IMPACT OF CLIMATE CHANGE ON WATER AVAILABILITY AND EXTREME FLOWS IN ADDIS ABABA

Contents

- Background of climate change
- Climate Change Studies in and Around Addis Ababa
- Impact of climate change on Water Availability
- Impact of Climate change on Extreme Flow Conditions
- Implications on Socio-economic setting of Addis Ababa

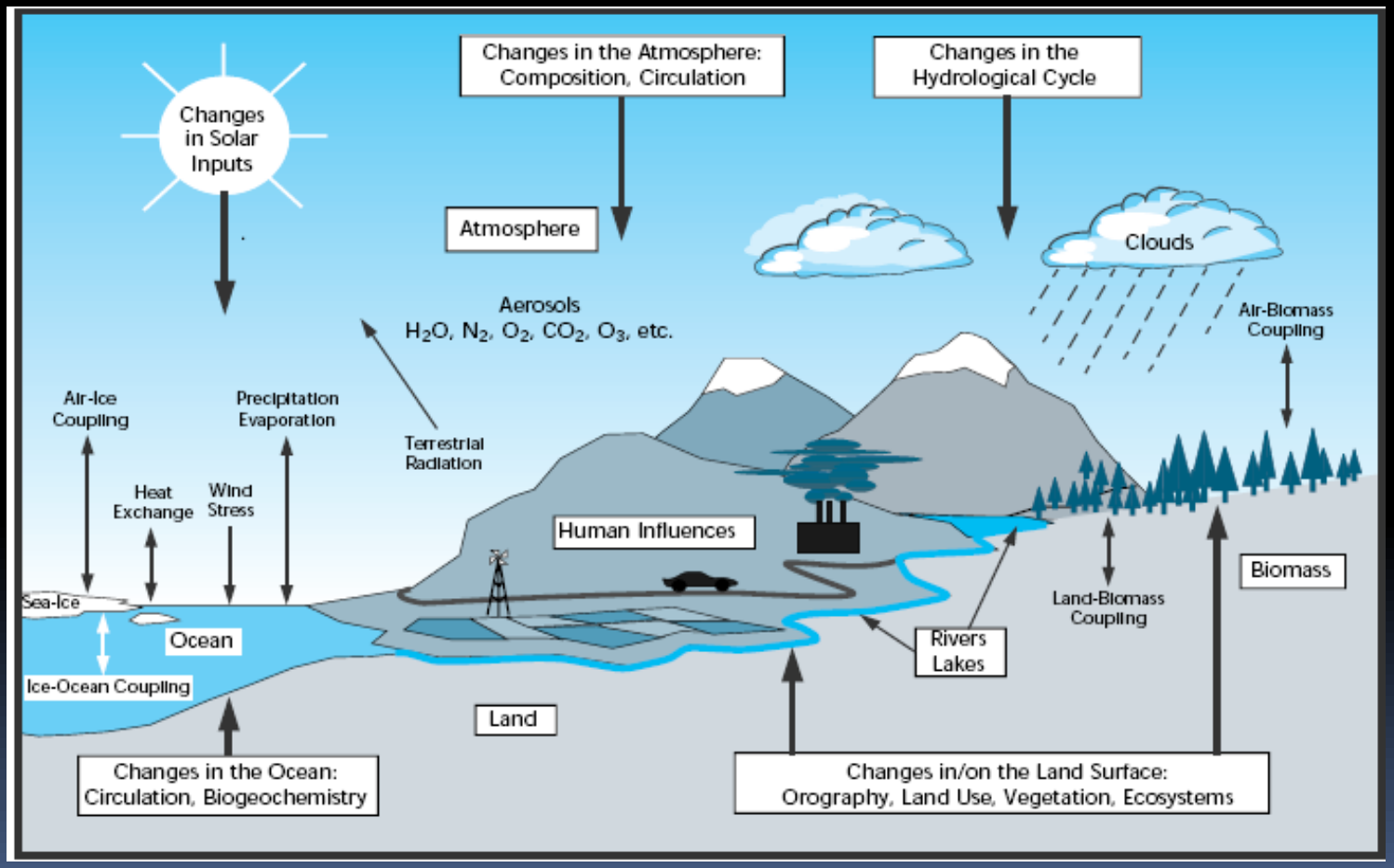
1: Global Climate Change

Weather is the short term (i.e. minutes to days) status of the atmosphere in terms of pressure, humidity, cloud cover, temperature, etc.

Climate is defined as the long-term average weather (IPCC, 1997)

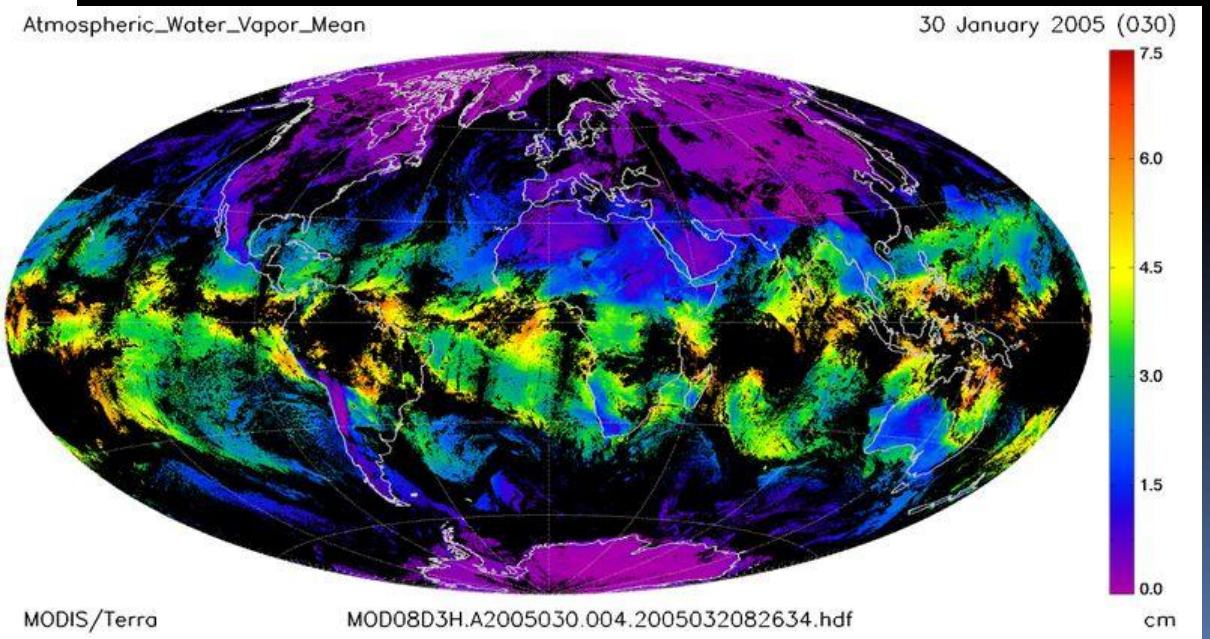
The statistical description of the mean and variability of temperature, precipitation, humidity, wind, and other climatic variables over several decades (typically 3 or more as defined by WMO) defines the climate of a region.

