Statistical Downscaling of Climate Change Scenarios Case of Dar es Salaam City

Presented at the workshop on Mainstreaming Climate Change Adaptation into Urban Development and Environmental Management Plans and Programs held in Dar es Salaam on 10th June 2014

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Presentation Outline

- Introduction and the context
- Methods used
- Some findings and Conclusion

Introduction and the context (1)

- Although Africa (Tanzania inclusive) is considered as one of the continents most vulnerable to the impacts of climate change, its real impact, particularly at a local scale, is still poorly understood (IPCC, 2007).

- This is because, prediction of climate change impacts in Africa is still based on Global Circulation Models – GCMs (Hulme et al., 2000).

Introduction and the context (2)

- Although, GCMs provide adequate simulations of atmospheric general circulation at continental scale, they do not capture the detail required for regional and national assessments (White et al., 2007).

- Consequently, the climate change impacts at local level cannot be accurately discerned and hence appropriate measures cannot be formulated and put in place.

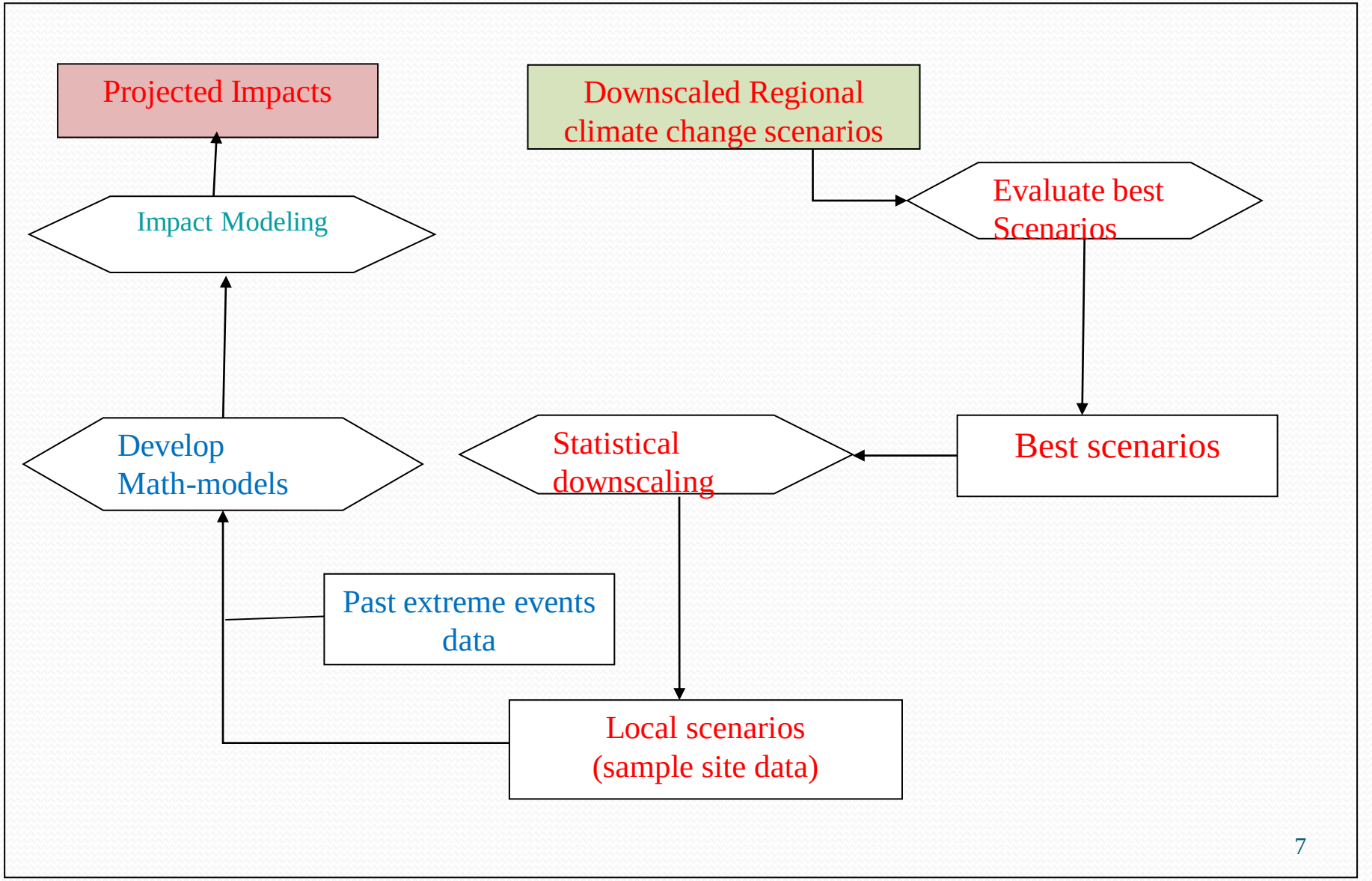
Research objectives

The main objective of this research was to predict the impacts of climate induced hazard (floods) for Dar es Salaam using mathematical modeling techniques in order to facilitate formulation of appropriate intervention measures against the hazard.

