International Conference on Soil and Water Assessment Tool (SWAT)
10th-12th Jan. 2018
IIT Madras, Chennai, India.

Extreme event analysis of Krishna river basin under future scenarios

भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Ch.Tirupathi, T. Shashidhar
Research Scholar, Associate Professor
Department of Civil Engineering, IIT- Hyderabad, India.
ce16resch01002@iith.ac.in

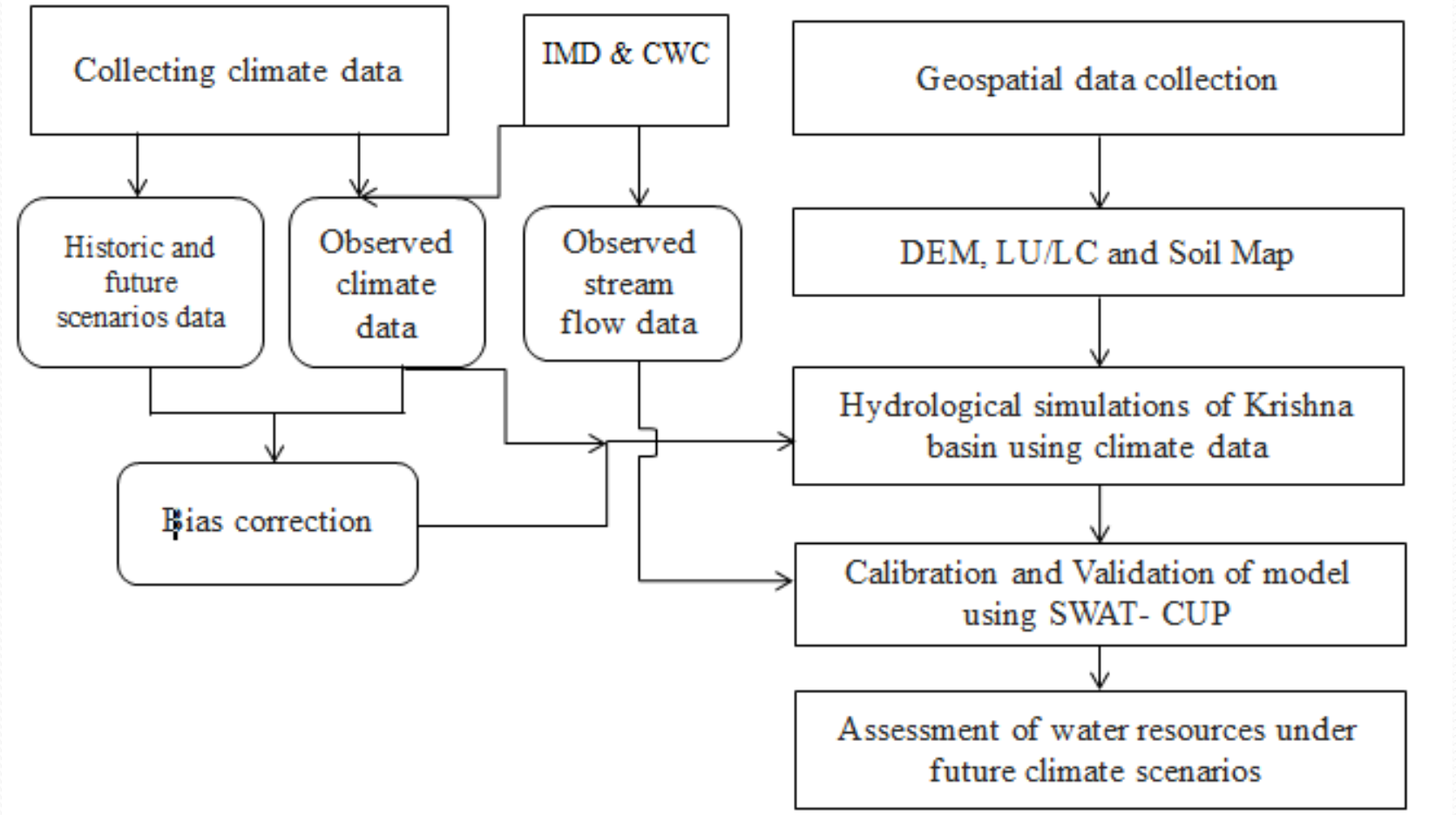
Problem statement

- Economy of the country mainly depends on vagaries of the weather especially on extreme weather events.
- The extreme events such as floods, drought, cyclone and heat waves have huge impact on India.
- According to the International Disaster Data Base “there have been 268 reported flooding events in India over 1950-2015 affecting about 825 million people, leaving 17 million homeless and killing 69,000 people”.
- IMD recorded 2016 as the hottest year since 1901.
- According IMD report 1600 people died due to extreme heat wave conditions whereas 475 lives were lost in floods and around 330 million people are affected by drought in India by the year 2016.
- Understanding the climate variability and its influence on the occurrence of extreme events such as floods and drought under future scenarios

