



SMHI

SUMMARY ANNUAL REPORT **2019**

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DIRECTOR GENERAL'S OUTLOOK

The year 2019 can be described with a single word – climate. It was the earth's second warmest year on record. The UN had the climate as its theme for the General Assembly, the 25th UN Climate Change conference (COP25) was held in Madrid, and the UN climate change panel (IPCC) presented several reports during the year, to name a few examples. But most importantly, the climate was the subject of many political, economic and social discussions throughout the world. For SMHI this has meant increased responsibility within this field and continued development of our work with climate change.

According to the IPCC the glaciers are shrinking and sea level is rising faster than ever. Land use affects the climate and the changing climate affects the way farming and forestry can be carried out in the future. Reports from the climate panel reinforce earlier conclusions about the seriousness of the situation, but also show that global warming can be slowed if strategic decisions are taken in time. But we cannot wait!

A change in the climate implies an increased risk for extreme weather, leading to significant disruptions to communities, and increased vulnerability. SMHI has an important role, where we can provide knowledge and decision support as well as working even more with communication. We need to continually develop our skills in the field of climate change.

SMHI's work with climate change has been ongoing for over ten years and is now well-integrated into our activities. During 2019 we continued to hone our work. This included further development of our expert council for climate change, an updated web portal for climate change adaptation and the launch of an educational web-based game on the subject. Our work is at the forefront when compared with international scientific research and during the year we organised a seminar for our European counterparts within the framework of the EUMETNET cooperation.

During the year we observed the hundred year anniversary of the merging of the Meteorological Central Office and the Hydrographic Office which formed SMHA, later renamed as SMHI. The decision to merge the two institutes was based on the analysis expressed by my predecessor Axel Wallén one hundred years ago, that we should increase awareness of the combined studies of both subjects, as hydrography and meteorology are connected. Having meteorology, hydrology, oceanography and climate gathered into one institute, with services for research, observation, databases and production of products and services, is a strength for SMHI and Sweden.

All our employees gathered for a session on the theme of "a hundred years of public service". Our decision support has contributed to large investments in infrastructure, such as the construction of water power stations, road construction, and city planning. We deliver, and will continue to deliver the best decision support analyses.

Our work builds on the ability to measure and observe the world around us. Our observation systems are central to this and during 2019 we have continued to invest in radar facilities as well as meteorological and hydrological stations.

The new research vessel Svea was named and launched during 2019. This is a big investment for Swedish infrastructure which will benefit both the collection of environmental data as well as research. This is also an example of how Swedish institutes can work together to share large costs.

Collaboration and cooperation are central to SMHI: we work together with other institutes, universities and research centres, both in Sweden and internationally. We work together with our European counterparts and sometimes also with the private sector. All in the name of better public service.

The relationship between the state meteorological services and those provided by the private sector has been discussed for several years in a number of international fora, continuing into 2019. These issues were central to WMO and Geo meetings. I can ascertain that there is a degree of curiosity from both sides, and an interest in cooperation. How this can be met needs further analysis. Cooperation could involve collecting and sharing data, purchasing super computers, developing models, forecast calculations and various services. There are many opportunities for developing this cooperation, while other services such as warnings should continue to be a national, state concern.

Collaboration with other north European institutes continues to deepen. The meteorological cooperation with our counterparts in Finland and Norway for forecast production has been expanded to include the meteorological institute in Estonia. SMHI and the meteorological institute in Norway have together invested in a powerful supercomputer. It is very cost-efficient to share the cost for the computer power needed for all our calculations and provides an important public service. The long term plan continues to aim towards a north European meteorological cooperation by 2027.

