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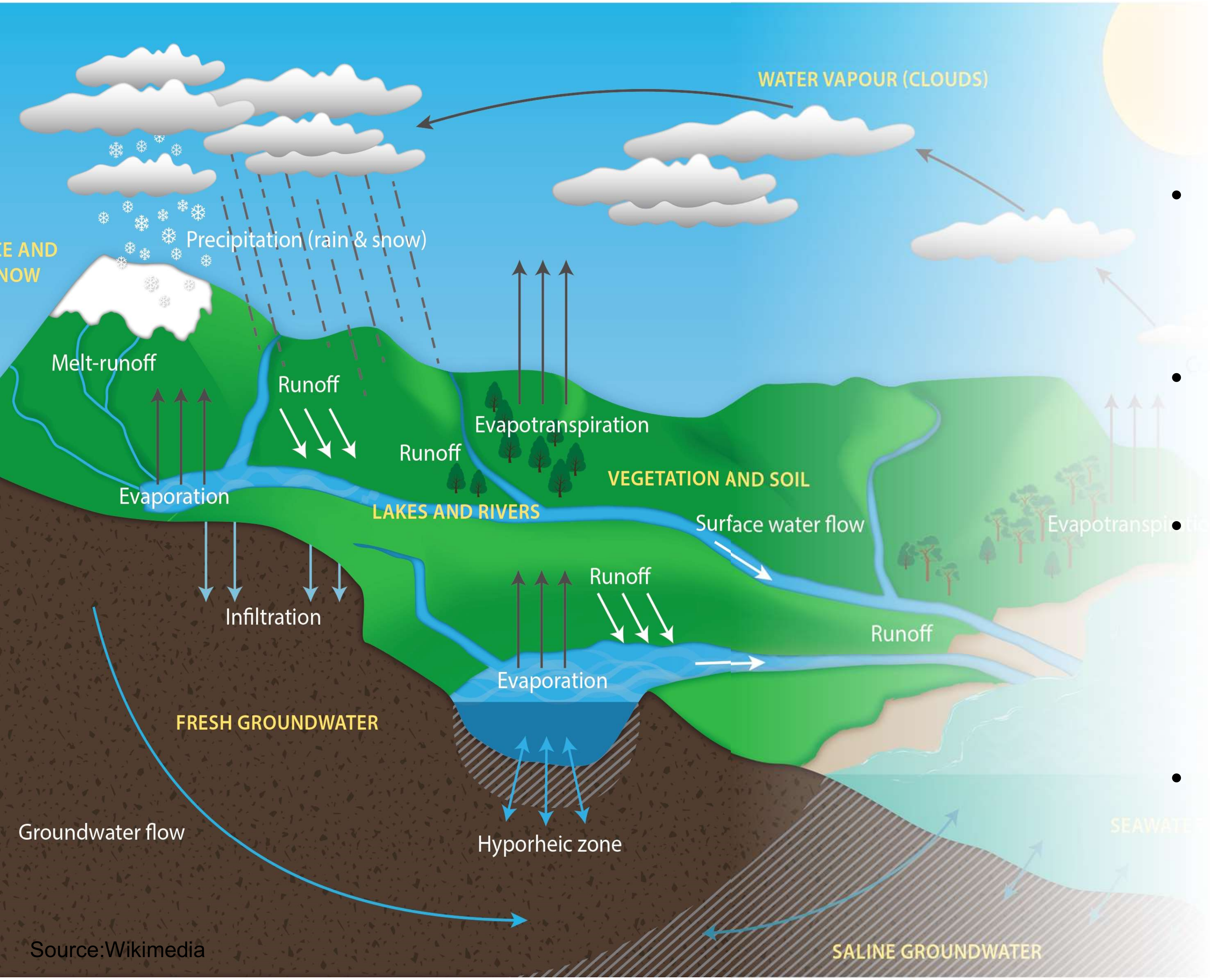
Temporal change dynamics of the hydrometeorological conditions of upper Subarnarekha River Basin (SRB) using geospatial techniques

Farhin Tabassum*
Akhouri Pramod Krishna

Department of Remote Sensing
Birla Institute of Technology, Mesra
India-835215

INTRODUCTION



Source:Wikimedia

- Water is a key resource for sustainable economic and social development. Hence it needs to be carefully monitored and managed.
- The effect of climate change has greater impact on the geo-hydrological system of river basin.
- These changes may be due to natural or anthropogenic activities, which may induce extreme aridity, excessive humidity, negligible rainfall, increased surface runoff, soil erosion, flood and drought.
- Watersheds are important units of which water and other natural resources can be strategically managed.

OBJECTIVE

Assessment of spatio-temporal changes in LULC

Assessment of spatio-temporal changes in climatic parameters such as rainfall and temperature

Their impact on the variability of groundwater level

STUDY AREA

Upper Subarnarekha River Basin falls in the tropical region of eastern India and is passing through the states of Jharkhand and West Bengal

It extended 22°01’ N to 23°35’ N latitude and 85°05’ E to 86°55’ E longitude covering an area 17,037 sq. km.

The main tributaries are Kanchi, Karkari, Kharkai, Raru, Garru, Dulang.

Annual average rainfall varies between approximately 1,200 and 1,800 mm with maximum rainfall experienced during June to October.

