



**Nile workshop: June 16-19, Addis Ababa, Ethiopia**

# **ASSESSMENT OF CLIMATE CHANGE IMPACTS ON THE HYDROLOGY OF GILGEL ABBAY CATCHMENT IN LAKE TANA BASIN, ETHIOPIA**

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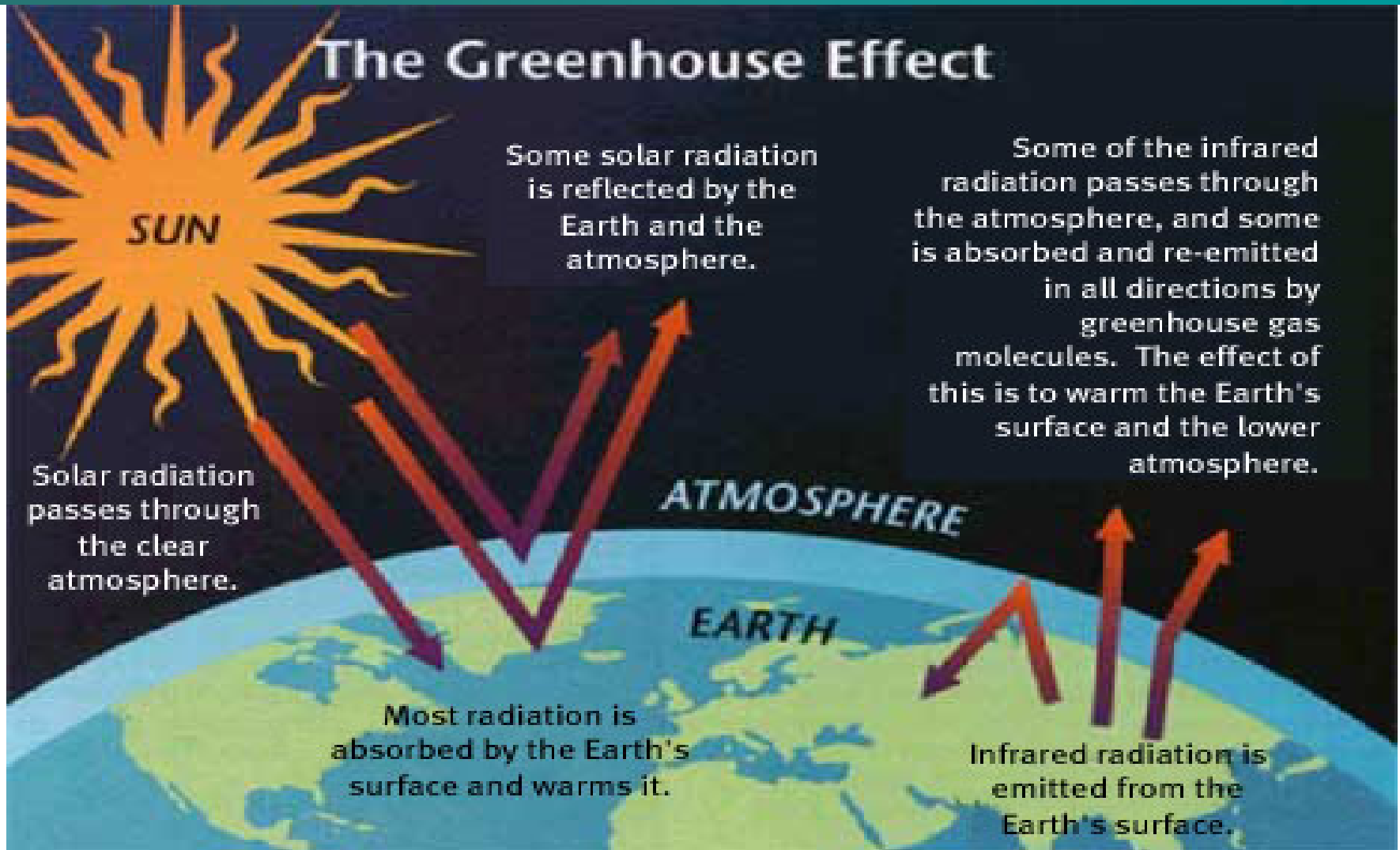


