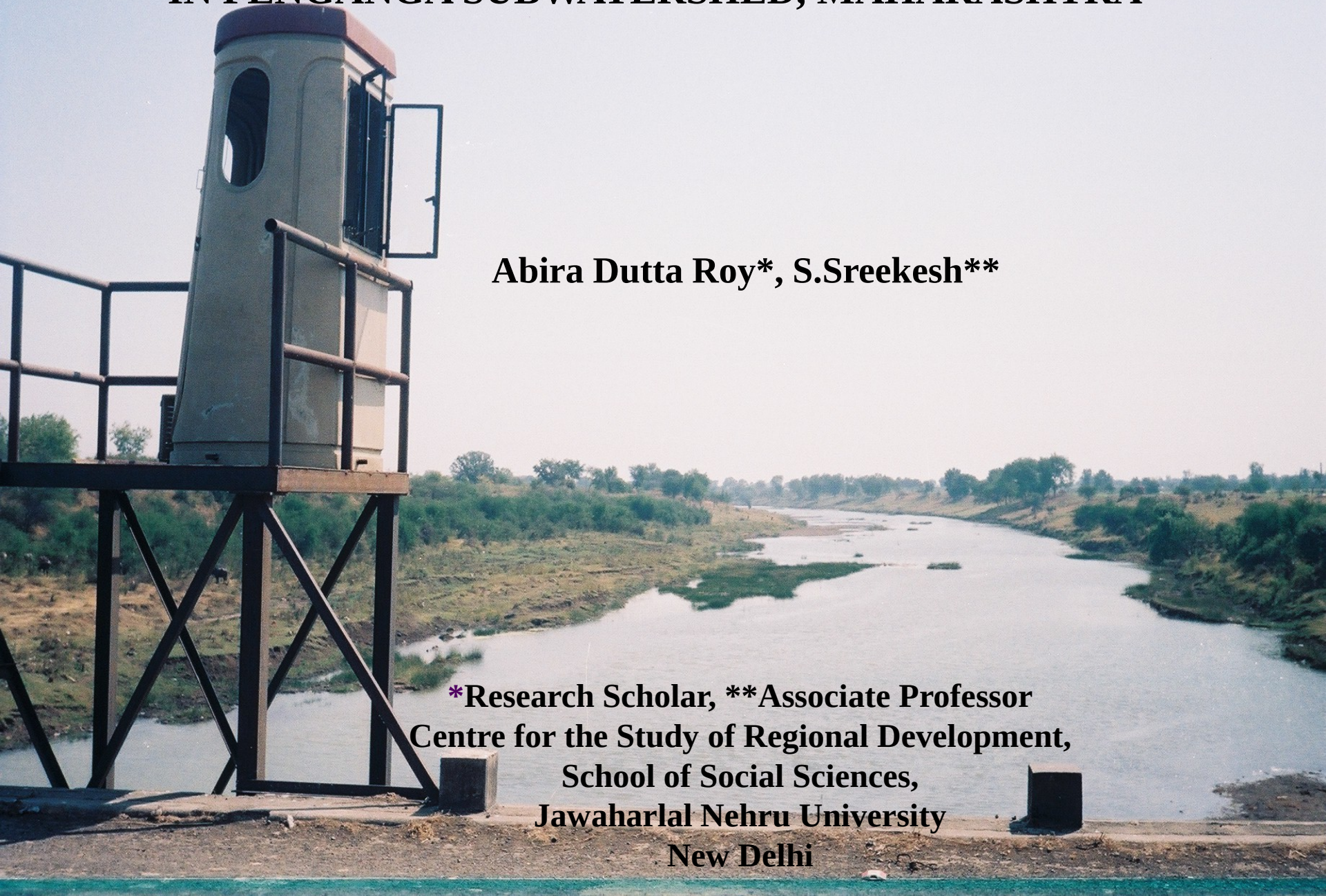
MODELING RUNOFF RESPONSE TO CHANGING LAND COVER IN PENGANGA SUBWATERSHED, MAHARASHTRA



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INTRODUCTION

- The runoff condition in a watershed is determined by the meteorological, hydro-geological, geomorphological, soil type and land use/land cover conditions.
- The dynamic aspect among the above driver variables are the climatic parameters and the land use land cover conditions.
- Increasing population pressure, increasing demands for food, consumer goods, employment, shelter have led to land use/land cover changes. Marginal and semi arid regions in the world are the most affected.
- Land use land cover changes and increasing demand of water have significant impact on the surface water resources of these regions

ISSUES IN THE SUBWATERSHED

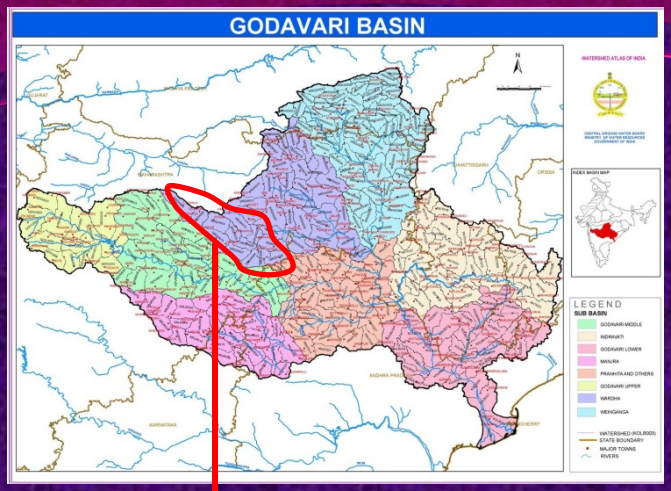
- Penganga sub watershed is situated in Central Indian on the Deccan lava belt and experiences scanty. sporadic as well as erratic rainfall.

- In this predominantly agricultural watershed, droughts and crop failure are frequently reported .

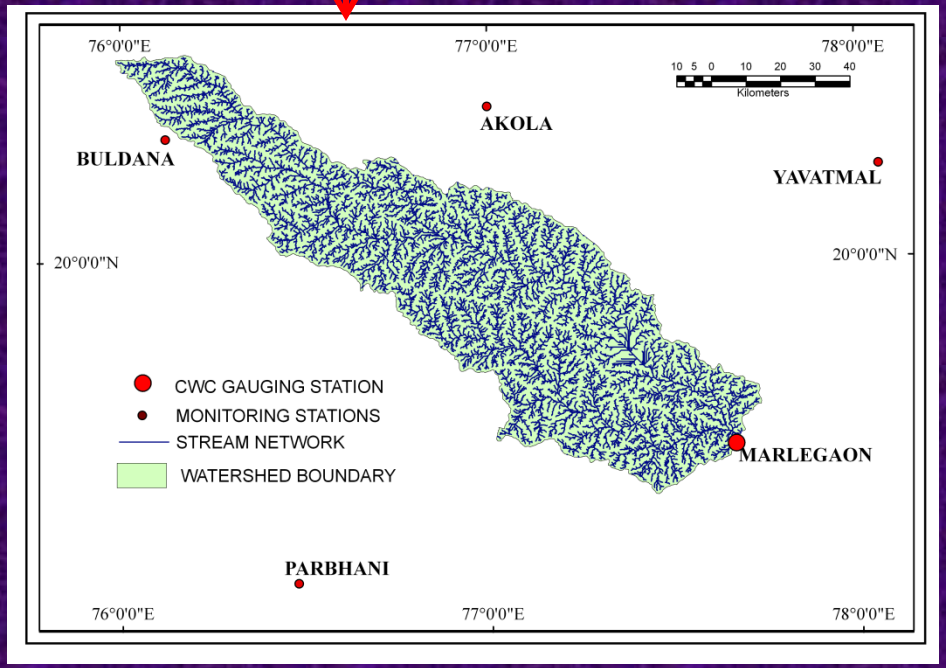
OBJECTIVES

- To scrutinize the impact of land use land cover changes under normal climatic conditions

STUDY AREA



Source : CWC



- Geographical Extent: 76ºE to 77ºE
  20ºN to 21ºN
- Area :7996.26 square km
  elevation ranges from 350-750m
  slope ranges from 0 -50°
- Length of the river: 676 km
- Districts within the watershed: Buldhana, Yavatmal, Hingoli ,Nanded and Washim.
- Mean Temperature in January :20-25°C
  Mean Temperature in April : 30°C
- Average annual rainfall: 200-300cm
  Periodic Droughts occur.
- 60% of the area is under agriculture.1/10th of it receives irrigation.
- Wells irrigate 60%, Canals 20% and tanks 20%
- Major crops grown in this area are Cotton, Tuar/Arhar, Jowar, Gram, Wheat.

DATA SOURCE

- Monthly rainfall for the year 1965-2001 were collected from Monthly Rainfall Report, India Meteorological Department (IMD) for the stations of Nanded, Buldana, Parbhani, Nagpur and Yavatmal.

- Land sat MSS data for 1976, Landsat TM data for 1990, Landsat TM data for 1999, and IRS P6 LISS III data for 2011

- Daily precipitation, temperature, solar radiation, relative humidity and wind speed data for the year 1975-76 were procured from IMD for the stations of Buldana, Akola, Parbhani, Nagpur and Yavatmal situated near the watershed for modeling runoff for the different scenarios.

- Daily runoff data was collected from Central Water Commission (CWC) for the years 1975-76 for Marlegaon gauging site.

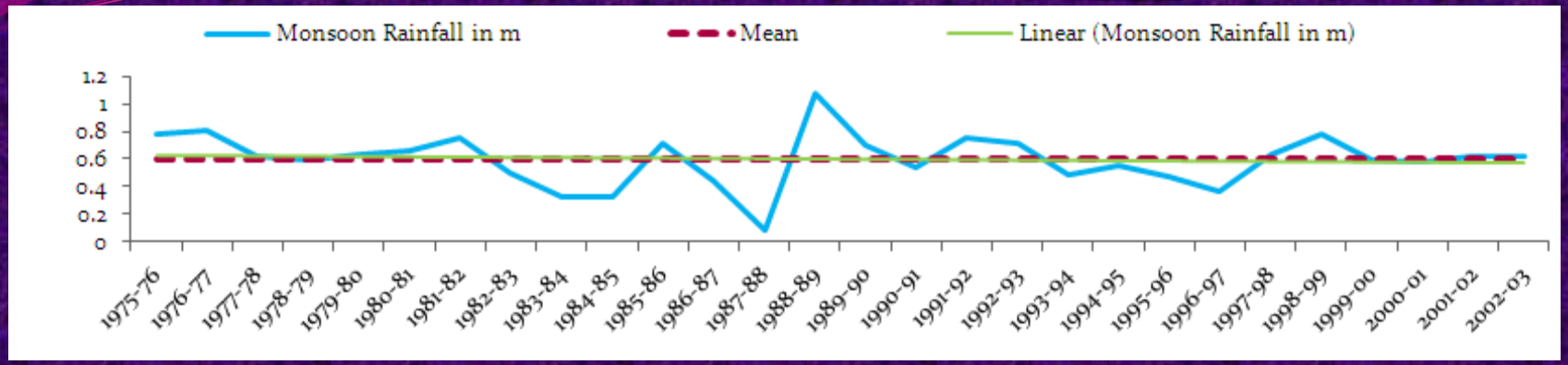
- For the years 1975-1982 the daily solar radiation data was downloaded from www.wrdc-mgo.nrel.gov/html/get_data_ap.html and for 1983- 2005 the solar radiation data was downloaded from eosweb.larc.nasa.gov/cgi-bin/ssc/global.cgi? For the above stations to use in modeling purposes.

