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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

Climate and water

Investigating the predictability of seasonal climate

A Water Research Commission (WRC) study investigated the predictability and attribution of the South African seasonal climate.

Background and rationale

The prospect of future improvement in seasonal forecasting underpins much of the development in frameworks for managing water resources. Yet, against this prospect, recent progress in forecasting the seasonal climate state has been incremental at best.

In this light, an urgent need was identified to determine how predictable the seasonal climate state is over South Africa, given the knowledge of the ocean state, land surface state and atmospheric composition that provide the conditions for predictions.

This WRC study undertook a first examination of how South African seasonal predictability varies from year to year and why it does so. It also examined the degree to which anthropogenic emissions may have altered the chance of extreme weather events, with implications on increasing predictability of the chance of these events under a changing climate.

This was a climate-model-based study, using a variety of novel climate model data products tailored to address the aims of the project.

Establishing the limits of predictability of SA seasonal climate state

The first part of the project examined the degree to which seasonal predictability, and thus the confidence in our forecasts, may be inherently changing through time.

Most analyses in this project addressing this aim use a unique climate model resource, the weather@home/SAF project, which included a large number of 'hindcast' (like forecasts but with perfect knowledge of the boundary conditions) simulations covering the 1960-2009 period, using a similar modelling system to that used by the operational seasonal forecast service issued by the University of Cape Town.

The ranges of simulations exhibit a strong east-west gradient in the case of precipitation, and a strong coastal-inland gradient in the case of temperature. Interannual variations in the spread of the simulations are larger than expected purely by chance given the number of simulations.

While the occurrence of El Niño and La Niña events in the tropical Pacific (known to strongly influence South African climate) are linked to variations in the spread of the simulations, robust relationships are not found for other areas of the ocean that are also considered to strongly influence South African climate.

While some suggestions of interannual variations in the spread of forecasts of stream flow in a major hydrological system, the Okavango River, are found, the evidence for a relationship is not conclusive.

Estimating the contribution of anthropogenic emissions to forecast predictability

The spread of model simulations shows long-term narrowing and widening trends for both monthly rainfall and temperature, with the nature of the trends varying as a function of location and season.

A narrowing of the width of precipitation spread occurs over inland provinces from late austral spring to summer. Trends in temperature spread exhibit narrowing tendencies along the coasts from spring to early summer.

These long-term trends are larger than expected due to sampling considerations, and in some cases amount to an appreciable fraction of the average spread of the simulations.

While a formal analysis linking the trends to anthropogenic emissions is not conducted, anthropogenic emissions are the major long-term driver of climate change, especially for temperature, and thus the narrowing and widening trends indicate the potential that anthropogenic emissions are substantially altering the nature of South African seasonal forecasts.

Characterising the relevance of the limits of predictability

The analyses of the variations in the spread of the simulations described above indicate some potential for added-value in the addition of a measure of confidence to seasonal forecast products. The variations in simulation spread found in this project are reflected in variations in mode forecast skill, indicating that the variations in simulation spread do indeed reflect real-world variations in seasonal predictability.

Furthermore, some long-term trends in spread amounted to a substantial fraction of the averaged simulation spread. However, how effectively such a measure of confidence can be implemented depends strongly on how seasonal forecasts are presented.

When described as an anomaly with respect to some baseline climatology, skills and confidence in the forecast may be increasing through time as a result of anthropogenic climate change, a somewhat artificial apparent increase in confidence that may overwhelm any real increases along the lines of those studied in this project.

Estimating the attribution of risk of extreme events to anthropogenic emissions

The second part of this project examined the degree to which anthropogenic emissions may be altering the chance of unusual monthly events. As the climate warms in response to anthropogenic e missions, many of the largest impacts are expected to be manifest through changes in the frequency and intensity of extreme weather events.

There has been much attention in the media over the question of whether anthropogenic emissions are 'to blame' for specific recent damaging weather events, and the question of liability may be emerging as a major component of a 'loss or damage' mechanism for distributing international climate change adaptation funding.

This project included further development of the Weather Risk Attribution Forecast (WRAF) service, a regular monthly assessment of the degree to which anthropogenic greenhouse gas emissions have altered the chance of weather of events around the world (frequently termed 'event attribution').

Using simulations generated through the WRAF system, it is found that event attribution estimates are neither sensitive to the choice of climate model used, nor to downscaling methods when examining the chance of flooding events in a hydrological system.

According to the analyses in this project, anthropogenic greenhouse gas emissions have at least doubled the chance of unusually hot months over South Africa during all times of the year, and similarly at least halved the chance of cold months.

Changes in the chance of unusual rainfall events are less strong, but there does appear to be at least a decrease in the chance of unusually wet months during the onset and cessation of the west season, with a concomitant increase in the chance of dry events.

Despite recent tendencies toward higher floods in the Okanvango Delta, analyses in this report indicate that anthropogenic emissions have decreased the chance of higher floods as a result of increased evaporation in a warmer climate.

Outputs from the project

At the time of completion of the final report work was nearing finalisation on setting up a new version of the UCT seasonal forecast using a more realistic modelling setup and using a much larger number of simulations. The latter is necessary for adding confidence guidance into the forecast product.

Nevertheless, the forecast system still does not include

dynamical interaction between the atmosphere and ocean: thus whether the ocean dynamics themselves exhibit variations in predictability is something that has not yet been examined with respect to the South African seasonal climate.

The attribution component of this project served as a trial experiment of the World Climate Research Programme's International CLIVAR C20C+ Detection and Attribution Project, both in terms of developing a template and for testing various aspects of the planned experimental protocols.

Lessons from this trial experiment are being applied in the fulfilment of the C20C+ D&A Project's core experiment. Lessons for development and operation of the Weather Risk Attribution Forecast are informing development of comparable services in the UK and the USA.

The event attribution capacity now existing at UCT, with extensions to hydrological impacts, is especially relevant given recent concern that Africa should be developing an attribution capacity to inform climate change adaptation funding mechanisms. Facilitation to further development of African capacity for attribution analyses, such as the workshop and fellowship being planned at the African Centre of Meteorological Application for Development (ACMAD) and other institutions outside Africa could thus form a major development in availability of scientific information supporting climate change adaptation activities.

Further reading:
To obtain the report, *Predictability and attribution of the South African seasonal climate* (**WRC Report No. 2067/1/15**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.