Specific objectives

1. To determine and evaluate appropriate climate scenarios (potential predictors) that can be used to predict climate change impacts for Dar es Salaam City.
2. To downscale regional climate change scenarios in order to provide high resolution data that can be used to assess climate change impacts for Dar es Salaam City.
3. To develop statistical model for predicting climate change impacts at local scale which will be used to formulate appropriate intervention measures against the climate induced hazard.
4. To assess and predict the impacts of climate induced hazard (flood) for the next 40 years (2011-2050)

Summary of Research Methodology

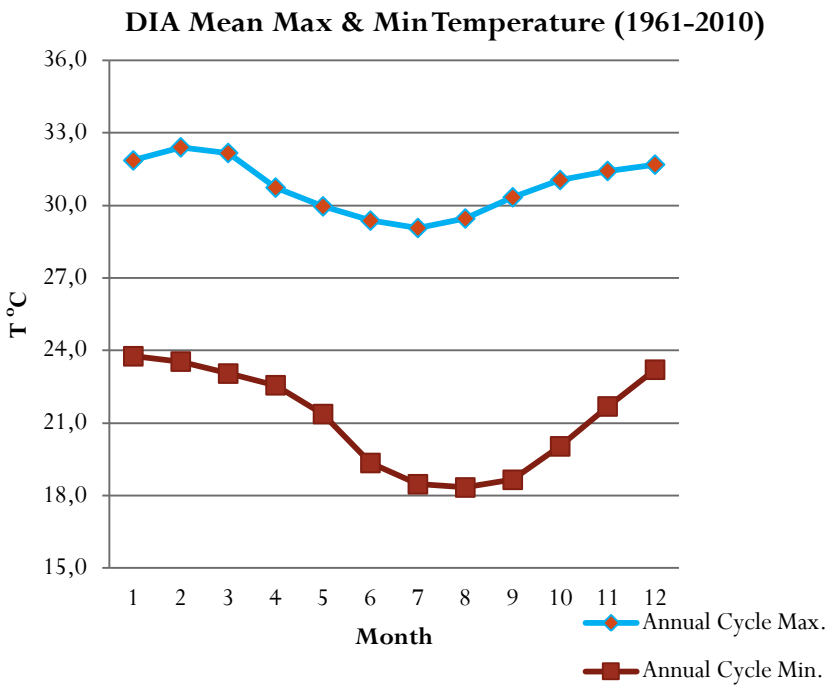


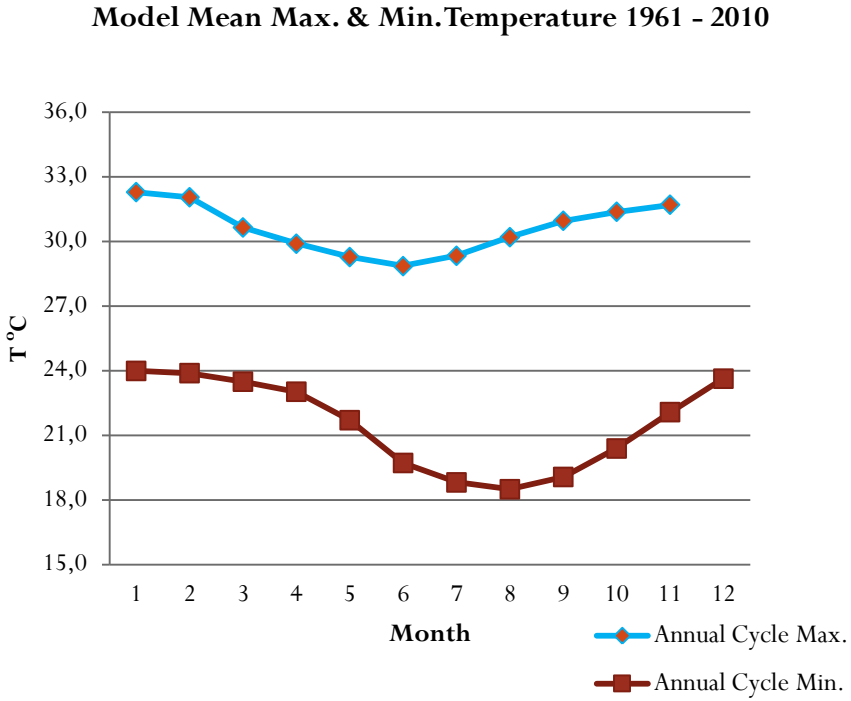
Data Used

- Model data (Regional Circulation Model)
  - Model data are of two scenarios RCP 4.5 and RCP 8.5,
  - Data range from 1957 – 2050 (daily mean records).
- Observed (Historical) data
  - Range from 1961 – 2010 (daily mean records aggregated to monthly mean records).
- Model data were transformed to match with historical data and (1961-2010) was set as a base period for analysis.