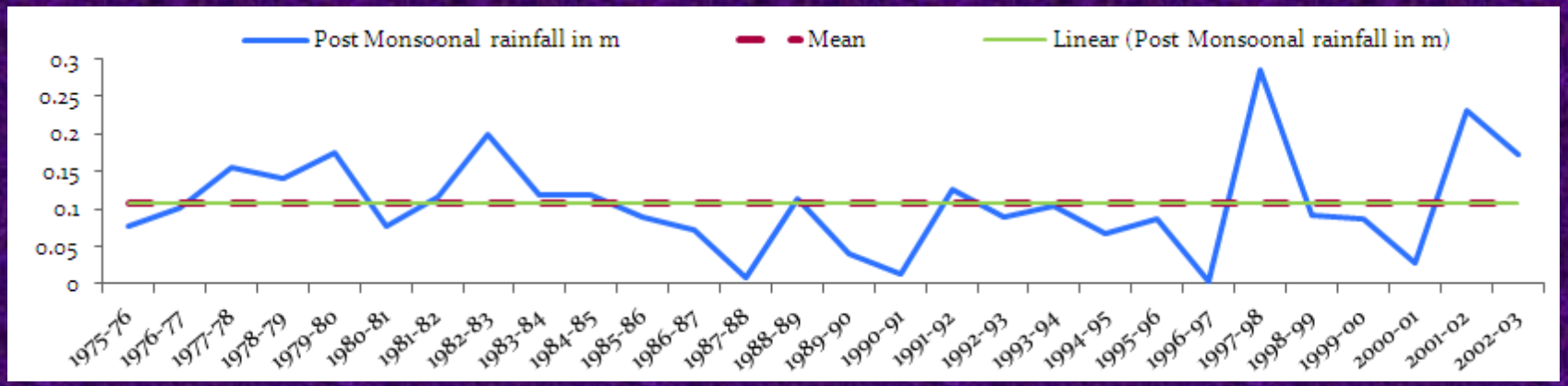
- www1.ncdc-noaa.gov/pub/data/ghcn/daily/gsn was used to download daily maximum minimum temperature , dew point temperature and daily precipitation for Akola and Nagpur for 1973-2011 and http://eosweb.larc.nasa.gov/cgi-bin/sse/daily.cgi was used to download the long term (1948-1970) daily maximum minimum temperature and daily precipitation data for the stations of Buldana, Parbhani and Yeotmal.

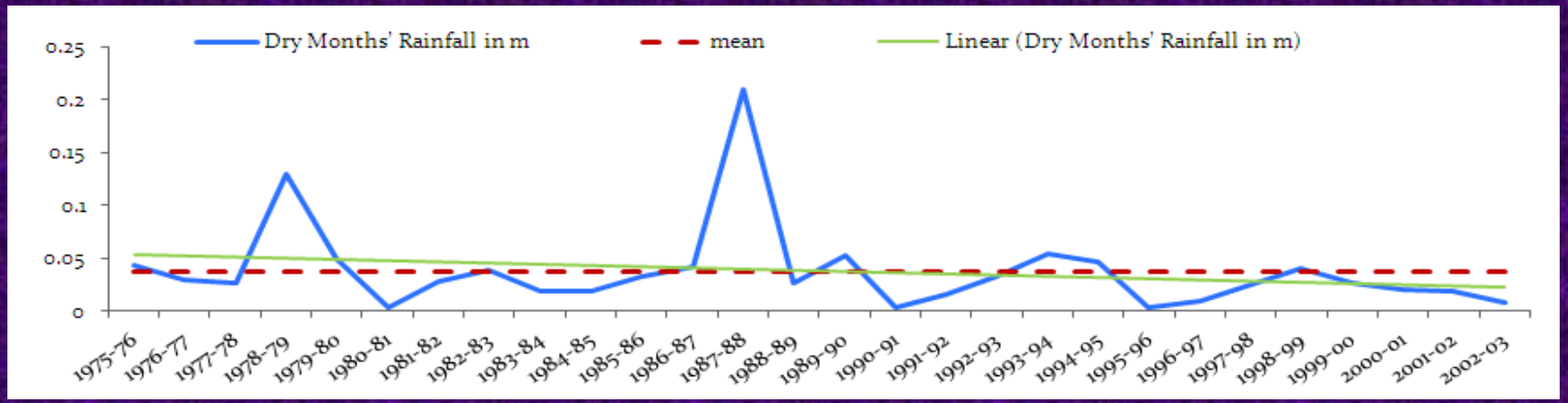
- For the years 1975 to 2011 the daily wind data were downloaded for Akola and Nagpur from www.ncdc.gov/cgi-bin/res40.pl?page=gsod.html. For the other stations of Buldana, Parbhani and Yeotmal the average monthly wind speed data were collected from http://eosweb.larc.nasa.gov/cgi-bin/sse/daily.cgi .

- Soil Map of 1:50,000 scale and Soil Characteristics data from National Bureau of Soil Survey and Land Use Planning, Nagpur.

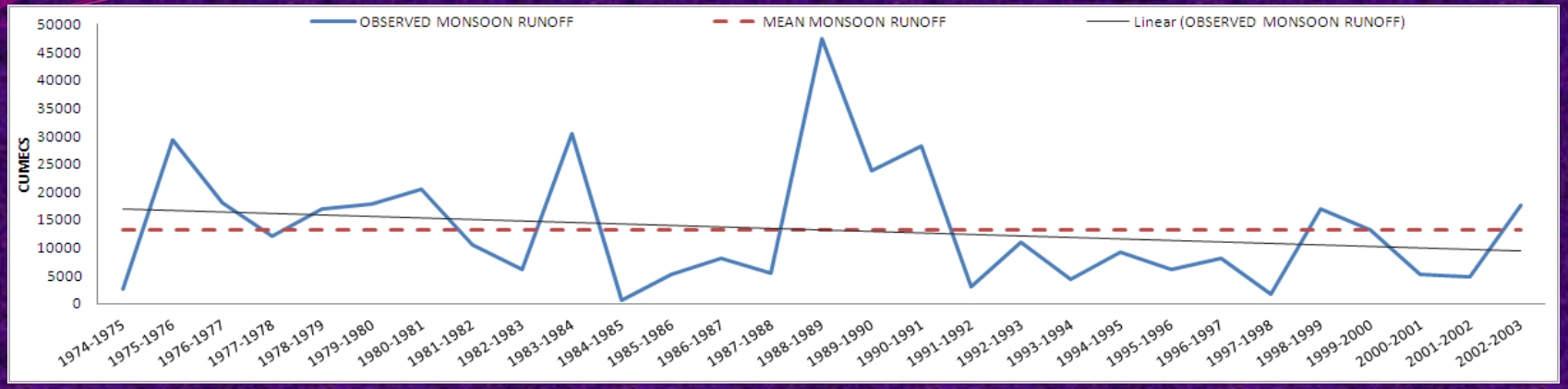
TREND IN SEASONAL RAINFALL CONDITION

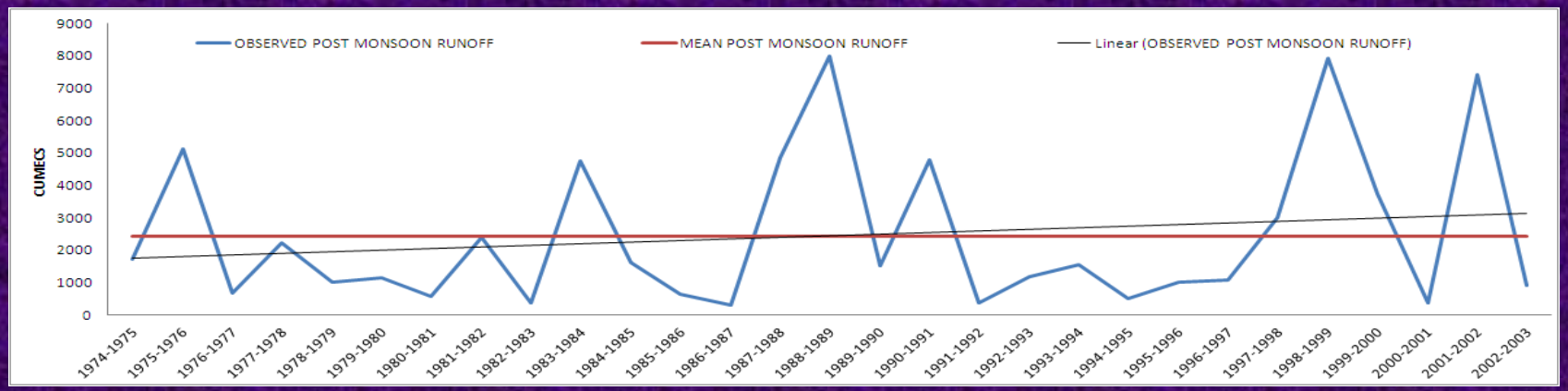


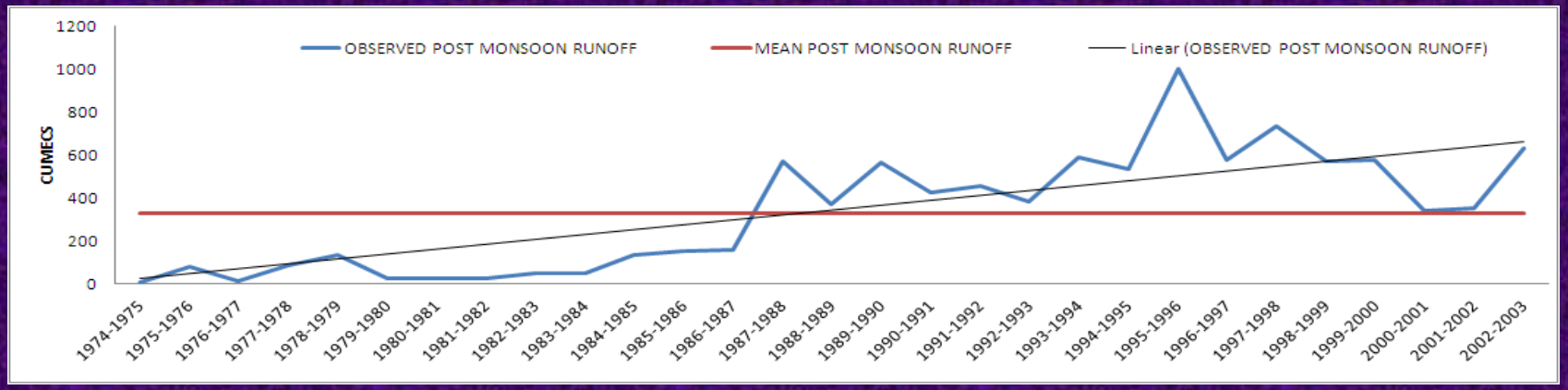




TREND IN SEASONAL RUNOFF CONDITION







METHODOLOGY

LANDUSE LAND COVER CLASSIFICATION AND CHANGE DETECTION

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GENERATION OF NORMAL WEATHER PARAMETERS

