Annual report 2013

NILU

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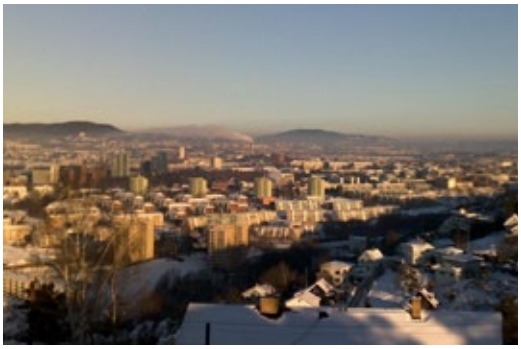


Editorial:
Christine F. Solbakken, editor.
Finn Bjørklid, Sonja Grossberndt, Ingunn Trones and Kari Marie Kvamsdal, contributions and adaptions.

Front page: Troll in Antarctica. From the moving of the observatory.
Photo: Are Bäcklund, NILU.

MILJØMERKET 241 013 TRYKKSAK

Research at the extremes

The recent IPCC report presents serious scenarios for our future climate and environment. Atmospheric research is an important part of climate research, so we may understand what affects the climate, the impact of climate change and what the most effective measures are.

NILU is one of the few research institutions in the world that performs atmospheric research at both poles. This really is global research, which is based on long time-series collected through extensive measurement programs in our monitoring stations and advanced observatories. The most important are the Zeppelin observatory at Ny-Ålesund, Svalbard, the Troll Observatory in Antarctica and the Birkenes Observatory in Aust-Agder.

The observatories are a cornerstone of NILU's atmospheric research. In 2013, CO_2 measurements from the Zeppelin observatory showed air concentrations of 400 ppm in the first five months of the year. This is the limit IPCC believes should not be exceeded, if we want to achieve the two-degree target.

At the Troll Observatory in Antarctica, NILU is building long time-series of atmospheric composition. Working with pollution levels in Antarctica is very challenging, and as the series develops, the Observatory contributes important new knowledge about the long-range transport of pollutants in the atmosphere.

Air quality, environment and health

Air pollution can have serious consequences for both nature and people. WHO reports that outdoor air pollution, caused by everything from diesel exhaust to coal, has an annual toll of 3.7 million premature deaths. Meanwhile, the EFTA Surveillance Authority (ESA) opened formal proceedings against Norway for breaches of the EU Air Quality Directive. The contamination levels in Oslo and several other Norwegian cities are above the allowed limits - and far beyond what is medically justifiable.

Interdisciplinary research on these issues is poorly developed today. NILU has and will continue to contribute to research that provides the scientific basis for the administrative authorities' decisions. Thus, we wish to strengthen the link between air quality, environment and health, because we see great positive potential in a multidisciplinary preventive cooperation.

Internationalisation

The institutes need to strengthen their room for strategic manoeuvers, primarily on the financial side. In general, it appears that access to resources is improving, but the management of the funds is becoming tighter. Thus, the institutes get reduced opportunities to work strategically, implement targeted expertise building and long-term commitment to themes we believe will be central in the coming years.

The EU programme Horizon 2020 is important, both professionally and as a research investment for Norway. The Norwegian government sends a clear political message, expecting Norwegian research groups to bring home a bigger share of the programme. In FP7, the previous Framework Programme, Norway has a return rate of 60 cent per Euro paid. The government will use the return rate in Horizon 2020 as a temperature gauge for the success of Norwegian international research.

However, it is important to remember that EU research involves more than financial returns. Norwegian researchers participate in large international consortia, which provides a base for knowledge sharing that have a much higher value than the return rate indicates. There is a clear political objective from the government to bring back an increased share of the Norwegian contribution. The institutes can and will contribute to this. However, it will require increased support to the institute sector. As of today, the institutes have low basic grants and a high success rate in EU Framework Programmes. The funding in H2020 is adapted to the European Institute and University sector, which has a higher basic funding from their governments.

World-leading applied research

The Norwegian government, as well as the institutes, wants Norway to develop more world leading centers for applied research. The long-term plan for research will describe what measures the ministry wants to use to achieve this. The institutes can and will be important tools in achieving this goal. As they are largely applied and innovative, a strengthening of the institute sector should be an important part of the long-term plan for research in Norway.

NILU's strategy is to be an important contributor to understanding climate change, atmospheric composition, air quality and pollution. We will continue to assist decision makers with science based knowledge on the effects of pollution and climate drivers, on local, regional and global levels and contribute with innovative solutions for both government and private sector.

Kari Nygaard
Managing Director

About moving Troll in Antarctica

Photo: Are Bäcklund, NILU

January 2014, Queen Maud Land, Antarctica: Three guys in blue anoraks peer toward the polar sun. A few meters above the ground hangs a container, shaking in a seemingly thin line on the way over to the truck bed that will carry it two kilometers away and 278 meters up. The time has come to move the Troll Observatory.


Chris René Lunder and Are Bäcklund in their new and indispensable electric friend: the ATV Vesla. Photo: Jan Wasseng, NILU

Christine F. Solbakken
Head of Communications

NILU has had the observatory in Queen Maud Land in Antarctica since the winter of 2007, monitoring pollution and global atmospheric changes. The main reason for the move was that NILU's measurements were affected by the activities in and around the main station at Troll. There are many scientists and construction workers from several nations at the station during the summer months, and despite strict restrictions some pollution is inevitable.

NILU went for both expansion and relocation. The "new" observatory is twice as large, with the possibility for accommodation in case of bad weather. It can accommodate additional measuring equipment, and most importantly of all: the location means far less risk of local contamination.

Three men, three containers and an ATV

Just after New Year 2014, Are Bäcklund, Jan H. Wasseng and Chris Lunder from NILU, went down to complete the moving process, which was initiated before Christmas. When they arrived, the Norwegian Polar Institute had already built the road up to the new site. The work had so far taken less than a month, with all necessary equipment transported by ship from Cape Town and on sled from the ice edge more than 200 kilometers away. The structure has to withstand winds up to double hurricane level, and to avoid oil spills and pollution, they chose to bolt the foundation to large stones rather than drilling into the permafrost, says Chris Lunder.

By 22 January, they had electricity and internet, and the foundation was complete. Now it was time to start moving

the station, consisting of two 20-foot and one 10-foot container and a range boxes and other equipment. Kongsberg Satellite Services (KSAT) assisted with a mobile crane and was of great help, but the NILU engineers later confessed to being very nervous when the first container more or less floated up in the air while the truck bed was still a short meter too far away... But it all went well, and with a little extra push and pull the observatory was moved to its new location.

A new and invaluable resource on the team is Vesla, a NILU-blue electric ATV with solid tires. She is ideal for transporting supplies and people up and down the mountainside, without the risk of affecting the measurements. Similar vehicles have been tested at the Ice Hotel in Jukkasjärvi, says Are Bäcklund. With a heated garage, he hopes that Vesla will cope with winter temperatures down to minus 40 degrees Celcius without much difficulty.

Short summer season

Summer in Antarctica is short, and during the winter season from February to November, only six people from the Norwegian Polar Institute stay at the main station at Troll. In the summer season (Norwegian winter) the "population" increases, with the arrival of a larger crew from the Norwegian Polar Institute as well as scientists and others from KSAT, various projects and NILU.

Normally, NILU sends a team of two to Troll for six weeks every year, but because of the move there were three this time. In addition to the move, all necessary instrument services needed to be performed, as well as completing the training of the new research technician from the Norwegian Polar Institute.

The research technician is replaced every year, and goes through strict training with NILU at Kjeller and at the NILU observatory at Birkenes. The training continues at the Troll Observatory in collaboration with the outgoing research technician, before the NILU staff comes in January and handles the detailed tutorial on site. After that, the technician is able to handle all measurements, instrument maintenance and necessary repairs alone for the next 11 months.

NILU on both poles

Most other observatories in Antarctica are located either on the coast or at the pole, while the Troll Observatory is located 2000 km from the South Pole and 220 km from the coast. Chris Lunder explains that this location provides the opportunity to measure in the transition zone between the costal zone and the inland ice plateau, as well as more knowledge about long range transported pollution to Antarctica.

In addition to the Troll Observatory in Queen Maud Land in Antarctica, NILU also runs the Zeppelin Observatory at Ny-Ålesund, Svalbard. The two observatories are set up with similar instrumentation, so that the same type of data can be collected from both polar regions.

NILU's measurements include mercury, total and tropospheric ozone, aerosols, UV radiation, persistent organic pollutants (POPs), hydrocarbons and carbon monoxide (CO). In addition, NILU measures more than 20 greenhouse gases, including halogenated greenhouse gases, methane and CO_2.

As one of very few research institutions in the world to conduct atmospheric research at both poles, NILU has the opportunity to compare measurement results from both "extremes". Through this, NILU hopes to gather new and important knowledge about transport and effects related to global pollution, and to provide an important contribution to international research in this area.

NILU's Observatory in Queen Maud Land, Antarctica. Photo: Are Bäcklund, NILU

MOCA – methane from sea to air?

In recent years, researchers have observed that the amount of methane in the atmosphere increases. Methane is a greenhouse gas that contributes to global warming. A change in the natural methane emissions may cause the temperature to rise both higher and faster than previously thought.

Christine F. Solbakken
Head of Communications

Methane is the second most important greenhouse gas in the atmosphere, and emissions arise mainly from agriculture, rice paddies, landfills and heating. In addition, the gas is released from natural sources, such as animals, fires, wetlands – and the seabed.

MOCA: A NILU initiative

Senior scientist Cathrine Lund Myhre explains that scientists wonder whether emissions of methane from the seabed may be one source of the increased methane levels. Methane is stored as methane hydrates – an ice-like substance – under the seabed, and scientists know that methane gas leaks from these deposits and form bubbles that rise in plumes towards the surface. Depending on the water depth, the bubbles may reach the ocean surface, or dissolve before the gas can enter the atmosphere. If the temperature of the sea rises, this may increase the methane discharge from the seabed to the sea, and thus contribute to a higher amount of methane reaching the atmosphere – with increased temperatures on Earth and in the ocean as a result.