# Outline of the presentation

- Introduction
- Objective
- Study Area
- Methodology
- Results
- Conclusion



# 1. Introduction





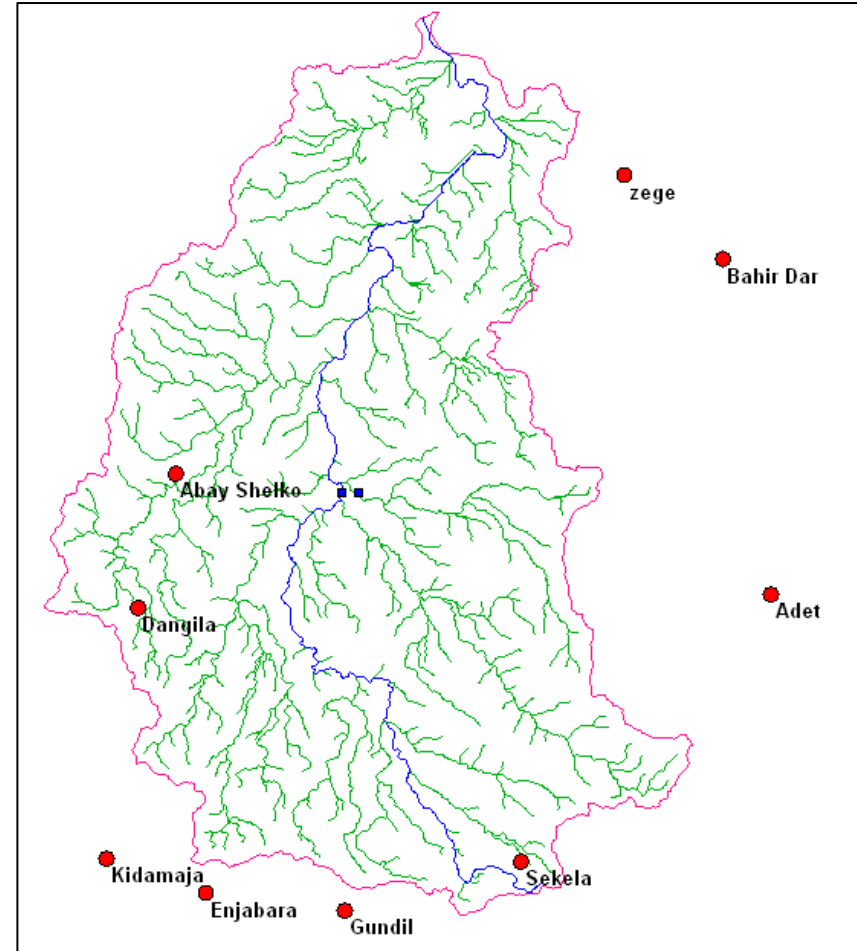
## 2. Objective

- ✓ The objective of this study are:
  - To develop and evaluate climate scenario data based on a General Circulation Model and a Statistical DownScaling Model
  - To quantify possible effects of climate change on the hydrology of Gilgel Abbay catchment
  - To develop incremental (synthetic) scenarios to assess the sensitivity of the catchment to climate change



# 3. Study Area

- ✓ Location: Northwest part of Ethiopia
- ✓ Area: 4100km<sup>2</sup>
- ✓ Topography:
  - Elevation 1787- 3518m
  - Slope 0-8%            70%
  - 8-30%            25%
  - >30%            5%
- ✓ Climate:
  - Rainfall:
    - high spatial and temporal variation
    - Annual amount 1200-2400mm
    - 70-90% of rainfall (June-Sep)
  - Temperature:
    - high diurnal change compared to seasonal variation





## 4. Methodology

It is a three step procedure:

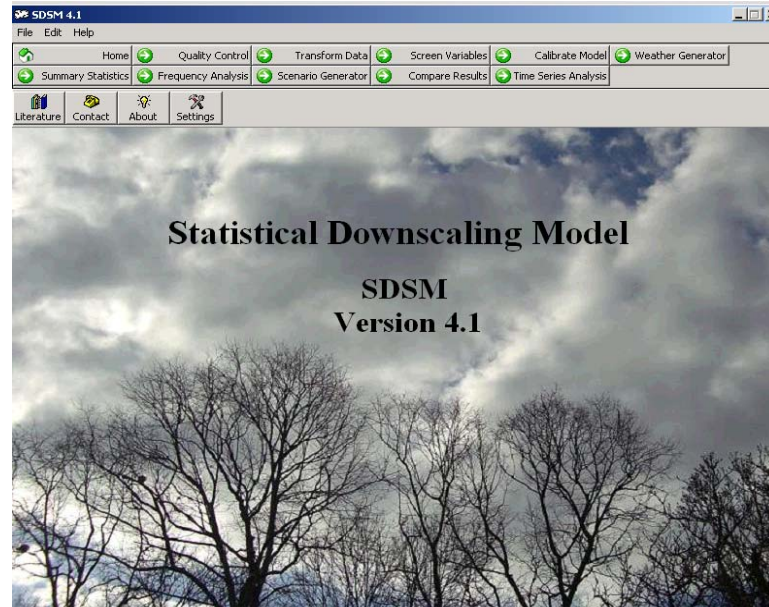
1. Use of GCM (HadCM3) to provide future global climate scenarios under the effect of increasing greenhouse gases
2. Use of downscaling techniques( SDSM) for downscaling the GCMs output to the scales compatible with hydrological models
3. Use of hydrological models (HBV-96) to simulate the effects of climate change on hydrological regimes at various scale



## 4. Methodology...

- Statistical DownScaling Model (SDSM)
- ✓ Statistical DownScaling Model 4.1 is a tool for the assessment of regional and local climate change impacts
- ✓ SDSM permit the spatial downscaling of daily predictor-predictand relationship using multiple linear regression techniques

