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# EXTREME CLIMATIC EVENTS IN CHALAKKUDY TOWN, THRISSUR DISTRICT, KERALA.

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**Abstract -** *In recent years mankind has faced the most disastrous climatic events such as high (and low) temperatures, very heavy rainfall, and very high wind speeds. The major reason behind all these events is the changes we made on the earth's surface. Increased anthropogenic activities and unscientific land use methods are collapsing the natural land cover system. These Land cover and land use (LCLU) changes induced by human and natural processes play a major role in global as well as regional scale patterns of the climate and biogeochemistry of the Earth system.*

*The present study involves the assessment of extreme climatic events in Chalakudy. The study area, Chalakudy is a municipal town situated on the banks of the Chalakudy river in Thrissur District of the Kerala State in India. In recent years different regions of the study area have experienced extreme climatic events such as high temperatures, very heavy rainfall, and very high wind speeds. On October 2nd, 2018 there was a destructive wind in Chalakudy town that ends with nonstop rain nearly for two hours. On August 15 and 16, 2018 there was heavy flooding in Chalakudy. Along with these extreme climatic events, studies have shown that the study area is vulnerable to earthquakes. On 18 September 2007, there was an earthquake of magnitude 1.6.*

***Key Words***: Geographic information system(GIS), Land Use Land Cover, NDVI, LST, LSE, ABT, etc.

## 1. INTRODUCTION

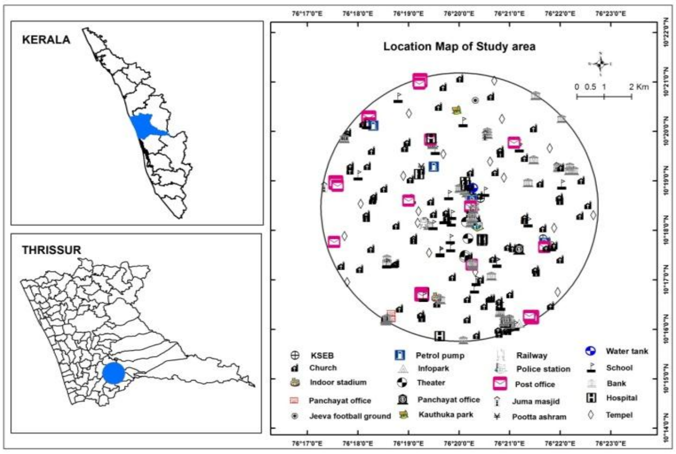
These studies have shown that there remain only a few landscapes on Earth that are still in their natural state. Due to chiefly environmental pollution and pollutants activities, the Earth's surface is changing dramatically in some way and human presence on earth and its use of land have a profound effect on the natural environment, thereby resulting in an observable pattern of land use/land cover over time. The study of land use/land cover (LULC) changes is very important for proper planning and utilization of natural resources and their management. Traditional methods for gathering demographic data, censuses, and analysis of environmental samples are not adequate for multicomplex environmental studies, since many problems are often presented in environmental issues and the great complexity of handling the multidisciplinary data set; we require new technologies like satellite remote sensing and Geographical Information Systems (GIS). These technologies provide data to study and monitor the dynamics of natural resources for environmental management.

Remote sensing has become an important tool applicable to developing and understanding the global, physical processes affecting the earth. GIS is an integrated system of computer hardware and software capable of capturing, storing, retrieving, manipulating, analyzing, and displaying geographically referenced (spatial) information to aid development-oriented management and decision-making processes. Remote sensing and GIS have covered a wide range of applications in the fields of agriculture, environments, and integrated eco-environment assessment. Several researchers have focused on LU/LC studies because of their adverse effects on the ecology of the area and vegetation.

Every year, disasters related to weather, climate, and water hazards cause significant loss of life and set back economic and social development over years. The term extreme weather event refers to an occurrence of a value of a weather or climate variable beyond a threshold that lies near the end of the range of observations for the variable. It is a weather event that is unusually intense or long, occasionally beyond what has been experienced before. Examples include very high (and low) temperatures, very heavy rainfall (and snowfall in cold climates), and very high wind speeds. The study involves the assessment of probable impacts of extreme climatic events in Chalakudy.