Determined potential scenario

- Annual cycles for Observation & Model data

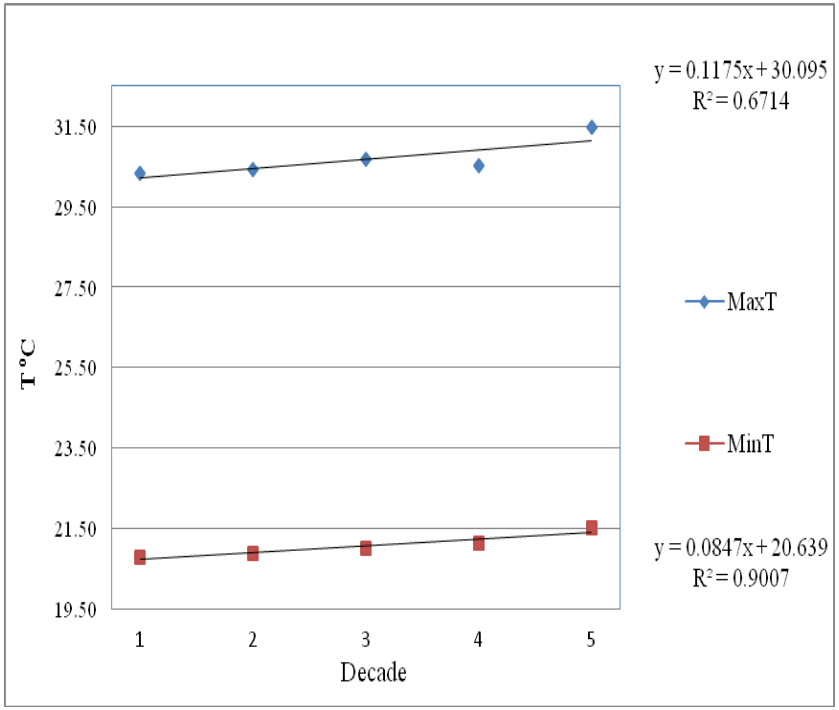




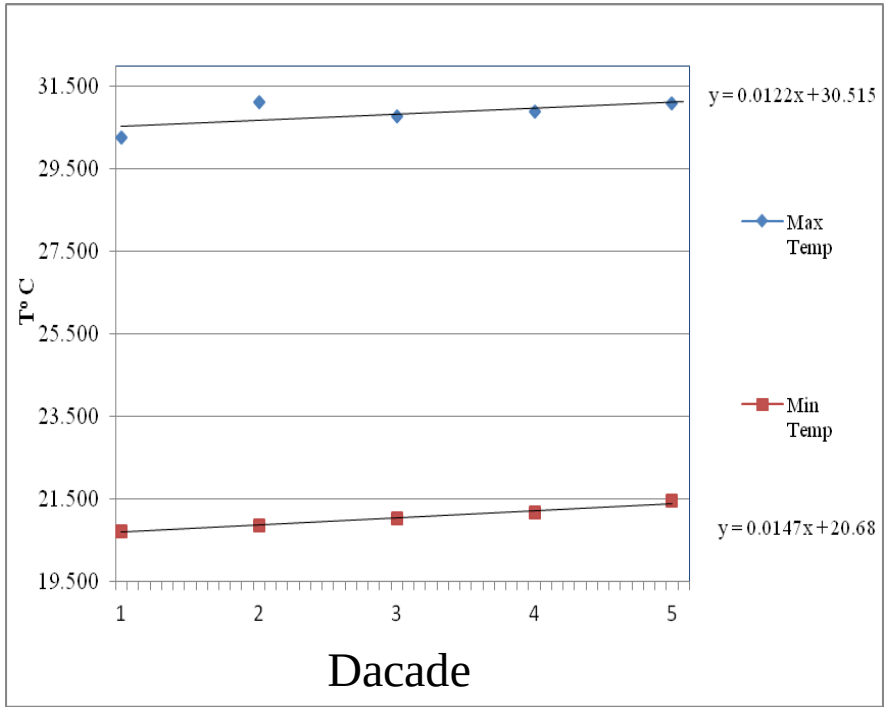
Comparing the Observed and Model data: Annual mean Maximum and Minimum Temperature variability is around 6.08 for obsv. And 8.05 for the model (more or less the same)

