdiction of the Flemish Government (regional government).

5.3 Water and Coastal Management

Managing the water sector in Belgium is complicated. Depending on the type of water a certain entity is responsible for its management. For instance, there are navigable waterways, non-navigable waterways, waterways of third category, the sea, lakes, ponds… As BLAST focuses on the coastal area only those actors relevant to the coastal area will be discussed in detail.

As described in the paragraph on global Belgian policies the responsibilities for the coastal area is divided over different policy levels and could categorised as:

- Safety at sea and coastal flooding from the sea
- Integrated water policy in Flanders for the waterways and sea channels
- MMM law for the protection of marine environment

To obtain an integrated approach and coordination for the execution of works or measures, a number of important policies management cooperation structures and partnerships have been established.

5.3.1 Seaside and Coastal Zone

The **Agency for Maritime and Coastal Services** (MCS) from the Flemish government is responsible for coastal protection and proper access to the marina's and ports situated at the Belgian the coast. The Coastal Division (part of MCS) aims to protect people from the sea, enables and stimulates recreational uses, creates maps (hydrography) of the sea and the parts of the river Scheldt and publishes the coastal weather forecasts. To do so the Coastal Division cooperates with the local coastal municipalities; the province of West-Flanders and other relevant entities (of for instance the Flemish government).

The **Taskforce Integrated Coastal Zone Management** is composed of several entities aiming at jointly discussing cross-sectoral themes. The Taskforce ICZM consists of the federal service of BMM (Beheerseenheid Mathematish Model Noordzee) responsible body for the MMM-law, MCS, the Institute for Nature conservation, the Flemish Nature

and Forest Agency (Agentschap Natuur en Bos, LNE) department of ROHM West-Flanders, and the provincial board of West-Flanders represented by the Coordination centre on ICZM.

The **Coordination centre on ICZM** aims to stimulate integrated management of the coastal zone in Belgium. The Coordination centre on ICZM is a cooperation of the following partners: Province of West-Flanders; the Flemish government (MCS and Nature and Forestry); the Federal Public Service of Health, Food Chain Safety and Environment and Flanders Marine Institute.

Another important body is the **Coast Guard**. They are responsible for the cooperation between the partners authorised for the North Sea area. The Belgian part of the North Sea measures 3600 km². The North Sea boasts a number of the busiest shipping lanes in the world. No less than 17 governmental institutions (both regional and federal) are authorised for all these activities. Consequently, a good cooperation within Belgium's marine region is of vital importance. The main responsibility of the Coast Guard is to ensure a good cooperation between all these partners so as increase the efficiency of operations at sea.

5.3.2 Landside Waterways and Sea Channels

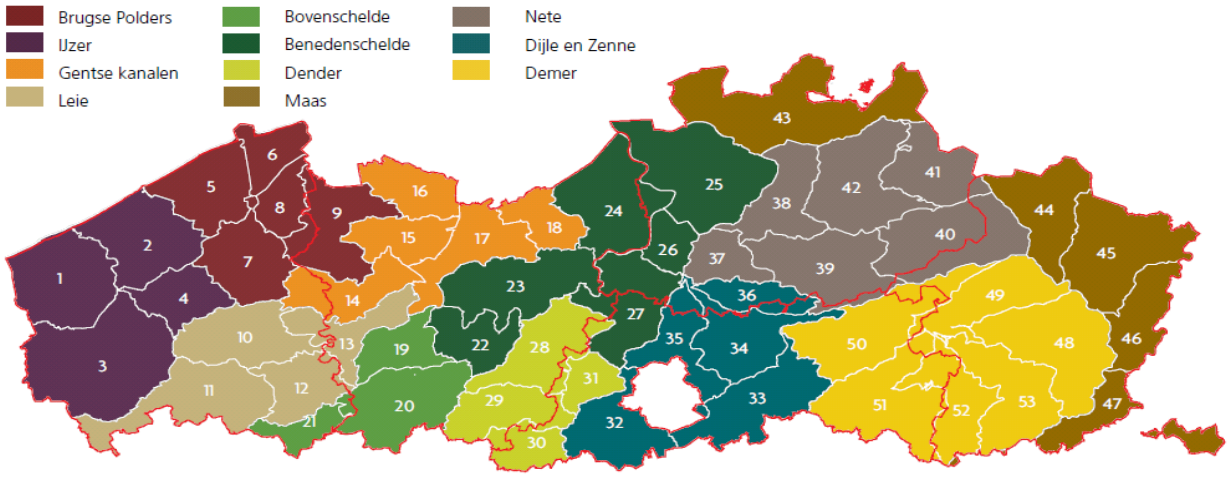
The juridical and organizational framework for integrated water policy in Flanders is described in the Decree on Integrated Water Policy of 18 July 2003. The Decree was the transposition of the EU Water Framework Directive (2000) in Flemish legislation. Flood risk management and other water related items were from the beginning incorporated in this Decree, although not required by the Water Framework Directive. The Decree on Integrated Water Policy establishes the principles for the policy.

The Integrated Policy Water Decree describes the geographical division of the water systems into:

- Two international river basin districts (*stroomgebiedsdistricten)*
- Four river basins (*stroomgebieden*)
- Eleven basins (*deelstroomgebieden* or *bekkens*):
- 103 sub-basins (*deelbekkens*)

The implementing order of 2005 also stipulates how the consultative structures described in the Decree should look like:

- The Coordination Commission for Integrated Water Policy (=CIW) on the Regional (Flemish) level (or river basin level);
- Boards, councils and secretariats on the basin level;
- Water Regulatory Authorities (Waterschappen) on sub-basin level. A Water Regulatory Authority is a cooperation between the Flemish Government, the provinces, the municipalities and the Marshes and Wetlands (*Polders en wateringen*).



Figur 11 53 water regulatory authorities, 11 basins and 10 provinces (red line = province border) (CIW, 2007)

As can bee seen in the figure above there are 4 areas directly located at the Belgian coast (#1,2, 5 and 6). These are represented by the “IJzer” and “Brugse Polders” basins.

Concerning the water-related policies in Flanders the CIW, established in 2004, is the competent authority at the Flemish level. It is a multi-disciplinary commission uniting different levels of water management and governance responsible for preparing, planning and monitoring of integrated water policy and for the implementation of the decisions taken by the Flemish government (Uyttendaele et.al., 2011).

The CIW is composed of the administrative entities of the Flemish region involved in water management (www.integraalwaterbeleid.be, 2012):

- Flemish level:
  - policy area Environment
  - policy area Transport
  - policy area Spatial planning
  - with advisory vote, policy area Agriculture and policy area Economy
- regional and local water managers:
  - umbrella organization of provinces
  - umbrella organization of cities and municipalities
  - umbrella organization of polders and drainage authorities
- water companies:
  - umbrella organization of water companies

In the figure below a schematic overview is given of all the levels and organisations involved in water policy in Flanders.

<table>
<tr><th>Level</th><th>Plan</th><th>Preparation</th><th>Advisory</th><th>Decision</th></tr>
<tr><td rowspan="2">Flemish Government</td><td>River basin management plan – end of 2009</td><td rowspan="2">CIW</td><td rowspan="2">SERV
MINA- council</td><td rowspan="2">Flemish Government</td></tr>
<tr><td>Water policy document – April 2005</td></tr>
<tr><td>Basin</td><td>Basin management plan – end of 2007</td><td>Basin Secretary</td><td>Basin council</td><td>Basin board</td></tr>
<tr><td>Sub basin</td><td>Sub basin management plan – end of 2007</td><td>Secretary Water Regulatory Authority</td><td>Local environmental councils</td><td>Water Regulatory Authority</td></tr>
<tr><td></td><td></td><td>Official pillar</td><td>Civil pillar</td><td>Political pillar</td></tr>
</table>

Figure 12 Schematic overview of the water policy in Flanders (CIW, 2007)

The European directive on flooding of 2007 relating to the evaluation and management of flood risks, which aims to develop a joint reference framework in the EU for the evaluation and prevention of risks linked to floods, whether they concern rivers, coasts, or streams in the urban sector, etc., builds on the structures and plans of the Water Framework Directive. Therefore It has been integrated in the Decree on Integrated Water Policy for Flanders in 2010 and falls also under the jurisdiction of the CIW.

