PRESENTATION

ON

Hydrological Response of Bhavani Sagar Reservoir Using SWAT

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- Statement of the problem
- Study area
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Introduction

- Soil - important ecosystem component on which depends all primary productions
- Identified by the International Soil Science Society - '**limited and irreplaceable resource** - 200-400 years to build up 1 cm of top soil
- India about 5334 M-tonnes of soil are being removed annually(CSWCRTI), Dehradun
- Soil Erosion – caused by detachment and removal of soil particles –one place to other place by water, wind etc

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- Generally soil erosion accelerated two kind of problems on catchment

    (i) **on- site** - less agricultural productivity

    (ii) **off-site** – reservoir sedimentation

- Sedimentation of a reservoir - natural phenomenon - leads to loss of live storage, which eventually leads to loss of hydropower, Irrigation, water supply etc
- Therefore assessment and prevention of on-site and off-site erosion problems becomes important

Statement of the problem

- In India - observed that soil erosion more severe in Northeastern states, Himalayan ranges and Western
- India - 2.45% of global geographic land area, which is 329 million hectare (M-ha) among that 147 M-ha of land affected by soil degradation[NBSS&LUP]
- The total extant of water erosion in India as per NBSS&LUP, (2005) is 93.68 M-Ha
- Reservoirs around the world have been filled with sediment at a rate of approximately 1% per year (WCD, 2000)

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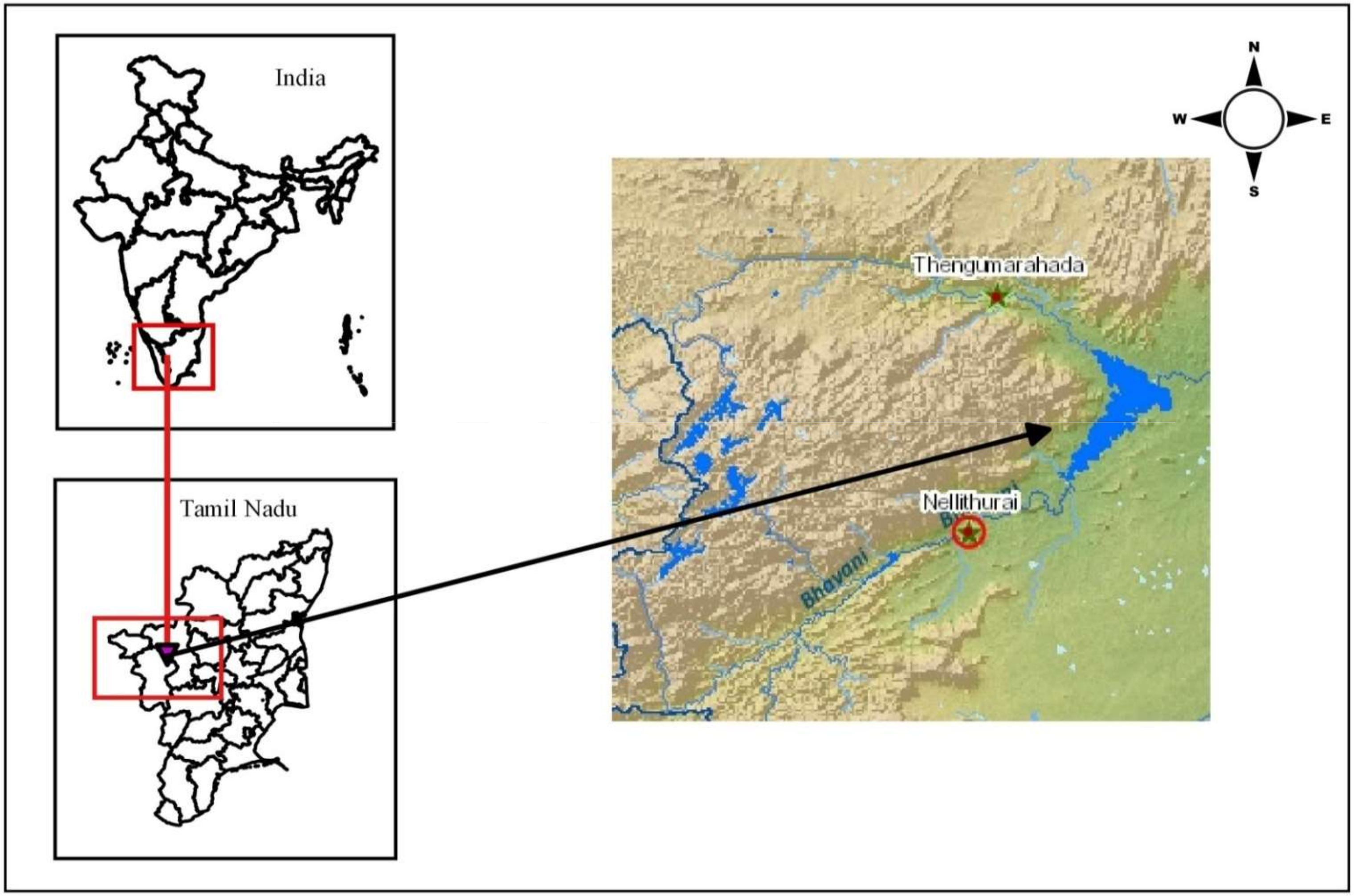
- In India As per CWC report in the year of 2015, it is observed that the actual rate of sedimentation is more than the design rate of sedimentation
- It has been found that ratio of actual rate of sedimentation to design rate of sedimentation value is more than 5, for 23 reservoirs out of 93 reservoirs in India
- The sedimentation survey (2006) by CWC reported that the **Bhavani Sagar reservoir** has lost its gross capacity around 159.21 M.cum from 975.18 M.cum with an average rate of siltation is 3.643 M.Cum/yr over 53 years