Objective

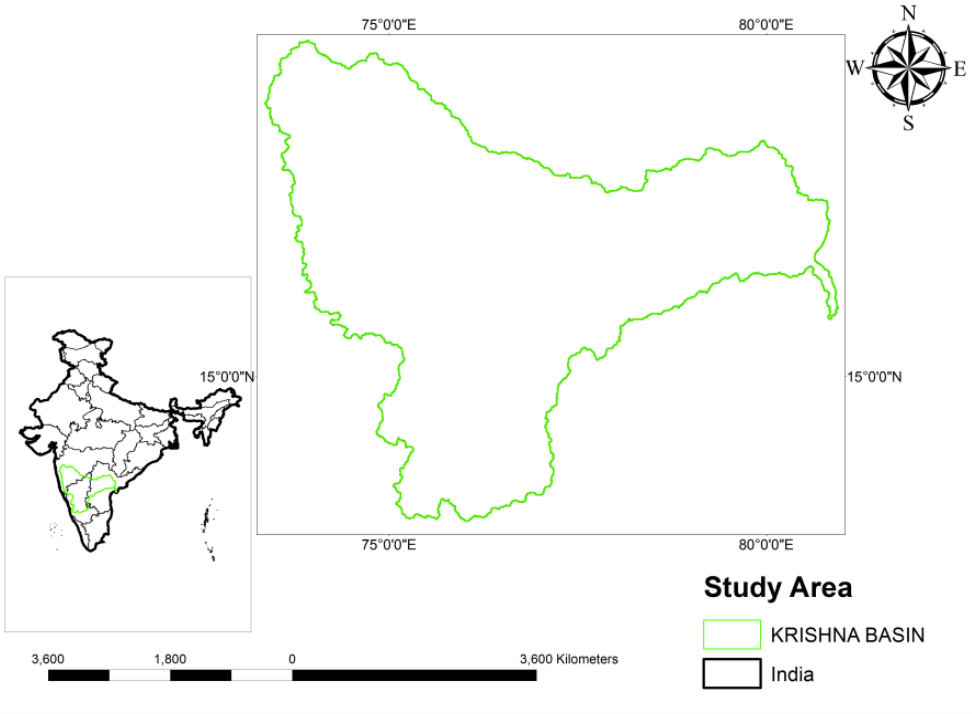
"Seasonal prediction of Indian summer monsoon rainfall along with predictions of extreme rainfall events"

Methodology



Study Area

- The annual average rainfall is about 784 mm
- Maximum and minimum temperatures of basin varies from 27.7°C to 40.4°C and 20.6°C to 27.2°C.
- Source: India-wris.nrsc.gov.in

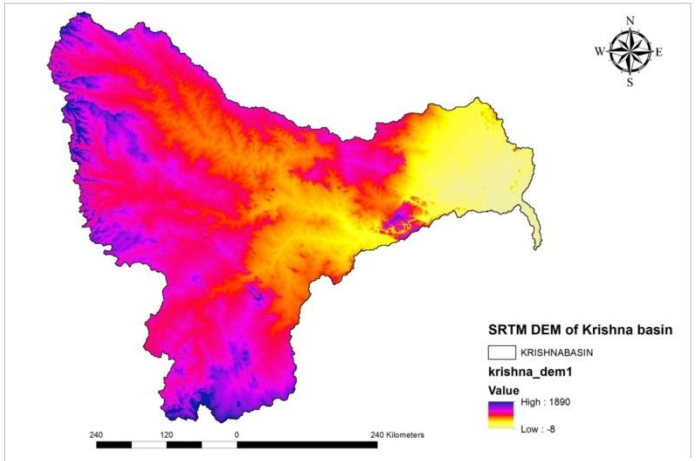


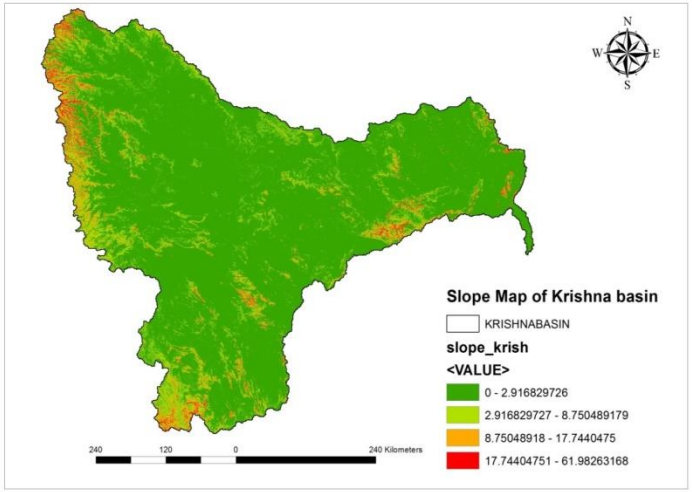
- It lies between 73°17'E to 81°9'E and 13°10' N to 19°22' N

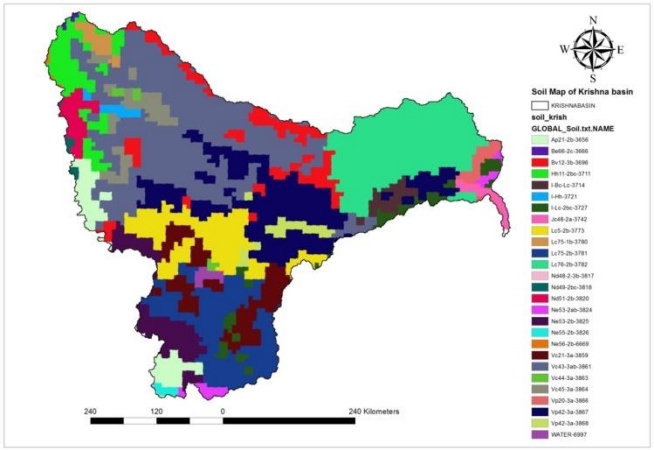
Krishna basin, India.

