

Spatio- Temporal Dynamics of Land Use/Land Cover Changes and It's Impact on Land Surface Temperature and Vegetation Health Status of Alibag Tehsil and It's Surrounding Region

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ABSTRACT

Natural phenomenon as well as human activities are the driving forces by which LULC is changed and it is directly affected on environment. Present study deals with Spatio-temporal variation of LULC to understand the impact on Land surface temperature and vegetation health status of the study region. The study was carried out by using the GIS and remote sensing technique. To understand the Spatio-temporal variation of LULC as well as the LST and NDVI, 30-year time span was considered and it has been observed that LULC has changed during this time span. Mangrove area, built-up area and aquaculture extensively increased while fallow land, agricultural land and rocky bare surface have decreased in the pre monsoon season. In the post monsoon season, hilly region of the study area have experienced widely increase of evergreen vegetation though fallow land, rocky bare surface have been decreased. Human interference is one of the reasons for the land transformation because of fast growing of heavy industries as well as the tourism industries, as the study region is situated in the vicinity of Mumbai. LULC changes is the causes of the alteration of vegetation health and land surface temperature and it is showing negatively correlated.

Keywords: LULC, GIS & Remote Sensing, LST, NDVI

INTRODUCTION

Land Use/Land Cover (LULC) changes are a dynamic phenomenon that is governed by human aspiration (Kale et al., 2016). The distribution of flora, water, soil and other physical properties of the land including those produced exclusively by human activities on the earth collectively referred to as the land cover. However, land use relates how human beings and their habitat have used land (Rawat & Kumar, 2015). LULC has changed slowly prior to the industrial revolution but after industrial revolution, globally LULC has changed hastily due to human activities like industrialization, urbanization, farming and worldwide rapid growth of population. Nowadays, impact of LULC dynamics is increasing widely, and it is not only directly affects environmental ecosystem but also soil erosion, soil degradation, salinization, desertification have accelerated due to land use changes, which is responsible for the degradation of ecological factors (Gholap, & Nalawade, 2022). Land use land cover are critical for comprehending the relationship between human activities and environment, therefore monitoring and detecting changes is essential for sustaining the ecosystem (Pandian et al., 2014).

Land surface temperature (LST) and normalized difference vegetation index (NDVI) are directly associated with LULC changes. Local temperature and vegetation dynamics has altered by LULC changes, which are basically brought about by urbanization and agricultural expansion. Land cover modification induces the surface albedo, which causes change in LST as well as air temperature and effects the local climate (John et al., 2020). In developing countries, vegetative area constantly decreases due to rapid growth of urbanization,

industrialization, and spread of agricultural land, which causes increase of land surface temperature. Particularly in urban areas, natural land covers are replaced with impermeable materials, responsible for the changes in the land surface energy process as well as the alteration of the biophysical environment (Fu & Weng, 2016). In northern India, LULC changes had resulted in a warming of 0.03°C, attributed to the decline of dense forests and expansion of dry lands (Nayak et al., 2021). The greatest concerns are now being realized as a result of human manipulation of the environment, which is causing local and global climate change as a result of LULC changes (Patil & Jamgade, 2019).

Numerous natural and man-made causes influence changes in vegetation activity, and the Normalized Difference Vegetation Index (NDVI), which is obtained from satellite data (Liu et al., 2015). Land use land cover changes have a substantial impact on NDVI, which show variation in the health and density of vegetation (Pande et al., 2021). Change in land use, especially the abandonment and intensification of agriculture, have a major influence on NDVI trends (Wright et al., 2012). The influence of urbanization on ecological health is shown by the large fall in NDVI values that results from changes in land use, notably urban expansion (Osgouei & Kaya, 2017).

Previously many researchers have worked on LULC changes and they tried to find out the causes behind it and how it effects the environment. Gholap, & Nalawade, (2022) studied land use land cover (LULC) changes by using the geospatial technology in Satara district of Maharashtra to observed the trend of land use and land cover change. They revealed that settlement and agricultural areas were considerably growing up in Satara district of Maharashtra. Mallupattu, & Reddy, (2013) analysed the land use land cover changes at an urban area of Tirupati, India by using the remote sensing data and GIS technique. This study showed that built-up areas significantly increase, on the other hand agricultural land, water bodies and forest areas decreases. They concluded that population growth and their development activities are the main reason for LULC changes in Tirupati. Bajocco, et al. (2012) discussed about land use land cover changes and its impact on land degradation dynamics along the coastal belt of Sardinia, Italy. Its result revealed that the unsustainable use of rural and peri-urban areas and land abandonment mainly affected the level of land sensitivity to degradation in the study area. Jie Yin et al. (2011) studied the Spatio-temporal dynamics and evolution of land use cover changes and urban expansion in Shanghai metropolitan area, China by using multi-temporal satellite images and geographic information systems (GIS). They had found that urbanization has accelerated at an unprecedented rate and this is leading to a considerable reduction in the area of farmland and green land which also led to environmental degradation.

Aims And Objectives

The main aim of the study is to assess the “Spatio- Temporal Dynamics of Land Use/Land Cover Changes and it’s Impacts on Ecological Factors of Alibag Tehsil and it’s Surrounding Region”.

To fulfil this aim the following objectives are considered

- To assess the Spatio- temporal changes of LULC in Alibag tehsil and its surrounding regions.
- To examine the Spatio- temporal variation of NDVI and LST with the change of LULC.

Study Area

Alibag Tehsil is a low elevated coastal taluka in Raigad district of Maharashtra with the latitudinal and longitudinal extension of 18°28'55"N to 18°49'37"N and 72°51'34"E to 73°5'6" E and is located about 120 km south of the Mumbai. Total area of Alibag Tehsil is 510 sq. km. that includes 500.25 sq. km. under rural area and 9.96 sq. km. under urban area. Alibag tehsil has a population of 2,36,167 as per the 2011 census and has a population density of 462 persons per square km. Alibag tehsil has 215 villages out of which almost 25 villages share the boundary with the sea. Alibag tehsil in bounded by the Arabian sea on the west, Pen Tehsil on the East, River Amba on the North and River Kundalika to the South. Alibag enjoys tropical climate wherein the summer rainfall (monsoon) is high, while the winters have very little rainfall. As per the

Koppen and Geiger's classification, Alibag has Aw type of climate with average annual temperature of 26.1°C (78.9°F) annual average rainfall of 2402mm (94.6 inch).

