Environmental Assessment for Climate Smart Decision Making

Good practice cases

International Association for Impact Assessment

Netherlands Commission for Environmental Assessment

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Netherlands Commission for
Environmental Assessment

The Netherlands Commission for Environmental Assessment (NCEA) is an independent advisory body of experts which advises the government in the Netherlands and governments abroad on the quality of environmental assessment and makes its extensive knowledge of environmental assessment available to all.

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Towards Climate Smart Decision Making

Good practice environmental assessment for projects and plans

introduction

Climate change affects various human and natural systems and poses a serious challenge to economic development and ecosystem sustainability. Adverse effects should - alongside potential benefits - therefore be explicitly considered in decision-making about proposed policies, plans, programs and projects. Addressing risks and opportunities is essential for taking decisions that will remain robust under future conditions, when many climate change impacts are expected to become more significant. Impact Assessment (IA), including environmental (and social) impact assessment (EIA/ESIA) and strategic environmental assessment (SEA), plays an important role here. It can ensure that the design of policies, plans, programs and projects properly addresses both needed mitigation of climate change to minimise greenhouse gas emissions, and adaptation to the effects of climate change on the proposal. This helps in reducing vulnerability to a changing climate and thus increase the resilience of natural and human systems. The role of IA is recognised by the UNFCCC[1] and we think that IA can further play a significant role in achieving national, regional or sectoral climate change objectives.

The Netherlands Commission for Environmental Assessment (NCEA) has taken the initiative to gather case examples where IA has contributed to climate smart development. This means that IA has influenced a project or plan in such a way that it is contributing to:

- Climate change mitigation: preventing further climate change, for example through reducing greenhouse gas emissions, and/or;
- Climate change adaptation: responding to expected climate change, and/or;
- Adaptive management or capacity: reducing uncertainty over time, for example through system monitoring and adaptation plans.

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[1] Article 4.1 f of the convention: https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

Members of the International Association for Impact Assessment have been asked for good practice cases. This resulted in the selection of the twelve cases that are described in this report. We hope that this publication inspires others to also share their good practice cases, so we can learn from each other and utilize the potential of IA in contributing to the Paris Agenda of the UNFCCC.

The below summary table provides an overview of the characteristics of these twelve cases. It shows that cases are derived from a variety of countries and sectors, and include E(S)IA for projects as well as SEA for plans.
A brief analysis of these cases shows that in most of those cases the following three step approach was applied:

- Step 1: Vulnerability assessment of the project and plan area to climate change effects in the short and long term, including social and economic aspects;
- Step 2: Assessment of the compliance of the proposed project or plan with available climate change policies. This ensures consistency with already available data, norms and standards. In absence of relevant policies use was made of expert judgment.
- Step 3: Development of a continuum of alternatives that are climate smart to a greater or lesser degree, including no-regret measures.

The introduction is partly copied from: Fastip No.3, February 2013: Climate Smart Decisions. Prepared by: Sabine McCallum with significant input from Phil Byer, Peter Croal, Wes Fisher, Arend Kolhoff and other members of the Climate change section.

contents

case 1

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SEA for a land use plan in Denmark

Renewable energy in the land use plan for Skive municipality

Type of impact assessment	Mandatory Strategic Environmental Assessment (SEA)
Type of project/plan	Land use plan (spatial planning)
Climate change related issues	Greenhouse gas emissions and risk of flooding
Influence of the SEA	Clear mitigation measures and choice of a more climate smart alternative

In the Skive municipality, an SEA including a Life Cycle Assessment was done for proposed renewable energy activities. The comparison of six alternatives led to selection of a 'climate smart' alternative with more production of wind energy than initially planned. The SEA also led to measures against flooding.

Climate change in Skive

Part of the land use plan for Skive municipality is 'GreenLab Skive', a renewable energy project. The purpose of GreenLab is to integrate multiple renewable energy technologies in order to reduce greenhouse gas emissions from the energy sector. Renewable energy sources, electrolysis, and biogas production will be combined in one system. The symbiosis consists of 1) sources of energy supply (electricity and heat): photovoltaic plant, wind turbines, heat pumps, combined heat and power engines; 2) facilities for biogas production & upgrading to methane, and electrolysis facilities; 3) 'grids' for natural gas, electricity and heat that connect the facilities.

Mitigating climate change is the driving force behind the symbiosis planning. Various factors determine how much mitigation is achievable. A key factor is the significant energy use for electrolysis, which needs to be fully based on renewables. Another is the impact of the biogas, which depends on the input.

As part of the mandatory SEA, the municipality had a non-mandatory screening Life Cycle Assessment undertaken to determine the carbon footprint of the system. Hotspots in its life cycle – and thus areas for improvement – were identified. Besides the focus on climate mitigation, the SEA also included an assessment of impacts related to the risk of flooding in the area, and means for mitigation across the different technologies and projects.

Assessing climate change risks for GreenLab

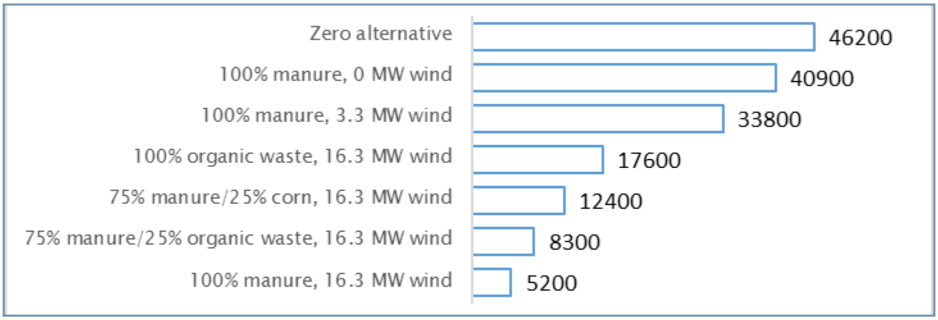
The screening LCA is an initial and basic understanding of the impact category 'Global Warming Potential' (GWP), i.e. a carbon footprint, and builds upon the IPCC 2013 GWP 100a method (IPCC, 2013). The functional unit in the LCA is: "Supply of the amount of electricity, heat, hydrogen, methane and oxygen that GreenLab delivers in a year".

The SEA compares six GreenLab alternatives and a 'zero alternative'.

Climate smart mitigation and adaptation in the SEA

For climate mitigation, the key points from the carbon footprint were (see results in the figure):

- Using manure for biogas production is better than using organic waste or maize.
- The system has a net impact in the first two scenarios because more energy is used than produced. This is taken from the grid, which includes some fossil fuel based electricity productions.



Climate effects for GreenLab alternatives, measured in CO_2-eq/year

- Not installing wind turbines gives impacts comparable to the 'zero alternative'. Wind turbines give the largest environmental benefit.

Regarding climate change impacts in the area, the SEA mapped and analysed the risk of flooding due to cloudburst and increasing ground water level. The SEA recommended adaptation measures of a) locating activities outside the most flood-prone areas – and instead developing nature in these areas, b) avoiding activities below ground level because of a high water table and c) ensuring local drainage of rainwater.

Conclusion: Climate smart design of GreenLab

A major contribution of the SEA is the integration of significant concerns *during* the planning process. The municipality was dedicated to securing the sustainability of the plan, which involved a continuous dialogue and search for solutions between different departments of the organisation, and with incorporation of public concerns and ideas. Another major contribution is the decision to make a non-mandatory master plan for the area. The aim of this is to secure integrity across individual projects – e.g. wind turbines and the biogas plant – before the mandatory local plans and ESIAs for each project are undertaken.

The SEA results also led to the following decisions: a) securing added wind energy, beyond what is needed according to the carbon footprint; b) clear mitigation measures regarding input to the biogas production – and concerning climate adaptation; c) adaptation measures for the whole area built into the master plan.

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Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- SEA increased commitment for plan ✓

Climate smart(er) because:

- Screening LCA proves to be a valid and efficient tool in planning for assessing the carbon footprint.
- Securing added wind energy to make a significant negative carbon footprint.
- Collective solution for rainwater handling and drainage.
- Flood-prone areas are assigned for nature development.

case 2

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ESIA for an infrastructure project in Belize

Belize Climate Resilient Infrastructure Project

Type of impact assessment	Environmental Impact Assessment
Type of project/plan	Belize Climate Resilient Infrastructure Project: Component 1: Climate Resilient Infrastructure
Climate change related issues	Frequent heat waves, droughts, high intensity rainfalls, rising sea levels
Influence of the ESIA	Mitigation measures for adverse environmental effects

The government of Belize has developed a project to make the country's main roads resilient to climate change impacts. An ESIA assessed the impacts of the project on the environment. For important impacts, such as noise, wildlife disturbance and pollution, mitigation measures were developed.