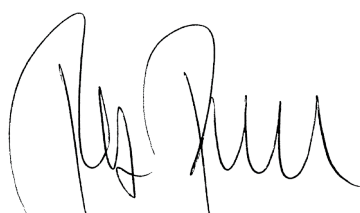
During the year international cooperation has also begun around climate modelling, to make better use of joint resources and to increase cooperation between the meteorological institutes. SMHI is leading a European cooperation for the development of a global climate model. During the year this has led to a large number of new climate scenarios which will be used as a base for the writing of the next big IPCC report to be issued in 2021.

During 2019 we have continued to strengthen and hone our organisation. Modernisation of our offices in Norrköping continues, making them more functional, and one of our buildings has now been completed. The offices in Uppsala started the move to a new site in Uppsala at the

end of the year and operations in Sundsvall and Malmö will be moved to the remaining three sites during 2020. Increased coordination between the meteorological forecasting departments is underway. This is necessary to meet higher demands on preparedness, sustain competence and contribute to a sustainable financial ground. It has meant significant changes for some individuals, but gives SMHI a stable foundation for the future.

SMHI's turn-over increased during 2019 but the overall result was negative. We reduced the grant savings to almost zero following a large grant saving at the start of the year. The accumulated result of the commercial services gave a negative result. The financial result has been burdened partly by the restructuring costs caused by the work to reduce the number of production locations.

We have also begun work on improving marketing and product planning. The goal is to be even better at converting our combined knowledge into services and products for society. The institute's security has also been prioritised during the year. We have strengthened our competence and resources in order to be better equipped to deal with existing risks and also to strengthen our capacity within national defence.



Rolf Brennerfelt
Director General

Photo: Fotofabriken - Niclas Kindahl



CORE SERVICES

The Core Services department administers Sweden's meteorological, climatological, hydrological, and oceanographic infrastructure. The department incorporates everything from measuring and collecting data to calculating, storing and processing them. Statistics and information are produced and used for important societal analyses, such as reaching national environmental quality goals. Work includes producing, compiling and communicating information and expertise, including climate adaptation needed for the current situation and for the future. The services for forecasts and warnings provide the information needed to reduce society's vulnerability. Cooperation with other institutes, both national and international, is important and SMHI represents Sweden in international organisations such as the European weather centre EMCWF, the UN World Meteorological Organization WMO and the European weather satellite cooperation EUMETSAT.

SMHI strengthened through Northern European collaboration

The meteorological institutes in the northern and Baltic countries have formed a cooperation forum where institutes exchange expertise and experience of observations. Administration and development of the Swedish meteorological, hydrological and oceanographic infrastructure required of SMHI is therefore more efficient, since issues concerning network quality, purchase, instrumentation, data storage, quality control and data exchange can benefit from the broader competence within the community. During the year this cooperation has resulted in common methods and equipment for quality assessment of observation sites, and a quality classification is also in progress. This cooperation has also led to an exchange of algorithms for quality control of observation data providing guidelines and support for automation of SMHI's manual observation network. It has also resulted in a common lightning localisation system between countries and an improved upgrade in Sweden. This provides the country with the best possible support during serious thunderstorms. A higher quality of all types of observation helps to better describe the current situation, which is a necessity in order to improve our warning and forecast services. Further, this cooperation provides better prerequisites to meet the requirements from WMO for common and standardised methods.

Continuously positive trend in monitoring of SMHI's forecasts

New targets for weather forecasts and warnings have been used since 2017. Warnings for hazardous events (classes 2 and 3) are included in the evaluation. In the weather forecasts, accuracy is reported as a comparison between forecast and measured values for temperature, precipitation and wind speed for the current day (day 1) and day 5.

During 2019 the warning accuracy was 67 percent, slightly higher than the previous year, and mainly due to fewer missed warnings. The accuracy for day 1 concerning the temperature showed a high value again for 2019, after a dip in 2018. For winds the value was the highest since 2012 while the accuracy for precipitation was lower than 2018 but still high when considered over a longer time period. For day

5 the accuracy for temperature was among the highest recorded. For wind and precipitation the accuracy for day 5 was lower than the previous year, probably due to the numerous showers during the summer and a very rainy autumn, which is difficult to forecast five days in advance.