DATA AND METHODOLOGY

Data Used: In the present study, satellite images have been used for the classification of LULC and calculation for NDVI as well as LST. 30 year time span is considered for LULC classification. Four Landsat satellite imageries were downloaded from the USGS Earth Explorer site for the present study. Two Landsat 5 TM images (1989, November & 1990, March) and two Landsat 8 OLI images (2020, April & November) were used to show the temporal and seasonal variation of LULC of the study region. Low cloud cover (10-15%) and low atmospheric and seasonal effected images had been considered for the LULC classification. Band 4, 3, 2 combination of Landsat 5 TM and band 5, 4, 3 combination of Landsat 8 OLI have considered to assess the LULC whereas Band combination of 2, 3 and 3, 4 of Landsat 5 TM and Landsat 8 OLI respectively used to calculate the NDVI while Band 6 of Landsat5 TM and band 10 of Landsat 8 OLI have considered to calculate the Land surface Temperature (LST).

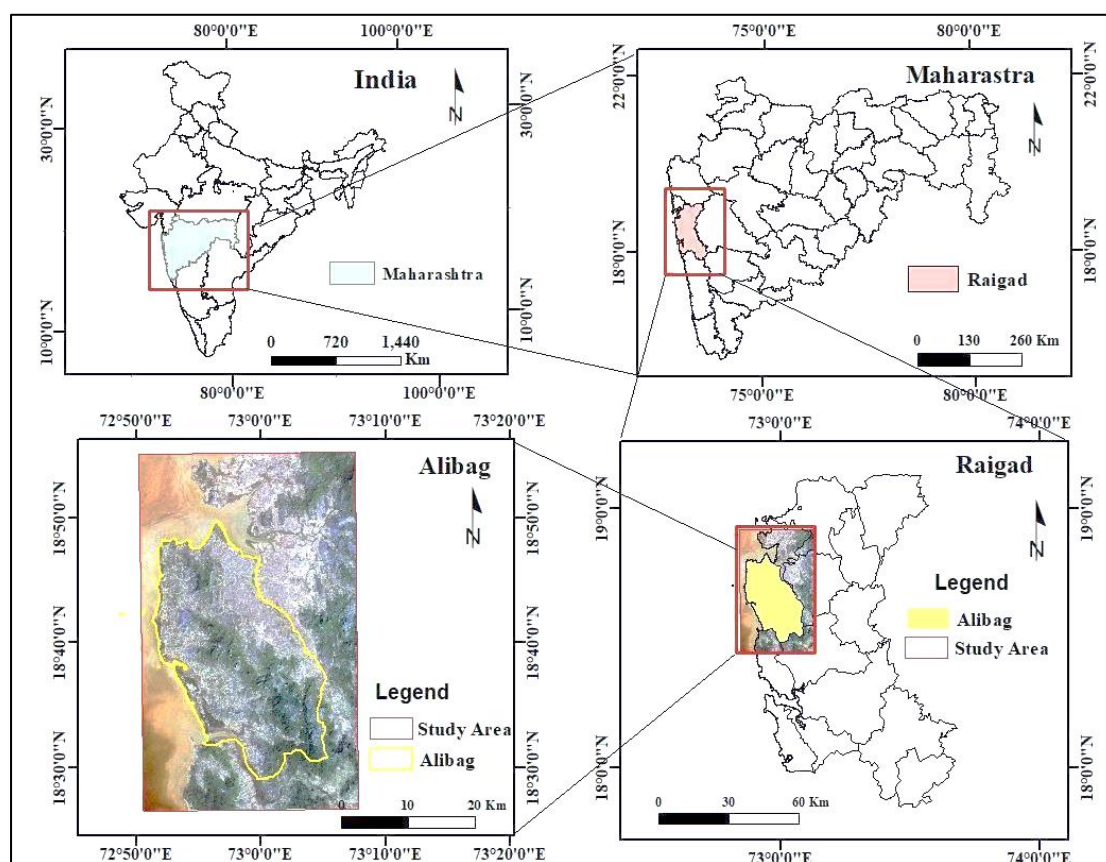


Figure 1: Location map of the study area

Extraction of LULC and accuracy assessment: Layer stacking was carried out after the downloading of the satellite images from USGS Earth Explorer to obtain the multi band composite false colour image and satellite data sets were enhanced by histogram equalization to improve the image quality in ERDAS Imagine. In this study, LULC maps were classified into thirteen different classes as ocean and rivers, lakes and reservoirs, mangrove vegetation, evergreen vegetation, deciduous vegetation, agricultural land, aquaculture, fallow land, mudflat, rocky bare surface, built-up area, sandy beach rocky beach. Signatures were collected from the satellite images, after that the maximum likelihood classification method was used for supervised classification and analysis was conducted by using ERDAS IMAGINE 2014 software. Accuracy assessment was carried out for all the supervised images by applying the standard procedure in ERDAS IMAGINE 2014 Software. 250 random points were generated to check the accuracy of the each classified image and overall accuracy and kappa statistics and error matrix have shown in Table 1, 2, 3 & 4.

Retrieval of NDVI and Land Surface Temperature (LST): The data of any satellite images are stored in the form of Digital Number (DN). Which indirectly represents the spectral radiance of the ground objects. LST is calculated through the following process.

The first step of the algorithm is the input of band 10. After band 10 had been inputted in the background, the tools uses formulas taken from the USGS webpage for retrieving the top of atmospheric spectral radiance ($L\lambda$):

$$L\lambda = M_L * Q_{cal} + A_L - O_i \dots\dots\dots(1)$$

Where M_L represents the band- specific multiplicative rescaling factors, Q_{cal} is the band 10 image and A_L is the band specific additive rescaling factors.