Determined potential scenario

Decadal annual cycles and trend

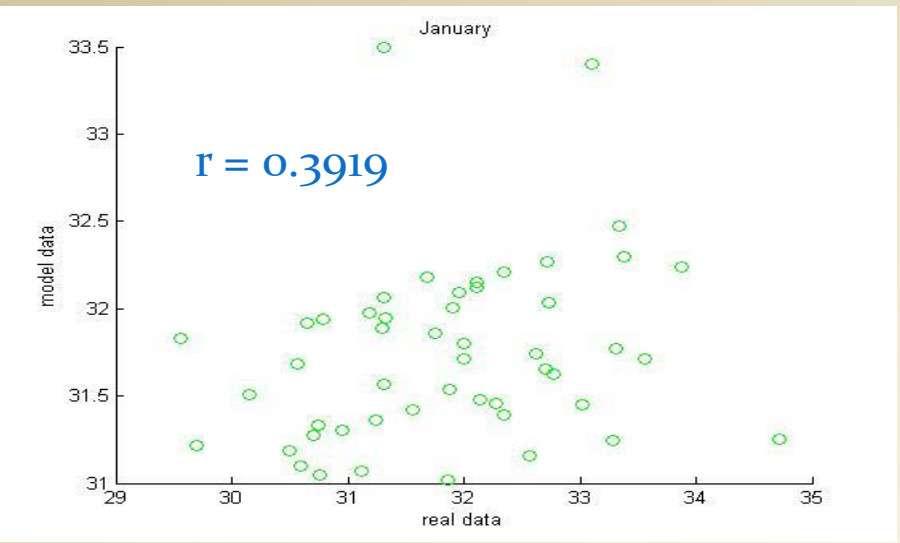


Model

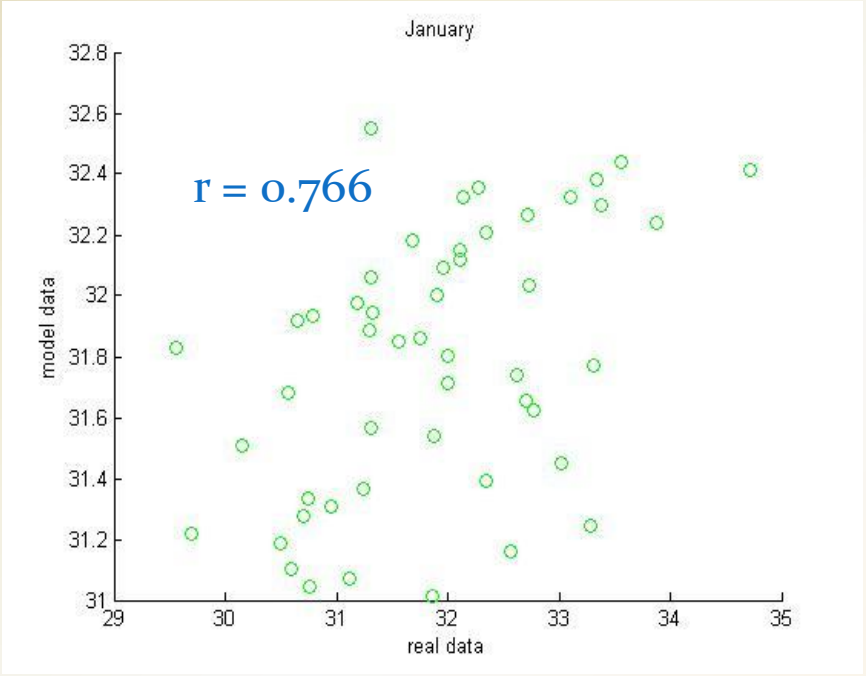


Observed

Both observation and model annual cycles show an increasing trend for both minimum and maximum temperatures

