Blue Nile Hydro-solidarity

Progress: Blue Nile hydro-solidarity research

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Dec. 8/2011

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Outline

- Part I Field Measurements
- Part II Draft Manuscript
- Part III Current status of the research

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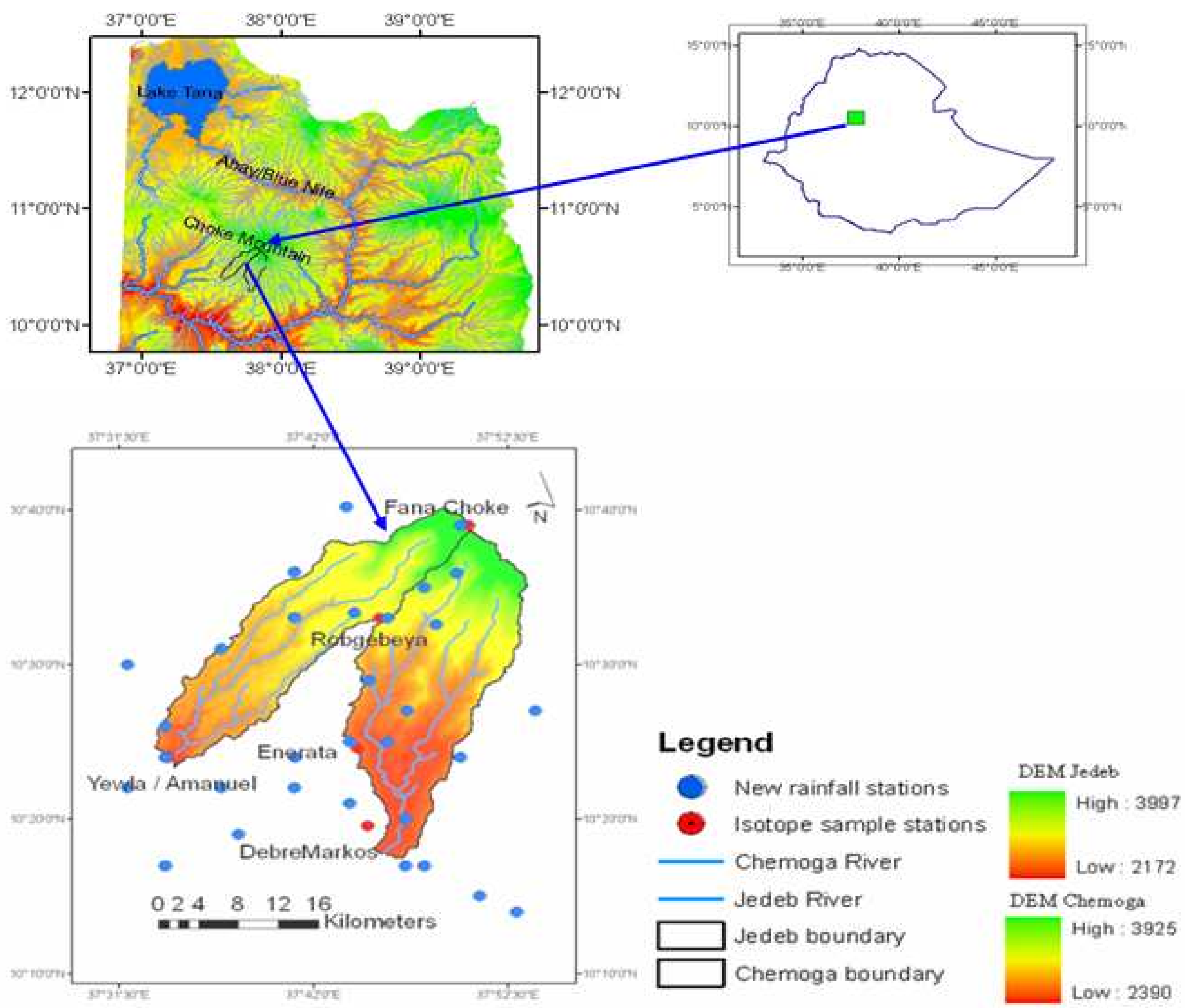
Part -I

FIELD MEASURMENT

Experimental catchment Chemoga and Jedeb



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Updating the rating curve at Chemoga and Jedeb rivers





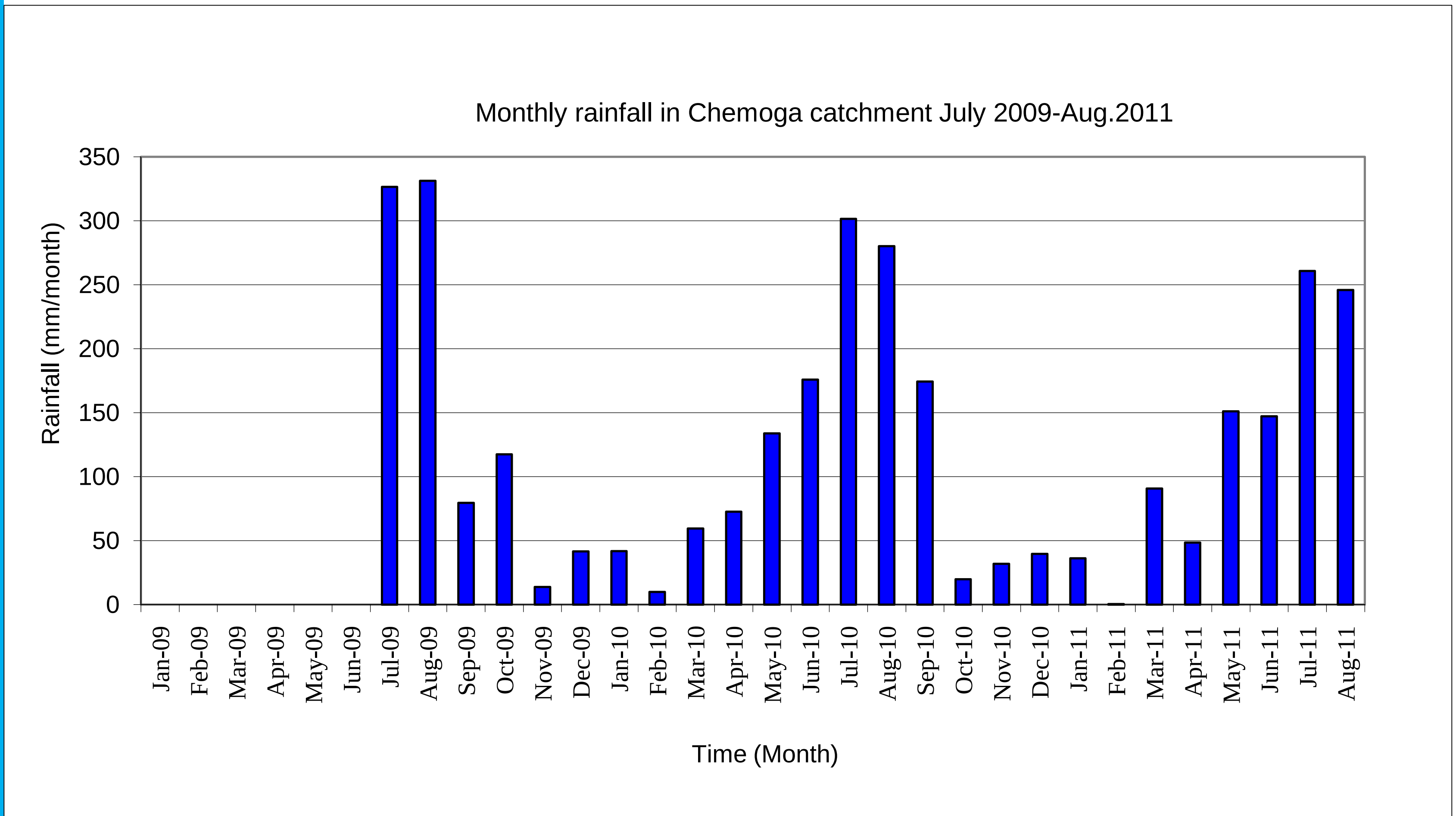





Updating the rating curve at Chemoga and Jedeb rivers

-16 and 14measurments have been taken at Chemoga and Jedeb respectively.

