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Hydrological Response to Climate Change of the Blue Nile River Basin

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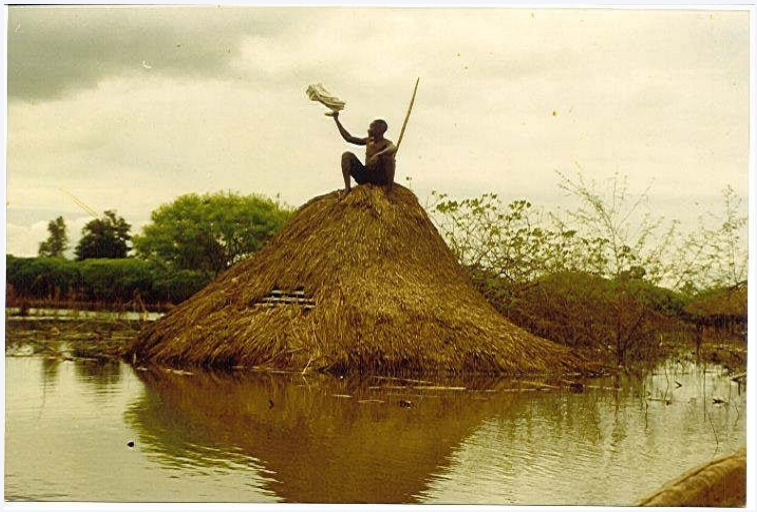
Introduction

Climate change

- refers to the change in the state of climate variables.
- the expected/projected temperature shows rise of 1.4 to 5.8^{o}C by 2100 (IPCC, 2007).
- the change in climate cause significant impact on the water resource by disturbing the normal hydrological cycle.
- the IPCC findings indicates that developing countries like Ethiopia will more vulnerable to climate change.

Drought impacts

Flood impacts

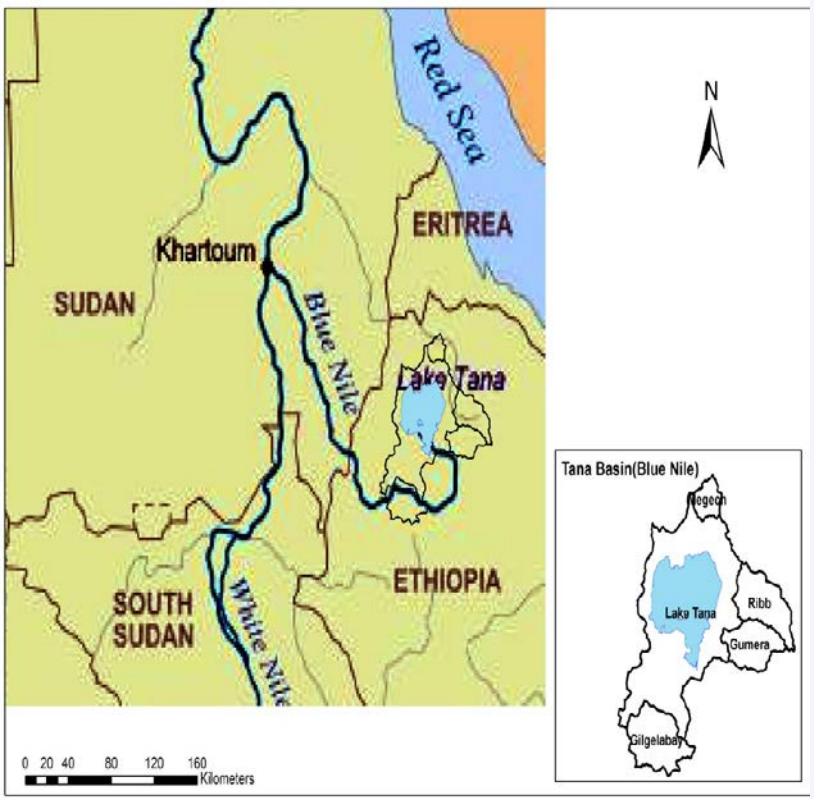


Objectives

- To evaluate the potential hydrological response to climate change at 2030`s (2035-2064) and at 2070`s(2071-2100)on the Upper Blue Nile basin under RCP`s scenarios.

general objective of this study was to evaluate the potential hydrological response to climate change at 2030`s(2035-2064) and at 2070`s(2071-2100)on the Upper Blue Nile basin under RCP`s scenarios.

