Impact of Climate Changes on Catchment Hydrology and Rainfall - Runoff Correlations in Karjan Reservoir Basin, Gujarat, India

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Introduction

- **Global and regional climate has been changing as evidenced by temperature increase, increase in rainfall intensity etc.**
- **The impacts of climate change primarily driven by global warming are highly extensive, complicated, and uncertain**
- **Availability and variability of water resources will be affected by climate change effect**

Introduction

- **The impacts of climate change on water resources have received much attention globally especially in the last 30 years. Rainfall, the main driver of the hydrological cycle, has been varying in the parts of the world.**

- **In this view, regionalizing the hydrologic response under a changing climate is a need of an hour for the better Water Resources Management of the basin.**

- **Therefore, to regionalize the hydrologic response under a changing climate the study is taken as:**

" Impact of Climate Changes on Catchment Hydrology and Rainfall – Runoff Correlations in Karajan Reservoir Basin, Gujarat"

Aims and Objectives of the study

- **To assess the change in the climate in the Karajan reservoir basin**
- **To assess the impacts of changing climate on the catchment hydrology of the basin**
- **To evolve the Rainfall – Runoff correlations under the changing climate in Karajan reservoir basin**

Study Area

- The karajan river is tributary of Narmada river in the state of Gujarat
- karajan dam is Located at latitude 22° 02‘’43” and longitude 73° 05‘ 02 "
- Karjan catchment has 1400.058 Sq. km. area

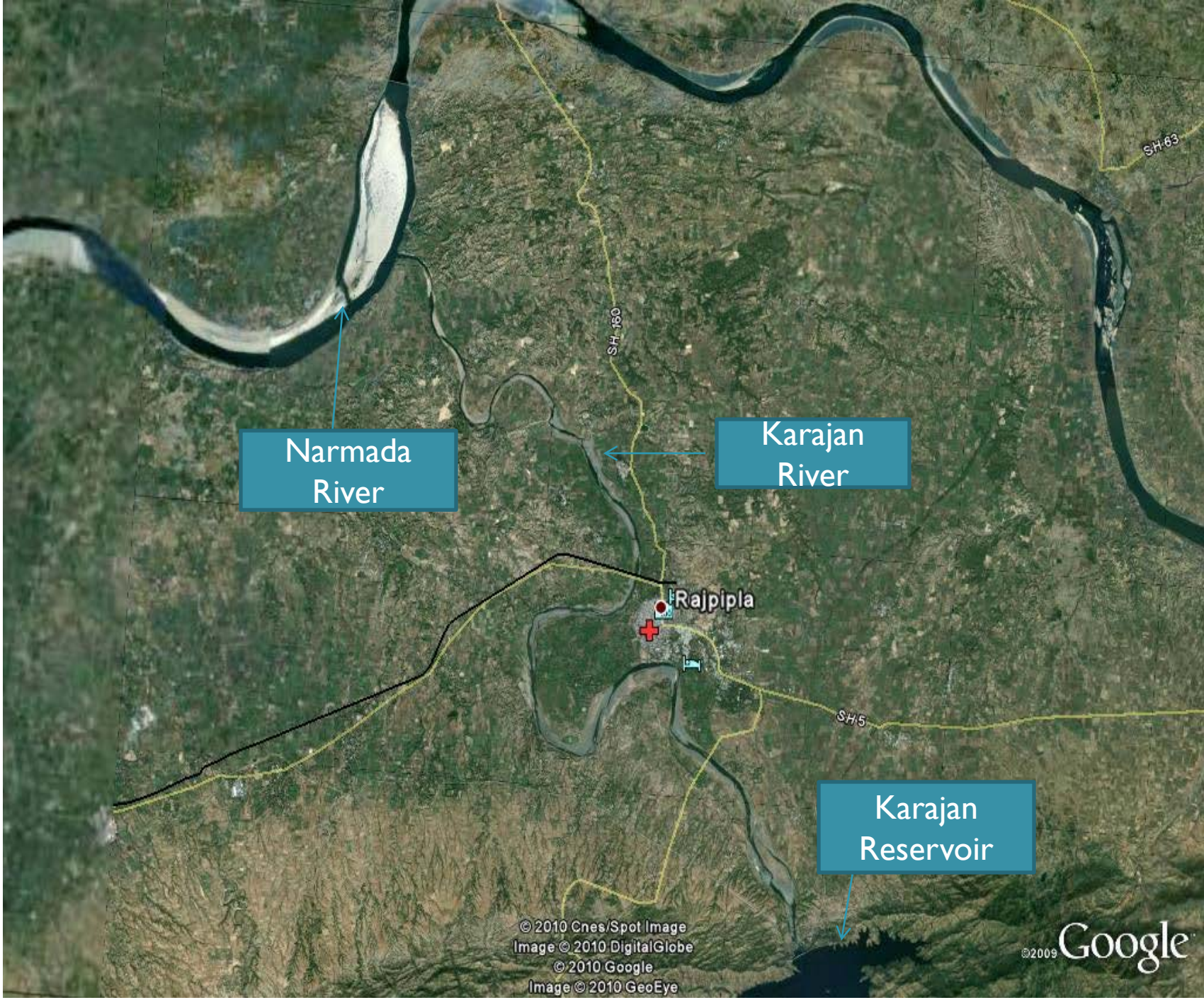
Narmada River
Karajan River
Karajan Reservoir
Rajpipla
SH 160
SH 63
SH 5
© 2010 Cnes/Spot Image
Image © 2010 DigitalGlobe
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Image © 2010 GeoEye
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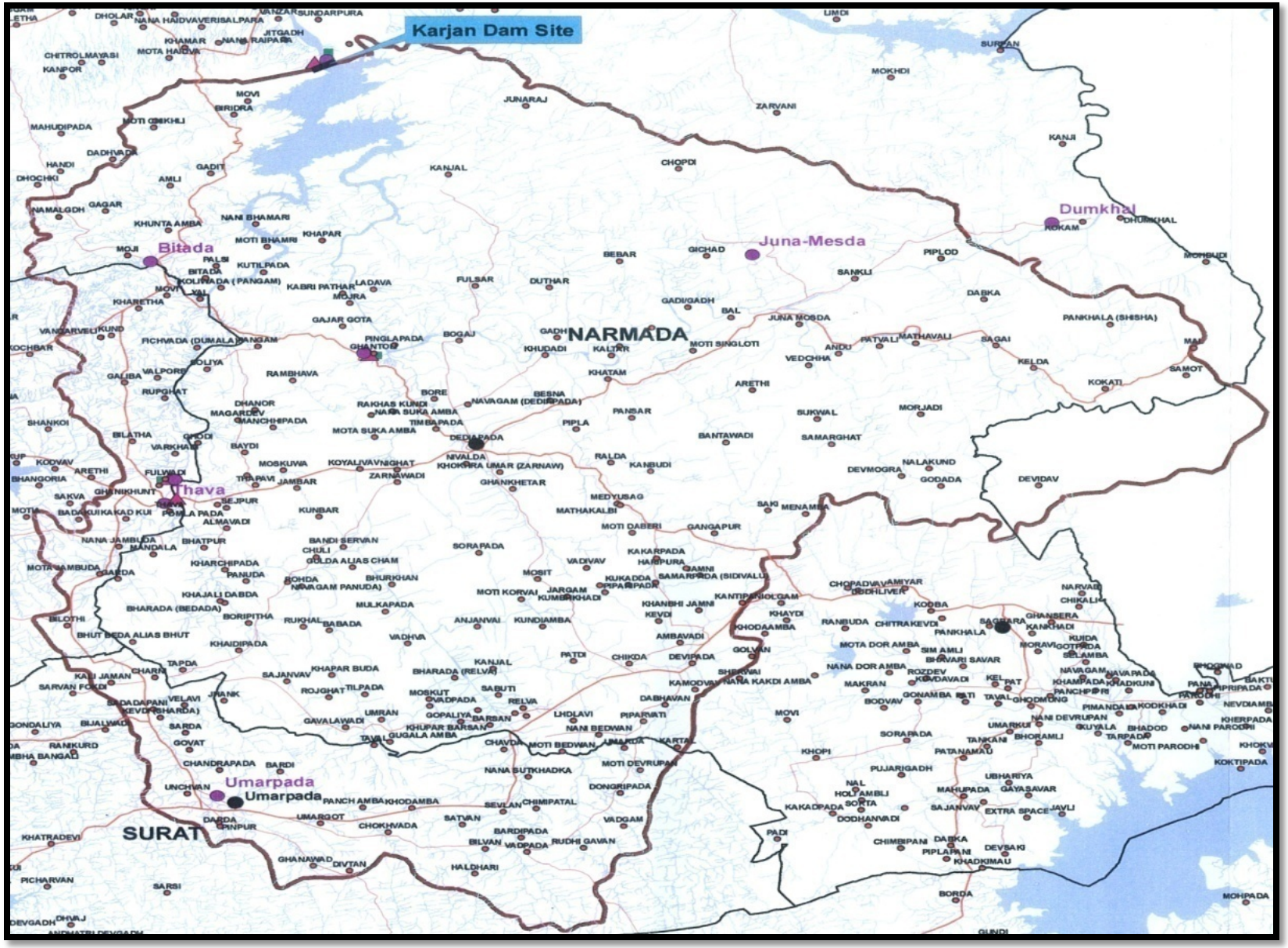
SALIENT FEATURES OF KARJAN RESERVOIR PROJECT

(a) Location

Name of Reservoir :	Karajan Reservoir Project	
River	:	Karajan
Village	:	Jitgadh
Taluka	:	Nandod
District	:	Bharuch and Narmada
State	:	Gujarat
Location of Dam site	:	Lat. 21^0 – 49’ N Long 73^0 – 32’ E

Karajan catchment area



Availability of Data

- There are 6 Rain gauge stations, 1 Weather station and 1 River gauge station at Karajan project located in a Karajan river basin