Table 1: Error Matrix, 1989, November

Class (1/11/1989)	Ocean & River	Lakes & Reser voirs	Mangr ove Veget ation	Evergr een Veget ation	Decid uous Veget ation	Agri cultu ral Land	Aquac ulture	Fallow Land	Mud flat	Rock y bare surfa ce	Built -up Area	Sand y Beac h	Rock y Beac h	Total
Ocean & River	52	0	1	0	0	0	0	0	0	0	0	0	0	53
Lakes & Reservoirs	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Mangrove Vegetation	0	0	4	0	0	0	0	0	1	0	0	0	0	5
Evergreen Vegetation	0	0	0	23	2	0	0	0	0	0	0	0	0	25
Deciduous Vegetation	0	0	0	2	27	1	0	0	0	2	0	0	0	32
Agricultural Land	0	0	1	1	1	59	0	3	1	1	0	0	0	67
Aquaculture	0	0	0	0	0	0	1	0	1	0	0	0	0	2
Fallow Land	0	0	0	0	0	2	0	27	1	0	0	0	0	30
Mudflat	0	0	1	0	0	0	0	0	7	0	0	0	0	8
Rocky bare surface	0	0	0	0	5	0	0	0	0	14	0	0	0	19
Built-up Area	0	0	0	0	0	0	0	1	0	0	3	0	0	4
Sandy Beach	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Rocky Beach	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	52	1	7	26	35	62	1	31	12	17	3	1	0	248

Overall accuracy (1989, November): **87.60%**

Overall Kappa Statistics: **0.8517**

Table 2: Error Matrix, 1990, March

Class (25/3/1990)	Ocean & River	Lakes & Reser voirs	Mangr ove Veget ation	Ever reen Veget ation	Decid uous Veget ation	Agri cultu ral Land	Aqu acult ure	Fallo w Land	Mud flat	Rock y bare surfa ce	Built -up Area	Sand y Beac h	Rock y Beac h	Tota l
Ocean & River	50	0	0	0	0	0	0	1	0	0	0	0	0	51
Lakes & Reservoirs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mangrove Vegetation	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Evergreen Vegetation	0	0	0	17	2	0	0	0	0	2	0	0	0	21
Deciduous Vegetation	0	0	0	3	34	0	0	0	0	1	0	0	0	38
Agricultural Land	0	0	0	0	2	53	0	3	0	0	1	0	0	59
Aquaculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fallow Land	0	0	0	0	2	1	0	40	0	1	0	0	0	44
Mudflat	0	0	0	0	0	1	0	0	9	0	0	0	0	10
Rocky bare surface	0	0	0	0	1	1	0	1	0	18	0	0	0	21
Built-up Area	0	0	0	0	0	0	0	1	0	0	2	0	0	3
Sandy Beach	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Rocky Beach	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	50	0	1	20	41	56	0	46	10	22	3	1	0	250

Overall accuracy (1990, March): **90.00%**

Overall Kappa Statistics: **0.88**

Table 3: Error Matrix, 2020, April

Class (22/11/2020)	Ocean & River	Lakes & Reser voirs	Mangr ove Veget ation	Ever reen Veget ation	Decid uous Veget ation	Agri cultu ral Land	Aqu acult ure	Fallo w Land	Mud flat	Roc ky bare surfa ce	Built -up Area	Sand y Beac h	Roc ky Beac h	Tota l
Ocean & River	51	0	0	0	0	0	0	0	1	0	0	0	0	52
Lakes & Reservoirs	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Mangrove Vegetation	0	0	15	0	0	0	0	0	1	0	0	0	0	16
Evergreen Vegetation	0	0	1	56	4	4	0	0	1	0	0	0	0	66
Deciduous Vegetation	0	0	0	1	11	0	0	0	0	0	0	0	0	12
Agricultural Land	0	0	0	0	1	59	0	3	0	0	1	0	0	64

Aquaculture	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Fallow Land	0	0	0	0	0	0	0	9	1	0	0	0	0	10
Mudflat	1	0	0	0	0	0	0	0	7	0	0	0	0	8
Rocky bare surface	0	0	0	0	1	0	0	0	0	7		0	0	8
Built-up Area	0	0	0	0	0	3	0	0	0	0	6	0	0	9
Sandy Beach	0	0	0	0	0	0	0	1	0	0	0	1	0	2
Rocky Beach	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	52	1	16	57	17	66	2	13	11	7	7	1	0	250

Overall accuracy (1990, March): **91.20%**

Overall Kappa Statistics: **0.8983**

Table 4: Error Matrix, 2020, November

Class (12/4/2020)	Ocean & River	Lakes & Reservoirs	Mangrove Vegetation	Evergreen Vegetation	Deciduous Vegetation	Agricultural Land	Aquaculture	Fallow Land	Mudflat	Rocky bare surface	Built-up Area	Sandy Beach	Rocky Beach	Total
Ocean & River	38	0	1	0	1	0	0	0	1	0	0	0	0	40
Lakes & Reservoirs	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Mangrove Vegetation	0	0	7	1	0	0	0	1	0	0	0	0	0	9
Evergreen Vegetation	0	0	0	34	2	0	0	0	0	0	0	0	0	36
Deciduous Vegetation	0	0	0	0	34	0	0	1	0	1	0	0	0	36
Agricultural Land	0	0	0	0	2	41	0	5	0	0	0	0	1	49
Aquaculture	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Fallow Land	0	0	0	0	0	0	0	22	0	0	0	0	0	22
Mudflat	0	0	1	0	0	0	0	0	8	0	0	0	0	9
Rocky bare surface	0	0	0	0	2	0	0	1	0	33	0	0	0	36
Built-up Area	0	0	0	0	0	1	0	0	0	0	8	0	0	9
Sandy Beach	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Rocky Beach	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	38	1	9	35	41	43	1	30	9	34	8	1	0	250

Overall accuracy (1990, March): **90.00%**

Overall Kappa Statistics: **0.8775**

After the digital numbers (DNs) are converted to reflection, the TIRS band data should be converted from spectral radiance to brightness temperature (BT) using the thermal constant provided in the metadata file. The following equation is used in the tool's algorithm to convert reflectance to BT.

$$BT = \frac{K_2}{\ln \left[\left(\frac{K_1}{L\lambda} \right) + 1 \right]} - 273.15 \dots\dots (2)$$

Where K_1 and K_2 stand for the band specific thermal conversion constants from the metadata. For obtaining the results in Celsius, the radiant temperature is revised by adding the absolute zero (approx. -273.15°C).

