SWFDP REGIONAL FRAMEWORKS AND THEIR IMPACT IN DEVELOPING AND LEAST DEVELOPED COUNTRIES

Submitted by WMO, with contributions from the CBS/DPFS and SWFDP-Southern Africa Regional Management Team chairpersons

1. INTRODUCTION

The Severe Weather Forecasting Demonstration Project (SWFDP) is a project carried out by WMO/CBS to further explore and enhance the use of outputs of existing numerical weather prediction (NWP) systems, including ensemble prediction systems (EPS). It aims to contribute to capacity building by helping developing countries to access and make use of existing NWP products for improving warnings of hazardous weather conditions and weather-related hazards. The SWFDP is primarily built on the Global Data Processing and Forecasting System (GDPFS) programme, in collaboration with the Public Weather Services (PWS) to improve severe weather forecasting and warning services. It coordinates, as appropriate, with other WMO Technical Commissions and Programmes to extend the range of targeted applications to broaden the benefits of the SWFDP to other user sectors in society.

The SWFDP follows a "Cascading" concept of the forecasting process (see *Workshop Paper entitled: "SWFDP and its Future Directions towards Strengthening/Sustaining WMO's Operational Centres"*) whereby global-scale products (made available by advanced GDPFS centres, i.e. Global NWP Centres), are integrated and synthesized by a regional centre (typically a designated Regional Specialized Meteorological Centre (RSMC)) to provide daily guidance for short-range and medium-range forecasts of hazardous weather phenomena such as heavy rain, strong winds and damaging waves to NMHSs in its geographical region, enabling those centres to issue effective severe weather warnings in their regions. Regional Centres also supplement the global products with locally produced data and information.

The expected outcomes include:

- Enhanced capability for NMHSs to forecast severe weather and issue warnings at national level, including improved accuracy and longer lead-times;
- Enhanced access to global and regional nowcasting products for very short-period forecasting;
- Established warning processes agreed with national disaster management and civil protection authorities, along with planned responses for protection of lives and property;
- Established forecast processes and Quality Management Systems (QMS), and strengthened forecast capabilities in support of other users sectors at the national level;
- Raised awareness of the value of NMHSs with national governments and their agencies, leading long-term to greater national support and investment, leading in turn to improved supply of observations and feedback into the GDPFS system;
- Reduced loss of life and damage to property with contributions to the Millennium Development Goals of eradicating extreme poverty and reducing child mortality.

The approach follows the Millennium Development Goal of a Global Partnership for Development and contributes directly to disaster risk reduction and climate change adaptation.

Advances being made in numerical weather and climate prediction by advanced GDPFS centres that run global systems (see *Workshop Paper entitled: "Anticipated Advances in NWP, including Strengthens and Weaknesses"*) would require downscaling and tailoring their products (e.g. by a Regional Centre) for practical use by NMHSs. While acknowledging the importance of the continued support from global centres that provide NWP/EPS and satellite-based products, it is recognized that Regional Centres play the backbone role in the implementation of the SWFDP. Strengthening and sustaining WMO operational centres within the SWFDP regional frameworks (especially Regional Centres and their linkages to NMHSs in their respective geographical regions, and with Global NWP Centres for continuous learning) would sustain and increase the beneficial

impacts of the development of much needed capabilities at NMHSs of developing and least developed countries (which typically lack the basic human and financial capacity) for delivering weather, climate and hydrological forecasting and warning services.

2. *SWFDP* – EXPLOITING THE *GDPFS* FOR ENHANCING AND SUSTAINING OPERATIONAL SERVICES

2.1 SWFDP regional frameworks

The principles applied to SWFDP planning and implementation (through regional projects) is built on efficient management frameworks at regional level, with appropriate guidance from the project Steering Group (that provides a linkage to CBS mechanisms), and with considerable support from the WMO Secretariat. Good project management practices have been encouraged, including the setting up of a continuous improvement cycle, with regular reporting and evaluation of progress and objective identification of technical gaps.

Why a regional framework? NMHSs in a geographical region (i.e. neighbouring countries) typically need similar (or the same) products and there would be efficiency gains in coordinating their requirements (collective needs). Similar views to the user requirements, therefore a regional framework would provide a forum for sharing expertise and experiences among forecasters, including on how to deal and liaise with with intra-government communication, emergency services, the media, etc. A regional framework also provides a coordinated, harmonized and consistent approach to address hazards (including high impact weather situations in a geographical region), as well as a continuous learning environment. At the same time, observational data are typically more widely shared among NMHSs within a regional economical body (directed by regional data policies), which could lead to regional forecast improvements.

The SWFDP management frameworks consist of individual regional project-specific implementation plans for which management teams (comprised of representative of global, regional and national centres) are accountable. Following the SWFDP guidance materials (i.e. the Overall SWFDP Project Plan and the Guidebook for Planning New SWFDP Regional Projects), each regional project-specific implementation plan describes key aspects. These include team members' responsibilities, and project activities and milestones (typically for 12-18 months) such as training and reporting. These actions build and sustain partnerships of WMO global to regional operational centres with less capable national centres in a geographical region. Country-specific/national implementation plans have been developed within the SWFDP (resources permitting), addressing gaps and weaknesses, and including a review of current levels of services, training requirements and outputs. Stakeholder engagement is very important and is also included. This should assist in ensuring long term sustainability of projects. For example the SWFDP engages with the meteorological-related groups within the regional economical bodies (i.e. comprising Heads of Meteorological Services and Ministries in charge of meteorology) encouraging regional ownership and sustainability of the benefits gained with the project.

SWFDP: a cross-cutting activity involving multiple WMO Technical Commissions and Programmes, led by the GDPFS

The World Meteorological Congress, at its sixteenth session (Cg-XVI, May 2011) agree that SWFDP should be an end-to-end cross-programme collaborative activity led by the GDPFS, that engages all WMO programmes that concern the real-time prediction of hydro-meteorological hazards, through their respective technical commissions: from observations, to information exchange, to delivery of services to the public and a range of targeted applications/user sectors, education and training, capacity development and support to LDCs, and to the transfer of relevant promising research outputs into operations.

Standards and guidance established by WMO are effectively implemented by WMO Members through projects like the SWFDP, in particular in developing new capacities, benefiting from new technologies, managing change and developing appropriate mentoring schemes. The success of

the SWFDP is in part because it takes a holistic, regional-driven approach, i.e. through improving the entire end-to-end chain from production to the delivery of warning services to the users, through the "Cascading Forecasting Process". Coordination with the Regional Programme (RP) – Regional Offices, including the Programme for LDCs, Education and Training Programme (ETR), Voluntary Cooperation Programme (VCP), and the Resource Mobilization Office (RMO), in the planning and implementation of regional projects has been (is) critical to ensure that desired, sustainable and relevant outcomes are achievable.

Many of the NMHSs of developing and least developed countries do not have an adequate programme for severe weather warnings, and insufficient use of modern NWP forecasts to increase the lead-time of anticipating the development of severe weather situations, several days in advance. Further implementation and development of the "Basic Systems" is required in order to establish and formalize national severe weather warnings programmes (coordinated by GDPFS in coordination with PWS) within their respective national disaster management and civil protection frameworks, with possibly a regional coordination of national programmes across national boundaries.

The SWFDP regional projects represent the regional infrastructure to support national warnings programmes, including in collecting and conveying the requirements for the "Basic Systems" (including coordination with WIGOS and WIS), while addressing aspects related to severe weather forecasting and warning services (e.g. this is the case for the SWFDP – Eastern Africa, where issues related to observational and telecommunication aspects are being considered/addressed). The SWFDP regional projects also represents a systematic approach for building capacity and for transferring knowledge and skills to NMHSs, especially to weather forecasters. Their framework has been used to implement a series of proven or modernizing enhancements to the forecasting process, as well as to provide a channel for the transfer of relevant promising S&T research and development outputs through trials, such as from the WWRP/THORPEX TIGGE project "Global Interactive Forecast System" (GIFS), and involves the WWRP/SERA to support effective propagation of benefits to society.