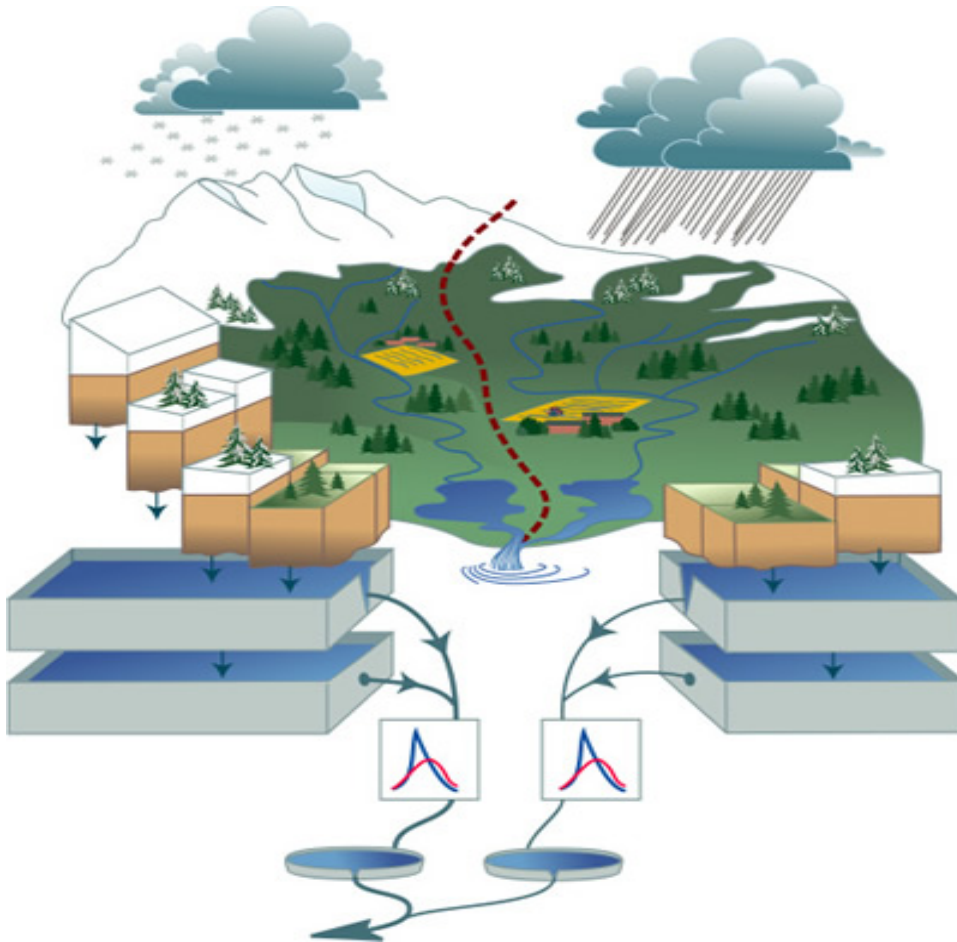
$$R = F(L)$$





# 4. Methodology

## HBV-96



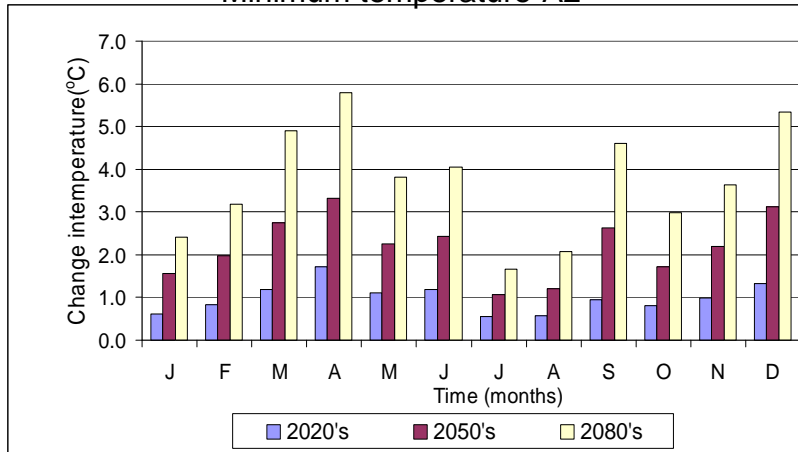
- ✓ Model description
  - Conceptual rainfall-runoff model
  - Semi-distributed model
  - Soil routine; response routine; transformation function
  
- ✓ Input data requirement
  - Precipitation
  - Temperature
  - Evapotranspiration
  - Runoff records for calibration
  - Geographical information about the river catchment