The long span data (1960 – 2010) have been made available for

- Monthly rainfall (mm)
- Max. daily rainfall of the month (mm/day)
- Weather data
- Monthly Inflows at Karajan dam site (MCM)

Availability of Data

Sr. No.	Name of the Rain gauge station	Location	station installed in year	Rainfall Data Available (Years)
1	Karajan	Lat 22° 02'43" Long 73° 05'02"	1961	1961-2010
2	Thava	Lat 21° 35' 59" Long73° 28'06"	1975	1975-2010
3	Dediapada	Lat 21° 38'10" Long 73° 35'19"	1962	1962-2010
4	Juna mosda	Lat 21° 43'09" Long 73° 41'57"	1972	1972-2010
5	Bitada	Lat 21° 43'11" Long73° 27'58"	1983	1983-2010
6	Umarapada	Lat 21°27'14" Long 73°29'07"		2002-2010

Availability of Data

Sr. No	Name of the River gauge station	Year
1)	Karajan dam	1956 - 2007

Sr. No	Name of the Weather station (Temperature data)	Year
1)	Karajan	2000 - 2010

Literature Review

- Climate change challenges water managers and researchers to find sustainable management solutions, in order to avoid undesirable impacts on water resources, environment and water-dependent sectors.(Fred Fokko Hattermann)
- All-India summer monsoon rainfall is free from any long-term trend although on subdivisional scale there are regions of increasing/decreasing trends.(K. K. Kumar (2010))
- Impact of climate change on water resources was carried out as a case study for mulunguzi and namadzi cathment area in southen malawi by D. Mbano2,3, J. Chinseu
- Impact of climate change in terms of rainfall and temperature on the water balance and response of catchments in extreme flood and drought condition was studied using NAM model (RPS Consulting engineers, Belfast.(2006))

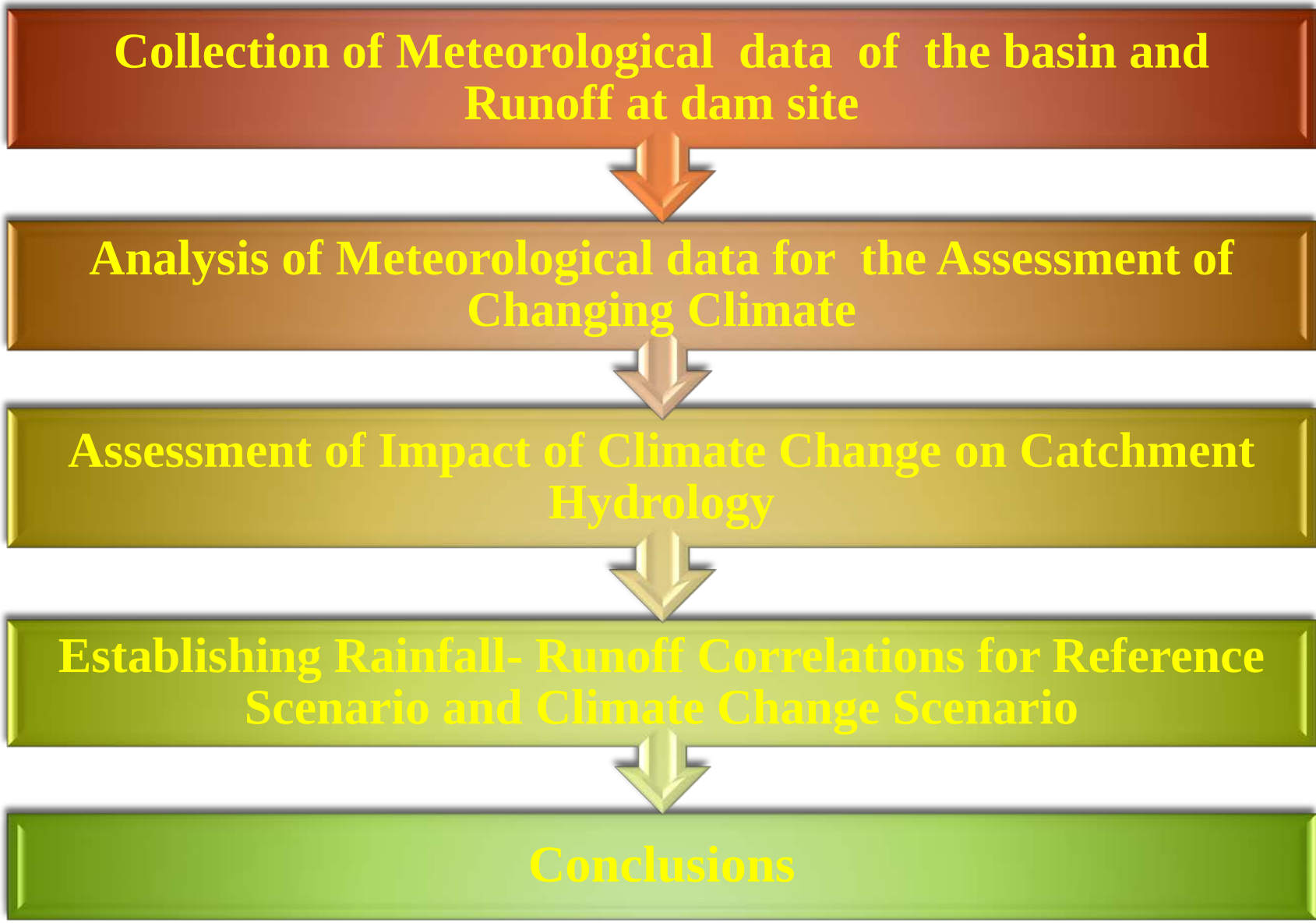
Literature Review

- The impact of climate change on runoff and soil moisture in 28 catchments of Australia were simulated by using a hydrological daily rainfall-runoff models (Chiew F. H. S. et. al. (1994))

- Modeling Climate impact on water for South Australia has been studied by Department of Environment and Sustainability (2011)

- Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability. The Effect of Climate Change on Rainfall Trends and Flooding Risk in the West of Scotland have been studied (Mansell M.G. (1997))