The research vessel "RV Helmer Hanssen" on its way out from Tromsø. Photo: Adam Durant

To find out more about the relationship between methane hydrates on the ocean floor and methane levels in the atmosphere, Lund Myhre and NILU, together with CAGE and CICERO, took the initiative to the research project MOCA in 2013. The project is a collaboration between NILU, CAGE – Centre for Arctic Gas Hydrate, Environment and Climate and CICERO Center for International Climate and Environmental Research. CAGE is a Norwegian Centre of Excellence at the University of Tromsø, and a world leader in research on gas hydrates. CICERO is one of the leading climate modeling communities in Norway, and does research on national and international climate change issues and policies.

Interdisciplinary multinational cooperation

The MOCA project is interdisciplinary, combining research groups that have not previously collaborated to promote better understanding of Arctic processes. The Norwegian Research Council funds MOCA via the Polar Programme, and the projects lasts 3 ½ years from 1 October 2013. During that period, the MOCA project and CAGE combine and coordinate measurements from ships, aircraft and on the seabed, as well as from the Zeppelin Observatory on Svalbard. The main purpose is to determine how much of the methane emitted from the ocean floor reaches up through the ocean and into the atmosphere. Furthermore, the results are used to quantify the effects methane from gas hydrates in the seabed has on the atmosphere today, and what a potential change in these processes may mean for the climate in the future.

In addition to NILU, the University of Tromsø and CICERO, MOCA also involves partners from Canada, France, Switzerland, Britain and Russia.

MOCA in 2014

The measurements starts in the summer of 2014, and in mid-June the research vessel "RV Helmer Hanssen" from UiT leaves Tromsø for a six-week long CAGE raid with MOCA to undertake marine and atmospheric measurements in the waters between Tromsø, Svalbard and the northern part of Svalbard. In the same region, CAGE will be placing monitoring equipment on the seabed. This equipment will measure ocean currents, temperature and methane emissions.

In addition to this, flight campaigns will be conducted in parallel to measure the methane concentration and variation in the atmosphere. The first plane takes off in June 2014, and will conduct research between Kiruna in Sweden and Longyearbyen on Svalbard, north of Svalbard and above wetlands in Sweden and Finland. This is in collaboration with the University of Cambridge. The second flight campaign takes place in Russia in late July to August, and runs from Novosibirsk, over Siberia and the wetlands there, and up to the area of the Kara Sea and Salekhard.

Cathrine Lund Myhre from NILU is head of project for the MOCA project. Photo: Adam Durant

Climate change and contamination in the Arctic

Photo: Are Bäcklund, NILU

Owing to the Arctic's unique ecosystems and physical characteristics, environmental changes occur more rapidly there than elsewhere. Investigating climate change effects on environmental pollutants in the Arctic can provide insight into changes that may later affect populations in other regions of the world.

Jozef M. Pacyna
Research Director

ArcRisk is an international EU FP7-funded research project. It has provided new knowledge on sources, fate, transport and effects of organic compounds (POPs) and mercury under changing climate conditions. This information is needed to improve current policies and strategies on reduction of contaminant effects in the Arctic in the view of climate change.

The project, implemented between mid-2009 and 2014, involved 21 institutes from 12 countries. NILU's role was to use the results from the project, supported by other research, and to evaluate strategies for abatement and adaptation to contaminants studied within the project.

Complexity versus constraints

The ArcRisk project has met the information requirements and policy aims of the European Commission, Arctic Council and other potential users of the project results by developing knowledge, improving the understanding of climate change impacts and by the development of assessment tools.

The assessment tools (databases, models and monitoring systems) developed and used in the ArcRisk project form a very good basis for further quantitative analysis of impacts of climate variability and climate change on the variations in human health exposure. Exposure varies depending on changes in contaminant origin, transport, fate and behaviour in the environment and uptake and transfer through the food chain.

The research performed in the project has illustrated the complexity of contaminant cycling and effects, as well as the limitations in our capability to predict how climate change may affect these processes. Therefore, the policy advice in relation to reducing future exposure and effects has comprised a number of recommended actions.

Choice of technologies

The only way to achieve a permanent and comprehensive reduction of human exposure to environmental contaminants lies in the maximal reduction of their use and in eliminating their emissions into the environment as far as possible.

The effects of climate policies on unintentionally produced POPs, mercury and other air pollutant emissions mainly take place in a limited number of sectors:

industrial, residential, and transportation. The choice of specific technology will have a direct impact on releases of greenhouse gas (GHG) emissions, as well as on mercury and unintentionally produced POPs.

It is recognised that high combustion temperatures designed to ensure complete combustion in various utility, industrial and residential boilers as well as motor engines minimize the formation of unintentionally produced POPs. Consequently, optimising the combustion conditions can have reciprocal advantages for both energy recovery and reduced GHG (greenhouse gases) emissions. At the same time, formation of unintentionally produced POPs during combustion of fuels can also be significantly reduced.

Maximised energy recovery significantly reduces the amount of fossil fuels needed to generate a given quantity of power and as such formation of unintentionally produced POPs. In general, climate policies are expected to have a positive effect on regional and local scale air pollution by reducing the creation and emissions of unintentionally produced POPs, as well as mercury.

Risk reduction

The task of identifying contaminants that pose the greatest risks for human and environmental health in the Arctic is challenging enormous and requires international collaboration. In addition, risk reduction measures must be adapted to the specific use and emission patterns associated with different groups of chemicals. The potential for long-range transport of many harmful contaminants means that international agreements such as the Stockholm Convention, the Convention on Long-Range Transboundary Air Pollution, and the Minamata Convention have a key role to play. In addition, potential synergies between existing international policies and agreements concerned with monitoring, risk assessment, and mitigation measures should be exploited.

Ove Hermansen and Are Bäcklund from NILU installs air inlet on the mast at NILU's Observatory on Zeppelin Mountain, Ny-Ålesund. Photo: Sanja Forsström, Norwegian Polar Institute

The ArcRisk project has identified the need to raise awareness, build capacity, transfer technology and provide technical awareness, particularly to developing countries on the issue of the benefits that can be achieved from the reduction of GHGs and unintentionally produced POPs emissions at the same source or within the same source category.

Advisories on human consumption of fish, seafood and mammals were also contacted within the project. It was concluded that food consumption guidelines and advisories can provide effective short-term solutions to minimise human exposure, in particular for critical groups.

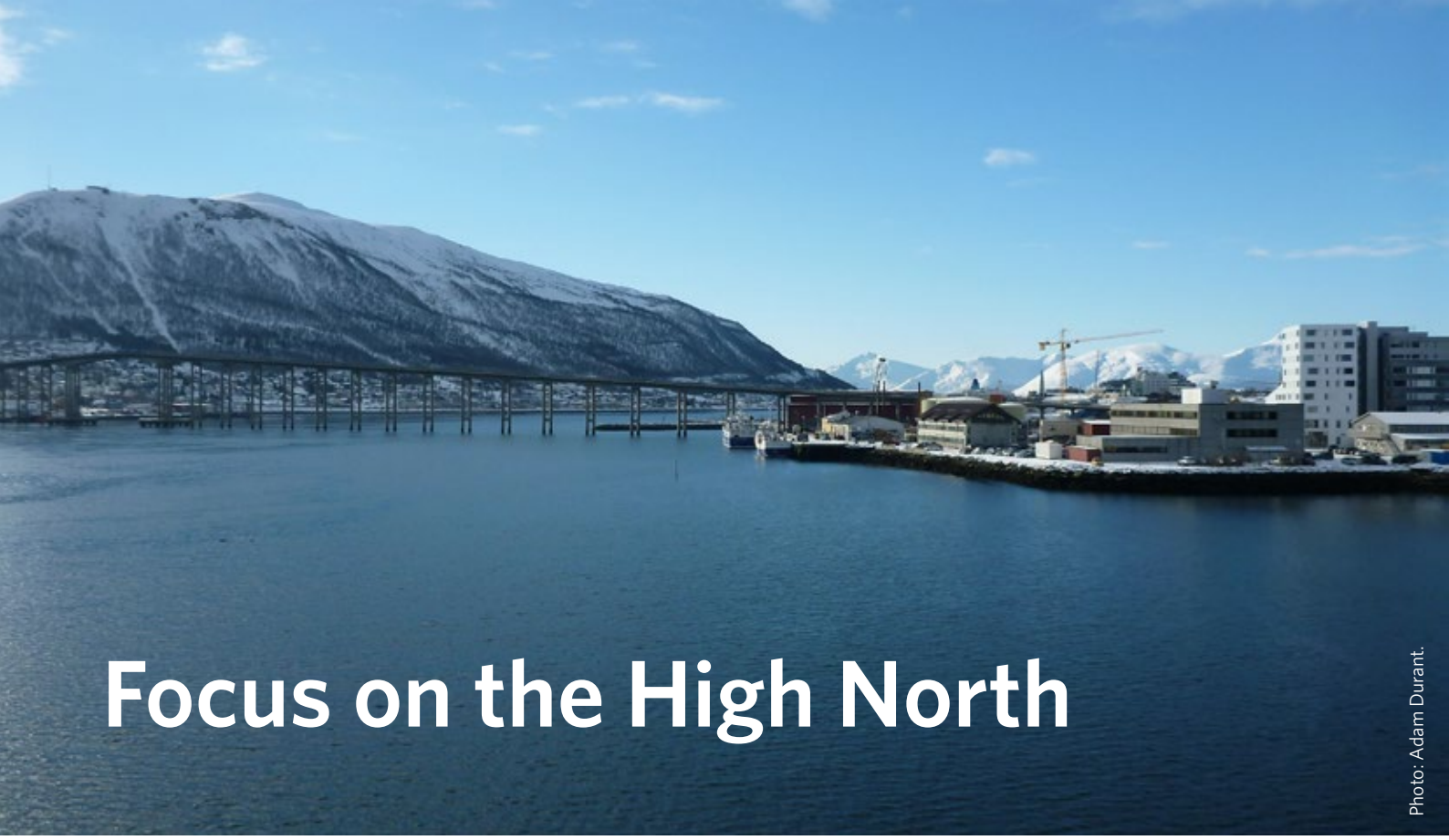
However, such advisories must be developed in close cooperation with local health professionals and the target groups themselves – in consideration of both risks and benefits of consumption of particular foods, including indirect benefits (such as cultural benefits).

