POLICY BRIEF

March 2019
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.

An integrated early warning forecast system for wet seasons

Southern Africa experiences extreme climatic conditions over time and space. Sea surface temperature anomalies have a pronounced impact on the region's weather, putting the region at risk of flooding. A Water Research Commission project set out to improve warning systems to manage flood systems in north-eastern South Africa by exploring the links between forecasting rainfall and streamflow. Among others the research successfully demonstrated that forecasts can provide accurate guidance on the spatial occurrence and timing of occurrence of major flood events induced by landfalling tropical cyclones.

Background

Southern Africa experiences significant climate variability over space and time. The interannual climate variability in the region is mostly driven by the fluctuations of sea surface temperature anomalies in the tropical Pacific Ocean, commonly known such as as El Niño and La Niña events, respectively.

With the exception of the south-western Cape, southern Africa receives most of its rainfall during the summer. This project focused on the north-eastern region of South Africa.

Improving the forecasting of floods

The north-eastern part of South Africa is characterised by a vast network of rivers. The region is also highly susceptible to the impact of tropical lows and cyclones. For instance, the landfall of tropical cyclone Eline in February 2000 caused severe flooding in the Limpopo River system, which led to devastating socio-economic impacts.

Seasons associated with flooding in north-eastern South Africa tend to be strongly associated with La Niña events. The seasonal predictive skill in giving early warning of such events is high.

This predictability, in combination with the high vulnerability of the region to flood events, gave rise to this project with its focus of a ***ready-set-go*** strategy to manage flood events in north-eastern South Africa.

The basic idea is that seasonal forecasts can provide early warning of potentially wetter than normal seasons, which may imply the occurrence of flood events (***ready*** mode). Those who are likely to be affected by floods as well as risk managers can then begin to monitor the medium-range forecast (up to 14 days) (***set*** mode) to ensure that contingency plans in risk-prone areas are updated.

The ***go*** part includes short-range weather forecasting for the next 48-hour period, which is the action step. Risk managers can then start to evacuate people to lessen the societal impacts of floods.

This project used the weather prediction system of the CSIR to explore the skill of forecasting rainfall and streamflow for north-eastern South Africa at seasonal to short-range timescales.

More specifically, the project aimed to:

- Expand on the Conformal Cubic Atmospheric Model (CCAM) seasonal forecasting capability of the CSIR by combining it with the Coupled Atmosphere Biosphere

Land Exchange (CABLE) dynamic land-surface model and using its river routing scheme.
- Expand the CCAM short-range forecast system to medium-range (forecasts up to 14 days ahead).
- Explore the impacts of very high spatial resolution on short-range and seasonal forecasts over the north-eastern interior of southern Africa.
- Develop statistical downscaling schemes for seasonal, medium-range and 48-hour forecasts of river flows over the north-eastern interior of South Africa by using the daily flow data hosted by the Department of Water and Sanitation.

Methodology

In order to address the aims of the project, the CCAM was used to generate short-range through to seasonal timescale forecasts over north-eastern South Africa. These forecasts were statistically downscaled to streamflows in quaternary catchment areas.

The study also explored the use of a dynamical river routing scheme within the CABLE dynamic land-surface model to simulate river states at daily and seasonal timescales. This work represents the first application of a dynamic river routing scheme in South Africa.

Main findings

A key project finding is that the seasonal forecast skill used to predict wet conditions over north-eastern South Africa during La Niña years does translate into a skill for forecasting anomalously high values of streamflow (as obtained through statistical downscaling).

This implies that numerical seasonal forecast systems can provide the ***ready*** stage of a ***ready-set-go*** early warning approach to manage floods over this region. These forecasts have been found to be skilful at lead times of one to three months.

Short-range weather forecasting in combination with statistical downscaling can indeed also function as the ***go*** component in a ***ready-set-go*** early warning flood management tool for north-eastern South Africa, with medium-range forecasts that can be used for the ***set*** stage of such a system.

In particular, the research demonstrates that such forecasts can provide accurate guidance on the spatial coverage and timing of occurrence of major flood events induced by landfalling tropical cyclones.

The findings of this study further show that the spin-up time period required by the CCAM CABLE with the dynamic river routing scheme, as well as the initialisation of streamflow within the river routing scheme, can be a limiting factor for the practical application of this system as an early flood warning management tool. However, at a high spatial resolution, many of the key South African river systems are resolved realistically, which indicates the potential of applying the system to seasonal forecast systems and climate change projections.

In summary, seasonal forecast skill in predicting wet conditions over north-eastern South Africa during La Niña years do translate into the skill of forecasting anomalously high values of streamflow, implying that numerical seasonal forecast systems can provide the set stage of a ***ready-set-go*** early warning approach for managing floods in north-eastern South Africa.

Associated project:
An integrated early warning forecast system for wet seasons and their relationship to flooding events: A predictability study in support of hydrological applications (**2522/1/18**). Contact the WRC at Tel: (012) 761 9300, or Visit: www.wrc.org.za.