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SUMMARY ANNUAL REPORT
SWEDISH METEOROLOGICAL
AND HYDROLOGICAL INSTITUTE

SMHI

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DIRECTOR GENERAL'S OUTLOOK

Water is a common denominator of the Swedish Meteorological and Hydrological Institute's disciplines. Meteorology, hydrology, oceanography and climate change all describe the different ways in which water moves, along with water's systemic circulation. Water also significantly affects the 2030 Agenda for Sustainable Development and the global goals for sustainable development.

During the past year, various worldwide weather phenomena have caused cloud bursts, massive blizzards, floods, droughts, fires and coastal erosion. Everything is linked to water; either too little or too much.

In Sweden, for the first time in a long time we have been faced with problems in several places relating to drought and low groundwater levels for a long period of time. In the spring of 2017, SMHI and the Geological Survey of Sweden jointly introduced the new service Risk of Water Shortage. It is presented together with SMHI's warnings, and is expected to help individuals, companies and public bodies.

2017 became the second warmest year ever globally, and the third consecutive year with record levels. This means that the observed climate change confirms the climate change scenarios which SMHI among others have developed. SMHI Rosby Centre, which has a responsibility for developing climate change scenarios, celebrated 20 years of operation with a number of activities, including scientific seminars. During the year, SMHI hosted the third IPCC lead author meeting on global warming of 1.5°C.

The Swedish National Knowledge Centre for Climate Change Adaptation manages the Climate Change Adaptation Network, and the joint collaborative effort now consists of 18 governmental authorities plus the county administrative boards. The Knowledge Centre paid out SEK 14 million during the year to other governmental authorities and county administrative boards for the purpose of developing action plans within the field of climate change adaptation.

The water issue, which is an extremely significant part of the sustainability efforts, was clearly in focus as a part of this year's Almedalen Week. SMHI's contribution consisted of well-attended seminars and venues to discuss climate, climate change adaptation and marine issues, as well as participation in events organised by others.

During the year, a decision was made to deploy the European Centre for Medium-Range Weather Forecasts' new supercomputer in a new data centre in Bologna, Italy, separate from the remainder of the operations and from the headquarters in Reading, England. Two new satellites that are to be used in Copernicus, the European system for monitoring the Earth, have been launched into space. These major investments mean that Sweden, together with other members of the European organisations, will be in a better position to deal with climate-related tasks and to help prevent risks and secure lives and property. The Nordic opera-

tional cooperation also took a step forward when the Finnish Meteorological Institute joined the Swedish-Norwegian cooperation concerning weather prediction models.

During the year, SMHI started the recruitment process for a professor in climatology. Later on we will recruit professors within our three other disciplines: meteorology, hydrology and oceanography. This is one way to further strengthen our scientific foundation and consolidate our place as a governmental authority with high public confidence, something several studies confirmed during the year. This is a position with obligations, and which we will constantly work to maintain.

With the vision A Sustainable Society in a Changing World, thanks to our knowledge concerning weather, water and climate, we make further efforts to continue to contribute to increased security and reduced vulnerability in Sweden and in other countries. During the year, the work with developing our communicative abilities continues on a broad front. Strengthening our innovation capacity over the long-term has been another important focus for us.

During 2017, several meetings of managers and in-service educational programmes have been held focusing on the role and duties of civil servants, working environmental issues, and the responsibilities of managers. A living base of core values is important for SMHI as an organisation. Our employees are SMHI's primary asset and systematic work concerning the working environment is well-integrated into our day-to-day operations.

The climate change issue is increasingly at the core of international development cooperation. SMHI has, together with some 40 other governmental authorities, signed a memorandum of understanding concerning work with Agenda 2030. In 2017, we also signed a memorandum of understanding with the World Bank concerning development cooperation in Africa, and previously have had a similar agreement with the UN World Meteorological Organization (WMO). Taken together, this means that we need to strengthen and clarify our work in this area. From 2018, some of SMHI's activities within international development cooperation linked to platforms such as Agenda 2030 and WMO, will be conducted within the framework of the SMHI's activities that are funded from grants.