Climate change in Belize

Belize is a small, middle income country endowed with the largest barrier reef in the Americas and pristine tropical forests. Since its discovery of oil in 2005 and the emergence of tourism, the economy has undergone a significant transformation. Belize is highly vulnerable to natural disasters, increased by the effects of climate change. The UNFCCC has identified it as one of the most vulnerable countries to the adverse impacts of climate change. More than 50% of the population and business centres are on or near the long, low lying coastline, mostly at sea level. Frequent heat waves, droughts, high intensity rainfalls, and rising sea levels are just some of the effects that make Belize sensitive to climate change.

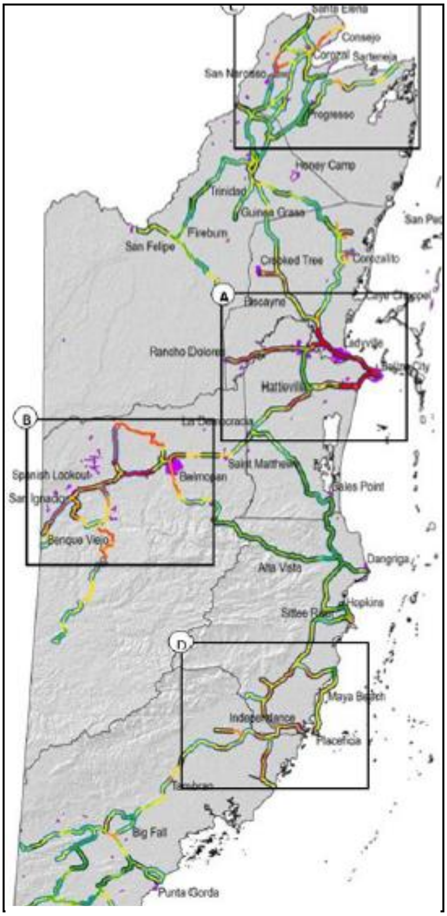
Assessing climate change risks for road infrastructure

The government of Belize developed a National Climate Resilient Investment Plan (NCRIP) to address the impacts of climate change on social and economic development. It seeks to fully integrate climate change adaptation, climate variability, and comprehensive disaster management into national development planning processes and actions. Under the NCRIP it has financed the Belize Climate Resilient Infrastructure Project (BCRIP). Critical roads will be made more resilient against flood risk and climate change impacts, and the country's capacity to respond to crises and emergencies will be improved. Specific measures are the (re)-construction of critical road segments, drainage systems, and stream crossings that are susceptible to natural hazards such as flooding, and other climate impacts.

The road networks prioritized under this initiative were selected due to economic importance, access of relief services to communities in the event of natural disaster events, and the benefits to poor populations and communities. They are situated in four geographical areas: A) The Greater Belize City area, B) West of Belmopan, C) Northern Area around Corozal, and D) Southern Area around Independence (see map).

Climate smart adaptation measures in the ESIA

The Environmental Management Framework (EMF) was prepared to meet World Bank safeguard policies. It provides a framework for development of ESIAs and Environmental Management Plans (EMPs). It includes a screening process for subprojects and a delineation of the ESIAs and EMPs appropriate to the types and scales of the impacts. The screening mechanism ensures that



The four project areas

no significant degradation or conversion of natural habitat will occur.

Only existing primary and secondary roadways are used in this project. Activities under the project include hydrological improvements such as small-scale creek alignment, straightening ox-bows, cut-and-fill, retaining walls along embankments, sizing of culverts for better water management along road networks, some replacement of culverts with small bridges; as well as road rehabilitation, road widening and shoulder improvement.

The ESIA for the project takes into consideration the mitigation measures for various construction impacts for the road rehabilitation activities. Some impacts such as noise, disturbance to wildlife, and pollution, have been accounted for and have appropriate mitigation measures. Overall, the outcome of the project will result in opportunities for environmental enhancement, improvements such as bridges, observation stations at bird congregation areas, reduction of wildlife mortality caused by vehicles, and speed bumps at wildlife crossing points.

Conclusion: Climate resilient infrastructure

The Belize Climate Resilience Infrastructure Project was approved in August 2014 with a closing date in 2019. The ESIA was conducted under the Environmental Management Framework for the four major roads in Belize. At the conclusion of this project, more than 170,000 Belizeans will benefit from the improved climate resilient roads and capacity to manage climate risks and impacts as a result of the World Bank's US$30 million approval. The project will provide the following benefits:

- Rehabilitate 30 km of roads and train 100 people on maintenance;
- Improve 12 bridges and culverts;
- Operationalise National Land Use Policy & develop 26 hazard maps;
- Train government staff in new flood tracking methods.

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Characteristics of climate smart(er) project:

- Three-step approach applied ✓
- Climate smart(er) project design ✓
- ESIA increased commitment for project ✓

Climate smart(er) because:

- Better road systems will minimize impacts of climate change and natural hazards.
- Climate resilience is incorporated in national strategies for infrastructure.

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SEA for a hydropower plan in Vietnam

Hydropower Plan for the Vu Gia-Thu Bon River Basin

Type of impact assessment	Mandatory Strategic Environmental Assessment (SEA)
Type of project/plan	Hydropower Development Plan (spatial rural and energy planning)
Climate change related issues	Increased rainfall intensity and variability; floods, larger sediment transport, sea level rise, increased evapotranspiration, lower dry season flows, salinity intrusion
Influence of the SEA	'Safe operations' identified to cope with climate change induced disasters; climate change parameters incorporated in design and management of infrastructure

The SEA for this hydropower plan showed that the pace and scale of the proposed activities were at an unsustainable level. Measures were taken to make the design and management of the infrastructure more climate smart.

Climate change in the Basin

During the past decade, energy demand in Vietnam has grown at a rate of 13-15% annually. Over the next decade, demand is expected to grow at a similar high pace and the share of hydropower is likely to increase from 60% to 80%.

The Vu Gia - Thu Bon River Basin in Quang Nam province is ranked fourth in Vietnam for potential hydropower generation. The hydropower potential of the Basin is estimated at 1,300 MW with an annual energy potential of 6 TWh.

Fisheries are of crucial importance in Quang Nam province, providing a major source of protein for residents and producing substantial export turnover. Potential impacts of hydropower on biodiversity could directly affect these fisheries.

UNFCCC forecasts heavy precipitation events to increase in frequency by mid-century in Vietnam. Intense tropical cyclone activity may also increase. The Basin already experiences extreme fluctuations in annual precipitation, which is expected to intensify with climate change. Upstream watershed erosion from degraded watersheds supplies increasing amounts of sediments to river systems, building up sediment deposits within the river channels. With continuing watershed degradation and climate change, the severity of

Quang Nam Province, Vietnam

flooding is expected to increase in downstream areas. Global increases in temperature will increase evapotranspiration, leading to decreased flows during the dry season.

Sea level rise worldwide will affect flooding in the seaward parts of the Delta. Trends towards larger extreme flood flows associated with worldwide climate change will cause much larger extreme sediment transport events, because of enhanced erosion and enhanced fluvial transport capability of the river system. Long term average sediment transport will also increase. Flooding associated with temporary and permanent deposition of fluvial sand will worsen.

Assessing climate change risks for the River Basin

In an SEA for the hydropower plan for this Basin, climate change was considered as one of 15 key issues. However, some climate change concerns were not quantifiable as predictive or spatial models for the study area, particularly for the 20 year time frame of the study, were not available. The analysis of climate change impacts was therefore largely qualitative, based on extrapolation from available literature. A range of important climate change impacts on the hydrology of the basin was identified: increased rainfall intensity and variability; increases in size of extreme flood flows, resulting in larger sediment transport and sand excavation; sea level rise affecting flooding in the seaward parts of the Delta; increases in temperature and higher evapotranspiration leading to lower dry season minimal flows with effects on salinity intrusion.

Climate smart alternatives in the SEA

The incorporation of climate change in the SEA has led to actions that address the climate variability that will occur in the future. The SEA demonstrated that the pace and scale of the proposed hydropower developments were at an unsustainable level and recommended a number of fundamental principles to enhance the sustainability and equity of the hydro sector in the basin. One of these principles highlights "safe operations", recommending the implementation of operational regimes and institutional arrangements to reduce droughts and floods, and prepare for disasters. The SEA also underscores the need to incorporate climate change parameters in design and management of all hydro infrastructure. In addition, the results from the climate change analysis gave support to some strategic recommendations regarding the need for (i) integrated river basin management; (ii) coordinated management and water release programmes for the 60 dams considered; (iii) needs for improved data collection on climate related issues.