Improvements for warnings and weather forecasts

During the year SMHI has taken several actions to improve the accuracy of weather forecasts and warnings for the 1–12 hour interval. For short precipitation forecasts (1–6 hours) SMHI uses information from all Swedish radar sites combined with meteorological forecast calculations. The shortest forecasts are mostly based on the radar data, after which the model data are used with increasing weight. Up until now it has only been possible to use information from either all or none of the radar sites. This method mostly works well, but for some weather situations the data from individual sites should be excluded when they give inaccurate data to the forecasts. The methods have therefore been refined so that the duty meteorologist can select whether or not to include data from individual radars in the forecast calculations. This refined method can lead to better information about when and where precipitation can be expected.

For temperature forecasts SMHI uses a method similar to that for precipitation forecasts. The duty meteorologist uses the current temperature values and combines them with the meteorological model calculations. Decisions about how to combine the current values with the modelled values are made with the help of artificial intelligence (AI). This method gives an updated forecast for the 1–10 hour period. The forecast is updated every hour. Temperature is the first weather parameter to use AI at SMHI.

SMHI has to issue warnings when there is a risk of weather or water related situations that can cause disruptions to society. SMHI has started a project to introduce consequence-based warnings. The project will run until 2021 together with a number of public stakeholders, for example the Swedish Civil Contingencies Agency and the county councils. Consequence-based weather warnings will be divided into three different warning levels based on the expected effect of the weather situation. The previous war-

ning classes 1, 2 and 3 will no longer be used, and will be replaced by the colours yellow, orange and red. The new weather warnings mean that information from SMHI, together with the assessment of their effect from the public stakeholders, will provide decision support for SMHI's warnings. This involves introducing a new way of working which will improve the ability for society to deal with serious water and weather related situations. The expected results are warnings that are adapted to different regions and which are issued based on the effects expected in each area. During this year much of the foundation work for this new way of working has been done.

Third party observations complement the observation data

Technical developments enable SMHI to carry out a number of tasks in new ways by using third party meteorological observation data. Modern technology often measures weather parameters since the weather is a generally relevant factor. This means that there is a large quantity of weather information that could be useful to SMHI as a complement to official observations. A denser observation network can provide a better picture of local weather phenomena such as downpours or temperatures within a town. In 2018 the service "My observations – WOW" was launched, with the purpose of refining data from private weather stations, and which could also be used in schools to spread awareness.

SMHI is also developing techniques to gather weather observations from aeroplanes. This is carried out in cooperation with EUMETNET with experience from the meteorological institute in the Netherlands, where weather forecasts have been improved by using the observations from aeroplanes.

The UN climate panel IPCC produces scientific reports

SMHI has continued work as the national contact point in Sweden for the UN climate panel IPCC, and has represented Sweden at three decision meetings: in Kyoto, Geneva and Monaco. The first meeting approved the revision of a method report for an inventory of greenhouse gases since 2006. The second meeting focused on decisions on the Special Report on Climate Change and Land, and the last meeting focused on the decisions for a Special Report on the Ocean and Cryosphere in a Changing Climate. The cryosphere is the part of the earth's surface and atmosphere that is made up of ice and snow. The two Special Reports support the decision-making processes for climate negotiations and take a wide grasp of the climate issue which are put into a wider perspective in connection with Agenda 2030.

As shown by this year's reports, within the space of one year the climate panel has produced three special reports and one method report, involving a far greater human effort that has previously been seen within the IPCC. During the year, SMHI has worked on making Swedish climate experts more aware of the opportunities to contribute to the work of the IPCC, both as authors and as reviewers of the various

IPCC draft reports. SMHI has initiated a new communications network around the IPCC and collaborates with institutes and agencies such as the Swedish Environmental Protection Agency, the Swedish Agency for Marine and Water Management, the Swedish Polar Research Secretariat, the Swedish Energy Agency and the Ministry of the Environment. This collaboration has involved both the gathering of Swedish experts comments on the reports produced, as well as communication of the final reports. During the year, two education events were held for journalists, as well as two press conferences. Information summaries and short films have also been produced in connection with the decision meetings for the special reports.