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SIMULATION OF RUNOFF WITH ACTUAL WEATHER DATA OF 1975 -76 ON THE LAND USE LAND COVER OF 1975-76 TO CALIBRATE THE MODEL

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SIMULATION OF RUNOFF WITH NORMAL WEATHER DATA ON DIFFERENT LAND USE SCENARIOS

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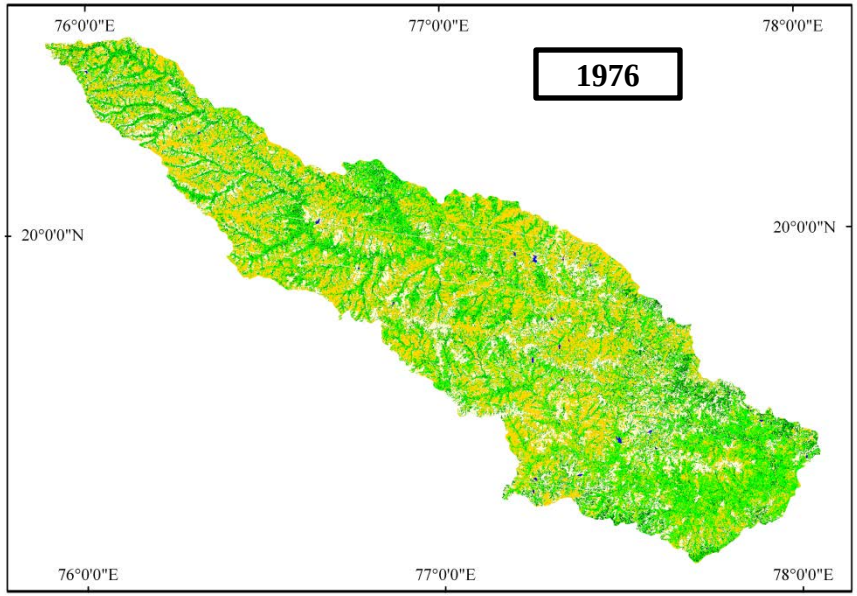
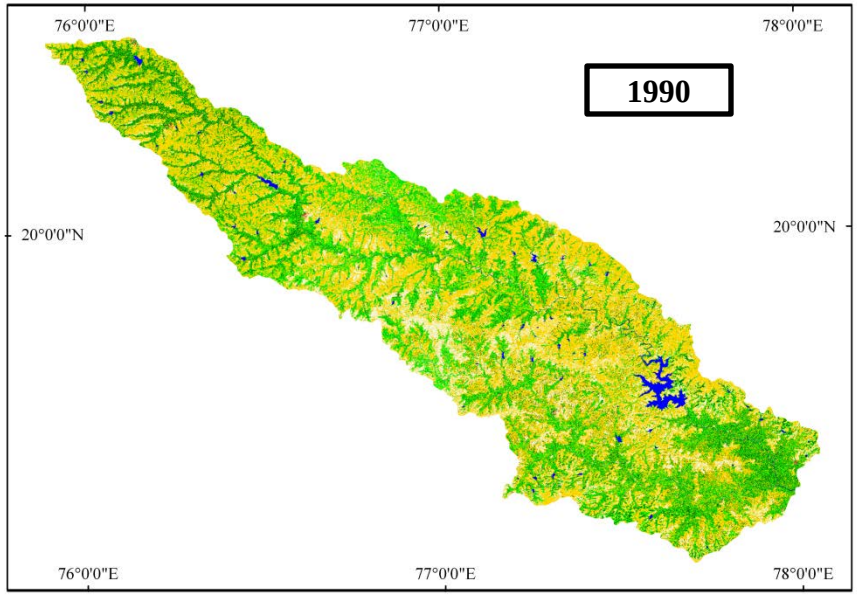
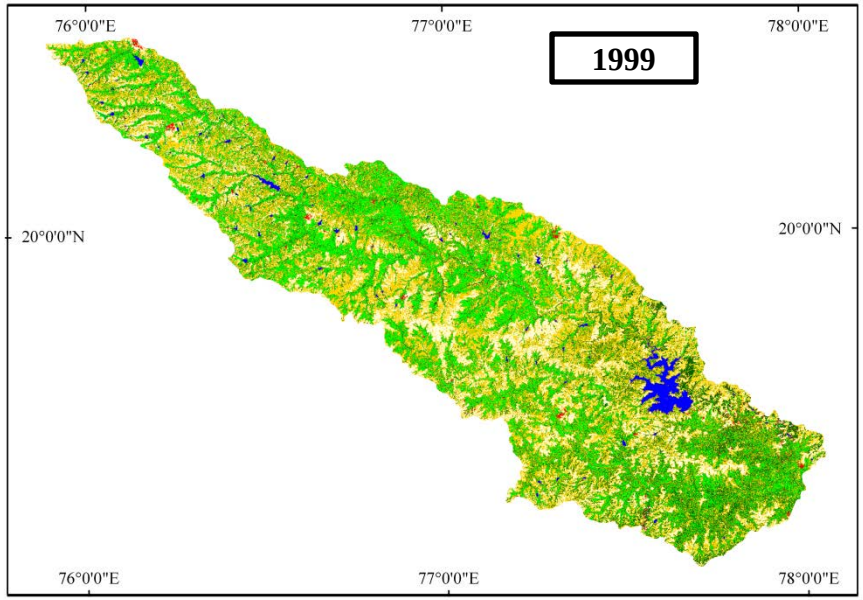
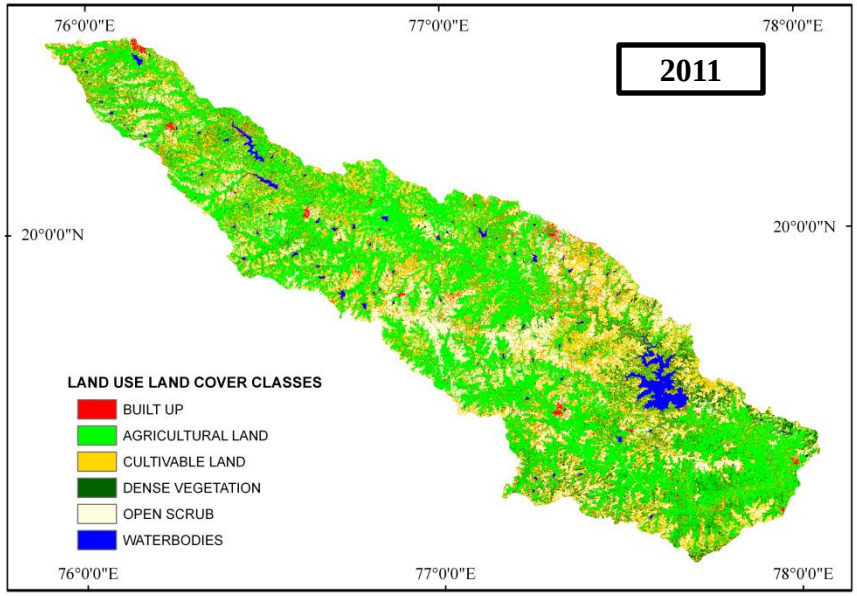
SPEARMAN RANK CORRELATION COFFICIENT BETWEEN CHANGING RUNOFF AND CHANGING LAND USE WAS CALCULATED