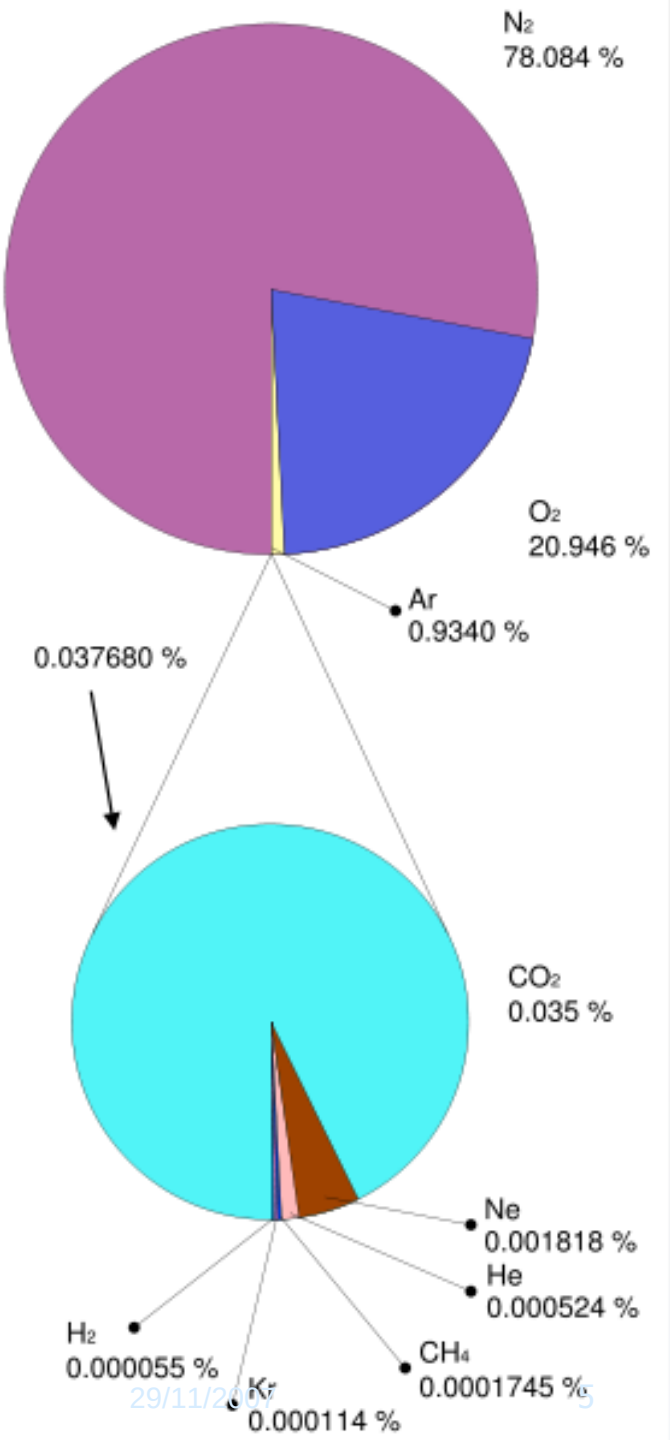
The Climate System



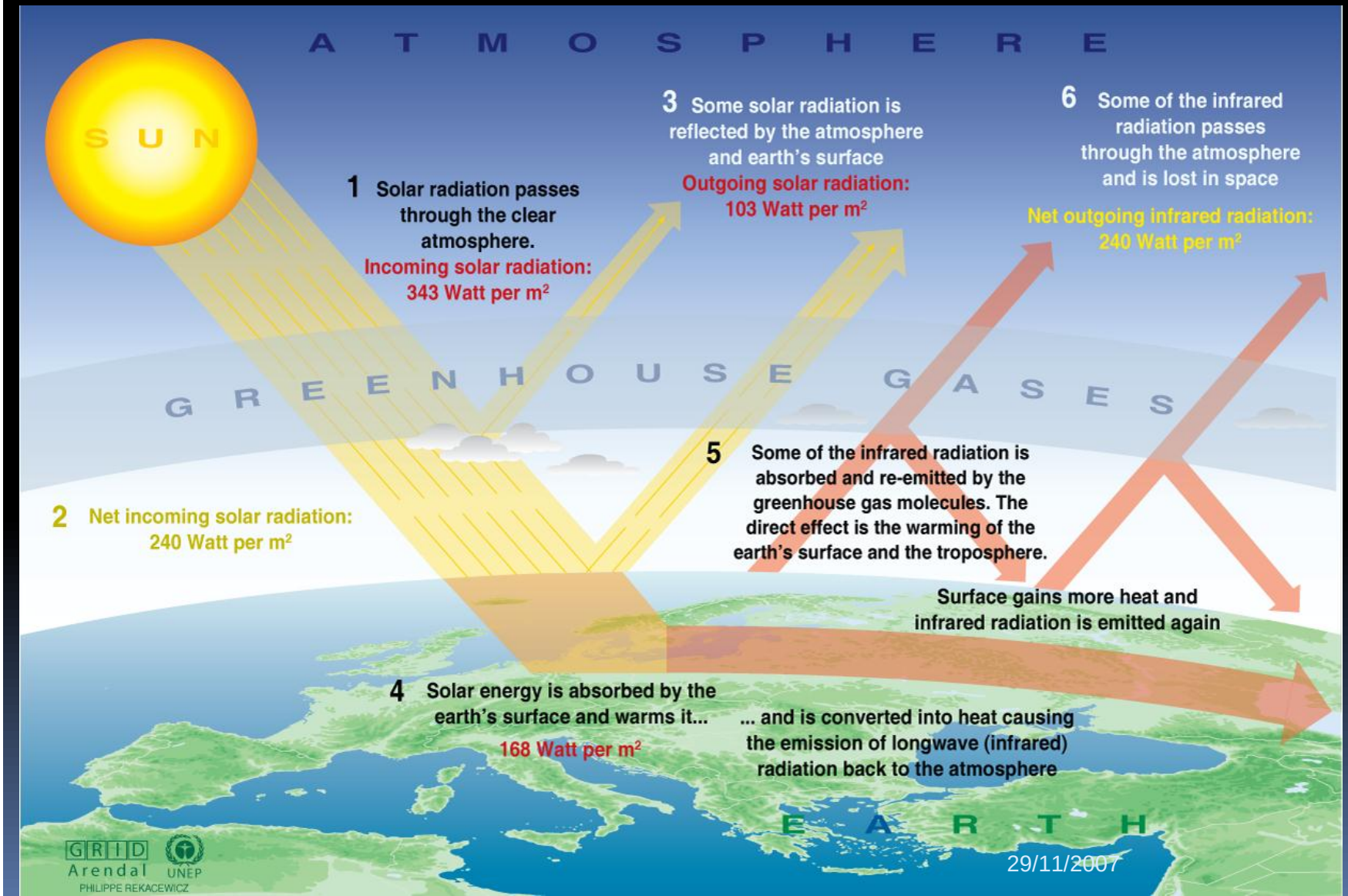
Atmospheric Composition

- Minor gases are as important as the major ones
- In addition we have 1-4% of water vapor





The Greenhouse Effect



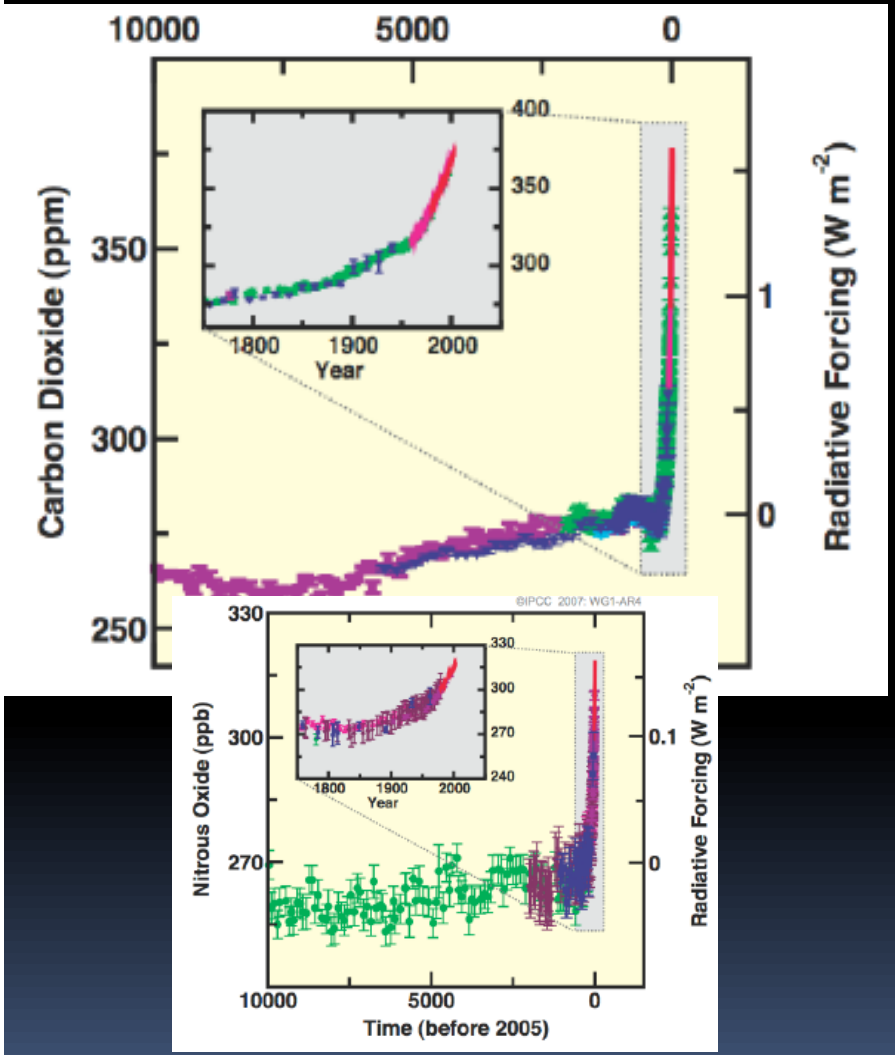
Global Warming

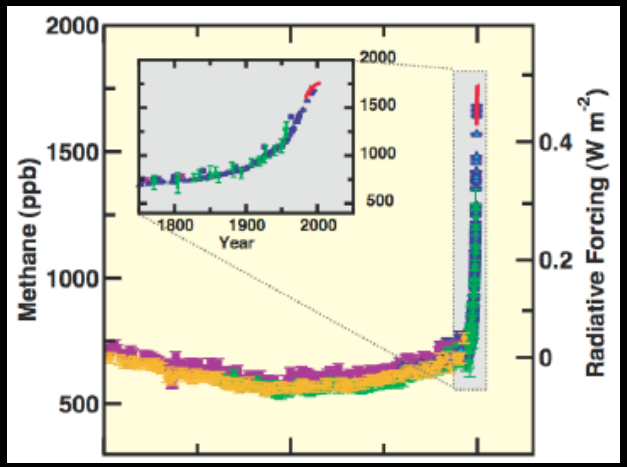
GHG	Pre-Industrial (1750-1800)	Current (2005)
Carbon dixoide	280 ppm	379 ppm
Methane	715 ppb	1774 ppb
Nitrous Oxide	270 ppb	319 ppb

