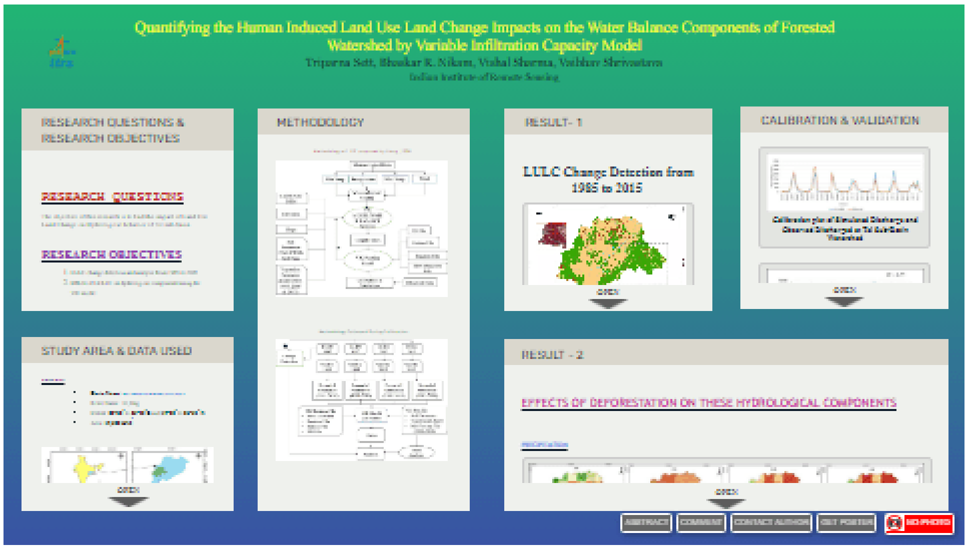
Quantifying the Human Induced Land Use Land Change Impacts on the Water Balance Components of Forested Watershed by Variable Infiltration Capacity Model



Triparna Sett, Bhaskar R. Nikam, Vishal Sharma, Vaibhav Shrivastava

Indian Institute of Remote Sensing

PRESENTED AT:

RESEARCH QUESTIONS & RESEARCH OBJECTIVES

RESEARCH QUESTIONS

The objective of this research is to find the impact of Land Use Land Change on Hydrological behavior of Tel sub-basin