Among the main challenges for the SWFDP, has been the need for very short-range forecasting (including nowcasting) tools, especially to address the rapid onset of localized severe thunderstorms that produce heavy precipitation and strong winds, in the absence of adequate real-time observational networks, especially in absence of weather radar coverage. In this context, following the outcome of the first phase of the SWFDP in Southeast Africa (in 2008), coordination has been established with the WMO Space Programme (SAT) to ensure that satellite-based products are available through each SWFDP regional project. Satellite-related training, satellite information (data and products) and dissemination mechanisms to support the SWFDP are now core component of the SWFDP. These products made available through the SWFDP also contribute to aeronautical meteorology (AeM).

Presently, four of the five SWFDP regional projects include NMHSs of countries that are within the footprint of Tropical Cyclone basins. Synergies (including specific collaboration and joint development work) are being established with the Tropical Cyclone Programme (TCP), and its Regional Bodies. Coordination with other WMO Technical Commissions and Programmes that address applications of meteorology is associated with the nature (i.e. the main focus) of each SWFDP regional project (see section below). SWFDP contributes to the WMO Quality Management Framework (QMF) through supporting efforts in NMHSs in their implementation of Quality Management Systems (QMS).

SWFDP regional projects

The SWFDP continues to experience important benefits and significant growth, with 5 regional projects (Figure 1), either underway or under development (Southern Africa, South-west Pacific, Eastern Africa, Southeast Asia, and Bay of Bengal/South Asia).

SWFDP – Southern Africa

The SWFDP in Southern Africa currently involves the participation of RSMC Pretoria (responsible for the basic guidance forecasts out to day-5; dissemination of NWP/EPS products; and preparation and dissemination of satellite-based and "blending" products), and RSMC La Réunion (responsible for tropical cyclone forecasting); NMHSs of the fifteen SADC (Southern African Development Community) countries (namely Angola, Botswana, Democratic Republic of the Congo, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Lesotho, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe), as well as the Comoros; and three global NWP centres (i.e. ECMWF, NOAA/NCEP and the UK Met Office) that provide NWP/EPS products to the regional project. The project is currently in Phase 4, under regional responsibility. In addition to heavy rain and strong winds (the two main hazards addressed by the SWFDP) associated or not with tropical cyclones, the regional project also include winter weather as well as high swell and waves, particularly important to South Africa and the small island developing states (SIDSs). The project is also establishing synergies with the Southern African Regional Flash Flood Guidance (SARFFG) project. Therefore, within the framework of the SWFDP – Southern Africa there has been coordination with TCP, MMO, and HWR programmes.

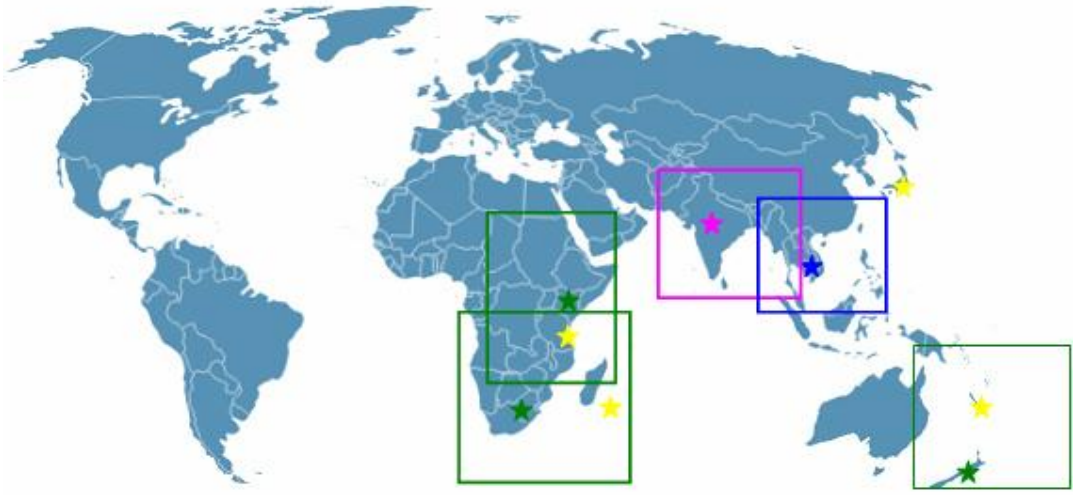

Figure 1 – SWFDP regional projects, either underway (Southern Africa, South Pacific and Eastern Africa – in green) or under development – in different stages: Southeast Asia – in blue (in development since 2010), and Bay of Bengal/South Asia – in pink (early stages of development). Regional Specialized Meteorological Centres (RSMCs), carrying out the central regional role for the project, are RSMC Pretoria, RSMC Wellington and RSMC Nairobi, respectively for the SWFDP regional projects: Southern Africa, South-west Pacific, and Eastern Africa identified (in green). New regional centres – Regional Forecast Support Centre (RFSC) are being established: RFSC Ha Noi for the SWFDP – Southeast Asia (in blue), and RFSC Dar (in yellow) for the Lake Victoria Basin. The RSMC with activity specialization in Tropical Cyclones (RSMC-TC) New Delhi is expanding its role to address other hazards and take the central regional role for the SWFDP – Bay of Bengal/South Asia. Other supporting centres, including RSMCs-TC in yellow.

SWFDP – South Pacific

The SWFDP in South Pacific currently involves the participation of RSMC Wellington (responsible for the basic guidance forecasts out to day-5 and dissemination of NWP/EPS products – a special forecaster's tool has been constructed to help generate the regional forecast guidance), RSMC Darwin (with geographical specialization) and RSMC Nadi (responsible for tropical cyclone forecasting); NMHSs of nine SIDSs (Cook Islands, Fiji, Kiribati, Niue, Samoa, Solomon Islands,

Tonga, Tuvalu, and Vanuatu); Fiji Meteorological Service provides daily routine forecasting for four SIDSs; four global NWP centres (i.e. ECMWF, JMA, NOAA/NCEP, and the UK Met Office) that provide NWP/EPS products to the regional project; and one global centre providing satellite-based products (JMA). In addition to heavy rain and strong winds associated or not with tropical cyclones, the regional project also addresses damaging waves, particularly important to South Pacific SIDSs. The project is also establishing synergies with the Coastal Inundation Forecasting Demonstration project (CIFDP) in Fiji. Therefore, within the framework of the SWFDP – South Pacific there has been coordination with TCP, MMO, and HWR programmes.

SWFDP – Eastern Africa

The SWFDP in Eastern Africa currently involves the participation of RSMC Nairobi (responsible for the basic guidance forecasts out to day-5 and an outlook up to day-10, and dissemination of NWP/EPS products), and RFSC Dar (which coordinates and provides specialized products from high-resolution NWP over Lake Victoria, together with daily forecast guidance products); NMHSs of Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda; four global NWP centres (i.e. ECMWF, DWD (for providing the GME data needed for nesting COSMO), NOAA/NCEP, and the UK Met Office (also provides high-resolution NWP over Lake Victoria)) that provide NWP/EPS products to the regional project. In addition to heavy rain and strong winds, the regional project also addresses hazardous waves (South-west Indian Ocean and Lake Victoria) and dry spells, which are particularly important to this region for agriculture and food security. An Agrometeorological component is included in the project, to benefit from the well-working relationships that the NMHSs have with their respective socio-economically important Agricultural sector. In addition to severe weather forecasting and warning services for the benefit of the general public and socio-economic sectors, in particular agriculture, for the entire project footprint, the SWFDP – Eastern Africa includes a specific component addressing severe weather forecasting and warning services over the Lake Victoria, addressing marine meteorological aspects for the safety and protection of fishers, living in nearshore communities and operating daily in small vessels. Plans include extending the forecast guidance to longer timescales (monthly and seasonal), in support of RCOFs and agricultural communities. Therefore, within the framework of the SWFDP – Eastern Africa there has been coordination with AgM, MMO and WCP programmes.

