Downscaling Climate Change AA area to Assess Climate change impacts on Availability and Extreme hydrological condition

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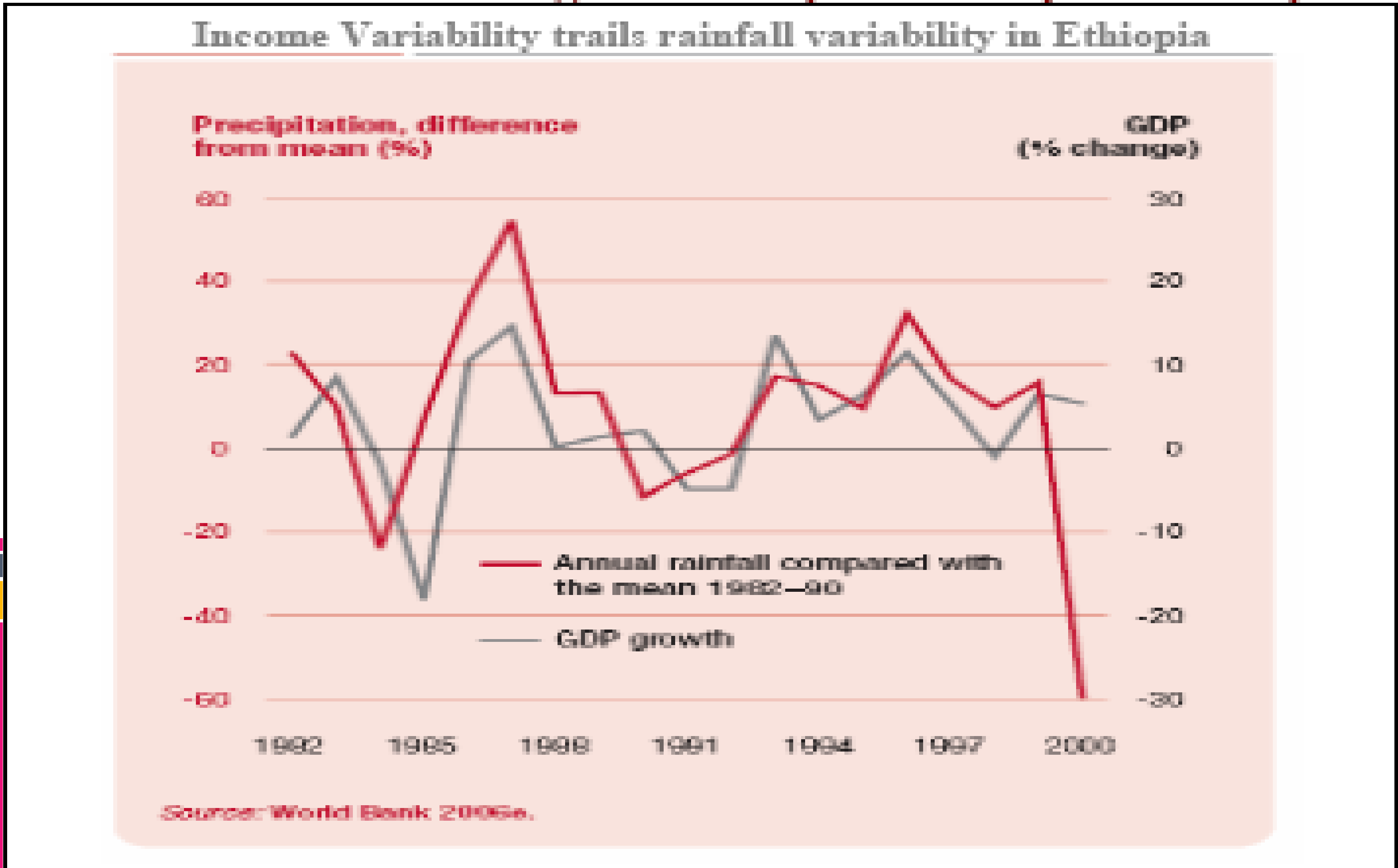
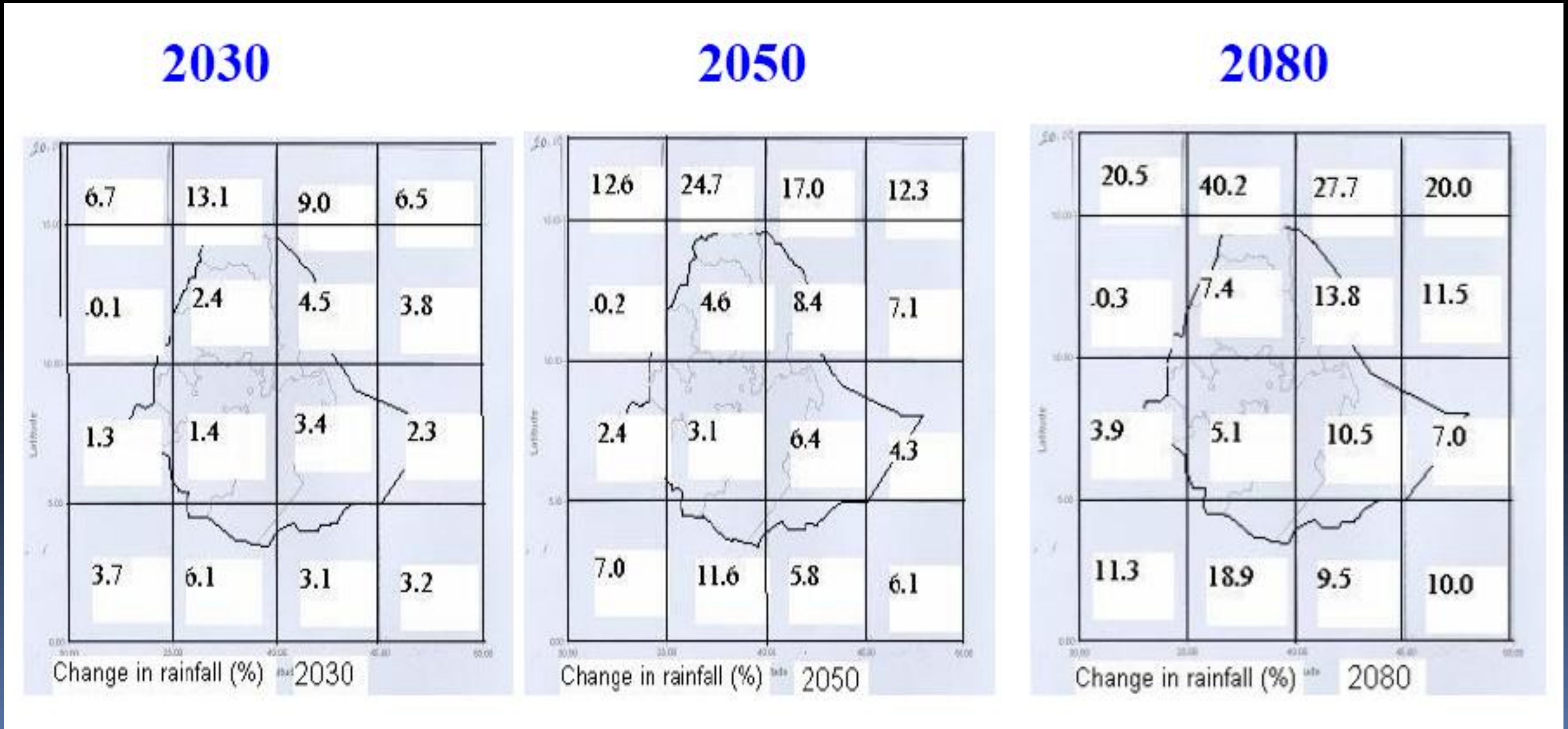
Background: economic

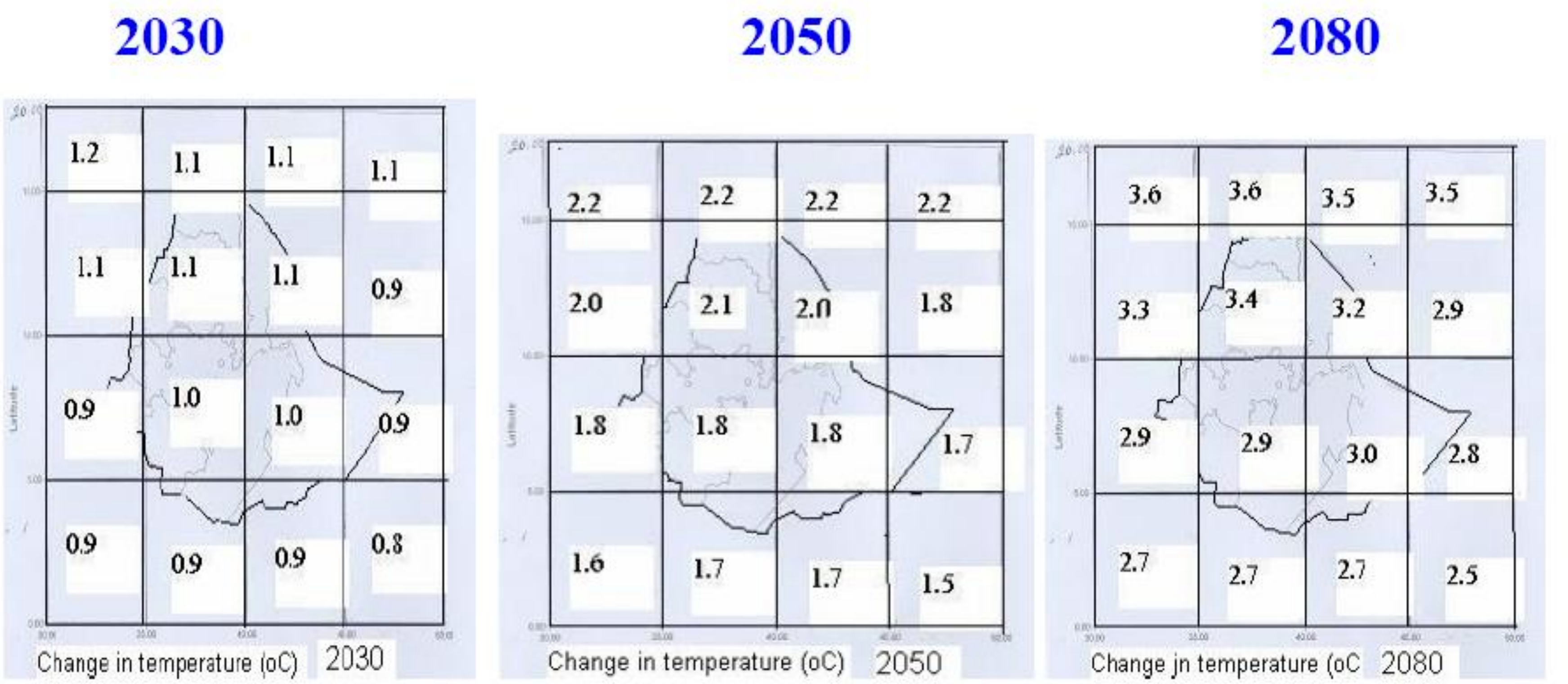


I. Background and Context: Projected climate Change

- Composite (average of 19 GCMs) percentage change (%) in rainfall relative to 1961-1990 normal for A1B emission scenario
  - A small increase in annual precipitation