Conclusion: Climate smart design of the plan

The SEA provided an overview of how variable weather and rainfall patterns of the river basin would be affected by climate change. This resulted in the identification of "safe operations" and development principles to ensure equity and sustainability can be achieved during the construction and operation of the hydropower facilities.

In addition, the SEA underscored the importance of integrated and coordinated river basin management as well as the need for more long term climate data gathering and analysis.

References

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Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- SEA increased commitment for plan ✓

Climate smart(er) because:

- Rainfall variability and intensity characteristics are incorporated into hydropower infrastructure planning and operations.
- "Safe operations" are incorporated into the overall hydropower scheme to take into account climate change induced floods/droughts.
- Climate change data are gathered and analysed during the project.

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ESIA for port development in South Africa

Expansion of the Port of Durban

Type of impact assessment	Mandatory Environmental (and Social) Impact Assessment (ESIA)
Type of project/plan	Port development
Climate change related issues	Significant inundation, more frequent and intense storm surge, increased GHG emissions
Influence of the ESIA	Design adapted to meet expected climate change effects; improved environmental management plan

The revised ESIA for expansion of the Port of Durban included a climate change impact report. As a result, a higher quay was designed to meet expected sea level rise. The environmental management plan was also improved: it now includes specific climate change effects, as prescribed by new legislation.

Climate change in eThekwini

The Port of Durban is situated in the eThekwini Metropolitan Municipality (EMM), in the urban centre of the region. It knows a warm maritime climate with an average temperature of 16℃ in winter and 27℃ in summer, and 1054 mm rainfall per year.

Approximately 1.3 million people live in the urban centre where the Port of Durban is located. Moreover, 56% of the EMM's total GDP stems from this area. It is the economic hub of the EMM and of great importance to the local and South African economy. The Port of Durban itself is considered the primary gateway port to South Africa. Port expansion is needed since the country's economy is growing and freight volumes increase. Without expansion, South Africa's economic growth will be constrained, as the port's influx grows three times faster than national GDP. The current capacity is expected to be maxed out in 2019. Moreover, the port's safety standards cannot be met due to increased vessel size and a rising sea level.

Climate change affects South Africa, but the effects differ per region. At the country's east coast, where the port is located, the annual sea level rise is highest. On average, the sea level is rising by 2.74 millimetres per year compared to 1.87 and 1.47 millimetres per year at the west and south coast respectively.

It is also expected that the Port of Durban will be subject to more frequent and more intense storm surges. It is therefore needed that the design of the port is adapted to these changing circumstances.

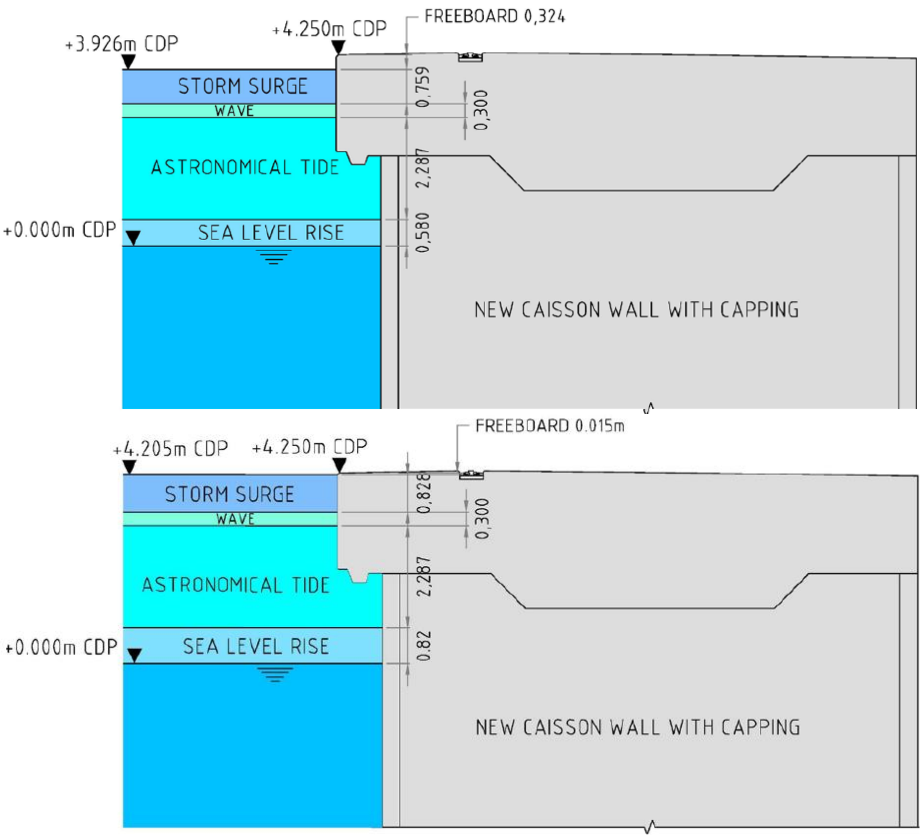
Assessing climate change risks for the port expansion

A special climate change impact report has been drafted for the revised ESIA of the Port of Durban expansion, after the first ESIA was rejected because climate change impacts were insufficiently addressed. Climate change risks were addressed through literature studies on long term sea level rise, storm surge, temperature increase, wind increase, currents, waves, rainfall and ocean acidification in the EMM.
The special report also takes into account the increasing GHG emissions that will be caused by the port's expansion. GHG emissions were calculated for three scenarios. These were then evaluated and compared with South Africa's national and international GHG policies.

Climate smart alternatives in the ESIA

The overall conclusion of the revised ESIA was that the port's expansion was designed without considering climate change criteria and did not meet climate change requirements. It therefore recommended to make some changes to the initial design. For example, it was recommended that the existing quay should be made higher. This should make the expansion of the port more durable. It was thought that the existing quay did not provide sufficient protection against a rising sea, nor did any of the proposed alternatives.

It was also recommended to develop an environmental management plan to cope with heavier rainfall and winds. The plan should be adapted to include 10% more erratic rainfall and 5% faster overall wind speeds.



Changed design due to the ESIA takes into account climate change expected for the years 2069 (top) and 2100 (bottom)

Moreover, GHG mitigation measures were recommended, including the expansion of rail freight for container transport. This would be more sustainable than the truck transportation proposed by the project.

Conclusion: Climate smart design of the port expansion

As a result of the revised ESIA and the climate change impact report, the port's quay was made 0.5 metres higher to protect the area to a (temporary) sea level rise of 4.5 meter. The new Port of Durban can withstand sea level changes of up to 6 metres. This should make it last for the proposed lifetime of 50 years.
An environmental management plan has also been developed in response to the ESIA. The plan meets new legislation that prescribes incorporating heavier rainfall and winds in management plans. Transportation modes have so far not been adapted.

Characteristics of climate smart(er) project:

- Three-step approach applied ✓
- Climate smart(er) project design ✓
- ESIA increased commitment for project ✓

Climate smart(er) because:

- Design has been changed to withstand sea level rise.
- Environmental management plan also addresses an increase in erratic rainfall and storm surges.

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SEA for a water plan in The Netherlands

Strategic water management plan: the Delta Programme

Type of impact assessment	Strategic Environmental Assessment (SEA)
Type of project/plan	Strategic Water management Plan
Climate change related issues	Sea level rise, more severe rainfall, temperature increase, high-impact floods
Influence of the SEA	New risk-based approach: more efficient protection at a lower cost and with opportunities for other services

The government of The Netherlands developed a Delta Programme to protect the country against high water. An SEA compared the 'business as usual' scenario to new strategies. A new protection standard was designed, based on not only the probability of flooding, but also the consequences of floods.

Climate change in The Netherlands

After the disastrous flood of 1953, the Dutch government took measures to better protect the country against flooding. Agreements were made regarding the height of dykes and coastal management.

But sixty years later, circumstances have changed:

- The sea level is rising while the land is subsiding;
- The number of rainy spells is increasing and rainfall is becoming more severe;
- The temperature is rising.

Furthermore, a flood would have a greater impact today than it would have had 60 years ago. The population of The Netherlands has increased, which means that in the event of a flood, there would be more casualties than in the past. Nearly 60% of the Netherlands is at risk of becoming inundated by flood waters. This area includes the largest cities as well as the economic centre of the Netherlands. For these reasons, adequate protection from flooding – from the sea and rivers alike – is of vital importance.

This is why the Netherlands needs to look far ahead and draw up sound plans for the future. The aim of the 'Delta Programme', in which various authorities and other organizations collaborate, is to ensure that flood risk management and freshwater supply are sustainable and robust by 2050. Thereby the country will be better equipped to withstand weather extremes.