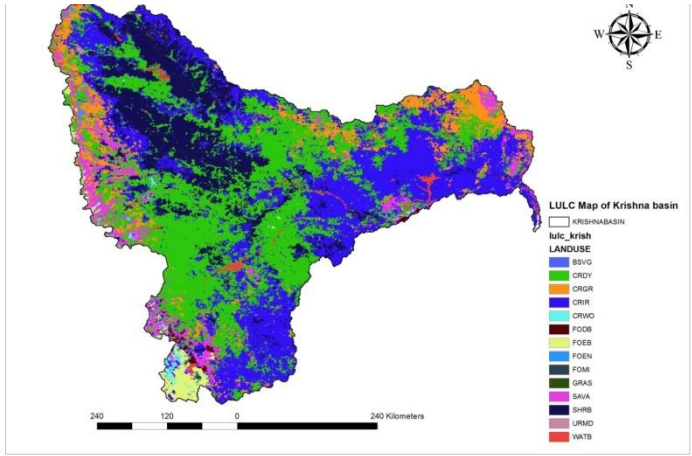
Data collection

Geospatial data









Sources: srtm.csi.cgiar.org and www.waterbase.org

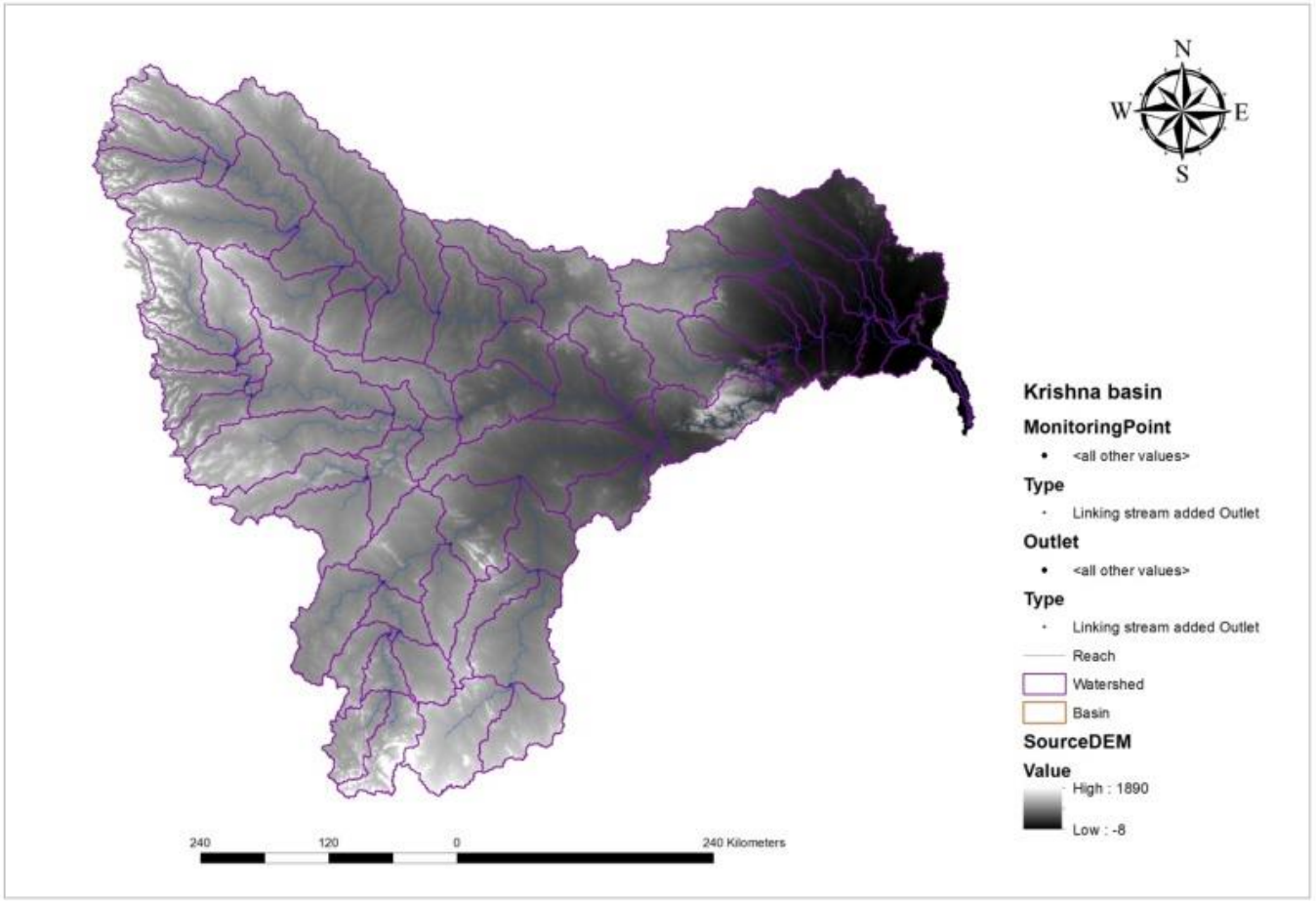
Climate Model Data

- The **observed climate data** i.e., rainfall (0.25°×0.25°) was obtained from Indian Meteorological Department (IMD), Pune, India, and temperature (0.25°×0.25°) were obtained from NCEP Climate Forecast System Reanalysis (CFSR).

Climate model data –RCM available with grid cell size 0.5°×0.5°.

- **Driving GCM model:** CSIRO-QCCCE-CSIRO-Mk3-6-0, NOAA-GFDL-GFDL-ESM2M, ICHEC-EC-EARTH, MPI-M-MPI-ESM-LR, IPSL-IPSL-CM5A-MR, MIROC-MIROC5, CNRM-CERFACS-CNRM-CM5 and NCC-NorESM1-M.
- Source: esg-dn1.nsc.liu.se (CORDEX)

Hydrological modeling of Krishna basin



Calibration and Validation of Krishna basin using SWAT- CUP

- SUFI-2 is used calibration and validation of the Model.
- From the available stream flow data model was calibrated for a period of 23 years (1984-2004) and validated for a period of 9 years (2006 – 2013) for the gauge stations of Wadenapalli and Matralayam.
- At the gauge station of Malkhed the calibration and validation periods were from 1990 – 2007, 1995-2007 and 2008 – 2013 respectively
- **Source:** Central Water Commission (CWC), Hyderabad