Climate adaptation game shows the consequences of decisions

The Swedish National Knowledge Centre for Climate Change Adaptation (Knowledge Centre) at SMHI has the main goal of contributing to a society that is sustainable both now and in the future. The work supports Swedish climate adaptation and provides expertise in the international climate adaptation efforts. The required effects of this work are that society has a stronger ability to adapt to a changing climate, as well as increasing awareness, knowledge and involvement. This provides conditions for good community planning and a sustainable secure society for the current and future climate.

In September the Knowledge Centre launched the Climate adaptation game. This aims to increase awareness of the consequences of a changing climate and how society can meet the challenges it brings, such as heatwaves and heavy downpours. The game is also accompanied by teacher support and can be used in education for sustainable development or to get started with climate adaptation in cities or counties. It is freely available from smhi.se in both a Swedish and an English version, and can also be used in the Minecraft environment. The game is based on serious gaming, which is a tool for training understanding of complex contexts. Players learn to see the consequences of decisions and how they are connected. During 2019 the game has been demonstrated at eleven different national and international events. It has been played by pupils at upper secondary schools and by politicians in Linköping, who were given the opportunity to discuss the challenges and possibilities of climate adaptation in their meeting. The game has also been tested at an international conference on climate modelling where climate researchers could acquaint themselves with the climate information needed by decision-makers. During the period September to December the game has been visited over 15 000 times at smhi.se, making this the most popular web page at SMHI during this period.

Increased knowledge about the role of the climate on fire risks

The wildfires over the last few years have shown that we need better calculations of fire risks in a changing climate. Humidity is an important parameter in this context, and

during the year SMHI has worked on building up the necessary competence and methods for calculating humidity. SMHI has also started working on combining the statistics on wildfires gathered by the Swedish Civil Contingencies Agency with SMHI's lightning observations to better understand fires caused by lightning and how they can be linked to the future climate. A better understanding is also needed about the spread of smoke and acid fallout over sensitive areas in Sweden, and the effect on public health. As a first step this year SMHI has carried out the groundwork ready for further analysis of the emissions from the fires in 2018.

Stronger cooperation with the Geological Survey of Sweden (SGU) concerning groundwater

During the recent problems over the last few years concerning water shortages and droughts the cooperation between SGU and SMHI has developed at several levels. Together the institutes provide the groundwork for the water situation concerning soil water, groundwater and surface water. Cooperation has been further strengthened during the year as SGU has started to provide forecasts of groundwater. The forecasts are calculated using a hydrological model from SMHI which is being further developed by SGU for use in groundwater models. SMHI provides an operational environment where the models can be run with indata from the latest weather forecasts. By running the model in SMHI's hydrological production system the groundwater forecasts can be delivered to the public in a reliable and cost-efficient way.

New reference level for sea level and warnings

For a long time the mean sea level figure along the coast of Sweden has been a calculated value for each year. Since this varies both geographically and over time due to land rise and

the rise in sea level, it leads to differences in the levels for land and sea. SMHI together with the Swedish Maritime Administration therefore combined and improved the sea level information in June by changing to RH 2000, Sweden's national reference system for height and depth, which is now used as the primary reference system for sea level observations. This transition is a step towards a uniform reference system at the national level and brings many advantages, for example to work that involves measurements from both land and sea. It also gives more permanent depth figures for nautical charts. SMHI's own reference points for height levelling have been adjusted to the benchmarks from Lantmäteriet (the Swedish authority for geography) for RH 2000, so that all sea level stations are linked to the national height reference network.