It will be necessary to update and complement the existing dietary advice according to our knowledge about the effects of chemical contaminants, and the corresponding increasing effects of climate change.

More information:

www.arcrisk.eu

NILU's Observatory on Zeppelin Mountain.
Photo: Ove Hermansen, NILU



Focus on the High North

Photo: Adam Durant.

NILU's strategy states that the Arctic is an important indicator for global processes such as climate change, transboundary pollution and environmental contaminants. New economic opportunities within growing industries like oil and gas, shipping and mining also lead to challenges with regard to environmental concerns in the Arctic.

Photo: Christine F. Solbakken, NILU

Eldbjørg S. Heimstad
Research Director High North

NILU uses its comprehensive competence to contribute relevant research to the Norwegian High North Strategy.

Environmental pollutants – effects on ecosystems and human health

As part of the follow-up of its strategy, NILU's Research Director Eldbjørg Sofie Heimstad is leading the research programme "Hazardous substances – effects on ecosystems and human health" at the Fram Centre in Tromsø. With its 15 Fram Centre based employees, NILU is one of 20 institutes that are carrying out interdisciplinary research, communication to management and dissemination within natural and societal science and technology.

Goals and intentions

The Fram Centre has five research programmes – or "flagships". The primary objective of the flagship "Hazardous substances" is to generate knowledge about transport, uptake and effects of environmental pollutants in the Arctic ecosystems, including humans. The results should be used to assess risks and to develop strategies for national authorities and international conventions, aiming at improving the environment.

Pollutants can travel over long distances and do not take into account any country borders. Measuring the pollution in the Northern regions is a good indicator for their global distribution. There are very few sources of environmental pollutants in the Arctic, but due to long-range transport of pollution, scientists keep on detecting high levels of environmental pollutants within species high up in the food chain, such as polar bear, arctic fox and glaucous gull.

Human impact

New chemicals are found in Arctic air, water and animals. For many of these substances knowledge is lacking with regard to both their sources and effects on animals and humans.

Heavy metals, persistent organic pollutants (substances with long degradation time) and radionuclides are defined as environmental contaminants. The main sources are industry, pest control and last but not least synthetic substances from products that we use in our daily life, such as in cosmetics, television screens, computers, clothes and furniture. The most known and well-studied substances, such as PCB or DDT, are now regulated by international conventions, but since PCB was extensively used until 1980 and due to long half-life, it is still detected in very high concentrations in Arctic samples.

Some synthetic chemicals, such as brominated flame-retardants or phosphorous flame-retardants for example, are used to protect humans and to prevent clothes, furniture and electric devices to catch fire. We use perfluorinated surfactants to keep us warm and dry, and our personal care products contain substances like parabens and siloxanes.

Research about distribution and effects of these environmental pollutants are important, because even though their primary function is to provide us a better and safer everyday life, the properties of many environmental pollutants are a threat to humans and animals when dispersed into nature through production, use and disposal.

International effects

Being present in the Arctic, with well-established research and measuring stations, provides unique opportunities for NILU and the other research institutes of the Fram Centre to contribute to international research and policy development on environmental contaminants. Environmental contaminants that can be detected in Arctic animals are usually long range (transported from sources in Europe and Asia), not easily degradable (persistent) and they tend to bioaccumulate, i.e. the uptake is larger than the elimination. Thus, they can have negative effects for animals, especially for top predators due to magnification up in the food chain.

According to international conventions, environmental pollutants with these properties are to be phased out. Research on contaminants in the Arctic provides important data that Norwegian environmental authorities can use as a bargaining chip in working with international conventions regulating contaminants such as persistent organic pollutants (POPs).

From 2014, the Fram Centre is going to extend its research activities with focus on the High North, by introducing the new flagship project: "Environmental impact of industrial development in the North (MIKON)". Over the next few years, MIKON will be the largest research programme of all six flagships in the Fram Centre, embracing most of the Centre's research activities. Thus, the project will contribute important knowledge to management and industry linked to development in the High North.

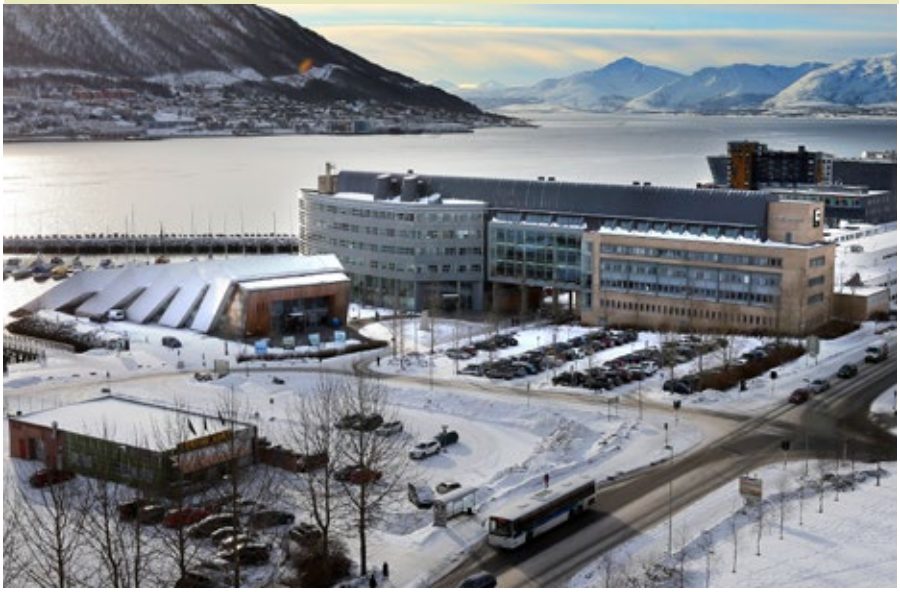
The Fram Centre

The Fram Centre consists of 20 institutes that are involved in trans- and interdisciplinary research, advisory, management and dissemination within natural science, social science and technology.

NILU and the other 19 institutes that are forming the Fram Centre have strong competence and several years of experience in cooperating within environmental research in the Arctic. In addition, there is solid competence within special areas such as environmental chemistry, ecology, epidemiology and socialsciences. This knowledge can strengthen the future research of environmental issues in the Centre.

The Fram Centre's institutes shall contribute to maintain Norway's position as an excellent manager of environmental and natural resources in the High North. The knowledge gained through the Centre's research will be shared with the government, the business sector and the public. The Centre is also going to strengthen the cooperation between research and education. In addition to their own research, the institutes in the Fram Centre cooperate on six research programs, so called "flagships". These flagship projects are "Environmental contaminants", "Ocean acidification", "Sea ice in the Arctic Ocean", "Climate change effects on sea and coastal ecology", "Climate change effects on terrestrial ecosystems" and "Environmental impacts of industry in the North".

More information:
www.framsenteret.no



Framsenteret, Tromsø. Photo: Ronald Johansen, iTromsø.no


Barcelona

NILU supports the development of the European air quality policy

2013 was the "Year of Air", and a thorough review of the European air quality policies formed the basis for a new strategy aimed at significantly improving air quality in the EU.

Christine F. Solbakken
Head of Communications

The new strategy aims to strengthen compliance and implementation of current legislation, proposing new measures and goals to protect health and the environment, promote innovation for cleaner products and processes, and improve alignment with other policies and international initiatives.

The Clean Air programme

An important part of the strategy is the new Clean Air Programme. The programme includes measures to ensure that existing targets are met in the short term, as well as new targets for air quality in the period up to 2030. The legislation package includes support measures to help cut air pollution, with particular focus on improving air quality, support research and innovation, and promote international cooperation.

In addition, the package includes a revised directive on national emission ceilings, with stricter national emission ceilings for the six major pollutants: particulate matter (PM), sulphur dioxide (SO_2), nitrogen oxides (NO_2), ammonia (NH_3), volatile organic compounds (VOCs) and ozone (O_3).

There is also a proposal for a new directive to reduce pollution from medium-sized combustion installations, such as energy plants for street blocks or large buildings, and small industry installations.

European cooperation

NILU has contributed to the work by putting together scientific information to support the development of this new legislative package, through our participation in the European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM). In connection with the revision of the national emission directive, NILU has helped to investigate how the reduction of PM levels in Europe will be affected if NH_3-emissions from agriculture are further reduced beyond the Gothenburg Protocol, which does not solve the problem on its own.

In addition, NILU led the work with assessment of air quality status and development in Europe for the European Environment Agency's (EEA) annual technical report "Air Quality in Europe", which was launched on 15 October 2013. The report has been a corner stone in the recent air quality policy review process that ended with a new air quality policy proposal from the European Commission in December 2013.

NILU's Cristina Guerreiro was the lead author of the air quality report, with Frank de Leeuw (RIVM) and Valentin Foltescu (EEA) as co-authors. The report received very good media coverage - according to the EEA more than 1,200 articles cited this report in the international press in the period up to January 2014. This report has the second highest


Paris


Lisboa


Burgas

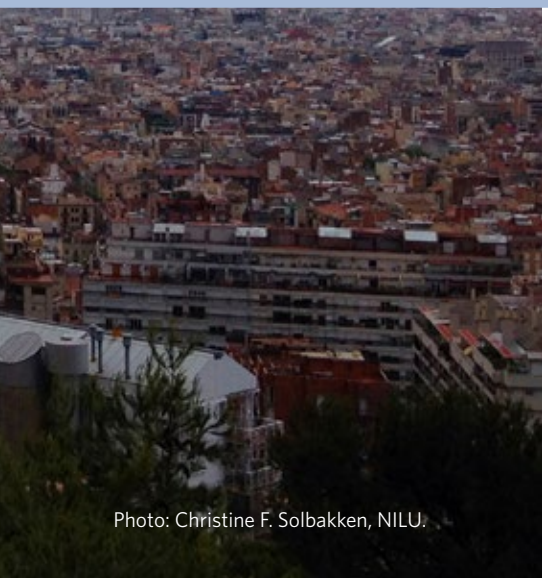


Photo: Christine F. Solbakken, NILU.

number of related articles ever, including postings on the websites of major news providers such as the BBC, New York Times, Spiegel online and Le Monde.

