



klimaat verandert ruimte  
climate changes spatial planning

# Climate *changes* Spatial Planning

Introduction to the Dutch national research programme



# Colophon

## Editors

J.A. Veraart (CcSP Programme Office, Wageningen University and Research Centre)

S. Brinkman (Brinkman Climate Change Consultancy)

J.E.M. Klostermann (CcSP Programme Office, Wageningen University and Research Centre)

P. Kabat (Scientific Director and Chair CcSP Programme Council, Wageningen University and Research Centre)

## With contributions from

J.C.J.H. Aerts (Vrije Universiteit Amsterdam)

K. Dorland, (Director CcSP Programme Office, Vrije Universiteit Amsterdam)

B.J.J.M. van den Hurk (Royal Netherlands Meteorological Institute)

R.W.A. Hutjes (Wageningen University and Research Centre)

T. Kram (Netherlands Environmental Assessment Agency)

F. de Pater (Vrije Universiteit Amsterdam)

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# Foreword

Dealing with climate change and climate variability is one of the largest challenges for the coming years, both on a national and global scale. The Intergovernmental Panel on Climate Change (IPCC) presents increasing evidence of impacts of climate change and suggests that most of the warming observed over the last 50 years is attributable to human activities. In the Netherlands, impacts of climate change are to be expected on land and water use, including infrastructure, ecosystems and agriculture. IPCC warns that water and land use may also add strains that increase vulnerability to climate change, so we are dealing with a complex system full of positive and negative feedbacks. A broad recognition of climate change and its impacts on natural resources and society is a *conditio-sine-qua-non* to develop an adequate and timely set of spatial policies for mitigation and adaptation.

The National Research Programme Climate changes Spatial Planning (CcSP) has been developed in close collaboration with a wide range of stakeholders, including the Ministries of Housing, Spatial Planning and the Environment (VROM), Agriculture, Nature Management and Food Security (LNV), Transport, Public Works and Water Management (V&W), Education, Culture and Science (OCW) and Economic Affairs (EZ). Other involved stakeholders were regional and local governments, the private sector and NGOs. Consortium partners include nationally and internationally recognised scientific institutes, securing the international position of the consortium. The programme has a total budget of 90 million euro (2004 – 2011) and is co-funded under the Dutch decree on subsidies for investments in the knowledge infrastructure (BSIK, formerly ICES-KIS-3).

*Prof.dr.ir. Pier Vellinga*  
Chairman of the Board  
Foundation Climate changes Spatial Planning

*Prof.dr. Pavel Kabat*  
Scientific Director  
Chairman Programme Council Climate changes Spatial Planning

*Kees Dorland*  
Director Programme Office Climate changes Spatial Planning



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# Introduction



Research indicates that the global climate is changing in a more rapid pace, due to higher greenhouse gas levels, such as CO<sub>2</sub>, in the atmosphere. The Intergovernmental Panel on Climate Change (IPCC) writes that most of the global warming in the past fifty years is likely to be caused by human activities. During the past decades, the emphasis has been to develop technologies for reduction of the amount of greenhouse gases (*mitigation*). This is of course still important, but next to this, new strategies have to be developed to deal with the climate change that is already happening, or cannot be prevented in the coming century (*adaptation*).

The Netherlands are expected to face climate change impacts on land and water use and therefore on spatial planning. Ways forward are to look for opportunities for an emission low (re)development of our spatial infrastructure and to increase the adaptive capacity of our society.

Spatial planners and the climate change community mostly had isolated (research) agendas so far. A major goal of the programme 'Climate changes Spatial Planning' (Klimaat voor Ruimte) is to enhance joint-learning between these communities. The programme aims to provide a sound knowledge base that interactively supports practitioners on how to cope with climate change. The mission of the programme is to introduce climate change and climate variability as one of the guiding principles for spatial planning in the Netherlands. The programme recognises that the benefits of climate research arise from the application of its findings in the management of land, water and nature.

## Main objectives and strategy of the research programme

- To offer the Dutch government, the private sector and other stakeholders a clustered, high-quality and accessible knowledge infrastructure on the interface of climate change and spatial planning.
- To engage in a dialogue between stakeholders and scientists in order to support the development of spatially explicit adaptation and mitigation strategies that anticipate on climate change and contribute to a safe, sustainable and resilient socio-economic infrastructure in the Netherlands.

The programme is organised in five main themes: climate scenarios, mitigation, adaptation, integration and communication (see figure). Projects were interactively designed to cover issues relevant to climate and spatial planning. Sectors include biodiversity, agriculture, fisheries, fresh water, coastal areas, transport on land and water, sustainable energy production, business, finance / insurance and governmental strategies.

### Theme Climate Scenarios

The theme 'Climate Scenarios' covers the role of atmospheric processes in shaping our climate, and the construction of specific climate change scenarios. It aims to improve our understanding of the climate system by supporting measurements and modelling of vital climate variables. Climate scenarios, time series and (paleoclimatological) reconstructions are developed and tailored to support spatial planning.

### Theme Mitigation

Research is focusing on mitigation strategies with opportunities or consequences for land use. It is a major aim to get a clearer picture regarding greenhouse gas emissions or sequestrations related to forestry and agriculture. The implications of renewable energy for spatial planning, such as bio-energy, are also a major research topic.

### Theme Adaptation

The CcSP programme introduces a 'climate proofing' approach for adaptation from a regional and sectoral perspective. Special attention is paid to sectors and regions such as transport, nature conservation and the Rhine river basin. The idea is to focus research on combinations of infrastructural, financial and institutional adaptation strategies.

### Theme Integration

The projects under the theme 'Integration' are meant to integrate activities within the former three themes with the aim to generate comprehensive decision support frameworks for policy making. The theme also enhances consistency across the whole programme.

### Theme Communication

The objective is to allow stakeholders to take part in the research



by informing them about projects in an early stage. When they are involved, the practical knowledge of the stakeholders can be used in the project and hence increase the practical usefulness of the research results.

**Examples of scientific results expected from the programme**

- Increased insight in cloud and aerosol interactions
- High quality climate scenarios, suitable for use in various impact assessments
- New multi-gas approaches to assess GHG emissions on ecosystems level
- A prototype of a multi-platform monitoring system for land use-related GHG emissions
- Spatial decision support systems for cross-sectoral adaptation strategies
- Innovation of methodologies to assess costs and (ancillary) benefits for adaptation and mitigation

**International position of the research programme**

The key questions and themes addressed by this programme reflect the priorities in the Netherlands within the IPCC conclusions, the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP). Currently, the IPCC is developing the

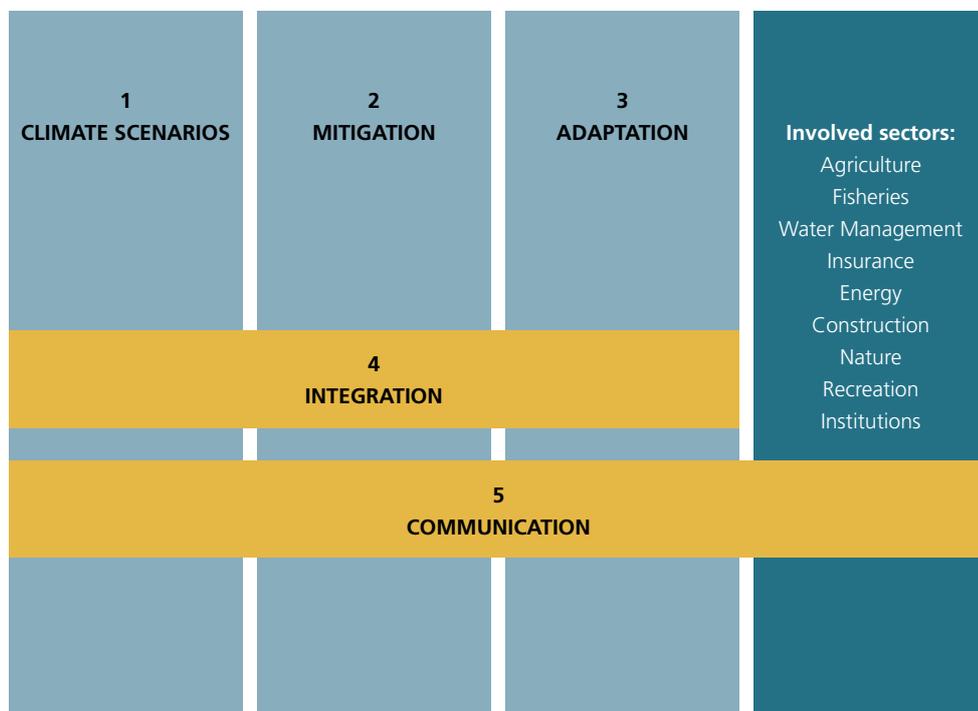
Fourth Assessment Report (AR4), which is presented in 2007. Many researchers in the CcSP programme are contributing to AR4 and it is likely that some initial results of the programme will be assessed in the AR4. CcSP research is complementary with the sixth and future seventh framework research programme of the European Union.

The process studies and development of prototype monitoring systems go along with worldwide monitoring initiatives such as global observing systems (GCOS, GOOS, GTOS) and operational networks of the WMO and UNEP.

**International policy networks**

The CcSP programme is closely related to international policy networks, such as the UNFCCC. For example, the programme co-operated with the Dutch Ministry of Housing, Spatial Planning and the Environment on writing the National Communications. CcSP research contributes to the improvement of the national greenhouse gas inventories and carbon budget on an annual basis to the UNFCCC (following Kyoto protocol and the Marrakesh Accords). The period after 2012 is addressed by contributing to preparation and vision building for the Post-Kyoto era.

One third of the programme's projects link directly to EU research projects. Examples are PRUDENCE (climate scenarios), Carbo-Europe (mitigation), NeWater (adaptation) and ADAM (Integration of adaptation and mitigation).



Main components of the Climate changes Spatial Planning programme.

# Climate information for land use planning



## Introduction

For land use planning and management of natural resources information is needed about possible changes to our climate in the foreseeable future. This information should be available at specific spatial and temporal resolution dedicated to regional scales. Only then information becomes relevant to the local user. Direct output from climate models is often only incidentally of relevance for policy makers and other stakeholders. A communication platform is established to develop climate scenarios that are tailor-made to users involved in mitigation and adaptation strategies. The research within CcSP has the following objects:

- To investigate the role of vital atmospheric processes in shaping our climate and improvement of measurements and modelling of vital climate variables.

- Production of climate scenarios and time series relevant for land use planning.
- Assessing the future by mining the past climate (paleoclimatology).
- Tailoring climate information for end users in a participatory way.

## Uncovering the role of vital atmospheric processes

The primary aim of process studies within CcSP is to improve our understanding of key properties of the climate system. The representation of important processes in climate models ensures that the predictive capability of these models increases. Major weaknesses exist in our understanding of the exchange of energy between surface and atmosphere, of the role of aerosols and clouds in affecting the radiative balance of the earth – atmosphere system, and of the effect of global climate change on regional atmospheric and oceanic circulation. Building on existing expertise in the Netherlands, projects are launched to collect new observational data and to improve the model representation of climate-relevant processes.

A major objective is to contribute to the development of an internationally coordinated ocean observing system by obtaining long term observations of ocean parameters relevant to climate variability (project CS1). Another objective is to quantify the influence of uncertainties in the simulated climate change (for instance, over the tropical oceans) on the simulated climate change over Europe (project CS5).

The Third IPCC-report has identified clouds and aerosols to be a main target area of research to improve climate models. Not surprisingly, the FP6 EU programme has issued several calls in 2003 and 2004 to extend research on clouds and aerosol interactions. The Netherlands seek to contribute to these calls by participating



The 200 m tower in Cabauw with in the foreground the radiation station that is part of the Baseline Surface Radiation Network (BSRN).  
Photo: Wouter Knap (KNMI).



in Networks of Excellence or Integrated Research Projects. The major players in research on aerosols and clouds in the Netherlands cooperate in project CS4. It includes an assessment of the implication of aerosol/cloud interaction for the regional (distribution of) climate change impacts, and an assessment of the effect of regional land use on the regional distribution of aerosol sources. Monitoring of aerosols, among other particles and gases, is taking place at the Cabauw Experimental Site for Atmospheric Research (CESAR) in the Netherlands.

To continue and extend this monitoring project, the programme provides essential infrastructure for continuation, extension and maintenance

of the CESAR observation programme (project CS2). Furthermore, the observations and associated research activities will lead to improved representations of processes concerning aerosols, clouds, radiation, turbulence, land surface fluxes and soil moisture and root water uptake (project CS3) in weather prediction and climate models (project CS6). This is an important activity in order to contribute to a reduction of the uncertainty in climate change scenarios.

### Climate scenarios and time series development

The programme is designed to obtain high quality climate scenarios for the Netherlands, suitable for use in various impact assessment applications. The scenarios are produced using a combination of

### Main structure of the new KNMI climate scenarios

KNMI (Royal Netherlands Meteorological Institute) is the Dutch data and knowledge centre for weather, climate research and seismology. In May 2006 KNMI presented new climate scenarios for the Netherlands (see [www.knmi.nl/climatescenarios](http://www.knmi.nl/climatescenarios)). New insights in possible changes in atmospheric circulation patterns are included in these scenarios, as well as consequences of these changes for extremely wet or dry periods. They will serve as reference climate scenarios for many other projects in the Climate Changes Spatial Planning Programme.