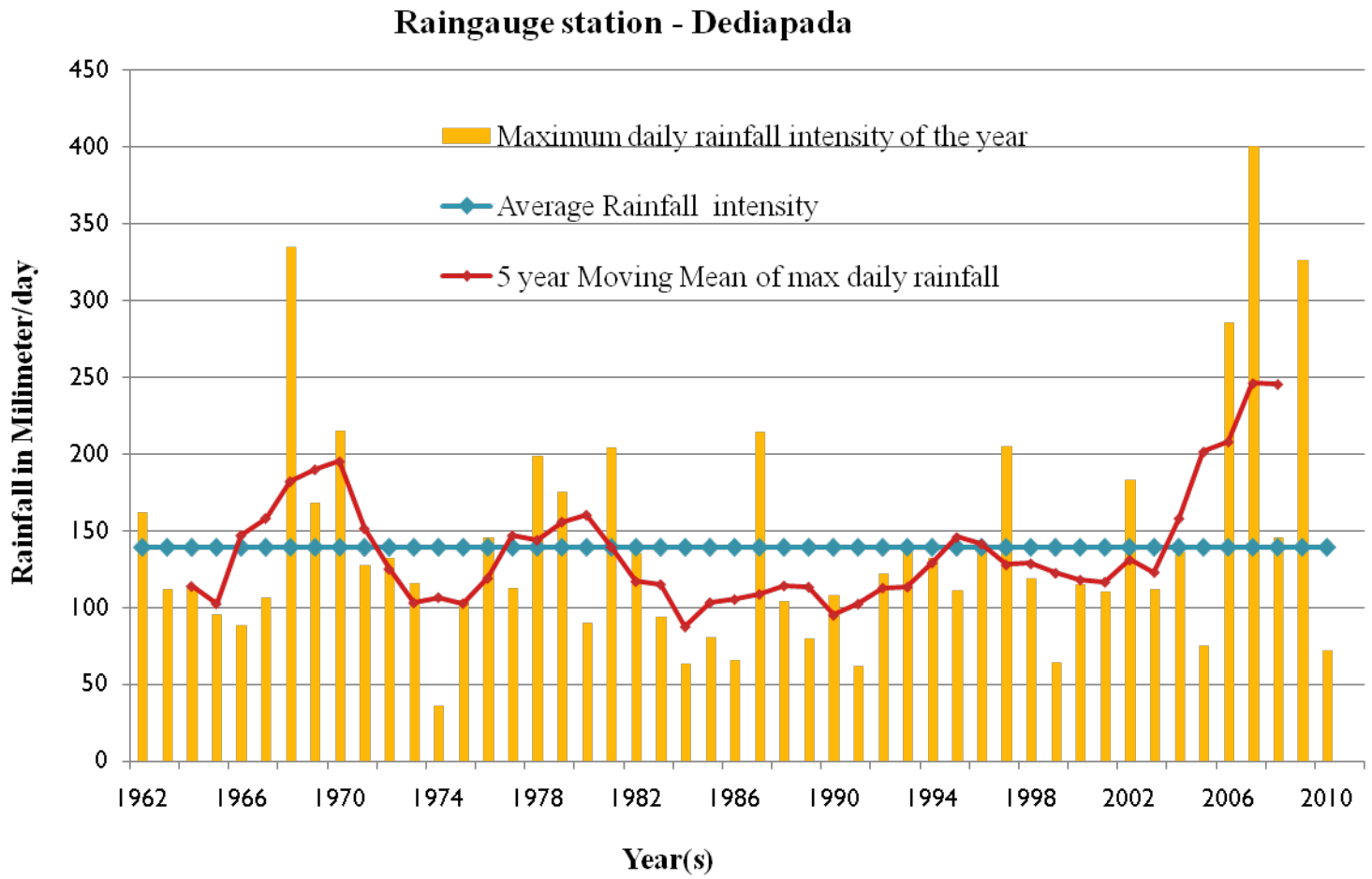
Methodology



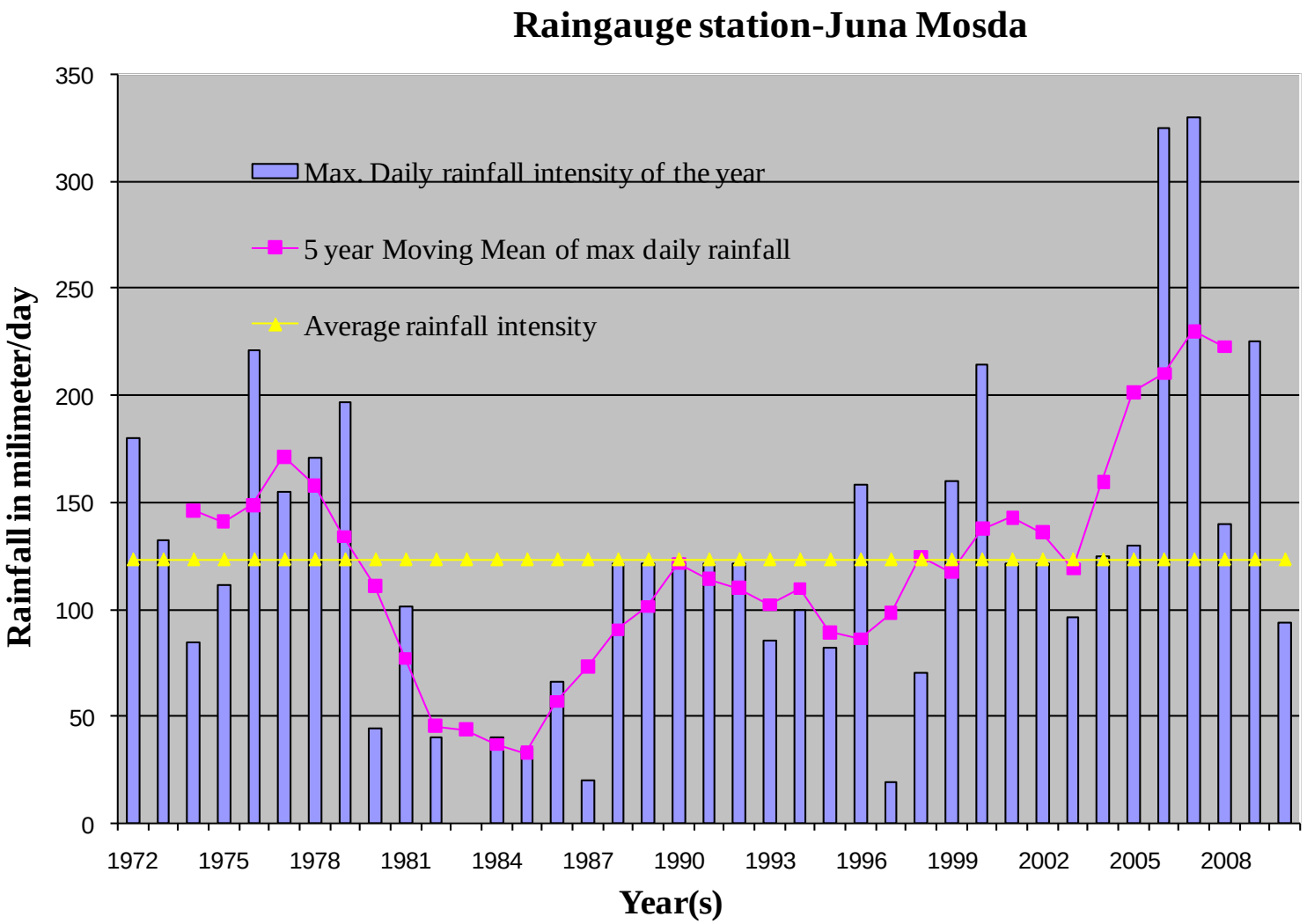
Assessment of Climate Change

Following parameters are considered for the assessment of climate change in this study

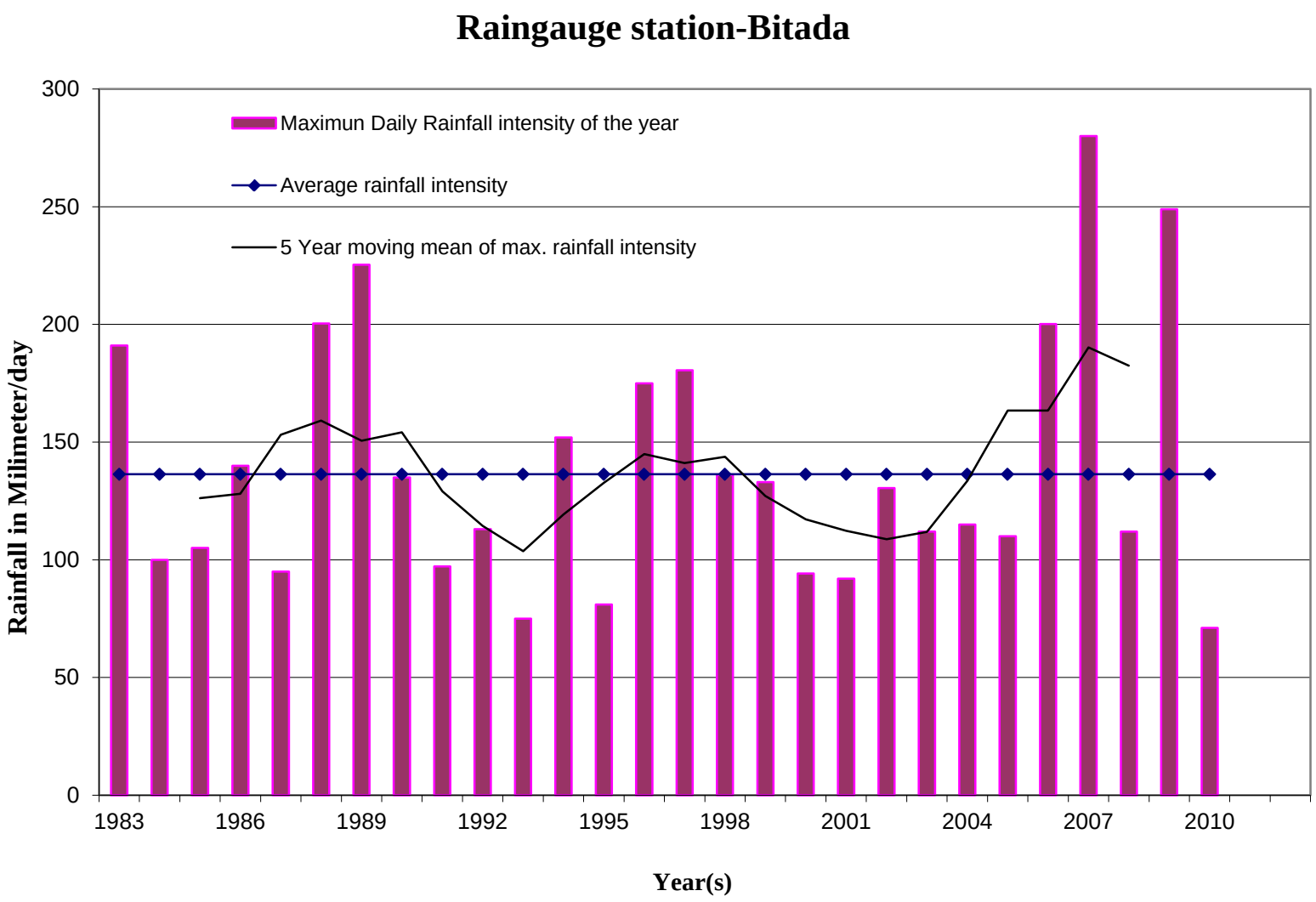
- Maximum Rainfall intensity (mm/day) of the year
- Mean temperature of the month
- Max/min. temperature of the year



