

**USE OF GEO-SPATIAL TECHNIQUES TO ASSESS THE  
IMPACT OF LAND USE AND LAND COVER CHANGES ON  
THE LAND SURFACE TEMPERATURE OF LAHORE-PUNJAB**



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**BY**

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## RESEARCH COMPLETION CERTIFICATE

It is certified that Sufah khan of Bachelors (2018-2022), Department of Geography has carried out research work entitled “ Use of Geo-spatial techniques to assess the impact of land use and land cover changes on the land surface temperature of Lahore-Punjab ” under my supervision.

It is assured that research work is original and has not yet been published anywhere else.

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In the name of Allah Almighty: the most Gracious, the most Merciful, the most Beneficent and the most Bounteous. His command is only when He intends a thing that He says to it, "Be," and it is (Surah Ya-Sin Verse No. 082). All praise to Almighty Allah alone, the Omnipresent and the most Merciful and compassionate. The words are bound, knowledge is limited and time is short to express His dignity. I am very thankful to ALLAH who gave a countless blessing. He is the only Master of the whole universe and the Day of Judgment.

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## **ABSTRACT**

Lahore city of Pakistan, has witnessed population growth, rapid expansion and developmental activities such as construction of new societies, roads and buildings due to these reasons major changes has taken place in land use. RS and GIS technique has been used to detect the land use and land cover changes (LULCC), Vegetation & non-vegetation and (LST) land surface temperature in Lahore city for the year 2000 - 2020. Images of Landsat 4-5 (TM) Thermal Mapper for 2000 & 2010, Landsat 7 for 2005 and Landsat 8 OLI 2020 & 2015 were used. By using supervised classification method land use land cover maps were developed. Vegetation & non-vegetation and temperature maps were developed. The results revealed that from 2000 to 2020, many changes in land use occurred. Vegetative land, water bodies and vacant land decreased while built-up area increases from 2000 to 2020. On the other hand, due to development of urban areas, land surface temperature have also increased. The temperature distribution map showed that in 2000 the land surface temperature was low as compared to the land surface temperature of 2020. The vegetation land decreases and non- vegetation land increased from 2000 to 2020. It is recommended that proper planning should be made to protect the green area from urban development and steps should be taken to lessen the land surface temperature effect such as planting more trees etc.

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## **LIST OF ABBREVIATIONS**

<b>Abbreviations</b>	<b>Full Form</b>
LULCC	Land use land cover changes
LST	Land surface temperature
GIS	Geographic Information system
USGS	United states geological survey
NDVI	Normalized difference vegetation index
ETM+	Enhanced thematic mapper plus
TM	Thermal mapper
TIR	Thermal infrared

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# CHAPTER 1

## INTRODUCTION

### 1.1 BACKGROUND

In developing countries, increase in urban development and decreasing in green spaces are the problems caused by increase in population. (Jarrah et al., 2019). Pakistan is a country that is dealing with serious issues such as global warming and climate change. (Khan et al., 2016). In addition to these opportunities, widespread urbanization plays an additional role in influencing overall weather. Land consumption & land pattern changes estimation plays an important role in assessing the influence of urban culture and possible temperature effect (Ding et al. 2013, Sadiq Khanetal.2020).

Humans make arrangements, activities, and inputs to generate, change, or perpetuate a certain type of land cover. Land consumption should be commensurate with land capacity, while respecting the environment and the global climatic system. Land usage is changing over time, with human need being the most essential factor. As the human population grows, natural ecosystems are being transformed into human landscapes.

Human's surroundings mostly large metropolis & manufactured areas, that have significant altered the terrain. The transition from passable and wet land use impervious and dry pavement and material for construction affected the energy budget and land surface temperature and many other surface properties such as flow, drainage system. Land is a common property that increase one's health, creating a desire to acquire more land. Low-cost travel allows people with real incomes to buy a larger houses as lower prices, on land around the city to go to work and to socialize every day, resulting in low-density urban land use.

About 2% of the earth surface is occupied by urban land, which accounts for more than half of the population. Throughout the last century, increasing urbanization trends have included many environmental impacts, and they never seem to stop, so the rate of the growth is expected to be even faster. Improving urban infrastructure is important for human well-being but it also destroy natural ecosystem in urban areas.(Azeem and Butt, 2016).

Now the settlement areas usually divided into two categories urban and rural. The increase in the number of facilities in urban areas has forced people to migrate from rural to urban, but living in a city has advantages and disadvantages. The drawbacks include a rise in land surface temperature as the vegetation cover increases as it converting into built-up area or decrease in natural resources and have a pressure on surrounding areas. The practical purpose of developing cities include

greater economic activity, better health and education etc. The planning and management is needed to keep cities functioning.(Shah and Ghauri, 2015).

Human changes to the land in order to obtain life and their other basic necessities. Land use & land cover changes (LULCC), far greater intensity & speed in the past leading to change in the natural ecosystem. The change include today's extreme concerns about the environment as well as climatic change. The evolution of global conditions is significantly influenced by LULC. (Arvind, Pandey and Nathawat, 2006). The rapid growth in urbanization is due to mass immigration and refugees flows. Urbanization is the development of city infrastructure is a result of increased in population because of human activities which result in change of LULC.

### **1.1.1 CHANGES IN LAND USE AND LAND COVER**

We discussed that the land consumption and land patterns Has a significant in the research and analysis of global change. (Arvind, Pandey and Nathawat, 2006). Natural resources being important on land. Land use changes means it is related to urbanization which are the driver of local geological, ecological and climatic change. These driver bring remarkable socio-economic changes in the neighboring rural areas leading to the urban development (Asadi. et al, 2010). Globally all the changes caused by human activities on earth surface which is known as land consumption and land pattern. The percentage or intensity of land consumption and land cover now-a-days is increases than the previous years. Theses variation and the modification are

responsible for the changes that occur at the extraordinary variation in the ecosystem and the process that taking place in environment (Fan, Weng and Wang. 2007). There are various factors that are affecting land use patterns such as cultural, economic, historical and political factors.

### **1.1.2 LAND SURFACE TEMPERATURE**

LST is the radioactive skin temperature of the land surface. The distance is estimated in the remote sensor's direction. The LST is calculated from Top-of-Atmosphere temperatures taken from the bands transmitted by a network of Geo-stationary satellites. (Metosat Second Generation, GOES, MTSAT/Himawari). The further assessment relies upon the albedo, the amount of plants and soil moisture. The LST is influenced by number of factors, including the earth energy balance, the thermal characteristics of the target surface, the quantity of solar exposure, and cloud cover. Land surface temperature has major influence on physical, chemical and biological process. LST land surface temperature is a combination of greens spaces and soil mixture. As these two terms respond quickly to variations in solar radiation induced by cloud cover and chemical load alteration, as well as fluctuation in illumination. The LST variations exhibits rapidly. As a result the LST distribute of energy between land and green spaces.

The distinct nature of man-made buildings which have lower albedo and greater heat storage capacity than the soil and plant, and are more impermeable to mixture than natural surfaces (Oke, 1982). This means the urban growth area tend to be warmer than the rural areas. (Bertz&Berdhai,

1997). The LST provides an accurate measure of the balance as the earth's and the atmosphere's energy exchange (Zhengming et al., 1989). The topography is one of the variables that determines the distribution of soil mixtures and consequently has an impact on surface temperature. Seasonal variation, time of day, sea breeze, surface air temperature, and land utilization are all factors to consider. may all impact LST variation. (Wang et al., 2008).

### **1.1.3 EXTRACTION OF LAND SURFACE TEMPERATURE**

In past, there is no concept of remote sensing technology, land surface temperature was measured through the use of an in-situ observation or a thermometer on bikes (Vogot and Oke., 2003), Thermal infrared remote sensing has supplied new criteria for the research of the urban heat island phenomenon with the development and arrival of satellite and aircraft thermal infrared remote sensing. The LST is extracted through the process, and the data is obtained from the satellite. For the extraction of land surface temperature, variety of sensors are used such as Landsat 4, 5, 7 and 8 (Xiao et al., 2007). Many causes contributed to variations in land surface temperature, including changes in land consumption, meteorological conditions, and economic growth. (Weng. Lu and Schubring, 2004). Land surface temperature in values is linked with the land cover types. Water and agriculture have very low surface temperature whereas urban areas or development areas like airport, residential societies and manufacturing areas have high temperature. The management is

really important as LST determine the effective radiating surface temperature of the earth (Malick, Rahaman and Singh, 2013)

#### **1.1.4 IMPACTS OF LAND SURFACE TEMPERATURE:**

Land surface temperature cause some serious health problem on human health because of extreme temperature like heat stroke, sunburn and fainting. The disease increase the high mortality rate (Pengelly et al., 2007). During a heatwave mortality increase. Rising temperature in a metropolis areas are causing uncomfortable environments for local residents. The demand of energy constantly increases. The effect of land surface temperature is distressing for more than 40 years (Zhang et al., 2009). Impacts due to increase in the size of construction site land surface temperature is increasing. Urban areas where natural areas are replaced by porous and high areas the external temperature LST effects of asphalt and concrete is mainly triggered by the built environment (Maloley, 2009). The soil covers gives less shade and result humidity to keep urban areas cool. The building has high surface and air temperature. The humidity is low in the areas which leads to less water evaporation. Land users are involved in the development or reduction of temperature in different cities (Jusuf, et al., 2007).

#### **1.1.5 LAND USE AND LAND COVER CHANGES**

Land usage and land cover are two different words that are often used interchangeably. Taken into account the distribution of flora, water, soil, and other physical aspects of the land, as well as those

generated entirely via human activities, the physical qualities of the earth's surface and those created exclusively through human activities (Dimiyati et al., 1996). Human habitats and the way in which land is used by humans typically with the emphasis on the functional role of the land for different economic interests is referred as land use. Considering welfare statistics and increasing demands for human necessities on the land and the land cover, the planning selection and implementation of land use schemes is very essential.

### **1.1.6 FACTORS LEADING TO THE LAND USE AND LAND COVER CHANGES**

Land use is mainly transform by the land consumption as land consumption is affected by the land patterns changes. Changes in the land cover due to the land use do not estimably point out to deprivation of the land. Somehow, ever changing the land patterns compelled by the range of social issues that conclude in the land pattern changes and also affect the budget water, radiation, biodiversity and also track down the gas emission and other various activities that come along to effect the biosphere and climate (Riebsame et al., 1994). The land consumption and land patterns changes uncovering is very important role for better information of landscape dynamics during and indicates the time spent maintaining land management. For appropriate land management and decision perfection understanding of the landscape patterns changes and the communication between the human activities and also the natural phenomena is very essential. Now a days land

consumption and land patterns changes detection studies the earth resources satellite data are very used full and applicable. Land is undergoing with enormous agricultural and population stress it is basically becoming a rare resource. As a result, to meet the expanding needs for human requirements and welfare, information on land usage and possibilities for their optimal use is needed to satisfy these requirements, the information on land consumption and prospects for their best use to overcome the growing demands (Wilkie and Firm, 1996). The urban centers where cities are growing at the expense of loss in agriculture or forest land is often termed as land use. Having harmful effects on people as at large urban sprawl is a matter of great interest in urban studies. Twice than the actual growth of population urban expansion are swallowing rural land and green fields which is manner of great concern (Sultane and Weber, 2007).

### **1.1.7 IMPACTS OF LAND COVER AND LAND USE**

The international energy agency estimates that 71% of widespread energy is associated with the carbon emissions which are emitted from urban areas and the proportion will continue to increase with increase in urbanization. Migration will require in large permanent changes to the energy system. Bringing new challenges involved in profound change, the structure of urban life also require change in the fundamental character of cities. The main key component is the change of natural ecosystem are emerging. These increasing number of problems is due to the increase development of urban areas. The reason for eliminating rainwater infiltration and restoring

groundwater is non-receptive surfaces seal soil surfaces. This will increase groundwater overflow. It plays a natural disaster. This heat releases causing temperature to rise, thereby increasing the energy consumption of the city field (Mishra, 2005). One of the numerous issues linked with urbanization is pollution. Pollutants can affect a variety of environments in different states which means they can solids, liquids, gases and even energy or people activities, the wasted energy has adverse effects. The effect are most concerned with here is overheating. When the city was built the changes are made to the existing environment these changes effect the energy balance alter the entire environment by altering the transition and storage of energy this leads in rise the sensation of land surface temperature. These temperature varies urban to urban and rural to rural.

### **1.1.8 IMPORTANCE OF GIS AND REMOTE SENSING**

One of the most important approaches for producing maps of land use and land cover is remote sensing. It is a technique known as image classification several aspects should be addressed for the image classification process to be effective, including the availability of high quality, Landsat imagery and secondary data an accurate classification procedure, and user experience and skill with the process. The goal of this city was to employ and to identify and categorize maps and land use/land cover regions, remote sensing and GIS techniques were used.

### **3.1 STATEMENT OF PROBLEM**

Due to excessive use of land cover, the surface temperature (LST) of land is increasing.

### **1.3 RATIONALE**

The study aimed to capture changes in land use, land cover and land surface temperature in Lahore city, from 2000 to 2020. Worldwide changes in earth surface caused by human activities are commonly referred as land use/land cover change. One of the main factors leading to changes in land use and land cover patterns is rapid urbanization. Land use and land cover changes lead to deforestation, loss biodiversity, loss of agriculture land, increased in natural disasters, floods and global warming. As the population increase, as people as people acquire more land leading to incredible changes in land use and land cover patterns. In order to meet human needs, barren land and vegetation rapidly being transformed into built-up structures that alter the earth natural surface. Changes in the material covering, the earth surface increased the absorption of solar energy. It causing urban surface temperature rise, leading to serious health problem. If land cover changes and it wasn't monitored and planned for years to come the impacts may change. It is important to study and addresses current changes in land use and land cover in order to protect and predict future states to restore environment quality. It is important to study the land surface temperature so that we know about the increase or decrease in temperature. As increase in temperature caused many health problem and try to address health issues and overcome them.