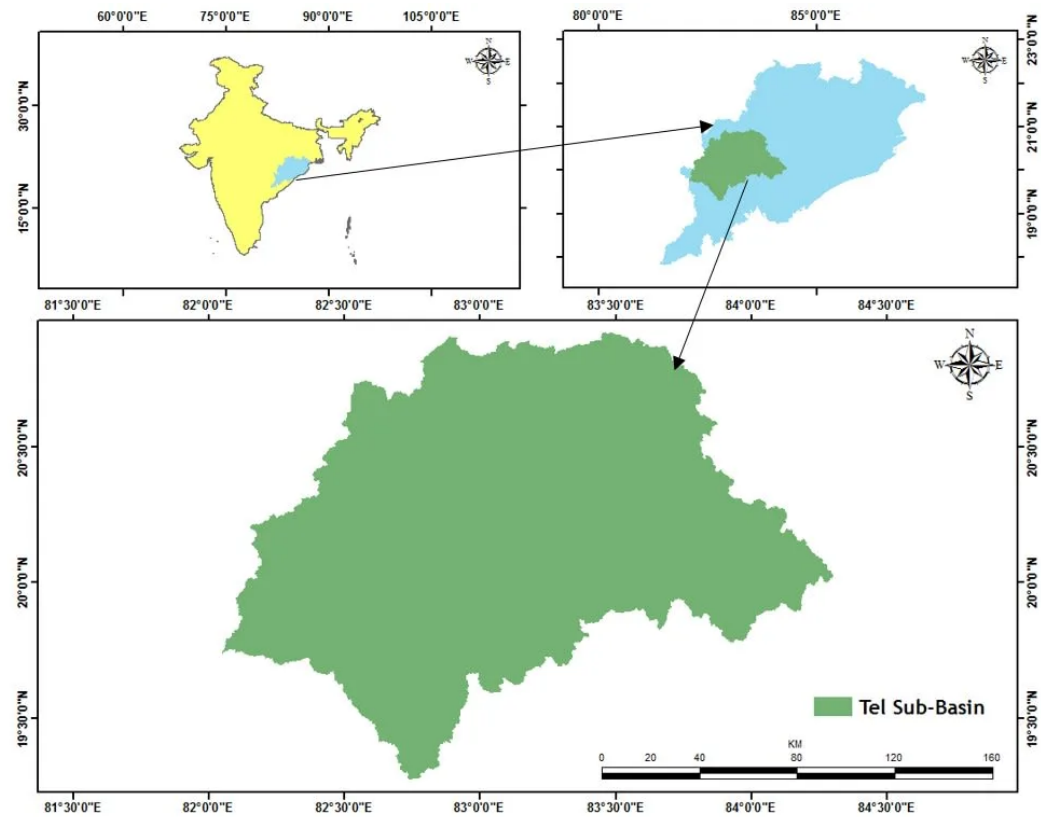
RESEARCH OBJECTIVES

1. LULC change detection and analysis from 1985 to 2005
2. Effects of LULCC on hydrological components using the VIC model

STUDY AREA & DATA USED

Study Area

- **Basin Name**: **Tel Sub-Basin of Orissa, India**
- River Name: Tel,Ong
- Extent: **80°30´** to **86°50´E** and **19°20´** to **23°35´ N**
- Area: **19,600 KM^2**