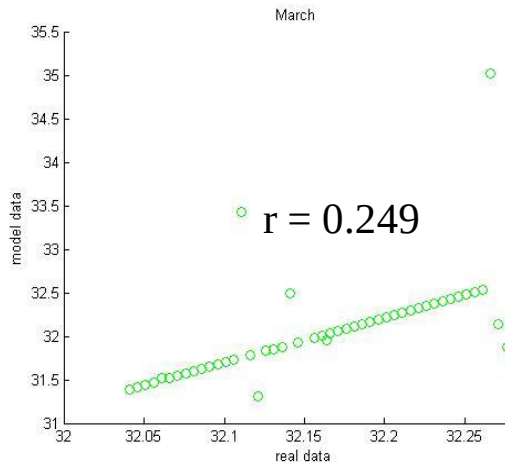


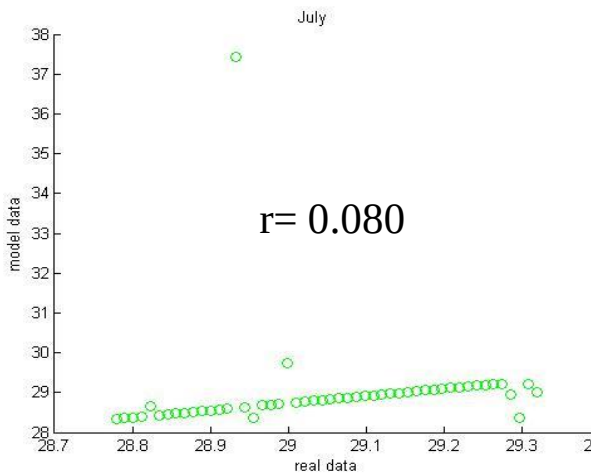
Real data vs. raw data RCP 4.5

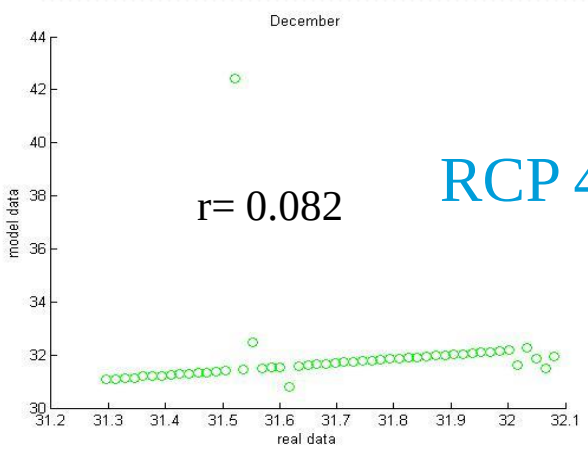


Real data vs. raw data RCP 8.5

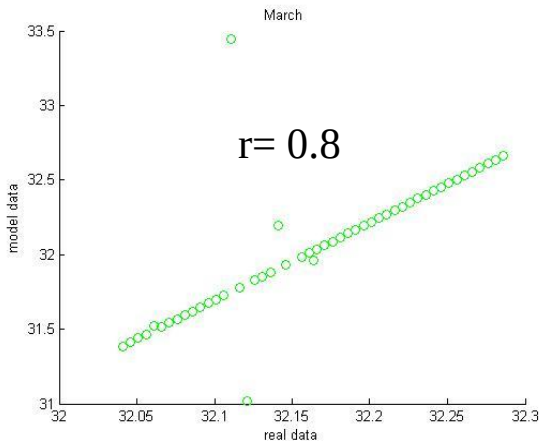
RCP 4.5 and RCP 8.5 Scenarios

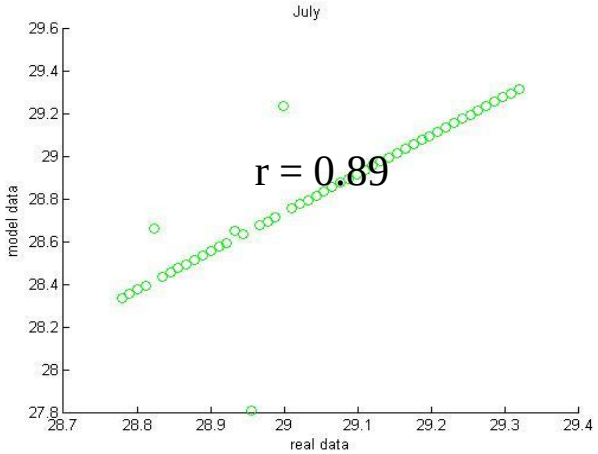


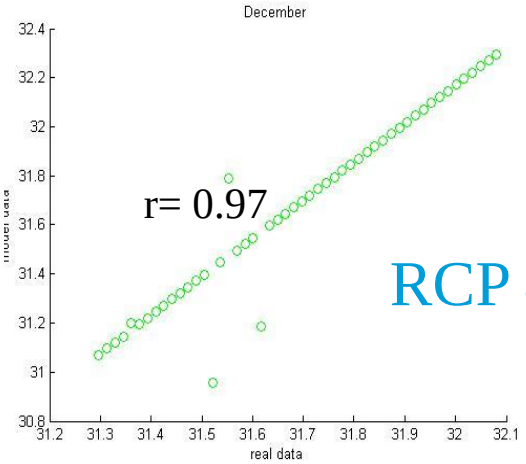




RCP 4.5







RCP 8.5

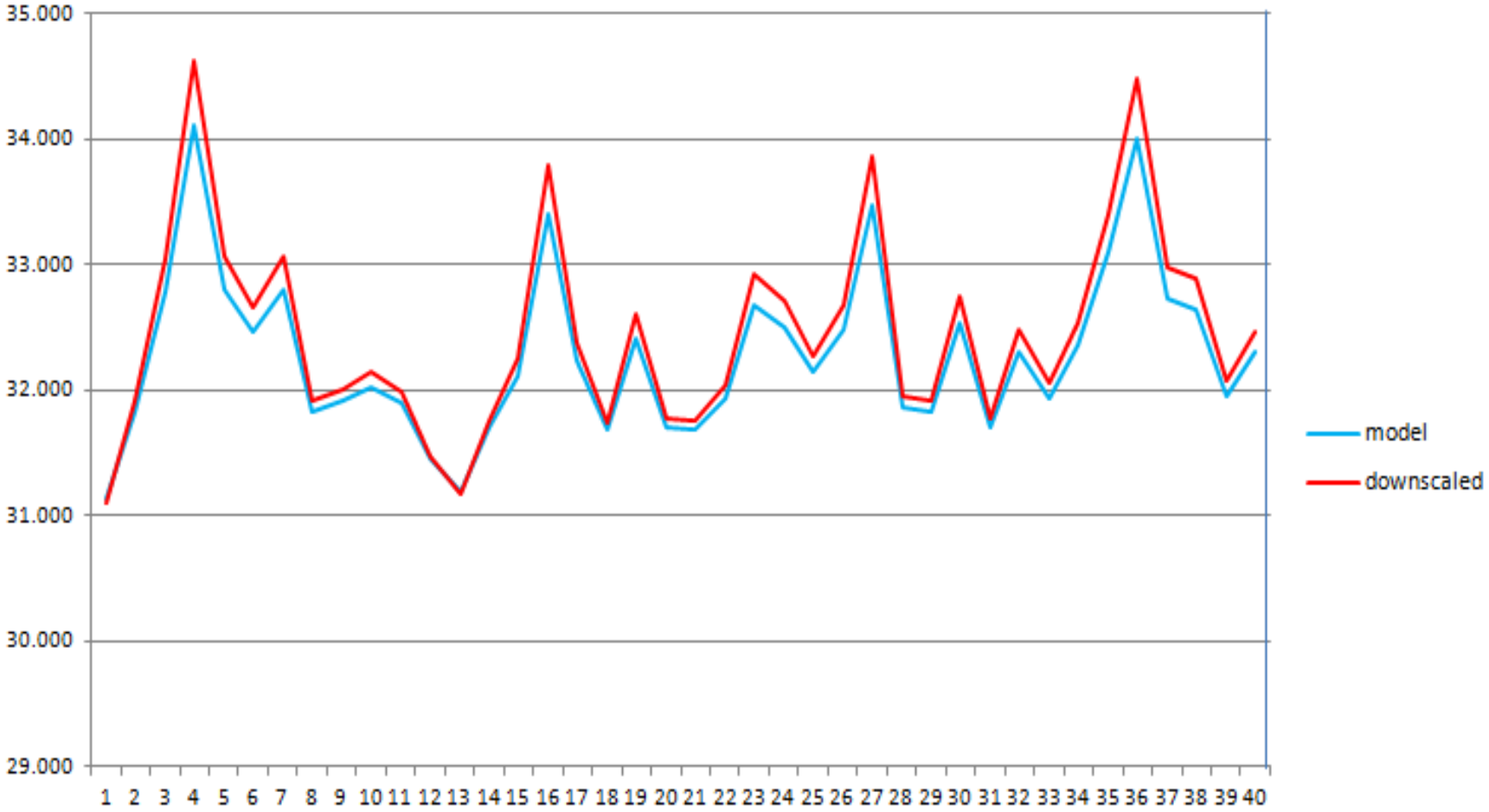
Findings (Appropriate Scenario)

- *Correlation analysis between historical and model data revealed that:*
  - Data from RCP 8.5 scenario were highly correlated with local historical data than RCP 4.5 for both temperature and precipitation
  - Data from RCP 8.5 were used for statistical downscaling

Prior to statistical downscaling

- Removed known biases (Annual Cycles, Anomalies and Trends)
- Simple linear regression analysis was used to determine the predictor and predictands relationship.
- Projection was done between 2011 and 2050 for both temperature and precipitation data