LAND USE LAND COVER CHANGES

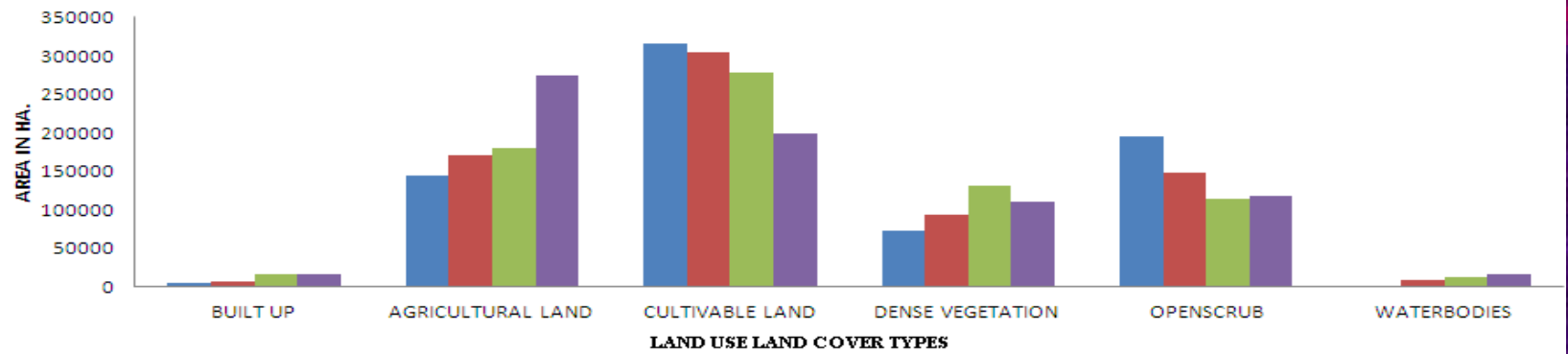








LAND USE LAND COVER CHANGES 1976-2011



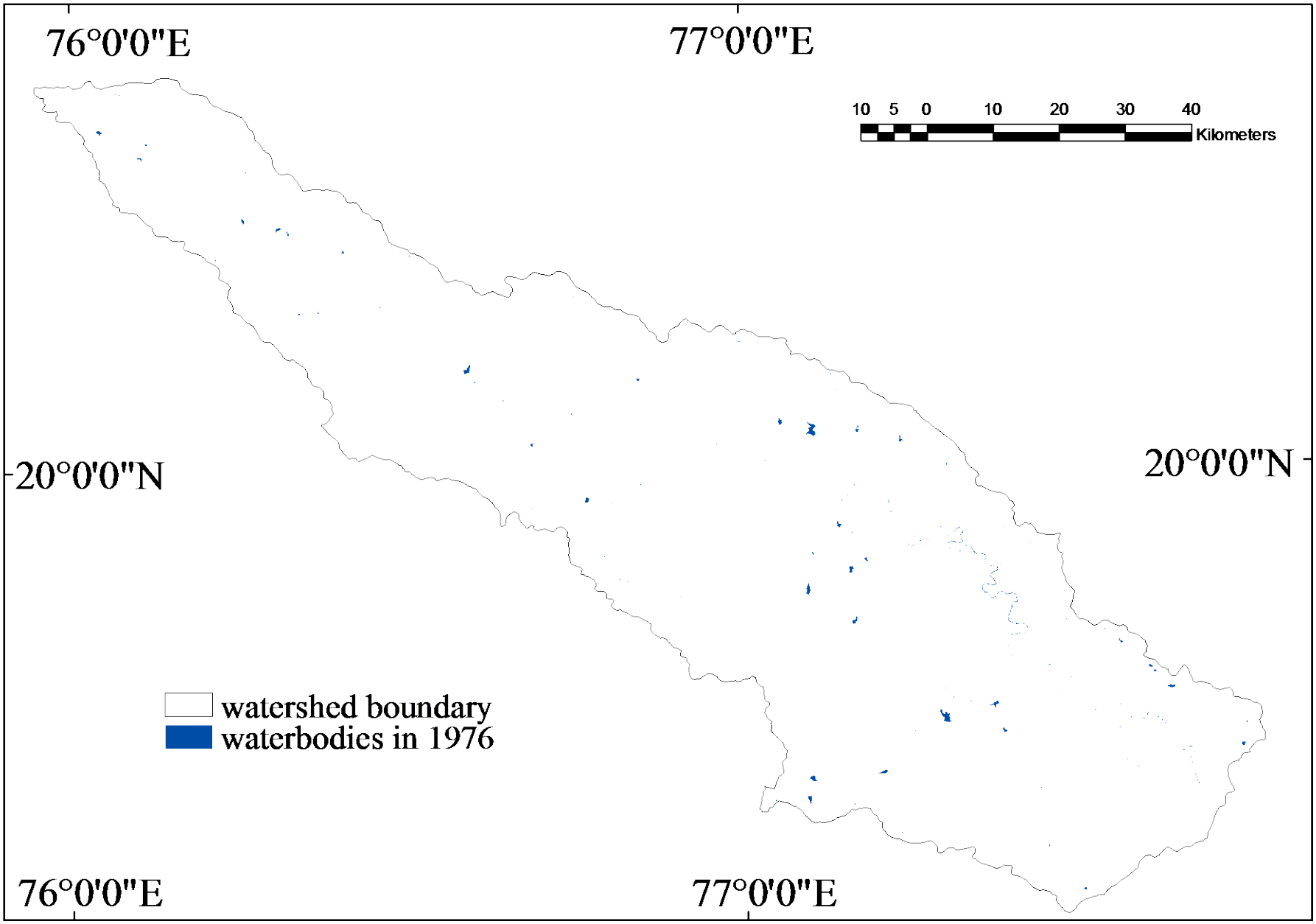
LAND USE LAND COVER CHANGE MATRIX (IN %)

1976-89	BUILT UP	AGRICULTURE	CULTIVABLE LAND	DENSE VEGETATION	OPEN SCRUB	WATERBODIES
BUILT UP	0.61	0.00	0.00	0.00	0.28	0.00
AGRICULTURE	0.26	11.61	12.81	6.26	1.99	0.39
CURRENT FALLOW	0.18	6.25	23.38	3.83	2.37	0.21
DENSE VEGETATION	0.10	3.17	3.48	1.59	1.25	0.19
OPEN SCRUB	0.27	2.25	9.65	1.02	6.24	0.23
WATERBODIES	0.00	0.00	0.00	0.00	0.00	0.12

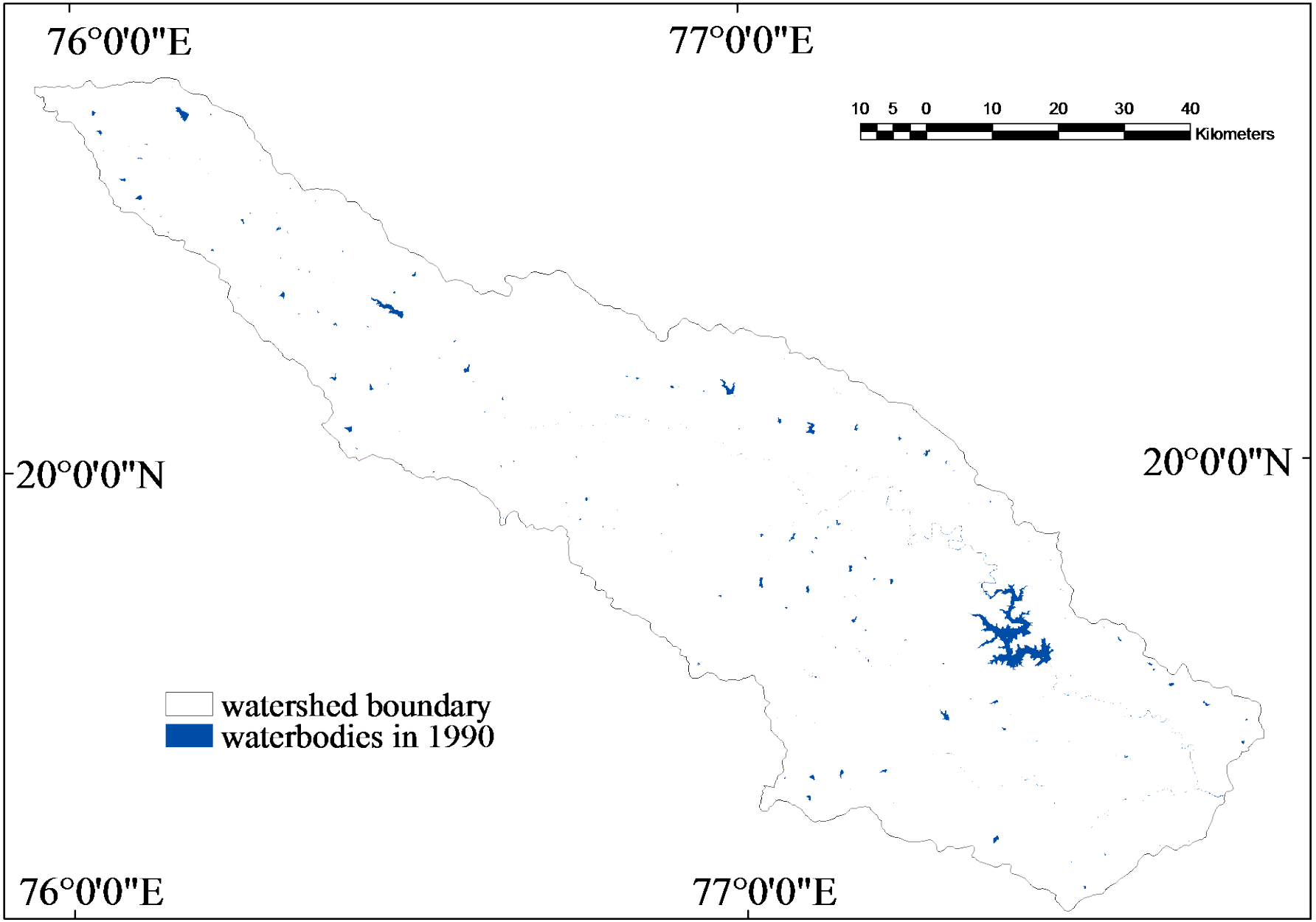
1989-98	BUILT UP	AGRICULTURE	CULTIVABLE LAND	DENSE VEGETATION	OPEN SCRUB	WATERBODIES
BUILT UP	0.68	0.00	0.00	0.00	0.15	0.00
AGRICULTURE	0.56	10.43	5.72	5.54	0.97	0.15
CURRENT FALLOW	0.77	7.99	24.73	8.09	7.93	0.30
DENSE VEGETATION	0.31	5.17	3.23	3.45	0.47	0.13
OPEN SCRUB	0.32	0.78	3.82	0.77	6.14	0.12
WATERBODIES	0.00	0.00	0.00	0.00	0.00	1.15

1989-2011	BUILT UP	AGRICULTURE	CULTIVABLE LAND	DENSE VEGETATION	OPEN SCRUB	WATERBODIES
BUILT UP	2.14	0.00	0.00	0.00	0.00	0.00
AGRICULTURE	0.13	18.95	2.82	1.91	0.63	0.13
CURRENT FALLOW	1.03	11.81	14.77	3.56	6.40	0.28
DENSE VEGETATION	0.16	9.56	3.97	3.42	0.81	0.09
OPEN SCRUB	0.43	1.74	4.80	0.55	8.09	0.03
WATERBODIES	0.01	0.03	0.05	0.00	0.00	1.55