Study area

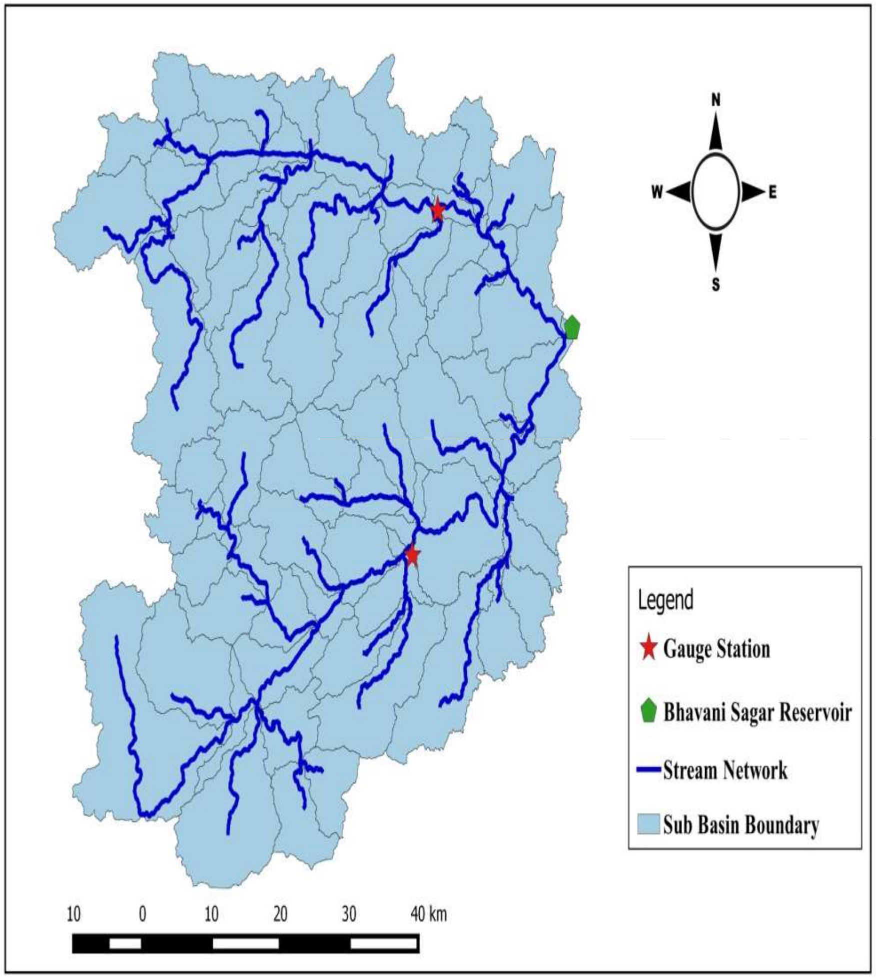


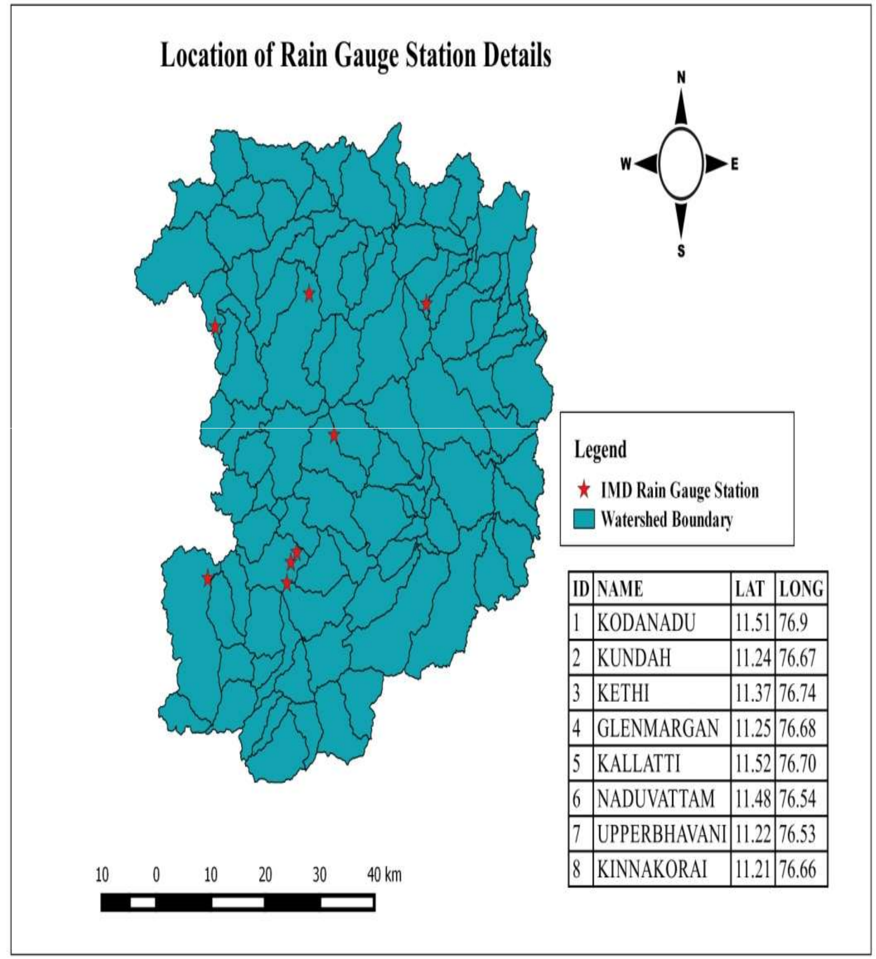
Location of study area

SWAT Setup

Digital Elevation Map (DEM)	http://earthexplorer.usgs.gov
Land use and Land cover map(LULC)	http://swat.tamu.edu/software/links/india-dataset/
Soil Map	http://swat.tamu.edu/software/links/india-dataset/
Meteorological Data (1994-2011) i) Rainfall Data ii) Temperature Data	State Ground & Surface Water Resources Data Centre ,Tamil Nadu