### 1.1 Study area

Chalakudy is a municipal town, with a population of about 50,000. It is located in the southern end of the Thrissur district in Kerala, India. The area is located between a latitude of 10°21'10.94"N to 10°15'45.68"N and a longitude of 76°17'16.30"E to 76°22'44.78"E. The study area is about 78 km$^2$ around Chalakudy town. The study has made use of various primary and secondary data. The Survey of India toposheet58 B/71 at 1:50,000 scale and satellite images were used in this study. Land surface temperature data were collected from Landsat 8. Field surveys were made for collecting details about floods. ArcGIS and QGIS were the software used.




**Study area map**

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### 1.2 Preparation of Land Use / Land Cover.

Using ArcGIS, the buffer zone of radius 5Km from Chalakudy town was marked. The Survey of India top sheet 58b71 at 1:50,000 scale is used to prepare a base map. QGIS is used for extracting the land use/ land cover layers, of the years 2008 and 2018 from satellite imageries.

### 1.3 Preparation of Land Surface Temperature.

In the present study, TIR bands 10 and 11 were used to estimate brightness temperature, and bands 4 and 5 were used to generate NDVI of the study area. Satellite data over the Chalakudy region of March years 2016, 2017, 2018, and 2019 have been used in this study. Landsat 8 provides metadata of the bands such as thermal constant, rescaling factor value, etc., which can be used for Calculations like LST.

### 1.4 Preparation of Wind Hazards.

The GPS locations of the affected areas were collected during the field survey. The affected regions were categorized into classes having descending values out of 10 according to wind intensity. The highly affected regions come under the value 10.

### 1.5 Preparation of Flood mapping.

A survey of the flood was conducted to collect the water levels. A flood intensity map was prepared using this data and according to flood intensity, the study area was classified into three zones, i.e. high flood zone, medium flood zone, and low flood zone.

### 1.6 Preparation of earthquake mapping.

The study of earthquakes in Kerala provided information about historical incidents. The studies have shown that there was an earthquake on 18 September 2007 and there are two epicenters within the boundary of the study area. The georeferenced locations were brought into the map layer in Arc GIS.

### 1.7 Preparation of earthquake mapping

The area consumed by human-made infrastructures such as buildings, roads, railways, etc. were added to the map layer to create a built-up density map. It was made to analyze the earthquake vulnerability of the study area.

## 2. RESULT AND DISCUSSION

### 2.1 Land Use Land Cover Change Analysis 2008 to 2018.

When it comes to 2018, the major changes have occurred in the classes of mixed cultivation, homestead with mixed cultivation, paddy field, major roads, and built. The change that s occurred in the mixed cultivation and paddy fields is noticeable. In 2008 the area covering mixed cultivation was about 3122.3ha which then declined to 1852.68ha in 2018. Paddy fields covered 1132.7ha of the total area in 2008 while it is only 848.16ha in 2018. This decline is associated with the conversion of paddy fields into coconut plantations and mixed cultivation. The increased population triggered the construction of homesteads in vegetated areas. There is a remarkable increase in the contribution of homesteads with mixed cultivation in 2018. HMC covered 2604.7ha of the total area in 2008 which then increased to 3828.77ha in 2018. In 2008 the contribution of built-ups was only 117.89ha which is 1.50% of the total area while it is about 338.42ha (4.31%) in 2018. These built-ups are concentrated in Chalakudy town In 2008 the area used by roads was 274.75ha (3.46%) which increased to 455.34ha (5.80%) in 2018. Another noticeable change is seen in the number of water bodies. The 83.38ha of water bodies reduced to 52.33ha in 2018.

