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RESEARCH PAPER

Effects of Commercialization on Microclimate of Lahore: Contextual Investigation of Karim Block, Allama Iqbal Town, Lahore

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ABSTRACT

Rapid urbanization has led to an extreme environment, especially in cities like Lahore that is overpopulated and overuse of land resulting in accelerating temperature. The research aims to investigate the commercialization impact on the microclimate of Karim Block, Lahore, which is being over-commercialized, and to propose a strategy to mitigate rising temperature from land use conversion. Theoretical review, policy analysis, ENVI Erdas Imagine, and GIS satellite imagery analysis are conducted to assess Land Surface Temperature from 2016 to 2023. It was revealed that the temperature has increased significantly due to land use change policies, elimination of green infrastructure, and traffic congestion. It highlights the importance of reclassifying land use, incorporating green infrastructure, and mitigating climate change impact. It is recommended to incorporate green roofing to reduce temperature significantly, reclassify Karim Block's land use by prioritizing green infrastructure, and develop future commercialization policies that cater to environmental susceptibility and promote pedestrianization.

Keywords: Commercialization, Environmental Susceptibility, Green Infrastructure, Land Surface Temperature, Microclimate

Introduction

Environmental transition can best be described as a formidable and most pressing challenge. The anticipated change in temperature can harm the human framework and nature-built environment of the planet (Garnaut, 2008 IPCC, 2007). It has become a daunting challenge to address and manage the impact of extreme weather conditions in urban planning of the 21st century. The fluctuating temperatures in urban areas have become a cause of major concern in recent years. This is triggered by continuous population growth globally; human activities are the major contributor to Climate susceptibility, specifically in the context of urban development worldwide.

Pakistan is one such country where overpopulation has resulted in land overuse and extreme weather events. It was ranked 5th most vulnerable country to climate change on the Global Climate Risk Index of 2023 due to intensive rainfall, smog and severe flooding. There is an urgent need to design and promote urban planning strategies for changing climatic conditions.

Rapid commercialization of areas like Karim Block in Allama Iqbal Town, Lahore is an example of rising temperature in the microclimate of that area. The expanding urban areas, extensive commercialization and elimination of green infrastructure is the major

contributors to higher temperatures of microclimate. The research emphasizes the direct relation between temperature and land use; it indicates that residential areas are minor contributors while commercial and industrial areas create a major impact on the environment.

The significance of green infrastructure in reducing environmental susceptibility is pressing. It is essential to mitigate temperature variation within the microclimates of Lahore to have an overall positive impact; this can be reached by the integration of green infrastructure within the urban planning of Lahore to achieve environmental sustainability

Literature Review

The pivotal role of urban planning has been to prioritize cities as a haven for residents as compared to rural areas; which are susceptible to extreme weather conditions causing floods windstorms, or fires. However, with environmental changes, the focal point of secure atmospheric conditions is under risk, due to significant changes in urban culture and infrastructure (e.g. Schelln Huber 2006; CABE/CIC 2007)

Environmental change can be best described as a test for humankind confrontation. Environmental changes can harm human infrastructure on planet (Garnaut, 2008. IPCC, 2007).

It can be best defined as "Any critical change in measures of atmosphere, (for example, temperature, moistness, precipitation, or wind)". The United Nation Framework Convention on Climate Change (UNFCCC), in its Article 1 describes climate change as: "Change of atmosphere which is credited specifically or in a roundabout way to human action that adjusts the arrangement of the worldwide air and which is notwithstanding normal atmosphere changeability saw over equivalent eras"

Adapting to Climate Change in the Least Developed Countries

49 nations come under the category of Least Developed Countries (LDCs); they are considered the poorest of all nations due to low per capita Gross Domestic Product (GDP). The consolidated populace of these 49 nations is 614 million which is equivalent to around 10% of the world populace, and still their world GDP is under 1%.

The UN General Assembly held the first LDC meeting in 1981 in Paris; which resulted in the initiation of a Significant New Program of Action (SNPA) for the following decade. LDCs financial situation did not get better despite multiple efforts. A second meeting was held in 1990 which led to the Program of Action for the 1990s. However, LDCs remained unaffected, leading to a third meeting in 2001. It was exemplified that LDCs' contribution to greenhouse gas emissions has made the environment susceptible causing drastic negative impacts on climate. Understanding this, LDC support was initiated, which aimed at eradicating of poverty and economic development (Garnaut, 2008; IPCC, 2007; Stern, 2006).

Climate Change Adaptation through Green Infrastructure

Green infrastructure plays a crucial role in addressing environmental susceptibility; which is presently thought the biggest threat to the future of humanity. Green infrastructures can help in the reduction and elimination of negative environmental changes and can overall have an impact in alleviating environmental

change (Nicholas Stern, 2006). There are multiple climatic conditions which are listed below which are overseen; that can be catered to by the addition of green infrastructures:

- High temperatures: evaporative cooling and shade caused by green infrastructure can ensure that towns and cities remain comfortable areas for users, specifically in urban territories.

- Water Resources: managing them involves the provision of water storage areas for reuse, allowing water to penetrate the ground for managing aquifers and river streams. Green infrastructure can also be utilized to filter water and maintain water quality for urban supply.

- Riverine Flooding: flooding management through green infrastructure can be enlisted by water storage and retention areas; which slow down the flow of water (Nicholas Stern, 2006).