Flow and Sediment(TSS) data	http://india-wris.nrsc.gov.in

SWAT Inputs





ID	NAME	LAT	LONG
1	KODANADU	11.51	76.9
2	KUNDAH	11.24	76.67
3	KETHI	11.37	76.74
4	GLENMARGAN	11.25	76.68
5	KALLATTI	11.52	76.70
6	NADUVATTAM	11.48	76.54
7	UPPERBHAVANI	11.22	76.53
8	KINNAKORAI	11.21	76.66

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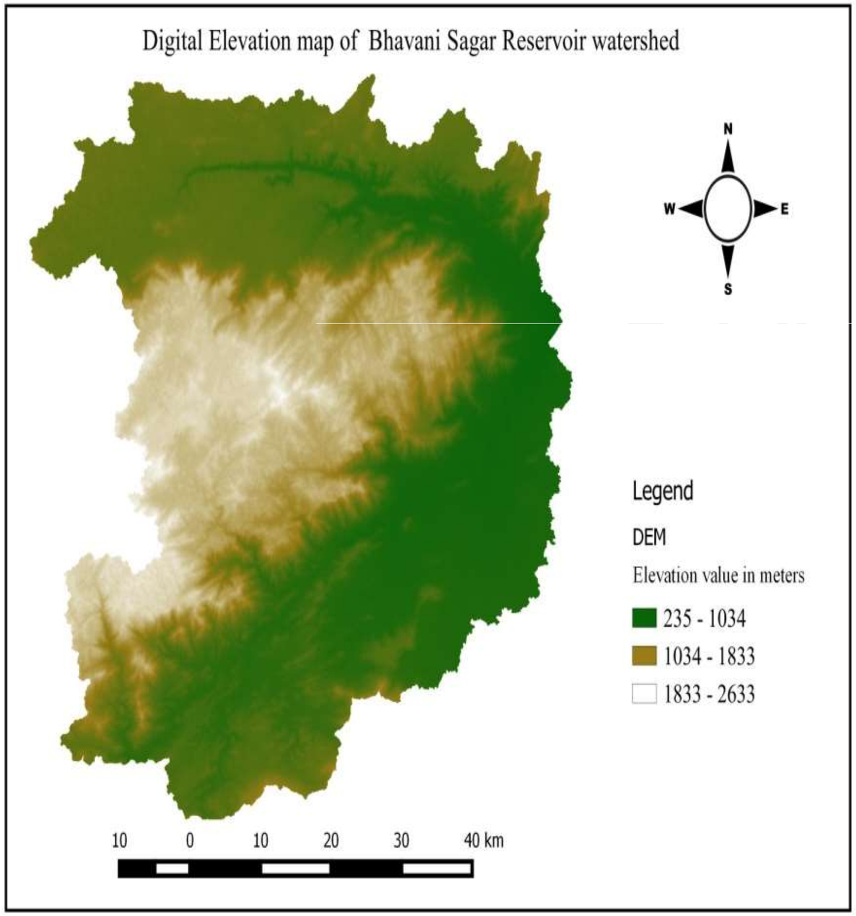
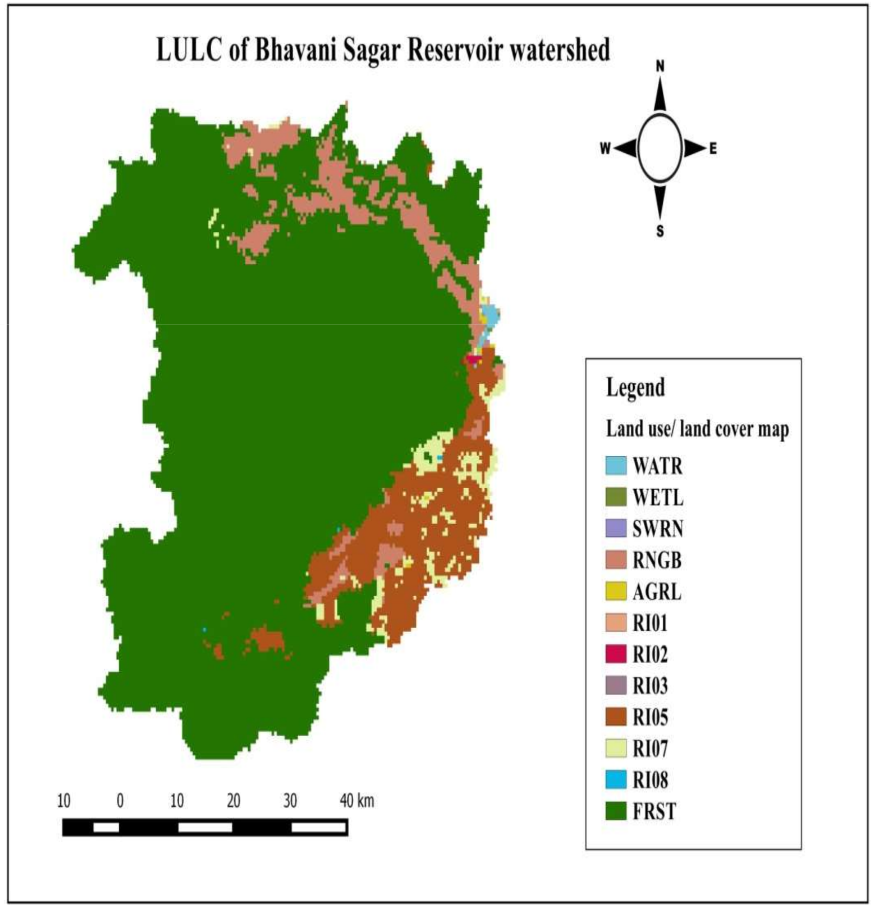