Table 1: Objective functions and their corresponding values

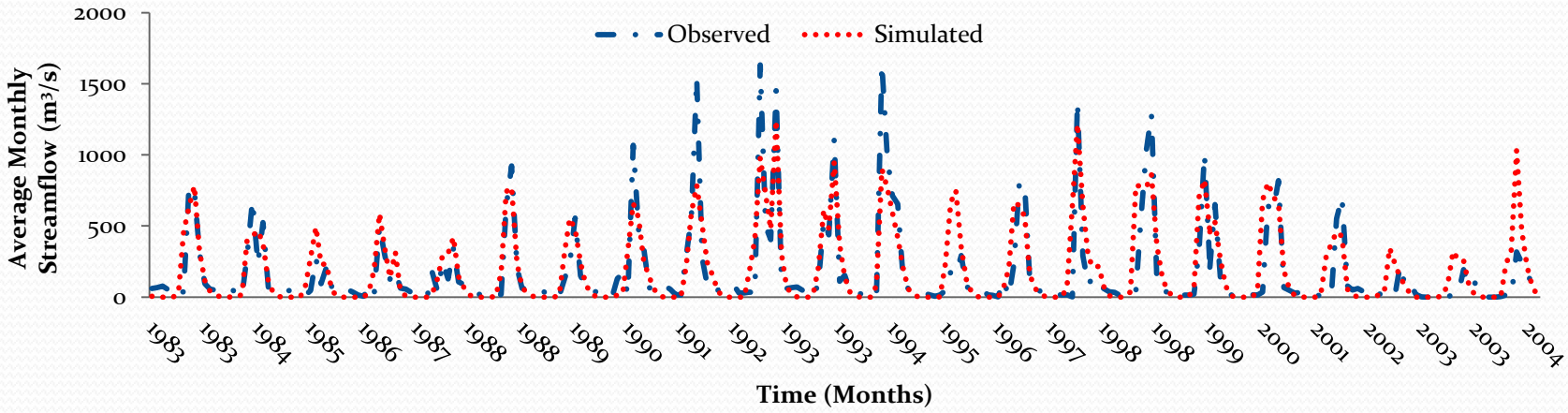
Gauge station	Calibration		Validation	
	R^2	NSE	R^2	NSE
Mantralayam	0.65	0.57	0.7	0.6
Malkhed	0.68	0.65	0.64	0.56
Wadenapalli	0.62	0.57	0.7	0.47

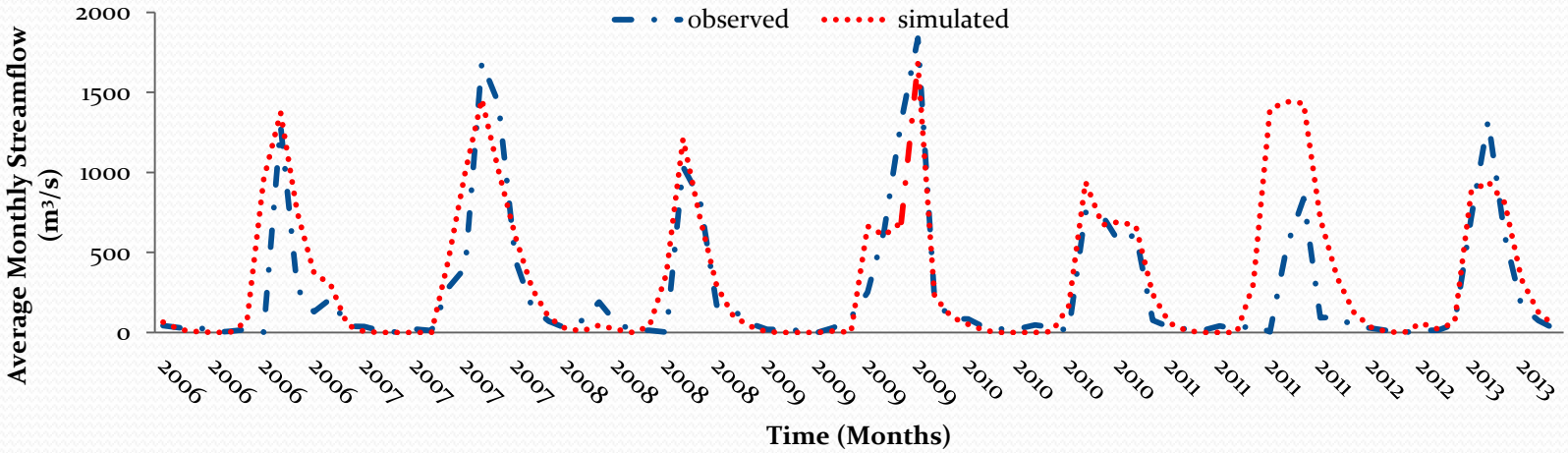
Table 2: Initial and final values of optimized parameters

Parameter	Unit	State	LULC									
			CRDY	CRIR	CRGR	SHRB	SAVA	WATB	FOEB	FOEN	FODB	CRWO
CN2		Initial	84	83.5	83.2	79.3	79.3	92	70	74.	79	82
		Final	76.5	76	75.5	73.5	73.6	92	63.5	67	72	74
GWREVAP		Initial	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		Final	.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179
SOLAWC	mm	Initial	125.5	126.52	125.5	124.4	121.8	128.6	120	117.81	117	117
		Final	118	119	118.3	117.3	114.5	121	113	111	110	110
ESCO		Initial	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
		Final	.0.31	.0.31	.0.31	.0.31	..0.31	.0.31	.0.31	. 0.31	.0.31	.0.31
GWQMN	mm	initial	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
		Final	994	994	994	994	994	994	994	994	994	994

