Report on

Implementation of ENACTS in The Gambia

Phase-1: Generating Historical Climate Time Series

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Summary

IRI and partners have been leading an initiative to simultaneously improve the *availability, access and use* of climate information at the national level in African. This initiative, named "Enhancing National Climate Services (ENACTS)", has already been implemented in Ethiopia, Tanzania, Madagascar and Rwanda. The Gambia is the latest addition. The implementation in The Gambia is lead by the Department of Water Resources.

The first step in implementing ENACTS is assessing the available station observations. The Gambia has few stations, particularly for observing temperature. However, the time series of the available data has been found to be very good in terms of completeness. The completeness of the data is better than many of the countries where ENACTS has been implemented. However, this does not mean that the number available stations are sufficient. More stations are needed particularly for temperature measurements. There has also been some decline in the number of stations as some stations have been closed owing to lack of resources. This trend would need to be reversed to maintain the completeness of the data. Data quality has also been found to be good relative other countries where ENACTS has been implemented.

The available data was quality controlled and merged with satellite rainfall estimates for rainfall and with reanalysis product for minimum and maximum temperatures. The proxies (satellite and reanalysis) will help in filling the spatial and temporal gaps in station observations. This work has resulted in ten-daily rainfall from 1983 to 2012 and temperature data from 1961 2012 for every 4km grid across The Gambia.

I spent two weeks in The Gambia, but there were only six working days in that period because of long weekends (Friday to Sunday) and three public holidays. However, I was able to completed data preparation, it was not possible to complete the training program. Training will be completed during the next trip. The timing of the next trip will depend on the status of the health situation in West Africa. This situation will also affect the implementations of the other components of ENACTS, i.e., installation of IRI Data Library, developing maprooms and associated trainings activities.

I. Assessment Available Station Data

The first step in assessing the data was trying to understand what was available, for where and when. The focus was on rainfall, as well as maximum and minimum temperatures. This involved assessing the spatial distribution of stations, as well as data completeness. Figure 1 presents the distribution of rainfall stations. Some of these stations may also measure temperatures and other parameters. There are about 35 stations measuring rainfall in The Gambia. Even though this number is small, the coverage is reasonably good because of the size of the country. Figure 2 shows that the Department of Water Resources was very aggressive in expanding station network during the early 1970's. Number of stations remained almost constant after that. Figure 3 shows that most of those stations have been reporting most of the times. This is significant given that decline in the number of stations and incomplete data have been big challenges to many African meteorological services.

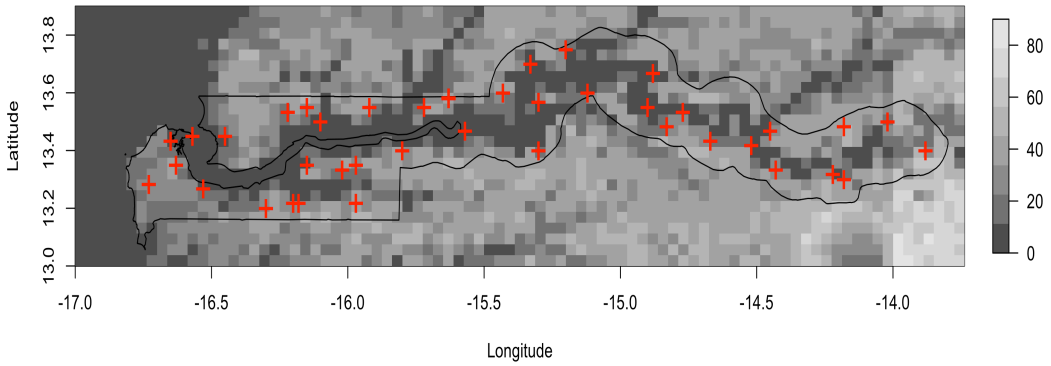

Figure 1: Distribution of stations reporting rainfall. The background is elevation in meters.

