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contact www.alterra.wur.nl/uk/research
The climate is changing

We simply have to accept it: the climate is changing. In the scientific world, there is a solid consensus on this topic. During the past century, the average surface temperature of the earth has risen by more than 0.7°C. The majority of climate researchers agree that global warming is the result of human activity, primarily the emission of greenhouse gases.

However, the climate is not simple. It is a complex system of physical, chemical and biological processes, all of which interact with each other. This in turn has consequences for the various components of the climate system: the atmosphere, the oceans, the snow and ice cover, the land and the biosphere. The consequences are different everywhere, also because the climate change results in more extreme weather conditions. These extreme conditions include drought, heavy rain, storms and extreme temperatures, and can cause severe local problems due to flooding, crop failures or human mortality from heat or drought.

Today, the climate has a high priority in society and politics. This makes sense, because climate change could cost a great deal of money. Money is required not only for stabilising or reducing the emissions of greenhouse gases – mitigation – but also for adapting to living with the warmer and more extreme climate – adaptation.

To ensure that the emission of greenhouse gases is reduced, research is needed into alternatives for fossil fuels, such as wind energy and solar energy. In addition, research is needed into new technology to make existing energy sources more climate-friendly and methods to reduce emissions from the transport sector. Researchers are also studying how greenhouse gases can be sequestered by means of forestry or agriculture.

In any case, climate change will lead to changes in how we live, for example to changes in land use. In this area, research is necessary to determine where cities can still expand without risking flooding. Researchers are involved with estimating flooding risks in specific areas and designing scenarios for an evacuation in case of a disaster. Nature must also adapt, and the question here is how land development can take place so that plants and animals can survive the new climatological conditions. Agriculture is faced with a similar question: what forms of agriculture will still be feasible in the future?

What can we offer?

The Environmental Sciences Group of Wageningen University and Research Centre comprises the department of Environmental Sciences of Wageningen University and Alterra, the research institute for the green environment. This combination ensures an exchange between fundamental and applied research and a fertile interaction with education. In addition, the Wageningen climate researchers participate in many national and international research projects.

The climate research of Wageningen UR is among the best in the world. Within the climate research team Wageningen UR has 4 IPCC authors who shared the 2007 Nobel Price with Al Gore.

Wageningen climate researchers have contributed to the scientific reporting of the Intergovernmental Panel on Climate Change of the United Nations from the very beginning. It is partly due to the Wageningen expertise on the role of vegetation in climate that land use has now been included in the international climate models as a determining factor for climate change.

Within Europe, the Environmental Sciences Group is participating in a network with the aim of measuring the emission of greenhouse gases. Wageningen is also a pioneer in measuring greenhouse gases that are sequestered in forests or peatlands, the so-called sinks. These measurements, both of emissions and sinks, are used for improving international climate models, among other purposes.

In the Netherlands, Wageningen UR is leading two major research programmes with the aim of ensuring that the Netherlands becomes climate resistant. In the programme Climate changes Spatial Planning: In cooperation and in dialogue with policymakers and stakeholders, expertise is developed regarding effective measures for reducing the emission of greenhouse gases (mitigation) and for dealing with the risks of climate change (adaptation).

In the Knowledge for Climate Change programme, the researchers focus on eight specific areas, all of which have their own problems and opportunities concerning climate change. In this programme, researchers investigate how investments in the space and infrastructure in these areas can help to make them climate resistant. Government agencies, public bodies and companies are participating in this programme.

International education

Wageningen UR offers Bachelors, Masters and PhD education on the climate system. Students learn about the physical, chemical, biological and societal processes that play a role in that system, and the consequences thereof for the atmosphere, the oceans, snow and ice cap, the land, the biosphere and people. The students are not only from the Netherlands, but from all over the world. The education is therefore as internationally oriented as the climate problem itself.