Chemoga monthly rainfall



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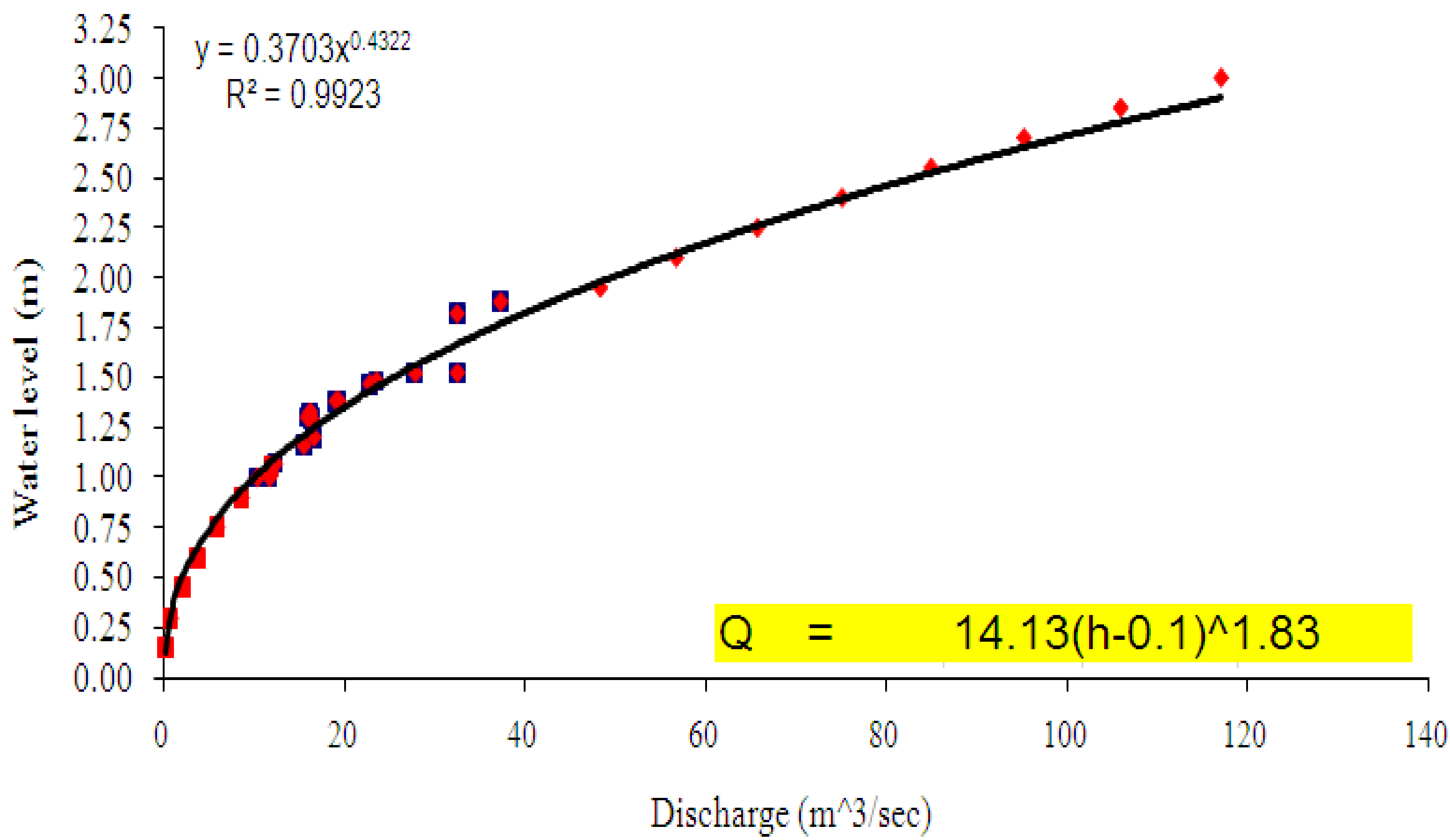
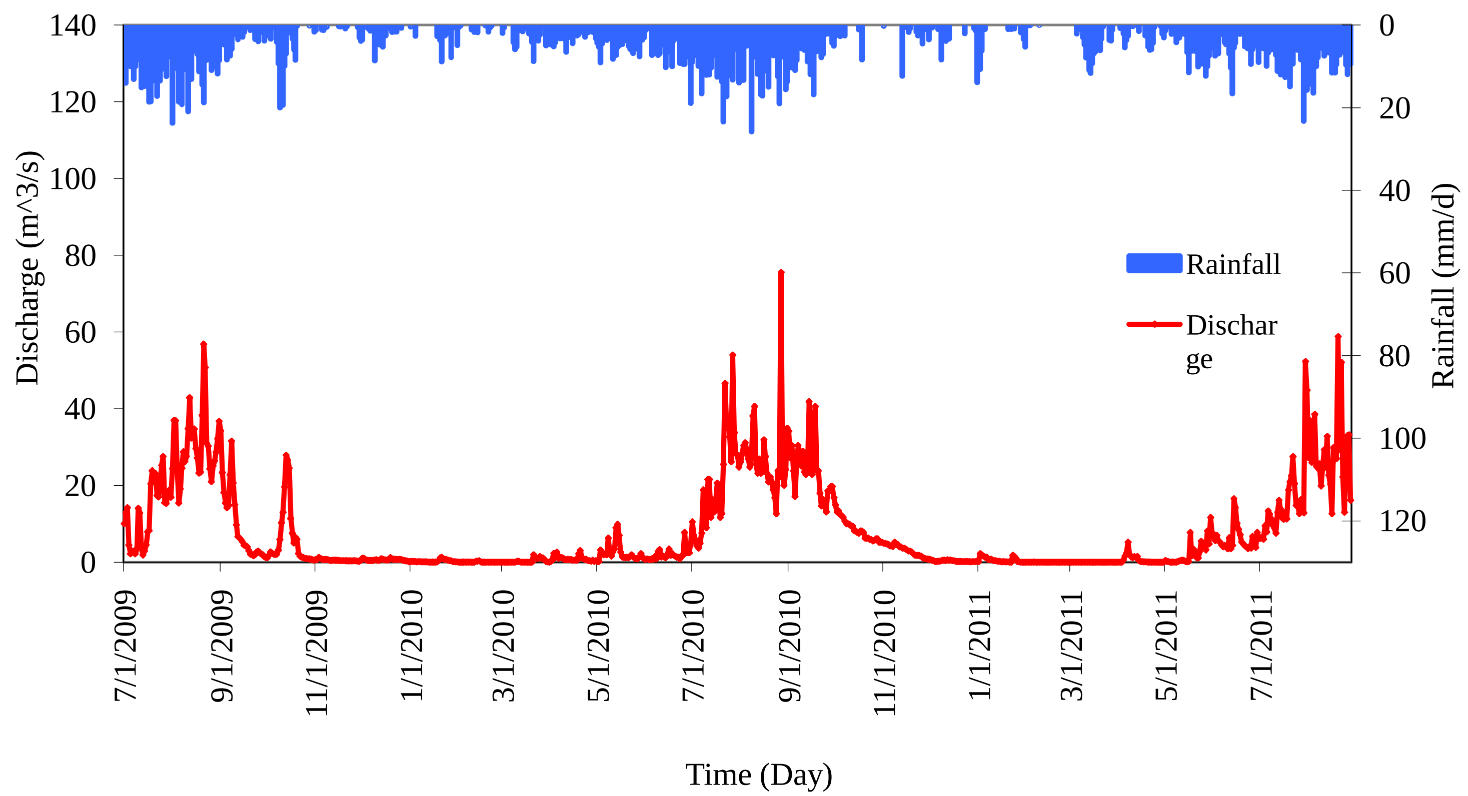
Rating curve Chemoga



Chemoga rainfall and discharge (July 2009-Aug.2011)



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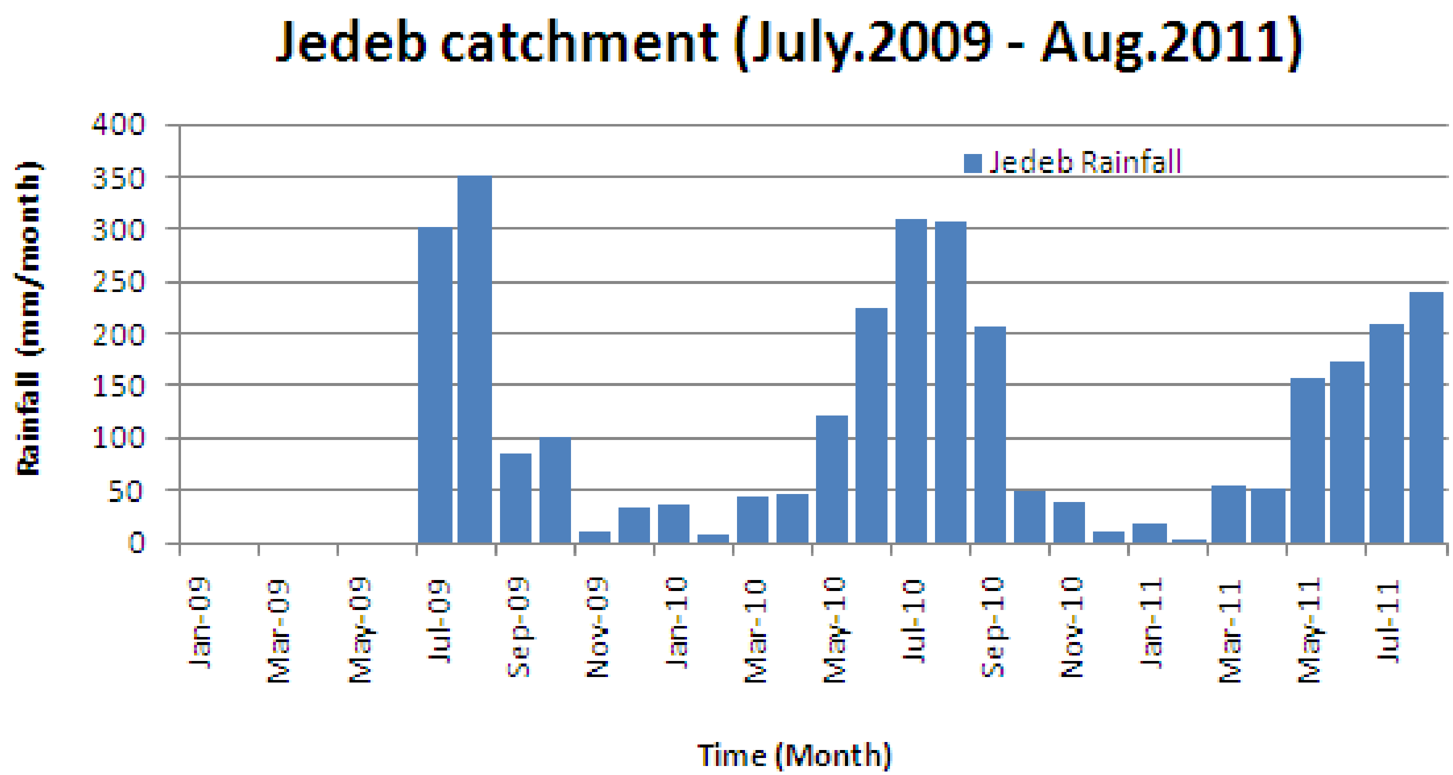
Jedeb monthly rainfall