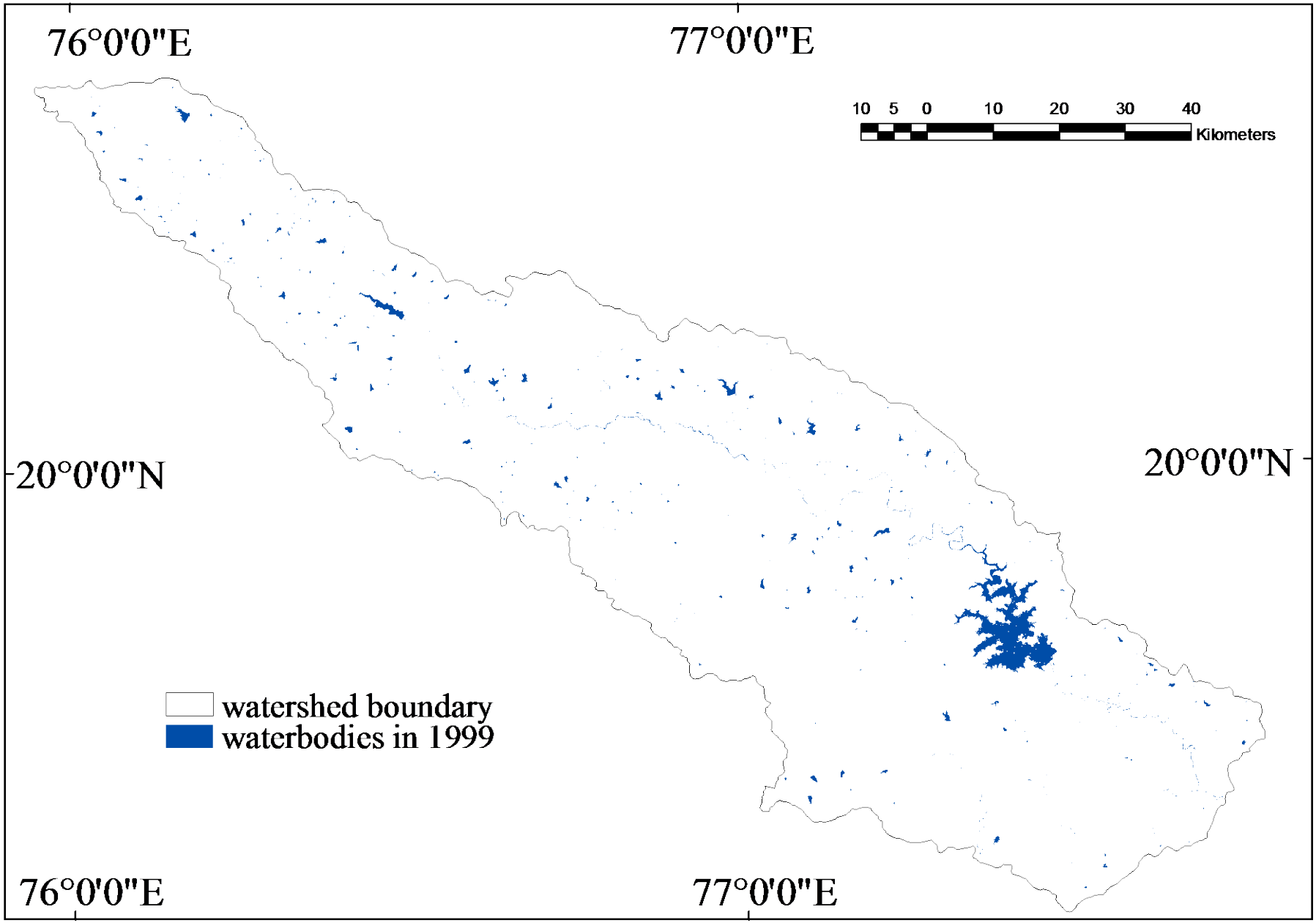
WATERBODIES AND HYDROLOGICAL STRUCTURES IN 1976



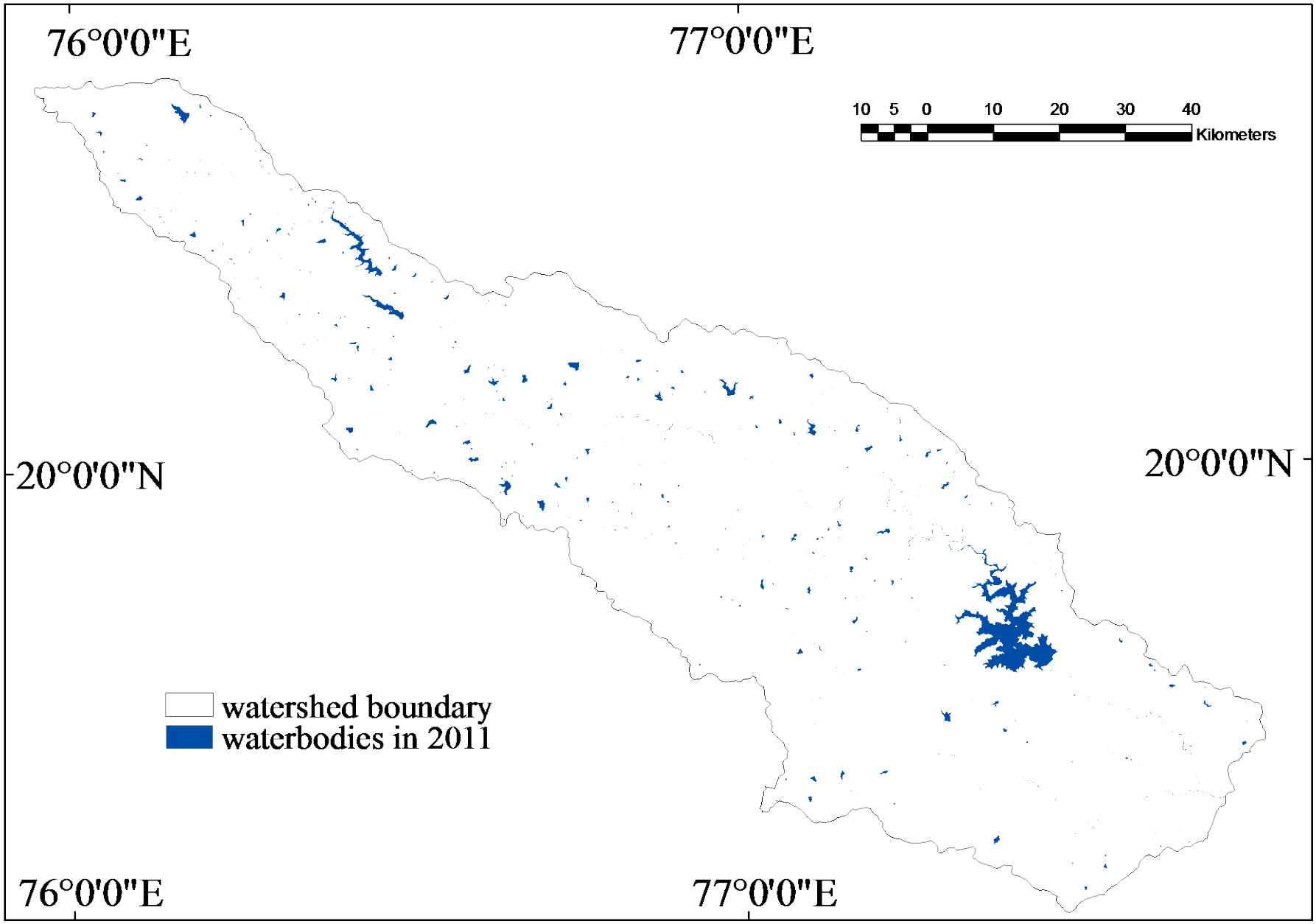
WATERBODIES AND HYDROLOGICAL STRUCTURES IN 1989



WATERBODIES AND HYDROLOGICAL STRUCTURES IN 1998



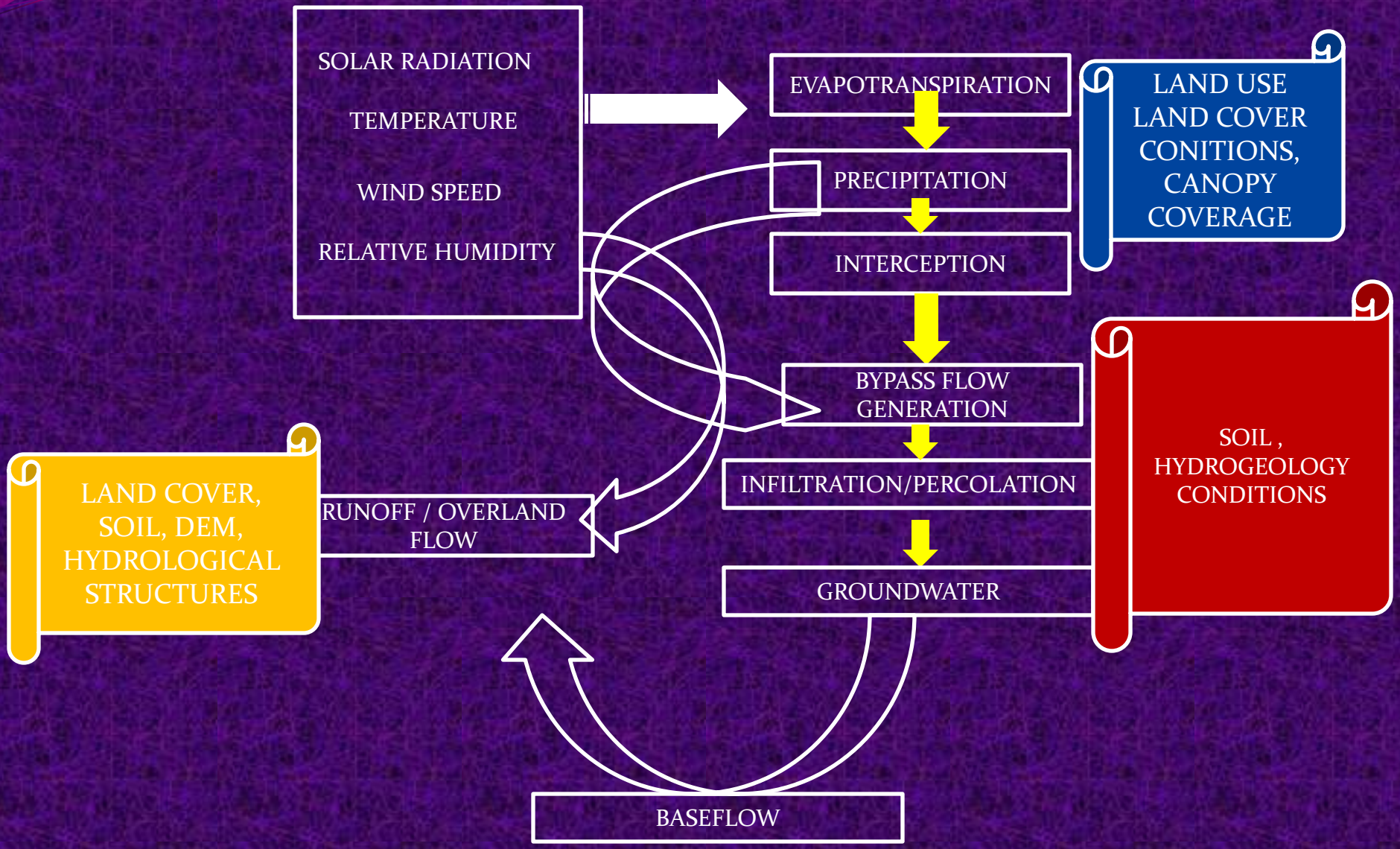
WATERBODIES AND HYDROLOGICAL STRUCTURES IN 2011