WHO estimates

The latest figures from the WHO show that 3.7 million deaths globally were due to outdoor air pollution in 2012, of which 482,000 occurred in Europe. In addition, WHO understands that indoor air pollution is the largest environmental health risk today, and estimates that it was the cause of 4.3 million deaths during 2012 (7.7% of total mortality). This means that in 2012, 8 million people died worldwide from causes related to air pollution.

– These last estimates are considerably higher than the previous ones, explains senior scientist Cristina Guerreiro, – because of better estimates of the exposed population, and better knowledge about the health effects of exposure to air pollution. At NILU we have worked continuously to develop methods for better exposure estimates, eg. using satellite data and improved emissions data combined with enhanced chemical transport models and ground measurements.

Urban threat

The report concludes that air quality remains a major challenge for the health, economy and environment in most European cities.

– This contamination can lead to disease and premature death, says Guerreiro. – We know that heart disease and stroke are the most common causes of death related to air pollution, followed by respiratory diseases and lung cancer. However, air pollution also causes damage to the environment, including biodiversity loss and reduced vegetation growth.

It is recognized that air quality policies must be followed both at a European level and at national and especially local levels, to achieve compliance with the European standards. NILU has supported the EEA and the European Commission (EC) in the evaluation of how policies and measures for air quality are monitored in several European cities. The work was part of the project "Air Implementation Pilot", and aimed to support the implementation of EU's environmental policy at a local level.

Economy, productivity and health

Europe has experienced a significant reduction in emissions, atmospheric concentrations and deposition of substances such as sulphur dioxide (SO_2), carbon monoxide (CO), benzene (C_6H_6) and lead (Pb) in the past decade. Despite these improvements, air pollution remains a serious threat to health and the environment, and has a significant negative impact on the European economy, productivity, and ecosystem health.

Emissions of air pollutants come from almost all economic and social activities, but action at both national and local levels has gradually led to a decline in many air pollutants. As a result, we see acceptable air quality levels in Europe for some pollutants, such as CO and lead. At the same time, road transport, industry, power plants, households and agriculture still contribute strongly.


Cristina Guerreiro from NILU is main author of the EEA report "*Air Quality in Europe*".
Photo: Ingar Næss

Combustion of solid fuels in households, such as coal and wood, are important sources of direct emissions of PM and polyaromatic hydrocarbons (PAHs). Agriculture is mainly responsible for emissions of ammonia (NH_3), which is detrimental to both health (as a precursor to particulate matter) and ecosystems. Such emissions have in the last decade either gone down very little (in agriculture) or not decreased at all (combustion of solid fuels in households). Nevertheless, the combustion of solid fuels is becoming an increasing source of air pollution. The reason is that the fuel is relatively cheap and considered to be environmentally friendly because wood is renewable and virtually carbon neutral.

Smart monitoring of air quality

In the near future it will be possible to simplify monitoring of urban air quality through citizens by using sensor technologies and mobile applications. The EU projects CITI-SENSE and Citi-Sense-MOB aim at empowering citizens to monitor the air quality in their immediate environment and implementing measures to influence politicians and decision makers.

Sonja Grossberndt
Scientist

Monday morning, 8 a.m.: A man is walking to work with his mobile air monitoring sensor activated. Just as usual. After a while he receives an alert on his smartphone about the high level of particulate matter (PM) right where he is walking. He knows that this is not good for his asthma and calculates an alternative walking route through less polluted areas by using his mobile phone.

Does this sound utopian? Not for Dr Núria Castell from NILU, who is project coordinator for CITI-SENSE.

About the project

CITI-SENSE is the abbreviation for "Development of sensor-based Citizens' Observatory Community for improving quality of life in cities". It is one out of five "Citizens Observatory" projects under the seventh EU framework programme (FP7) within the topic "Developing community-based environmental monitoring and information systems using innovative and novel earth observation applications". These projects include community based environmental monitoring, collection and interpretation of data and systems of information delivery.

Photo: Finn Bjørklid

Citi-Sense-MOB encompasses the installation of air quality sensors on buses and bikes. They shall serve as mobile units for continuously monitoring of the environment in Oslo.

All five projects aim to develop new technologies and applications for Earth Observation by involving citizens. This shall enable them to influence environmental policies and administrative priorities by help of smartphones, tablets and other portable devices.

NILU is coordinating the CITI-SENSE project, comprising almost 30 partner institutions from Europe, South Korea and Australia. The project provides new opportunities for citizens in nine European cities to monitor their local environments, as well as including indoor air measurements in selected school buildings.

– Even though air quality has been improved tremendously within the last decades, there are still challenges that require action. Since citizens know best what kind of environmental issues they are facing we wish to provide them with both the technologies and the competence to solve these problems, explains Dr Alena Bartonova, Research Director at NILU and scientific coordinator for CITI-SENSE.

From idea to reality

CITI-SENSE activities are carried out in the following nine European cities: Barcelona, Belgrade, Edinburgh, Haifa, Ljubljana, Oslo, Ostrava, Vienna and Vitoria. Volunteers will be equipped with mobile sensors to monitor air quality in their communities. The sensors deliver their data to a central unit and citizens will receive useful information in return such as maps with real-time data showing environmental pollution.

Data obtained from the citizens' mobile sensors and phones will be processed together with data from static monitoring stations. They will be made available through both the internet and newly developed mobile applications. Since communication is an important part of the project, people from all over Europe will be able to use these virtual meeting places to exchange information and learn from each other. They will also receive tools and training about how to evaluate and use the obtained information to influence decision makers.

– Key elements in CITI-SENSE are participation and empowerment, continues Bartonova. – Citizens receive technologies and tools for monitoring and electronic communication, but at the same time they will also be trained in the skills to act based on the monitoring results and to communicate with others that are interested, as for example public authorities.

Citi-Sense-MOB

NILU is also scientific coordinator and one of five Norwegian partner organisations that collaborate with the city of Oslo and the companies for public transport Ruter # and Nobina in another project: Citi-Sense-MOB (Mobile Services for Environment and Health Citizens' Observatory).

This project, carried out in Oslo, involves the installation of air quality

NILU is coordinating the CITI-SENSE project that will provide citizens in nine European cities with the possibility to monitor their own local environment through mobile sensors and phones. Project coordinator for Citi-Sense-MOB, Núria Castell, is demonstrating their use.
Photo: Finn Bjørklid, NILU

sensors on buses and bikes which serve as mobile units for continuous monitoring of the environment in the city.

Just as in CITI-SENSE, the data will be processed and presented in a user friendly and informative layout via web services and applications for a range of technical devices.

– We are going to collect real-time data at places and with a resolution that has not been available until now, says NILU-scientist Dr Núria Castell, scientific coordinator for Citi-Sense-MOB. – In addition NILU will examine new ways to combine the data from crowdsourcing, mobile sensors, traditional monitoring stations and air quality models, and explore how these data can contribute to support a sustainable development in Oslo.

Make cities more enjoyable

Citi-Sense-MOB will deliver mobile services for monitoring road emissions, concentrations of pollutants and health effects caused by air pollution. This will raise awareness amongst citizens about both the air quality in their immediate environment and about the road traffic's carbon footprint.

– We wish to help both, citizens and public authorities to take decisions that are required to maintain and improve quality of life in our cities, says Castell.

Testing technologies

CITI-SENSE and Citi-Sense-MOB cooperate to test different microsensor technologies and methods to monitor urban air pollution.

– The use of these new technologies has the potential to improve our understanding of the dynamics between air pollution, environmental health and climate changes in urban environments, closes Castell.

More information:

www.citi-sense.eu
www.citi-sense-mob.eu

Photo: Finn Bjørklid

Citi-Sense-MOB

The "Citizens' Observatories" projects are five ongoing projects, partly funded under EU's Seventh Framework Programme (FP7) within the topic ENV.2012.6.5 "Developing community-based environmental monitoring and information systems using innovative and novel earth observation applications" which started in fall 2012.

The projects are aiming at developing new technologies and applications within earth observation. In addition they try to make use of the existing possibilities using portable devices (smart phones, tablets, etc) to allow the effective participation of citizens within environmental management, based on a broad involvement of interested groups and citizens to support both society and political prioritisation.

Citi-Sense-MOB is a two-year EMMIA project (European Mobile and Mobility Industries Alliance) that started in autumn 2013. The project objective is to develop and use innovative mobile technologies for real-time management and sustainable urban development through services related to air quality and climate change.

Measuring indoor environment in museums

"MEMORI" is a system for measuring indoor air quality to assess the risk of damage to sensitive objects. The measuring system is designed specifically for museums and collections, archives, historic buildings and other institutions responsible for cultural heritage objects in indoor environments.

Terje Grøntoft
Senior scientist

The MEMORI technology was developed through several EU projects over a period of ten years, and was finally completed in the EU project "MEMORI" in 2013.

NILU has cooperated with the Fraunhofer Institute in Germany on the development of a dosimeter, and with English Heritage to develop methods for evaluating measurement results against the risk of damage to cultural heritage objects. Eleven other European research and cultural heritage institutions have been partners in the MEMORI project.