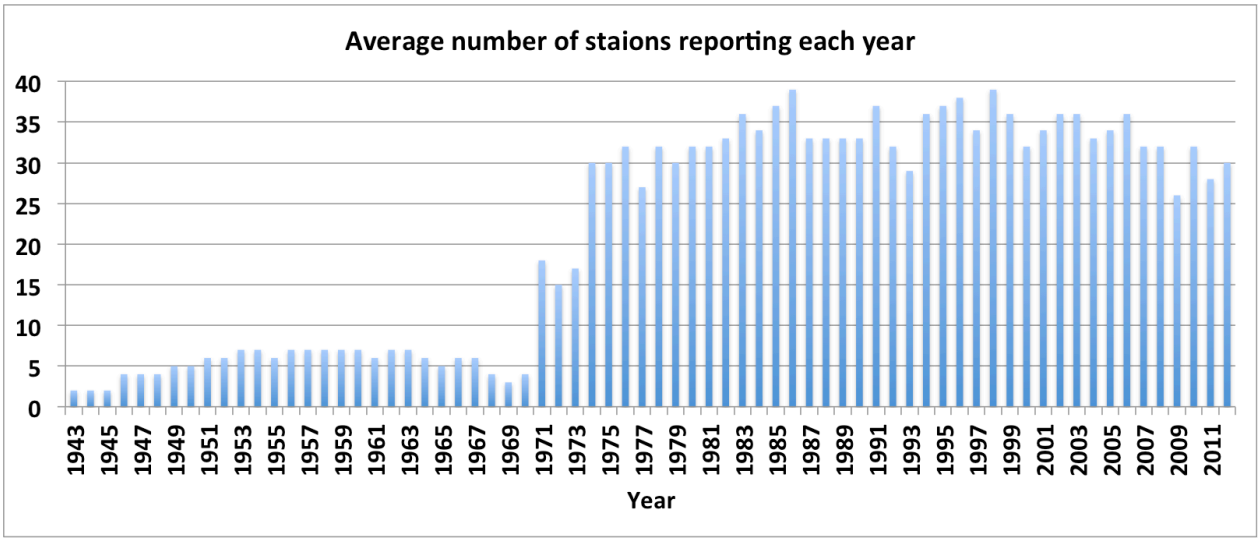

Figure 2: Number of stations measuring rainfall between 1943 and 2012.

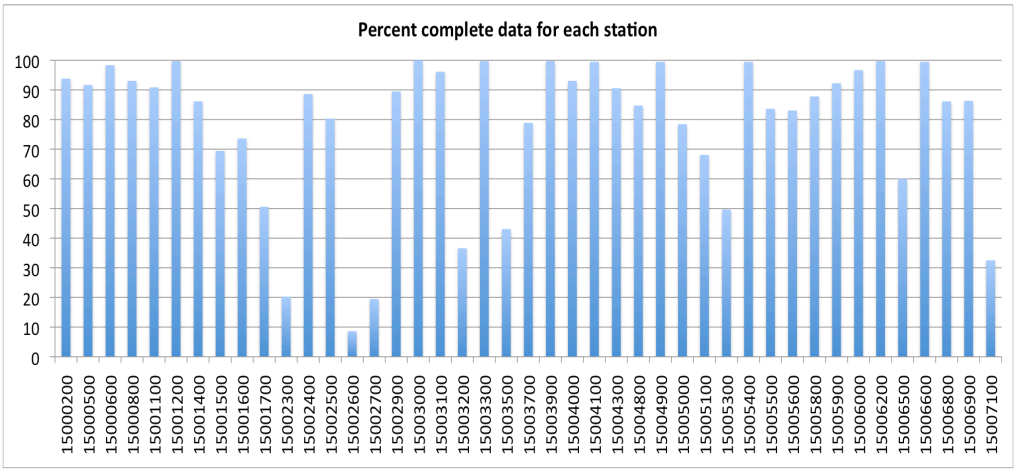

Figure 3: Data completeness for the rainfall stations (X-axis is station ID).

There are only about ten stations for temperatures (Figure 4). Though the number is very small, it is fairly constant (Fig. 5) and most of these stations have been reporting most of the time (Fig. 6).