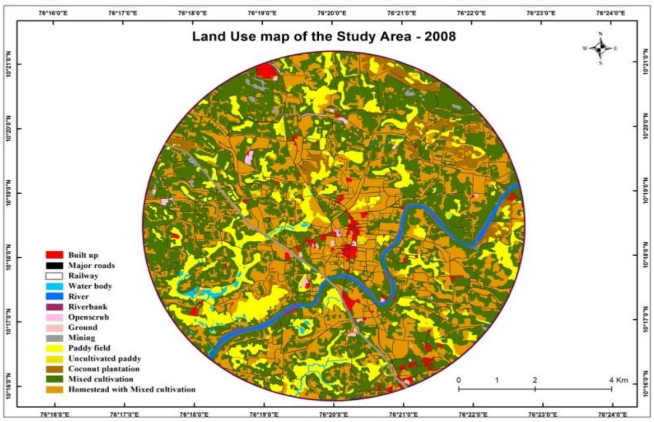


**Table -1: Land use land cover during 2008**

| Sl.No | Category | Area (Ha.) | Percentage of total area |
|---|---|---|---|
| 1 | Built up | 117.89 | 1.50 |
| 2 | Major roads | 274.75 | 3.46 |
| 3 | Railway | 10.64 | 0.18 |
| 4 | Water body | 83.38 | 1.06 |
| 5 | River | Waterbody | 1.54 |
| 6 | Riverbank | 39.63 | 0.50 |
| 7 | Open scrub | 34.68 | 0.44 |
| 8 | Ground | 11.56 | 0.15 |
| 9 | Mining | 26.98 | 0.27 |
| 10 | Paddy field | 1132.7 | 14.43 |
| 11 | Uncultivated paddy | 29.14 | 0.37 |
| 12 | Coconut plantation | 242.7 | 3.09 |
| 13 | Mixed cultivation | 3122.3 | 39.76 |
| 14 | Homestead with Mixed cultivation | 2604.7 | 33.25 |
| **Total** | | **7852.26** | **100.00** |

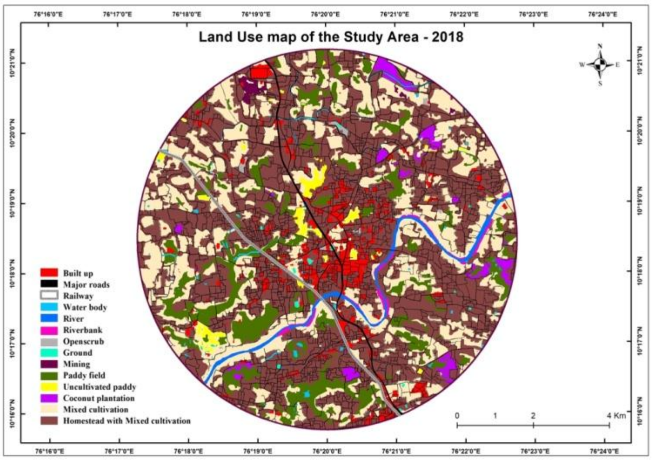


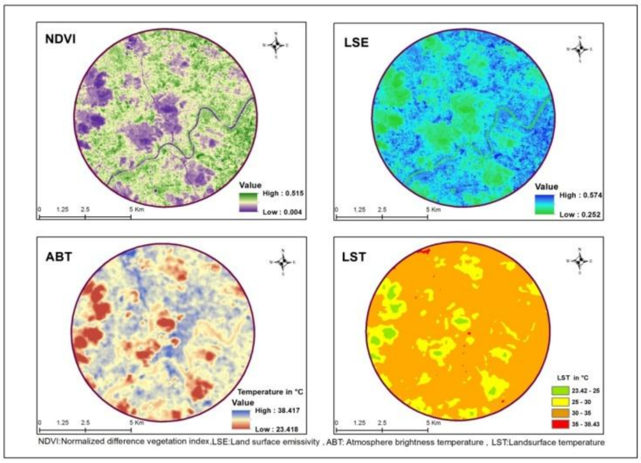

**Table 2 : Land use land cover during 2018**

| Sl.No | Category | Area (Ha.) | Percentage of total area |
|---|---|---|---|
| 1 | Built up | 338.42 | 4.31 |
| 2 | Major roads | 455.34 | 5.80 |
| 3 | Railway | 10.64 | 0.14 |
| 4 | Water body | 52.33 | 0.67 |
| 5 | River | 128.62 | 1.64 |
| 6 | Riverbank | 24.3 | 0.31 |
| 7 | Open scrub | 32.5 | 0.41 |
| 8 | Ground | 12.5 | 0.16 |
| 9 | Mining | 27.96 | 0.36 |
| 10 | Paddy field | 848.16 | 10.80 |
| 11 | Uncultivated paddy | 121.39 | 1.55 |
| 12 | Coconut plantation | 118.65 | 1.51 |
| 13 | Mixed cultivation | 1852.68 | 23.59 |
| 14 | Homestead with Mixed cultivation | 3828.77 | 48.76 |
| **Total** | | **7852.26** | **100.00** |