Normalized difference vegetation index (NDVI) is retrieved by surface reflectance of Red and NIR band by applying the equation no 3.

$$NDVI = \frac{NIR - Red}{NIR + Red} \dots\dots\dots (3)$$

After calculating the NDVI, the proportion of vegetation (P_v) is calculated according to the given formula.

$$P_v = (NDVI - NDVI_{\min} / NDVI_{\max} - NDVI_{\min})^2 \dots\dots (4)$$

The land surface emissivity (LSE) must be known in order to estimate LST, since the LSE is a proportionality factor that scales blackbody radiance (Plank's law) to predict emitted radiance, and it is the efficiency of transmitting thermal energy across the surface into the atmosphere. The following equation is applied for calculating the LSE

$$LSE (\epsilon) = 0.004 * P_v + 0.986 \dots\dots\dots (5)$$

The last step of retrieving the LST or the emissivity corrected land surface temperature (T_s) is computed as follow

$$T_s = \frac{BT}{\left[1 + \left\{ \left(\frac{\lambda BT}{\rho} \right) \ln \epsilon_\lambda \right\} \right]} \dots\dots\dots (6)$$

Where T_s is the LST in Celsius, BT is at sensor BT ($^\circ\text{C}$), λ is the wave length of emitted radiance (for which the peak response and the average of the limiting wavelength ($\lambda = 11.5$) will be used), ϵ_λ is the emissivity calculated in and

$$\rho = h \frac{c}{\sigma} = 1.438 * 10^{-2} \text{ m K} \dots\dots\dots (7)$$

Where σ is the Boltzmann constant ($1.38 * 10^{-23} \text{ J/K}$), h is Planck's constant ($6.626 * 10^{-34} \text{ J s}$), and c is the velocity of light ($2.998 * 10^8 \text{ m/s}$), thus $\rho = 14380$

RESULTS AND DISCUSSION

Changes in LULC (Pre-monsoon): It clearly shows that land use and land cover in pre-monsoon season has been considerably changed during the time period of 1989 to 2020. On the given maps (figure 2), it is observed that lake and reservoirs, mangrove, evergreen vegetation, aquaculture, mudflat and built-up area have increased whereas agricultural land, fallow land and rocky bare surface area have decreased. Most of the changes are noticed in 30 years span in mangrove vegetation and built-up area throughout the Alibag tehsil and its surrounding regions. Mangrove area has increased to 3.44% (Table no 5 & Figure 3) to its total geographical area. Mangrove areas have expanded along the Dharamtar creek and along the Amba River in the north and River Kundalika in the south, on the other hand patches of mangrove area has grown near the Poynad region in the vicinity of Amba River. Salt water has intruded into the land ward side which may provide the favourable environment to grow the mangrove vegetation and causes the vast expansion of mangrove vegetation in the vicinity of creek and coastal region (Das et al., 2022).

Built-up area has been gradually increasing in Alibag tehsil and its surrounding region and it is showing a positive trend. Built-up area has increased to 1.70% (Table no 5 & Figure 3) to it's total geographical area during this 30-year time span. Basically built-up area has increased in the norther part of the study region and around the Alibag town area. It also increases along the road and coastal region due to the proximity of Mumbai which also causes the development of heavy industries and tourism industries.

