Royal Netherlands
Meteorological Institute
Ministry of Infrastructure and the Environment

KNMI

ANNUAL REPORT 2011

Delivering all year round

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Contents

Frits Brouwer

Director-General KNMI

KNMI is changing ...

I am very proud to present the public edition of KNMI's annual report for 2011. Our last annual report used the twenty-four hours of the day as a framework for describing the institute's year. This time, we have chosen to reflect our wide-ranging activities in the twelve months of the year. There are pieces on the earthquake, tsunami and nuclear accident in Japan, the presentation of de Bosatlas van het Klimaat, the creation of a modern computer centre to house our new supercomputer (the second-biggest in the Netherlands) and the drought updates for water management in an extreme dry spring season.

In this foreword, I would like to focus particular attention on an important topic for KNMI: the provision in the Rutte/Verhagen coalition agreement of October 2010 that 'KNMI's current responsibilities shall be reviewed (possible privatisation)'. The Ministry of Infrastructure and the Environment accordingly set a reform process in motion for KNMI, with particular emphasis on the following:

- KNMI 's status (public or private), including definition of KNMI's public meteorological activities, their significance to the community and the role that weather companies are willing and able to play
- The tension between the independence of KNMI's scientific research and the fact that KNMI is subject to ministerial responsibility.
- The government's wish to reduce its agency support grant to KNMI.

In order to prepare for decision-making with regard to KNMI's future, Cees Moons joined the Institute's Board in the temporary role of director Change-Management. Under his leadership, standpoints on the topics listed above were formulated for the State Secretary. The intention was that State Secretary Joop Atsma would present a plan to parliament before the summer. However, the fall of the Rutte/Verhagen administration inevitably stalled the process. The delay is unfortunate, because it meant that the uncertainty is prolonged, which is undesirable for all concerned, not least KNMI's workforce.

The State Budget for 2013 did at least provide some clarity regarding funding cuts. In the period up to 2018, KNMI's agency support grant will be cut by 12.5 per cent, which must be covered by increased efficiency. Furthermore, from 2013, any national government entities that commission non-core services from KNMI (i.e. services other than weather warnings and management of the national meteorological instrument network) will do so on a demand-led commercial basis.

Against that background, I can warmly recommend the two interviews contained in this annual report: regional water authority chairman Luc Kohsiek talks about the role of KNMI in water management and Jan Staman, Director of the Rathenau Institute, gives his views on the relationship between science and politics.

Naturally, it is not pleasant for an organisation like KNMI to be the focus of such attention. However, I am confident that the outcome of the reform process will be a KNMI that is capable of fulfilling its mission as the national institute for weather, climate and seismology for a very long time to come. Working on a daily basis, month in, month out, in service of the nation. This time next year, I shall undoubtedly be able to write in more detail about how exactly that will be realised...

In the meantime, I hope you enjoy reading our 2011 annual report.

June 2012,

Frits Brouwer
Director-General KNMI

01 KNMI offers location-based warnings

In order to provide road users, air traffic and shipping with the best possible information about weather hazards, KNMI meteorologists often work on location nowadays. It is an approach that enhances efficiency and increases the scope for delivering bespoke services

The forecasting office in De Bilt is the KNMI meteorologist's home base. It is from there that forecasts and warnings are issued to road users, air traffic and shipping, and of course to the general public. However, our meteorologists go out to provide clients with on-the-spot advice whenever the weather conditions or other circumstances make it desirable. KNMI meteorologists are often to be found in the control tower at Amsterdam's Schiphol Airport, for example. Since 2003, they have been supporting the air traffic controllers with direct information and advice, enabling them to respond quickly and efficiently when weather conditions change. For the last three years, there has been a meteorologist on permanent standby, ready to join the staff at the National Road Traffic Centre (VCNL) in Utrecht. Whenever weather conditions pose a potential hazard to motorway traffic, we can quickly have someone in the VCNL control room to provide specialist advice.

Direct assistance is also given to the agency responsible for sea defences in the province of South Holland. When water levels rise to critical levels, a KNMI meteorologist is dispatched to the Maeslant Barrier to monitor local developments and advise on closure of the gates. Plans are in place to make on-location KNMI support available to the Storm Flood Warning Service (SVSD) in Lelystad too. At present, a weather centre-based maritime meteorologist at KNMI is in telephone contact with the SVSD's hydrologists in the event of high water. However, the efficiency of the crisis response system can be enhanced by having a meteorologist at the heart of the decision-making process. Providing advice is an increasingly important aspect of the work that KNMI meteorologists undertake. Professional weather users are seeking more detailed and specific information, together with guidance on the interpretation of probability data. Delivering that advice on location improves communication and increases efficiency by enabling agencies and emergency services to prepare better and improve decision-making. Another advantage is that KNMI personnel become more attuned to the needs of professional users. Conversely, our clients are able to get a better picture of the support that KNMI can offer. ■

Control centre of National Road Traffic Centre (VCNL) in Utrecht

Jan Bitterling | Supervisor Tower / Approach | Dutch Air Traffic Control (LVNL)

"KNMI's Meteorological Advisor always sits in on the operational briefings that we have four times a day. The briefings are attended by KLM, Schiphol Airport Authority, LNVL and KNMI. Weather information is central to all operations at the airport. The alignment of the runways here and variability of the local weather can throw up some complex challenges. So personal input from a KNMI meteorologist is very useful in the context of processes such as calculating runway capacity. We need really detailed information. And having a Meteorological Advisor on hand to talk to the traffic controllers makes it a lot easier to respond quickly and appropriately to dynamic situations. Short, direct lines of communication are vital to us. We also find that having the advisor here with us leads to better advice, because the meteorologist gets to see how we work and therefore understands our needs. The KNMI meteorologist has an important role within our day-to-day operations. He is there each morning at five o'clock when we start our planning, helping to make sure that unexpected problems are kept to a minimum. If the forecast is for fog an hour later, we adjust the plans accordingly. His expertise is invaluable."

Edwin Büsscher | Safety Meteorologist, KNMI

"Another KNMI meteorologist and I take it in turns to be on standby to help at the Maeslant Barrier. There are pre-defined call-out triggers: we get called if the sea level is expected to rise above 2.60 metres at Rotterdam and 2.30 metres at Dordrecht. The call-out may be up to 24 hours before the high water is forecast. At that stage, the situation is not critical, so there is adequate time for formulating a response. I have to be on site within two hours of the pager going. When I get there, I act as a member of the Maeslant Barrier operations team. That mainly involves monitoring developments and advising the team accordingly. There are decision points at various stages of the procedure when I have to provide meteorological input. Throughout the crisis, I remain in constant contact with the maritime meteorologist back at the KNMI weather centre. We liaise regarding the current status of the weather models: can I trust them entirely, or do I need to allow for anomalies? I need to consider the wind speed, the wind direction, the surge level and precipitation. Local conditions are very important in relation to the Maeslant Barrier. You need to have the most detailed information possible and you have to constantly reassess the information that is coming in."

Ellen Moens | Crisis Coordinator / Operational Traffic Manager, National Road Traffic Centre (VCNL)

"For the last few winters, we have often had a KNMI meteorologist attached to the VCNL Crisis Team. It works well. Direct input is really useful if we need to scale up our activities because of hazardous weather conditions. Naturally, keeping a close eye on the weather is a central component of traffic management, so we are in regular telephone contact with the KNMI forecasting office at all times. However, there are times where we need additional support. If snow is forecast, we need to know exactly where it will fall, how heavy it will be and how long it will continue. Localised snow showers can create particular problems on the road. An in-house meteorologist enables us to plan and respond better by providing the team with greater insight into the weather parameters that apply. Our attached meteorologist doesn't just tell us what the forecast is; we also get first-hand advice about what the uncertainties are. Of course, we could in principle pick up the phone and ask the same questions, but having someone sit in on Crisis Team meetings provides much more scope for interaction and therefore gives us a fuller picture. The KNMI advisor can present maps to the team and team members can ask follow-up questions. You build up mutual understanding as well: each side sees how the other works and has the opportunity to adapt. The net result is that we can tell road users what to expect at the earliest possible juncture, so that they can anticipate problems and crises are less likely to develop."

Control tower Schiphol Airport

KNMI Serious #fire at Chemie-Pack plant in #Moerdijk. A very large cloud of smoke was produced, which spread over Dordrecht and the surrounding area.

5 Jan 2011

KNMI #Earthquake at Stedum, Groningen, with a magnitude of 2.5 on the Richter scale.

19 Jan 2011

KNMI The President of Germany's National Meteorological Service (@DWD - Deutscher Wetterdienst) visits @KNMI. Weather, climate and seismology are international issues, so cooperation is important.

28 Jan 2011

KNMI Many people in North Groningen heard a #bang and felt tremors. Source appears to be an #explosion of #munitions on the island of #Borkum.

30 Jan 2011

02 KNMI monitors from space

Using the Ozone Monitoring Instrument (OMI), KNMI is able to measure atmospheric constituents from space. By doing so, an extremely detailed and almost real-time picture of the atmosphere's composition can be compiled.

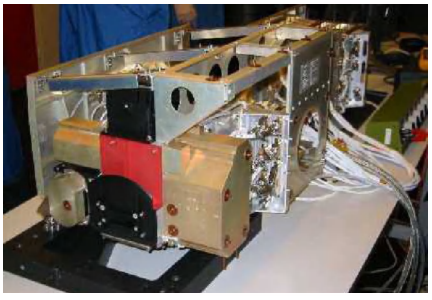
OMI is installed on board NASA's EOS-AURA satellite which orbits the earth every 98 minutes. On each orbit around the globe, the instrument sweeps a band 2600 kilometres wide. So, within a day, OMI covers the whole globe in fourteen sweeps. The device measures substances such as ozone, nitrogen oxides, sulphur oxides, soot, particulates and volcanic ash. And it delivers a very detailed daily picture of the entire atmosphere including for example air pollution above large cities and major transport routes. KNMI is responsible for scientific management of OMI, as well as controlling the instrument and processing the data it yields. It was built under the control of Dutch space agency NSO (previously NIVR) by Dutch Space, TNO and the Finnish industrial sector. With OMI having been in space since summer 2004, a new orbital instrument is now under development: TROPOMI is scheduled for launch in 2015. ■

OMI shows air pollution large cities

Working with Germany's Max Planck Institute, KNMI is able to measure nitrogen oxide emissions from cities around the world using the Dutch Ozone Monitoring Instrument (OMI). In large cities, road traffic and other sources produce thousands of tons of nitrogen oxides every day, with significant implications for air quality.

OMI is the first instrument in existence that can check the quality of the world's whole atmosphere in detail on a daily basis. So, for example, it can accurately measure air pollution levels in the world's largest cities and monitor the dispersion of the pollutants in question (e.g. nitrogen oxides, sulphur oxides, soot and particulates).

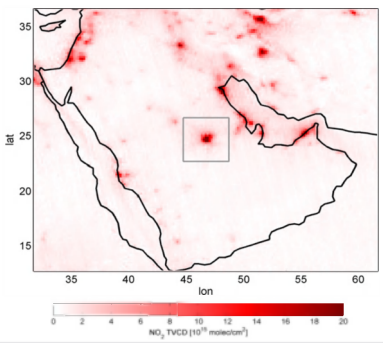
KNMI has been using OMI to measure nitrogen dioxide concentrations since 2004. However, researchers at the Max Planck Institute in Mainz have teamed up with KNMI to analyse the air pollution patterns associated with various wind directions on the basis of higher-resolution OMI data (13x24 kilometre grid). As a result, both the amounts of nitrogen oxide emitted from cities such as Hong Kong and Riyadh and the lifetime of the pollutants can now be ascertained simultaneously for the first time.
This is significant, because the accurate quantification of air pollution depends on knowing not only the concentration of a particular substance at a given point in time, but also how long that substance remains in the atmosphere. Where nitrogen dioxide is concerned, lifetime depends on numerous chemical factors. By measuring the amount of nitrogen dioxide in the air at fifteen kilometre intervals and combining the findings with wind speed data, it has been possible to quantify both the amounts emitted and the persistence. The research results were published in the journal *Science* in 2011. ■



Ozone Monitoring Instrument

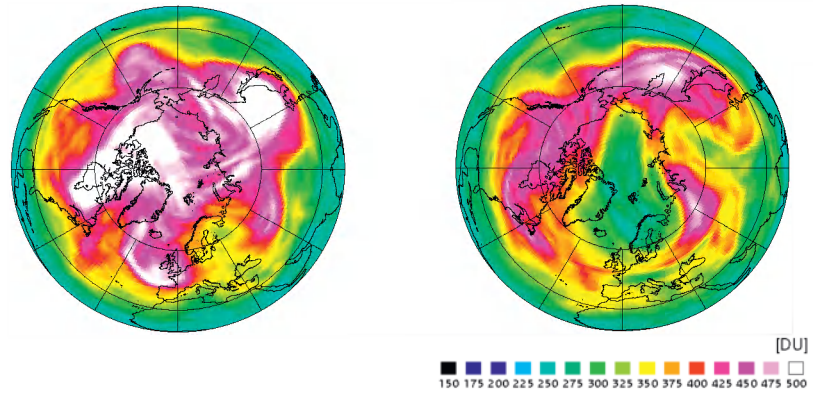
http://www.knmi.nl/cms/content/94894/ozone_monitoring_instrument

http://www.tropomi.eu/TROPOMI/Home.html



Average nitrogen dioxide concentrations above the Middle East in the period 2005-2009, as measured by OMI in still conditions..

KNMI / NASA
OMI



Measurements by OMI of the ozone layer on 26 March 2010 and 2011 (right image). The colours indicate the differences in ozone. The blue-green colour shows the large ozone breakdown over Scandinavia on 26 March 2011. (Source: KNMI)

Major ozone depletion North Pole

In the winter and spring of 2011, depletion of the ozone layer above the North Pole reached previously unrecorded levels. The cause was an unusually long period of extremely low temperatures in the stratosphere. Data from the Dutch-Finnish Ozone Monitoring Instrument (OMI) revealed that the ozone hole extended as far south as Scandinavia. KNMI research published in *Nature* revealed that the ozone depletion above the North Pole in 2011 was roughly as large as that observed in some years above the South Pole.

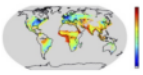
Since the eighties, a hole has formed in the ozone layer above the South Pole every September. Lying about 20 to 35 kilometres above the earth's surface, the ozone layer protects us against harmful ultraviolet radiation. The hole above the South Pole forms during periods of extreme cold, when chemicals produced by humans are converted into forms that destroy ozone. The same processes are active above the North Pole in the winter, but less ozone depletion usually takes place, because it is not quite as cold as in the south.