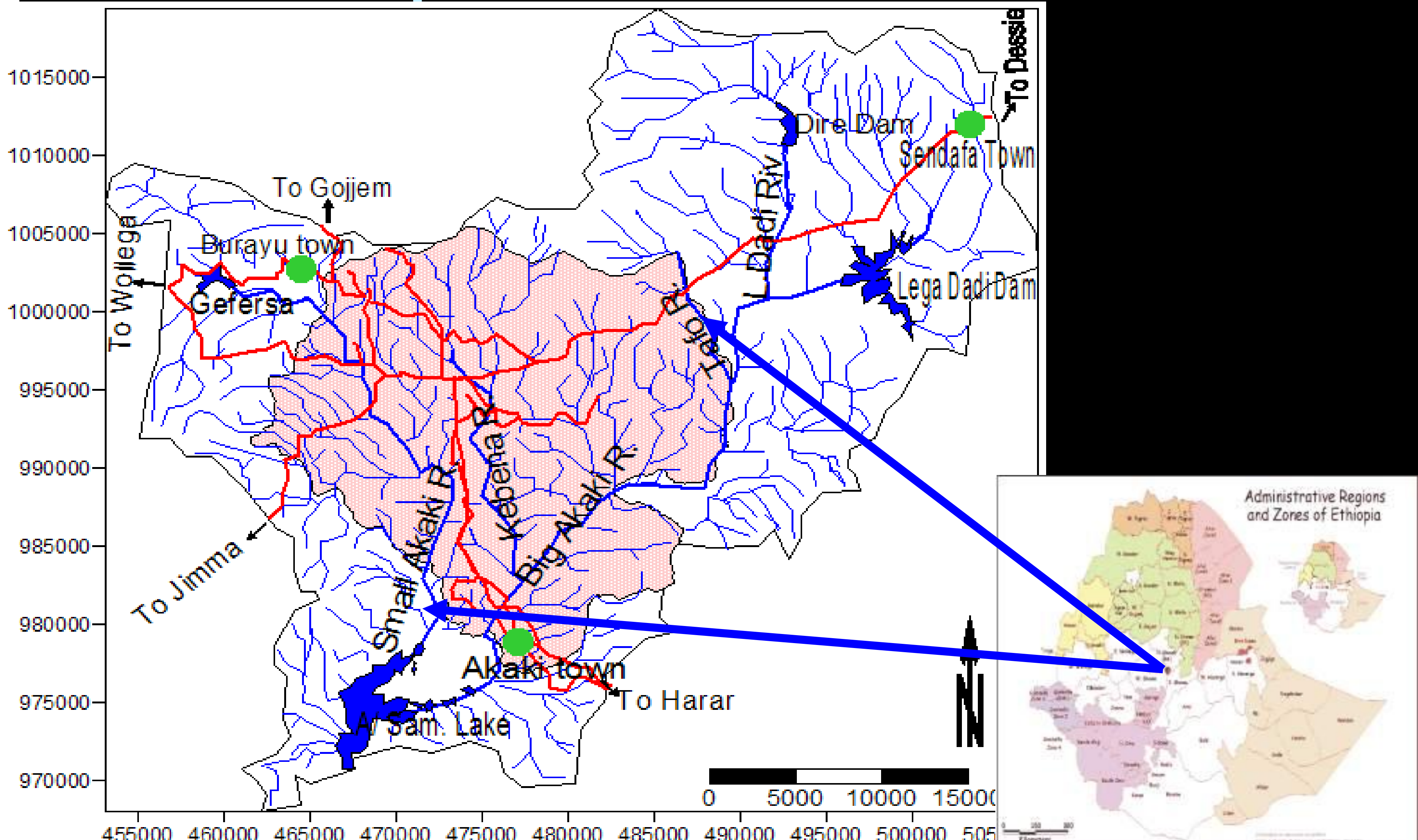
- the mean annual temperature will increase in the range of 0.9 -1.1 °C by 2030,
- in the range of 1.7 - 2.1 °C by 2050
- in the range of 2.7-3.4 °C by 2080



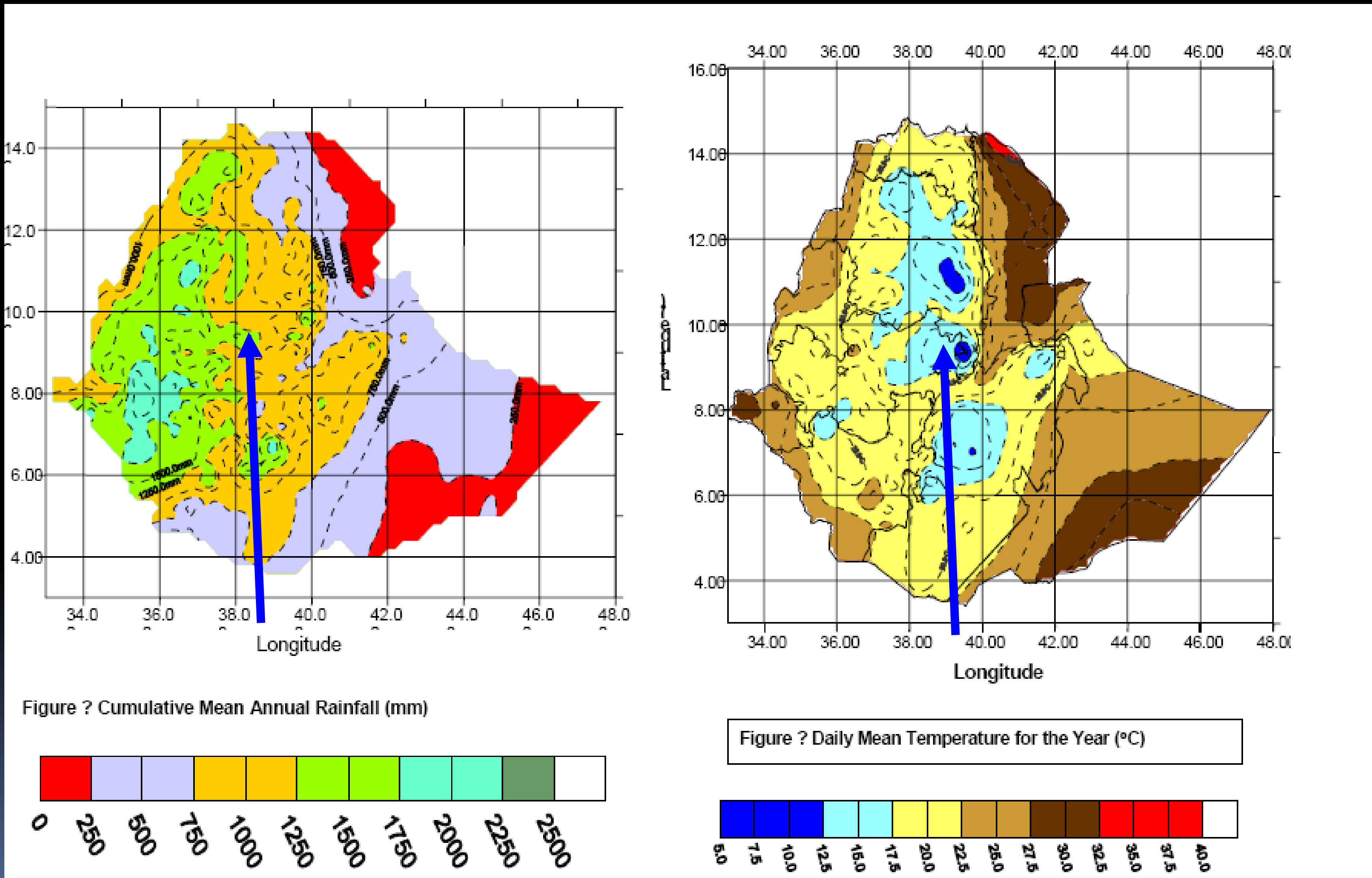
Objective of the Study

- Future climate change Scenario for Addis Ababa and Surrounding areas
    - **GCM → RCM → LOCAL MODELING**
- Water availability from surrounding Rivers under various climate change scenarios
- Extreme hydrological conditions including flooding (flood areas and extent) under various CC scenarios
    - **HEC-HMS CALI/VERIFICATION -> RUNOFF OUTPUT UNDER DIFFERENT CC SCENARIO**

Study Area, Addis Ababa and ...