SWFDP – Southeast Asia

The SWFDP in Southeast Asia, which is in development, currently involves the participation of RSFC Ha Noi (which is a newly established regional centre, responsible for the basic guidance forecasts out to day-5 and dissemination of NWP/EPS products), Hong Kong Observatory (for training and technical support), and RSMC Tokyo and RSMC New Delhi (for Typhoon / Tropical Cyclone forecasting support); NMHSs of Cambodia, Lao PDR, Philippines, Thailand and Socialist Republic of Viet Nam; six potential global NWP centres (i.e. CMA, DWD (for providing the GME data needed for nesting COSMO), ECMWF, JMA, NOAA/NCEP, and KMA) that provide NWP/EPS products to the regional project; and one global centre providing satellite-based products, and TC track forecast and TC strike probability maps, using the TIGGE CXML data under the THORPEX North Western Pacific Tropical Cyclone Track Ensemble Forecast (NWP-TCTEF) research project (JMA). Target severe weather are heavy rain and strong winds associated or not with typhoon/tropical cyclones. The project is also establishing synergies with the Flash Flood Guidance System of the Mekong River Commission. Therefore, within the framework of the SWFDP – Southeast Asia there has been coordination with TCP, WWRP and HRW programmes.

SWFDP – Bay of Bengal (South Asia)

The SWFDP in Bay of Bengal (South Asia), which is in development, currently involves the participation of RSMC-TC New Delhi (which is expanding its role as RSMC for Tropical Cyclone Forecasting to carry out the role of the regional centre for the project, responsible for the basic guidance forecasts out to day-5 and dissemination of NWP/EPS products); NMHSs of Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand; five potential global NWP centres (i.e. ECMWF, IMD supported by NCMRWF, JMA, NOAA/NCEP, and UK Met Office) that provide NWP/EPS

products to the regional project; and two global centres providing satellite-based products (IMD and JMA). Target severe weather are heavy rain and strong winds associated or not with tropical cyclones, and marine-related hazards (i.e. damaging waves and storm surges). The project is focused on the safety of coastal communities, and therefore is also establishing synergies with the CIFDP in Bangladesh and in India. I.e., within the framework of the SWFDP – Bay of Bengal (South Asia), there has been coordination with TCP, MMO and HRW programmes.

2.2 Role of Regional Centres

Based on the lessons learnt, so far, with the implementation of the SWFDP regional projects, it should be strongly underlined that the most critical condition for success has been the engagement of high quality and efficient leading centres at the regional level. The role and functions of these centres as focal point and central hub for all information exchange between the various global, regional and national partners have been essential, including the production of coordinated forecast guidance. Several important lessons have been identified relative to the functions of the SWFDP regional forecasting support centre (e.g. existing designated Regional Specialized Meteorological Centre, "RSMC", expanded RSMC for Tropical Cyclone Forecasting, or a new established Regional Centre "RSFC" – see *Workshop Paper entitled: "SWFDP and its Future Directions towards Strengthening/Sustaining WMO's Operational Centres"*):

- The Regional Centre is an unarguable project critical component of the SWFDP, in processing, downscaling and tailoring products from advanced global centres (including forecast guidance, especially for high impact weather) for practical use by NMHSs;

- The Regional Centres provides an appropriate environment to trial new proven S&T research products, in preparing the daily severe weather forecasting guidance, and provide feedback;

- The Regional Centre should be the central source for severe weather forecasting guidance, and operational coordination of the SWFDP region;

- The Regional Centre functions are largely daily and real-time, and include labour-intensive components;

- The Regional Centres could act as Training hub for forecasters in severe and high-impact weather;

- Regional forecasters need training and experience in forecasting weather hazards of their geographical region;

- Observational data, collected at the national level, relevant to monitoring of severe weather development need to be shared in real-time with the Regional Centre;

- The Regional Centre could assist NMHSs to implement post-processing methods that objectively adapt NWP forecasts with in-situ observations;

- The Regional Centres could coordinate warnings across their geographical region.

The experience acquired with the SWFDP is actually been used to redefine the role of a regional centre with geographical specialization, to become an RSMC with activity specialization in Forecasting Hydro-Meteorological Hazardous Phenomena, which provides forecasting guidance to NMHSs in a geographical region, in support of their national severe weather warnings programmes.

Annex I provides an example of an SWFDP Regional Framework, including the roles and responsibilities of a lead regional centre for the project (in this case, RSMC Pretoria) and its relationship with NMHSs in its geographical region, with showcases.

2.3 Service Benefits to NMHSs and to society in Developing and Least Developed Countries

Although no detailed socio-economical study and cost-benefit assessment have been made up to now, there are a number of evidences, including the article *"Public benefits of the SWFDP in south-eastern Africa"* (WMO, 2008; http://www.wmo.int/pages/publications/meteoworld/archive/dec08/swfdp_en.html) – in Annex II, that clearly indicate the service benefits of the SWFDP to NMHSs and to society in developing and least developed countries.

Quoting from a message from Sacrasta Nchengwa, the representative from Botswana's Department of Meteorological Services (DMS) to the SWFDP (WMO, 2009; http://www.wmo.int/pages/publications/meteoworld/archive/aug09/swfdp_en.html):

> *"… I would like to report to you that your (with your partners) dedication and tireless efforts in helping developing countries' NMHSs to improve their capability to forecasts severe weather has not gone unnoticed. Recently, the DMS through its Weather forecast issued two press releases to the public through the media and the Disaster Management Office and true to the forecasts the expected conditions did occur. The press releases were first read over all the radios as part of the news bulletins. Though we have already entered into the winter season in Botswana, our confidence in the forecasts as issued by the modes was so high that we did not even hesitate to issue a press release (which contained advisories) at least 72 hours before the onset of the expected events. The feedback was massively positive and for the first time in a long time, DMS got commendations from a lot of customers including high profile figures in the society. Most feedback we got was through the telephone and during the week following the issue of the first press release our telephone lines were busy with more requests for warnings and forecasts from a more appreciative public. What took us by surprise was the huge interest and publicity generated by those press releases … I can confidently and categorically state that the public's view about DMS has changed for the better and the DMS visibility has been enhanced as a result. Our participation in the SWFDP project surely played a huge part in this recent achievement." (2 July 2009).*

These statements recognizably noted that SWFDP led to an increase in lead-time for alerting users, up to 3 to 5 days, and a definite positive impact on NMHS' ability to forecast severe weather events, and reinforces forecasters' confidence in issuing their warnings, which is an important element in communication to users, including government stakeholders and the public. It has therefore improved interactions of NMHSs with disaster management and civil protection agencies, and contributed to welcome improvements in public image and profile, as well as improved status and enhanced visibility of the NMHSs in the country, thereby encouraging national investment in Early Warning Systems. It's through its public weather services' (PWS) component that SWFDP assists NMHSs in building effective relationships with users, including stakeholders in the context of emergency preparedness and response.

The SWFDP engages with groupings of directors of NMHSs within the regional economical bodies (i.e. comprising Heads of Meteorological Services and Ministries in charge of meteorology), who agree that SWFDP is relevant to regional socio-economic benefits and development, and support the implementation of the SWFDP at regional and national levels (i.e. within the SWFDP regional frameworks). As examples,

(a) At the meeting of the Regional Technical Implementation Team of the SWFDP for Southern Africa (WMO, 2011; http://www.wmo.int/pages/prog/www/CBS-Reports/ documents/Report-RTIT-SWFDP-SA-Mauritius-July2011.pdf):

> *"The meeting noted that NMHS members of the Meteorological Association of Southern Africa (MASA) had requested WMO to continue to support the SWFDP, including all countries of the southern Africa region. The WMO Executive Council, at*

its sixtieth session (2008), responded positively to this request. The meeting further noted the commitment made by the Meeting of SADC Ministers Responsible for Transport and Meteorology (Pemba, Mozambique, May 2010) to support the SWFDP in Southern Africa. The Chair invited Mr Mark Majodina, representing MASA to make a statement in this regard.

