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SUMMARY ANNUAL REPORT **2020**

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DIRECTOR GENERAL'S OUTLOOK

The pandemic affected the entire world – including Sweden – in 2020. As a result, both SMHI and society as a whole have had to make changes. Our employees have done a fantastic job, demonstrating an excellent ability to adapt to the situation. Under these extraordinary conditions, SMHI has maintained good operational results and a high level of activity, despite the challenges of the past year.

Most of SMHI's employees mainly worked from home from March 2020 and for the rest of the year. Certain functions have required staffing in the office, but with considerably fewer employees on site. Our field workers, such as those who maintain our observation stations or carry out environmental monitoring at sea, also had to adapt to new routines. Remote working has generally worked well, and we have striven to maintain a good working environment and energy levels within the organisation through various initiatives.

SMHI activated its crisis management plan in March, and has worked with an adapted crisis organisation to lead and coordinate its operations in the best possible way. A crisis staff was set up to monitor developments within society, to analyse risks and to deal with situations as they arose. We learnt to work in new ways, particularly in terms of using digital tools for communication and cooperation. Activities have been adapted, planned travel has been cancelled, and meetings and events have taken place entirely digitally.

In summer 2018, SMHI decided to coordinate its meteorological forecasting production at three offices. A project has since been carried out to plan the new production processes at our offices in Norrköping, Gothenburg and Uppsala. During the spring, the transfer of operations to these units from the former Malmö and Sundsvall offices was completed. This has resulted in more integrated, robust production, and will ensure a sharper focus on coordinated, long-term skills provision.

The Uppsala office opened in new premises at the beginning of 2020, having previously been located in Upplands Väsby. Our Norrköping premises are also being modernised to better suit our future operational needs. In August, we were able to bring a new entrance foyer and modern meeting rooms into use. The property owners will be carrying out the rebuilding and renovation work in several phases, which are planned to continue until 2022.

One of SMHI's operational cornerstones is collecting observations within all four of our disciplines: meteorology, hydrology, oceanography and climatology. Major investments have been made, and several large projects were completed during the year increasing both the number and the quality of observations. Modernisation of the Swedish radar network is also almost complete. All this will ensure access to better, more detailed data for our work.

SMHI's research plays an important role, contributing scientific data for answering complex questions. This research is primarily carried out via externally financed projects in partnership with other agencies, universities and colleges, both nationally and internationally. Our ambition is to make results available quickly to the wider world. Despite the pandemic, we have been able to continue doing so to a lar-

gely unchanged extent thanks to digital solutions.

The goals of Agenda 2030 are central to SMHI. SMHI has long worked with international capacity development and knowledge transfer to countries with poorer economic conditions. This has mainly taken place through education, research and consultancy assignments for various clients, such as ministries, government agencies and international organisations. The overall objective is to make an active contribution to the global implementation of the international conventions that Sweden has signed and aims to be a driving force for.

In terms of the weather, 2020 has certainly left an impression. 2020 was the warmest year on record in Europe: 0.4°C warmer than the previous warmest year, 2019. Globally, 2020 was as warm as 2016, the previous warmest year, and the sixth consecutive exceptionally warm year. The last decade, 2011-2020, was also the warmest recorded decade. The annual mean temperature for Sweden during 2020 was the highest recorded since national observations began in around 1860.

SMHI's knowledge spans the entire chain of climate science. It contributes to increased understanding of how climate change will affect society so that it can be equipped to deal with forthcoming consequences. During the year, we have focused on drawing up information that is adapted for target groups and decision-making data for climate change adaptation in Sweden. The production of climate information has also been improved, allowing for more easily accessible, more usable climate services.

SMHI is part of the international cooperation on global climate modelling, which contributes towards the UN Intergovernmental Panel on Climate Change's summary of the scientific knowledge situation. As a national contact focal point for the IPCC, we are currently working with the ongoing sixth assessment cycle, in which several special reports and interim reports put climate change, its consequences and its possible solutions into a global perspective.

Within the government remit for greater information about water extraction, SMHI has investigated the conditions for gathering this information in a more systematic manner. Access to water is affected by how much water different stakeholders use. Mapping water extraction makes planning access to water easier and provides data for preventing water shortages and adapting society better in line with access to water.