## 2.2 LST Analysis.

**Table -3: LST temperature ranges and areas for the month of March 2016**

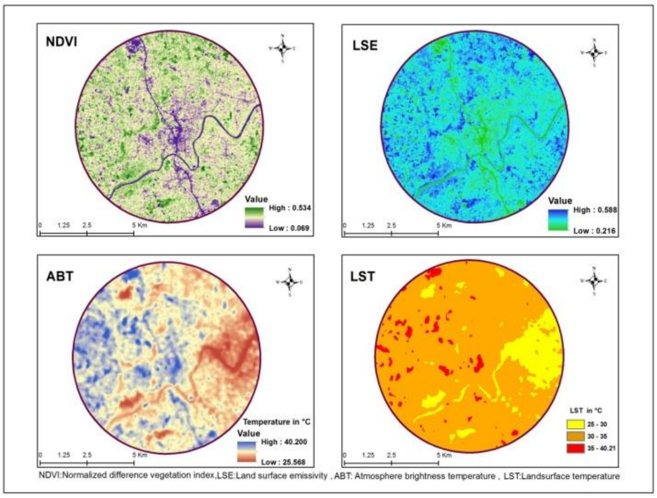
| Sl.No | Temperature (°C) | Area (Ha) | Percentage (%) |
|---|---|---|---|
| 1 | 23.42 - 25 | 165.66 | 2.11 |
| 2 | 25 - 30 | 1405.66 | 17.90 |
| 3 | 30 - 35 | 6257.17 | 79.69 |
| 4 | 35 - 38.43 | 23.77 | 0.30 |
| **Total** | | **7852.26** | **100** |




**LST temperature ranges and areas for the month of March. 2016**

**Table -4: LST temperature ranges and areas for the month of March 2017**

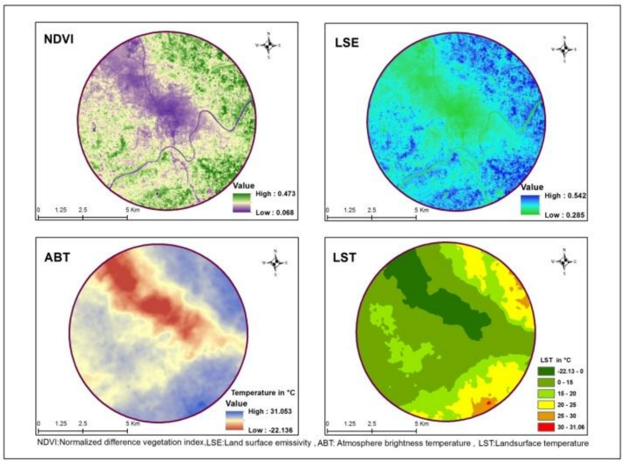
| Sl.No | Temperature (°C) | Area (Ha) | Percentage (%) |
|---|---|---|---|
| 1 | 25.57 - 30 | 1023.69 | 13.04 |
| 2 | 30 - 35 | 6540.91 | 83.30 |
| 3 | 35 - 40.21 | 587.66 | 3.66 |
| **Total** | | **7852.26** | **100** |




**LST temperature ranges and areas for the month of March 2017.**

### Table -5: LST temperature ranges and areas for the month of March 2018

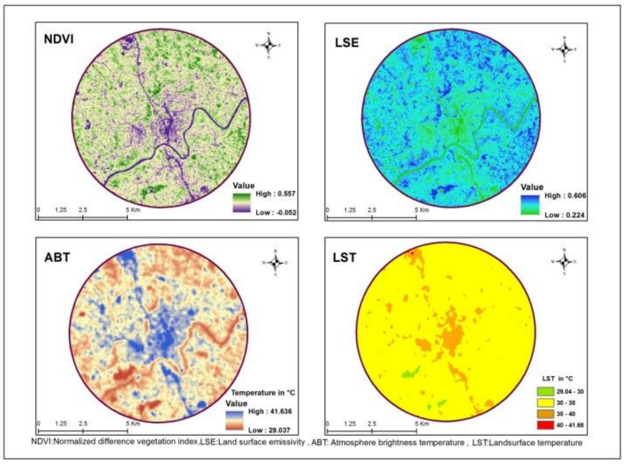
| Sl.No | Temperature (°C) | Area (Ha) | Percentage (%) |
|---|---|---|---|
| 1 | -22.13 - 0 | 1036.98 | 13.21 |
| 2 | 0 - 15 | 3857.09 | 49.12 |
| 3 | 15 - 20 | 1614.69 | 20.56 |
| 4 | 20 - 25 | 1178.04 | 15.00 |
| 5 | 25 - 30 | 161.87 | 2.06 |
| 6 | 30 - 31 | 3.59 | 0.05 |
| **Total** | | **7852.26** | **100** |