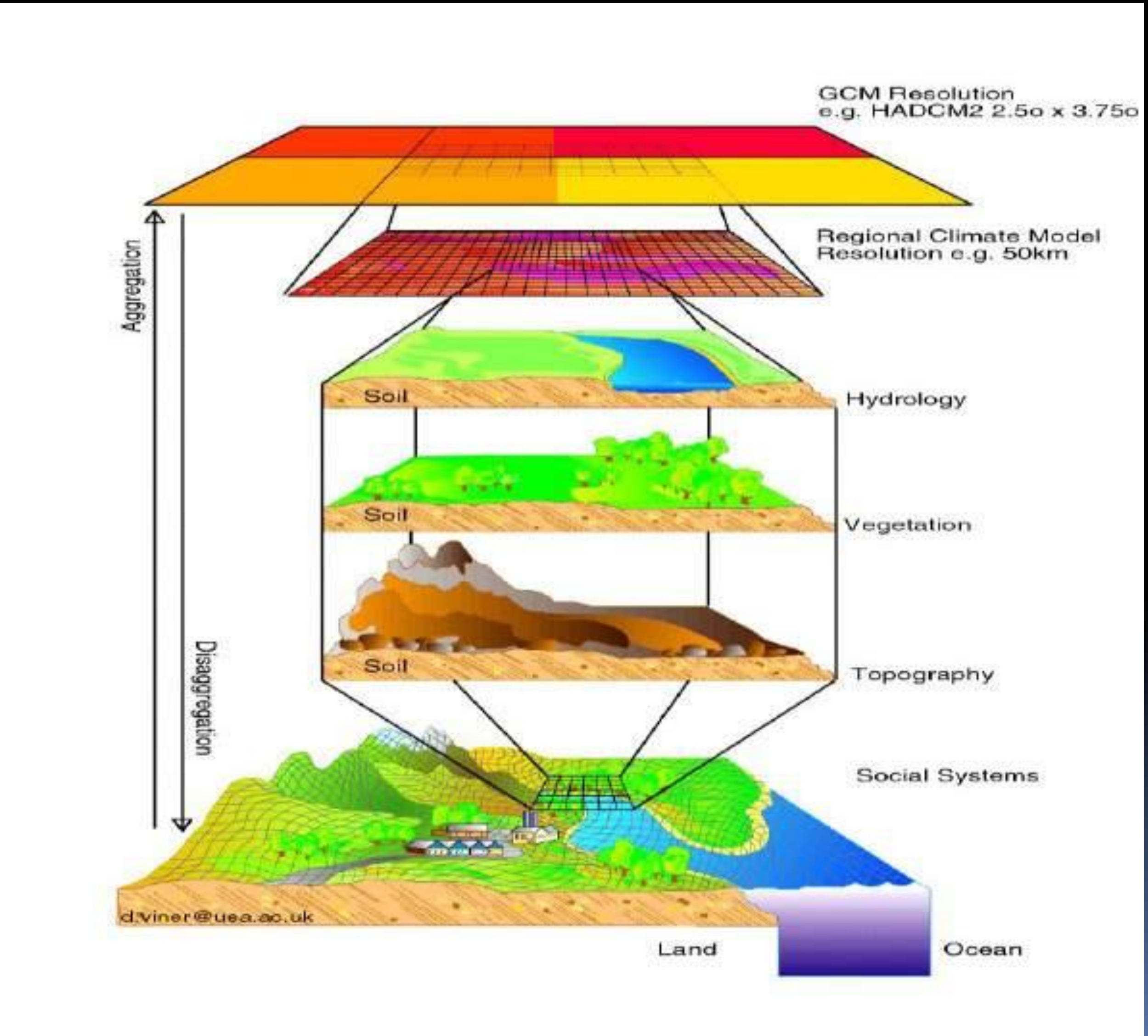


Rainfall and temperature

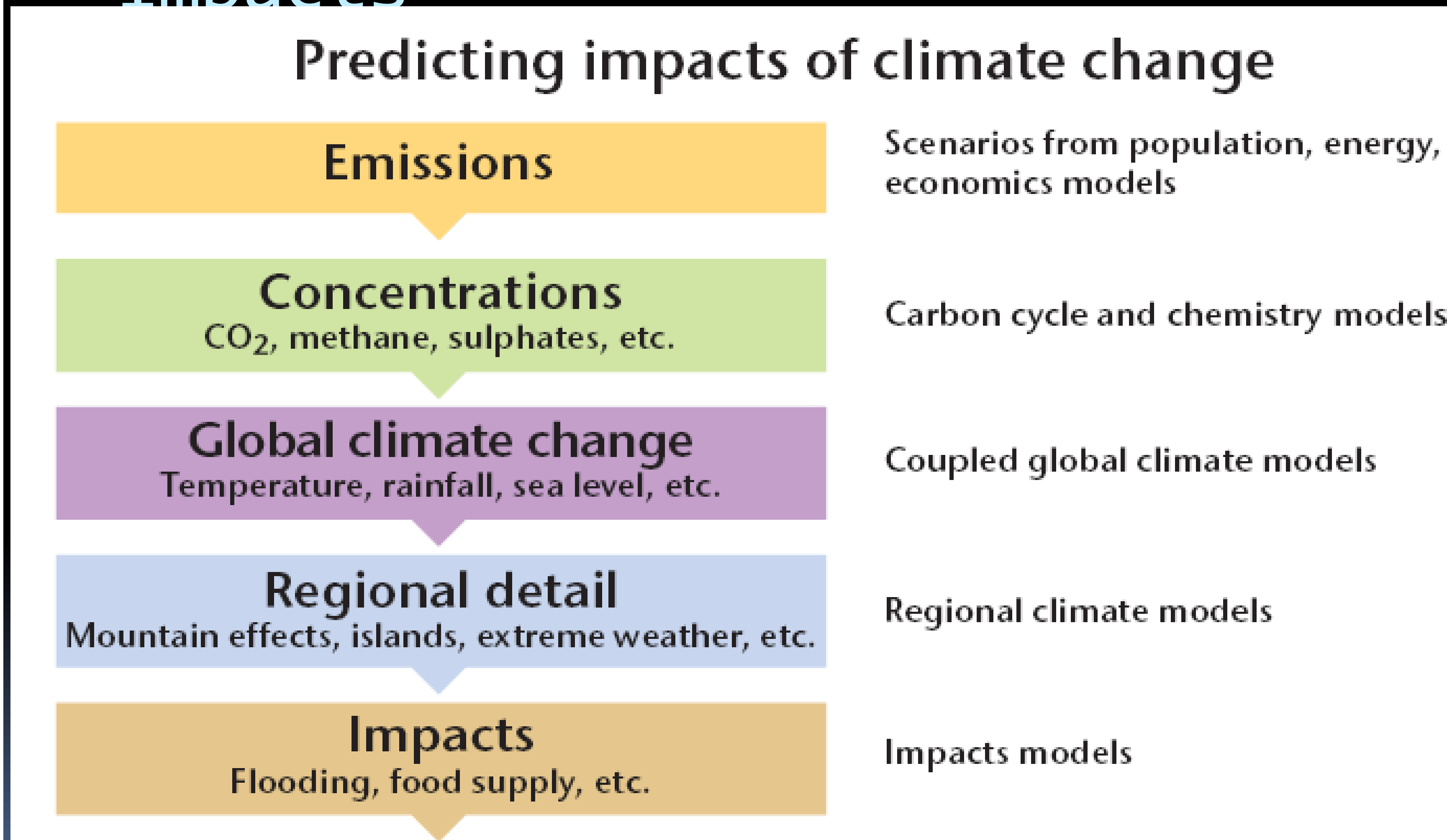


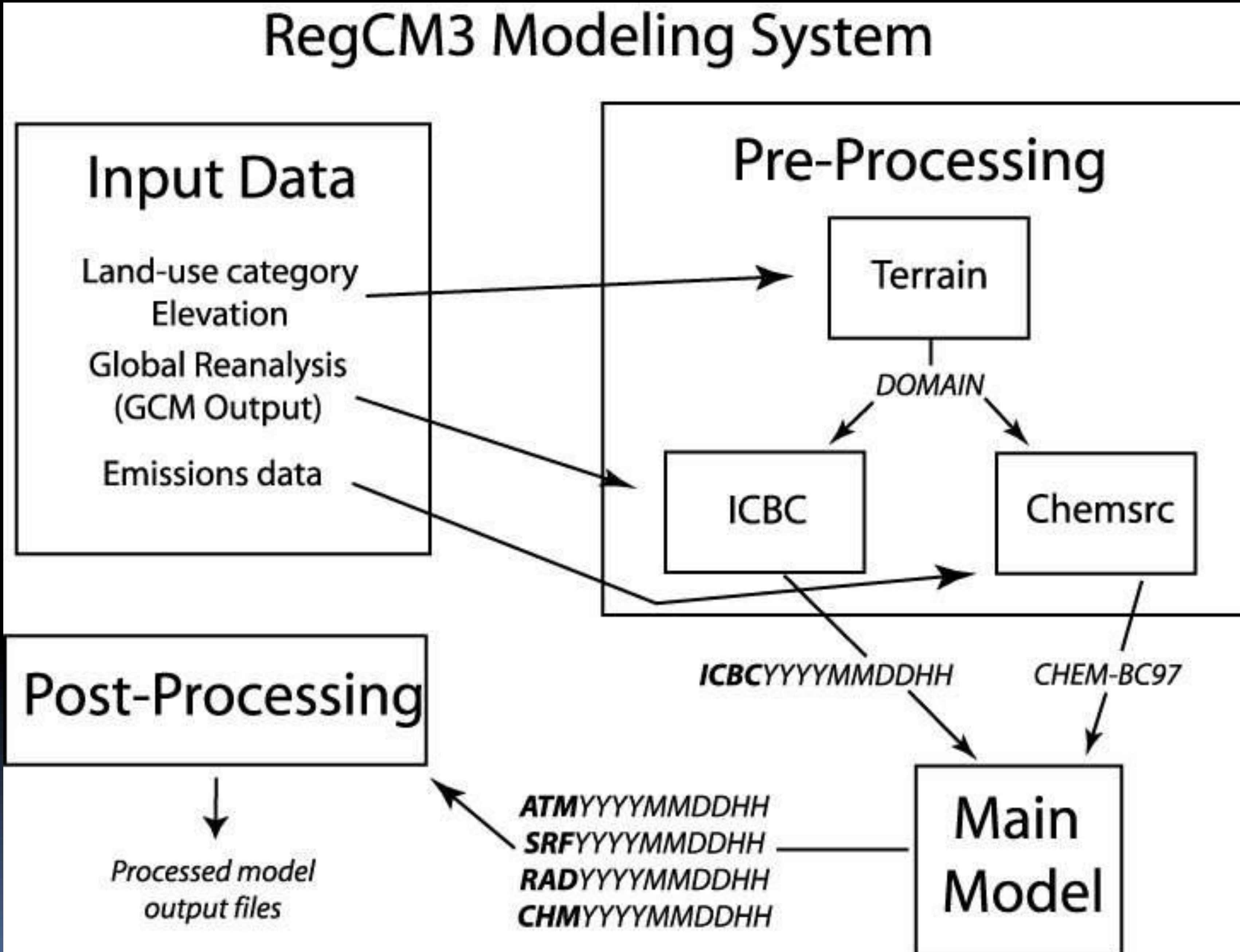
Methodology

Regional Downscaling (RegCM3) RwgCM3

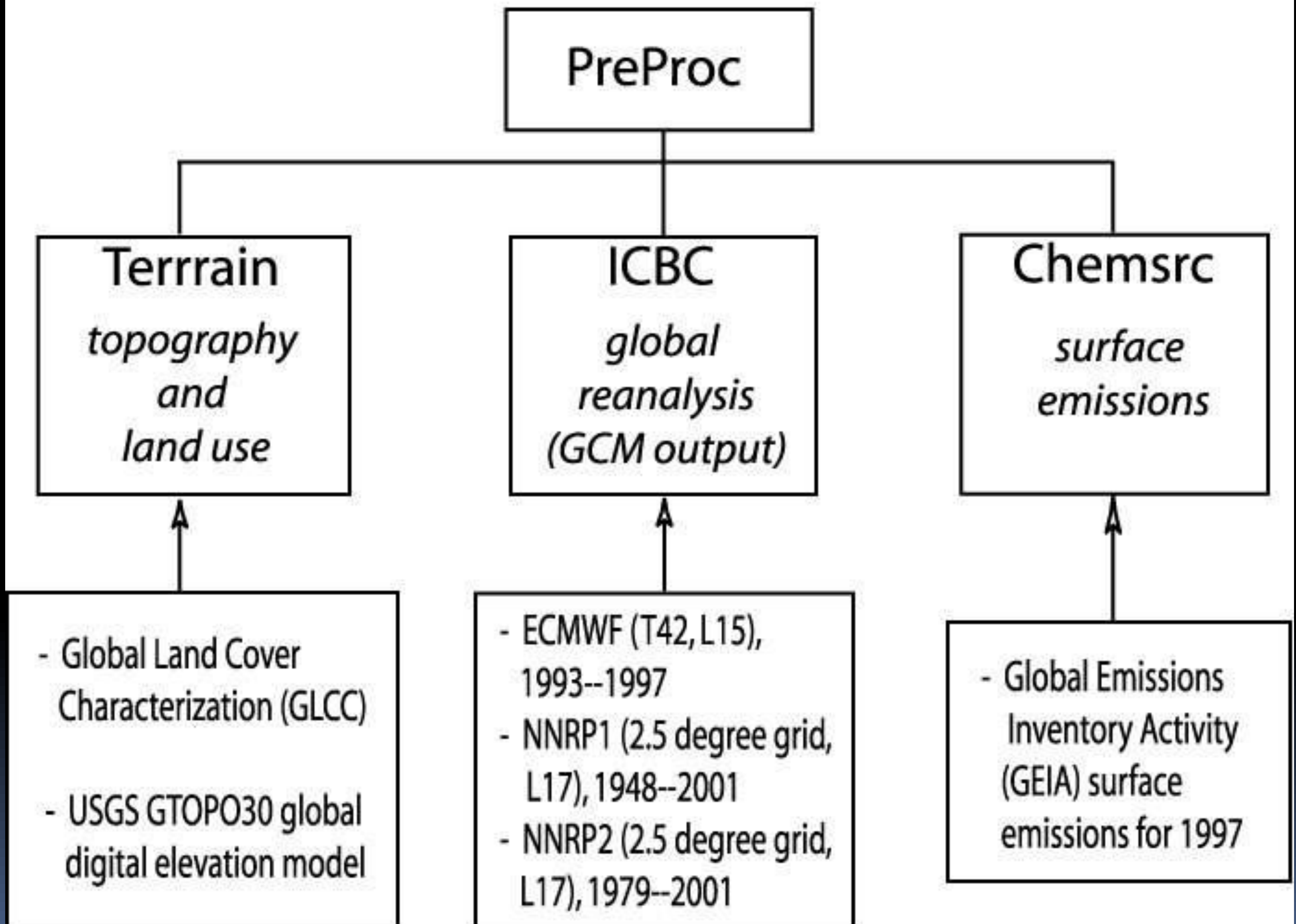


Methodology: Climate Change Impacts



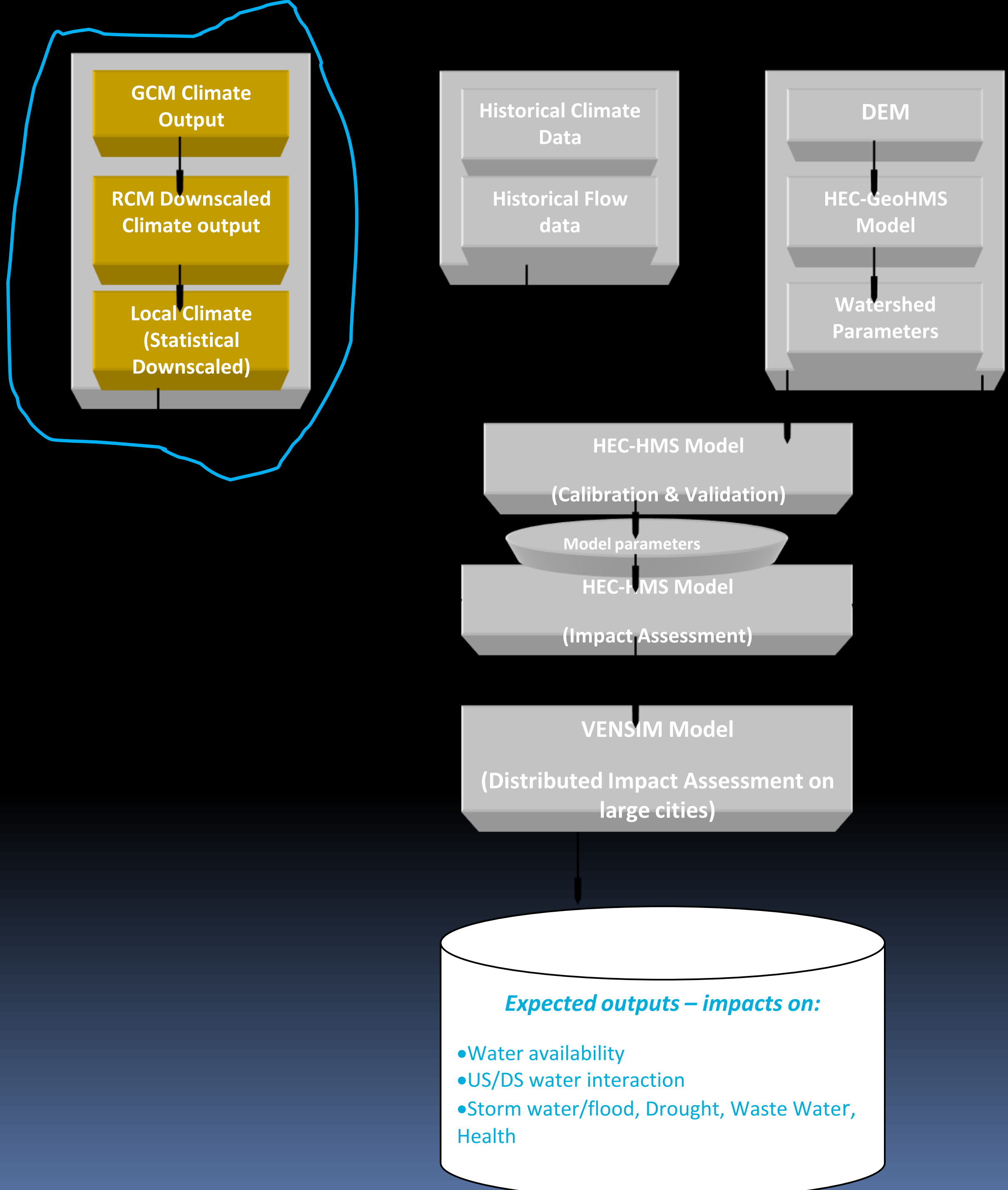

RegCM3 Modeling System
Input Data
Land-use category
Elevation
Global Reanalysis
(GCM Output)
Emissions data
Pre-Processing
Terrain
DOMAIN
ICBC
Chemsrc
ICBCYYYYMMDDHH