The KNMI'06 climate change scenarios are based on the following rationale:

1. The range of global temperature increase projected by IPCC serves as basis for scenarios in 2050. The observed temperature increase since base year 1990 makes an older 'low' scenario (+0,5°C in 2050) to be redundant.
2. A range of possible changes in large scale atmospheric circulation for Western Europe are accounted for (during winter possibly more western winds, during summer possibly more eastern winds) This results in four regional / local scenarios for the Netherlands and surroundings, based on rising temperatures and changing circulations.

	G +1°C	G+ +1°C	W +2°C	W+ +2°C
Global temperature rise	+1°C	+1°C	+2°C	+2°C
Change in air circulation patterns	no	yes	no	yes
Winter *				
average temperature	+0.9°C	+1.1°C	+1.8°C	+2.3°C
coldest winter day per year	+1.0°C	+1.5°C	+2.1°C	+2.9°C
average precipitation amount	+4%	+7%	+7%	+14%
number of wet days (≥ 0.1 mm)	0%	+1%	0%	+2%
10-day precipitation sum exceeded once in 10 years	+4%	+6%	+8%	+12%
maximum average daily wind speed per year	0%	+2%	-1%	+4%
Summer *				
average temperature	+0.9°C	+1.4°C	+1.7°C	+2.8°C
warmest summer day per year	+1.0°C	+1.9°C	+2.1°C	+3.8°C
average precipitation amount	+3%	-10%	+6%	-19%
number of wet days (≥ 0.1 mm)	-2%	-10%	-3%	-19%
daily precipitation sum exceeded once in 10 years	+13%	+5%	+27%	+10%
potential evaporation	+3%	+8%	+7%	+15%
Sea level				
absolute increase	15-25 cm	15-25 cm	20-35 cm	20-35 cm

\* 'winter' stands for December, January and February, and 'summer' stands for June, July and August.

Regional Climate Modelling, analysis of Global Climate Model simulations, and processing time series of high resolution observations (projects CS7 and CS8). The scenarios include time series which are needed to drive models of river discharges and storm surges for the present and a range of future climate conditions. Special attention is paid to extreme weather events. Efforts in the Netherlands to produce climate scenarios are embedded in a large European-funded research project called ENSEMBLES, where the main target areas for scenario production include the river Rhine and Meuse catchment areas.

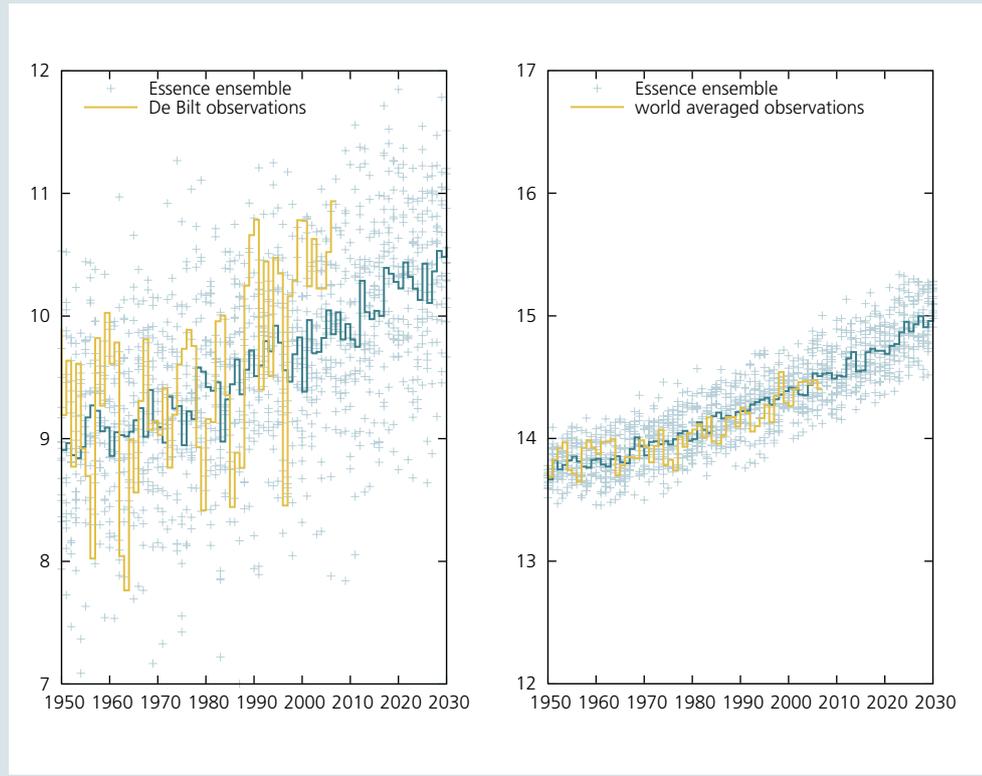
**Analysis of historic climate data**

Our climate archive is vast, and consists of many existing data sets,

encompassing all areas of the globe. A challenging aspect is to explore climate data from the past, which may help to understand today's climate, serve as reference for climate change scenarios, or can be used to evaluate the accuracy of climate models. In a dedicated project (project CS8), high resolution precipitation and temperature datasets covering the 18th century until present will be digitised, at very high (sub-daily) time resolution. In addition, analysis of the paleoclimate contributes to a better understanding of long-term climatic evolution, and provides a wider range of climatic extremes and their impacts on the environment. Paleoclimatic analysis provides the natural background of climatic and environmental conditions without substantial human influence on climate and land use.

Summer temperatures in the Netherlands as observed (in green) and as simulated by a global climate model (in orange). Observed variations in solar radiation, concentrations of the major greenhouse gases (GHG) and aerosols are prescribed until the year 2000. Beyond 2000, changes in the GHG concentrations are prescribed according to a business-as-usual scenario. An ensemble of 62 simulations are produced, differing only in a small random perturbation of the initial

condition. Due to the chaotic nature of the climate system, different but equally likely evolutions of the climate system are obtained. It allows an assessment of rare extreme events such as hot and dry summers. The probability of extremely hot summers, like in 1947 and 2003, increases substantially. This increase is not only due to the rise of the mean temperature, but also to a drying of the soil.



Annual-mean surface temperature for the 17 ensemble members (light blue crosses) of the MPI-ECHAM/OM model run in the context of the Dutch CKO ESSENCE project (see <http://www.knmi.nl/~sterl/Essence>), their mean (blue line) and observations (red line) for (a) the global average and (b) station De Bilt (the Netherlands).

### Development of tailor-made scenarios

For the design of spatial adaptation options, such as flood retention areas, accurate knowledge is required of trends and changing likelihood of extremes. The CcSP programme will deliver regional climate scenarios, tailored to these practical needs. Assumptions to be made in the climate scenario development are assessed jointly with key stakeholders. The practical conditions for efficient use of time series of climatic variables are also identified in a participatory way. Pilot studies are used to serve as an example for other regions and stakeholders in the Netherlands:

- Local and national water management
- Extreme river discharges for the Rhine
- Regional water management
- Crop yield in agriculture
- Projections for wind-energy
- Coastal defence

The aim of the pilot studies is both to develop and to demonstrate the possibilities of tailoring climate information. The tailored climate information will become publicly available.

The increased awareness of climate change results in an increased demand for climate information. The first version of the climate scenarios for the Netherlands was developed in 1998 for national water management. However, new information needs and scientific insights gave rise to a new generation of climate change scenarios, issued in 2006. Insurance companies may be interested in the occurrence of storms. Energy companies are more interested in average and extremely low temperatures in winter. For the construction of bridges information on maximum wind speeds is needed. In the 'Tailoring' project an inventarisation of the information requirements of potential users is made, as well as an overview of available methods and the data that can be delivered.

### Theme Climate Scenarios: overview of projects

- CS1** North Atlantic Ocean monitoring and modelling
- CS2** Monitoring and profiling with the Cabauw Experimental Site for Atmospheric Research (CESAR)
- CS3** Representation of soil moisture and root water uptake in climate models
- CS4** The regional climate impact of aerosols
- CS5** Remote influences on European climate
- CS6** Climate scenarios of wind and precipitation for the Netherlands with a high-resolution regional climate
- CS7** Tailoring climate information for impact assessment
- CS8** Time series information
- CS9** Modelling and reconstructing precipitation and flood frequency in the Meuse catchment during the late Holocene

# Mitigation and land use



## Introduction

Today's concentration of carbon dioxide (CO<sub>2</sub>) in the atmosphere is higher than in the past 420,000 years or maybe even in the past 20 million years, and it continues to rise. Human activities have caused an increase in atmospheric concentrations of greenhouse gases since the pre-industrial era by 30% for CO<sub>2</sub>, by 50% for CH<sub>4</sub> and by 17% for N<sub>2</sub>O [IPCC (2001), Climate Change 2001, The Scientific Basis, Third Assessment Report]. The primary causes are fossil fuel combustion and land use change (deforestation, fen/peat management and agricultural practices). Our understanding of the interactions between land use change and climate is still limited. Natural vegetations and crops can be both a source and a sink for greenhouse gases. For effective and efficient reduction of greenhouse gases in the atmosphere, a clearer picture of these processes is needed.

The CcSP programme picks up the scientific challenge of establishing a full greenhouse gas budget of the Netherlands with acceptable accuracy. This also has political relevance on the long-term. In the hard-fought Kyoto protocol and its successors, parties agreed to reduce emissions for the first commitment period (around 2010) by a relatively modest percentage relative to 1990 emissions, for example 6% for the Netherlands. For post-Kyoto commitments after 2012 much more demanding GHG emission reductions (between 20 and 50%) are foreseen, requiring significant transitions in energy, industry and land use.

Alternatives for fossil fuel combustion such as bio-energy and offshore wind energy have distinctively larger spatial claims compared to conventional energy resources. For example, substituting biomass for oil derivatives in power generation and chemical industry will require vast acreages for growing biomass. GHG 'efficiency' of bio-energy also critically depends on logistics. These issues require a clear but also broad vision of emission reduction options and the development of a long term agenda that leads to their realisation.

## Research aims

There is no single technique available that allows accurate deter-

mination of the GHG balance of the land surface for regions at the size of nations. The CcSP programme intends to contribute to a system that allows the best possible 'bottom up' estimate of the GHG balance of the Netherlands. This system can lead to a better management of GHG emissions, hence emission reductions, and, eventually, observable effects on atmospheric concentrations of GHGs. Therefore, the research has the following aims:

- Verification of emission estimates based upon atmospheric concentration of GHGs with inverse methods. Atmospheric concentrations of GHGs are determined by the net flux in and out of the atmosphere. An important aim of this verification methodology is to separate natural emissions from anthropogenic emissions. For CO<sub>2</sub> the magnitude of gross natural fluxes is an order of magnitude larger than anthropogenic emissions, while for CH<sub>4</sub> and N<sub>2</sub>O natural and anthropogenic emissions are of similar magnitude (project ME2).
- Development of simple, yet physically grounded parameterisations to link small-scale field studies to regional and national-scale GHG flux estimates and to construct land use related emission factors for Dutch natural and agricultural ecosystems (project ME1).
- Assessment of the sensitivity of coupled GHG fluxes and budgets to land use change and water management, in order to identify possibilities for emission reduction (project ME1). Focusing on the Dutch fen meadow areas, it will be investigated how emission reduction can be combined with other policy targets such as nature conservation and water quality improvement (projects ME5 and ME6).
- Development of country specific methods (ranging from simple emission factors to explicit models) to quantify pool changes in forests and soils (Tier-3), instead of using globally identical default values (Tier-1) (project ME3).
- Development of an integrated framework and related analysis tools that can support renewable energy supply systems based upon biomass and wind energy. The research will provide tools to optimise the spatial claims, the climate efficiency (emissions) and energy supply (joules) of renewable energy resources within the Netherlands (project ME4).





Photo: Dolman en Maas.

### New approaches to assess GHG emissions at ecosystem level

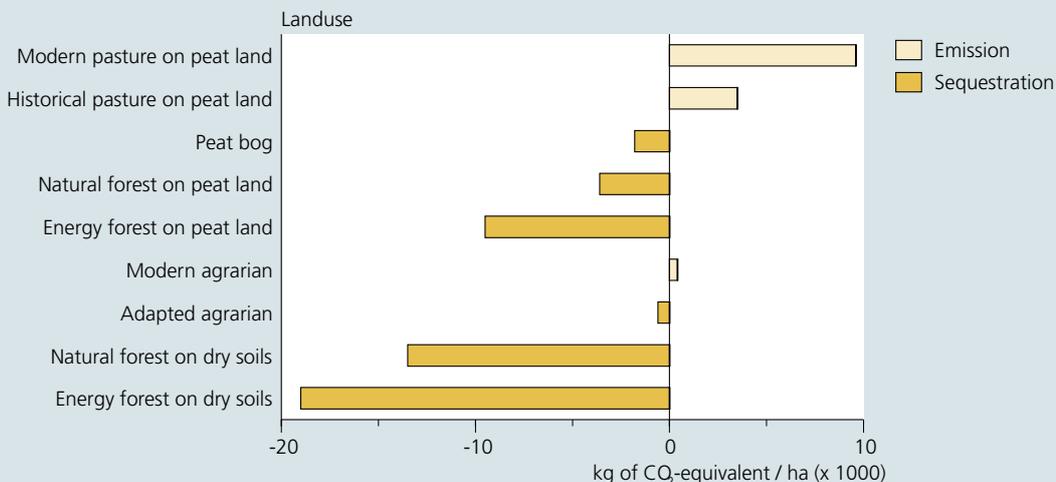
Because of trade-off effects between the emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O gases, the net greenhouse effect can only be assessed adequately if these gases are considered together. A considerable part of the total emissions originates from the land surface. Unfortunately, reliable estimates of land-surface emissions and emission factors are still lacking. Unlike industrial emissions, emissions related to land use are controlled by a combination of biological and climatological factors with potentially positive feedbacks to climate change.