Another government remit has involved developing a system for monitoring and evaluating climate change adaptation work which is in accordance with the national strategy for this area. A report has now been produced which gives the Government proposals for how national climate



Photo: Fotofabriken - Niclas Kindahl

change adaptation work can be evaluated. The system is intended to be a tool for the Government, but also for all the other stakeholders who work with climate change adaptation at national level, in order to monitor how the ongoing adaptation work contributes towards reduced vulnerability to climate change.

The annual accounts for 2020 show that economic challenges remain. The growth in income that SMHI enjoyed in recent years has tailed off. Research revenue rose somewhat, while revenue from fees and other income declined. SMHI's income is affected by the market situation and by the priorities of the Government, government agencies, businesses and research funders. Several operations have also been directly affected by the pandemic, resulting in lower income as investments have been replanned or deferred.

Despite a reduction in travel and other effects of the pandemic, it has not been possible to adapt costs to a corresponding degree. The year also witnessed a largescale discontinuation of global shipping operations, and discontinuation costs have affected our results for 2020. Overall, we have recorded a loss for the year. The work to achieve balanced finances has been intensified during 2020, and will remain a focus in 2021.

SMHI's operational results for 2020 are the outcome of our entire staff's fantastic efforts, but not of my own. I did not become Director General of SMHI until February 2021, and the agency was led by my predecessor and a temporary DG during 2020. I am proud and delighted to be taking over the reins, and to hear about the impressive work that the agency has carried out. All four of SMHI's areas of expertise are cornerstones of a sustainable society. I look forward to working with all our employees as we continue to develop the agency and the important knowledge that SMHI contributes.

Håkan Wirtén
Generaldirektör

CORE SERVICES

SMHI's remit to administer Sweden's meteorological, climatological, hydrological and oceanographic infrastructure is mostly carried out by the Core Services department. The department's operations cover everything from measuring and collecting data to calculating, storing and processing it. Statistics and information are drawn up and form the basis for socially important analyses, including those used to achieve national environmental quality objectives. This work includes producing, compiling and conveying information and knowledge, including about climate change adaptation, both for today's society and for the society of the future. Forecasting and warning operations have a direct impact on society's vulnerability. Cooperation with other agencies and institutions – both nationally and internationally – is important, and the department deals with SMHI's role of representing Sweden within international organisations, such as the European Centre for Medium-Range Weather Forecasts (ECMWF), the UN's World Meteorological Organization (WMO) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

A more robust observation network and observations with higher temporal resolution

One essential requirement in order for SMHI to be able to carry out its remits is the development and sound administration of Sweden's meteorological, hydrological and oceanographic infrastructure. During the year, modernisation of the final quarter of the 138 meteorological measuring stations was completed. This means that the modernisation of several observation networks, which began in 2017, is now complete. The meteorological stations now report once a minute instead of once an hour. This brings opportunities for improved production and monitoring of forecasts and warnings. For example, SMHI will get a more detailed picture of a storm's progress.

SMHI has also gathered observations from third parties to increase the number of observations in a cost-effective manner to benefit forecasts and warnings. The observation gathering process works well despite many different data formats, and data analyses can begin in 2021. Examples of third-party observations include data collected via aircraft and from private weather stations. More observations means a greater need to quality assure data. During the year, the agency has started working to develop automatic data reviews using AI. This will enable us to process larger quantities of data cost-effectively.

A modernised weather network

The development of the Swedish weather radar network is almost complete. SMHI began modernising the twelfth and final weather radar facility, near Kiruna, during the autumn. An extensive review of the other eleven previously modernised facilities was also carried out at the beginning of the year, to ensure a well calibrated weather radar network. The calibration was necessary to make full use of the modern facilities' capacity. This will provide better data for meteorological and hydrological forecasting models, and may be of great significance for making rapid decisions in the event of torrential rain, for example.

Work to transfer ownership of the Swedish Armed Forces' radar facilities to SMHI is also continuing. During the year, the facilities at Karlskrona and Ängelholm were transferred to SMHI. The aim is to achieve more effective admini-

nistration through a single agency having overall responsibility. All facilities were designated civilian protected objects during the year.