CFCs were not present in the atmosphere before the 1930s

Source: IPCC 2007, IPCC 1997

Global Warming

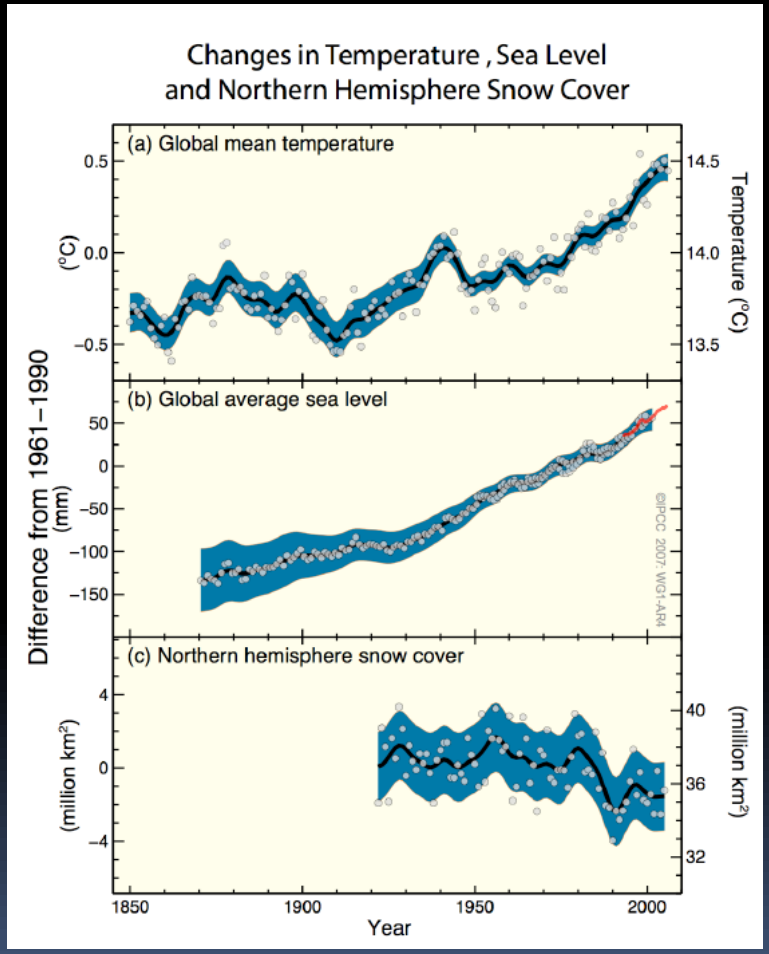




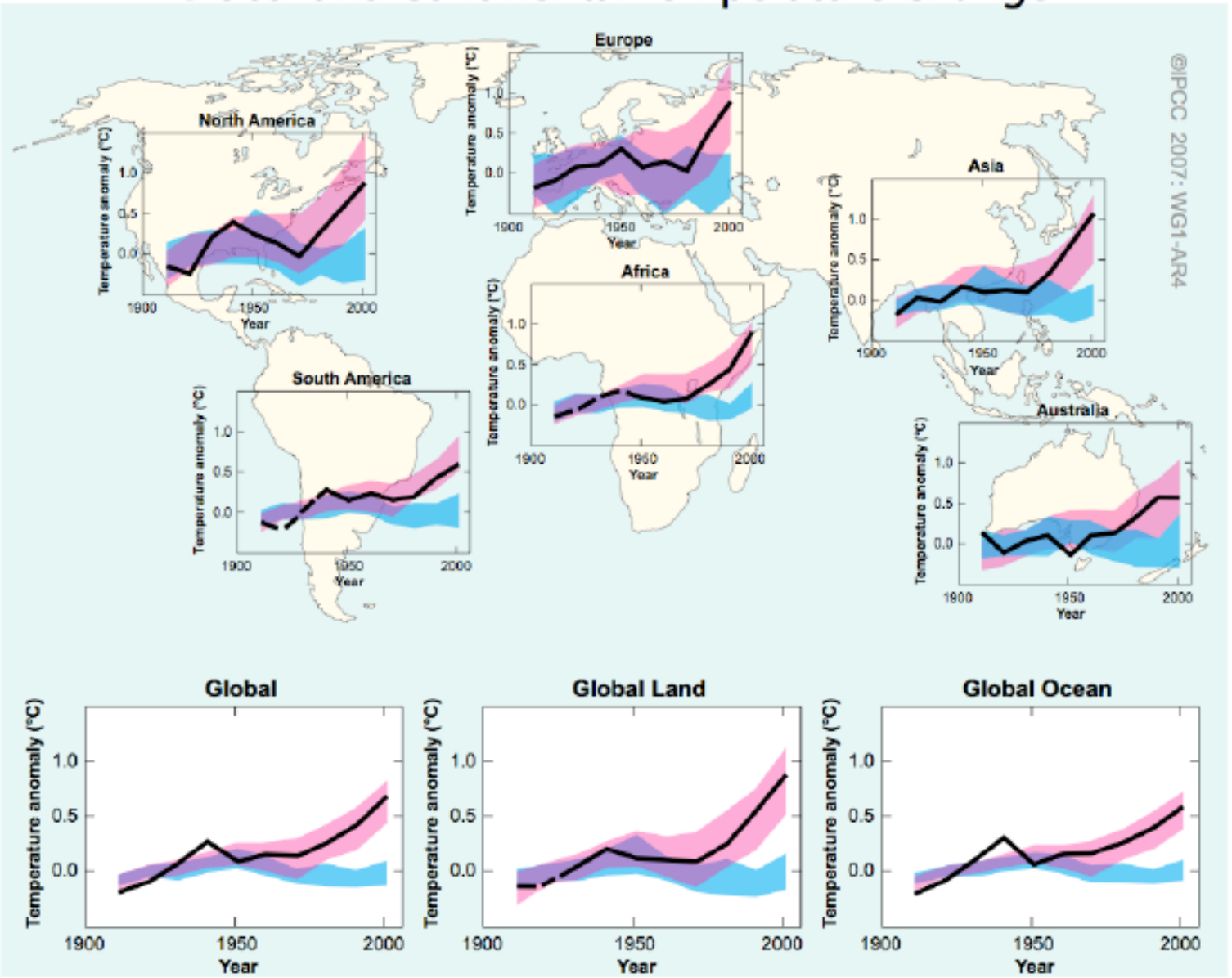
Source: IPCC 2007

What Happened till Now?

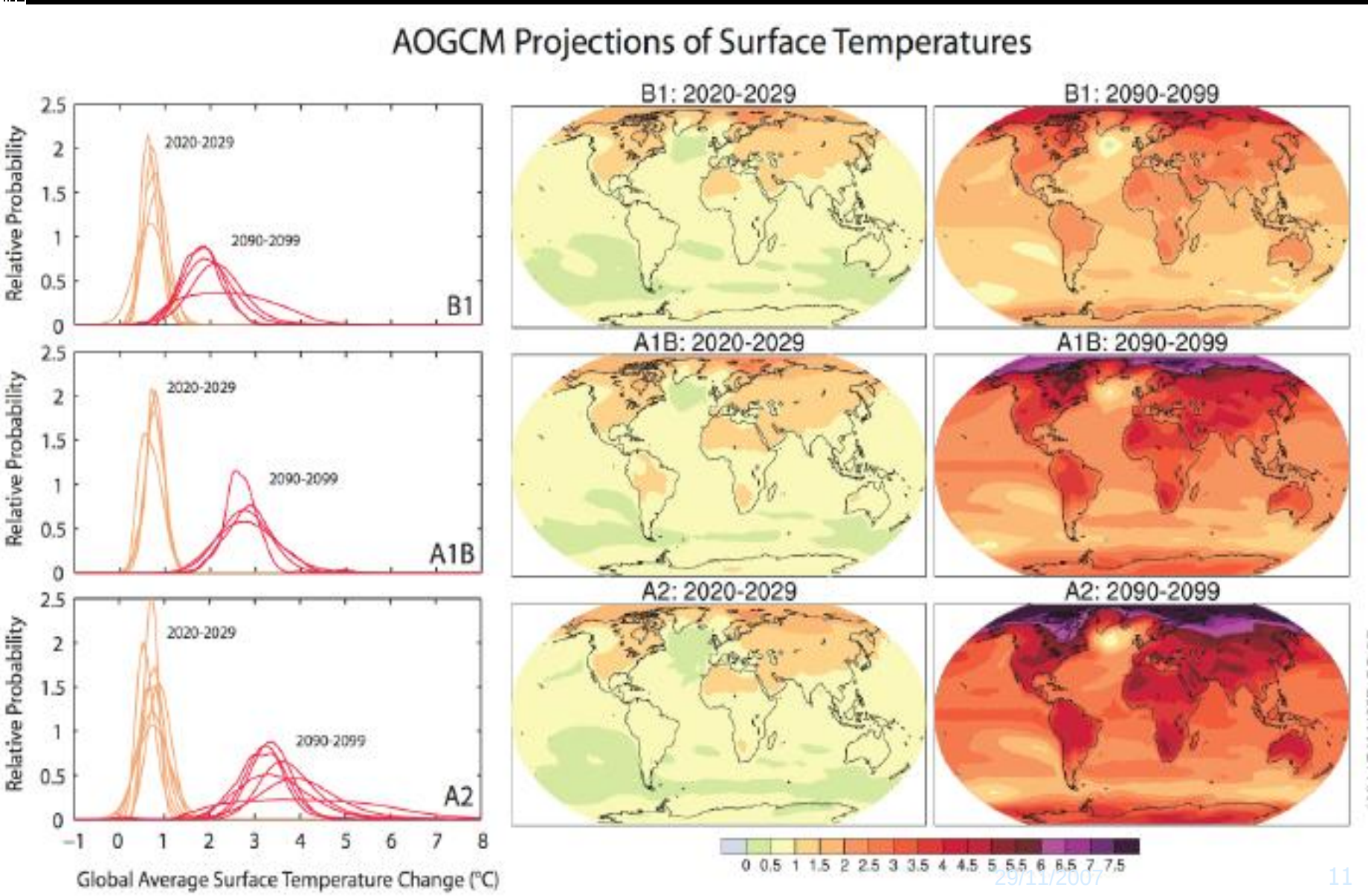
- 11 of the last 12 years (1995 - 2006) rank among the 12 warmest years (since 1850).
- The 100-year linear trend (1906–2005) is 0.74 [0.56 to 0.92]°C. The linear warming trend over the last 50 years is 0.13 [0.10 to 0.16]°C per decade)
- The average atmospheric water vapour content has increased



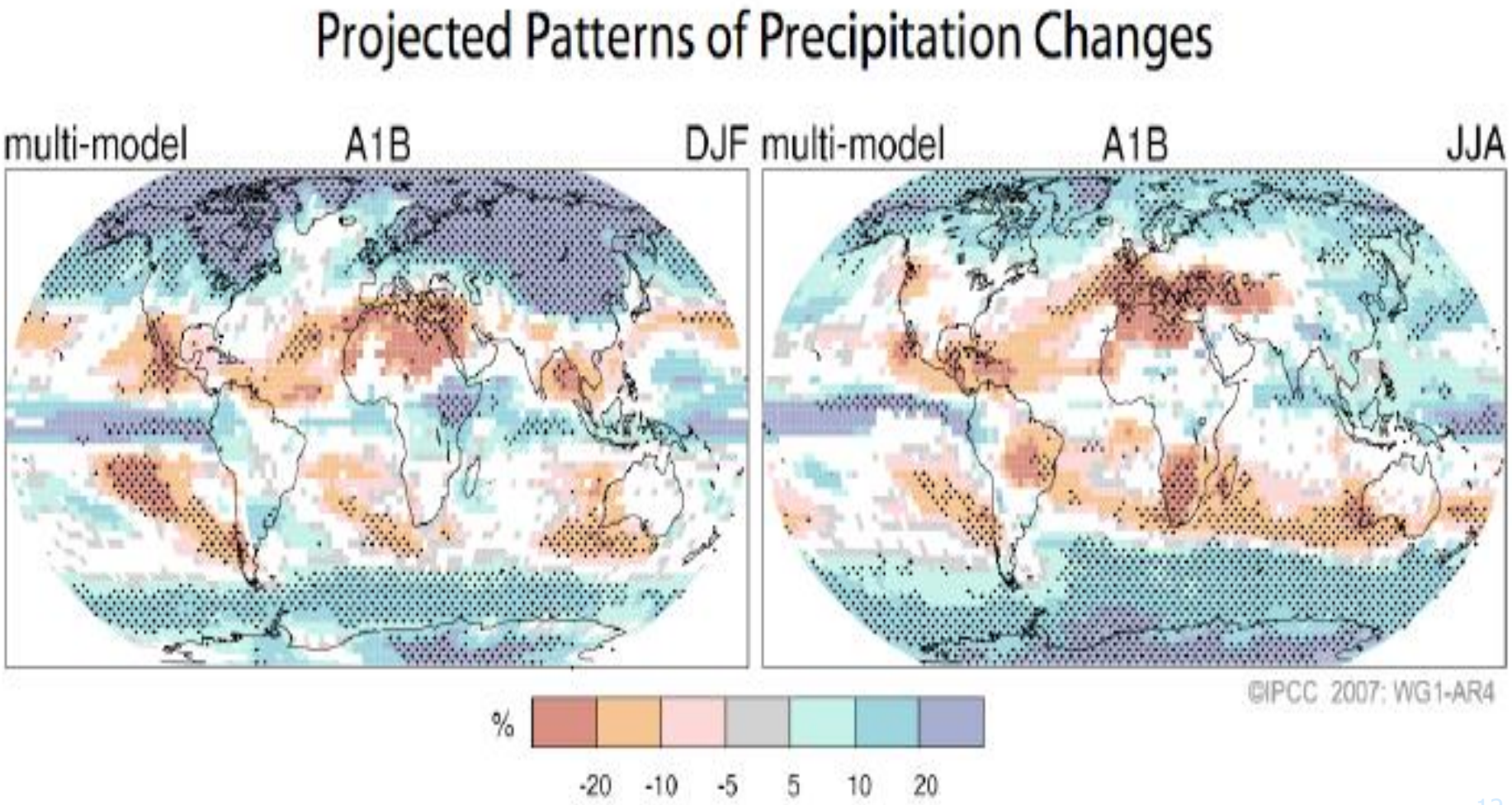
Global and Continental Temperature Change



What is Expected?