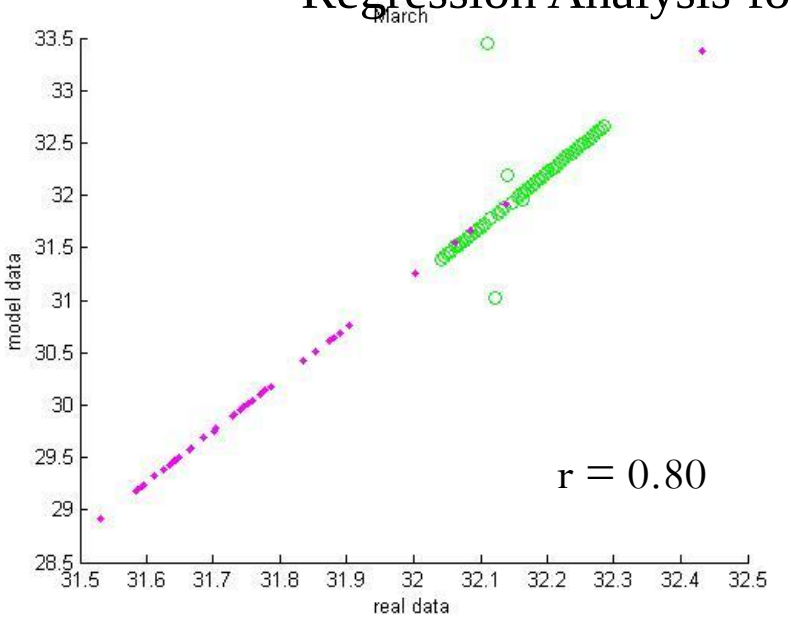
RCM Vs. Model Downscaled

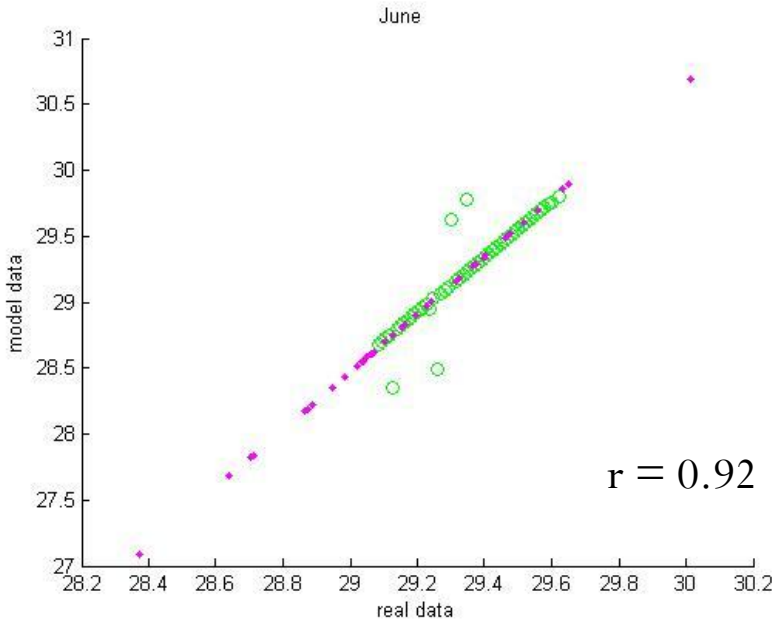


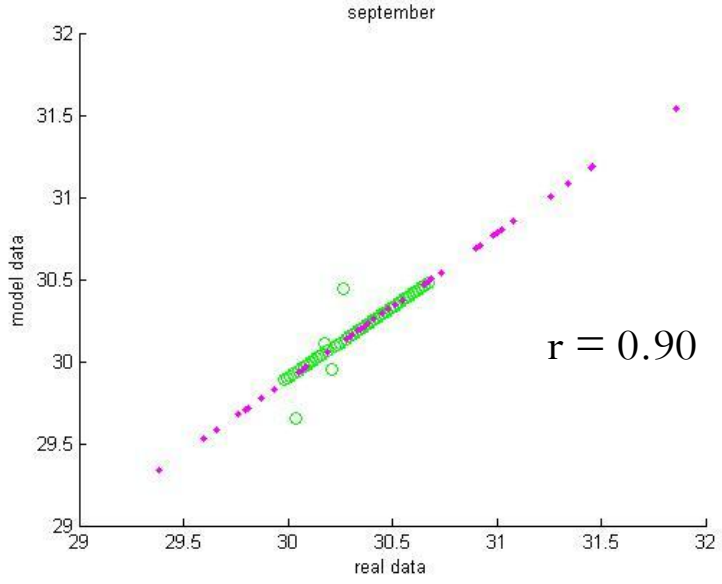
Generally the RCM under estimated the temperatures than those statistically downscaled