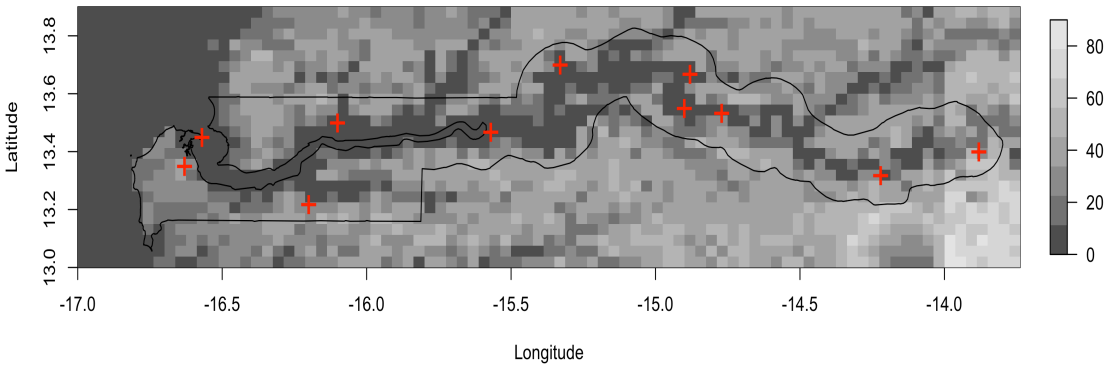

Figure 4: Distribution of stations reporting temperature

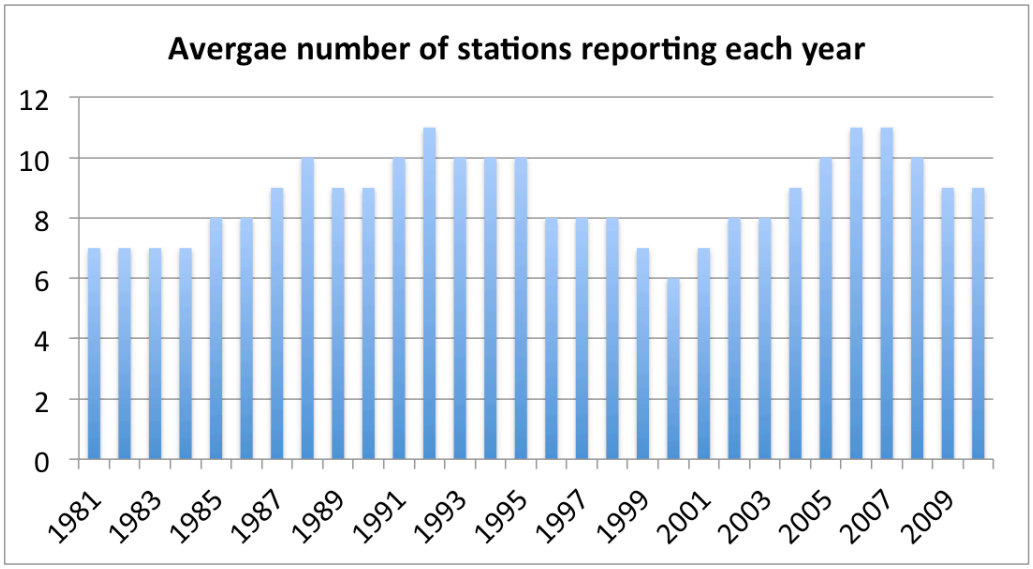

Figure 5: Number of stations reporting temperature between 1981 and 2012.

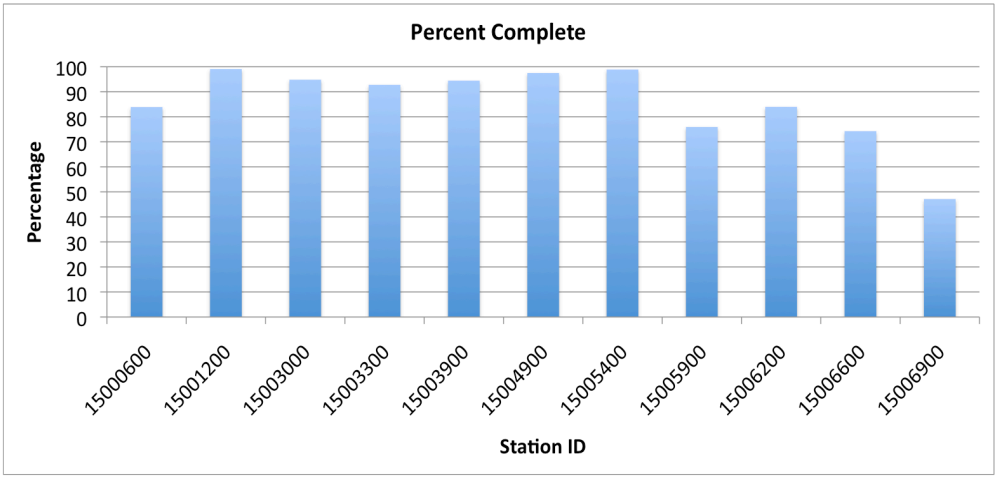

Figure 6: Data completeness for temperature stations (X-axis is station ID).