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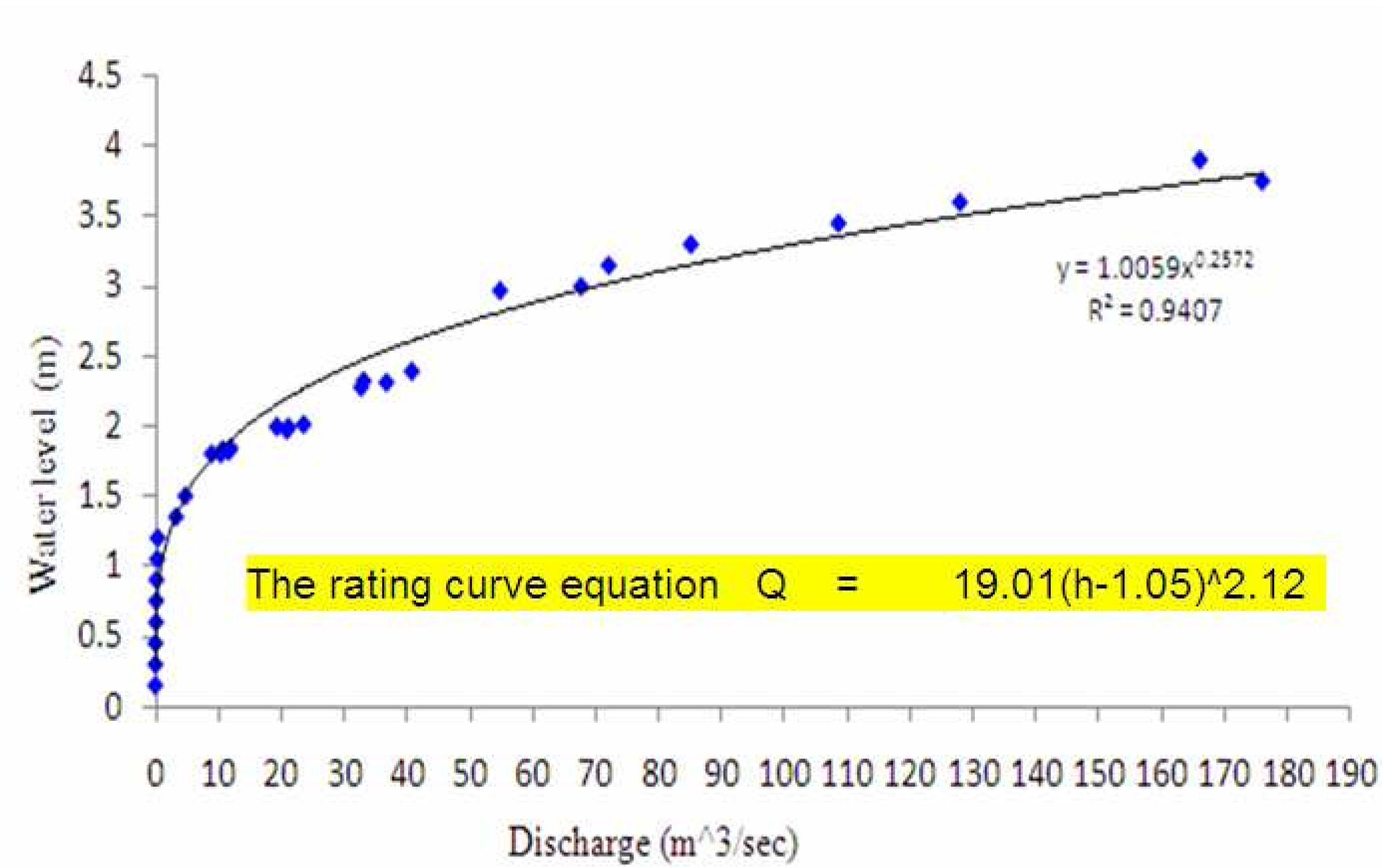
Rating curve Jedeb



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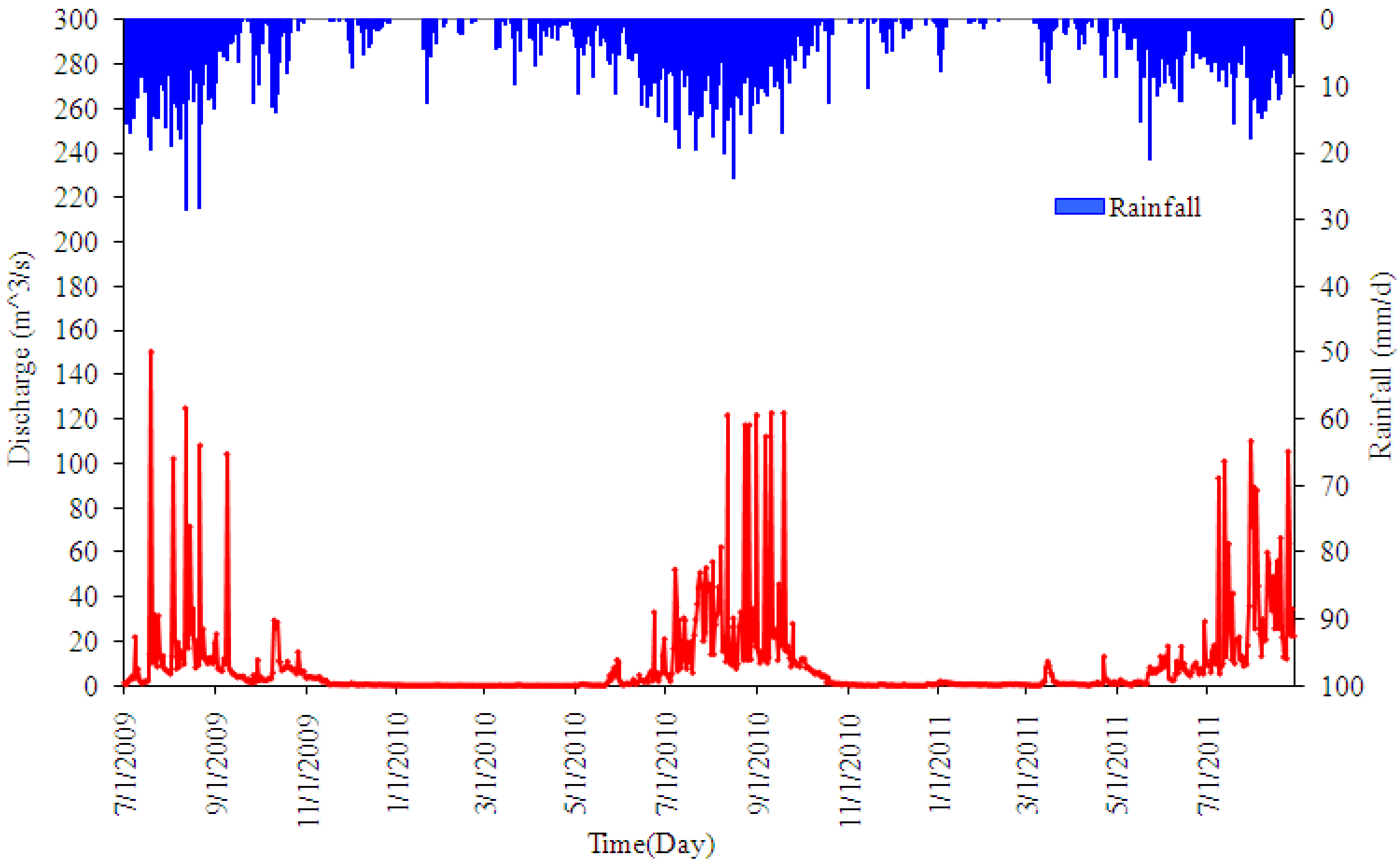
Jedeb rainfall and discharge (July 2009-Aug.2011)



PART II

Draft Manuscript

Hydro-climatic trends in the upper Abay / Blue Nile basin

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Hydro-climatic trends in the upper Abay / Blue Nile basin, Ethiopia