CHEM-BC97
Post-Processing
Processed model
output files
ATMYYYYMMDDHH
SRFYYYYMMDDHH
RADYYYYMMDDHH
CHMYYYYMMDDHH
Main
Model

Data Required to Run the Model



* data are available at http://www.ictp.trieste.it/~pubregcm/RegCM3

Proposed Modeling framework

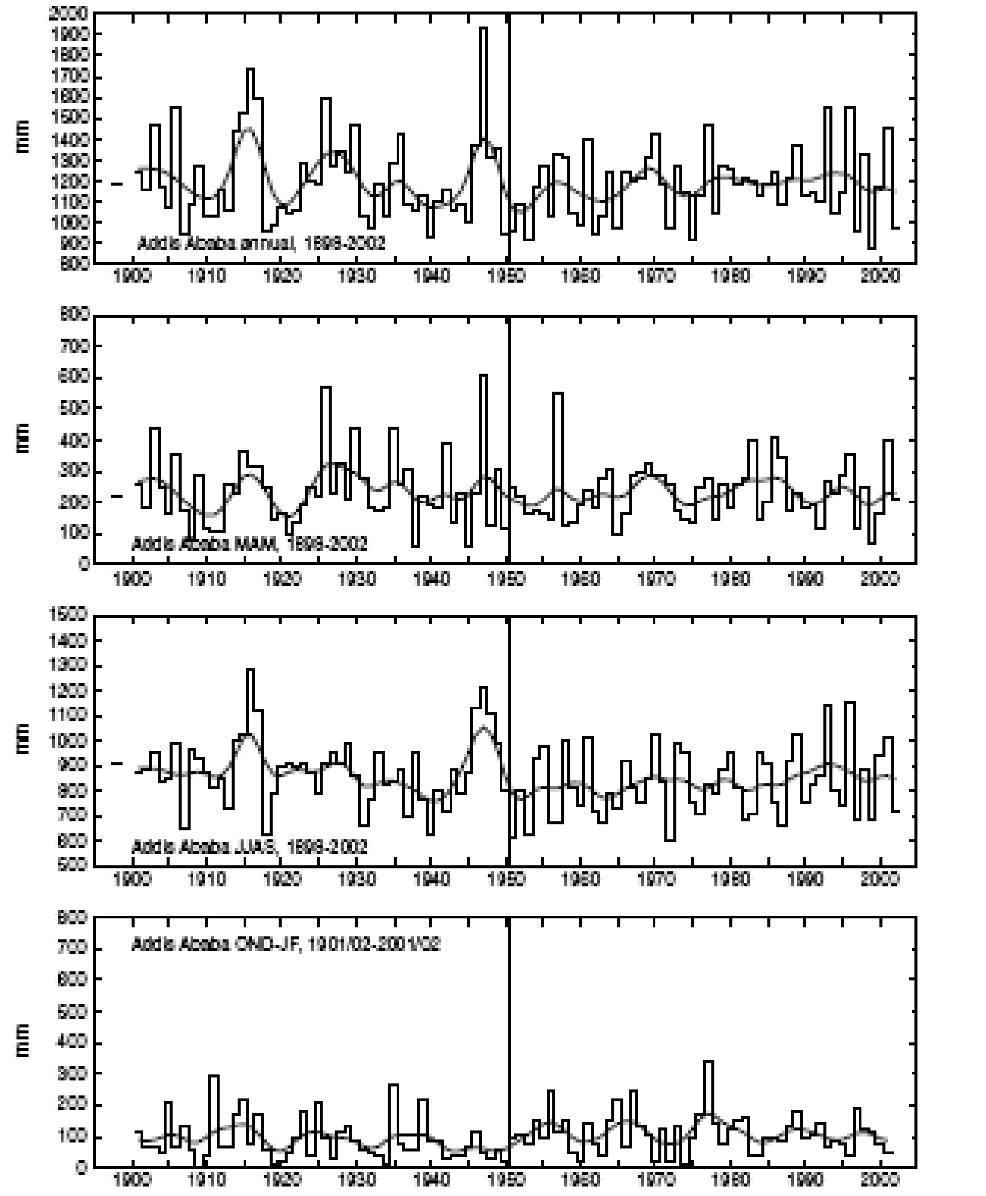


Results

- The model provides future scenario output for surface and atmospheric parameters
  - Precipitation
  - Temperature (mean, max and minimum)
  - Relative humidity
  - The wind speed at 10 m

