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Evaluating Spatio-Temporal Decline to Agriculture through Satellite Imagery from 2010-2022

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The failure of Pakistani cities to adopt a vertical expansion strategy has led to the encroachment of urban areas onto farmland and pastures. Agricultural land is constantly being lost as cities expand, putting stress on farmers and lowering agricultural productivity. The agricultural industry of Pakistan is vital to the country's economy. It employs 42.3% of the working population and contributes 18.9% to GDP. In addition to bringing in much-needed foreign currency, it helps other areas of the economy flourish as well. Mapping of LULC change is an essential strategy for assessing, managing, and protecting a region's natural resources, and information on present land use is one of the most critical prerequisites for supporting better use of terrain. The examination of LULC variations at all scales—watershed, catchment, and basin—can benefit greatly from the use of remote sensing and Geographical Information system (GIS). The synoptic view and multi-temporal LULC data that can be gathered with remote sensing are valuable. This research determines the spatial and temporal dynamics of change in the Jehlum watershed, an area that has seen significant shifts in its LULC as a result of human and environmental activity. During the course of time, from 2010 to 2022, the study region saw significant changes in the spatial extent of forest cover (8640.239 to 6756.592 ha), horticulture (6891.458 to 8519.483 ha), built-up (858.91 to 2830.438 ha), and agricultural (19483.05 to 18060.83 ha). Changes in LULC over time in the watershed have been linked to deforestation, population growth, and urbanization.
Keywords: Spatio-Temporal, Decline to Agriculture, Satellite Imagery

Introduction

The failure of Pakistani cities to adopt a vertical expansion strategy has led to the encroachment of urban areas onto farmland and pastures [1]. Agricultural land is constantly being lost as cities expand, putting stress on farmers and lowering agricultural productivity [2]. The agricultural industry of Pakistan is vital to the country's economy. It employs 42.3% of the working population and contributes 18.9% to GDP [3]. In addition to bringing in much-needed foreign currency, it helps other areas of the economy flourish as well. Mapping of LULC change is an essential strategy for assessing, managing, and protecting a region's natural resources, and information on present land use is one of the most critical prerequisites for supporting better use of terrain [4]. A massive change in land use has become a significant global issue due to conversion of a rural society in to urban one, together with the associated changes in the physical environment [5]. In contrast, the term "urban expansion" refers to the process of changing undeveloped land or natural environments into built urban fabrics, such as homes, factories, and roads [6].

Studies conducted in the 2000s suggested that more than 47% of the world's population was residing in urban regions [7]. In 1800 CE, the worldwide urban population was approximately 3%. The urban population presently accounts for roughly 53.857% of the world's total population, according to 2015 data from the World Bank and the United Nations' 2014 assessment. A frightening 83% of Jordanians live in urban areas, according to data from 2011 [8]. The world's urban population is expected to grow by another 12 percent by 2050, with Jordan seeing an increase of 6 percent. Even in more developed areas, the majority of people will be living in cities by 2050 [9].

The effects of ethnicity, religion, culture, and lifestyle on spatial growth in urban areas are just some of the factors that make it difficult to measure urban development. Understanding the urbanization process is not simple because it has evolved over time as a result of a complex network of changes in human behavior or land use policy, as well as societal pressures and activities in cities [10].

In the early 20th century, some nations began to recognize the phenomenon of rapid urbanization. As an illustration, the United Kingdom has passed regulations that, if followed, would ensure a greenbelt policy is followed to regulate sprawl[11]. Researchers in the United States and China have increasingly referred to it as an urban development boundary that help policymakers to regulate and plan urban expansion. Many research, notably those employing AI, have zeroed in on the urban growth boundary recently. While an increasing number of studies attribute the growth to the expansion of economic urban activity, some attribute it mostly to rising populations regardless of the causes, the result is urban sprawl, which eats into farmland and other environmentally important areas. Models like the Future Land Use Model (FLUS), the Markov, Patch-generating Land Use Simulation (PLUS), and the Artificial Neural Network (ANN) are used to predict LULC change due to the need to prepare for future growth in light of the current desire for development. Certain Remote Sensing (RS) studies provide crucial data on LULC shifts in relation to LST, which may be used to predict shifts that may have an effect on climate change and help policymakers create efficient land resource management plans [12].