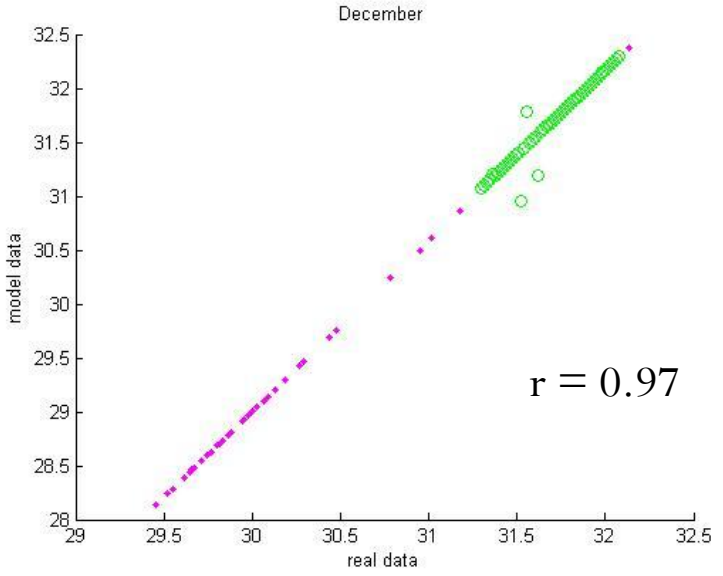
Statistical downscaling

Regression Analysis for 2011-2050

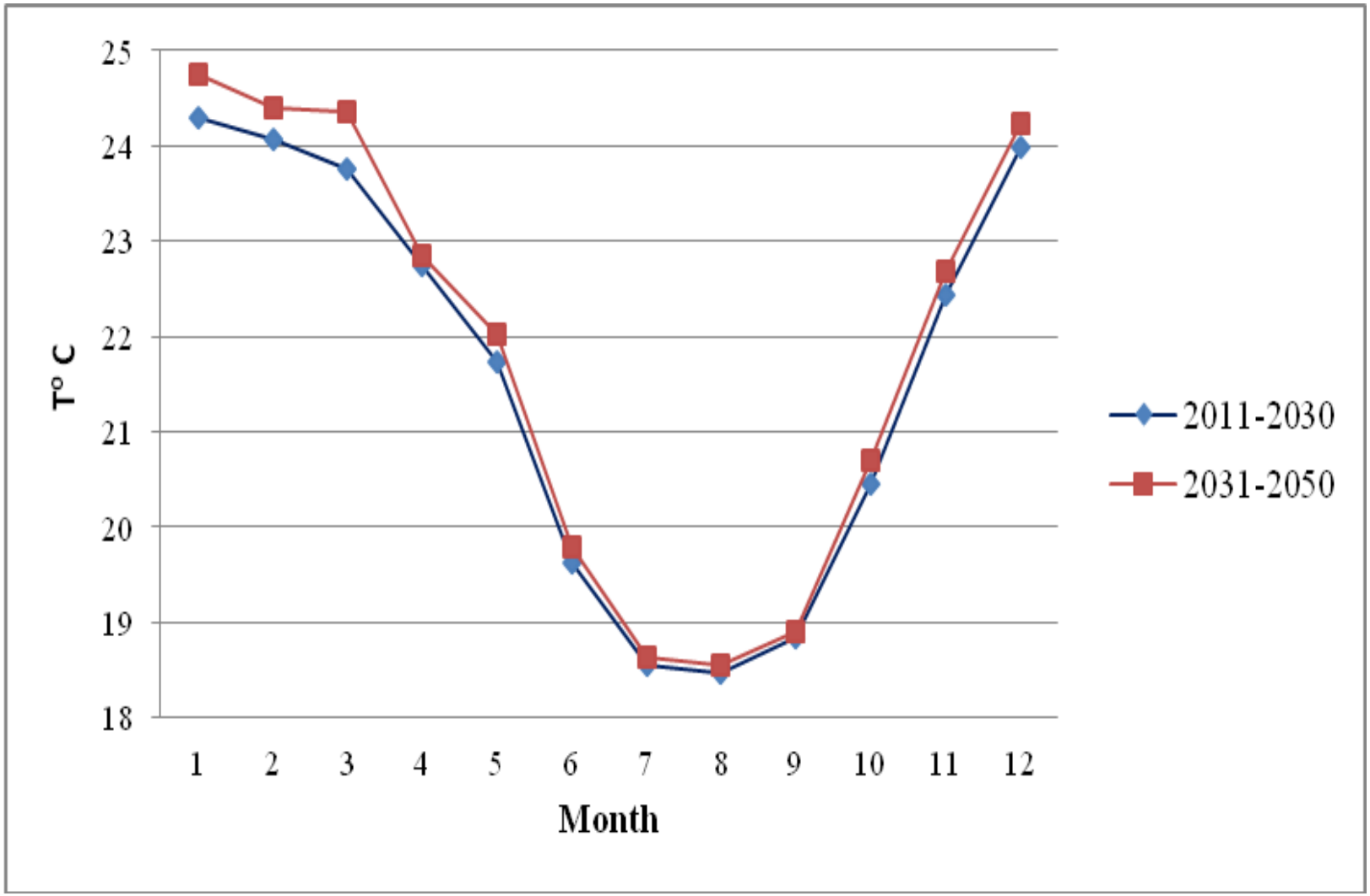








Comparing 2011-2030 and 2031 - 2050



From 2031 – 2050 the difference is much higher for all the months than 2011-2031 (0.5 ^{o}C- 0.68^{o}C) to (0.8^{o}C to 3^{o}C) respectively

Conclusion and recommendation

- The results show that RCP 8.5 is highly correlated with historical data than RCP 4.5 for the Dar es Salaam City
- The downscaled scenarios, particularly temperatures, predicted relatively higher temperatures than the model data (RCP 8.5) scenario.
- Generally the difference between model projections (RCP 8.5) and downscaled data is relatively inconsequential for short period of time; in this case (2011-2031).
- The downscaled data can be used as an input in flood modeling studies at a local scale level e.g., catchment level.