Annual average temperatures vary from 23°C to 28°C.

Geologically, the basin is divided into three formations Pre-Cambrian (upper and middle parts of the basin), Tertiary formations and Quaternary formations (lower part of the basin).

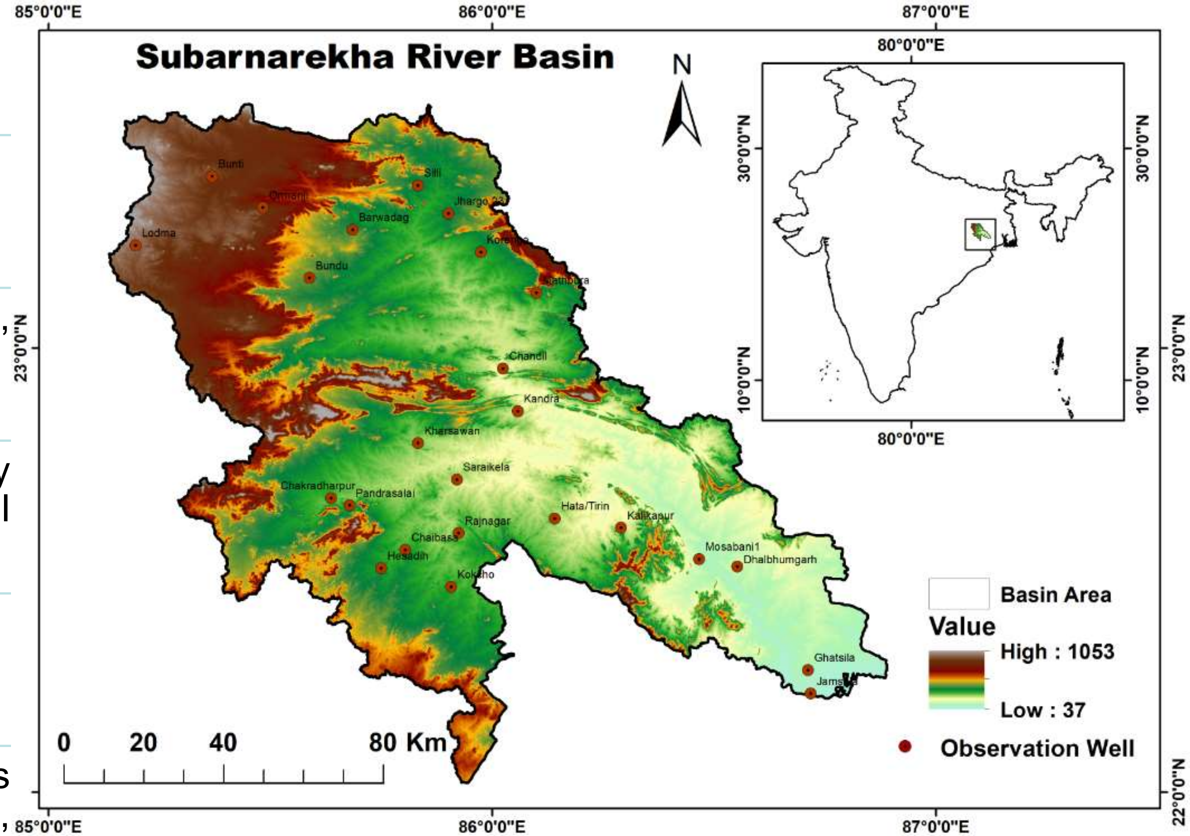


Fig-1: Location map of the upper Subarnarekha River basin with groundwater observation well points on SRTM 30 m DEM

Data Used

A. Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System (FLDAS)

1. Variable – Temperature
2. Source - https://ldas.gsfc.nasa.gov/fldas/
3. Time Span – 2001 to 2020
4. Spatial Resolution – 0.01^{o} (Resampled to 0.05^{o})

B. Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)

1. Variable – Precipitation
2. Source – https://data.chc.ucsb.edu/products/CHIRPS-2.0/
3. Time Span – 2001 to 2020
4. Spatial Resolution – 0.05^{o}