5.4 Spatial planning in Belgium

In the Flemish region plans and policies are made up at the regional, provincial and municipal level. Figure 1 show the way spatial planning is taking place at different levels within the three Belgian regions.

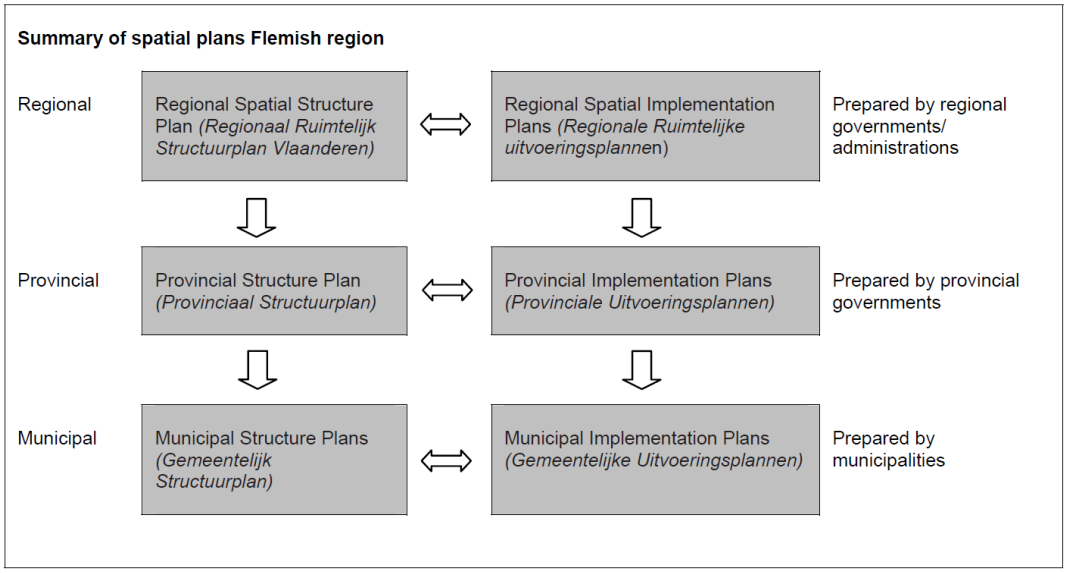


Figure 13. Spatial planning at different levels within the three Belgian regions

Since 1970 the Belgian regions have been acquiring complete and autonomous planning power, which was previously a federal competence. The regions have each developed their own Decrees for spatial planning:

- Flemish region: *Decreet houdende de organisatie van de ruimtelijke ordening* (2003)
- Wallonian region: *Code Wallon de l'aménagement du territoire, de l'urbanisme et du patrimoine* (C.W.A.T.U.P.) (2003)
- Region of the Brussels-Capital: *Ordonnance Organique de la planification et de l'Urbanisme* (1991)

The Flemish decree on spatial planning *(Decreet houdende de organisatie van de ruimtelijke ordening)* holds rules and regulations for spatial planning (from policymaking to maintenance) in the whole Flemish region. It also states the general planning goals and regulations on commissions and institutions. The decree forms the framework for all planning instruments (plans and permits) at the regional, provincial and municipal level.

The "Ruimtelijk Structuurplan" forms the policy framework for the desired spatial structure. It holds a long term vision on spatial planning of its territory. It also takes into account subjects like mobility, nature and environment including public safety. Most *Ruimtelijk Structuurplannen* are translated into several *Ruimtelijke Uitvoeringsplannen,* either focusing on urban regions, countryside regions, economic areas or infrastructure and transport.

6 From global to local scenarios

Researchers use climate models in order to calculate future changes in the emission of greenhouse gasses and their effect on climate as a whole. Since the knowledge of climate change and its drivers is insufficient, these models need to be simplified versions of reality. This results in a certain level of uncertainty about the accuracy of the results. The results obtained for the indicators of temperature are most accurate since they are less spatial dependant than precipitation and wind speed. Using mean values of climate parameters instead of extreme values further enhances reliability of results.

Greenhouse gas emissions in Flanders contribute to global climate change. Regardless of the location of the exact emissions greenhouse gasses reach the earth's atmosphere and remain there for years to come – therefore climate change is a global challenge. To explore possible climate change on the level of Flanders global climate change scenario's developed by the IPCC have been used (of the 4th Assessment Report, 2007). These scenarios use different future assumptions as input data, e.g. economic trends, demographic evolutions, technological progress etc.

The scenarios for Flanders are base on the PRUDENCE regional climate predictions for the area of West-Europe. They were calculated using 12 linked global and regional climate models. This resulted in a range of possible effects for Flanders towards the end of this century (2071-2100). These results where further interpreted and analysed by researchers of the Catholic University of Leuven (KUL) and the Belgian Royal Meteorological Institute (KMI). They deducted three possible future scenarios: a wet, moderate or dry climate scenario. These last three scenarios include both possible greenhouse gas emissions as uncertainty that belong to the used climate models. Furthermore natural climate changes – possible coincidence in which weather phenomena can occur in time – where incorporated in the results.

6.1 Direct climate impacts in Belgium

Climate change is a long term phenomenon. The next paragraphs will describe how Flanders could be affected by climate change on the long term (towards 2100).

6.1.1 Climate scenarios

The three climate scenarios developed KUL and KMI (see previous subchapter) identify the most possible developments of climate change in Flanders.

The **wet scenario** leads to the biggest increase of superficial drainage of precipitation, high water levels of rivers, floods, soil moisture en groundwater levels in winter and a strong increase of the average temperature in summer and in winter. In summer there will a higher risk of water scarcity, since although summer rain showers will be more intense they will occur less often. Also, the evaporation of water will increase due to increase average temperatures.

The **dry scenario** will lead to biggest problems concerning low water levels and low ground water levels during dry summer periods. In spring higher ground water levels

could occur. Temperature increase in this scenario will be less than in the wet scenario. At the coast and the tidal rivers sea level rise will negatively influence the chances of flooding. The chances of flood elsewhere in Flanders will not change much or even decrease in the dry scenario.
The moderate climate scenario will lead to moderate results, for both high- and low water levels as for wet and dry periods.

Each climate scenario for Flanders results in increase of the chance for more and more extreme dry periods. Especially the evolution to more dry and hot summers will, together with the changes in precipitation intensity, have a negative impact on the quality and availability of ground- and surface water – and therefore the certain supply of (drinking) water. In spite of a decrease in summer precipitation an increase in summer thunderstorms can be expected. The risk of economic damage due to floods varies a lot for the three different climate scenarios.

6.2 Socio-economic developments and spatial planning

Besides solely looking at climate change from a physiological point of view, it is interesting to take into account socio-economic developments as well, in particular demographic evolution and the use of public space and spatial planning in general. When looking at demographic evolution it is important not only to take into account population growth, but also qualitative characteristics like age, number of households and domestic characteristics. The population of Flanders is expected to grow between 2005 and 2030 with 12%. It is expected that the trend of less people per household will continue. The use of (public) space will change in accordance with social dynamics. Flood risks should be handled by a more integrated approach in spatial planning and spatial land use. The Flemish documents of Milieuverkenning 2030 and Natuurverkenning 2030 already explore this way of thinking.

7 CLIMAR project for the Flemish Coastal Zone

The CLIMAR project has provided large quantities of input for the Belgian National Climate Change Adaptation Strategy and therefore is mentioned quite elaborately.

