The Use of Satellite and Reanalysis Products for Enhancing National Climate Services Across Africa

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I. Challenges to Data Availability and Use in Africa

II. The ENACTS (Enhancing National Climate Services) Solution
   1. Improving Availability
   2. Improving Access
   3. Improving Use

III. Summary

IV. What is next?
I. Major Challenges

- Number of weather stations not adequate over many parts of Africa
- Most stations are located along main roads
  - Limited availability climate information and services to our rural community
- Serious gaps in observations (missing data)
- Questionable data quality
- Limited access and use of the available data
Declining Number of stations used in some gridded products

Average number of stations in a 250kX250km grid box used for the GPCP gridded data set
Challenges with climate observation in Africa

Percentage of CLIMAT reports received compared to what is required

Data source: WMO
But that is not the whole story: Many NMS have much more data than what is accessible outside the country/NMS. Different stories for different countries.
Tanzania

Number of Stations Each dekad

1983011, 1984033, 1985062, 1986091, 1987113, 1989022, 1990051, 1991073, 1992102, 1994011, 1995033, 1996062, 1997091, 1998113, 2000022, 2001051, 2002073, 2003102, 2005011, 2006033, 2007062, 2008091, 2009113, 2011022
Rwanda: It is different
II. The ENACTS Approach

• Strives to simultaneously improve **availability**, **accessibility** and **use** of climate information.

• Focuses on the creation of reliable climate information for **local decision-making**.

• Data availability is improved by blending station data with **satellite and reanalysis products**.

• Access is improved by developing online tools for data analysis and visualization.

• Use is improved by engaging users.
The Three Pillars of ENACTS

**Improve Availability**
- Build capacity of NMS
- Organize and QC station data
- Blend station data with satellite and other proxies

**Improve Access**
- Install IRI-DL at NMS
- Develop tools (Map Rooms)
- Make information products available online

**Improve Use**
*Sustained engagement with users:*
- awareness raising
- training
- involving in product generation (*Iterative*)
1. Improving Availability

Checking and correcting quality of station data

i. Identifying and correcting unlikely extreme values

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Improving Availability

Checking and correcting quality of station data

ii. Identifying fixing breaks in station time series
Improving Availability: Data Blending

Station

Satellite

Combined

Reanalysis

Elevation

Question mark

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2. Improving Access: Map Rooms

**Monthly Climate Analysis**
Rainfall and temperature time series (1983-2010) reconstructed from station observations and remote sensing proxies. This interface allows users to view rainfall, maximum and minimum temperature climatologies and anomalies.

**Dekad Climate Analysis**
Rainfall and temperature time series (1983-2010) reconstructed from station observations and remote sensing proxies. This interface allows users to view rainfall, maximum and minimum temperature climatologies and anomalies.
The Climate Analysis Maproom

Variable to map: rainfall
Local time series at: Woroda
level near or at: lon 40.53472 °E lat 8.41952 °N

Time:
- Sep
- Aug
- Oct

Monthly Climatologies for Guradamole, Bale, Oromiya

Temperature, °C

Rainfall, mm
The Climate Monitoring Maproom

- Rainfall amount for the latest dekad
- Latest dekad rainfall compared to the mean
- Cumulative rainfall since the start of the current season compared to the mean
The Climate Monitoring Maproom

Merged Station-Satellite Rainfall for Kigoma, Tanzania

- (a) Merged Rainfall [mm]

- (b) Rainfall Anomalies

- (c) Cumulative Rainfall
  - 2013 Apr 1, 2013 Jul 1, 2013 Oct 1, 2014 Jan 1

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The Climate Forecast Maproom

Tercile forecast at any point along with historical precipitation terciles at that point
What is the probability that the coming season will be (dry/normal/wet) given ENSO is (La Nina/Neutral/El Nino)
3. Improving Use

i. Awareness raising

Public Launch of the new data and services in Ethiopia

“… we are moving from one-table service to one-click service.” Director NMA
ii. Training

Training in Madagascar
Improving Use

iii. Involving users in product generation

The Agriculture and Food security group discusses what should be improved or add to the current information products

AGRHYMET, Jan 2014
III. Summary: major outputs

• Over 30-years of climate data for every 4km/5km grid across each country:
  o Now data available where there are no stations

• Installation of the IRI Data Library at NMS
  o A powerful tool for generating climate information

• Unprecedented online access to information products:
  o Satisfies the needs of many users
  o Overcomes (partly) the challenges of data access

• Built capacity at NMS and some user communities
Summary: major outputs

ENACTS has been implemented in Ethiopia, Gambia, Madagascar, Rwanda, Tanzania and CILSS countries at regional level

Some Map Rooms:
http://maproom.meteo.go.tz/maproom/
http://map.meteomadagascar.mg/maproom/
http://cradata.agrhymet.ne/maproom/
IV What is next for ENACTS?

**ENACTS 1**
- **Data:** RR, TT (dekadal)
- **Products:** Generic Map Rooms (Analysis, Monitoring, Forecast)

**ENACTS 2**
- **Data:** RR, TT ( + Daily), RH, ET/PET
- **Forecast:** Seasonal and sub-seasonal
- **Products:** Sector-Specific Map Rooms (Agr, Water, Health, ...)

**ENACTS 3**
- **Data:** Climate + Sectoral
- **Products:** Decision Support Systems (DSS) Data upload and analysis
Improving Availability: Data Blending

Procedure: Rainfall

1. Simple method: Bias removal
   1. Extract satellite values at station locations for each dekad
   2. Calculate GG-Satellite difference (bias)
   3. Interpolate the bias at all satellite locations (pixels)
   4. Add the interpolated bias to the satellite map

2. More sophisticated approach: Regression Kriging/Gridding
   1. Develop regression model between station and satellite values
   2. Apply model to all satellite pixels
   3. Calculate residuals
   4. Interpolate residuals at satellite locations
   5. Add interpolated residuals to output from step(2)
Improving Availability: Data Blending

Procedure: Temperature *(new approach)*

1. Downscale Reanalysis data from 50km to 4km /5km

2. Calculate climatological adjustments factors for each dekad (1 to 36) using data from 1981 to 2010

3. Interpolate the adjustment factors

4. Apply the adjustment factors to all reanalysis data from 1961 to 2013 *(this produces over 50-yrs time series)*

5. Combine corrected reanalysis with station measurements for each dekad for 1981 to 2012
### Evaluation

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</table>

- Merged with about 80
- Reference gridded data from 400 stations
- Averaged over 30 km
Use of Renalysis for TT

Figure 3: Comparing Original (left), downscaled (center) and adjusted (right) minimum temperature (CC (adjusted) = 0.89). Validation data is from 1961 to 1980, which was not used for calculating the adjustment factors.