CcSP research quantifies the magnitude and variability of fluxes of water vapour, CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in Dutch landscapes. The programme performs long-term (at least 2-3 years) continuous flux measurements using techniques that allow high temporal resolution of the flux data, and have good intrinsic capabilities of area averaging. Continuous, micrometeorological observations of the fluxes

In fen meadow areas, the conversion of meadow into woodland or marshland is expected to contribute to a decrease in the emission of greenhouse gases. By making areas wetter and intensified agricultural use, oxidation of peat and the rate of land subsidence in the lower parts of the Netherlands will slow down. The land is currently subsiding at the rate of 0.5–1 cm per year. The GHG emission estimates for Dutch fen meadow areas presented in the figure but their dependence on water and farm management are highly uncertain. Therefore, manipulation experiments were designed. The manipulation experiments (project ME1) aim to assess the possibility

of water level management as a tool to reduce GHG emissions. The variability in the short (1-10 years) and the role of land use history in the exchange processes of water, energy and greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, en N<sub>2</sub>O) is addressed. Aspects under investigation are the effect of fertilisation, different groundwater table regimes and animal husbandry management interventions on GHG emissions. Three experimental sites have been identified to represent on one hand undisturbed wetland with a high water table outside agricultural exploitation (Horstermeer), and on the other drained fens under agricultural exploitation (Reeuwijk).

### Emission of greenhouse gasses



Source: MNP (2005) The effects of climate change in the Netherlands, MNP report nr 773001037, MNP Bilthoven (figure 4.12, page 68).

provide such a tool. Also, stand-scale, process-based models will be developed further in order to interpret the data properly, and to design simple, yet physically based parameterisations for upscaling purposes. This modelling effort will provide a basis for the formulation of mitigation strategies. A network of micrometeorological stations will be established to cover relevant ecosystems and land use systems in the Netherlands. The measurements will be executed at three sites that also contribute to the CarboEurope network<sup>1</sup>, the two sites related to a manipulation experiment (see box) and two agricultural sites in Groningen and Noord-Brabant. Additional observations will be made using two quasi-mobile stations, at sites representing ecosystems or land-use systems which can have a large impact in GHG flux balances in the Netherlands.

### Upscaling of GHG emission observation to the national level

The development of a verification tool at a regional to national scale is challenging and in part of a different nature, compared to tools

<sup>1</sup> CarboEurope Integrated Project is a research programme that will provide an assessment of the European Terrestrial Carbon Balance funded under 6<sup>th</sup> framework programme of the European Commission (see <http://www.carboeurope.org/>).

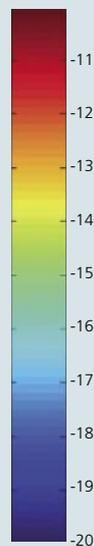
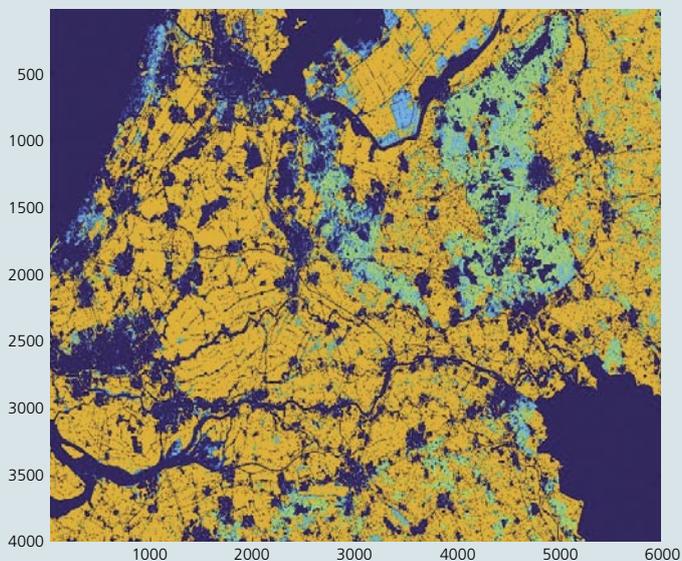
for larger, continental to global scales. Small scale tools have to deal with a number of problems such as a large variability of fluxes between landscapes such as cities and forests, covariance of fluxes and atmospheric planetary boundary layer (PBL) dynamics, the resulting problems of representativity and aggregation of data, and with the poorly known lateral in / out flux of GHGs. Therefore, at these scales it is imperative to make use of all the different data streams and account for the constraints imposed by these data streams. The modelling effort uses knowledge of ecosystem behaviour (natural and man made) and of atmospheric dynamics as embodied in state-of-the-art models (project ME2).

### GHG reporting for land use and forestry towards UNFCCC

The Netherlands is committed to report its land-based national greenhouse gas inventories and carbon budget on an annual basis to the UNFCCC (following Kyoto Protocol and the Marrakesh Accords). The IPCC Good Practice Guidance for Land Use, Land Use

In the methodology to scale up biogenic emissions to the national scale, airborne flux measurements are used. Combining directly observed regional fluxes with simple process models and detailed land cover maps allows spatially explicit modelling of carbon uptake. The graph shows the halfhourly Nett Ecosystem Exchange (NEE) for the central part of the Netherlands. For a 3-week study period the

total forested area in this domain [Miglietta F., et al. (2006), Net regional ecosystem CO<sub>2</sub> exchange from airborne and ground-based eddy covariance, land-use maps and weather observations, Global Change Biology] acted as a sink of 52 kT (green in the graph) while grassland and cropland were sources of, respectively, 39 and 140 kTon of carbon (orange in the graph).

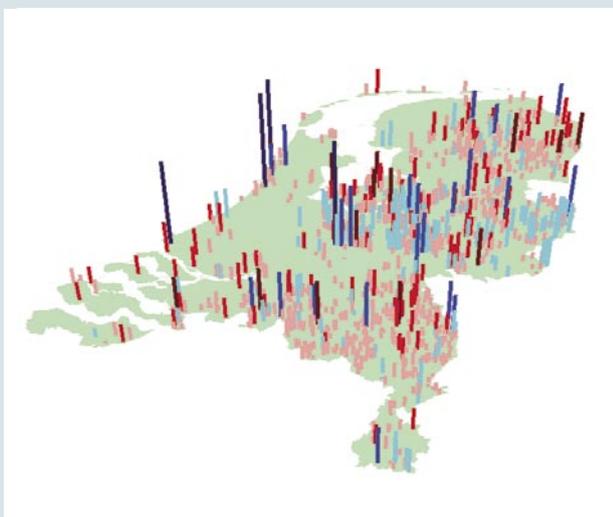


Change and Forestry (LULUCF) requires countries to report their main national emissions and sinks at a high certainty level, and for Kyoto reporting, even at a high spatial distribution. In order to do this, a National System for greenhouse gas reporting of the LULUCF sector has been developed.

CcSP aims to innovate the current, inventory based greenhouse gas budgeting for the Netherlands. This means that annual budgets of all greenhouse gases will have to be assessed to a level of high certainty and on a detailed level of land use type stratification for the following pools: aboveground biomass, belowground biomass, various fractions of litter and soil organic matter. The research improves the current GHG-budget method by distinguishing between these pools, increasing the spatial accuracy, and by relating changes in pools to management activities. In this way the management activities may become accountable for meeting emission reduction targets. In addition, algorithms are needed to downscale the National Emissions database for all categories of sources. We will use more country-specific methods, ranging from simple emission



This figure is based on the National System of Greenhouse Gas Reporting for Forest and Nature Areas under UNFCCC in The Netherlands (2005). It shows the Net flux as assessed for each national forest inventory database data point for the whole of the Netherlands (blue = source due to harvesting, red = sink). This 3D map is a mere visualisation of the spatial distribution of sinks and sources.



Source: Nabuurs, G.J. Wyngaert, I.J.J. van den Daamen, W.D. Helmkink, A.T.F. Groot, W.J.M. de Knol, W.C. Kramer, H. Kuikman, P.J. 2005. National system of greenhouse gas reporting for forest and nature areas under UNFCCC in the Netherlands Wageningen: Alterra, 2005 (Alterra-rapport 1035.1) - p. 57.

factors to explicit models, to quantify pool changes in forests and soils (Tier-3), instead of using globally identical default values (Tier-1) (project ME-3).

### Spatial aspects of renewable energy resources

Renewable energy supply in the Netherlands amounts 2% of the total energy supply (2005). EU policies target 12% of energy supplies should be renewable by 2010, the Netherlands aim at 9%.

### Offshore wind energy

Wind energy is one of the few renewable energy options for which the Netherlands have a clear locational advantage compared to other European countries. At the medium and long-term, wind energy could give a substantial contribution to the total energy supply, up to 50%. Therefore, this option receives a lot of attention in energy policy, press and politics. Cost - benefit analysis for research and implementation of wind energy creates many questions. For the Netherlands, the policy target for offshore wind is 6 GW by the year 2020, of which the recent cost-benefit analysis by CPB and ECN states it is too ambitious for 2020, but possible by the year 2030. Offshore wind could supply much more energy in the later future, but its effects on marine ecology and optimal spatial allocation in an intensely used shelf sea need to be addressed.

### Biomass production and energy supply

Most key global energy outlooks and scenarios expect that biomass will be the most important renewable energy source in the next 50

years. The potential global supply of biomass for energy use is huge. However, the bulk of this potential awaits active development. The Ministry of Economic Affairs states that the Netherlands could cover 1/3 of its energy needs by biomass in the year 2040 ( $\pm$  600 - 1000 PJ) and, in addition, biomass could replace 30-40% of the used oil derivatives in the chemical industry. Experts judge that approximately 10 million ton biomass could be produced in the Netherlands for these goals. However, they also state that great progress needs to be made in technology and policy. Furthermore, economic markets for sustainable energy should become more profitable.

In all possible Dutch scenarios a lot of the biomass has to be imported. This leads to questions about the efficiency of different bio-energy options, and to moral issues concerning competition of biomass production with food production in poor countries. Sustainability of bio-energy has to be assessed, based upon the whole chain of production, logistics, conversion and final use. In the assessment, it should also be taken into account that perceptions about the sustainability of bio-energy are very different between scientists, NGOs and policy makers.

Production and use of biomass for energy and biomaterials need to be aligned with regional conditions. In the specific case of the Netherlands, where the land is scarce and biomass production has to compete with other spatial functions, the present share of bio-energy in the total energy production is still modest (2%). This share could grow to a maximum of 7 - 10% (250 PJ) of the national energy supply, based on the present technology, knowledge and available biomass. If new technologies are used to recover fractions of crops for the production of bulk chemicals and fuels, this potential can be increased [Sanders (2004), Oration Lecture, Wageningen University and Research Centre].

Most bio-energy studies focus on biomass potential. They do not specify how to turn potentially available biomass into actually available biomass, which is the aim of our programme. Tapping into the

national potential is quite difficult because new biomass delivery chains require high investment costs, integration of activities and collaboration between different and unfamiliar stakeholders. On top of that, bio-energy competes heavily with other land use functions in the Netherlands.

To address the possibilities and impossibilities of biomass energy in the Netherlands, the programme develops the following activities (project ME4):

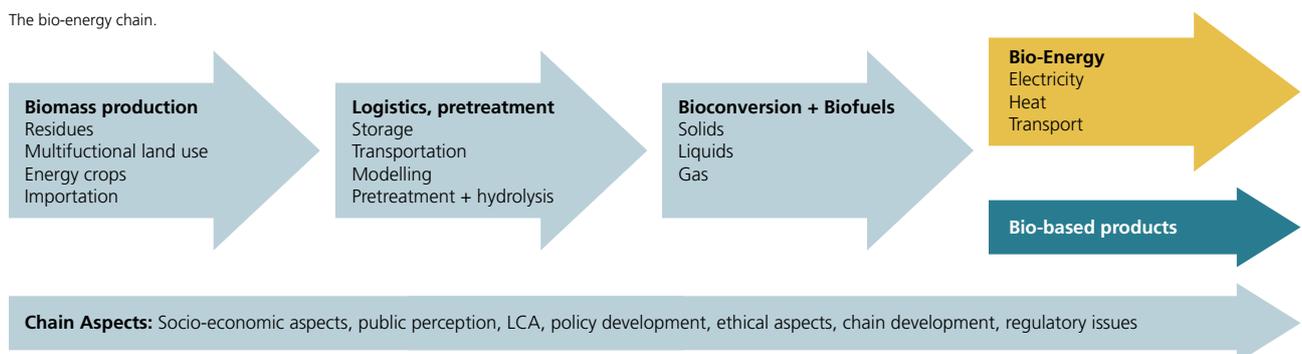
- Performance of a strategic scenario analysis, in cooperation with stakeholders.
- Judgement of bio-energy chains with spatial methodologies as well as an analysis of regional effects of large scale biomass production systems based on case studies.
- Development of methods for sustainability certification of biomass chains.
- Generation of more insight in possibilities for new biomass, including foreign biomass.