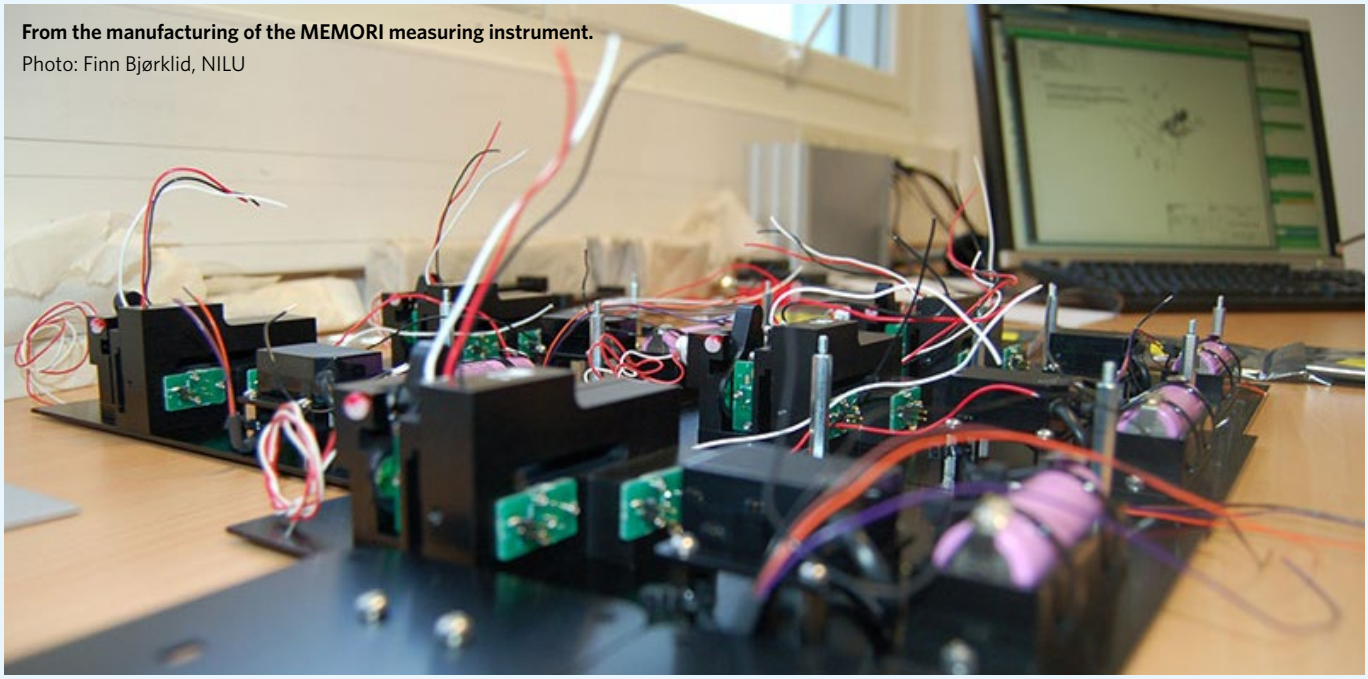
The technology

The MEMORI technology consists of three different parts: a so-called dosimeter, a small instrument reading the dosimeter, and a website for performance assessment and information.

The dosimeter is a small holder for two tiny pieces of glass, which reacts with pollutants in the air. One piece of glass (EWO, "Early Warning Organic") is coated with a thin synthetic polymer film that reacts with oxidizing gases such as nitrogen oxide (NO_2), ozone (O_3), and ultraviolet light. The reaction is also dependent on temperature. The other piece (GSD, "Glass Slide Dosimeter") has a special composition similar to historical glass. It contains much potassium and reacts specifically with acidic gases, also depending on the humidity.

The reactivity of the glasses in an indoor environment is known, so by measuring how the glasses have changed after exposure, the quality of the indoor environment is determined.

The dosimeter is a small holder for two tiny pieces of glass, which reacts with pollutants in the air. Here it is in a display case in the Museum of Cultural History in Oslo. Photo: Anne Sommer-Larsen, Museum of Cultural History.



From the manufacturing of the MEMORI measuring instrument.
Photo: Finn Bjørklid, NILU

Red, yellow and green signal

The measurement is made in the corresponding reader instrument before and after the dosimeter is placed in for example a museum, and occurs automatically when the dosimeter is inserted into the instrument.

The change of the glasses is measured as a reduction in the transmission of light through the glasses at specified wavelengths (UV and IR). The measurement results are stored in the instrument and uploaded to the MEMORI website for review. The assessment is based on a three months exposure time for the dosimeter.

The relatively long exposure time makes for a high sensitivity to even small amounts of contaminants, and the result represents an average situation for the objects. The result is shown on the website as a "traffic signal". The color of the signal will depend on which of the 22 possible materials is selected. "Green" indicates that it is unlikely that the material will change significantly over the next 30 years. "Red" indicates that damage is likely to occur to objects within three years and that damage will require interceptive conservation. "Yellow" indicates a situation in between those two.

Risk indication is also given in a diagram where the measured values for the two dosimeter glasses are displayed on each of the axes. Comparison of critical loads for the materials and the test result for the MEMORI dosimeter is based on research in the MEMORI project and available information from conservation literature.

Proper for a first diagnosis

Since the indoor environmental factors which can influence the two dosimeter glasses are known, the diagram facilitates a first diagnosis of what might be the problem. A high value on the horizontal "EWO-axis" typically indicates poor protection against NO_2 and O_3 from the outside air, such as from traffic. This is a typical result for naturally ventilated buildings in cities.

A high value on the vertical "GSD axis" typically indicates much organic acids in the air, mostly from the degassing of materials. This is a typical result inside showcases, especially wooden ones.

MEMORI now

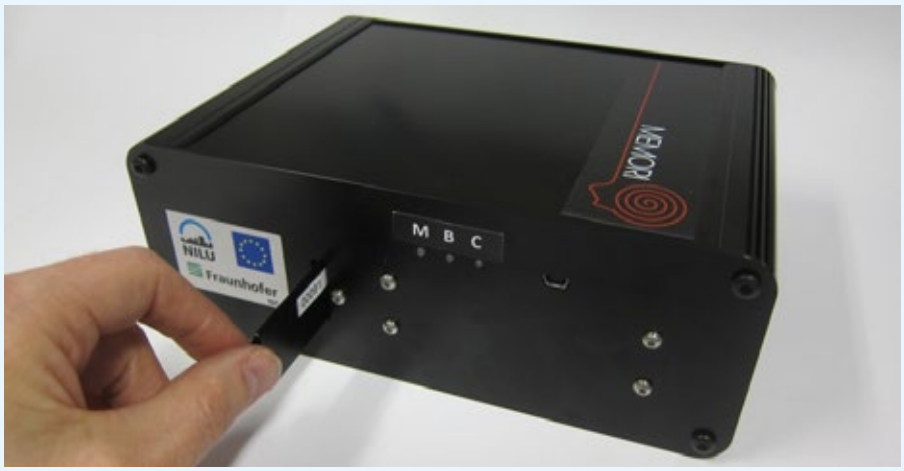
The MEMORI dosimeter was used in many museums throughout Europe in the EU project "MEMORI". Dosimeters can now be purchased from NILU, and have since the MEMORI project (mid-2014) been used to evaluate the indoor environment of museums in Norway (the National Museum and the Technical Museum in Oslo) and abroad (Tate and Museu Nacional d'Art de Catalunya).

NILU sends and receives dosimeters, performs the measurement in the new instrument and reports the results on the MEMORI website. As of today, NILU has five reader instruments that museums and others may use in cooperation with NILU.

In 2014, NILU will conduct a "MEMORI Verification Project" in cooperation with Innovation Norway. This project will further verify the MEMORI measuring instrument and technology, with respect to reliability and user functionality, and adapt it for sale.

More information:

memori.nilu.no
www.memori-project.eu



The measurement is made in the corresponding reader instrument before and after the dosimeter is placed in for example a museum, and occurs automatically when the dosimeter is inserted into the instrument. Photo: Terje Grøntoft, NILU