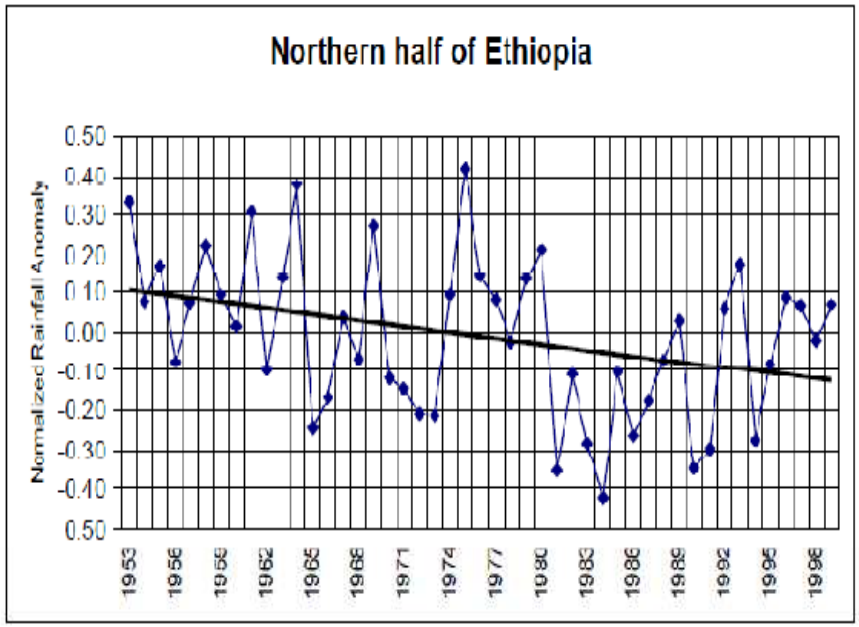


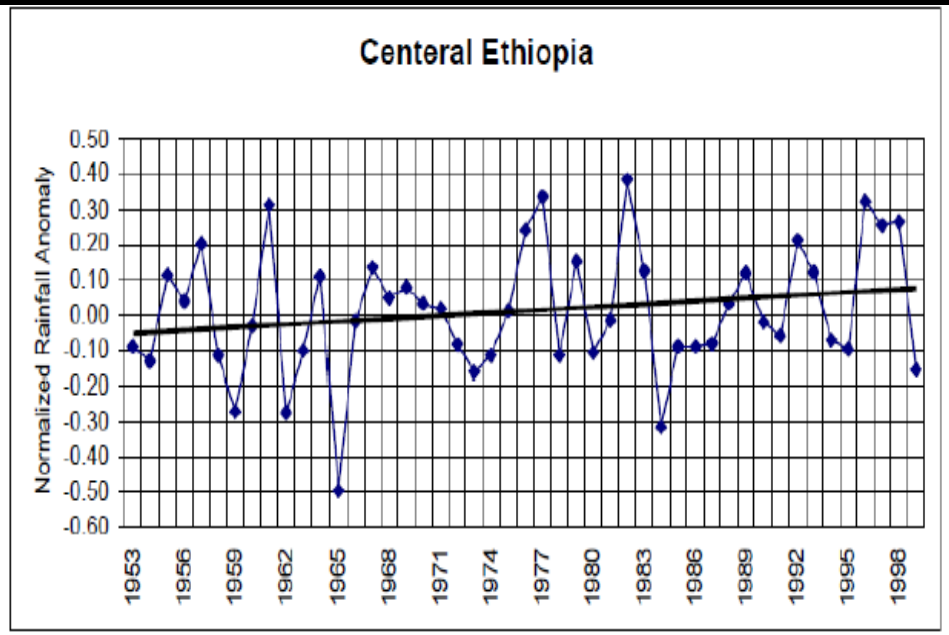
What is Expected?



Figure

What is the observational data show over Ethiopia?

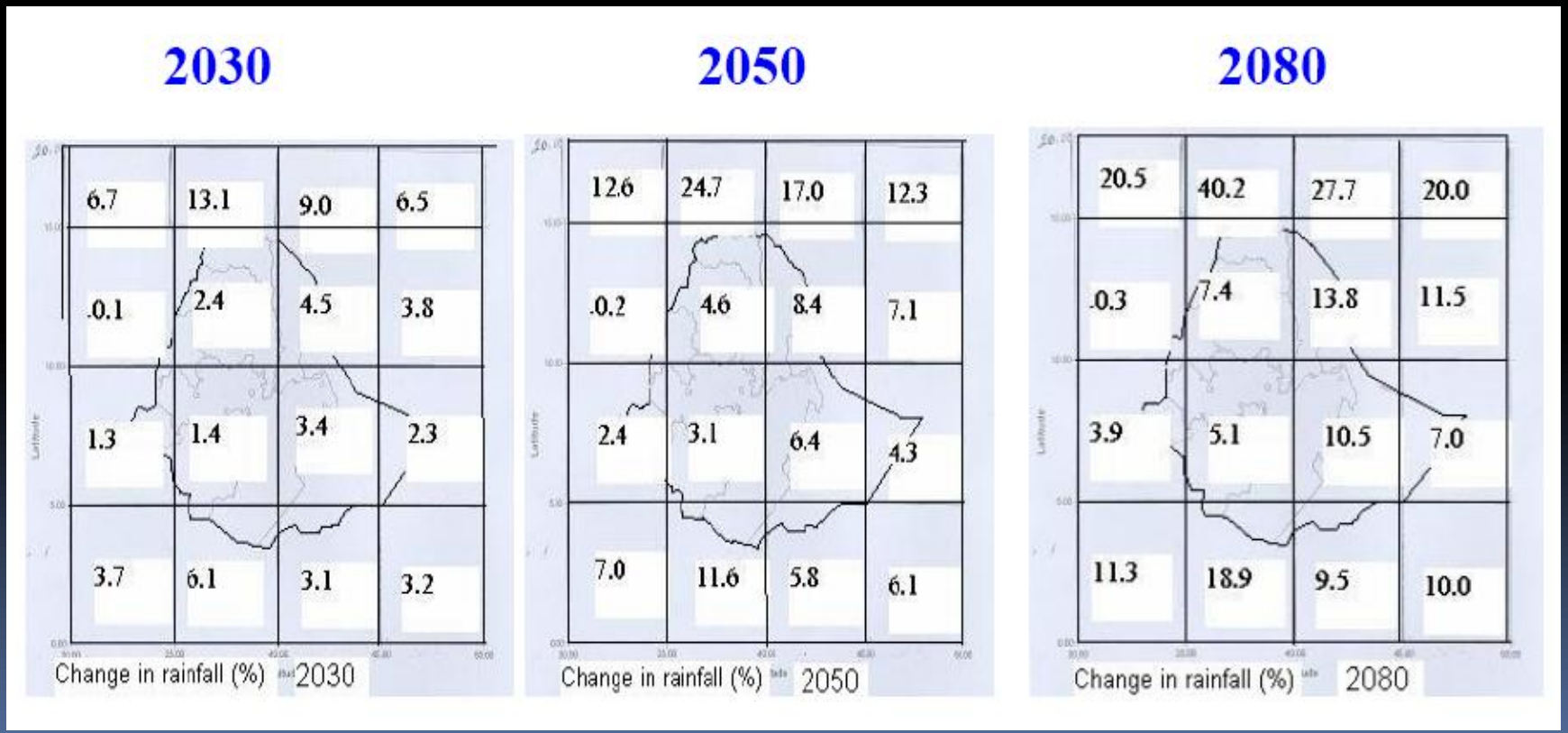




Annual variability of rainfall over Northern half (left side) and Central (right) Ethiopia expressed in normalized deviation (NMSA, 2001) - from 42 met stations

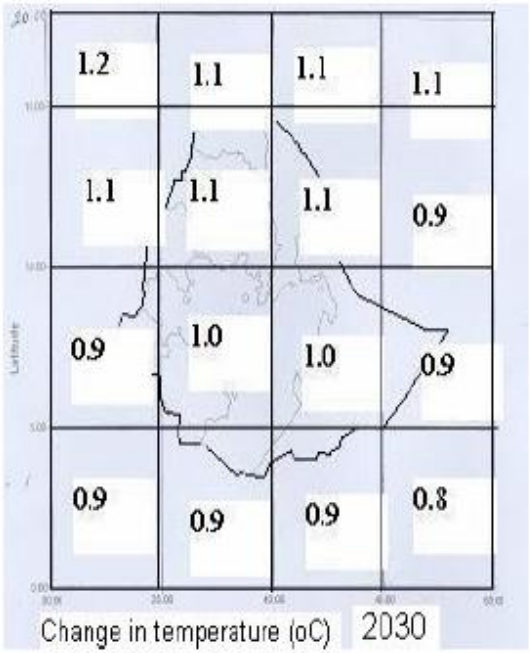
Projected climate Change over Ethiopia

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

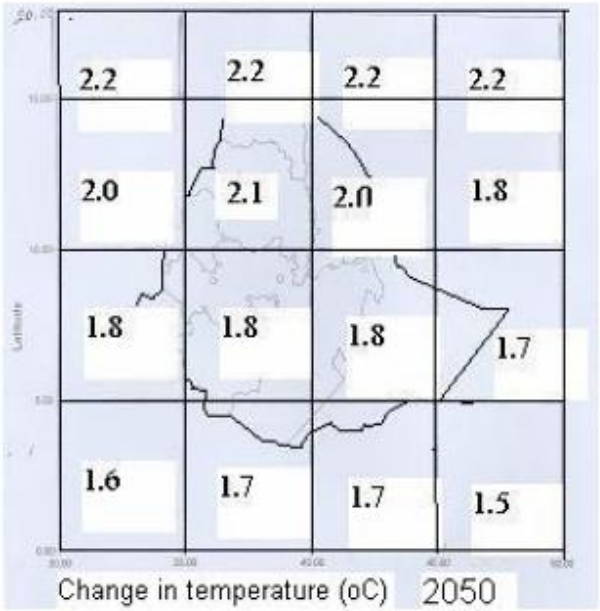


- the mean annual temperature will increase in the range of 0.9 -1.1 °C by 2030,
- in the range of 1.7 - 2.1 °C by 2050
- in the range of 2.7-3.4 °C by 2080