In 2011, however, the cold period in the northern polar region lasted thirty days longer than average, leading to previously unseen levels of ozone depletion. Although the amount of ozone depletion above the North Pole was similar to that seen above the South Pole, the ozone concentration above the North Pole in 2011 remained higher than is typical for the South Pole. The reason for that was that Arctic ozone concentrations at the start of the winter are higher than Antarctic concentrations.
Since the Montreal Protocol was agreed in 1989, the levels of ozone-depleting substances in the atmosphere have decreased significantly. However, the chemicals in question are very persistent, meaning that southern polar thinning of the ozone layer and the possibility of large-scale ozone depletion above the North Pole will continue for several decades to come. ■

http://www.knmi.nl/omi

www.nature.com/nature/journal/v478/n7370/full/nature10556.html

KNMI Various reports of tremors and thuds from #Friesland. Analysis of the #infrasound signals for the Netherlands showed that the source was on #Vlieland. On the #Vliehors, a military exercise was in progress, which involved jets dropping bombs. Although the disturbance near the #Vliehors, for example on Texel, was not serious, a strong wind at a height of 6 km carried the noise to Friesland. Infrasound diverted to Friesland by the eastward wind was perceived by people on the mainland, forty kilometres or so from the #Vliehors, as thuds and tremors.
3 Feb 2011



KNMI #Satellite data is used to determine the chemical composition of #aerosol particles, shedding light on the impact of #environmental protection measures.
21 Feb 2011

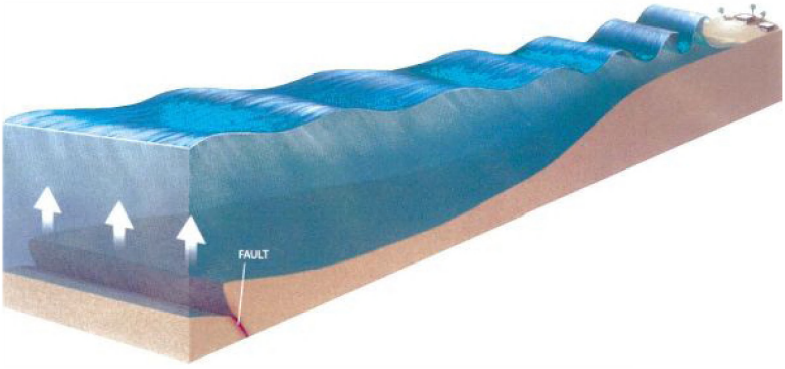
KNMI #Earthquake in #New Zealand with a magnitude of 6.1. The quake is one of the series of after-shocks that follow the earthquake of 3 September 2010. It is the sixth quake with a magnitude exceeding 5.0.
21 Feb 2011

KNMI The final signature is put on the EUMETSAT #Third Generation Meteosat agreement. This new generation of #weather satellites is to be operational by 2018 and will remain in service for at least 25 years.
25 Feb 2011

03 KNMI analyzes earthquake Japan

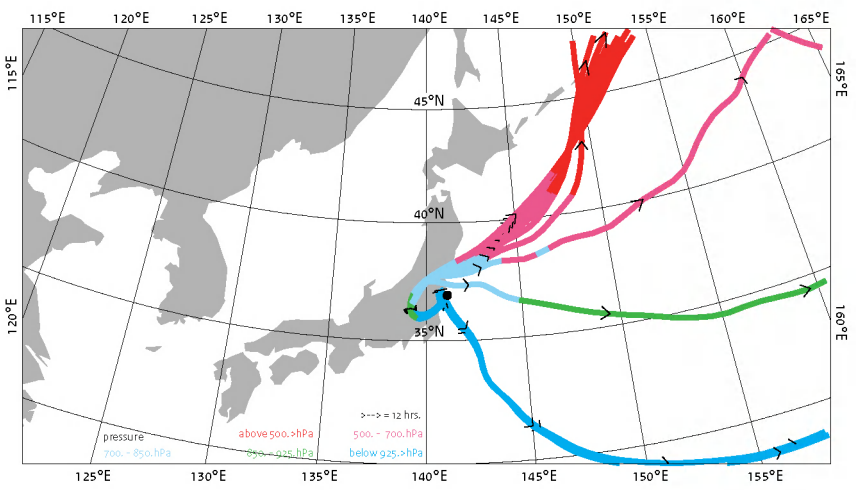
On Friday 11 March, Japan was struck by a major earthquake measuring 8.9 on the Richter scale. The quake caused a devastating tsunami which washed away entire villages and seriously damaged the nuclear power plant at Fukushima.

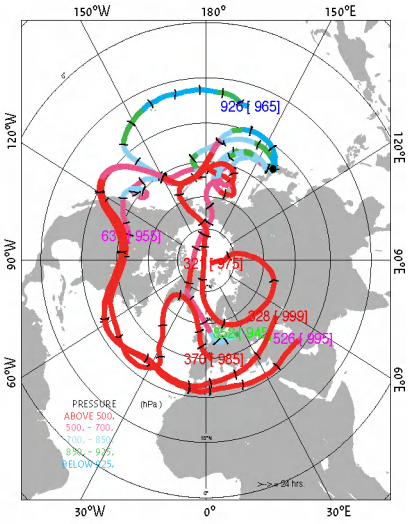
The earthquake, the epicentre of which was just northeast of the island of Honshu, happened at 14:46 local time (06:46 Dutch time). This was the strongest quake to hit Japan since records began in 1900, and the fourth largest anywhere in the world.
The region is particularly susceptible to seismic events: it is where the Pacific oceanic plate meets and is 'subducted' (pushed under) the Eurasian continental plate.
Because the powerful tremors were approximately ten kilometres below the sea's surface, a tsunami was inevitable. This type of tidal wave develops whenever there is a submarine earthquake at a moderate depth with a vertical movement and a magnitude greater than 7. The entire water column above the tremor is then disturbed.
At some points along the coast, the tsunami reached a height of ten metres. The entire east coast of Japan was affected and the tidal wave spread throughout the Pacific region.
Between the morning of Friday 11 and Monday 14 March, over three hundred aftershocks were recorded. They were of decreasing strength, although there were incidental tremors measuring 7 on the Richter scale.
The vibrations from the Japanese earthquake were detected at the KNMI seismic monitoring stations in the Netherlands some ten minutes after the event. Our instruments showed that the Dutch subsoil was displaced by between two and three centimetres, although this movement was too weak for human perception. ■



The earthquake below sea causes a tidal wave that grows in height when it reaches shallower water.

Havoc after tsunami in Japan





KNMI tracks radioactive cloud

The damage sustained by the nuclear power plant in Fukushima was serious enough to cause a release of radioactive material. KNMI produced maps showing the projected path of the radioactive cloud, allowing the Dutch authorities to assess the level of risk.

Within hours of the tsunami making land on Friday 11 March, it was clear that the Fukushima nuclear power plant had been seriously damaged and that radioactive material had escaped into the atmosphere. To protect Dutch citizens, whether in Japan or at home in the Netherlands, it is crucial that the government has full information about the risks involved in an incident of this type.
KNMI's role in providing some of this information derives from the National Nuclear Emergency Response Plan (NPK), whereby we work alongside a number of other organizations. For example, KNMI staff form part of the Radiological Information Back Office (BORI) which is managed by the National Institute for Public Health and the Environment (RIVM). BORI produces regular situation reports, together with computer simulations of the movement and strength of any atmospheric radioactivity. This information is combined to produce maps showing the current and likely situation.

Whenever a nuclear incident occurs anywhere in the world, KNMI provides the meteorological data needed to calculate the direction and speed of radioactive particles in the atmosphere. Hisso Homan is a KNMI crisis meteorologist who works very closely with the RIVM computer modellers. Following the Fukushima incident, he gathered all available information about the structure and stability of the atmosphere over Japan and the global air currents.

Based on satellite pictures and computer simulations, KNMI could then produce 'trajectory maps' showing the most likely route of the radioactive cloud given the current climatic conditions. The changing composition of the cloud was also monitored, based on a combination of measurements taken by RIVM, satellite pictures and computer modelling. The computer simulations revealed that it would take approximately twelve days for the radioactive cloud from Fukushima to reach Europe. In the event, RIVM's analysis of air samples taken in the Netherlands revealed that the concentration of radioactive particles was so low as to be negligible. ■

↖ ↑
Trajectory forecasts for Fukushima nuclear power plant releases. Trajectories are the paths that windblown radioactive particles are expected to follow in the atmosphere. The height of the particles is represented by the colour, ranging from dark blue (500 m) to red (5-8 km). The elapsed time since the incident is indicated by the black chevrons, which are at 12-hour intervals starting on 14 March. Modelling indicated that it would take about twelve days for material from Fukushima to reach Europe.

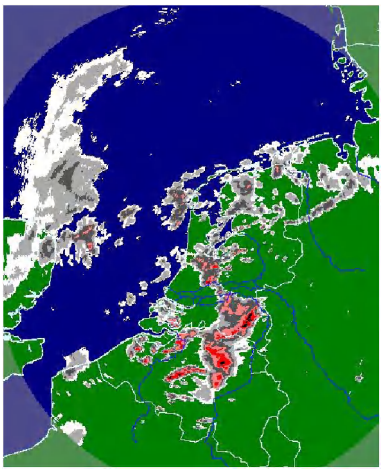
http://www.rivm.nl/Onderwerpen/Onderwerpen/O/Ongevallen_en_rampen/Kernongevallen

KNMI On 15 March, #Rotterdam The Hague Airport became the final regional airport to adopt automated observations (#AUTO METAR). Schiphol is now the only airport in the Netherlands to have a human observer.
15 Mar 2011

KNMI Minor #earthquake with a magnitude of 2.1 at #Sappemeer, Groningen.
28 Mar 2011

04 KNMI produces data

Measured data underpins everything that KNMI does. KNMI is in effect a huge data factory, where data of many different kinds are collected, validated, processed, stored, exchanged and delivered. Data for weather forecasts, data for climate research and data for the localisation of earthquakes.



A large number of land, marine, aerial and orbital instruments constantly feeds measured data and observations back to De Bilt via various communication channels. Roughly 1500 gigabytes of raw data is received every day, which KNMI converts into professional and accessible weather, climate and seismology products. To make all this possible, KNMI has an extensive observation network comprising:

- Precipitation radars at De Bilt and Den Helder
- A synoptic instrument network for measuring wind, pressure, temperature, visibility and cloud height, made up of 35 automated observation stations distributed around the Netherlands and observation equipment on drilling platforms, ships and aircraft
- A precipitation network of 325 volunteers who measure precipitation on a daily basis and report their findings to KNMI
- A lightning detection system to record discharges
- Radio probes that are sent up twice a day to measure pressure, temperature, humidity and ozone
- Instruments on various satellites, which constantly relay data to earth
- A seismological instrument network to record earthquakes. ■

Precipitation radar

The best-known rain detection system is the precipitation radar. KNMI has two precipitation radar stations, at De Bilt and Den Helder, which provide the data. The radar stations have a horizontal reach of 300 kilometres. The signals actually travel further, but the curvature of the earth means that, after about 300 kilometres, they are travelling above the clouds.
A radar station sends out pulses of radio waves, which bounce back off things such as banks of rain. From the direction of the signal and the time that elapses between a signal being sent and its echo being received, it is possible to work out where the precipitation is. On the radar charts, colours are used to indicate how heavy the detected precipitation is. Very light precipitation, such as drizzle, does not show up on normal radar, because the droplets are too small to reflect the radio signals and because drizzle only forms in the lowest 100 metres of the atmosphere. However, Delft Technical University has developed an experimental radar system that can detect drizzle within a limited radius. The equipment is set up at KNMI's measuring mast in Cabauw.

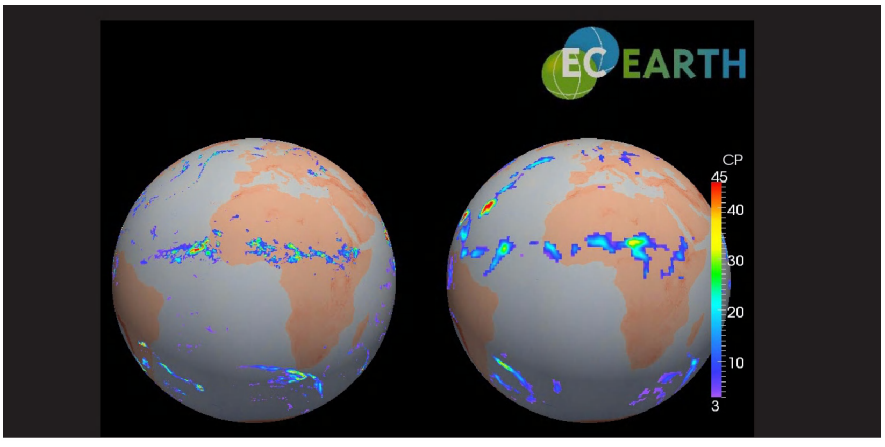
Lightning monitoring

KNMI and the Dutch Air Force share a lightning detection system that records electrical discharges and lightning strikes. The time, location and intensity of the events are determined using SAFIR (*Surveillance et Alerte Foudre par Interférométrie Radioélectrique*). Belgium's national meteorological institute also uses this system. Twenty-metre antennas are installed at eight sites: four in the Netherlands (Den Helder, Valkenburg, Deelen and Hoogeveen) and four in Belgium (Dourbes, Oelegem, Doornik and Gileppe). The equipment records the electromagnetic energy released in a lightning discharge. Both vertical lightning from cloud to earth and horizontal lightning from cloud to cloud are recorded. The data are fed back to KNMI at De Bilt and its Belgian counterpart KMI in Ukkel, where up-to-date geographical distribution charts are generated.

EC Earth shows future weather

In 2011, KNMI presented its new climate model EC Earth, which can simulate the state of the atmosphere, oceans and sea ice, as well as the land surface. The unique feature of EC Earth is that it is based largely on the highly advanced European Centre for Medium-Range Weather Forecasts (ECMWF) model.

EC Earth is capable of simulating the future climate. Its high resolution means that weather extremes, such as storms, droughts and heavy precipitation can be studied in detail. Unlike other models, EC Earth uses a grid that is fine enough to register small-scale phenomena. As a result, it represents an important step forward for both national and international climate research. EC Earth has been developed by a KNMI-led consortium of more than twenty institutes from ten European countries. Because of the extensive international cooperation between meteorological institutes, universities and supercomputing centres, EC Earth is a suitable platform for studying many aspects of the earth system. Within the Netherlands, EC Earth has a cohesive influence on climate research: in the years ahead, Wageningen University, Utrecht University and Delft Technical University will input additional data that better describe the complex interaction between vegetation, ice caps, land and climate. As increasingly powerful computers become available, it becomes possible to combine more and more data. The development and refinement of EC Earth is therefore a continuous process, which will make the climate model more versatile and enable it to perform increasingly detailed simulations. Output from EC Earth will be used for the IPCC's fifth climate report. ■



Simulation of rain. On the left the more detailed climate model EC Earth and on the right a climate model with less resolution.

KNMI State Secretary @Joop Atsma of IenM was presented with the first copy of #State of the Climate 2010. This annual publication by the @PCCC summarises developments in climate science. http://www.knmi.nl/bibliotheek/klimaatbrochures/staatvanhetklimaat2010.pdf
7 Apr 2011

KNMI A #higher technical class from Bussum has been investigating whether they can distinguish between #rain and #hail using an acoustic disdrometer and their own discernment solution. The attempt to tell the two forms of precipitation apart resulted in some particularly interesting and creative ideas. 7 Apr 2011

KNMI State Secretary @Joop Atsma presented the last #royal awards to seafarers who made meteorological measurements at sea. Although data collection at sea remains necessary, the processes are now almost entirely automated. http://www.knmi.nl/cms/content/96801/laatste_onderscheidingen_zeevarenden 8 Apr 20111

KNMI Historical geographer and weather historian @Jan Buisman was made a #Knight of the Order of Orange-Nassau. The royal distinction was awarded for his series #A thousand years of weather, wind and water in the Low Countries. His latest book – #Extreme weather! – appeared on 15 April 2011.
29 Apr 2011

http://www.knmi.nl/cms/content/93989/knmi_lanceert_klimaatmodel_ec-earth

Jan Staman, Director of the Rathenau Institute, on the relationship between science and politics

"It's important that KNMI is genuine"

As a knowledge institute answerable to the Ministry of Infrastructure and the Environment, KNMI is directly affected by political decision-making. The worlds of science and government work in different ways, and that sometimes causes tensions. "You need to try to understand each other and stick to your task," advises Jan Staman, Director of the Rathenau Institute.

"Science is getting closer to the people and taking hold of us. Science is in your body, in your soul, all around you. Our world is dominated by science and technology. We can't live without them and we don't want to live without them. People know where their prosperity and comfort come from, and they recognise that the benefits of modern life come at a price. But there is a downside to progress," says Jan Staman, Director of the Rathenau Institute, about the paradoxical effect of science on society. "Science presents us with normative and ethical challenges, and it changes the balance of power and social relationships, including the relationship between the state and its citizens. Think of the electronic child dossier. Everything is checked nowadays. Such far-reaching effects inevitably generate resentment and resistance."
Staman therefore believes that it is vital that science and technology – and, indeed, politics – engage with the public and listen to people's concerns. "If you don't involve people, you are bound to meet opposition. The co_2 storage reservoir at Barendrecht is a good example; so is vaccination against cervical cancer and, of course, climate change. Whenever science touches on government or people's day-to-day lives, it will be called into question. The validity of the research will be challenged and everything will be minutely examined."

Sticking to the task

In recognition of the contradiction between the waning authority of

academia and the demand for evidence-based policy, the Rathenau Institute decided to examine the relationship between science and government, as part of the activities organised to mark the Institute's silver jubilee in 2011. Politicians and policy-makers need ever more reliable scientific information in order to arrive at sound decisions. Yet science cannot always provide hard, unequivocal information. Science can even breed mistrust and alienate people if its message is difficult to deal with.

For KNMI, as a knowledge institute answerable to the Ministry of Infrastructure and the Environment, such contradictions are part and parcel of everyday life. In its three domains of expertise – weather, climate and seismology – KNMI provides enormous scientific and technological insight, but no absolute certainties of the kind that politicians and policy-makers want to deliver to the public. In a publication entitled *Policy and the evidence beast*, the Rathenau Institute makes recommendations for improving relations between politicians, policy-makers and scientists. At their heart is the need to stick to the task and develop mutual understanding. Evidence-informed policy is more realistic than evidence-based policy.