**LST temperature ranges and areas for the month of March 2018.**

### Table -6: LST temperature ranges and areas for the month of March 2019

| Sl.No | Temperature (°C) | Area (Ha) | Percentage (%) |
|---|---|---|---|
| 1 | 29.04 - 30 | 51.18 | 0.65 |
| 2 | 30 - 35 | 7209.39 | 91.81 |
| 3 | 35 - 40 | 583.54 | 7.43 |
| 4 | 40 - 41.65 | 8.15 | 0.10 |
| **Total** | | **7852.26** | **100** |

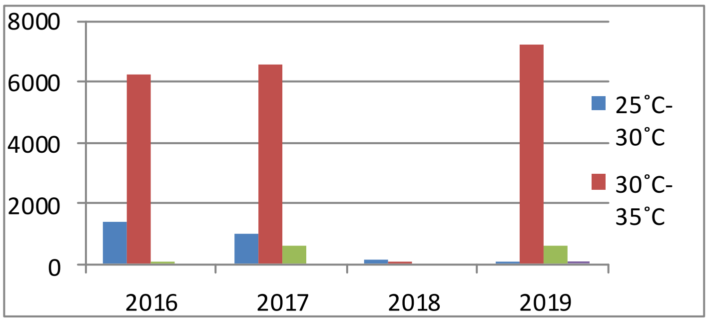



**LST temperature ranges and areas for the month of March 2019.**

### Table -7: LST analysis of the past 4 years.

| Sl No | Year | Temperature 25˚C-30˚C | Temperature 30˚C-35˚C | Temperature 35˚C-40˚C | Temperature above 40˚C |
|---|---|---|---|---|---|
| 1 | 2016 | 1405.66 | 6257.17 | 23.77 | - |
| 2 | 2017 | 1023.69 | 6540.91 | 587.66 | - |
| 3 | 2018 | 161.87 | 3.59 | - | - |
| 4 | 2019 | 51.18 | 7209.39 | 583.54 | 8.15 |

The LULC analysis shows that there has been an increase in urban areas from 117.89 ha to 338.42 ha during the last decade. These land cover changes have also influenced the local climate. The areas having temperatures between 30˚C and 35˚C are increasing over years. In 2016 it was 6257.17 ha but in 2019 it is about 7209.39 ha area. Along with this change, the areas coming under the temperature between 25˚C and 30˚C are decreasing. In 2016 the area coming under this class was 1405.66 ha. In 2019 area decreased to 51.18 ha.




**Graphs of LST analysis of past 4 years.**

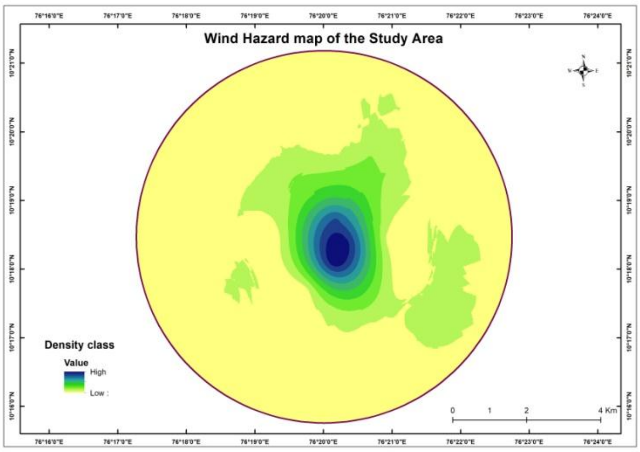
Apart from all other years, 2019 shows a new class of areas having a temperature above 40˚C. Increased LST in certain urban pockets in comparison to their surroundings due to the increase in paved surfaces is known as the urban heat island (UHI) phenomenon. A landscape of concrete, asphalt, and densely packed buildings can enhance heat.

### 2.3 Wind Hazard Analysis.

Cities contribute to a number of several that might lead to more thunderstorm births or storm enhancement.