#### Theme Mitigation: overview of projects

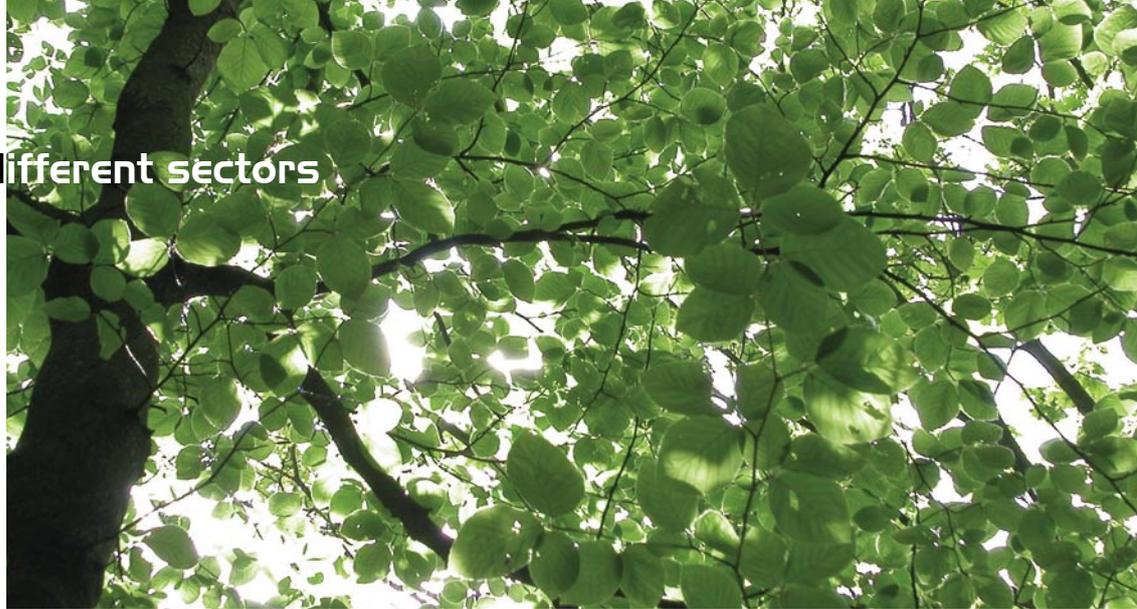
- ME1** Integrated observations and modelling of greenhouse gas budgets at the ecosystem level in the Netherlands
- ME2** Integrated observations and modelling of greenhouse gas budgets at the national level in the Netherlands
- ME3** Soil carbon dynamics and variability at the landscape scale: its relation to aspects of spatial distribution in national emission databases
- ME4** Renewable energy and spatial planning
- ME5** Optimization of the spatial arrangement of Dutch fen meadows for multifunctional use: knowledge base development and participatory decision support
- ME6** Spatial decision support for management of Dutch fen meadows

Under the Integrated Scenarios theme future scenarios for mitigation in land use and other sectors and across regions are addressed, integrated with adaptation measures, and compared using consistent cost-benefit analyses.

The bio-energy chain.



# Adaptation in different sectors



## Introduction

**In the Netherlands, many key decisions about future investments in infrastructure and spatial planning are being taken now. Incorporating climate-change risks and opportunities into these decisions, as was called for by the senate of the Dutch Parliament (Motie Lemstra) in 2005, is therefore essential. Adaptation to climate change does not mean a zero-risk, which would not be realistic or economically viable approach for any country. The acceptable risks are determined to which risk a society or economy wish to accept or to pay for precautionary measures. Moreover, conscious adaptation to climate change also has potential for realisation of new economic opportunities.**

The Netherlands are known worldwide for their knowledge and technical skills to cope with dangers from extreme events such as floods and storm surges. An example is the 'Delta plan', a comprehensive system of protective dykes and surge barriers, which was built to reduce flood risks along the Dutch coast. In economically important and densely populated parts of the Netherlands, the standards of flood defence are the highest in the world; dykes protect these areas from a flood event expected to occur once every 10,000 years. However, we can no longer assume that the future climate can be predicted on the basis of patterns of the past, which was the assumption for the Delta plan. The climate system is too complex and there are too many uncertainties about future socio-economic development, which also determines the level of impact from climate change. The safety standards that were used to design our current protective infrastructure may not longer serve their purpose. Furthermore, applying technical measures only will not meet the requirements for a safe society. Clever adaptation measures are needed that use our space more effectively and that reflect a higher awareness of 'living with increased climate variability'.

## General research aims

The CcSP programme introduces a 'climate proofing' approach for adaptation. Climate proofing does not mean reducing climate based risks to zero – this would be an unrealistic goal for any country. The idea is to use a combination of infrastructural, institutional, social and financial adaptation strategies to reduce risk and optimise op-

portunities for large scale innovations to a quantified level accepted by society [Kabat et al. (2005), Climate proofing the Netherlands, Nature]. Projects within this adaptation theme are realised in a multi-disciplinary network. They aim at developing based upon impacts of climate change and adaptation strategies that are simulated through using climate scenarios prepared under theme 1. Special attention will be paid to climate proofing in the following sectors and regions:

- The Rhine river basin
- The coastal zone (including housing and infrastructure)
- The rural area
- The National Ecological Network (ecosystems and nature conservation)
- The North Sea
- Transport
- Financial arrangements (e.g. insurance as adaptation)
- Practical projects

In a later stage, projects will be commissioned regarding urban planning, tourism, recreation and human health.

## The Rhine River basin

### Cross-boundary issues around floods and droughts

In the Netherlands as well as in Germany measures are taken to alleviate the negative impacts from floods and droughts in the Rhine basin. However, a basin wide discussion on the impacts of future climate change is still in a preliminary stage. Furthermore, each country has its own specific legislation such as safety standards. The flood risk management strategy in the Netherlands presently aims at providing equal safety levels for all areas protected by dikes. Along the Rhine, this target safety level is 1:1250 years for the Netherlands whereas German safety standards are set to 1:500 and in some instances 1:200 years.

The 'full control' flood risk management approach of the Netherlands is questioned by many people. Some consider it ecologically unsound, others too expensive in the long term, and others state that the risks are still unacceptably high in view of the near-flood events of 1993/1995 and the prospect of increasing peak discharges due to climate change.

1976 and 2003 were the last two years in which water shortage had a serious economic (agriculture, energy supply, navigation) and environmental impact on the Netherlands. A major drought is estimated to occur less than once in a hundred years – however, less extreme and local water shortages occur regularly. Climate change is expected to enhance the variability in water excess and droughts.

### Research issues

The current hydrological modelling capacity is not sufficient to adequately calculate effects from both climate change and cross-boundary adaptation measures. High resolution models exist for the Dutch part of the river basin, for example the SOBEK model [Dhondia (2004), Good modelling practice using Sobek – An integrated hydraulics modelling package, World Scientific Publishing Company]. SOBEK is a 1D and 2D model which is also used for flood forecasting in the Rhine basin. However, SOBEK and other available basin wide models for the Rhine lack both temporal resolution and accurate initial soil moisture conditions to simulate the timing of extreme events correctly. Furthermore, the impact of (climate induced) land use change on basin hydrology is not modelled accurately.

The CcSP programme develops a coupled atmospheric-hydrological model describing both the energy and water balance for the whole Rhine basin (project A7) in order to support the development of cross-boundary adaptation measures. Representation of the (non-linear) feedbacks between soil moisture, evaporation, energy balance and precipitation are important research objectives, necessary to assess the effectiveness of adaptation strategies for flood protection and water retention (drought). To unravel these mechanisms, new Soil-Vegetation-Atmosphere-Transfer (SVAT) models are used in a high resolution meso-scale and coupled with SOBEK. These models will be evaluated against existing approaches.

Within CcSP research, adaptive water management is the basic concept for defining adaptation strategies in the Rhine basin. This refers to the ability of both the water system and water management to adjust in characteristics and behaviour, in order to cope with (future) stressors and uncertainties. Combinations of infrastructural, institutional, social and financial adaptation strategies will be evaluated. The effects of these different adaptation strategies on the economy and the environment are determined under different climate scenarios, using the Planning Kit (In Dutch: 'Blokkendoos', developed by WL-Delft for RIZA), and the Waterwise model developed by Alterra (Wageningen UR) in the EU project NEWATER. This analysis is done in dialogue with stakeholders. The project also describes the role and problems of regional water boards in dealing with extreme events. It includes specific spatial planning measures for local water managers as a part of new cross-boundary adaptation strategies.

### Safety in the coastal zone

After the major sea flood in 1953, the Netherlands has invested \$15 billion in today's dollars in the Delta Works to protect the land against such floods. In the nineteen seventies, half way during the construction of the Delta Works, environmentalists and fishermen argued that the complete closure of the Eastern Scheldt was disastrous for nature and fisheries. Stakeholder groups were successful in changing the plans by active public participation in the political debate [Saeijs et al. (2004), Changing estuaries, changing views, Erasmus University Rotterdam and Radboud University Nijmegen]. Instead of a closed dam, a permeable dam was constructed, allowing two-thirds of the tidal volume to pass through.

The safety standards for sea defence in the Delta Plan were based upon the economic capital, the number of people at risk and the knowledge at that time about strength of waves during storms. Since then, the gross national income (GDP) in the coastal zone has increased five-fold. Currently, 70% of the gross national product (GDP) is earned in the Dutch coastal zone. The population living in the Dutch coastal zone increased, and agriculture became less important while recreation increased. In the long run, climate change and sea level rise will lead to situations where the safety against flooding no longer meets the official standards.

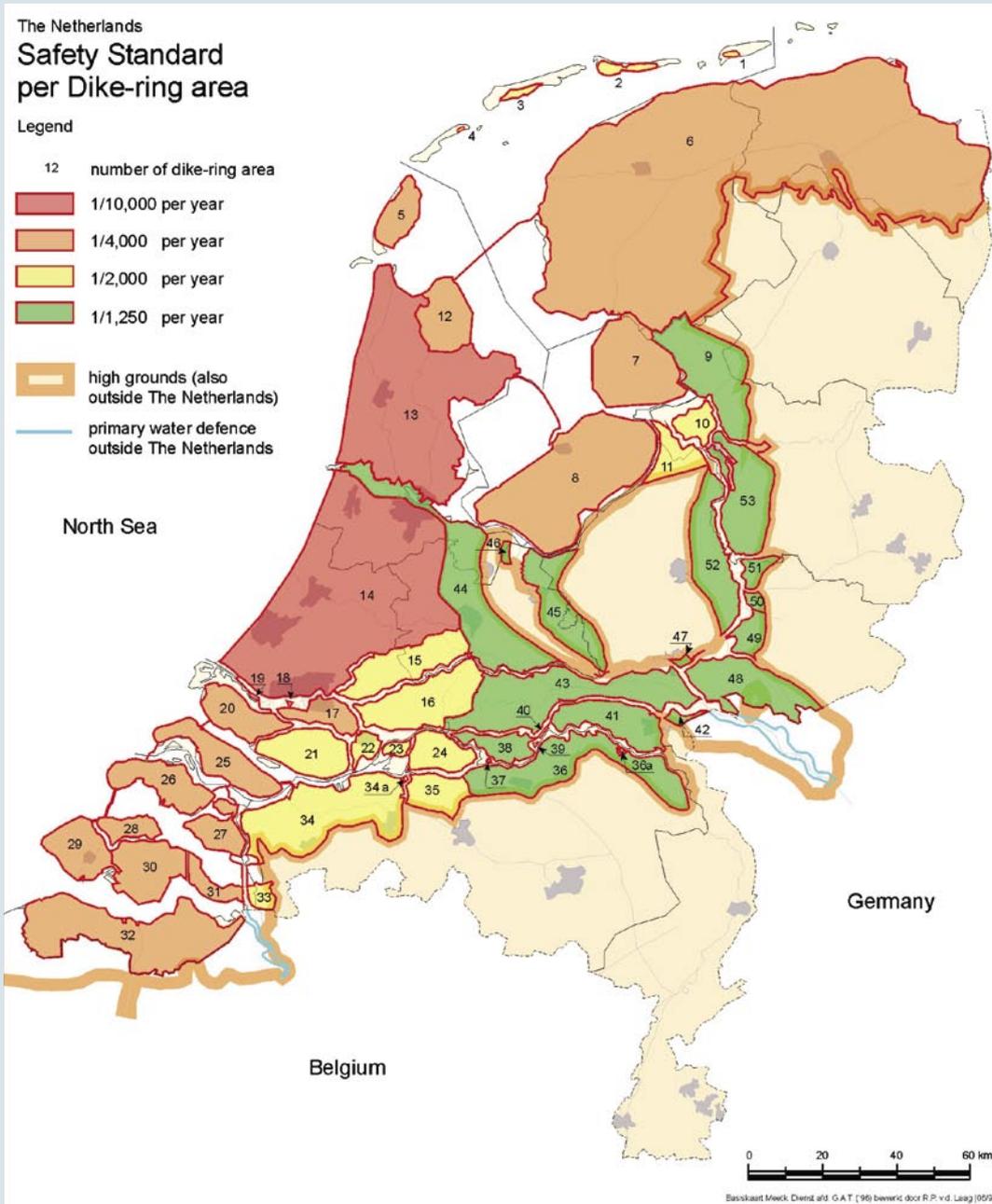
CcSP research contributes to the improvement of long-term policies regarding flood protection in the coastal zone. The assumption is that developing a climate-proof strategy today is more cost effective than taking corrective measures later. The programme improves and develops methods to evaluate long-term policy goals in a changing world, taking the lessons learned from the past, such as the Delta Plan, into account.