The Bachelors curriculum (with Dutch as the language of instruction) comprises the following programmes:

- Soil, Water and Atmosphere: concerns the physical, chemical and biological processes in soil, water and atmosphere.
- International Land and Water Management: concerns the management of the natural resources of land and water.
- Meteorology and Air Quality: concerns the physical processes in the atmosphere and their interaction with the soil, water and vegetation on the Earth’s surface.
- Climate Studies (Earth System Science): concerns the processes of climate change and the challenges they fuel to natural and social science.
- International Land and Water Management: concerns the scientific analysis of physical, environmental, technical and socio-economic aspects of land and water management.
- Forest and Nature Conservation: graduates help to increase knowledge on forest and nature areas, effect conservation and realize sustainable management and policy of our natural resources.

Wageningen UR offers various PhD programmes where students can work on their PhDs in the multidisciplinary and international scientific climate of Wageningen.
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Climate impact research is required

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The Bachelors curriculum (with Dutch as the language of instruction) comprises the following programmes:

- Soil, Water and Atmosphere: concerns the physical, chemical and biological processes in soil, water and atmosphere and their mutual relationship.
- International Land and Water Management: concerns the management of the natural resources of land and water.
- The Masters curriculum (with English as the language of instruction) comprises the following programmes:
  - Meteorology and Air Quality: concerns the physical processes in the atmosphere and their interaction with the soil, water and vegetation on the Earth’s surface.
  - Climate Studies (Earth System Science): concerns the processes of climate change and the challenges they fuel to natural and social science.
- International Land and Water Management: concerns the scientific analysis of physical, environmental, technical and socio-economic aspects of land and water management.
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NeWater: New Approaches to Adaptive Water Management under Uncertainty

Situation

In the catchment areas of the major rivers, the consequences of climate change play an important role. This requires adaptation of water management, while taking account of all interests that play a role in the catchment areas. In these areas, people should be able to live, work and play safely. Valuable natural habitats should be protected. For farmers, beneficial conditions are required to grow vegetables and keep livestock. In addition, other issues play a role such as drinking water supplies, energy production and a wide range of local and regional interests.

To ensure that river management is climate resistant, water management must take account of risks, vulnerability, resilience and support within the catchment areas. In other words, water management must take account of the adaptations that are necessary to deal with the consequences of climate change. Present-day water management is not sufficiently equipped to take on this challenge, but that is going to change. Gradually, more emphasis is being placed on an integral and flexible approach to water management. The development of such an adaptive form of water management is the topic of the NeWater research project.

Aim

NeWater aims to develop expertise to ensure that water management becomes climate-resistant, so that the effects of climate change can be properly estimated and that flexible water management is established, which takes account of the consequences of climate change. The research also focuses on the social, economic, spatial, policy, and organisational adaptations that are required in relation to climate change.

Approach

NeWater concentrates on the sub-aspects of current water management that are essential for climate-resistant water management. These aspects are being studied in practice in the catchment areas of the following rivers: the Rhine, the Elbe, the Guadiana, the Tisza, the Amurdarya, the Nile and the Orange.

This research concerns the following aspects:

- A broad and horizontal participation of interested parties, such as municipalities, provinces, nature conservation organisations, water boards, resident associations and farmers organisations.
- Integration of water management with the spatial planning process, adaptation of water management to the consequences of climate change and a cost-
benefit analysis of the measures.
• Integration of processes within political, institutional and executive bodies.
• Dialogue with interested parties, development of scenarios, modelling and monitoring.
• Innovative methods of storage and buffering.
• New financial instruments, public-private risk approach.
• Bringing together science, policy and practice.

Results

In the NeWater project, the Environmental Sciences Group of Wageningen UR focuses primarily on the relationships between climate change, water quality, water quantity, land use, the ecosystem and the financial and economic consequences. These insights will be used for the education and training of interest groups in the catchment areas.

NeWater will deliver the following products:
• Estimations of the uncertainties resulting from extreme weather conditions.
• Insight into the vulnerability of communities and how organisations deal with the effects of climate extremes on water management.
• Concepts and preconditions for a more adapted form of water management that can deal with uncertainties and has methods to support the change process.
• An optimisation method for land use that takes account of desired water discharge under given control measures.

• International exchange of expertise and experience between the various catchment areas.
• Materials for training and expertise development, as well as an online curriculum.