Staman does not believe that evidence-based policy is even possible. For one thing, science does not speak with a single voice. Whatever policy is decided upon, it will attract criticism. Criticism of the policy will be accompanied by examination of its scientific basis and alternative interpretations of the facts. Scientists have to recognise that, when they ally themselves with policies and politics, they compromise their objectivity. "When you start accepting commissions and letting outsiders determine what you are going to study, you start acting in the interests of the client. Scientific institutes need to have a clear understanding of their position and their role," Staman argues. "You also need to know who you are dealing with. What values does the politician or policy maker adhere to? He or she works in an environment that is wholly alien to you, an adversarial environment. You may, as a scientist, offer cautious conclusions and recommendations, but they may not be received in the way that you expect." Scientists need to accept that their involvement ends once they have handed over and explained their research to the politicians and policy-makers. Daniel Sarewitz (author of *How science makes environmental controversies worse* in Environmental Science & Policy, JL) warns: You are entering a world that you don't understand. You may know all about research and probabilities and risks, but policy development and politics is another world. Even when it comes to the realisation of policy goals, different points of view are always possible. You are confronted by an 'objective excess': scientists from other disciplines who see the same phenomenon in a very different way. If you venture into this other world, you are stepping onto quicksand. You are bound to meet resistance and opposition.

"Scientists are in a position to look ahead, but don't always win praise for reporting what they see."

"The politician works in an environment that is wholly alien to the scientist."

Impartiality

For a scientific institute, independence and impartiality are very important. In an era when people are acutely aware of the cost of research and demand-led working is increasingly the norm, it is more important than ever to ensure that these values are upheld. Like KNMI, the Rathenau Institute deals increasingly with paying clients. "Many of them, such as parliamentary committees and the European Parliament, are quite neutral. But inevitably a ministry or a commercial organisation has its own agenda. Institutes like ours have to ask themselves why they are seeking to secure additional income from the market. The motivation has to be something more than the need to compensate for the reduction in direct funding." Demand-led working obliges an institute to consider its image, its identity, its sense of what it is. "How do you remain impartial and independent? If we accept a commission, we always insist on the right to publish," explains the Rathenau Institute's Director. "We always publish and publish immediately, even if the results aren't to the client's liking. If a prospective client wants to make publication subject to approval, we don't accept the commission. There are people who would like to control the research that we do; as scientists we have to guard against that." Of course, politicians shop around for research that supports their outlook. "Everyone who has a political goal is looking for evidence to support their argument. Politics is not a field in which people are used to looking

dispassionately at all the evidence for and against something before drawing conclusions, as scientists are taught to do."
As well as supporting policy-makers and politicians, one of a scientific institute's most important functions is drawing people's attention to things. The urge to do so is innate in scientists, according to Staman. "Scientists don't do research simply for the sake of it. They see it as their role to discover things and to tell people about their discoveries, so that they can be put to practical use. That's the way it should be: there is nothing wrong with a scientist saying, 'This is important to society, politician; you have to listen to us and take this on board.' A climate scientist has as much right as any other to point to his or her findings and shout, 'Hey, do something about this.'"
Scientists are in a position to look ahead, but do not always win praise for reporting what they see. "No one thanks you for highlighting what's in store. You always meet resistance. Then the job becomes an exercise in damage limitation. It's part of being a scientist."

Translation

The same can be said of translating your research for the general public. Staman believes that scientists who work in policy-support organisations have an obligation to present their research in accessible language. "If, as a leading scientist, you are not able to explain your work to a journalist or tell a group of MP's what they need to know, then you are a liability to your institute," Staman asserts. "If you don't speak the same language as the public or politicians, if you can't connect with them, your institute is going to contract very quickly. It won't be long before a ministry starts asking itself what you are there for. Every institute has to engage with the outside world. Communication and media appearances are in the job description. You have to prepare your people for that. At the Rathenau Institute, you don't count for much unless you can also perform in the media."

"It's better to remain on the sidelines of some debates, because involvement is unproductive."

The influence of the media is now so great that Staman believes that any institute that doesn't deal well with the press faces an uncertain future. "Even if its existence isn't threatened, an institute that isn't media-savvy will inevitably go into decline. It's all very well saying in your annual report that you are leading your field and you've published lots of scientific papers. It won't cut much ice with a politician who has the power to decide your fate."

Opposition

The Rathenau Director finds the climate debate somewhat extraordinary. Uniquely, from his viewpoint, scientists everywhere seem to have gone into a sort of five-to-midnight mode. "It's like a black hole. The IPCC is sucking in every single line of scientific thought and trying to translate it into coherent advice that governments can use. The idea, of course, is to neutralise criticism by getting everyone on board. Everything and everyone has been brought within the IPCC fold. But it's not working. There will always be scientists who say, 'That's nonsense' or 'I don't believe that.' We shouldn't have a problem with that: science needs dissident voices. However, if you say that we've got to move ahead together and hammer out some kind of consensus at any cost, because it's five to midnight – and if you try to accommodate every shade of opinion and come up with a single universally supported policy – you can be sure of one thing: you are going to fail."

First of all, Staman contends, it is impossible to bring together all schools of thought on climate change. The IPCC has to listen to the sceptics and dissidents, but it does not have to embrace their ideas. "In science, disagreement is par for the course. We simply have to accept that alternative views will be voiced in the media and by certain politicians. That's democracy."
Second, the IPCC's reasoning is too authoritarian. The scientific world is engaged in a process which results in advice whose authority derives from the process itself. "In effect, what the IPCC is saying is that the process was really good, the entire global scientific community was involved, including all the finest minds around, we took every nuance of opinion into account, and we've come up with conclusions that everyone is backing. It's a very authoritarian line, which rubs a lot of people up the wrong way."

Caution

In the context of the climate debate, it is important that an institute

like KNMI understands its role and does not engage in public argument. “It is important that KNMI is genuine. KNMI tends to be quite good in that respect. As a knowledge institute, your role is to explain, highlight research, provide facts.” A knowledge institute needs to be cautious and consider the timing of its contributions, Staman continues. “It has to be clear that the institute is not ignoring the debate, but informing the debate as and when that will facilitate progress. Everyone within the organisation has to be clear about that. Sometimes a member of staff here at the Rathenau Institute will get particularly exercised about an issue and will be all for leaping into the thick of the debate. At times like that, I have to say, ‘Best stay out of it; this isn’t the time for getting involved.’ It’s better to remain on the sidelines of some debates, because involvement is unproductive or even counterproductive. You need to be cautious.” Staman adds that it is not about who wins the debate, but about who controls it. The stance taken by climate sceptics tends to be hostile. “That’s how scientists perceive it. They feel threatened,” he says. “Often, the sceptics come from a very different background and there is consequently a risk of people conversing on separate levels. Climate sceptics also tend to reduce the argument to black and white; they are apt to criticise, to be negative and to appeal to popular emotion. It’s an approach that’s possible only in the public domain, with the oxygen of journalistic publicity. A climate sceptic is nothing without the media. As a climate scientist I’m not prepared to share a podium with sceptics; the best place to engage them is on neutral territory, away from the media spotlight. Then you can have a normal conversation – and a productive one, in my experience. But the outside world doesn’t get to hear about exchanges like that.”

The Rathenau Institute promotes the formation of political and public opinion on science and technology. To that end, the Institute studies the organisation and development of science systems, publishes about the social impact of new technologies, and organises debates on issues and dilemmas in science and technology. The Rathenau Institute is operationally independent, having been established in 1986 by the Dutch Ministry of Education, Culture and Science, which also funds the institute. Based in The Hague, the Rathenau is administratively part of the Royal Dutch Academy of Science (KNAW).

Rathenau Instituut
http://www.rathenau.nl/en.html

Policy and the evidence beast
A Dutch study of the expectations and practices in the area of evidence-based policy
http://www.rathenau.nl/publicaties/policy-and-the-evidence-beast.html

05 KNMI measures drought

The Netherlands' weather in 2011 was characterised by two very dry periods. Very little precipitation fell in spring and autumn. The drought was so extreme that action was necessary to maintain water levels and water quality.

Spring drought

Very low precipitation and high levels of evaporation led to a major precipitation deficit in spring 2011. In March, April and May, an average of just 49 mm of precipitation fell on the Netherlands, compared with the normal 172 mm. It was the lowest value recorded for that period since 1901. Evaporation was very high because spring 2011 was also the second warmest and sunniest since observations began. A strong high-pressure system persisted over Western Europe, deflecting rain-bearing Atlantic depressions away to the north and south, and keeping the continent unusually dry.

For several years now, there has been an increasing precipitation deficit in the spring, due to higher levels of sun-induced evaporation and, to a lesser extent, higher temperatures. The precipitation deficit in spring 2011 was out of step with the recent trend: spring precipitation has generally been increasing. Last year's extremely low precipitation is regarded as a natural fluctuation. On the other hand, the higher spring temperatures are consistent with KNMI's climate scenarios.

Autumn drought

November's very low precipitation was particularly unusual. The national average precipitation amount was 9 mm, in contrast to the normal 82 mm, making November 2011 the driest since 1906. There had also been little rain in the second half of October. The autumn drought was the result of persistent high pressure over Eastern Europe, which drew dry south-easterly winds across Western Europe. A blocking high of this kind is very unusual in the autumn. Last year's autumn drought should not be regarded as a symptom of climate change: KNMI's climate scenarios point to drier summers and wetter winters becoming normal over time. However, year-to-year fluctuations are always possible, meaning dry weather can still occur in November. ■

Drought updates

KNMI supplies meteorological data to the National Water Distribution Coordination Committee (LCW) within the Public Works and Water Management Directorate. LCW coordinates response activities if the amount or quality of water available in the Netherlands declines to the point where rationing is required. Low river levels have implications for shipping, agriculture, drinking water supply and water quality. Every spring, LCW starts by issuing a drought update, setting out the water distribution and water quality position for the benefit of everyone involved in water management in the Netherlands. The drought update makes use of KNMI precipitation and temperature forecasts for the Rhine and Meuse region for the next four weeks. KNMI also provides information about the precipitation deficit or surplus in the Netherlands. If the rates of flow at Lobith or Sint Pieter (where, respectively, the Rhine and Meuse enter the Netherlands) fall below critical values, the LCW issues a Potential Drought and Heat Alert. In response, KNMI provides LCW with relevant meteorological data. If the drought becomes more serious and a state of Material Drought and Heat is declared, KNMI gives advice to LCW's Drought Management Team (MTW). Between the end of April and mid-July 2011, KNMI was involved with seventeen drought updates, eleven LCW discussions and six MTW meetings. In the autumn of 2011, it was so dry that LCW had to intervene again. In November and December, there were two drought updates and three LCW meetings.

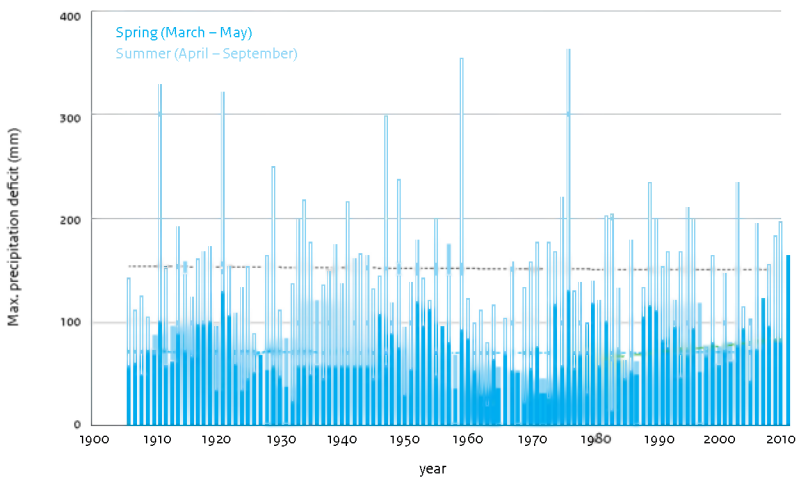
Lauwrens Faasse | Inland shipping company Faasse-de Ruijter vof | Hardinxveld-Giessendam

"The dry spring of 2011 cost our company a lot of lost income. We transport bulk goods, such as coal, ores, scrap iron and containers, throughout Europe. The low river levels meant we had to reduce our loads, so that the barges didn't sit so deep in the water. For example, we can normally use a draught of 2.70 to 3 metres on the Danube, but during the drought, the maximum was just 1.50 metres. In other words, we had to reduce the amount of freight we were carrying by 50 to 60 per cent. Half the load means half the income. The drought didn't come entirely out of the blue and normally you can cushion the blow by carrying more during the wet periods. You build up a buffer against the lean times. However, with the financial crisis, demand has been down, so the scope for buffering has been reduced. If low river levels become a regular thing, we might have to look at using smaller vessels, which weigh less and can handle the cargo more easily. But the cost per unit load will be higher."

Anton Vos | Vos Asparagus Farm | Roosendaal

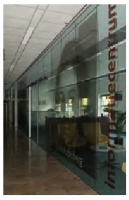
"To begin with, we were pleased with the dry weather last spring. It was easier to work outside and plan your activities. The structure of the ground was excellent. It looked like a positive turn of events. However, once everything started growing and the young plants needed more moisture, it was a different story. We had to use the sprinkler systems a lot. There was a ban on using surface water for irrigation, but fortunately we have wells on our land, which we are allowed to pump from. All the same, the water table was falling, making pumping more difficult. It was quite a worry for a while, but the rain came just in time. We had some real downpours in July, which restored the groundwater levels. The crops were able to recover, so that it was a good harvest in the end. On the other hand, the unexpected oversupply on the market meant that potato and union prices plummeted. And the heavy late summer rain saturated the ground, making harvesting difficult in August. When it's time to harvest, you have to do it, regardless of the ground. Otherwise the harvest will rot where it stands, or you'll have your clients after you for playing havoc with their schedules. Never mind, though: we are used to coping with extreme weather and try to anticipate. With our own wells; and we dig deep trenches to enable the fields to drain if we get heavy rain. We have acrylic sheeting to protect against extreme frost. The weather always keeps us busy, one way or another. In that sense, nothing's changed in the last thirty years."

Spring drought and summer drought



←
Precipitation deficit in the Netherlands in spring (dark blue) and summer (light) from 1906-2011. The dotted lines indicate trends over the whole period, the green line indicates the trend of spring over the last 30 years (right side of the figure).

KNMI Start of the European #ECLISE-project, in which #climate services are to be developed to enable organisations to prepare better for the effects of climate change.
9 May 2011



KNMI @KNMI's new #information centre, the #Kittie Koperberg Room, is opened. The centre provides even more information about the weather, climate and seismology in both #digital and #analogue forms.
20 May 2011

KNMI #Eruption of Iceland's #Grimsvötn volcano. The smoke and #ash cloud from the volcano rose 20 kilometres into the atmosphere. @KNMI provides the #air transport industry with weather information and, where necessary, advice.
21 May 2011

KNMI @KNMI organised the international #MACC Conference (MACC = Monitoring Atmospheric Composition & Climate) on air quality, aerosols and greenhouse gases. Topics addressed included #summer smog, #Saharan sand in Europe, the #ozone hole and eruption of Iceland's #Grimsvötn volcano.
23-27 May 2011

06 KNMI monitors gas quakes

Earthquakes felt in the North of the Netherlands are caused by natural gas extraction. In 2011, KNMI recorded 94 quakes in this region. Most were in the Groningen field and had a magnitude of less than 1.5 on the Richter scale.

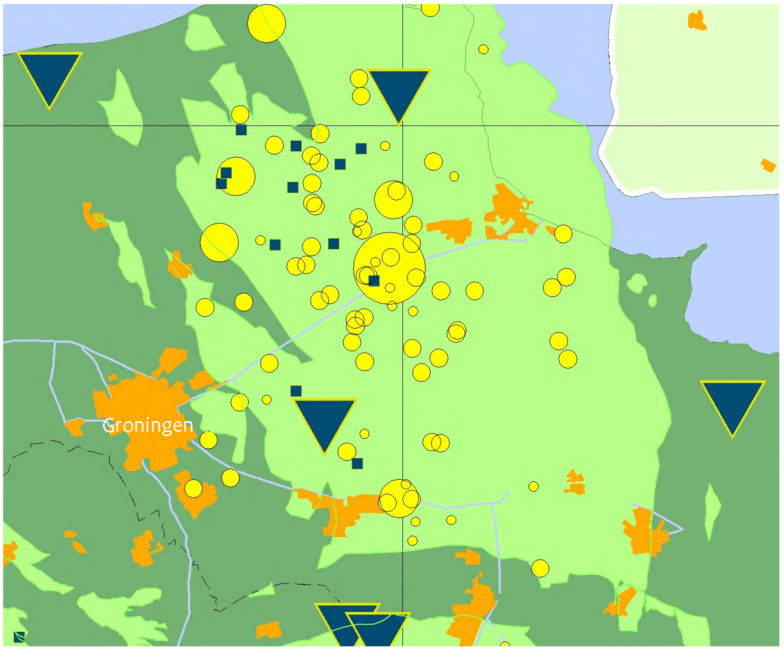
Of the 94 earthquakes in the northern Netherlands recorded by KNMI, 81 were caused by the extraction of gas from the Groningen field – Europe's biggest on-shore gas field. 9 quakes in smaller fields and 4 under the North Sea were also recorded. Because most of the quakes measured less than 1.5 on the Richter scale, they were not apparent to people going about their daily lives. However, three of the quakes that occurred in the northern Netherlands in 2011 were strong enough to be noticed.