## 1.4 OBJECTIVES

- ✚ To determine the land use land cover changes in Lahore using Remote sensing
- ✚ To monitor and analyze the change of urban land use.
- ✚ To estimate the LST.
- ✚ To study the effect of land use change on land surface temperature..

## 1.5 HYPOTHESIS

$H_1$  = Land surface temperature increase with decrease in vegetation.

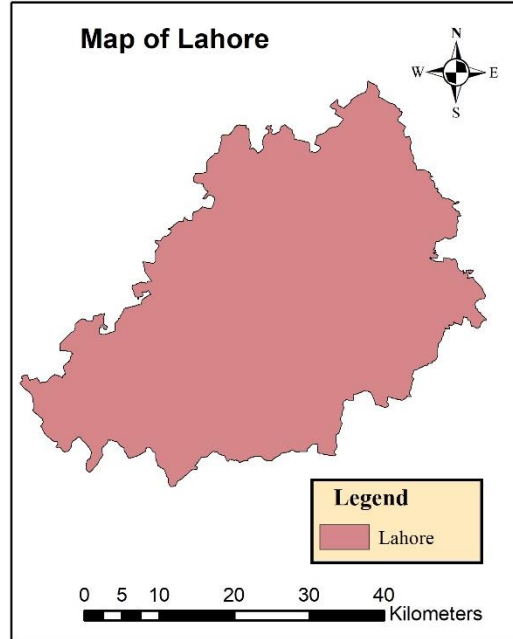
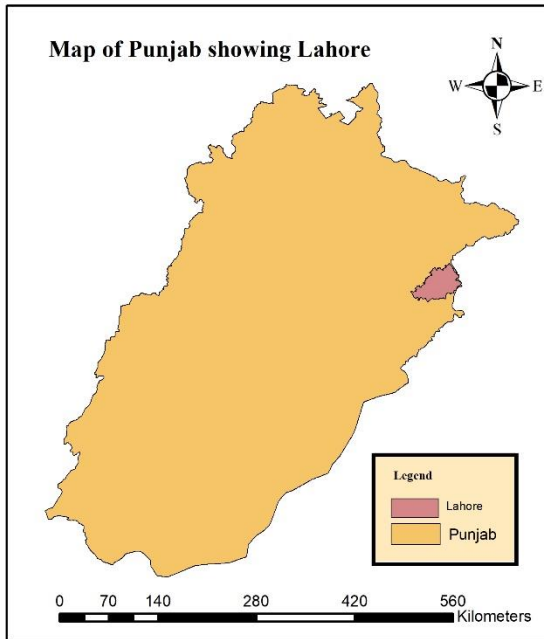
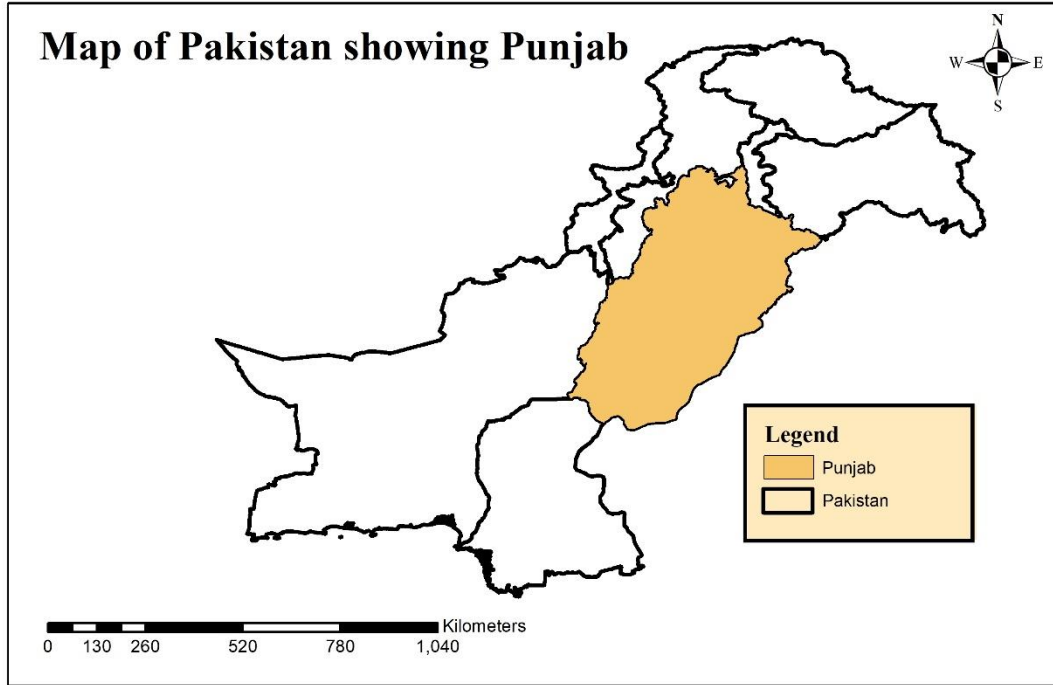
$H_0$  = Land surface temperature not increase with decrease in vegetation

## 1.6 STUDY AREA

The research region was defined by the district of Lahore, which is located in Pakistan's north-eastern Punjab province and was chosen for LULC and LST changes using RS and GIS methodologies. In terms of population, it is Pakistan's second largest city. Lahore is situated on the Ravi River's western bank.. It is located in the center of the country, with 25 kilometer international border with India. Lahore is located between longitudes  $74^{\circ} 19' 45''$  E (east) and the latitude of  $31^{\circ} 34' 55''$  N (north). Lahore plays an important role in India and Pakistan movements. The Lahore is famous for their history landmarks which is next to the walled city like Lahore Fort and Badshahi Masjid. Modification in urban land consumption have a signature significantly effect on land surface temperature over the last two decades, Lahore a Pakistani city has been significant urbanized.

The following map shows the study area of this Research.

### *Study Area*



**Figure 1.1 Map of study Area.**

## CHAPTER 2

### LITERATURE REVIEW

(S. Youneszadeha, 2008). The influence of land use change on surface temperature in the Netherlands was investigated. The Netherlands is a relatively large small country population that experienced rapid land use change between 2000 and 2008. Land use change in particularly relevant to urban change spread and surface temperature which include industrialization and population growth. The research paper reports a survey on remote sensing, the application of geographic information combined with statically methods provide quantitative information on impact of land use change on the land surface temperature. In this study remote sensing technology was used to retrieve the land surface temperature (LST) using satellite imagery products.

Aboelnour, M., & Engel, B.A. (2018) analysis land surface temperature in response to land use and land cover changes in Greater Cairo, Egypt (GCE). The Greater Cairo Egypt experienced rapid urban expansion and extensive development over the past several decades. The result shows that due to development, the area suffers from many environmental impacts. To migtrate this consequence it is crucial to measuring historical changes in GCE spread and its impacts on the land surface temperature. Land use/ land cover map from Landsat 5 TM Landsat 8 OLI in 1990, 2003 and 2016. These images used a variety of classification techniques. This rapid urbanization development has significantly reduced the area of vegetation therefore LST increasing and change in urban climate.

Agarwal, Sharma, and Taxak (2014) studies the urban heat island phenomena by using remote sensing technique. The study area of research was Nagpur. The main focus of the research was to find the relation between LST, NORMALIZED Difference vegetation index (NDVI), and Normalized difference impervious surface index (NDISI). For this purpose Landsat TM and ETM+ were used for estimation of LST from different season. The result revealed that the relation between LST and impervious area was strongly co-related for all season while the relation between LST NDVI was not strong, it varies by season.

Akbar et al., (2014) studies the spatial-temporal land sue patterns by using geo-spatial techniques. The study area chosen for this research was Gujranwala. The focus of the research was to examine temporal land use patterns, the data was collected through residents, stakeholders and Landsat satellite images of the year 1947, 1985 and 2009. In order to obtain results ArcGIS and ERDAS imagine software were used. The results reveal that residential areas, agricultural, road network and commercial areas are cover significant areas.

Cao et al. (2008) Using remote sensing data from China's Sangong River Basin, researchers looked at how land surface temperature fluctuates in response to changes in land use and land cover. The study area is an oasis on the edge of the dessert. To achieve the goals they selected and analyzed two Landsat TM/ETM+ images from 1990 and 1999, respectively to retrieve land use/ land cover and leads to Land surface temperature (LST). Based on the average LST values they calculated the rate of LST change for each land use between 1990 and 1999. They found that the LST was significant response to LULCC. The overall result shows that land use/land cover change significantly due to the rapid growth in 1990-1999, which required more land and the average LST increased by about 10% during this period.

Imran, H.M. et al. (2021) analyzed the impact of land cover change on the surface temperature and human thermal comfort in Dhaka, Bangladesh. Urbanization has led to the construction of various urban infrastructures in urban areas for housing, transportation, industrial and other uses that leads to significant changes in land use template. Therefore it significantly affects the land surface temperature (LST) through and imbalance surface energy budget. Remote sensing (RS) technique and Geographic information system (GIS) technique were used for detailed investigation. In this study they create they land use and land cover map RS data from 1993, 2007 and 2020 of Dhaka city, for March-May season, to analyze LST's and generate the maps using GIS technique.

Jiang et al., (2010) In Beijing, China, the influence of land use/land cover changes on land surface temperature was investigated using remote sensing techniques (RS). The city is surrounded by mountains on three sides and plains on the other sides. The main focus of research to examine the impact of land use changes on LST. For this study three Landsat images with clear weather taken on April 9, 1995 and April 30, 2000 were selected. In order to determine the effect of land use changes on LST, temperature vegetation index was constructed. The land use and land cover classes were extracted by using supervised and unsupervised classification method. The result shows that land use changes showed an increase in LST. Due to urbanization cultivated land and forest land changes into built-up land from 1995 to 2000. The current study is that land use change causes pixels to migrate from cold to hot surface condition.

Karakus, C. B. (2019) analyzed the impact of land use /land cover change (LULCC) on land surface temperature for Sivas city center. In this research, relationship between LULC, NDVI and LST in Sivas city downtown and surrounding areas examined using Landsat satellite imagery and Urban heat island (UHI) was demonstrated from 1989 to 2015. The result shows that it is obvious

urban development and agricultural land use increased while wasteland decreases during study period. Changes in LST can be monitored based on building material such as the presence of green spaces, the unique location and topography of the city.

Kausar (2016) examined the temporal land use and land cover patterns by using technology of remote sensing and geographical information system. The study area chosen for this research was Murree which is the most famous tourist place in Pakistan. The main objective of this research was to investigate land use changes. For this purpose, Landsat 4 TM and Landsat ETM+ for the years 1998, 2004, 2005 and 2010 were used. Maximum likelihood classification algorithm was applied. The result revealed that there was a rise in built-up area and reserved forests whereas there was a consistent decline in dense forest and grassland.

Khan and Omar (2014) studied the impacts of LST. The study area of the research was Karachi, which is the largest city of Pakistan. The aim of this research was to monitor the changes in LST and formation of urban heat island. Landsat ETM of the years 2000, 2006, 2010, 2011 and Landsat TM of the years 2000, 2011 were used to monitor LST. ERDAS Imagine 9.3 and ArcGIS 10.1 were used for image processing. The satellite images were compared by using unsupervised classification method showing the difference of built-up area and population growth, furthermore the LST land surface temperature was extracted by Landsat images. The result was found in the past few years Karachi has experienced extreme urbanization. Moreover the increase in urbanization has a direct effect on land surface temperature (LST) which is resulting in environmental changes.

Li, Lin, et al. (2014) analyzed the results of land pattern and population density on the surface temperature, a case study in Wuhan, China. The rapid development of urbanization and the living

standards have improved but changes in the urban thermal environment have improved but changes in the urban thermal environment have change and now become serious and alarming situation. The urbanization of the population is driving force for the expansion of residential areas. Mainly affects the land surface temperature (LST). The city of china, Wuhan received land cover and LST maps for Landsat 5 images in 2000, 2002 2005 and 2009 discussing the distribution of land use/ land cover change on LST. Analyze the co-relation between the population distribution of the residential areas and the LST value area. The result show the large difference in land cover types expressed as the area of arable land was reduced and the constriction area was expanded. Area with high LST conclude resident ion and industrial areas with less vegetation cover.

Mohsin and Bhili (2015) described fast urban growth, in Bahawalpur. In 2012, the centr5al population was predicted to be 560,588 people, up from 408,305 in 1998. The influence of fast urban growth manifested itself in the form of local city enlargement. With a large rise in residential areas of 1,468.78 acres 1974, the city urban land expanded and rose while the area of agriculture; land declined by approximately 3802.55 acres in 2010 and reduced by about 1,176.06 acres to just 1972.00 acres in 1974.

Naseem, Tubbsum and Shah (2013) monitored the urban growth alongside highway through satellite imageries in Islamabad and a part of Rawalpindi. The purpose of the study was to observe the LULC with the help of RS and GIS. The software used during the research were the ER Mapper. The results were proved by the data of bahira town. The conclusion of these studies were most qualitative and quantitative in nature mainly.