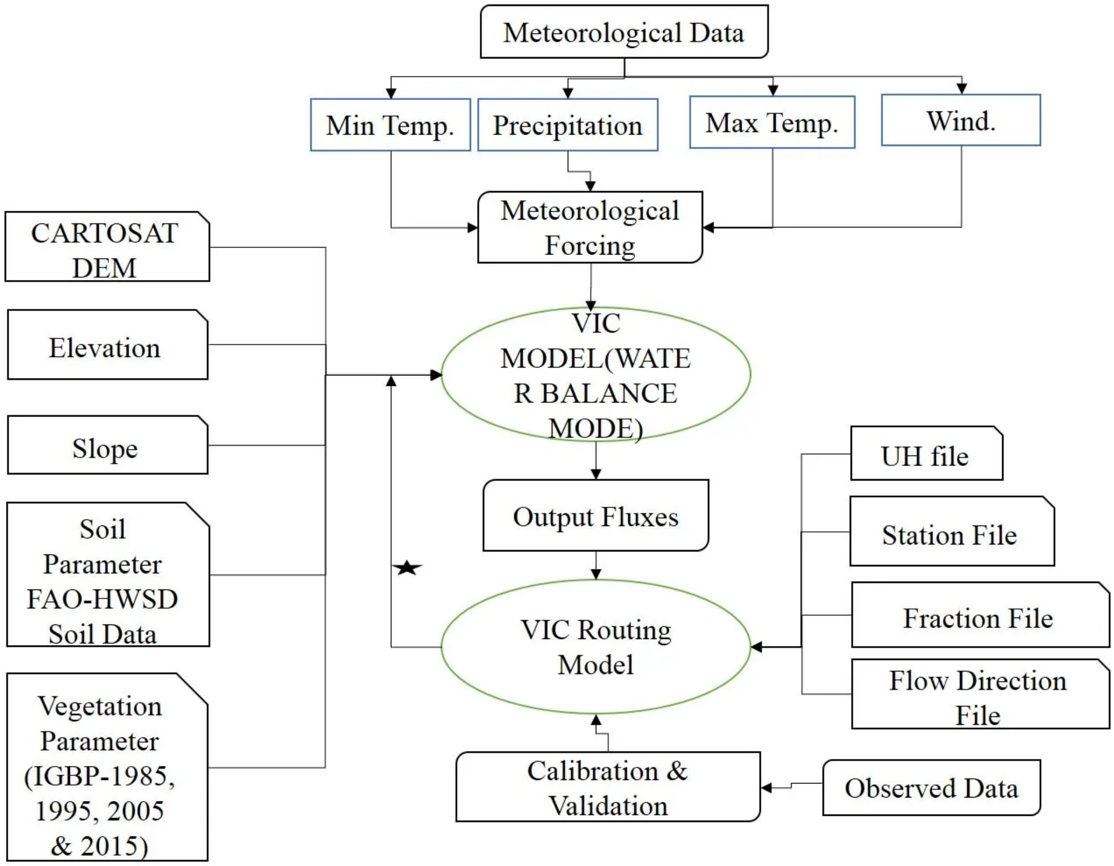


Data Used

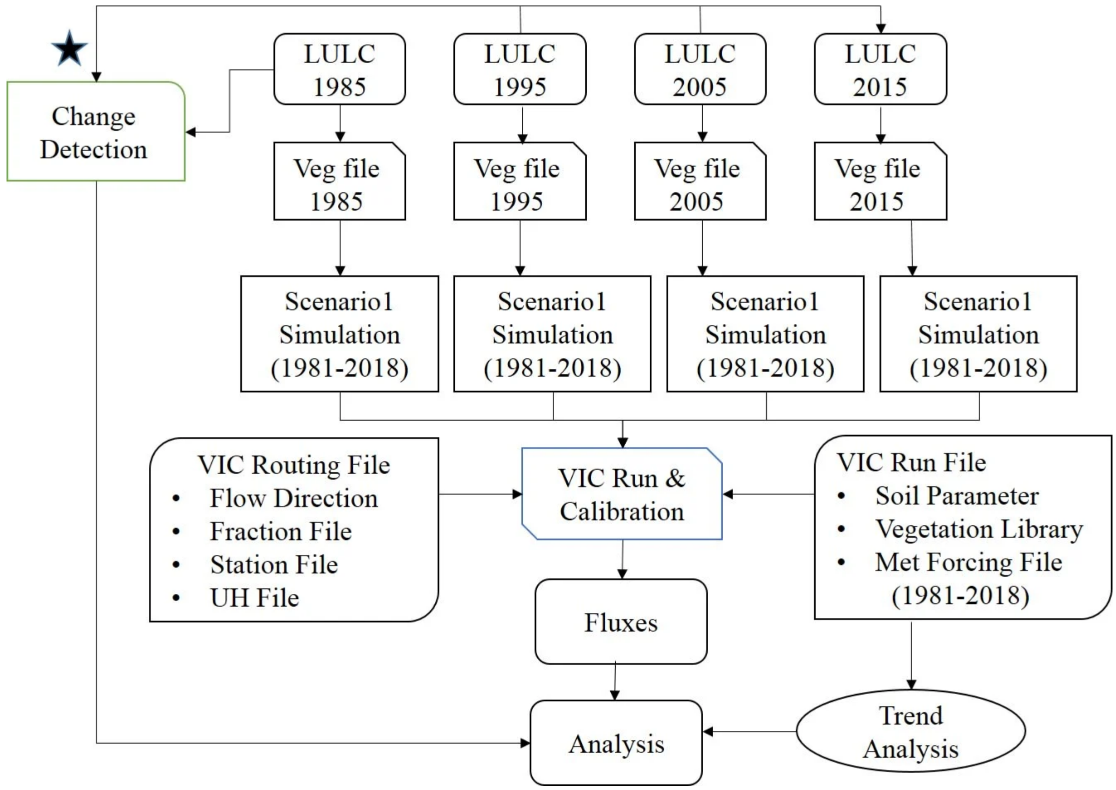
- **DEM**: SRTM DEM (30 m resoltion)
- **Soil data**: FAO (at HWSD)
- **LULC**: ISRO Biosphere-Geosphere based decadal Maps(100 m resolution)-1985, 1995, 2005, 2015
- **Meteorological data**: ERA5 reanalysis data from Copernicus Climate Change Service (C3S) (daily)

METHODOLOGY

Methodology of VIC proposed by Liang ,1996



Methodology Followed During Calibration



Change Detection
LULC 1985
LULC 1995
LULC 2005
LULC 2015
Veg file 1985
Veg file 1995
Veg file 2005
Veg file 2015
Scenario1 Simulation (1981-2018)
Scenario1 Simulation (1981-2018)
Scenario1 Simulation (1981-2018)
Scenario1 Simulation (1981-2018)
VIC Routing File
Flow Direction
Fraction File
Station File
UH File
VIC Run & Calibration
VIC Run File
Soil Parameter
Vegetation Library
Met Forcing File (1981-2018)
Fluxes
Analysis
Trend Analysis