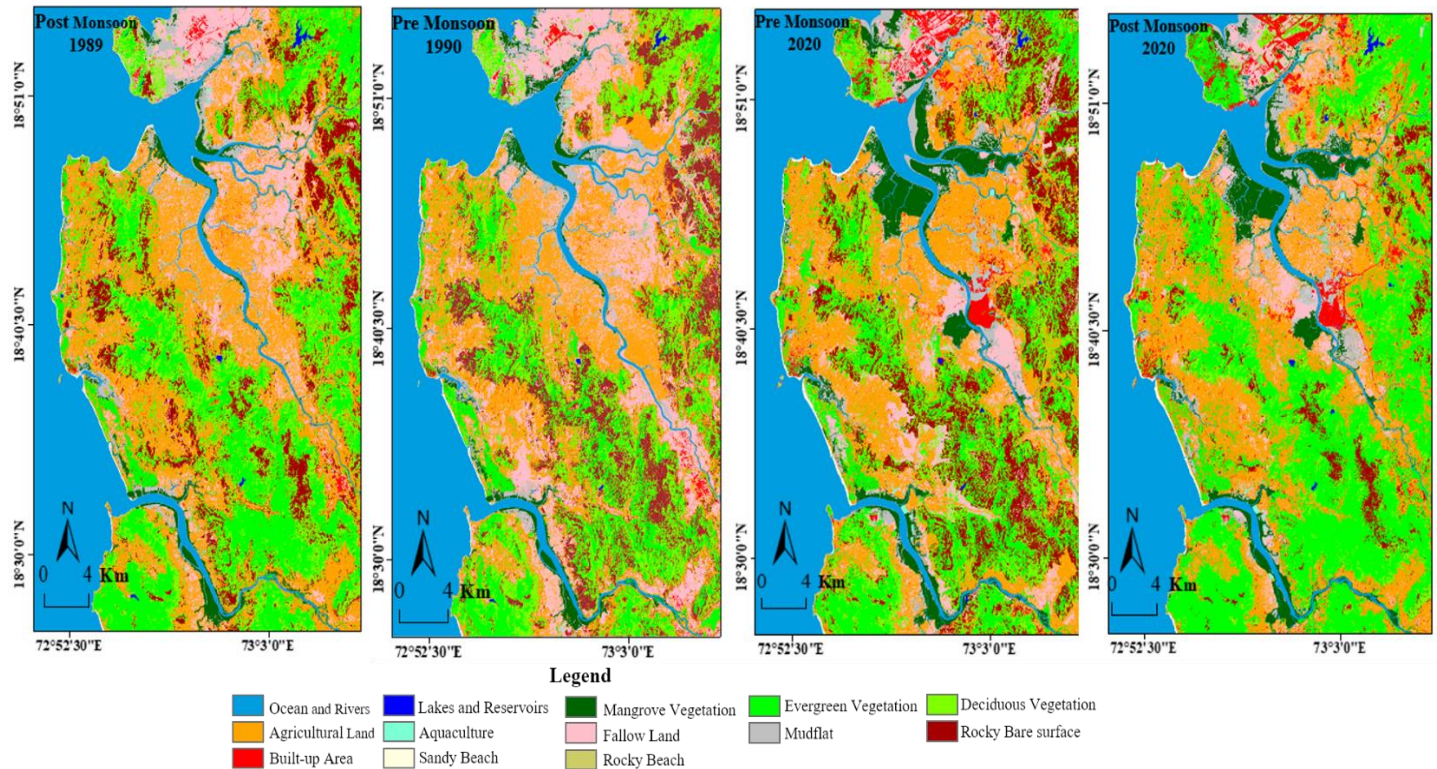


Figure2: Land use land cover changes from 1989 to 2020

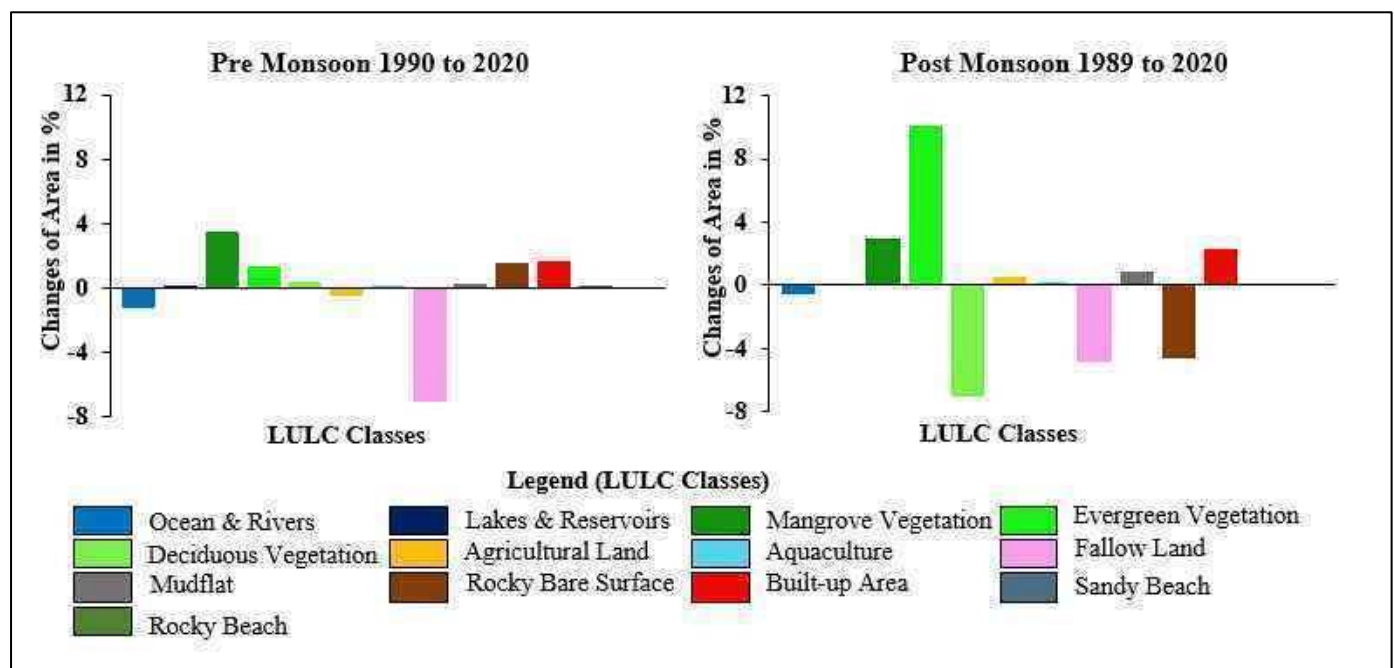


Figure 3: Percentage wise changes of area

There are few famous heavy industries are found in the study region like Jindal Steel Works (JSW), Rastriya Chemical Fertilizer (RCF), Reliance Industries. Area of the aquaculture has also shown the positive change

and it increases to 0.15% (Table no 5 & Figure 3) to the total geographical area of the study region from March, 1990 to April 2020. It is clearly indicating that peoples are more interested to fishery development than the agricultural activities. Agricultural land submerges by creek water during high tide which causes agricultural land get saline. So peoples are converted their agricultural land into aquaculture to cultivate the prawns and other fishes.

Table5: Percentage wise changes of area

SL NO	LULC Class	Pre Monsoon (1990)	Pre Monsoon (2020)	Changes of Area in % 1990 (PrM) to 2020 (PrM) w.r.t Total Area	Post Monsoon (1989)	Post Monsoon (2020)	Changes of Area in % 1989 (PM) to 2020 (PM) w.r.t Total Area
1	Ocean and Rivers	377.928	357.267375	-1.285056538	372.4551	362.5544	-0.615805531
2	Lakes and Reservoirs	1.6317	3.137625	0.093666032	2.6928	4.5855	0.117722794
3	Mangrove	30.0879	85.434975	3.442496082	28.9881	76.0149	2.924988804
4	Evergreen Vegetation	134.523	156.075525	1.340531236	237.0744	399.2207	10.08522727
5	Deciduous Vegetation	232.7679	237.991275	0.324885244	236.5173	123.0964	-7.054593036
6	Agricultural Land	320.1102	312.6546	-0.463725929	376.8786	384.7219	0.48783867
7	Aquaculture	0.8343	3.24405	0.149882445	1.692	5.5467	0.239755934
8	Fallow Land	253.7622	139.08915	-7.13247313	165.1905	87.69915	-4.819833184
9	Mudflat	54.6507	58.659075	0.249314263	41.6844	55.67918	0.870451747
10	Rocky Bare Surface	179.01	203.381325	1.515855911	126.1908	51.4755	-4.647167488
11	Built-up Area	13.0644	40.39065	1.699647335	10.1754	46.46813	2.257347179
12	Sandy Beach	3.9312	6.483375	0.158741043	4.1935	6.365025	0.135065246
13	Rocky Beach	5.4585	3.951	-0.093763995	4.0275	4.3326	0.018976713