As the independent reference institute appointed by the mining industry regulator and the Dutch government, KNMI monitors earthquakes in the Netherlands' northern provinces closely. The Seismology Department also estimates the likelihood of quakes. Since the new Mining Act of 2003, each new concession is subject to a monitoring plan and a risk analysis. KNMI measurements and observations are used in damage evaluation, damage cause management and geomechanical reservoir modelling undertaken in tandem with TNO.

Fifty years of gas extraction

Gas extraction has been taking place in the Netherlands since the sixties. The first bore hole was sunk into the Groningen field (also known as the Slochteren field) in 1963. It was not until 1986, however, that the north of the Netherlands began feeling earthquakes caused by the extraction. The first one shook the town of Assen on 26 December 1986. Since then KNMI has recorded a few hundred quakes in the northern Netherlands, the biggest measuring 3.5 on the Richter scale. One of the characteristics of a gas quake is a hypocentre quite close to the surface. Occurring just 2-3 kilometres below ground, gas quakes are much shallower than natural earthquakes. The reason for that is that the gas lies about three kilometres below ground, where it is trapped in porous rock (like sandstone) capped by non-porous rock (like rock salt). Following extraction, the porous rock, no longer 'inflated' by the pressurised gas, is compressed by the weight of the three kilometres of rock above. As a result, the higher strata sink down a little. Usually the sinking is very gradual, but sometimes there is a more sudden movement, causing a tremor. ■

The earthquakes in the North of the Netherlands in 2011 are indicated with yellow circles. Gasfields are shown in light green, cities in orange and KNMI seismic stations in dark blue.



Gas storage at Bergermeer

The former Bergermeer gas field near Alkmaar is now being used as a gas storage reservoir. As part of the permit application procedure, KNMI and TNO modelled the most serious negative effects likely to occur. The Ministry of Economic Affairs, Agriculture and Innovation also asked KNMI to monitor the seismicity of the Bergermeer field, with a view to ensuring that the gas storage operation is safe and responsible.

Positive assessment external review of KNMI research

In general, research personnel at KNMI are inspired, authoritative and highly motivated. Moreover, their research leads the world in various fields. That is the assessment of the international committee that reviewed KNMI's research activities. According to the committee, KNMI's research makes a substantial contribution to the Dutch community, and KNMI is working hard to ensure that it continues to do so. The committee makes the point that the research programme needs to receive proper support if KNMI is to go on fulfilling its vital role in Dutch society. The reviewers additionally made a number of key recommendations about general aspects of KNMI's research, such as the formulation of a new, more precisely defined research strategy, the reinforcement of central research coordination, the improvement of cooperation between the various research groups, and the enhancement of research-related internal and external communication.

KNMI @KNMI was presented with the #HIER Climate Award by Princess Laurentien, in recognition of its valuable contribution to familiarity with and understanding of #climate change. 24 Jun 2011

KNMI #Earthquake with a magnitude of 2.7 at #Appingedam. @KNMI received dozens of #reports from people in the region who felt the shock.
27 Jun 2011

http://www.knmi.nl/seismologie/geinduceerde-bevingen-nl.pdf

Willem de Winter | Westeremden, Groningen

Willem de Winter remembers it like yesterday. "It gave me quite a fright. I was asleep at the time, and the bed shook quite violently. There were several dull thuds and loud bangs. It didn't last long, though; everything settled down before I could even get to my feet, so we just turned over and went back to sleep." It was 8 August 2006 at 5.04 am when Westeremden in the province of Groningen experienced its largest earthquake measuring 3.5 on the Richter scale. The tremor was not the first below the village, but none of the others had been really obvious to local people. The quake caused damage to some houses: several months afterwards, Willem de Winter noticed two cracks in his wall, for which he was compensated by the NAM. Because of his experience, De Winter had no hesitation in agreeing when KNMI seismologists Bernard Dost and Femke Goutbeek asked him if they could install an accelerometer in his outhouse. Enclosed in a hermetically sealed container, the instrument measures movements in the earth's surface, as a basis for deciding how discernible a quake is. "Bernard and Femke were walking along our street," De Winter recalls. "We were sitting in the garden having a sandwich. As usual for a weekday in our village, there weren't many people about. Anyway, they came up to us and asked whether we'd mind having an instrument set up in our house. They had initially approached someone else, but the person in question had changed their mind at the last minute. I couldn't see any reason not to do it, though: we've got a good outbuilding where the thing can be set up without getting in anyone's way. Besides, the whole business intrigued me: the idea of the earth moving and people being able to measure it is fascinating. I was interested to know more about what was involved. So I was glad to give their instrument house room. Now, if anything happens, we will have evidence to present to the NAM. That's important, because we can't match the NAM's power and influence."

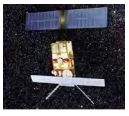
07 KNMI advises on climate

Various sectors of the Dutch economy benefit from information and advice from KNMI about long-term meteorological and climatic effects. For example the transport and agricultural industries, water and environmental management bodies and energy companies.

Weather phenomena such as unusually heavy rainfall, drought, heat waves and high winds all have implications for business, government and the emergency services. Climate-related information helps such organisations to improve safety measures, prevent injury and damage to people and property, increase process efficiency and reduce vulnerability. The net result is a nation that is more resilient and more able to adapt to a changing climate.
Customised KNMI observation data and bespoke climate models are used in connection with sea defences (Public Works and Water Management Directorate), extreme river drainage (Waterdienst, the national water service), potential changes in the yield of non-fossil energy sources (ECOFYS), national water management (Waterdienst) and local water management (water authorities, FutureWater).
Reliable climatic advice depends on sound climate research. KNMI therefore follows the tried and tested scientific procedure: observation, modelling, analysis and advice. Control and verification are of course integral to the process.
International contact is necessary so that knowledge, models and observations can be shared, tested and compared. The more exchange and cooperation, the greater the pool of knowledge and insights that can be drawn upon. After all, weather and climate are not confined by national boundaries. ■

KNAW

KNMI The #KNAW evaluation of space research 2006-2011 resulted in a very positive assessment of @KNMI. The Netherlands has built up an excellent technical and scientific reputation, reflected in KNMI's Principal Investigator roles on the #OMI and #TROPOMI projects.
4 Jul 2011



KNMI After sixteen years' loyal service and nearly #85,000 orbits of the earth, the European Space Agency @ESA's successful #ERS-2 satellite has been retired. The satellite has significantly influenced the design of a new generation of meteorological and atmospheric satellites.
7 Jul 2011

KNMI The torrential #rain and stormy winds of 13 and 14 July caused #flooding, brought down trees, damaged property and resulted in various injuries.
14 Jul 2011

KNMI Following an article published in the #Telegraaf, MP @René Leegte visited @KNMI, where he discussed the background to the article and issues surrounding climate research and the climate debate.
14 Jul 2011

Climate Service Desk

Enquiries about and requests for climatological data are handled by KNMI's Climate Service Desk. Customised information is delivered to clients in their preferred form. Examples of the support provided by the Climate Service Desk in 2011:

- The Justice Department and the police approach KNMI's Climate Desk regularly for weather reconstructions. In some cases, the desk staff simply need to point the enquirer to public data on the KNMI website. When a detailed investigation or legal evidence is required – in connection with a serious road accident or crime, for example – KNMI provides extensive expert advice based on climatological data.
- The Central Gelderland Health Service asked the Climate Service Desk for climatological information to assist their research into the relationship between interior and exterior temperatures in Arnhem.
- A request for extensive weather data was made by the Dutch Safety Board (OVV), which was investigating the capsize of the Frisia, a vessel that capsized off Terschelling on 14 December 2010. Working closely with KNMI's shipping meteorologist, the Climate Service Desk provided a comprehensive picture of the weather conditions on that day.
- Many people are fascinated by unusual or extreme weather. So, when something out of the ordinary happens weather-wise, there are often related enquiries for the Climate Service Desk to deal with. In response, the Desk provides explanatory information supported by facts and figures. If a large number of enquirers ask for information about a particular weather event, a background story will often be added to *het Kenniscentrum* (the Knowledge Centre) on the KNMI website. ■

The city as an Urban Heat Island

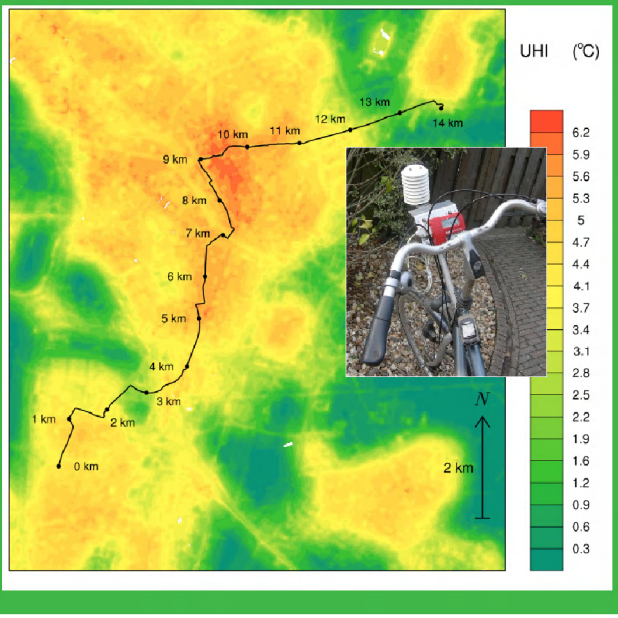
The urban climate is very different from the rural climate. Traditionally, KNMI gathers data only at rural sites where undesirable environmental factors are minimal. That is because high buildings, the absence of vegetation and the presence of a lot of brick and concrete are liable to bring about localised high temperatures and low winds. So, in order to build up a representative picture of the climate, weather stations are located away from the distorting influences that exist in cities. However, this inevitably means that relatively little is known about the climate in the very places where most people live.

In recent years, KNMI researchers have been paying more attention to the urban climate, because of the growing interest in 'Urban Heat Islands' (UHI's). In cities it is usually hotter than in the countryside and, in a heat wave, the localised high temperatures can have significant public health implications. Awareness of UHI's has consequently risen sharply since the hot summers of 2003 and 2006.

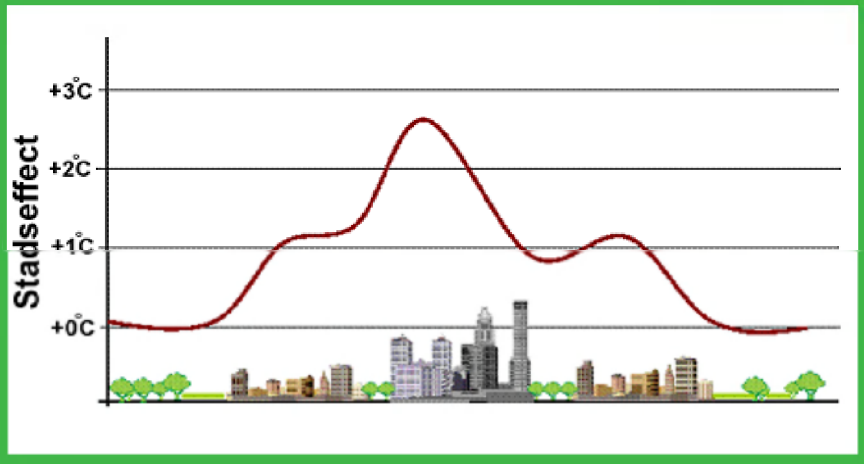
Using innovative methods and detailed weather models, KNMI researchers are learning more and more about the urban climate. In 2011, KNMI's Dirk Wolters and Theo Brandsma published their research into Urban Heat Islands. For their work, the pair drew from a source not previously used by KNMI: observations by weather stations of amateur meteorologists in the city. By comparing this information against figures from official weather stations in non-urban locations, Wolters and Brandsma were able to estimate the strength of the UHI effect. They found that in summer, the city is an average of up to one degree hotter than the surrounding countryside, but in certain spots the discrepancy can exceed five degrees. The UHI effect is greatest at night, especially at times when there is little wind and significant cloud cover.

Between 2006 and 2009, Theo Brandsma also performed a series of unorthodox measurements to chart temperature and humidity distributions in the city of Utrecht. He attached instruments to the bicycle he uses for his daily commute across the city to De Bilt, enabling him to gather data as he went. The figures he compiled were used to construct a spatial profile of the Utrecht UHI. By combining the distribution data with information about land use and the built environment, Brandsma and Wolters were able to draw up a temperature map for the Utrecht area. The UHI effect proved to be much more pronounced in the city centre than elsewhere. The city centre has a high concentration of brick, concrete and asphalt, plus narrow streets and high buildings that trap the heat. UHI effects have been incorporated into the detailed new Harmonie weather model. Using an integral urban module, the model can be used to produce city-specific forecasts.

http://www.knmi.nl/cms/content/92301/warmte-eilandeffect_van_de_stad_utrecht



← *Maximum UHI in the Utrecht area, estimated using bicycle-collected data, plus photograph of mobile weather station attached to bicycle. Black line: route taken when gathering data. Source: KNMI*



↓ *Urban temperature cross-section. Source: KNMI*

08 KNMI publishes the Climate Atlas

One of the biggest successes of 2011 for KNMI was *De Bosatlas van het Klimaat* (Bos Climate Atlas). In this book, KNMI presents the new 'normals' for the Dutch climate in the period 1981-2010. The atlas is a 'popular science' publication, which makes dry statistics accessible and appealing to a wide audience.

On 25 August, the first copies of *De Bosatlas van het Klimaat* were presented to State Secretary Joop Atsma and TV weather presenter Helga van Leur. Both expressed their admiration for the colourful publication, which provides not only tables and graphs, but also clear explanations of the weather in the Netherlands and its influence on people, nature and the economy.
The publication of so-called 'normals' is one of the duties expected of a national meteorological institute, such as KNMI. To be able to accurately assess the current weather, it is necessary to compare it with what is normal for the time of year. That is why, every ten years, KNMI calculates the long-term averages, looking back over a period of thirty years. By referring to the 'normals', it is possible to say, for example, whether 25 degrees is normal for April. And, if it is not normal, just how unusual it is.

Reference values

The normals serve as the reference values that are used for weather and climate products and help to underpin a wide range of climatological products, including climate monitoring. The World Meteorological Organisation (WMO) advises every country to calculate long-term, 30 year averages for a number of meteorological variables – like temperature, wind and precipitation – every thirty years. KNMI is responsible for making the calculations for the Netherlands. KNMI's normals form the basis for *De Bosatlas van het Klimaat* and the associated website www.klimaatatlas.nl.
De Bosatlas van het Klimaat was the product of collaboration between KNMI and publisher Noordhoff, the Netherlands' atlas publishing specialist. Working with Noordhoff, KNMI climatologists Rob Sluijter and Mieke Reijmerink consistently sought to strike a balance between the presentation of accurate scientific information and the creation of an attractive, readable product. The atlas's development involved intensive collaboration between professionals from the public and private sectors – as represented by KNMI and Noordhoff.