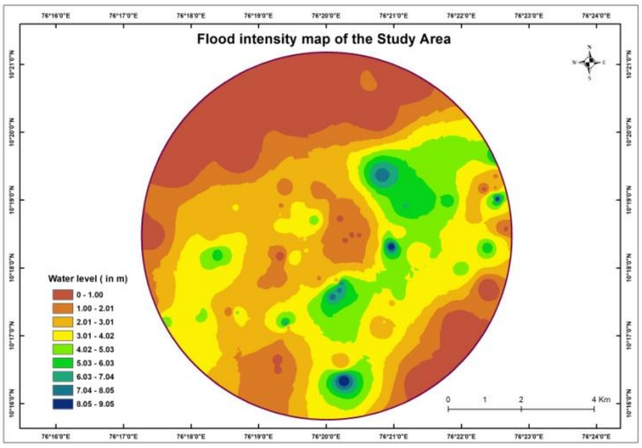
The urban heat-island effect: A landscape of concrete, asphalt, and densely packed buildings can enhance heat. Low-pressure forms atop the urban area with higher pressure in surrounding rural areas. The scenario might cause low-level atmospheric convergence; which forces air up into thunderstorms. Localized areas of upward moving air resulting from increased surface roughness. A cityscape modifies wind direction and speed, which might lead to enhanced convergence and thunderstorm formation.

In 2008, 117.89 ha of the total study area was covered by built-ups. In 2018 built-ups cover 338.4coveredof the total area. It is a noticeable change and it may be the reason for the unpredictable cyclone that occurred in Chalakudy town.




### 2.4 Flood Hazard Analysis.

On August 15 and 16, there was heavy flooding in Chalakudy River as the dams in Tamil Nadu were opened releasing a huge amount of water to the river leading to the overflow of Peringalkuthu Dam upstream Athirappally Waterfalls. The water flows into the Peringalkuthu reservoir in Kerala from the Parambikulam and Tamil Nadu Sholayar dams resulting in the Chalakudy river overflowing and the town flooding. The Full Reservoir Level of the Parambikulam dam was 1,825 feet. As the inflow to Parambikulam and Tamil Nadu Sholayar dams increased, the water was released into the Peringalkuthu reservoir and onto the Chalakudy river. 35,000 cusecs of water were released from the Parambikulam dam and 30,000 cusecs from the Tamil Nadu Sholayar dam which flowed into the Chalakudy river.




### 2.5 Flood Zone Area.

The total study area is categorized into three zones, low flood, medium flood, and high flood according to flood intensity. 4868.33 Ha, which is 62% of the total study area was highly affected. The flood covered a 3 to 4 km distance from the Chalakudy River. The water level reached a peak of 9.05 meters from ground level. The most affected areas are those close to the river. The flooded areas with a water level of about 1 to 2.01 come under medium flood and it covers 1282.23 ha of the total area, which is 16.33%. The low flood zone covers 1701.70 ha (21.67%) of the study area with a water level of 0.69 to 1 meter.

Causes of floods are due to natural factors such as heavy rainfall, high floods, high tides, etc., and human factors such as blocking of channels or aggravation of drainage channels, dam failures improper land use, deforestation in headwater regions, etc. Floods result in losses of life and damage to properties. Population increase results in more urbanization, more impervious areas and less infiltration, and greater flood peak and runoff.

**Table -8: Flood zone area.**

| Sl.No | Zone Class | Range of Water level (In m) | Area (Ha.) | Percentage of total arethe a |
|---|---|---|---|---|
| 1 | Low flood | 0.69 - 1.00 | 1701.70 | 21.67 |
| 2 | Medium flood | 1.00 - 2.01 | 1282.23 | 16.33 |
| 3 | High flood | 2.01 - 9.05 | 4868.33 | 62.00 |
| **Total** | | | **7852.26** | **100** |