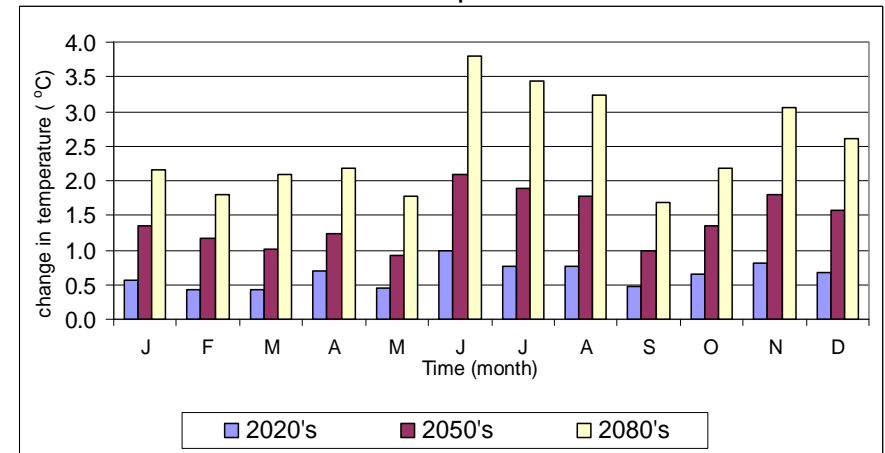
# 5. Results

## Downscaling the GCM for future scenario

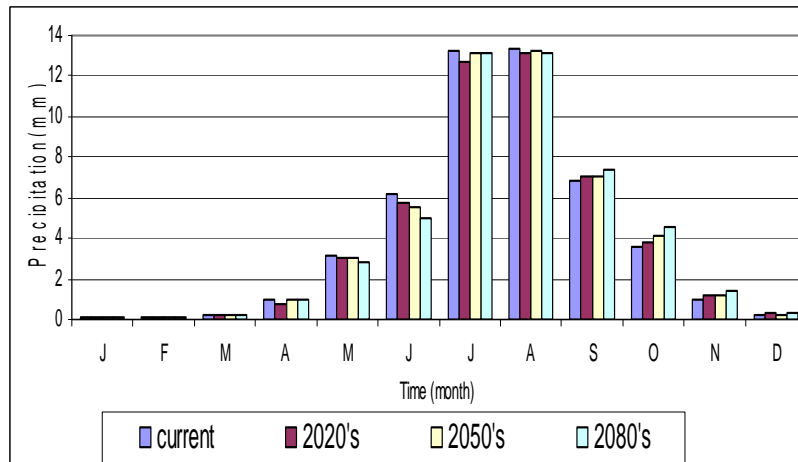
Minimum temperature-A2



Maximum temperature-A2



Precipitation-A2



Periods	Min temp	Max temp
2020s	+1	+ 0.6
2050s	+2.2	+1.5
2080s	+3.7	+2.5

### Precipitation

Decreasing trend – May & Jun (-18% in June by2080)

Increasing trend -Sep & Oct (+8.5% in Sep by 2080)

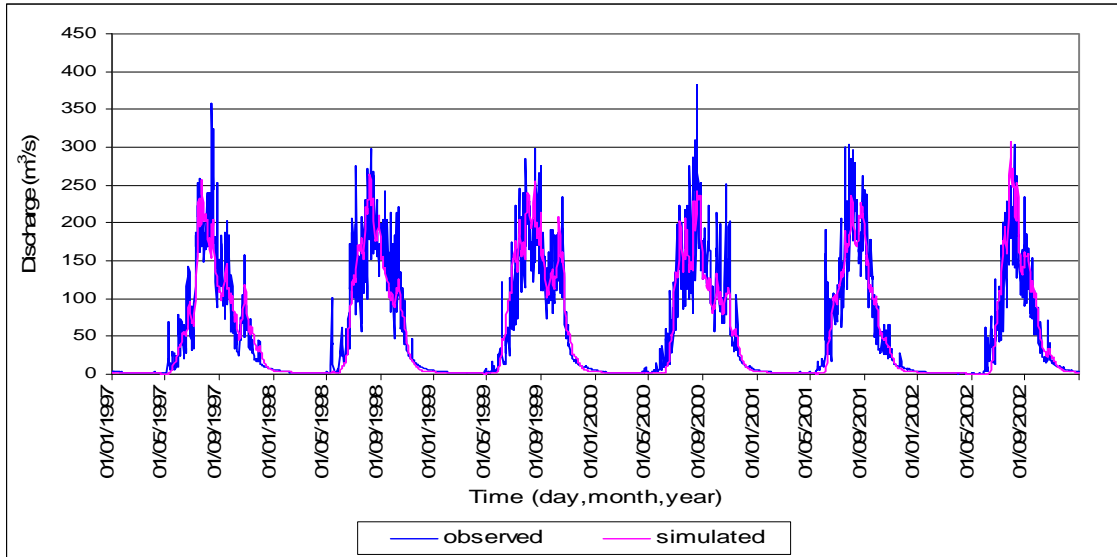
Monthly variation is more significant than annual variation





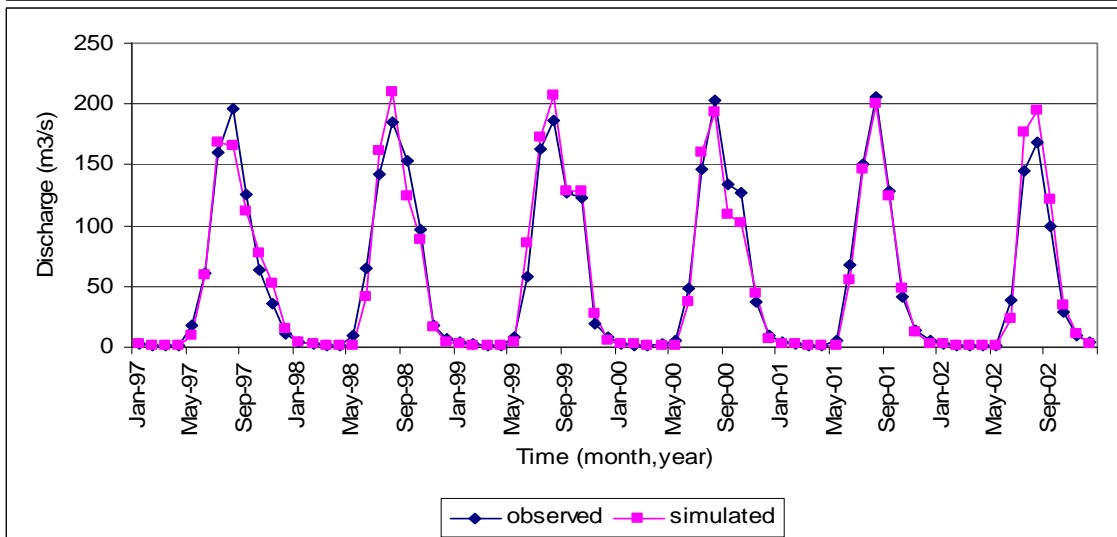
# 5. Results...