An advanced research vessel for environmental monitoring and marine research

Sweden's new research vessel R/V Svea carried out their first sea-going expedition during December. This new sea vessel has been much anticipated. Since U/F Argos was scrapped in 2011 the activities at sea have been carried out with temporary solutions. For several years SMHI together with the Swedish University of Agricultural Sciences (SLU) have planned the construction of Svea which is now equipped with the most modern oceanographic equipment and can provide a more detailed mapping of the sea environment. The vessel is specially adapted to the requirements of SMHI and SLU for monitoring the sea environment but is also available to other users, such as Swedish universities and colleges. Svea is owned by SMHI and crewed by the Swedish Maritime Administration. The main users are SLU and SMHI who together with the Swedish Agency for Marine and Water Management finance most of the environmental monitoring at sea.

RESEARCH

The research department carries out applied research and development to increase knowledge and outreach with information for meteorology, climatology, hydrology and oceanography. Research and development is carried out at every level of SMHI's production chain, for observations, in model development, in quality control and analysis of data, with improvements to forecast and warning systems, and in the development of decision support for a sustainable society. A large part of the research and development provides deeper knowledge about the changing climate and its consequences, such as storms, floods, downpours and droughts. There is also a lot of focus on research that provides better decision support systems for reducing the negative effects on the environment. SMHI's research and development is carried out in close cooperation with users within the institute and in society.

RESEARCH FOR SOCIETY'S BIG CHALLENGES

An understanding of the natural patterns and processes in the air, waters and sea and the way they are affected by human activities is the main subject of several international agreements that have been signed by SMHI and that permeate Swedish environmental and climate politics. Research at SMHI contributes to fulfilling the global goals of the UN's Agenda 2030, to strategies for reduced emissions and decision support for climate adaptation following the Paris Agreement, and to the UN Sendai Framework for disaster risk reduction. During the year 72 percent of research projects at SMHI were within the strategic areas of climate and environment.

Knowledge sharing, user dialogues and workshops

SMHI wants to make research results available quickly, in an easy and open way that supports the societal needs for its knowledge, for example through publication in open access journals. SMHI shares data and information with other agencies and sister institutes, as well as through national and international research projects. The projects are often user-controlled and use an agile method of operation where any new understanding of user needs is taken into consideration. This method of working provides more useful and lasting services after the end of the research projects.

Development of open web services

In order to facilitate the work with climate adaptation and risk assessment of extreme weather, SMHI offers data and information for research projects via web-based climate services. SMHI launched a new version of the in-house developed web service HypeWeb, providing global hydrological data, analyses and the open source code. SMHI has contributed to an international web service with new data from global and regional climate modelling, and new ocean climate data has been published on smhi.se. These web services are used frequently. SMHI has developed climate services within the Copernicus programme – the European system for monitoring the earth – for both European and global users. Through the WMO SMHI was tasked by the Green Climate Fund to develop a new data portal for global water and climate data.

Sharing expertise at conferences

The SMHI research department has participated in several large scientific conferences, giving 222 presentations both nationally and internationally, of which 65 percent were in the field of climate, environment and energy. The World Climate Research Programme has commissioned SMHI to be the host organisation for the International Project Office for Cordex for regional climate modelling. During the year Cordex and SMHI organised an international conference in Beijing, China, on regional climate modelling information, to discuss current climate research and how it can be used for sustainable development within city planning, and in the water, energy, and agriculture sectors.

SMHI organised two conferences on downpours, flooding and risk management as part of a research project, as well as a meteorological method conference together with the Swedish Armed Forces.

SMHI participated in the International Council for the Exploration of the Sea (ICES) Annual Science Conference and during World Water Week with research on the sea and how information and communication technologies can contribute to sustainable water-related development.

During the European research and development days SMHI demonstrated a game that can increase understanding of how hydrological seasonal forecasts can be used for decision support, showing a good example of user-friendly products created in the framework of EU's Horizon 2020.