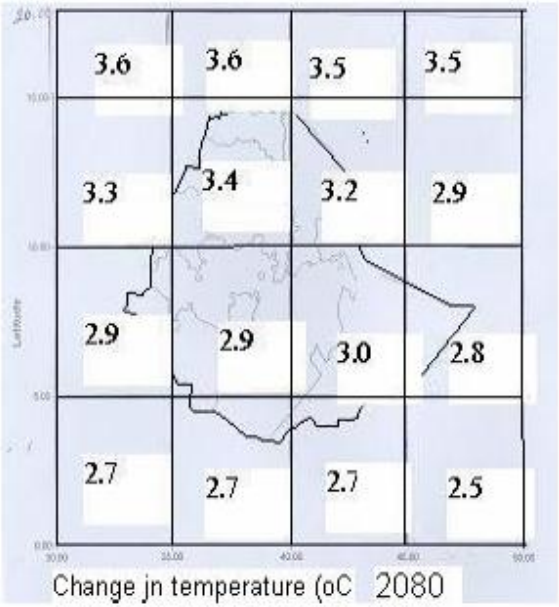
2030



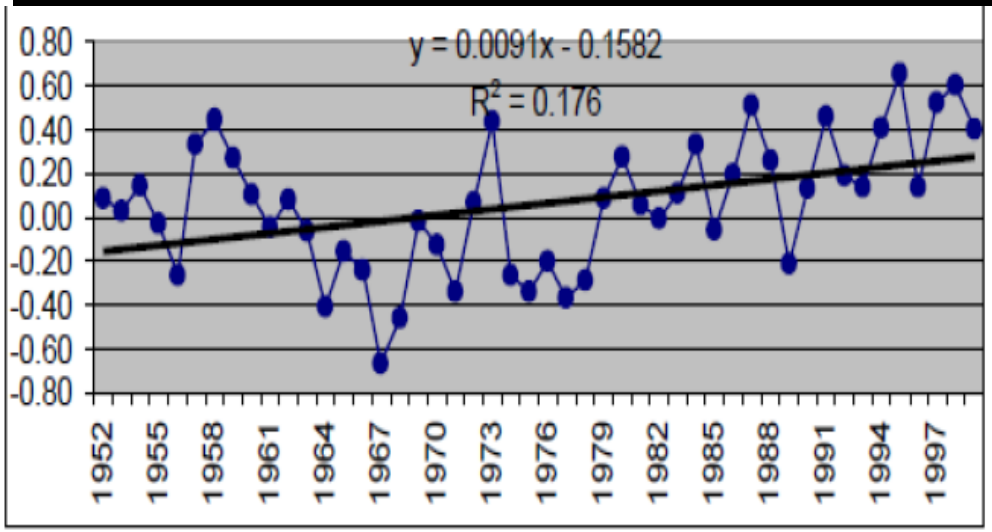
2050

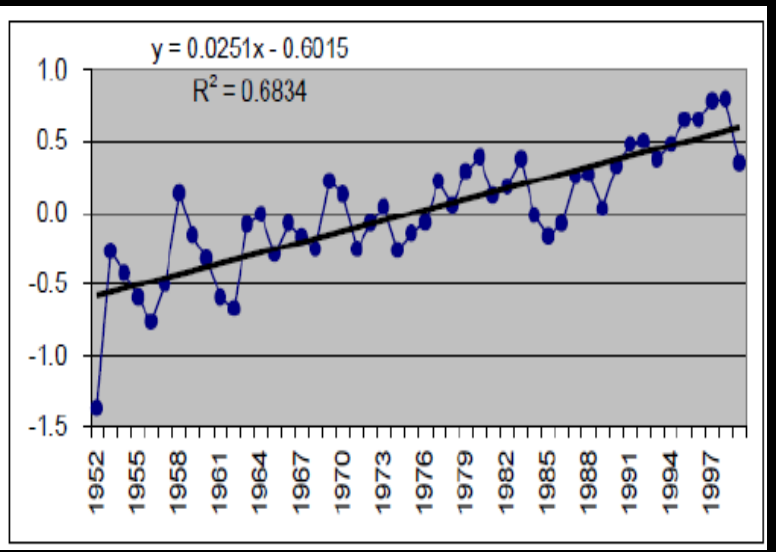


2080



What is the observational data show over Ethiopia?





(a) Annual mean maximum and (b) minimum temperatures variability and trend over Ethiopia (NMSA, 2001)

conclusion

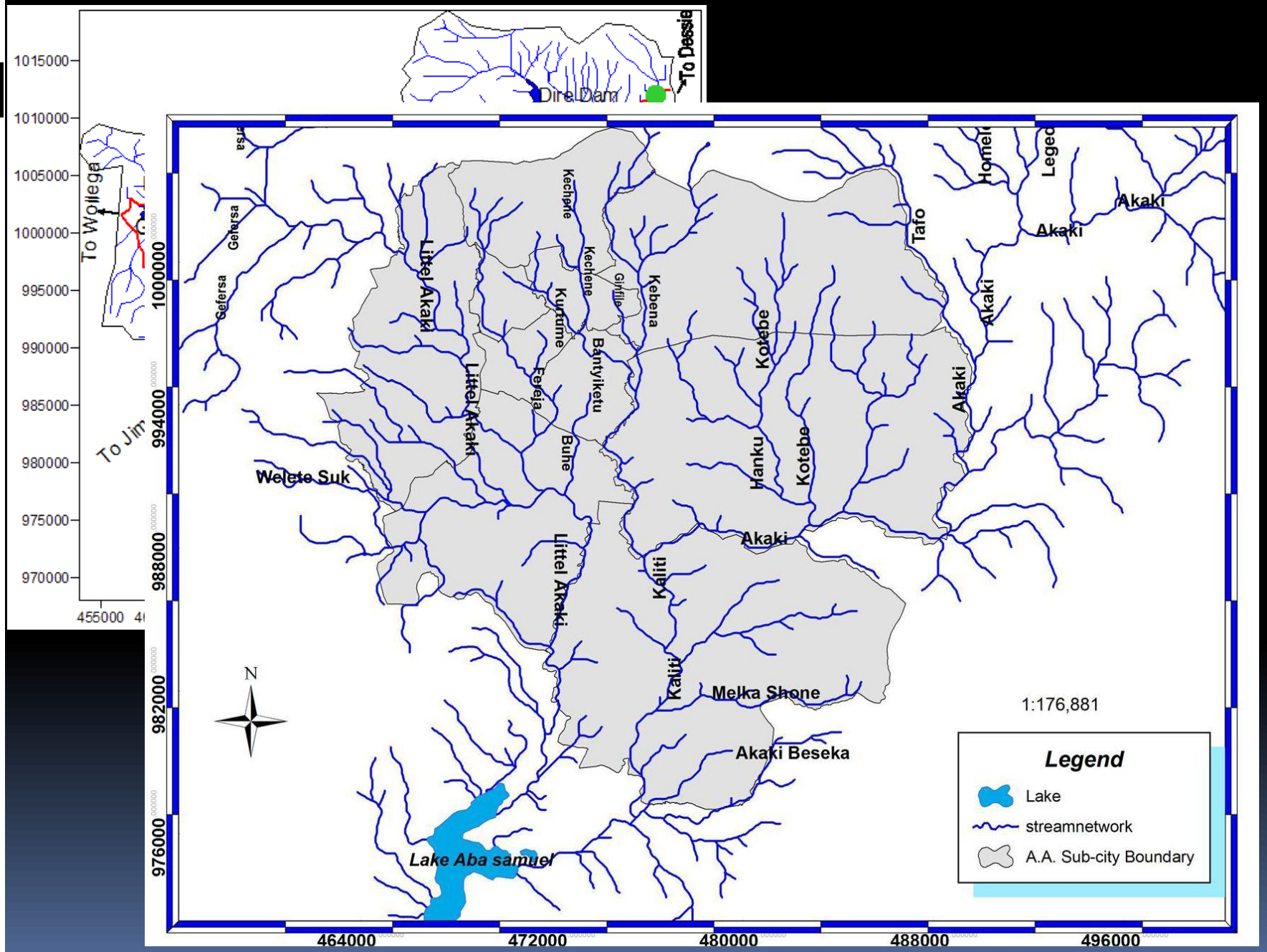
- Both GCM and Observational data indicates Climate Change is likely real and happening at both global, Regional and local Scale?

Part II

WHAT ABOUT IMPACT OF CLIMATE CHANGE IN AND AROUND ADDIS ABABA?

1. Background: Important Rivers in AA Drainage Network

Basin	Area River (Km^2)	Length River (m)	River Slope
West Akaki	172.2	35.6	1/50-1/100
Little Akaki	30.8	20.5	1/25-1/100
Kebena	59.8	23.9	1/20-1/100
➢ Upper Kebena	54.8		
➢ Lower Kebena	5.0		
Bantyiketu	29.3		
➢ Bantyiketu	5.4	11.2	1/100
➢ Kechene	13.6	9.3	1/20-1/50
➢ kurtume	10.3		1/20-1/50
Hanku	11.1	8.6	1/50-1/70