Climate smart alternatives in the SEA

Since 2010, the Delta Programme has been developing frameworks for a new approach, in collaboration with authorities, civil society organizations and the business community. All available and new knowledge has been used. In 2014, these efforts led to proposals for five 'Delta Decisions', on (i) flood risk management, (ii) fresh water supply, (iii) spatial adaptation, (iv) the Rhine-Meuse Delta and (v) the IJsselmeer Region. An SEA approach was used to ensure that these decisions would be environmentally sound.

In the SEA, the 'Business as usual scenario' (National Water plan 2009-2015) was compared to new strategies. For flood risk management, the protection standard used to be based on the probability of flooding only. The Delta Programme proposed a risk based approach that takes into account both the risk of flooding and possible ensuing consequences. The scale and scope of the consequences determine the level of the standard. During the

process more drastic strategies were also considered, such as a much higher general protection level.
The SEA showed that the new risk-based approach combines more efficient protection with lower costs and better local opportunities for other services, like nature conservation, landscape and cultural heritage. More drastic strategies were dis-

Scheduled dyke improvements 2016-2021

carded for the next decades (until 2050), because of high costs and high impacts and appreciating the uncertainties regarding climate change and economic and spatial developments in the future.

Conclusion: Climate smart design of the Programme

The Delta Decisions ensure that the Netherlands is prepared for various future scenarios. The government has chosen strategies and measures that enable a flexible response to new situations on the ground and to new climate insights. The Delta Decisions make sure that the required measures will be taken. Supplementary measures are ready to be implemented, should these be needed in the future. This approach is called 'adaptive delta management'. All stakeholders view this approach as a pragmatic solution for dealing with uncertain developments.

References

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Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- SEA increased commitment for plan ✓

Climate smart(er) because:

- Attention was paid not only to the probability of flooding, but also to consequences of floods.
- The flexible 'adaptive delta management' approach allows for appropriate measures to various climate change scenarios.

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EIA for a waste incinerator in Denmark

Construction of a waste incinerator at Nordforbrænding

Type of impact assessment	Mandatory Environmental Impact Assessment (EIA)
Type of project/plan	Construction project – a new waste incinerator at Nordforbrænding
Climate change related issues	Emissions of greenhouse gases and flooding from rainwater
Influence of the EIA	Public participation leading to incorporation of climate change risks; measures to decrease risk of flooding

A planned new waste incinerator will be located in an area which is at risk of flooding – a risk that will increase under climate change. During public hearings as part of the project's EIA, inclusion of climate risks was requested. This led to mitigation measures which will decrease the risk of flooding.

Climate change in Denmark

For Denmark, various climate change effects are predicted. These include a 1-4°C temperature rise by 2100, increased precipitation of up to 40%, and more frequent intense rains, cloudbursts and severe storms. The sea level is expected to rise by up to 1.2 metres by 2100. These issues pressure the water infrastructure and will cause more frequent and severe floods from e.g. overflowing sewers and water courses.

In this context, waste handling company Nordforbrænding wants to build a new waste incineration oven. The company, located north of Copenhagen, aims for this new, more efficient and low-pollution oven to replace two older ovens. The new facility will also be used for heat and power production, with a capacity of 10 tons of waste per hour, and an energy efficiency of 99%. It will allow the company to increase its energy production with sufficient electricity for 13,000 households and heat for 5,000 households, while incinerating the same quantity of waste.

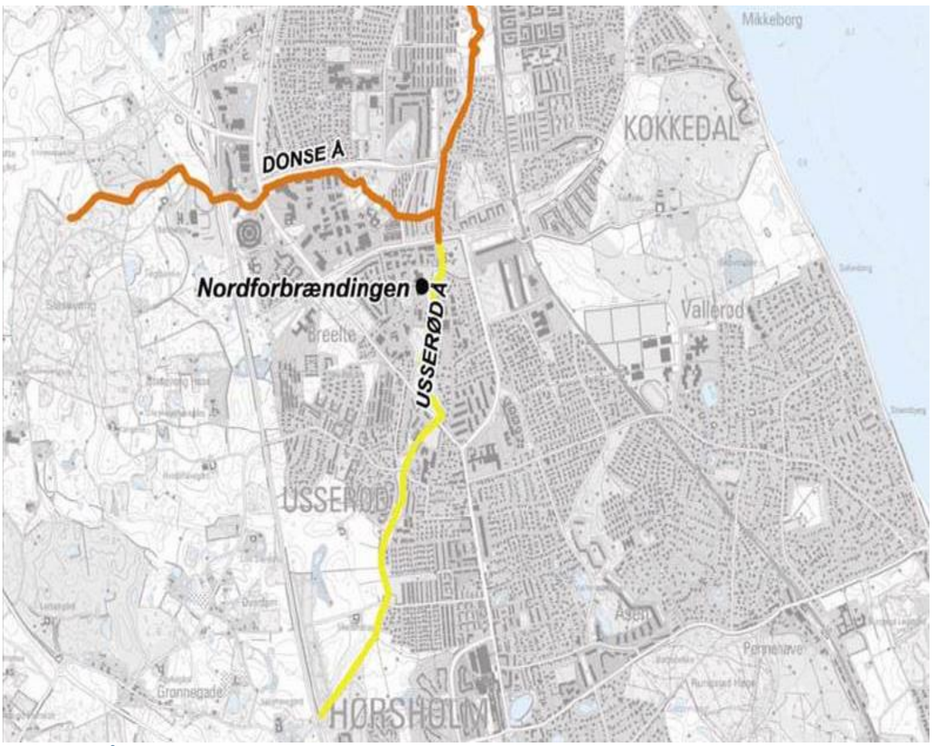
Nordforbrænding's incineration plant is located close to a small river, Usserød Å, which has previously flooded its low-lying surroundings. This causes considerable disturbance to local residents and damage to infrastructure. The three municipalities through which Usserød Å runs have established a joint climate change adaptation strategy to prevent further flooding. Among the initiatives highlighted in the strategy are wetlands to store water and delay discharge (with recreational values as a bonus) and a barrier in the river (sluice) to regulate water levels.

Assessing climate change risks for the incinerator

In the common climate change adaptation strategy, part of Nordforbrænding's area is mapped as being at risk of flooding. Currently, rainwater from the existing incineration plant is discharged partly into the sewage system and partly directly into Usserød Å. An assessment showed that an increased discharge can be part of the flooding problem in the river system, both on Nordforbrænding's area and elsewhere along the river. In order to minimise this risk, a goal was set: a maximum of 7,200 litres of water per hectare can be discharged to the river system. As part of this project, the cover of 1,250 m^2 of the area will change from gravel and grass (in which rainwater can percolate) to hard sealed surfaces. This means that more rainwater needs to be discharged, adding to the pressures on the river system and the risk of flooding. With the new project, 3,036 m^3 of water will be discharged into Usserød Å each year. These climate change risks were included in the EIA, based on a request during the hearing phase from one of the affected municipalities.

Climate smart mitigation measures in the EIA

In order to mitigate potential floods, 2,300 m^2 of the new roofs of the facility will be constructed as green roofs. They can absorb some of the rainwater that falls on the site, and delay another part of the water to prevent flooding in cases of cloud-bursts. The green roofs can absorb a total of 690m3 of rain per year. The total discharge from Nordforbrænd-ing's area with the mitigation measures in place will be ca. 500 m^3 lower than in the 'zero alternative'. Without mitigation measures, more water would be discharged in the new project than in the zero alterna-



Usserød Å and Nordforbrænding

tive, making the project less attractive. In order to build further capacity for delaying rainwater, an underground basin is added that allows a 10 minute delay of a high intensity rainfall (occurring once in five years).

Conclusion: Climate smart design of the incinerator

The design of the new incinerator has been adaptive to climate change, using green roofs and an underground basin to decrease and delay rainwater discharge into the river system. This decreases the risk of flooding. The measures do not only benefit the facility, but are part of an overall strategy to adapt the river system to climate change. Together, the measures allow the discharge to stay below the maximum of 7,200 litres per hectare.

References

Miljøvurdering indeholdende VVM-redegørelse – For Ny ovnlinje 5 på Nordforbrænding I Hørsholm Kommune. 2012. www.mst.dk/media/mst/Attachments/VVMredegrelse.pdf.

Olesen et al. 2014. Fremtidige klimaforandringer I Danmark – Danmarks Klimacenter rapport nr 6. Danish Meteorological Institut.