Delta Works.



The Netherlands have been divided into so called 'dike areas'. Each of them has specified safety standards. The densely populated areas (provinces of North and South Holland) have to be protected against floods that could occur once in every 10,000 years. The river areas have to be protected against river discharges which could occur

once in every 1,250 years. These standards were determined about 50 years ago. Recent knowledge about climate change, possibly resulting in a rising sea level and more extreme river discharges, has not been included in the current standards.



Source: RWS-DWW.

### The rural area and agriculture

At the moment, there is a large transition of rural areas to non-agrarian use in Europe. This is due to globalisation, increasing imports of agrarian products and lower prices. The EU has decided to fundamentally reform the Common Agricultural Policy (CAP). Although the pace of reform is still unclear, eventually it will result in an abolishment of subsidies and tariffs protecting EU-farmers against internal and external competition.

Climate change impacts are an additional stress factor for the future, but not the main driving force. Adaptation as well as mitigation strategies may offer new opportunities for rural economies in Europe. Landscapes already contribute to the regional income because of their recreational values. Other services such as carbon storage, water management, and natural values may lead to extra income for farmers in the near future. The CcSP programme explores the opportunities and risks of adaptation to climate change for agriculture and the national ecological network in the rural area. Research takes place at the national and regional scale with special attention for multi-functional land use.

### Combination of market and climate scenarios for agriculture

The IPCC Special Report on Emission Scenarios (SRES) has formulated four alternative storylines based on narratives of possible markets and societal developments during the 21st century. For Europe these scenarios are downscaled to EU-15 regions and used in combination with an environmental stratification to assess potential effects of global change on European agriculture for 2020-2080 [Ewert et al. (2005), Future scenario's of European agricultural land use, Agric. Ecosyst. Environ.]. However, the spatial and temporal detail of the obtained results are too coarse for the development of national and regional adaptation strategies. Therefore, the CcSP programme will integrate the IPCC scenarios with the CAP-reform/liberalisation scenario for relevant time slices up to 2080. They will be downscaled for regional application to the EU25 regions (the Netherlands has four: North, South, East and West, three provinces each). The climate scenarios for the regions will be based on the KNMI '06 climate scenarios. Changes in frequency and magnitude of extreme events receive special attention since they function as early warnings for stakeholders and may be crucial for the competitiveness of agriculture in regional economies. This will result in regional 'climate-

Floating Greenhouses. Photo: Dura Vermeer.



and-market-change-integrating-competitiveness-maps' for three agrarian sectors (dairy farming, arable farming and horticulture), showing the expected ability of the four Dutch regions to compete in these three sectors on the European market.

**Pilot study: Adaptive agriculture in Northern part of the Netherlands**

A reliable set of methods to assess the climate robustness of agriculture in the context of market change is not yet available [EEA (2005), Vulnerability and adaptation to climate change in Europe]. The CcSP programme develops such a set of methods in a participatory way. The method will be tested in a pilot region, the Northern part of the Netherlands (provinces Friesland, Groningen, Drenthe). This EU25 area is selected because the present agricultural sector is relatively flexible regarding liberalisation of the market (large holdings) and spatial claims from other sectors are relatively low. Special attention will be paid to adaptive management in agriculture that copes with progressive salinisation and extreme weather events (storms, droughts) due to climate change.

**Pilot study: Multifunctional land use as an adaptation strategy**

Together with stakeholders, new multifunctional spatial arrangements will be explored for the low lying peat meadows in the western part of the Netherlands (Utrechtse Venen) and for the higher sandy area in the eastern part of the country (De Achterhoek; Winterswijk). With this approach we aim to support regional development in the light of climate change, biodiversity conservation and agricultural policy. The economic potential of multifunctional land use will be analysed in the form of 'green' and 'blue' services.

**Ecosystems and landscapes**

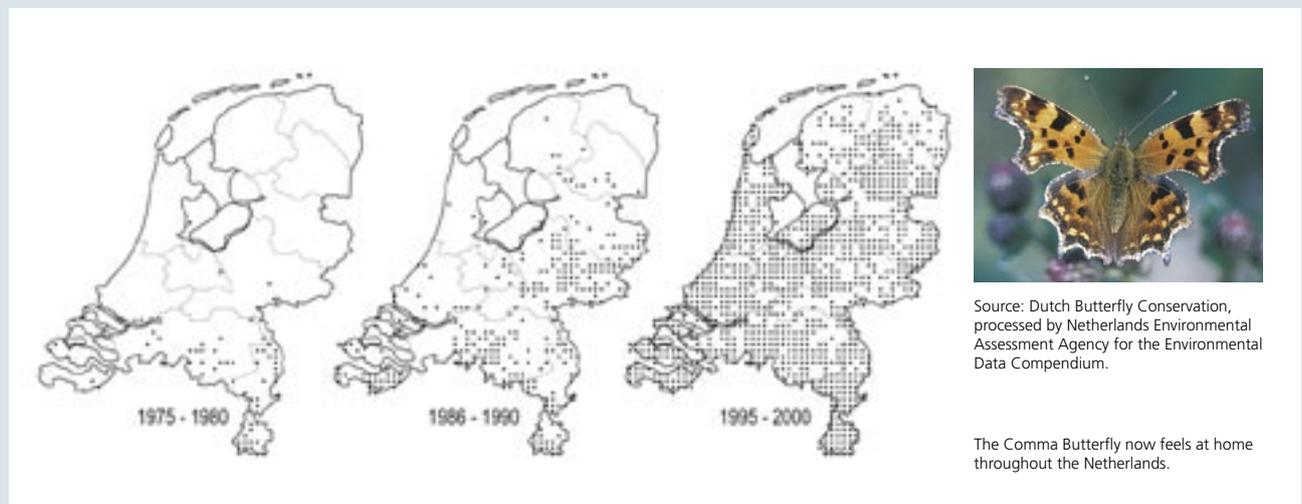
The Dutch National Ecological Network (NEN) is a strategy to conserve biodiversity in a highly fragmented landscape, which is under heavy pressure of an increasing economy and growth of the human population. An ecological network is a set of ecosystems, linked through robust corridors, that provides space for relatively rare species and allows them to migrate from one protected area to another. The NEN incorporates European nature policy targets, e.g. the protection of habitats according to the Habitats Directive. The current design of the NEN assumes a static equilibrium for ecosystems. The design criteria are based on the assumption that the presence of target species will not change under changing conditions, such as climate change. This is questionable.

CcSP research improves our understanding about the resilience of the NEN taking into account the effects of climate change on meta populations, habitat distribution and land use change (projects A1 and A2). Three risk groups can be defined [Cormont (2006), Versnippering en klimaatverandering. Hoe maken we de EHS climate change proof, TOPOS, vol. 2]:

1. Species that are likely to disappear under all climate scenarios;
2. Species for which the Netherlands will become suitable due to climate change, but the fragmentation of the European landscape inhibits migration to the North;
3. Species which are vulnerable to extreme weather events.

Protective measures in landscapes are not planned for single species, and spatial planners are no ecological experts. Therefore, CcSP research will look for simple indicators, focusing on ecological groups

**Occurance of the Comma Butterfly 1975 – 2000**



of species and ecosystems. To provide an empirical basis for these indicators, the programme will analyse current datasets from monitoring programmes, using available ecological models to extrapolate the results in time and space, and to generalise the risks to other groups of species.

### Ecology and use of the North Sea

Although the marine ecosystem of the North Sea has responded to climatic changes throughout its relatively short geological history, there is a growing concern about the present temperature increase and its effects on the ecosystem. Ecological changes are also related to other anthropogenic factors such as fishing and nutrient loading. Seasonal, interannual and even interdecadal changes in the Waddensea and North sea are closely monitored in records of numbers,

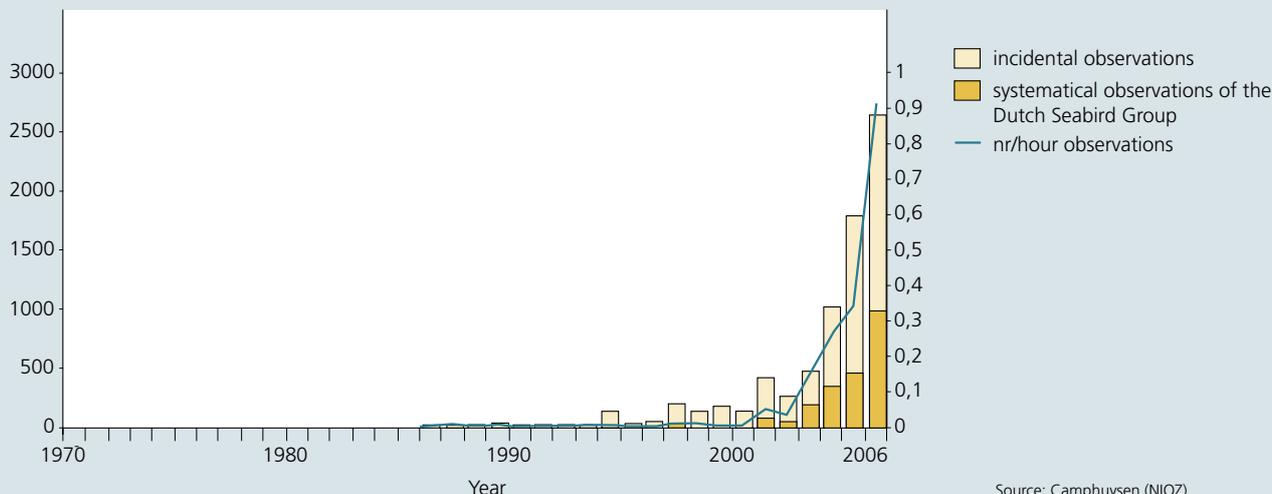
growth rates and compositions of benthic animals, fish and birds. Observations of the plankton composition, the decreased number of seabirds in the northern part and the habitat shift of porpoises indicate that the rise in the temperature of the North Sea is one of the possible causes of all these phenomena.

CcSP generates more insight into the complex relationships between marine food chains, direct anthropogenic influences such as fishing, and climate change by developing indicators of ecosystem performance (project A6). Changes in planktonic CO<sub>2</sub> uptake in the North Sea will be quantified by field measurements and ecosystem modelling. The seasonal and spatial changes of distributions of plankton blooms will be measured by satellite remote sensing. The relationship between temperature, food quantity and quality and steering processes (such as reproduction and recruitment) of the population

The temperature of seawater in the northern North Sea has become higher since the end of the 1980s. It is difficult to determine if the North Sea became warmer due to climate change or due to other factors. For example, the North Atlantic Oscillation (NAO) affects the water temperature, stratification and currents of the seawater as well. Water temperatures already have a measurable impact on the ecosystem of the North Sea. The plankton species that prefer warm conditions have extended northward, whereas the diversity of plankton with a cold preference has decreased. The peak in plankton blooming is not synchronised anymore with the larval stage of fish and, therefore, fewer herbivorous fish reach maturity. This means that a limited amount of food is available for the higher levels in the food chain, such as carnivorous fish (in particular the lesser sand eel,

an important food source in the ecosystem of the North Sea), birds and whales. The harbour porpoise (*Phocoena phocoena*, a small whale) became virtually extinct in Dutch coastal waters in the early 1960's. A small, but gradually increasing number of sightings in the mid-1980's to early 1990's was followed by a proportional rate of increase of 41% per annum over the last 15 years. There is evidence that distributional shifts rather than population fluctuations underlie the observed trends. The re-distribution of harbour porpoises in the North Sea may have been triggered by local reductions or shifts in principal availability of plankton in the Wadden Sea, possibly caused by the observed increase in temperature [Camphuysen C.J. (2004), The return of the harbour porpoise (*Phocoena phocoena*) in Dutch Coastal waters, Lutra 47].

Observed number of porpoises off the Dutch coast (1970 – 2006)



Source: Camphuysen (NIOZ).



dynamics of benthic organisms will be investigated by means of field experiments. These experiments will use autonomous sampling, experimental devices and spatial modelling of benthic population dynamics under different environmental conditions. Modelling will also take into account the consumption and production of fish assemblages over large temporal and spatial scales.

### Transport systems

It is possible that the expected changes in climate will affect the functioning of the transport sector, mainly through changes in daily variation in wind and precipitation. The climate impacts will affect generalised transport costs, defined as the total costs of transport including monetary costs, time costs, costs of inconvenience and costs of unreliability. Changes in generalised costs of transport will affect travel mode choice and travel patterns. In the long run, changes in the transport system will affect location choices of firms and households.