Evergreen and deciduous vegetative area is quite less in pre-monsoon season as compare to post monsoon. However vegetative area is slightly increased in this region due to the various afforestation schemes implemented by state government as well as the central government. In the hilly region few patches of rocky bare surface has increased and mudflat also increase along the creek region.

It is showing that both the fallow land and agricultural land have considerably decreased by 7.13% and 0.46% (Table no 5 Figure 3) during this time period due to the rapid growth of industrialization as well as the population growth. Both the land have turned into industrial area or settlement area.

Changes in LULC (Post-monsoon): (Figure 2 & 3) explains the variations in land use/ land cover of post monsoon season during the study period 1989 and 2022. November months have taken into consideration for post monsoon supervised classification because of availability of cloud-free satellite images. In this season, it clearly shows that evergreen forest area has rapidly grown (10.08%) (Table no 5 & Figure 3) in the highly elevated area while deciduous forest and rocky bare surface area have decreased by 7.05% and 4.81% (Table no5 & Figure3) respectively.

Heavy rainfall during the monsoon is responsible for the growth of evergreen vegetation in the hilly region of the study area whereas the mangrove vegetative area have slightly decreased in post monsoon season. Fallow land has also decreased by 4.82% between the time periods of 1990 to 2020 as mention above that Alibag is one of the fastest economically growing region. In the post monsoon season agricultural land has slightly increased.

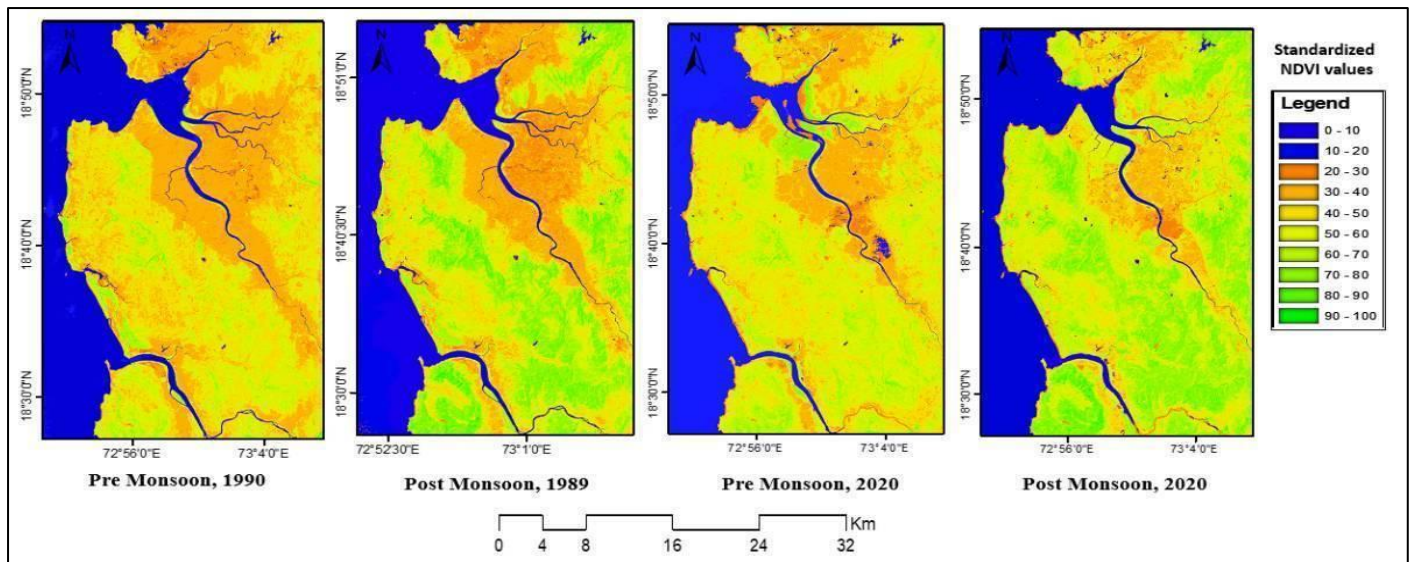


Figure 4: Variation of NDVI from 1989 to 2020 at Alibag tehsil and its surrounding regions

NDVI: (Figure 4) shows the Spatio- temporal variation of vegetative area from 1989 to 2020 of Alibag tehsil and its surrounding regions. There are significantly rise in vegetative area over this time period. (Figure 4) illustrated the NDVI of the study region and it is observed that NDVI value is high at the elevated region as compare to flat area. In pre monsoon season, 1990 NDVI value was quit low at the elevated region as well as along the coastal region as compare to the 2020. As previously discussed, mangrove area has considerably increased along the Amba River, Karanja creek, Dharamtar creek, vicinity of Poynad and also northern part of the Alibag tehsil and at that particular regions, NDVI value is quite higher in 2020, April which indicates healthy mangrove vegetation. On the other hand in hilly region and the area covered by agricultural land, low NDVI value reflects poor health status of vegetation. In 1989 to 2020, November, NDVI value has increased in the hilly region indicates healthy vegetation whereas in mangrove covered area has experienced low NDVI value which indicates poor health status of mangrove vegetation. According to institute of wood science and technology (IWST), 14 type of pests (seven caterpillar species, two beetle species, one leaf miner, two snail species and three grasshoppers) attack in mangrove vegetation, which is the cause of poor health status of mangrove vegetation in post monsoon season (Hindusthan Times 2018).