Expertise

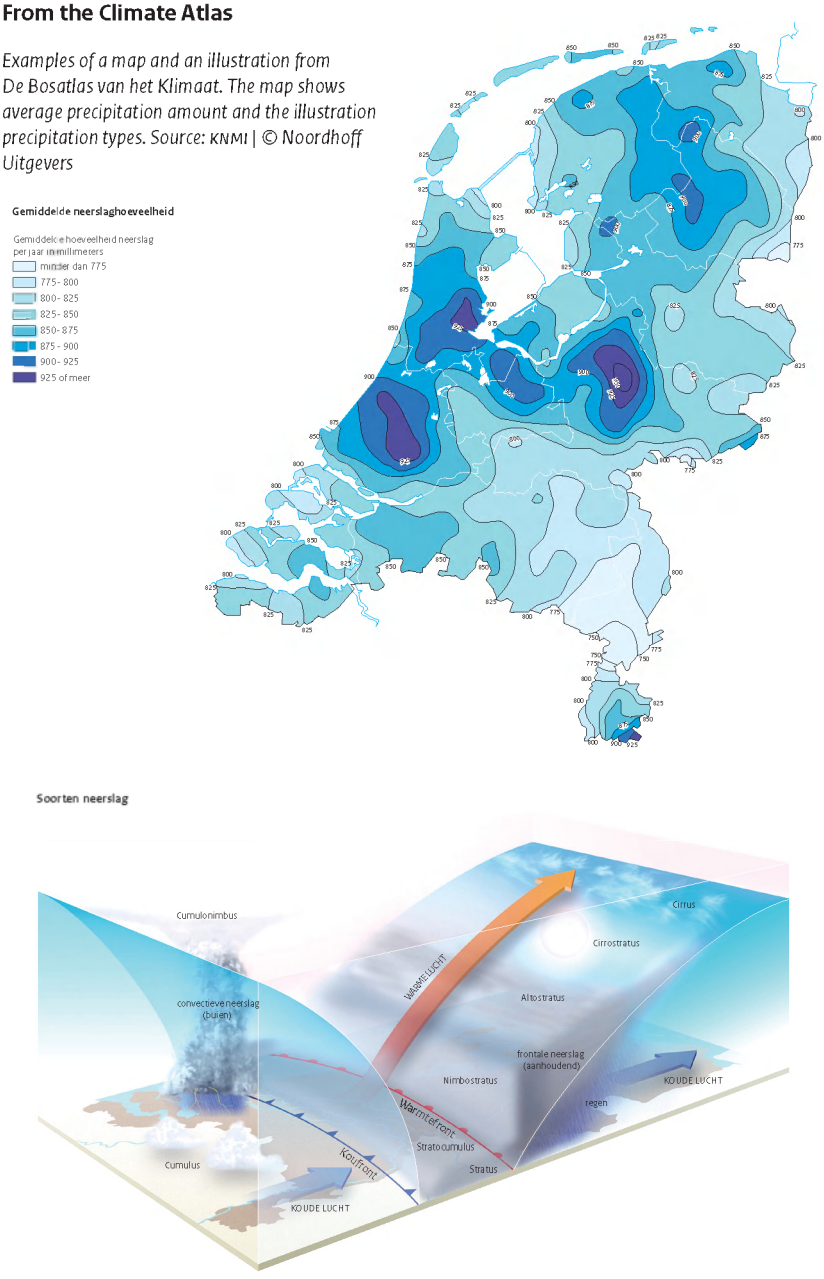
KNMI's expertise in various fields was utilised to ensure the reliability of the measured and calculated data. The atlas drew upon KNMI's understanding of Geographical Information Systems (GIS s), for example, and special algorithms (series of equations in computer programmes) were developed to work out the new normals. To that end, technicians had to determine when changes occurred at the weather measurement stations and check the homogeneity of the data series, since observation methods changed somewhat during the period in question. On their own, tables and graphs of the weather are of little interest to most people. So the atlas's developers placed a lot of emphasis on explaining and clarifying the statistics for the period 1981-2010. For instance, the atlas tells readers why heavy showers are much more common nowadays, especially in summer; and why Dutch winters have been getting wetter for the last 100 years. Why the Veluwe gets more rain than other parts of the country is also explained. By way of illustration, the atlas points out that, on average, 850 litres of water fall on every square metre of the country, compared with 700 litres a little more than a hundred years ago.
Special attention is given to the way the weather affects nature, people and the economy. Frost means high energy bills, snowfall causes huge traffic jams, torrential downpours cause flooding and heat waves cause mortality rates to rise. The atlas also addresses climate change, of course, and Dutch cloud formations are described and illustrated in their many forms. ■

www.klimaatatlas.nl

Joop Atsma and Helga van Leur receive first copies

From the Climate Atlas

Examples of a map and an illustration from De Bosatlas van het Klimaat. The map shows average precipitation amount and the illustration precipitation types. Source: KNMI | © Noordhoff Uitgevers



Peter Vroege | Atlas Publisher | Noordhoff Uitgevers

"*De Bosatlas van het Klimaat* is a very accessible, readable product. It's the sort of thing that people will show to their friends and neighbours. The maps bring the complex scientific information about the climate to life. However, cartographers tend to generalise; making the main features clear at the cost of some of the detail. Scientists are not so appreciative of that last part. It wasn't until the project was underway that I realised that every block of text would have to be discussed widely within KNMI. Rob Sluijter made sure that everything fitted into the original concept while also remaining scientifically sound. It was a difficult balancing act, and he did well to have everything ready on time. Everyone working on the project was very positive about it. And the outcome is a publication that translates KNMI's expertise into a form that is accessible to a wide audience. On average, Golden Delicious apple trees now blossom ten days earlier than they did twenty years ago, because the springs are warmer. That was what hit the headlines."

KNMI @KNMI measuring mast at Cabauw was the location for the launch of @icos_nl, the joint initiative to create a monitoring infrastructure to support research into the Europe's #greenhouse gas balance. The project partners are @VU, @ECN, @KNMI, @SRON, @Alterra, @univgroningen, @UniUtrecht and @WageningenUR.
18 Aug 2011

KNMI @KNMI's #weather warnings are now also published on #Twitter, in addition to the regular reports on the KNMI website.
21 Aug 2011

KNMI Thursday 18, Sunday 21 and Tuesday 23 August saw frequent, heavy #thunder storms, caused by atmospheric instability and major temperature variations. In some places, @KNMI recorded more than 500 lightning discharges across an area 50 km by 50 km, within the space of 5 minutes. One of the storms occurred directly above Belgium's #Pukkelpop music festival, resulting in five deaths and many injuries.
23 Aug 2011

KNMI #Earthquake just off the coast of Groningen, beneath the #Uithuizerwad mudflats. The quake measured 2.6 on the #Richter scale and occurred three kilometres below the surface.
31 Aug 2011

KNMI Lecture and debate at @KNMI with @Fred Singer, us physicist and #climate sceptic, who disputes that #global warming is due to human activities, such as the emission of greenhouse gases.
31 Aug 2011

Luc Kohsiek, Chairman of water authority Hollands Noorderkwartier

"We live and work in a bathtub"

When you have communities living below sea level, you have to pay constant attention to flood defences and water levels. In addition to all the water held at bay by the dykes, one has the threat of the low-lying 'polders' being swamped by extreme precipitation. Rapid, accurate weather modelling is therefore very important for water authorities, such as Hollands Noorderkwartier. That authority's chairman, Luc Kohsiek, talks about the 'North Holland bathtub', his organisation's new 'precipitation radar for disasters' and the importance of bespoke information.

Whenever water authority chairman *(dijkgraaf)* Luc Kohsiek drives across North Holland's polders – land reclaimed from the sea – he is struck by what an extraordinary part of the country it is. North Holland is a province that lies mostly below sea level, crossed by drainage channels that all have their own level. At his desk in the town of Heerhugowaard, the man responsible for the dykes at the Hollands Noorderkwartier Regional Water Authority remains acutely aware of the areas' reliance on the dykes and surrounding water channels: he sits two metres below the normal sea level.

"We live and work in a bathtub. To see the difference in water level, all you have to do is stand on a dyke. On one side the level is often considerably higher than on the other. Less apparent is that every drainage channel has its own water level. Managing the complex interrelationships is something of an art; even in this technological age

"The more accurate the forecasts, the more opportunity the water authority has to prepare for the weather"

personal judgement is an indispensable factor. It's something special, in no small part because we are so successful that problems very rarely arise."
However, Kohsiek is one of the few Dutch people who are really conscious of the never-ending balancing act that keeps the country dry. The majority, especially in the cities, do not give a second thought to living between the dykes in houses that are three metres lower than the sea. In a way, that is a good thing: it speaks for the confidence that people have in the nation's water management. Everyone simply assumes that the flood defences are in good hands.
Luc Kohsiek understands that and takes it in his stride, but also feels he has a duty to highlight what actually goes on. Last year, his authority started a publicity campaign under the banner "Living safely below sea level". However, rather than delivering dry practical advice, the posters featured people walking on stilts, representing the depth of water that there would be without the flood defences. Hollands Noorderkwartier also uses educational projects about living and water to promote awareness amongst school pupils and young people visiting museums. "A water authority needs to keep reminding people what it does and what it exists for. It's hard to persuade people that they need to pay rates for living below sea level. Farmers tend to understand the situation, but they are the exception. Most people question why the rates they pay their water authority are so high and what they are getting for their money. I'd like them to think of their rates as the price of living in a polder. Hollands Noorderkwartier levies higher water rates than, for example, the water authority Dommel, because Dommel has no dykes and people there don't have to pump water away whenever there's a heavy shower. In Brabant, the water simply flows from the higher land, down into the rivers; here, we have to make the water go uphill."

Water devastation

For Kohsiek, the most important thing is that the Netherlands does not forget the importance of constantly maintaining the dykes. He points to the devastation caused in the US by 2005's Hurricane Katrina and to the recent Asian tsunamis. Those disasters underline how much damage water can do and what happens if your flood defences are not well maintained. "That kind of catastrophe could happen here any time. To prevent it, we have to make sure that the perimeter of our country is protected by state-of-the-art defences. Interior defences are a slightly lower priority. Of course, it's dreadful if a drainage channel overflows its containment and floods the lower-lying land. The cost can run into millions. But it's unlikely anyone will die. If, on the other hand, the sea breaks through a perimeter dyke, a large and very important part of the Netherlands will be gone; the whole country will be thrown into chaos. People will lose their homes, public and commercial buildings will be ruined, industry will shut down, agriculture will be impossible; everything will have to be drained and rebuilt. That's not millions; that's billions. As a nation, we mustn't ever lose sight of what's at stake. Take the dyke between Durgerdam and Edam. It ought to be strong enough to reduce the failure risk to one event in ten thousand years. At the moment, the risk is one in a thousand. People shrug and say, 'One thousand, ten thousand – is it such a big deal?' Yes it is, if the one time is tomorrow. I don't mean to sound alarmist, but I do want everyone to be aware that getting on with everyday life below sea level isn't something you can take for granted. So we fully intend to reinforce that dyke."

Delta Programme

Naturally, the water authority chairman is very pleased with the appointment of Wim Kuijken as Delta Programme Commissioner – the statutory vehicle for flood prevention. "The Netherlands is going to have more forward-looking policies on water supply and water management, which anticipate the transition to a warmer climate. When Wim Kuijken publishes his Delta Programme Strategy in 2014, I expect that he will outline a vision for the next twenty years. What do we need to pay more attention to? What's not so important? What should our attitude to water be? I feel we have an obligation in that regard. The whole world thinks of the Netherlands as the one nation that really knows how to manage water. It's a status that opens a lot of doors for us. Also, technology keeps advancing. What are you doing with those innovations in the Netherlands? And why?"
The standards that dykes have to meet are getting stricter, Kohsiek acknowledges. That's necessary for no other reason than that, in the last fifty years, the standards have remained unchanged, while the value of everything that the dykes are protecting has increased enormously. Just as fire insurance has to rise as the value of your building contents increases, so flood

"Life below sea level isn't something you can take for granted."

protection has to be upgraded as the value of what's in the polder goes up. "Hurricane Katrina was a wake-up call for the Netherlands. People started saying, 'Shouldn't we be looking at our dykes?' The point is that, for a long time, we have been working to the standards of the sixties. The Delta Programme Commission has got everyone thinking with its proactivity." The result is an act of parliament, special funding arrangements and a commissioner to oversee the programme, which should ensure that the Netherlands' dykes are properly maintained and upgraded for many years to come.

Clustered showers

It is not only the water that presses against the dykes that threatens North Holland; so does the water that comes down from the sky. Ordinary showers are not such a problem, but clustered showers can be challenging. "Excessive precipitation has to be pumped out of the polders," explains Kohsiek. "We can pump away 1.5 centimetres a day, but clustered showers can easy involve 80 to 100 millimetres of rain. We've had precipitation on that scale three times in the last five years. When that happens, the whole place is just a sheet of water and it takes us a week to move it. Unfortunately, if we get that much rain when there are bulbs in the ground, they're lost."

Kohsiek therefore hopes for even more accurate forecasts from KNMI, so that his water authority has more opportunity to prepare. "If, for example, KNMI were able to predict a day in advance that an area would be hit by a clustered of showers, instead of a few hours in advance, we could have pumps draining the relevant area before the rain hit, increasing the land's capacity to absorb it. As things are, pumping doesn't start until the water in the drainage channels gets too high." Even better for Hollands Noorderkwartier would be if one day they could link accurate weather models to their 3Di software to simulate dyke failures. Recently developed, 3Di is a computer program that provides a real-time picture of how water would flow in to the province if a dyke failed and which facilities would be threatened. It is like precipitation radar for disasters.

"We know to within a centimetre how high the water will be everywhere in North Holland. Every variation can be charted. Suppose a dyke fails. This software lets us see in minutes where the water will go and how soon it'll get there. We've actually been able to predict that sort of thing for some time, but until now it involved hours and hours of work. Now, by the time you hold your crisis meeting, you've already got a clear picture of what areas are threatened, which translates into faster, more accurate warnings and intervention."

The 3Di program can also model rain falling on the polder and show where the precipitation will go. How much water will enter the drainpipes, how much will be absorbed by the soil and how much will find its way into the drainage channels? "Everything like that can be calculated if you have the right measurements and data."

Kohsiek likes to envisage the potential of linking super-fast weather models to 3Di. "If that were possible, you could monitor the situation on a minute-by-minute basis, entering the very latest data. You'd be able to see the location of clustered showers and where the water would go after coming down. On the basis of such information, I'd know exactly where to intervene and deploy emergency pumps even while the rain was still falling. A huge amount of damage could be prevented that way."

Response

Hollands Noorderkwartier's recent Delta Vision Document utilised KNMI statistics covering the last hundred years. Climate data on temperature, wind and precipitation were combined with other data, such as economic figures from the Central Planning Bureau. "You always come back to the same question: can we still afford dyke maintenance under the lowest-growth scenario? And what more can we do with our dykes under the highest-growth scenario? Our Delta Vision underpins our future planning and intervention in conditions that are warmer and drier, or warmer and wetter, as well as more saline."

KNMI climate scenarios and data are also used by the water authority to inform operations such as building pumping stations, Kohsiek continues. "We've had pumping stations on the polder for almost forty years. You don't want a pumping station to be too small, of course, but it shouldn't be too big either. KNMI's insight enables us to base our decisions on the likelihood of heavy precipitation or drought." Naturally, exact predictions are impossible, so a margin of error has to be incorporated. "The uncertainties in the scenarios continue to pose challenges. We focus mainly on the trend. Then we take a modular approach to pump-station construction: we go with two stations, but leave open the possibility of adding a third. And the stations we create can pump in either direction. That's more expensive, but gives us

Hollands Noorderkwartier Water Authority is responsible for water management in the province of North Holland. There are twenty-five water authorities in the Netherlands. They manage waterways, maintain flood defences and ensure an adequate supply of clean water. Water authorities are government bodies run by elected executives. Because North Holland is largely below sea level, with water on three sides, the priority for Hollands Noorderkwartier is to protect the province against flooding by means of dykes, sand dunes, dams and river walls. Hollands Noorderkwartier also carefully monitors the water level in the polders and works to prevent salinization.

www.hhnk.nl

the flexibility we need to cover an uncertain future."

