

Extreme events

Investigating the attributes of extreme rainfall

A completed WRC-funded research project studied past and future changes in the attributes of extreme rainfall and the dynamics of their driving processes.

Background

Extreme rainfall events are often associated with significant societal and infrastructural impacts through human and animal fatalities, damage to or loss of property, loss of agricultural products, and flood insurance claims, which are costly.

This research study sought to investigate changes in the characteristics of extreme rainfall by establishing relationships between existing station data and the daily synoptic states.

Objectives and methodology

The dynamic aspects of heavy rainfall in contemporary climate to provide a process-based understanding of observed changes were investigated and a basis for understanding future projected changes established. This was done in order to:

- Produce a rainfall station data set that had been quality controlled according to international standards; and to
- Identify key synoptic processes that resulted in extreme rainfall based on the cleaned station data and atmospheric circulation fields as well as trends.

Station data quality control methods were applied to station data obtained from the Computing Centre for Water Research (CCWR), the Agricultural Research Council (ARC) and the South African Weather Service (SAWS). This procedure identified errors in the station data, conflicts in the metadata between the three data sources as well as complexities around station nomenclature.

However, through this procedure, a quality controlled station data set was generated that could be used in the rest

of the study from which stations that had 95% data present between the period 1979 and 2009 were selected. This process yielded 696 stations suitable for analysis.

To identify circulation states related to extreme rainfall, a Self Organising Map (SOM) was used to characterise circulation states in the 31-year period. General synoptic circulation modes over the country were generated by the SOM and those associated with seasonal extreme rainfall were identified.

To investigate the regionally specific characteristics of extreme rainfall nine regions based on rainfall regimes were assessed. This assessment identified specific synoptic states that were associated with extreme rainfall in particular seasons.

Characterisation of heavy rainfall

Summer rainfall extremes are related to a sub-tropical low pressure over the interior and winter extreme rainfall to mid-latitude cyclone types of circulations. Shoulder season extreme rainfall is associated with both summer and winter types although dominant circulation modes are not as apparent as in the core winter/summer seasons.

However, South Africa experiences a number of rainfall regimes which affect different regions of the country. Summer recorded the highest occurrence of extreme rainfall in all regions with the exception of the South Western Cape and South Coast regions (winter and spring respectively) and was usually associated with a surface low of varying depth over the central or western interior and a high pressure over the south and/or east coast.

In the Western Cape extreme rainfall occurred primarily in winter and was associated with a surface low in the

mid-latitudes and over the region and an upper air trough to the south west.

Extreme rainfall in the South Coast region occurred in the shoulder seasons and winter and was associated with the passage of a cold front a ridging high pressure and strong surface linkages between the sub-tropics and the mid-latitudes. Seasonal changes in the frequency of occurrence of circulation modes were very evident in the shoulder seasons and less so in summer and winter.

These shoulder season trends were evident in both frequently occurring circulation modes as well as those that occurred less frequently.

Implications and future research

Further research is recommended to:

- Identify extreme rainfall regimes as opposed to general rainfall regimes used,

- Investigate an event-based classification procedure of extreme rainfall synoptic circulation modes,
- Undertake a climate change study to investigate projected changes in the characteristics of extreme rainfall within the Co-Ordinated Regional Downscaling Experiment framework and
- Downscale to the station scale the new CMIP 5 general circulation model data which will be available in 2012 for comparison with contemporary station data.

Further reading:

To order the report, *Extreme events: Past and future changes in the attributes of extreme rainfall and the dynamics of their driving processes* (**Report No. 1960/1/12**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za to download a free copy.