Adapting to Climate Change: A Fresh Perspective on Sustainable Planning

It is becoming a critical challenge to manage the impacts of climate change in sustainable urban planning of the 21st century. The efforts of addressing climate change impact will become necessary in the urban context as the global population is becoming increasingly urbanized. This is widely acknowledged and is based on scientific consensus (Schellnhuber 2006; IPCC 2007), that the primary cause of recent global climate change is human activities. The population, ecosystem and infrastructures of cities are at risk of being drastically affected by climate change as human activities are expected to only increase in the coming period.

However, actions are being taken to mitigate climate risks such as air pollution, and extreme heat islands to safeguard human care and health (Fan and Sailor, 2005). With time, the focus on resilient responses is becoming essentially prominent in urban planning. This shift will have an influential impact on infrastructure developments and the development of sustainable infrastructure standards. Climate change will present numerous new challenges for developing a better urban practice for a sustainable future.

Environmental Change in the Context of Pakistan

According to the National Climate Change Policy most significant climate change risks in Pakistan, including those mentioned below but not limited to are:

- Noticeable rise in intensity and frequency of extreme weather events, caused by monsoon rains; resulting in frequent flooding and mass-scale droughts.

- Due to global warming and the deposition of carbon soot caused by pollution across the border, there is an anticipated retreat of the Hindu Kush-Karakoram-Himalayan glaciers; which is posing a threat to the inflow water system if the Indus River.

- Frequent flooding due to increasing sediments in major dams.

- Reduced agriculture activity in arid and semi-arid regions of Pakistan due to a continuous elevation of temperatures, causing an increase in heat level and reduction in water level.

- Depletion of the forest is causing acceleration making the environment most susceptible, affecting the ecological system.

Evolution of Environmental Patterns in Pakistan

Pakistan is being categorized as "most at risk" in economic impacts of environmental degradation, according to the Climate Change Vulnerability Index (CCVI) (Maplecroft,n.d). there is in general lack of awareness and a limitation of resources to take effective measures to address the impacts of climate change in Pakistan (Lead Pakistan, n.d.). Pakistan's climate varies from region to region with temperature rising to 52^{o}C in central arid plains and decreasing to -26^{o}C in the northern mountains region. With a population estimated to be 242.8 million in 2024 and an annual growth rate of 2.3%, Pakistan is experiencing a demographic expansion in acceleration as compared to neighbouring countries like Sri Lanka, India, Nepal and, Bangladesh (Lead Pakistan, n.d.). Pakistan is observing an annual increase of 0.57 ^{o}C in temperature on an average scale, along with this in the past two decades Pakistan has faced over 150 extreme weather events.

According to World Bank, Pakistan's GDP can shrink by 18-20% by the year 2050, due to environmental degradation, climate-related events and air pollution. Climate change has caused a significant impact on Pakistan's ecosystem and biodiversity in multiple regions. In 2023, Pakistan was placed fifth in being the most vulnerable country to climate change on the Global Climate Risk Index due to extreme flooding and severe monsoon season in that year.

Impact of Commercialization Policy on Environmental Conservation

Extensive commercialization is a major contributor to affecting the climate of any region; specifically the microclimate of that region creating an impact on the overall climate. Lahore is one such city which has attracted a large influx of migrants from rural regions, resulting in rapid urbanization and intensified commercial activities. As commercialization is directly linked with climate change, a policy for regulating commercialization and safeguarding the environment is needed. Lahore Development Authority (LDA) has created a policy for plans of commercialization but it lacks the enforcement needed to protect the environment and it undermines environmental protection efforts. Karim Block is one such area where land use is rapidly being commercialized resulting in the area becoming a hub for major microclimate change. The commercialization is on both legal and illegal scales resulting in the area being over-commercialized.

Impact of Transportation System: The rapid conversion of residential properties into commercial hubs without proper planning and adequate infrastructure has significantly disrupted the traffic flow, high commercialization has attracted a high level of user flow resulting in dense traffic and disruption on roads due to visitors occupying service lanes and roadsides for parking their vehicles.

Parking Challenges: upon discussion with users, it was revealed that 60% of users travelling via car experienced difficulty in finding proper parking space. A study conducted for this research revealed that 367 cars were parked along the main entrance of the street in Samnabad and 526 cars occupied the main lane of Allama Iqbal Town during Peak shopping hours (7 pm to 9 pm). 80% of the parked cars were occupying service lanes while 15% were utilizing designated parking spots in front of shops. Dense traffic volume and chaotic road parking have not only caused violations of traffic rules but also caused major traffic congestion in those areas. This also leads to excessive pollution as well as fuel consumption.

Impact on Residents: 75% of residents residing in the properties adjacent to commercialized areas opposed permission for commercial expansion in residential areas. They showed concern about commercialization not only invading their privacy but also causing great difficulty for them to reach their residences and just in general creating delays in their everyday tasks due to extensive traffic. They also highlighted the fact that the area surrounding them is getting polluted and suffocating due to dense commercialization.

Lahore's Commercialization Policy for Individuals

In Karim block and areas adjacent, it is encouraged to convert their private properties into commercial by paying 20% of the commercial value of the plot; it is paid as a commercialization fee. For this purpose, no NOC from surrounding neighbours is required, and to encourage commercialization, property owners are given the option to pay in multiple instalments. If someone pays the fees upfront, they get a 5% discount. Along with this temporary commercialization is also allowed for hospitals, bus stands, and universities for an annual fee of 3% of the prescribed fee, if there are no structural changes made to the existing building and if parking is provided on-site. Temporary commercialization is allowed on streets which were not initially designed for commercial activity, such as internal streets which are allotted for residential construction. If the streets later get approved for commercialization, the temporary statues of areas can be converted to permanent ones. This has led to the establishment of private hospitals, colleges, universities and offices on residential streets. Due to this, residents living in these areas face heavy traffic congestion and security threats.