Characteristics of climate smart(er) project:

- Three-step approach applied
- Climate smart(er) project design ✓
- EIA increased commitment for project ✓

Climate smart(er) because:

- Green roofs and underground basin absorb rainwater and delay rainwater discharge.
- The pressure on the Userød Å river system is minimised.
- The project and climate change adaptation measures are connected to a broader adaptation strategy.

case 7

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SEA for an energy land use plan in Germany

Integrated (renewable) energy in the land use plan of Langquaid

Type of impact assessment	Voluntary Strategic Environmental Assessment (SEA)
Type of project/plan	Integrated Energy Land Use Plan
Climate change related issues	Increase in energy demand and subsequent land use conflicts arising from diverse land use claims
Influence of the SEA	Better selection of sites for renewable energy production; higher commitment of local community and politicians

The SEA for the Integrated Energy Land Use Plan of an ambitious German community followed a unique model with extensive public participation. This led to increased acceptance of and commitment to the project and the selected sites for renewable energy production.

Climate change in Langquaid

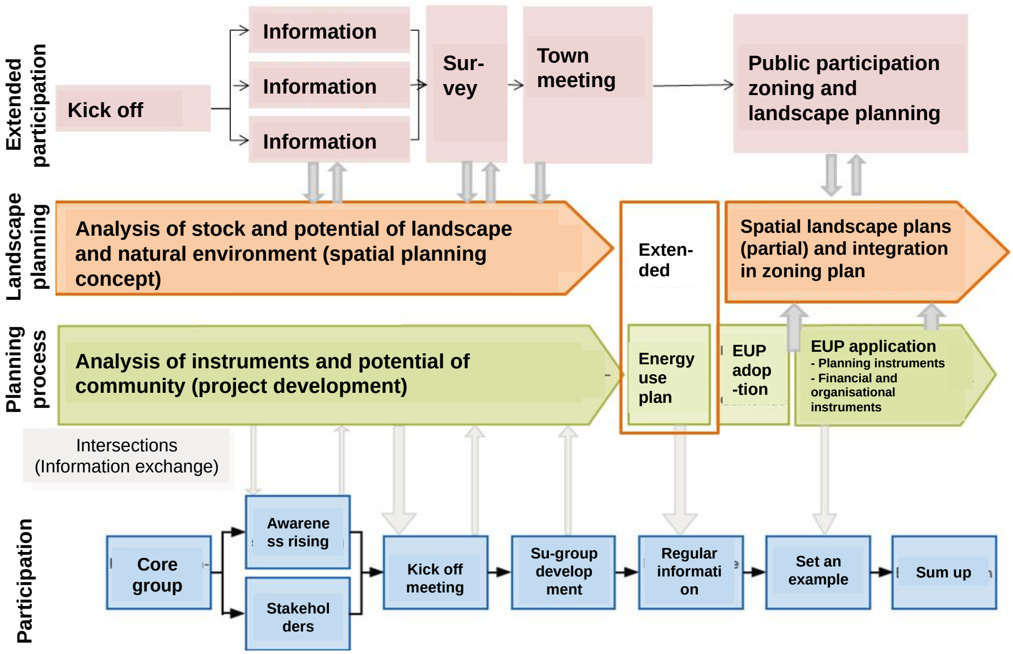
The Bavarian renewable energy policy sets ambitious targets for communities to move towards renewable energy strategies. The market town of Langquaid, located in lower Bavaria and home to 5,350 inhabitants, is the first community to start an integrated model project, combining ecological, social and economic aspects. Currently, half of the domestic energy consumption originates from fossil fuels. Langquaid developed broad, binding environmental principles and guidelines to be applied in all political decisions. In 2012, explicit climate change goals were formulated, based on the Kyoto Protocol, EU 20-20-20 targets, German legislation, and Bavaria standards. The ambitious goals include CO_2 equivalent reduction of 65% by 2020 (compared to 1990), 100% renewable energy by 2030, and annual reporting of achievements. All targets are set 5% higher than national targets.

To achieve these targets, Langquaid increases its efforts in energy saving and alternative energy sources. German legislation requires an SEA for this type of plan. Langquaid wants its strategies to be in line with other values such as nature and wildlife conservation, livelihoods and historic preservation. Therefore, it extended the SEA to a new model, the Integrated Energy Land Use Plan (ELUP). This involves citizens, landscape and spatial development in planning processes and investigates opportunities to deal with challenges through joint planning instruments.

Assessing climate change risks for the ELUP

The SEA follows a unique model (see figure), incorporating local processes into the provincial energy planning model to generate recommendations for locations of renewables. Contrary to existing models, this landscape based approach creates an open process, incorporates all citizens, acts as social mobilizer, and increases public acceptance of energy planning and resulting policies.

An inventory of regional landscapes and conservation areas formed the basis of the process. It documents protected areas and habitats, as well as local features deserving protection, and potential zones for compensatory measures. Based on these areas and additional restricting factors (e.g. planning policies, monument preservation), six potential sites for alternative energy sources (wind turbines and photovoltaic systems (PV)) were selected. These sites were subsequently used in an extensive participatory process with information sessions and a question-



Framework for integrating local planning processes (pink and orange) into the provincial energy planning model (green & blue)

naire. In a choice experiment, citizens played an active role in planning, by steering the type and site selection of alternative energy systems (AES). This helped to identify AES sites compatible with natural und social values, and decreased the risk of future climate change induced land use conflicts.

Climate smart alternatives in the SEA

Of the four potential wind turbine sites, two were rejected during community participation and one was subsequently dismissed by the council for monument protection. The two potential PV sites were both accepted. The resulting sites, which are in coherence with natural, social, and local planning capabilities, were evaluated in the SEA.

The SEA and ELUP have many benefits: (1) participation facilitates the screening process and the selection of AES; (2) the integration of landscape planning improves the environmental assessment and development of mitigation measures; (3) extended participation contributes to the discussion of AES and their sites, including local preferences; (4) the process increases acceptance of planning and of the results presented in the SEA; (5) it significantly improves commitment by the local council and regional politicians; (6) the SEA embedded in the ELUP supports the definition of compensation and mitigation measures for the AES. Lastly, the SEA provides a monitoring strategy for the community.

Conclusion: Climate smart design of the plan

The town of Lanquaid developed a model for an integrated energy land use plan, leading to an improved local zoning plan. The quality of the SEA and the acceptance of the overall planning process profited from the ELUP. The early integration of environmental issues into the planning process increases the commitment and engagement of the local population in climate change understanding and adaptation. The objective of generating a citizen oriented energy land use plan and the incorporation of this plan into long-term regional planning was fully achieved.

Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- SEA increased commitment for plan ✓

Climate smart(er) because:

- Integration of landscape planning leads to better mitigation measures.
- Selection of locally acceptable AES sites decreases the risk of future climate change induced land use conflicts.
- The process increased awareness and commitment of the population on climate change issues.

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SEA for touristic and urban planning in Mexico

Land use planning for urban development in Escuinapa, Sinaloa

Type of impact assessment	Voluntary Strategic Environmental Assessment (SEA)
Type of project/plan	Land use planning and bioclimatic design for touristic and residential planning
Climate change related issues	Climate change mitigation actions by reducing CO_2 emissions and increasing carbon sinks
Influence of the SEA	Guidance for investors to choose cost-efficient measures for emissions reduction that meet legal requirements

For urban development planning in Mexico, alternatives for carbon emission reduction and carbon sequestration were assessed in an SEA. After identification of the most energy consuming elements, 'energy efficiency' options were investigated. This resulted in guidance for investors.

Climate mitigation in Mexico

In order to meet international climate change conventions, Mexico's government has decreed binding policies including for the tourism sector. As a result, the National Fund for the Development of Tourism (FONATUR) has been promoting the first Mexican urban (residential, commercial and touristic) development which takes into account different alternatives for climate change mitigation. It combines reduction of carbon emissions with carbon sequestration. Alternatives were investigated in a voluntary SEA.

Assessing carbon emissions balance in the SEA

Carbon emissions were quantified while taking into consideration energy consumption under two scenarios: (1) Business as usual (BAU), and (2) Energy efficiency (EE). The BAU assumes no further action to reduce energy consumption and vegetation loss. Carbon emissions were estimated by using information from the master plan on design of buildings.

By analysing each type of land use, elements of major energy consumption were identified. For each, options for EE scenarios were investigated. These considered reduction of carbon emissions through:

- reduction in energy consumption by bioclimatic architecture and construction materials;
- alternatives for lighting, air conditioning and electric appliances;
- allocation of buildings considering the situation of vegetation;
- production of renewable energy such as biogas, photovoltaic panels and water heaters on roofs.