RESULT- 1

LULC Change Detection from 1985 to 2015

[VIDEO] https://res.cloudinary.com/amuze-interactive/image/upload/f_auto,q_auto/v1669469907/agu%20fm2022/8b-f5-6e-bf-12-73-f8-90-19-75-c4-c3-42-12-f3-34/image/lulc1_qhwydu.mp4

LULC of 1985 of Tel Sub-basin

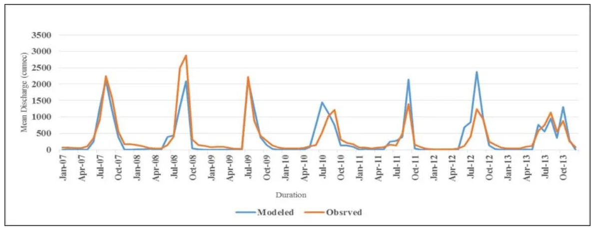
[VIDEO] https://res.cloudinary.com/amuze-interactive/image/upload/f_auto,q_auto/v1669469907/agu%20fm2022/8b-f5-6e-bf-12-73-f8-90-19-75-c4-c3-42-12-f3-34/image/lulc2_kuoiwx.mp4

LULC of 2015 of Tel Sub-basin

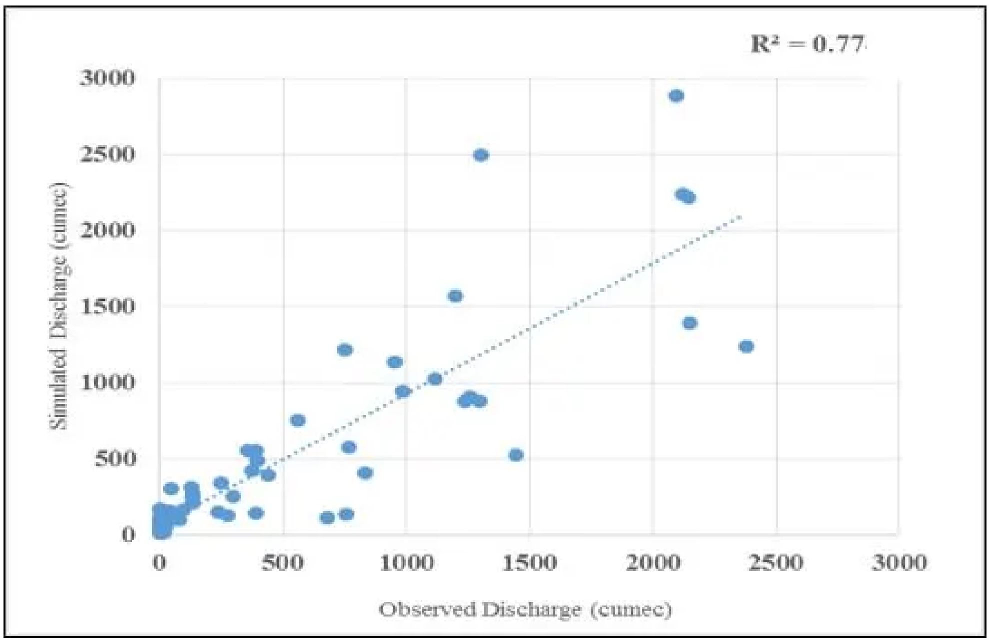
Value	Class	LULC_1985 (km^2)	LULC_2005 (km^2)	LULC_Change(%)
1	Deciduous Forest	735034	597079	18.80
2	Cropland	1196523	1314537	9.87
3	Built-Up	7068	8130	15.20
4	Mixed Forest	152491	148279	2.77
5	Shrub land	135439	150740	11.20
6	Barren Land	1858	3764	102.85
7	Fallow Land	4529	6390	40.40
8	Wasteland	183	1926	952.45
9	Water bodies	36196	38523	6.370
10	Plantation	1498	1271	14.75