Quality in research

Research and development at SMHI should have a high scientific standard, from researchers with high academic merits and with national and international contacts. 77 percent of staff in the research department hold a doctorate, while four are associated professors at Swedish universities. At the end of the year there were 17 research leaders at SMHI, which is an internal career path for merited researchers. SMHI is recruiting professors to lead the research work, to make SMHI's research more useful, to supervise doctoral candidates and junior researchers, to find external funds and to improve cooperation with universities. During the year SMHI began the recruitment process to find a professor of meteorology. SMHI's research department has supervised seven degree projects and 14 doctoral theses to-

gether with educational institutions, and has housed one guest researcher during the year. The International Association of Hydrological Sciences, made up of 8 600 members from almost 200 countries, elected a researcher at SMHI as their next chair person.

SMHI's research results are mostly published in peer-reviewed scientific journals. During the year 113 research articles were published, which is more than the internal goal of one research article per researcher and year. Several articles were published in high impact journals. SMHI ensures that research is relevant to society, innovative and of a high scientific quality, by ensuring that the research is mostly carried out in externally financed projects where the research application is judged in competition with others. During the year SMHI was involved in 135 research projects. SMHI coordinates nine large national and international research projects, and is involved in 20 projects with EU's Horizon 2020, where SMHI is also the coordinator for one of them.

RESEARCH AREA: INCREASED KNOWLEDGE OF CLIMATE CHANGE

SMHI produces expertise about climate change through a number of product chains extending from development of climate models to calculations of climate effects all the way to services to the public.

During the year SMHI has led the development work for a global climate model and carried out global calculations for a changing climate as well as calculations for an overshoot scenario. The calculations can be used to understand how the climate is changing and as the groundwork for limiting climate change. The development of a regional very high resolution climate model has continued and SMHI uses this model for detailed calculations on the kilometre scale. For the Baltic sea SMHI has published new future scenarios for nutrients. The models for sea level simulations in the current and future scenarios have been further developed. SMHI has also improved the national hydrological model with calculation routines for wetlands and sediment transport, and has analysed the trends and effects of measures to limit eutrophication and high water levels in rivers, as well as low water levels. SMHI has also carried out several studies to understand how high temperatures are experienced in towns, providing decision support for future city planning. Researchers have continued working with the Arctic, where the climate is changing more rapidly than in the rest of the world.

RESEARCH AREA: SUSTAINABLE SOCIETY

Weather, air quality and water levels in rivers, lakes and seas affect social and economic activities on a daily basis. Weather extremes can threaten life, health and properties. SMHI's research contributes with method development and analyses for increased understanding of weather extremes and how research can contribute to a sustainable and less vulnerable society. During the year SMHI led the European cooperation for weather forecasting systems and improved

methods for meteorological weather forecasts, including forecasts for the next twelve hours, and has tested and evaluated high-resolution weather forecasts for mountain environments, as well as developing methods and forecasts for wind and solar power. SMHI has assisted the European Space Agency (ESA) with user requirements for a supplemented Arctic weather satellite system, the Arctic Weather Satellite. The open source code project Pytroll celebrated its tenth anniversary. The model used with the Copernicus programme for air quality forecasts over Europe has been developed during the year, both vertically and horizontally. The hydrological forecast model has been developed to better describe rapid changes caused by downpours. SMHI supports its sister organisations around the world by helping to develop warning services and during the year has continued work on a hydrological forecast and warning system in Western Africa.

RESEARCH AREA: SUSTAINABLE ENVIRONMENT

SMHI carries out research in order to better understand how human activity affects the environment. Research on the water environment is carried out for the whole chain, from the source to the sea. Hydrological water quality and load calculations contribute to a better understanding of water quality on land, as well as how the water quality in the coastal zone and out at sea is affected by land activities. SMHI's research also increases the understanding of the effects of eutrophication and hypoxia in the sea and how these can be rectified. During the year SMHI has investigated the leakage of poisonous substances from fibre banks outside older paper mills. SMHI contributes to understanding how fresh air can be ensured, aiming to reduce the negative effects on humans and nature, and during the year a toolbox has been developed for improving the air quality in towns.