To Dessie
Dire Dam
To Wollega
To Jim
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1010000
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Gefersa
Sefersa
Kechene
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Kechene
Gifilile
Kebena
Kotebe
Kotebe
Kotebe
Tafo
Akaki
Akaki
Akaki
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Kuftume
Bantyiketu
Tereja
Bune
Hanku
Welete Suk
Kaliti
Kaliti
Melka Shone
Akaki Beseka
Lake Aba samuel
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Legend
Lake
streamnetwork
A.A. Sub-city Boundary
994000
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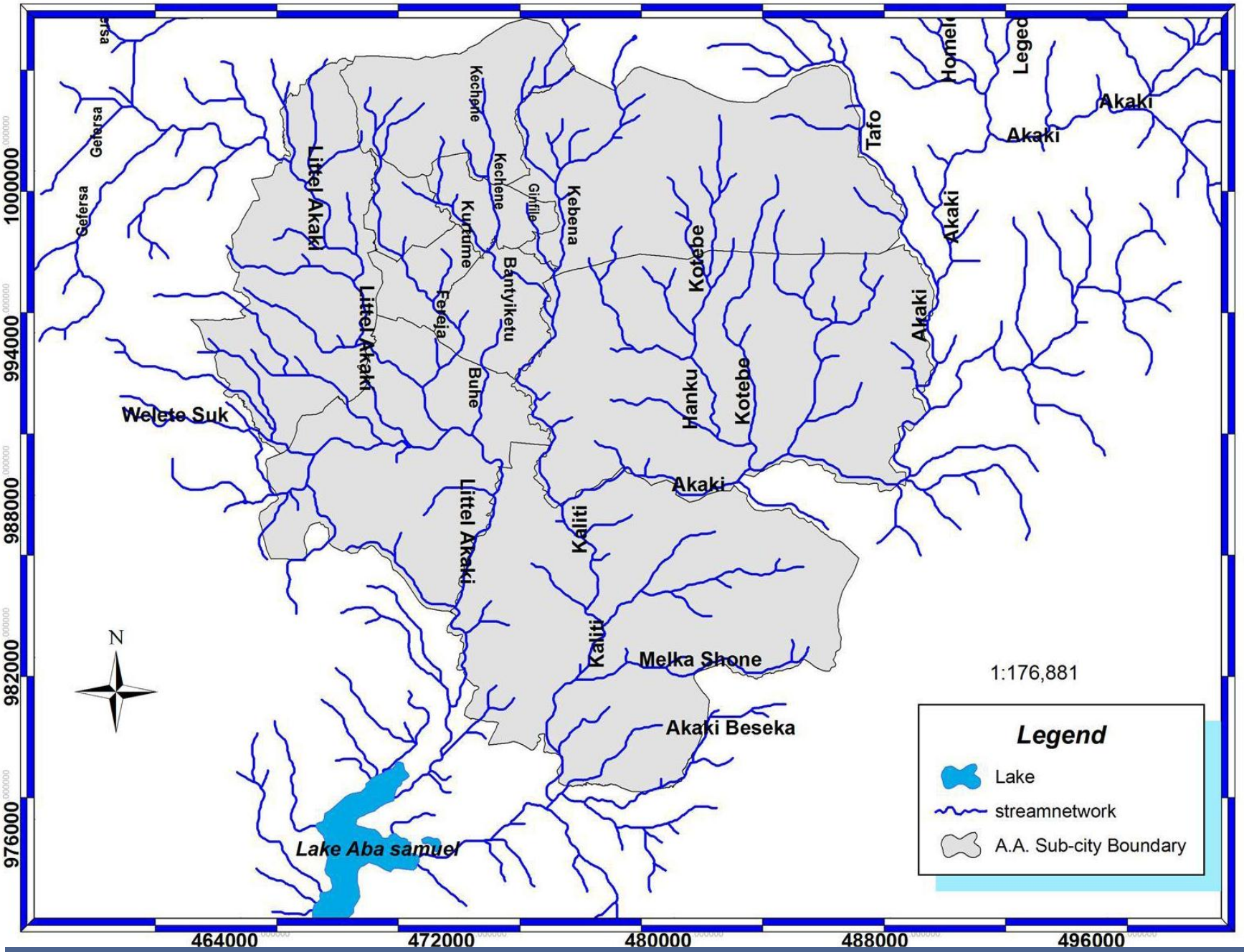
Gefersa
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Kebena
Kotebe
Hanku
Kotebe
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streamnetwork
A.A. Sub-city Boundary
1000000
994000
988000
982000
976000
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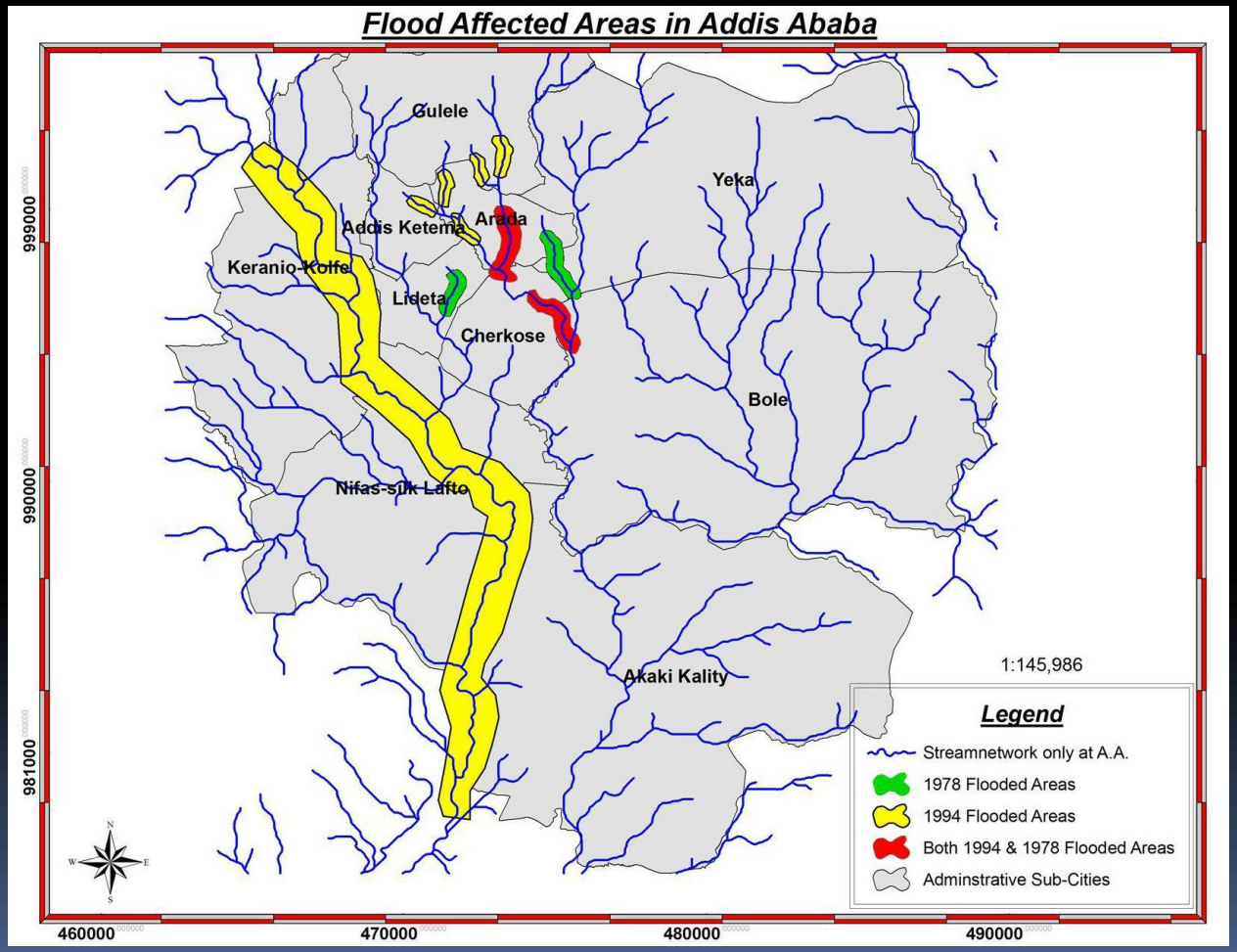
1. Background: Flood damages - Past and future- Past

Damages of the 1978 and 1994 floods (Source: M.J. Dyer, 1994)

Damage	Time	
	1978	1994
People killed	12	3
Houses damaged	1255	954
Affected population	6000	7655
Made homeless	'many'	2880
Cost of damage	N/A	15.4 Million Birr

Flood Affected areas



1. Background: Flood damages - Past and future - Forecasted (2020)

- The projection made by the study (JICA Flood Study) showed that
  - 4,324,928 people,
  - 757,868 houses,
  - 33,590 trailers,
  - 17,024 service organizations, and
  - 4,455 whole sellers are estimated to be under the risk of flooding in 2020
- This has to be verified through modeling efforts

Climate Change Prediction AA - methodology

GCM Climate Output

RCM Downscaled Climate output

Local Climate (Statistical Downscaled)

Historical Climate Data

Historical Flow data

DEM

HEC-GeoHMS Model

Watershed Parameters

HEC-HMS Model

(Calibration & Validation)

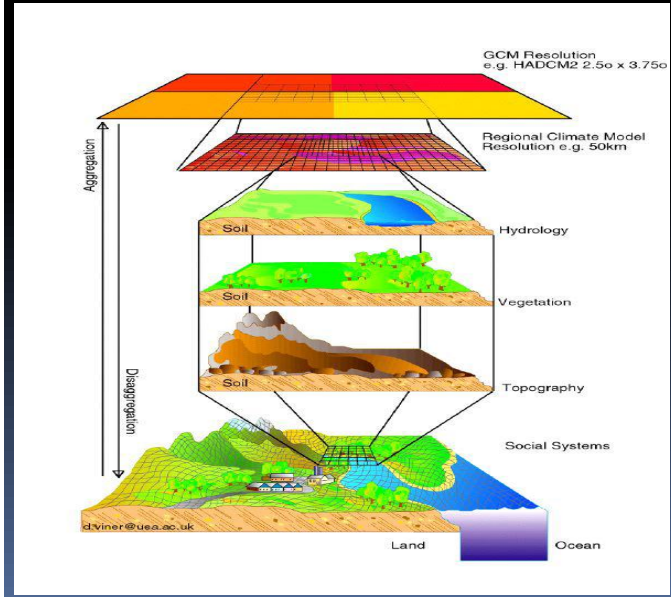
Model parameters

HEC-HMS Model

(Impact Assessment)

VENSIM Model

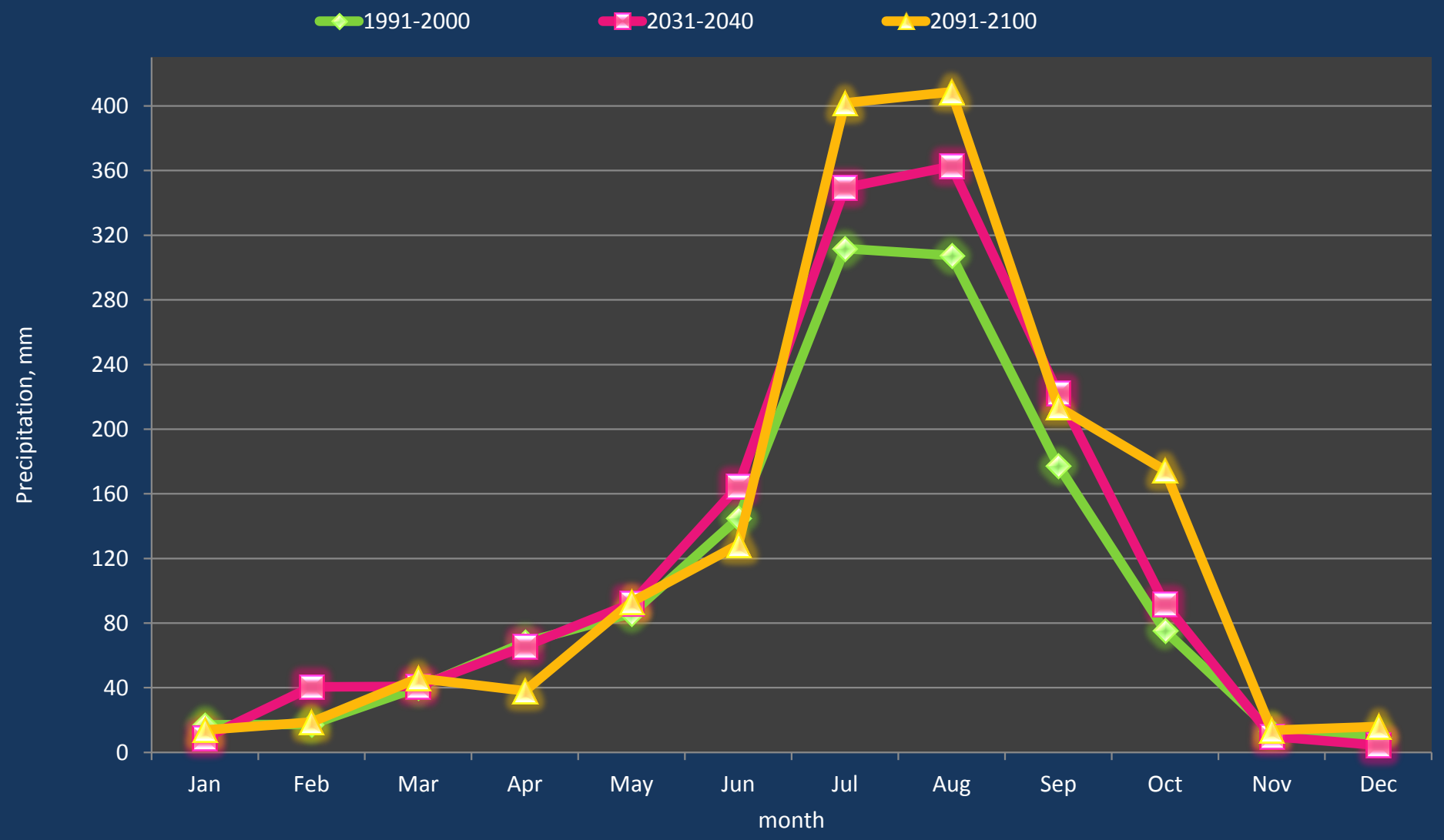
(Distributed Impact Assessment on large cities)