The objective of the CLIMAR project was the elaboration of an evaluation framework for adaptation scenarios/measures as a response to climate induced ecological, social and economical impacts and this for the Belgian North Sea environment (Van den Eynde, D., R. De Sutter et al., 2011). The end report of this project – funded by Belspo federal science policy - can be found at
http://www.belspo.be/belspo/SSD/science/pr_terrestrial_nl.stm.

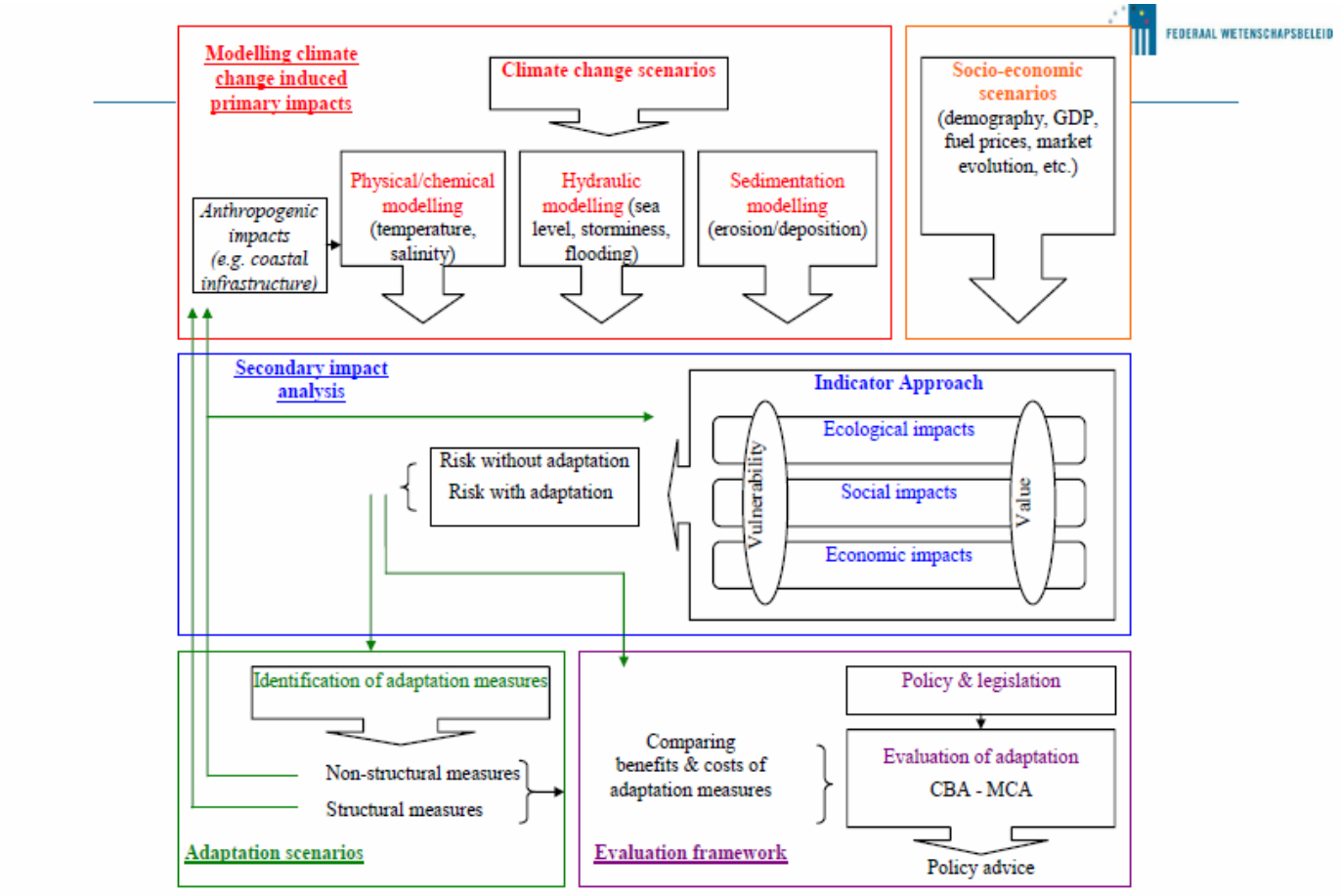


Figure 14 Framework of adaptation strategies, as result of Climar.

The following paragraphs are summarized from (Volckaert A., De Sutter R., 2008).

In general there are four broad categories of climate change impacts on coastal and marine sectors, their competitiveness and sustainability:

1. **Direct climate change impacts**: impacts that are a direct result of the primary effects or with other words the wide-range of climate-induced environmental changes (~ mainly secondary ecological effects) such as attractive climatic conditions, water availability and quality, biodiversity loss, geographical shift, coastal erosion, damage to infrastructures.
2. **Indirect climate change impacts**: impacts arising from these direct climate changes (mainly ecological effects) or from other secondary effects (mainly economical and social) such as loss of income or jobs, new economical businesses.

   As becomes clear, the direct and indirect effects can also be divided into ecological, economical and social secondary effects. The chosen division between economic,

ecological and social effects is, as any division, a human attempt to classify a complex system. These categories are highly interconnected and thus mutually influencing.

3. **Impacts of mitigation policies**: national or international mitigation policies (policies to reduce GHG emissions) may have an impact on a sector - e.g. stronger regulations can lead to increased transport costs and may foster environmental attitudes that lead tourists to change their travel pattern. This type of impacts is not considered within CLIMAR as they are the result of mitigation measures, while within CLIMAR the focus is on adaptation.
4. **Indirect societal change impacts**: Climate change is thought to pose a risk to future economic growth and to the political stability of some nations. Any such reduction of global GDP due to climate change would reduce the discretionary wealth available to consumers and have negative implications for anticipated future growth in certain sectors. These impacts will to a certain degree be taken into account by developing socio-economic scenarios.

In CLIMAR an overview is given of the different secondary climate effects, i.e. the economic, ecological and social impacts of climate change (both the direct and indirect climate change impacts) in a sectoral approach. The sectoral approach allows a more specific completion of the secondary effects, while the common terminology allows a comparison of the ecological, economical and social effects over the different sectors. In the two subchapters below a short description on both the primary and secondary effects will be given.

7.1 Primary effects

In the first phase of the CLIMAR research mentioned in the previous chapter, the primary impacts of climate changes were assessed.

A literature study on the influence of climate changes on physical parameters showed that the influences are clear, but that still large uncertainties exist in the results of the climate models on the exact local effects. Regional differences can be important. Therefore, it is still difficult to formulate reliable prediction for the climate effects on the Belgian Part of the North Sea (BPNS). A literature study on the influence on the chemical and biological parameters emphasized the complex effects of the climate changes on the ecosystem.

To assess the primary effects on the BPNS, first of all a number of time series of measurements were analysed. Linear regression of the sea level rise at Oostende from 1927 to 2006 showed a sea level rise of 1.69 mm/year, a value higher than the values reported until now. Other regression models show a possible increase in the sea level rise during the last decade(s). Since 1992 a sea level rise of 4.41 mm/year was found.

Measurements from the significant wave height from 1978 to 2007 and of the wind speed from 1980 to 2008 were analysed, together with the meteorological wind fields from the Norwegian Meteorological Institute. No clear trend was found in the data. The wind speed at the BPNS shows a small decrease, especially since 1990-1995. This is also found in recent literature, pointing to a decrease in storminess in the southern North Sea. Analysis of measurements of seawater temperature show an increase in sea water temperature varying between 0.023 °C/year in the northern North Sea to 0.053 °C/year in the southern and the central North Sea.