Pal. Swades, and S. K. Ziaul. (2017) examined the consequence of land use and land cover (LULC) on land surface temperature (LST) in English Bazar Municipality of Malda District using multi

spectral and multi temporal satellite data. The estimated temperature gap is also strongly controlled by LULC. As the LULC pattern is getting changed, its imprint is reflected on LST and for temperature. So immediate thinking about new urbanism should be adopted, started and implemented to arrest the rising temperature and effect on urban heat island.

Sajjad Hussain, (2021) the goal of this study was to evaluate land use and cover (LULC) and the impact of land surface temperature (LST) in Khanewal district, Punjab, Pakistan using remote sensing technique (RS). Data was being processed using ERDAS software 15 and ArcGIS 10.4 software for overlay, mosaic and partial adjustments of Landsat imagery. The results of this study show that the geometry of the Khanewal district has changed drastically due to the rapid increase in population density, urban development and other infrastructure development.

Shah and Ghauri (2015) studied the mapping in comparison to the urban heat island with land use and land cover of Lahore. The aim of this study was to know the connection between land surface temperature LST and land use and land cover changes (LULCC). To acquire data remote sensing based satellite images were from Landsat TM and ETM+. Calculations were done utilizing infrared bands (TIR) band 6 and Planck's constant. The results revealed that the built up area within the city in 2011 has increased 25% since 2000. This has caused the land surface temperature increase.

Sheikhi, A., K. D. Kanniah, and C. H. Ho (2015) analyzed the land surface temperature (LST) and established a relationship among LST and land use/land cover changes with numerous vegetation and urban surfaces in the Iskandar Malaysia region (IM). Iskandar Malaysia is certainly considered among the rising financial gateway of Malaysia, and envisaged to transform into a metropolis by 2025. The alternate change in increase in temperature therefore we conducted a study by using Landsat image to convert the study region to estimate LST, classify different land cover and

calculate spectral indices. The results shows the urban surface has highest LST and the lowest temperature was recorded in forest rubber and water bodies.

Waseem, Sarah and Omar Khayyam (2019) analysis the loss of vegetation cover and increased in the land surface temperature in Islamabad, Pakistan. The vegetation cover become the assuming way of accelerated emission carbon. It leads to increase in land surface temperature (LST) and consequently preforming in global warming. The study has done with remote sensing (RS) and GIS to observe LST variation in Islamabad. This research is also study the vegetation cover loss for the time spam of 25 years. From 1992 -2017.

Xiao et al. (2007) examines the effects of changing land use and land cover on land surface temperature in GUIZHOU province, southwest China including four counties. It is a mountainous agricultural province, approximately 73% karst. Satellite imagery was taken and corrected to remove atmospheric effects. All data is then projected onto a common UTM coordinates system. Using a hybrid image classification system five land use/land cover (LU/LCC) were s3leted including natural vegetation, water, and agricultural, urban and wild land.

Zhou et al., (2011) They retrieved geographical data while researching how LST responds to urban expansion patterns of LST and land use in 1992 and 2006 from Landsat images of 16<sup>th</sup> August 1992 and 19<sup>th</sup> May 2006. They classified TM images into five land use-types including construction land, water bodies, vacant land, forest and farmland. Them they used remote sensing to describe land use types. To investigate the impact of LU/LCC on LST patterns land use detection was performed. Then overlay the altered area with and LST layer to calculate the difference between 1992 and 2006.

## CHAPTER 3

### METHODOLOGY

Following software's were used to complete the work.

**Table 3.1 Methodology used for the Study.**

<i>Software's Names</i>	<i>Application</i>
USGS	Used to download satellite image
ArGIS 10.7	Used for the image processing
SPSS	It is used for making graphs
Microsoft Word	Used for final presentation of research work

## **3.1 Pre-processing of satellite images**

### **Downloading**

In this study, Land use land cover changes (LULC) and land surface temperature (LST) were calculated using Landsat satellite imagery. Landsat 8, 7, and 4 were employed, and it is part of NASA's Landsat series. The data of Landsat 8 is available on google earth explorer website free of cost. Cloud free Landsat 4-5 and Landsat 8 of 2000, 2005, 2010, 2015 and 2020 respectively. The brightness temperature was estimated using TIR bands 10 and 11, and the NDVI of the research region was calculated using OLI spectral bands 2, 3, 4 and 5. Landsat 8 provides band Meta data such as the thermal constant rescaling factor value, which may be used to calculate algorithms such as LST. The research area was obtained from the USGS Earth Explorer website. They downloaded images were of different months. The details of satellites images are shown in table.

The table below displays the year and characteristics of satellite pictures downloaded for the land surface temperature procedure.

**Table-2 Data Sources: Earth Explorer, USGS, 2019**

**Table 3.2 Satellite Data from 2000-2020**

<b><i>Sr. no</i></b>	<b><i>Year</i></b>	<b><i>Date</i></b>	<b><i>Satellite Parameter</i></b>	<b><i>Path/Raw</i></b>	<b><i>Spatial resolution</i></b>	<b><i>Spectral Resolution</i></b>	<b><i>Day/Night indicator</i></b>
1	2000	19 <sup>th</sup> September, 2000	Landsat 4-5 TM	140-038	30m	7 bands	Day
2	2005	25 <sup>th</sup> September, 2005	Landsat 7 TM	140-038	30m		Day
3	2010	7 <sup>TH</sup> September' 2010	Landsat 4-5 TM	140-038	30m	7 bands	Day
4	2015	29 <sup>th</sup> September, 2015	Landsat 8 OLI	140-038	30m	11 bands	Day
5	2020	10 <sup>th</sup> September ,2020	Landsat 8 OLI	140-038	30m	11 bands	Day

## 3.2 Estimation of Land Surface Temperature

### Landsat 8

Thermal bands from Landsat 8, 4-5, and 7 were used to compute land surface temperature. It was a simple plugging a series of equation into a raster image calculator. Landsat bands were used to calculate the land surface temperature. Band 10 & Band 6 serves as a temperature band whereas band 4 and band 5 are utilized to generate the normal difference vegetation index (NDVI).

### Process

The following other steps of calculating land surface temperature. Firstly we will discuss the formulas for Landsat 8 and 9. These formulas are placed in GIS raster calculator. It is done step by step. Add study area map and then Type and search “extract by mask” from the search bar of the geo-processing toolbox.

### Top of Atmospheric Spectral Radiance

The value of TOA spectral radius (L) is calculated by multiplying multiplicative rescaling factor (0.000342) of TIR bands with their respective TIR bands and then adding additive rescaling factor (0.1).

$$L\lambda = ML * Q_{cal} + AL$$

- Where,  $L\lambda$  - Top of Atmospheric Radiance in watts.
- ML - Band specific multiplicative rescaling factor (radiance\_mult\_band\_10/11)

- Qcal - band 10/ 11 image.
- AL - Band specific additive rescaling factor (radiance\_add\_band\_10/11)

## **Brightness Temperature Brightness temperature**

The microwave radiation radiance travelling upward from the top of the earth's atmosphere is known as brightness temperature. The calibration method was carried out in order to convert thermal radiance DN values from TIR thermal bands to TB. The Top of atmospheric (TOA) spectral radiance was required to determine the TB of a region. The following formula was used to calculate TB for both TIR'S bands.

$$BT = K2/Ln (K1/L\lambda+1) - 273.5$$

- Where, K1 and K2- thermal conversion constant and it varies for both TIR bands
- $L\lambda$  – Top of Atmospheric spectral radiance.

## **Normalized Difference Vegetation Index NDVI**

NDVI was determined using GIS software after layer stacking of OLI bands 4 and 5. The maximum and lowest values of the vegetation index are determined by the NDVI output result. The NDVI picture was classed into soil and vegetation to obtain the NDVI minimum and maximum, and the classified data were used to determine the proportion of vegetation.

$$NDVI = (Band 5 - Band 4) / (Band 5 + Band 4)$$

The proportion of vegetation ( $P_v$ ), which is heavily connected to the NDVI, and emissivity ( $\epsilon$ ), which is related to the  $P_v$ , must be computed after the NDVI has been determined.

$$\text{NDVI} = \text{Float}(\text{Band } 5 - \text{Band } 4) / \text{Float}(\text{Band } 5 + \text{Band } 4)$$

## Proportion of Vegetation

$P_v$  is the ratio of the vertical projection area of vegetation on the ground (which includes leaves, stalks, and branches) to the total vegetation area.

$$P_v = \text{Square}((\text{NDVI} - \text{NDVI}_{\min}) / (\text{NDVI}_{\max} - \text{NDVI}_{\min}))$$

The NDVI image's minimum and maximum values are usually presented immediately in the image (both in ArcGIS, QGIS, ENVI, and Erdas Imagine), but if not, you must examine the raster's attributes to retrieve those values.

## Calculation for Emissivity $\epsilon$

The emissivity is the proportional step in vegetation. The mean and difference were calculated after producing percentage vegetation for both TIR and NIR bands.

$$\epsilon = 0.004 * P_v + 0.986$$

Simply enter the formula into the raster calculator; the value of 0.986 corresponds to the equation's correction value.

## **Land Surface Temperature:**

Finally apply the LST equation to obtain the land surface temperature map.

$$\mathbf{LST = (BT / (1 + (\lambda * BT / 14388) * Ln(\epsilon)))}$$

There is a map of the Land Surface Temperature as a consequence of the created procedure; it should be noted that it is not equivalent to the air temperature.

### ***3.3 Estimation of Land Surface Temperature***

#### ***Landsat 4-5 &7***

##### ***Step-1 DN into Radiance:***

Geometrically, the satellite data products were not adjusted. The temperature reflectance of Landsat 4-5 & 7 data set was used to rectify the data. The information for the satellite pictures is displayed in the table above. The following equation is used to convert the DN (Digital Number) values of band6 to at-sensor spectral radiance in the proposed study.

$$L_{\lambda} = ((LMAX_{\lambda} - LMIN_{\lambda}) / (QCALMAX - QCALMIN)) * (QCAL - QCALMIN) + LMIN_{\lambda}$$

Where,

$L_{\lambda}$  is the cell value as radiance

QCAL = digital number

$LMIN_{\lambda}$  = spectral radiance scales to QCALMIN

$LMAX_{\lambda}$  = spectral radiance scales to QCALMAX

QCALMIN = the minimum quantized calibrated pixel value

QCALMAX = the maximum quantized calibrated pixel value

##### ***Step2: Conversion of radiance into BT (In Kelvin)***

The TIRS band data should be converted to brightness temperature (BT) using the thermal constant after converting DN values to at-sensor spectral radiance. Image metadata from a satellite Variable K1 K2 Value Description The following equation represents thermal constants.

$$T = K_2 / \ln(K_1 / L_\lambda + 1)$$

$T$  = Top of atmosphere brightness temperature

$L_\lambda$  = TOA spectral radiance

$K_1$  = Band-specific thermal conversion constant from the metadata

$K_2$  = Band-specific thermal conversion constant from the metadata

Where  $K_1$  and  $K_2$  are the thermal constants that will be found in the metadata file with the satellite picture.

### ***Step 3: Convert Degree Kelvin into Degree Celsius***

It is essential to update the values in Celsius by adding absolute zero, which is approximately equal to -273.15. The atmospheric influence is not taken into account in obtaining the LST since the atmosphere in our research location is very dry and so the range of water vapor values is quite modest.