Change detection showing in KM^2

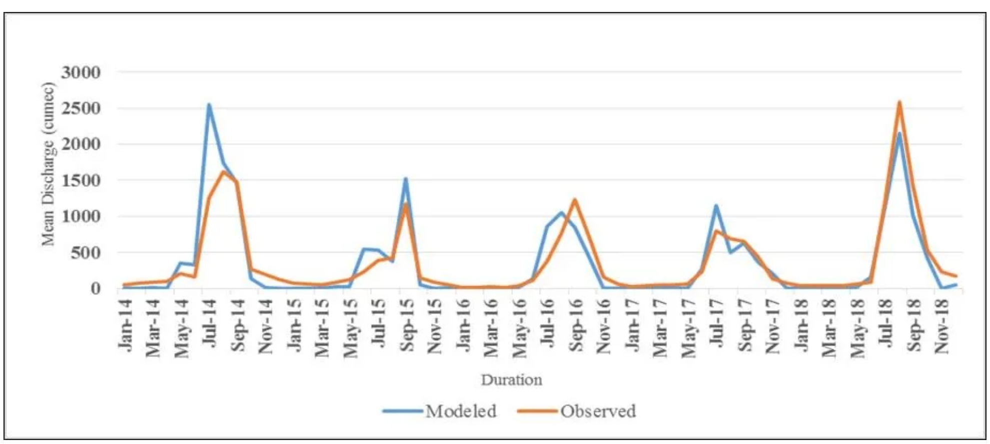
CALIBRATION & VALIDATION



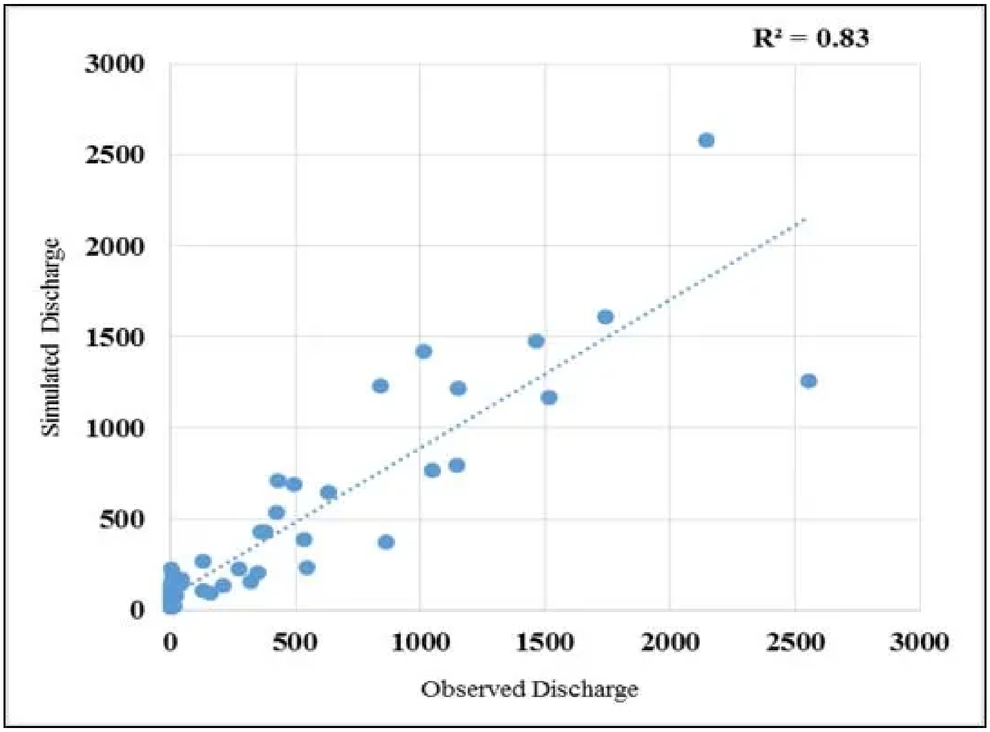
Calibration plot of Simulated Discharge and Observed Discharged at Tel Sub-Basin Watershed