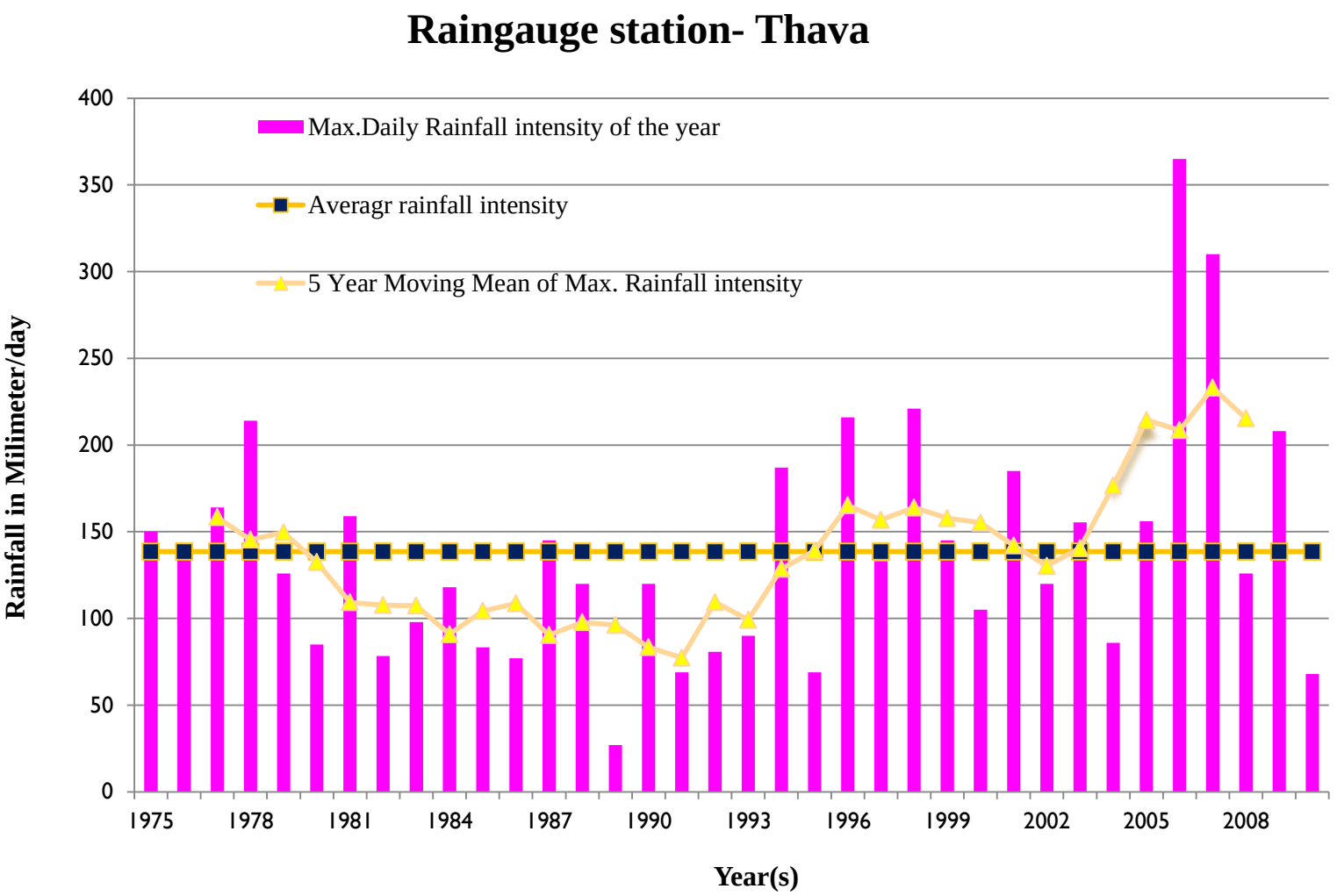
Maximum daily rainfall intensity of the year abruptly increases after year 2000 at raingauge station Dediapada of the Karajan basin



Maximum daily rainfall intensity of the year abruptly increases after year 2002 at raingauge station Junamosda of the basin



Maximum daily rainfall intensity of the year abruptly increases after year 2002 at rain gauge station Bitada



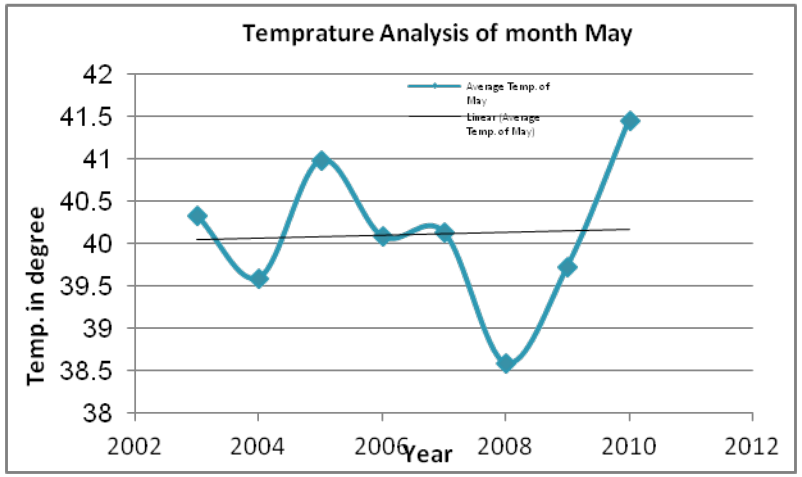
Maximum daily rainfall intensity of the year abruptly increases after year 2002 at raingauge station Thava of the basin

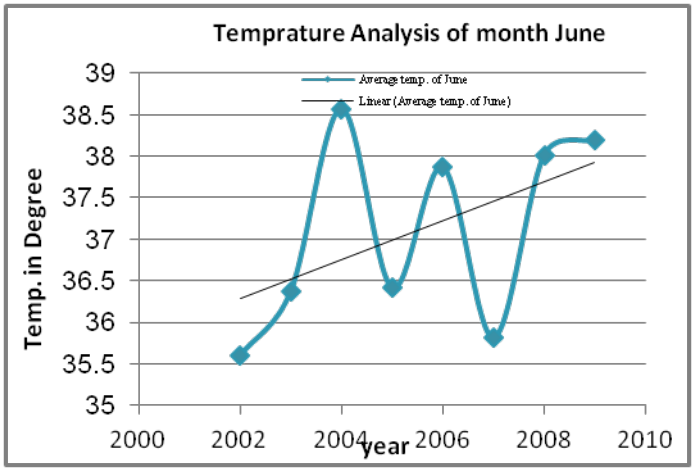
Assessment of Climate Change

- Climate change is a continuous process but it is analyzed in this study that there is a abrupt change in maximum daily rainfall intensity of the year from year 2000 onwards
- The time spell before year 2000 is referred in this study as Reference Scenario, while time spell after year 2000 has been referred in this study as a climate change scenario
- The impact of climate change after year 2000 is assessed on catchments hydrology & rainfall –runoff correlation.
- The rainfall –runoff correlation after year 2000 (Climate change scenario) have been compared with that of before year 2000 (Reference scenario).

Assessment of Climate Change

Mean monthly temperature of Summer and Winter Season





- Temperature data was available only after year 2000, the temperature analysis was carried out for Climate change scenario
- Mean monthly temperature are increasing in the month of June comparison to the month May
- Similarly mean monthly temperature reduces in the month of February in comparison to the month of December and January

Average depth of rainfall over a basin

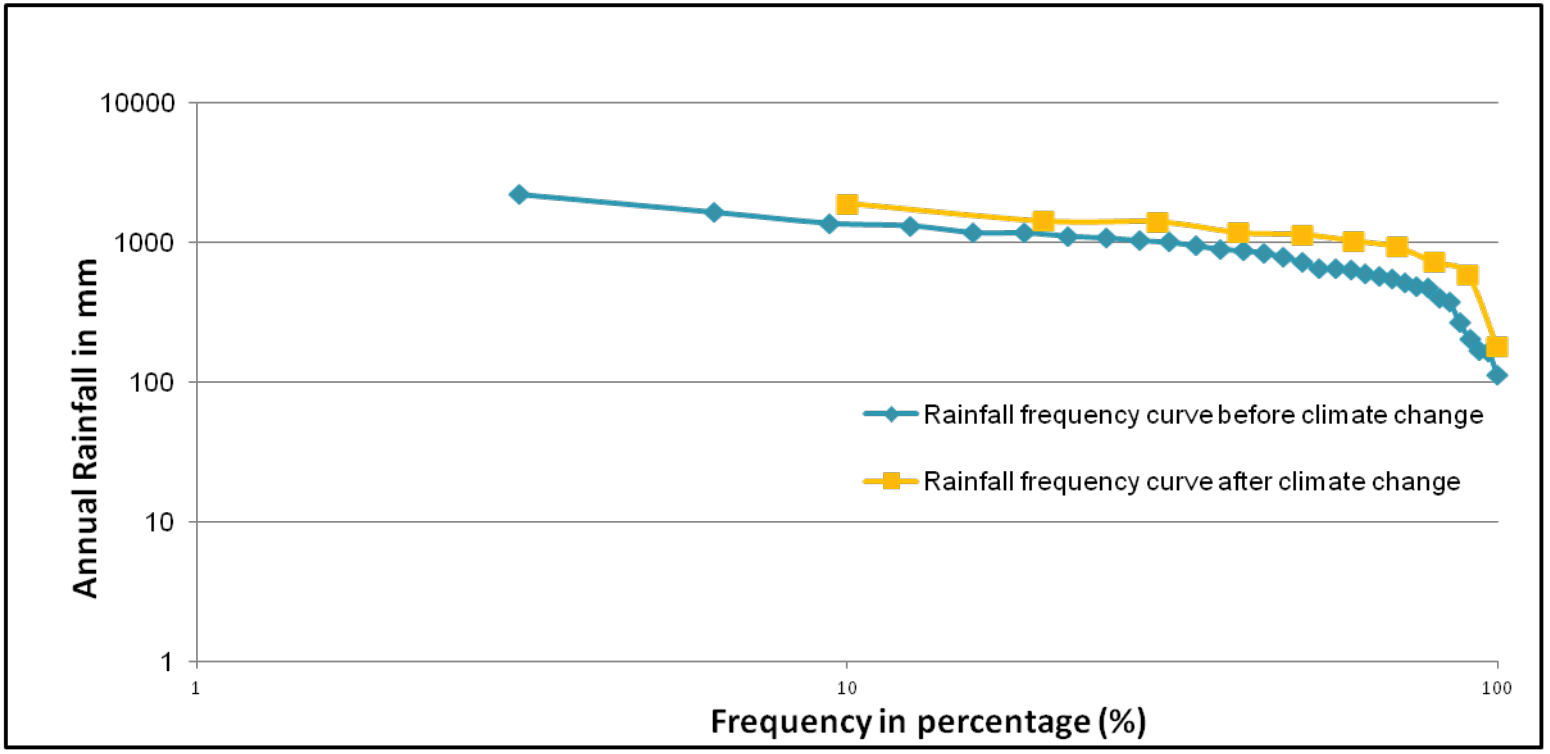
- To get Average depth of rainfall over a basin, Thession polygon method is used

- The rainfall value mentioned further in this study is the average value of rainfall over a drainage basin computed by Thession polygon method

Impact of Climate Change on Catchment Hydrology

- The impact of climate change have been assessed on rainfall and runoff pattern and magnitude
- The recurrence interval and frequency of a storm of Climate change scenario (after year 2000) have been compared with Reference scenario (i.e. before year 2000)