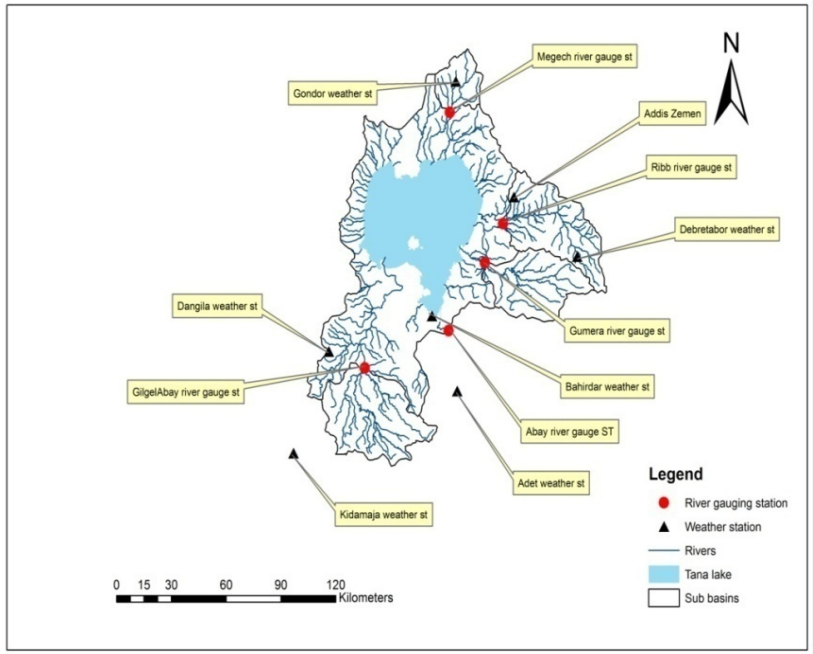
Study area



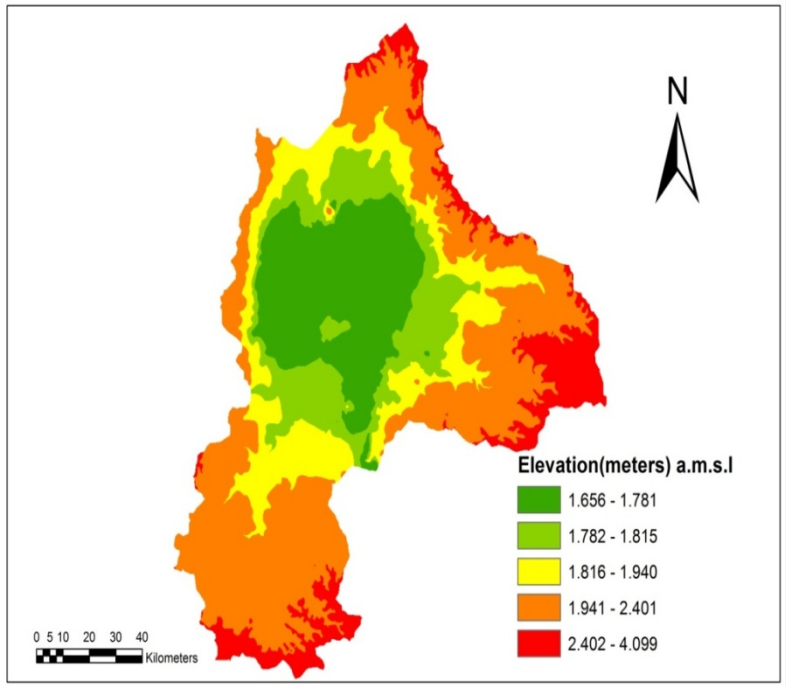
- The **Upper Blue Nile Basin** is located in north-western Ethiopia (latitude 10.95° and 12.78°N, and longitude 36.89° and 38.25°E) with a drainage area of about **15,000 km²**
- The major rivers feeding the Lake Tana are **Gilgel Abay, Gumera, Ribb, and Megech**.
- The mean annula rainfall is around **1465mm**,maximum temperature is 26 °C and minimum temperature 11 °C.
- Blue Nile River has an average of annual runoff of about 52 BCM at the Eth-Sudan border.

Study area cont…

- Gauging and weather stations



Elevation



Data and methods

- Arc-GIS 10.2
- HEC-HMS 3.5 hydrological model software
- Global mapper software
- SRTM 90m DEM data
- Hydrological and metrological data
- CMIP5 of RCP 4.5 and RCP 8.5 emission scenario climate data.
- Standard tables &Charts

Results and Discussion

Outputs of GCM's

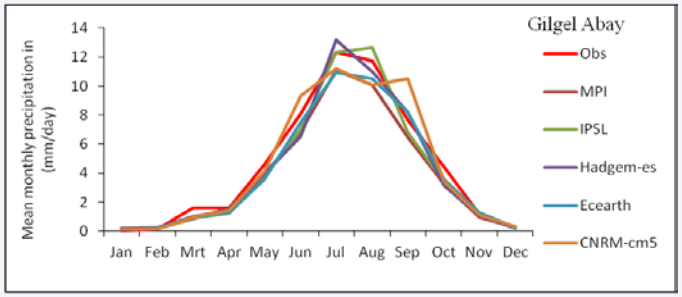
❖ **Base Period (1971-2005)**

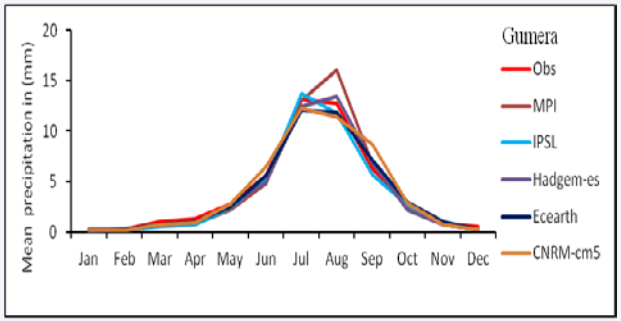
➢ Precipitation and PET

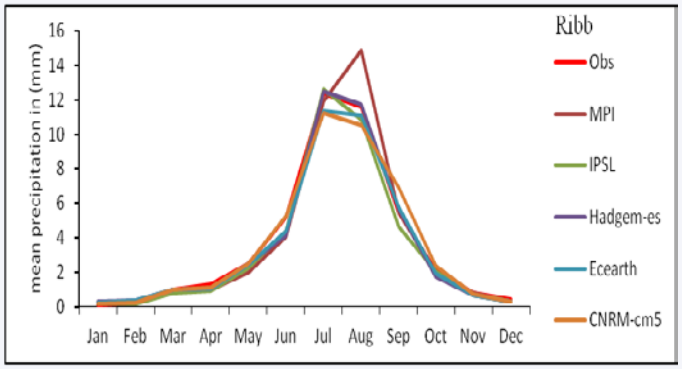
The long term monthly average daily arial pptn of the GCMs and the weighted observed pptn indicated that R^2=0.96