Mr Majodina, expressed the view of the Meteorological Association of Southern Africa, that the SWFDP has been enormously beneficial to its members, and represented a genuine partnership between the developed and the developing world in meteorology. The demonstration has been important for this region, from the initial project that involved five NMHSs, and at the request of MASA in 2008, expanded to all sixteen countries of the southern African region with additional support from WMO. At the annual meeting of the Ministers of SADC, it was recognized that 1) the SWFDP was a contribution to climate change adaptation in improving the prediction of severe weather; 2) NMHSs were requested to secure the future of the project by allocating sufficient budget to ensure its continuation; and 3) SWFDP is relevant to regional socio-economic benefits and development. It was recognized that LDCs were not likely in a position to allocate adequate budget to permit their full participation, and therefore resource mobilization efforts are needed.
(…)
The meeting concluded that the support of MASA was important to ensure governments of the region will favour and further develop this project into the future, including providing overarching direction on its goals and priorities, as well as ensuring adequate resources are mobilized to support its activities, especially for regular technical training and developmental activities, and project coordination. At the same time MASA requested that the participation of the global and regional centres, and that coordination with WMO, continue."

(b) *"The East African Community (EAC) Heads of National Meteorological Services participated in the second meeting of the Regional Subproject Management Team (RSMT) for the Severe Weather Forecasting Demonstration Project (SWFDP) in Eastern Africa to be informed of achievements and challenges, and provide direction on its future implementation and possible expansion. The outcome of the meeting will inform the EAC five-year Meteorological Development Plan and Investment Strategy.*

The Heads welcomed the significant contributions of the SWFDP to disaster risk reduction, sustainable development and climate change resilience, as well as to vital socio-economic sectors as agriculture and fisheries. They agreed that the Project has enhanced the authority and visibility of National Meteorological Services (NMSs), and built public and government confidence in the accuracy and reliability of forecasts and warnings of severe weather events.

The Heads acknowledged that the SWFDP represents a systematic and practical approach for strengthening capacity in and for transferring new knowledge and skills to NMSs in developing and least developed countries, to deliver improved forecasts and warnings of severe weather to save lives, livelihoods and property.

The Heads therefore recommended that the Project should be sustained and strengthened as it moves from demonstration to operational stage. This will necessitate additional resources and commitment at regional and national levels to ensure EAC leadership in transforming the Project into an integral part of the forecasting and warning services of NMSs in the region." (EAC, 2013)

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RSMC PRETORIA

South African Weather Service

BACKGROUND

On request of RA1, the South African Weather Service (SAWS) was mandated by WMO in the mid 1990's to be a Regional Specialized Meteorological Centre (RSMC Pretoria) with geographical specialization (Southern Africa). Under this mandate RSMC Pretoria have the following functions (from the WMO *Manual on the Global Data-Processing and Forecasting System*):

- Providing the interface between WMCs and NMCs by formatting and distributing global products to meet the needs in a particular Region;
- Providing regional analysis and forecasting products for 12–48 hours, for designated areas;
- Providing meteorological assistance to United Nations humanitarian missions, in the event the relevant associated NMC is facing an emergency or is in catastrophic distress and out of service;
- Coordinating with other RSMCs as appropriate.
- RSMCs shall also carry out verification and intercomparison of products and arrange regional workshops and seminars on centres' products and their use in national weather forecasting.

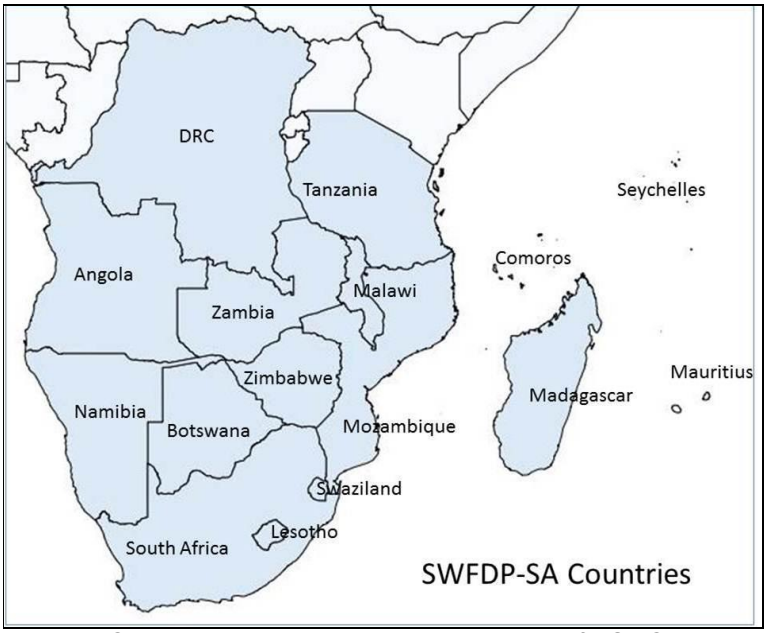

Figure 1: Countries within the responsibility region of RSMC Pretoria.

OVERVIEW OF RSMC PRETORIA AND ITS ACTIVITIES

Introduction

The daily forecasting activities of RSMC Pretoria are performed by the National Forecasting Centre (NFC) of the SAWS Forecasting Department in Pretoria, with support from the other departments in SAWS, specifically ICT, Research and International Relations. RSMC Pretoria has developed a dedicated RSMC Pretoria website (Figure 2) through which NMCs in the region can access various kinds of information, including products from the UM SA12 running in SAWS over the SADC region, and satellite-based nowcasting products developed in SAWS for the region. It is password protected to allow only NMCs to have access to the products. RSMC Pretoria is supporting NMCs in their countries and thus do not provide products to other users within other counties. This webpage is due to undergo a revision to comply with standards, make provision for additional products and cater for the needs of the NMCs.

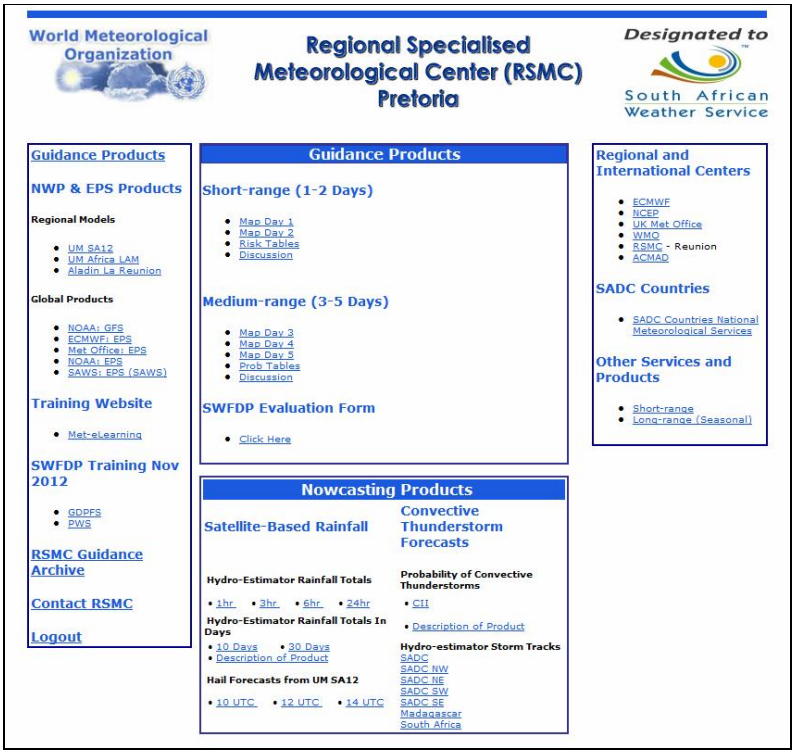

Figure 2. RSMC Pretoria website, dedicate for use by NMCs within its responsibility region.