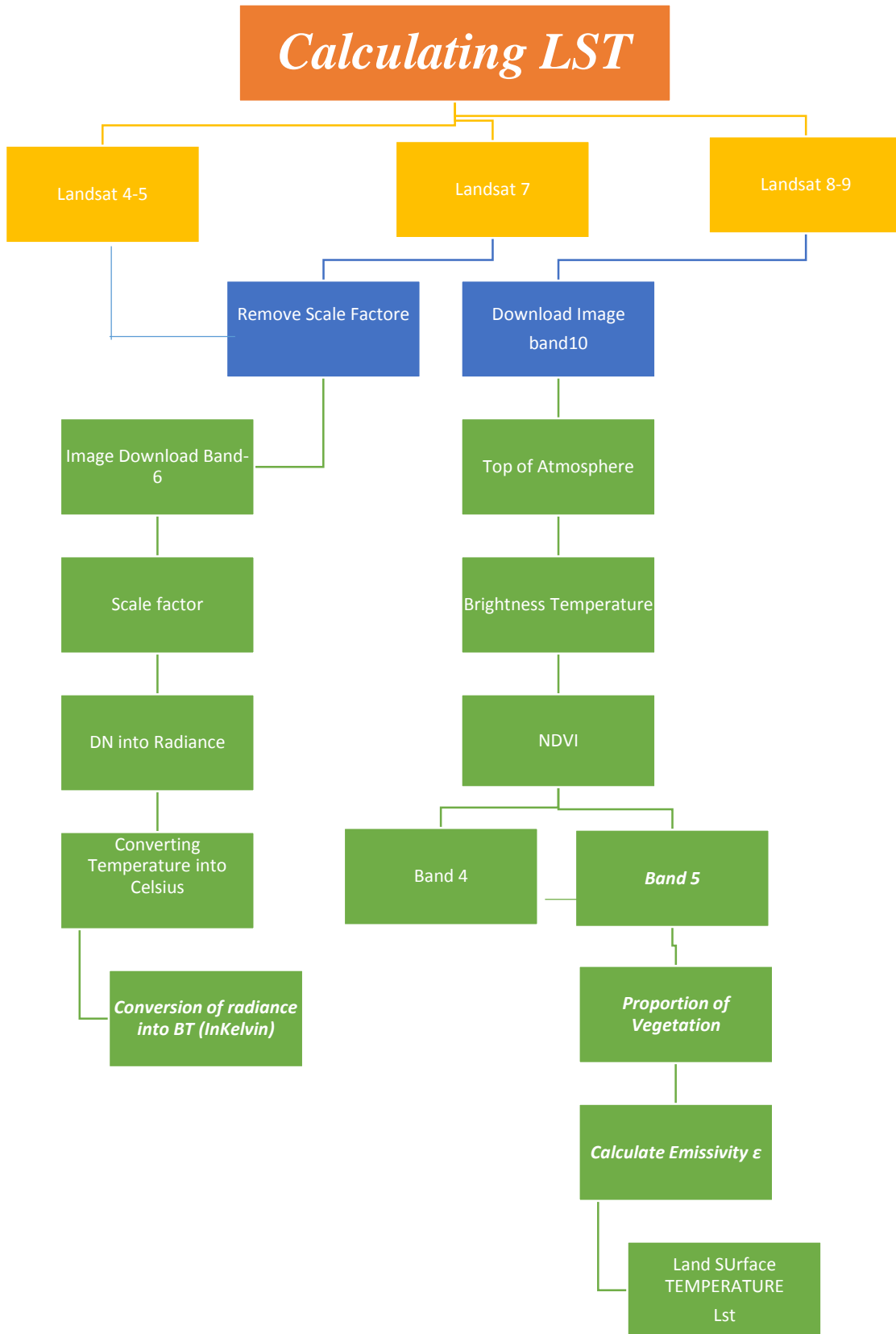
$$C = T - 273.15$$

*Data source MTL Document.*

*Table 3.3 Variables and their values*

<b>Variables</b>	<b>Description</b>	<b>Landsat</b>	<b>Value</b>
<i>K1</i>  <i>K2</i>	<i>Thermal Constant</i>	  8-9    7    5    4	<i>K1 = 774.8853</i> <i>K2 = 1321.0789</i>    <i>K1 = 666.09</i> <i>K2 = 1281.71</i>    <i>K1 = 607.76</i> <i>K2 = 1260.56</i>    <i>K1 = 671.62</i> <i>K2 = 7284.30</i>
<i>Lmax</i>  <i>Lmin</i>	<i>Minimum &amp; Maximum value of radiance</i>	4 – 5 & 7	          <i>Max = 15.303</i>          <i>Min = 1.238</i>
<i>Qcalmax</i>  <i>Qcalmin</i>	<b>Minimum &amp; Maximum Values of Quantize Calibration</b>	4-5	<b>Max = 255</b>          <b>Min = 0</b>

Figure 3.1 Methodology Flowchart



## **3.4 Land use & Land Cover**

### **Step-1: Downloading**

As first step is downloading image. Satellite images were collected by downloading from earth explorer from USGS. The images downloaded were accurate and availability of less cloud cover, and available free on the website. The downloaded images were of month of September for both years 2000 and 2020. The details of images were discussed in the above table.

### **Step-2: Layer Stacking**

Layer stacking is the process of combing the spectral layers to get a multispectral image actually it ties up the spectral layer to comprise an image. The band stacking process is performed by using ArcGIS band stacking from analysis image or simple search it from search Bar.

All the downloaded satellite images were in bands form, as 2000 consist of 7 bands images and 2020 consist of 11 bands images. Further in order to fulfil the requirement for image pre and post processing, the images were changed into "image" format as they were in "tiff" format. For this purpose, composite layer stacking of the bands 1 to 7 was done for the both year images by using layer stacking tool of ArcGIS.

### **Step-3: Clipping**

Clipping is a useful mechanism of extracting area of interest from a large dataset but it is application dependent. After doing the layer stacking, the next step was to clip the study area. For this purpose layer stacking images were opened in ArcGIS. Further study area was clipped with the help of shape file. The shape file add from add data and then it will clipped as the shape file and downloaded images consisted of different cities. As study area was Lahore, and then clipped area were saved. This process was done to both years,

#### Step-4: Image Enhancement

Image enhancement is a technique for improving the visible differences between image characteristics. Noise in remotely sensed photographs makes it harder to comprehend the image. The goal of picture enhancement is to build new images from old ones in order to gain additional information.. To improve the quality of images, image enhancement was done to both year images. The bands 5, 4, 3 for 2000 and for 2020 bands 7, 5, 3 were selected for the identification of land cover classes. Then brightness contrast was set for each year image

#### **Step -4: Classification**

It is the process of sorting the pixels into finite number individual categories or classes, of the data depending on values of data file. If a pixel fulfils a certain set of standards. Then the pixel is assigned to the class that corresponds to that standard.

## **Identification of Land Cover Classes**

After the image enhancement, next step was to identify land cover classes. Four land cover classes were identified, following classes were developed:

- Vegetative Land
- Vacant Land
- Built up Area
- Water Bodies

## **Step-5: Image Classification**

The next step after the identification of urban growth classes was clipped images classification. The classification box will be open by doing right click on bar, list of tools options can be seen, select Image Classification Training sample manager was selected by zooming the images to pixel level. Drawing tools such as lines, rectangles and circles were drawn to categorize pixels into different classes. Signatures were specified with the help of draw polygon on image classification box. And that's how it will be digitize.

## **Step-6: Class Merging:**

Depending on the type of attribute grid cells are coded to signify variables as continuous or binary variables. The images which were remotely sensed were merged with other geocoded resources in

GIS. This allowed several layers of information to overlap with remotely sensed images. The urban growth data was calculated through detecting the change in vegetative land, barren land and built-up area.

## **CHAPTER 4**

### **RESULTS**

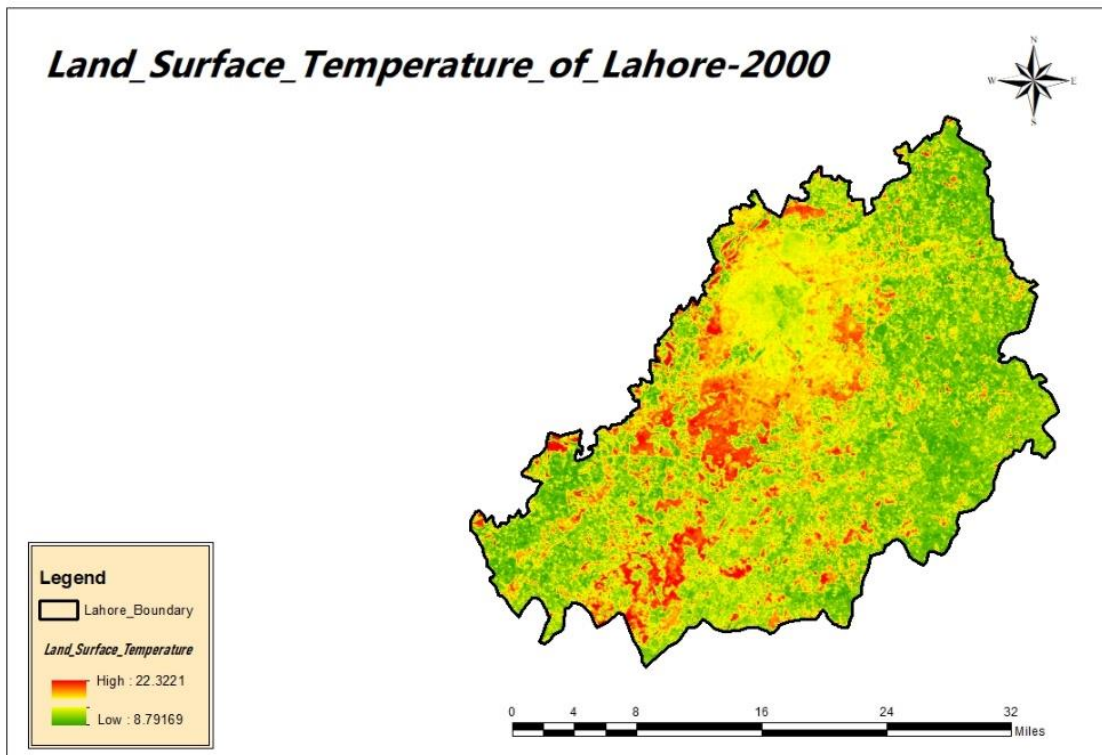
#### **4.1 Land surface Temperature Maps:**

Remote sensing is an important source of Earth observations from a variety of platforms and sensors. The quality of large-scale work with cheap, accurate, and faster results than other methods. The processing and analysis of data gathered predominantly in the infrared (TIR) region of the electromagnetic spectrum is the subject of thermal remote sensing (EM). Thermal remote sensing primarily captures radiation emitting from the ground to estimate land surface temperature. Besides surface temperature, surface emissivity, soil moisture and evapotranspiration are other important biophysical parameters estimated from TIR observations. Since these parameters determine land-atmosphere interactions and energy fluxes, careful evaluation is required to understand Earth behavior. The Earth's Surface Temperature (LST) represents the temperature of the Earth's surface. A globally changing climate also contributes to overall environmental conditions (Akanwa et al., 2019).

In this research, the land surface temperature is detected by the application of Remote sensing and ArcGIS. The LST is measured and shown below in the form of maps. The regional distribution of LSTs with defined temperature zones was generated using Landsat thermal bands of the month of September. The temperature was calculated of year 2000, 2005,2010,2015,2020 &2021. Theses maps were generated from ArcGIS. The land surface temperature was divided into two zones higher and lower temperature. As Lahore is a populous city of Pakistan. The city become urbanized day by day, so due to increase in urbanization the land surface temperature was increasing as the vegetation decreases. With increase and decrease of vegetation the land

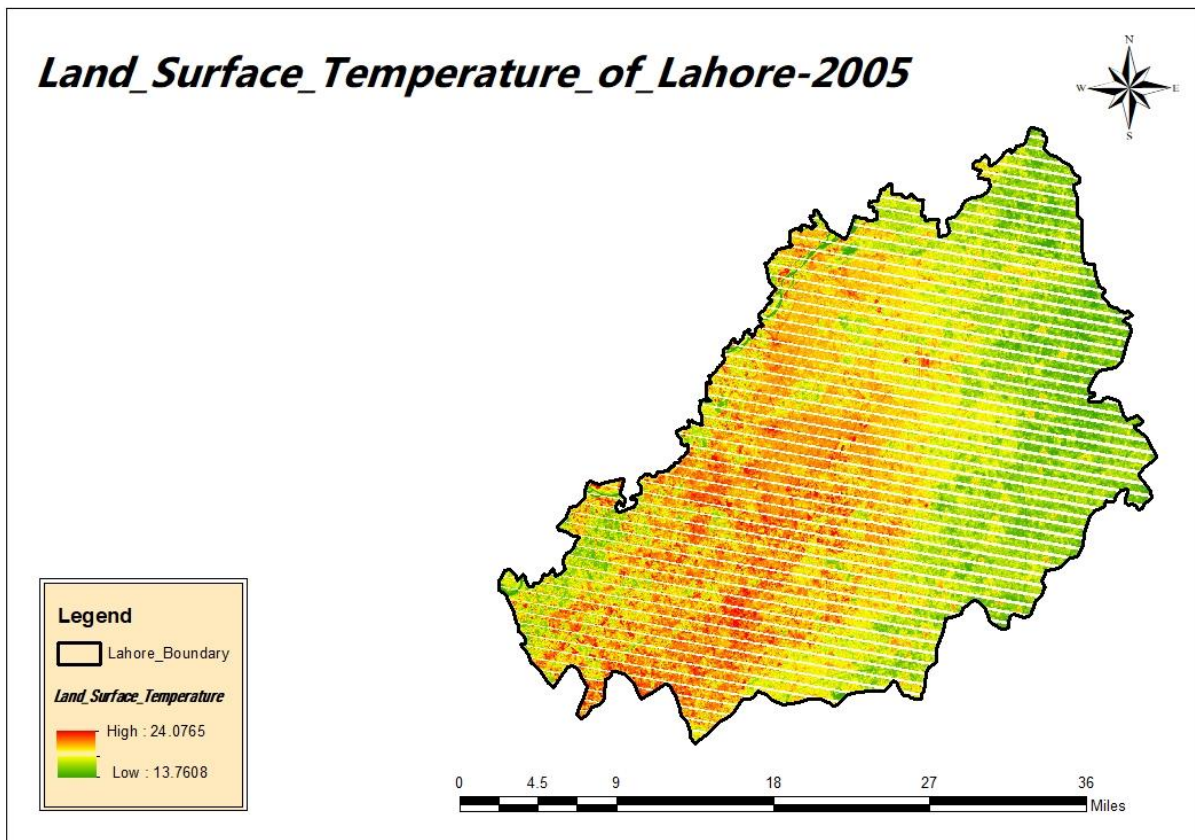
surface temperature increased or decreased. The NDVI (Normalized Vegetation Index) had the correlation with Land surface temperature. The following map show the higher and lower temperature of the city of Lahore.

In 2000, the most of the city detected as the lower temperatures while little significant areas were detected as extreme temperature. The higher temperature was calculated is 22.3221 and the lowest temperature recorded 8.79169 Degree Celsius.



