Is Climate Change a Real-Time Situation?

Case Studies on Water Bodies in India

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Climate change is no longer a prediction, rather, it is real. As a result of climate change, the temperature of the earth is increasing, and rainfall is declining. Water bodies are a perfect feature to understand the impact of climate change in reality. Three study areas have been taken to understand the climate change impact. Three areas belong to the different ecosystems i.e. forest ecosystem, urban ecosystem and wetland ecosystem. The study area has been chosen accordingly that anthropogenic pressure does not affect our results so that a clear picture of climate change can be shown. The results show that there are considerable changes in the extent of the water and surface water bodies are drying. Therefore, we should stop saying that climate change is not real, rather our focus should be on the rejuvenation and conservation of these water bodies. Use of the GIS and remote sensing is suggested to develop climate change models and appropriate plans for water management.

Dr Shyamli Singh

Ancient Global Scenario of Climate Change

It has always been a topic of debate whether climate change is real or not. Climate change is believed to be a big challenge of the 21st century for water bodies. Waterbodies are a significant component to understanding climate change and its impact on any ecosystem. They are important as they serve various functions to get rid of the destructive effects of climate change, serve as a perennial source for groundwater recharge at times of drought, act as a sponge at the time of floods, act as a carbon sink for greenhouse gases, act as a heat sink for deducing the urban heat island effects, act as a better cooling agent than green spaces in any ecosystem (Rao, 2021). According to the IPCC (2007), the world has been experiencing a deteriorating impact on water resources. To manage the water resource, we need to understand the enhanced societal demand and be aware of the climate change effect on various components of the water cycle (Abbaspour et al., 2009). According to IPCC (AR5, 2014), the global temperature is expected to rise to 4°C and will heavily influence water resources and their demand across the world. The reason for this change is the alteration in precipitation, evapotranspiration and Spatio-temporal distribution of water resources (Kumar et al., 2017). Climate change creates flood or drought conditions in any area. These are a result of alterations in precipitation, temperature and evapotranspiration normal values. Higher precipitation will cause more surface runoff which leads to flood conditions and lesser groundwater recharge. The escalation of the temperature causes evapotranspiration which leads to drought conditions. Moreover, global warming creates other disastrous conditions like forest fires, and this warming of the atmosphere makes the air hold moisture which results in heavier and more frequent precipitation (Rao, 2021). To achieve water management objectives to overcome future challenges, the impact of climate change on the water balance needs to be checked from regional to larger scales (Kumar et al., 2017). India has different geographies at different places which pose difficulty in generalisation of the impact of climate change on water bodies, and it is still a matter of research (Goyal et. al., 2018). To understand the fact that climate change is real and that it also poses an impact on water bodies, three study areas have

been taken which belong to the different geographic locations and different ecosystems in India. To check the impact of climate change on water bodies, a large temporal gap is needed here. We have taken a time gap of a minimum of 20 years and a maximum of 30 years to find significant spatial differences.

Trends of Precipitation and Temperature in India

Rainfall: Our study area covers North Eastern (Manipur), North Western (Rajasthan) and North India (Delhi). In India, the majority of the monsoon is a result of the southwestern winds or monsoon, while a minor decrease in rainfall is observed all over India. In the North Eastern States of India, no particular trend of rainfall is observed but this region receives heavy rainfall (Jain et al., 2013; Goyal et al., 2018) while a minor increasing trend is observed in the North-Western region, which is again unusual for an area like Rajasthan. On comparing the 20th and 21st-century rainfall data, 21st century has experienced dry years. Based on the predictive analysis, 7-18.7% of rainfall is expected to increase by the year 2099 (Chaturvedi et al., 2012; Goyal et al., 2018).

Temperature: IMD has reported a warming trend over the years since the 20th century. Based on the analysis of the temperature data from 1881-1997, a rise of 0.57°C per hundreds of years has been observed (Pant & Kumar, 1997). Western India showed an increase in annual mean temperature (Arora et al., 2005). Also, a temperature rise is observed in northern and North-Eastern India (Goyal et al., 2018).