COMPUTATION OF DAILY NORMALS OF THE WEATHER PARAMETERS USED IN SWAT MODEL

SOLAR RADIATION	DAILY NORMAL SORAL RADIATION = ∑ DAILY SOLAR RADIATION FOR THE i^{th} DAY OF A MONTH FOR ALL THE YEARS UNDER STUDY/ NUMBERS OF YEARS UNDER STUDY
TEMPERATURE	DAILY NORMAL MAXIMUM OR MINIMUM TEMPERATURE= ∑ DAILY MAXIMUM OR MINIMUM TEMPERATURE FOR THE i^{th} DAY OF A MONTH FOR ALL THE YEARS UNDER STUDY/ NUMBERS OF YEARS UNDER STUDY
PRECIPITATION	•FREQUENCY OF NON RAINY DAYS IN THE i^{th} DAY OF A MONTH FOR ALL THE YEARS UNDER STUDY WERE COMPUTED •IF 50 % OF THE YEARS UNDER STUDY HAVE EXPERIENCED BOTH RAINY AND NON RAINY DAYS, IT HAS BEEN ASSUMED TO BE A RAINY DAY. •DAILY NORMAL RAINFALL= ∑ RAINFALL FOR THE i^{th} RAINY DAY OF A MONTH FOR ALL THE YEARS UNDER STUDY/ NUMBERS OF YEARS UNDER STUDY
RELATIVE HUMIDITY	DAILY NORMAL RELATIVE HUMIDITY= ∑ RELATIVE HUMIDITY FOR THE i^{th} DAY OF A MONTH FOR ALL THE YEARS UNDER STUDY/ NUMBERS OF YEARS UNDER STUDY
WIND SPEED	DAILY NORMAL WIND SPEED= ∑ WIND SPEED FOR THE ith DAY OF A MONTH FOR ALL THE YEARS UNDER STUDY/ NUMBERS OF YEARS UNDER STUDY

RUNOFF SIMULATION IN PREDAM AND POST DAM SCENARIOS WITH THE HELP OF SWAT HYDROLOGICAL MODEL



SWAT DATABASE COMPUTED FOR THE STUDY

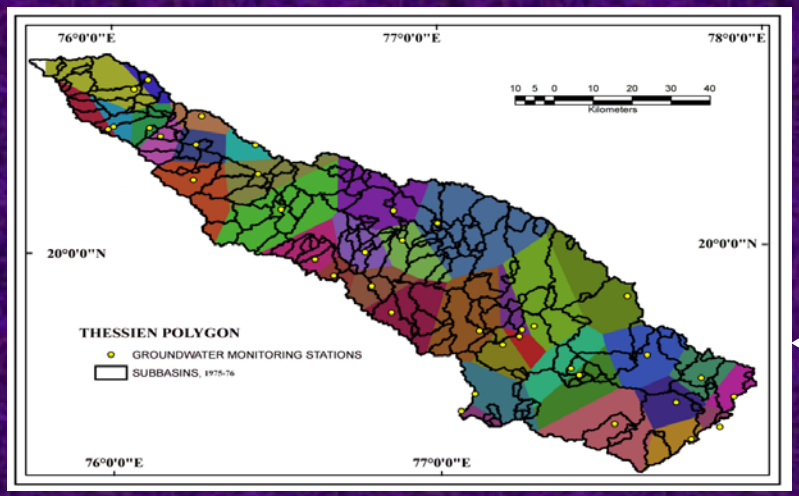
Crops	Akola	Buldana	Nagpur	Parbhani	Yavatmal	Watershed level
Jowar	1898.48	1940.96	1960.70	2249.68	2112.87	2032.54
Cotton	2939.45	2797.70	3061.57	3057.51	3008.15	2972.88
Wheat	2413.09	2529.95	2513.51	2862.89	2689.04	2601.70
Tur	1922.30	1860.34	2002.06	2035.70	1987.09	1961.50
Gram	2599.64	2653.86	2663.74	2962.46	2766.64	2729.27

- PHU

$$PHU = \sum_{d=1}^{m} HU$$

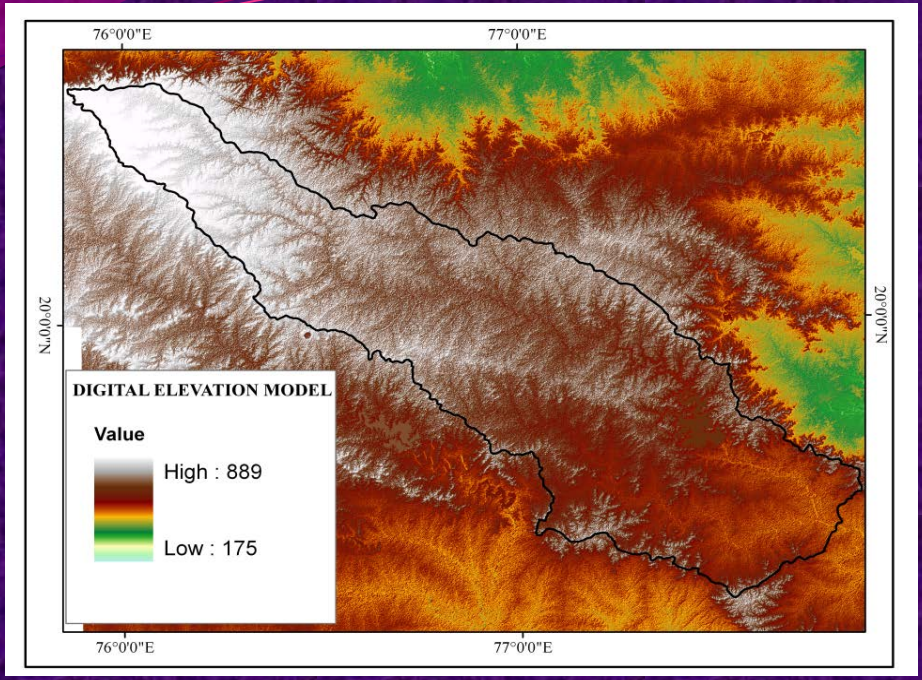
$$HU_0 = \overline{T}_{av} \qquad \overline{T}_{av} > 0^{\circ}C$$

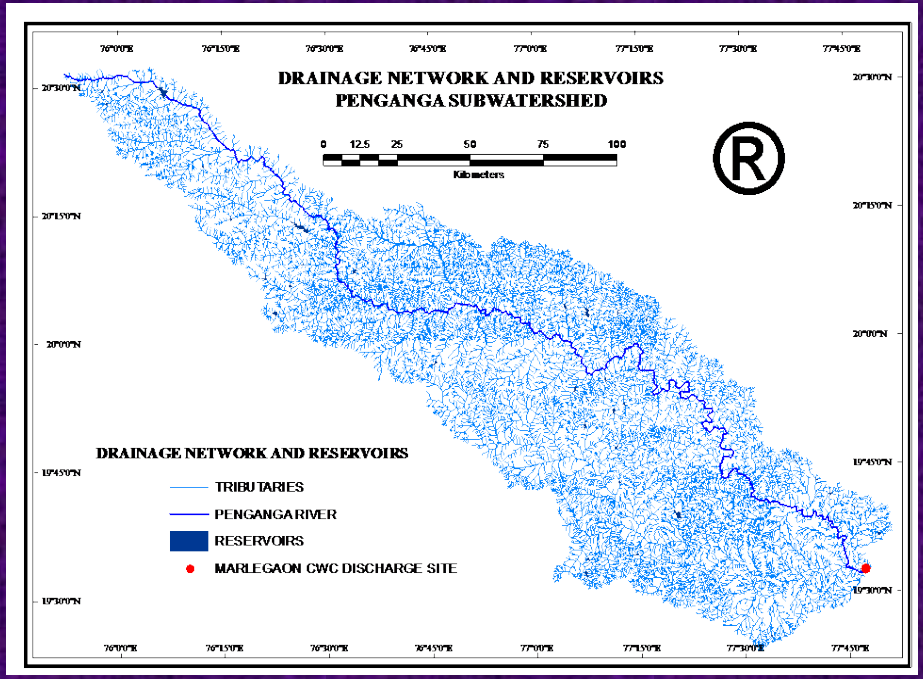
- MAXIMUM POSSIBLE SOIL CRACK VOLUME
- GROUND WATER DATABASE ALPHA_BF , SHALLST, DEEPEST