Digital Elevation map of Bhavani Sagar Reservoir watershed
N
W
E
S
Legend
DEM
Elevation value in meters
235 - 1034
1034 - 1833
1833 - 2633
10 0 10 20 30 40 km



LULC of Bhavani Sagar Reservoir watershed
N
W
E
S
Legend
Land use/ land cover map
WATR
WETL
SWRN
RNGB
AGRL
RI01
RI02
RI03
RI05
RI07
RI08
FRST
10 0 10 20 30 40 km

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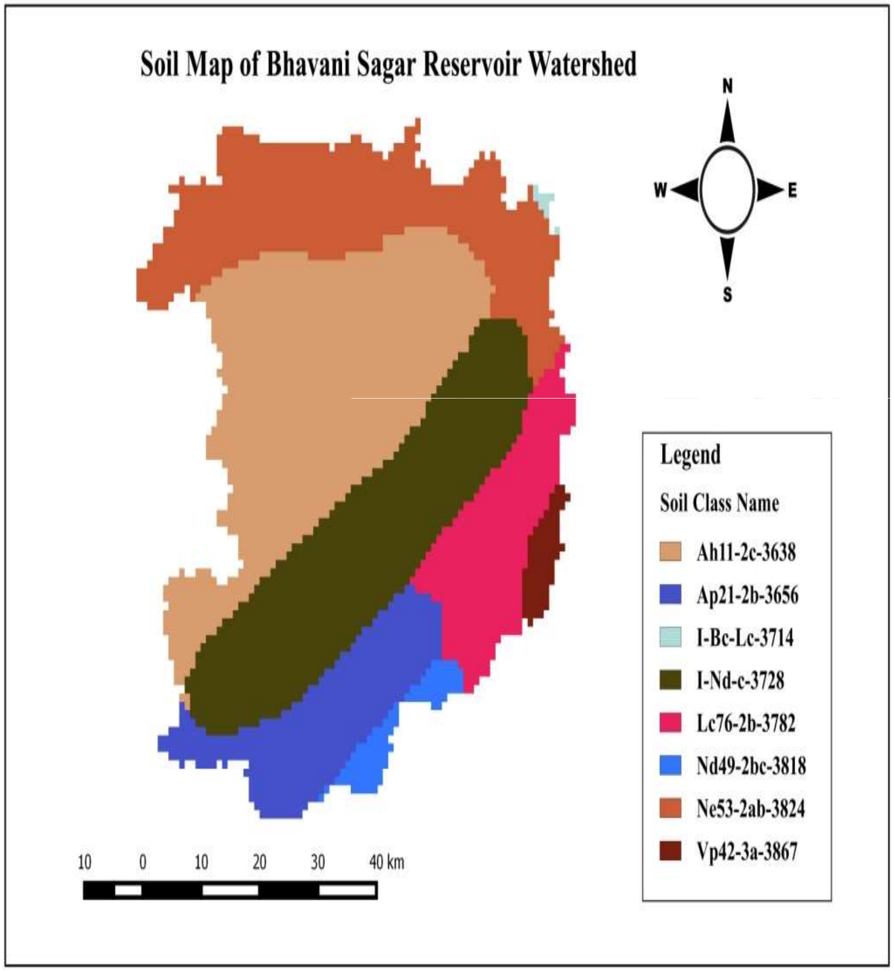