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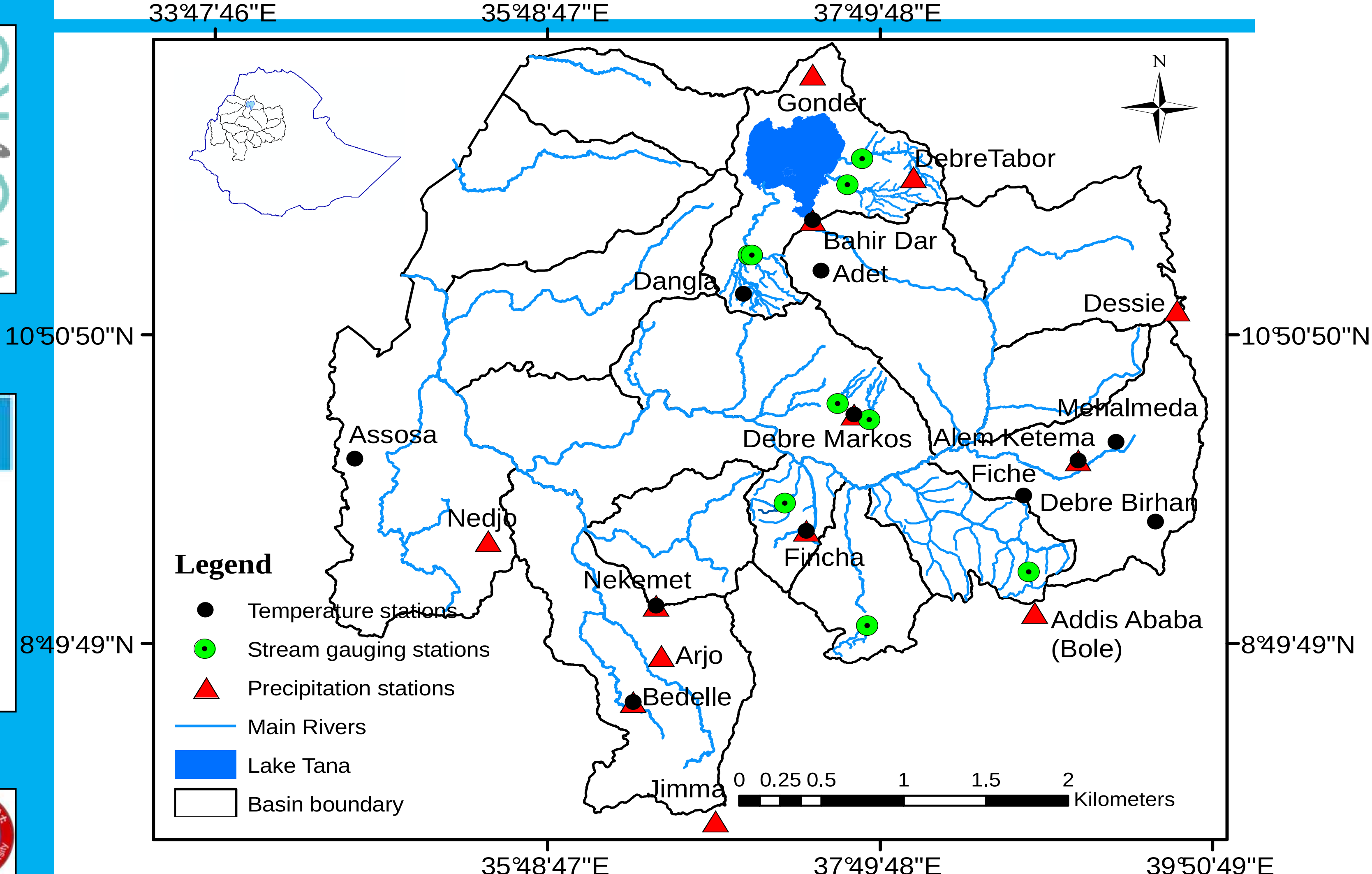
1. Introduction



Study area

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2. Objective

- To identify and investigate trends in hydro-climate of upper Abay / Blue Nile basin.

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3. Data used

- Daily streamflow from 9 stream gauging stations over different time period (31-38 years)

- 13 precipitation and 12 temperature stations

- Monthly Precipitation and temperature data (21-44 yrs fir temp & 29-57years)

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4. Methodology

- Mann-Kendall trend test

- The MK test statistic S is given by the formula:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}(x_j - x_k)$$

$$\operatorname{sgn}(x_j - x_k) = \begin{cases} 1 & if \; x_j - x_k > 0 \\ 0 & if \; x_j - x_k = 0 \\ -1 & if \; x_j - x_k < 0 \end{cases}$$

$$VAR(S) = \frac{n(n-1)(2n+5)}{18}$$

$$Z = \begin{cases} \frac{S-1}{\sqrt{VAR(S)}} & if \; S > 0 \\ 0 & if \; S = 0 \\ \frac{S+1}{\sqrt{VAR}} & if \; S < 0 \end{cases}$$

- Pettitt change point test

$$U_{t,T} = \sum_{i=1}^{t} \sum_{j=t+1}^{T} \operatorname{sgn}(X_i - X_j)$$

$$\operatorname{sgn}(x_i - x_j) = \begin{cases} 1 & if \quad x_i - x_j > 0 \\ 0 & if \quad x_i - x_j = 0 \\ -1 & if \quad x_i - x_j < 0 \end{cases}$$

$K_T = Max\,|U_{t,T}|$ is the change of point in the time series

- Evaluated at 5% significance level

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5. Results

Streamflow trends

Sreamflow variables	Catchment								
	Gilgel Abay	Koga	Gumera	Rib	Jedeb	Chemoga	Muger	Guder	Neshi
Mean annual	-0.51 (0.60)	1.46 (0.15)	1.09 (0.28)	-0.09 (0.63)	-0.68 (0.50)	0.15 (0.81)	0.05 (0.96)	0.87 (0.38)	**1.98 (0.05)**
Summer	-1.41 (0.14)	0.85 (0.37)	**2.45 (0.01)**	-0.12 (0.89)	-0.74 (0.46)	-0.39 (0.63)	-0.45 (0.65)	0.44 (0.61)	**2.08 (0.03)**
Winter	0.29 (0.76)	1.21 (0.18)	1.11 (0.27)	0.00 (1.00)	-1.11 (0.27)	0.22 (0.82)	0.39 (0.70)	1.32 (0.17)	0.7 (0.40)
Spring	**-2.65 (0.00)**	0.67 (0.48)	**3.47 (0.00)**	-0.34 (0.71)	0.25 (0.80)	0.23 (0.80)	-0.71 (0.48)	**2.89 (0.01)**	0.18 (0.82)
1-day annual minima	**-4.49 (0.00)**	0.64 (0.53)	1.16 (0.24)	0.66 (0.51)	0.14 (0.89)	-1.70 (0.09)	**-2.01 (0.04)**	**2.59 (0.01)**	0.02 (0.99)
7-day annual minima	**-5.16 (0.00)**	0.25 (0.8)	1.13 (0.26)	0.20 (0.84)	-1.19 (0.23)	-1.57 (0.12)	-1.78 (0.07)	**2.58 (0.01)**	0.26 (0.80)
1-day annual maxima	0.06 (0.95)	1.38 (0.17)	-0.87 (0.38)	-0.87 (0.38)	1.37 (0.17)	0.11 (0.91)	0.73 (0.47)	**2.37 (0.02)**	**2.16 (0.03)**
7-day annual maxima	-1.7 (0.09)	0.28 (0.57)	0.22 (0.45)	0.76 (0.45)	-0.36 (0.72)	-1.23 (0.22)	0.55 (0.58)	0.43 (0.67)	**2.53 (0.01)**

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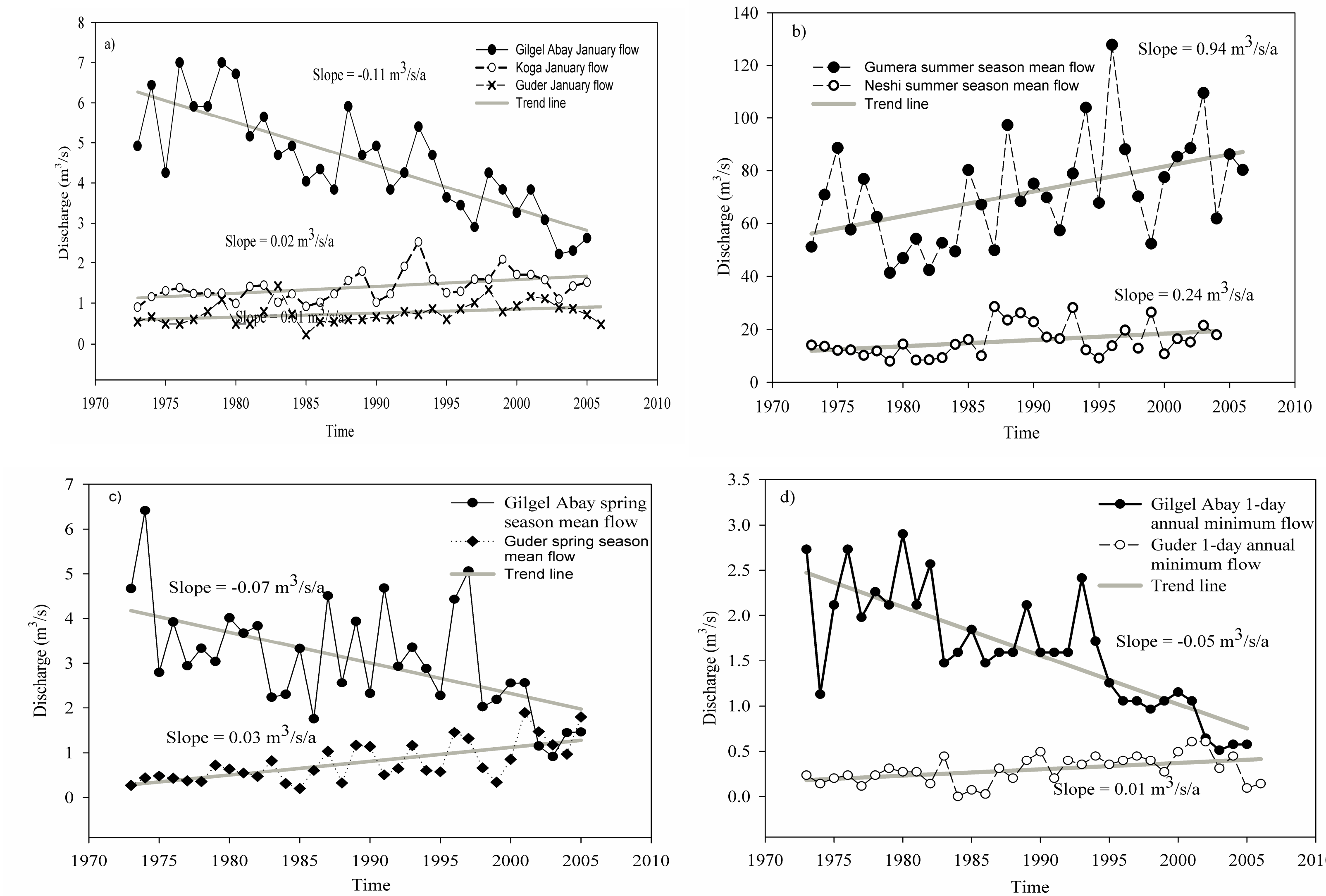
Streamflow trends