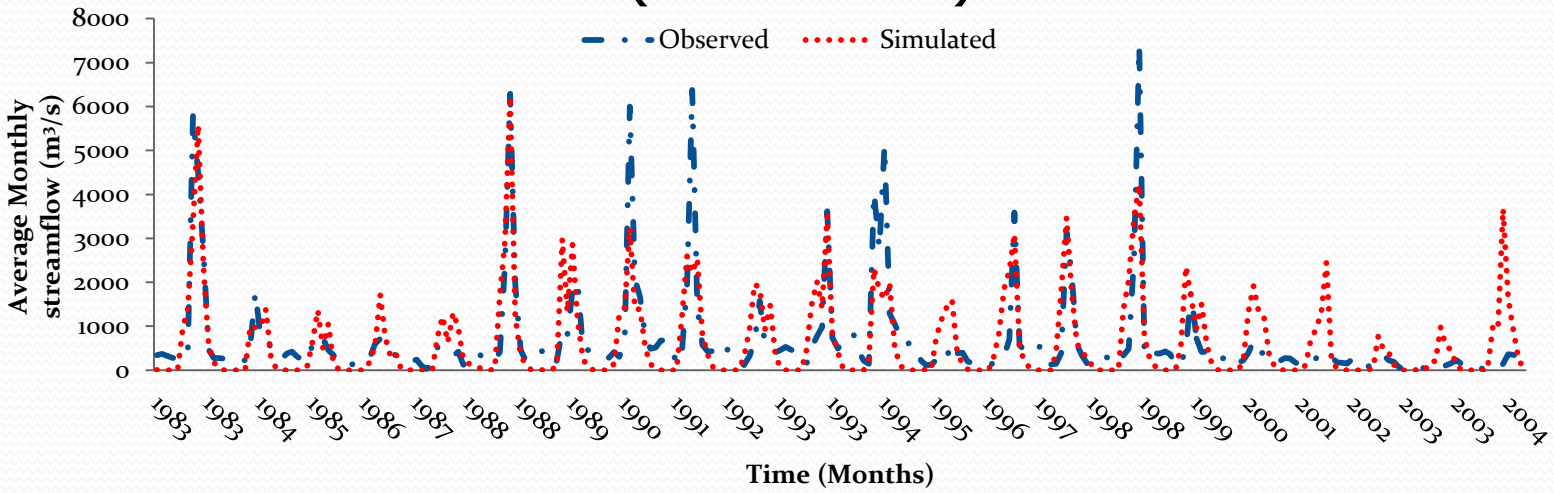
Note: CN2: SCS Curve Number II; GW_REVAP: Ground water “revap” coefficient; SOL_AWC: Available water capacity of the soil layer; ESCO: Soil Evaporation Compensation Factor; GWQMN: Threshold depth of water in the shallow aquifer required for return flow to occur.

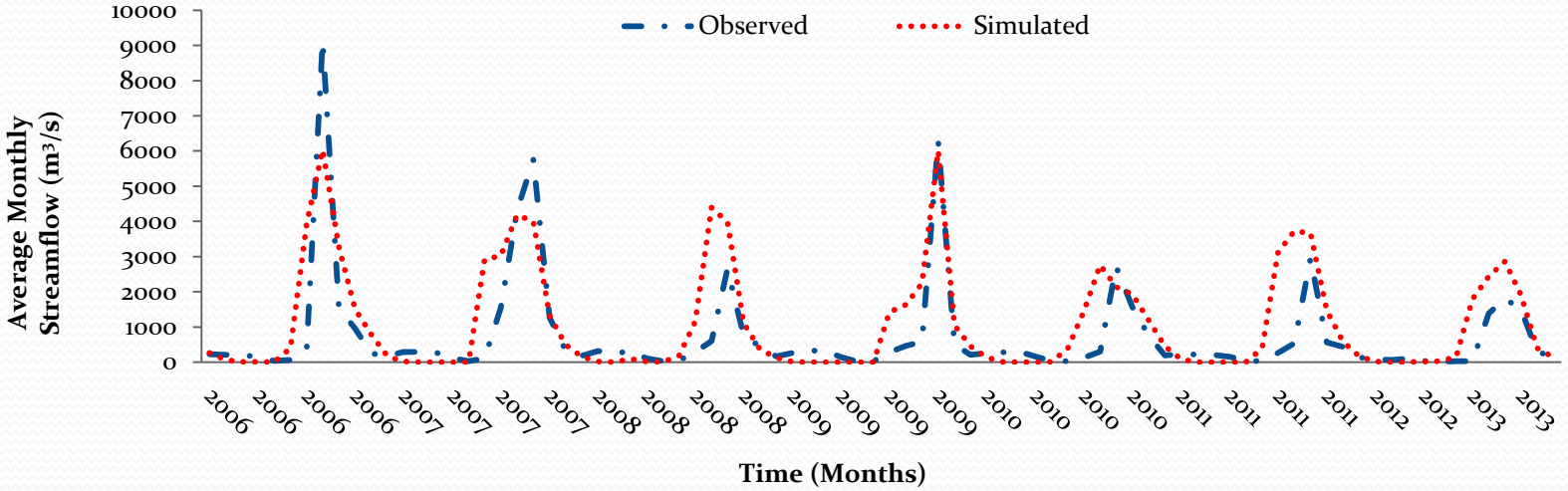
Mantralayam sub-basin Calibration (1983-2004) and validation (2006-2013)