SMHI's financial performance for the year is close to breaking even, and the appropriations credit has largely been regulated. Over the course of 2017, SMHI completed a pro-



Foto: Fotofabriken - Niclas Kindahl

ject to restore the finances following the Swedish Government's withdrawal of SEK 6 million from the 2016 framework funding. Our strategy of being an active party in delivering operational Copernicus services has once again proven to be successful, and revenues in that area have increased compared to their 2016 levels. The business activities, including income from services export, are negative overall,

since certain segments in particular have not developed as much as we would have liked. The aeronautical meteorological operations will face financial pressure in the coming years, due to decisions within the EU, and competition will continue to be fierce in several business segments. The work with SMHI's long-term finances will therefore continue to be important.

A handwritten signature in black ink, appearing to read "Rolf Brennerfelt".

Rolf Brennerfelt
Director General

CORE SERVICES

The core services department manages the meteorological, climatological, hydrological and oceanographic infrastructure in Sweden. Operations include everything from measuring and collecting data to calculating, storing and processing data. The data then becomes statistics and information that serves as the basis for calculations important to society, for example analyses for achieving national environmental quality goals. Delivering decision-making data that contributes to a sustainable society is the key. Forecasting and warning operations have a direct impact on the vulnerability of society. Work with climate change adaptation is important to society both now and for the future, and has taken on even greater importance in recent years. The work includes compiling and communicating information and knowledge. Cooperation with other authorities and institutes is very important, both nationally and internationally. Since 2013, SMHI has been designated as the national provider of aviation meteorology services, and its work is moving towards greater cooperation, particularly in Northern Europe. The department also manages SMHI's role in representing Sweden in international organisations, such as the European Centre for Medium-Range Weather Forecasts (ECMWF), the World Meteorological Organization (WMO) and the European weather satellite cooperation Eumetsat. SMHI's expert competence is requested in connection with referrals and also by other authorities.

Positive trend in new 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 and new evaluation methods have been implemented. 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 warnings for 2017 had an accuracy of 60 percent, which is slightly lower than the previous year, due to more missed warnings and false alarms. The weather forecasts for day 1 for all three parameters show a higher accuracy in the period 2015-2017 compared with the previous years. This is primarily due to the implementation in 2014 of a new version of the forecast model, with higher resolution. Even the accuracy of the temperature forecasts for day 5 shows a clear positive trend in recent years. Wind and precipitation forecasts also show a slight positive trend in accuracy. These forecasts are based primarily on data from the European Centre for Medium-Range Weather Forecasts (ECMWF), where new versions of the forecast model have been developed and implemented over the years.

Broadened and up-to-date weather information

The radar and lightning service at smhi.se shows – in real time – when it is raining or snowing, and is based on data from the radar network. The service is updated every five

minutes, making it easier to follow the development and track of precipitation showers.

The Sea and Coastal Weather Service at smhi.se is aimed at small boats moving along the coast of Sweden. The service has been updated with new forecast maps for wind, wave heights, currents as well as surface water temperature and sea ice, showing the most relevant weather information for safe boating.

A new version of the app designed for tablets has been developed, where users can look at forecasts based on the latest high resolution model. The app also has more maps and more detailed charts than the previous version. Additional small towns as well as islands, lakes, watercourses, inlets and lighthouses have also been made searchable in weather services at smhi.se to facilitate the search possibilities for local forecasts.

New information service for risk of water shortages

The years 2015 and 2016 experienced periods of low precipitation in most parts of Sweden, which periodically affected the water supply. For the summer of 2017, SMHI therefore introduced the Risk of Water Shortage service in cooperation with the Geological Survey of Sweden. Notifications of risks are published on smhi.se and are also sent directly to the relevant county administrative boards. The intention is to provide a coherent picture of water availability in both groundwater and surface water storage reservoirs, as well as an assessment of likely development in the immediate future. Demands for this information have been expressed by both county administrative boards and municipalities, in order to support the introduction of restrictions on water usage both locally and regionally.