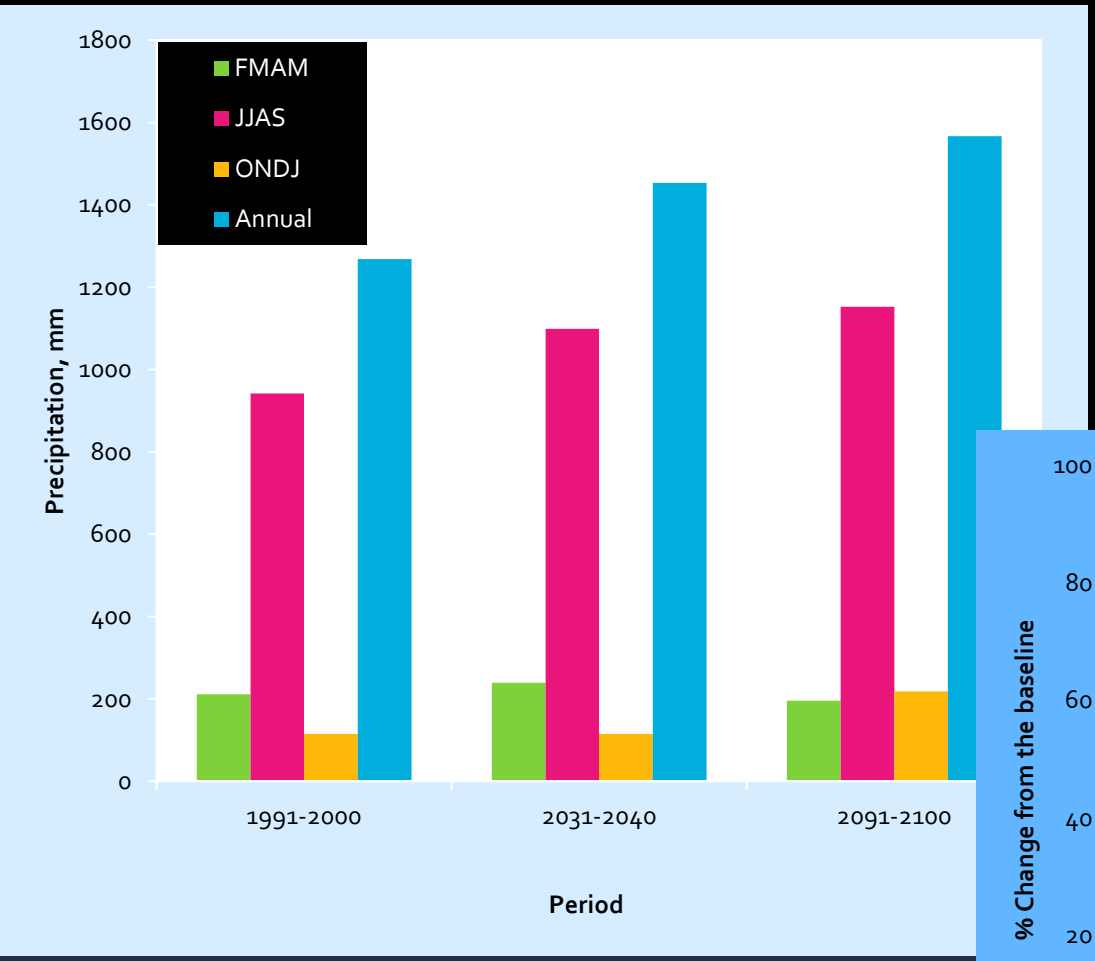
Expected outputs – impacts on:

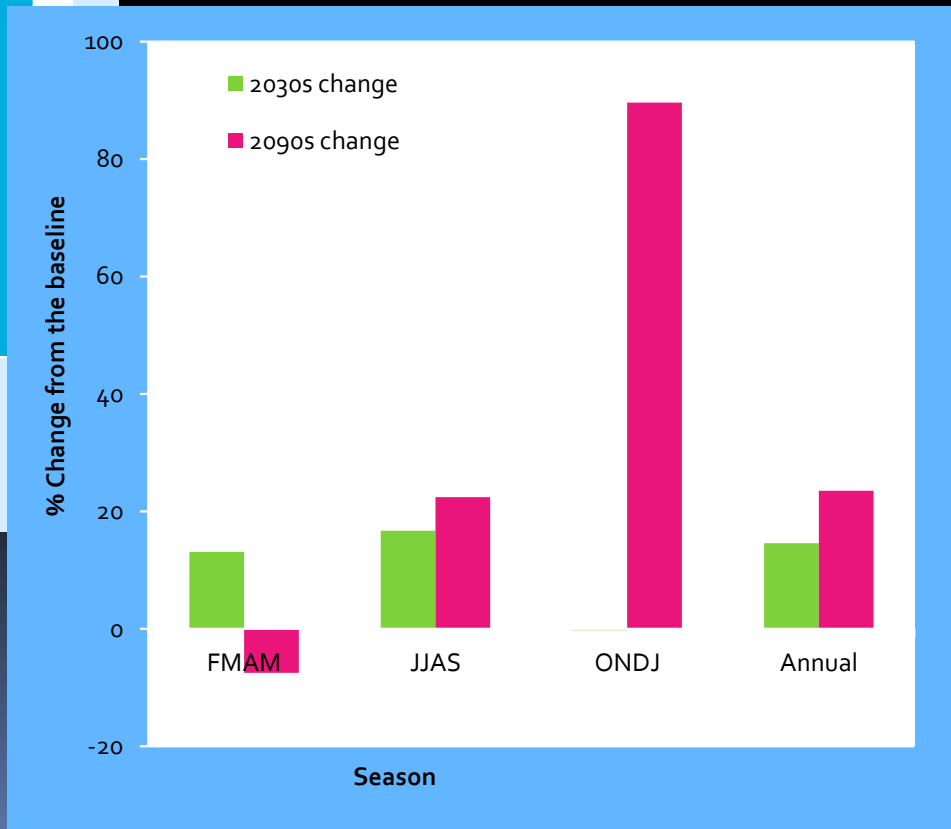
- Water availability
- US/DS water interaction
- Storm water/flood
- Drought
- Waste Water