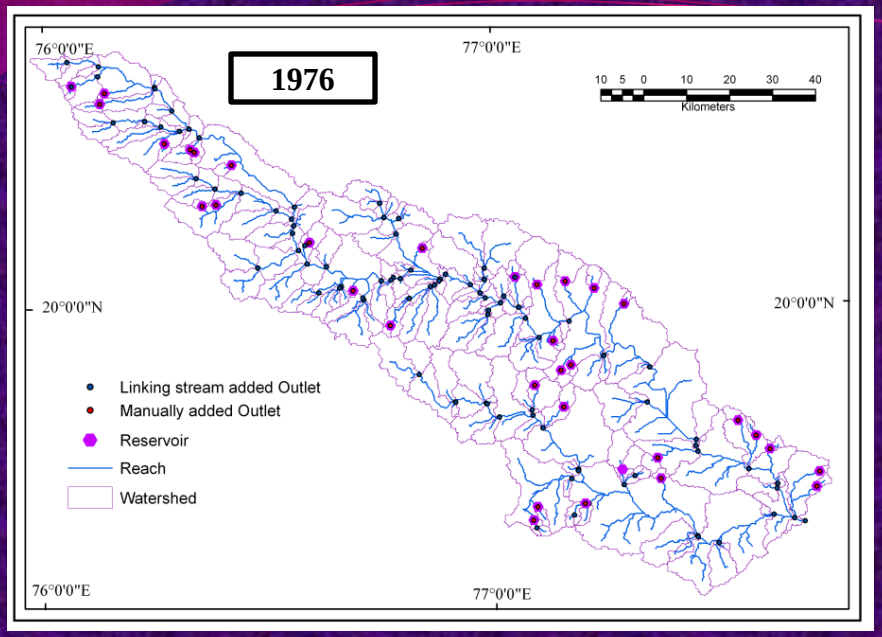
GROUNDWATER MONITORING STATIONS,CGWB

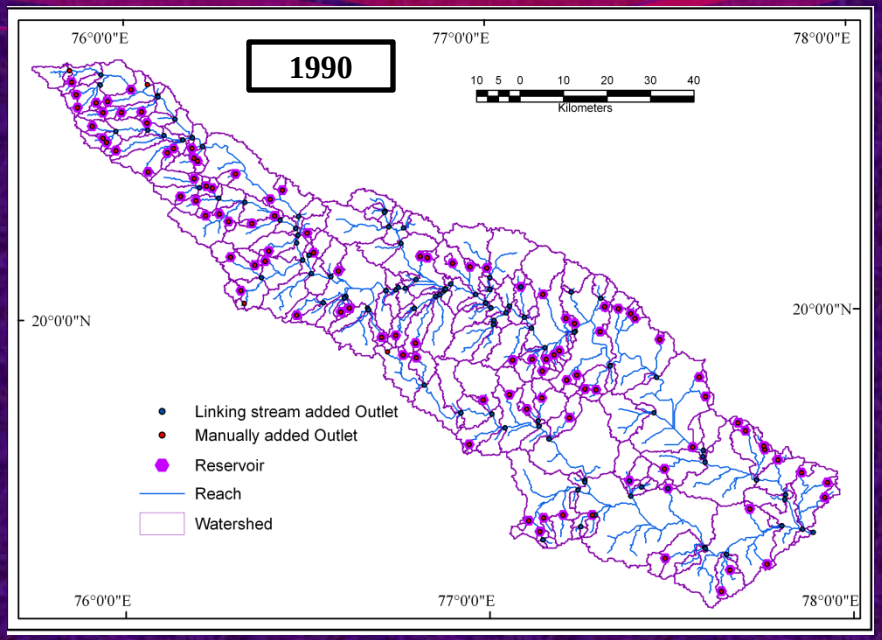
WATERSHED DELINEATION

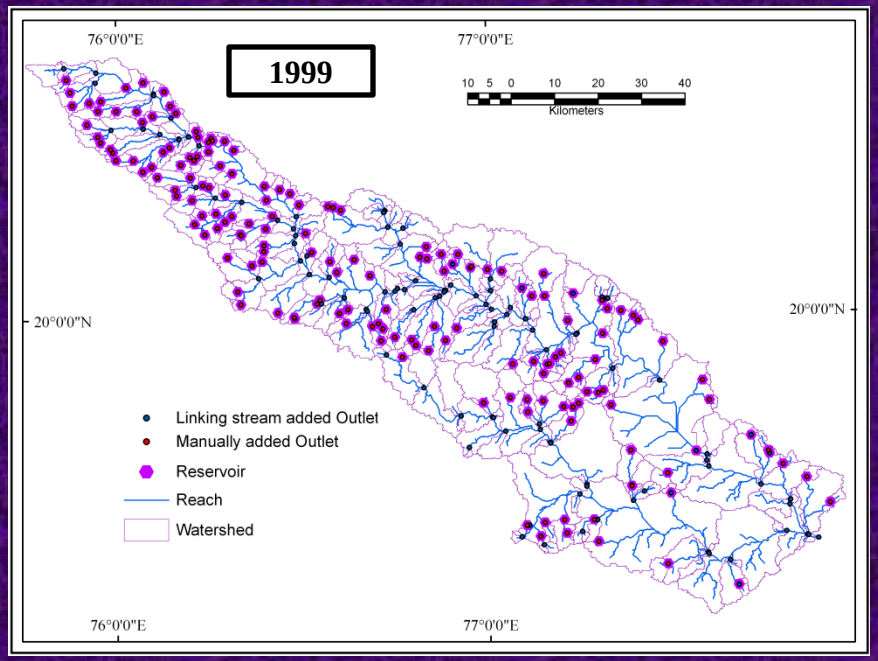


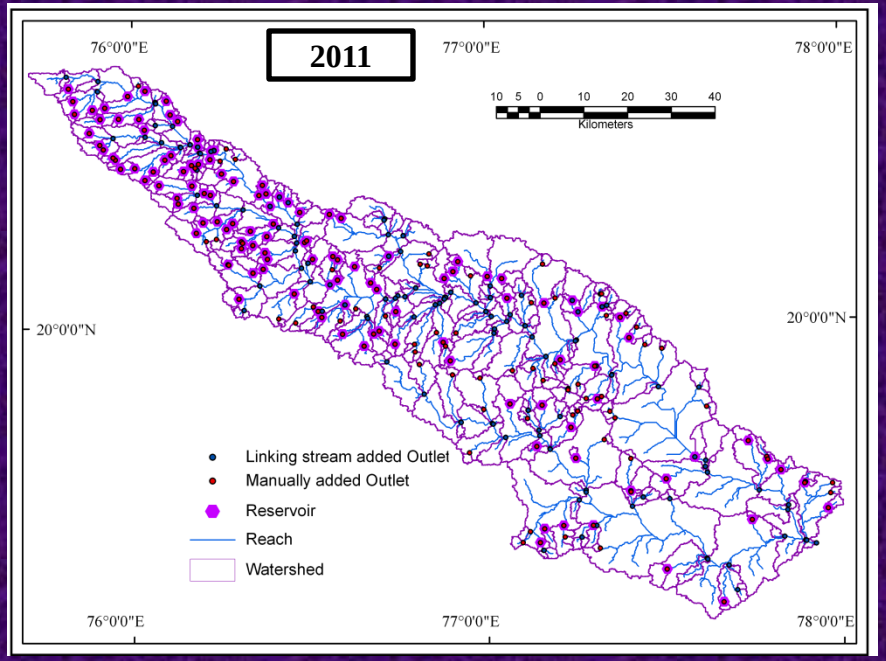


SUBBASINS DELINEATED

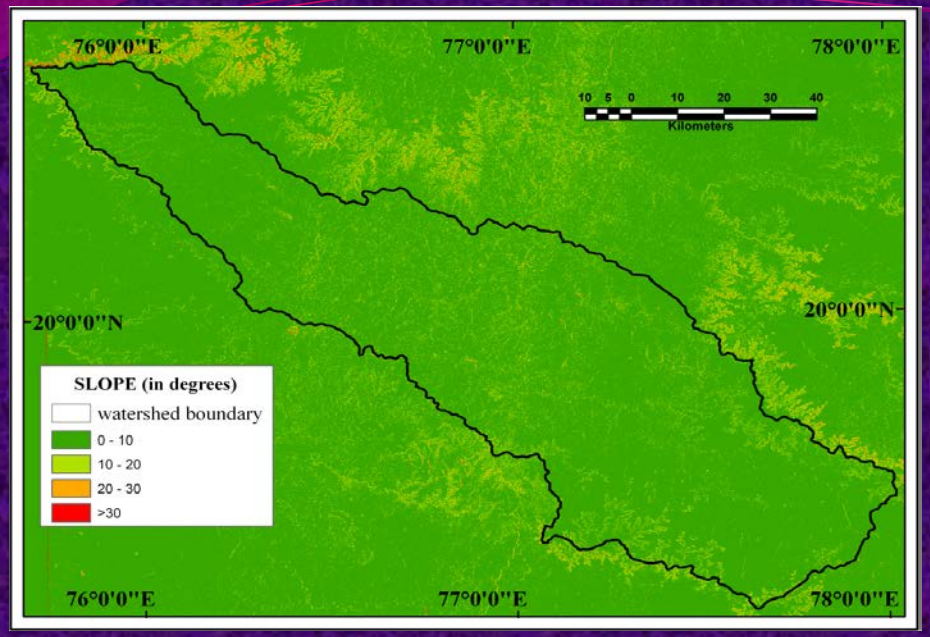


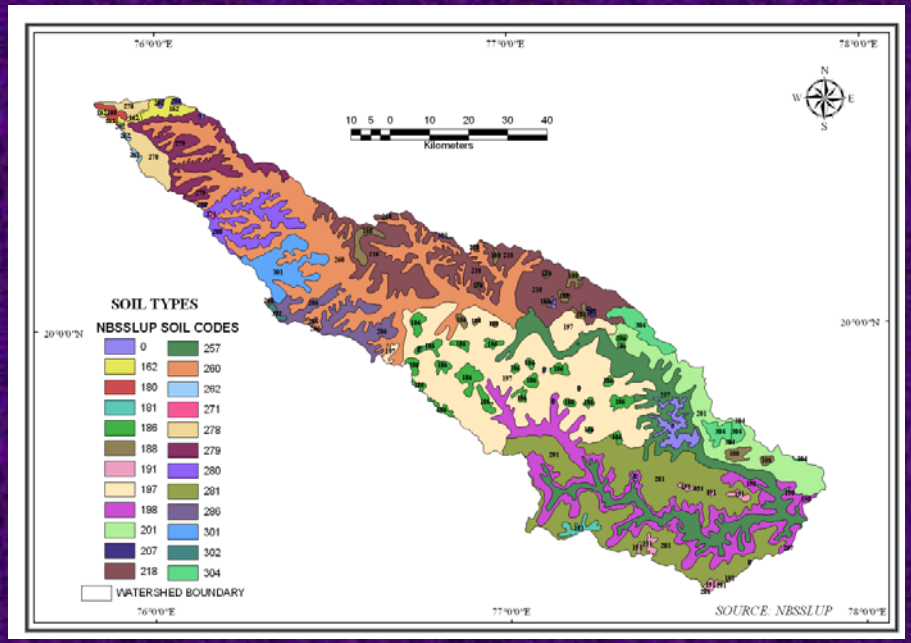




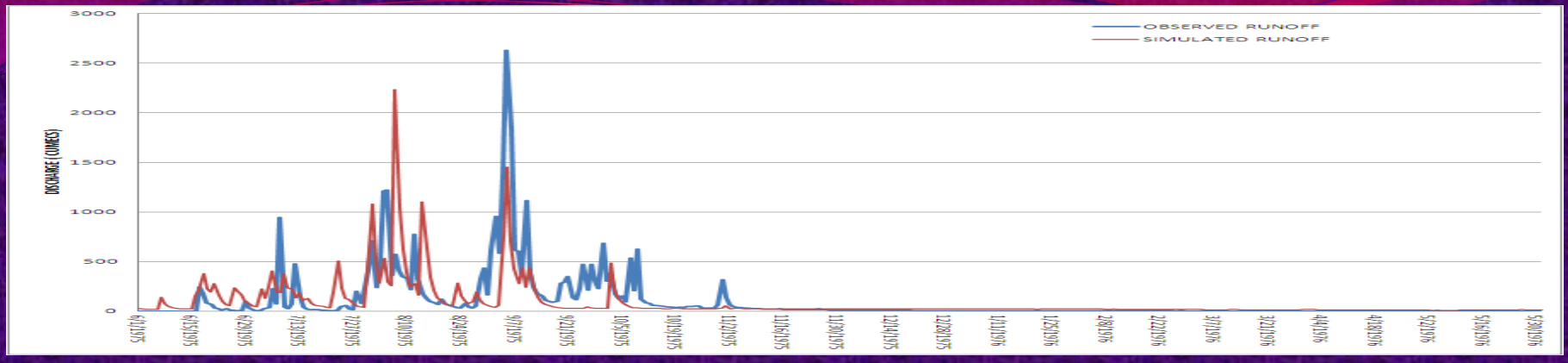


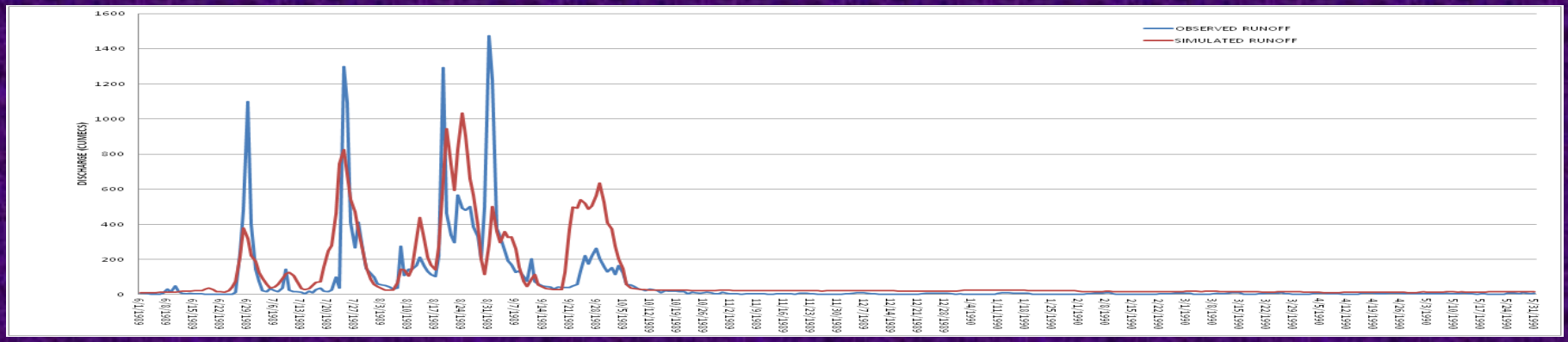
GENERATION OF HYDROLOGICAL RESPONSE UNITS