Scatterplot between Observed and Simulated Discharge for Tel Sub-Basin Watershed



Validation plot of Simulated Discharge and Observed Discharge at Tel Sub-Basin Watershed



Scatterplot between Observed and Simulated Discharge for Tel Sub-Basin Watershed

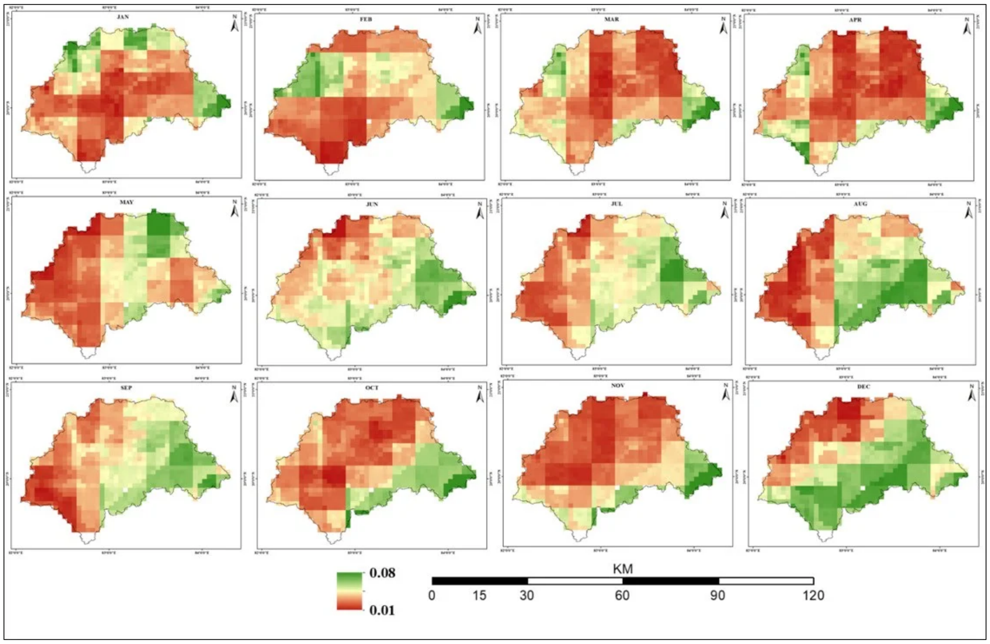
	Calibration	Validation
R^2	0.77	0.83
NSE	0.75	0.78