The CcSP programme develops different adaptation strategies for the transport sector (freight and passengers) under different climate

The consequences of climate change scenarios are surveyed for water levels and inland navigation. A possible scenario is that less freight transport will occur to the port of Rotterdam. The freight would then be rerouted towards competing ports in Belgium and Germany, with implications for the Dutch economy and spatial developments around the Rotterdam harbour. The potential loss in market share of inland navigation for various markets is analysed as well as adaptation options.



scenarios (project A8). Impacts are identified, based on research inside and outside the Netherlands, and used to estimate the implications for generalised costs of transport under various climate change scenarios. An analysis is made of the consequences for freight transport including modal shifts, with special attention to the impacts of climate change on inland navigation and its competitive position vis-à-vis rail and road transport, and destination choice, for example the position of Rotterdam Harbour compared to Antwerp. Themes in passenger transport are the impacts of climate change on non-motorised transport modes such as cycling and walking, on public transport, and on the costs of congestion due to higher weather variability. The analysis focuses on the spatial consequences in freight and passenger transport for land use.

### Insurance, risk and disaster

Extreme precipitation, river flooding and droughts can inflict a lot of damage, especially in low-lying deltaic areas such as the Netherlands. IPCC concluded that the amount of damage from weather-related natural disasters in Europe has increased rapidly over the past decades, mainly because of the growth of capital in areas at risk. Climate change will be an additional factor increasing the risk of damage in the future. An emerging question is whether current water management measures are sufficiently robust against extreme weather conditions. In addition, it is needed to identify and evaluate financial tools such as insurance as options for adaptation. Commercial insurance to cover damage from rainfall is available for individual households and very recently also for agriculture (Aquapol). However, since the major flood in 1953, no commercial insurance is available to cover damage due to failures in dikes. In the latter case, the national government acts as an 'insurer of last resort' by providing damage relief.

### Research aims and methodology

The approach followed within the CcSP programme is to develop financial arrangements for flood related risk sharing in the Netherlands, taking climate change into account (project A9). An inventory of the currently available financial arrangements is made, including Dutch and EU policies. Damage risks for different locations are assessed by analysing historic data on damage and extreme weather events. It is investigated how financial strategies can become consistent with water management.

Spatial risk and damage maps for extreme weather events are developed at high resolution for the case study 'Rivierenland', the region in the Netherlands that is enclosed between the rivers Rhine and Meuse. Maps are made both for the current situation and under projected climate change by using the so-called FutureView methodology. The role of FutureView is to depict spatially differentiated possibilities for retention and conservation of excessive precipitation in the present and the future. The results are extrapolated to the na-

tional scale by using the most recent national land use map (LGN4) and attitude map (DEM). The possibilities to redistribute risks and financial arrangements are explored. This includes spatial differentiation of risks and shifts in responsibilities between government and the private sector.

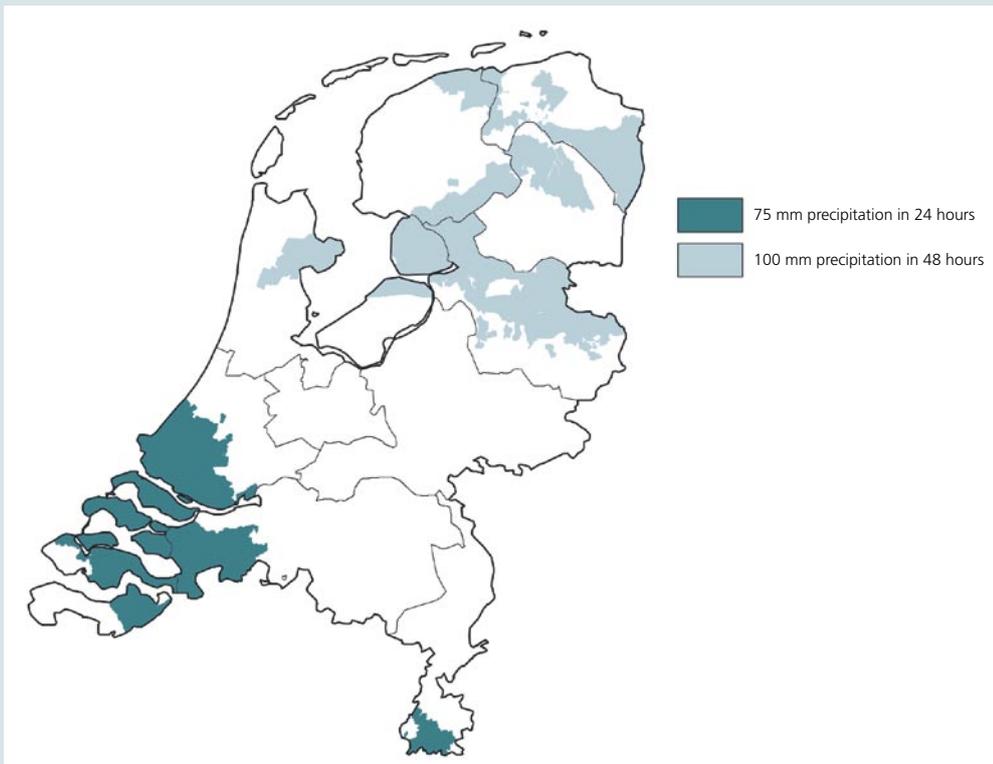
The developed sets of financial arrangements will be evaluated in the context of social, environmental and economical sustainability. First of all, a classification is made of costs and benefit categories, which undergo significant change under considered climate scenarios. Financial arrangements are designed on the basis of risk maps by using mathematical-probability insurance models that take private costs, climate specific risks and interest rates into account. A theoretical analysis is performed to arrive at general insights about

the social welfare aspects of the developed insurance arrangements. Particular behavioural responses of stakeholders are examined through interviews.

Extreme precipitation and agriculture: In 1998, two extreme events took place in two different regions of the Netherlands. Some regions had 75 mm of rain in 24 hours, others 100mm in 48 hours (Map: Alterra, WUR). Total agricultural damage has been estimated

to be 371 million Euro. A part of the damage has been refunded to the farmers by a national law on refunding for natural disasters and large accidents. However, not everything is compensated or even acknowledged as damage by the government.

**Regions that claimed damage under the 'Compensation Damage by Disasters and Heavy Accidents' (WTS) Act in 1998**



Source: MNP, 2005. The effects of climate change in the Netherlands, Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands.

# Hotspots for climate change adaptation



Zuidplaspolder. Photo: Florrie de Pater.

## Introduction

The CcSP programme has selected example areas and sectors in the Netherlands where sensitivity to climate change is expected to be high and where innovative adaptation methods could be implemented, the so-called 'hotspots'. A hotspot can also be a region where in the current situation the ability to adapt to climate change is low, but where a high social and economical output can be achieved by climate proofing the planned (infrastructural) investments. This approach is chosen to promote practical adaptive innovations, in combination with improvement of existing vulnerability frameworks. The key to identifying hotspots is assessing the vulnerability of human interests as well as ecosystems to the impacts of climate variability and change. The term vulnerability is very broad and is explained in several ways in both science and policy. Within this research programme we may add a new dimension to the term.

## The commenced Hotspots are:

- Biesbosch: a freshwater wetland with the status of a National Park, where solutions are sought for high water problems
- Zuidplaspolder, an area near Gouda in which a large number of new houses is planned, even though it is one of the lowest and wettest parts of the Netherlands (project A14)
- Tilburg: a city that has been rewarded as one of the most sustainable cities in the Netherlands, and is now willing to try a new participative concept, involving all local stakeholders to adapt to climate change (project A16)

In a later stage of the programme another two hotspots will be selected. Next to these formally denominated hotspots, several case studies of the projects mentioned before qualify as hotspots: Rivierenland (projects CS7, A7, A9), Utrechtse Venen, Winterswijk (both project A2) and the Northern provinces of the Netherlands.

## Theme Adaptation: overview of projects

- A1 Biodiversity in a changing environment: predicting spatio-temporal dynamics of vegetation

- A2 Strategies for optimizing the nature conservation potential of the Dutch Ecological Network and the surrounding multifunctional farm landscape under predicted climate change scenarios
- A6 Adaptations in the NCP (Netherlands Continental Shelf)
- A7 Adaptations to extreme events in transboundary river basins
- A8 Transport, climate change and spatial planning
- A9 Financial arrangements for disaster losses under climate change
- A10 Hotspots for climate change adaptation
- A11 Routeplanner 2010-2050
- A13 Definition Study: Safety, climate change and watermanagement
- A14 Hotspot Zuidplaspolder
- A16 Hotspot Tilburg

# Integrated scenarios for the future

## Introduction

**Assessments about the nature, rate and impacts of, and responses to climate change are dealing with change in coupled environmental-human systems. Assessments of future strategies concerning climate variability and change, covering mitigation and adaptation are therefore faced with the challenge of making assumptions about future social and economic changes, often over the long-term. In a stand-alone assessment, the analyst would be largely free to develop appropriate, tailored scenarios. In a complex, cross-sectoral research programme, like CcSP, it is useful to develop a set of common approaches and assumptions. Different temporal and spatial scale levels are most relevant to address different aspects of the overall set of questions, calling for due attention for linkages across scales This is one of the major objectives of this theme.**

The projects under the theme 'Integration' are meant to integrate activities within and across themes 1, 2 and 3. Whereas the research in the first three themes is often multidisciplinary, but sectoral, the research under the Integration theme is often partly disciplinary and partly multidisciplinary, but typically cross-sectoral. It will improve consistency across the whole programme. Integration will be achieved by use of

- integrated assessment
- cost benefit analysis
- governance studies
- participatory methods

## General research aims

- To develop a consistent framework for socio-economic scenarios on land use change at the national and regional provincial level, consistent with an international context, that can serve as the backdrop against which to explore and evaluate adaptation and mitigation strategies at the sub-regional and local scale.
- To evaluate, develop and extend land use models and databases in order to project the spatial implications of adaptation and mitigation strategies under different climate scenarios and socio-economic scenarios.
- To develop a set of policy indicators and visualisation tools that supports analysis of potential co-benefits and conflicts of land use change in different sectors (such as nature, water, agriculture) as a result of future climate policy (adaptation and mitigation).
- To investigate how institutional (legal, policy and organisational) frameworks at different administrative levels promote or hamper the realisation of effective, efficient and legitimate climate policy.
- To develop a consistent method for identifying costs and benefits of adaptation and mitigation measures related to land use, taking into account uncertainties, ancillary benefits, non-monetary values and joint outputs.

- To develop a method to map out the argumentation patterns of stakeholders in decision making about climate policy and the use of scientific knowledge in this process.

## Cross-sectoral assessment of adaptation and mitigation

Climate change affects land use at large scales rather than at small scales. However, larger scale land-use changes may affect the potential and viability of mitigation options. At the same time, it will be necessary to explore how local initiatives can contribute to national adaptation strategies, and how potential synergy between sectoral solutions can be realised at the local scale. This should be done in such a way that conflicting claims on natural and economic resources are reconciled as optimal as possible on all different scales. There is a need to identify climate-change driven spatial changes in land use and land development. These changes can then be integrated into balanced national visions and regional solutions for agriculture, industry, housing, nature conservation and water management. For all impacts, integrated adaptation strategies are identified by exploring possible and feasible re-arrangements of land use in the Netherlands at local scale and national scale (project IC3).

The cornerstone for assessing scenarios of land allocation under climate change within CcSP research is the 'Space Scanner' (RuimteScanner / RS model; [Schotten and Boersma (2001), Het informatiesysteem RuimteScanner, KNAG, Vrije Universiteit]). The scenarios will be displayed as a grid map (100x100m) which specifies for each grid-cell either the presence of a specific function (e.g. housing), or the probability of occurrence of a certain function, or the percentage allocated to multiple functions (e.g. housing=60%; agriculture=40%). The RS model is based on the demand-supply interaction for land, with sectors competing for allocation within suitability and policy constraints. This approach requires inputs from sectors, such as agriculture, housing, nature, in terms of suitability maps and land-use claims for adaptation strategies. These inputs are provided by other CcSP projects and other on-going research in the Netherlands. The improved RS model balances competing spatial claims by suggesting allocation solutions grounded in economic rationality. In doing so, the model highlights conflict hotspots and implicitly proposes solutions to intersectoral conflicts for the allocation of the same land.

Case studies for water management and nature conservation are used in order to test the plausibility of the developed land allocation scenarios and derived spatial conflicts with stakeholders. The case studies are also used to validate the downscaling process of climate scenarios to grid maps of 100x100m (case study Rivierenland). The selection of indicators is used to extend the GIS-based evaluation tool LARCH (part of the RS) in order to calculate the costs and economic benefits of developing ecosystem networks under climate change.



In the area of Waterboard Rivierenland, the provincial government estimated that 22,000 acres are necessary to accommodate possible floods resulting from peak river discharges of the River Rhine and Meuse for a total quantity of 18,5 million m<sup>3</sup> water. This is based upon the central climate scenario from KNMI (1997). To find sufficient land surface, the province of Gelderland and waterboard Rivierenland have determined a (multi-dimensional) search area of around 44,479 acres in their draft water management plan. The main challenge for land allocation lies in making these search areas smaller by multiple land use combined with water storage [ESPACE (2004), Guiding Models for Water Storage].