Material and Methods

The research methodology consists of three perspectives; Theoretical perspective, analytical perspective and, experiential substantiation. The theoretical perspective is used by utilizing the literature review technique. It has been used to highlight the significance and severity of changing climatic conditions, essentially temperature variations.

The analytical perspective involved data collection and analysis for understanding climate change patterns in the selected area. For the past few years, the Spectral Radiance Scaling Method has been utilized for assessing temperature changes.

Experiential substantiation presents the outcome gathered by data analysis, incorporation of calculated formulas and, empirical evidence. This aims to establish a connection between the essentiality of adapting means to mitigate climate change and the provision of green infrastructures in urban planning, based on pre-analyzed temperature variation models. This part signifies the practical implication of research.

The area of Karim Block, Allama Iqbal Town, Lahore is selected for research based on extensive conversion of land use in this area particularly. Karim Block and its locality have been assigned for commercialization by LDA. The possible impact of change in land use on the microclimate of area, specifically temperature is accessed and it is also analyzed how the impact can be minimized by incorporation of green infrastructure.

Data Collection and Analysis

Data was collected from LDA and NESPAK for land use surveys spanning different years. Furthermore, to access temperature variation over multiple years,

distinctive Landsat images were downloaded through Glovis, (USGS Global Visualization Viewer, Dec 2023). To interpret the data, the analysis of collected data was done by utilizing different software such as ENVI Erdas Imagine and GIS.

ERDAS Imagine: it is a raster geo-handling software, used in GIS programs. It is capable of extracting information using satellite and aerial images through Remote Sensing and Photogrammetry techniques. This set of tools enables data visualization from multiple sources and presents it in formats ranging from 2D maps to 3D models.

ENVI 6.0: ENVI stands for "Environment for Visualizing Images" is an advanced software designed for image processing, specifically for utilization of data gathered through satellite. It has comprehensive image analysis and processing capability in multiple dimensions. It facilitates GIS data and layers integration into the picture-handling work process. One of the key feature of the software is its integration of Record-Based and Band-Baseband systems with interactive functionalities.

The first step for data collection was to mark the boundary of an area of interest for Karim Block, Lahore. The boundary is marked through consideration for Classification and reclassification ok map. In the next step, Karim Block was divided into individual land uses and was compared with a provided map of Karim Block from 2016. For this research. The comparison was created through the provided data from 2016 and a comparative analysis by collecting the latest data. Land use activity is divided into the following categories:

- Residential
- Commercial (permanent, temporary & Illegal)
- Graveyard
- Roads
- Industrial block
- Educations
- Park
- mosque

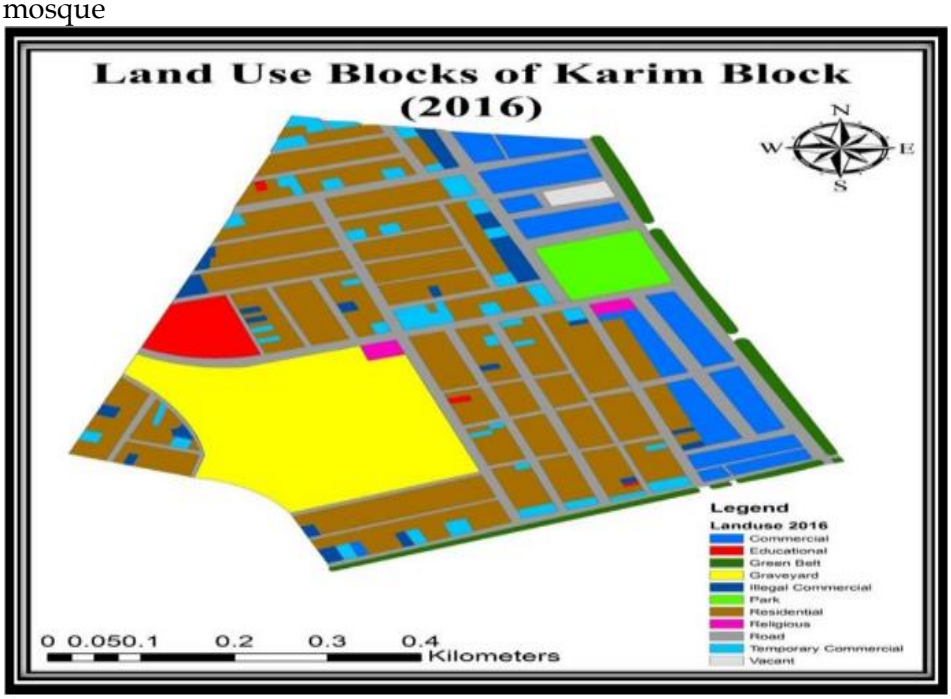

Figure 1 Land Use Blocks 2016

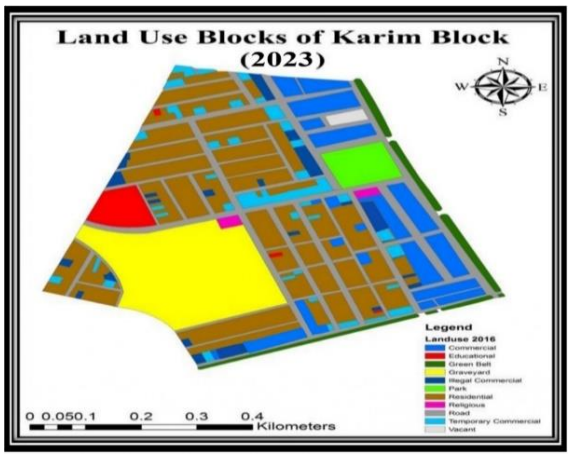

Figure 2 Land Use Blocks 2023

Figures 1 and 2 show variations in land use from 2016 to 2023. It shows a significant increase in commercialization, legal and illegal. It furthermore shows a reduction in residential areas due to conversion to commercial areas.