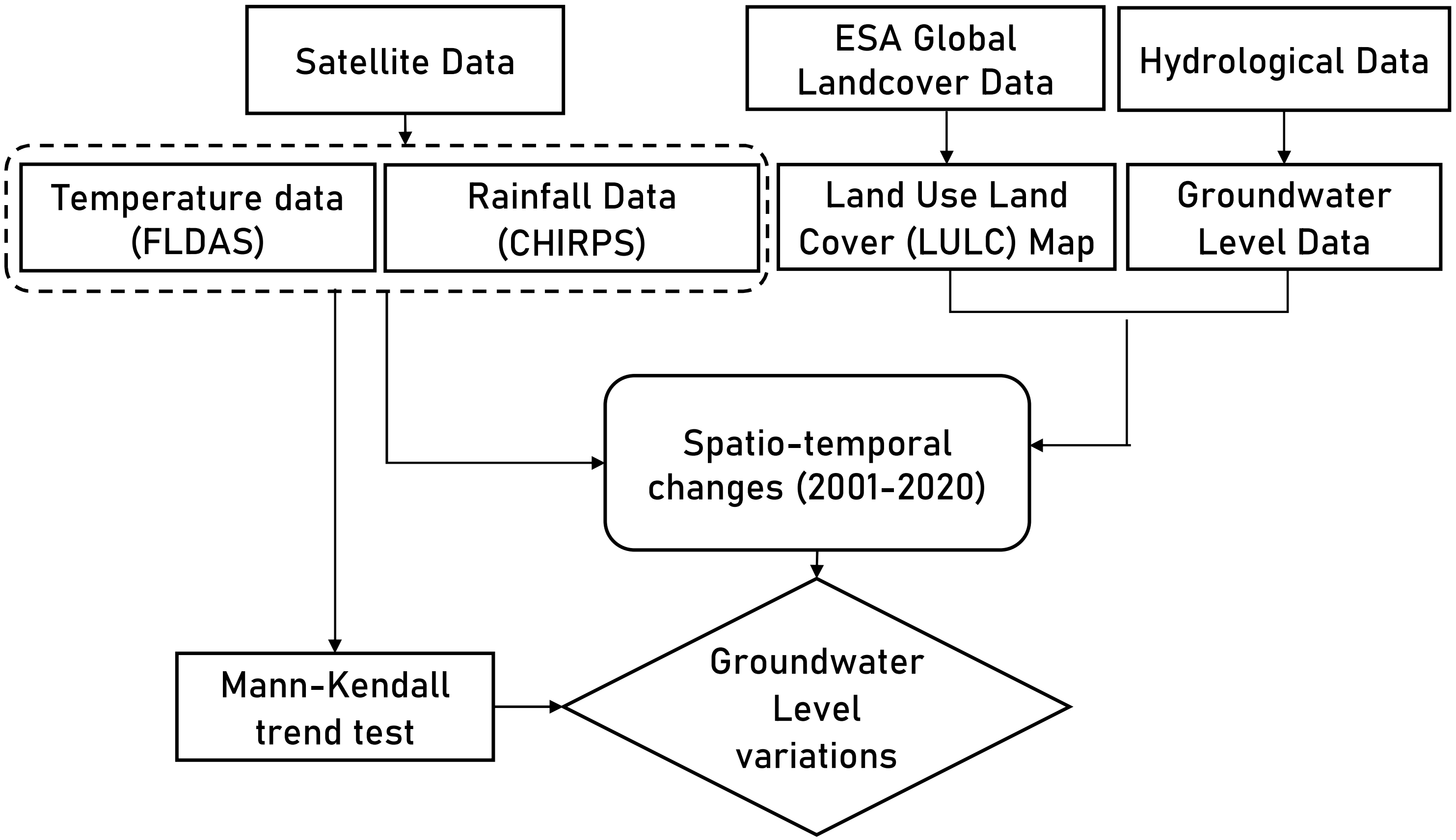
C. Ground water Level Data

1. Variable- Ground Water Level
2. Source- https://indiawris.gov.in/wris/#/groundWater
3. Time Span – 2001 to 2020

D. European Space Agency (ESA) Climate Change Initiative (CCI), Global land cover map

1. Source – https://www.esa-landcover-cci.org/
2. Variable - Land Use Land Cover
3. Time Span – For the year 2001, 2010, and 2020
4. Spatial Resolution – 300m