Expertise

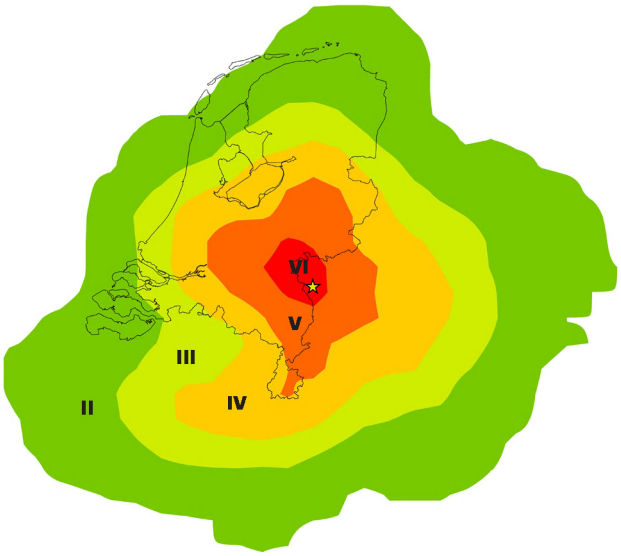
Kohsiek sees other opportunities for using KNMI data as well. He envisages climate scenarios and data being adapted to regional conditions in the Netherlands and KNMI providing support with the interpretation of statistical probability data. "Probabilities are often difficult for outsiders to understand and confuse the decision-making process. KNMI could provide on-the-spot guidance. For us, KNMI is primarily an applied institute, which supplies products that help us do our job." So, for example, Hollands Noorderkwartier also utilises KNMI's seismology expertise, because of the earthquake vulnerability of the Bergermeer gas storage facility. "In a region where dykes are all that stand between you and extensive flooding, earthquakes are a real threat, because of their potential to trigger dyke failures. KNMI calculates the likelihood of quakes occurring. It's important that we know what the chances are, even if they're small." The water authority expects KNMI professionals to identify personally with issues that face North Holland. "We really need the seismologists to be aware that there's a gas storage facility at Bergermeer, in an area reliant on sea defences and the retaining structures beside the drainage channels. We also benefit from the seismologists understanding what we do with the data and calculations. The same goes for the climate figures. How exactly are climate data used? What is the significance of that information for us? We expect KNMI personnel to think about such issues and about why we depend on scenarios and calculations." According to the water authority chairman, the importance of specialist knowledge and expertise is only likely to grow – especially in the context of crisis management. "If you've got to deal with a dyke failure, it's vital that you have all the relevant experts around the same table. People from the railways, from national traffic management, from the inland waterways and, of course, from KNMI. We did an exercise recently, which underlined the importance of these people being able to share information. It's not enough that they provide information when asked – we need them on the team." If everyone sits down together in a crisis management meeting, they can listen to each other, see what people in other organisations are up against, and realise how a piece of information may be trivial in one profession but critical in another. "In our dyke failure exercise, for example, a meteorologist was able to point out that a force 10 gale was expected. That enabled the rail planner to say that evacuation by rail was no longer an option: they don't run trains if the wind gets above force 10. Sometimes it's that simple. In a crisis, you need small multidisciplinary teams of experts. That's the approach that works best. Decisions have to be made quickly and every detail counts."

09 KNMI records Goch earthquake

On the evening of Thursday 8 September, just after nine o'clock, many people in the Netherlands, Belgium and Germany felt the ground shake. The origin of the tremors was nine kilometres below the earth's surface, beneath the German city of Goch, 33 kilometres southeast of Nijmegen. Measuring 4.5 on the Richter scale, the quake was felt by large numbers of people and caused minor damage within a radius of 30 kilometres of the epicentre.

Many people called KNMI about the event and almost four thousand filled in KNMI's on-line questionnaire. Working from the reports, KNMI drew up an intensity map, showing where and how strongly the quake was felt.

The earthquake's location was interesting, in that it was not on the Viersen fault – the fault in the earth's crust that runs along the Dutch-German border. Instead it was five kilometres to the northeast, suggesting that the fault system extends further than previously supposed. The Goch quake also prompted seismologists to review two earthquakes that had been felt in Nijmegen in 1972 and 1979. At that time, the instrument network in that region was not good enough to allow accurate localization of the epicentres. Consequently, it is possible that the '72 and '79 quakes were also down to movement in the Viersen fault system. Further research has since been started, in collaboration with German and Belgian colleagues. ■



Intensity map of the earthquake near Goch. Intensities quantify the effects of an earthquake on the Earth's surface to humans and buildings. Intensities are written in Roman numerals..

The Mercalli intensity scale

I ***Not felt.*** *Only registered by instruments.*
II ***Hardly felt.*** *Only felt under favourable conditions.*
III ***Weak.*** *Felt by some people. Vibrations similar to the passing of a truck.*
IV ***Fairly strong.*** *Felt by many.*
V ***Strong.*** *Felt by nearly everyone.*
VI ***Slight damage.*** *Many frightened. Some heavy furniture moved. Minor damage to less solid houses*

Earthquakes in the South of the Netherlands in 2011

16 April, Mamelis, M = 0,9
9 May, Maastricht, M = 2,3
30 May, Voerendaal, M = 1,0
1 December, Heerlen, M = 1,4

Experiences of people who felt the earthquake

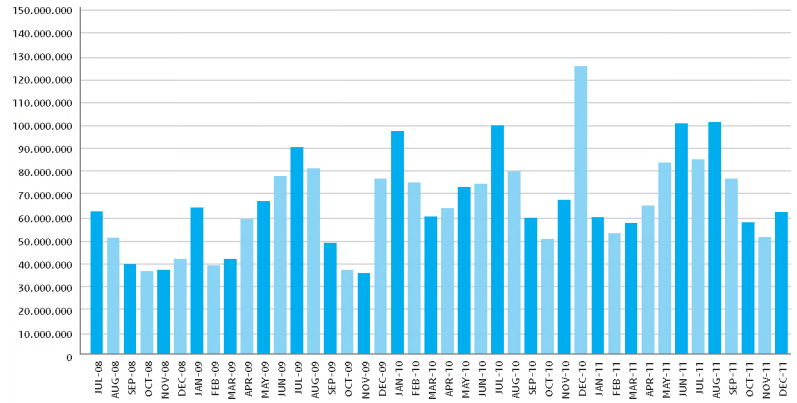
Venlo "It was as if we had a giant mole burrowing underneath us."
Deurne "Felt like a tank driving on our balcony ... except that we don't have a balcony!"
Berghem "The vibrations reminded me of a lorry driving down our street from the east."
Oudenbosch "It was like being on the deck of a boat on a gently heaving sea."
The Hague "My husband, who was on the third floor, felt it too. He came up and said: "Did you feel that?"
Malden "At first, I thought: "Maybe it was a minor explosion". Then the walls began to shake."

Webstatistics

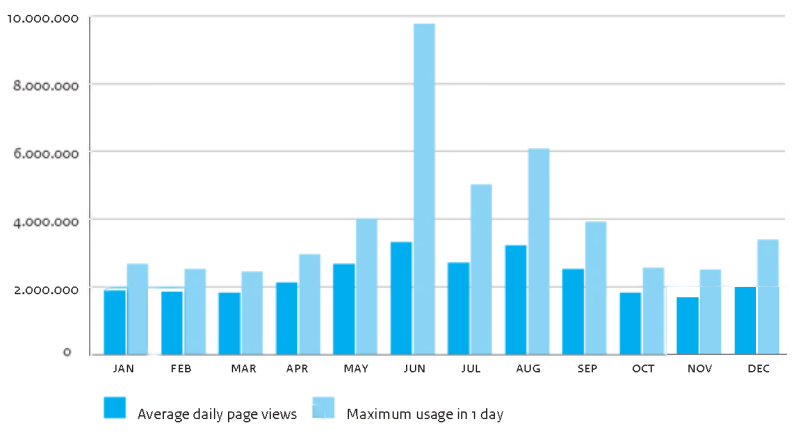
KNMI's website again attracted many visitors in 2011. People are particularly likely to look on the site for warnings and information when there is extreme or unusual weather. One day attracted far more visitors than any other: on 28 June, the site recorded 9.7 million page views. It was a very hot day, when temperatures soared above 30 degrees and KNMI issued a code orange (Weather Alert) of heavy thunderstorms. The site's second-busiest day was 21 August, when more than 6 million pages were viewed. Again it was a day when KNMI issued a code orange.

The busiest months of 2011 were June and August, each of which saw 100 million page visits, promoted by the five codes orange issued during those months. Visitor numbers also rose sharply in response to the eruption of the Icelandic volcano Grímsvötn and following various earthquakes. When there is an earthquake in the Netherlands, many people record their experiences using KNMI's on-line questionnaire.

Use of KNMI website. Page views per month 2008 – 2011



Page views 2011



KNMI The US survey vessel R.V. Knorr deploys @KNMI #instruments in the Strait of Denmark, between Iceland and Greenland.

1 Sep 2011

KNMI #Summer 2011 was the #wettest summer since national precipitation records began in 1906. @KNMI calculated that the average rainfall for the whole country was about #350 mm, compared with the normal 225 mm.

6 Sep 2011

KNMI Historical weather records provide pointers to our future climate. #Accounts given by people aboard #ships travelling to remote destinations, weather station data from former colonies and #logs from early twentieth-century navy vessels provide a detailed picture of the weather as it used to be. However, #historical weather data cannot be used for climate research without first being converted into #computer files. That is a very labour-intensive undertaking (www.oldweather.org), which also requires careful international coordination. #Climate historians from all over the world therefore met at @KNMI to discuss the issues.

19 Sep 2011

10 KNMI calculates in new computer centre

After nine months of excavation, pile driving, drilling and building, the new KNMI computer centre was completed in 2011. The centre is to house a new supercomputer – more eco-friendly, secure and future-proof than its predecessor, which was dogged by cooling and ventilation problems, as well as the lack of space. Being five years old, KNMI's outgoing machine had also reached its computational limit. More precise forecasting and climate models demand more computer power. Fitted with a thermal storage system, KNMI's new computer centre is a more environmentally sustainable building. Groundwater is pumped from forty metres underground or cooled water is brought down from the roof. The picture sequence below gives an impression of the construction of the centre, which on 16 March 2012 officially became home to the second-fastest supercomputer in the Netherlands, BullX B500.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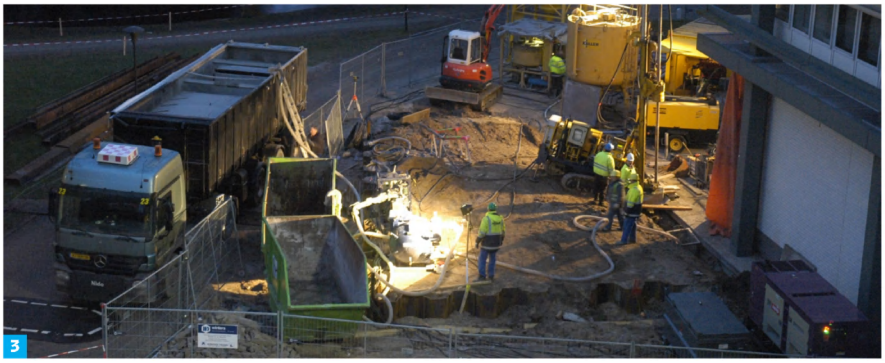
2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8

1, 2. *Retaining walls are driven into the ground.* | 3. *The building pit is excavated.* | 4. *The building pit initially serves as a loading and unloading area, and will later become a light well.* | 5,6. *Building work is halted for an archaeological survey.* | 7. *The shaft of the old bunker is demolished.* | 8. *A diamond saw is used to cut through the old bunker wall to create openings into the space that will become the computer centre.*

9. The diesel generator that will provide an emergency power supply arrives. | 10. Pipework of the thermal storage system on the roof. | 11. Interior pipework of thermal storage system. | 12. The final tile is laid.

Mediaeval remains

In the second week of 2011, during excavation of the light well alongside the future KNMI computer centre, archaeological remains were discovered. Because the KNMI compound in De Bilt is known to be a site of special archaeological interest, an archaeologist had to be in attendance during the excavation work. On Monday 10 January, the site archaeologist was called to look at traces of mediaeval earthworks and construction rubble 1 metre below the surface. Excavation work had to be halted immediately, while the remains were properly examined. The most notable find was made on Tuesday 11 January: the oak piles and decking of a little bridge were uncovered 2.5 metres below ground. The structure dated from the sixteenth century, when a monastery stood on the site. Animal bones, glass, stone, nails and footwear were also found. Archaeological consultants Raap excavated, recorded, examined and archived all the finds.

KNMI All 325 volunteer #precipitation observers who make daily measurements for @KNMI were invited to KNMI's HQ. As well as having the opportunity to see exactly what happens to their data, they were briefed on #snow depth measurements in the coming winter.
7 Oct 2011

KNMI Deputy Secretary-General of the @WMO, @Jerry Lengoasa made a short visit to @KNMI. Topics discussed included #climate scenarios, the new #HARMONIE weather forecasting model and the #forecasting office.
7 Oct 2011

KNMI Insurers find that, when @KNMI has issued a #Weather Alarm about high winds, rain or thunder, claims relating to #home contents increase threefold, while claims for structural damage are five times as likely and claims for vehicle damage from natural causes are seven times as common, according to an analysis by the #Society of Insurers.
11 Oct 2011

KNMI Two government ministries – Security and Justice and Infrastructure and the Environment – teamed up with the Zeeland Regional Safety Board and the Borssele Nuclear Power Plant to organise a national emergency response exercise called #Indian Summer. The exercise involved government agencies, emergency services, expertise centres and Belgian partner organisations putting the #National Radiological Response System to the test over a two-day period. The government's crisis response mechanisms and the use of new means of communication were also tested out. As part of the team in the Radiological Information Back Office (#BORI), @KNMI was tasked with providing meteorological support for distribution modelling and status reporting. BORI is coordinated by @RIVM.
12 and 13 Oct 2011

KNMI A strong #earthquake, measuring 7.2 on the Richter scale, hits eastern #Turkey. There are hundreds of #victims and extensive #damage.
23 Oct 2012

KNMI For one day, @KNMI returned to #Sonnenborgh in Utrecht to take part in the #October Knowledge Month activities.
23 Oct 2012

11 KNMI studies fog

In November, large parts of the Netherlands were affected by persistent fog. Problems were particularly bad in the middle of the month, when many places were fogbound for more than a week. Although fog is one of the characteristics of autumn, such a prolonged period of fog is unusual.

November's persistent fog was all the more unusual because, over the last thirty years, fog has become a lot less frequent in many parts of Europe. One of the main reasons for that has been the improved air quality since the eighties. Another significant fact in the Netherlands has been the greater prevalence of westerly winds in winter. Nevertheless, fog remains a common phenomenon, especially in the autumn. In mid-November 2011, an area of high pressure became established over the Netherlands and there was almost no movement in the atmosphere. Consequently, the fog bank covering the country remained where it was, merely thinning by day before thickening again overnight, as the temperatures fell. Poor visibility on roads and runways led to considerable road and air traffic problems.

Fog forecasting

Fog is formed by the complex interaction of various factors, and the process is subject to considerable regional variation. Fog will form only under certain atmospheric conditions: for radiation fog, it has to be clear overnight, so that the air cools. There has to be very little wind, otherwise the fog will be dispersed as quickly as it forms. However, if there is no wind at all, fog formation will be impaired, because turbulence promotes vertical growth of the fog bank. By monitoring the relevant atmospheric conditions and drawing on data from visibility meters, weather models and external sources, such as motoring organisations and the National Road Traffic Centre, KNMI meteorologists are able to make fog forecasts. For the road and air transport sectors, it is very important to know where and when fog will develop, how thick it is liable to be and when it will clear. When fog is present or expected, a KNMI meteorologist is deployed to Amsterdam's Schiphol Airport to provide air traffic controllers with the most recent and accurate forecasts possible.

Visibility measurements

Good fog forecasts are important, but not easy to produce. The timing of a fog bank's development and dispersal depend on numerous local factors. Fog forecasting is therefore one of the focuses of KNMI's research. At the Cabauw weather station, KNMI has instrumentation set up to gather data with a view to improving understanding of the process of fog development. How are the water droplets formed? What subtle changes in the atmosphere influence fog formation, and how? Answers to such questions can be used to inform the refinement of weather models such as Hirlam and Harmonie.
Fog is measured using a forward scatter meter: a visibility meter with two interconnected, downward-inclined scopes. The one scope projects a continuous beam of light, which the other monitors. If the air is largely free of particles, the beam is sharply defined and visibility is good. Conversely, a high concentration of particles will scatter the beam and visibility will be poor. Visibility is re-measured in this way every ten minutes and the data posted on the KNMI website.