Fuel savings were proposed by:

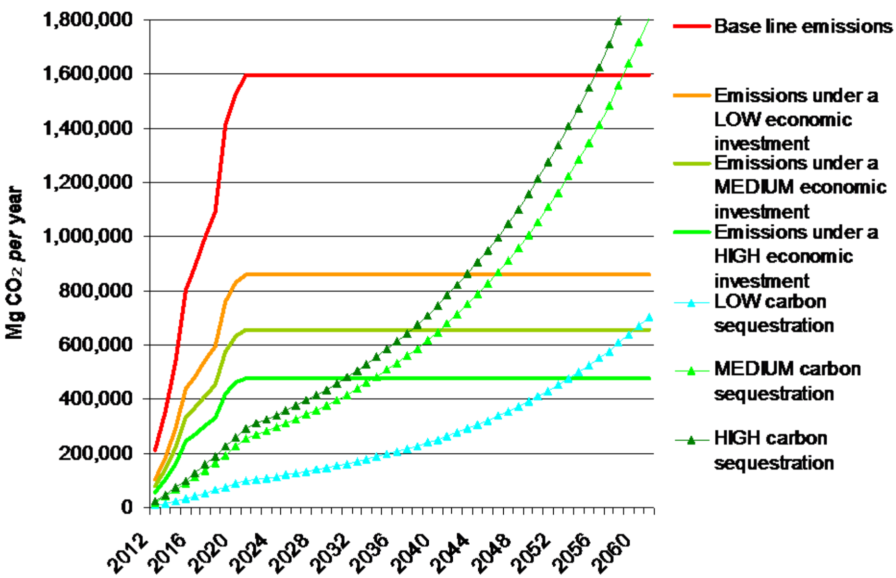
- encouraging the use of public transport instead of cars, by locating parking lots in the outer ring of the tourism complex;
- promoting walking and biking by creating separate lanes.

For carbon sequestration, reforestation plans considered plant density, species growth and shading effects. Moreover, from field inventory and satellite imagery, carbon stocks were estimated. This helped to identify suitable spots for carbon conservation and for compensation by reforestation with native species. Finally, carbon emissions and carbon sequestration were formulated into the same CO_2 equivalent units, to facilitate comparison (see figure).

Carbon emission trends

Carbon emissions were projected for different stages in urban planning. Projections show an increase between 2012 and 2022 when urban development is expected to be finished. Energy consumption will be more stable after 2022. Carbon emission estimates in the BAU scenario showed a maximum consumption of non-renewable energy of 2,053 GWh per year. Air conditioning and lighting are the main sources of consumption. Nearly 50% of the energy consumption can be reduced by proper bioclimatic designs, shading effects and energy efficient appliances. About 30% reduction can be obtained by renewable sources, and the rest can be compensated by sequestering carbon on vegetation biomass.

Carbon sequestration shows an exponential growth over the planning period. Carbon stocks in vegetation were estimated between 20 and 54 GgC), with an increment of storage on 1.5 GgC through green façades and roofs. The use of vegetation plays an important role, not only in carbon sequestration but also in reduction of solar heat in buildings.



CO_2 equivalent estimations of BAU and under three different EE scenarios of energy consumption and carbon sequestration. Where carbon emissions are equal to carbon sequestration, the project is carbon neutral.

Climate smart alternatives

The main elements that drive carbon emission reductions are:

- Reducing internal heat in buildings through heat proof layers and shading, spatial organisation of buildings, and use of specific construction materials.
- Reducing air conditioning use through a proposed technology to avoid low temperatures.
- Using natural light to partially replace artificial light.
- Generating renewable energy (biogas and photovoltaic).

Conclusion: Climate smart design of urban development

The final design of the master plan considered the recommendations done in the SEA. Though there is no legislation in Mexico to enforce the private sector to implement these recommendations, they were incorporated as guidance. A monitoring report system via sustainability indexes was developed. With these, the master plan allows the investors to choose the most economical investment for carbon emissions and carbon sequestration as long as they fulfil the minimum standards established. Even with a minimum investment, a reduction of about 50% of carbon emissions is possible and another 10% through carbon sequestration by the year 2025.

Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- SEA increased commitment for plan ✓

Climate smart(er) because:

- The master plan considered zones to reduce carbon emissions and promote sequestration.
- Investors are encouraged to reduce emissions.
- Main energy/fuel use sources were identified and alternatives selected to reduce emissions.

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SEA for a land use plan in Kenya

Land use plan for the Tana River Delta

Type of impact assessment	Voluntary Strategic Environmental Assessment (SEA)
Type of project/plan	Land Use Plan (spatial rural planning)
Climate change related issues	Increase in excessive floods, increased periods of drought, food insecurity, social unrest
Influence of the SEA	Zoning of the area according to expected climate change effects, with corresponding adaptation measures

One of the climate change effects in Kenya's Tana Delta is increased flooding. The SEA for a land use plan on the area led to a distinction between low, flood-prone areas and high, safer areas. Measures were taken according to this distinction, to increase the population's safety and secure their livelihoods.

Climate change in the Delta

The Tana River Delta lies at the end of Kenya's longest and largest river and is located in the dry zone with an annual precipitation of about 600 millimetres per year. The availability of water from the Tana River is one of the most important drivers for the regional economy. In the dry season the river discharge is low, and during the wet season floods occur.

About 100,000 permanent residents inhabit the area and make a living as farmers, fishermen or pastoralists. At the end of the dry season the area is also used for grazing and watering by pastoralists from outside of the area. The area is rather isolated from the rest of the country due to poor infrastructure and it is an important area for biodiversity.

The availability of water is under pressure because of climate change. It is considered one of the major drivers of environmental and social problems, such as food insecurity and conflicts over scarce resources. Furthermore, climate modelling predicts an increase in exceptional flood events because total rainfall will increase and become more erratic. Since the population in the area is expected to increase, the impacts of these floods will be higher, affecting more people. Increasing evapotranspiration, on the other hand, puts pressure on the overall water quantity. Decreasing water

availability is further strengthened by an increased demand for fresh water, although climate change is one of the main drivers. This combination will lead to future water scarcities that have already led to social conflicts.

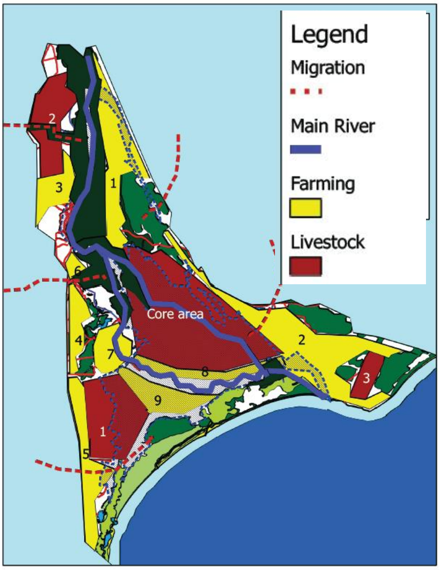
The Tana River Delta Land Use Plan aims to address, among others, these social and environmental conflicts.

Assessing climate change risks for the Land Use Plan

The SEA on the Land Use Plan incorporates Google Earth ground level heights and extrapolates these to identify areas prone to flooding. In the SEA it is concluded that further research on climate change in the Tana River Delta is lacking but necessary. The use of Google information is a first step towards incorporating climate change impacts in strategic plans for the area.

Climate smart alternatives in the SEA

The incorporation of climate change in the SEA has led to measures that should make the local population less vulnerable to climatic changes. A major contribution of the SEA is that it shows the minimum water flow that is needed to support basic livelihood needs.



One of three alternatives in the SEA

The SEA further recommends to limit population growth in the area to stay within environmental thresholds. Settlements should be moved to areas outside the floodplain to make the people living there less vulnerable to floods. The SEA therefore suggests that the Land Use Plan should include measures that discourage people from living in areas exposed to maximum flood risk. Moreover, grazing of livestock from people living outside of the delta should be minimized due to the expected increase of droughts. Also planned sugarcane production should not be allowed to grow, as it will cause an even greater pressure on water availability in the future.

Conclusion: Climate smart design of Tana River Delta Land Use Plan

The SEA provided for an overview of the environmental and social impacts of the planned policies in the Land Use Plan. Several of these have been incorporated in the eventual plan for the Tana River Delta.

The eventual Land Use Plan distinguishes two areas: a higher area used for settlements and a lower floodplains area. The floodplains are used for tourism, area conservation, and a limited amount of livestock grazing. This should ensure a safe and liveable place where people are less exposed to climate change issues such as droughts and floods.

References

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Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- SEA increased commitment for plan ✓

Climate smart(er) because:

- Delta area is divided into two zones, reflecting climate change vulnerability.
- Measures will be taken to encourage people to live in the less vulnerable areas.
- The vulnerable area is assigned for grazing and biodiversity protection.

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ESIA for a housing project in England

Land use for housing development in North West Cambridge

Type of impact assessment	Environmental (and Social) Impact Assessment (ESIA)
Type of project/plan	Land Use Project (housing development)
Climate change related issues	Lower annual rainfall, higher winter rainfall, intense storms, summertime overheating, water conservation
Influence of the ESIA	Rainwater capture and recycling scheme for water conservation; project design based on ESIA outcomes

The ESIA for this housing project was supplemented with a carbon reduction strategy and sustainability assessment. The ESIA identified climate change adaptation and mitigation measures. A rainwater capture and recycling scheme was selected as the most feasible alternative for water conservation.