Another need is to develop, improve, and test an overall framework for assessment of national, land use related mitigation options in an international context. CcSP research will improve the land use module of the IMAGE 2.4 model [Bouwman et al. (editors) (2006), Integrated modelling of global environmental change. An overview of IMAGE 2.4, MNP] and allow for downscaling of key indicators. The IMAGE model, already advanced in its detailed treatment of land use under alternative policies, will be further enhanced to serve the purposes of the CcSP programme (project IC2). New capabilities will address climate related crop growth factors, including irrigated systems (water availability) and enhanced region specific factors and processes determining land allocation. CcSP research improves this by integration of new crop growth models (Lund-Potsdam-Jena models, LPJ; [Prentice I.C., et al. (2006), Dynamic global vegetation modelling: quantifying terrestrial ecosystem responses to large-scale environmental change. In: Terrestrial Ecosystems in a Changing World], forestry models (EFISCEN), socio-economic land allocation models (GTAP, LUMOS, CLUE) and hydrological models (LPJ). Changes in climate variability and their impacts on managed and unmanaged land-use activities will be considered specifically as well.

This overall framework based upon IMAGE 2.4 will be coupled with decision support systems (DSS) for mitigation strategies aimed at European wide, national, regional and farm level. These decision support systems evaluate environmental policies directly related to greenhouse gas emission reductions and also include the indirect effects of policies related to water, air and soil quality (chemistry). The regional DSS take possible interactions, feedbacks and trade-offs into account with reference to stakeholder perceptions of viability and acceptability, and economic effectiveness.

### **Cost-benefit analysis of adaptation and mitigation strategies**

A fundamental problem is how to assess the costs and benefits of various mitigation and adaptation options for climate change and land use in the Netherlands, given the uncertainties and irreversibili-

ties of climate change. In a policy setting the calculation of the full costs and benefits of alternative adaptation and mitigation strategies is not sufficient, because investment costs are to be distributed amongst separate funding agencies and stakeholders with different goals and associated evaluation criteria. Calculating incremental costs of separate components of an investment does not provide an adequate solution either, as most projects cannot be broken down into separate constituent parts so simply.

Another methodological issue regarding cost benefit analysis (CBA) for climate policies is how to deal with short-term costs and long-term benefits. For example, if adaptation strategies are implemented too early, irreversible investment costs are made. On the other hand, if the policies are implemented too late, serious and irreversible damages will occur. Furthermore, it is difficult to express the effects of investments in climate policies on the environment, nature and safety in monetary terms, because there are no well established markets, and therefore no prices for these goods.

CcSP research focuses on the methodological issues for cost benefit analysis (CBA) and multi-criteria analysis (MCA) in a spatially explicit and dynamic context, including ancillary benefits and the issue of how to allocate costs to various domains, if ancillary benefits exist (project IC5). This implies a novel approach, because very often in traditional cost benefit analysis the focus in the design of projects is on single issues, and impacts on other policy domains are analysed only partially. By practical application of research in a couple of case studies, special attention is given to spatial claims related to biomass production and its implications for agriculture and nature conservation, water management (including retention areas) and spatial claims for recreation, housing and infrastructure in river systems and coastal zones.

The analysis is in line with the OEI-method. This is the national guideline for cost benefit analysis for infrastructural investments applied by the Netherlands Bureau for Economic Policy Analysis (CPB). The analysis of CcSP contains several extensions, related in particular to the question of how to deal with risk and uncertainty. The research is based on economic valuation methods that are appropriate, like CVM, hedonic pricing, production function approach, travel cost method for recreational values and a valuation of possible impacts, based on the stated preferences on risk reduction. The choice of these valuation methods depends on the specific aspects that are included in the costs benefits analysis. The position of various stakeholders in water management is analysed by means of game theory.

### **Government, governance and climate change**

Climate change is expected to become a major driving force in spatial planning in the

Netherlands. National climate policy is currently still centrally governed and includes energy policy, nature policy, agriculture, industry, urban infrastructure, waste, transport and water. Since 2000, spatial planning in the Netherlands generally acknowledges that the traditional 'admission planning' (e.g. restrictive regulatory measures and zoning plans which state what is and what is not permitted in a specific area) is no longer adequate. The concept of 'development planning' was introduced, which means that the freedom in decision making for provinces, private enterprises and local communities will be increased (decentralisation).

Governance studies within CcSP assess the robustness of the Dutch institutional infrastructure in the light of climate change, decentralisation and integration of sectoral policies. The framework of national spatial and climate policy and legislation is a central focus. The research includes the domains of water management, agriculture (including biomass), nature conservation and urban planning. It investigates at which points the institutions can be improved in order to increase the adaptive capacity. It also researches how international instruments relate to national, regional and local policies. Policies that are relevant at EU and international levels include regulations, directives and agreements on water (both fresh and coastal), agriculture, nature and the building sector. CcSP research analyses the textual (formal understanding of the relationships between relevant instruments) as well as the contextual (how people use and interpret these instruments) level.

### **Participatory methods for a multi-stakeholder dialogue**

Over the last decade, there has been a growing attention for participatory approaches in integrated environmental assessment. There is still much work to do on improving the quality of participatory assessments, especially the ability of stakeholder assessments to articulate and reflect upon conflicting knowledge claims, which play a role in problematic issues like climate change. The articulation of knowledge claims is not the exclusive domain of scientific experts, since stakeholders may surpass scientists by their expertise in specific knowledge domains. The basic assumption underlying the concept of Integrated Assessment is that the outcomes of scientific tests may help stakeholders to make choices with respect to the preferred course of action. Hence, it is necessary to develop a method supporting stakeholder assessments by mapping out the argumentation patterns of the different actors (stakeholders and scientists in particular) involved in a specific issue (project IC8).

CcSP's primary aim is to address the need for methods and tools that may, in a structured and transparent way, assist in the articulation and assessment of conflicting lines of argument, thereby using the available scientific information from CcSP research on climate change. Theories that have been developed to capture and understand different lines of argument in policy and science discourse

will be studied, such as the Policy Delphi Method, Repertory Grid Analysis and Multi-Criteria Analysis. This is done in order to build a typology from these conceptual models. Models and scenarios that have been used in previous stakeholder dialogues about climate change in the Netherlands will be evaluated. The final goal is to develop and test a method in different participatory assessments, carried out in the context of CcSP research.

### **Theme Integration: overview of projects**

#### **IC1 Communication theme (see COM projects)**

**IC2** Integral analysis of mitigation options within sectors and regions

**IC3** LANDS: Land-use and climate change;

**IC5** Cost-benefit analysis of adaptation and mitigation strategies

**IC8** PRObing a method to Facilitate the Interactive Linking of Expert knowledge to Stakeholder assessment

**IC10** Communicating climate change: tools for framing climate risks and benefits

**IC11** Socio-economic scenarios for climate change assessments

**IC12** The Dutch institutional framework and governance of adaptation strategies



# Communication



## Introduction

The communication activities contribute to achieving the overall objective of the Climate changes Spatial Planning programme, which is to strengthen the Dutch knowledge infrastructure by increasing insights into the relationship between climate change and land use, transferring scientific knowledge to target groups in society and transferring practical know-how to scientific target groups.

The objectives of the communication by the Climate changes Spatial Planning programme are:

- To ensure that parties with a role in spatial planning are well informed about the results of scientific research into climate change and to make them conscious of their role in limiting the effects of and responding to climate change.
- To ensure that scientists in the climate domain are well informed about the latest developments in policy and practice in relation to spatial planning.
- To create support within society for climate policy by keeping the general public informed about climate change.
- To strengthen education in the field of climate and spatial planning.

The communication activities focus on specific target groups in the scientific community and civil society, on governmental bodies and on the general public. Different objectives were formulated for the different target groups, depending on the extent to which they already are involved with the CcSP programme: the proximate–remote dimension. Using this criterion, three broad target group – target combinations were identified:

- The groups that are already involved in the knowledge consortium. This group consists of many scientists, people from governments, NGOs and the business community. They submit projects, carry out projects or are represented in the organisational structure such as the Board or the Programme Council. For this group the objective is to strengthen the network, in other words to intensify the relationships between the various parties and foster the exchange of knowledge.
- The parties that need to be involved more closely with the programme are people from provincial and local authorities,

water boards, the business community, and NGOs. The objective is to draw these people into the knowledge consortium and initiate a dialogue with them. These target groups have the highest priority in the communication strategy.

- The general public of the Netherlands. The objective is to inform this group, or give them the opportunity to stay informed. A well-informed public will help to achieve the overall objective of the programme. After all, well-informed citizens can force private organisations and governmental bodies to give more backing to climate programmes.

## Scientists

The Programme Office is an important body regarding the day-to-day communication with the involved people and scientific institutes from the consortium. The Programme Office organises workshops and symposia in order to tighten co-operation between involved parties. The programme website [www.klimaatvoorruiimte.nl](http://www.klimaatvoorruiimte.nl) and a two-monthly e-newsletter are managed and produced by the Programme Office. In addition, a virtual data portal is developed to allow the research projects to exchange data.

## PhD summerschools

Approximately 40-50 PhD positions have been initiated by the CcSP programme. Given the multi-disciplinary character of the research programme it is important that this group of young researchers is able to follow tailored, high quality training programmes with contributions of international experts (summer schools). These summer schools are also open for people from outside the Netherlands. An important secondary objective is that PhD researchers learn to work in multi-disciplinary groups and become experienced in writing multi-author papers and reports.

## Platform on Communication on Climate Change (PCCC)

PCCC is a scientific platform to strengthen collaboration between research institutes in communication about climate change research towards society. The platform discusses the role of science in the public and policy domain (self-reflection) and enhances scientific debate about controversial issues regarding climate change. The

platform produces brochures and hosts the website [www.klimaat-portaal.nl](http://www.klimaat-portaal.nl) in order provide society with basic scientific information regarding climate change.

### Regional policy makers and the business community

Since establishing a dialogue with the stakeholders is an objective of the communication strategy, intensive dialogue is at the heart of all communication activities. Communication activities are linked to the various research domains in the CcSP programme and to the regions or scales at which the studies are being conducted.

A dialogue is initiated by organising workshops and symposia supported by the Programme Office. However, this is not enough. Personal contact with stakeholders is the most effective form of communication and therefore the CcSP programme has installed a network manager whose principal task is to maintain relations with the provincial and local authorities, water boards, central government, the ministries, political parties and the business community. The members of the executive bodies of the CcSP programme (the Board, the Programme Office, the Programme Council, the Social Advisory Council, the International Scientific Advisory Council) and the projectleaders will also be actively involved in this process. Even in the internet age there is still a place for the printed word.

CcSP does not issue its own magazine but looks for strategic alliances with other partners in order to produce magazines tailored for specific target groups. The function of special issues devoted to climate change is to create a bond between members of a particular professional community, to keep them informed of the latest news and to present information in a less transient format than a website.



In March 2005, the Senate of the Dutch Parliament called attention for the fact that the national government did not take climate change into account in key decisions such as major spatial investments. A dialogue between policy makers and the CcSP was initiated. Finally, on the 29th of November 2005 the congress 'Coping with Climate Change in Dutch institutional multi-level governance

networks' was organised by the CcSP programme in Scheveningen. About 250 policymakers and scientists participated and the Dutch prime minister Jan-Peter Balkenende announced the launch of ARK (Adaptation Programme for Spatial Planning and Climate), an broad policy initiative in order to enhance the development of climate-proof spatial investments.

Photo's: Michelle Muus.



### The general public

The visible changes taking place in the present time and in their own environment are actively communicated to the public in several ways. Mass media (television, newspapers) will play a role in this effort. The main strategy is to get 'free publicity' at moments when the public and media are susceptible, for example, when international environmental meetings are on the agenda or when extreme weather conditions occur. The CcSP programme collaborates intensively with intermediary organisations (NGOs, government) in communication towards the general public. Other important tools to reach the general public are education at secondary schools and the internet, such as Nature's Calendar (project COM6).

### Education for secondary schools

Teaching methods about climate change for secondary schools encompass the entire chain from producing the teaching materials through marketing and distribution to incorporation in the curricula for examination purposes. Besides awareness raising, a secondary objective of education about climate change is to encourage school

children to choose a technical education in their later life. Education packages include not only the upper segment of secondary education (HAVO, VWO) but also Preparatory Secondary Vocational Education (VMBO), which has the largest intake of students.

### Theme Communication: overview of projects

- COM1** A virtual dataportal for CcSP projects
- COM2** Quickscan climate communication in the Netherlands
- COM3** Platform Communication on Climate Change (PCCC)
- COM4** Network Officer
- COM5** Programme website ([www.klimaatvoorruijnte.nl](http://www.klimaatvoorruijnte.nl))
- COM6** Natures Calendar ([www.natuurkalender.nl](http://www.natuurkalender.nl))
- COM7** Summerschool Climate and the Hydrological Cycle
- COM8** The National Climate Change Quiz (Television programme 2005)
- COM9** Special issue Change Magazine
- COM11** Delta's on the move
- COM12** PhD education
- COM13** School education

Nature's Calendar ('de Natuurkalender') is an ecological monitoring programme based upon observations from approximately 5000 volunteers. The goal of this project is three-fold. First of all, Natures Calendar is an important tool to raise awareness about climate change in a broad audience in an interactive way. Secondly, it supports scientific research by delivering a large volunteer network that is able to do ecological observations. Thirdly, Natures Calendar develops modules to implement phenological observations and models

in the practice of health services, agriculture and (public) gardening. It is an innovative example in which ecological research is combined with several communication tools, such as the internet ([www.natuurkalender.nl](http://www.natuurkalender.nl)), radio broad casting (every Sunday at national level), Nature Pubs for Children and educational work packages. In 2004 en 2005, about 200 national and regional newspaper articles were written about Natures Calendar and 30 TV programmes paid attention to this CcSP communication project.