Urban growth models have been shown to accurately describe and predict urban development throughout time, giving planners enough data to access threats to food security. Due to the very non-linear nature of urban growth over time, Artificial Neural Networks (ANNs) are increasingly being employed in a variety of sectors to determine the limit of urban expansion [13]. Changes in LULC is on the rise worldwide as a result of both natural and human-caused factors that are having an effect on the world's ecosystems [1]. Owing to anthropogenic activity, the landscape is being dramatically transformed in one way or other. Furthermore, human requirements on earth have had an enormous impact upon the natural environment, leading to a discernible trend in LUCL across time. One of the most vital parts of any ecosystem is the land itself. Regrettably, it has been misused and overused by every culture ever [3].

As a result of rising demands from both agricultural and population, land is becoming increasingly valuable. Proper land management and decision improvement necessitate an appreciation of landscape pattern, and connections between human activities and natural phenomena [14]. Making maps of terrain characteristics can aid in spotting shifts and investigating the patterns. Ecological goals in the landscape often include monitoring for changes. The information gathered by earth observing satellites has advanced rapidly in recent years, making it a valuable tool for comprehensive mapping, resource management, and research on environmental shifts [15].

Space-based observations of Earth are now indispensable for gauging the long-term effects of human activities on the planet's natural resources [16]. Satellites capture multispectral remotely sensed data on a regular basis, which allows for a synoptic examination of landscape pattern and changes over time at local, regional, and global scales [17]. Latest emerging technology of RS and GIS have become an important tool for more refined ecological management [18]. Improving natural resource monitoring and management is possible with the help of GIS and satellite data, which give policy and decision-makers a bird's-eye view of the entire area[19][20].

Current research has shown that geo-spatial technology is widely used in the decision-making process of mapping and monitoring to evaluate a temporal decline to agriculture that ultimately effects the regional GDP.

Study Site

The spatial extent of study site (Figure 1) is located between 33°25' and 34°40' North latitude and 73°55' and 75°35' East longitude is where the Jhelum River begins its journey to the sea. The Jhelum River flows into the Chenab River, which flows into the Indus River. The Jhelum basin in Jammu and Kashmir, India, is the focus of the research. With a major channel length of 165 kilometers, the Jhelum basin is approximately 17622 square kilometers in size. Jhelum basin is roughly 1830 meters above sea level on average. It begins at an average altitude of 5,500 feet on the north-west side of Pir Panjal and flows parallel to the Indus River. It traverses the alluvial soil of Kashmir Valley, which covers an area of around 2300 km2. Large glacial sources, located on the northern edge of the Kashmir valley, feed the Jhelum River. Coarse sediments are deposited near Baramulla as the river moves north-west through Srinagar, the capital of Jammu and Kashmir, before merging with the Dal and Wular lakes. Following its departure from the Baramulla, the river travels along a gorge that is 80 miles long and has a mean slope of 33 feet per mile. It reaches its terminus at the Chenab River.

Material and Methodology

LULC changes in the Jhelum watershed were studied using satellite images from 2010 and 2022. For the most consistent mapping results across seasons, we chosen images captured at the same time of year. Landsat TM (30 m, Path/Row-149/36, and IRS LISS-III (23.5 m, Path/Row-92/46) were downloaded. Using a topographical map and a satellite image, researchers set out to track how LULC in the Jehlum watershed has been changed over time.

Data Pre-Processing

The survey sheets of study site at a scale 1:50000 were scanned and digitized as a part of the pre-processing phase. In order to make the processed images more interpretable, several digital image processing techniques, such as contrast manipulation and edge improvement, were applied. In order to do the spatial analysis, the images were geometrically rectified and registered to the same projection, specifically Transverse Mercator WGS 1984.

Supervised Classification.

Classification of digital photos was performed using an on-screen interpretation strategy based on some fundamental image properties (viz. tone, texture, pattern, size, shape, shadow paired with site/location and associated features) that aid in the interpretation of earth features.

Spectral Signature.