To account for uncertainties in the predictions of the climate changes, climate change scenarios are used. Based on a literature study, on the data analysis and on the climate change scenarios set up in the neighbouring countries, different scenarios were developed for the Belgian situation. These scenarios vary from a moderate scenario, with an expected sea level rise of 60 cm by 2100, to a worst-case scenario (WCS) with an expected sea level rise by 2100 of 2 m, and an increase in wind speed of 8 %.

7.2 Secondary impacts

Furthermore, the secondary impacts of the climate changes were assessed, both for the ecological system of the BPNS, and for the socio-economic activities. Three case studies focused on the coastal defence, on the fisheries and on the coastal tourism sector.

An inventory of the different effect categories was established. These effect categories are common for all different sectors, while the effects themselves are specific. The ecological effect categories consist of, amongst others, water quality, changes of habitat and biodiversity. Economic effect categories are the change in production and economic damages. Safety, employment and health are examples of social effect categories.

Quantifying the secondary impacts

For the quantification of the secondary impacts an indicator approach has been chosen. An indicator is a variable or measure describing a “key-element” (here the main ecological/ social/ economical effects) of the system. The indicator takes into account both the element at risk (e.g., number of tourists) and their vulnerability (e.g., mobility, protection status by existing adaptation measures, etc.). Indicators have been worked out for the most significant climate risks (high priority score).

Based on the climate change scenarios and taking into account the socio-economic scenarios, the impacts were quantified according to the methodology presented.

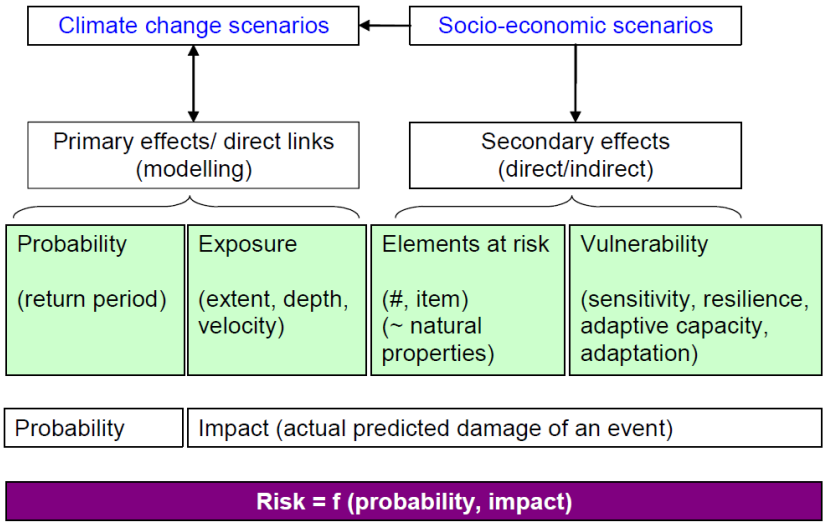


Figure 15 Quantification of climate impacts

8 Primary effects of climate change on the physical parameters

8.1.1 Temperature

The three climate change scenarios all indicate that at the end of the 21st century Flanders will have an increase in temperatures throughout the year. The actual increase in temperature remains uncertain.

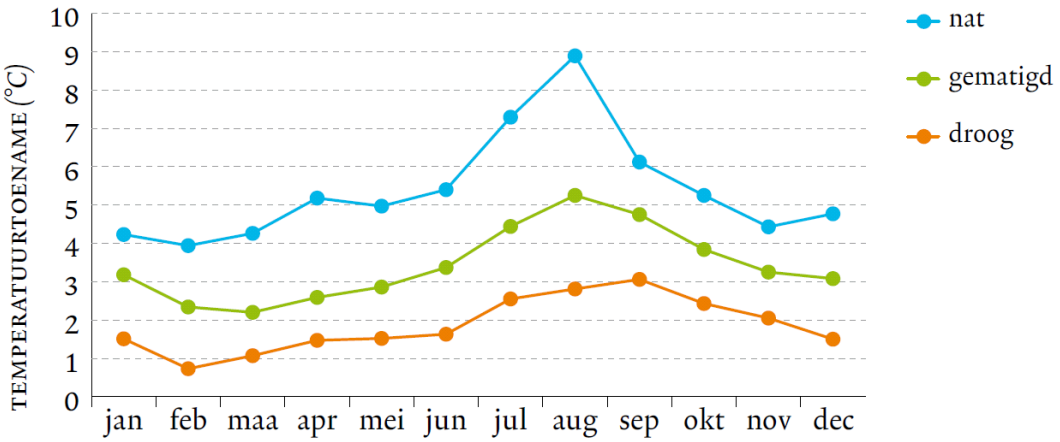


Figure 16: Possible increase of mean temperatures according to the three climate scenarios (Ukkel, targeted period: 2071-2100 compared to the period of 1961-1990) Source: Milieuverkenning 2030 (MIRA-VMM)

Not only will the average monthly temperature increase, but also the temperatures on the warmest and coldest days of the year. The expected increase in day temperature for the 10% of coldest days will be between 1.5 and 6°C during winter (the seasons where the increase is most visible will be autumn and winter). For the 10% of warmest days

this increase will be between 3.2 and 9.5°C. This means that at the end of the 21st century there will be more warm days than during the summers during the reference period of 1961-1990.

8.1.2 Evaporation, precipitation and drought

Due to an increase in temperature there will we more evaporation, both in winter and summer. For instance in February, depending on the used climate scenario the amount of evaporation can vary between -3% tot 37%. In August this could increase to 73%. The scenarios for spring indicate both a decrease and increase is possible.

Precipitation will also increase in winter. For the summer periods the situation is more complex:

- The total amount of precipitation is likely to decrease
- The number of rain showers will decrease
- The intensive summer thunderstorms could occur more frequently and more extreme.

The figure provides an overview of the changes in average monthly precipitation. The global climate scenarios displays more diverse pattern of changed precipitation in the area around Belgium. For Belgium this could result in an evolution towards dryer summers – but some more global models result in an increase in precipitation in summer.

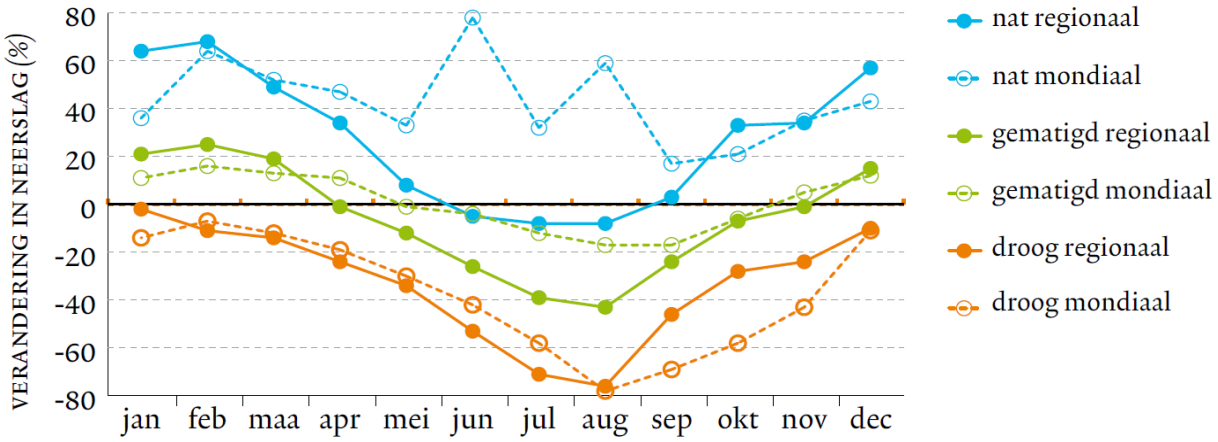


Figure 17 Changes of the mean monthly precipitation according to the three climate scenarios. (Ukkel, targeted period: 2071-2100 compared to the period of 1961-1990) 'Regionaal' concerns the results of regional climate models. "Mondiaal" are the global climate models.