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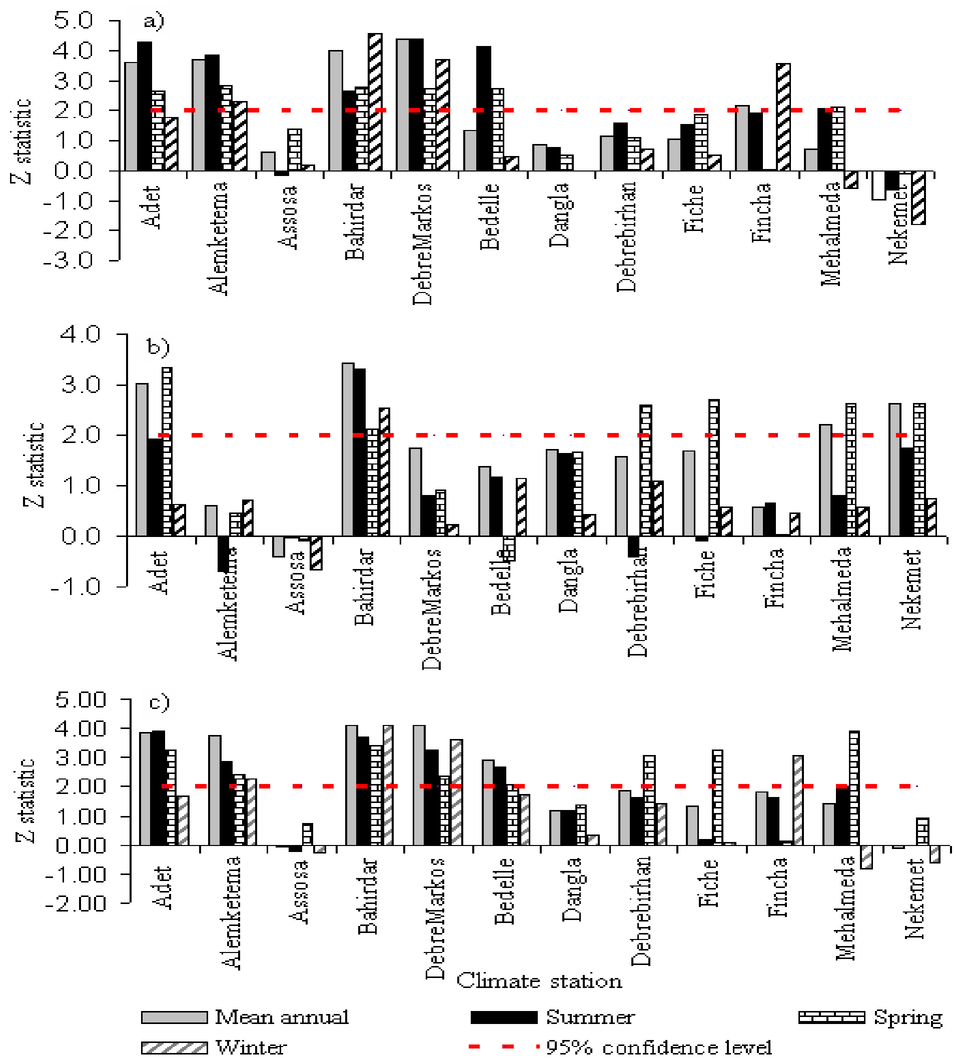
Temperature trend



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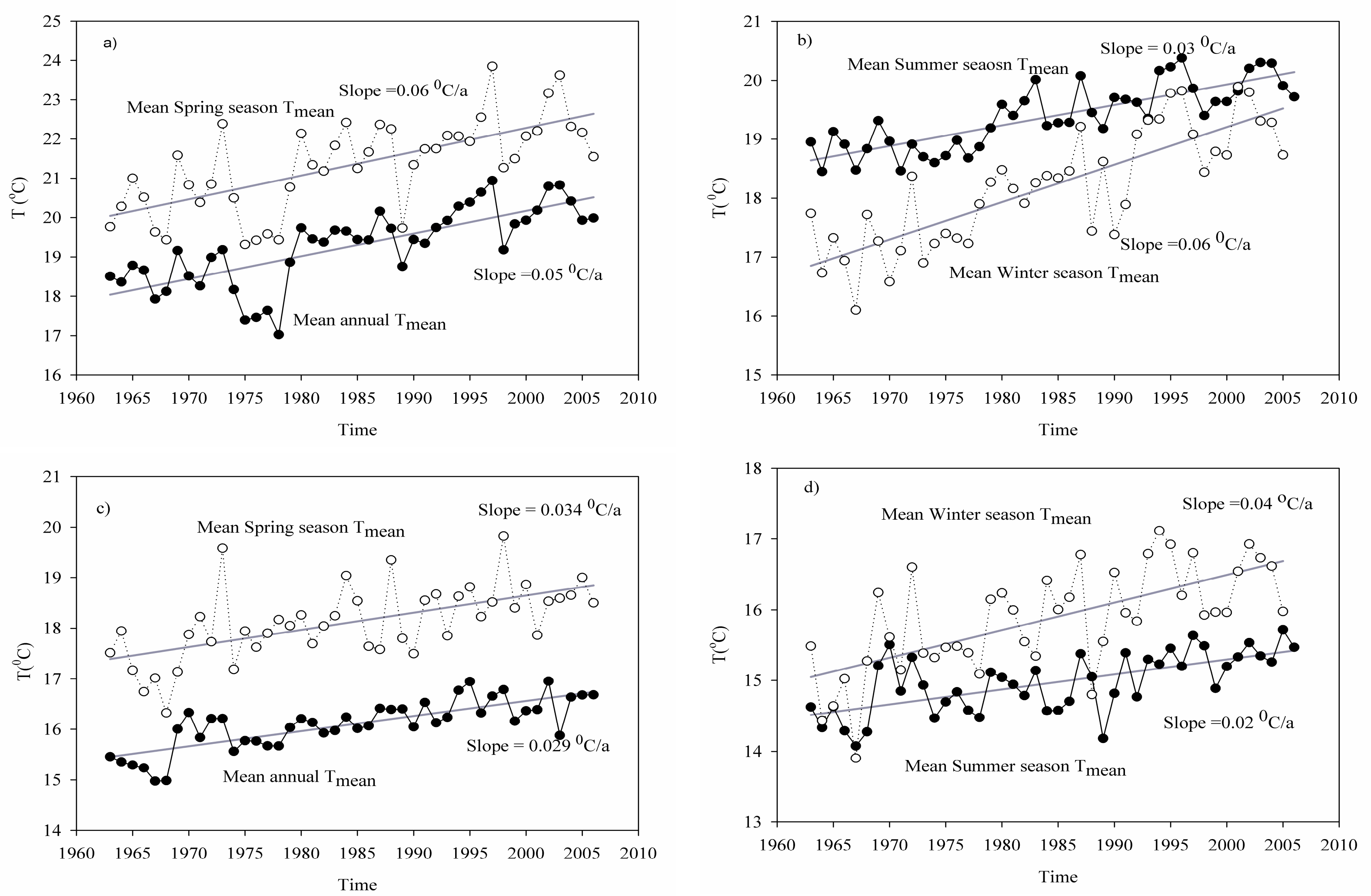
Results contd…



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Streamflow change of point detection

Sreamflow variables (m^3/s)	Catchment								
	Gilgel Abay	Koga	Gumera	Rib	Jedeb	Chemog a	Muger	Guder	Neshi
Mean annual flow	1981(-) (0.21)	**1995(+) (0.02)**	**1987(+) (0.01)**	1986(+) (0.53)	**1983(-) (0.05)**	1993(-) (0.82)	1993(+) (0.7)	1982(+) (0.23)	**1986(+) (0.00)**
Summer	1981(-) (0.30)	1995(+) (0.18)	**1987(+) (0.01)**	1978(+) (0.76)	1983, (-) (0.06)	1993(-) (0.28)	1994(-) (0.057)	1982(+) (0.7)	**1986(+) (0.00)**
Winter	2000(+) (0.69)	1989(+) (0.10)	1991(+) (0.23)	1981(+) (0.86)	1993(-) (0.08)	2000(+) (0.79)	1977(-) (0.56)	1995(+) (0.19)	1995(+) (0.73)
Spring	**1997(-) (0.01)**	1986(+) (0.19)	**1991(+) (0.00)**	1979(-) (0.19)	1992(+) (0.41)	1986(+) (0.5)	1997(-) (0.09)	**1988(+) (0.01)**	**1984(+) (0.02)**
1-day annual minima	**1994(-) (0.00)**	1991(+) (0.13)	**1990(+) (0.00)**	1988(+) (0.42)	1992(+) (0.69)	1993(-) (0.07)	1997(-) (0.03)	**1998(+) (0.00)**	1985(+) (0.24)
7-day annual minima	**1994(-) (0.00)**	1988(+) (0.22)	**1990(+) (0.00)**	1979(-) (0.49)	1997(-) (0.23)	1993(-) (0.11)	1997(-) (0.02)	**1998(+) (0.00)**	1985(+) (0.06)
1-day annual maxima	1988(+) (0.40)	1994(+) (0.01)	1997(-) (0.50)	**1981(-) (0.00)**	**2002(+) (0.01)**	2001(+) (0.76)c	1988(+) (0.28)	**1988(+) (0.02)**	**1986(+) (0.00)**
7-day annual maxima	1997(-) (0.07)	1994(+) (0.14)	1987(+ (0.13)	**1980(-) (0.04)**	1983(+) (0.26)	**1994(-) (0.03)**	1988(+) (0.54)	1982(+) (0.43)	**1986(+) (0.00)**

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6. Conclusion

- Streamflow trends are not consistent across the examined stream gauging and climate stations.