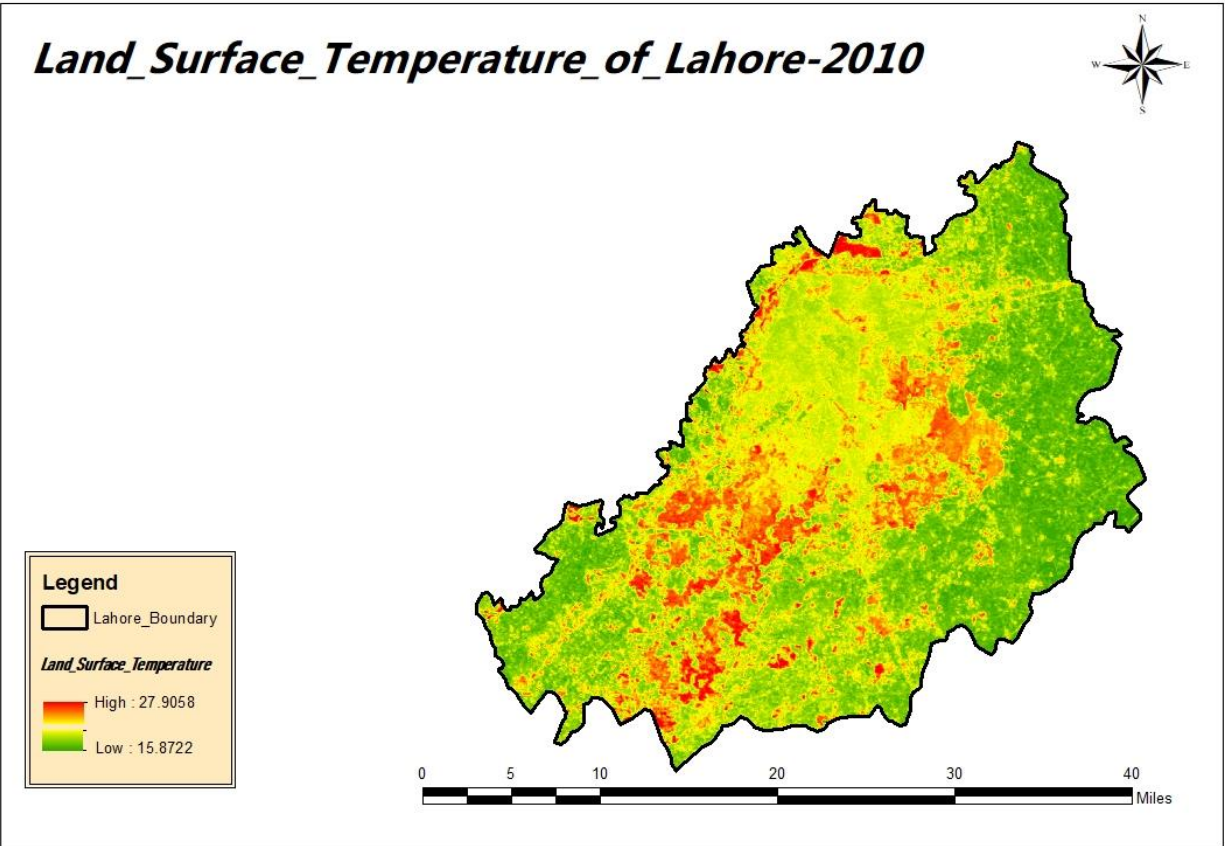
**Figure 4.1.1 Map of Land Surface Temperature of Lahore 2000**

In 2000, the most of the city detected as the lower temperatures while little significant areas were detected as extreme temperature. The higher temperature was calculated is 22.3221 and the lowest temperature recorded 8.79169 Degree Celsius.



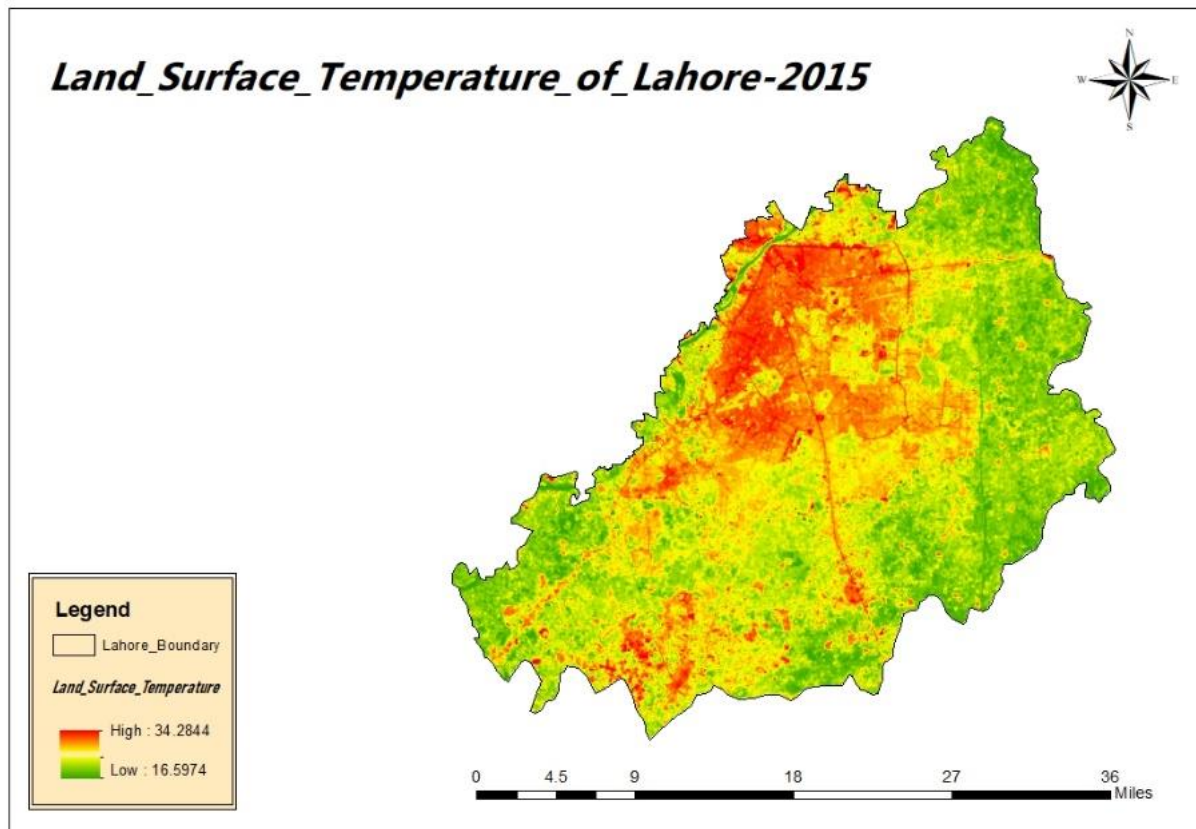
**Figure 4.1.2 Map of Land Surface Temperature of Lahore 2000**

In 2005, the metropolis detected the decrease temperatures as well as hot temperature. As compared to 2000 the temperature of the city was increased. The lower and higher temperature both are increased. The higher temperature was calculated is 24.0755 and the lowest temperature recorded 13.7608 Degree Celsius.



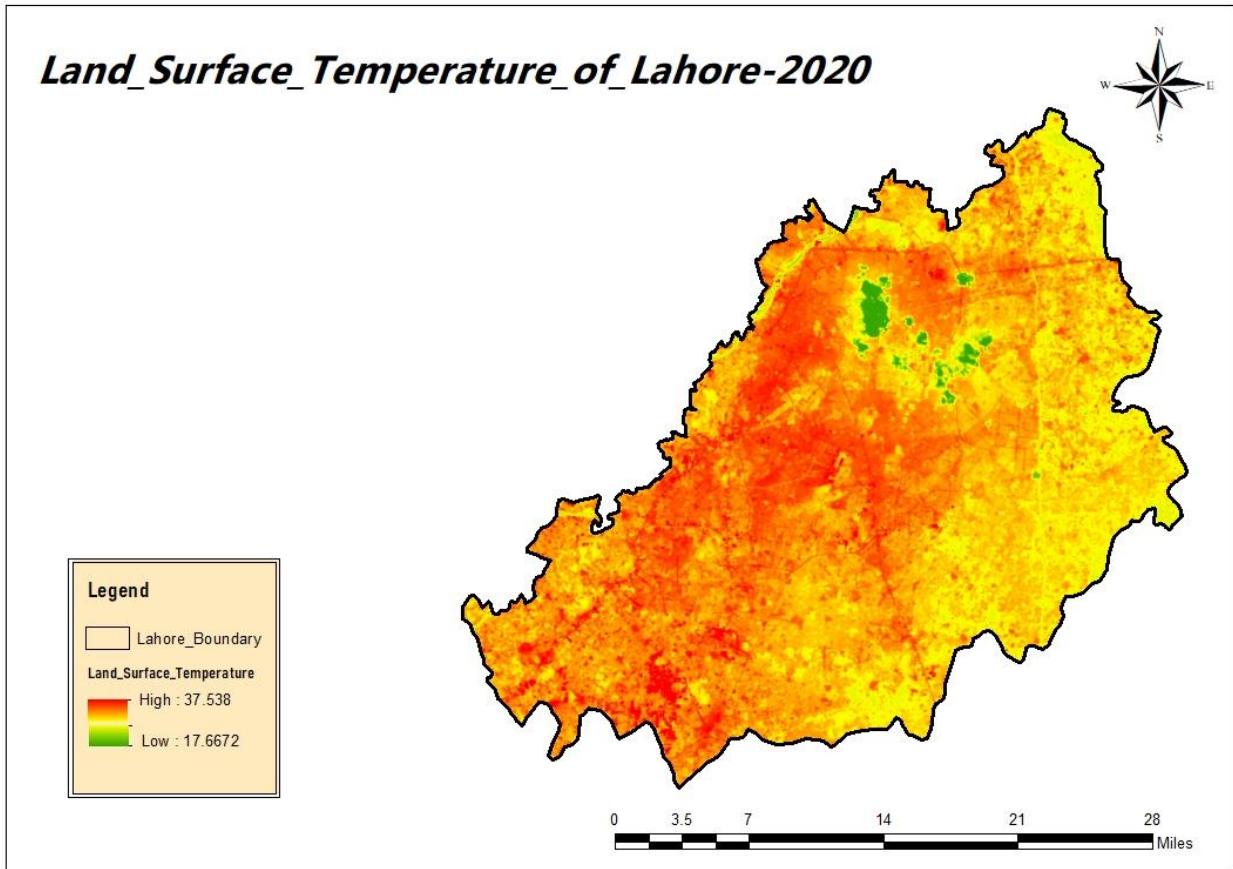
**Figure 4.1.3 Map of Land Surface Temperature of Lahore 2010**

In 2010, the city detected the decrease temperatures as well as high temperature. As compared to 2000 and 2005 the temperature of the city turned into increased. The lower and better temperature both are accelerated.. The increase in temperature was calculated more as compared to last years. The difference in increase of temperature was about 5 degree. The higher temperature was calculated is 27.9058 and the lowest temperature recorded 15.8722 Degree Celsius.



**Figure 4.1.4 Map of Land Surface Temperature of Lahore 2010**

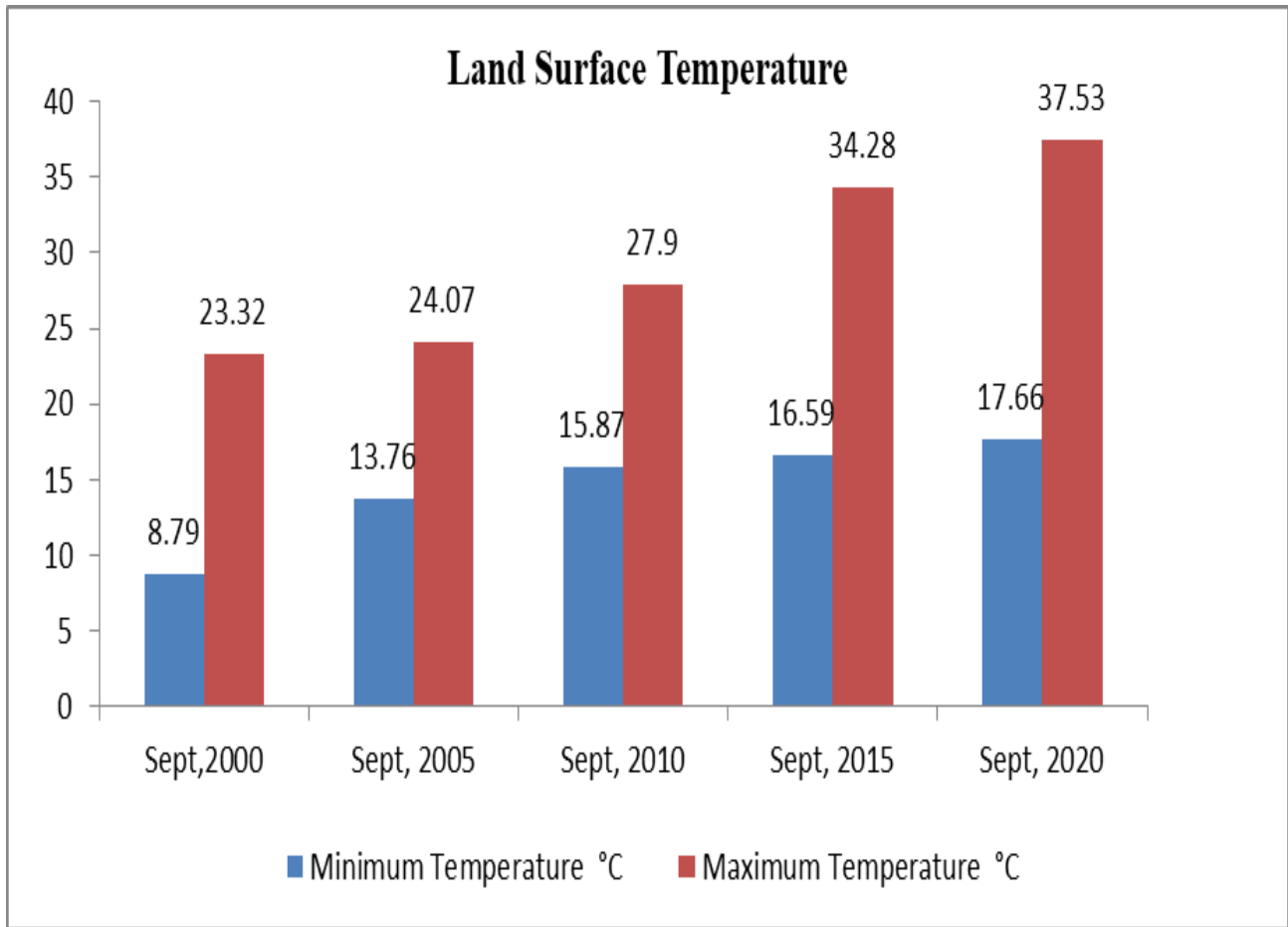
In 2015, the city detected the lower temperatures as well as extreme temperature. As compared to 2000, 2005 and 2010 the temperature of the city was increased. The lower and higher temperature both are increased. The increase in temperature was calculated more as compared to last years. The difference in increase of extreme temperature was about 8 degree, but the lower temperature become increase as compared to 2010. The higher temperature was calculated is 34.2844 and the lowest temperature recorded 16.5974 Degree Celsius.