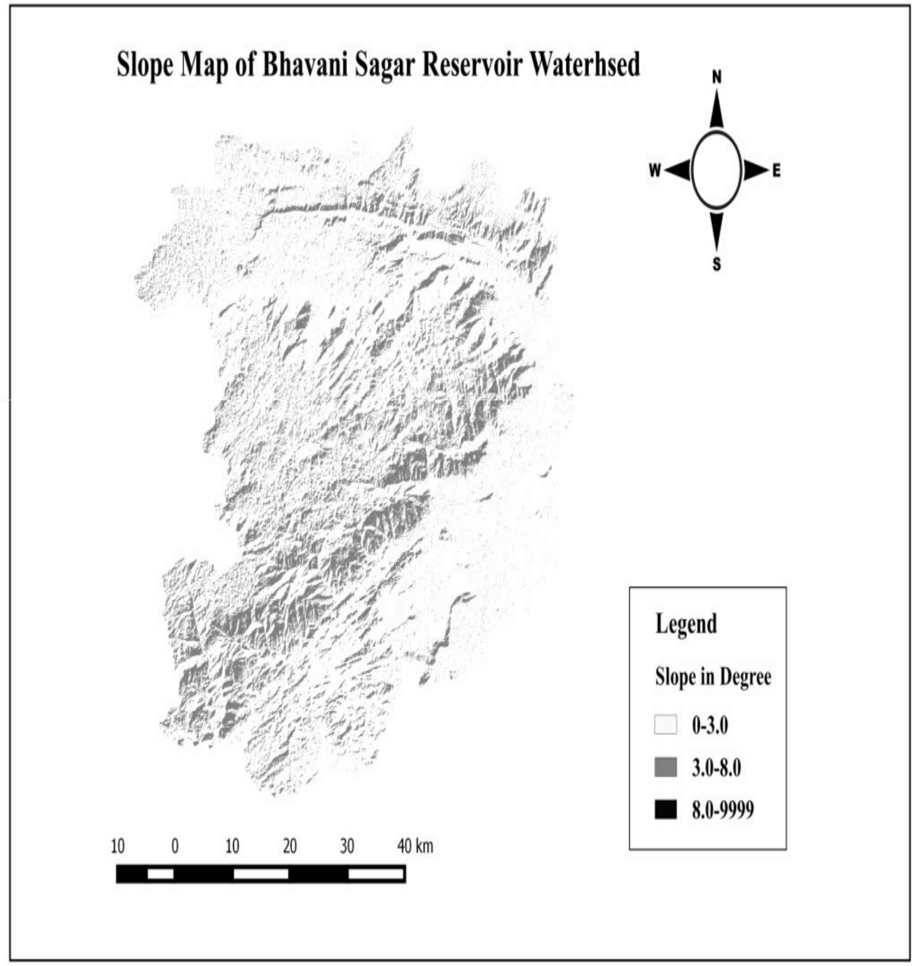


Soil Map of Bhavani Sagar Reservoir Watershed
N
W
E
S
Legend
Soil Class Name
Ah11-2c-3638
Ap21-2b-3656
I-Bc-Lc-3714
I-Nd-c-3728
Lc76-2b-3782
Nd49-2bc-3818
Ne53-2ab-3824
Vp42-3a-3867
10 0 10 20 30 40 km



Slope Map of Bhavani Sagar Reservoir Waterhsed
N
W
E
S
Legend
Slope in Degree
0-3.0
3.0-8.0
8.0-9999
10 0 10 20 30 40 km