In 2006 WMO approached RSMC Pretoria with the request to be the first RSMC that will test the concept of the Severe Weather Forecasting Demonstration Project (SWFDP). Since 2007 RSMC Pretoria has dedicated significant effort and contribution to the success of the SWFDP project in Southern Africa. This included providing guidance products every day for the following five days on potential severe weather over the entire RSMC Pretoria domain. In support of its SWFDP activities, the RSMC Pretoria webpage was modified to include relevant SWFDP products, including the guidance forecasts. Other regular activities include hosting the annual training events, and since January 2012 acting as the regional secretariat for the operational SWFDP activities as the project entered the final Phase 4 of the SWFDP program.

In 2009 RSMC Pretoria was requested by WMO's Hydrological Department to also be the regional centre for the Southern African Regional Flash Flood Guidance system (SARFFG) sub-regional project. This required RSMC Pretoria to coordinate regional input in terms of data provision during the development of the regional flash flood warning system. The system is anticipated to be operational from October 2013 whereupon RSMC Pretoria will host and manage the SARFFG

modelling system on a dedicated computer, and provide guidance and support activities similar to SWFDP for the seven participating SARFFG countries. This will add additional responsibilities to the activities of RSMC Pretoria.

With time, it is anticipated that the Regional Early Warning System (REWS) of SADC will develop additional components to the current SWFDP and SARFFG activities. Through these projects and activities RSMC Pretoria is fulfilling its role as RSMC regarding how it should perform its functions mentioned above.

Impact of RSMC activities on SAWS

The RSMC activities are provided currently as an in-kind service by SAWS. In a nutshell these include about 50% of a senior forecaster shift per day (approximately 4 to 5 hours), focussing on preparing the guidance products every day, seven days a week. When the SARFFG system becomes operational, this activity is likely to become even more time-consuming (by a matter of a few additional hours per day to ensure that an effective service is still delivered. Other core operational activities unrelated to SWFDP already put undue pressure on the forecaster to maintain situational awareness during episodes of severe weather, whilst simultaneously devoting extended periods of time to the creation of SWFDP products. Naturally, in extreme circumstances, this type of scenario is likely to compromise the quality of the SWFDP guidance products. Consequently SAWS will in future be forced to consider devoting a dedicated shift, manned by a senior forecaster for RSMC activities.

Other staff impacts are:

- The requirement of variable senior staff time to perform the secretariat functions, specifically preparing reports,
- Arranging of training workshops,
- Attending relevant meetings in the SADC region and abroad,
- Lecturers at the training sessions including the time spent on preparation of lectures,

System development relates to:

- *Ad hoc* time of research staff to develop products specifically for the RSMC region related typically to the UM SA12 model and MSG satellite nowcasting, and
- RSMC webpage maintenance and development.

SPECIFIC ACTIVITIES OF RSMC PRETORIA

SWFDP (Severe Weather Forecasting Demonstration Project)

Introduction

The SWFDP project aims at supporting NMCs of developing and least developing countries to have access to modern forecasting technology (such as NWP and Ensemble Prediction System products) that they never before had access to in order to improve their forecasting services . It thus tested the concept of cascading of specialized forecasting information from World Meteorological Centres (WMCs) via RSMC Pretoria to the National Meteorological Centres (NMCs). RSMC Pretoria also had to provide regional guidance every day for the next five days on potential severe weather based on an analysis of the global and other products, provides higher resolution regional model products from its own NWP suite to the NMCs and developed nowcasting products based on the MSG satellite for the region. A major component of SWFDP is to develop the in-country coordination between NMCs and their local disaster management authorities and media. Another coordination component developed through SWFDP is coordination on a daily, and more intensively on a severe weather event basis, between the forecasters of the various NMCs and also with RSMC Pretoria's forecasters.

SWFDP in Southern Africa (SWFDP-SA) has progressed by December 2011 to the final Phase 4 of the WMO's SWFDP Programme. Phase 1 was the planning phase that started in 2006. Phase 2 was the 1-year demonstration phase that lasted from Nov 2006 to Nov 2007 and during which the concept of SWFDP was successfully demonstrated in Southern Africa using three global WMCs, RSMC Pretoria, and five NMCs. From there SWFDP-SA moved to Phase 3 during which the activities of the demonstration phase was rolled out to all 15 countries in SADC plus the Comoros, including SAWS as an NMC. This phase took four years beyond which SWFDP-SA progressed to the final phase 4.

SWFDP-SA Phase 4

Phase 4 is the Continuous Development Phase of SWFDP aimed at sustainability of the SWFDP concepts within the regional early warning system. It focuses on transferring oversight to the region, broadening the activities of the SWFDP to other areas and ensures sustainability of the SWFDP concept to avoid a fall-back to the previous status where NMCs do not have access to advanced forecasting technologies. During Phase 4 WMO has already withdrawn itself from managing the regional project in Southern Africa in favour of spending their available time and funds on the other four SWFDP regional projects elsewhere in the world that were recently established based on the success in Southern Africa. The management of SWFDP-SA transferred to the region, and specifically to MASA. This includes the basic financing of activities of SWFDP-SA, although WMO supported financially the recent training workshop with additional funds from extra–budgetary funds. WMO, however, will still monitor the progress of SWFDP-SA in case it needs to provide specific assistance to aid the sustainability of the system.

Operations

RSMC Pretoria is providing daily guidance forecasts as prepared by their forecasters for the next five days to the SWFDP activities. The supervisor shift in the NFC spends a few hours per day to prepare the five relevant maps and four documents every day, totalling 9 separate products. NWP products from the UM SA12 are also provided to the RSMC Pretoria webpage, and regional satellite-based nowcasting products developed by researchers of the SAWS research department are available on the webpage.

By nature the secretariat functions (previously provided by WMO) are now performed by RSMC Pretoria, including collecting semi-annual country reports and preparing the regional reports to MASA and the WMO, and the relevant training activities. RSMC Pretoria chairs the Regional Technical Implementation Team and liaises with international activities such as THORPEX TIGGE who have an interest in supporting the SWFDP projects.

Training activities

RSMC Pretoria is now responsible for arranging and conducting the SWFDP two-week regional training workshop for the SADC NMCs. During phase 4 the first major training activity was the 2-week SWFDP 2012 Training Workshop conducted from 12-23 November 2012 in Pretoria. This was the first major workshop entirely planned by the region, and funded by MASA with significant financial support also from the WMO. The organizing committee included the RSMC Pretoria SWFDP secretariat, NFC staff involved with the RSMC, the Regional Training Centre in SAWS, International Relations, and the MASA secretariat. This training session followed more or less the proven concept of previous SWFDP training workshops in Pretoria and elsewhere in the world. The successful workshop involved a forecaster per country for two weeks, and a PWS focal point per country for one week.

The 2-week training workshop is anticipated to continue annually for the foreseeable future. Another anticipated training activity related to SWFDP will include testing a RSMC Training Desk (with initial support from WMO) hosted at the RSMC Pretoria forecasting centre where a forecaster from a relevant NMC can be attached for two weeks to learn from the RSMC Pretoria forecasters.

Examples of Successful Coordination

There are various examples of the successful coordination between NMCs and RSMC Pretoria using the SWFDP principles. This is illustrated by the following two examples.