In the next step Karim Block Area of Interest was extracted by the addition of band4,4 and 6 in Erdas Imagine of years 2016 and 2023, the band 6 is a representation of the thermal band. Each band covers a specific area which covers 185km by 185 km space. Each band is added separately and defined area of Karim Block is layered over it. The area of interest is extracted from each band. The AOI (Area of Interest) for each band is visible in Figures 3 and 4.

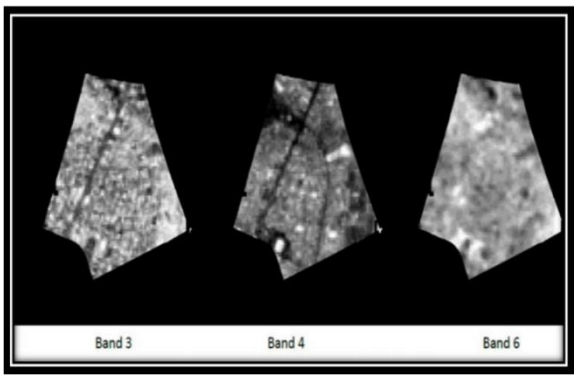

Figure 3 Extracted Area of Interest from 2016 Image

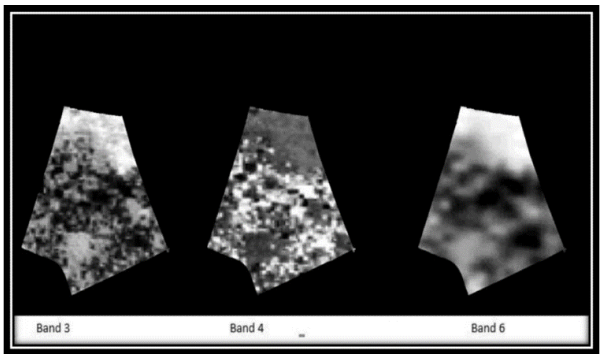

Figure 4 Extracted Area of Interest from 2023 Image

Each Area of Interest Image is next converted to standards ENVI 6.0 and a Radiance Data Layer is created using ENVI Landsat calibration. After this step formula of the spectral radiance scaling method is applied to measure the amount of radiation that goes through the surface.

$$L_\lambda = \left(\frac{LMAX - LMIN}{QCALMAX - QCALMIN} \right) * (DN - QCALMIN) + LMIN$$

Where

Figure 5 The spectral radiance formula

In remote sensing, brightness temperature is utilized for analyzation of thermal infrared images and microwave data to study Earth's surface temperature. The brightness temperature for 2016 and 2023 is calculated by applying the formula, T = K2/ ln (K1/L+ 1)

Where K1 and K2 are constant. Both have different values for Land Sat-5 and Land Sat-7.

A normalized Difference Vegetation Index(NDVI) is next generated to understand the density of green structures by applying the formula (b1- b2)/ (b1+b2) where b1 is R4 and b2 is R3.

This calculates the minimum and maximum vegetation value of both images from 2016 and 2023.

The vegetation is next calculated using basic measurements based on wavelengths that emit on land (NEO GEO, April 2009). The formula for calculating the proportion of vegetation is

$Pv = [(NDVI - NDVI\text{min}) / (NDVI\text{max} - NDVI\text{min})]2$

Calculating Land Surface Emissivity is the next step, it is generated to understand the level of radiation a surface emits in the form of energy. This is achieved by applying the formula

Emissivity (E) $=0.004*PV+ 0.986$

The land Surface Temperature (LST) of the area is next produced by calculating the brightness temperature and emissivity through the formula for the years 2016 and 2023 for comparative analysis

The final step for the comparative relationship of Karim Block's land use with the temperature of the area was conducted formation of the Zonal Statistical Table for the years 2016 and 2023. The table also showed the densification of vegetation in the area as well.

After the application of analytic procedures, multiple maps were generated to showcase the findings of land surface temperature and normalized difference vegetation index. These maps were generated to showcase temperature variations and level of vegetation density concerning land utilization for the years 2016 and 2023.

Analysis-based Findings for the Year 2016

Land Surface Temperature of the year 2016: The following are the maps generated to demonstrate the land surface temperature variation for land use activities of Karim Block, Lahore.

LST maps in Figures 6,7,8 showcase the maximum, minimum and mean Land surface temperature for the year 2016. The findings determine that areas near green infrastructure are cooler as compared to areas with high activity levels.