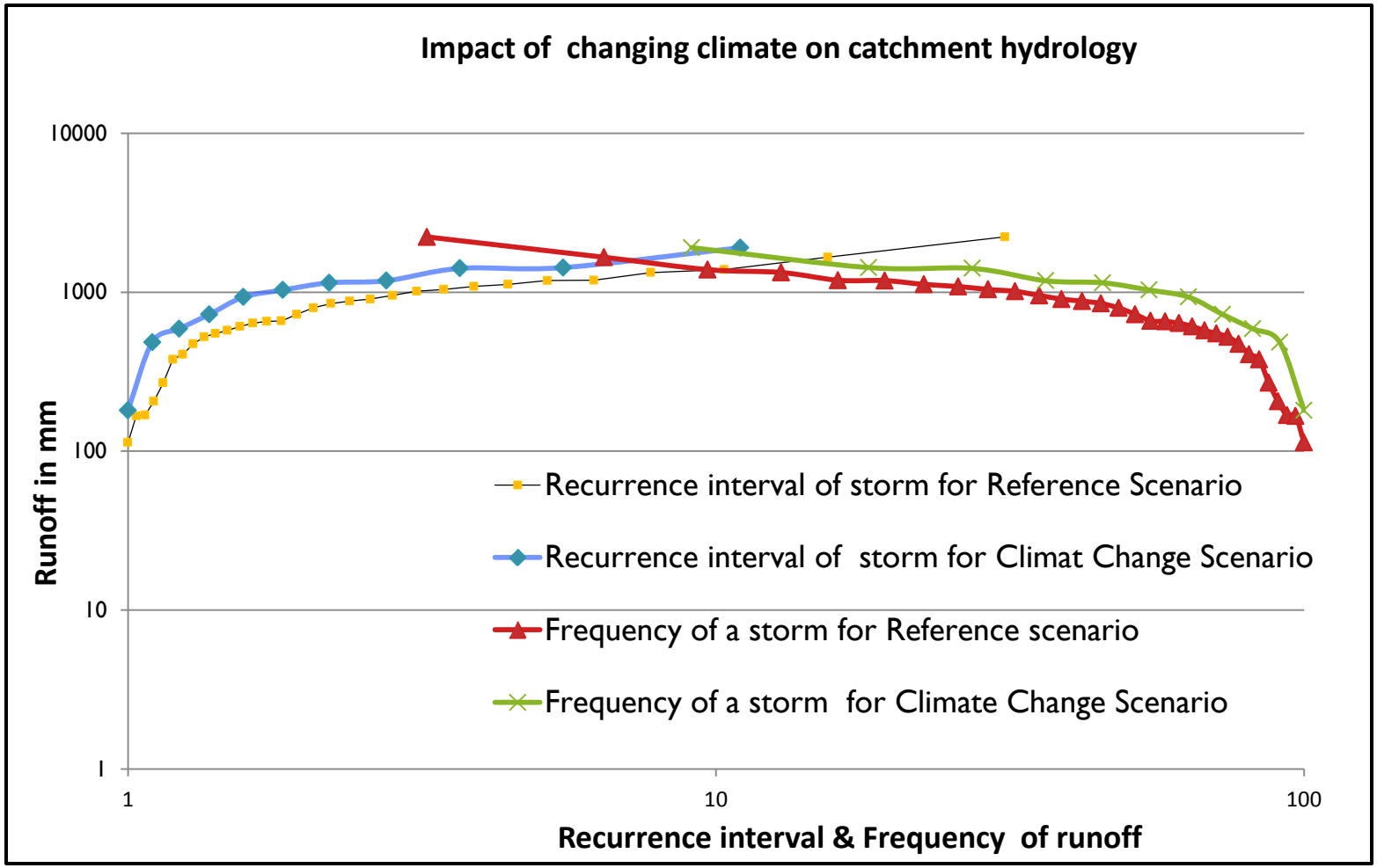
Impact of Climate Change on Catchment Hydrology



For the same magnitude of rainfall, the frequency of occurrence increases in a climate change scenario in comparison to reference scenario

Impact of changing climate on catchments hydrology

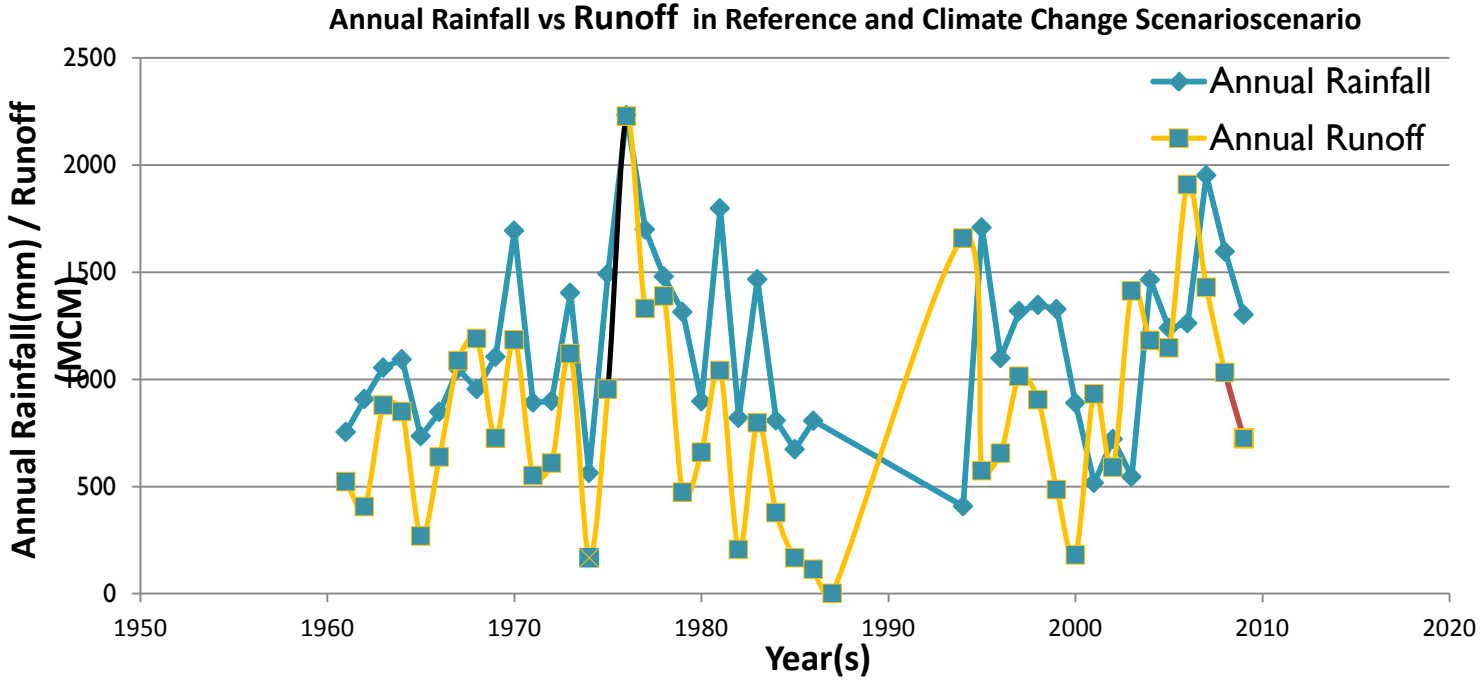
- Frequency analysis of the runoff in the river at Karajan dam site for reference scenario and climate change scenario



Recurrence interval and frequency analysis of Rainfall and Runoff

- Frequency of occurrence of given magnitude of annual runoff increases in climate change scenario in comparison to the reference scenario
- Also the recurrence interval of the given magnitude of the annual runoff reduces in climate change scenario in comparison to reference scenario

Comparison of Annual rainfall and runoff for reference and climate change scenario – Impact of Climate Change on Catchment Hydrology