Follow-up

NeWater is working on an in-depth study in the catchment areas of the rivers the Rhine, the Elbe, the Guadiana, the Tisza, the Amurdarya, the Nile and the Orange, and on synthesising the results of the various working groups to achieve usable concepts and recommendations for application. The Environmental Sciences Group of Wageningen UR is working on a further integration of water management with the spatial planning process, solving conflicts concerning water quality, water quantity and ecology, incorporating the developed expertise in the curriculum, and strengthening the advisory and training components.

www.newater.info

Funded by
European Commission, Sixth Framework Programme, Priority Global Change and Ecosystems.

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Situation

Climate change is resulting in effects such as global warming, rising sea levels and more extreme weather conditions. Worldwide, researchers are working in international frameworks of cooperation to jointly tackle both the causes and consequences of climate change by seeking strategies for mitigation and adaptation. Mitigation concerns preventing the emissions of greenhouse gases which cause global warming. Adaptation concerns measures to ensure that regions become climate-resistant.

Various international agreements have been made to take measures to counteract climate change. The agreements within the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol have established the international policy context for the ADAM project. These agreements require far-reaching measures to reduce the concentration of greenhouse gases in the atmosphere. In addition, modifications of land use and water management are required to deal with the consequences of higher temperatures.

To arrive at a balanced international and European climate policy, an integral approach is required. A high level of mitigation reduces the need for adaptation, and the reverse. Therefore, a complete and integral analysis must be made of possible measures for mitigation and adaptation and the costs and effects of such measures.

Aim

The aim of ADAM is to develop an instrument with which the various policy options regarding mitigation and adaptation can be evaluated in terms of effectiveness and costs: the Policy Assessment Framework

Approach

The research within ADAM focuses on four sub-aspects:

- Working out the details of future scenarios for the climate in Europe, including the consequences of climate change for the policy on mitigation and adaptation.
• Evaluating the costs and effects of possible policy with respect to mitigation at the European and international levels.
• Analysing the vulnerability of Europe with respect to climate change, the social, technical and environmental factors, and possible solutions for these problems.
• Integrating the results in the Policy Assessment Framework.

Results

The Policy Assessment Framework is an instrument that allows policymakers, politicians and scientists to investigate in various climate scenarios how various measures work out with respect to mitigation and adaptation and what the costs of these measures are. The results of ADAM support the development of the European climate policy in relation to the negotiations that are being conducted about the Kyoto Protocol and the global climate policy.

Follow-up

Together with European policymakers, the research team will test the first applications of the Policy Assessment Framework. This will improve the interaction between policy and science and will enable researchers to adapt the underlying models and data in the framework to the changing policy needs.

Contact

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Funded by

European Commission, Sixth Framework Programme, Priority Global Change and Ecosystems

www.adamproject.eu
Measuring the turbulent atmosphere

Situation

Scientists are convinced that climate change is partly caused by the emission of greenhouse gasses due to human activity. In the Kyoto Protocol, it has been agreed that these emissions will be reduced by 8% in 2012 (compared to 1990). The Netherlands has made a commitment to reduce emissions in 2012 by 6%. After this date, it will be necessary to reduce the emissions of greenhouse gases even further.

As part of the programme Climate changes Spatial Planning, a study has begun to determine the magnitude of these anthropogenic (human-caused) emissions of greenhouse gases. In the study, measurements will be combined with model calculations. One of the uncertain factors in the transport of greenhouse gases is the turbulence of the atmosphere. This is the most effective transport mechanism for heat and water vapour and therefore has a great effect on the transport of greenhouse gasses in the atmosphere.

Aim

The research will contribute to understanding the turbulent atmosphere and how it affects the transport of greenhouse gasses. In addition, the measurements are intended to improve model calculations and the interpretation of satellite images.

Approach

In cooperation with the KNMI (Royal Netherlands Meteorological Institute), scintillometers and ceilometers have been placed at various locations in the Netherlands and Germany. Scintillometers measure the exchange of heat and water vapour between the Earth’s surface and the atmosphere, also known as the surface fluxes of heat and water vapour. Researchers use ceilometers to determine the thickness of the turbulent layer in the atmosphere (the so-called boundary layer). The researchers combine these measurements with model calculations and in this way acquire more insight into how greenhouse gasses move through the atmosphere.