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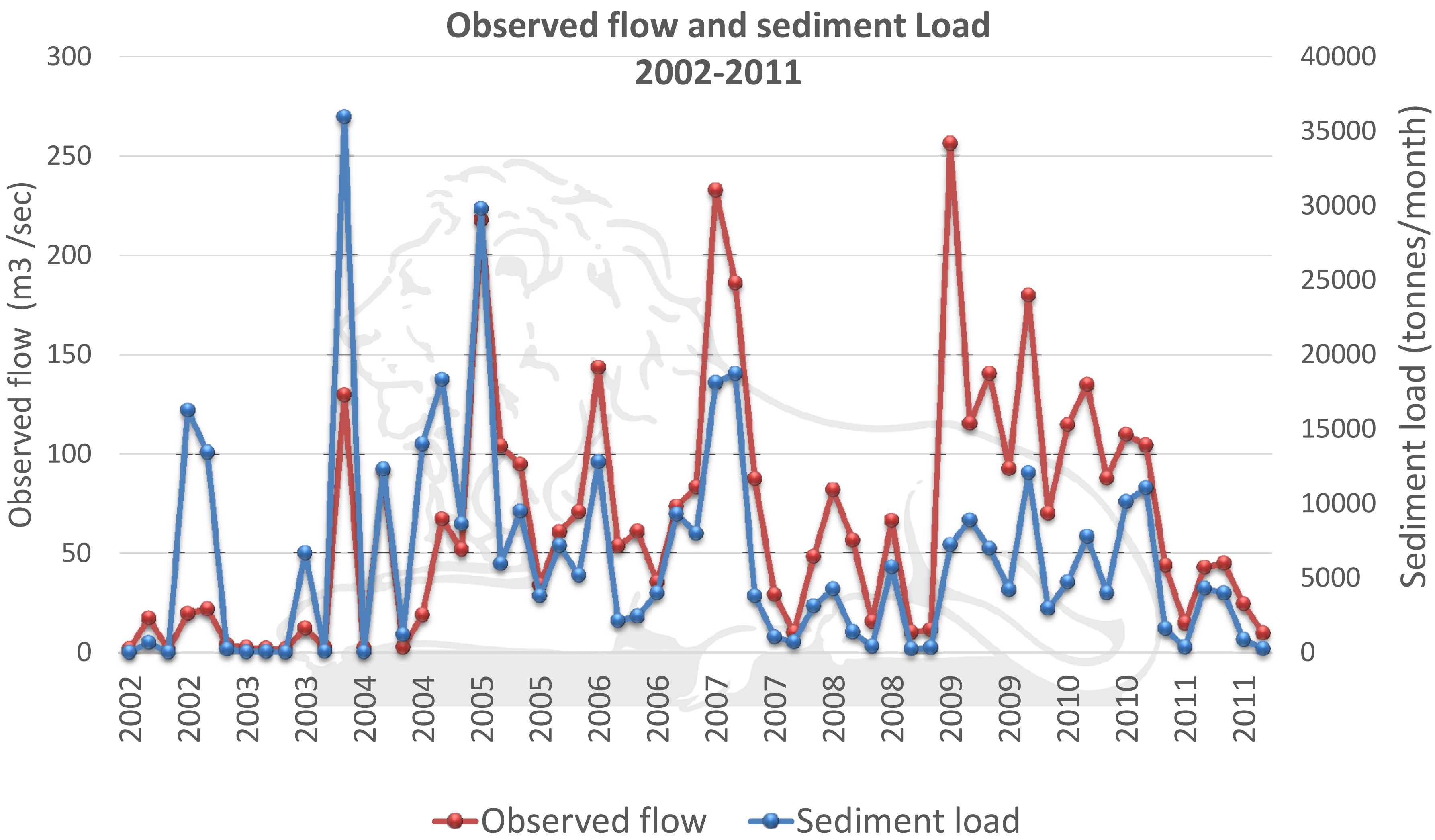

Observed flow and sediment Load
2002-2011
Observed flow (m3 /sec)
Sediment load (tonnes/month)
300
250
200
150
100
50
0
40000
35000
30000
25000
20000
15000
10000
5000
0
2002 2002 2003 2003 2004 2004 2005 2005 2006 2006 2007 2007 2008 2008 2009 2009 2010 2010 2011 2011
Observed flow
Sediment load

Results and Discussion

- Summary of Global sensitivity analysis for Runoff

Parameters name	P-value	t-stat	Rank
A__GWQMN.gw	-12.87	0.00	1
V__GW_REVAP.gw	-8.91	0.00	2
R__CN2.mgt	4.79	0.00	3
V__SLSUBBSN.hru	-3.35	0.00	4
A__REVAPMN.gw	3.19	0.00	5
A__GW_DELAY.gw	-3.08	0.00	6
V__ALPHA_BF.gw	2.20	0.03	7
V__CANMX.hru	-1.28	0.20	8
V__CH_S2.rte	-1.01	0.31	9
A__RCHRG_DP.gw	-0.95	0.34	10
V__ESCO.hru	-0.95	0.34	11
V__BIOMIX.mgt	0.80	0.43	12
V__CH_N2.rte	-0.49	0.62	13
R__SOL_AWC(..).sol	0.21	0.83	14
V__SURLAG.bsn	-0.11	0.92	15
V__EPCO.hru	0.02	0.98	16

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- Runoff Parameters range and most fitted value

Parameters name	Min_value	Max_value	Fitted_Value
R__CN2.mgt	-0.1	0.1	-0.0626
R__SOL_AWC(..).sol	-0.2	0.2	0.122
V__ESCO.hru	0.4	0.6	0.4482
A__GWQMN.gw	-1000	1000	-490
V__GW_REVAP.gw	0.02	0.2	0.12674
A__RCHRG_DP.gw	-0.05	0.05	-0.0025
A__REVAPMN.gw	-750	750	-139.5
V__ALPHA_BF.gw	0	1	0.357
A__GW_DELAY.gw	-30	60	1.590001
V__CANMX.hru	0	20	13.3
V__SLSUBBSN.hru	10	150	14.62
V__BIOMIX.mgt	0	1	0.895
V__SURLAG.bsn	0.05	24	11.47415
V__EPCO.hru	0	1	0.663
V__CH_S2.rte	0.001	10	6.850315
V__CH_N2.rte	0.01	0.3	0.01609