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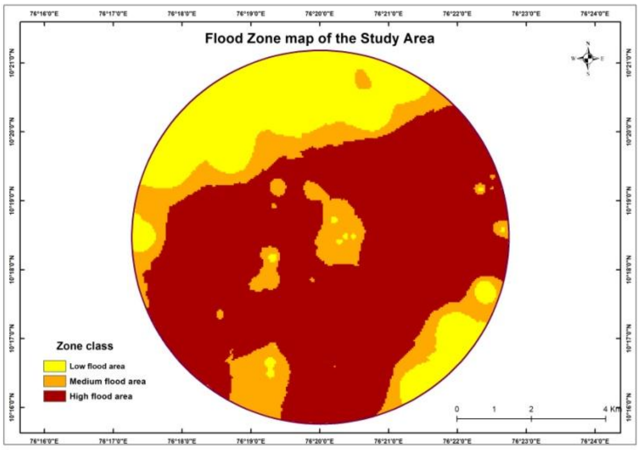
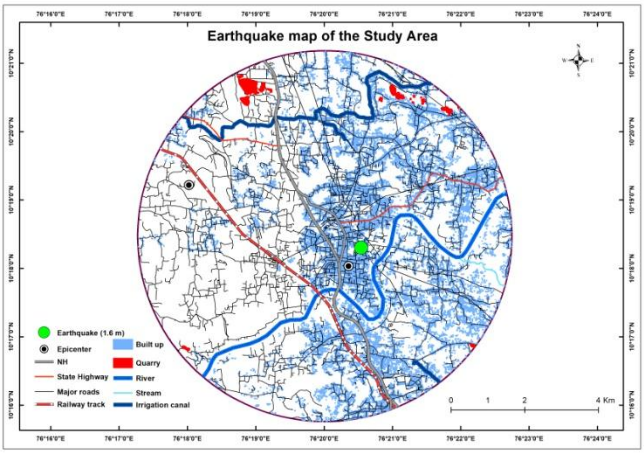


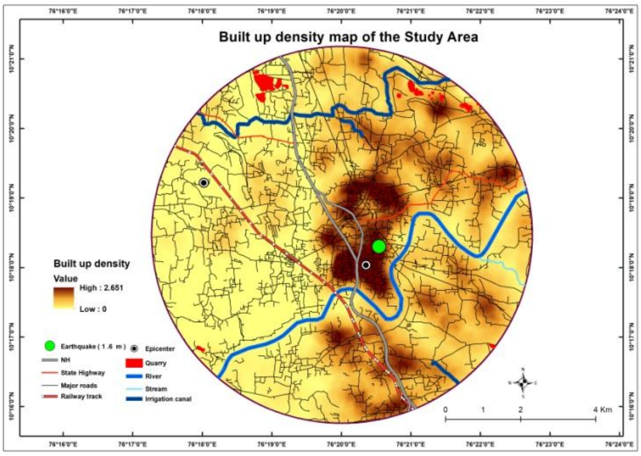

**2.6 Built-up density and Earthquake vulnerability analysis.**

On 18 September 2007 at latitude 10.30 and longitude 76.34, there was an earthquake of magnitude 1.6. The distances from epicenters to the spot are 6km and 4.8 km. According to the Richter scale, 1.6 comes under micro earthquake. There are two epicenters in the study area.

Quarries present in the vicinities of epicenters increase the risk of earthquakes. Quarries are located at a distance of 5.4 km and 2.9 km from the epicenters. The removal of material from the earth can cause instability, leading to sudden collapses that trigger earthquakes.

The increased built-up density is one of the probable reasons for earthquakes. In 2008, 117.89 ha of the total study area was covered by built-ups. When it comes to 2018, built-ups cover 338.42 ha of the total area. There was an earthquake in 2007 which means that the study area is vulnerable to earthquakes. The unplanned expansion and development in disaster-prone areas are the reason for the increased impacts of disasters.




## 3. CONCLUSIONS

Chalakudy has become a disaster-prone area because of climatic events that happened in the past years. The people living in this area have faced floods, destructive wind, and high temperatures. According to the present study, LULC changes play a major role. The decreased amounts of wetlands increased the impact of floods. Nowadays flash floods are very often due to poor drainage systems. In the case of the appearance of strong wind, the increasing amounts of human-made infrastructures play a major role. Anthropogenic materials such as concrete, glass, etc. have high heat capacity. The urban heat island effect forms a low pressure atop the urban area with higher pressure in surrounding rural areas. The scenario might cause low-level atmospheric convergence; which forces air up into thunderstorms.

The study area was included in the high-impact zone of cyclone Gaja in November 2018. It was dissipated but it could damage the entire area.

In 2019 there were low flooding and strong wind in the study area which mean these events are becoming part of our life. They may get worse if we do not make decisions about global warming and climate change.

Overall these climatic events are somehow related to LULC changes. Now it is time to pay for what we did which made all these happen. We must do things to retain the carbon balance and reduce the impacts.

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