Study Area:

The three areas covered for the study are (i) Sariska Tiger Reserve, Alwar, Rajasthan (Northwestern area), (ii) New Delhi, Delhi (Northern area), and (iii) Loktak Lake, Manipur (Northeastern area). The study area has been chosen to check the impact of climate change in different ecosystems i.e. Sariska Tiger Reserve (Forest Ecosystem), Urban Ecosystem (New Delhi), Loktak Lake (Wetland Ecosystem). The STR region is of major importance as it is a reserved area and anthropogenic pressure is negligible, So the changes measured will be because of the climatic variation. The Loktak Lake is also a wetland of international importance and is marked as a Ramsar site (A Ramsar Site is a wetland site designated to be of international importance. The Ramsar Convention on Wetlands, also known as the Convention on Wetlands, is an intergovernmental treaty for the conservation and wise use of wetlands) of India. A special and unique feature of this wetland is the presence of floating islands called 'phumdis' which also supports the rich biodiversity of the region.

Methodology:

The Landsat and Sentinel Satellite data has been used to extract water bodies. Detailed methodology is given in Figure 1.

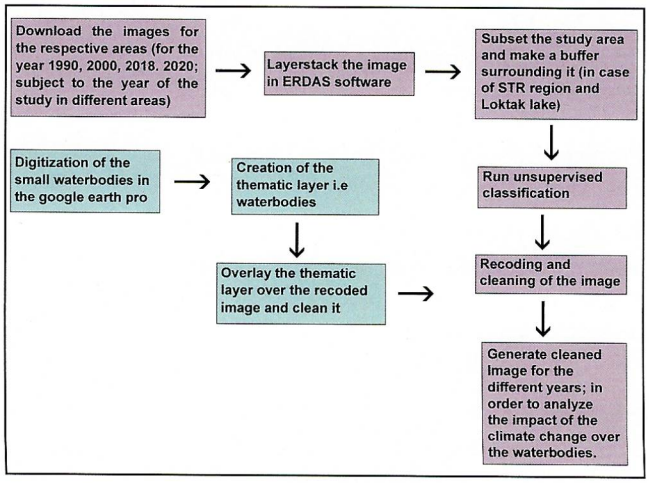


Figure 1: Methodology adopted for the extraction of water bodies in the study areas (i.e. STR, Delhi, Loktak Lake)

Data Used for the Study

The detailed spatial and temporal information for the different study sites is shown in Table 1.

Table 1: Data Type Used for the Study

S. No.	Satellite Used	Data Type	Date
Sariska Tiger Reserve			
1	LANDSAT 7 ETM+	Spatial data (30m)	January 2000
2	LANDSAT 8 OLI/TIRS	Spatial data (30m)	February 2018
Delhi			
1	Landsat 5 (Thematic Mapper)	Spatial data (30m)	February 2000
2	Sentinel-2A	Spatial data (10m)	October 2020, December 2020
Loktak Lake			
1	Landsat 5 (TM)	Spatial data (30m)	March 1990
2	Landsat 8 OLI/TIRS	Spatial data (30m)	March 2018

Results:

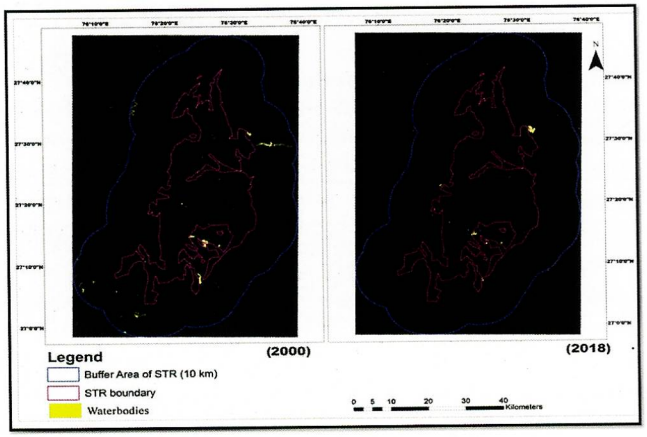
Case Study 1: Forest Ecosystem: Sariska Tiger Reserve

The STR is comprised of the Sariska Wildlife Sanctuary and adjoining areas in the Alwar District of Rajasthan. The Reserve lies within the Aravallis Mountain Range with altitudes ranging from 270 to 360 m. The Reserve's core geographical extent is 27° 5′ to 27° 33′ N latitude and 76° 17′ to 76° 34′ E longitude. The total area of 881.11 km2 is notified as CTH (Critical Tiger Habitat) by the Government of Rajasthan (GOR) in 2007. This includes the Reserved Forest (604.97 km2) and the Protected Forest (276.14 km2) in STR. (GOR, 2004). The study area covers the STR region and its 10 km buffer.