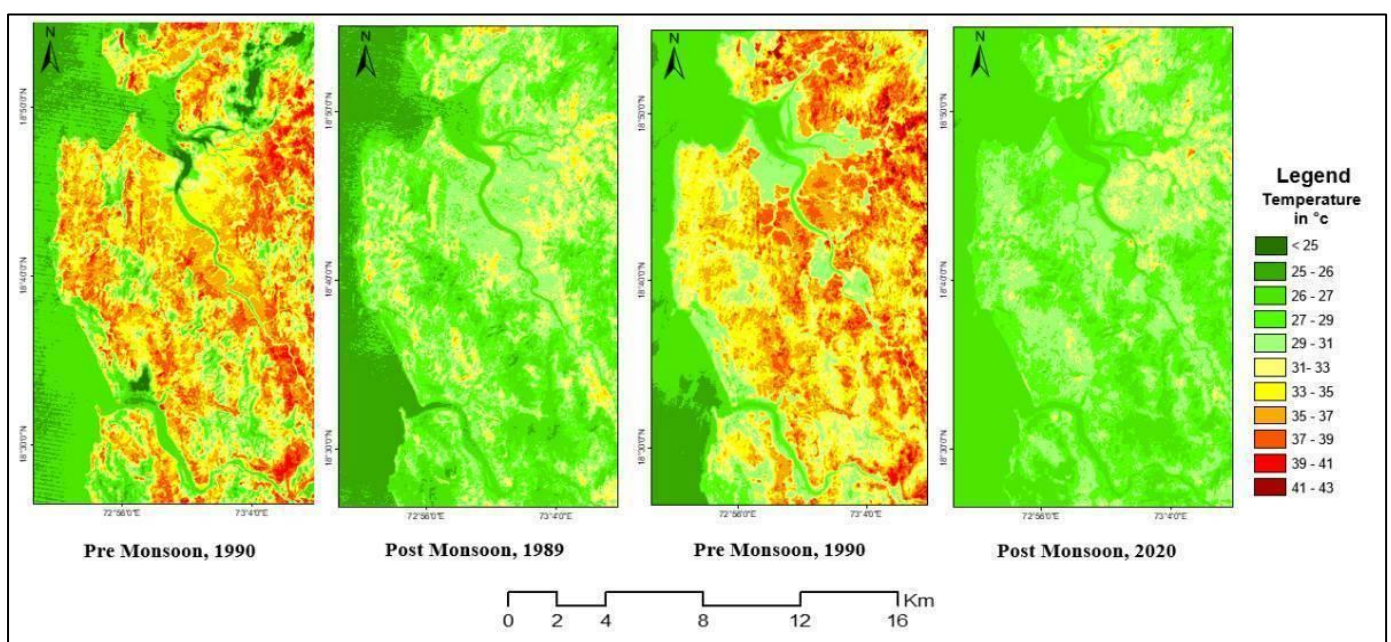


Figure 5: Variation of LST from 1989 to 2020 at Alibag tehsil and its surrounding regions.

LST: (Figure 5) represent the Spatio- temporal variation of land surface temperature from 1989 to 2020. It shows that in pre monsoon season in 1990 coastal area and interior part has experienced high temperature ranges between 31°C to 43°C, whereas the vegetative area has experienced low temperature ranges between 25°C to 31°C. In 2020, April it is observed that mangrove covered areas have experienced 2°C to 3°C low temperature to its surrounding region.

In post monsoon season temperature ranges between 25°C to 39°C it is low as compare to pre monsoon season, but average temperature in post monsoon season has increased almost 2°C. Overall it is observed that in pre monsoon season rocky bare surface and fallow land have experienced highest temperature as compare to the area covered by the vegetation.

Relation between NDVI & LST: (Figure 6, 7, 8 & 9) depicts the correlation between NDVI and LST and it indicates that both are strongly negatively correlated. Previously observed bare surface and open land experienced relatively high temperature compare to the vegetative covered area. So, it is concluded that land use land cover changes reasons for the alteration of land surface temperature which alter the local as well as the global climate and also effects the ecological factors.

CONCLUSION

The present study depicts the impact of land use land cover changes on LST and NDVI. As Alibag is situated at the vicinity of Mumbai, so the notable changes of LULC have been observed throughout the 30-year time span. Built-up area, rocky bare surface and mangrove area have increased but fallow land and agricultural land decrease in the pre monsoon season, conversely in post monsoon season rocky bare surface and deciduous forest have shown in decreasing trend but evergreen forest and agricultural land have increased. Present study reveals that average land surface temperature has increased in post monsoon season but in pre monsoon season it has decreased.

Availability of Data and Materials

The data generated within the research is available in <https://earthexplorer.usgs.gov/>