Periods with extreme levels of precipitation will know even greater changes than the average mean levels of precipitation. Extreme daily precipitation will increase every 10 years with a few percent.

Possible changes in precipitation display small regional difference within Belgium as is displayed in

Figure 18 Regional differences in seasonal averages according to the three climate scenario's (Belgium,targeted period: 2071-2100 compared to the period of 1961-1990). Source: Milieuverkenning 2030 (MIRA-VMM)
Figure . The expected changes in the coastal zone are 10% higher than for the inland territory. For the summer period this means that the decrease in precipitation will be less for the coastal zone (the future climate will be more like the current climate). In the winter period additional increases in precipitation with 10% will result in an increase in humidity of the coastal zone.

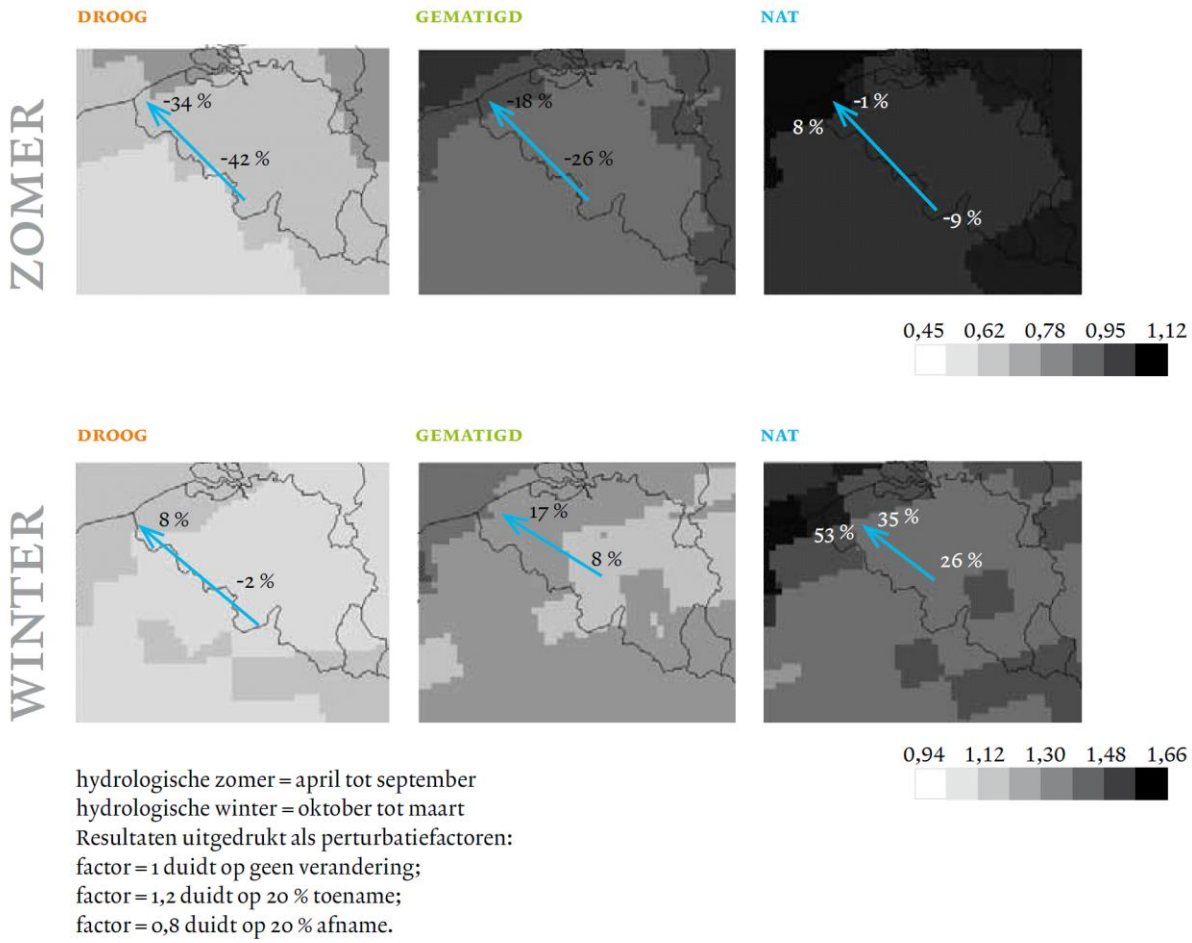


Figure 18 Regional differences in seasonal averages according to the three climate scenario's (Belgium,targeted period: 2071-2100 compared to the period of 1961-1990). Source: Milieuverkenning 2030 (MIRA-VMM)

For each climate scenario for Flanders the chances on dryer periods increase and they will become more extreme. The evolution towards dryer and warmers summers will, combined with the changes in the intensity of precipitation, have a negative influence on the quality and availability of ground- and surface waters. Climate change influences not

only the supply but also the demand for water: in extreme periods of drought peak usage will increase.

8.1.3 Wind

The results for the changes in precipitation have already shown that climate change influence the occurrence of thunderstorms. Thunderstorms are not only influenced by precipitation alone but also by wind speed. Calculations show (for all three scenarios) and increase in average wind speed during the winter months. The expected increase in wind speed will be about 10 to 20% higher than during the end of the 21st century. Results for the summer months are not conclusive.

8.1.4 Sea level rise

Prognoses for sea level rise have been presented by the IPCC and for more information we refer to the previous BLAST WP6 report: state of the art: Future sea levels, a comparative study for the North Sea region. Extrapolating historical trends result in a further increase of SLR of about 20 to 200 centimetres for the period between 1990 and 2100. The temperature of the sea itself will also increase. An expected change in wind climate could result in an altered frequency and height of the wind waves at the North Sea during the 21st century. This could increase high water levels along the Belgian coast and at the river Scheldt.

9 Secondary impacts for the Flemish water ways and the coastal zone

There are many indirect effects of climate change, and many sectors can be effected by climate change that can influence each other. In short for the sector “water” the following categories can be distinguished:

- Impact on the quantity of the water system;
  - Climate change influences the hydrological cycle and will lead to:
    - Greater variances in discharge, water levels, verblijftijden in rivers and ground water levels.
    - Changes in the intensity and frequency of floods
    - Changes in the intensity and frequency of drought and water scarcity.
  - Calculating the wet, the moderate and the dry climate scenarios allows to study the effects on high- and low water discharges on Flemish rivers.
- Impact on the quality of the water system;
  - Climate change can influence the physical-chemical and biological quality of the water in a negative way. It can also influence the hydrological network on land, the physical-chemical impact on the coastal zone or vice versa (for instance salinization).
- Impact on sediment and morphology;
- Impact on hydro morphology and water related biodiversity.
  - Changes in bio diversity due to the climatological change are already visible and will get even more visible in the future. The aquatic and water dependant terrestrial

ecosystems and bio diversity should be maintained and enforced during climate change. The “services” that ecosystems provide are part of the essential basics for our well-being. This varies from usable water to the pollination of vegetables and fruit and climate control.

- Impact on flood risks;
  - The increase of wave loads on the tidal stroke cause a strong erosion of beach and dune areas, and of the frequency of breaches of dikes and/or dunes. It has been calculated that when SLR will reach 50 cm the risk of flooding will increase by a factor 10 (more details in detailed report below).
- Socio-economical impact:
  - The effects of climate change on high water and low water discharges in the Flemish waterways were translated into possible economic damages due to flooding. Damages were calculated based on land-use, local social-economical context (housing prices of the municipality, production of agricultural land, price of agricultural products, prices of vehicles, …).
- Impact on swimming water
- Impact on (drinkable) water provision
- Impact on sanitation infrastructure.