- The increasing in temperature trends are consistent with the prediction of climate models, which shows significant increasing trends for the majority of the stations.

- Insignificant trends in precipitation data at mean annual or seasonal scale in the upper Abay / Blue Nile basin might suggest to look at land use change impact on streamflows.

- More research work is needed for quantifying the effects of land use, or climate change / variability on streamflows in the basin.

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PART III

- Current status of the research

1. Integrative paper with Ermias

- Assessing land use change impact on hydrology of the Jedeb catchment

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2.Objective

- The main objective of the paper is to assess the influence of land use change on the changes in flow variability of Jedeb meso scale agricultural dominated catchment.

- *Hypothesis:*
- *Null hypothesis(Ho): land use change is the dominant contributary factor for the change in flow variability.*
- *Alternative hypothesis (H1): Land use change is not the dominant factor for the change in flow varibility.*

3. Data

- Climatic data:
- 57 years of daily rainfall data from Debre Markos station (1954-2010)
- 46 years of daily temperature data from Debre Markos station. (1963-2010)
- 21 years of daily rainfall data from Rob Gebeya station (1989-2010)
- 17 years of daily rainfall data from Anjeni station (1988-2004)
- Hydrometric data: streamflow (1973-2010)
- Due to the data quality, only 32 years are considered.

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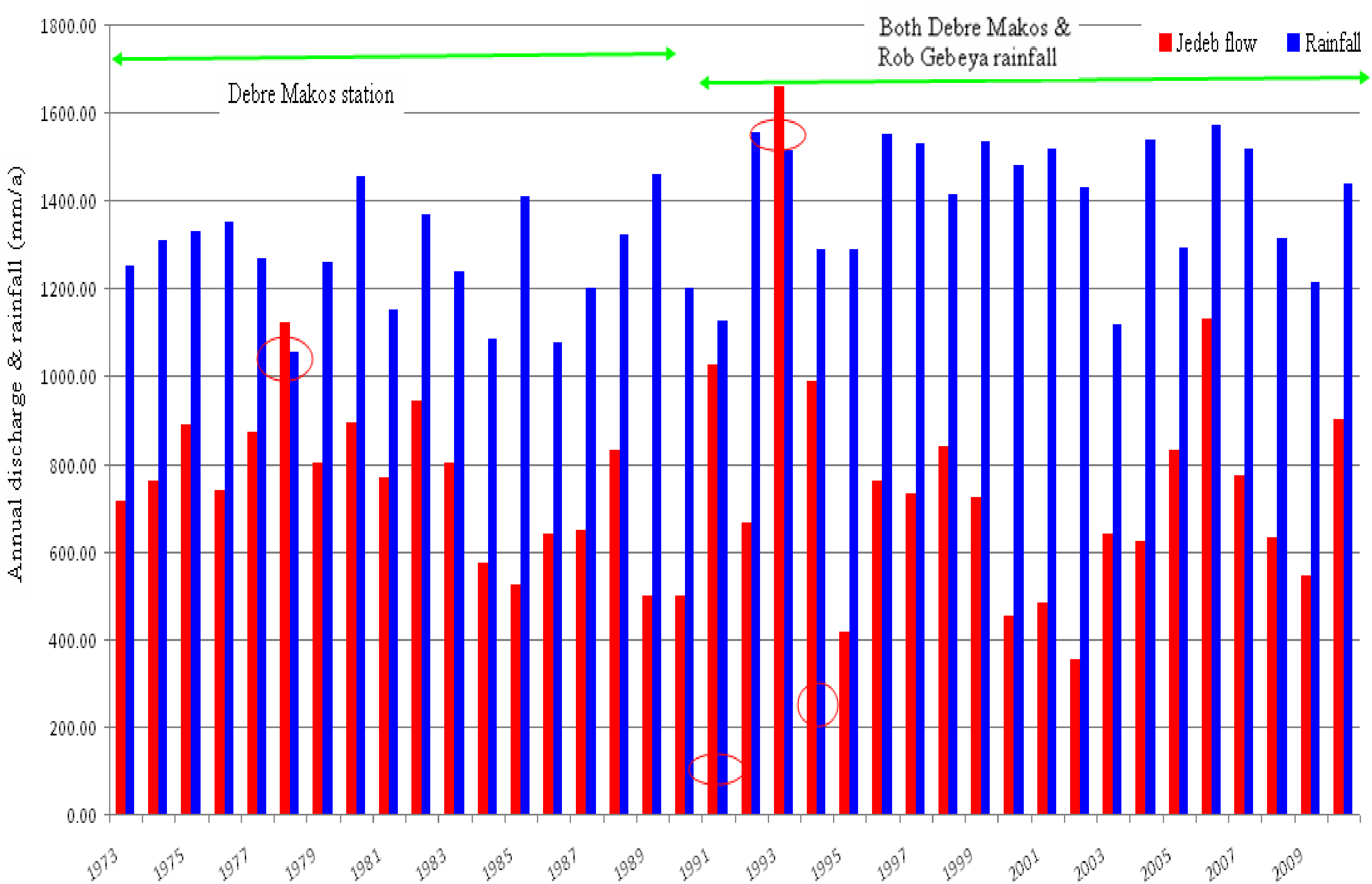
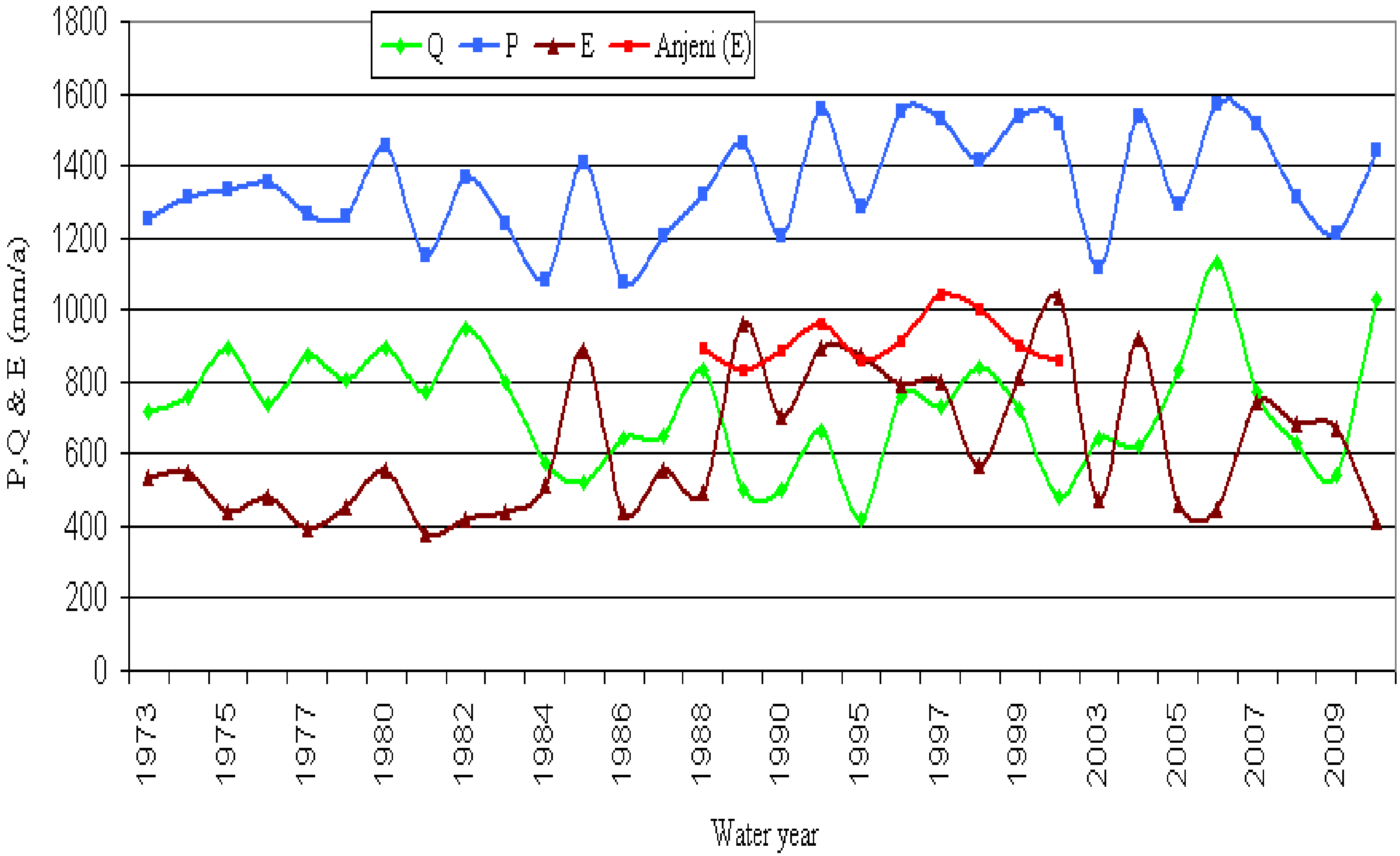
Data contd…