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Not applicable

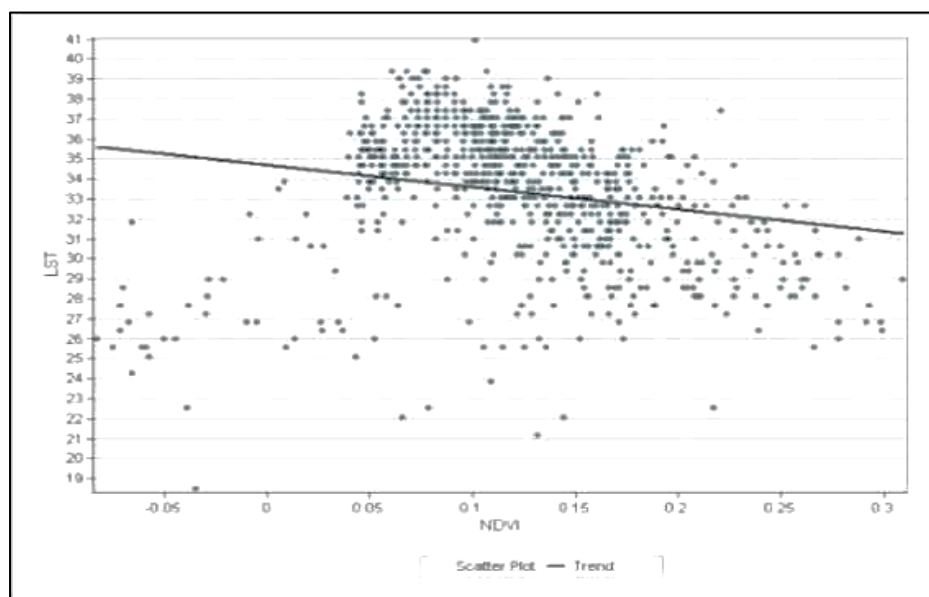


Figure 6: Correlation between NDVI & LST in 1989, November

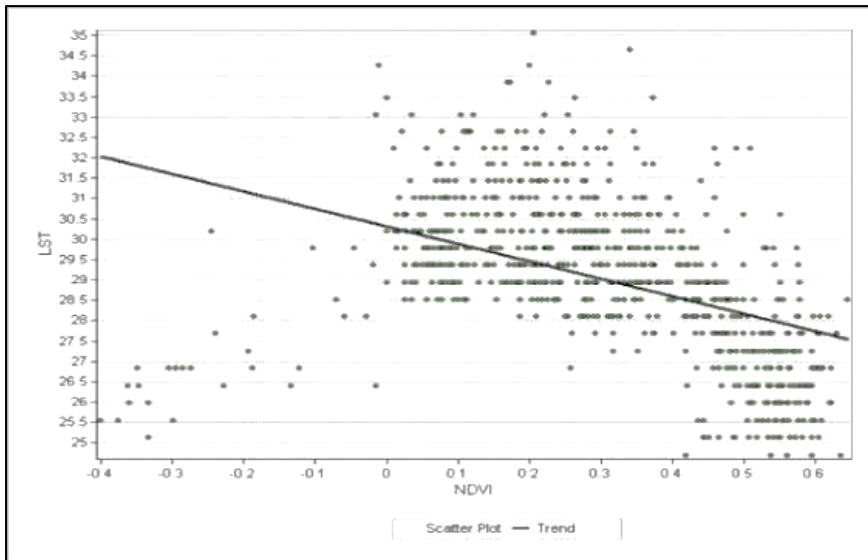


Figure 7: Correlation between NDVI & LST in 1990, March

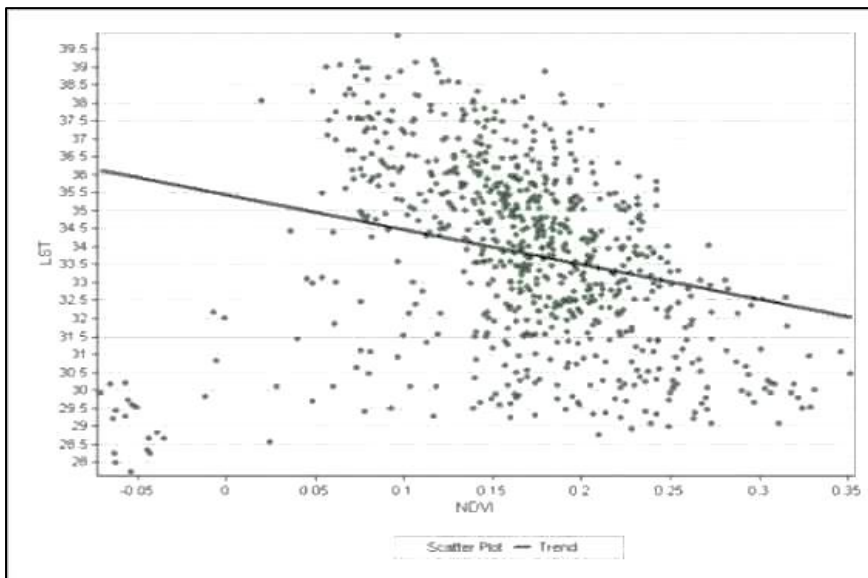


Figure 8: Correlation between NDVI & LST in 2020, April

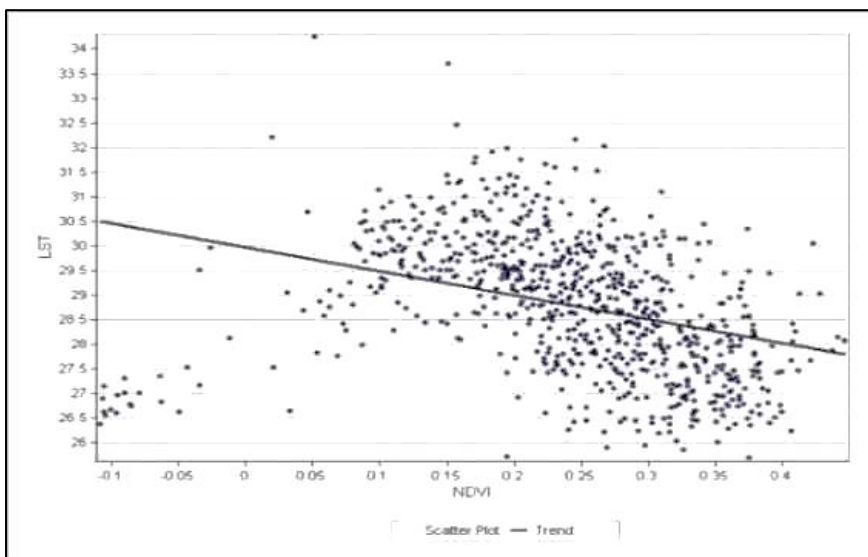


Figure 9: Correlation between NDVI & LST in 2020, November

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Contributions

Ram S. Kolapkar contributed to data curation, formal analysis, Software handling and writing of original draft Rajat Bar contributed to data curation, formal analysis and Software handling; Anargha Amit Dhorde contributed to Visualization of maps, supervision and manuscript review.

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Ethics declarations

Conflict of interest

The authors declare that they have no relevant financial or non-financial conflict of interests.

Ethical approval

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

Ethical Approval and Accordance

Not applicable. This study involved the analysis of groundwater and environmental samples only and did not involve human participants, animals, or sensitive personal data.

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