Ice chart collaboration

In November, SMHI and the Finnish Meteorological Institute launched a joint production of the daily ice chart for the Baltic Sea. The ice chart shows which parts of the sea are covered with ice, and this joint product is published on several channels, including smhi.se. The two institutes share the production of the ice chart, alternating each week. This joint cooperation provides a more uniform picture of the ice conditions in the Baltic Sea, improving support for decisions relating to the planning of activities at sea. The joint cooperation leads to increased cost-effectiveness and a higher quality of product for both institutes, as well as providing access to more joint expertise and additional observation data.

SMHI takes over the Swedish Armed Forces radar facilities

An agreement was signed during 2017 so that SMHI will become the owner of the Swedish Armed Forces' radar facilities. Administration should become more efficient with one authority having the overall responsibility.

The Swedish weather radar network currently consists of twelve facilities, seven of which are owned by the Armed Forces and five by SMHI. Modernisation of the network started in 2014, and so far a total of six facilities have been

modernised (three during 2017). SMHI takes over the respective radar facilities as they become modernised.

The purpose of the modernisation is to be able to measure precipitation intensity more accurately and to be able to distinguish between different types of precipitation. This provides an improved basis for meteorological and hydrological forecasting models, and can be of significant importance when making decisions, such as in the event of torrential rain.

New low-level air traffic system

SMHI collaborates in the field of aviation weather with the meteorological institutions in Denmark, Finland, Norway, Iceland, Estonia and Latvia under the Northern European Aviation Meteorology Consortium (NAMCON). The objective is to jointly produce reliable and cost-effective meteorological services for aviation for the whole of Northern Europe.

In 2017, a new production and visualisation system was introduced for forecasting private flights and helicopter traffic below 4 000 metres. The system makes the forecasting work more efficient – for example the area of the forecast is not predefined, but is instead specified based on current requirements for each forecast. The system is in use in Sweden and Denmark, and an extension for Finland is being planned. The collaboration between the meteorological institutes in the Nordic and Baltic countries in the field of aviation weather forecasting is unique, and has been followed with great interest by the rest of Europe. The work within NAMCON received a special mention by the European Commission in 2017 during the airline industry's World ATM Congress held in Madrid.

IPCC – The Intergovernmental Panel on Climate Change

SMHI is the national host for the Swedish IPCC Focal Point, and during the year Sweden has been represented at two decision-making meetings, in Guadalajara (Mexico) and Montreal (Canada). The focus on this year's meetings has been to decide on the contents of the next two special reports: Special Report on the Ocean and Cryosphere in a Changing Climate, and Special Report on Climate Change and Land. In addition, decisions have been made concerning three main reports: Climate Change – The Physical Science Basis, Climate Change – Impacts, Adaptation, and Vulnerability, and the third, Climate Change – Mitigation of Climate Change. There will also be a greater focus on regional issues. During the year, a number of Swedish scientists have been nominated and accepted as authors for IPCC reports. Information about the IPCC's processes and results is continuously disseminated in several ways, including publication on smhi.se. This helps to increased knowledge and awareness among Sweden's citizens about the possibility of influencing the work of the IPCC.

During the year, Sweden hosted the third of a total of four "lead author meetings". The meetings are an important of the process for producing the IPCC's Special Report on Global Warming of 1.5 Degrees. The meeting was held in

Malmö in October, and brought together more than one hundred international scientists and experts. The main purpose of the meeting was to review the input from external reviewers, and to jointly discuss the conclusions based on what is currently known. In connection with the meeting, several communication activities were arranged in Malmö targeting students, decision-makers and other information users. A briefing session for members of the Swedish Parliament was also arranged and live-streamed through smhi.se.

Activities within the Swedish National Knowledge Centre for Climate Change Adaptation

The Swedish National Knowledge Centre for Climate Change Adaptation (The Knowledge Centre) was established by the Swedish Government in 2012 and its long-term existence was secured in 2016. The objective of the Knowledge Centre is to contribute to good community planning, and a sustainable and secure society, in the present climate and the climate of the future. The work contributes to Sweden's implementation of Agenda 2030, with a primary focus on Sustainable Development Goal 13: Take urgent action to combat climate change and its impacts. The Knowledge Centre will establish the preconditions for work on climate change adaptation in society, which in the longer term will lead to reduced vulnerability to climate change. The activities within the Knowledge Centre focus on raising awareness and knowledge about climate change adaptation, collecting, processing and providing information, development of support and tools for decision-making, as well as creating meeting opportunities and forums for collaboration.