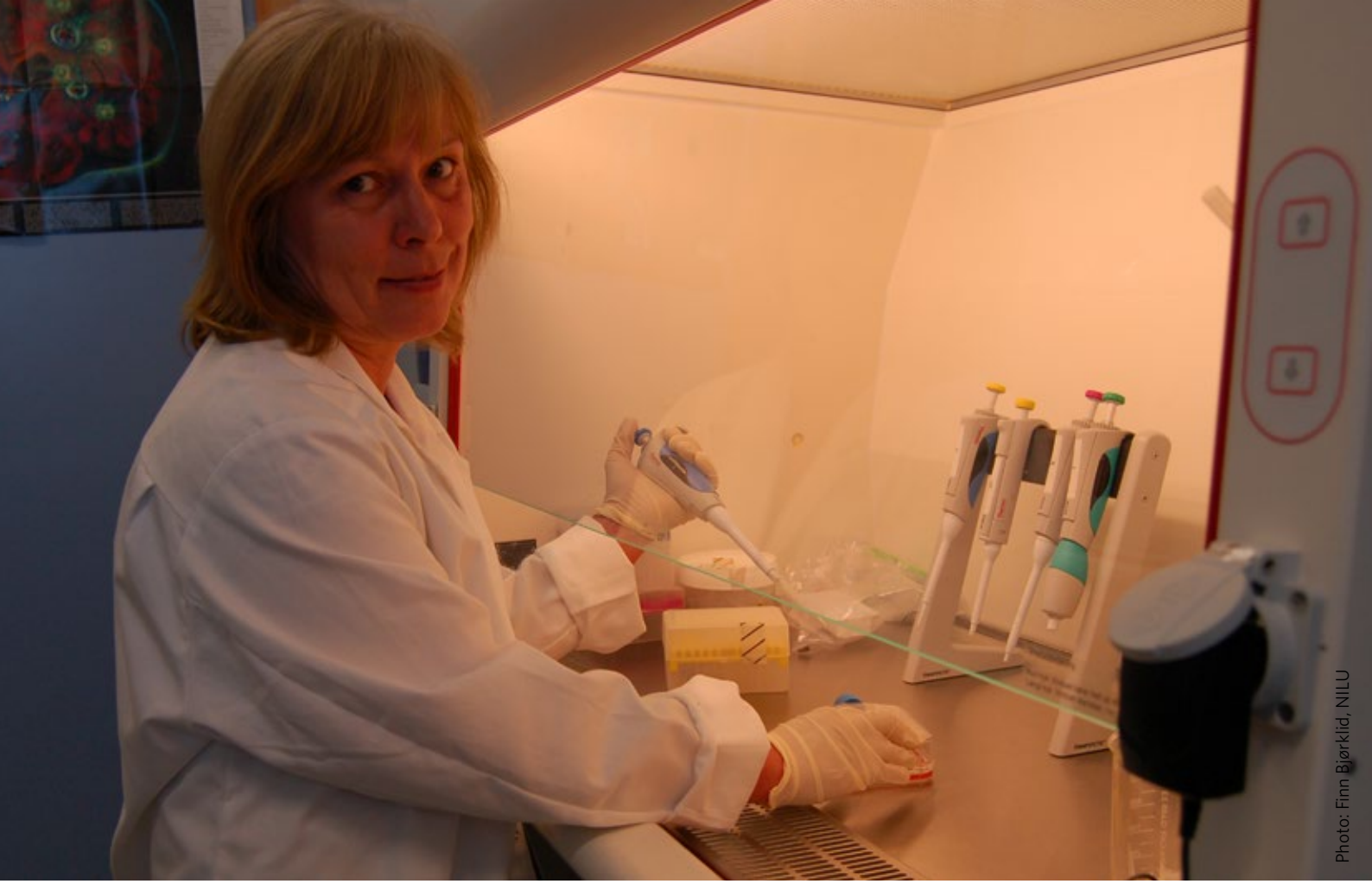


Photo: Finn Bjørklid, NILU

Top flight health effect laboratory at NILU

We surround ourselves with more and more new chemicals, and are exposed daily to a vast amount of substances and mixtures of chemicals we do not really understand the effect of on an individual. We get in contact with these chemicals through food, clothes, cosmetics, furniture, air, water and other media.

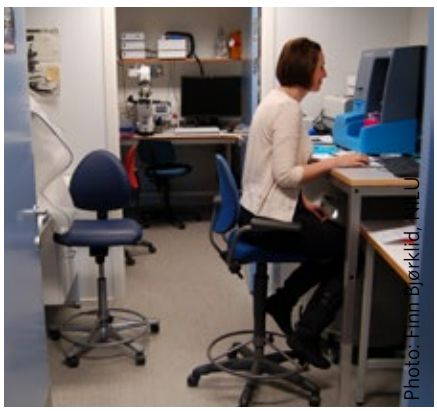


Photo: Finn Bjørklid, NILU

Svein Knudsen
Senior Scientist

Some of these chemical compounds have important properties, such as providing flame retardant substances in clothes, but they also have the potential to affect both the environment and human health. The impact of these substances, but also the impact of chemical mixtures, requires better documentation and is an important part of NILU's research agenda.

Outstanding in Norway

To investigate these effects, NILU has invested in a new health effect laboratory with focus on human toxicology. The laboratory is based on the comprehensive research of Dr Maria Dusinska at NILU, and is Norway's only laboratory of its kind, offering quality assurance according to GLP (Good Laboratory Practices). The laboratory offers methods to examine if chemical compounds, nanoparticles, particles and mixtures are toxic, genotox-

ic or carcinogenic, affecting the immune system and/or our genes.

Throughout history there have been many examples of chemical compounds that have been proven to be dangerous for health and environment. One of the most known examples is probably smoking and the addition of lead to gasoline. Results from the health effect laboratory are used to assess the impact of emission of amines under the planned carbon capture at Mongstad, and TCM (Technology Centre Mongstad).

Societal benefit

It is important for society to identify the effects of these compounds before they are adopted, while at the same time society should be able make use of new technologogical developments as soon as possible. The laboratory will thus be able to contribute to making new chemicals and nanomaterials safely accessible for society.

The laboratory has extensive research activities going on, including participation in several European research projects. It is also providing industry and authorities with services, such as evaluation of safety of compounds and toxicity tests. The close connection to research ensures continuous access to the most modern and updated methods, which are being tested and validated through international project cooperation.

When testing for health effects, cell cultures (i.e., cells cultivated and contained in beakers/petri dishes) are being exposed to environmental compounds, micro particles or nanomaterials. The scientist observe if the cells change their behaviour, are damaged or even die. These methods replace use of animal experiments and in addition reduce the time it takes to acquire results that demonstrate if certain substances or mixtures are harmful for human health.

Industrial partners that are cooperating with NILU's health effect laboratory are assured that the products they are developing and selling are not harmful for human health and the environment. The laboratory will facilitate the options of using already existing methods, and where necessary adopt or develop new methods to study mechanisms and evaluate new substances. This also enables us to study new research questions.

More information:

www.healtheffectslab.com

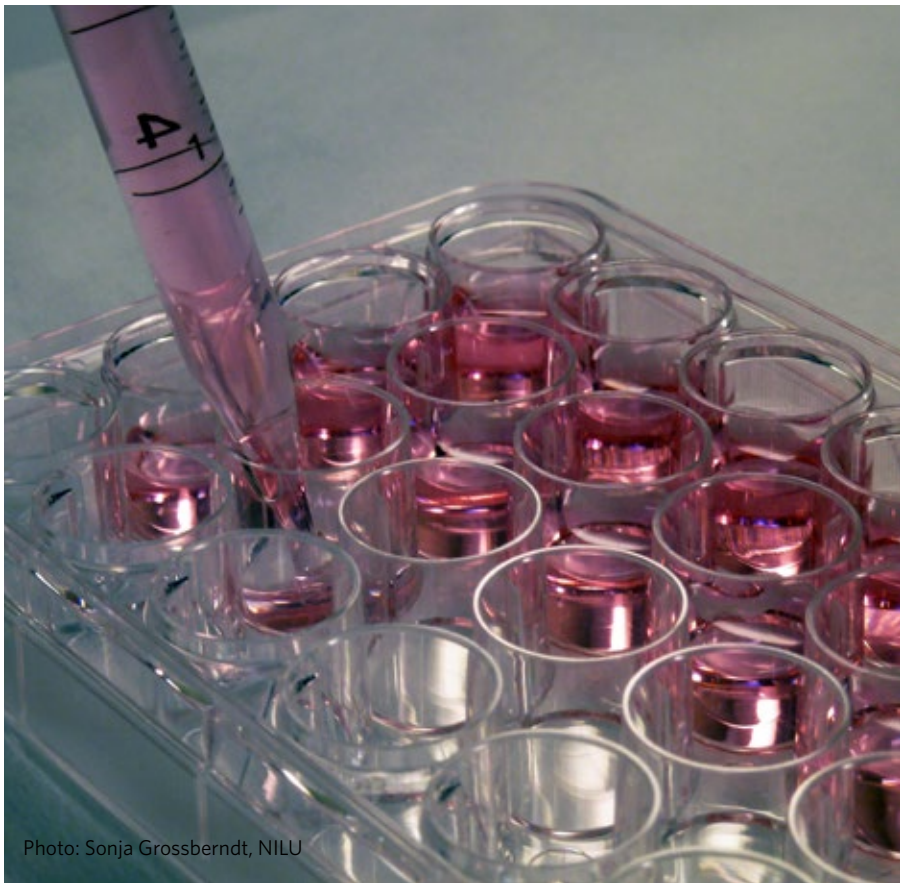


Photo: Sonja Grossberndt, NILU

Nanoparticles

Nanoparticles are tiny particles with a diameter between one and 100 nanometres. In comparison: one human hair is about 60 000 nanometres thick, while a DNA-molecule measures between two and twelve nanometres.

Nanoparticles have many areas of application, such as additive to paints, cosmetics and skin care products, in TV-sets and batteries, and in clothes and detergents to create antibacterial properties. They are also used in the development and production of lighter and stronger materials for airplanes or cars.

The use of nanotechnology within medical science is called nanomedicine. This includes the use of nanomaterials in diagnostics and treatments, as well as use of nanoelectronic biosensors. Some examples of these nanomaterials are carbon nanotubes, gold, silver, quantum dots (QU), silica, metal oxides and nanopolymers. These are the type of nanomaterial under investigation at the Health effects laboratory.

Pioneer of accreditation: NILU in Abu Dhabi

November 2013: EAD's standardisation laboratory for air quality in Abu Dhabi will be the first ISO/IEC 17025 accredited laboratory of its kind in the region.

Leif Marsteen
Quality Manager/Senior Scientist

NILU has for the past six years operated a fleet of twenty permanent and two mobile air quality monitoring stations on behalf of the Environmental Agency (EAD) in the Arab Emirate of Abu Dhabi. As part of the contract NILU established a Standardisation unit with the purpose of assuring the quality of the measurement data collected from the monitoring stations.

Secure the quality

The responsibility of the Standardisation unit is to maintain the quality system by which the monitoring network is operated, secure the quality of calibrations in the network and periodically validate the network operation.

To assure the quality of the work performed by the Standardisation unit and to strengthen its position as a calibration laboratory in Abu Dhabi and the UAE, EAD asked NILU to seek accreditation for the unit's operation. As part of accreditation, an accreditation body evaluates a laboratory's quality system to ensure technical competence. The accreditation would be according to the requirements of the international standard "ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories".

The Standardisation unit's quality system is based on the quality system already implemented by Innovation NILU's daughter company uMoya in South Africa. uMoya's calibration services are similar to the Standardisation unit's tasks, and their laboratory is accredited. The quality system was adapted to the Standardisation unit's operation in 2012, and in early 2013 it was considered ready for accreditation.