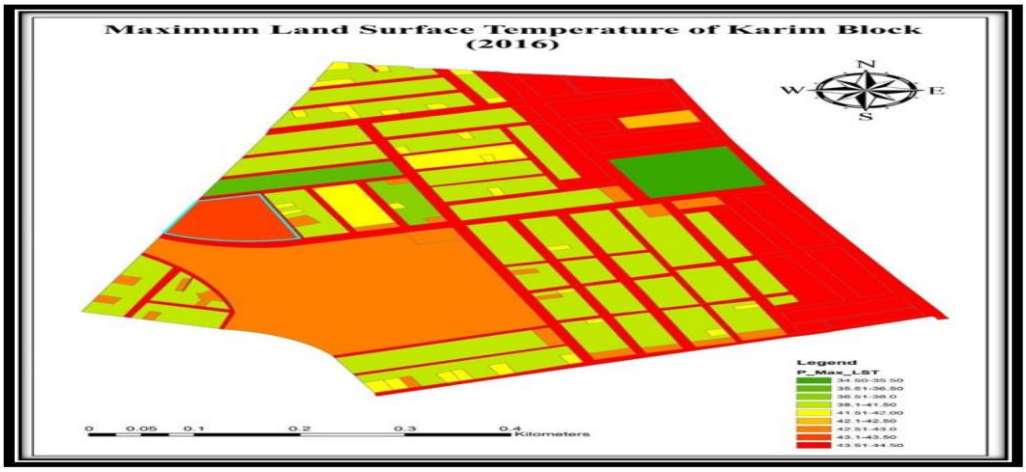

Figure 6 Maximum Land Surface Temperature, 2016

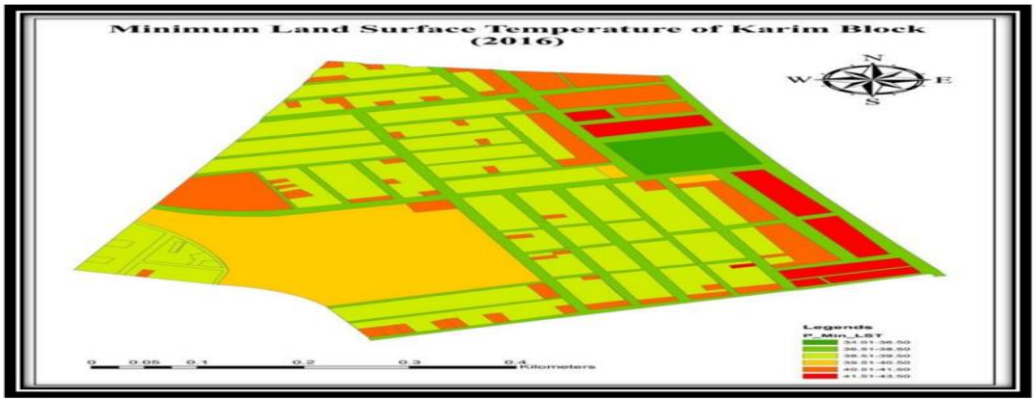

Figure 7 Minimum Land Surface Temperature, 2016

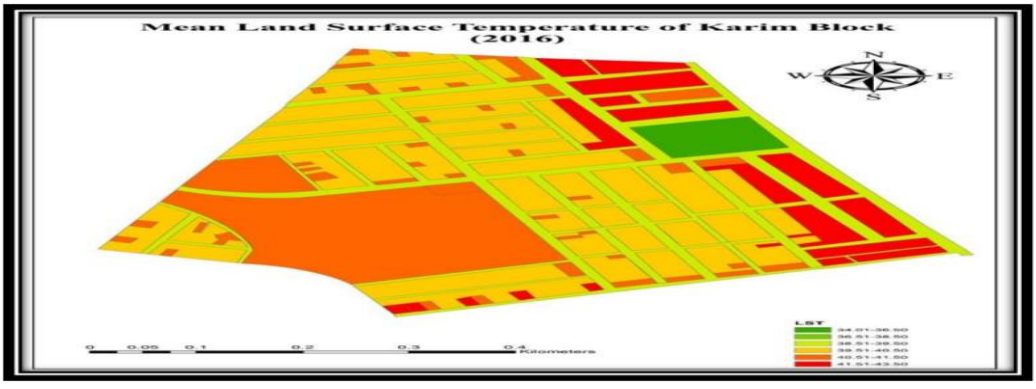

Figure 8 Mean Land Surface Temperature, 2016

Furthermore, the co-relation of the graphic analysis visible above can in context with land use activities can be seen in Table 1 the findings emphasize the maximum land surface temperature being directly related to the higher activity areas. In this case, it can be seen that areas with green infrastructures have lower land surface temperatures while the commercial areas have the highest temperature values.

Table 1
Values of LST of 2016

Land Use	Max_LST	Mean_LST	Min_LST
Commercial	40.645	40.38	39.65
Graveyard	40.22	39.22	38.32
Parks	36.96	35.73	34.12
Public Buildings	40.76	39.81	39..34
Residential	41.24	40.04	39.44
Road	41.59	40.35	39.23
Vacant	41.25	40.39	40.385

Normalized Difference Vegetation Index of the year 2016: The NDVI map in Figure 9 shows the vegetation on different parts of Karim Block in 2016. It showcases that areas closer to Green infrastructure have higher vegetation levels as compared to areas further away from green infrastructure.

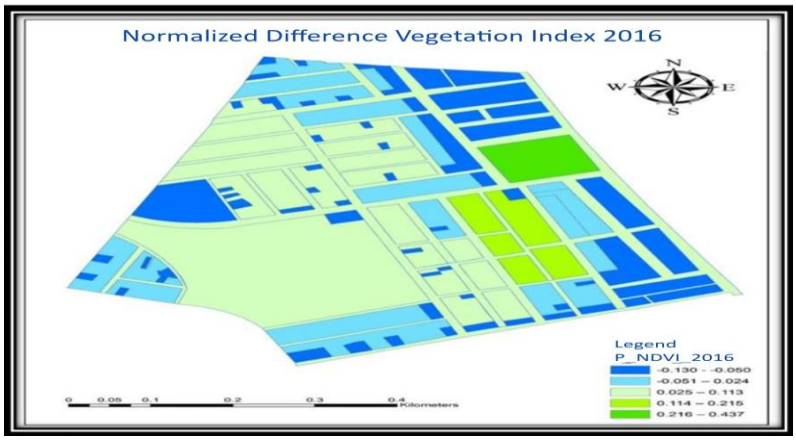

Figure 9 Normalized Difference Vegetation Index 2016

According to the co-relation analysis of NDVI for the year 2016 indicates that commercial areas with high NDVI values show that there are more green infrastructures and open spaces near commercial areas resulting in High value as compared to other land use. Furthermore, it can be seen that vacant areas with the absence of green infrastructure have negative NCDI value as the space is being utilized for illegal commercial activities and parking of vehicles. This is further visible in Table 2