An important part of the provision of knowledge is to create an overview of the work of the Swedish governmental authorities and other bodies in the field of climate change adaptation and make it more visible. During the year, compilations of activities have been produced and published on the climate change adaptation portal, klimatanpassning.se. Expert support is continually provided to the Ministry of the Environment and Energy, covering for example international activities including participation in the European Commission's Climate Change Adaptation Working Group, and development of international standards for climate change adaptation efforts.

The climate change adaptation portal is one of the primary channels for making knowledge in the area more accessible. During the year, the portal was supplemented primarily with descriptions of practical climate change adaptation measures and information relating to funding possibilities. The English language version of the portal was also expanded with a number of climate change adaptation examples.

New educational material on the climate and climate change adaptation has been developed. This is primarily aimed at Swedish upper secondary school students, but could also be used by others, for example study circles or public interest organisations. The material is intended to inspire teachers and students to work with the Learning for Sustainable Development theme, on the basis of the climate

change issue. The students are also the primary target group for a Minecraft game, where the players in the virtual environment try to protect various parts of a city from climate-related risks. The game was developed over the course of the year and aims to create an understanding of climate change adaptation. An initial evaluation has been made after the schools have had the opportunity to try out the game. The results show that the experience of both students and teachers was that the game stimulates learning.

A new web-based service, a Guide for climate change adaptation, has been produced to help small and medium-sized municipalities to get started on climate change adaptation and to guide them in their work. The web-based service shows the various different steps, as well as appropriate support for various measures and processes, such as physical planning or risk and vulnerability assessment. Over the course of the year, 15 municipalities and six county administrative boards participated in the project. As well as developing the service, the working meetings with the municipalities resulted in a dissemination of knowledge about adaptation to more parties, as well as increased dialogue between the Knowledge Centre, county administrative boards and municipalities.

Calculation of sea levels and method of calculation for transient precipitation

SMHI has produced material concerning the future sea levels for Sweden's coastline within the framework of the Developing Guidelines for the Calculation of Dimensioned Sea Levels for different parts of Sweden for both the present climate situation and for the future climate. The project, which commenced in 2015, provides the supporting documentation for planning construction in coastal areas, infrastructure and other activities important to society, and increases awareness of rising sea levels for a broader public. During the year, a high resolution, zoomable map display service was prepared for future average water levels along Sweden's coastline, along with a web-based service with information concerning high sea levels. The latter will be launched in 2018.

Since 2015, SMHI has had an assignment from the Swedish Government to conduct an investigative study concerning methodology for calculating the worst possible short-term rainfall (severe cloudbursts). In 2017, the flood

project continued to work on the development of a methodology for capturing extreme periods of short-term rainfall. The results show better accuracy compared with the previous year.

Reporting of distributed grants

SMHI has had an assignment from the Swedish Government to allocate SEK 14 million to other governmental authorities for the development of action plans and tools for adapting to a changing climate within their respective areas of responsibility. Funds were allocated to 13 governmental authorities, primarily in the prioritised sectors of the society: food production, human health, Sweden's environmental objectives, as well as community planning and construction. The financial support has resulted in a stronger focus on climate adaptation among the governmental authorities and municipalities that have received the funds, and has enabled new collaborations. The funds for the municipalities have also contributed significantly to the development of the web-based Guide for climate change adaptation.

Collaboration relating to marine monitoring

SMHI and the Swedish Maritime Administration have separate water level networks, and in some places the measurement stations are very close to each other. These observation networks are in the process of being merged, and the water level gauges are also being upgraded in order to increase the quality and accessibility of the observations. SMHI has also provided sensors for temperature and salinity to the Swedish Maritime Administration's current profiler in Öresund. This means that both the volume and density of the water that flows through the Öresund can be followed in real time, which is important in order to be able to understand how the environment in the Baltic Sea is affected.

During the year, the Swedish Maritime Administration placed a wave buoy at the entrance to the oil harbour in Brofjorden, where the maintenance and data collection is managed by SMHI. The data from the wave buoy contributes to a better working environment for the pilots who board ships at Brofjorden, and a demand for this has been expressed from both the shipping industry as well as recreational vessels.