Tropical Cyclone Favio – February 2007

In the aftermaths of earlier flooding Mozambique had to deal with tropical cyclone Favio as it tore into the country on 22 February 2007 near the town of Vilanculos in the Southern Province of Inhambane. Favio developed as a tropical depression on 12 February far north-east of Mauritius. It was classified as an intense tropical cyclone by RSMC La Reunion on 20 February as it rounded the southern tip of Madagascar on its way towards Mozambique. It weakened marginally before making its landfall near Vilanculos. Moving inland in a north-westerly direction towards Zimbabwe, it weakened further though wide spread heavy rain and flooding still occurred.

Based on the information from RSMC La Reunion, ensemble tracks of ECMWF and other numerical model information, the guidance products from RSMC Pretoria (Figure 3) indicated landfall close to Vilanculos in Mozambique five days in advance, even though there were disagreement between different model products on the position of the cyclone. Forecasts for the subsequent days were quite consistent, and the movement towards eastern and northern Zimbabwe was well predicted five days in advance.

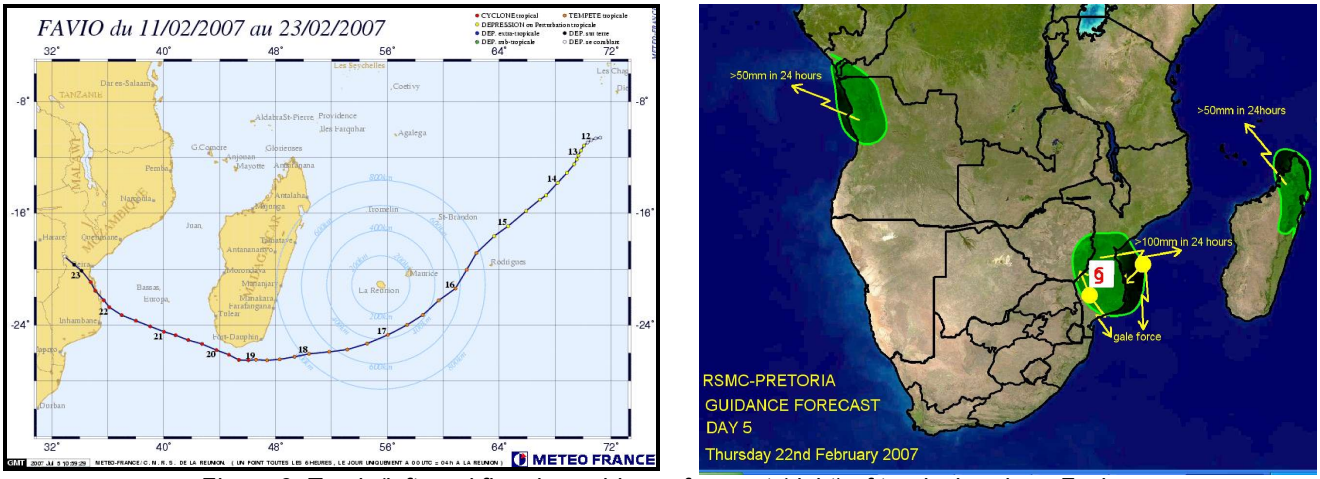

Figure 3. Track (left, and five day guidance forecast (right) of tropical cyclone Favio.

The SWFDP products were used by the National Institute of Meteorology of Mozambique (INAM) and the Meteorological Services Department of Zimbabwe (ZMSD) as guidance to warn their disaster management authorities and the public days in advance of the approaching threat.

Public warnings were initiated on the 20th when Favio was in Mozambican territorial waters. Warnings were disseminated by INAM to the media and to the Technical Emergency Committee on the status of forecasts and warnings. The response of the population, local authorities to the warnings and the measures being announced was remarkable. It prevented major loss of life given the impact of the cyclone. Scores of volunteers were ready to move people to the relative safety of schools and churches. As part of the government disaster coordinating body, the Mozambique Red Cross, supported by the international Federation of Red Cross and Red Crescent societies, were preparing for the impact of the cyclone on the Inhambane and Sofala provinces and surrounding areas a few days in advance already.

The Department of Civil Protection in Zimbabwe received the first early warnings from the ZMSD with 7 days to go. By 14 February, It was evident to ZMSD that Favio was heading towards the mainland and towards the northeast of Zimbabwe given the skill and agreement of the available guidance. Alerts were issued to Government and Civil Protection and Disaster Management Authorities by the 15th whilst early warnings were disseminated to the Public from the 16th. Despite failure by some members of the public to heed warnings, the level of disaster preparedness by Civil Protection Committees was quite high.

In South Africa the RSMC Pretoria informed South Africa's National Disaster Management Centre (NDMC) about the potential threat of tropical cyclone Favio on South Africa, as well as its likely impact on the Southern African region.

A key goal of the SWFDP was to improve the lead-time of alerting of severe weather events - and the case of Favio demonstrated success in this regard.

Tropical Cyclone Irina – March 2012

Within six weeks of the devastating impact of tropical cyclone Dando in January 2012 over southern Mozambique and South Africa, tropical cyclone Irina threatened the same region in early March. Irina was difficult to forecast as the ensemble prediction system model products from the global centres were not able to provide consistent guidance between different model runs (Figure 4). Initially the indications were that it will follow Dando into the subcontinent, but eventually it moved around just east of the sub-continent before it weakened.

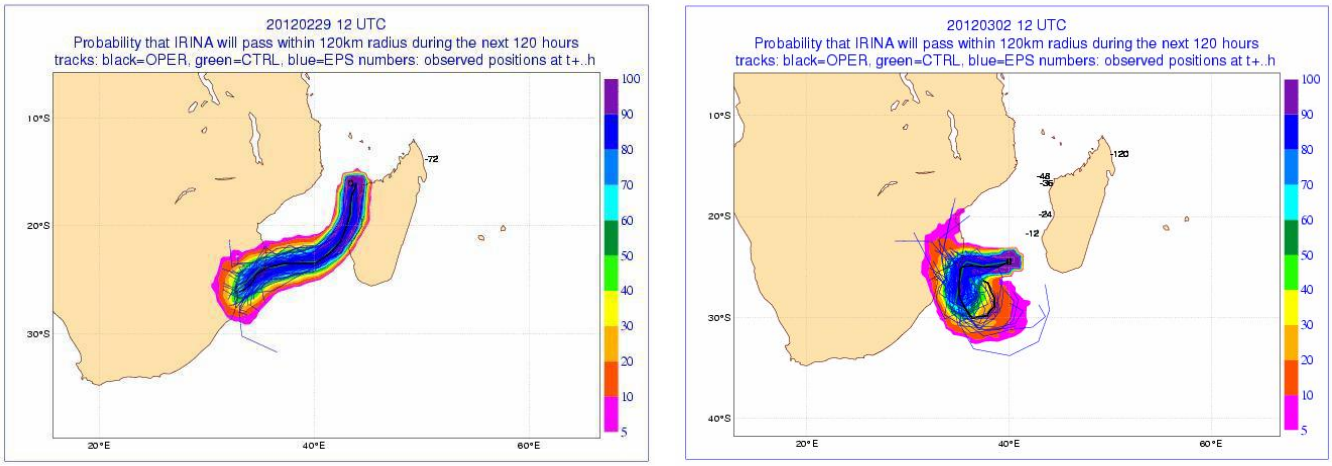

Figure 4. Conflicting products indicating the potential landfall of tropical cyclone Irina on 29 February (left) and 2 March (right).

This has lead to outstanding coordination between the RSMC Pretoria and the NMSs of Mozambique and Swaziland to predict the most likely path and impact of Irina. Frequent phone calls and email exchanges were made as the storm moved approached the sub-continent, changing its track daily. A couple of times every day during this period forecasters personally discussed the likely path based on the latest information available and the most appropriate communication to the relevant disaster management authorities. This forecasting coordination is an excellent example of what SWFDP is about, and the level of coordination achieved in the project.