R^2 and NSE value during
Calibration and Validation

RESULT – 2

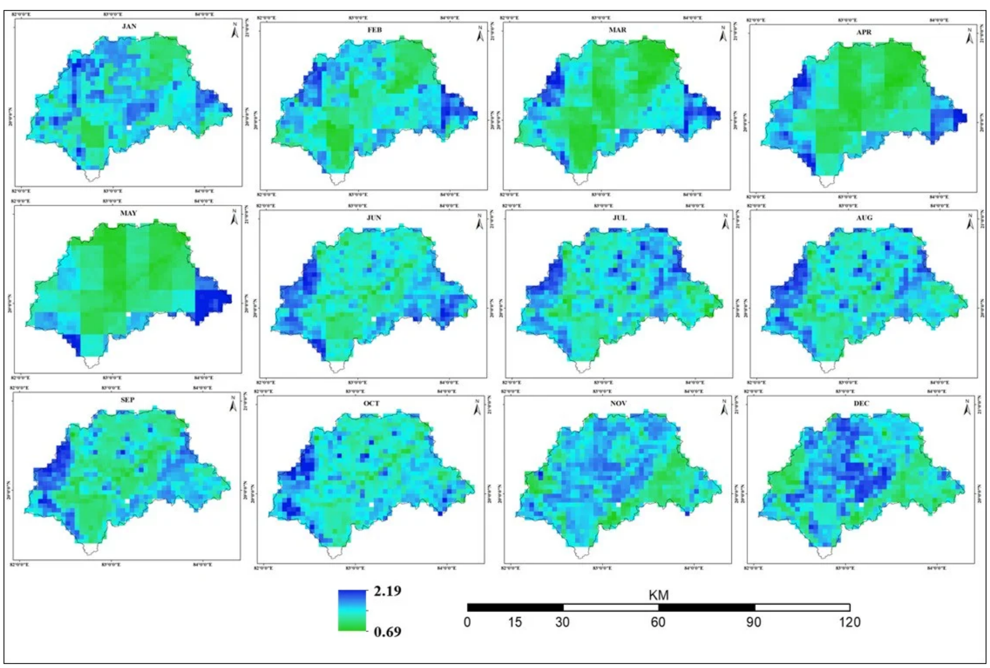
EFFECTS OF DEFORESTATION ON THESE HYDROLOGICAL COMPONENTS

PRECIPITATION



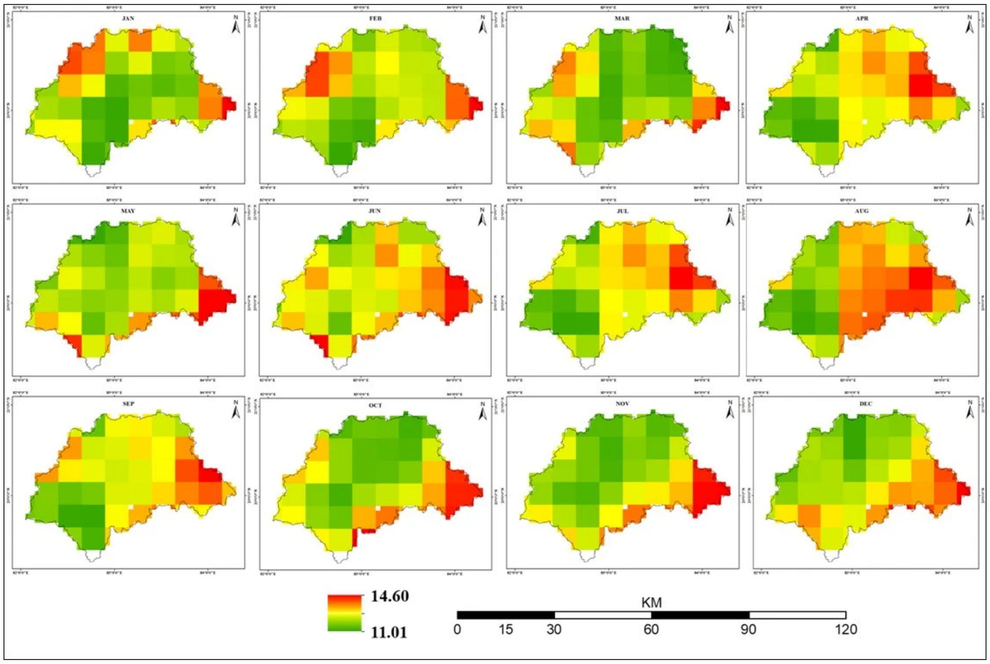
MONTHLY AVERAGE OF PRECIPITATION FROM 1985 to 2015