SMHI has also provided data to several studies investigating the effects of the air quality on public health. During the year the calculation model for air quality has been improved so that it better describes the link between ozone and the effects on the ecosystem. A project coordinated by SMHI has investigated how climate change and particle dispersion could affect the nature and ecosystems in mountainous areas in Scandinavia and southern Europe. This decision support information is used by decision-makers, consultants and other researchers, both nationally and internationally.

PROFESSIONAL SERVICES

The Professional Services department offers branch-specific, customer-integrated services for both businesses and the community. The services are based on experiences and expert knowledge within all of SMHI's competence fields, in cooperation with external partners. The benefits to the customer are increased safety, sustainability and more confident decisions, both in Sweden and internationally. During the year our work has been developed and adapted in several areas. Our goal is to continue to improve the usability of our customers' activities. Some marketing areas have shown improved results, while others continue to be restructured. Work is ongoing to review the profitability for some marketing areas and to develop internal processes.

Further development of services to shipping contributes to reduced emissions

By continuing to focus on quality and services with added value for weather-related products to commercial shipping, SMHI has retained its position as one of the five leading global players. SMHI guides vessels day and night around the world, contributing to safer and more energy-efficient transport. During the year SMHI has continued to develop products, including a new and more efficient route planning tool, in order to provide more precise guidance to vessels, and therefore further improve safety and fuel savings. This year's investment on more efficient products enables SMHI to contribute to a further reduction of carbon dioxide and sulphur emissions, which is an important focus area for shipping. During the year SMHI has also run calculations to show how SMHI services contribute to reduced carbon dioxide emissions for shipping. The results show that SMHI services reduced carbon dioxide emissions by about 700 000 tons during 2018.

Developing an air quality system in Bosnia

According to the World Health Organization (WHO) Bosnia is one of the European countries with the worst air quality, where thousands of citizens die prematurely due to the poor air quality. On behalf of the Swedish Environmental Protection Agency SMHI is working in a project financed by the Swedish International Development Cooperation Agency (SIDA) to construct a system to manage air quality monitoring in Bosnia. During the period 2019-2021 SMHI will develop a data hosting system for the air quality in Bosnia. SMHI already hosts the Swedish data system for air quality, and the Bosnian system will be built on this. A coherent, national data hosting system creates the structure for efficient data collection and publication of measurements from different providers in Bosnia. This leads to an increased availability for the community and facilitates research and modelling studies.

In addition to hosting the data for air quality, SMHI will also investigate the cause of the poor air quality, to better understand which emission sources contribute to the poor air and to what extent. A pilot study has begun, and a procurement of measurements has been made, including an emission inventory and dispersion calculations using air quality models.

Dispersion calculations reduce the risk of oil leaks from shipwrecks

There are a number of wrecks around the coast of Sweden from vessels that have sunk over the years. The Swedish Agency for Marine and Water Management (HaV) has been tasked with decontaminating the wrecks from dangerous substances. To reduce the risk of oil and other pollutants from reaching the coast during decontamination HaV has commissioned SMHI to carry out dispersion calculations for around thirty wrecks along the coast. Currents, waves and temperature vary throughout the year and the calculations have therefore been produced for individual wrecks for each of the four seasons. Decisions can be taken based on these results to decide which season has the lowest risk for the dispersion of pollutants when decontaminating a specific wreck. Simulations show how the leakage of oil from the wrecks can be transported by the sea, for example towards Natura 2000 areas.