First in the region

The Australian accreditation body NATA had a pre-assessment visit to Abu Dhabi in March 2013 and a full assessment visit in late May. After a final evaluation, the Standardisation unit received its accreditation on 28 November 2013. The accreditation is the first of its kind in the region, and covers calibration of gas analysers and certification of calibration gas cylinders.

The work was performed by Leif Marsteen (quality manager, NILU Norway), Greg Simes (head of Standardisation unit) and Mohammed Tareq (quality manager, Standardisation unit).

Photo: Finn Børklid, NILU

NILU with «supersites» in European science cooperation

Quality-assured and harmonized measurements in Europe and the rest of the world is very important for us when analyzing and understanding the composition of the atmosphere. Both regarding the climate changes we are experiencing today - and those that will happen in the future. Measurements at NILU's observatories play an important role in this work.

Christine F. Solbakken
Head of Communications

NILU is the Chemical Coordination Centre for EMEP (European Monitoring and Evaluation Programme), and coordinates the work with atmospheric monitoring under the Convention on Long-range Transboundary Air Pollution. This scientifically based and politically driven program is highly relevant to NILU's involvement in, and relationship with, international projects with a research infrastructure.

NILU is particularly involved in the projects ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network) and ICOS (Integrated Carbon Observation System).

ACTRIS: A common European understanding

ACTRIS is a European collaborative project that started in 2011 and will continue until 2015. The project is funded through the EU's Seventh Framework Programme (FP7) within the theme "Research Infrastructures for Atmospheric Research," and aims to integrate European land-based research through a joint strategy for atmospheric measurements from 20 "supersites" located in different climate zones. From the Norwegian side, NILU contributes data from observatories on Svalbard (Zeppelin), Antarctica (Troll) and in Aust-Agder (Birkenes) as well as providing the technical development that underpins the project.

The ACTRIS cooperation plays an important role in understanding changes in the atmosphere. Besides providing freely available high quality data, ACTRIS will contribute to building knowledge and a better basis for action on climate change, air quality and transboundary pollution.

ACTRIS aims to integrate European land-based research stations through a joint strategy for atmospheric measurements from 20 "supersites" located in different climate zones. NILU contributes with data from our observatories on Svalbard (Zeppelin), Antarctica (Troll) and Birkenes in Aust-Agder (pictured). Photo: Harald Willoch, NILU

ICOS: Climate monitoring

ICOS is a network of observatories and research stations, continuously measuring variations in greenhouse gases (CO_2, CH_4 and NO_2) in the atmosphere. The backbone of this network is 30 atmospheric monitoring observatories, where NILU's Zeppelin, Troll and Birkenes stations are included.

The objective is to monitor the exchange of energy and greenhouse gases between the biosphere and the atmosphere, in order to better predict future climate changes and their effects on ecosystems. Together, the ICOS network consist of between 40 and 70 different monitoring stations on land and on ships, all of which utilize standardized measurement techniques and instruments.

Atmosphere and Ocean

The oceans and seas are a complex socio-ecological system that is subject to international regulations. Norway is a leader in a marine ecosystem-based management of healthy oceans and productive ecosystems. NILU is contributing to this work with transdisciplinary expertise and as a global leading institute of atmospheric research. The atmosphere is playing an important role for the ecosystem processes such as ocean acidification and eutrophication.

Alice Newton
Senior Scientist

Norway has an extensive coastline that includes large areas of the North Sea, the Norwegian Sea and the Barents Sea. Since the atmosphere is in contact with the ocean and seas, atmospheric processes and transport are very important to the marine environment.

The atmosphere, as well as rivers and land runoff, transports contaminants such as toxic metals and persistent organic pollutants to the ocean. The contaminants may affect the state of marine organisms and also accumulate in seafood, thus potentially impacting human health.

Atmospheric deposition also transports nitrogen in the form of nitrate, NOx and ammonium to the ocean and seas. The limiting nutrient for plant growth in marine waters is usually nitrogen, which is an important component of proteins. An imbalance of nutrients may disturb the basis of the food web and changes the state of marine ecosystems.

NILU's contribution

As member of the European Economic Area Norway has adopted the EU Water Framework Directive that includes coastal waters. For offshore waters, Norway is a contracting party in OSPAR (Oslo-Paris Convention) for protecting and conserving the North-East Atlantic and its resources. Norway has also established management plans for the Barents Sea, the Norwegian Sea, the North Sea and Skagerrak.

NILU scientists have actively contributed by providing decision-makers with the appropriate science-based knowledge. This includes, amongst others, the European Monitoring and Evaluation Programme (EMEP), a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution (CLRTAP) for international co-operation to solve transboundary air pollution and the OSPAR Comprehensive Atmospheric Monitoring Programme (CAMP). From 2000, NILU participated in several ELOISE projects (European Land-Ocean Interaction Studies) that contributed with scientifically based knowledge to the Water Framework Directive in coastal waters. NILU scientists have also participated in the national expert group for the drawing up of the Norwegian seas management plans.

Increased understanding

NILU's scientists have participated in two projects under the EU 7th Framework Programme that support the implementation of the EU Water Framework Directive. The project Knowledge-based Sustainable Management for Europe's Seas (KnowSeas) provides a comprehensive scientific knowledge base and a practical guidance for the application of the Ecosystem Approach to the sustainable development of Europe's regional seas. The DEVOTES project aims at the development of innovative tools for understanding marine biodiversity and assessing good environmental status. This project will continue until 2016. DEVOTES has the objective of improving the understanding of how the marine biodiversity is effected by human activities in combination with effects caused by climate change.

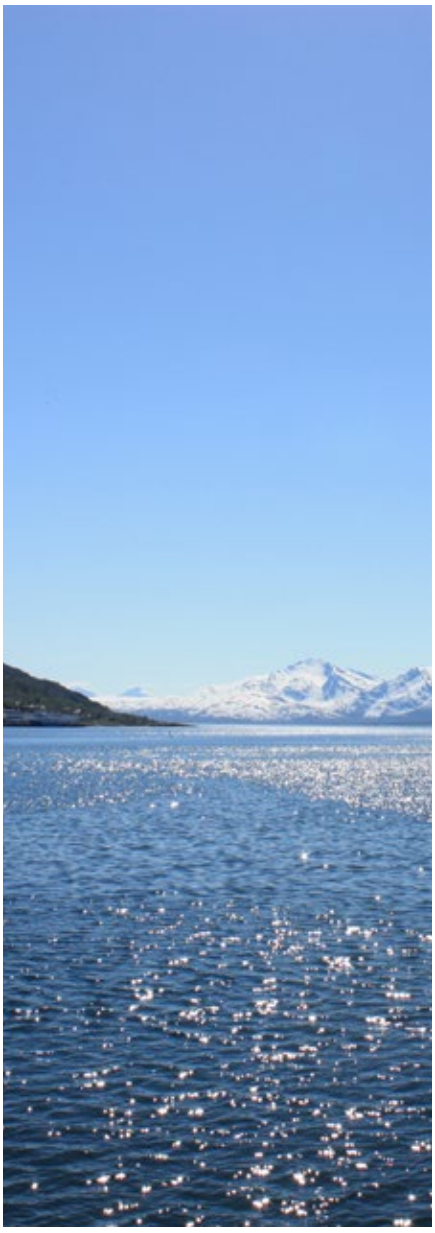


Photo: Christine F. Solbakken, NILU

Free environmental data to the public

CIENS' innovation forum decided in the autumn of 2013 to establish a web portal that will make environmental data available for everyone, free of charge. This project demonstrates how social innovation works in practice.

The Thanh Nguyen, NILU. Photo: Ingar Næss

The Nguyen Thanh
Senior adviser

The idea behind the project is that the CIENS institutes' open environmental data should be easily available to the public, regardless of format and accessibility.

Environmental data for all

The CIENS institutes offer a unique and exciting diversity of data on environment, climate and society. CIENS' innovation forum wants to make this data more accessible, through a single portal, so the public easily can find information about environmental challenges in their everyday life.

In addition, CIENS believes that the web portal may also increase public interest in, and awareness of, environmental issues. Environmental data is an important part of basic research, and with this project CIENS wants to give the data a significant boost beyond its traditional value.

Make your own environmental app

NILU leads the project, and is responsible for developing an IT solution that will make it easy to download monitoring data to develop apps for smart phones and tablets.

The project will be completed in the autumn of 2014, and project manager The Thanh Nguyen from NILU looks forward to seeing more innovative and socially beneficial environmental applications emerging by utilizing open and free environmental data.

Photo: Christine F. Solbakken, NILU

CIENS

CIENS – The Oslo Centre for Interdisciplinary Environmental and Social Research – is a strategic co-operation between the research institutes CICERO, MET, NIBR, NILU, NINA, NIVA, TØI and the University of Oslo. In CIENS, leading groups in various natural sciences and social sciences come together, and constitute one of Europe's largest research communities on environment, climate and society. The collaboration will leverage this joint expertise for the benefit of society, the institutions themselves and for the future.

Ingjerd Sunde Krogseth

On December 16, 2013 Ingjerd Sunde Krogseth defended her PhD thesis entitled *From emissions to exposure – environmental behavior of volatile methyl siloxanes and short-chain chlorinated paraffins.* The thesis has been compiled at the Department of Chemistry, Biotechnology and Food Science (IKBM) of the Norwegian University of Life Sciences (NMBU, previously UMB) in cooperation with NILU.

Ingjerd Sunde Krogseth, NILU. Photo: Christine F. Solbakken, NILU

This PhD thesis is a part of the Norwegian Research Council's research programme Norwegian environmental research towards 2015 (MILJØ 2015). This wide, cross-disciplinary research programme shall generate knowledge about key environmental questions and create a foundation for designating future policy.

Harmful properties for the environment

In her thesis, Ingjerd has studied two groups of chemicals – siloxanes and short-chain chlorinated paraffins. Both substances are suspected to cause harm to the environment. Siloxanes are often used in cosmetics and skin care products, whereas chlorinated paraffins have been used amongst others as flame retardants and as softening agents in plastic. Both compound groups are listed as chemicals that should be phased out in Norway by 2020, but knowledge on how these substances behave in the environment has been limited.