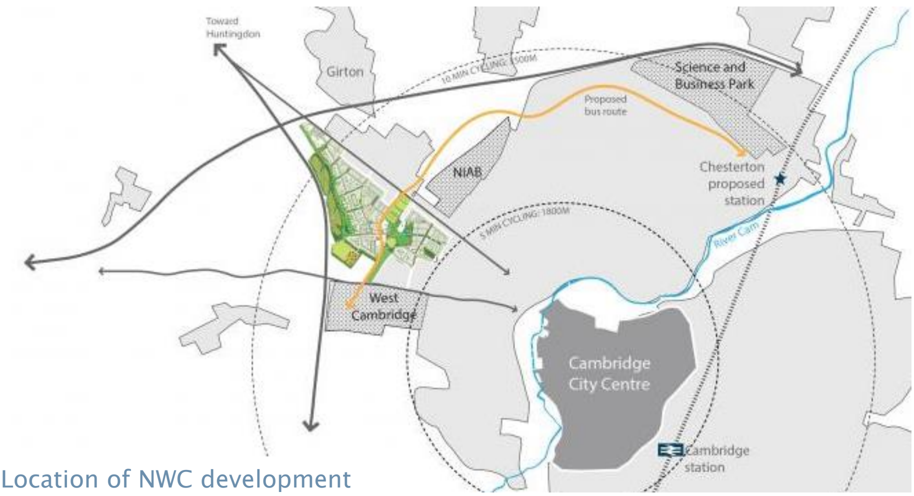
Climate change in the area

The *North West Cambridge (NWC) development* involves building of 1,500 homes for University workers, 1,500 homes for sale, accommoda-tion for 2,000 students and a wide range of community facilities on the 150 hectare site. This project has been brought forward by the University of Cambridge to create the highest standards of environmental sustainability and is designed to minimise carbon emissions. Climate change impacts such as droughts, higher temperatures, and more frequent intense weather events may also affect the development area.

There are two major reasons why the project took a more climate smart planning direction. First, the local authority, Cambridge City Council, has moved forward its policy on climate change by setting a strong target with regard to the building code. Second, the land ownership strongly supported a climate smart approach. The project has been promoted by the University as a 'model' for sustainable living which will be an exemplar new settlement, meeting the University's future research and accommodation needs and enhancing the local area.

Assessing climate change risks for the housing project

In identifying likely climate change impacts, the assessment has been largely guided by the fifth generation of climate information for the UK, UKCP09 data. Moreover, current meteorological data on rainfall, temperature and wind speed were used. A number of recommendations concerning design, construction and operational requirements based on the assumptions were suggested. As an example, current and historical



Location of NWC development

rainfall data from the Meteorological Office's standard 5 km grid point data set was used to predict average annual rainfall events for the crossing site over a maximum 100 year return period including predicted impacts of climate change.

Detailed climate change information was not outlined in the main ESIA report but in supplementary documents such as a Carbon Reduction Strategy and Sustainability Assessment. The ESIA indicated that the NWC development will "actively engage in design that accommodates the potential effects of climate change through adaptation strategies, and design so as to mitigate as far as reasonable the potential adverse effects of the proposed development on climate change." A Climate Change Adaptation Strategy was prepared parallel with the ESIA.

Climate smart adaptation and mitigation in the ESIA

In the ESIA, along with adopting Sustainable Drainage Systems (SUDs), extensive green infrastructure and open spaces were suggested to reduce flood risk and improve water management. It also highlights principles to combat thermal discomfort in buildings. Some examples are: careful control of solar gains; designs to incorporate openings for purge ventilation in summer; and overheating studies which consider the impacts of thermal mass in living areas and kitchens.

Four water conservation scenarios were developed and their performance modelled against predicted future rainfall: 1) business as usual; 2) a site-wide rainwater capture and recycling scheme; 3) a site-wide rainwater-to-potable scheme; and 4) a blackwater-to-nonpotable scheme. A feasibility study concludes that scenario 2 has the lowest risk and the highest chance of successful implementation. Voluntary actions will also be taken for the new buildings, including Code for Sustainable Homes (CSH) level 5 for all dwellings (the largest development known at this level), and BREEAM Excellent for all non-domestic buildings.

Overall, the ESIA identified how engineering design and operation of project components can be adapted to climate change impacts, rather than focusing on impacts of the project on biophysical environments.

Conclusion: Climate smart design of the project

The ESIA provided an overview of climate change impacts associated with the proposed project in NWC.

Throughout the NWC project, there has been a close link between the adaptation study team and the master planning design team, which has ensured that results and initial ideas coming from the ESIA have been fed into the design directly. Further, the timing of the adaptation project has coincided well with the detailed design stage of the project.

In fact, a large number of design elements, in particular the design of mechanical and electrical services and building structures, make extensive use of design codes and compliance guides. The ESIA also acknowledged this point by stressing that these codes and guides should incorporate adaptation issues and design factors for adaptation to be effectively included in projects.

Characteristics of climate smart(er) project:

- Three-step approach applied ✓
- Climate smart(er) project design ✓
- ESIA increased commitment for project ✓

Climate smart(er) because:

- Green infrastructure and open spaces suggested to reduce flood risk and improve water management.
- Site wide rainwater capture and recycling scheme.
- Adaptation measures will be taken for all dwellings.

References

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Henderson et al., North West Cambridge, Climate Change Adaptation Strategy, City Council and South Cambridgeshire District Council, Cambridge (UK), 2013.

case 11

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ESIA for infrastructure design in the Philippines

Design of climate resilient roads

Type of impact assessment	Mandatory Environmental and Social Impact Assessment (ESIA)
Type of project/plan	Transportation project (222 km of roads)
Climate change related issues	Storms and typhoons, increased rainfall, sea level rise, floods and landslides, heat waves
Influence of the ESIA	Climate smart choices in engineering design based on general solutions in the ESIA

The ESIA for this project assessed climate change risks over the next 20 years for proposed infrastructure. Measures were identified to adapt to these risks, and were further detailed in engineering design. During typhoon Haiyan, the roads remained largely intact and were crucial in emergency response.

Climate change in the country

The Philippines is one of the most disaster prone countries in the world. It ranks among the five most affected by weather-related events, including storms, floods, and heat waves. This poses challenges, including in infrastructure design.

Assessing climate change risks for the road project

The Millennium Challenge Corporation (MCC) partnered with the Government of the Philippines to build 222 km of roads on Samar Island. The project included rehabilitation of 60 bridges (in total 3 km) and construction of 35 slope protection areas, at a total cost of $228 million.

The ESIA for the project concluded that over the next 20 years, the road would be vulnerable to a higher frequency and intensity of rainfall, as well as sea level rise. It also identified landslide prone areas, which are important given increasing rainfall.

Climate smart adaptation measures in the ESIA

To adapt to the risks associated with climate change, a number of measures was identified, including:

- Raising bridges;
- Upgrading culverts and drainage pipes;
- Widening water channels/canals;
- Improving road embankments;

Objectives	Investments	Costs
Increase hydraulic capacity: • of 60 existing and new bridges • of drainage systems and culverts	Rehabilitate and replace bridges to sustain high storm surges	$2 million
	Upgrade box culverts to handle 1 in 50 year flood (before 1 in 25)	$9 million
Strengthen road embankments, protect road shoulders, shore up slopes to guard against landslides	Construct gabions, sheet piling, articulated concrete, anchors, structural walls, piles, reinforced ground	$10 million
Protect the road from the sea	Build seawalls	$2 million
Total	$23 million (10%)	

Adaptation objectives, investments and costs for Samar Road

- Remediation of slopes/landslides;
- Installing seawalls.

The work initiated under the ESIA was carried forward through engineering design. While the ESIA was useful in identifying problems and general solutions, the solutions were fully fleshed out during engineering design. This included work that flowed from (but was not part of) the ESIA, such as detailed hydrology of studies, the calculation of return periods and increased storm intensity, and the translation of these findings into engineering details (e.g. sizing of bridges and culverts).

In the case of the Samar Road, the total cost of the adaptation measures was approximately 10 percent of project costs (summarised in the table on the previous page).

Conclusion: Climate smart design of road infrastructure

The value of the Samar Road adaption investments became clear in November of 2013. One of the strongest storms ever to make landfall, Typhoon Haiyan had sustained winds of over 190 miles per hour when it struck the Philippines. While the road was directly on the storm's path, it survived largely intact. It provided a crucial artery for the emergency response, subsequent reconstruction, and the ongoing development of Samar Island. The Government of the Philippines is now applying climate smart design standards to other national roads.