II. Quality Control of Station Data

Data quality control is a critical component of ENACTS. A significant amount of time is spent on this aspect of the work. Data quality control involves checking station coordinates, identifying outliers as well as checking for the homogeneity of the time series for each station. The homogeneity check identifies sudden changes or breaks in the station time series.

Even though there were some outliers both in rainfall (Table 1) and temperature (Table 2), the quality of station data was found to be reasonably good. The homogeneity check did find some discontinuities in some temperature time series (e.g. Fig.7), but there were not many.

ID	Lat	Lon	Date	Observec	Spatial.cl	Test_sigr
15003300	13.5	-16.1	2012063	532	1	100
15004100	13.45	-16.45	2012082	450	1	99.997
15005300	13.35	-15.97	2010092	421	1	100
15001200	13.317	-14.22	1999082	419	1	99.995
15004300	13.283	-16.73	2010091	401	1	99.986
15005500	13.55	-15.72	2004073	400	1	99.997
15006200	13.55	-14.9	1999082	399	0	100
15004100	13.45	-16.45	2012083	397	1	99.985
15004300	13.283	-16.73	2008083	396	1	99.889
15004100	13.45	-16.45	2010091	394	1	99.999
15005600	13.3	-14.18	1999082	392	0	99.975
15004300	13.283	-16.73	1996073	387	1	99.998
15004300	13.283	-16.73	1999081	386	1	99.991
15000500	13.433	-16.65	1994081	376	1	100
15006600	13.4	-13.88	1999082	369	0	100

475 mm in one day

Table 1: Output from a quality check procedure for dekadal rainfall data. The "observed" column shows observations that were identified as suspects. For instance, the first suspect value of 532 mm is a result of an erroneous daily value (475 mm), which was found to be a typing error.

ID	Lat	Lon	Date	Observed	Spatial.check	Test_signif
15003900	13.533	-14.77	2004021	99.9	1	99.87
15003900	13.533	-14.77	2004022	99.9	1	99.86
15003900	13.533	-14.77	2004023	99.9	1	99.77
15001200	13.317	-14.22	1998053	28.23	1	98.17
15000600	13.7	-15.33	1993051	26.66	0	98.60
15000600	13.7	-15.33	1991081	26.47	1	98.28
15005900	13.217	-16.2	1997063	26.37	1	97.26
15000600	13.7	-15.33	1991082	25.99	1	97.57
15001200	13.317	-14.22	1998033	25.97	1	97.22
15005900	13.217	-16.2	1998082	25.96	1	98.44

Table 2: Output from a quality check procedure for dekadal temperature. The observed 99 values are typing errors of -99 for missing values.

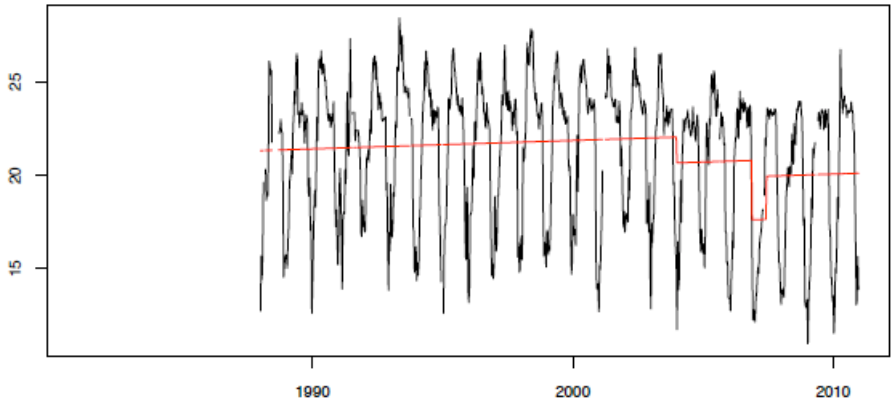

Figure 7: An example of homogeneity check for temperature time series at a given station.