Table 2
Values of NDVI of 2016

Land Use	NVDI_Max	NVDI_Min	NNDI_Mean
Commercial	0.0324	-0.0191	0.00665
Graveyard	0.0391	-0.0493	-0.0051

Parks	0.0581	-0.0311	0.0135
Public Buildings	0.0958	-0.0252	0.0353
Residential	0.0892	-0.0457	0.02175
Road	0.1414	-0.086	0.0277
Vacant	-0.0481	-0.1164	-0.08225

Finding of Analysis Based on 2023

Land Surface Temperature of the year 2023: The procedure used for the analysis of 2016 Temperature and Green structure relation with land use, was utilized for the analysis of 2023 findings. Fig 10, 11 & 12 show the maximum, minimum and mean values of LST. It is visible that temperature has escalated toward higher values in 2023 as compared to 2016

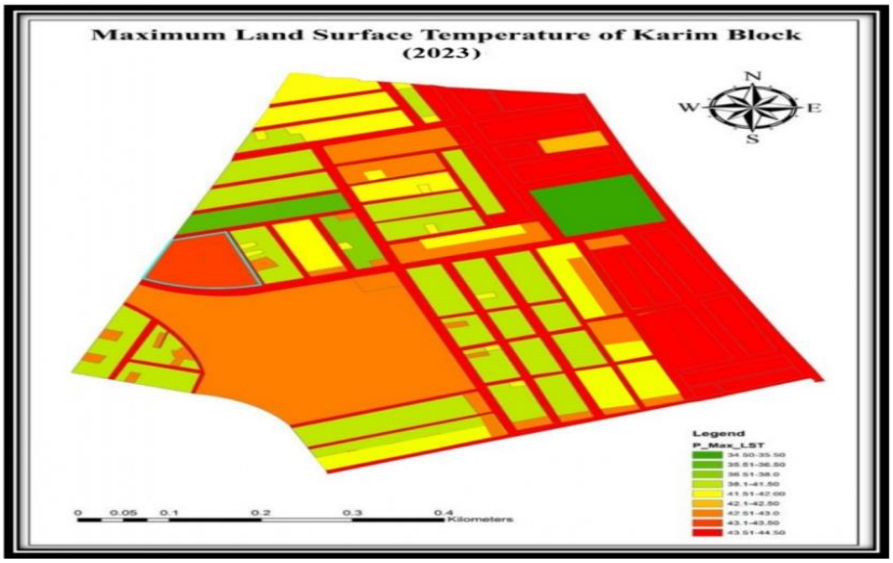

Figure 10 Maximum Land Surface Temperature, 2023

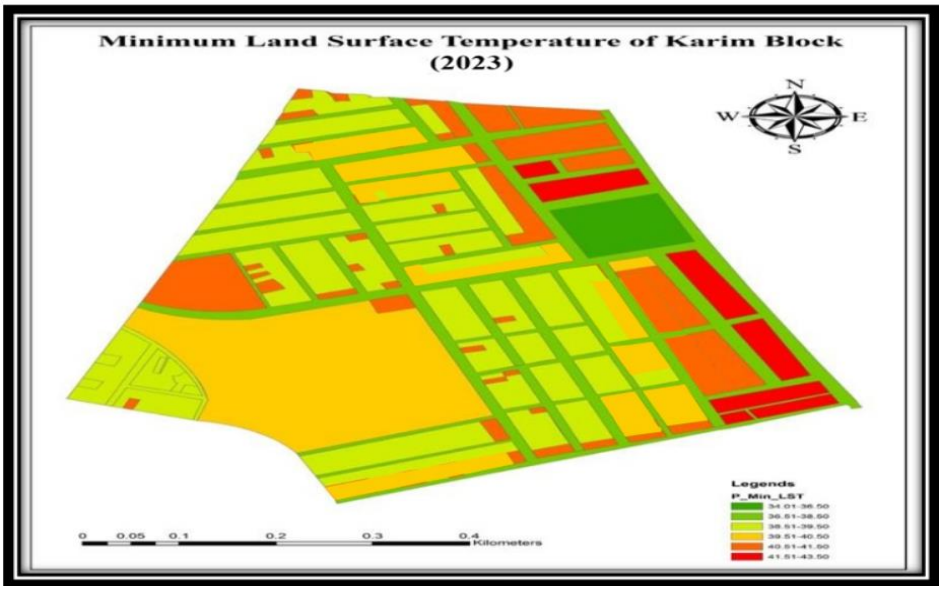

Figure 11 Minimum Land Surface Temperature, 2023

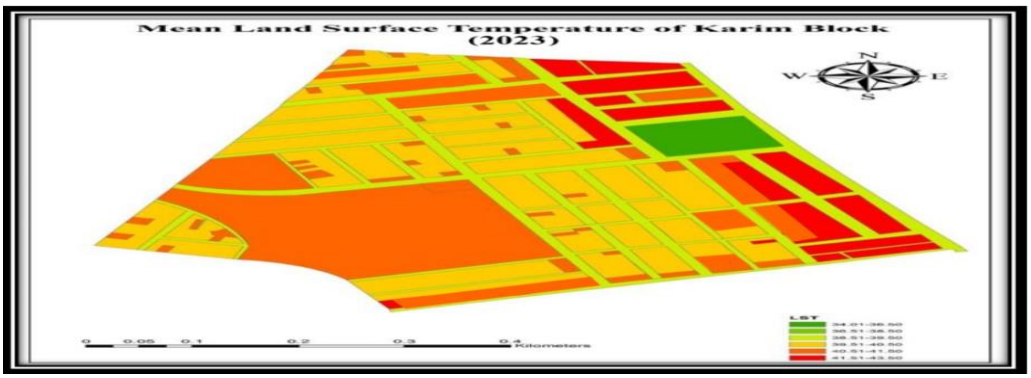

Figure 12 Mean Land Surface Temperature, 2023

Table 3 further elaborates on how the microclimatic temperature of Karim Block has risen as compared to 2016.

Table 3
Values of LST of 2023

Land Use	Max_LST	Mean_LST	Min_LST
Commercial	43.94	43.30	41.23
Graveyard	43.29	42.68	40.65
Parks	39.84	37.55	35.96
Public Buildings	43.25	42.75	40.81
Residential	43.15	42.77	40.72
Road	43.35	43.29	41.93
Vacant	43.28	43.19	41.26

Normalized Difference Vegetation Index of year 2023: The NDVI map demonstrates the connection between green infrastructure and land use. Through the map it is visible that there is a significant decrease in green infrastructure due to increased commercial activity as compared to 2016. It has further affected the laid grounds for heightened LST. It is visible in figure 13 which shows the normalized Difference Vegetation index of 2023 for comparison with the one generated for 2016.

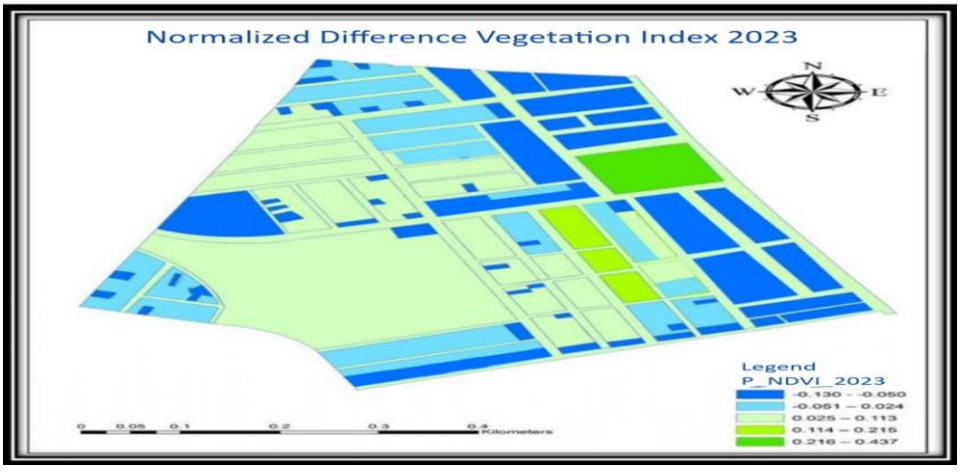

Figure 13 Normalized Difference Vegetation Index 2023