**Figure 4.1.5 Map of Land Surface Temperature of Lahore 2020**

In 2020, the metropolis detected the lower temperatures as well as extreme temperature. As compared to 2000, 2005, 2010 and 2015 the temperature of the city become elevated.. The higher temperature was increased. The lower temperature which was calculated decreases. The increase in temperature was calculated more as compared to last years. The difference in increase of extreme temperature was about 4 degree, but as compared to the whole past years it makes a huge difference in increase in extremes temperature in the month of September. The lower temperature become high as compared to 2015. The higher temperature was calculated is 37.538 and the lowest temperature recorded 17.6672 Degree Celsius.

The following graph shows the temperatures of following years



**Figure 4.1.6 Graph of Land Surface Temperature of Lahore.**

The above graph table shows the increase in temperature.

## 4.2 Vegetation and non-Vegetation of land of Lahore

The land covers along with grass, shrub, and timber are grouped as Vegetation land and other land cover sorts such as roads, homes, and many others. Are grouped into non-Vegetation. The normalized difference vegetation index (NDVI) has been implemented to know about the vegetation and non-vegetation area of the land. Total green space was calculated for the month of September a largely cloud-free a month in the study region. This research shows the map of two years with distinction of 20 years which shows the drastic change in vegetation and non-vegetation land of Lahore.

The following map show the green spaces and the built-up spaces of Lahore land in 2000

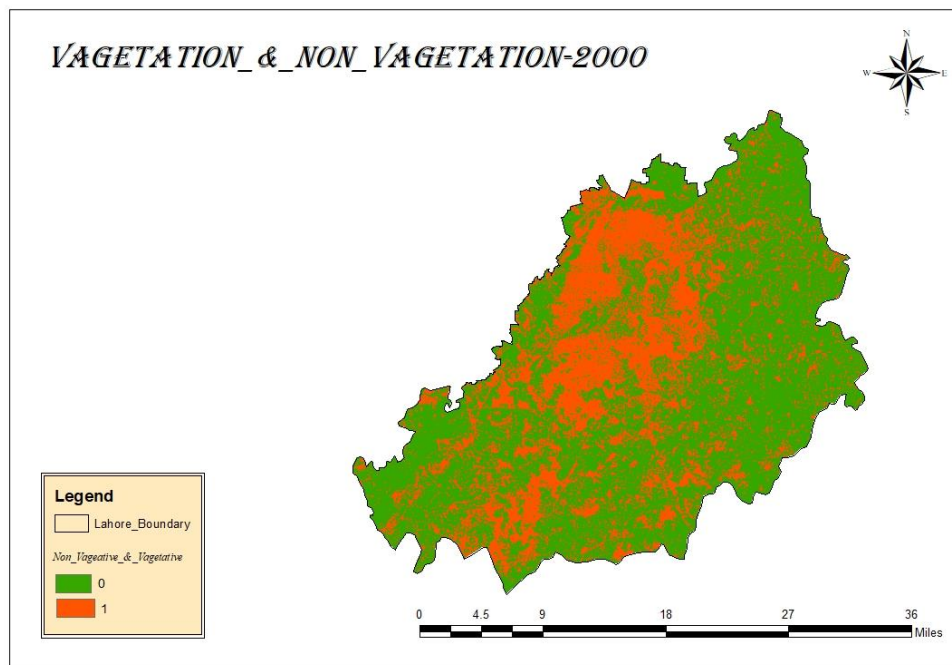


Figure 4.2.1 Map of Vegetation and non-vegetation of Lahore 2000

The following map shows the vegetation and non-vegetation area of Lahore land in 2005

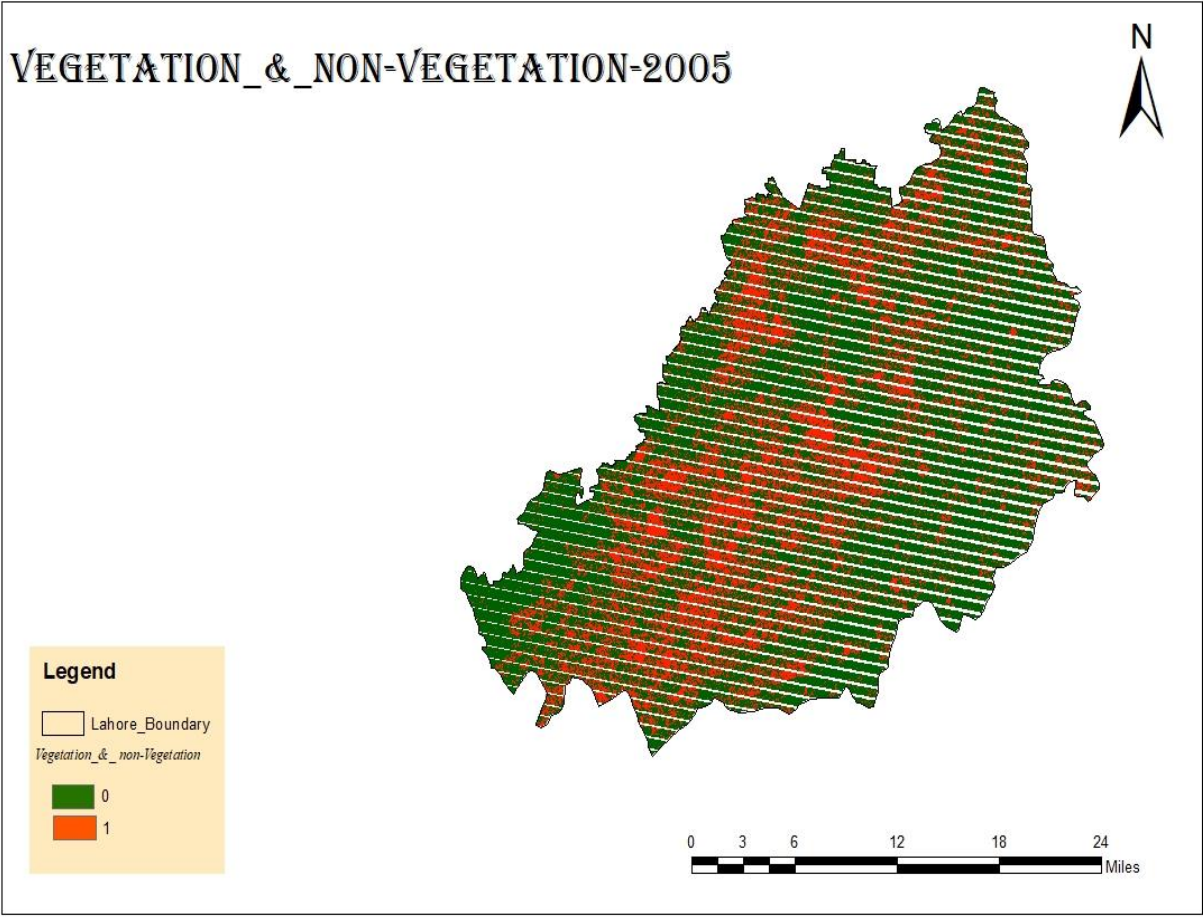
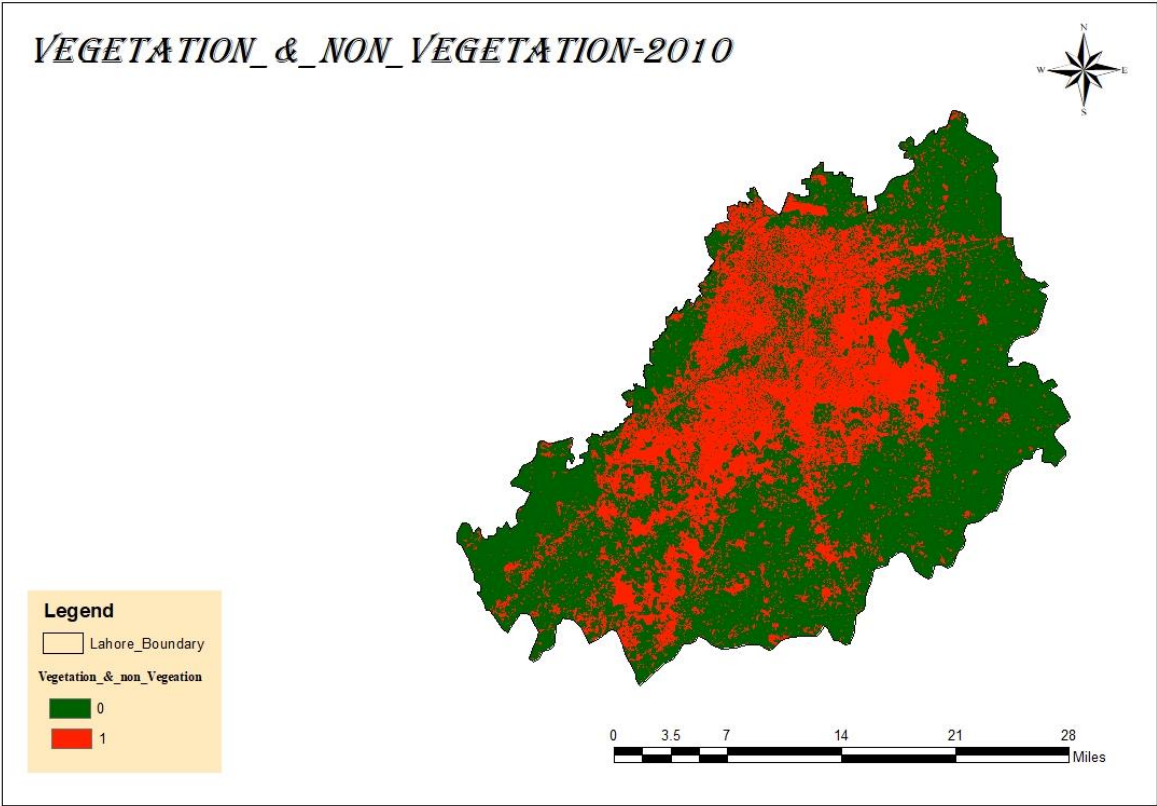


Figure 4.2.2 Map of Vegetation and non-vegetation of Lahore 2005

The following map shows the vegetation and non-vegetation area of Lahore land in 2010



**Figure 4.2.3** Map of Vegetation and non-vegetation of Lahore 2010

The following map shows the vegetation and non-vegetation area of Lahore land in 2015

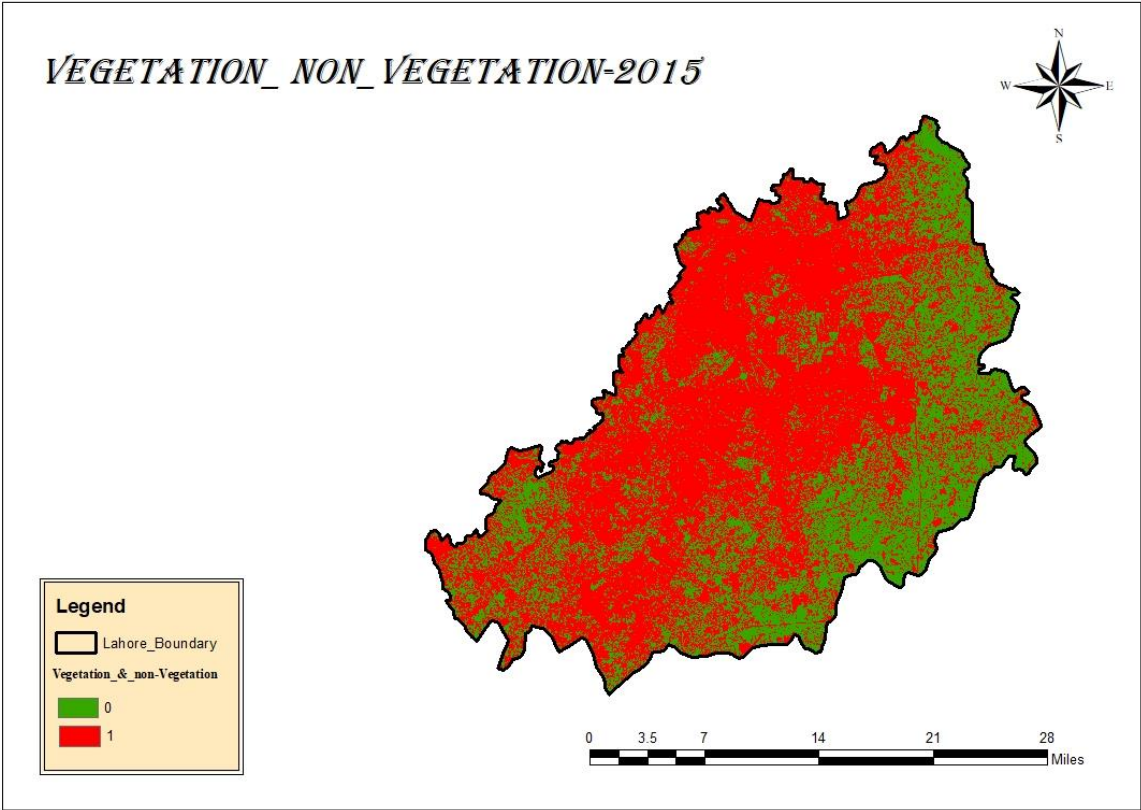


Figure 4.2.4 Map of Vegetation and non-vegetation of Lahore 2015

The following map shows the vegetation and non-vegetation area of Lahore land in 2020