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.

The level of accuracy in 2020 was 71 percent, a little higher than during the previous year. This is mainly due to a large number of issued hydrological warnings and the majority of these being assessed as correct.

Accuracy for the current day regarding temperature improved further during 2020 and is the best reported since 2012, strengthening the upward long-term trend. The 2020 wind speed value represents a small dip compared to the previous year, but in the long-term there is a continued rising trend. Accuracy for precipitation has improved somewhat since 2019, but did not reach the record value for 2018. Accuracy for temperature five days in advance was the highest recorded since 2012. In terms of wind speed, accuracy was lower than the previous year. However, the accuracy for precipitation was slightly better. Several of the incorrect wind forecasts have been just outside the interval of ± 2 m/s.

Improvements for warnings and weather forecasts

During the year, SMHI mainly focused its improvement measure resources on impact based weather warnings, which SMHI will switch over to in spring 2021.

The aim of introducing such warnings is to provide better decision-making data and to enhance the ability of society and individuals to deal with serious weather and water events. Impact based weather warnings involve the relevant stakeholders within society following a new way of working that is based on existing routines and forms of collaboration within Sweden's crisis management system. With this new method, SMHI will intensify its cooperation with agencies and other stakeholders at local, regional and central levels

before deciding to issue a warning. The relevant stakeholders' assessments of the anticipated impact and the overall situation will provide data for SMHI's weather warnings. For all stakeholders with operational preparedness for weather warnings, the new warning system will involve greater participation and better opportunities to prepare their organisations correctly, which in turn allows for more efficient resource management.

SMHI has developed its warning services to be able to issue impact based weather warnings at smhi.se and via the weather app from spring 2021 onwards. At the end of the year, SMHI also launched an initial version of the technical documentation for forthcoming warning data via SMHI's open data at smhi.se. This development was based on needs analyses and target group analyses to ensure that the services contribute towards society's increased ability to deal with serious weather and water events. User testing provided additional feedback on the user-friendliness and clarity of the services. At the end of the year, SMHI launched the initial version of the technical documentation for forthcoming warning data via SMHI's open data at smhi.se. Using this documentation and test data examples, technical users have been able to start preparing their systems for the transition to impact based weather warnings.

SMHI has worked with communication initiatives to spread knowledge and understanding of the new warning system. These initiatives have been aimed primarily at stakeholders within society and conveyors of warnings, such as communicators at county administrative boards and weather presenters in various media channels. Communication activities aimed at the general public have also begun. For example, a webinar was held for the media, resulting in reports both on national radio and in the daily press.

Developing decision-making support for fire risk forecasts

Society needs nationally uniform, reliable and continuously updated fire risk forecasts. These forecasts are used as decision-making data for protective measures or for designing extinguishing methods, and as data for analyses and evaluations. SMHI has been commissioned by the Swedish Civil Contingencies Agency (MSB) to continue developing the basic fire risk forecasts, and has devised a new decision-making support system for vegetation fires in Sweden. The system was brought into use by SMHI and MSB before the fire risk season in January 2021. These fire risk forecasts are the information basis for MSB's fire risk mobile app.

MSB has also tasked SMHI with cooperating with the Nordic countries to produce a decision-making support system to suit Nordic conditions. This will provide operational support in connection with fires and when carrying out analyses after a fire. At the same time, SMHI is building up expertise and developing methods within this area.

Sweden's work within the IPCC

In February, SMHI took part in one of the IPCC's decision-making meetings in Paris. Here, formats and a timetable for the IPCC's future work were discussed, primarily in

view of the conditions for providing scientific climate data for the processes within the Climate Convention. The main decision points on the agenda related to various chapters of the IPCC's forthcoming Sixth Assessment Report (AR6) and a proposed strategy and implementation plan for gender issues within the IPCC. The processes for producing new reports have been delayed as a result of the coronavirus pandemic. This means that the entire IPCC report production timetable has been postponed until summer 2021.