Samar Road facilitates emergency response after Typhoon Haiyan

This approach creates value both for project beneficiaries and financiers (i.e. taxpayers). Considering climate risks during project design can lead to "best value" (rather than least cost) designs. These designs increase the likelihood that infrastructure provides benefits over its long useful life, even in the face of a changing climate.

As this case shows, the past may not be an accurate predictor of future risks. Many aspects of infrastructure design respond to past experience such as the frequency of major storm events. But these frequencies are changing. This poses a challenge when designing infrastructure with service lives that span decades. We need complimentary approaches to assess and address risk. Given the uncertainty, it can be useful to implement no (or low) regret approaches that perform well under a range of scenarios.

This case is an example of an ESIA that is influential because general solutions were properly integrated in the design phase. Engineering design includes analytical work that flows from (but may not be a part of) an ESIA. To be effective, environmental assessment and design processes should be integrated, with environment and engineering teams working closely together.

Characteristics of climate smart(er) project:

- Three-step approach applied ✓
- Climate smart(er) project design ✓
- ESIA increased commitment for project ✓

Climate smart(er) because:

- ESIA identified broad solutions which were further detailed in design phases.
- In the face of uncertainty, engineering design was robust to a range of future climate scenarios.
- 'Best value' design benefits users but also financiers.
- Experience with Typhoon Haiyan demonstrated the value of resilient design.

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SEA and ESIA for a spatial plan in The Netherlands

Dike reallocation Lent

Type of impact assessment	Strategic Environmental Assessment (SEA) and Environmental and Social Impact Assessment (ESIA)
Type of project/plan	Spatial Plan (ESIA), preceded by 'physical planning key decision' (SEA)
Climate change related issues	Increased flooding risks, periods of drought
Influence of the SEA and ESIA	Climate smart design solutions adopted

The SEA for the 'Room for Rivers' plan was followed by ESIAs for individual projects, including the dike allocation project in Lent. Both SEA and ESIA assessed climate change effects and proposed measures. In the dike allocation project, various climate smart solutions were applied to 'make room for water'.

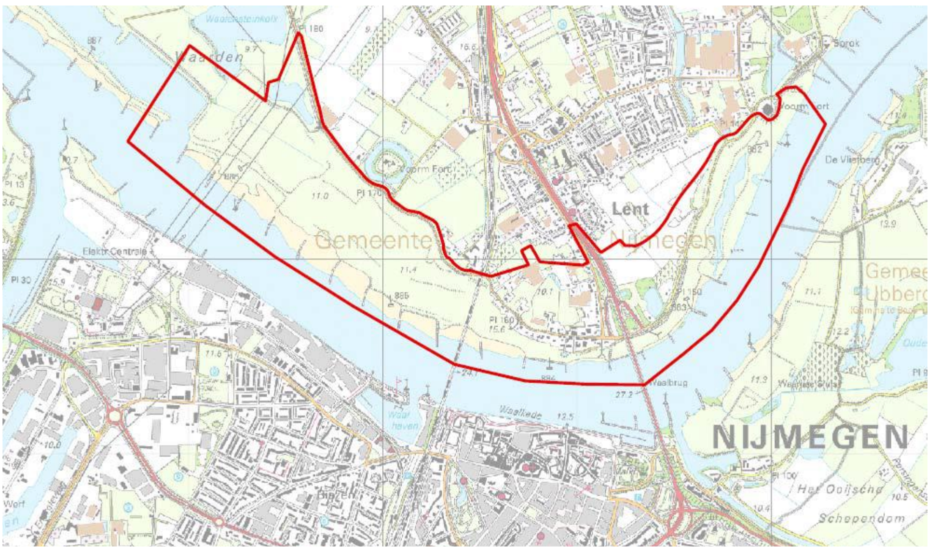
Climate change in the area

The plan 'Room for Rivers' aims to define the necessary measures to protect The Netherlands against flooding of the river Rhine, now and in the future. During the 1990s, floods nearly took place on two occasions. It is expected that the risk of flooding will be even higher in the future, when more intense upstream rainfall is projected.

More specifically, the plan defines packages of measures for the three main branches of the Rhine: the rivers IJssel, Nederrijn/Lek, and Waal. Packages are combinations of two types of measures:

- Dike improvement or heightening (the traditional approach);
- A new – climate smarter – approach, aiming to create more space for water discharge or retention in the river foreland or riverbed (hence the title 'Room for Rivers'). This is done, for instance, through removal of obstacles, deepening of the riverbed, creation of retention ponds, or relocation of dikes.

An SEA for the Room for Rivers programme was undertaken to enable planners and decision makers to find the best compromise of safety, environmental benefits and low costs. Also, the SEA took an integral view of the entire river system, since the three branches are interconnected and because upstream and down-



The city of Nijmegen and the dike reallocation area stream measures may affect each other.

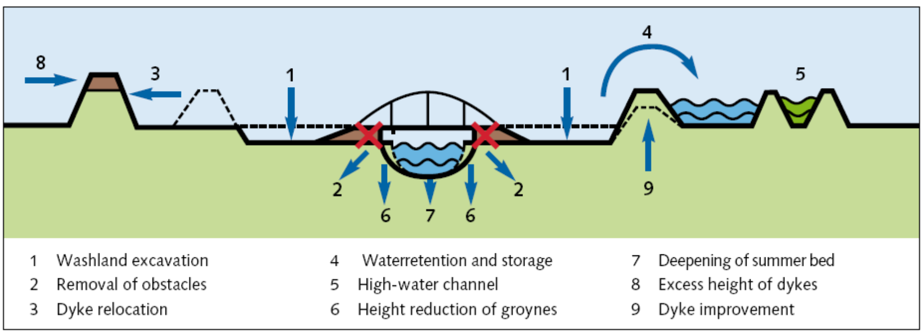
In the final programme, forty individual projects were proposed. One of these projects was 'dike reallocation Lent', near the city of Nijmegen. For more detailed design and implementation of this project, an ESIA was undertaken. The river Waal bends sharply near Nijmegen and narrows itself in the form of a bottleneck (see map). Adequate measures were necessary in order to protect the inhabitants of the city against the dangers of the water. In the case of Nijmegen, this involved moving the Waal dike in Lent and constructing an ancillary channel in the flood plains. This has created an island in the Waal and a unique urban river park in the heart of Nijmegen with room for living, recreational activities, culture, water and nature.

Assessing climate change risks for the plan

In the SEA and ESIA, for the development of alternatives and assessment of their impacts, a set of criteria was used, including on lowering of expected high water levels and robustness to change/flexibility. Measures should not only solve short term problems of floods, but should also be future proof. In the next decades, climate change will cause both longer periods of intense rainfall and periods of drought.

Climate smart alternatives in the SEA

In the SEA Room for Rivers, packages of climate smart measures were assessed. Most measures are aiming to create more space for water. This space will function for both water storage (during high waters) and retention (low waters).



Climate smart measures identified in the Room for Rivers SEA

Conclusion: Climate smart design of the dike allocation

For the dike reallocation Lent, all alternative options focus on climate smart solutions: creating space for the river and providing space for other activities. For instance:

- An ancillary channel (150-200 metres wide and 3 kilometres long) collects part of the discharge at high waters, which will prevent flooding. The channel facilitates nature development and can also be used for recreation.
- A new quay was constructed as a paved sloping surface that gradually disappears in the water. The quay can be used for cycling, strolling etc. A cut-off wall was constructed to prevent seepage.
- A new island in the middle of the river offers room for urban development. Bridges link the island to both the new quay of Lent and the other side of the river.

Characteristics of climate smart(er) plan:

- Three-step approach applied ✓
- Climate smart(er) plan design ✓
- ESIA and SEA increased commitment for plan ✓

Climate smart(er) because:

- The dike allocation offers solutions for both periods of high waters and periods of drought.
- The project creates space for water storage and retention and for other activities, such as housing, recreation and nature.

References

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Authors

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Climate change affects human and natural systems and poses a serious challenge to economic development and ecosystem sustainability. Its effects should therefore be explicitly considered in decision making about proposed policies, plans, programmes and projects. Impact assessment, including environmental (and social) impact assessment (EIA/ESIA) and strategic environmental assessment (SEA), plays an important role here. It can ensure that the design of a policy, plan, programme or project properly addresses both needed mitigation of climate change and adaptation to the effects of climate change on the proposed project or plan.

This compendium presents twelve cases in which impact assessment has contributed to climate smart development. These ‘good practice’ cases can inspire practitioners in impact assessment and/or climate change adaptation or mitigation. They can also be used as a point of departure for discussions and mutual learning between the impact assessment community and the climate change community, to work towards climate smart decision making.