Radiation fog

The fog that affected the Netherlands in November was radiation fog: a type that forms on clear nights, when heat can radiate from the ground. The air above the ground cools, reducing its capacity to retain water vapour. When saturation point is reached, the vapour condenses to form fog. If a breeze mixes the cold layer of air with warmer air above, the fog bank deepens. Fog formation begins above ditches or low-lying meadows. Near to motorways, visibility is often better than on either side, because the cars warm and disturb the air, thus dispersing some of the fog. A bank of fog will disappear if the wind picks up, or if the earth's surface is warmed by solar radiation. However, in the late autumn and winter, the sun is very low and therefore takes a long time to burn off a deep fog bank. As a result, the fog will not clear until the wind picks up or the droplets coalesce into rain. ■

A cloud close to the ground

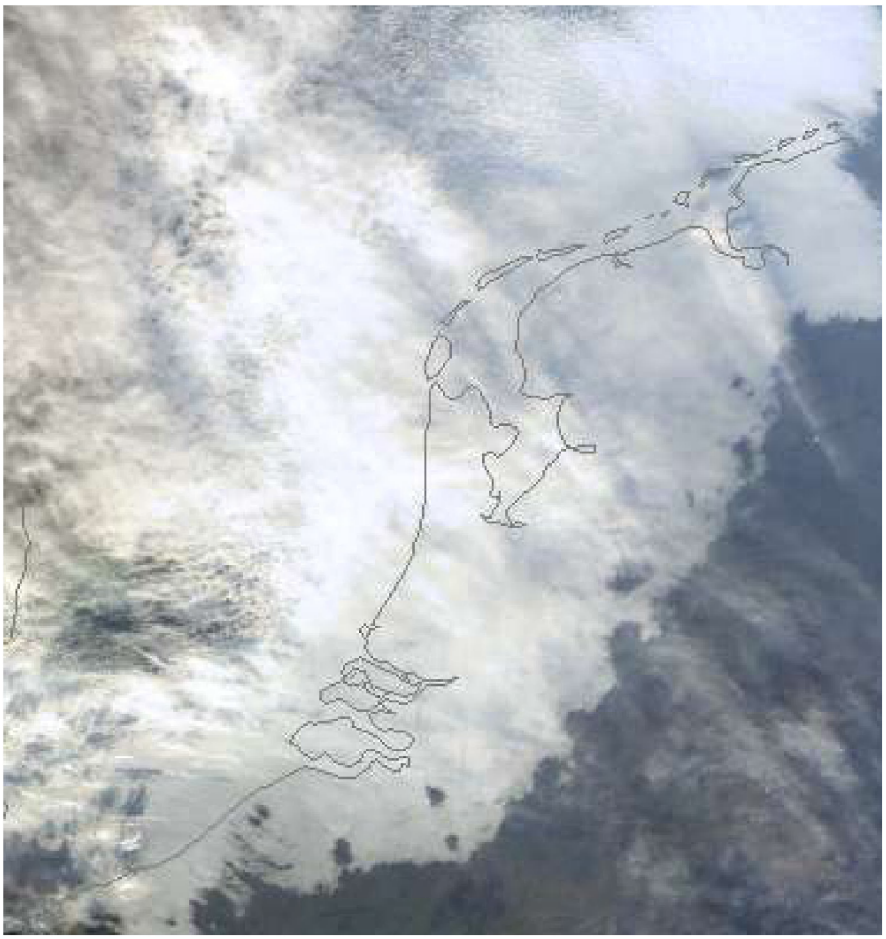
Fog is made up of tiny water droplets suspended in the air, which impair visibility. In other words, it is really just a cloud, close to the ground. Meteorologists define fog as a body of suspended droplets sufficient to reduce visibility to less than 1000 metres. Fog is said to be thick if visibility is less than 200 metres and very thick if it is less than 50 metres.
In foggy weather, regional differences are often very considerable. Where the fog lifts, the sun can break through and the temperature quickly rises. In November, for example, southern Limburg – influenced by conditions in Germany and Belgium, where a large area cleared – enjoyed sunny weather and temperatures of 12 to 13 degrees. In other parts of the country, however, the fog lingered and the temperature did not get above 2 to 5 degrees. At sea, fog can form when a body of warm air passes over cold seawater. Sea winds can then blow the fog ashore, to the displeasure of beachgoers. The sun disappears quite suddenly and the temperature can quickly fall by more than 10 degrees.

KNMI The Dutch Society of the promotion of Meteorology (#NVBM) gave @KNMI climate researcher @Geert Jan van Oldenborgh the NVBM Research 2011 award.

15 Nov 2011

KNMI @KNMI is responsible for meteorological services in the Netherlands' Caribbean territories (#Saba, #St Eustatius and #Bonaire), which are delivered by @Meteorological Service of Curaçao. A new collaboration agreement is signed.

18 Nov 2011



→

Fog dissipates more rapidly in cities than in rural areas. This is caused by the anthropogenic heat production, a dryer surface and less radiation. The cities of Antwerp and Ghent can clearly be seen as black spots in the fog in the satellite image.

12 KNMI clarifies 2011's weather

In 2011, the Netherlands experienced some interesting weather. The winter never really got started. The spring was very mild and sunny, with record low levels of precipitation. By contrast, the summer of 2011 was unusually wet and dull. Yet the autumn, like the spring, was warm, sunny and dry. The seasons seemed to be all topsy-turvy. However, unseasonal weather is in fact a normal feature of the Dutch climate.

Despite the changeable weather, 2011 was a warm year. The average annual temperature at De Bilt worked out at 10.9°C, compared with the long-term average of 10.1°C. That made 2011 equal third in the list of the warmest years recorded since 1901. First place in that list is shared by 2006 and 2007, when the average temperature was 11.2°C.

Mild winter and spring

January and February 2011 were both mild. Frosts were infrequent and the temperature was rarely more than a few degrees below freezing. The lowest temperature recorded anywhere in the country was at Volkel, where the thermometer dropped to minus 8.5°C on 30 January. Spring 2011 was extremely mild. The seasonal average was strongly influenced by the exceptionally mild April, which joined the fourth month of 2007 as the equal mildest April since 1706. A total of thirteen days in April 2011 were classed as 'warm', compared with fourteen in 2007. At De Bilt, the temperature reached summer levels (25 degrees or more) on 22, 23 and 24 April. Meanwhile, the town of Westdorpe in Zeeland recorded summer temperatures for seven days in a row. In the last hundred years, only April 2007 has had more 'summer days'.

Cool summer

After the lovely spring, the summer's weather was disappointing. The temperature hovered around or just below the long-term average for almost the entire season. July was particularly cool. The average temperature at De Bilt was 15.9°C, two degrees less than the long-term average of 17.9°C. Indeed, there was not a single day in July warm enough to be classed as a 'summer day'. The weather remained chilly in August, so that the summer ended with an overall average temperature of just 16.3°C, compared with the normal 17.0°C. The total number of 'summer days' recorded was just seven: well below the normal twenty-one. The highest temperature anywhere in the Netherlands was 34.5°C, recorded in Eindhoven and Hupsel on 28 June, when the area enjoyed a brief influx of very warm air.

Warm autumn

After the cool summer, September turned out to be one of the mildest months of the year, with several 'summer days'. There were even a couple at the start of October, which is quite unusual. That had previously happened at De Bilt only six times since 1901. A few places in the south actually recorded three 'summer days'. December 2011 was ultimately the fourth mildest final month of the year in more than a century, with an average temperature of 6.5°C, compared with the normal 3.7°C. ■

Cool and wet summer

Low water in the Waal, spring 2011

2011 very wet and very dry

In 2011, the Netherlands experienced an unusual pattern of alternating very dry and very wet periods. The national average for the year was 781 mm of precipitation: below the normal 847 mm. March was an exceptionally dry month, with a national average of 13 mm of precipitation, whereas the long-term average for the month is 60 mm. The driest part of the country was the north-west, where some places had just 5 mm of precipitation. The drought continued into April, which saw a national average of 11 mm, far less than the normal 44 mm. Again, some parts of the country had less than 5 mm. May was a little wetter, but the national mean of 25 mm was still well down on the long-term average of 61 mm. Various places on the western seaboard and in the south-east received less than 10 mm. Consequently, spring 2011 was the driest in at least a century, with just 49 mm of rain, compared with the normal 172 mm.

Very low precipitation and high levels of sunshine-induced evaporation led to a record high potential precipitation deficit. By the end of May, the national average precipitation deficit was already 135 mm, significantly greater than the 110 mm experienced in 1976, the year with the previous highest deficit.

June, however, was a wet month. A national average of 96 mm of precipitation fell: nearly half as much again as the normal 68 mm. In July, the country saw an average of 140 mm of precipitation, which was almost double the normal 73 mm. Nationally, it was the sixth wettest July since 1901. August turned out wet as well: the nationwide average was 110 mm, compared with the normal 78 mm. Overall, summer 2011 was the wettest since 1906, with 350 mm of rain in a period for which 225 mm is normal. Previously, summer 2004 had been the wettest, with 333 mm. However, the pendulum swung dramatically back in the autumn. November was the driest on record, with a paltry national average of 9 mm of precipitation, in contrast to the long-term average of 82 mm. Before last year, November 1920 had been the driest, with a national average of 11 mm of precipitation.
The dry November was followed by an unusually wet December: 150 mm fell, compared with the normal 80 mm. December 2011 ended up being the fifth wettest last month of the year. The very wettest recorded was December 1965, when there was 168 mm of precipitation.■

Sunny 2011

2011 was a sunny year, with a national average of 1,836 hours of sunshine, compared with the normal 1,639 hours. However, there was a marked contrast between spring and summer. The spring was the sunniest in at least a century, with a national average of 713 hours' sunshine, while 517 hours is normal. The old record had been 662 hours, set in 2007. The sunny spring of 2011 was mainly down to a very sunny April, when the Netherlands had an average of 262 hours' sunshine, in contrast to the normal 178. At De Bilt, the sun shone for 249 hours, making it the third sunniest April since 1901.
It was followed, however, by the gloomiest summer in fourteen years, with only 528 hours' sunshine. July was the most overcast summer month, seeing a national average of 158 hours' sunshine, compared with the normal 212 hours. August's weather continued in much the same vein, with an average of 153 hours' sunshine across the country as a whole, against a long-term average of 195.
In 2011, the sun was most in evidence along the west coast: KNMI's station at Hook of Holland recorded 1,967 hours' sunshine. The lowest figure was recorded at Eelde, where there were 1,727 hours' sunshine. At De Bilt, the sun was visible for 1,788 hours, compared with the normal 1,602.

KNMI On the #operational service front, the @KNMI's Infrastructure and Weather sectors were certified under the #ISO and #Single European Sky (aviation) schemes. The sectors came through the external #audits successfully, enabling the #certificates to be renewed.
1 Dec 2011

KNMI The unusually heavy #rain and #flooding in #Thailand were the most serious in fifty years; the average interval between such events is at least #250 years. Millions of Thai people were affected by the floods and the #economic damage was huge.
2 Dec 2011

KNMI @KNMI, @Wageningen University and the @British Atmospheric Data Centre won the #SURFnet prize by demonstrating how you can create innovative applications by using the power of #e-Infrastructure.
7 Dec 2011

KNMI The first draft of part of the fifth #IPCC report on climate change appeared. The #IPCC is inviting experts to comment.
16 Dec 2011

KNMI @KNMI's new Bull #supercomputer successfully passed its endurance tests and was formally #handed over. The computer enters operational use in 2012.
28 Dec 2011

DECEMBER

12

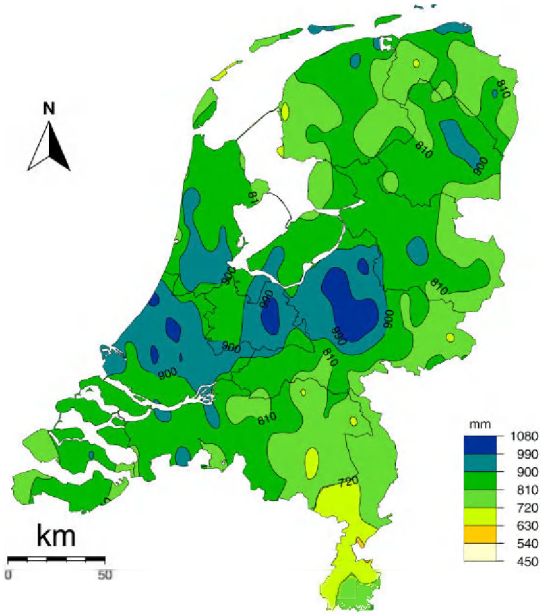
	Normal	2011	
Freezing days	8	1	Maximum temperature below 0.0°C
Cold days	58	46	Minimum temperature below 0.0°C
Warm days	85	93	Maximum temperature of at least 20.0°C
Summery days	26	20	Maximum temperature of at least 25.0°C
Tropical days	4	2	Maximum temperature of at least 30.0°C

	Monthly average temperature (°C) De Bilt		Total sunshine duration (hours) De Bilt		Monthly precipitation amount (mm) De Bilt	
	Normal	2011	Normal	2011	Normal	2011
Jan	3.1	3.5	62.3	69.2	69.6	86.7
Feb	3.3	4.6	85.7	66.2	55.8	63.2
Mar	6.2	6.0	121.6	185.3	66.8	24.1
Apr	9.2	13.1	173.6	248.6	42.3	8.2
May	13.1	14.0	207.2	251.9	61.9	30.5
Jun	15.6	16.1	193.9	211.5	65.6	114.5
Jul	17.9	15.9	206.0	157.4	81.1	179.3
Aug	17.5	16.9	187.7	138.1	72.9	95.6
Sep	14.5	15.6	138.3	158.5	78.1	89.1
Oct	10.7	11.4	112.9	151.1	82.8	68.1
Nov	6.7	7.2	63.0	97.6	79.8	10.8
Dec	3.7	6.5	49.3	52.5	75.8	139.0
Total	10.1	10.9	1601.5	1787.9	832.5	909.1

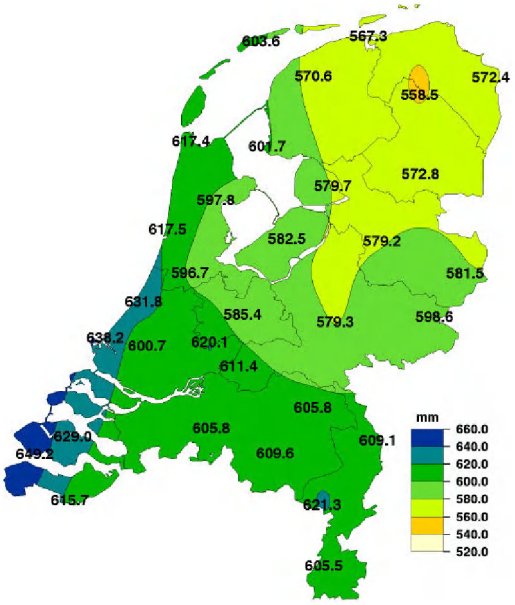
Codes orange in 2011 (Weather Alerts)	
5 January	Black ice
11 January	Black ice
1 February	Black ice
28 June	Heavy thunderstorms
18 August	Heavy thunderstorms in the south-east of the country
21 August	Mainly in the east and south-east thunderstorms and extreme wind gusts
23 August	Heavy thunderstorms in the south, east and south-east of the country
26 August	Heavy thunderstorms with rain and chance of extreme wind gusts
10 September	Thunderstorms

No code red has been issued in 2011.

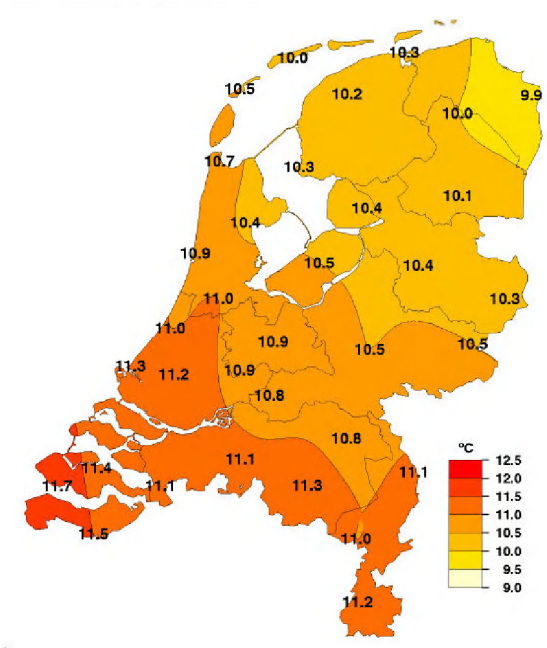
Total precipitation amount 2011



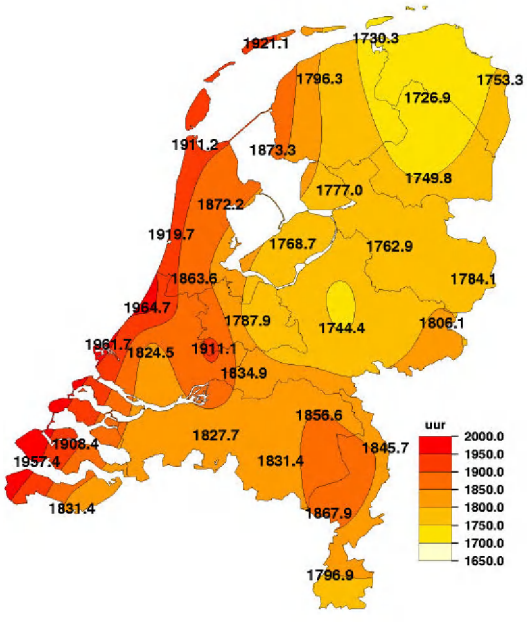
Potential reference crop evaporation 2011



Mean annual temperature 2011



Total sunshine duration 2011



Doctorates, awards and appointments

Doctorates

Around the world in twelve days

Under certain circumstances, smoke clouds from large forest fires can spread further and persist longer than was previously supposed. That is the view set out in a thesis by climate researcher Ruud Dirksen of the Climate Observations Division. Entitled *On satellite observations of atmospheric composition and their interpretation*, the thesis secured Dirksen a doctorate from the Technical University of Eindhoven on 28 January 2011. Dirksen studied the movement of a smoke cloud from one of the severe bush fires that hit Australia in December 2006. The smoke rose more than 12 kilometres into the stratosphere, where it was entrained by the jet stream (a band of strong winds high above the earth's surface) and encircled the world in twelve days. Dirksen was able to ascertain those facts by examining data from the Ozone Monitoring Instrument (OMI) and the CALIOP Lidar satellite instrument (a sort of radar). Under certain circumstances, therefore, the persistence and range of smoke clouds from forest fires can be increased considerably, potentially influencing the earth's radiation balance.

