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

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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.

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

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).

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

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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 fig (*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.

Five day guidance from RSMC Pretoria for 22 February produced on 18 February based on ensemble predictions and other NWP guidance.

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.

On 19 February, as *Favio* was becoming a threat to Mozambique, INAM issued special warnings to the National Emergency Operations Centre (CENOE) of the National Institute for Disaster Management, which had been activated during the floods in the central part of Mozambique in January. These warnings were to allow for CENOE to take preparedness measures. Public warnings were initiated on 20 February, when *Favio* was in Mozambican territorial waters. The provinces of Maputo, Gaza and Inhambane in the southwere put on BLUE ALERT. On 21 February, Gaza, Inhambane and Sofala were on YELLOW ALERT. On 22 February, the provinces of Inhambane and Sofala were on RED ALERT (the highest level. Warnings were disseminated by INAM to the media (print and broadcast) and INAM's onsite meteorologist at CENOE provided updates to the Technical Emergency Committee on the status of forecasts and warnings.

By 14 February, It was evident to ZMSD that *Favio* was heading towards the mainland and towards the north-east of Zimbabwe, given the skill and agreement of the available guidance. Alerts were issued to government and civil protection and disaster management authorities by 15 Feburary, whilst early warnings were disseminated to the public from 16 February. Regular updates followed early warnings until the event in different media as newspapers, radio and television. The radio is the most effective communication tool in Zimbabwe as it reaches even remote communities in real-time.

In South Africa, RSMC Pretoria informed and interacted with South Africa's National Disaster Management Centre (NDMC) about the potential threat of *Favio* on South Africa, as well as its likely impact on the entire southern African region.

Impact of the storm and response of disaster management authorities and the public

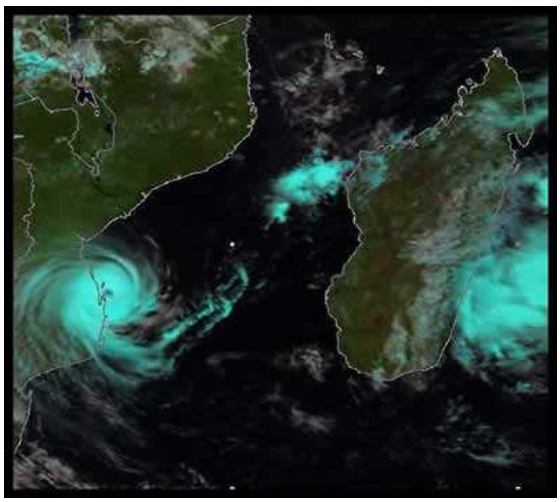
The Mozambican Disaster Management Institute (INGC) was on high alert following the warnings of INAM since 19 February. It declared an alert status and prepared to respond through the coordination of activities of the members of the Technical Emergency Committee that involves government, NGOs and the UN system. INGC, through the media and local government, advised the population of the areas at risk of precautionary measures to take. The response of the population, local authorities to the warnings and the measures being announced was remarkable. The response prevented major loss of life, given the impact of the cyclone. Unfortunately, nine people were killed by *Favio* and 92 injured in the province of Inhambane. The mayor of Vilanculos told Reuters (BBC News, 2007) that roads were blocked by falling trees, homes damaged and further flooding occurred.

The South African disaster management authorities (through the NDMC) offered support to their counterparts in Mozambique during relief operations as and when needed. However, the latter were far better prepared than in 2000 when tropical cyclone Eline ravaged the country and were quite capable to deal with the situation following the lessons learned from that disaster.

Scores of volunteers were ready to move people to the relative safety of schools and churches. INAM advised the provincial authorities to start implementing preparedness measures in areas likely to be impacted by *Favio*. 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 already preparing for the impact of the cyclone on Inhambane and Sofala provinces and surrounding areas a few days beforehand. They activating their early warning procedures and contingency plans, alerting their provincial delegations which disseminated information through their staff and volunteers to local communities.