METHODOLOGY

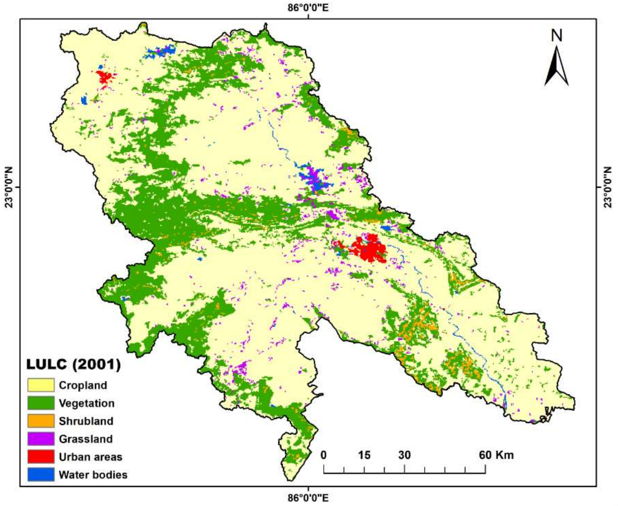


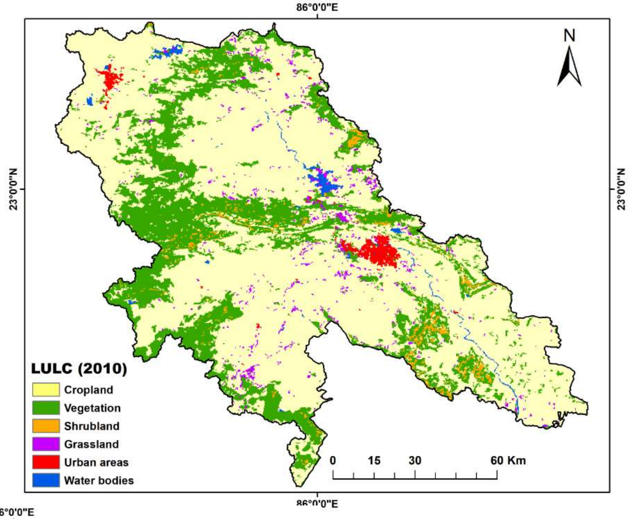
RESULTS

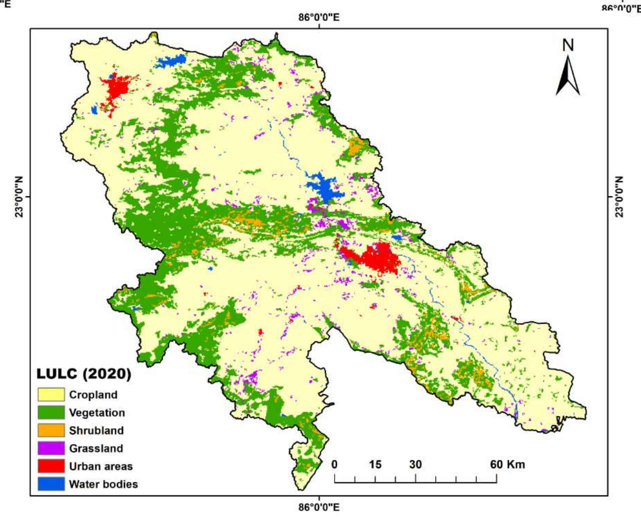
- There is a rapid increase in built up area, water bodies, barren land and shrub land.
- There is a decrease in vegetation and cropland.

LULC Class	Change 2001-2020			
	Total Area (sq.km)	Total Area (sq.km)	Change in Area	% Change in Area
Cropland	9882.92	9705.09	-177.83	-1.80
Vegetation	3424.07	3377.36	-46.71	-1.36
Grassland	282.70	279.51	-3.19	-1.13
Urban areas	100.19	212.79	112.60	112.39
Shrubland	201.35	288.31	86.96	43.19
Water bodies	104.19	141.80	37.61	36.10

Assessment of Land Use / Land Cover changes

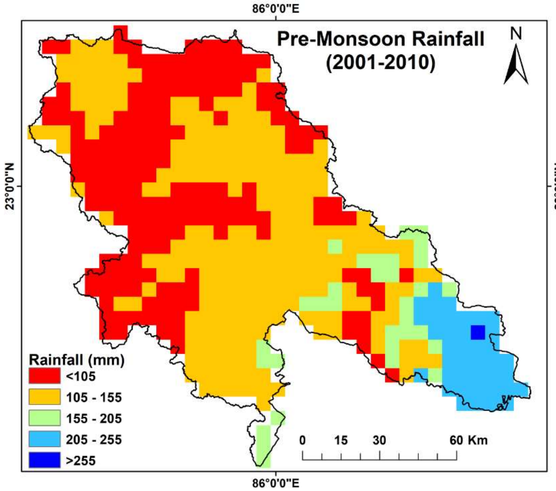


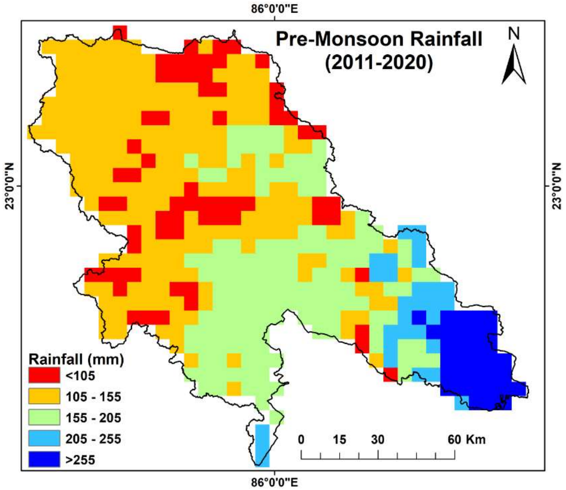


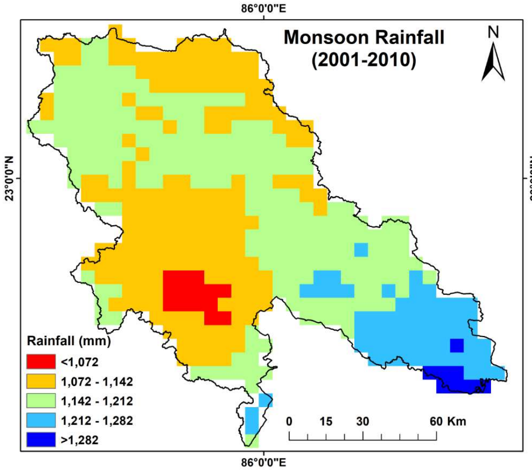


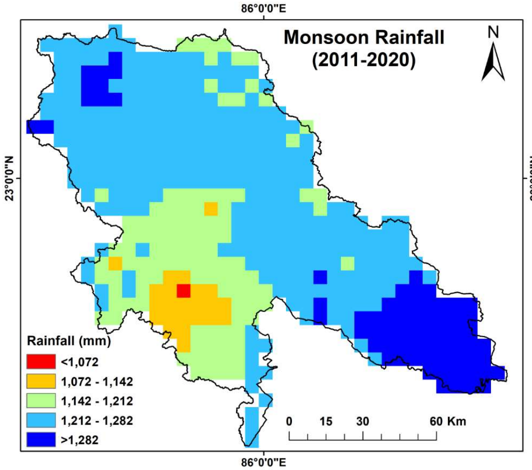
Spatial and temporal distribution of Rainfall