Results

Advanced measurement equipment is now operational in Wageningen, Batenburg, Lutjewad, Speuld, Bonn (Germany) and on the measurement towers of the
KNMI Cabauw facility. At some of these locations, measurements have been taken since 1999, resulting in the availability of an extensive database. These results can also be used for other research projects and are being used in the education programme of the Meteorology and Air Quality Group.

For this research project, the Meteorology and Air Quality Group of Prof. Bert Holtslag developed the Large Aperture Scintillometer (LAS), the first instrument that can measure the surface flux over a distance of up to 10 kilometres. The scintillometer measures the intensity fluctuations (known as scintillations) of infrared light or radio waves that are caused by the atmosphere. The sender emits a light beam that is affected by the turbulence in the atmosphere before it is picked up by the receiver. The degree of turbulence in the atmosphere can be derived from the fluctuations in intensity.

**Follow-up**

In the future, the national scintillometer network van Wageningen UR and the KNMI can be expanded to a European scale.

www.climatechangespatialplanning.nl

**Funded by**

Dutch Ministry of Housing, Spatial Planning and the Environment, as part of the BSIK programme Climate changes Spatial Planning.
CarboEurope: Quantifying the European carbon balance

Situation

Emissions of the greenhouse gas CO$_2$ have a major effect on the climate. In addition to the other greenhouse gases methane and nitrogen dioxide, climate scientists believe that CO$_2$ contributes to the climate change that is leading to global warming and more extreme weather conditions. The most important sources of CO$_2$ emissions are fossil fuels and deforestation. However, on land carbon is also sequestered in so-called sinks, such as forests and peatlands. Now scientists are concerned that this carbon, due to changing land use, will be released as CO$_2$ after reacting with oxygen in the air, which would counteract all efforts to reduce CO$_2$ emissions with technical means in a single blow.

Not very much is known scientifically about these sinks. For example, we do not understand how they respond to climate change and changing land use, and how they are distributed across the continents. However, the Kyoto protocol does take account of sources and sinks of carbon on land. The carbon budget of a continent determines how that continent stands in relation to the global climate issue. But there are still many uncertainties in that carbon budget, both in calculating the emission of CO$_2$ and calculating the quantity of carbon that is sequestered on the land.

Aim

CarboEurope has the aim of understanding and quantifying the current carbon balance in Europe and determining the uncertainties that play a role at the local, regional and continental levels. This means:

- Understanding the European carbon balance in terms of time and space.
- Understanding the processes and mechanisms of the carbon cycle in European ecosystems.
- Developing an observation system that monitors both the atmospheric and ecosystem-related carbon stocks and takes account of the European obligations under the Kyoto Protocol.

Approach

CarboEurope is the result of a framework of cooperation that has been developing since 2000 between more than 60 research institutes and about
30 other partners from 17 European countries. It is an interdisciplinary research community with expertise in various ecosystems, the atmosphere, measurements and modelling. Within this community, work is taking place on reducing the uncertainties in the European carbon balance. The researchers are looking at how the carbon budget is changing from four points of view. By comparing the measurements of CO$_2$ concentrations at different levels of scale, they can improve the quantification of the CO$_2$ concentrations in the atmosphere. At the ecosystem level, they are researching the influence of land use on the carbon balance. And from a regional perspective, they are looking at the influence from outside the region. By integrating all the data and placing them in a single system, an integral monitoring system is created for the carbon balance of the European continent.

**Results**

Due to CarboEurope research, measurement networks, ecological sampling and atmospheric observations have been integrated into a monitoring system for the carbon balance at the local, regional and continental scales. As a result, both the CO$_2$ in the atmosphere and the carbon that is sequestered on land can be tracked. The most important innovation of CarboEurope is that all experiments and models are part of a single overarching strategy.

