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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

POLICY BRIEF

Disaster management

Improving early warning systems for climatic events

A completed Water Research Commission (WRC) study has sought to enhance the early warning system against flash floods in South Africa.

Background

Almost 95% of all natural disasters occurring in South Africa are weather related. Of these, the most numerous disasters on record since 1920 involving loss of life and property are due to floods and flash floods.

Floods have the most significant impact of all natural disasters on communities and their livelihoods in South Africa. The expected changes in the frequency and intensity of heavy precipitation due to climate change could lead to an increase of flood events worldwide.

In South Africa, impacts are exacerbated by progressively increased urbanisation over the last 100 years, which has increased the vulnerability of people as more communities settle in floodplains. In response to this threat, this study for the WRC was conducted in order to enhance the early warning system against flash floods in South Africa.

Floods have a significant impact on the communities of South Africa. (Credit: Africa Media Online)

The main focus of the study was the improvement of the so-called SAFFG – a hydrometeorological modelling system that simulates the most likely hydrological response of 5 366 small river basins to rainfall estimated from weather radars and the Meteosat meteorological satellite. The study further sought to enhance the prediction tool to support water resource and disaster managers in flash flood risk evaluation and analysis, river flow forecasting as well as precipitation estimation.

The primary sources of error in SAFFG was found to be the quality of the radar and satellite precipitation estimation, as well as the calibration of the basins to allow realistic simulation of soil moisture conditions affecting runoff production. These problem areas were a major focus to improve SAFFG.

Another important development area was to device special products and information and information, based on the SAFFG output, for enhancing the decision-making capacity of forecasters and disaster managers.

Main results

The study succeeded in improving the application of SAFFG in the flash flood warning system in South Africa in two main areas:

- The SAFFG modelling system was enhanced through the improvement of the rainfall estimation techniques and identification of calibration issues affecting performance of hydrological models;
- User-oriented products were developed aimed at improving the application of SAFFG in the decision-making systems used by weather forecasters, water managers and disaster managers.

An analysis of the archived output of SAFFG revealed that it performed reasonably well in capturing a climatologically realistic pattern of flash flood potential, particularly during organised convective rainfall situations, when using rainfall estimated by the S-band radars (using a 10 cm wavelength) in Gauteng, KwaZulu-Natal and the eastern parts of the Eastern Cape. A number of prominent and serious flash flood events were well captured by SAFFG and provided useful guidance to weather forecasters.

C-band radars (5 cm wavelength) radars in Port Elizabeth, and for a few months in 2012 in Durban, experienced serious interference from radio LAN operated by private companies and individuals in the radar domain. Filters deployed to reduce this interference led to significant underestimation of rainfall by these radars and their data had to be removed from the rainfall estimation data field.

Satellite rainfall estimation, which relies heavily on cloud-top temperature measurement, is more effective for convective clouds with high cloud tops than for stratiform clouds with much lower cloud tops. Consequently, serious underestimation of rainfall by satellite occurred during stratiform rainfall situations, as experienced during the winter in the Western Cape.

This resulted in very few flash flood events being simulated realistically. To overcome this issue, the satellite convective rainfall estimates were blended with the stratiform rainfall forecasts from numerical weather prediction products of the UK Met Office United Model, run at the South African Weather Service (SAWS). This new combined rainfall product proved to be an improvement, which led to more realistic capturing of flash flood potential ion the Western Cape.

An important component of any early warning system is the link between the forecaster and the disaster manager, which ensures effective response by communities at risk to the warnings issued. This requires a complete package of user-oriented information that allows disaster management to translate the warning into disaster risk information that allows life-saving decisions to be made.

Workshops were conducted with various disaster management centres to determine user needs regarding flash flood forecasting and warning products. This resulted in the development of a series of new user-oriented products, including maps at local municipality level, for alerting users in local municipalities to potential flash flood problems.

Conclusions and way forward

The flash flood warning system in South Africa has brought together the meteorological, hydrological and disaster management sectors, ensuring mutual collaboration. The WRC project succeeded in making important improvement to the SAFFG modelling system following its initial implementation in 2010. It has been the catalyst for a number of subsequent activities aimed at improving the entire flash flood warning system in South Africa.
A system similar to SAFFG, the Southern African Regional Flash Flood Guidance System (SARFFG) has been implemented for nine countries in the southern African region by the World Meteorological Organisation (WMO). Compared to SAFFG, SARFFG, uses only satellite information and covers the nine southernmost countries in southern Africa, but at a lower resolution. Improvements made in the SAFFG system will also benefit the SARFFG.

Parallel to this WRC project, SAWS has entered into a separate project agreement with the Hydrologic Research Centre (HRC) in San Diego, USA, who are the developers of SAFFG. The purpose of this project is to perform additional upgrades to the modelling system, based on the recommendations of the WRC project.

Other subsequent activities include a project by WMO, to start in 2015, which aims to integrate SARFFG into the Severe Weather Forecasting Demonstration Project, developed as a SADC regional severe early warning system, with SAWS as the regional specialised meteorological centre.

An innovative outcome of the project is an initiative to move beyond forecasting the hazard towards forecasting the impact of the hazard. An impact forecasting concept will be further developed in a collaborative effort between SAWS and disaster management for operational implementation in South Africa over the next few years.

Further reading:
To order the report, *Improvement of Early Preparedness and Early Warning Systems for Extreme Climate Events – Flood Warnings* (**Report No. 2068/1/15**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.