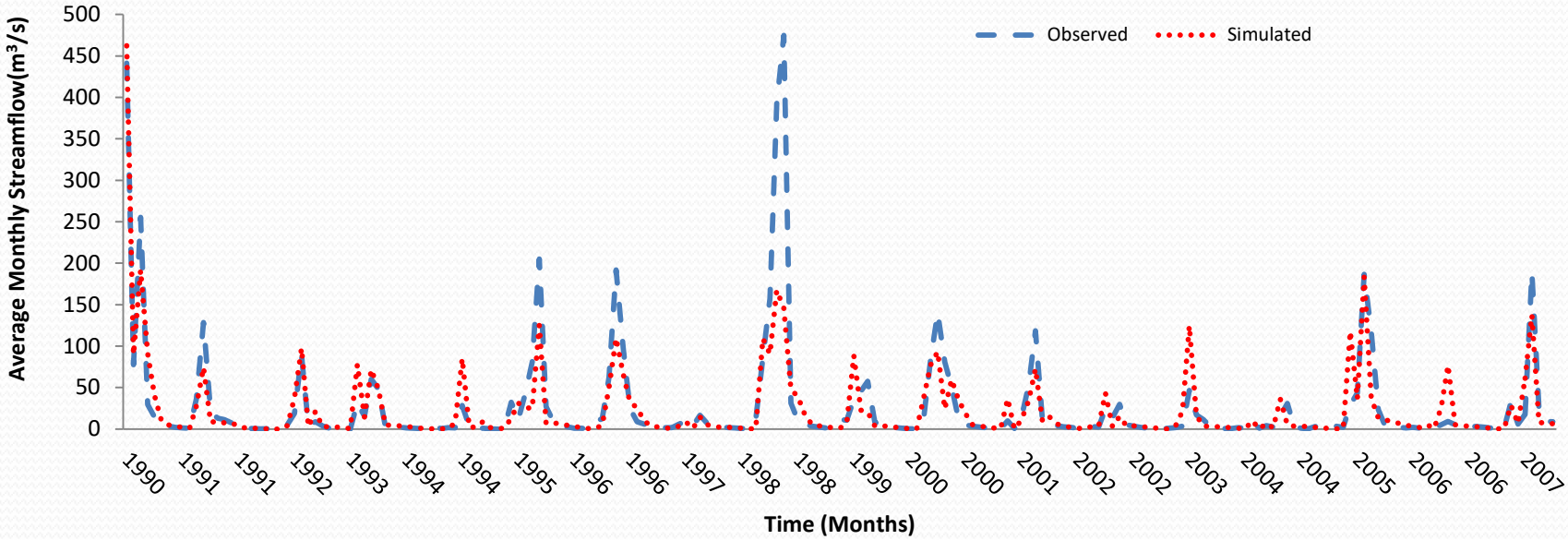


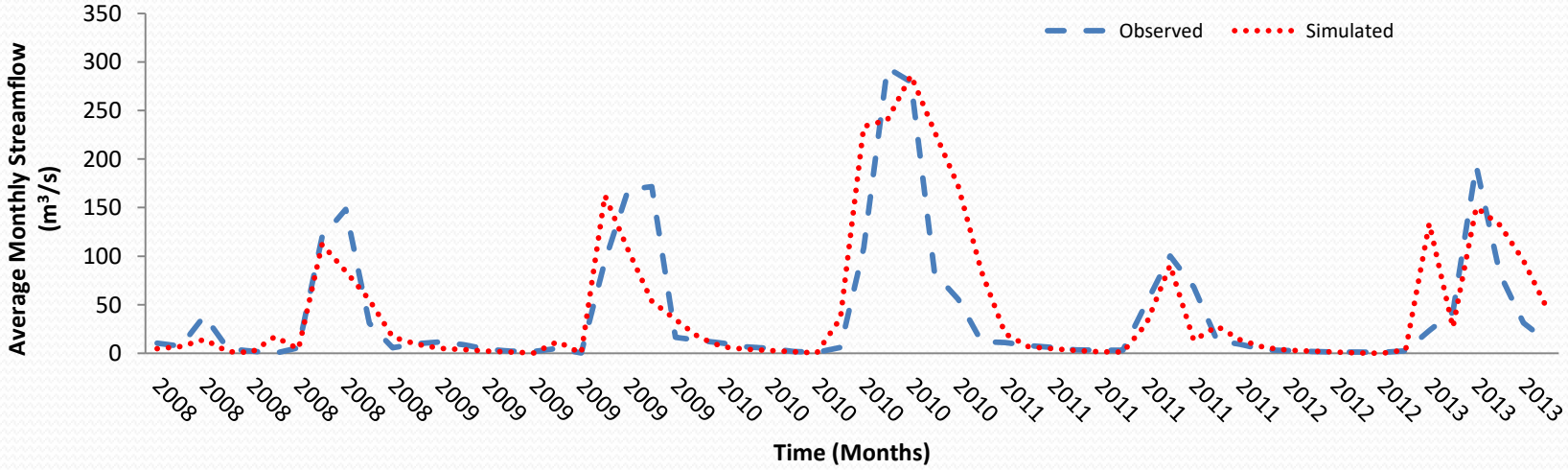
Wadenapalli sub-basin Calibration (1990-2007) and validation (2008-2013)