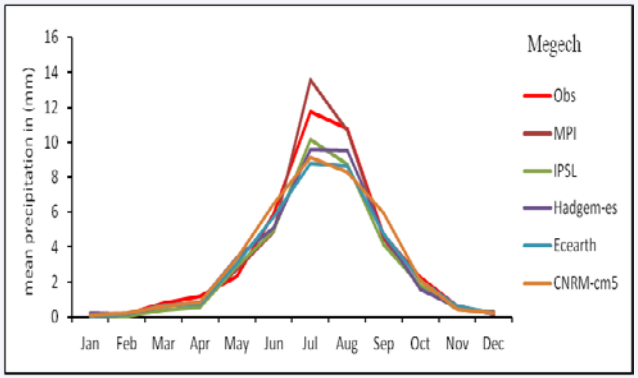
Results and Discussion cont…

Precipitation



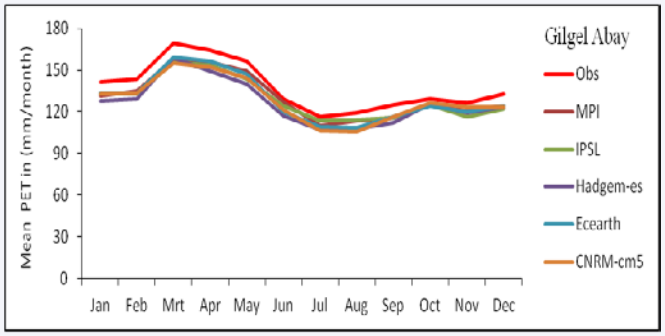


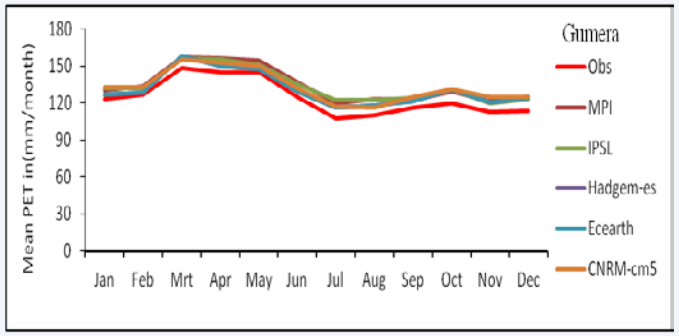


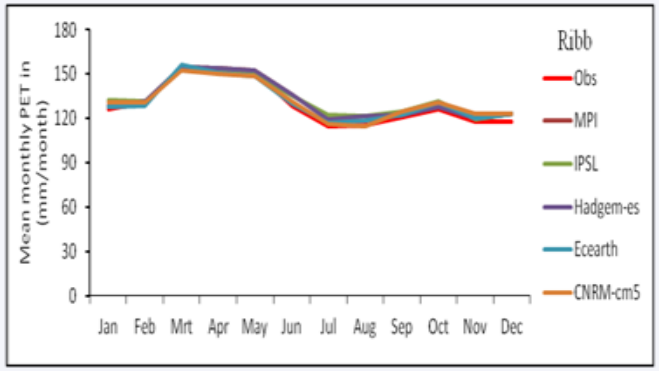


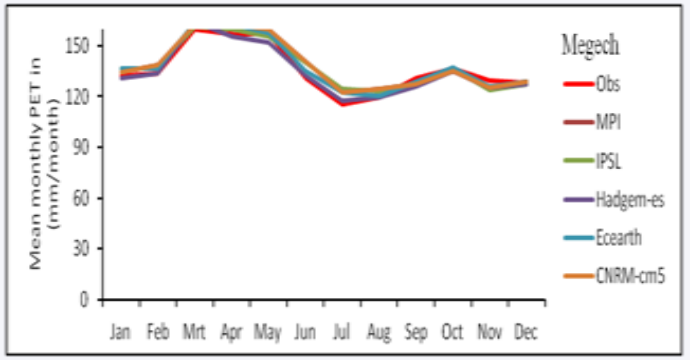
Results and Discussion cont…

Potential Evapotranspiration(PET)









Results and Discussion cont…

Scenario Developed for the Future 2030's (2035-2064) and 2070's(2071-2100)

Precipitation Scenario

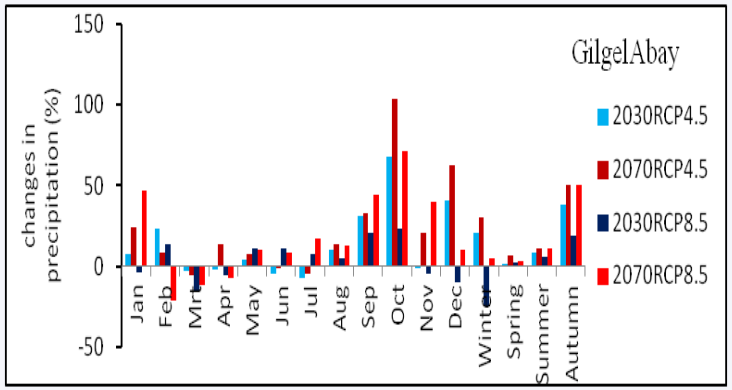
•The long term average monthly percentage change of precipitation with respect to the base period, multimodal GCM at 2030's and 2070's indicates that a great percentage change during the dry months is exhibited.