EVAPOTRANSPIRATION



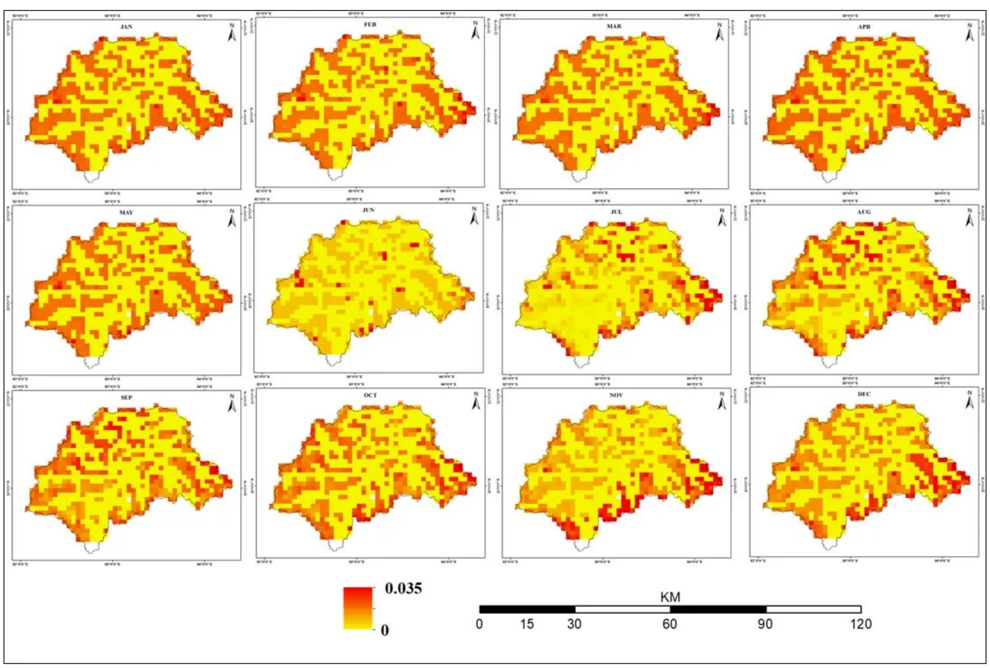
MONTHLY AVERAGE OF EVAPOTRANSPIRATION FROM 1985 to 2015

RUN-OFF



MONTHLY AVERAGE OF RUNOFF FROM 1985 to 2015

BASEFLOW



MONTHLY AVERAGE OF BASEFLOW FROM 1985 to 2015

DISCUSSION

- The VIC hydrological model was used to look at the sub-basin of the Mahanadi basin called the Tel catchment to see what effect LULCC would have on its hydrological regime. Three different scenarios from 1985 to 2015 were used to look at how LULC changed over time.

- At the basin scale, each LULC class showed significant changes within these periods, according to the findings. The greatest change was observed in the forest cover, which was transformed into agricultural land, and the built-up area over time.
- Later, it was looked into how these changes in LULC affected the hydrological parts of the sub-basin. Wherever the changes in LULC between 1985 and 2015 were significant, there was a major change in the basin's water balance.
- In areas where forest cover has decreased, runoff has greatly increased. In urbanized areas, on the other hand, there was a general trend toward more runoff and less ET. Since the amount of vegetation covering the land has gone down, the amount of runoff has gone up. The decrease in plant surface decreases transpiration, which is shown by a drop in ET as a whole.

ABSTRACT

The LULC change in relation to climate change, which inevitably includes human aspects, has an effect on hydrological processes. It may alter somewhat, and this may have an impact on the water yield because different hydrological processes clearly link the two. The management and planning of land use in this changing environment will have a significant impact on the future availability of water supplies. However, ongoing human interactions continue to change the land use and land cover (LULC) in order to meet the increased demand, particularly as a result of the population's sharp expansion and the creation of better facilities. As a result, these changes have an effect on all hydrological processes in terms of the availability of water. Planners and administrators of water resources are already concerned about it. This research investigates the viability of applying the **Variable Infiltration Capacity (VIC)** model to estimate runoff, evapotranspiration, and baseflow from 1985 to 2015 on Tel sub-basin. The model simulation indicates that evapotranspiration has decreased 1.63 %, runoff has increased 1.15 %, and baseflow has risen 3.87 %. The rate of runoff generation is significant in regard to the 1600 km^2 of forest converted to agricultural land. It is also analyzed that forest cover decreased by 8.20%, agriculture increased by 7.08 %, the urban area increased by 0.32 % from 1985 to 2015 which lead significant impacts on water balance components of these estimated scenarios. It can be deduced that between scenarios S1 and S4 (2015 to 1985), the overall trend of runoff is significantly enhanced by 67.33 mm while ET is dropped by 167.48 mm due to the lack of deep-rooted vegetation cover, and baseflow is also increased by 108.25 mm. Changes to the LULC resulting from deforestation, urbanisation, and agricultural development resulted to a reduction in canopy cover. This causes decreased rate interception and transpiration, contributing to a decline in ET and a rise in runoff and base flow. This study confirms the hydrological changes caused by LULCC, thereby contributing to the sustainable ecology-based integrated management of water resources