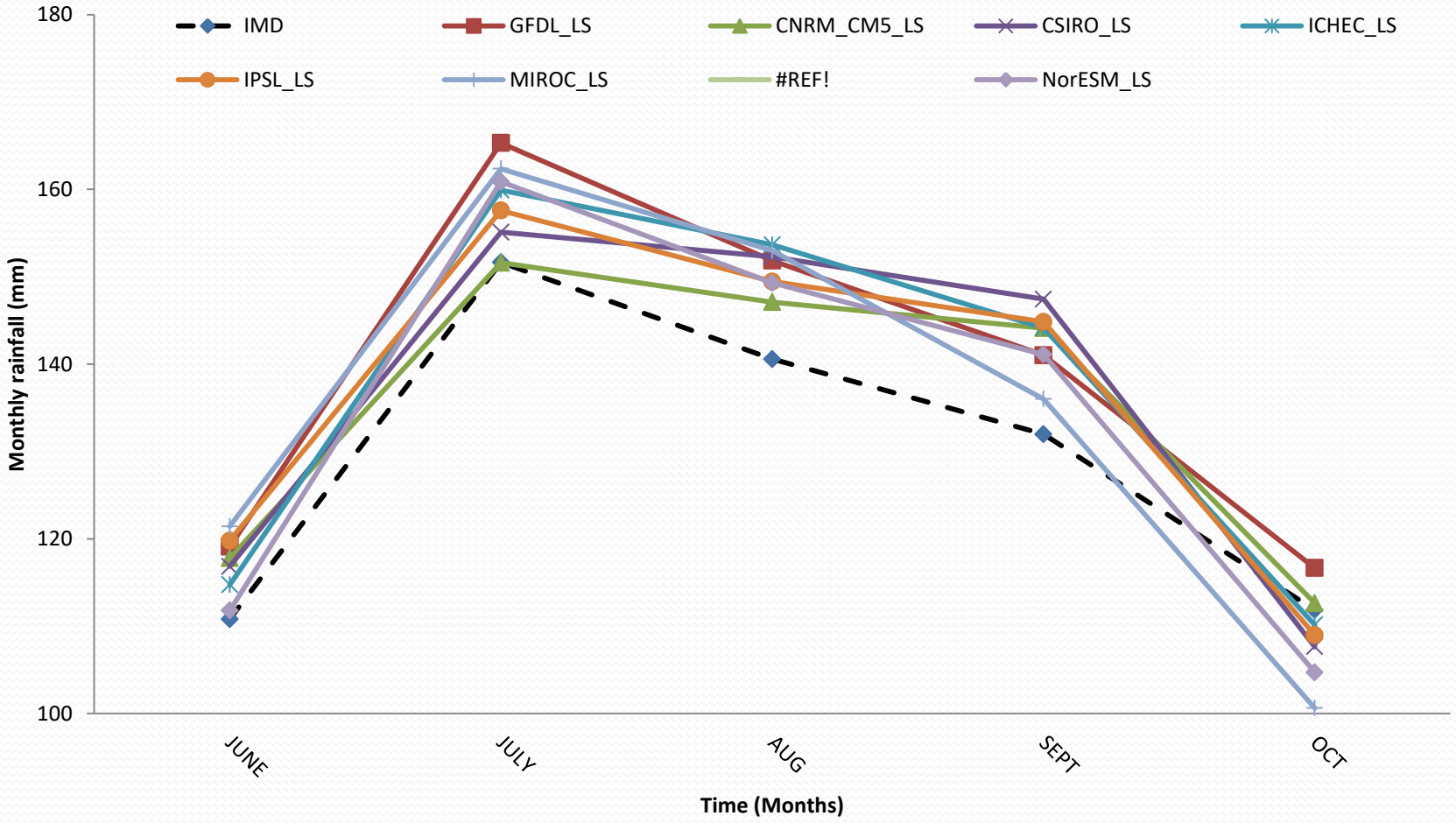


Malkhed sub-basin Calibration (1990-2007) and validation (2008-2013)

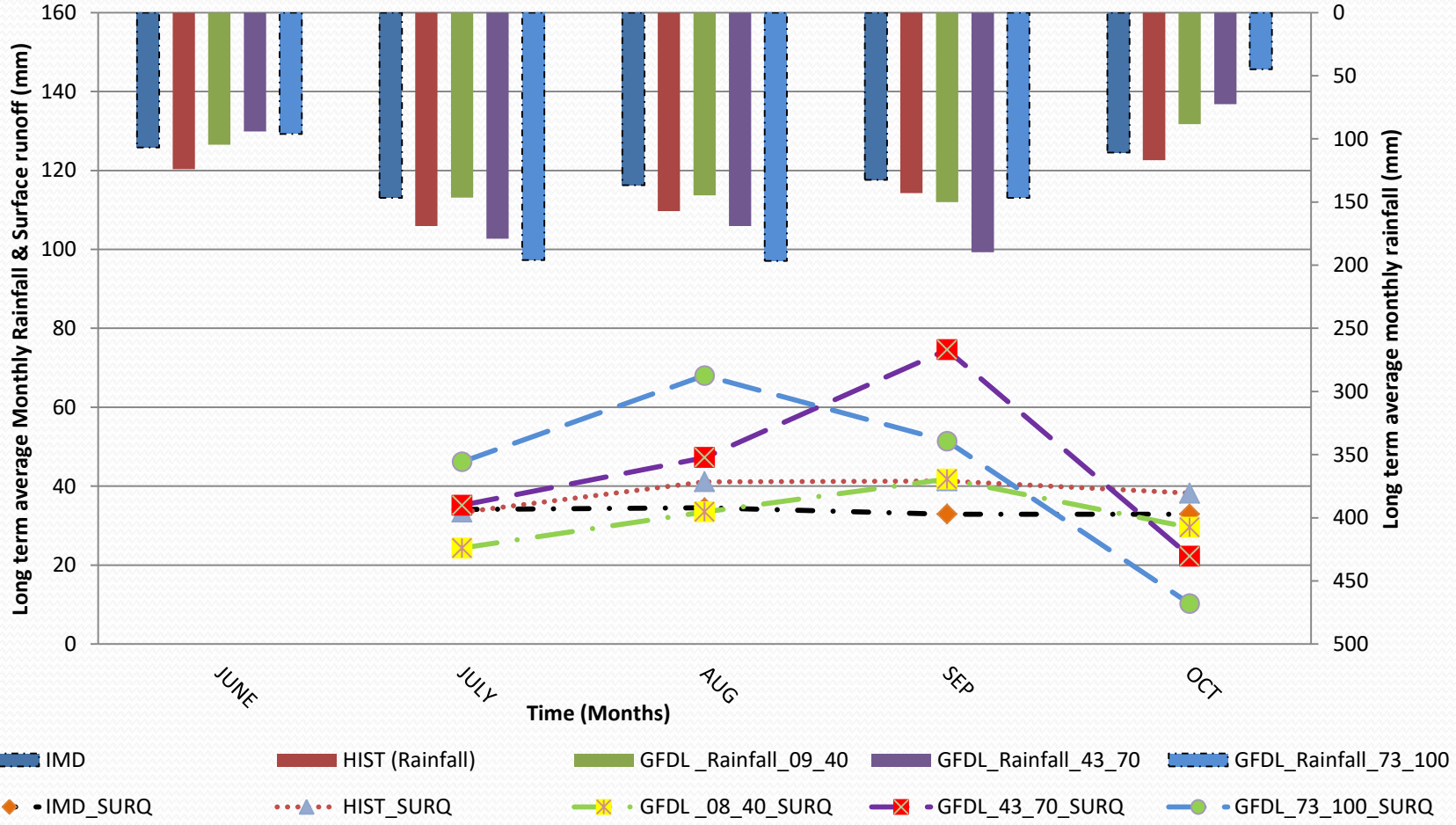




Monthly variation of rainfall (IMD vs HIST)