This has created a system that supports the implementation of the Kyoto Protocol because it provides quantitative information about the complete carbon budgets at the local, regional and continental scales. The Environmental Sciences Group of Wageningen UR is providing important contributions to monitoring and model development at the level of ecosystems and regions and is also contributing to the compilation and analysis of data for making a forest inventory at the continental level.

**Follow-up**

CarboEurope has already resulted in a coherent, comprehensive integration of land-based and atmospheric carbon science that can serve as an example for the United States, Japan and China. In addition, the results of CarboEurope will establish the basis for future agreements on efforts to sequester CO$_2$ and reduce its emissions.

www.carboeurope.org

**Funded by**

European Commission, Sixth Framework Programme, Priority Global Change and Ecosystems.
Carbopeat: Carbon, climate and people in tropical peat swamp forests

Situation

Tropical peat swamp forests in Southeast Asia contain many valuable products for the local population, such as wood, bark, resins and latex. Farmers obtain these products from the forests by the slash and burn method. Moreover, the Indonesian government, among others, formerly promoted large-scale reclamation with the intention of converting the low productivity peat swamp forests into productive rice and palm oil plantations.

Due to the reclamation process, the peat soil dries out and begins to oxidise. Because the carbon in the peat reacts with oxygen in the air, the greenhouse gas CO$_2$ is released. Although tropical peat soils comprise only 0.25% of the land surface, this peat contains 3% of the carbon that is sequestered in soil and forests. Due to the reclamation of the tropical peat swamp forests, they are transformed from a large storage depot of carbon into a significant emission source of the greenhouse gas CO$_2$.

The reclamation of the tropical peat swamp forests also causes a rich ecosystem to disappear. These forests are, for example, an important habitat for orang-utans in Kalimantan. In addition, the marsh lands are an important source of drinking water and irrigation water. The reclamation of the peat swamp forests has a destructive result: a gradual subsidence of the peat soil, local flooding, increasing emissions of greenhouse gases and local peat fires that can cause nuisance hundreds of kilometres away.

Aim

Carbopeat promotes a better understanding and awareness of the interactions between carbon, climate and people in tropical peat swamp forests. The aims of Carbopeat are:

- Precisely determine how much carbon is sequestered in tropical peat soils worldwide.
- Conduct an international exchange of expertise about the carbon balance in tropical and other peat soils.
- Conduct research into cost effective ways to manage the carbon sequestered in peat.
- Explore potential compensation for and trade in this carbon.
- Provide expert assistance to international conventions, industry, the EU and government agencies and public bodies.
Approach

Carbopeat is based upon the results of the previous projects Strapeat and Restorpeat. In 2005, Strapeat resulted in a series of recommendations for the sustainable management of tropical peat swamp forests; Restorpeat focused more on the restoration of degraded tropical peat swamp forests. In the Carbopeat programme, scientists, policy makers, politicians and other stakeholders work together to study which role the tropical peat swamp forests play in the emission of greenhouse gases worldwide, nationally and regionally, and what solutions there are to reduce these emissions. The emphasis lies on Southeast Asia because this region contains 70% of the tropical peat swamp forests. Within Carbopeat, five working groups are focusing on the global importance of tropical peat swamp forests, the interactions between carbon, climate and people, estimating the risks, obtaining insight into compensation and trade in carbon, and providing advice to policymakers and politicians.

Resultaten

Carbopeat integrates the expertise that was acquired in the Strapeat and Restorpeat projects and ensures that this knowledge and experience is disseminated in international frameworks such as the UNFCCC (United Nations Framework Convention on Climate Change) and the European Union. As a result, the tropical peat swamp forests are now included in the worldwide discussion about climate change. Alterra has been involved since the beginning in Strapeat, Restorpeat and Carbopeat and focuses specifically on the relationship between land use, the water table and the emission of CO₂.

Follow-up

The challenge is now to provide practical measures for REDD (Reduced Emissions from Deforestation in Developing Countries), a mechanism that was agreed to in 2007 at the climate conference on Bali. The intention of this scheme is to make it economically attractive for developing countries to wisely manage their sequestered peat carbon, also in the future.

www.carbopeat.org

Funded by
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