The Value and Benefits of SWFDP

At its 2009 and 2010 session, the Commission of Basic Systems of WMO noted that the project continues to demonstrate the following:

- An accelerated implementation into operational use of outputs of advanced NWP/EPS systems;
- Continuous learning by forecasters as an effective way of capacity building;
- A sustainable "tight" cycle of demonstration, adapting to regional needs, evaluation, and operational implementation;
- Its contribution to adopting probabilistic forecasting methods;
- Increase in the visibility, credibility, and value of meteorological services in public and economic sectors;
- A possible new role of RSMCs of the GDPFS to synthesize and to provide forecasting guidance on severe weather forecasting to regional groups of NMCs.

Feedback from NMCs on the value of SWFDP

From the quarterly and annual reports of the SWFDP project in Southern Africa the benefits of the SWFDP project and its implementation to all Southern African countries are numerous. Among these are the following:

- Improvement of the early warning services in countries through the enhanced use of modern early warning technology such as NWP and ensemble prediction systems (EPS).
- Improve the early warning services to build resilience in support of disaster risk reduction
- Increase in the lead-time of warnings based on solid scientific information and guidance products.
- Increase in the support to national forecasters through the guidance products from RSMC forecasters, and additional NWP and EPS output, leading to enhanced confidence of forecasters in issuing forecasts, advisories and warnings.
- Capacity building of forecasters and thus NMHSs in using modern forecasting technology such as NWP and EPS.
- Increase in the access of forecasters from developing countries to modern forecasting information and improved forecasting systems.
- Increased collaboration between forecasters and their local disaster management and news media structures.
- Increased regional coordination between NMHSs, and also with the RSMC on forecasts, advisories and warnings.
- Opportunity to share, coordinates, and collates all weather warnings in the region.
- Enhanced severe weather warning services for the end-users including the general public
- Enhanced cooperation between RSMCs in the region
- Improved relationships between NMHSs, RSMCs and Global Centres
- Afford the opportunity to evaluate the performance of the global models including the usefulness of the products to forecasters

The country by country responses of the progress of SWFDP Phase 4 against the SWFDP Goals, as received in the individual country reports can be summarized as follows:

SWFDP Goal 1: To improve the ability of NMHSs to forecast severe weather events

From the input provided there is a unanimous conclusion that SWFDP-SA is still providing important guidance and products to improve the ability of NMHSs to forecast severe weather events. The RSMC Pretoria website remains the most important vehicle to get access to the products. The guidance products available on the website, the NWP and ensemble prediction system (EPS) products, as well as the limited area model products from UM SA12 and La Reunion Aladin is highly appreciated and has contributed to improved forecasts in most countries.

SWFDP Goal 2: To improve the lead-time of alerting these events

It was unanimously responded that the lead-time has increased due to the products provided through SWFPD. The role of EPS in this regard is evident.

SWFDP Goal 3: To improve the interaction of NMHSs with Disaster Management and Civil Protection authorities (DMCPAs), the media and the public, before, during and after severe weather events

A number of countries have significantly improved their relationships with their stakeholders during the project. There are still a few countries where NMHSs struggle to establish appropriate access to the DMCPAs where they do not exist properly, or others where new DMCPA structures recently were established. Other countries have developed excellent relationships, or report continuous improvement, with their DMCPAs. A number of countries are now also conducting, or planning to conduct, user surveys to establish user satisfaction. More need to be done in this regard, however.

SWFDP Goal 4: To identify gaps and areas of improvements (Addendum 1, table 4)
Gaps in the overall process have been identified and are addressed. These refer usually to the need for new specific products needed by the forecasters to address some specific forecasting issue. Other gaps in some countries relate to some training needs, lack of enough observation systems, internet speed challenging in some countries, and to the fact that in some countries forecasting is not a 24 hour service.

SWFDP Goal 5: To improve the skill of products from Global Centres through feedback from NMHSs
Individual comments and suggestions are made by countries as reflected in the summary report. It is evident that the products are very useful and global centres are applauded for continuing to provide them to the region.

Southern Africa Regional Flash Flood Guidance (SARFFG) System

Introduction
The WMO requested RSMC Pretoria in 2009 to be a regional centre for the implementation of their Flash Flood Guidance System (FFGS) project in a part of SADC. The FFGS (or SARFFG as the SADC regional version is called) uses satellite-based rainfall estimation as major input to the soil moisture and runoff modelling system over the 8000 river basins covering 7 countries and the model update times are 6-hourly. The main aim of the flash flood guidance systems such as SADC SARFFG is to provide guidance to weather forecasters on the potential for flash flooding in a specific basin. It is thus very similar in purpose than Numerical Weather Prediction models, but focussing on hydro-meteorological nowcasting. It is not intended to provide directly products to the public, but guidance to forecasters. It will be a significant development of the Regional Early Warning System in Southern Africa, of which the SWFDP is a principle component, and will build on the coordination framework already developed by SWFDP. This includes coordination between NMC forecasters and their disaster management authorities, and between the NMCs and RSMC Pretoria.

Progress of SADC SARFFG
The development and implementation of the SADC SARFFG system is funded by USAID. The development phase, Phase 1 of the FFGS project, was done by the Hydrologic Research Centre (HRC) in the USA. SADC SARFFG is currently running as a beta test system for more than a year at the HRC. Phase 2 implies operational implementation of the system and has commenced in January 2013. Operational implementation includes training of forecasters and the transfer of the main computer workstation to RSMC Pretoria as the operational host of the modelling system. This workstation accommodates the hydro-meteorological modelling system of SADC SARFFG. Forecasters of 7 SADC countries will then access the flash flood guidance products from this computer by internet (Figure 5). Training sessions for RSMC forecasters, ICT staff and SADC forecasters at RSMC Pretoria also forms part of Phase 2.

RSMC Pretoria will manage and maintain the SARFFG modelling system on the dedicated workstation, and its forecasters will provide guidance and support activities similar to SWFDP for the seven participating SARFFG countries on a daily basis. It is anticipated that a secretariat function, including reporting and an annual training session for the forecasters of all countries involved, will be performed by RSMC Pretoria.

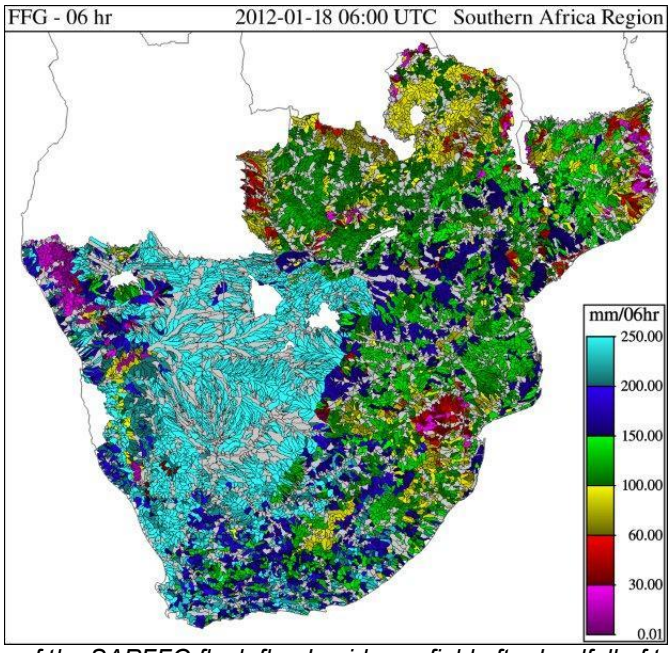

Figure 5. An example of the SARFFG flash flood guidance field after landfall of tropical cyclone Dando

CONCLUSION

RSMC Pretoria reports also to the Meteorological Association of Southern Africa (MASA), the association of SADC meteorological services. The two programme activities mentioned above, SWFDP and SARFFG, are currently the two main development activities involving RSMC Pretoria, and both are key projects for MASA. In this way RSMC Pretoria is attempting to fulfil its mandate as required by WMO, and to support the region, and specifically the SADC NMCs, with short-range forecasting activities.