Fluxes on annual basis



Some annual evaporation results from different sources

- Water Watch (2007) Beles catchment for the year 2001
- Evaporation varies between 250mm/a-1500mm/a
- Tana basin 672 mm/a

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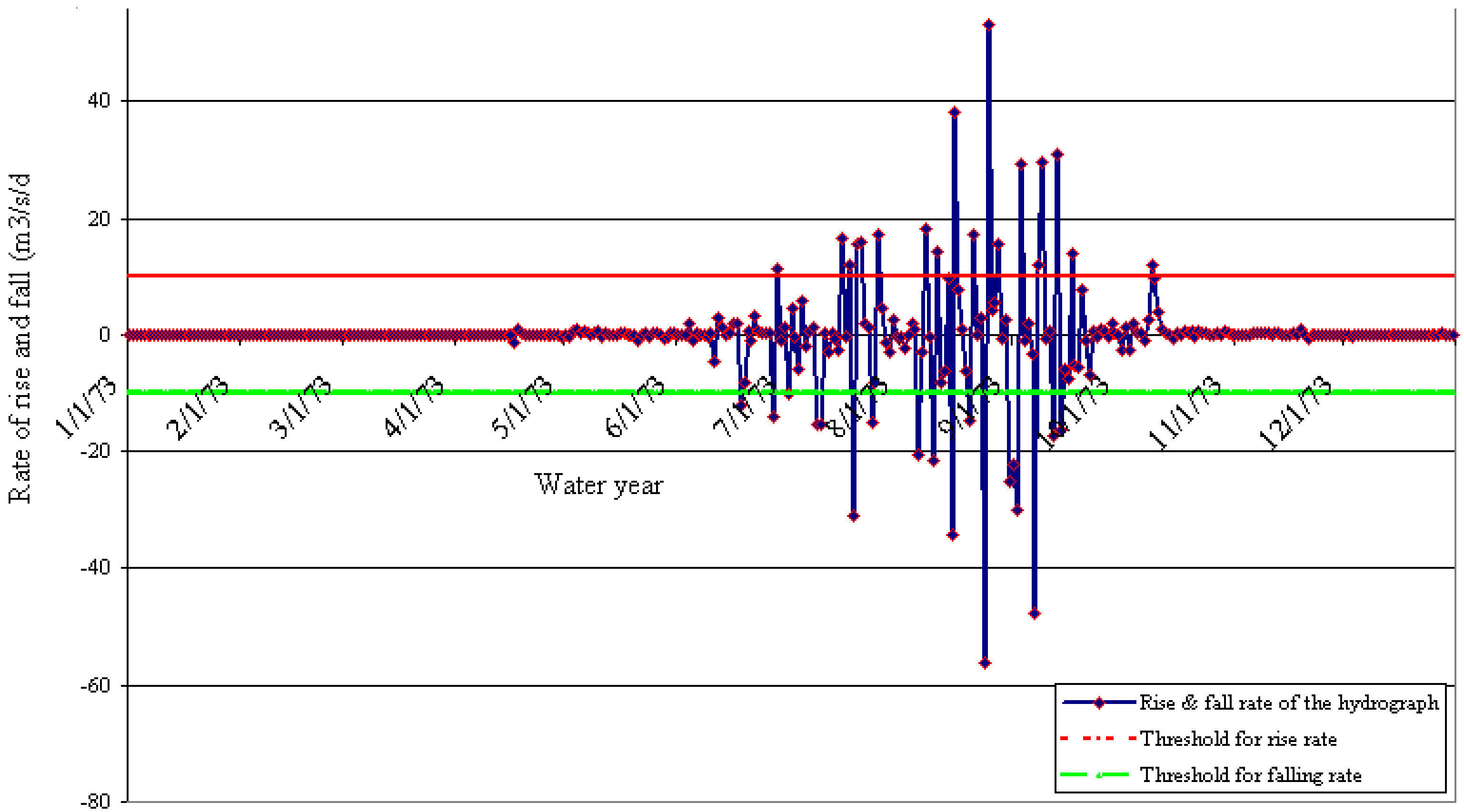
4.Methodological approach

I. *Streamflow analysis*



-Frequency, duration

Methods contd..

- See the rate of rise and fall of the hydrograph, taking threshold of median rise rate and median fall rate.

II. *Rainfall analysis:*

-Analyze frequency of wet days above a certain threshold value.

-The frequency can be the indicator of the rainfall intensity

- Develop regression model to predict the expected no. of flow pulses and duration from rainfall.
- The residual can be attributed to the land use change.

III. *Link the land use history and transition of changes in relation to the change of flow variability*.

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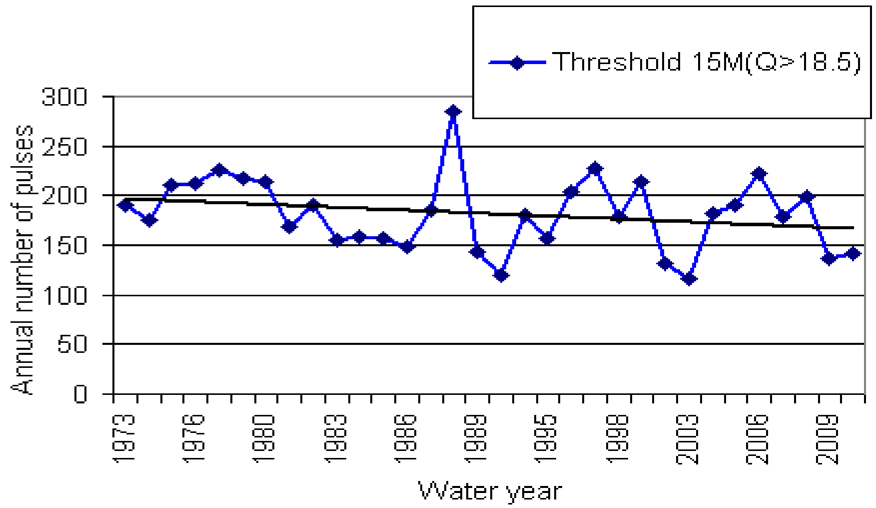
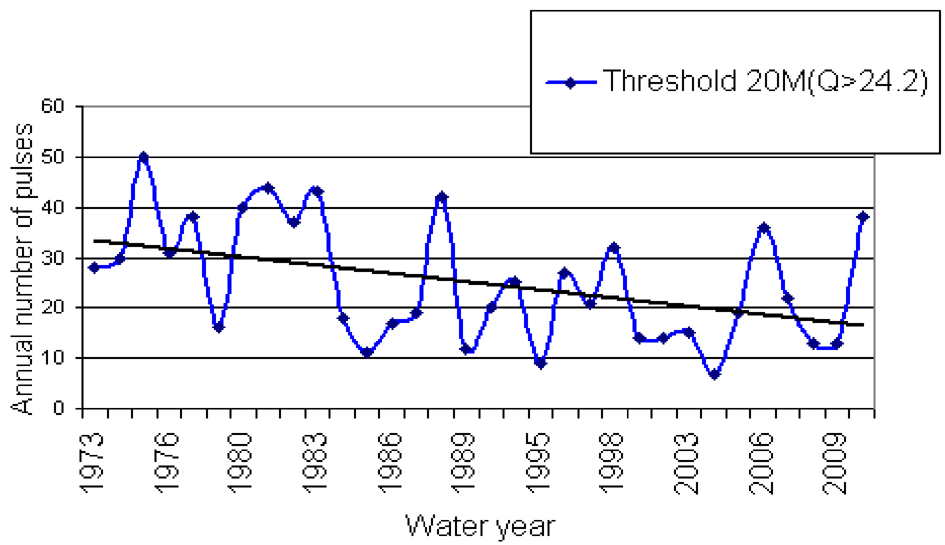
5.Some preliminary findings
Annual number of pulses for different threshold discharge values





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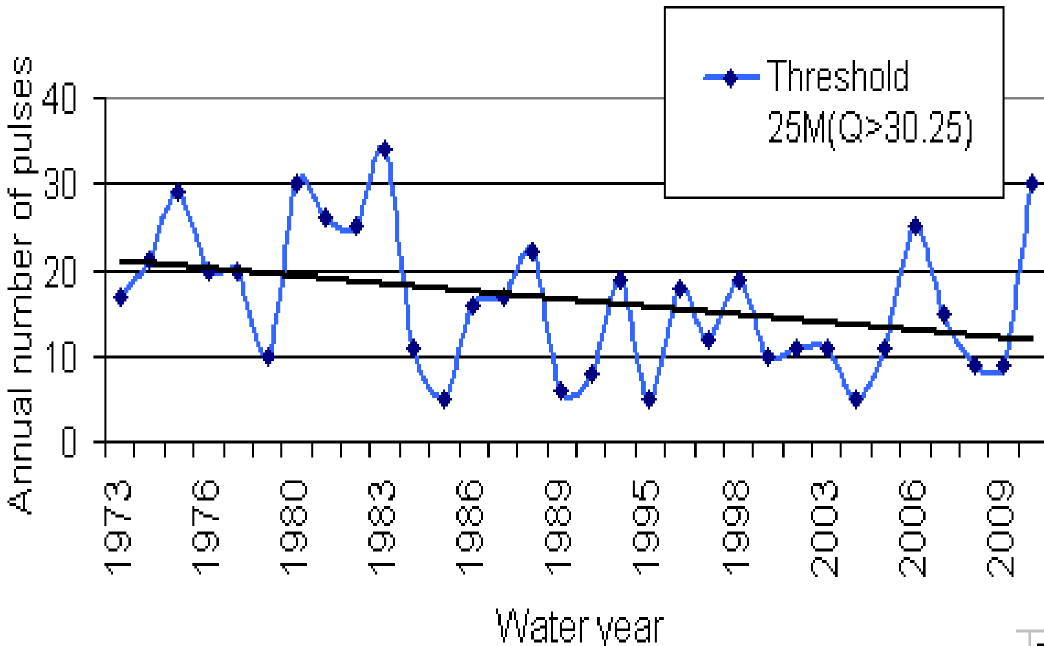
Result contd..