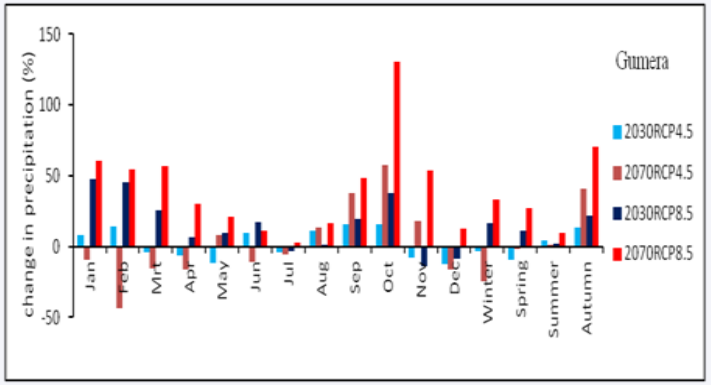
• At 2070`s maximum precipitation change projected during the month of October ranging from +71.4% to +255.2% .

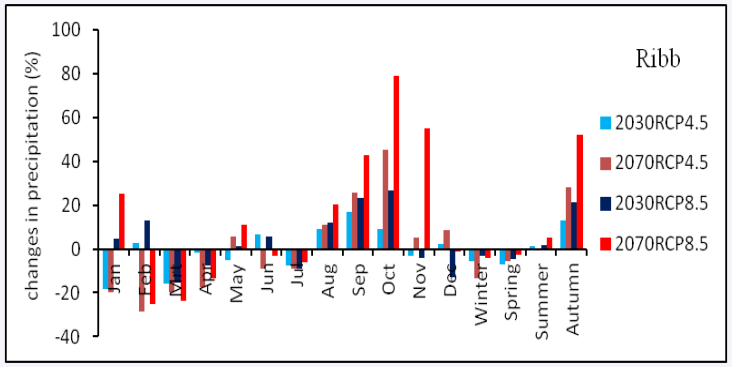
• Generally the mean monthly and seasonal precipitation increases in both future periods under both RCPs emission scenarios over the basin.

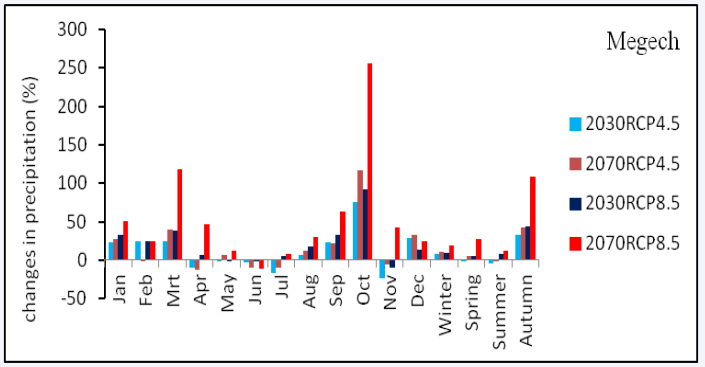
Results and Discussion cont…

❖ **Mean monthly and seasonal multimodal projected percentage change of pptn from the base line level**







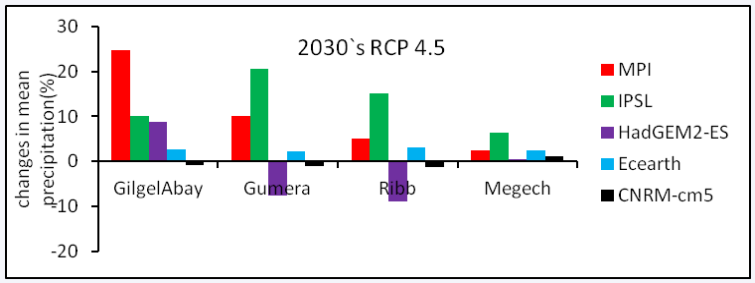


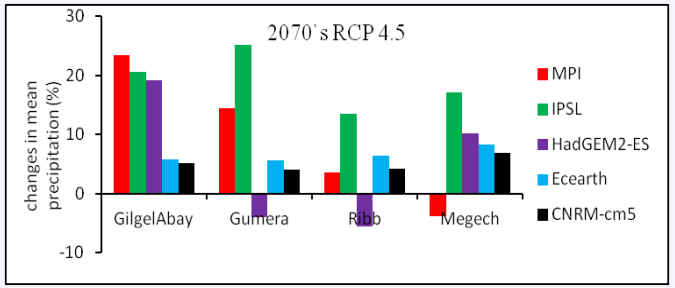
Results and Discussion cont…

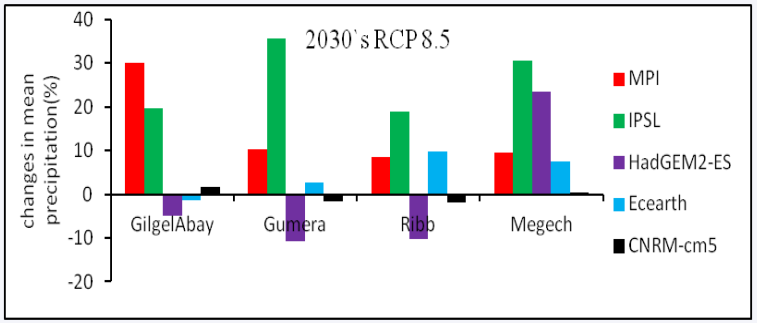
❖ **Average annual projected percentage change of Ppt from the base line level.**