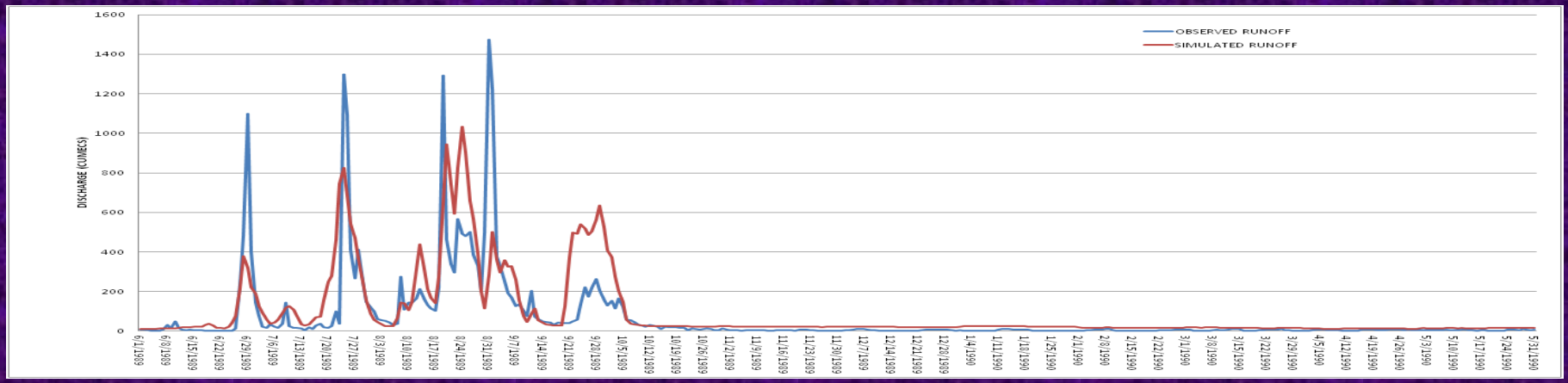




MODEL CALIBRATION







MODEL CALIBRATION (CONTD...)

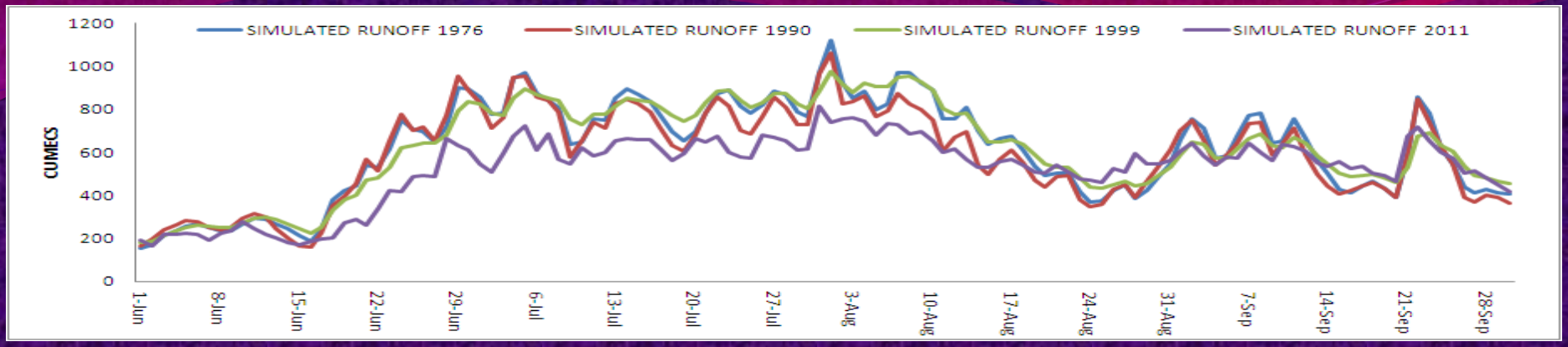
$R^2 = 0.60$

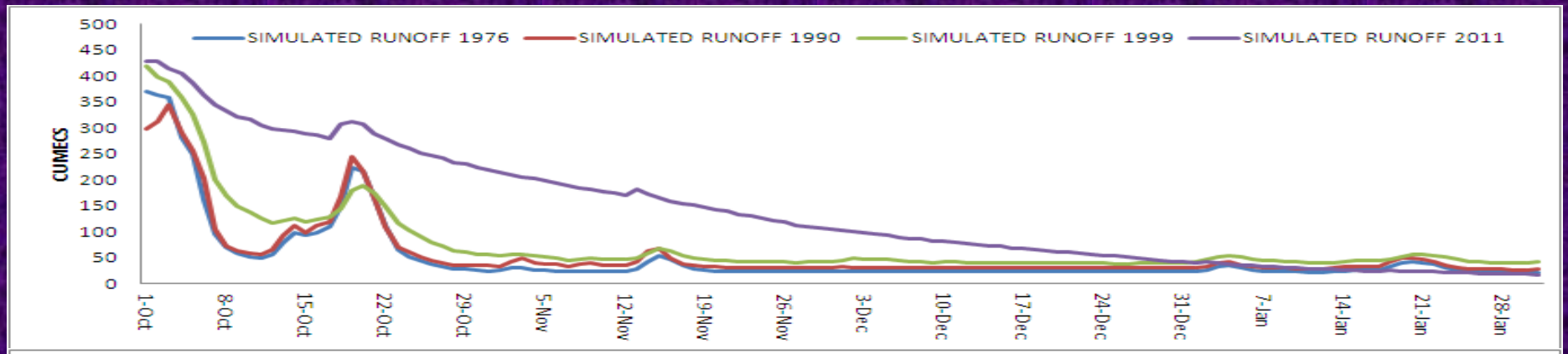
NSE= 0.40

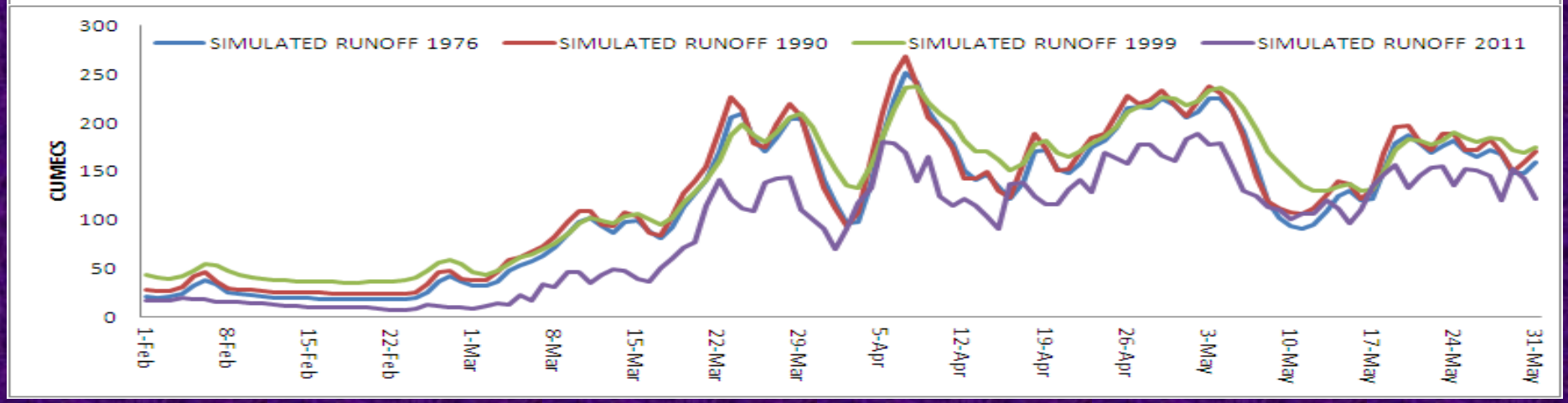
SENSITIVE PARAMETERS

PARAMETERS FOR MODEL CALIBRATION	VALUES
PHU	2459
ESCO	1
EPCO	0
GW_DELAY	245
ALPHA_BF	0.085
SURLAG	24
CH_N1	0.19
CH_N2	0.044

SIMULATED RUNOFF UNDER NORMAL WEATHER CONDITIONS







SPEARMAN RANK CORRELATION BETWEEN LAND USE AND RUNOFF CHANGES

CHANGES IN LULC		1976-90 runoff	1989-98runoff	1998-11runoff
BUILT UP	Correlation Coefficient	.285**	.152*	**.236****
AGRICULTURE	Correlation Coefficient	**.588****	.139*	0.075
CULTIVABLE LAND	Correlation Coefficient	-.635**	-0.109	-0.004
DENSE VEGETATION	Correlation Coefficient	-.339**	-0.052	-0.061
OPENSCRUB	Correlation Coefficient	.609**	0.023	0.04
WATER	Correlation Coefficient	.428**	.169*	0.095

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

CONCLUSION

- The Dams are seen to have reduced the natural monsoon flow and have increased the post monsoon and pre monsoon flow at the Marlegaon gauging site and also all across the subwatershed

- The conversion of open scrub and barren area to an arable one has reduced the overland flow as well as the runoff.

- It is necessary to grow less water intensive crops to make the region sustainable

THANK YOU