-Both annual pulses and duration are Significantly decreasing for medium threshold.
-Pulses numbers are increasing for higher threshold

Threshold	Sprearman correlation
15M	-3.46
20M	-2.54
25M	-2.09
70M	4.92
80M	5.28

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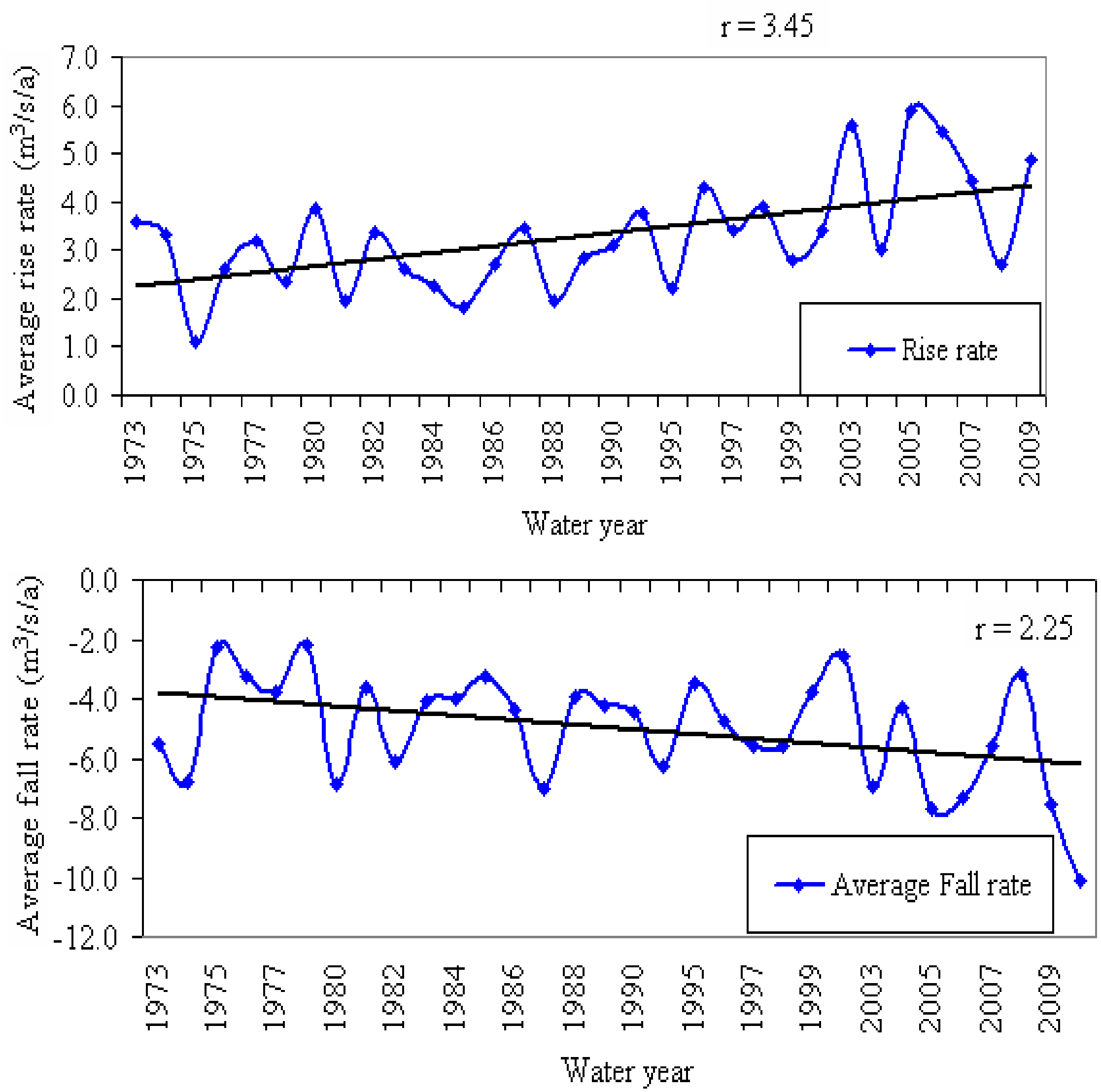
Average rise and fall rate of the hydrograph



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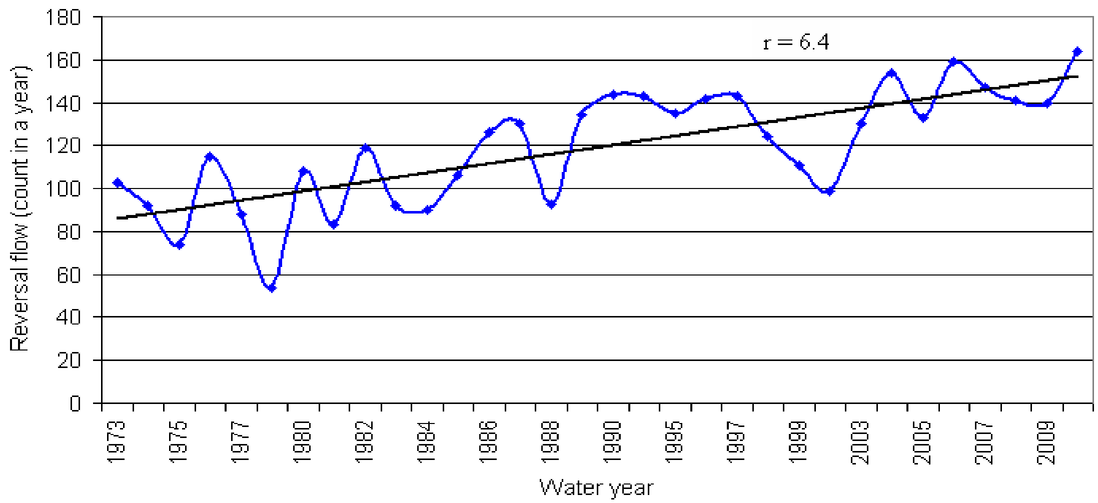
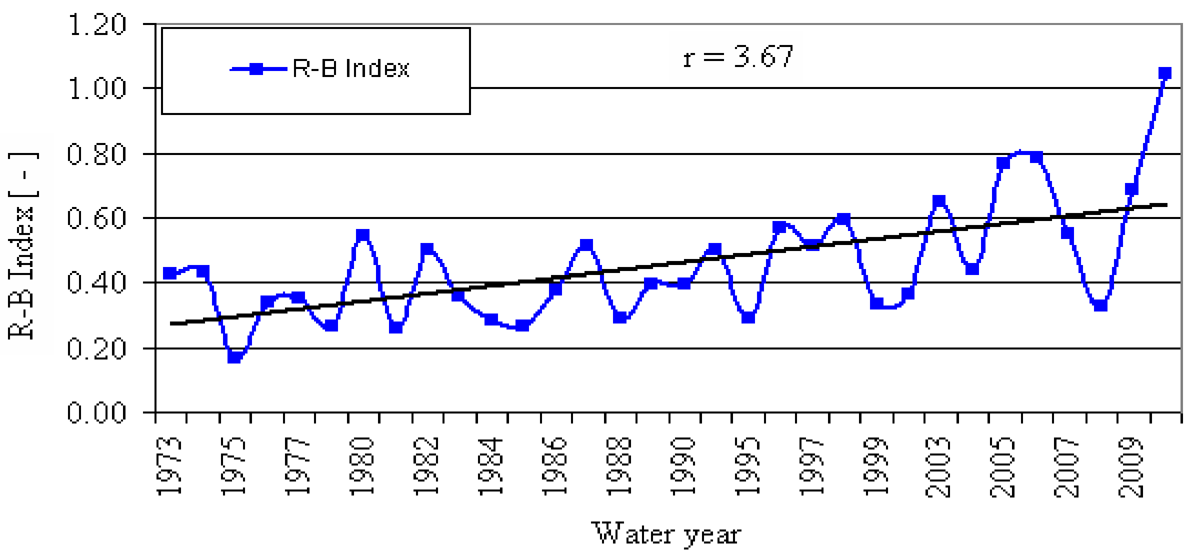
Reversal flow & flashy ness Index

Flashy ness reflects the frequency and rapidity of short term changes in streamflows (Baker et., al 2004)





Analyze the rainfall pulses in progress…

- What are the causes for the changes in hydrograph characteristics?
- It is going to be analyzed…….
- Suggestion…

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Thank you!!