## Hydrological model calibration and validation results



Daily observed and simulated hydrograph during calibration period

	Calibration	Validation
R <sup>2</sup>	0.86	0.76
r	0.92	0.9

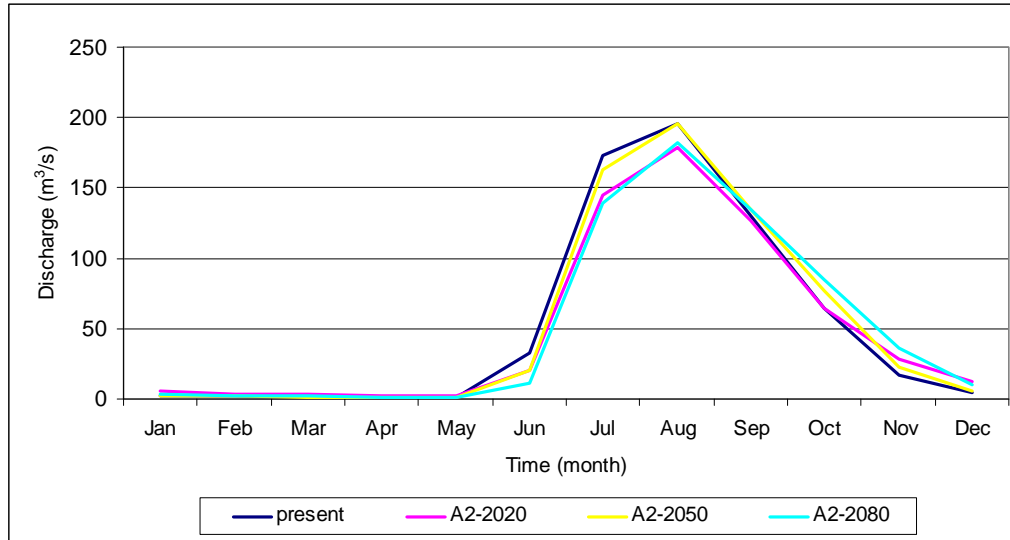


Observed and simulated mean monthly hydrograph during calibration period



# 5. Results...

## Hydrological impact of future climate change scenario



✓ Monthly and seasonal variation is larger than annual variation

Time	A2-2020	A2-2050	A2-2080	B2-2020	B2-2050	B2-2080
Seasonal runoff (Jun-Sep)	-11.6	-3.5	-12.2	-13.3	-1.4	-10.1
Annual runoff	-5.4	0.2	-2.6	-6.8	0.4	-2.9



# 5. Results...

## Uncertainties and sensitivity analysis

- ✓ Uncertainties

1. General Circulation Models
2. Downscaling models
3. Hydrological models

- ✓ Incremental scenario

10 incremental (synthetic) scenarios were applied

As much as 33% of runoff will be reduced if an increase of 2°C and 20% reduction of rainfall will occur simultaneously in the catchment



## 6. Conclusions

- ✓ Both the minimum and maximum temperature show an increasing trend in all future time horizons for both A2 and B2 scenarios
- ✓ For precipitation there is decreasing trend in the beginning of the rainy season (May & June) and increasing trend towards the end of rainy season (Sep & Oct)
- ✓ The HBV model simulates the runoff reasonably well for the study area
- ✓ The hydrological impact of future change scenarios indicates that there will be high seasonal and monthly variation of runoff compared to the annual variation



# THANK YOU !

## LET US SAVE OUR CLIMATE