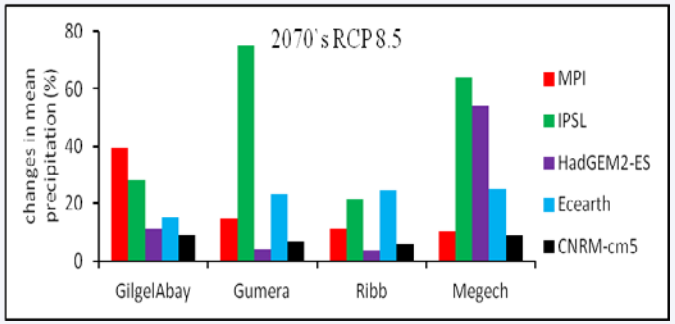
❖ **Average change in between -20% and +30 %**

Average change in between -20% and +30 %





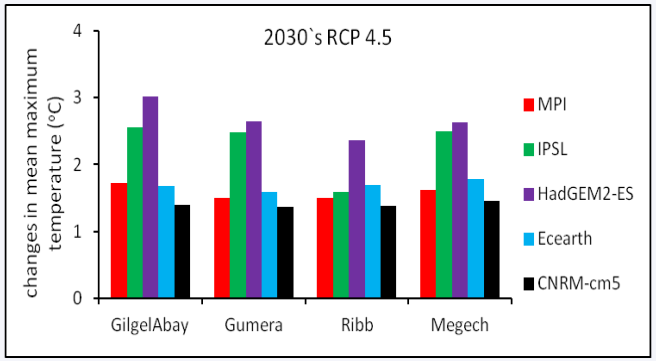


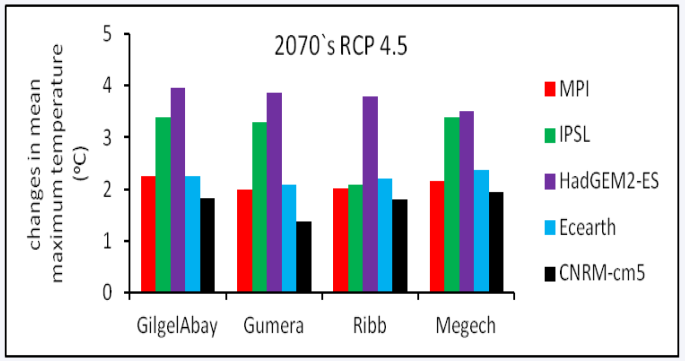


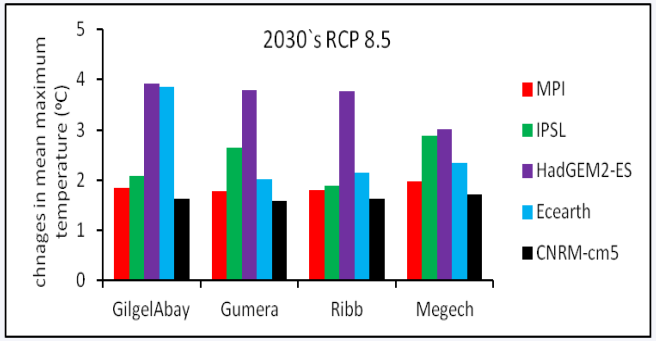
Results and Discussion cont…

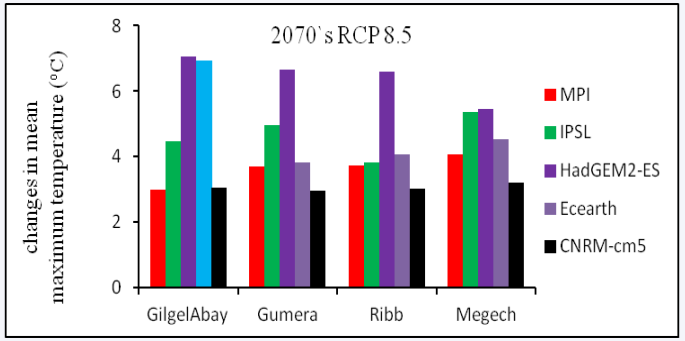
Future Temperature Scenarios

Average annual max Temp. increases up to +3.9 ^{o}c for RCP 4.5 & 7.1^{o}c for RCP 8.5