New normal period enhances knowledge about climate change

In order to study the climate and how it is changing, SMHI needs to use long time series – ideally 30 years or longer. Normal values are used to describe the climate at a certain location during a set period of time. They are also used to study how the climate has changed at a location between two time periods. This type of information is required by various sections of society, including climate change adaptation and energy production. The end of the year marked the completion of a new 30-year normal period, 1991–2020. The normal values for the period have been successively calculated during the year. In connection with this, SMHI has developed a new method for calculating normal values. This means that it will be possible to describe the climate in a better way for both new and previous normal periods.

Overall effect targets for climate change adaptation

During 2020, the Swedish National Knowledge Centre for Climate Change Adaptation has worked to achieve three overall effect targets:

1. Strengthen the ability to adapt to climate-related effects and natural disasters in Sweden

The Knowledge Centre has worked with knowledge-enhancing initiatives to increase knowledge and provide tools to strengthen the target groups' ability to adapt in line with climate-related effects and natural disasters in Sweden. The Knowledge Centre has provided examples of climate change adaptation work, which in turn has created the right conditions for the target groups to learn from others and work more effectively with climate change adaptation. Agencies, county administrative boards and municipalities have been prioritised target groups.

Two basic climate change adaptation training courses – aimed primarily at municipalities – have been held remotely, with a total of 125 participants. The course evaluations show that 89 percent of participants felt that the courses led to an increased ability to work with climate change adaptation.

The klimatanpassning.se online portal is one of the Knowledge Centre's main communication channels. During the year, additional content included information about climate change adaptation linked to the Paris Agreement and the Sendai Framework. New content was added to the English-language version of the portal, which was also given a facelift.

2. Contribute to integrated, appropriate frameworks for climate change adaptation, both nationally and internationally

The implementation of Ordinance (2018:1428) on Agencies' Climate Change Adaptation is a key element of Sweden's climate change adaptation work, and the agencies affected by the ordinance are an important target group for the Knowledge Centre. The Knowledge Centre has arranged workshops and drawn up guidelines, guidance and reports to support Sweden's climate change adaptation work and the implementation of the ordinance. These activities contributed towards cooperation and exchanges of knowledge, which in turn can be assumed to lead to more effective climate change adaptation work among participants. Following up on these activities has shown that all the participating agencies believe the Knowledge Centre's work has helped to create good conditions for implementing the climate change adaptation ordinance.

3. Improve education and awareness in terms of limiting the consequences of climate change and related adaptation

The Knowledge Centre has produced two new climate change adaptation films to raise awareness of climate change and climate change adaptation among target groups that have not previously worked with these types of issues. One of the films was released in the spring, and had been watched more than 100,000 times by the end of the year. The other film is being released in 2021.

In order to introduce climate change adaptation to new target groups, SMHI's climate change adaptation game was presented to school pupils, teachers, the public and researchers on nine occasions, both nationally and internationally. The game involves equipping a fictitious city and its surroundings to deal with a changed climate. Following up on the game has shown that it is popular with upper secondary school teachers, who use it in their teaching, and with municipalities.

Deeper cooperation with SGU for better ground water calculations

SMHI's hydrological calculation model has already been specially adapted by the Geological Survey of Sweden (SGU) for ground water calculations. During the year, the model was also launched in SMHI's hydrological production environment to provide ground water calculations with

forecasts for the whole of Sweden. The calculation results are used to generate ground water maps on SGU's website. These maps are updated weekly. The cooperation is taking place within the framework of a multi-year initiative to develop ground water information at SGU. This includes historical maps, scenario maps, new maps of measurement stations and calculated levels. By using SMHI's existing technical infrastructure, the initiative has quickly created benefits for society.

SMHI contributes to marine AI innovations

SMHI plays a key role in the Ocean Data Factory, a project financed by the Swedish innovation agency Vinnova. This data-driven project produces AI solutions for digitalising the marine and maritime sector. During the year, SMHI has contributed general knowledge about marine data and has enhanced its own AI competence. This year, SMHI provided inspirational materials for producing a forecasting tool to predict toxic algal blooms, with decision-makers, need owners and those responsible for marine environments being the intended target groups. The aim was that the tool should be brought into use and partly administered by SMHI. Aquaculture and tourism can benefit greatly from being able to predict toxic algal blooms to protect human health.