III. Merging Station with Satellite and Reanalysis Proxies

Historical rainfall time series is generated by combining station observations with satellite estimates for each dekad (ten day period) of each year. Quality-controlled station observations are combined with satellite rainfall estimates as follows:

i. Calculate climatological adjustments factors for each dekad (dekads 1 to 36);

ii. Interpolate the adjustment factors to the required grid points; and

iii. Apply the adjustment factors to all satellite time series from 1981 to present;

iv. Merge the adjusted satellite estimates with station data for each dekad as shown in Fig.8.

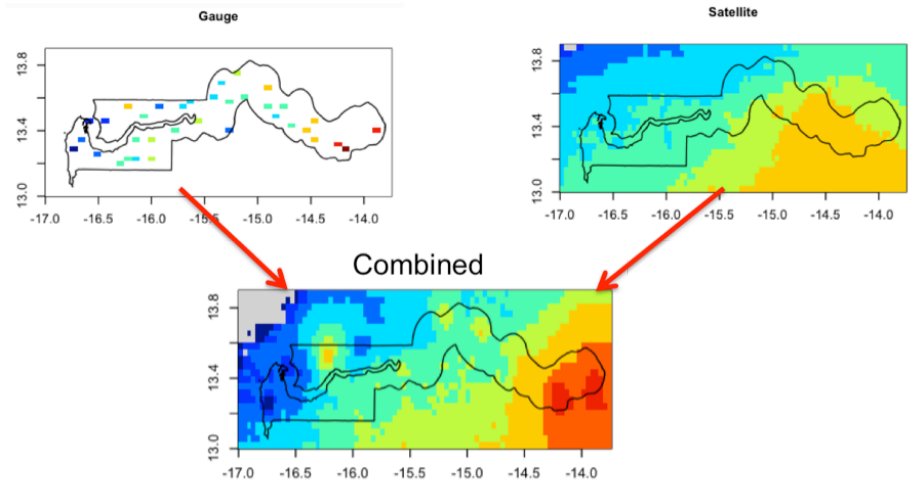

Figure 8: Merging station rainfall observations (top left) with satellite estimates (top right) to generate a merged product (bottom). The colors represent rainfall ranges.

Figure 9 compares the satellite estimate and the merged station-satellite product with station data. This validation was done using six independent stations that were not used in any of the steps. The final merged product is very close to the merged product. The assumption here is that the merged product will be as good at locations where there are no stations.

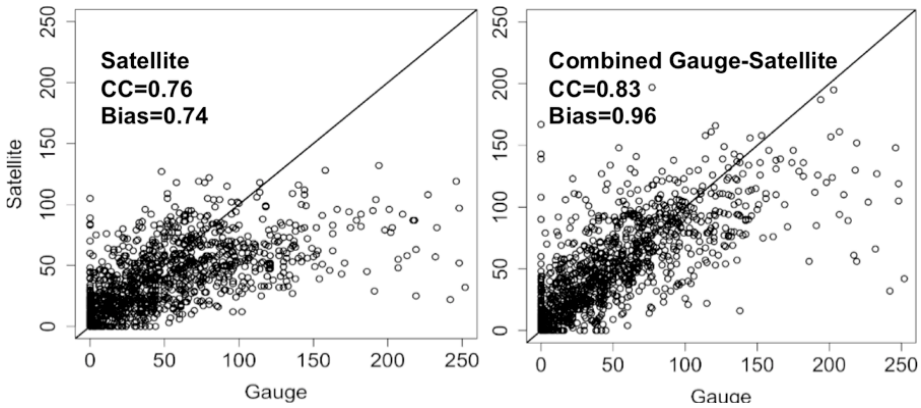

Figure 9: Evaluation using just six stations that were not used in the process. This is a point comparison.