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Model Calibration for Stream flow

- The calibration of SWAT model for stream flow was done by using the monthly observed stream flow data at the outlet of the study watershed (Nillithurai gauge station) for the periods 2007 - 2009.
- The model was calibrated by using the values of the 16 parameters that were identified as highly sensitive to runoff
- The model calibration was seen to achieve convergence in 1000 iterations

Validation for stream flow

- The model validation done manually for the periods 2010-2011

Calibration Results

Statistical parameters	Nellithurai Gauge station	
	Calibration (2007-2009)	Validation(2010-2011)
	Runoff	Runoff
R^2	0.74	0.73
NSE	0.73	0.62
PBIAS	3.5	17.43

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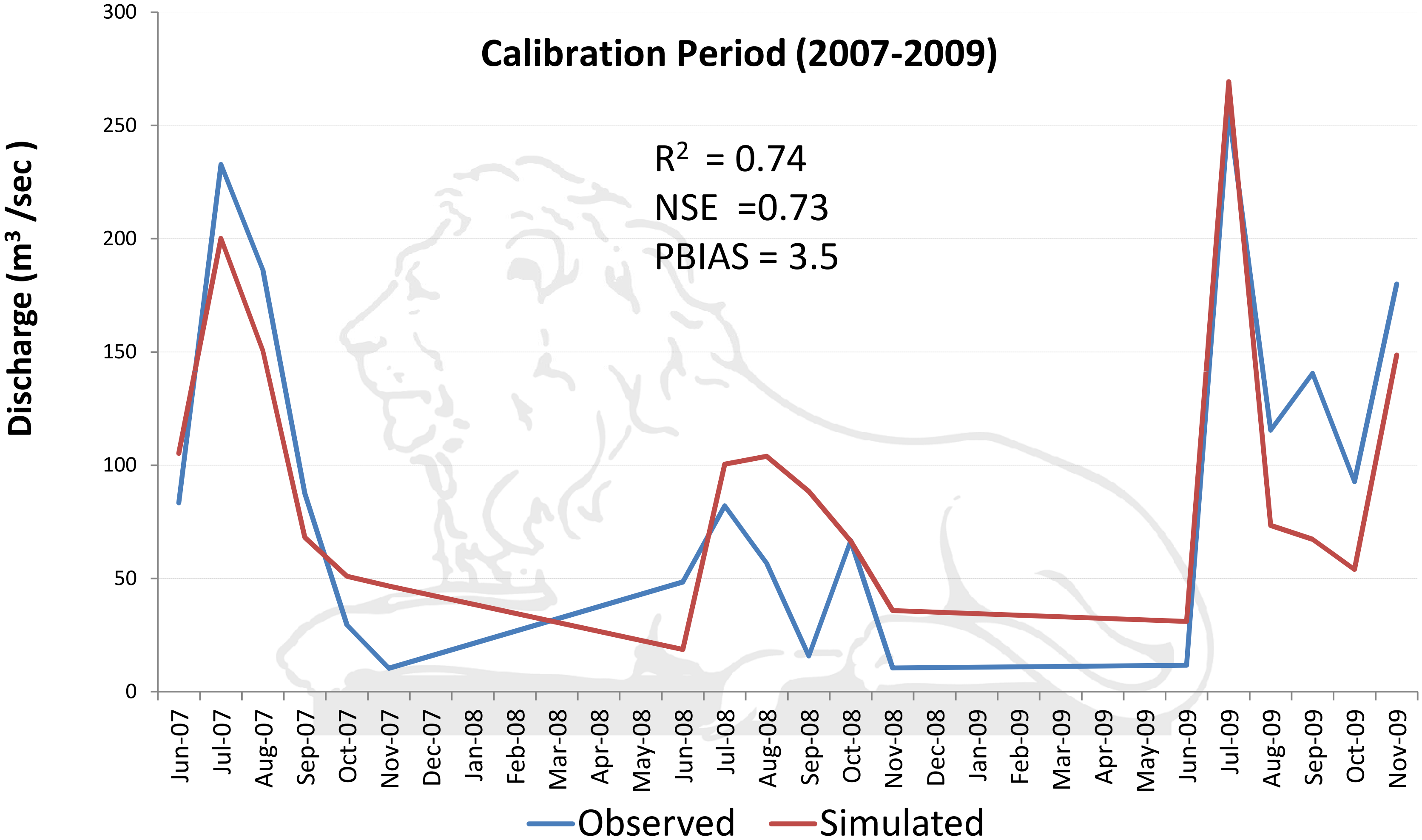
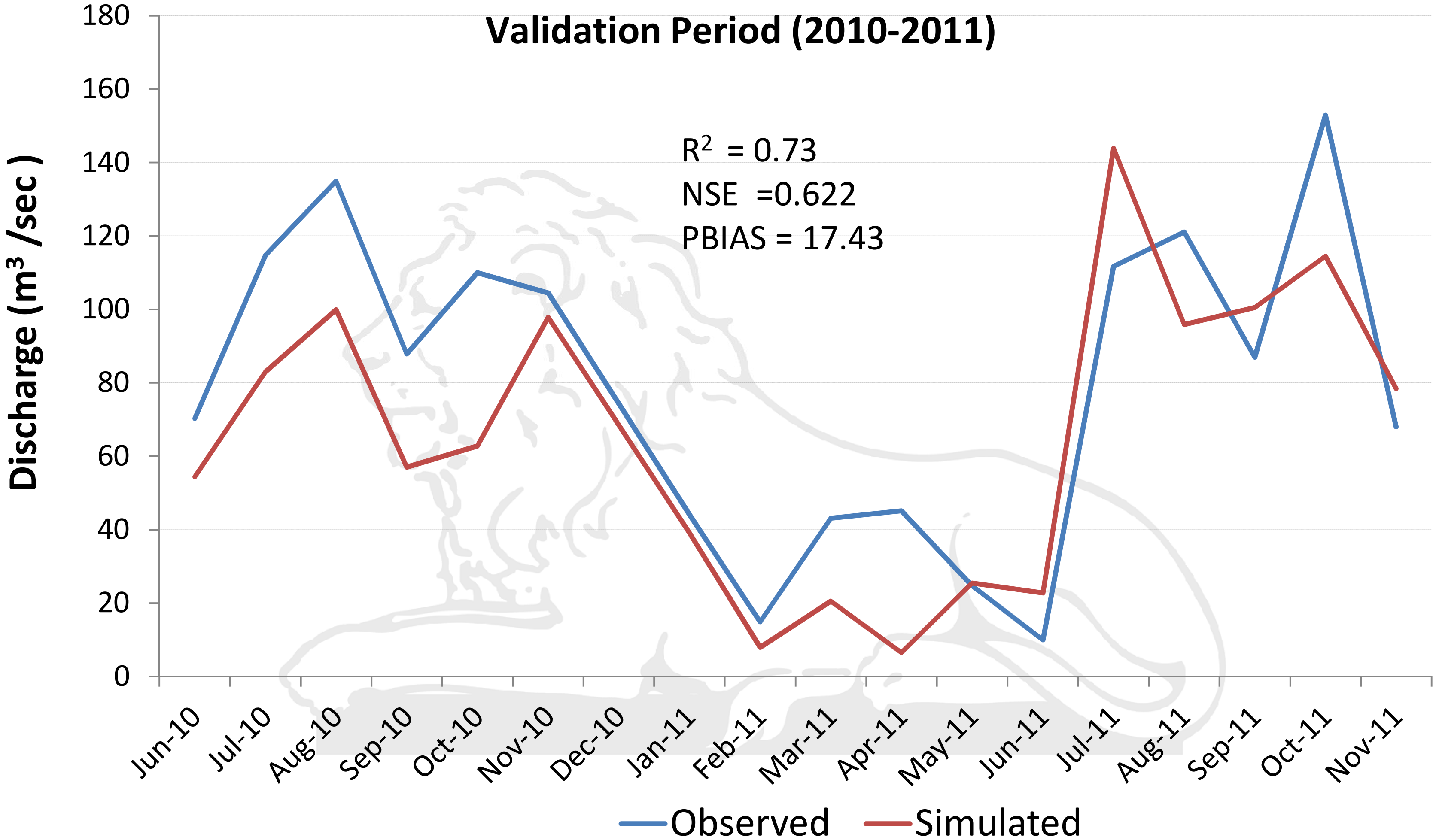


Calibration Period (2007-2009)
R² = 0.74
NSE =0.73
PBIAS = 3.5
Discharge (m³ /sec)
300
250
200
150
100
50
0
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Observed
Simulated

Continued...



Validation Period (2010-2011)
R^2 = 0.73
NSE =0.622
PBIAS = 17.43
Discharge (m³ /sec)
180
160
140
120
100
80
60
40
20
0
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Observed
Simulated

Conclusions

- The study demonstrated that, SWAT has the capability of simulating runoff from Bhavani Sagar Reservoir watershed but problem in simulating sediment yield from the watershed
- Watershed elevation varies from 264 to 2629 m and major rain gauge stations located in higher elevation
- Major portion of the Bhavani Sagar Watershed is covered by forests (81.40 %) followed by grassland (6.84 %) and the remaining area (11.76 %) is agricultural land.
- Recommendation for further sediment analysis ,checking rainfall pattern and observed flow is important.

Future Work

- Simulate the sediment yield from Bhavani Sagar Reservoir watershed and compare the result with actual sediment yield of Bhavani Sagar Reservoir watershed
- Identification of critical sub watersheds and to analyze the impact of soil conservation measures on sediment yield under different scenarios

Thank you