Improved environmental monitoring of the Baltic Sea

SMHI has taken part in the Bonus Fumari project, which evaluated the Baltic Sea's environment monitoring during the year in relation to national and international legislation and directives. Bonus Fumari's financial backers include the EU and Formas. The evaluation led to proposals for roadmaps and methods for improvements to monitoring that can contribute towards the sustainable management of the Baltic Sea's ecosystems. This includes how new methods can be introduced with low costs and broad applicability alongside the classic parameters, such as nutrients, oxygen, salt and temperature. The evaluation is based on a review of reports, scientific articles and interviews with decision-makers, which shows that data collection generally needs to be increased in terms of both time and scope. The results have been summarised in several policy documents, scientific articles and a database in which those responsible for marine environment monitoring, decision-makers and the general public can search for information about new measurement methods.

RESEARCH

The Research and Development department carries out applied R&D within the following focus areas: improved knowledge about a changed climate, sustainable societies and a sustainable environment. The department contributes R&D to strengthen SMHI's operations and develop the production chain within observations, models, quality assurance and data analysis, forecasting systems and warnings, and for decision-making data within meteorology, hydrology, oceanography and the climate. This research mainly takes place through externally financed projects in partnership with other agencies and academia, both nationally and internationally, and in close cooperation with end-users to ensure that the research is relevant and can be of immediate use. The results are presented in scientific journals and at conferences. Developments are being carried out to improve calculation models, systems, products and services at SMHI and to meet the needs of external funders, for example within the Copernicus programme and for international capacity development.

RESEARCH TO ADDRESS GLOBAL CHALLENGES

Research and development at SMHI contributes towards society's sustainability by improving knowledge and understanding of status and changes within air, water, sea and climate. The goals of Agenda 2030 are central, as are the Paris Agreement and the Sendai Framework. A sustainable societal transition requires an overview with links between nature, biodiversity, the climate, societal development, economics and public health from a global perspective. Data and calculation models create a foundation for this understanding. During the year, SMHI has continued to occupy a strong international position within climate research and climate impact research.

User dialogues: a success factor for relevant decision-making data

SMHI's research and development shall have an immediate benefit within society. One success factor for this is that the focus of research is determined together with users. Experience can then be generalised to meet the needs of larger user groups. SMHI operates several projects in which user dialogue has been a clear element. The Hazard Support product has strengthened Sweden's climate change adaptation efforts by working together with municipalities, city planners and insurance companies to draw up decision-making data to manage risks in the event of natural disasters. A newly started project will combine knowledge about the environment and society to strengthen the ability to deal with the effects of a changed climate in Eastern Siberia. The project brings together researchers from Japan, Russia and Sweden. It is being led by SMHI, which is also providing hydrological expertise to develop a forecasting system for flooding and ice conditions.

Research and development for international capacity development

Fulfilling the goals of Agenda 2030 requires a global transformation. SMHI contributes knowledge transfer to countries with poorer economic conditions by offering Swedish calculation models and tools which are then jointly developed and adapted in line with local circumstances. Within the Fanfar project, which was funded via the EU's

Horizon 2020 research programme and coordinated by SMHI, 17 West African countries have worked together to resolve the urgent need to deal with flooding through operational hydrological forecasts. Useful project results show how research findings can be included in an operational production chain and bring societal benefits. The Economic Community of West African States has signed an agreement with the regional technical organisation Agromet, a partner in the Fanfar project, to start using the system at its flood observatory. This is a major initiative at regional level with support from the World Bank. However, more funding is needed for aspects such as forecast production, capacity building and further development to create long-term benefits.

RESEARCH FIELD: IMPROVED KNOWLEDGE ABOUT A CHANGED CLIMATE

In order to improve knowledge about ongoing climate change to benefit society's work with emissions reductions and climate change adaptation, SMHI works with the entire modelling chain within the climate. SMHI is part of European development cooperation on the EC-Earth global climate model and the HCLIM regional climate model. The regional climate calculations are part of the Coordinated Regional Climate Downscaling Experiment (CORDEX), for which SMHI hosts the international project office. SMHI also calculates global, regional and local climate effects – in other words, how global climate change affects air, water and sea, and the environment within these areas. Focuses include changes in extreme weather and their consequences.