Remote sensing observations of nitrogen dioxide and particulates

In his thesis, *Tropospheric Nitrogen Dioxide Inversions based on Spectral Measurements of Scattered Sunlight*, Tim Vlemmix of the Climate Observations Division describes a method of deriving columns and simplified profiles of tropospheric nitrogen dioxide (NO_2) from data obtained by MAX-DOAS (Multi-Axis Differential Optical Absorption Spectroscopy). The MAX-DOAS instrument was sited on the roof of the KNMI building for fourteen months, yielding a unique dataset. Comparison with data from RIVM's NO_2-Lidar, the orbiting Ozone Monitoring Instrument and the Lotos-Euros air quality model demonstrated that MAX-DOAS measurements are very suitable for validation and fulfil an important need. The observation process can be fully automated and, because the instruments are relatively cheap, they are ideal for use in large networks, such as a European network. Tim Vlemmix presented his thesis at the Technical University of Eindhoven on 15 December 2011.

Awards

Technical physics student Jerôme Schalkwijk was named the Technical University of Delft's Graduate of the Year. Supervised by KNMI's Pier Siebesma, he did an internship at KNMI, studying the turbulent boundary layer: the lowest layer of the atmosphere, in which the air is very turbulent, due to interaction with the ground. Schalkwijk began by investigating how representative a measurement made at a given point is for a wider area. To what extent, for example, is a methane emission figure obtained at one spot in a meadow valid for the meadow as a whole? One cannot assume that an individual measurement is representative, because major turbulent structures may be present in the turbulent boundary layer. Schalkwijk did his final research project at Delft, under the watchful eye of Harm Jonker and Pier Siebesma, who is an affiliate professor at the university. For the project, Schalkwijk studied the cloudy atmosphere, particularly the boundary layer below low cumulus clouds ('fair-weather clouds'). He also contributed to the development of a simulation programme that utilises a video card and can model cloud development in great detail. Using the simulations, he examined the mechanisms that are responsible for the formation of cumulus clouds.■

Appointments

Bram Bregman, Senior Advisor at the Climate Services Division, joined the Dutch Polar Programme's Assessment Committee as a policy expert, on the nomination of the Ministry of Foreign Affairs.■

Pepijn Veefkind, researcher at the Climate Observations Division, was appointed to the Dutch delegation to the European Environment Framework Programme by the Ministry of Infrastructure and the Environment. ■

Peter van Velthoven, Head of the Chemistry and Climate Division, was nominated by the Ministry of Infrastructure and the Environment to join the Impacts and Science Expert Group of the ICAO/CAEP (International Civil Aviation Organization / Committee on Aviation Environmental Protection).■

From 1 September, Pieternel Levelt and Pepijn Veefkind, respectively Head of the Climate Observations Division and researcher at the same division, have taken up posts at the Technical University of Delft (TUD) as professor and lecturer. Both now work part-time at the new Department of Earth and Atmospheric Sciences, within the Faculty of Civil Engineering and Geosciences (CITG). The department in question runs the Delft Climate Centre and has a staff of about eighty personnel drawn from various faculties within TUD.■

Publications

In 2011 KNMI has published 135 articles about research results in scientific journals. These are all peer-reviewed publications which means that the article is evaluated by an expert within the same field of activity.

The Climate and Seismology department of KNMI has issued 114 articles, mainly in international scientific journals like *Nature*, *Science*, *Journal of Climate* and *Geophysical Research Letters*.
Examples of climate research issues are the application of climate scenarios in the Netherlands, improved measurement of nitrogen oxides, precipitation forecasts in the Rhine basin, applications of infrasound, the relationship between temperature and precipitation, better understanding of ocean currents.

Most of the 21 articles published by the Weather Research department of KNMI are issued in *Journal of Geophysical Research*, *Tellus* and *Quarterly Journal of the Royal Meteorological Society*. Research issues covered in them are, for example, heavy precipitation, quality enhancement of numerical weather models, optimizing the use of observations to make weather forecasts, sea ice detection methods to improve interpretation of satellite data, and improving the information content of weather satellite data. ■

http://www.knmi.nl/publicaties/

High water in the Nederrijn near Rhenen

Three publications of 2011

Tracing the upper ocean's 'missing heat'

Contrary to expectations, the upper layer of the world's oceans (the first 700 metres below the surface) did not continue getting warmer between 2003 and 2010. Scientists had generally expected that most of the extra heat retained by the earth as a result of the increased greenhouse effect would be absorbed by the oceans. However, a recent KNMI study has shown that the extra heat is often not taken up by seawater near the surface, because of natural variations in the climate. The fluctuating El Niño phenomenon in the Pacific caused more heat to be radiated into space, while changes in the North Atlantic currents carried heat deeper into the ocean (more than 700 metres below the surface). Because of the natural variations, a relatively short-term trend in the heat-content of the water is not a good indicator for the enhanced greenhouse effect. To get an impression of the impact of global warming on upper oceanic layer temperatures, one needs to look at the long-term trend. On the basis of the observation data then available about phenomena such as the development of La Niña, KNMI researchers predicted that the upper layers of the ocean would soon start warming up again. The most recent data supports this prediction.

Katsman, C.A. and G.J. van Oldenborgh, Tracing the upper ocean's 'missing heat', Geophys. Res. Lett., 2011, 38, L14610, doi:10.1029/2011GL048417. Katsman, C.A. and G.J. van Oldenborgh, Correction to 'Tracing the upper ocean's 'missing heat', Geophys. Res. Lett., 2011, 38, 20, L20602, doi:10.1029/2011GL049834

Rapid Arctic warming

Simulations performed using EC Earth show that the cold layer of air just above the earth's surface is responsible for winter warming of the Arctic region. The reason is that energy cannot escape into space from the air layer. The Arctic is warming up three to four times as quickly as the rest of the world. Why that should be, is not entirely clear. KNMI researchers Richard Bintanja, Rune Grand Graversen and Wilco Hazeleger have used the EC Earth climate model to demonstrate that there is a relation between Arctic warming of the lower layers of the atmosphere and reduced infrared radiation to space. Near to the North Pole, in winter the air close to the surface is much colder than that higher in the atmosphere. The presence of this inversion layer creates a threshold for the radiation of heat, which in turn inhibits the dissipation of energy to space. The energy in the warmed layer of air consequently remains within the climate system, accelerating Arctic warming.

Bintanja, R., R.G. Graversen and W. Hazeleger, Arctic winter warming amplified by the thermal inversion and consequent low infrared cooling to space, Nature Geoscience, 2011, 4, 758-761, doi:10.1038/ngeo1285.

KNMI and water authorities anticipate extreme weather

Roughly half of the Netherlands is below sea level. The country therefore depends on effective protection against heavy precipitation, high river levels and high sea levels. The responsibility for regional water management lies with water authorities. KNMI in conjunction with the Dutch Association of Regional Water Authorities has developed a warning system for extreme precipitation in support of anticipatory water management. For each participating water authority, the extreme conditions that constitute a regional risk have been profiled. The level of risk depends not only on the amount of precipitation forecast and the probability of the forecast, but also on the region's buffer capacity and the extent to which the residual capacity has been diminished by recent precipitation. The warning system checks the latest meteorological data against the profiles on an hourly basis. That involves monitoring radar data, running the Hirlam weather model and referring to composite forecasts. If conditions are more extreme than those defined in one or more profiles, a warning is automatically e-mailed to the relevant authority. The published article describes and evaluates the system currently in use. It also examines the scope for defining risk situations more precisely by taking account not only of extreme precipitation (or drought), but also of forecast wind speeds and directions, and water levels.

Kok, C.J., B.G.J. Wichers Schreur and D.H.P. Vogelezang, Meteorological support for anticipatory water management, Atmospheric Research, 2011, 100, 2, 285-295, doi:10.1016/j.atmosres.2010.08.013.

Operations

HRM KNMI's HRM policy is geared to personal development and career guidance, within the context of the realisation of corporate targets. At KNMI, career development is therefore always linked to competence management, long-term employability, absenteeism prevention and diversity. Because 2011 saw the start of KNMI's adaptation to its future role and activities, HRM policy includes various initiatives designed to promote internal and external mobility and provide associated guidance. Against that background, a number of workshops and a Career Market were held in 2011.

Because diversity breeds creativity and improves performance, KNMI seeks to ensure a diverse staff composition. With a view to facilitating the recruitment and retention of women, KNMI has a women's network called Diva, which organises regular lectures and workshops. KNMI is also affiliated to Gaia, the network for women working in the earth sciences. Plans were drawn up in 2011 to improve KNMI's retention of young people and guidance of their personal and career development. The first practical steps will be taken in 2012. KNMI also aims to take thirty interns per year. Unfortunately, that target was not achieved in 2011.■

KNMI Staf

31 Dec 2011	Men	%	Women	%	Total
Number of staff	322	77%	96	23.4%	418
Average age	48.8 year		44.9 year		47.9 year
Number of part-timers	61	18.9%	59	61.5%	110
Average working hours	35.1 hours		29.5 hours		
Rate of absence					3.6%

31 Dec 2010	Men	%	Women	%	Total
Number of staff	345	75.5 %	112	24.5 %	457
Average age	47.9 year		42.4 year		46.6 year
Number of part-timers	55	15.9 %	71	63.4 %	126
Average working hours	35.15 hours		28.56 hours		
Rate of absence					4.13%

SWO-KNMI Staf*

31 Dec 2011	Men	%	Women	%	Total
Number of staff	20	69.0%	9	31.0%	29
Average age	35.7 year		32.2 year		34.6 year
Number of part-timers	6	30.0%	2	22.2%	8
Average working hours	33.0 hours		35.1 hours		
Rate of absence					1.9%

31 Dec 2010	Men	%	Women	%	Total
Number of staff	13	72.2%	5	27.8%	18
Average age	32.1 year		30.6 year		31.7 year
Number of part-timers	5	38.5%	1	20.0%	6
Average working hours	30.5 hours		33.6 hours		
Rate of absence					2.5%

* Because of the cutback of the Balkenende IV government the Foundation for Scientific Research (SWO) KNMI was revitalized, designed to provide a temporary employment to researchers working on externally financed projects.

FINANCE For several years prior to 2011, KNMI had made a small budgeted operating loss. A change to the established pattern was seen in 2011. The targets defined in the context of the Balkenende IV cutback should have been realised by 1 January, but the year began with KNMI overstaffed by roughly twenty FTE's. The target was finally achieved in the course of the year. The overstaffing was the main reason for KNMI recording an operating loss of € 1.2 million for the year. The loss has been charged to the Institute's 'equity capital', which consequently fell to € 0,6 million. The reduction in personnel over the last year is accounted for in the profit and loss account, under 'Personnel'. Expenditure during 2011 was € 1.1 million less than in 2010.

Funding from KNMI's parent ministry within the Dutch government has remained stable for several years at a little more than € 30.0 million. However, an increasingly large part of that sum is related to the Delta Plan Infrastructure and incidental items. KNMI has performed its mainstream activities on a contracting budget. In 2011, KNMI's share of the NMDC (National Modelling and Data Centre) was € 0.5 million. Total costs increased by € 1.9 million in 2011, mainly due to higher expenditure on earth observation (€ 1.2 million), incidental NMDC costs and structural costs arising out of investments such as construction of the new computer centre. On the balance sheet, such capital expenditure is included under 'Tangible fixed assets'. Because of the investments, the book value of KNMI's assets has risen considerably over the last two years. Some of the total of € 9.9 million invested has been financed by loans from the Ministry of Finance, which are included under 'Liabilities'.

Balance sheet*

Assets	31 dec 2011	31 dec 2010
Fixed assets	16.217	8.643
Work in progress	1.497	1.277
Accounts receivable	3.535	5.356
Liquid funds	17.129	19.350
Total assets	**38.377**	**34.626**

Liabilities	31 dec 2011	31 dec 2010
Equity	1.801	1.910
Results	-1.190	-109
Provision	656	1.109
Accounts payable	37.110	31.716
Total liabilities	**38.377**	**34.626**

Profit and loss account*

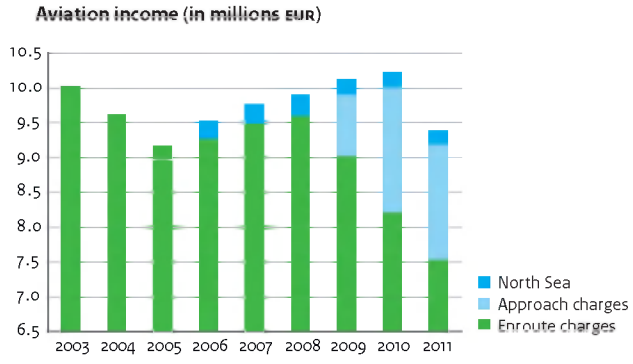
Income	2011	2010
Agency contribution	39.488	38.089
Third-party revenue	19.180	19.765
Interest received	115	1
Extraordinary revenue	77	225
Total income	**58.860**	**58.080**

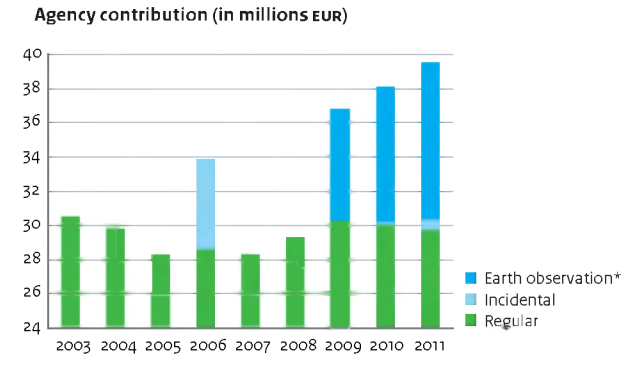
Expenditure	2011	2010
Staff	33.206	34.326
Material		
• Outsourcing	984	1.543
• Maintenance and operation	4.282	3.255
• Rent and lease	3.288	3.258
• Contributions	11.998	10.944
• Remaining	3.764	2.675
Interest	210	152
Depreciation	2.318	2.036
Total expenses	**60.050**	**58.189**

* Amounts in euro 1.000

Costs per product group*

Productgroep	2011	2010
Weather	30.279	30.310
Climate	18.646	17.954
Seismology	1.998	1.998
Earth observation	9.127	7.909
Extraordinary expenses		18
Total costs	**60.050**	**58.189**





* Since 2009 the EUMETSAT contribution is part of the Agency contribution

Management

Director-General
Dr F.J.J. Brouwer

Weather Service
F. Hanneman MSc (acting)

Product- and Process Innovation
Dr J. Verbeek

Forecasting
A. van Loy

Reasearch and Development
Dr G.J.H. Burgers

Stakeholder and Contract Management
F. Hanneman MSc (acting)

Climate and Seismology
Dr H.W. Haak

Climate Observations
Prof Dr P.F. Levelt

Global Climate
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Regional Climate
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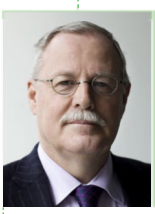

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