The co-relation Analysis of NDVI for 2023 shows Maximum, Minimum and Mean NVDI values. It can be seen that there is a significant decrease in vegetation and green

infrastructure, due to permanent and temporary commercial structures, also for making space for more parking to cater to the High usage of the area.

Table 4
Values of NDVI of 2023

Land Use	NVDI_Max	NVDI_Min	NNDI_Mean
Commercial	0.1268	-0.0075	0.06715
Graveyard	0.0841	-0.0247	0.0297
Parks	0.1516	-0.0078	0.0719
Public Buildings	0.1167	-0.006	0.06135
Residential	0.1316	-0.0305	0.05055
Road	0. 0972	-0.1019	-0.00235
Vacant	0.126	0.0065	0.06625

Land Surface Temperature vs Normalized Difference Vegetation Index: LST and NVDI co-relation proves that the absence of green infrastructure has resulted in higher temperatures in areas with low NDVI values. Even though graveyards and parks have sufficient green infrastructure, their temperature has also risen as compared to 2016. It is due to the surrounding areas where residential activities have been replaced by commercial activities and vacant spaces have been occupied by informal commercial activities and informal parking. Based on this there is an average of 3.29 Celsius increase in temperature between 2016 and 2023.

Land Use Percentage

The land use percentage has been calculated based on analysis. It can be seen in Table 5. the land usage has shifted drastically in the past 8 years. Commercial usage has seen a 5.01% increase while residential activity has reduced by 5.24%. it might not look like much but a 5% margin in the conversion of residential activity to commercial activity means the usage typology also changes. The space that was designed to cater to families of 5-10 people is now catering to a significant number of users including buyers and sellers, that come along with the vehicle. Resulting in an influx of users and vehicles creating a dense environment.