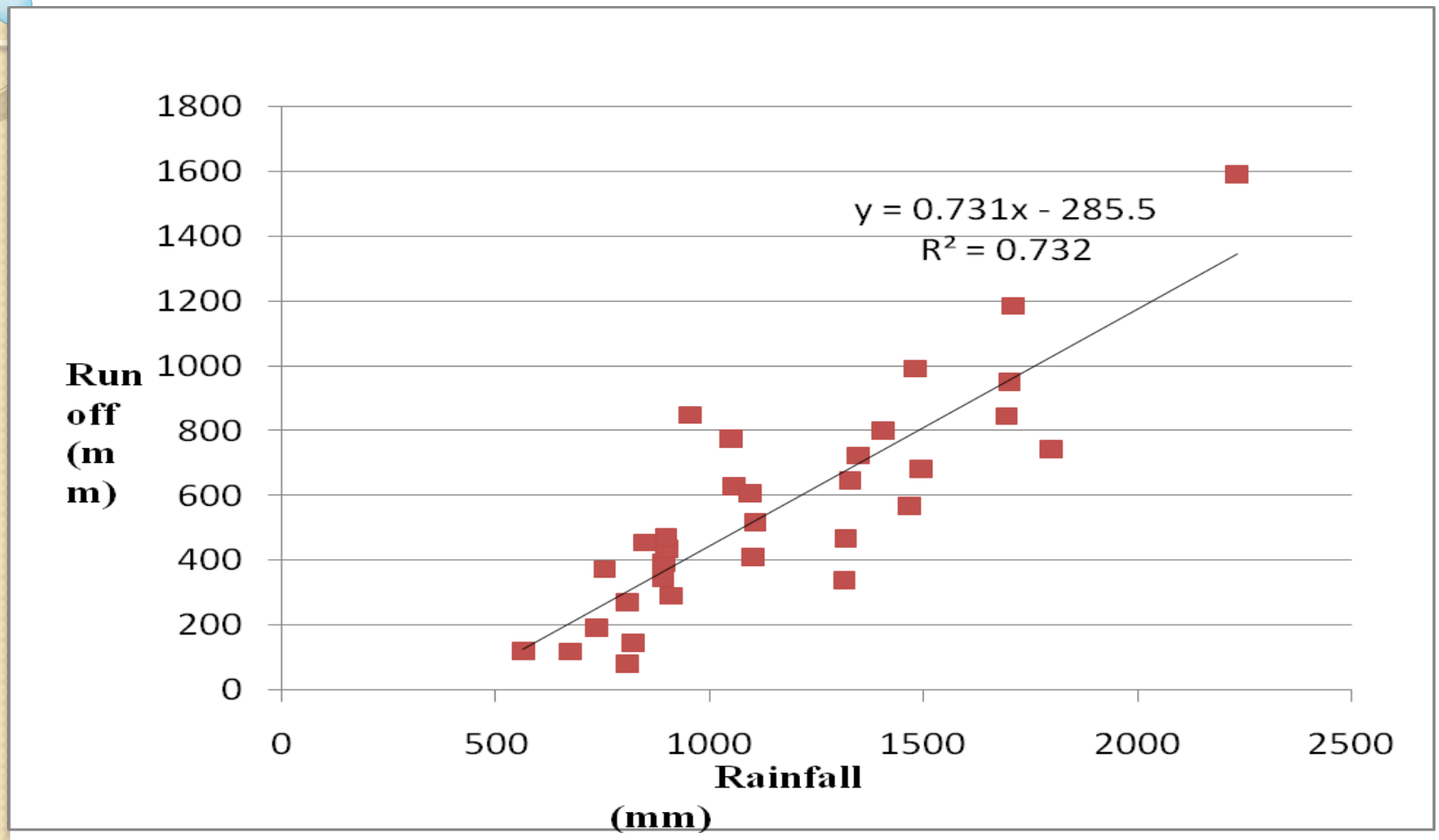


- Annual runoff in (MCM) is higher with the annual rainfall in climate change scenario in comparison to reference scenario

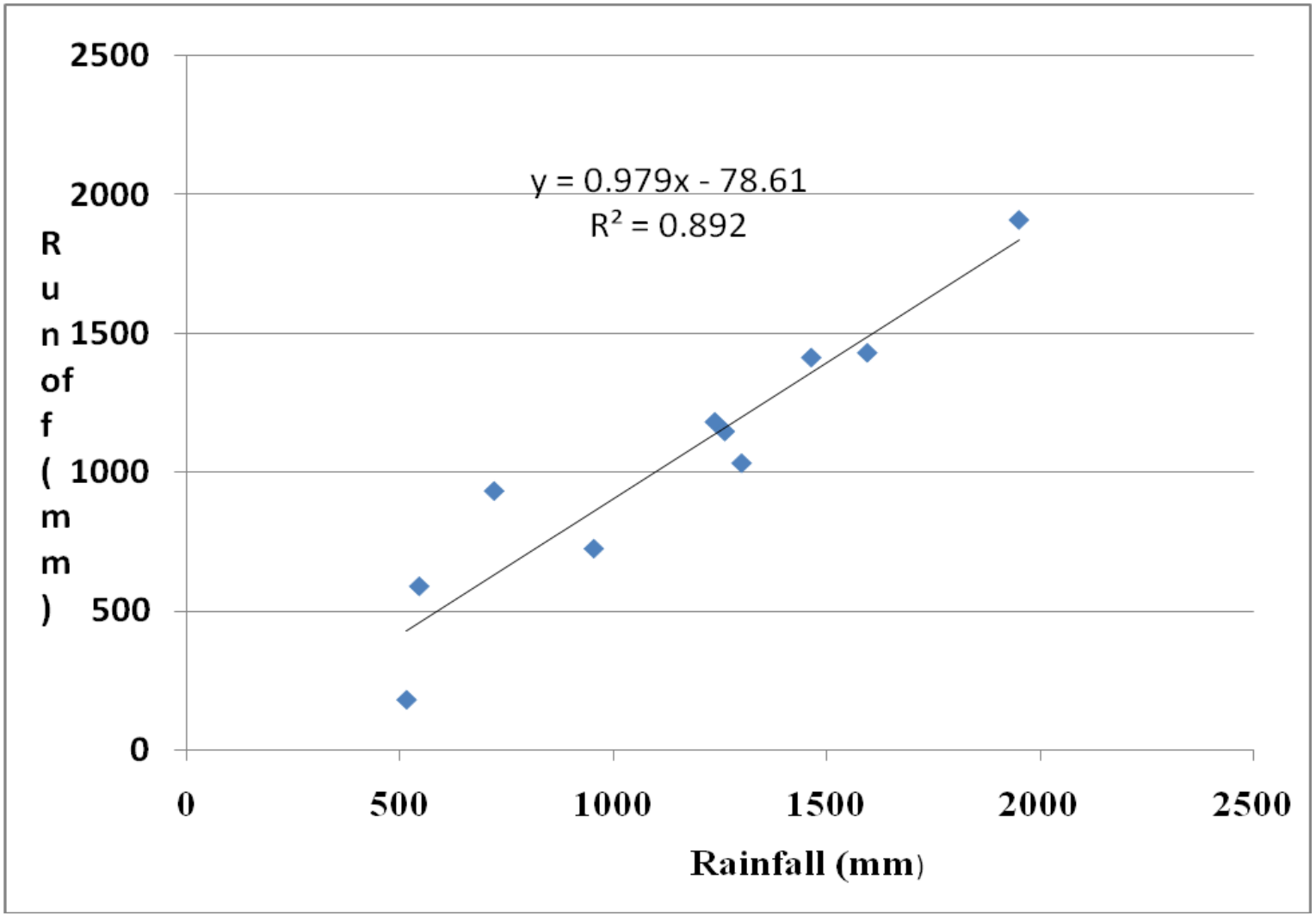
Impact of Climate change on Rainfall – Runoff correlations

a) Annual rainfall – runoff correlations
b) Monsoon rainfall – runoff correlations
c) Monthly rainfall – runoff correlations

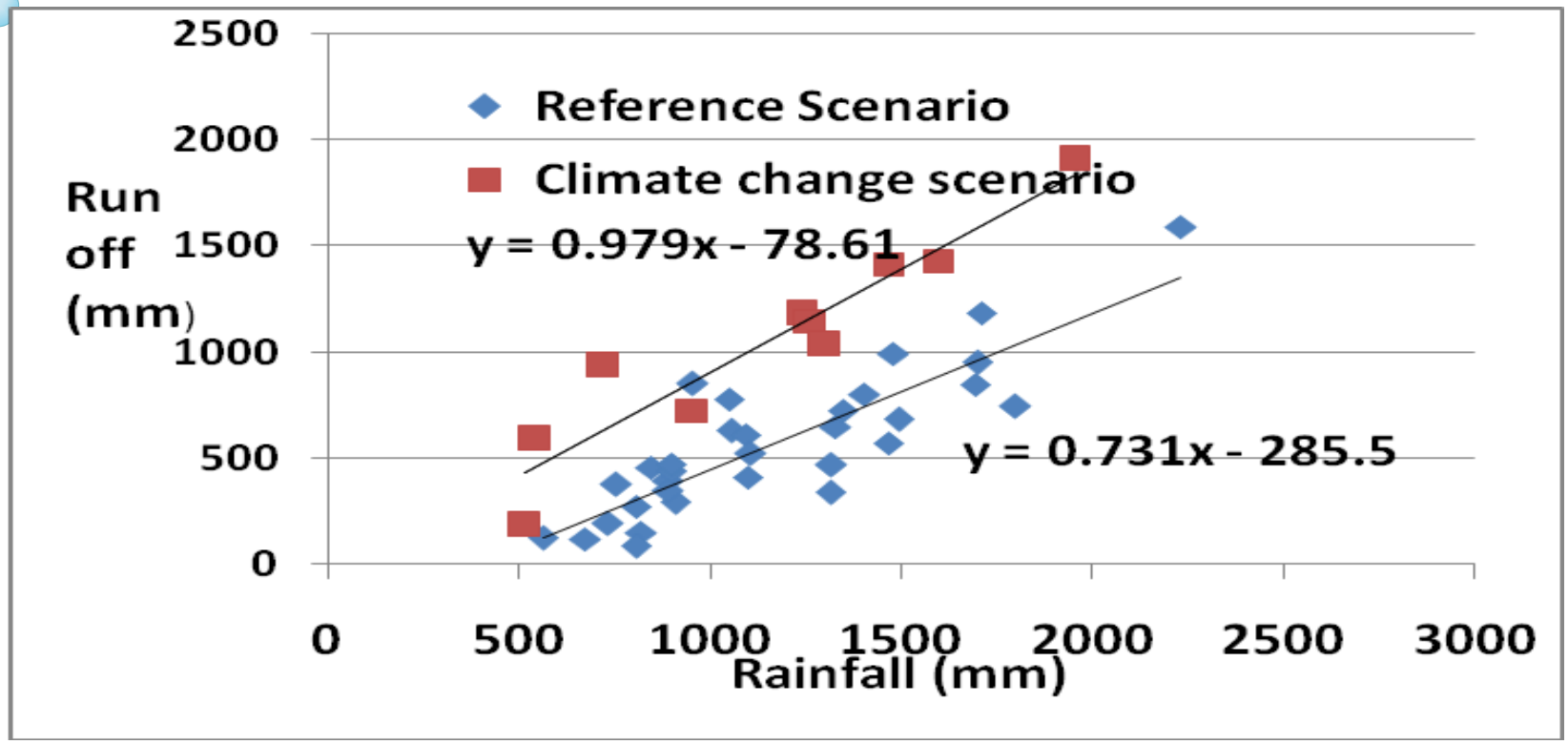
Annual rainfall – Runoff for Reference Scenario