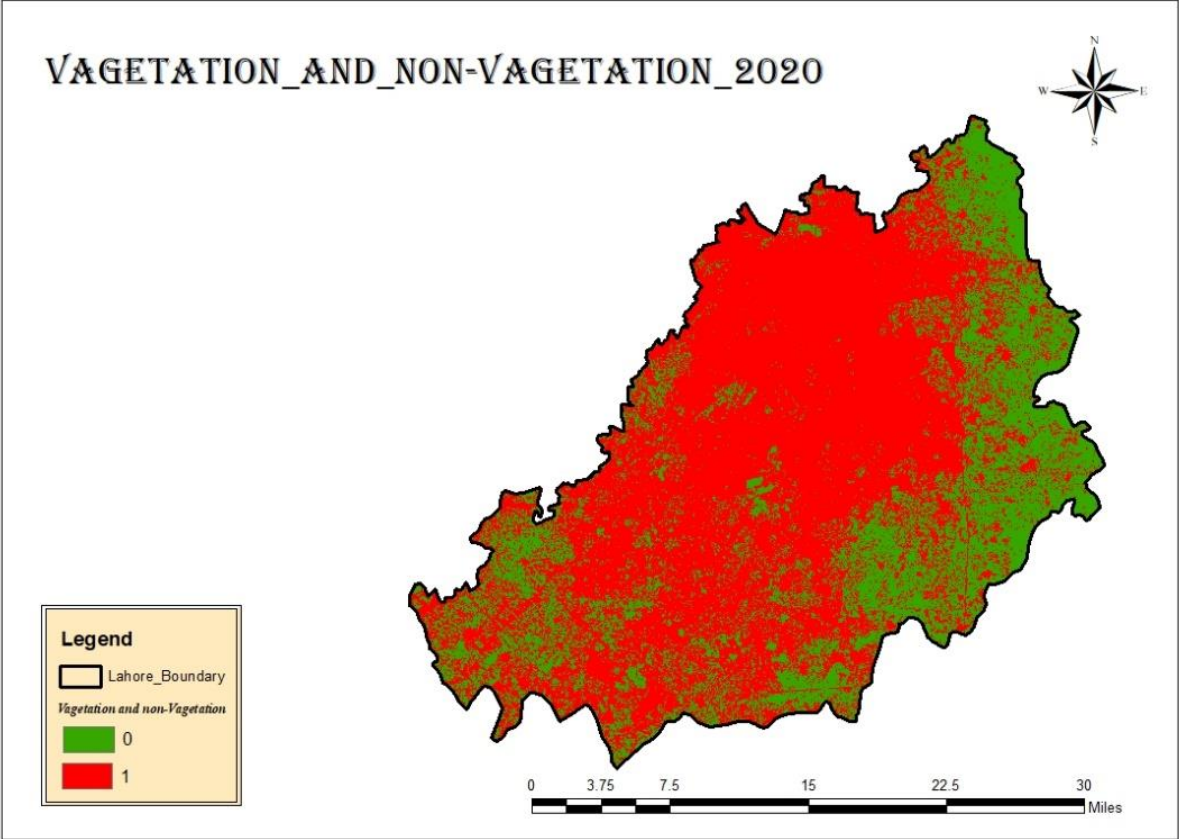


Figure 4.2.5 Map of Vegetation and non-vegetation of Lahore 2020

The following table shows the non-vegetation and the vegetation area.

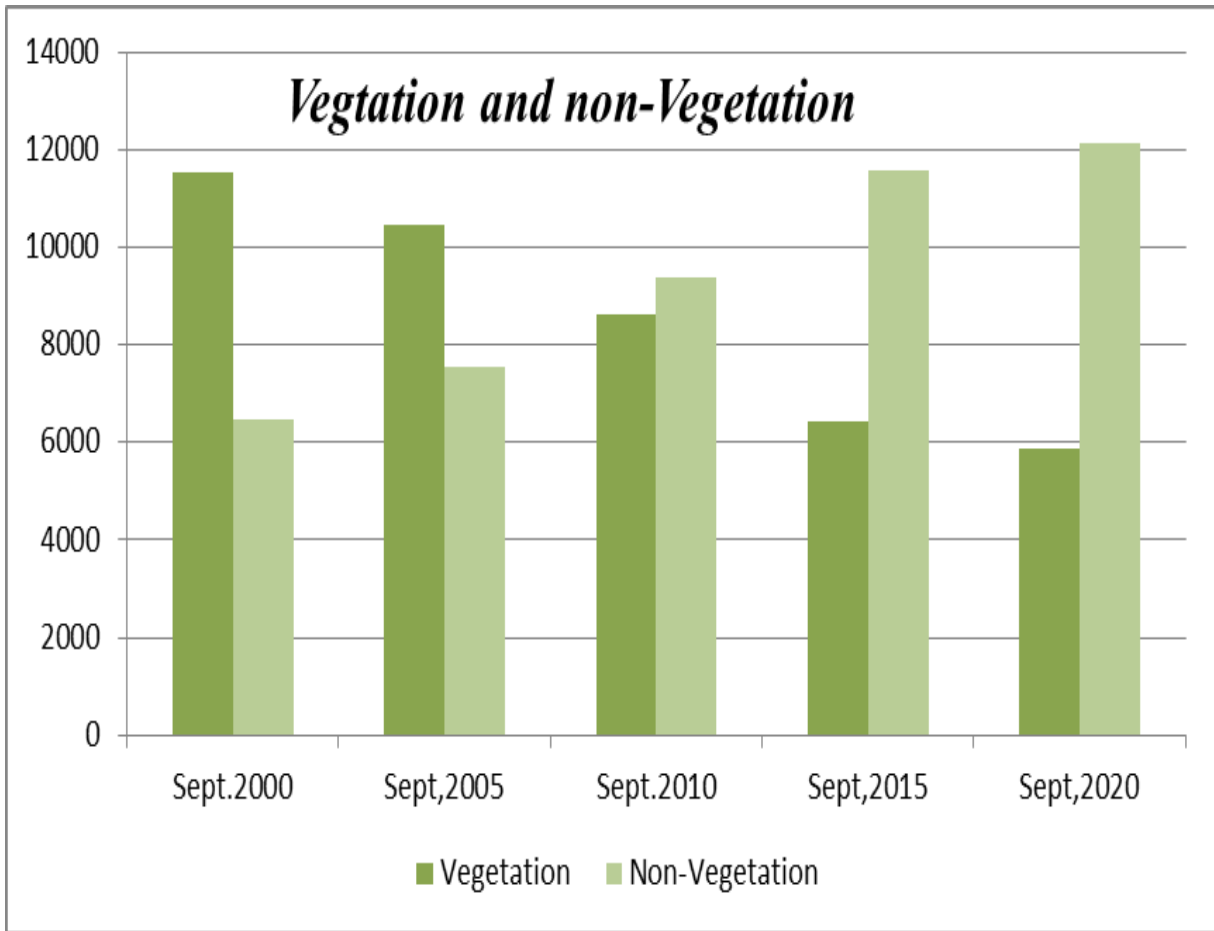
Table 4.1 Vegetation and non-vegetation Area

<i>Year</i>	<i>NDVI Threshold</i>	<i>Category</i>	<i>Value</i>	<i>Area.sq.km</i>
<i>2000</i>	<i>&lt; 0.3</i>	<i>Vegetation</i>	<i>0</i>	<i>11548.06</i>
		<i>Non-Vegetation</i>	<i>1</i>	<i>6457.833</i>
<i>2005</i>	<i>&lt;0.3</i>	<i>Vegetation</i>	<i>0</i>	<i>10625.54</i>
		<i>Non-Vegetation</i>	<i>1</i>	<i>7562.53</i>
<i>2010</i>	<i>&lt;0.3</i>	<i>Vegetation</i>	<i>0</i>	<i>8027.77</i>
		<i>Non-Vegetation</i>	<i>1</i>	<i>9378.12</i>

<b>2015</b>	<b>&lt;0.3</b>	<b>Vegetation</b>	<b>0</b>	<b>6445.65</b>
		<b>Non-Vegetation</b>	<b>1</b>	<b>11560.24</b>
<b>2020</b>	<b>&lt; 0.3</b>	<b>Vegetation</b>	<b>0</b>	<b>5889.96</b>
		<b>Non-Vegetation</b>	<b>1</b>	<b>12115.93</b>

Table 1

## Vegetation and non-Vegetation



**Figure 4.2.6 Graph of vegetation and non-vegetation.**

The above graph shows the increase or decrease in Vegetation and non-Vegetation land of Lahore in past years,

### **4.3 Land use and Land Cover**

Remote sensing and GIS techniques together gives a unique and beneficial data about urban growth. The accuracy of results depends on the analysis. That how the pixels are taken and classified. The research on urban expansion is relevant to the assessment and analysis of sustainable development of any city. Lahore is the developing city of Pakistan. It is the largest most populous city of Pakistan. In last 10 years, Lahore experienced rapid urban and economic growth and increase in population. Some parts of Lahore are so crowded and congested while some are still under develop areas.

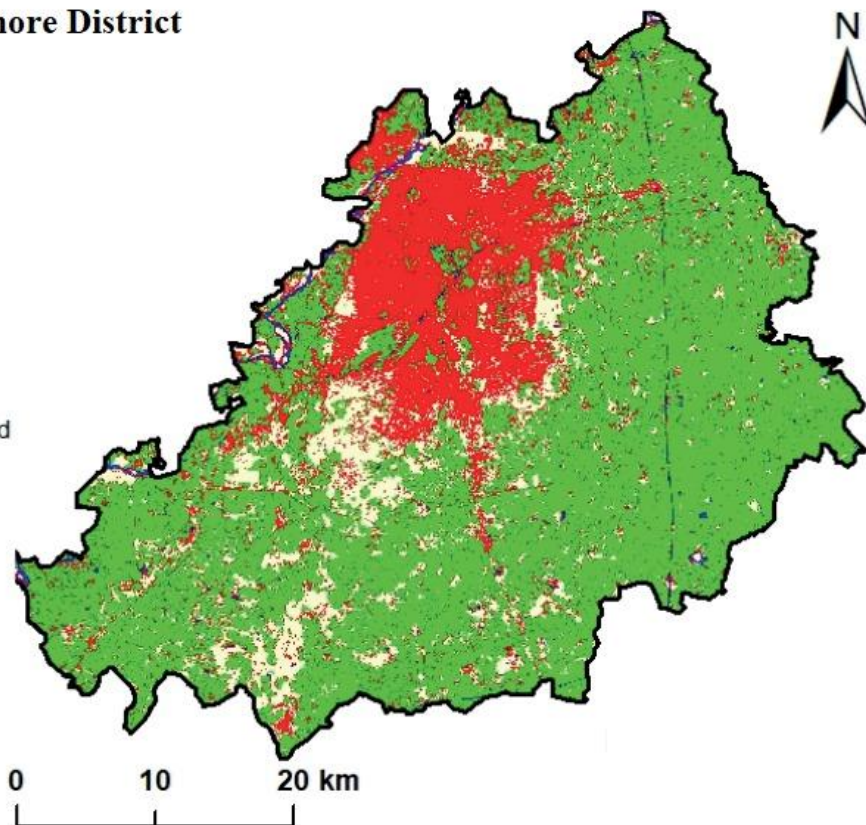
In this research Urban Expansion was detected by the application GIS. Supervised Classified Images of the year 2000 and 2020 were used to obtain the results. The urban Expansion was divided into four classes' built-up area, vacant area, and Vegetative area and Water bodies.

The land use and land cover changes uncovering is very vital for better knowledge of landscape dynamics during and identifies period of time having maintain management. Foe appropriate land management and decision perfection understanding of the landscape patterns changes and the communication between the human activities and also the natural phenomena is very essential. Now a days land use and land cover changes detection studies the earth resources satellite data are very used full and applicable.

The following map shows the land use and land cover of Lahore in 2000

**Land use of Lahore District  
2000**

- Legend**
- Built-up Area
  - Vacant Land
  - Agriculture Land
  - Water



**Figure 4.3.1 Map of Land use land cover of Lahore 2000**

The following map shows the land use and land cover of Lahore in 2020.