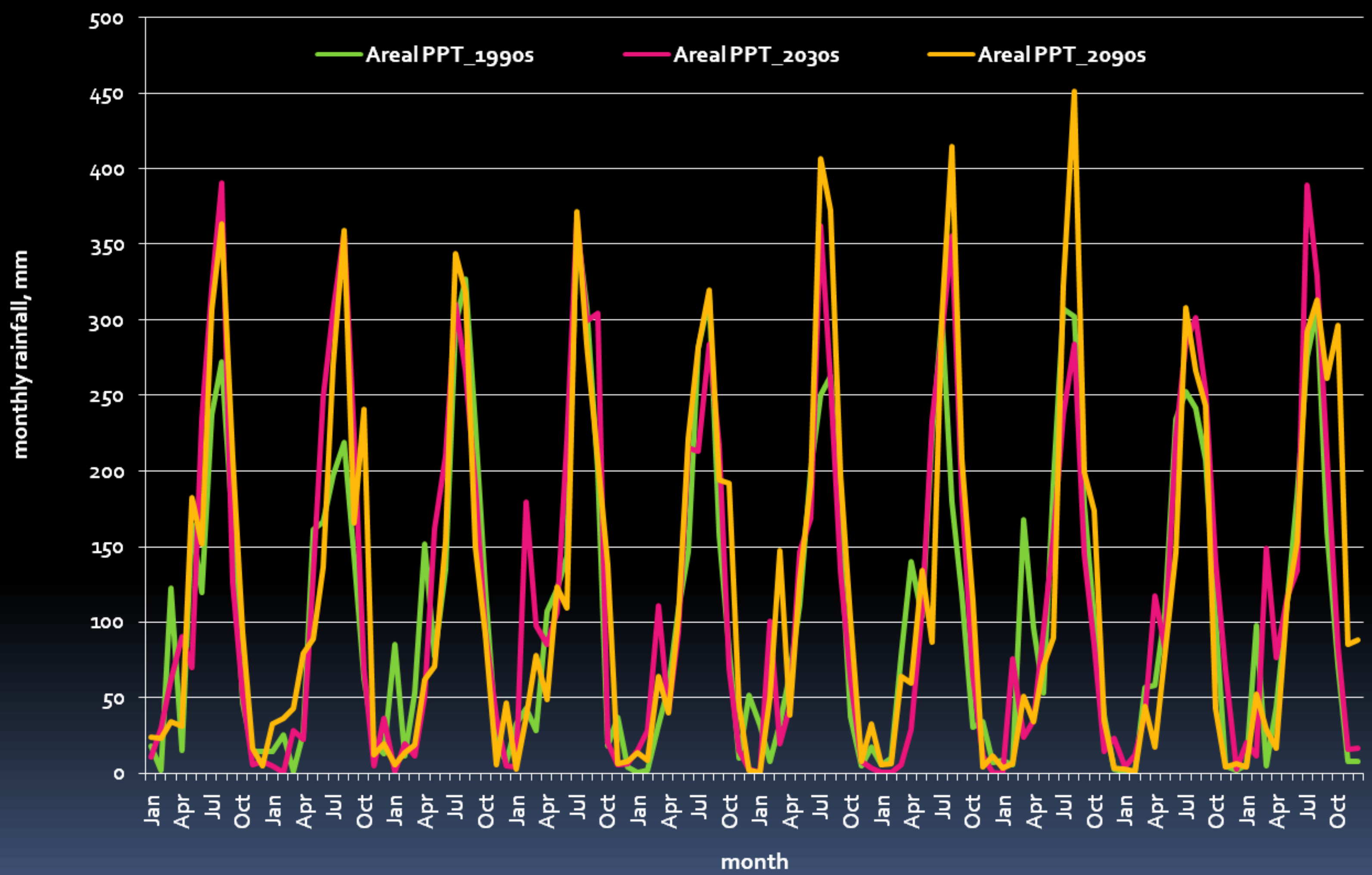
Previous Study output(Conway, 2004)

period of study (1898-2002)

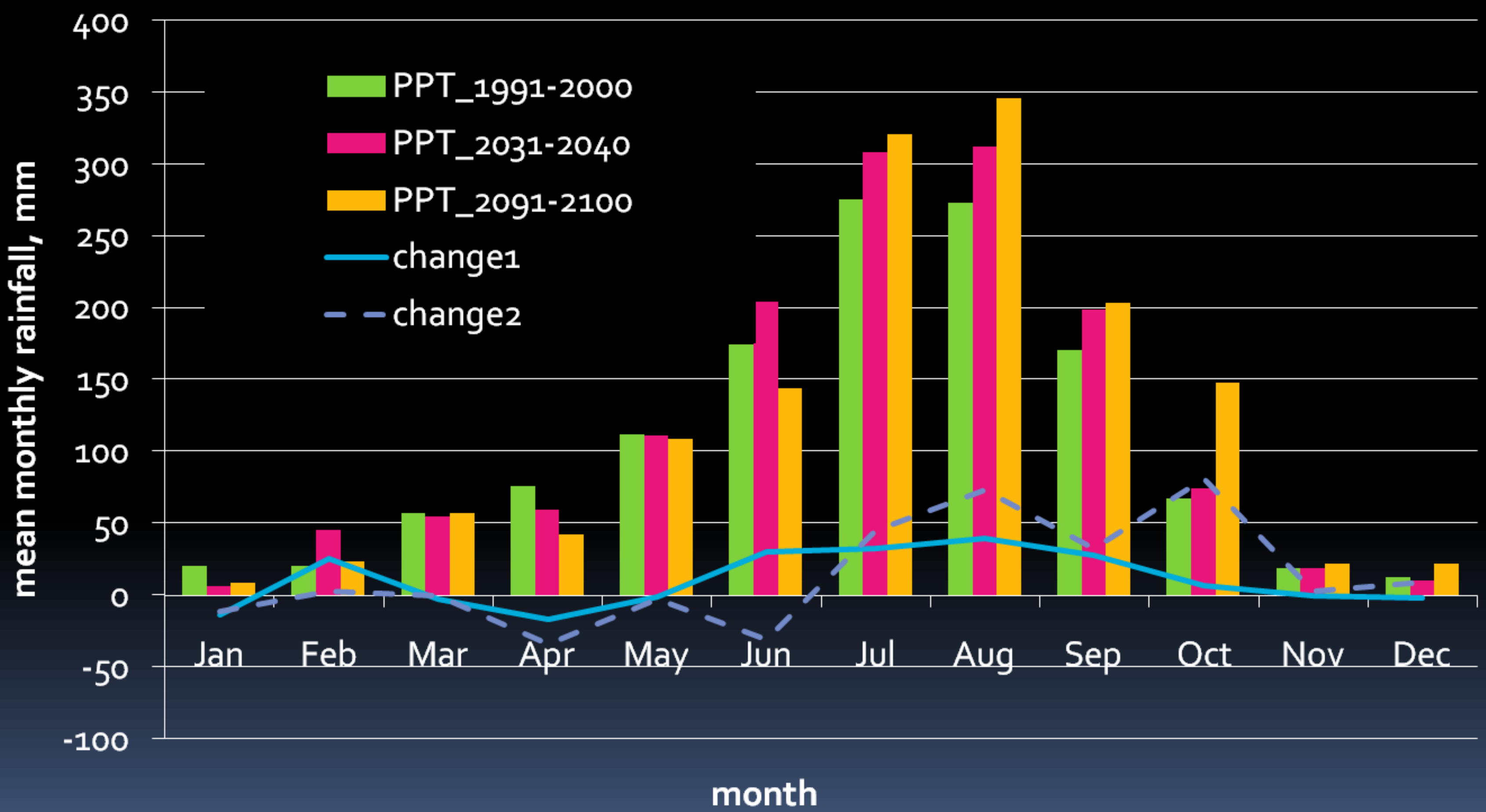


2. Annual and seasonal rainfall in Addis Ababa, 1898 to 2002 with 10 year filter applied to annual series. Vertical line highlights start of AAO record