Table 5
Land Use Percentages 2016-2023

Land use	2016 (%)	2023 (%)
Commercial	14.48	19.49
Graveyard	17.47	17.47
Park	2.94	2.94
Religious	0.56	0.56
Road	23.01	23.01
Vacant	0.52	0.52
residential	38.52	33.28

Expected Temperature of Karim Block

Under the commercialization rule, Karim Block is permitted to construct buildings to the height of 60 feet resulting in multi-story commercialization. This leads to an increased number of users in low-surface areas. the expected temperature increase for the future is visible in Table 6 The prediction does not include future traffic density due to the limitation of the study. It can be analyzed that with rising activity the

microclimatic condition of Kareem block is going to be further susceptible due to increasing commercial activity, which is also taking over green infrastructures for commercial activities.

Table 6
Expected Temperature for future

Land use	2016 (%)	2023 (%)	Difference in Land Use	LST 2016	LST 2023	Difference in LST	Predicted Change in Land Use Per Year	LST Per Annum
Commercial	14.48	19.49	5.010	40.65	43.30	3.29	0.3100569	0.47
Graveyard	17.47	17.47	0.001	40.22	42.68	3.08	0.0000548	0.44
Park	2.94	2.94	0.006	35.73	37.55	1.82	0.0003459	0.26
Religious	0.56	0.56	0.009	39.81	42.75	2.94	0.0172832	0.42
Road	23.01	23.01	0.004	40.35	43.29	2.94	0.0000187	0.42
Vacant	0.52	0.52	0.006	40.39	43.19	2.80	0.0000288	0.40
residential	38.52	33.28	5.246	40.04	42.77	2.73	-0.3275387	0.39

The table shows the increase in commercial activity from 14.48% to 19.49% while residential activity has decreased from 38.52 to 33.28, from the year 2016 to 2023. With an expected increase in temperature by 0.47% per year and land usage conversion to commercialization by 0.32% per year.

Conclusion

In numerous cities all around the world, the environmental susceptibility caused by urban development and commercialization is widely acknowledged resulting in precautionary measures being taken to mitigate the consequences of high commercialization. Despite having limited resources, Pakistan is a country where even with restricted resources, the urbanization activities are growing rapidly. Lahore being second Largest city in Pakistan is facing adverse climate change impacts due to extensive urbanization and the removal of green infrastructures for further urbanization. The excessive commercialization of Karim Block, which has plans to expand further, is facing a significant rise in temperature due to increased commercial activity and heavy traffic, which is resultant of commercialization. The research focused on analyzing the depth of damage and necessary measures that could minimize these effects.

For analyzing the impact of land use conversion on climate and understanding the role of green infrastructure on LST, Data from 2016 to 2023 was calculated and linked and compared with each other. In 2016 the temperature of the commercial area of Karim Block was comparatively lower as compared to the residential activities. This is due to the reason that in 2016 the commercial development was among green spaces, which normalized the temperature of commercial area as compared to surroundings. But in 2023 commercial activity jumped by 5% replacing green infrastructure with commercial activities. This soared the temperature rise from 40.65 ^{o}C to 43.30 ^{o}C creating a difference of 3.29 ^{o}C in 7 years. The temperature of the residential area has also increased by 2.73 ^{o}C. This has not only affected the areas with conversion in land usage but has also affected the surrounding areas where land usage has remained the same. In the past 7 years, green spaces have seen a decline in green infrastructure with the majority of vegetation restricted to parks and graveyards. The amount of existent green structure is insufficient to lower the temperature of the entire Karim Block. It is further observed that the green areas have also seen an increase in temperature of 3.08 ^{o}C.

Karim Block's commercialization was the main focus of the research paper as it is responsible for major environmental degradation. The reason is that commercial areas

usage of air conditioners to fight heat, which is a major contributor to air pollution. Along with this traffic is also a huge contributor as according to studies by LDA, it was revealed that Karim Block's traffic growth rate is 2.5%. This study shows that there is an urgent need to take preventive measures to address climate change susceptibility. In the case of Karim Block, land use conversion and environmental degradation is occurring rapidly due to:

- The authority's responsibility is not generating a reclassification plan due to a lack of interest in occurring problems.
- At the strategic level, residential areas are experiencing failure in monitoring and anticipating the demand for commercial land.
- The allocation standards for commercial use are inappropriate, and building regulations are inadequate
- There are no legitimate commercialization policies for environmental susceptibility being implemented by regulatory bodies.

Consequently, the situation is attracting high traffic, leading to extreme transportation problems due to the lack of proper parking spaces. This results in traffic congestion, and environmental degradation along with noise and air pollution. It is crucial to implement a commercialization policy for managing the present and future commercial development of Karim Block. It should focus on environmental concerns, ensuring that climatic change is not overlooked in making commercialization policy

Sustainable urban planning can play a vital role in the adaption of urban systems for mitigating the impacts of climate change. By using local resources, urban planners can establish sustainable strategies for planning. The planning should include the adaption of appropriate green structures and link it with design principles, to ensure that new developments can adapt and that existing developments can be adequately retrofitted.

Recommendation

There are several recommendations presented below that are based on analysis and findings of research.

- Viewing the land use plan of 2023, there is an urgent need to reclassify the land use of Karim Block, the potential of climate change impact should also be taken into consideration. The reclassification plan should have a significant focus on increasing traffic which will only be increasing further with expanding commercialization. The emission of traffic would lead to significant temperature rise and air pollution
- The increased traffic generated from commercialization and its emissions should be taken into account when planning commercialization policy.
- The concept of green roofing should be implemented in commercial land usage as the green infrastructure is being eliminated for commercialization. This can reduce the temperature of commercial areas by 4^{o}C
- While planning housing schemes, the focus on green spaces should be essential in overall planning rather than them being designed in specific areas. Green spaces can reduce the neighbourhood temperature significantly, despite the typology of land use.

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