10 Adaptation Strategies

10.1 Assessment of adaptation measures

The CLIMAR project looked at several adaptation measures that could be taken at the Flemish coast. According to CLIMAR a multi-criteria analysis (pre-MCA) should be executed to select (first screening) the most efficient measures as basic input for the adaptation strategy (Volckaert A. and R. De Sutter, 2008).

The multi-criteria analysis has been based on a number of important characteristics of the adaptation measures. These evaluation criteria are the result of a literature study of existing analysis tools, expert knowledge and public participation (sector).

Following **evaluation criteria** have been taken into account:

- **Adaptation typology:** Adaptation measures exploiting the positive consequences of climate events should be higher scored than the measures resulting in loss or avoidance behaviour due to climate change.
- **Importance:** The importance of an option reflects the level of necessity to implement the option. Important options can reduce major risks and/or preserve essential function provided by our surroundings. In principle, important options generate substantial benefits, though potentially at high costs. Besides, their policy relevance is evaluated as medium to high.
- **Technical feasibility:** The technical feasibility relates to the technical difficulties and challenges which accompany the realization of the adaptation measure.
- **No-Regret measures:** Decision options that are assessed to be worthwhile now (in that they would yield immediate economic and environmental benefits which exceed

their cost), and continue to be worthwhile irrespective of the nature of future climate, are termed No-Regret options.

- **Ecosystem approach:** The interrelationship between the ecological and socio-economical consequences of climate change should clearly be defined. Preference should be given to adaptation measures acting on both the ecological and socio-economical aspects in a balanced way.
- **Multi-sectoral character of measures:** Adaptation measures developed to tackle specific impacts (ecological, social, and economical) of climate change on one sector can positively influence another sector. Searching for these synergies can have an added value with respect to adaptation strategies.
- **Urgency:** The urgency of the option relates to the need of implementing the adaptation option immediately or whether it is possible to defer action to a later point in time. Long-lasting investments and conservation of the existing situation require early planning, and therefore a long period of waiting before implementing the option will render the option redundant (*e.g.,* raising awareness), much more costly (*e.g.,* for large infrastructure projects) or impossible (*e.g.,* for conserving nature).
- **Institutional complexity:** As the institutional complexity of implementing an adaptation grows, there are more adjustments of the official, bureaucratic organizations, existing procedures and arrangements necessary, more cooperation between institutional separated domains and thus there is a bigger tension with existing practices and structures.

10.2 Formulation of adaptation strategies

Four different adaptation strategies ("scenarios") have been defined in CLIMAR:

1. Business-as-usual strategy (BAU): consisting of the most commonly used adaptation measures, so with the emphasis on bear loss, shear loss and technical measures;
2. Adaptive approach (ADAPT): gradual adaptation strategy starting with a common combination of adaptation measures on a short term, but giving the possibility to diversify to a certain direction as more information about *e.g.*, climate impacts or socio-economic scenarios become available;
3. Adaptive approach+ (ADAPT+): essentially the same as ADAPT, but the intensity of the measures is larger;
4. Reactive approach (REACT): fixed adaptation strategy for mid and long term, with the risk on a 180° switch if new information becomes available.

10.3 Costs and benefits of adaptation strategies

The following paragraphs are summarized from (Volckaert A., De Sutter R., 2008).

A climate adaptation strategy represents a combination of measures and options chosen to meet a particular risk (European Environment Agency, 2004). The strategy should increase the robustness of long term (infrastructure) investments, enhance the adaptability of vulnerable natural systems, improve societal awareness and preparedness, increase the flexibility of vulnerable marine activities (*e.g.*, ease of change of activities or locations). The success of the full strategy depends on numerous factors such as the

effectiveness of the measures, the acceptance of the introduction, the potential for benefits that outweigh the costs, the consistency of the measures with other sectoral initiatives, etc.

In order to stimulate the abovementioned preconditions for the sectoral adaptation strategies, an evaluation framework has been developed within CLIMAR that can assess the value of the scenarios for each specific marine sector. The evaluation tool is based on the principles of sustainable development and scores economical, ecological and social merits and damages of the adaptation strategy. Hence the adaptation strategies have to undergo a sustainability test.

Integrated assessment should combine, interpret and communicate knowledge from different disciplines. Generally, current assessment techniques only fulfil part of this need. Furthermore when considering climate change impact and reduction, less attention has gone to assessing adaptive strategies while focusing on prevention strategies. Among others, consideration has gone to:

- multi-criteria analysis (MCA) - using indicators of impact and indicators for efficiency of measures;
- (social) cost-benefit analysis (CBA) - valuing all costs and benefits over time on the base of “willingness to pay”;
- cost-effectiveness analysis (CEA) - taken a predetermined objective and seeking a way to accomplish it “as inexpensively as possible”.

The evaluation tool exists of a combined MCA and CBA analysis tool (including the benefits of both approaches) and integrates different aspects: climate change scenarios, socio-economic scenarios, impact analysis and quantification, adaptation strategies. Furthermore, it includes a sensitivity test (Monte Carlo permutation) on both the calculated values and the importance (weight) of the different criteria.

The methodological framework for the tool has been developed consisting of following steps:

- Selection of the different adaptation strategies to be compared. This demands a choice of the accompanying climate change scenario, socio-economic scenarios and time horizon.
- Quantification of the ecological and socio-economical effects based on the indicator approach.
- Calculation of the avoided risk for the selected adaptation measures of one adaptation strategy combined with specific information about the costs of these adaptation measures. This serves as an input for the criteria of the MCA/CBA analysis. The criteria can both be expressed on a monetary as well as semi-quantitative scale.
- Ranking of the different adaptation strategies/ scenarios based on the calculated avoided risk, the costs and the importance (weight) of the different criteria of the model.

- Performing a sensitivity analysis to evaluate the weights of the criteria.
- Performing an uncertainty analysis to evaluate the uncertainty on the calculated impact values.

11 General policy principles in relation to adaptation

11.1 Belgian way of working

- In the 2nd Flemish Climate Plan the need for an adaptation plan was acknowledged.
- The overall picture has been described in the Flemish coalition agreement and in the policy document of Living Environment and Nature 2009 – 2014 (Beleidsnota Leefmilieu en Natuur 2009 – 2012).
- The National Adaptation Strategy (published by NKC) described the most important principles of the adaptation strategy, and has provide the kick-off for the national adaptation plan. The Flemisch Adaptation Plan will provide input for the National Adaptation Plan, together with similar plans of the Walloon district, the Brussels district and the federal government.
- This (national) adaptation plan answers the demand of the European Union to provide an adaptation plan by the end of 2012.

A new policy framework for Flanders (Flemish Plan for Adaptation (Dutch: Vlaams Adaptatieplan) is currently (dd2012) being developed. This new policy framework will most probably take into account features like resilience, climate change, adaptation, mitigation, …. Furthermore the approach needs to be integrated, for instance taking into account climate change and population needs in spatial planning. Spatial planning should also be able to deal with uncertainties, focussed on the long term and the general policy itself should be well supported by both practitioners as society as a whole.

The Flemish Plan for Adaptation will be the regional plan, alongside the, already existing Belgian National Climate Change Adaptation Strategy.

Identify the different actors and inform, educate and sensitize them on the issue of adaptation is a crucial element when initiating the work on a future National Adaptation Plan. In parallel with the identified needs and priorities, the differences and gaps in terms of people that need to be informed and/or sensitized will have to be identified. In developing these communication methods, it is important to consider whether the communication is most effective stand-alone or that a broader spectrum should be sought out, either by working together regionally, or to coincide with the communication concerning mitigation. Given the locally embedded nature of adaptation, it is crucial to ensure a moment in the process of writing the NAP to allow stakeholders express their opinion on the on-going work, and to use this valuable input in the further development of the NAP. An overview of the different information campaigns that will be started (or have already been conducted) on the issue of adaptation in its diverse sub-themes could prove useful in this regard.