Fewer accidents and reduced fire risk with new tools for forestry machinery

As a step towards providing end-users with innovative decision support, SMHI is working together with the Swedish-based manufacturer of forestry machinery Komatsu, resulting in new tools with dynamic soil moisture maps and forest fire forecasts. These tools are now available in the majority of Komatsu's machines in Sweden. A contractor can quickly access these tools that help to avoid damage to the machines as well as highlighting significant fire risks that require specific actions to be taken.

Better forecasting of electricity prices using AI and machine learning

For several years SMHI has worked with Montel-EQ, a Norwegian information company that provides branch-specific information for electricity trading. During the year SMHI has worked with Montel-EQ to further develop electricity pricing forecasts and visualisation support for energy traders with the help of artificial intelligence and machine learning. The development phase has now moved into a marketing phase with the first paying customers using the new web-based online platform. The platform creates the material and advanced planning needed by the energy sector in order to make better decisions.

Semi-automated text production

SMHI manually produces a large volume of text, especially during the winter period, for decision support in connection with snow clearance and icy roads. Due to the extent of the texts it has only been possible to update them at certain times of the day, so that customers have been warned via telephone or SMS when forecasts need correcting. During the winter of 2018/2019 SMHI technical support for text production was put into operation. The aim was to generate automatic suggestions for the text forecasts for a meteorologist to use as a starting point. The meteorologist then decides if the suggestion is good enough or needs rewriting. No automatic texts are sent out without first being manually reviewed. This technical support has been developed and introduced in stages over several years. The result has been positive so that during the year SMHI was able to increase the number of text types supported by the new technical support. This means that the forecasts can be updated more frequently and formulated more clearly, so that the customer is familiar with the forecast texts and can more easily take the decisions required. This has also led to a better working environment for the meteorologists.

International education programme on climate change

Since the middle of the 1990s SMHI has been supported by the Swedish International Development Cooperation Agency (SIDA) in offering an international education programme on climate change and climate adaptation measures. During the year there were 97 participants from 68 organisations in ten different African countries. These eight-month long courses continue to be very popular and contribute directly to strengthening the capacity of the participation organisations, following the Paris agreement, and to implementing the global goals of Agenda 2030. Several examples show how these courses lead to concrete capacity improvements in the African countries. During the year SIDA decided to extend the programme with a further four courses to be held during 2020 – 2022. SMHI also directly supports sister organisations for both meteorology and hydrology in Ethiopia and Zimbabwe with the development of forecasting and warning services. This is an important part of the programme for sustainable development in these countries.

FINANCIAL PERFORMANCE

Income statement - (EUR 000) 2019

Exchange rate - Average rate for the current year	10,5892
Operating income	86 461
Personnel expenses	-45 436
Premises expenses	-2 826
Other operating expenses	-36 632
Financial expenses and amortisation	-3 879
Operating expenses	-88 774
Surplus/deficit of the year	-2 313

Balance sheet - (EUR 000) 2019

Exchange rate - Closing rate on 31 December 2019	10,4336
Non-current assets	
Intangible assets	2 719
Tangible assets	12 027
Total non-current assets	14 746
Current assets	
Inventories	331
Receivables	25 194
Cash and cash equivalents	3 888
Total current assets	29 412
Total assets	44 158
Equity and liabilities	
Equity	4 489
Provisions	1 768
Liabilities	37 901
Total equity and liabilities	44 158

SMHI plays a vital role as a reliable expert authority. Thanks to our robust knowledge of weather, water and climate, we contribute to a more sustainable society.

We collect vast amounts of data which we process, model and visualize based on different scenarios. We monitor global developments and use our own research to build and disseminate knowledge and services that are rooted in science. We evaluate, analyse, forecast and conduct follow-ups. Every hour of every day, all year round.

That is why we can promise you up-to-date decision support that facilitates short and long term planning – from recreational hikes to future infrastructure. Our support helps society achieve the Swedish environmental quality goals and manage tomorrow's global challenges.

SMHI. Always the best support for your decisions.



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