Analysis of climate simulations increases knowledge for emissions reductions

SMHI has contributed to the international development and evaluation of climate models and the production of climate simulations. SMHI has produced climate simulations covering the entire spectrum from low to high levels of warming at the end of the 21st century using the EC-Earth global climate model. The simulations generally show faster warming than previous calculations, which is partly due to

the climate sensitivity of the model and partly due to updated emissions scenarios. This work provides a foundation for studies of climate effects and data for emissions reductions and climate change adaptation. The data is published via an international data service, and is thus easily accessible to researchers and other interested parties.

New regional climate scenarios for Europe provide data for climate change adaptation

SMHI is coordinating collaboration from eight other European research institutes within a project producing new regional climate scenarios for the Copernicus programme's climate service. The regional climate models are operated at high resolution, providing more detail and making the results suitable for climate effect studies and climate change adaptation measures in Sweden and the rest of Europe. The project has contributed towards a significant increase in the number of freely available climate scenarios published via the Copernicus programme's data service.

RESEARCH FIELD: SUSTAINABLE SOCIETIES

The weather affects society in many different ways. Extreme weather can have devastating consequences for society's infrastructure and for human life and health. SMHI's research and development contributes increased knowledge about the occurrence and variability of extreme weather. One key focus area involves using research and development to improve the models and tools used for the agency's forecasts and warnings. In this way, society can best protect itself against the consequences of issues such as storms, torrential rain and flooding from watercourses, lakes and seas. SMHI also contributes towards a sustainable society by producing data that strengthens a sustainable energy transition.

New methods develop weather forecasts and re-analyses

Within European cooperation, SMHI is further developing a numerical weather forecasting system. During the year, SMHI has worked with satellite data to describe the land surface's properties, giving more accurate weather forecasts in locations such as coastal areas. SMHI has worked closely alongside the Norwegian and Dutch weather services to develop and implement a system for using observations more effectively, providing better descriptions of location weather phenomena and extreme weather. SMHI works continuously to introduce new high-resolution observation types, including from air traffic control. These have compensated for the loss of observations from aircraft during the coronavirus pandemic, and have the potential to improve the quality of future forecasts. In a project funded by the Swedish National Space Board, SMHI has investigated the possibility of incorporating satellite observations of current land conditions into the start of the forecast calculation, which has proven to be difficult in a varied landscape featuring different types of land use. The lessons learnt from the project can be used in new studies into how satellite data can be used

over sea, where open water only interacts with surfaces covered by ice and snow. Within the Copernicus programme, SMHI has contributed towards a numerical calculation system for re-analyses for the Arctic. This data will be useful for understanding climate changes in the Arctic, and for preparing society to deal with these changes.

Evaluating the ability of a new research satellite to measure winds

SMHI has worked with the Norwegian weather service and the Swedish Institute of Space Physics in Kiruna to evaluate the ability of the Aeolus research satellite to measure winds in the atmosphere and their impact on weather forecasts in the Nordic region. The Aeolus observations show good agreement with other types of wind observations, and SMHI has obtained an insight into how the new measurements can be used in the forecast model. The project has helped to characterise the instrument's measurement accuracy under different conditions, which is of great importance for its international use. The Swedish work was part-financed by the Swedish National Space Board, and is a cornerstone of joint work coordinated by the European Space Agency.

RESEARCH FIELD: A SUSTAINABLE ENVIRONMENT

Creating a sustainable environment is a long-term effort. In many cases, society is currently dealing with the effects of emissions produced during the previous century and that continue to affect the environment. With knowledge, data and calculation models, SMHI can contribute towards knowledge about how human activity affects nature and evaluations of the environmental effects different actions can have. The focuses of research and development include water quality and the eutrophication of lakes and watercourses, coastal zones and seas, as well as the presence, spread and deposition of particles and nutrients, and how this can affect the weather, the climate, vegetation and human health, not least in urban environments.