Table 2: Results for the Change in Water Bodies of the STR Region

Year of Study	Area	% of the Whole Area
2000	869.32 ha	0.003
2018	334.19 ha	0.001
Net change in the area of the water bodies	535.13 ha	0.002

Figure 2: Spatial Results for the Water Bodies of the STR Region for 2000 and 2018



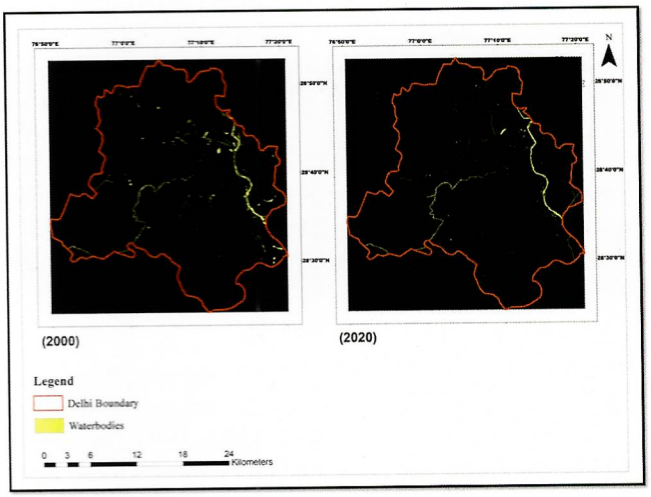
Case Study 2: Urban Ecosystem

The urban ecosystem must include a metropolitan city. We are taking Delhi as our representative of the urban ecosystem as it is the largest metropolitan city in India. Delhi has the coordinates of latitude 28.7041° N and longitude 77.1025° E. The city experience a high rate of industrialisation, urbanisation and it is a habitat of a large population; therefore; it has a high anthropogenic constraint.

Table 3: Results for the Change in Water Bodies of the Delhi Region

Year of Study	Area	% of the Whole Area
2000	2370.15 ha	0.015
2020	1754.78 ha	0.011
Net change in the area of the water bodies	615.37 ha	0.004

Figure 3: Spatial Results for the Water Bodies of the Delhi Region for 2000 and 2020



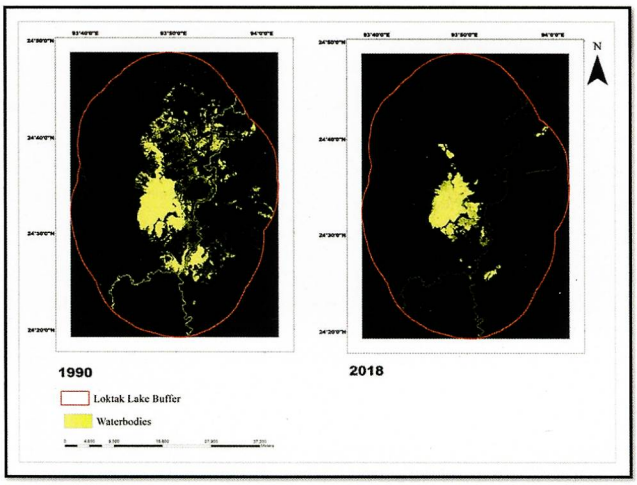
Case Study 3: Wetland Ecosystem

The study covers a wetland of international importance i.e. Loktak Lake. This area is of significance as it is an ecotone between terrestrial and aquatic ecosystems. This area is a part of the Indo-Burma biodiversity hotspot. This lake lies at 24° 38′ 24.0792″ N and 93° 52′ 11.7624″ E. The southern area of the lake is a part of the world's only floating national park i.e. Keibul Lamjao National Park and a natural habitat for the highly endangered Sangai deer. The area has a lesser anthropogenic constraint as compared to the city of Delhi.