World Meteorological Organization

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ANNEX II

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Weather • Climate • Water

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Public benefits of the Severe Weather Forecasting Demonstration Project in south-eastern Africa

by Eugene Poolman[1], Hector Chikoore[2], Filipe Lucio[3]

Introduction

The Severe Weather Forecasting Demonstration Project (SWFDP), conducted by WMO in south-eastern Africa from November 2006 to November 2007, tested a new concept for capacity-building of National Meteorological and Hydrological Services (NMHSs) in developing and Least Developed Countries to improve warning services to communities. The project received considerable support and interest, even before conclusion of the demonstration phase. What caused this interest? Maybe the answer is that it produced positive results quickly at a relatively low cost, demonstrating a practical way of supporting NMHSs of Least Developed Countries in applying modern forecasting techniques not easily accessible to them, in order to provide real benefit to their communities.

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2 Former Principal Meteorologist, Meteorological Services Department of Zimbabwe, Harare, Zimbabwe
3 Former Director, National Institute of Meteorology of Mozambique, Maputo, Mozambique

Background to the project

The science and practices of weather forecasting have improved around the globe at a tremendous pace over the past two decades. Major contributors to these improvements were the dramatic development in numerical weather prediction (NWP) systems, including ensemble prediction systems (EPS), giving guidance to weather forecasters many days in advance of potential hazardous weather conditions (ECMWF, 2003).

Weather services worldwide are taking advantage of these and other technological developments to improve their forecasting and severe weather warning services to the emergency management authorities and the public. The lead time of warnings of approaching severe weather has increased far beyond the traditional two days, and useful forecasts are given five days in advance with outlooks beyond that. Prospects for the future are exciting and advances in these technologies will increasingly push closer to the limits of predictability and improve services to communities (McBean, 2000).

The SWFDP Regional Subproject Management Team met in Maputo, Mozambique, from 27 February to 2 March 2007.

Against this exciting background, a different picture can be painted of the actual capabilities and services in many developing countries and Least Developed Countries in particular, where limited budgets and inadequate infrastructure hamper development and access by NMHSs to the latest technology. Very few of these NMHSs have adequate access to high-resolution NWP products, and even fewer use EPS products to extend the lead time of forecasts beyond two days.

The consequence is that a significant gap exists in the level of service that NMHSs of developing countries and Least Developed Countries can provide, compared to those in more prosperous countries. This gap is likely to increase in coming years as forecasting technology continues to advance. In an attempt to reduce this growing gap, WMO decided to explore ways to utilize existing numerical forecasting products in NMHSs where the sophisticated products are currently not used.

The Severe Weather Forecasting Demonstration Project

The Severe Weather Forecasting Demonstration Project (SWFDP) was initiated by the WMO Commission for Basic Systems to utilize the network of Global Data-processing and Forecasting System centres to provide NWP and EPS products through a cascading forecasting process from global centres via regional centres to a group of NMHSs. The first regional subproject was conducted in south-eastern Africa from November 2006 to November 2007. Its aims included the improvement of the ability of NMHSs to forecast severe weather events, improving the lead time of alerting to these events and improving the interaction of NMHSs with emergency management authorities before and during events.

Special NWP and EPS products were made available by the Global Product Centres involved, namely the European Centre for Medium-Range Weather Forecasts (ECMWF), National Centers for Environmental Prediction (NCEPs) (USA) and the United Kingdom Met Office. Regional Specialized Meteorological Centre (RSMC) Pretoria, designated to the South African Weather Service, was responsible for the distribution of NWP and EPS products through a dedicated Website to the participating NMHSs. RSMC Pretoria also provided daily guidance products of potential heavy rain or strong wind for the next five days based on an analysis of all available NWP and EPS products.

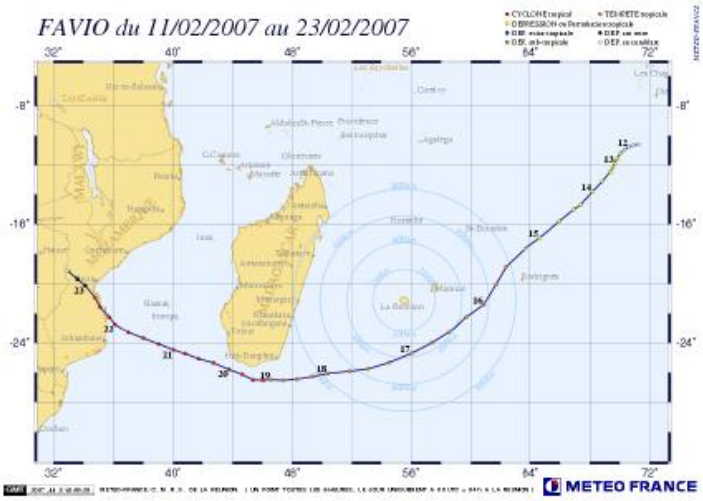
RSMC La Réunion, which is the RSMC responsible for tropical cyclone forecasts in the South Indian Ocean, maintained its normal operations and supported the project with valuable information used to prepare the guidance products. The participating NMHSs of Botswana, Madagascar, Mozambique, United Republic of Tanzania and Zimbabwe were then trained to use the guidance and model products on the RSMC Pretoria Website in deciding whether to issue warnings to their emergency management authorities of approaching hazardous weather in the next five days.

In the review of the project outcomes, it was noted that the project contributed significantly to the forecasting capabilities of the NMHSs involved (WMO Secretariat, 2008), and to the "quality and usefulness, including increased lead times of forecasts and warnings and increased confidence of forecasters". The review mentioned that the project improved significantly the lead time for alerting users to potential severe weather events, in some cases up to five days in advance. This allowed early dissemination of advisories and warnings to disaster management authorities and the media, which was appreciated by them and by the public.

In the final analysis, however, the project's success has to be determined by the impact it had on services to local communities through the warning chain. An appropriate test was the impact of the SWFDP process on potential human catastrophe before, during and after the landfall of tropical cyclone Favio on 22 February 2007 in Mozambique, and as it weakened and moved into Zimbabwe.

Forecasting *Favio*

Still struggling from the aftermath of earlier flooding in the central parts of the country that had left 120 000 people homeless (BBC report), Mozambique had to deal with *Favio* as it tore into the country on 22 February 2007 near the town of Vilanculos in the southern province of Inhambane. *Favio* developed as a tropical depression on 12 February north-east of Mauritius (see figure (*Favio* track)). By 19 February it had reached tropical cyclone status just south of Madagascar, and then started to turn to the northwest. *Favio* was classified as an intense tropical cyclone by RSMC La Réunion, with an estimated central pressure around 920 hPa (comparable to a Category 4 hurricane) on 20 February as it rounded the southern tip of Madagascar on its way towards Mozambique. It weakened marginally before making landfall with a central pressure estimated at 945 hPa. The local weather station recorded a wind speed of 195 km/h before it was blown away. Moving inland in a north-westerly direction towards Zimbabwe, it weakened though widespread heavy rain and flooding still occurred.



Track of Tropical Cyclone Favio *according to RSMC La Reunion*

Based on the information from RSMC La Réunion, ensemble tracks from ECMWF and other numerical model information, the guidance products indicated landfall close to Vilanculos in the Inhambane province of Mozambique five days in advance, despite disagreement between different model products on the position of the cyclone. Forecasts for the subsequent days were quite consistent (see fig (SWFDP guidance maps)), and movement northwards over Sofala province towards eastern and northern Zimbabwe was well predicted five days in advance.

The SWFDP products were used by the National Institute of Meteorology of Mozambique (INAM) and the Meteorological Services Department of Zimbabwe (ZMSD) as guidance to warn their disaster management authorities and the public up to five days in advance of the approaching threat. Both INAM and ZMSD used the guidance products during the subsequent days as guidance in support of their operational warning activities.