As mentioned before, adaptation to climate change is an issue that cuts through different sectors. Although this variety of sectors needs a diversified approach, it is then crucial to develop climate proof and general coordinated policies and laws applied in the different subthemes. The need for this is found in order to create a win-win situation or at least, to avoid a duplication of efforts and a wasteful use of money. Although maybe not carried out in the short term, it is necessary to identify opportunities for mainstreaming adaptation in policy and legislation before or during the development of the NAP.

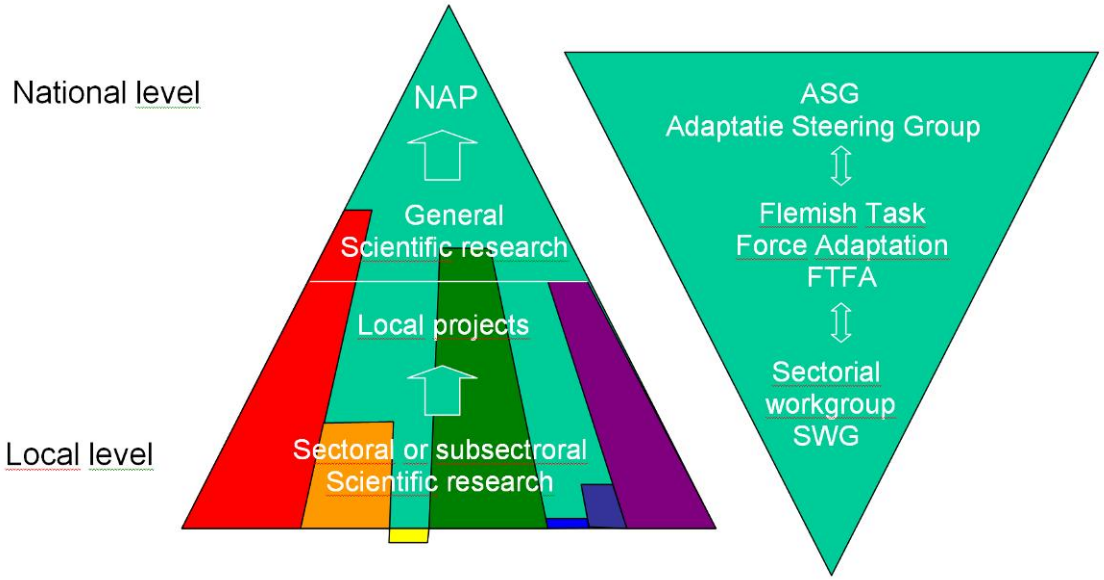


Figure 19 Creating the National Adaptation Plan

For future planning across all sectors of society reliable, comprehensive information is necessary. Sound and regularly updated research findings are necessary to develop adaptation measures. Such information should be able to answer questions such as: What changes are likely to affect specific regions? What threats exist, and what is the probability that these risks will occur? This means that information and data must be prepared in a comprehensible form, and made readily available and accessible on a targeted basis. It should also be clear what countermeasures are possible and who is responsible in each case. For example, on the costs of adaptation to climate change in Belgium, there is a clear lack of research in this area, yet policymakers are highly aware of this need. Therefore, the importance of improving the scientific knowledge base through research activities is clear, and is also recognized in the EC White Paper. So, in preparation of the NAP, the institutions and actors who can conduct such research should be identified. It is possible that, based on the knowledge base in Belgium, it is decided to focus the Belgian research on certain specific areas of expertise and for other aspects rely more on the work done in the OECD or within the United nations.

It is important to include climate change adaptation as a theme in the policy dialogue with our partners. In its efforts to improve mainstreaming of climate change adaptation in the cooperation with partner countries, Belgium therefore respects the principles of the Paris Declaration (ownership, alignment, mutual accountability, results based management and harmonization). The needs and adaptive strategies of our partner countries as well as corresponding opportunities for the Belgian development cooperation should be identified.

Furthermore, Belgian efforts to tackle climate change, including a National Adaptation Plan, should respect the concept of "Policy Coherence for Development", namely making sure that measures taken in Belgium to adapt to climate change don't have a negative impact on developing countries.

11.1.1 Underlying assumptions and important principles

- Adaptation has to be cost effective. A just and timely implementation of adaptation measures will cost less than being unprepared or having to take extreme measures at a later stage.
- In many cases climate change is an extra pressure on a system, which will already under pressure. Adaptation measures would be a continuation, adjustment and/or intensification of already existing actions.
- Development of the adaption policies will have to be done across policy domains and in close cooperation with one another.
  - Maladaptation, where one set of measures burdens another policy area with the negative effects of climate change, should be avoided.
  - Adaptation can lead to win-win situation, where a measure can not only have a positive effect in dealing with climate change, but has other positive advantages as well (e.g. in the domain of ecology, economy,).
- Adaptation measures should be robust, which means that these have to retain their value independent of the variation in climate change.
- Almost all adaption measures should be tailor-made:
  - Measures should be implemented on a suitable point in time. This does not have to be equal to "as soon as possible".
- Climate adaption develops means and policy instruments that could be interesting knowledge to export to other countries.

11.2 General policy principles within the Flemish water sector

The general policy principles within the water sector can be summarized as follow:

11.2.1 Anticipate instead of trying to fix it afterwards

- To structural implement adaption to climate change in governmental policies, water management, and in the way water companies operate.

- To optimise and expand essential systems for reliable forecasts and warnings regarding floods and periods of drought – including providing active and targeted information.
- Climate change could be a motive for technological progress, changing production and consumption patterns, creating new economical activities, a growth of sustainable industries, developing new knowledge and long-term thinking.
- During and after crisis situations of floods or drought one should act thoroughly. In order to do so the water managers and the responsible people in contingency planning and crisis committees should work closely together.

11.2.2 Shared responsibility

- It is important that all policy domains, policy levels, different entities are involved and work together. Area targeted approaches in ”spearhead areas” in catchment water management plans will create experience and insights into further future approaches.
- This approach implies that all stakeholders have enough capacity, knowledge and know-how. Clustering and communicating all available knowledge and information in Flanders is necessary.
- The government can not solve everything or guarantee everything. Individual citizens and companies are being confronted with an overload of choices concerning risk prioritisation and possible protections measures, just like governments. The question is how individuals and companies can be supported and how their resilience can be improved. Known instruments such as infrastructure, enforcing a set of rules and charges remain necessary but should be expanded with other instruments such as information and advise, sensibilization, pre-financing, altered insurance, etc.
- Increase awareness of the risks of water shortages and drought and risk perception on acts that are increasing the risks of floods (such as solid surfaces) through communication and education. This is needed not only for the realisation of adaptation measures and permits or evacuation and contingency planning, it also needed to create a support base among the public.

11.2.3 Safety and sustainability as main pillars

- Preventing and controlling the costs and threats for society due to increased chances on serious water shortages, increased number of extreme thunderstorms in summer, risk on economical damage due to flood, health problems due to heath, …
- A policy aiming at sustainability encompassed that the goals is to use water, energy and other fossil fuels as efficient as possible, in a way that quality of life is maintained or even improved, where people can meet there own needs without endangering generations to come.

11.2.4 Enhancing resilience of aquatic- and water dependant terrestrial ecosystems

- To maintain aquatic and water dependant terrestrial ecosystems and biodiversity in times of climate change. Services that ecosystems provide form the basis of our well

being. This ranges from usable water to pollination of fruits and vegetables to climate control.