Annual Rainfall-Runoff for Climate Change Scenario

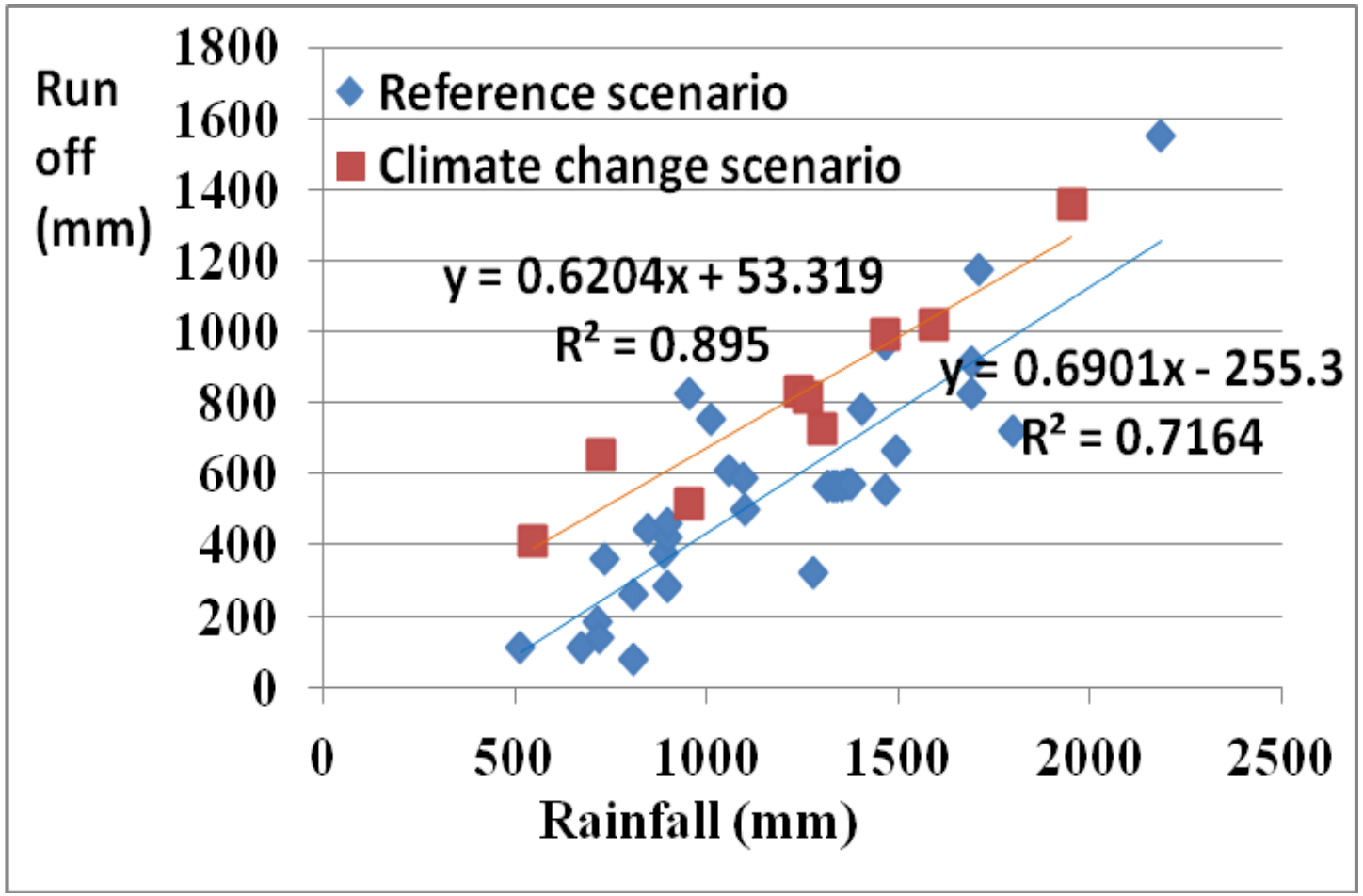


Annual Rainfall - Runoff correlations for Reference and Climate Change Scenario



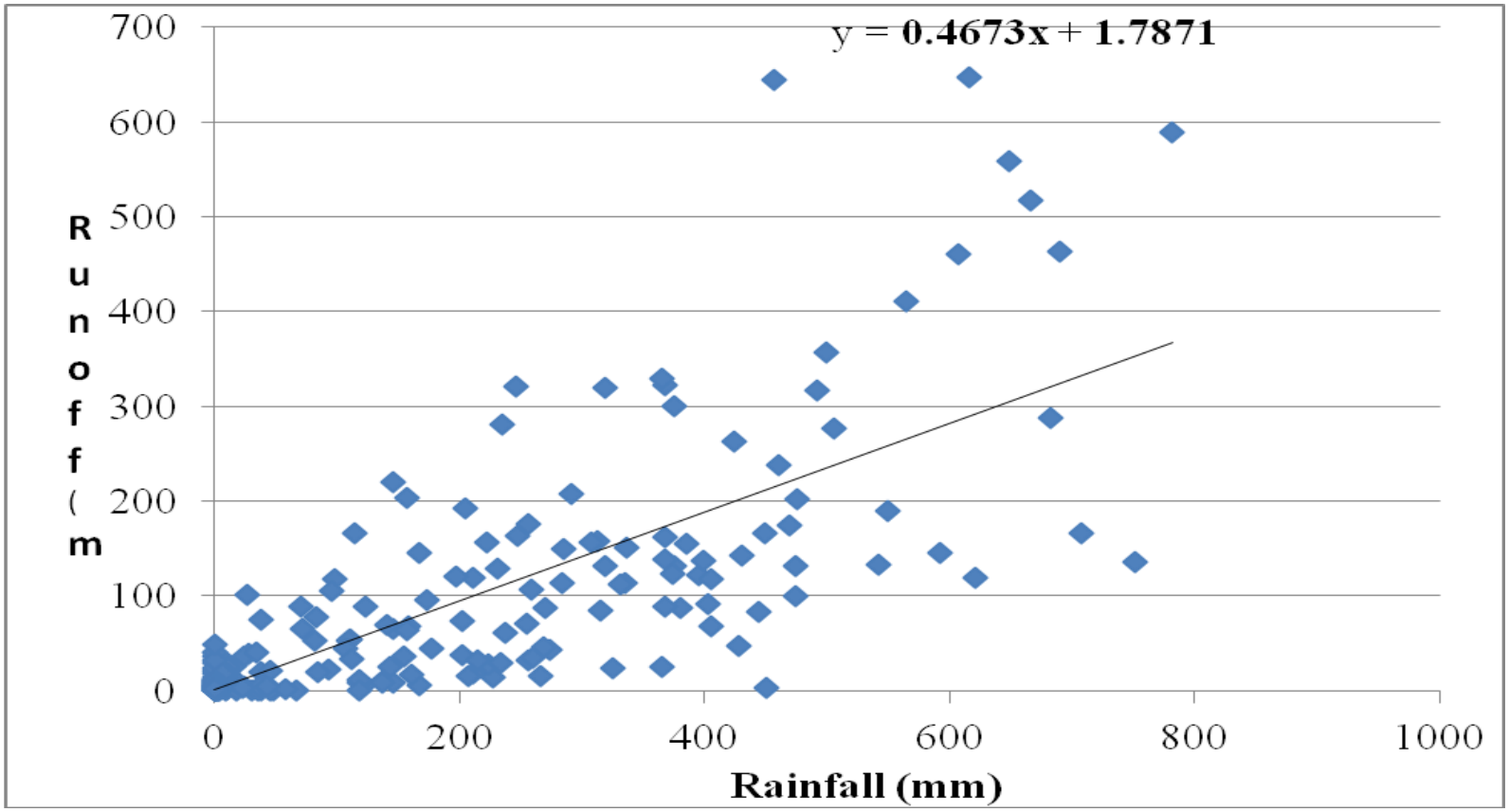
Comparing the annual rainfall runoff correlation of reference and climate change scenario, it is found that runoff potential increases in climate change scenario.