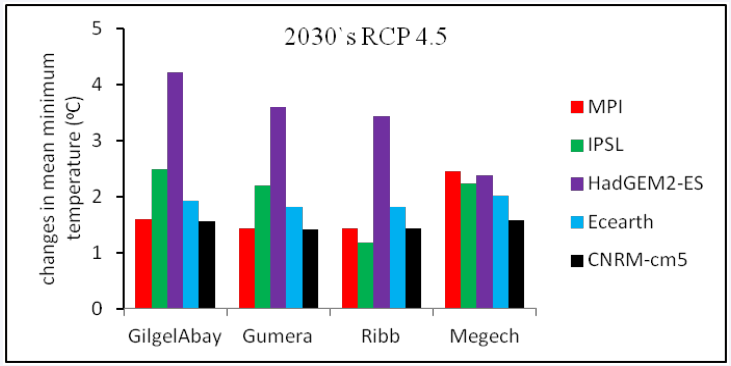


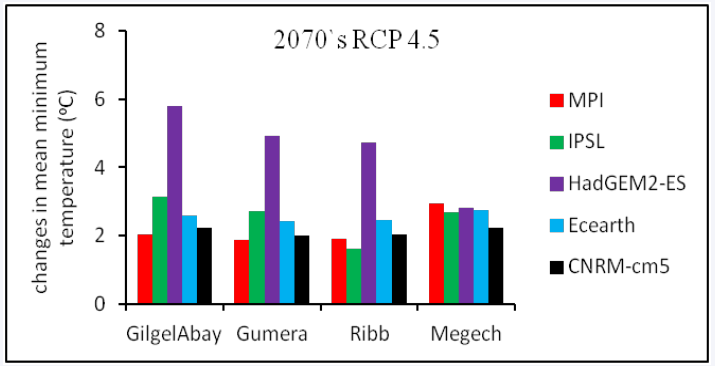


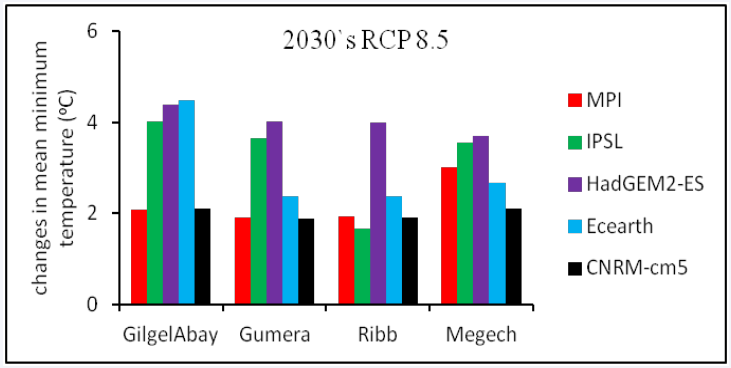
Results and Discussion cont…

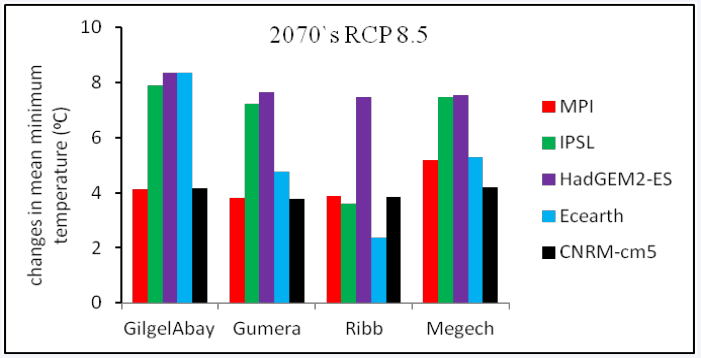
Future Temperature Scenarios

Average mini Temp increases up to 4.5 °c for RCP 4.5 and 8.4 °c for RCP 8.5





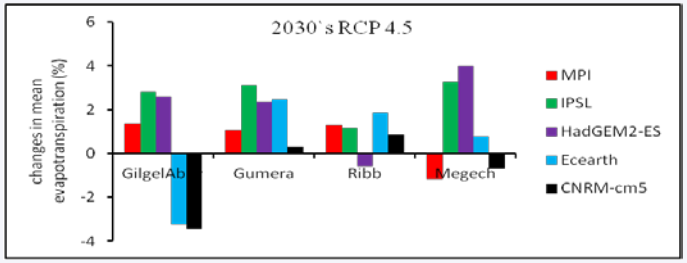


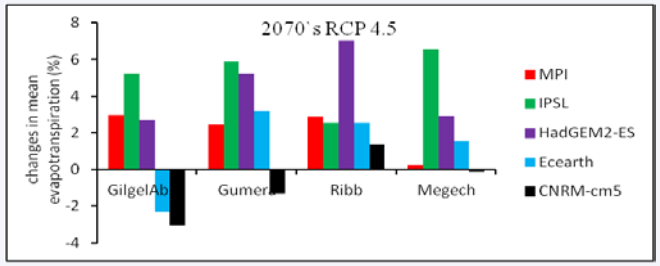


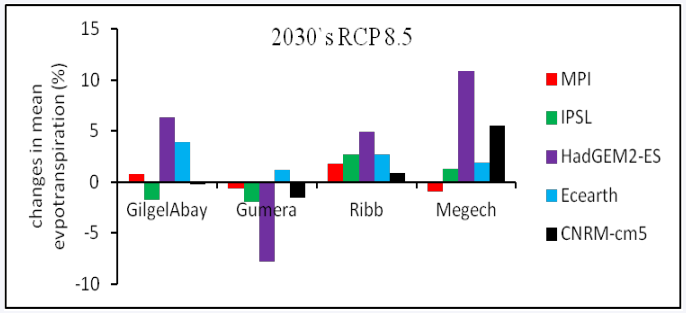
Results and Discussion cont…

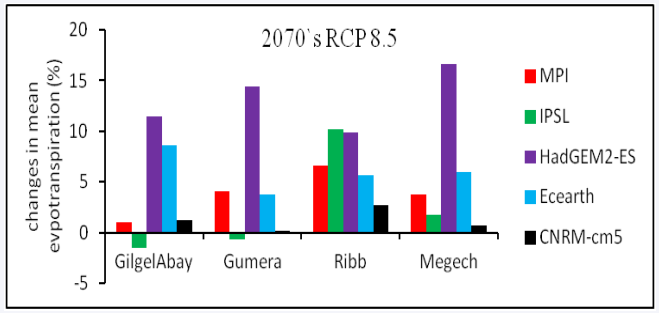
Future Potential Evapotranspiration(PET)

Average changes in between -3.4 % and +7% for RCP 4.5
-7.8% and + 16.7% for RCP 8.5





