LINKING SEASONAL FORECASTS TO USER NEEDS IN THE LIMPOPO BASIN IN SOUTHERN AFRICA

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Zone 4: Central Mozambique, southern Malawi, northern half of Zimbabwe, most of Zambia, southernmost DRC, south-eastern half of Angola, bulk of Namibia, western half of Botswana, most of central and western parts of South Africa, western parts of Lesotho.

Increased chances of normal to below-normal rainfall

DECEMBER 2015-JANUARY-FEBRUARY 2016

Zone 4: Southern third of Zimbabwe, eastern half of Botswana, north and central South Africa, eastern Lesotho, Swaziland and southern Mozambique.

Increased chances of normal to below-normal rainfall
“If there is a drought, the small farms will collapse, they won’t function, they will get no profit from their animals…

… if I can get advance about drought, then I will be able to organise some feeds for the cattle, I will be able to see to it that my dam is up to date, you know, water is enough in the dams”

Stephen Lebotsa, Chairman
Mobidibeng dairy Cooperative
Limpopo Province, South Africa

“The situation is that there is not enough water in Southern Africa, the rainy season is short…. 

... so we need research to better manage the water resources”

Jakkie Venter, Area Manager, Department of Water Affairs, Tzaneen area office, Limpopo Province, South Africa

An evidence-based protocol for designing and implementing drought early warning systems

The DEWFORA Approach

- What is the science available?
- What are the societal capacities?
- How can science be translated into policy?
- How can society benefit from the forecast?
SEASONAL HYDROLOGICAL FORECASTING OF USER RELEVANT VARIABLES: LIMPOPO BASIN

- Droughts in the Limpopo:

Questions:

Do we have the science to provide skilful (hydrological) drought forecasts?

and

Do these provide variables that are useful to water users?
METHODOLOGY

Meteorologic forcing
• Precipitation
• Temperature (mean, max, min, - ensembles)

"Pre-processing"
• Bias-correction of precipitation
• Estimation of potential evaporation (PE)

Hydrological forecasting
• PCR-GLOBWB hydrological model
• DELFT-FEWS forecasting shell

Results
• Predicted (ensembles) streamflow, soil moisture, and other hydrological fluxes

ECMWF S4
Ensemble Streamflow Prediction
ESP Conditioned on ENSO

Possible states of the forecast → Probability of (not) exceeding thresholds
Forecast is justified if it supports better decision making → then it has value

- Major use in the basin: irrigation.
  - Meaningful indicators for a better decision making:
    - Standardised Runoff Index (SRI)
    - Agricultural drought (soil moisture)
    - Reservoir levels: curtailments in irrigation

- Verification skill scores (assess quality):
  - ROC → Ability of the forecast to discriminate between events and non-events
  - BSS → Relative skill of the probabilistic forecast over that of climatology
  - Rank histogram → How well does the ensemble spread of the forecast represent the true variability (uncertainty) of the observations
**SKILL ASSESSMENT: ROC DIAGRAMS**

SRI6 ≤ -0.5 : Skill in predicting moderate drought at 5 months lead time

*ROC Score: area under the curve.*

1 : Perfect
< 0.5 : No skill
ROCS SOIL MOISTURE & WATER LEVEL IN RESERVOIRS

Tzaneen Dam
Curtailments (hedging) to irrigation & water supply if reservoir levels lower than normal

ROCS for: Water Level (WL) < 50th percentile (upper plot), and WL < 37.5th percentile (lower plot) for the FS_S4 forecasts

Does seasonal forecasting gain importance in the future due to climatic change?
- Do critical weather conditions (that may benefit from forecasting) occur more frequently?
- Can these then be forecast with skill?

Critical conditions for subsistence farming:
- Rainfed agriculture (Maize):
  - Dry Spells
- Dairy farming (cows):
  - Extreme Heat Index
- Concentrate on forecasts for DJF wet season

Possible evolution of the climate
- Multiple climate models
- Conditioned on A2 emission scenario
- Downscaled using Regional climate model over Southern Africa (CCAM)

7-month ahead probabilistic seasonal forecast – updated monthly
- 15 ensemble members
- 0.5 degrees scale
- Climatology: ERA-Interim (1978 – 2014)
FORECASTING SKILL FOR DJF SEASON

Frequency of events in DJF period

Lead time [months]

Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Expected number of dry spells longer than 5 days

Probability of non-exceedance

Expected number of days with Temperature Heat Index > 78

Changing climate
**How well can we forecast events?**

Skill of forecasts of **dry** spells longer than 5 days

Skill of forecasting **days** with Temperature Heat Index > 78

Skill reduces with lead time [months]

STREAMFLOW FORECASTING IN THE INCOMATI BASIN (ONE BASIN SOUTH OF THE LIMPOPO) USING STOCHASTIC FORECASTS

The ROC curve of streamflow forecast by seasonal SST, ENSO, rainfall and flow at Dolton

SPATIAL DISTRIBUTION OF DROUGHT VULNERABILITY INDEX


Country Average: 0.56

4,3M people affected in Kenya

Drought 2010 - 2011

Turkana
Budget: £5.4 million
Sectors: Rural water, sanitation, hygiene; emergency food security & livelihoods
Mode of implementation: Operational

Source: Fewsnet September 2011
CONCLUSIONS

- There is skill in seasonal forecasting in Southern Africa with lead times of up to some 5 months, though that depends on the variable being forecasted.
- Forecasts should focus on variables that relate to decisions users make (e.g. farmers, irrigators, reservoir operators).
- Communicating warnings, and responses to cope with droughts needs to be developed to achieve the desired social performance.

Experts from agencies & institutions across Africa interviewed on critical issues that need to be addressed in drought forecasting & warning (40 people, 18 countries)
“The **challenges** that are ahead for drought forecasting and monitoring are basically data, **we don’t have enough data**…

The **methods** for forecasting drought have **not** been properly done, so there is also a challenge there…

And lastly the **socio-economic** aspects of droughts; we have **poverty** issues within the African **communities**, that would really interfere with **coping** with drought, **whether we forecast it or not**”

Gilbert Ouma, 2013
ICPAC & University of Nairobi