Table 4: Results for the Change in Water Bodies of the Loktak Lake Region

Year of Study	Area	% of the Whole Area
1990	16,014.2 ha	0.09
2018	7707.81 ha	0.04
Net change in the area of the water bodies	615.37 ha	0.05

Figure 4: Spatial Results for the Water Bodies of the Loktak Lake Region for 1990 and 2018



Conclusion:

The last few decades have shown that the environmental status has been altering alarmingly. Forest cover decrease, soil erosion, siltation, drying up of lakes, dams, rivers or any other surface water resource are a few examples of this alteration in the environment. Fossil fuel burning and the rising of GHGs also adds to global warming. The high rate of urbanisation, economic development, and degraded ecosystems has left the world vulnerable to the impacts of climate change. Floods and drought conditions are the result of climate change. The negative impact of these natural or man-made situations has compromised the ability of water bodies to deliver ecosystem services. Most of the water bodies in the country are experiencing water quality issues like toxicity, cyanobacterial blooms, eutrophication, etc., and these unfavourable ecological conditions are not only affecting the aquatic flora and fauna rather it is deadly to human health also.

The Sariska Tiger Reserve is a conserved area and, therefore, negligible anthropogenic pressure would be there. The 10km buffer of the STR has been taken to conduct our study. The spatial results clearly show that water bodies are declining whether we look into buffer areas or the STR area. The study site belongs to North-Western India and hence, experiences high temperature and lower rainfall, while an unusual little hike trend of rainfall is observed during monsoon time in NW areas which is also a result of climate change. The challenge of the drying up of the water bodies in the STR Region is a result of climate change and no anthropogenic pressure is involved in it. A total spatial loss of 535.13 ha is observed. Water pollution from the tourism industry is the only anthropogenic pressure waterbodies facing there, e.g. Pandupol area (Shahabuddin et al., 2004).

Records from 1970 to 2008 of Delhi have shown a 21% decline in water bodies. There are records of the vanishing of dry water bodies. According to a study by Singh et al. (2013), there is a decline in the number of water bodies as well as their quality. A similar kind of results has been observed in our study in the temporal gap of 20 years (2000-2020), the water bodies have shown fall off in the area of 615.37 ha. The city experiences semi-arid type of climatic conditions as the temperature has been rising and the rainfall has declined with time, and therefore, the natural or climatic constraint is there. While if we look into the anthropogenic constraint, high water pollution is being faced by the water bodies, and one of the examples is the Yamuna Action Plan. Increasing industrialisation and population in the megacities are a threat to the water bodies. The Government is spending crores to rejuvenate the dying lakes (Kumar, 2019).

Loktak Lake is found to be shrinking along with the water bodies in the buffer area. The impact of climate change is seen there as the temperature rise is an important parameter for this decline and, the rainfall is found to be a 20-30% deficit in Manipur in the last few years (Devi, 2021). As the situation of the lake is deteriorating, climate change is not the only parameter affecting the scenario, while anthropogenic pressure is also a major influencer. The construction of the Ithai Barrage altered the hydrology of the lake and affected the socio-economic living conditions of the locals of Manipur (Bhanduri, 2019). The challenge posed by this natural or anthropogenic pressure is that the migratory route of the fishes has been blocked. The lake is experiencing siltation issues because of the constant water level resulting from barrage construction causing the thinning of the phumdis. The absence of an outlet for the water is also adding to water pollution.

Based on the results derived from the above-mentioned case studies, we can say that climate change is real. We have taken study areas where no anthropogenic (STR)/less anthropogenic (Loktak Lake) and high anthropogenic pressure (Delhi) are there, but all the results have shown that there is a considerable change in the extent of the water bodies. Therefore, one should stop saying that climate change is not real and start taking measures to conserve and rejuvenate the degraded water bodies to make the country climate-change resilient. Strategy-making should be based on the identification of key climatic zones where the impact is going to be severe, the use of remote sensing and GIS to develop climate change models and appropriate plans for water management.

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