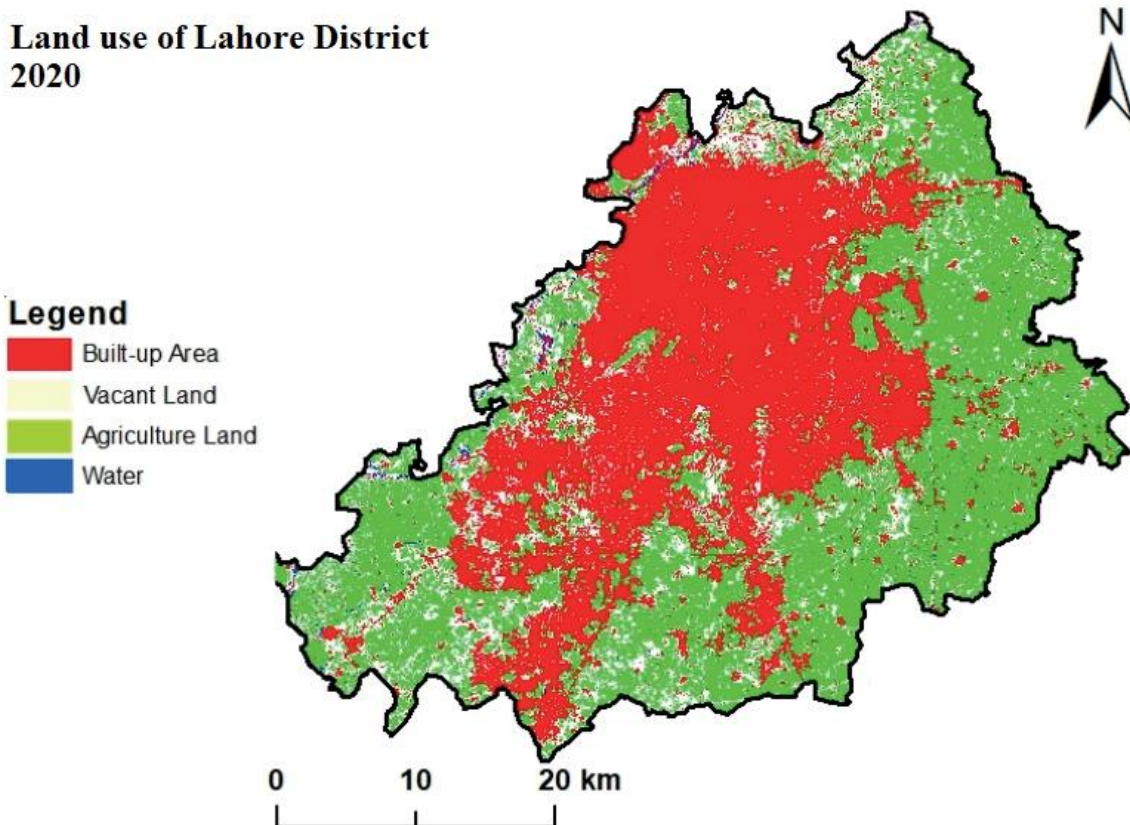


Figure 4.3.2 Map of Land use land cover of Lahore 2020

There are many methods for the interpretation of the results. One of the easiest method to interpret the information is in the form of tables. The following table shows shows the urban growth of 2000 and 2020 and the difference between 20 years is also visible. The percentages of the categories are also shown. The percentage change of the urban growth area for each category was calculated by the following formula:

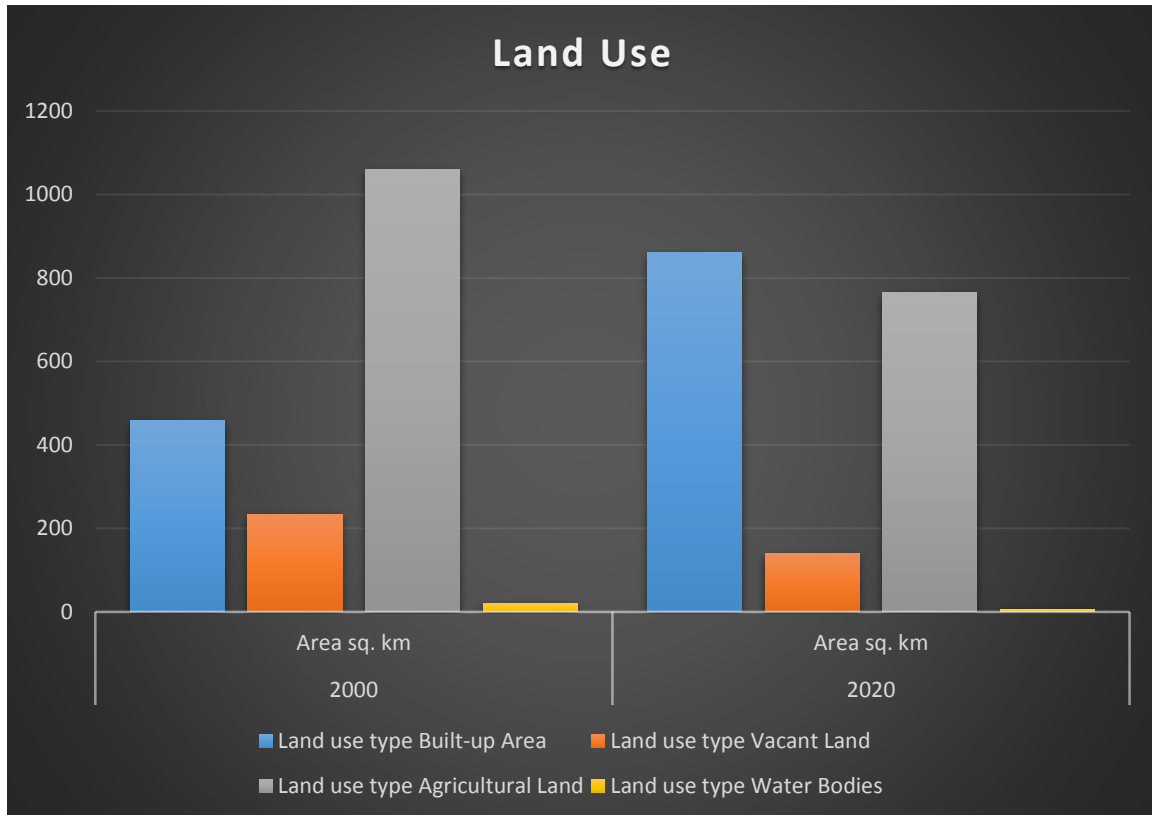
$$\text{Percentage: Area of each category} \div \text{sum of the categories} \times 100$$

**Table 4.3.1 Land use area or Lahore**

<i>Land use</i>		<i>2000</i>		<i>2020</i>	
		<i>Area</i>		<i>Area</i>	<i>%</i>
		<i>Sq.km</i>	<i>%</i>	<i>Sq.km</i>	
<i>Land use type</i>	<i>Built-up Area</i>	458	25.9	860	48.5
	<i>Vacant Land</i>	234	13.2	140	7.9
	<i>Agricultural Land</i>	1060	59.8	765	43
	<i>Water Bodies</i>	20	1.1	7	0.6
<i>Total Area</i>	<i>Sq.km</i>	1772	100	1772	100

### *Graph of Urban Growth Changes*

The detailed and more accurate information can be shown through graphs. The graph for the year 2000 and 2020 also shows that there has been decrease in vegetative land and increase in built up areas and barren land while water bodies are same.



**Figure 4.3.3 Graph of land use**

The graph clearly shows that the built-up area in 2000 is 29.9 %, and in 2020 it is 48.5% the vacant land in 2000 is 12.3 %, and in 2020 it is 7.9%. The agricultural land IN 2000 is 59.8% and in 2020 it is 43%. The water bodies is 1.1% in 2000 and in 2020 it is 0.6%

## Chapter 5

### Discussion

The activities that are performed by humans are responsible for the changes in land use. Human activities that changes the land include urbanization, agricultural activities. Construction and development of infrastructure etc. These activities effects climate, livelihood system and sustainable development.

The land use land cover graph reveals that built-up area was 25.9% in 2000 which increased to 48.5% in 2020. The built-up areas mainly consist of human activities such as building, Transportation, communication and development of an area. The main reasons of rise in built-up area are urban expansion and rapid increase in population. The agricultural lands which are mainly utilized for the food production, paddy plus vegetables are decreased from 59.8% in 2000 to 43% in 2020. The study area Lahore consists of large amount of vegetative land which is changed into new societies and other urban development activities. Increase in population always effects in land use changes. The Lahore population increase as the development increase in this area. This increases the burden on land resources and therefore promoted the land use changes. At that time basic necessity was shelter which resulted in urbanization. As Khattak et al., (2015) analyzed the land use changes of Peshawar and found the similar reason that Peshawar population also increased after the Soviet occupation of Afghanistan in 1979 and as result vegetative and barren land decreased due to urbanization. Within the few years, land use pattern is almost changed. These land use modifications have shown a major change in the city in the form of residential societies and roads leading to different cities of Punjab.

There are various factors that contribute in developing land surface temperature such as artificial construction of urban land use planning, which changes the city underlying surface structure and also underlying surface properties, a large number of industrial and vehicle emissions, these heat emitted in the air, thus resulted in increased temperature of city. So urban heat island effect has a close relationship with human activities. Which is caused by human beings.

The land surface temperature graph showed that there is a development of land surface temperature in 2020. In 2000 the temperature was low but in 2020 it increased which is from 37 C and it mostly exist in the urban area. Since in 2000, in the urbanized boundary of Lahore small areas temperature was observer but in 2020 due to increase in built-up area urban temperature also increased. Similarly Kaya et al, (2012) studied urban heat island in Istanbul and found the same result that in 1987 UH was less but in 2007 it increased because of rapid increase in urbanized area.

Urban area comprises of industries, residential area, commercial area and buildings. Moreover due to building structure, wind circulation is limited in urban area. More heat is released from air condition which results in increase in temperature.

Due to the rapid increase in the urbanized area of Lahore, urban boundaries have been extended and barren land and green land have been changed into urbanized areas. Also during the period of 2000 and 2020, construction of buildings, industries and residential area have led to the development of urban heat island Increased in the residential areas is related to increase in number of vehicles. Development of industries and also increases load of traffic which causes emission of dangerous gases. This has direct impact on air quality and also contributes to air and noise pollution. These gases affect the human health. Many people suffer from different diseases Such as lung cancer and throat infection etc. Rapid increase in population also affect the

Quality of water. Poor sanitation system pollutes the water which causes water born disease.

In coming years if land use land cover changes remained unmonitored and unplanned it can have adverse impacts, mostly most important health issues and increased land surface temperature. It is very important to study and deal with current land use cover changes so that future status can be predicted in effect to restore the quality of environment.

### ***Step-1***

*H1* = Land surface temperature increases with decrease in vegetation.

*H0* = Land surface temperature not increases with decrease in Vegetation.

### ***Step-2***

Level of Significance = 0.05 = 5%

### ***Step-3***

The “Pearson” co-relation test will be used.

### ***Step-4***

Output

<b>Correlations</b>			
		Higher Temperature	Vegetation
Higher Temperature	Pearson Correlation	1	-.976**
	Sig. (1-tailed)		.002
	N	5	5
Vegetation	Pearson Correlation	-.976**	1
	Sig. (1-tailed)	.002	
	N	5	5

\*\* . Correlation is significant at the 0.01 level (1-tailed).

***Interpretation:***

The Pearson correlation value = 0.976

The P-value for Pearson correlation test = 0.02

### ***Conclusion***

It can be observed that Pearson's correlation test has a highly statically significant value that is  $0.002 < 0.5$  therefore it can be concluded that alternative hypothesis accepted which is Land surface temperature increases with decrease in vegetation.

## **CHAPTER 6**

### **CONCLUSION**

The study concludes that during 2000 to 2020, significant changes were determined in land use land cover changes (LULCC) and land surface temperature (LST) in district Lahore. The land use land cover changes (LULCC) and land surface temperature (LST) is detected by different techniques such as remote sensing and GIS. The Landsat satellite images were used for the analysis of different years. The remotely sensed data of the study area was classified by using supervised and unsupervised classification which gives reliable accurate piece of information in our maps regarding land use land cover (LULC) and Land surface temperature (LST). The images land use land cover of study areas were divided in to four categories water bodies, agricultural land, built-up area and vacant land. The image of land surface temperature shows the high and low value of the temperature in the study area. Human activities and increase in population contribute a strong impact in changing of district Lahore land. One of the effect of land use and land cover changes was rise in temperature due to the decrease in vegetation and increase in concrete structure due to which absorption of heat is become less. From the comparison of land surface temperature map it shows that the temperature is increasing every year. The vegetation and non-vegetation maps shows the land use of district Lahore from the year 2000 to 2020. And it clearly shows that the land use and land cover changes occur and Lahore is becoming urbanized day by day. Land use and land cover changes are important factor which is leading in increase in land surface temperature (LST).

## **LIMITATION**

One of the limitation that occurred to me during my research was the non-availability of data.

## **RECOMMENDATIONS**

- This study proves that the combination of both remote sensing and Geographic information systems (GIS) play a significantly powerful tool for urban planning and management.
- It analysis that the land use land cover changes and Land surface temperature in Lahore district is very beneficial in making in policies and awareness in people and urbanization management,
- From this study number of steps should be taken as this is alarming situation for Lahore district and make policies like planting more trees, development of green area like parks and the most vtop priority of increasing in urban land and temperature. As increase in urban land there should be proper planning in Lahore district.

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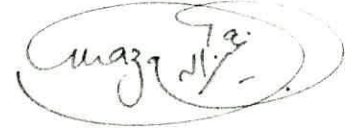
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