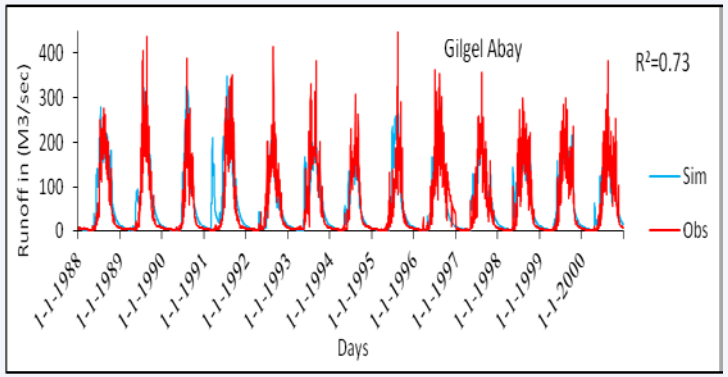


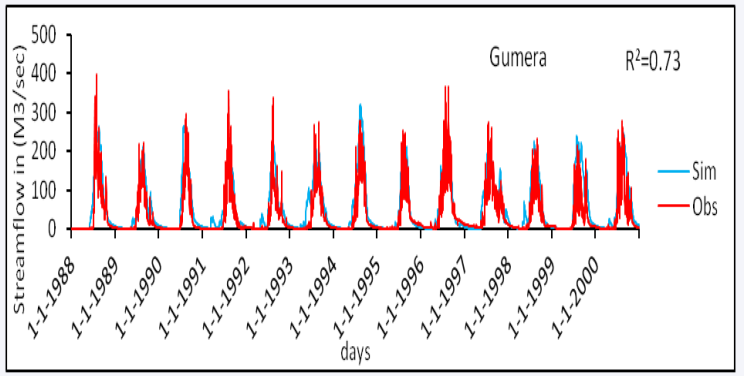


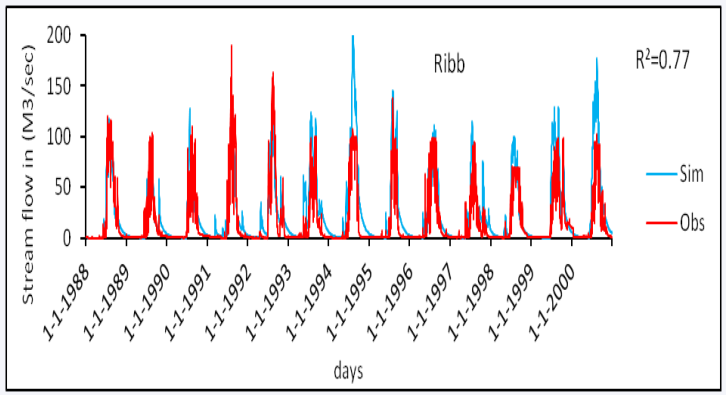
Results and Discussion cont…

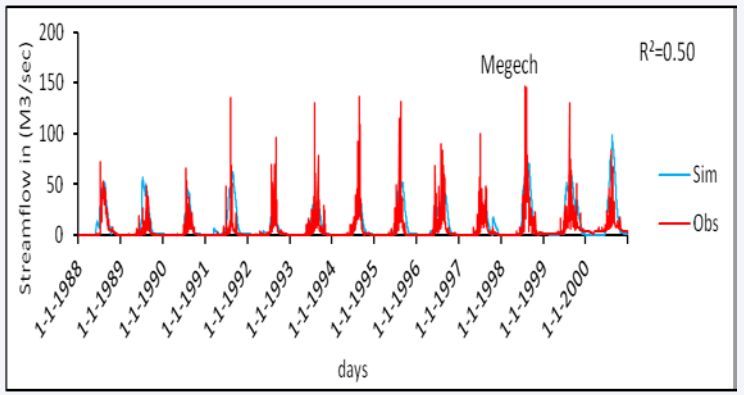
HEC-HMS_ Model Calibration(1988-2000)

❖The Nash- Sutcliffe model simulation efficiency (NS),is on average greater than 0.5, the R^2 is also greater than 0.5,which is acceptable.