11.2.5 Choosing sustainable solutions

- Solutions (in particular infrastructural solutions) should be robust. In other words; the need to be able to function in a divers range of situation, offer stable answers and cost controllable. In some cases this could result in low-technological, easy maintenance, energy efficient and simple systems that are aimed at prevention and protection, aiming at more spatial solutions instead of technical solutions. Furthermore sustainable and robust (high) technological solutions will aid climate adaptation.
- Emphasis lies in developing “no regret measures”, this implies finding measures that we will not regret, where effectiveness is independent of climate change, and that result in benefits regardless of the scenario. Taking into account flexibility of the measures or expandability towards the future, within the frame of higher climate impact and socio-economic foundations are equally necessary.
- The most optimal solutions are often tailor made and encompass a mix of instruments form several disciplines or sectors.
- Adaptation can lead to win-win scenarios, where a measure can have both a positive effect in countering the effects of climate change but also have advantages in for instance the areas of mitigation, ecology, economy, socially.

11.2.6 Developing and sharing knowledge and experiences

- The existing uncertainty about the timing and extent of climate change, the possible consequences, the solutions and opportunities, remains. The uncertainty will not disappear instantly. One of the goals of the policy is to posses as much knowledge and know-how as possible to deal with the level of uncertainty. In other words: not only research, pilot cases and procedures should be part of the policy, but also regular policy evaluations, alterations, learning-by-doing and so on. In figurative speech: adaptation policy will adapt itself in the hands of time.

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13 Conclusion: Integrated spatial management and stakeholder involvement is important

The several scenarios that have been discussed in this report show the possible climate changes that can occur toward the end of the 21st century. In time, as science progresses, the insight into the possible changes will improve.

It has become apparent that we will be confronted with increased temperatures in all seasons and precipitation during the winter. Summers may be dryer on average, but rain showers will likely be more intense. Sea level rise will continue at an increased rate.

Although there remains a level of uncertainty, countries need to adapt to climate change. Adaptation measures should be efficient and effective, and also flexible enough to permit alterations if needed. Adaptation to climate change will not be enough on its own; mitigation measures should be taken as well.

Integrated spatial planning has an important role to play in adaptation to climate changes by enabling better land management, improving landscape coherence and helping to restore ecosystem functions. An integrated approach to spatial planning can increase landscape permeability and help establish multifunctional zones for flood prevention, safeguarding Europe's biodiversity and its associated ecosystems goods and services and protect the citizens in the coastal areas.

In order to achieve these goals, it is necessary to bring together different policy sectors in an integrated and co-operative way, so that land-use priorities can be determined in a sustainable and intelligent manner at a strategic level, over a large enough geographical area (e.g. at municipal, regional or catchment level). Moreover, climate change makes it necessary to move towards ICZM. This concept has been widely advocated as the paradigm that spatial planners and natural resource managers should adopt. This is based on the recognition that coastal systems are complex and are 'adaptive or 'self organizing', and that management systems must be able to readjust within the system. In practical terms, this means considering the impact on cities and ecosystems of extreme precipitation or flooding at all stages of the planning process, rather than making planning decisions that are subsequently subject to ecological and 'climate proofing' impact assessments. Authorities and stakeholders at the local level should be engaged at the earliest possible stage in the planning process, particularly as they have a crucial role to play in its implementation of the plans. For the sake of coherence, these local spatial planning strategies then need to be supported by an overall policy framework that sets clear objectives, targets and timetables.

IPPC indicates that ICZM is a good instrument. It is therefore important to look at the local level and not just let decisions be based on EU standards

14 Appendix

Table III: Considered effect categories of CLIMAR

Effect categories	*Effect (definition + example)*
Ecological effect categories (mainly direct effects)	
Water quality	Related to physico-chemical aspects such as oil pollution, turbidity, salinity
Habitat quality	Leading to degradation (or improvement) of coastal/marine habitat (*e.g.*, litter on beach)
Habitat change	Change/loss of natural habitat such as loss of fishery grounds, nature areas or change due to offshore structures
Ecosystem productivity	Change in the timing, abundance or composition of primary producers
Geographical shift	Moving/replacement of species (composition) due to climate change (temperature increase, etc.)
Establishment of non-indigenous species	Introduction and survival of species not naturally occurring in WesternEurope
Ecosystem component interactions	Decoupling of phenological relationships with impact on recruitment, food availability, etc.
Biodiversity	Change in biodiversity as a result of one or more of the described effect categories
Other biological events	Other biological effects such as harmful blooms
Economical effect categories (mainly indirect effects)	
Change in production	Decrease in production due to destruction of certain facilities, damage to boats, difficulties/restrictions for executing job (# sea days), ecological consequences, etc. Increase in production due to better ecological consequences, etc.
Production value	Expressed in terms of the "price of the product" and determined by the availability of the product and the changes in cost (~ exploitation, damage)
Exploitation costs	The costs needed to exploit a unit (quantity) of the considered product (~ activity, transport)
Damage costs	Damage as a function of maintenance and insurance costs *e.g.*, damage to private or public properties (buildings, equipment, stocks, machinery), damage to transport infrastructure, damage to service networks (gas, water, electricity, telecommunication, coastal infrastructure)
New opportunities	Such as new activities or new "climate proof" technological initiatives

Effect categories	*Effect (definition + example)*
Economic result	Expressed as profit (positive) or loss (negative) and calculated by decreasing the total turnover (= revenues) with the total costs (wages, rent, fuel, raw materials, interest on loans and depreciation)
Social effect categories (mainly indirect effects)	
Attractiveness coastal and marine area	Overall term used to describe the degree in which the society attaches importance to the coast (recreational value, leisure opportunities)
Employment	Direct loss/ increase of jobs
Human settlement	Availability and occupation of coastal housing units
Safety	Risk of accidents, *e.g.,* flooding of houses (human settlement), flooding of business property, accidents at sea (transport), accidents during work activity (exploitation)
Accessibility	Accessibility of the coast expressed in time needed to reach the coast and the status of the transport infrastructure (public and road) Accessibility of the marine ports expressed in time needed to enter the port
Health	Health effects considered are mortality in function of extreme temperatures (heat, cold); stress related problems; diseases due to bad water and seafood quality
Cultural value	Coastal cultural heritage and values
Welfare (individual and family life)	Indirect effects as a result of social changes (changes in employment, human settlement, safety, health, etc.). It deals with the aspect of "life quality" (~purchasing power; ~family relationships).

Table II: Ranking of adaptation measures: Score-table

Score	0	1	3	5
Adaptation typology	*Share loss* *Bear loss*	*Avoid changes*	*Prevent (technical, regulatory)*	*Exploit opportunities*
Importance ***(~effect reduction)***	Very low level of importance (failure risk reduction irrespective cost)	Low level of importance (moderate effect reduction; low to medium policy support)	Medium to high level of importance (cope with effect; medium to high policy support)	Very high level of importance (take advantage (extra benefits (> 100 % effect reduction); potentially at high costs; medium to high policy support)
Technical feasibility	Technically very complex (100% fixed; no experience; very high risk)	Technically complex (100% fixed; few experience; large scale and/or "all or nothing" (f.ex. Managed retreat); high risk)	Technically moderate complex (> 50% fixed; medium to large experience; small scale and/or gradual implementation f.ex. Climate proof standards (house by house); medium to high risk)	Technically hardly complex (> 50% flexible few/ large experience; adaptive (f.ex. Beach nourishment); low risk)
No-Regret measures	Affect directly the livability of a sector; Very low net-benefits	Low net-benefits	Medium to high net benefits	Very high net benefits
Ecosystem approach	No interrelationship	Both ecological & socio-economical, emphasis on ecological aspect	Both ecological & socio-economical, emphasis on socio-economical aspect	Both ecological & socio-economical in balanced way
Multi-sectoral character of measures	Significantly negatively influencing on other sector(s)	Possibly slightly negatively influencing on other sector(s)	Neutral or no influence on other sector(s)	Overall positively influencing other sector(s)
Urgency	Very high level of urgency	Medium to high level of urgency	Low level of urgency	Very low level of urgency

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