Monsoon rainfall – runoff correlations

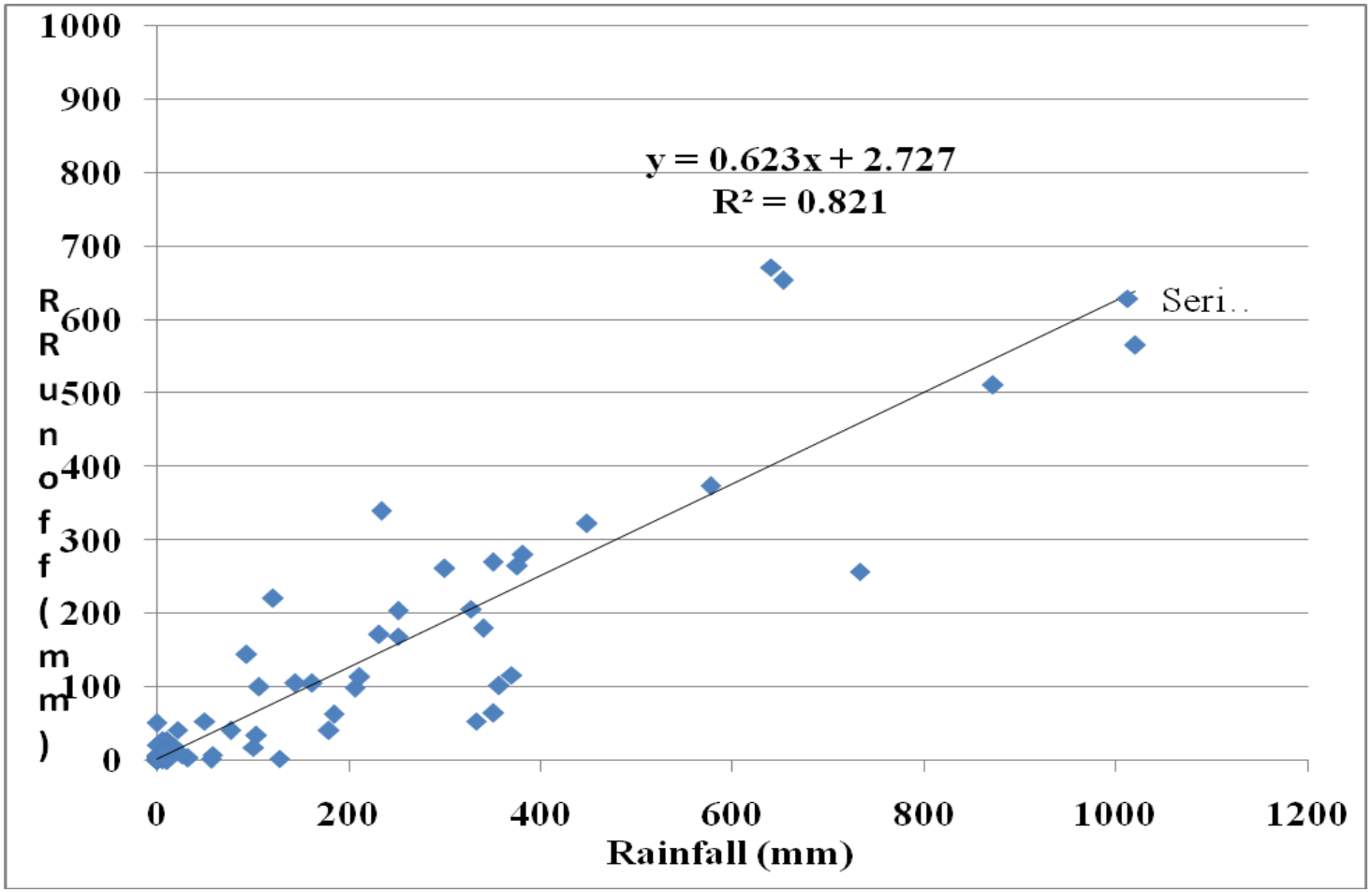


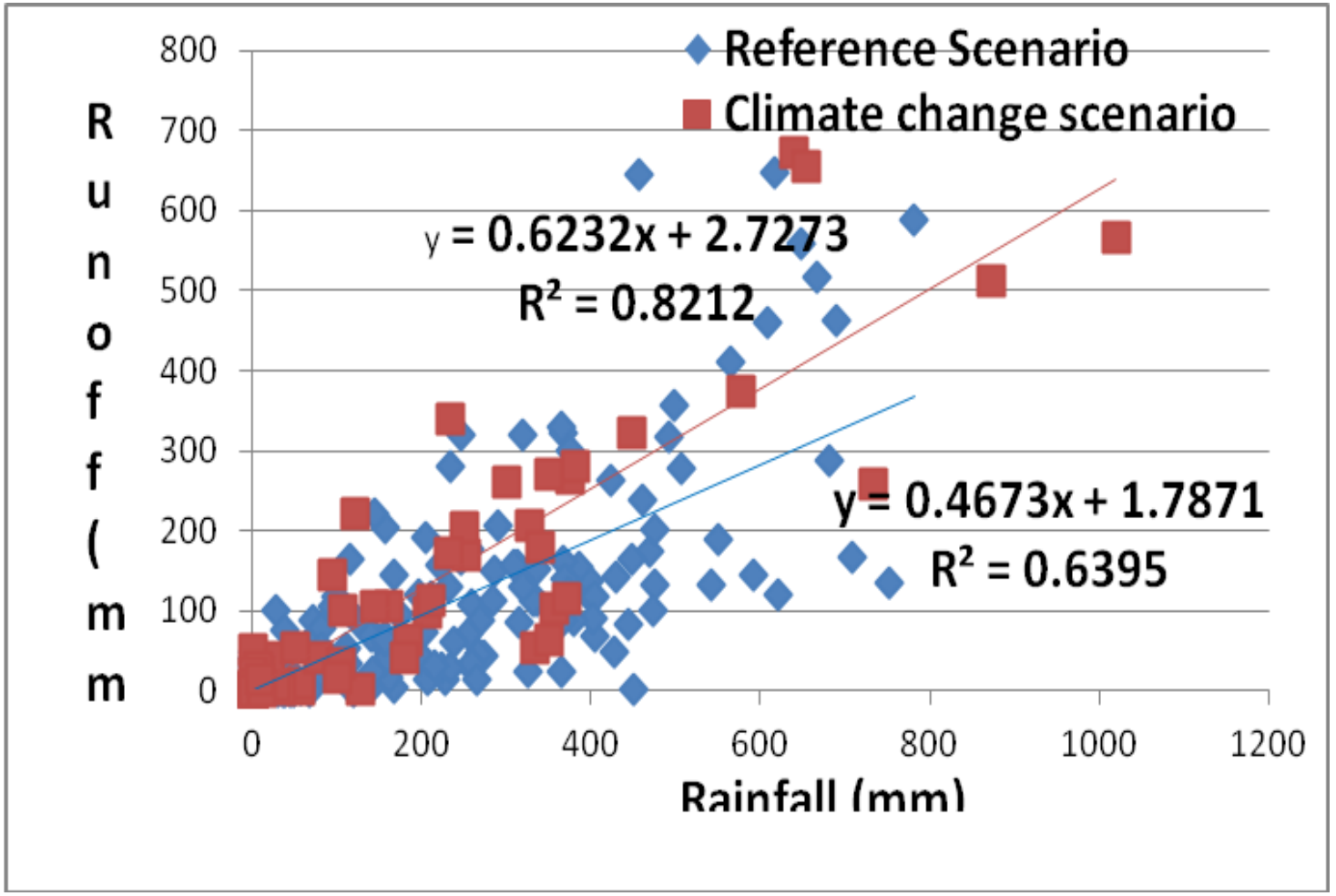
On Comparing the monsoon rainfall - runoff correlation of reference and climate change scenario, it is found that runoff potential increases in climate change scenario

Monthly Rainfall – Runoff Correlations for Reference Scenario



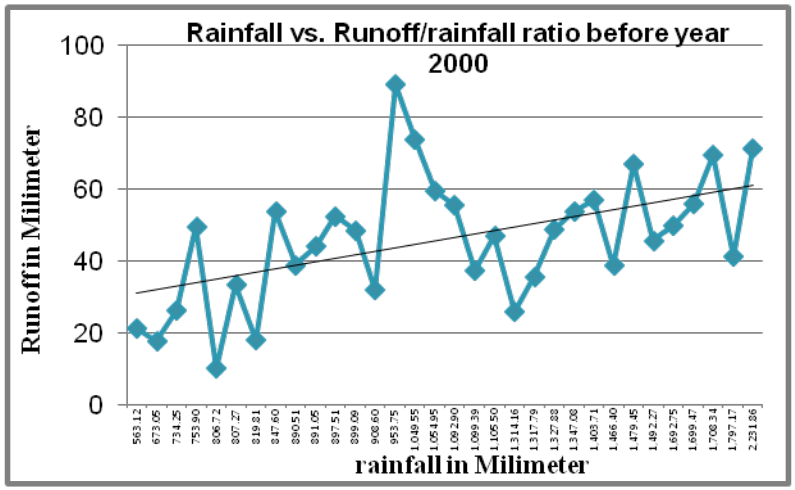
Monthly Rainfall-Runoff correlations for Climate Change Scenario

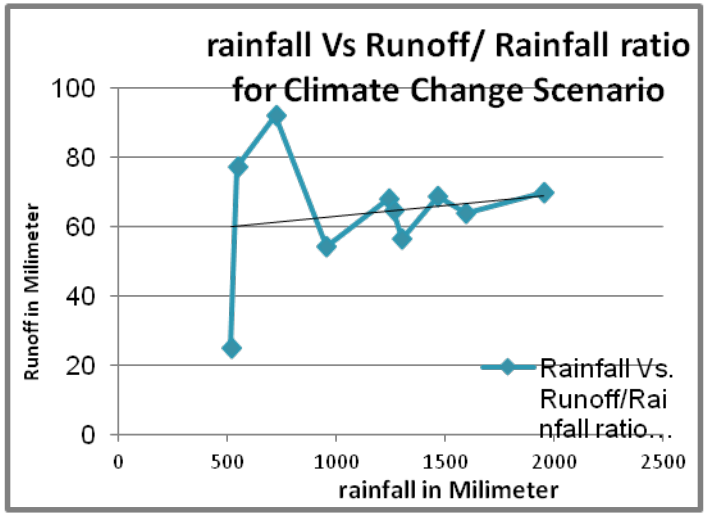




On Comparing the monthly rainfall - runoff correlation of reference and climate change scenario, it is found that runoff potential increases in climate change scenario

Binnies diagram for reference and climate change scenario





Runoff potential increasing with rainfall in climate change scenario in comparison to reference scenario

Analysis and Conclusions

- It is analyzed that the climate in the region i.e. in the catchment of Karajan Reservoir project has significantly changed after year 2000
- The impact of climate change on catchment hydrology indicates that frequency of high rainfall increases also, the frequency of higher runoff increases
- The annual rainfall-runoff, monsoon rainfall-runoff and monthly rainfall-runoff could be established satisfactorily with correlation coefficient reasonably good

Analysis and Conclusions

- It is concluded from the annual, monsoon season and monthly rainfall-runoff correlations the impact of climate change (after year 2000) in the basin has increased the runoff potential of the basin
- The result will prove beneficial to the Karajan Project authorities for the better management of the Water Resources in the basin and to decide sustainable reservoir operating policy for both monsoon and summer season

Analysis and Conclusions

- The increased volume runoff can be planned for supplying the urban water demand of the cities
- The surplus water can be planned to divert for hydropower generation through canal bed power house
- Results of this study will be useful towards preventing the cities against climate change impacts

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Thank you