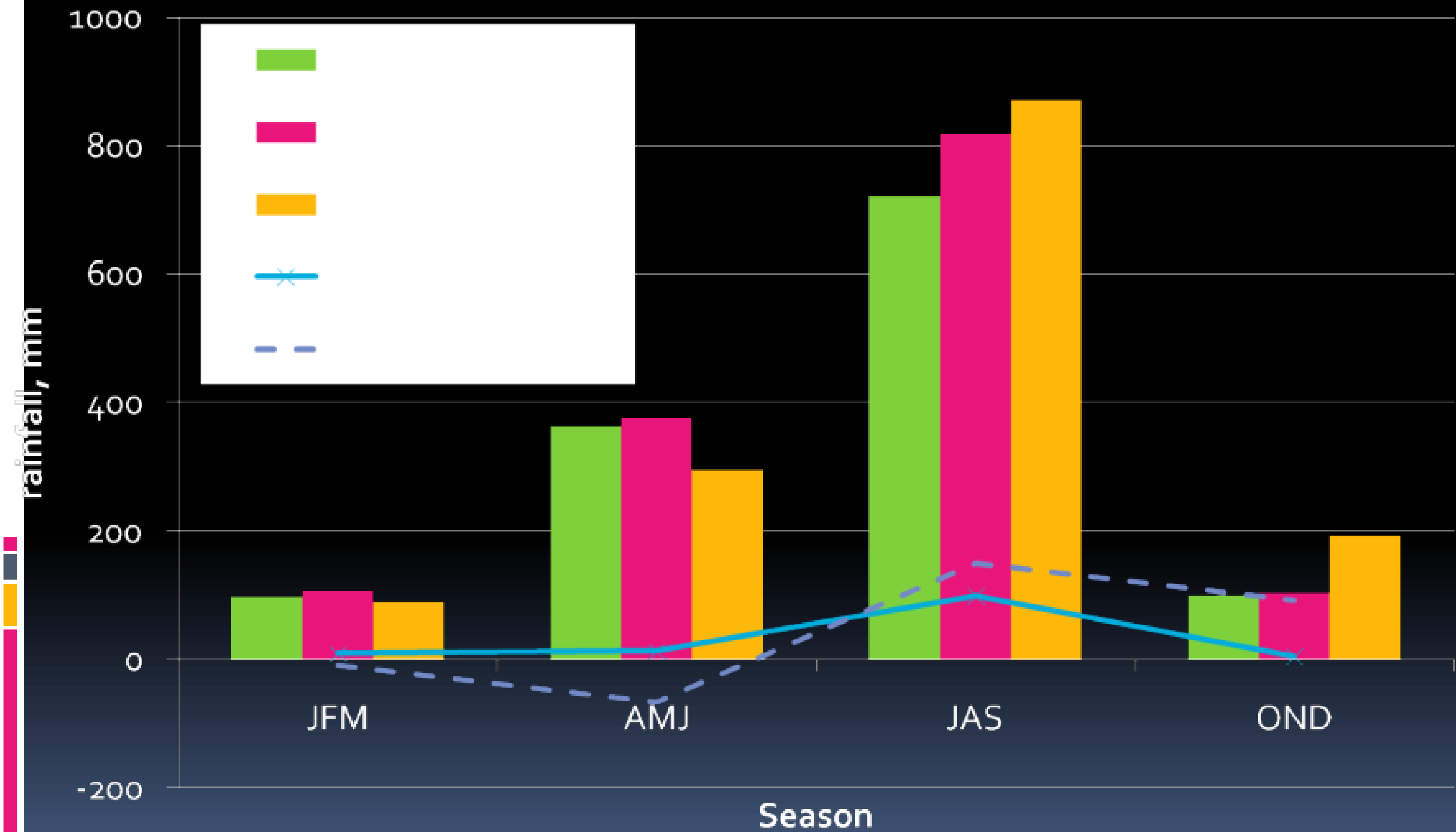
Precipitation



Seasonal Precipitation



Seasonal rainfall



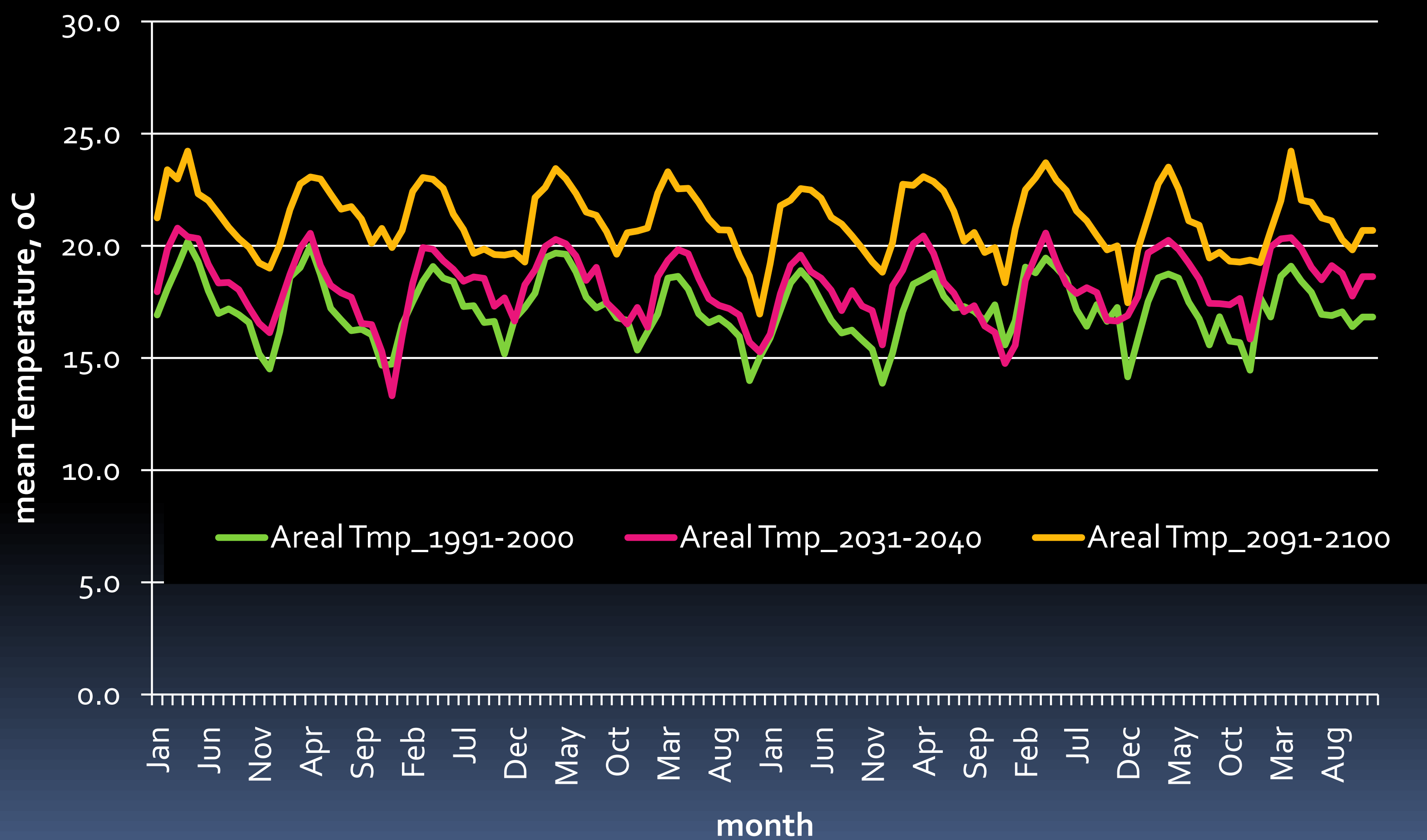
Result shows

- Highly likely increase of rainfall during the rainy season (July-August-September) consistently in 2030s and even in 2090’s
- Significant reduction of rainfall during season April-May-June
- Significant increase of rainfall during the seasons of Oct-Nov-Dec
- In terms of annual volume, there will increase of total rainfall annualy

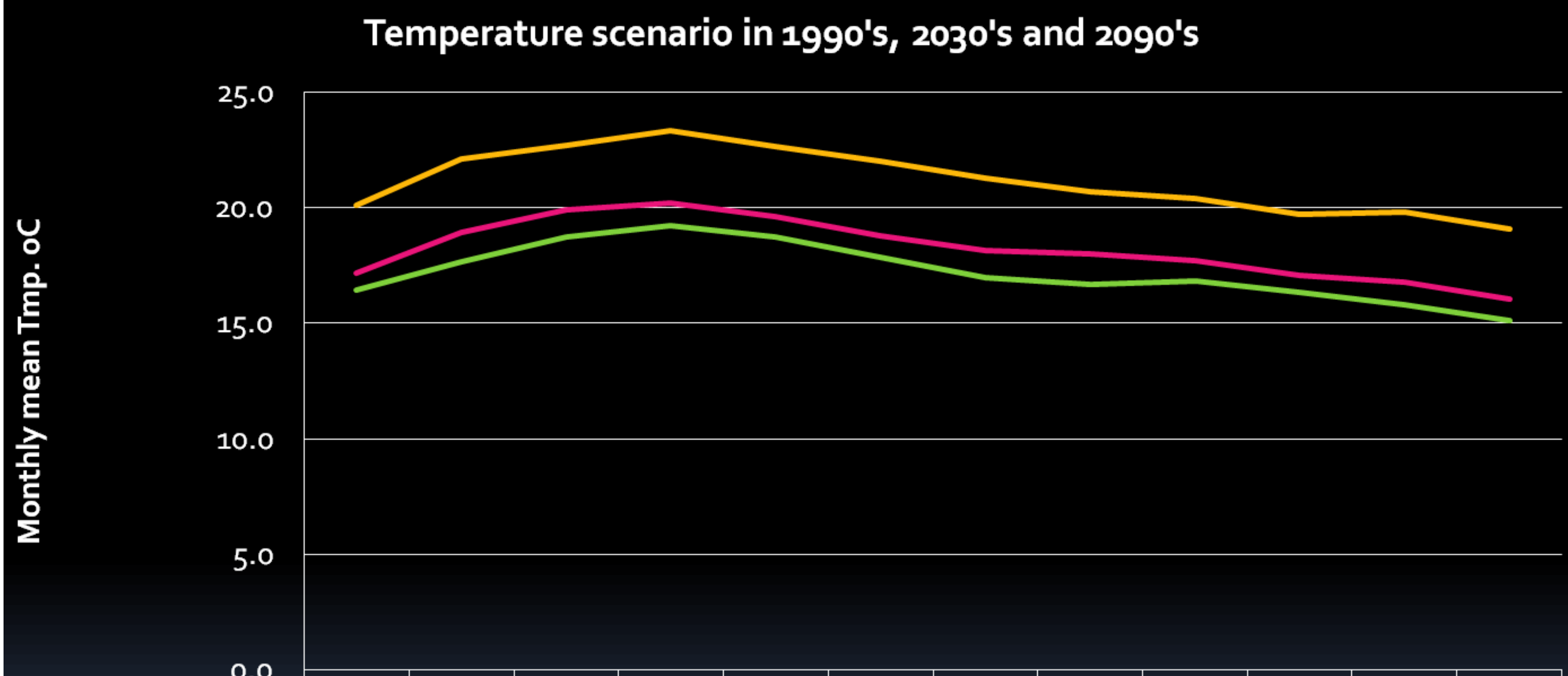
What does it mean?