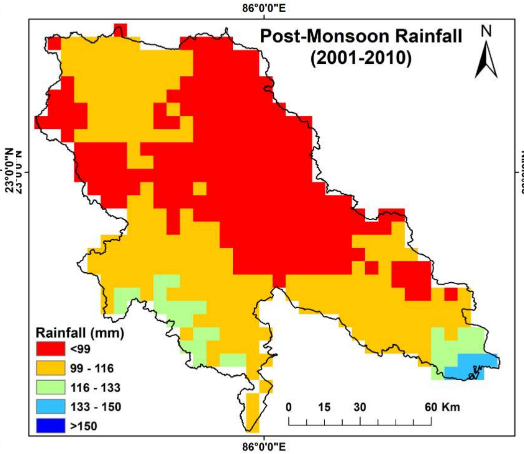
- A noticeable increase in both the precipitation and temperature is evident in all seasons from 2011-2020
- The map highlights consistently higher rainfall in the south-eastern part of the basin

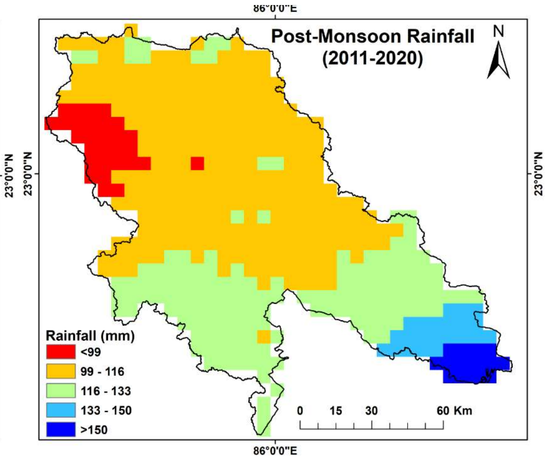






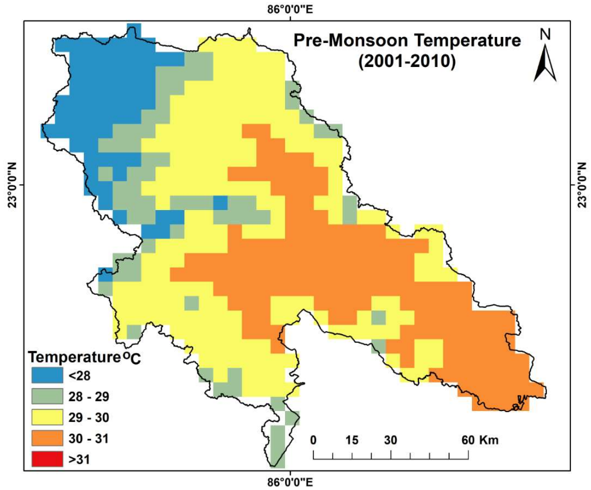


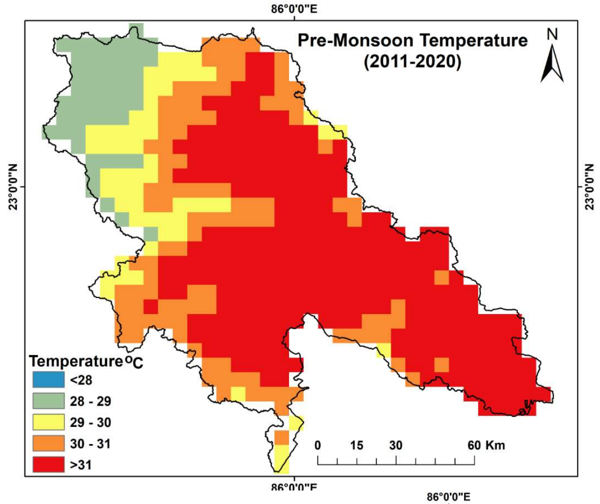


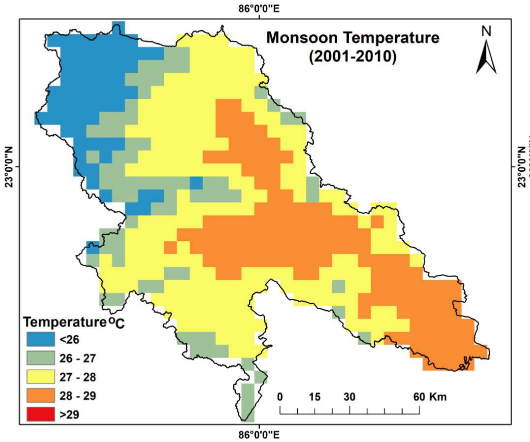


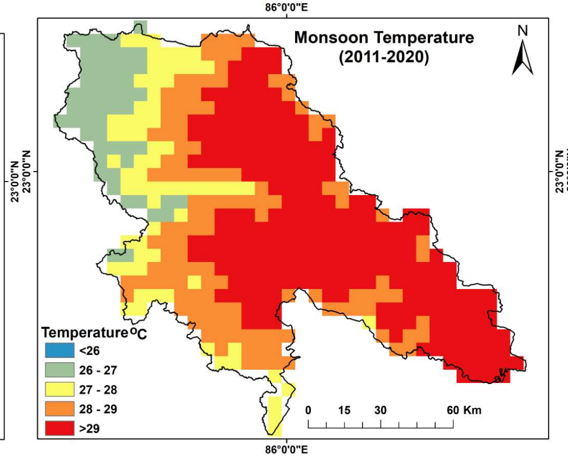
Spatial and temporal distribution of Temperature

