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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.

TECHNICAL BRIEF

Disaster management

Investigating a short-term heavy rainfall forecasting system for South Africa

A completed study, funded by the Water Research Commission, has studied a short-term heavy rainfall forecasting system for South Africa.

Typical heavy rainfall occurrence in South Africa

The heavy rainfall events resulting in widespread flooding and disruption of infrastructure and even loss of life do occasionally occur in some parts of the country. However, heavy rainfall may also occur in isolated areas from so called meso-scale weather systems, resulting in flash flooding.

In order to understand the characteristics of heavy rainfall better, the climatology was developed over a homogenous area in South Africa – the Gauteng Province. The results generated from the climatology were then used to understand the atmospheric circulation and thermodynamics associated with heavy rainfall over Gauteng.

Most of the summer rainfall over South Africa is convective in nature as demonstrated by the copious amounts of annual lightning. In order to understand the occurrence of rainfall associated with lightning six years of lightning data was used to identify areas prone to the initial development of convection.

Aims of the WRC project

The project aimed to develop an ingredients-based heavy rainfall forecasting system for South Africa placing emphasis on the forecast period from 0-24hrs. The forecasting ingredients consist of detailed rainfall climatology on different time scales, sounding derived parameters, lightning characteristics and METEOSAT Second Generation (MSG) features, a Convective Initiation index as well as forecasts from Numerical Weather Prediction (NWP) models.

Results and findings

A heavy rainfall event occurs when the average rainfall exceeds 15 mm while a very heavy rainfall event is when the average rainfall exceeds 25 mm. January months have the highest monthly average rainfall as well as the highest number of heavy and very heavy rainfall days. The month with the second highest number of heavy and very heavy rainfall days is February followed by March and October.

December has the second highest monthly average rainfall and the most days with rain. However, it is also the month with the lowest number of heavy and very heavy rainfall days. The highest 24-h rainfall recorded at a single station during the 32-year period was 300 mm in December 2006.

The central and north-western parts of the province experience the most events where the rainfall at a single station surpasses 75 and 115 mm. Truly significantly high seasonal rainfall is associated with above normal rainfall in late summer.

The parameters which could be used to identify heavy rainfall over Gauteng were identified. A striking feature of the seasonal variation of these parameters is how the atmosphere changes from one with a very distinct extra tropical nature in October to one which is clearly tropical in February months. The parameters associated with moisture provide the best guidance in distinguishing days with heavy rainfall over Gauteng.

Heavy rainfall over Gauteng is often associated with winds with a northerly component but wind shear is not

associated with heavy rainfall. The average wind speed in the 800-600 hPa layer is below normal in late summer when heavy rainfall occurs.

The synoptic circulation patterns associated with heavy rainfall also changes significantly from early to late summer. In all months heavy rainfall is associated with an increase in depth of the surface trough over the interior of Southern Africa. However, the average position of the surface trough when heavy rainfall occurs differs from month to month. It lies over the western interior in October months but over the Free State in January and February months.

In early summer heavy rainfall over Gauteng is associated with a westerly trough west of South Africa at 700 and 500 hPa. In late summer this trough is located further south with a weak 700 hPa ridge over Gauteng. There is also an easterly inflow of moisture north of Gauteng in late summer when heavy rainfall occurs.

There is more than 200 000 lightning strokes in Gauteng in summer. December is the month with the highest number of lightning strokes and March the least. When average heavy rainfall occurs over Gauteng there is significantly more lightning than the average value. When heavy rainfall occurs at a single station the number of lightning strokes over the province is still more than the average values but less than when average heavy rainfall occurs.

This indicates that widespread heavy rainfall over Gauteng is convective in nature. Most lightning strokes occur in the southeast of the province, with significant less lightning in the north. There is a direct relationship between the number of lightning strokes over Gauteng and convective cloud base height.

The precipitation forecasts from 4 NWP models were combined into a 6-hourly rainfall ensemble. The rainfall ensemble was verified against automatic weather station data at several grid points over South Africa for the 2010/11 summer rainfall season.

Two categories of rainfall were also verified: rainfall events greater than 1 mm and rare rainfall events of 6 mm over six hourly time intervals. The ensemble showed some skill in predicting rainfall over South Africa, however these skills were low and during some months the ensemble forecasts performed worse than persistence.

Implications

This project provided the opportunity for capacity building where several meteorology students participated and benefitted. At least one research paper was published and several research presentations were given at South African Society for Atmospheric Sciences (SASAS) conferences. Understanding short-term heavy rainfall is useful for disaster risk reduction and management of effects of extreme events associated with such a heavy rainfall event.

Further reading:
To order the report, *A short-term heavy rainfall forecasting system for South Africa with first implementation over the Gauteng Province* (**Report No. 1906/1/12**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za to download a free copy.