RESEARCH

The research department works in an applied and problem-oriented manner to meet SMHI's and society's need for new knowledge. Research is conducted in meteorology, hydrology, oceanography and climatology. The work is largely focused on developing and applying calculation models. It includes developing analyses and products based on remote analysis from satellites and radar as well as different types of local data. Through its research activities, SMHI can provide reliable data for decision-making, apply international research results and build expertise on societal challenges in the climate and environment areas. The activities constitute an important infrastructure with their extensive model development and production of different scenarios. This infrastructure gives both Swedish and international research groups data to build on in e.g. impact studies. Both nationally and internationally, society benefits greatly from the results of SMHI's research, for example in the adaptation of society to a changing climate.

International funding is increasing

SMHI's research is primarily project-financed. SMHI applies for external funding in competition with other national and international research institutes and universities. More than half of the activities are funded via national research funds, the EU's 7th Framework Programme for Research and Technological Development, Horizon 2020, and the Copernicus Programme. The remaining funding comes primarily from grants, but also from internal SMHI assignments and other financial sources.

International funding continues to increase. From the societal perspective, it is important for Sweden to obtain its share of research funding from sources within the EU. In this respect, SMHI has been successful in its areas of activity. The EU Framework Programmes and the Copernicus Programme accounted for 37 percent of the total external funding of SMHI's research activities in 2017.

Large weather data archive freely available

The production of weather data archives is a core activity within the fields of meteorology and climatology. SMHI coordinated a major European project – UERRA – which produced a European weather archive with high geographic and temporal resolution over the past 55 years through reanalysis. A reanalysis is a way of processing existing data, often with new tools, in order to create a longer contiguous and consistent volume of data. These analyses of the weather for long periods of time are important in both research and a number of business sectors, such as renewable energy, agriculture and insurance. The data is freely available for download.

New climate change calculations for the UN Intergovernmental Panel on Climate Change – IPCC

With climate models, scientists calculate how the climate changes with different emission levels of greenhouse gases to the atmosphere. SMHI coordinates the development of the global earth system model, EC-Earth, which has been developed within a European consortium. In 2017, the de-

velopment of a new version of the model was completed. It can now be used for calculations that will form the basis for future reports from IPCC, the UN Intergovernmental Panel on Climate Change. The calculations correspond to the intentions of the Paris Agreement and also contribute information concerning what happens with the climate if the limitations on climate-influencing emissions are delayed. The calculations can also be refined and form the basis of the development of climate change services, which can be used by various areas of society, including climate change adaptation.

Education initiative for climate and climate adaptation in Africa via Cordex

In many countries in Africa, the need to develop climate change information is particularly great. More knowledge is needed in order to provide information locally and regionally, and climate change information is now also required by decision-makers. For several years, SMHI has worked with African scientists to increase knowledge, with special support from the Swedish government. SMHI has carried out a series of workshops in South Africa with participants from several African countries within the framework of the international Cordex cooperation for regional climate change modelling. The issues that have been covered were prioritised jointly with the participating countries. The first phase of creating a climate change impact atlas for Africa has also been implemented. The work has been led by scientists at the University of Cape Town, with support provided by SMHI, which has also been a way of transferring knowledge. When the climate change impact atlas is ready, it is expected to provide information that can form the basis for decisions concerning climate change adaptation.

Efficient water management with “open data”

SMHI has recently completed a four-year project within the EU's 7th Framework Programme for Research and Technological Development. The project was coordinated by SMHI and developed 14 web-based information services for more efficient water management based on open data. All services have business plans and nine of the services have paying customers (with a total of 34 paying customers at the conclusion of the project). In addition, the project has contributed to a new research infrastructure where scientists can engage in joint efforts and review each other's work. This has led to the publication of several scientific papers. The project supports the EU's Open Innovation, Open Science and Open to the World strategy, and has shown how open data can help strengthen economic growth, research and environmental work within the EU.