National nitrogen budget can reduce the impact on biodiversity

SMHI and IVL Swedish Environmental Research Institute have contributed towards a national nitrogen budget for Sweden. The deposition of reactive nitrogen from the atmosphere contributes to eutrophication and thus the potential loss of biodiversity. SMHI has compiled a detailed nitrogen budget with flows from European countries to land and water ecosystems in Sweden and Sweden's nitrogen emission exports. This will be used to map the effects on ecosystems, and is part of Sweden's contribution to the UN's Air Convention. This research has led to improved methods and quality review within the area of Sweden's national environmental monitoring carried out by SMHI on behalf of the Swedish Environmental Protection Agency, and has generated knowledge that affects several of the UN's Sustainable Development Goals.

Methods for investigating the spread of environmental toxins from fibre banks

In Northern Sweden, there are banks of old residues from the forest industry on lake and sea beds. These fibre banks also contain heavy metals and organic environmental contaminants. SMHI has used its coast and sea models to come

up with methods for investigating how these environmental toxins may be spread if they are released from sea beds, both in coastal areas and in the open Baltic Sea. This is of interest for national coastal management in the work to achieve a toxin-free environment and a sea in balance, and internationally for Sweden's neighbours around the Baltic Sea.

PROFESSIONAL SERVICES

According to its remit, SMHI's operations shall benefit society through commissioned activities for other agencies and by carrying out professional services. The Professional Services department offers industry-specific and customer-integrated services for both industry and society. These services are based on expert knowledge and experience within all SMHI's areas of expertise. The customer benefits include sounder decisions, enhanced safety, economic efficiency and sustainability, primarily in Sweden but also in selected areas internationally.

DATA FOR SOUNDER DECISIONS AND SUSTAINABILITY

SMHI's Professional Services department offers advanced products and services that contribute towards good social planning, less environmental impact, economic efficiency and reduced vulnerability in society – today, next week and a hundred years from now. Situational decision-making data may be of a one-off nature or in the form of regular documentation.

Using air quality analyses in town planning

Sweden's municipalities and rural districts are obliged to monitor air quality within their districts in order to take any necessary action. SMHI has been commissioned by the City of Linköping to carry out a pilot study before deciding whether to implement a new action programme. SMHI has carried out calculations for three scenarios in central Linköping, where the air quality has been evaluated at 18 locations within the street network. These locations have been selected due to their air quality being deemed to be in the risk zone for exceeding environmental quality norms for particles or nitrogen dioxide. The results show that the norm for nitrogen dioxide is harder to comply with than the norm for particle levels. According to the calculations, nitrogen dioxide levels are currently exceeding the environmental quality norm on several of the city streets. By studying different scenarios, these calculations have clearly shown that implementing Linköping's traffic objectives for the future would result in a dramatic reduction in air pollutant levels. The results of SMHI's calculations show that the environmental quality norms for several street sections will be exceeded if traffic continues to increase.

New system for simpler gathering of air quality data

All EU countries are obliged to review their air quality, and there is considerable demand for air quality data. Since several years, SMHI has on commission by the Swedish Environmental Protection Agency, developed and implemented a system for gathering air quality data. During the year, the Norwegian Institute for Air Research (NILU) and SMHI worked together to start developing the next generation system which will make data gathering easier. There has been a particular focus on new functions for meeting end-users' needs. NILU has worked on the validation and scaling of measurement data, and SMHI has dealt with aggregation for statistical analysis.

How lakes affect fish farms

When applying for a new permit for fish farms in lakes, or renewing an existing one, there is often a need for in-depth knowledge about the lake's hydrodynamics, the fish farm's impact on nutrient levels in the lake and the impact on the ecological status. SMHI has been commissioned by an environmental consultancy company to apply a three-dimensional flow model for Lake Landösjön in Jämtland. Locally adapted calculations have also been carried out using SMHI's hydrological calculation model to investigate the impact from one of the lake's fish farms. The results from this modelling show that material from the fish farm affects the area directly next to the farm, and that this area makes up less than 0.1 percent of the lake's total bed area. The model results also show that phosphorous levels at the lake's outlet have risen from a very low average background level to a continued low average level during 2019 with the fish farms permitted load. The simulated levels with the maximum

permitted load are calculated to remain at the same levels after 2020. Together, the different models give a comprehensive picture of the impact that nutrients from fish farms have on lakes.