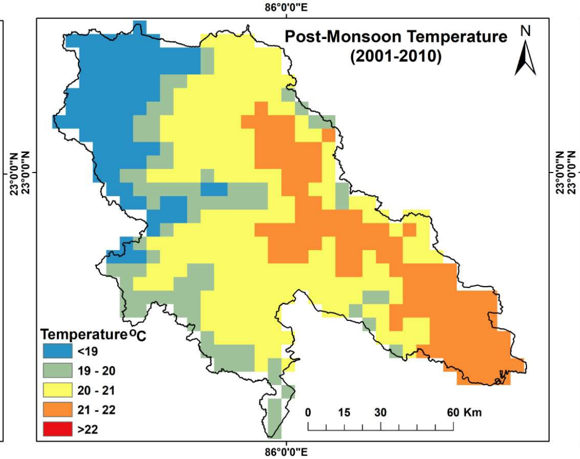
- Higher temperatures have expanded towards the southeastern part of the basin, aligning with rainfall patterns.
- Increased temperatures can boost evaporation and the atmosphere's water-holding capacity, potentially leading to more rainfall

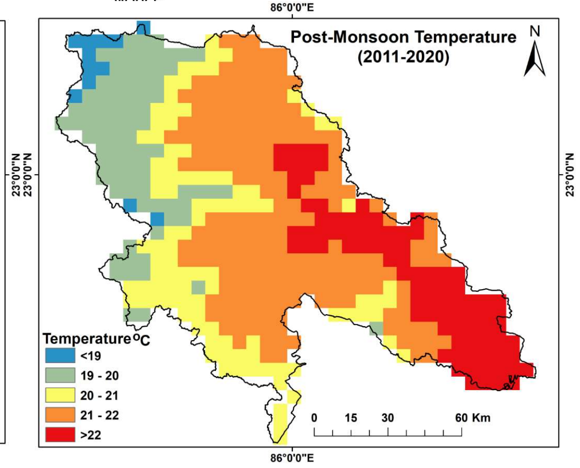




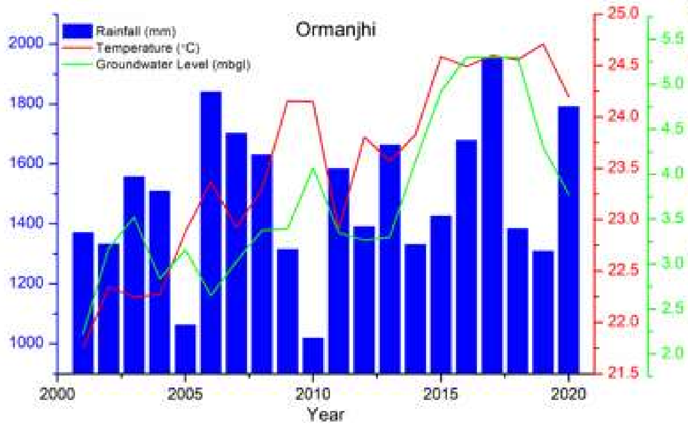


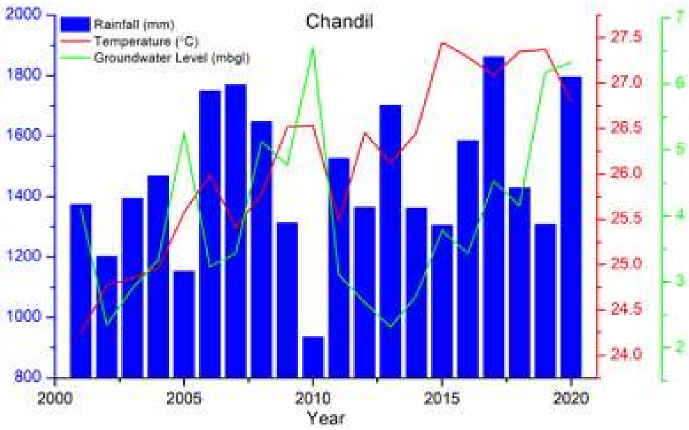


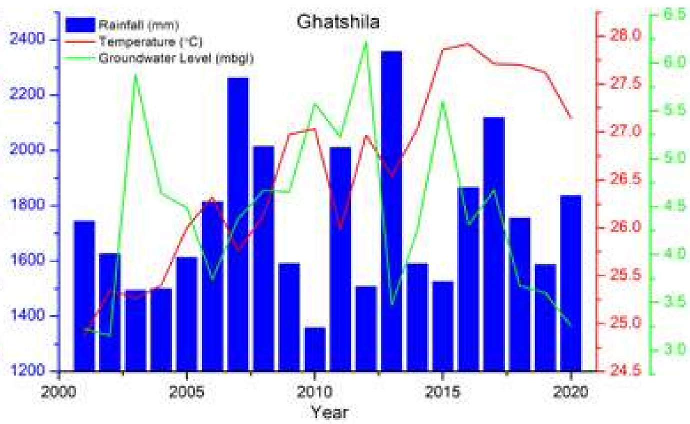




Station wise variation of Groundwater level relative to rainfall and temperature