The impact of climate change in the Baltic Sea

The EU-funded Baltic Sea Research has largely been conducted within the Bonus Programme, a research programme conducted in cooperation between eight EU countries around the Baltic Sea. SMHI has contributed with simulations of a changed climate for the Baltic Sea, based on the UN IPCC scenarios and global model projections. These have been further processed in several projects within the

programme, for example, in order to study how the ecosystem and ecosystem services could change, how the problems with algal blooms and hypoxic bottoms might change, as well as how winter maritime shipping may need to be adapted to climate changes.

Collaborative efforts improves air quality in Brazil

Within the framework of a bilateral agreement relating environmental and climate change work between Brazil and Sweden, SMHI has initiated cooperation with the city of Curitiba in order to improve the air quality in the city. The

project has resulted in a new understanding, particularly for the traffic emissions of particles and soot. The results indicate unknown emissions of particles in residential areas, and the project has calculated the possibility of improvement based on new transport solutions in the city. The efforts have established very good cooperation internally between different municipal departments and with the larger universities. The bilateral cooperation confirms the hypothesis that Swedish participation can help to facilitate increased internal cooperation in other countries. The project also shows that environmental aspects are closely linked to energy and efficiency for transport in a large city.

PROFESSIONAL SERVICES

The professional services department offers industry-oriented and customer-integrated services for society, industry and commerce. The services are based on experiences and expertise in all of SMHI's areas of competence as well as cooperation with external partners. The customer benefits are increased safety, sustainability and safer decisions, both in Sweden and internationally. During the year, activities have been developed and adapted in several areas. New steps have been taken to better match the internal organisation to the external market. The goal is to further increase the ability to increase the advantages for our customers' organisations. A number of market areas have shown good improvements in earnings, while other areas are still undergoing restructuring. An initiative is underway to further establish SMHI in international aid and relief work.

Forecast services to the Swedish Transport Administration

SMHI supplies weather data to the Swedish Transport Administration's presentation system for weather observations and forecasts throughout the year, with particular focus on the winter season. SMHI's forecasts contribute to a secure and sustainable society by assisting the Swedish Transport Administration's contractors to work proactively to reduce the risk of skidding. SMHI's information is also helpful in the Swedish Transport Agency's environmental work, where the forecasts assist the Swedish Transport Administration's contractors to become more accurate, taking action against freezing only when it is really needed, while avoiding unnecessary salting and snow removal efforts. As a result, exhaust emissions are reduced, wear and tear and particle dissemination on the roads is limited, and the spreading of salt is minimised. The accuracy of SMHI's forecasts also means that it is easier for road authorities and managers to determine not only the volume but also what kind of sand or salt is to be used.

Climate change education strengthens regional work

As a part of Agenda 2030, SMHI has been commissioned by SIDA to conduct ten international training programmes (ITP) in Africa over the 2015-2020 period. So far, five training sessions have been completed. The ITP Program deals with the topics of climate change and climate change adaptation. In total, approximately 300 decision-makers from nine African countries will participate in the programs. During 2017, SMHI has conducted two sets of international training sessions, one in East Africa and one in West Africa. Three new courses have begun in West Africa, South Africa and East Africa. The training is wide-ranging and encompasses everything from the latest climate change research to how societies can be adapted and crises prevented. Special emphasis is placed on water resources and agriculture. The objective is to strengthen both individuals and their organisations in terms of knowledge, while at the same time contributing to the development of the regional cooperation between various parties.

New business areas for future markets

Digitalisation, technological innovation, new forms of collaboration, mobility, urbanisation and many other forces are changing the world and society. This changes the preconditions for SMHI's customers and thus also SMHI's activities. As a part of meeting the challenges, SMHI has formed a special working group "New Ventures," with the task of working with new markets within SMHI's business activities. The purpose is to find tomorrow's business with a focus on social benefits. New Ventures is part of SMHI's work relating to innovation, and is an activity with a strong focus on entrepreneurial spirit. A first product from New Ventures has been launched last year, the SMHI Timbr digital service, which was developed for forestry companies. It contributes to a better understanding of the preconditions that apply for forestry machines that need to drive on a specific area or field without causing damage. The service con-

tinues to be further developed in close dialogue with most of the large forest companies in Sweden.