Results and Discussion cont…

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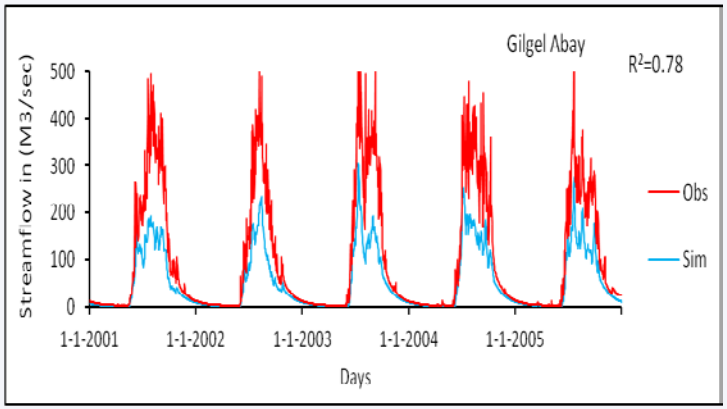
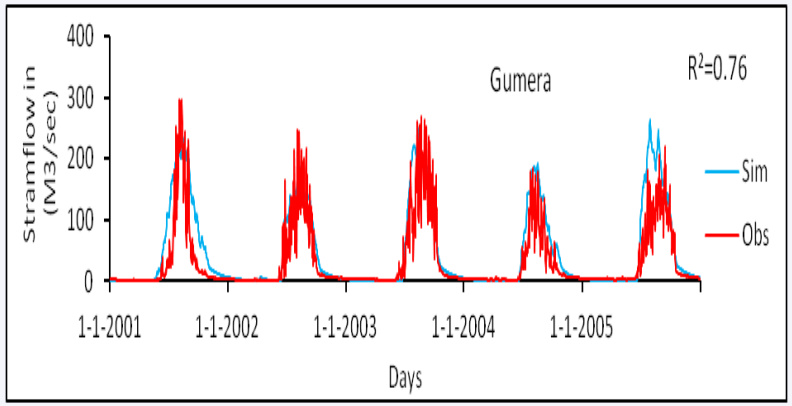
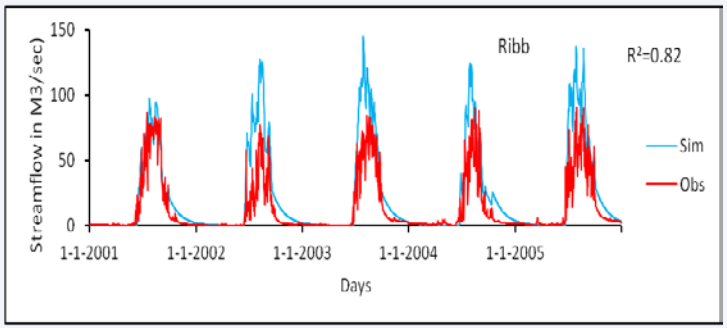
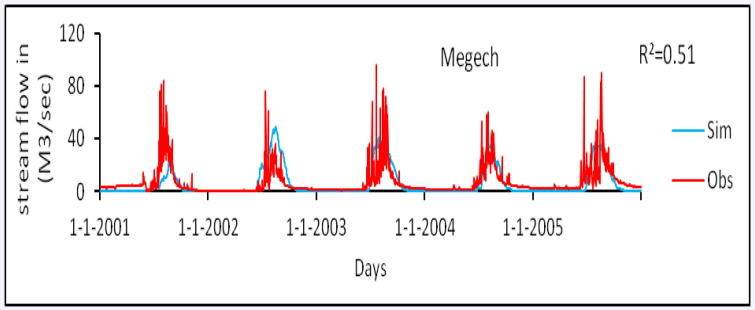
HEC-HMS_ Model validation (2001-2005)









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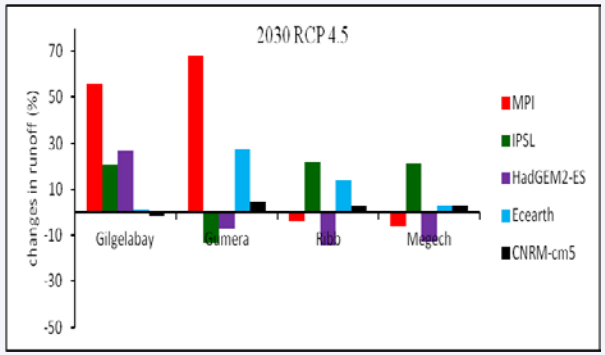
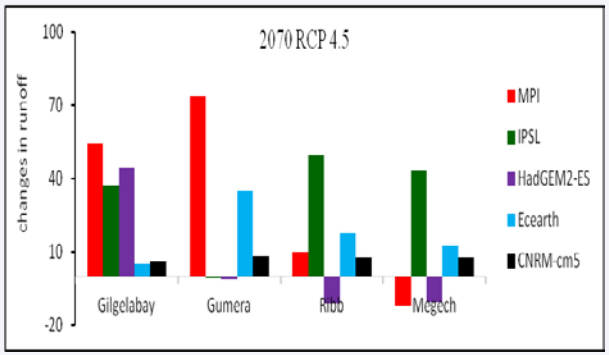
Results and Discussion cont…

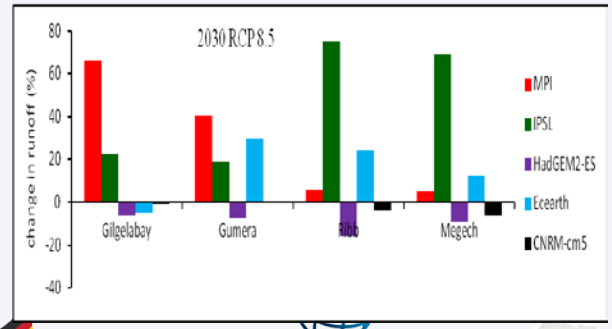
Future runoff

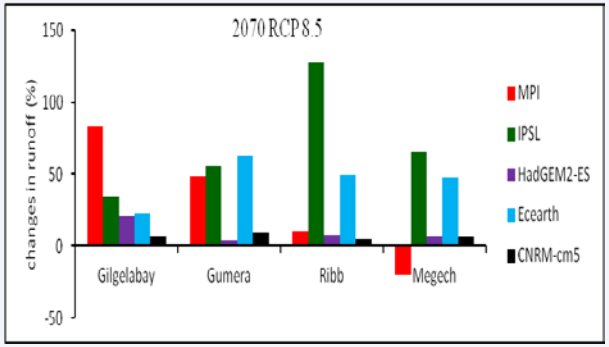
❖Average Runoff projection based on five GCMs model projections

At 2030`s increases up to +55.7 % for RCP4.5 & +74.8% for RCP 8.5
At 2070`s increases up to +73.5 % for RCP 4.5 & +127% for RCP 8.5









Conclusions

At 2030`s and 2070`s

- precipitation
- temperature
- potential evapotranspiration &
- annual runoff increases

❖In general, future water resources availability of the basin increases and would meet the future water development demand with a planned strategy.

❖**Integrated action towards transboundary cooperation for sustainable water development and environmental sustainability is important!!**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THANK YOU!