There are no satellite temperature estimates going back 30 years. Thus, climate model reanalysis data are used as a proxy for reconstructing temperature time series. Reanalysis are climate data generated by systematically combining climate observations (analyses) with climate model forecasts using data assimilation schemes and climate models. The Japanese 55-year Reanalysis, or JRA55 was used for this work. The data period covers the 55 years from 1958 and is available at spatial resolution of 0.5-degrees. This is a relatively coarse spatial resolution. Thus, the reanalysis data was downscaled to 4km. The following steps were used to reconstruct the temperature time series:

i. Downscale reanalysis data to 4km;

ii. Calculate climatological adjustments factors for each dekad;

iii. Interpolate the adjustment factors; and

iv. Apply the adjustment factors to all downscaled reanalysis data from 1981 to 2012.

v. Merge adjusted reanalysis maps with station observations for each dekad of each year.

Figures 10 and 11 compare the downscaled reanalysis data, climatologically adjusted reanalysis product and the final merged product with station data. This validation was done using three stations, which were not used in any of the steps. The final merged product is very close to the merged product. The actual merged data would slightly better because it will also include the three stations used here for validation.

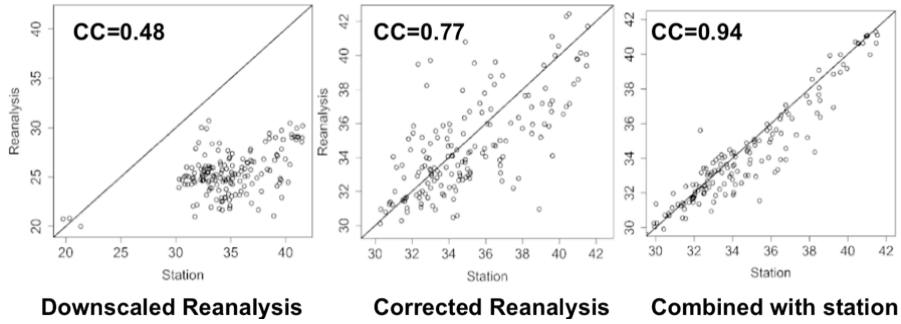

Figure 10: Evaluation for maximum temperature using three stations that were not used in the process.

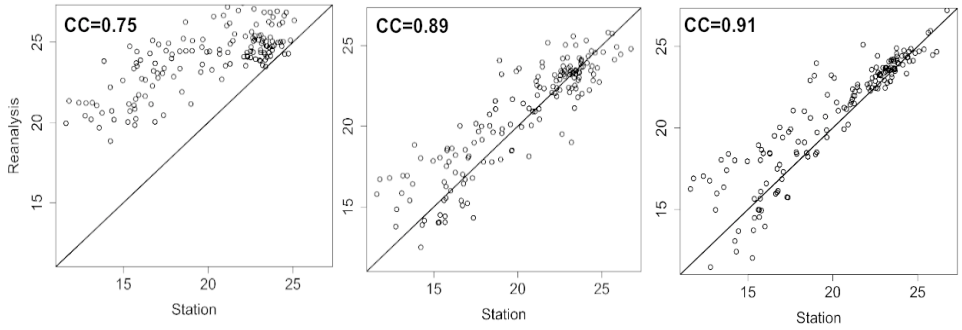

Figure 11: Same as Fig 10, but for minimum temperature.

IV. Summary

Though the available time was much less than I planned for, I did mange to complete the reconstruction of historical rainfall and temperature time series for The Gambia. The available number of stations for The Gambia is small, but the country is also small. The distribution of station is reasonably good for rainfall, but temperature stations are too few. The completeness and quality of the available station data was also found to be reasonably good. The data reconstruction work has accomplished the following:

- Quality-controlled station rainfall data: 1983 to 2012;
- Quality-controlled station temperature data: 1981 to 2010;

- Satellite rainfall estimates extracted over Gambia: 1983 to 2014;
- Model Reanalysis data processed for Gambia: 1961 to 2013;
- Merged gauge-satellite rainfall data, 10-day time scale and 4km resolution: 1983 to 2012;
- Corrected reanalysis time series, 10-day time scale and 4km resolution 1961 to 2013;
- Merged station-reanalysis data, 10-day time scale and 4km resolution: 1981 to 2010.

V. Next Steps

- Completion of the training on data quality control and merging station data with satellite and reanalysis proxies;
- Installation of IRI Data Library and associated training;
- Development of Maprooms, incorporating the maprooms to the department's webpage and associated and training.