- *Likely increase of flooding and community vulnerability to flood damage?*
- *Likely change the way we design our drainage structures*
- *……………….*
- *………………*
- *……………….*
- *Need multi-descipilinary professions in the detection of impacts*
- *Need multi-disciplinary professsion in the response*

Monthly Temperature



Seasonal Temperature



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmp_1991-2000	16.4	17.7	18.7	19.2	18.7	17.9	17.0	16.7	16.8	16.3	15.8	15.1
Tmp_2031-2040	17.1	18.9	19.9	20.2	19.6	18.8	18.2	18.0	17.7	17.0	16.8	16.0
Tmp_2091-2100	20.1	22.1	22.7	23.3	22.6	22.0	21.3	20.7	20.4	19.7	19.8	19.1

Remarks about Temperature

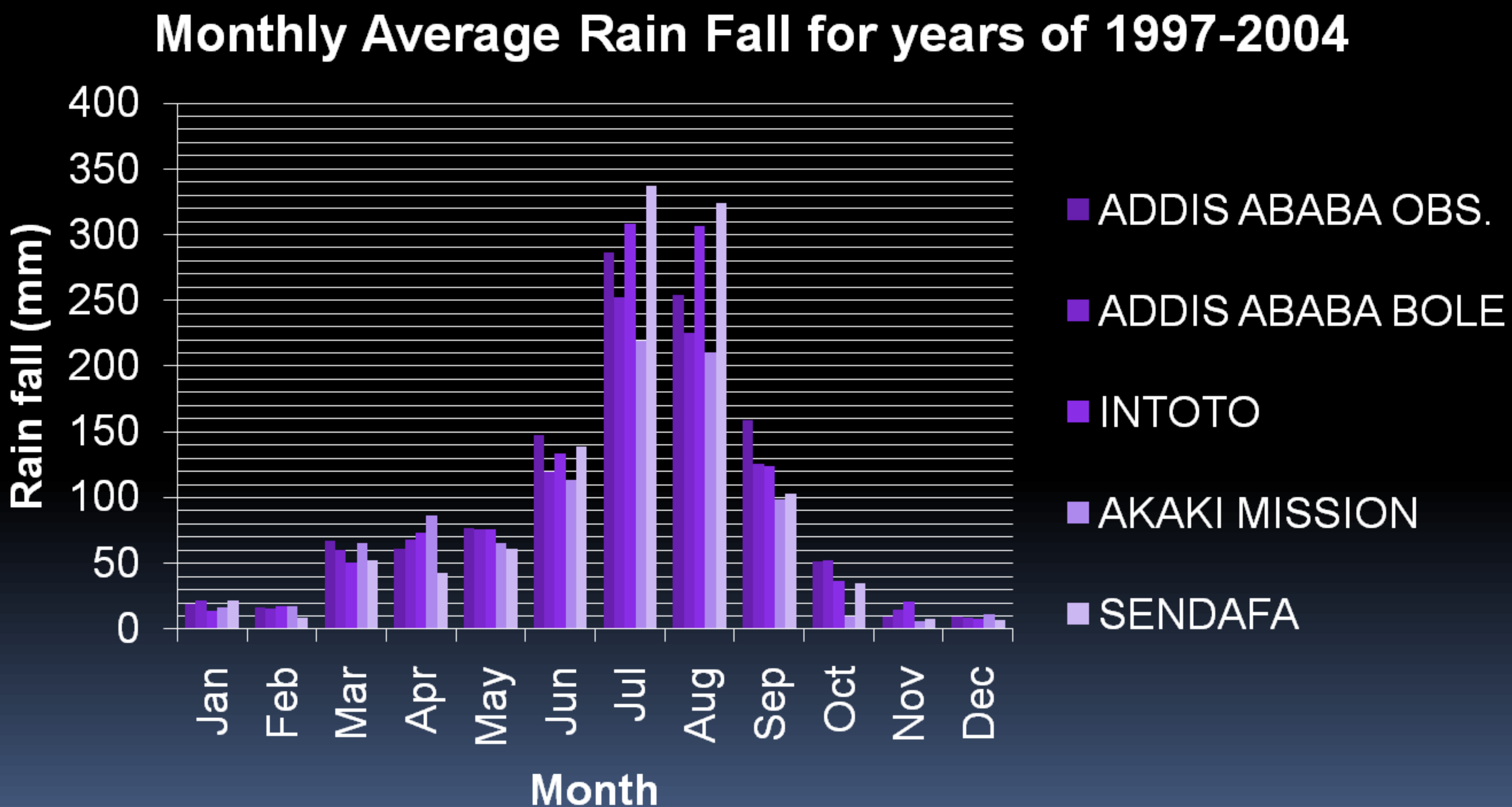
- Consistent increase of temperature as predicted by IPCC – 0.370c/dekad
- Relatively no much change in terms of seasons
- What does it mean in terms of real life on the ground????
  - ***Movement of malaria to highland areas like Addis Ababa***
  - ***More water consumption***
  - ***More energy consumption***
  - ***Change in biota of the study area***

Impact assessment of water availability – using hydrological model

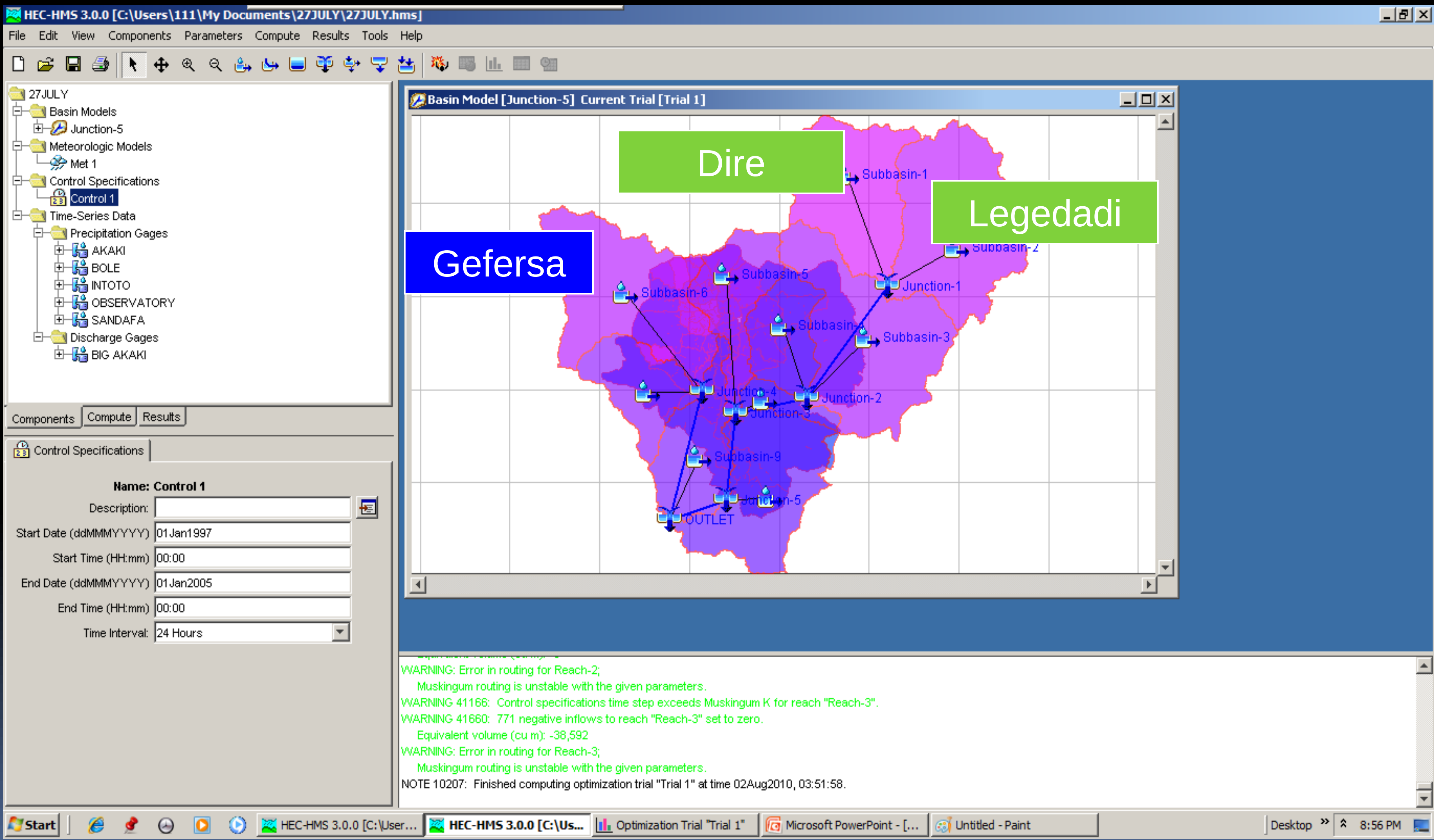
- A case of Akaki catchment

Addis Catchment

Metrological data - preciptation



HEC-HMS Configuration



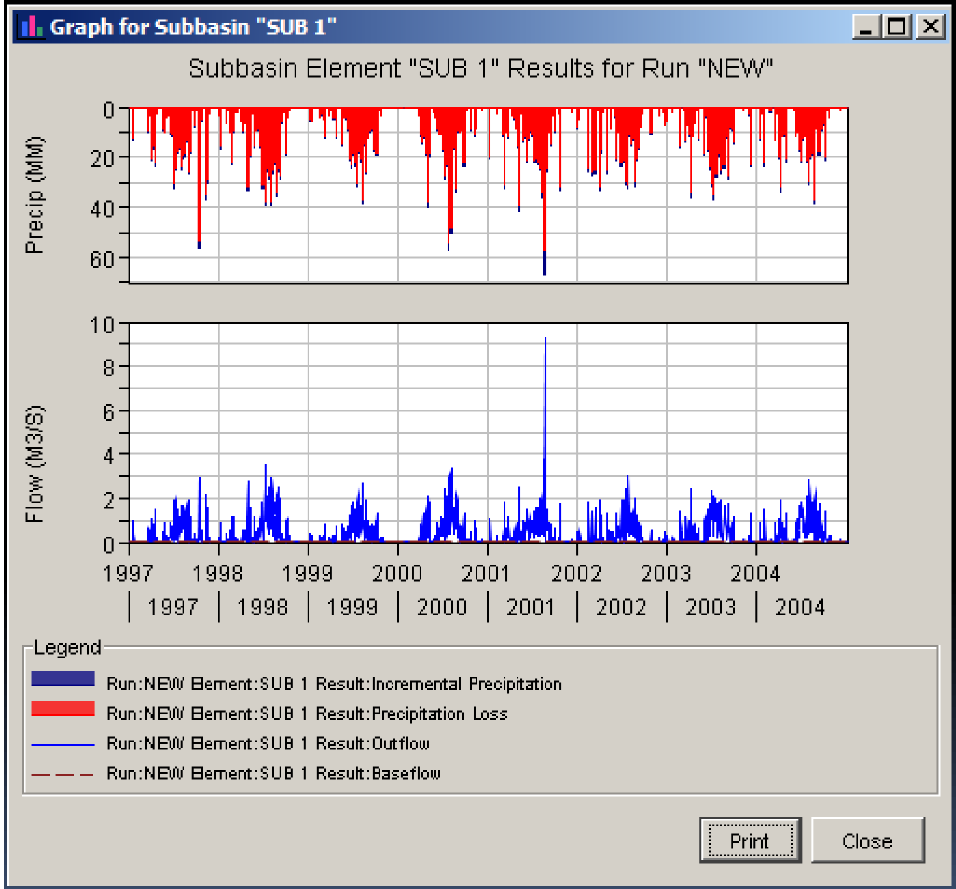
Physical Characteristics of the sub-Catchments