Coastal water sampling for Bohuslän water conservation association

As part of the Bohus Coast Water Conservation Association's control programme, SMHI carried out measurements, analyses and reporting of hydrography and phytoplankton during the year at a total of 14 stations along the Bohus coast, from Kosterfjorden in the north to Valö in the south. One aim of the programme is to study short- and long-term changes in hydrographic conditions, which control many of the biological processes in the marine environment. Another aim is to investigate biodiversity, algal blooms, the presence of harmful algae and the environmental situation in accordance with the EU's Water Framework Directive. Sampling and analyses are carried out regularly each month. The water samples are analysed at SMHI's oceanographic lab and are reported to the water conservation association. At the end of each year, the year's measurement results are compiled in an annual report and are analysed and compared with the previous year's results. The programme is part of wider regional environmental monitoring. By describing environmental conditions and showing whether environmental quality targets are met, it is also possible to identify the need for and carry out any actions.

New calculation model shows how the weather affects the need for cooling in buildings

In a changed climate, it is likely that the need for comfort cooling will continue to grow. Thanks to a new calculation model, the SMHI Kyl-Index, SMHI can offer the opportunity to visualise the weather's impact on the need for cooling. The new model makes it possible to simulate energy in complex buildings, in the form of both heating and cooling. It is also possible to address what happens inside the building in greater detail, and it is easier to adapt products in line with the building or devise consultancy services in a cost-effective manner. The SMHI Kyl-Index measures how the

energy requirements for comfort cooling diverge from the norm for a specific location. This in turn provides excellent decision-making data, and helps to control the building's costs.

A focus on physical risks caused by climate change

A warmer climate will mean that society needs to deal with drought, flooding, hurricanes and heatwaves more often. Rising sea levels and ecosystem changes can result in damage and costs. There is a broad consensus that the finance market has an important role to play when it comes to developments towards a more sustainable society. The Swedish parliament also has a finance market policy goal stating that the financial system should contribute towards more sustainable development.

SMHI has held a seminar with participants from banks and asset owners. The aim was to show businesses how to identify, assess and report on physical risks caused by climate change. SMHI has carried out assignments to build up economic climate resilience among banks and asset owners as a form of climate change adaptation. There is a rapidly growing need for this type of assignment, which is an example of how SMHI provides sector-specific climate services in the Nordic region.

Updated weather alert service for businesses with sensitive operations

SMHI's customised weather alert service has been specifically developed for businesses that are particularly sensitive to bad weather, and that therefore require costly protective measures. It is important to be well prepared in order to minimise damage and to speed up protective measures. SMHI's weather alerts are tailored according to each customer's operations, and apply for a customised area. The subscription service has now been updated, giving it a more user-friendly web interface with a more comprehensive forecast overview, thereby making it easier to read weather alerts on a computer screen, a tablet or a smartphone. The forecasts included in the service are updated every three hours, and cover the next seven days. The customer also has the option of direct contact with meteorologists, and weather alerts are sent out by both text message and e-mail.

FINANCIAL PERFORMANCE

Income statement - (EUR 000)

2020

Exchange rate - Average rate for the current year	10,4867
Operating income	80 532
Personnel expenses	-45 688
Premises expenses	-2 784
Other operating expenses	-32 583
Financial expenses and amortisation	-4 109
Operating expenses	-85 165
Surplus/deficit of the year	-4 633

Balance sheet - (EUR 000)

2020

Exchange rate - Closing rate on 31 December 2020	10,0375
Non-current assets	
Intangible assets	1 710
Tangible assets	12 612
Total non-current assets	14 321
Current assets	
Inventories	123
Receivables	21 133
Cash and cash equivalents	4 523
Total current assets	25 778
Total assets	40 100
Equity and liabilities	
Equity	1 501
Provisions	1 829
Liabilities	36 770
Total equity and liabilities	40 100

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.



SMHI – SWEDISH METEOROLOGICAL AND HYDROLOGICAL INSTITUTE
SE - 601 76 Norrköping • Visiting address Folkborgsvägen 17
Phone +46(0)11 495 80 00 • Fax +46(0)1149580 01 • www.smhi.se