Improved fuel statistics within maritime traffic

The Swedish Energy Agency is the governmental authority responsible for reporting sales statistics from Swedish bunker suppliers that provide fuel for maritime shipping. More stringent demands are made for improved quality in the dividing up of these sales figures between domestic shipping (fuel which is consumed during voyages between two Swedish ports) and international shipping (consumption for voyages involving primarily one Swedish harbour). In order to improve the quality of the statistics, SMHI has conducted a modelling with the Shipair system, based on the ship's AIS data which indicates the ships' identity and position with a high level of temporal resolution.

The results showed major differences between the collected sales statistics and the modelled calculations. SMHI's calculations showed that the model followed seasonal variations in sales statistics very closely, with clear peaks in the summer months when ship traffic intensified. At the same time, major differences between the model and the sales figures appeared. Accumulated over the course of the year, the modelled fuel consumption gives double the values of what is shown by sales statistics. The new methodology, based on AIS data, is considered more credible and reliable than the methodology based on reported sales figures.

The need for integrated systems for merchant shipping – on land and sea

SMHI is one of five leading parties in the global market for weather-related services in merchant shipping. The market for SMHI continues to grow globally. SMHI's shipping customers operate in a competitive market, where the number of vessels within certain areas exceeds the needs of the market. The demands on continually optimising the operations are high.

Together with various partners, SMHI develops maritime shipping services within two focus areas. One deals with optimising how ships and entire fleets are operated. The focus is on showing the effects of weather impact on arrival times, fuel consumption and safety. SMHI participates in the EU Sea Traffic Management project, which focuses on sharing information from ships with multiple stakeholders. The shared information can reduce the risk of collisions and adapt the speed to the port based on available berths, in

order to achieve more efficient consumption of energy on board.

The other area of focus deals with documentation of the vessel's performance. Here, SMHI carries out performance calculations based on manual or automatic reports from a ship. Over the course of 2017, SMHI has been working to comply with the new EU regulation for the Monitoring, Reporting and Verification of carbon dioxide emissions from maritime transport, which will take effect in January 2018.

Measuring tool for precipitation

With the insight that knowledge about actual precipitation can result in significant benefits to society, SMHI, Ericsson and Hi3G Access have developed the MicroWeather method to measure rainfall. The method is based on measuring the amount of rain by measuring the attenuation of the signal in the microwave links between the cellular/mobile phone masts to the volume of rain falling within a certain period of time. The method has attracted a great deal of interest internationally, where the possible market for MicroWeather is huge, for example in developing countries where traditional rainfall measurement is often lacking.

The method provides a higher resolution in time and space than traditional weather radar can provide. The vast amount of microwave connections in densely populated areas can provide detailed precipitation maps in the cities, as well as the capability to measure in areas where there is no weather radar coverage. The measurements are also closer to the ground than the weather radar measurements, which reduces the risk of rain from low clouds not being included, or that the rain which is measured evaporates and thus does not actually reach the ground.

Climate change statistics for adapted product development

SMHI's extensive database of weather observations is useful for various industries that need to adapt their operations to the climate. IKEA is one example of a company that, using SMHI's climate statistics for temperature and humidity, can develop products that suit different climates in the world. The assignment that SMHI received from IKEA 2016 meant producing a comprehensive statistical report which made recommendations concerning how the world markets can be divided into regions with similar climate.

FINANCIAL PERFORMANCE

Income statement - (EUR 000) 2017

Exchange rate - Average rate for the current year	9,6326
Operating income	82 715
Personnel expenses	-43 369
Premises expenses	-2 868
Other operating expenses	-32 547
Financial expenses and amortisation	-3 047
Operating expenses	-81 831
Surplus/deficit of the year	883

Balance sheet - (EUR 000) 2017

Exchange rate - Closing rate on 31 December 2017	9,8497
Non-current assets	
Intangible assets	1 787
Tangible assets	8 593
Total non-current assets	10 380
Current assets	
Inventories	411
Receivables	30 263
Cash and cash equivalents	8 995
Total current assets	39 669
Total assets	50 049
Equity and liabilities	
Equity	2 270
Provisions	733
Liabilities	47 046
Total equity and liabilities	50 049
Contingent liabilities	49 212

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

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