Climate Change Prediction AA – Precipitation

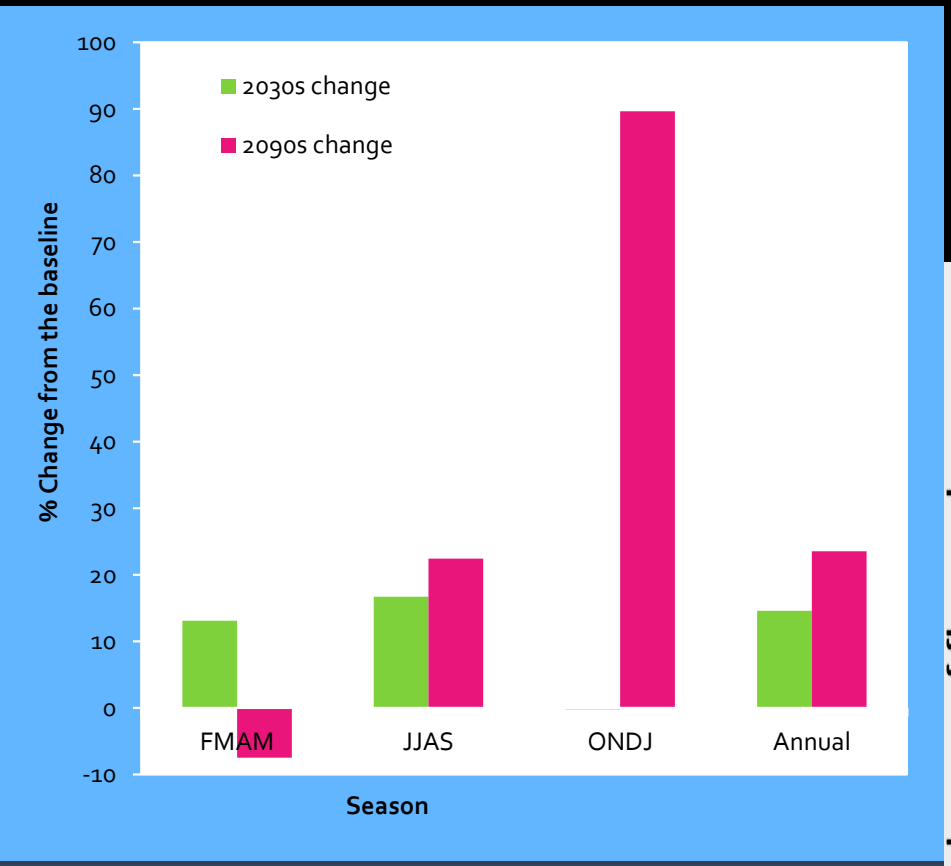


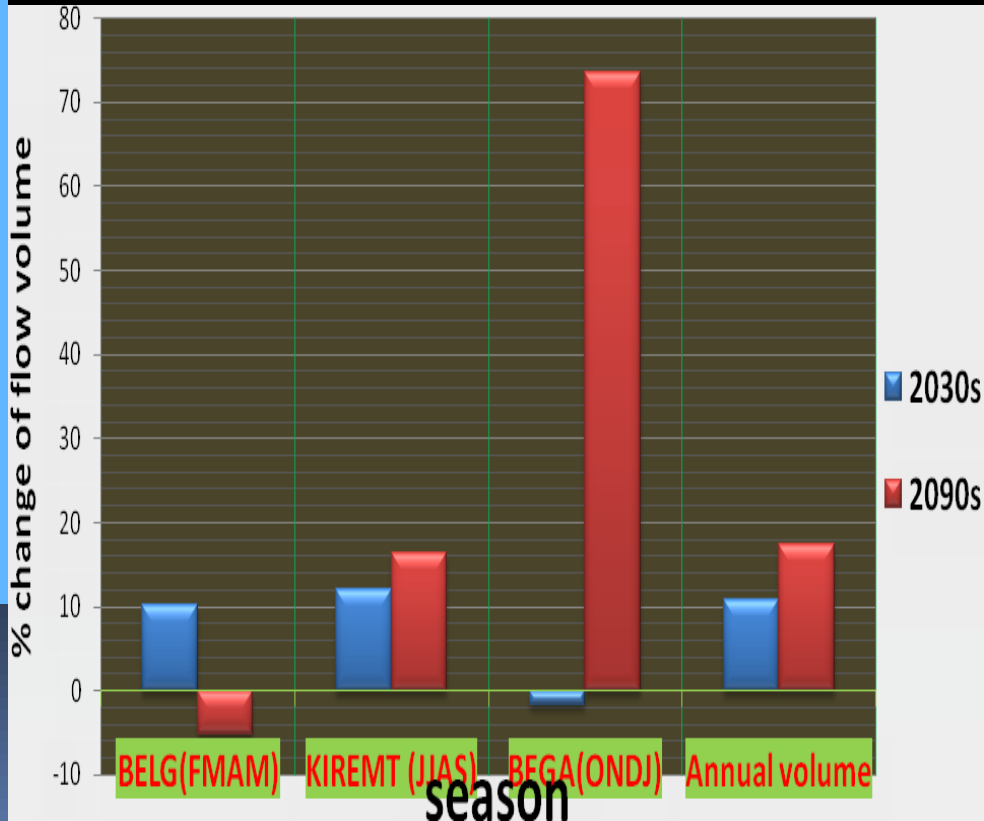
Precipitation



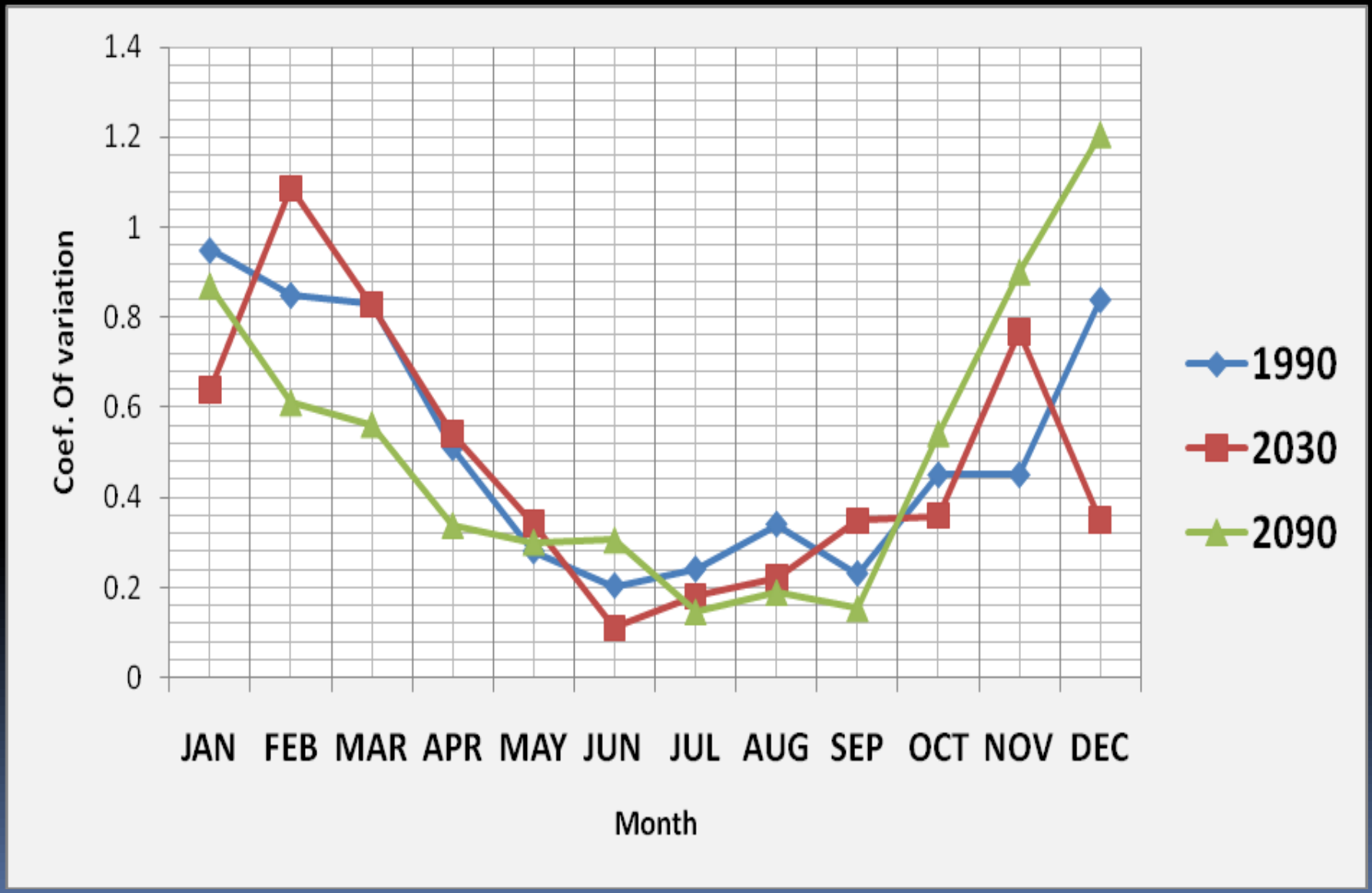


Impact of the projected CC on Water Availability - Akaki Flow

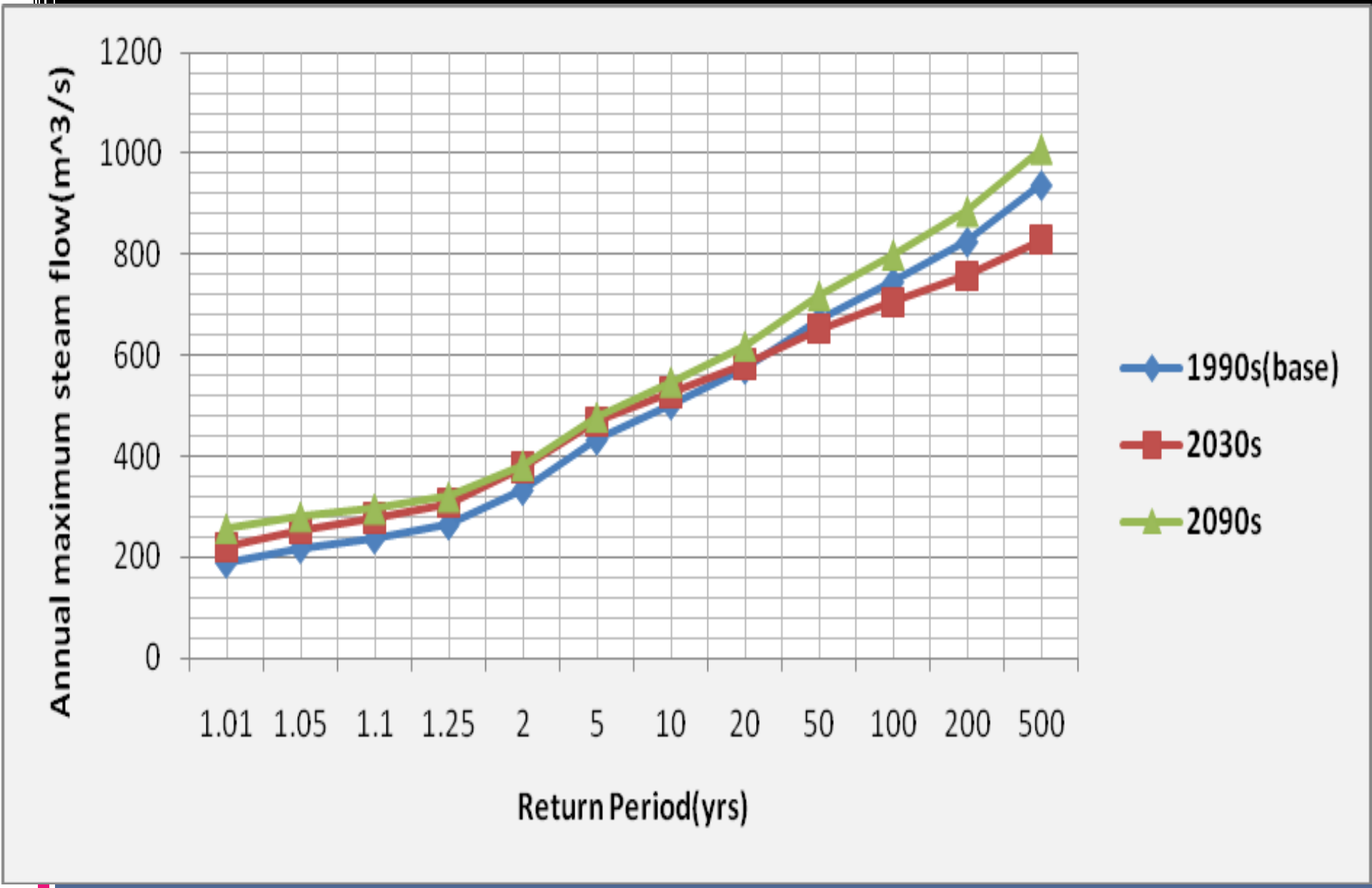




Coefficient of variation



Extreme flow distribution



Implications

1. ***For water supply Availability***
   - *In terms of overall availability water from Akaki River, the supply is likely to be more*
   - *In terms seasonal water availability, it is likely to be more in Kiremt and Autumn Season*
     - *– this doesn't mean the availability will be adequate to the city as other demand driving forces are extra-ordinarily groining*

Implications

1. ***For Extreme hydrological Events***
   - *The recurrence of the extreme floods may be more in 2030s for relatively small floods while the high floods is likely to be more in 2090s*
   - *More likely urban flooding – street flooding due to increased rainfall*
   - *Need to modify urban infrastructure design criteria*

Implications

Socio-economic

- Enhanced Rainfall means the impact will be more higher at the downstream community as Autumn rainfall is tending to increase
- The farmers worry at downstream will increase with rainfall increase in Autumn