Two different methods have been tested to measure siloxanes in air. Two selected siloxanes, D5 and D6, have been detected in air samples from Svalbard, and the substances have been found in concentrations that are 100-1000 times higher than typical levels of the known environmental pollutants PCBs. The fact that there are only few sources of these substances at Svalbard confirms the suspicion that they have been travelling from areas much further South. This is a reason for concern.

Valuable knowledge

The thesis has combined practical measurements of siloxanes and chlorinated paraffins in the environment with computer models to increase knowledge about how these substances behave under Nordic environmental and climate conditions. This knowledge can provide valuable input to the authorities' assessment about whether these substances should be regulated or not.

The experience with combined measurements and use of computer models to understand siloxanes will be continued in a new project where scientists want to study the behavior of siloxanes in lakes under Nordic climate conditions. This project will be led by NILU in Tromsø and is also funded through the MILJØ 2015 programme.

Linda Hanssen

Linda Hanssen from NILU at the Fram Centre took her PhD in Medical Sciences at the Arctic University of Norway (UiT) in Tromsø on October 25, 2013. She defended her thesis entitled *Human biomonitoring of perfluoroalkyl substances and cyclic volatile methyl siloxanes. Concentrations in plasma, serum and whole blood from pregnant, delivering or postmenopausal women, and cord blood.*

Linda Hanssen, NILU. Photo: Christine F. Solbakken, NILU

We are exposed to a large number of environmental pollutants through diet and use of products that are meant to improve our everyday life. To find out more about these substances is important to implement measures that reduce our exposure.

Linda Hanssen has studied two groups of contaminants: perfluoroalkyl substances (PFAS) and cyclic volatile methyl siloxanes (cVMS). The source of exposure to PFAS is usually food, whereas for cyclic siloxanes it is the application/use of skin care products.

Study objectives

The primary objective was to study the exposure to PFAS by measuring their amount in the blood of delivering women and their new-borns (umbilical cord). This study has been limited to women living in South Africa, Norilsk (an industrial town in the Arctic areas of Russia) and in rural areas close to the Aral Sea in Uzbekistan.

Hanssen was also interested in finding out if cyclic siloxanes were detectable in the blood of the general population in Norway and if there could be a correlation between these findings and the use of skin care products.

Some results

Concentrations of PFAS in blood of delivering women were highest in the Arctic areas of Russia, followed by South Africa and Uzbekistan, whereas the concentrations have been generally lower in the Western parts of the world. This has led to the conclusion that these substances are present everywhere, but the PFAS concentrations varied from non-detectable to 15.9 ng/ml.

From the majority of these women, blood of the umbilical cord was available and the results showed that also unborn children in the mothers' womb are exposed to these substances.

For the first time cyclic siloxanes have been detected in the blood of the general Norwegian population, represented by pregnant and postmenopausal women in Northern Norway. The concentrations of cyclic siloxanes in their blood varied between non-detectable and 12.7 ng/ml. Even though skin care products are known to be an actual source, Hanssen could not prove a direct correlation between the use of skin care products and siloxane concentrations in the blood.

As for now, it is unknown how long-term exposure to PFAS and siloxanes can impact the human body, but together with the 200 other chemicals that have been detected in human blood they can be considered as contributors to the so called "cocktail-effect" whose consequences are still not known.

Research for a clean atmosphere

NILU – the Norwegian Institute for Air Research was established in 1969. The aim of our research is to increase the understanding of processes and consequences in our core areas: atmospheric composition, climate change, air quality and hazardous substances. We hold strong national and international positions in these areas. We also deliver services closely linked to our research.

National and International activities

NILU has extensive experience of coordinating national and international research projects, and undertakes a range of assignments both in Norway and abroad. More than 30 per cent of our revenues are from international research assignments.

Our main clients are the EU, The Research Council of Norway, national and local authorities and industry.

Major international NILU clients

- The European Commission
- European Environmental Agency
- Environment Agency Abu Dhabi
- World Bank
- World Meteorological Organization
- World Health Organisation
- UN Environmental Programme
- UN Economic Commission for Europe

The institute takes an active part in EU's framework programs for research, and plays a central role in the coordination of measurements of air pollution and climate drivers in Europe. NILU coordinates the chemical measurements in EMEP (Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe). EMEP involves approximately 40 countries, and contributes to political agreements on emission reductions (under the Convention on Transboundary Air Pollution, CLRTAP).

NILU also participate in the global atmospheric monitoring program Global Atmosphere Watch (coordinated by the World Meteorological Organization, WMO). We host the World Data Center for aerosols (WDCA), and we are represented in many of the center's scientific advisory groups.

NILU also contributes measurements to these international measurement programs, from our observatories Birkenes, Troll and Zeppelin, as well as from a number of regional monitoring stations.

Since 2007, NILU has cooperated with the authorities in Abu Dhabi, working with project oriented research and research-based services. The main activities are related to air pollution, climate change, noise and indoor environment.

The institute holds interests in environmental research companies in Poland and South Africa.

Air quality

Research into local air pollution is one of our core activities.

Traditional air pollutants are decreasing in industrialised countries, but at the same time there is an increase in new substances and in known gases which are detrimental to human health, like nitrogen oxide, NO_2 and ground level ozone. New measures in urban planning can cause new pollution problems, posing dangers to health and the environment, and in fast-growing economies rapid urbanisation and industrialisation can lead to increased air pollution.

We offer research based consultancy services, drawing on our considerable skills and experience in air research, combined with highly qualified researchers and software developed in-house.

Climate research and surveillance

From observatories in Norway, the Arctic and the Antarctic, NILU monitors climate forcers, greenhouse gases, environmental pollutants, air quality and long-range transport of pollution. Our data are available to researchers from all over the world.

There is increasing national and international geopolitical interest in the Arctic and the northernmost regions of the world. The Arctic can give crucial early warning of global processes, and our monitoring there gives us valuable knowledge. New, growing industries, like oil and gas exploration and shipping and mining in the north, brings to the fore new issues relating to the Arctic environment.

NILU has a lot to contribute to Norway's Arctic and northern areas Initiative.

NILU's observatories in Norway, the Arctic and Antarctic supply scientists all over the world with important data about pollution, climate gasses and climate drivers. Here: NILU's observatory at Ny-Ålesund on Svalbard.
Photo: Are Bäcklund, NILU

Laboratories

NILU's accredited chemical laboratories are among the most advanced in Europe. We are at the forefront of research into, identification of, and impact analysis of new hazardous and other substances harmful to health and the environment. Using advanced analytical tools, including several high-resolution mass spectrometers, we carry out very accurate readings of both organic and inorganic pollution.

Innovation

NILU seeks to contribute to the development of the knowledge based society through innovation.

We market our innovations through NILU Innovation AS. This wholly owned subsidiary is also a holding company for Nicarnica Aviation AS, Comet Biotech AS and PortsEye AS.

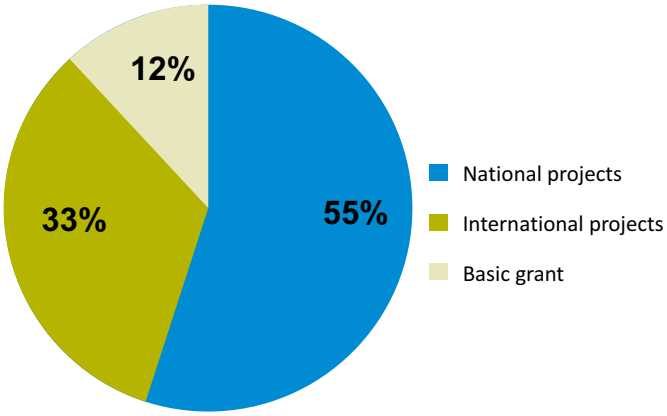
Key figures

Extract from the annual statements: All figures in MNOK

INCOME STATEMENT (MNOK)	2013	2012
Project revenue	170,8	185,1
Basic grant	24,6	23,8
Other operating income	0,8	0,9
Operating revenue	**196,2**	**209,8**
Wages and social expenses	-138,4	-133,8
Direct project expenses	-23,5	-34,5
Other expenses	-39,0	37,8
Operating profit	**-4,7**	**3,7**
Net financial items	-0,7	-2,1
Tax	0,1	1,6
Profit for the year	**-5,3**	**3,2**

BALANCE SHEET (MNOK)	31.12.13	31.12.12
Fixed assets	108,9	114,4
Management funds	1,1	39,0
Current assets	63,5	72,4
Total assets	**173,5**	**225,8**
Total equity	97,7	105,3
Long-term liabilities	21,8	20,0
Management funds	1,1	39,0
Short-term liabilities	52,9	61,5
Total equity and liabilities	**173,5**	**225,8**

PROJECT PORTFOLIO – PERCENTAGE 2013



NUMBER OF MAN-YEARS	2013	2012
Total	180	180
– whereof research man-years	102	98
– whereof man-years of other personnel	78	82
Turnover per reseach man-year (MNOK)	**1 924**	**2140**

NUMBER OF EMPLOYEES		
Total	198	200
– whereof women	90	89
– whereof men	108	111
Number of employees holding a doctorate	**65**	**61**

PROJECT PORTFOLIO - PERCENT		
National projects	54 %	57 %
International projects	33 %	32 %
Basic grant	13 %	11 %
Total	**100 %**	**100 %**

PROJECT PORTFOLIO - NUMBERS		
0 – 100 000	90	87
101 000 – 500 000	114	113
501 000 – 2 000 000	54	56
2 001 000 and over	16	20
Total	**274**	**276**

NILU's PUBLICATIONS		
Peer-review articles	121	151
Scientific reports	51	43
Technical reports	1	1
EMEP/CCC reports	5	4
Lectures	143	109
Posters	18	21
NILU scientists contributed to the publishing of:		
External reports	29	16
Chapters/articles in books/reports	39	71

Peer-review articles

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