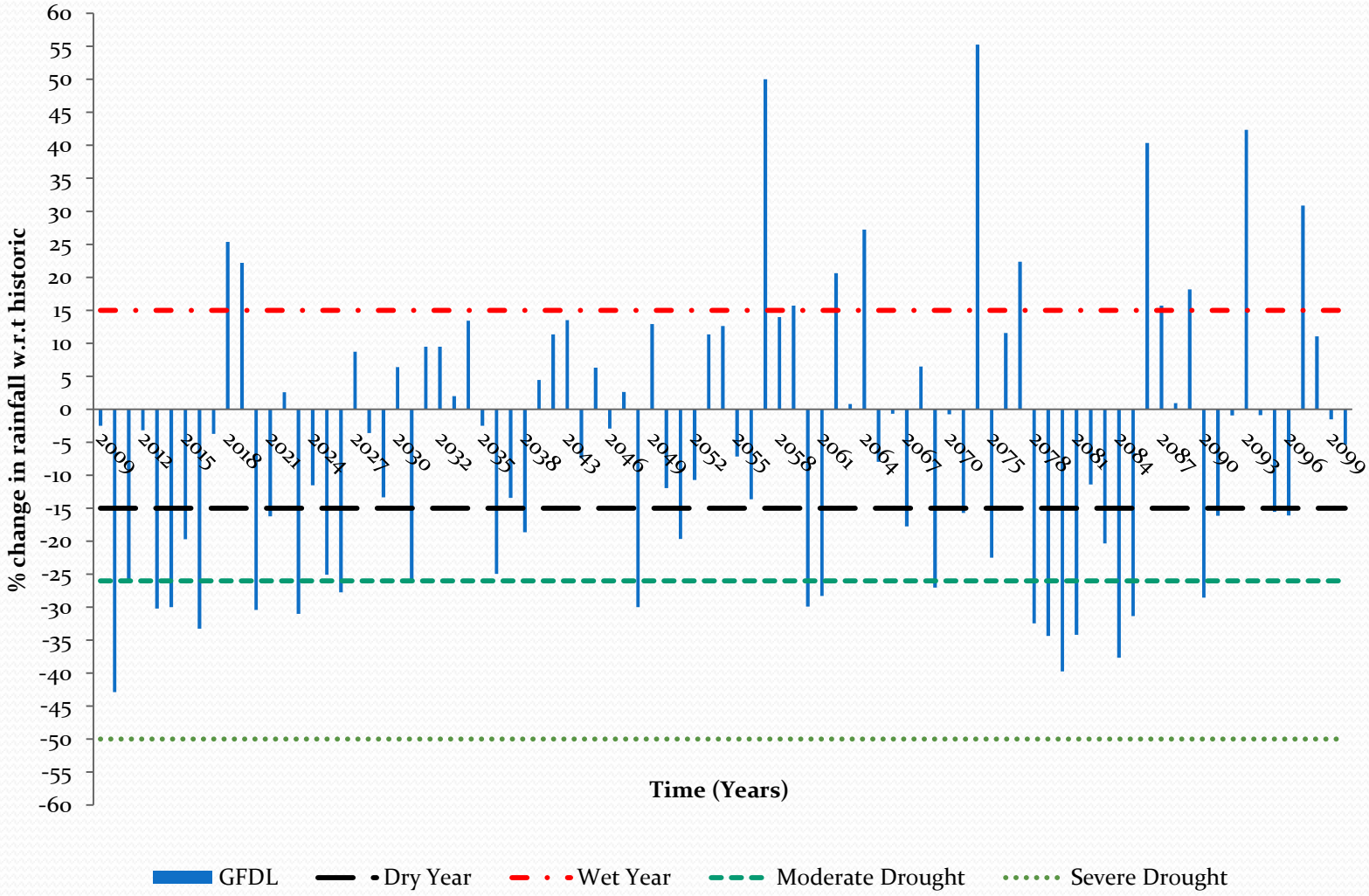
Rainfall and surface runoff variations in the future scenarios (RCP 4.5)



Number extreme events under future scenarios

Event	IMD	HIST	09_40	43_70	73_100
Normal Years	11	11	17	18	8
Dry Years	5	4	6	2	6
Wet Years	4	5	2	4	7
Moderate Drought	2	2	8	4	7
Severe Drought	0	0	0	0	0

Extreme events under future scenarios (GFDL_ESM2M)



Conclusions and Further Work

- In this study water balance components such as surface runoff, water yield and evapotranspiration were simulated under future climate scenarios using GFDL-ESM2M with RCP 4.5 scenario.
- GFDL-ESM2M with RCP 4.5 showed the rainfall decrease by 10.5% in the early century (2006-2040) whereas mid-century and end century it decrease by 0.8% and 4.2%.
- The amount of rainfall in October continuously decreasing in all the future scenarios.
- In the end century, there may be a continuous drought between 2078 to 2085 under RCP4.5
- Frequencies of extreme weather events are more under the future climate scenarios
- Further the results may be improved by including human interventions such as study effect of reservoirs on the basin and also incorporating land use changes.

References

- Abbaspour KC, Rouholahnejad E, Vaghefi S, Srinivasan R, Yang H, Kløve B (2015) A continental-scale hydrology and water quality model for Europe: Calibration and uncertainty of a high-resolution large-scale SWAT model. Journal of Hydrology 524:733-52
- Arnell NW, Reynard NS (1996) The effects of climate change due to global warming on river flows in Great Britain. Journal of hydrology183 (3):397-424
- Arnold JG, Srinivasan R, Muttiah RS, Williams JR (1998) Large area hydrologic modeling and assessment part I: Model development1 73-89
- Barnett TP, Adam JC, Lettenmaier DP (2005) Potential impacts of a warming climate on water availability in snow-dominated regions. Nature 438(7066):303-9
- Ghoraba SM (2015) Hydrological modeling of the Simly Dam watershed (Pakistan) using GIS and SWAT model. Alexandria Engineering Journal 54(3):583-94
- Gosain AK, Rao S, Basuray D (2006) Climate change impact assessment on hydrology of Indian river basins. Current science 90(3):346-53
- Guo S, Wang J, Xiong L, Ying A, Li D (2002) A macro-scale and semi-distributed monthly water balance model to predict climate change impacts in China. Journal of Hydrology 268(1):1-5
- Huntington TG (2006) Evidence for intensification of the global water cycle: review and synthesis. Journal of Hydrology 319(1):83-95
- Kulkarni BD, Deshpande NR, Patwardhan SK, Bansod SD (2014) Assessing Hydrological Response to Changing Climate in the Krishna Basin of India. Journal of Earth Science & Climatic Change 2014

THANK YOU