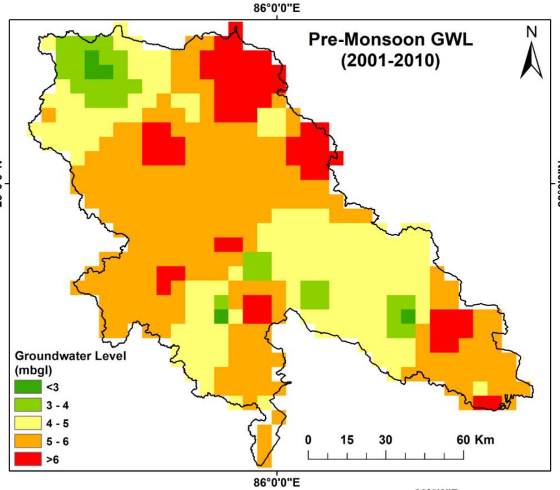


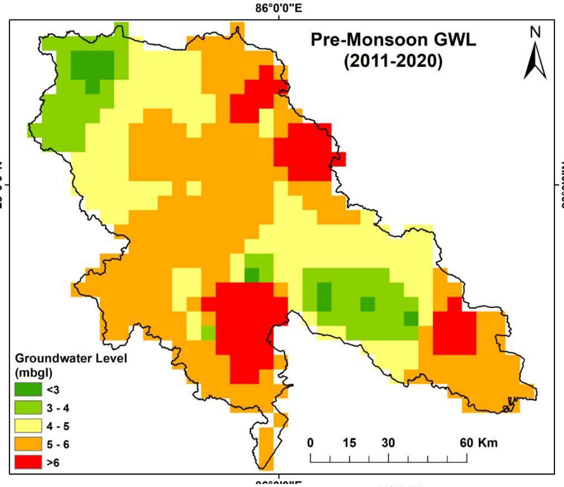


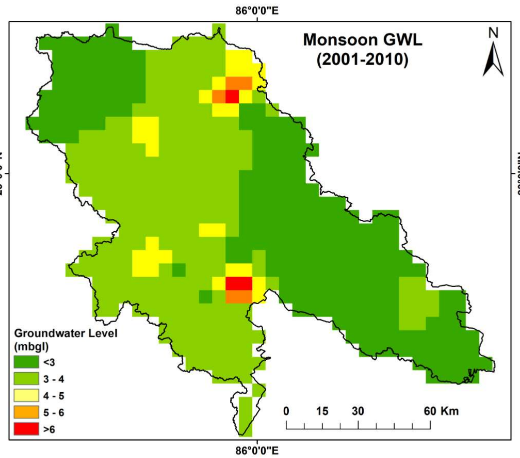
Elevated levels of rainfall correspond to an increase in groundwater levels

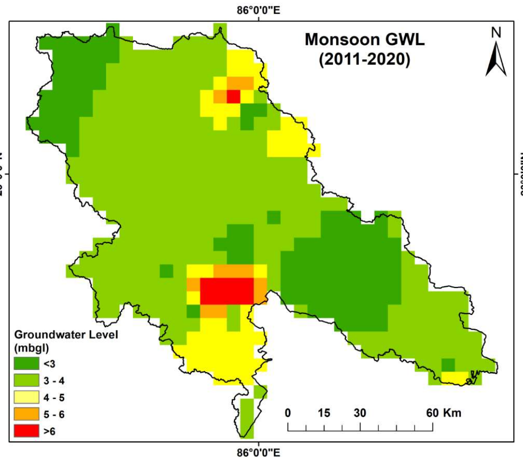
Spatial and temporal distribution of groundwater level

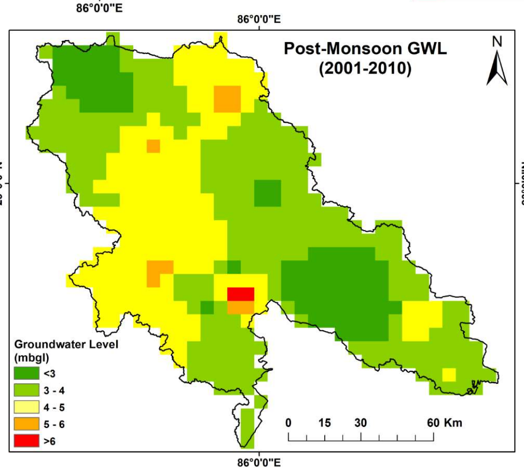
In the pre-monsoon season, there is a noticeable decline in the mean water level, with a significant portion of the basin recording groundwater level below 6 meter below ground level (mbgl) in both decades