Photo: Arnold van Vliet.

# Organisation & Finance



A broad consortium (see overview of partners), consisting of scientific institutes, ministries, NGOs and regional institutional bodies have initiated the 'Climate changes Spatial Planning' programme. The development of the programme and its management is coordinated by Wageningen UR, Vrije Universiteit Amsterdam, the Netherlands Environmental Assessment Agency (MNP) and Royal Netherlands Meteorological Institute (KNMI). A foundation was set up to act

as a legal body to interface between the government and the consortium and execute the CcSP research programme. The Board of the Foundation, chaired by prof.dr. Pier Vellinga, decides about the allocation of the budget, supported by scientific advice from the Programme Council, which is led by the scientific director, prof.dr. Pavel Kabat.



Prof.dr. Pier Vellinga.  
Photo: Com VU/Peter Smith.

Prof.dr. Pavel Kabat.  
Photo: Bright Design.

Kees Dorland.  
Photo: Daniëlle Roeleveld.

The Programme Council, chaired by prof.dr. Pavel Kabat, is responsible for the preparation of the strategic planning contents of the programme. It represents the main scientific disciplines involved as well as representatives from the involved stakeholders.

## Board Foundation

<b>Prof.dr. Pier Vellinga</b> <i>(chair)</i>	Vrije Universiteit Amsterdam
<b>Prof.dr. Wim van Vierssen</b> <i>(vice chair)</i>	Wageningen University and Research Centre
<b>Toon Bullens</b> <i>(treasurer)</i>	Interpolis N.V.
<b>Jan G.A. Coppes</b>	Witteveen en Bos
<b>Kitty E. Roozmond</b>	IPO
<b>Sible Schöne</b>	Klimaatbureau
<b>Dr. Frits J.J. Brouwer</b> <i>(observer)</i>	Royal Netherlands Meteorological Institute
<b>Joop A. Oude Lohuis</b> <i>(observer)</i>	Netherlands Environmental Assessment Agency
<b>Kees Dorland</b> <i>(ex-official)</i>	Vrije Universiteit Amsterdam
<b>Prof.dr. Pavel Kabat</b> <i>(ex-official)</i>	Wageningen University and Research Centre

## Programme Council

<b>Prof.dr. Pavel Kabat</b> <i>(chair)</i>	Wageningen University and Research Centre
<b>Prof.dr. Frans Berkhout</b> <i>(vice chair)</i>	Vrije Universiteit Amsterdam
<b>Dr. Jeroen Aerts</b> <i>(theme co-ordinator Adaptation)</i>	Vrije Universiteit Amsterdam
<b>Prof.dr. Bart van den Hurk</b> <i>(theme co-ordinator Climate Scenario's)</i>	Royal Netherlands Meteorological Institute
<b>Dr. Ronald Hutjes</b> <i>(theme co-ordinator Mitigation)</i>	Wageningen University and Research Centre
<b>Dr. Tom Kram</b> <i>(theme co-ordinator Integration)</i>	Netherlands Environmental Assessment Agency
<b>Florrie de Pater</b> <i>(theme co-ordinator Communication)</i>	Vrije Universiteit Amsterdam
<b>Prof.dr. Ekko van Ierland</b>	Wageningen University and Research Centre
<b>Erik Schellekens</b>	Arcadis
<b>Dr. Bart van Tooren</b>	Natuurmonumenten
<b>Remko Ybema</b>	Energy Research Centre
<b>Kees Dorland</b> <i>(observer)</i>	Director Programme Office Climate changes Spatial Planning
<b>Dick Brand</b> <i>(observer)</i>	Ministry of Housing, Spatial Planning and the Environment





Programme Council and Programme Office in September 2005.  
 From left to right standing: Jos Bruggink, Jeroen Aerts, Judith Klostermann, Bart Makaske, Danielle Roeleveld, Eric Schellekens, Ottelien van Steenis, Ralph Lasage, Juan Selva Lopez, Ekko van Ierland, Dick Brand, Kees Dorland, Bart van den Hurk, Ronald Hutjes, Tom Kram. From left to right sitting: Jeroen Veraart, Pavel Kabat, Frans Berkhout.  
 Photo: Judith Klostermann.

Daily management of the CcSP programme is done by the Programme Office, led by Kees Dorland. It includes scientific support to project leaders, administration, communication and the organisation of workshops and symposia.

The International Scientific Advisory Committee (ISAC), chaired by prof.dr. Leen Hordijk (IIASA), consists of world-leading scientists. The Societal Advisory Committee (SAC), chaired by prof. Pieter Bouw (former CEO of KLM and Swiss Airlines) evaluates the programme mid-term and at the end (on programme level). The societal board includes top-management people from the ministerial departments, NGOs and private sector. They do not have a formal evaluation function, but they give, at any time, advice to the programme and have an important role in making the programme known at the national decision making level.

For further information visit our website: [www.klimaatvoorruijmt.nl](http://www.klimaatvoorruijmt.nl)

### Quality assurance of the CcSP programme

In 2003, before the start of the CcSP programme, the programme proposal was reviewed by international scientific reviewers coordinated by the Royal Dutch Academy of Sciences (KNAW). From the 32 proposed research plans the CcSP programme received the highest score regarding scientific quality. The Netherlands Bureau for Economic Policy Analysis (CPB) evaluated the socio-economic relevance of this research and concluded that this investment in knowledge infrastructure was legitimate. CPB also gave recommendations to increase the economic relevance. A revised research plan was set up based upon these reviews, which was finally commissioned by the Dutch government in November 2004.

At the programme level the progress of the CcSP programme is yearly monitored by a monitoring team consisting of SenterNovem (an agency of the Ministry of Economic Affairs), NWO (Dutch national Science foundation) and a governmental expert panel. This monitoring team reports yearly towards the Dutch government on how the commissioned subsidies are be-

ing spent. This team is also responsible for the mid-term review (planned in 2007) and the final evaluation of the results towards the government.

Each individual project within the programme is reviewed on its scientific quality and social relevance. We make a distinction between scientific projects and communication & practically orientated projects within the quality assurance trajectory. This is necessary in order to bridge our two-fold objective to deliver high quality science and to be practically useful.

### Scientific projects

A prerequisite for funding of a research project is a positive review of the project proposal by NWO. Each project proposal is also judged on societal and economic relevance by at least two independent and anonymous reviewers who are appointed by the Board of CcSP. Based upon these reviews the Programme Council formulates an advice for each project proposal, which in turn is the basis for the decisions of the Board.

### Communication and practically oriented projects

Society and policy making is dynamic. During the first year of the programme (2005) it appeared that it was also necessary to accommodate projects that were able to react on dynamic information needs within the Dutch governments. These projects answer practically oriented questions on a regional level regarding climate proofing of spatial decisions. These type of projects are designed for knowledge transfer and valorisation of knowledge. These projects are only reviewed on their socio-economic relevance and consistency within the CcSP programme by the Programme Council.

### Finance

The Programme is financed by the Dutch decree on subsidies for investments in the knowledge infrastructure (BSIK, formerly ICES-KIS-3). The total budget of the programme is about 90 million Euro of which 40 million is funded by BSIK. The rest of the budget consists of contributions from consortium partners.

# Overview of projects\*

## Climate scenarios

- CS1** North Atlantic Ocean monitoring and modelling
- CS2** Monitoring and profiling with the Cabauw Experimental Site for Atmospheric Research (CESAR)
- CS3** Representation of soil moisture and root water uptake in climate models
- CS4** The regional climate impact of aerosols
- CS5** Remote influences on European climate
- CS6** Climate scenarios of wind and precipitation for the Netherlands with a high-resolution regional climate
- CS7** Tailoring climate information for impact assessment
- CS8** Time series information
- CS9** Modelling and reconstructing precipitation and flood frequency in the Meuse catchment during the late Holocene

## Mitigation

- ME1** Integrated observations and modelling of greenhouse gas budgets at the ecosystem level in the Netherlands
- ME2** Integrated observations and modelling of greenhouse gas budgets at the national level in the Netherlands
- ME3** Soil carbon dynamics and variability at the landscape scale: its relation to aspects of spatial distribution in national emission databases
- ME4** Renewable energy and spatial planning
- ME5** Optimisation of the spatial arrangement of Dutch fen meadows for multifunctional use: knowledge base development and participatory decision support
- ME6** Spatial decision support for management of Dutch fen meadows

## Adaptation

- A1** Biodiversity in a changing environment: predicting spatio-temporal dynamics of vegetation
- A2** Strategies for optimising the nature conservation potential of the Dutch Ecological Network and the surrounding multifunctional farm landscape under predicted climate change scenarios
- A6** Adaptations in the NCP (Netherlands Continental Shelf)
- A7** Adaptations to extreme events in transboundary river basins
- A8** Transport, climate change and spatial planning
- A9** Financial arrangements for disaster losses under climate change
- A10** Hotspots for climate change adaptation
- A11** Routeplanner 2010-2050
- A13** Definition Study: Safety, climate change and watermanagement
- A14** Hotspot Zuidplaspolder
- A16** Hotspot Tilburg

## Integration

- IC2** Integral analysis of mitigation options within sectors and regions
- IC3** LANDS: Land-use and climate change
- IC5** Cost-benefit analysis of adaptation and mitigation strategies
- IC8** PRObing a method to Facilitate the Interactive Linking of Expert knowledge to Stakeholder assessment
- IC10** Communicating climate change: tools for framing climate risks and benefits
- IC11** Socio-economic scenarios for climate change assessments
- IC12** The Dutch institutional framework and governance of adaptation strategies

## Communication

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\* as of January 2007



# Overview of consortium partners and extended partners\*



## Consortium partners

Arcadis  
CBRB, Central Office for Rhine and Inland Navigation  
COS Nederland, the Netherlands Association of centres for international cooperation  
ECN Energy Research Centre of the Netherlands  
FSD Foundation for Sustainable Development  
Futurewater  
Port of Rotterdam  
KIWA NV, water research  
KNMI, Royal Netherlands Meteorological Institute  
Leiden University  
MNP, Netherlands Environmental Assessment Agency  
NIOZ, Royal Netherlands Institute for Sea Research  
NWO, Netherlands Organisation for Scientific Research  
RIKZ, National Institute for Coastal and Marine Management  
RIVM, National Institute for Public Health and Environment  
RIZA, Institute for Inland Water Management and Waste Water Treatment  
SOVON, Ornithology research  
SRON, Netherlands Institute for Space Research  
Synergos Communication  
TNO, Netherlands Organisation for Applied Scientific research  
Technical University Delft  
University of Groningen  
Utrecht University  
Vlinderstichting, butterfly foundation  
Vrije Universiteit Amsterdam  
Wageningen University and Research Centre

## Extended partners

Applikon Analytical  
At Osbornen  
Brinkman Climate Change Consultancy  
CaTec BV, measurement equipment  
CEA, consulting organisation sustainable development  
CLM, Foundation Centre for Agriculture and Environment  
DPC Nederland, Diagnostic Products Corporation  
City of Tilburg  
GIDO, foundation for a sustainable living environment  
Climate Neutral Group  
Klimaatverbond, foundation of councils and provinces for strengthening (inter)national environmental and climate policy  
Ministry of Agriculture, Nature conservation and Food Quality  
Natuurmonumenten, nature conservation in the Netherlands  
NCDO, National Committee for international cooperation and sustainable development  
Netherlands Society for Nature and Environment  
Province of Gelderland  
Rabobank  
Oikos, an ecumenical non-governmental organisation focussed on stimulation processes (sustainable development) of change in the Netherlands  
Stowa, Foundation for Applied Water Research  
Stroming BV, nature and landscape development  
Waternet, Watercompany Amsterdam and surrounding areas  
Water Board Rivierenland  
Waterwatch, remote sensing services for quantifying water management  
Witteveen+Bos, consultancy and engineering services

\* as of January 2007



**Programme Office Climate changes Spatial Planning**  
[www.klimaatvooruimte.nl](http://www.klimaatvooruimte.nl)

c/o Climate Centre, Vrije Universiteit, FALW  
de Boelelaan 1085  
1081 HV Amsterdam  
the Netherlands  
**T** +31 20 598 8648  
**F** +31 20 598 9904  
**E** [office@klimaatvooruimte.nl](mailto:office@klimaatvooruimte.nl)

c/o Alterra (Wageningen UR)  
P.O. Box 47  
6700 AA Wageningen  
the Netherlands  
**T** +31 317 48 6540  
**F** +31 317 42 6101  
**E** [info@klimaatvooruimte.nl](mailto:info@klimaatvooruimte.nl)

**Background information**

At the CcSP website ([klimaatvooruimte.nl](http://klimaatvooruimte.nl)), more information on the programme is available.