In Zimbabwe, the city of Mutare was still recovering from the considerable damage it experienced in 2000 from Eline, when ex-*Favio* moved in on 22 and 23 February. A newspaper reported (Zunidza, 2007) that, by 24 February, several roads in the area were virtually impassable and villages were cut off as bridges had been washed away. No outdoor activity was possible, and businesses had to close down. It appeared that less damage occurred than when Eline hit the area, despite the continuous heavy rain that started on the evening of 22 February and lasted for more than 36 hours. However, according to the report, the warnings from ZMSD went largely unheeded by residents in the Mutare region until the heavy downpours began. This may suggest mistrust of the public of severe weather warnings issued by ZMSD, based on previous experiences. Previously, before EPS- based storm tracks, tropical cyclone forecasting was based largely on persistence and they lacked skill. Despite lack of attention to warnings by some members of the public, the level of disaster preparedness by civil protection committees was quite high (Herald, 24 February 2007).

The Department of Civil Protection in Zimbabwe received the first early warnings from ZMSD seven days ahead. A key goal of the SWFDP was to improve the lead time of alerting to severe weather events—and the case of *Favio* demonstrated success in this regard. The Department convened meetings with key stakeholders in disaster management, including ZMSD, hydrology, the police, Air Force and health, and the areas at greatest risk were mapped out. It was from these meetings that warnings were formulated and disseminated to civil protection committees in the affected areas and to the public via the different media.



Satellite image of Tropical Cyclone *Favio* at landfall on 22 February (Meteosat Second Generation)

Lessons for the future

The SWFDP focused attention on developing the scientific capacities of participating NMHSs in the early warning cycle. However, *Favio* gave the SWFDP an opportunity to test the application of the cascading early warning process and its impact on preparedness of disaster-management authorities and communities in an operational disaster situation early in the project's demonstration phase.

During the progress meeting of the SWFDP's Regional Subproject Management Team held coincidentally from 27 February to 2 March 2007 in Maputo, the roles of disaster management authorities in the dissemination phase of the project were discussed. As an example of input received, the Department of Civil Protection (responsible for disaster management activities in Zimbabwe) observed: "there has been a marked improvement in severe weather information and products provided by the Service (the NMHS) since the commencement of the SWFDP in November 2006" (WMO, 2007). It further stated: "there is still need for more detail and specifics with regards to the actual locations that would be hit by severe weather"—a sentiment shared by most disaster management authorities.

At the end of the demonstration phase, a number of lessons had been learned learned and gaps in the early warning process related to the public benefits identified. These gaps need to be addressed in future activities following on from the SWFDP. Although, in some instances, collaboration between NMHSs and disaster management authorities proved to be quite healthy (as shown in the case of *Favio*), it was not always the case with all the participating countries and this aspect needs to be addressed in more depth in the future. Prompting reaction from communities at ground level on the basis of the information provided by the NMHS is a challenge that will need special attention.

The SWFDP clearly proved its value in building the capacity of NMHSs in developing countries and Least Developed Countries to improve their early warning service and extend the lead time of warnings. The WMO review of the project (WMO, 2008), however, also emphasized that the value of the SWFDP was not only limited to severe weather forecasting in the region; it also supported day-to-day routine weather forecasting. Moreover, it played an important role in harmonizing the day-to-day forecasts of the NMHSs in the region. The SWFDP showcased a concept that worked for these five countries to such an extent that the other nine countries of the Southern African Development Community requested that it should be rolled out as an operational activity for them also. This was and will be done during 2008 and 2009. It should not end there, however. Hard work is needed in the coming years to address the gaps already identified, particularly to develop stronger links between the NMHSs and the emergency preparedness and response agencies and regional organizations. The use of the services provided by the NMHSs to these agencies for national disaster risk reduction actions must be enhanced to realize real benefit to the communities of all countries in southern Africa in the face of looming weather-related disasters.

Special recognition for the success of the project must be given to the management, forecasters and support staff of all the participating countries, the regional and global centres, and to WMO,which initiated, supported, funded and guided the project.

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