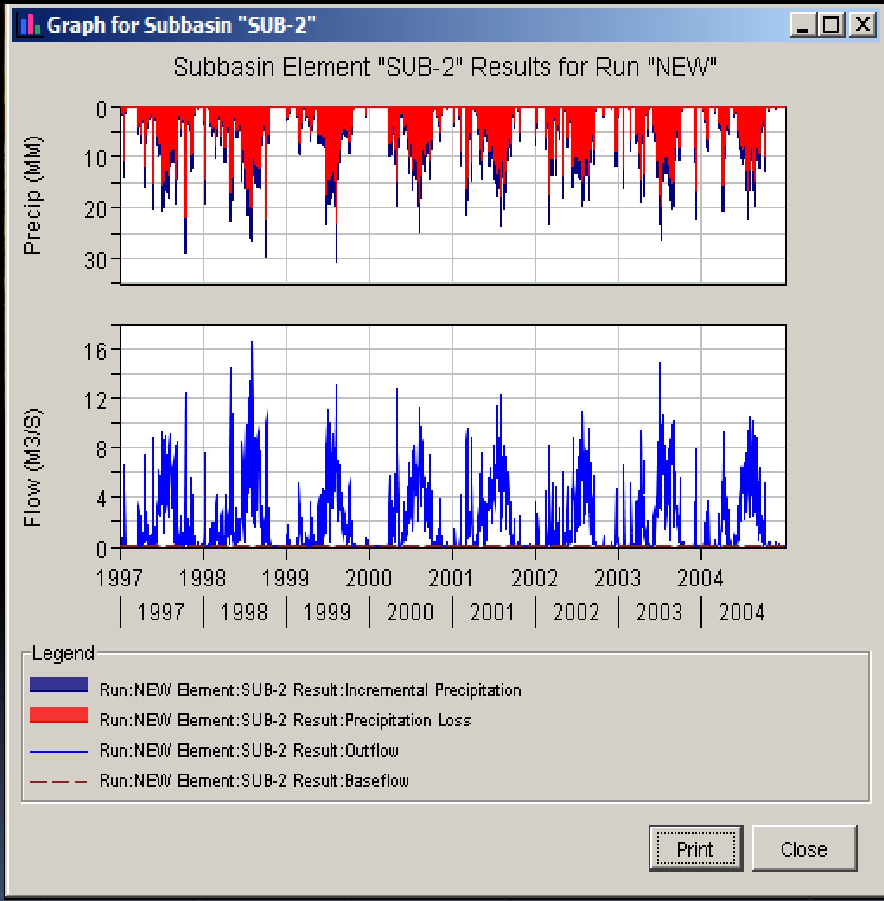
Name of sub catchment	Area (km^2)	Slope (%)	L (km)	Lc (km)
SUB-1	165.97	17	11.6	10.57
SUB -2	225.97	15	11.55	10.03
SUB-3	241.19	15	24.7	9.5
SUB -4	80.55	15	1.1	7.26
SUB -5	97.14	31	9.73	12.28
SUB -6	**204.38**	**13**	**21.78**	**13.23**
SUB-7	98.73	29	3.92	7.04
SUB-8	26.65	25	9.12	4.74
SUB-9	104.05	24	8.35	22.22
SUB-10	174.83	21	25.92	11.03

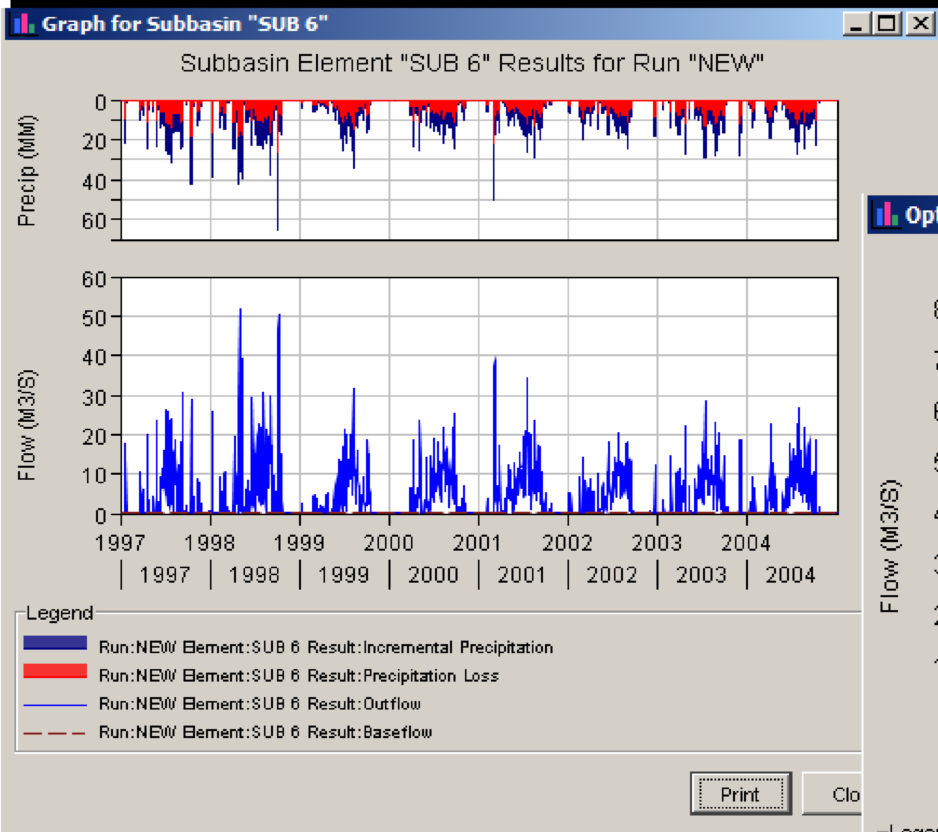
Simulation results

- Period of Study 1997 – 2004
- Simulation time Step - Daily
- Calibration/verification in the process – not yet done
- Simulation of results using nearly physical characteristic parameter
- Typical results are given for Dire, Legedadi and Gefersa catchments
- Can't model downstream without proper consideration of the reservoirs

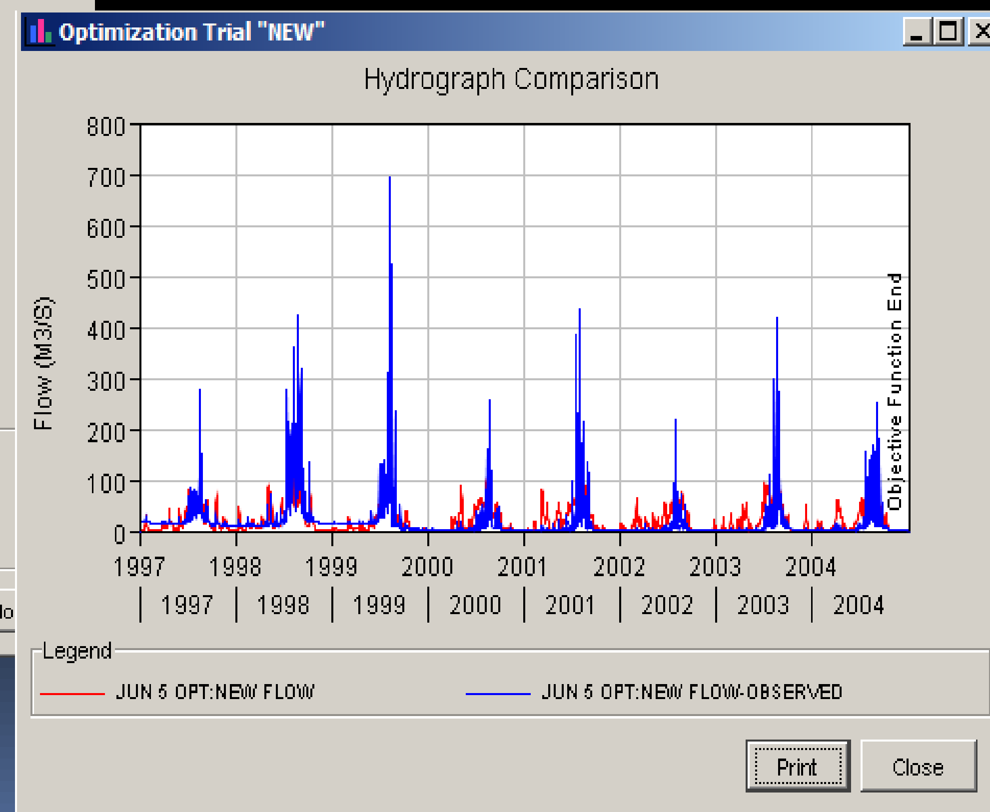
Simulation results







Graph for Subbasin "SUB 6"
Subbasin Element "SUB 6" Results for Run "NEW"
Precip (MM)
0
20
40
60
Flow (M3/S)
60
50
40
30
20
10
0
1997 1998 1999 2000 2001 2002 2003 2004
1997 1998 1999 2000 2001 2002 2003 2004
Legend
Run:NEW Element:SUB 6 Result:Incremental Precipitation
Run:NEW Element:SUB 6 Result:Precipitation Loss
Run:NEW Element:SUB 6 Result:Outflow
Run:NEW Element:SUB 6 Result:Baseflow
Print



Optimization Trial "NEW"
Hydrograph Comparison
Flow (M3/S)
800
700
600
500
400
300
200
100
0
Objective Function End
1997 1998 1999 2000 2001 2002 2003 2004
1997 1998 1999 2000 2001 2002 2003 2004
Legend
JUN 5 OPT:NEW FLOW
JUN 5 OPT:NEW FLOW-OBSERVED
Print
Close

limitations

- Due to the reservoirs are not considered, the peak discharge is not properly simulated
- The volume of water available annually is perfectly matching
- Calibration of each sub-catchment is difficult due to only observed Q data is available at on site – Big Akaki

Acknowledgement

- Dr. Solomon seyoum
- Who has assisted me in running the RegCM3 regional model
- Other colleagues of mine from department of civil engineering and IWMI colleagues