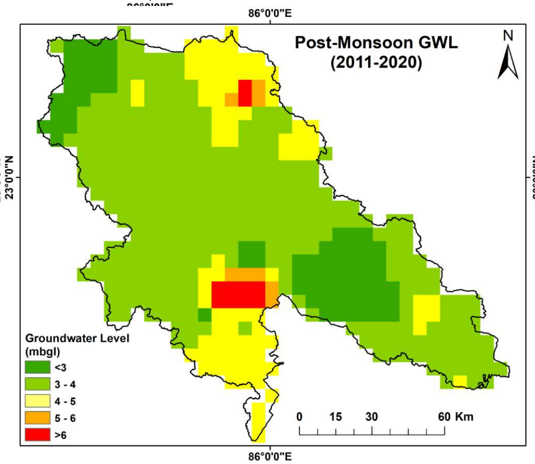






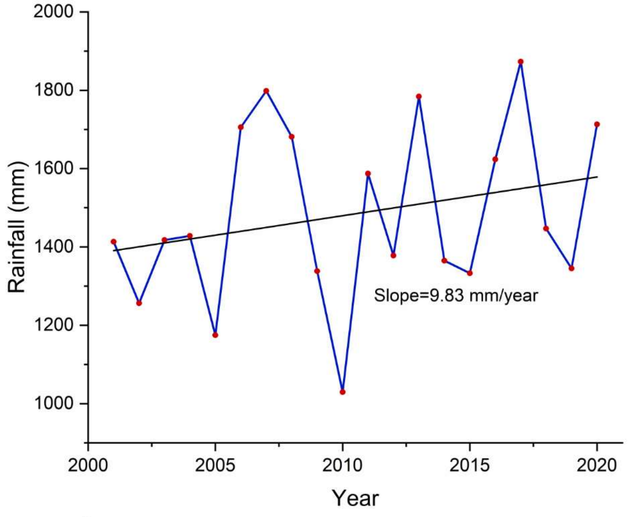


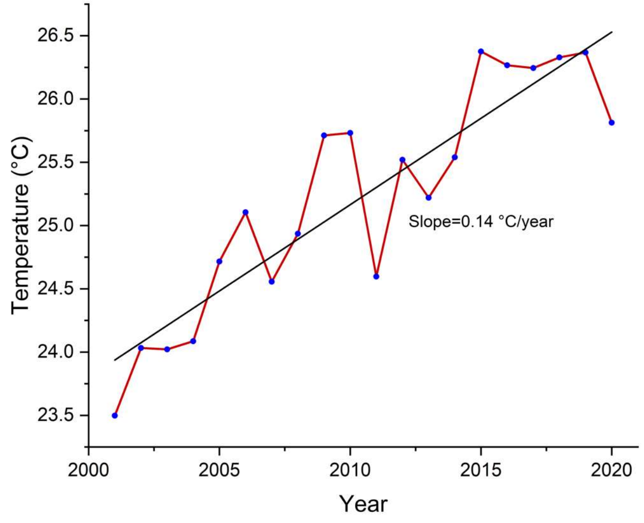




Mann-Kendall trend results for Rainfall, Temperature, and Groundwater Level

	Pre-monsoon			Monsoon			Post-monsoon		
Station	Kendall Tau	P value	Slope	Kendall Tau	P value	Slope	Kendall Tau	P value	Slope
Chaibasa	0.526	**0.001**	0.625	0.432	**0.009**	0.513	0.468	**0.004**	0.416
Chandil	0.132	0.436	0.071	0.247	0.135	0.079	0.332	**0.044**	2.013
Hata/Tirin	-0.337	**0.039**	-0.117	-0.042	0.818	0.000	-0.358	**0.027**	-0.056
Hesadih	-0.426	**0.009**	-0.146	0.042	0.820	0.018	-0.363	**0.027**	-0.134
Kharsawan	-0.395	**0.016**	-0.101	-0.116	0.496	-0.020	-0.268	0.105	-0.098
Mathbura	0.442	**0.007**	0.177	0.400	**0.015**	0.254	0.337	**0.041**	0.151
Pandrasalai	0.026	0.896	0.000	0.411	**0.011**	0.121	0.274	0.095	0.060
Rajnagar	0.063	0.720	0.054	0.295	0.073	0.165	0.353	**0.031**	0.275
Saraikela	-0.447	**0.006**	-0.095	-0.168	0.314	-0.033	-0.316	**0.055**	-0.089





Discussion & Conclusion

- There is an increasing trend of precipitation in the basin area which was also reported by Yaduvanshi et al., (2019)

- Mandal et al., (2021) projected an increase in precipitation and surface runoff by 8 to 48% and 28 to 110% respectively in the SRB.

- Their projections also anticipate an escalation in maximum and minimum temperatures within the basin, with a change ranging from -2.6°C to 4.7°C and -0.5°C to 5.6°C, respectively, for future timeframes spanning 2030, 2050, 2070, and 2080

- The spatio-temporal distribution of ground water level shows increasing trend for a number of station as well as decreasing trend for others, which may be due to the changes in LULC pattern.

- The groundwater level shows a positive relationship with precipitation.

- Changes in LULC coupled with other climatic parameters may cause direct impacts on quantity as well as a quality of groundwater resources. Hence it needs to be carefully monitored.

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THANK YOU!