The fluctuation in a material's reflectance or emittance with respect to wavelengths, or reflectance/emittance as a function of wavelength, is known as a spectral signature. The incidental EM wavelength and the material's interaction with that region of the electromagnetic spectrum determine an object's spectral signature.

Figure 1. Location of Study Site

Analysis of changes in the LULC over the 2010–2022 were carried out using change detection method. Analysis for detecting changes between two or more photos of the same scene taken at various times or under different lighting conditions involves a wide variety of techniques. Using a simple method, change detection investigates differences between two photos that were taken at the beginning and end of a process.

Kappa Coefficients and Accuracy Assessment

A joint analysis of remotely sensed imaging and in-the-moment field observations can improve the accuracy of biomass estimations [21]. For the estimation of forest-related characteristics, a wide range of remote sensing datasets are available, such as optical data (passive remote sensing), microwave data, such as Radio Detection and Ranging (RADAR) and Light Detection and Ranging (LIDAR) data, etc. These datasets have great spatial and temporal resolution and can reliably cover enormous areas in a single sweep [22]. Several researchers have demonstrated the effectiveness of optical remote sensing for mapping forested landcover, monitoring the health of the forest, and detecting pest and disease infestations [23]. Its accuracy is a result of the various satellites' high spatial and temporal resolution, such as Quick Bird, which can capture the location at a spatial resolution of up to 0.61 meters. Leaf level information may be accurately extracted by high resolution satellites. Through numerous online addresses, optical data is sometimes provided for no cost or for very little money [24]. We performed ground validation by establishing a connection between the trained map and the real-time Google Earth images in order to evaluate the accuracy of the supervised classification. The accuracy index was calculated using the well-defined Kappa Coefficient. A correlation between identified map features and actual ground reality is found using the Kappa Coefficient [25]. Pin points are used to indicate features on the categorized map throughout this phase to determine whether they are actually there on the ground or not. Several pin points are marked in this manner to determine the accurate locations as opposed to misleading ones. It is also known as expert accuracy, and the method below can be used to calculate it.

$$Accuracy = \frac{CP_s}{TP_s} x100$$

Where CPs and TPs, respectively, stand for corrected and total points. The following expression can be used to estimate the kappa coefficient.

$$Kappa = \frac{[TP_s * CP_s] - \sum[\text{Col*Rows}]}{TP_s^2 - \sum[\text{Col*Rows}]} x100$$

All the input factors are arranged in rows and columns for the computation of the Kappa coefficient, for example, the input values for the vegetative and non-vegetative area are as follows in Table 1

Table 1. A brief description of Kappa coefficient in rows and columns.

Class	Vegetated	Non-Vegetated	Total (User)
Vegetated	Corrected	Wrong	=Corrected + Wrong
Non-Vegetated	Wrong	Corrected	= Wrong +Corrected
Total Producer	=Corrected + Wrong	= Wrong +Corrected	Total of Samples

If the results of the categorized map have a Kappa coefficient (K), K>0.80, there is good agreement; if 0.40K0.80, there is moderate accuracy; and K0.40, there is poor accuracy.

Normalized Difference Vegetation Index (NDVI).

NDVI is the indicator of vegetation cover that ranges between -1 to 1 where all values near to 1 represents healthy and lush green vegetation and vice versa. Basically, it is the ratio of red and near infrared band. We used Google earth engine to compute NDVI of the study site.

Land Surface Temperature (LST).

LST represents the distribution of temperature over various existing landuse in the study site. Waterbody represents the lowest temperature values while the urban areas show high temperatures due to anthropogenic activities. The vegetation has moderate temperatures, we computed the LST for various landuse classes using buitin algorithm of google earth engine.

Results

Figures 2 display results of classifications of several land use types, including farmland, urban areas, forests, gardens, pastures, plantations, scrub land, snow, bodies of water, and wetlands. LULC classifications were shown to have undergone spatial expansion and contraction during the course of time period, from 2010 to 2022. Table 2 displays the results of the analysis for changes. Table 2 shows that the most depleted land use type in the watershed is dense forest, with a loss of -4.5%, followed by agricultural land (-3.7%), pasture land (-2.4%), and plantation land (-1.9%). Urbanized areas, agricultural land, scrub, desert, and savanna are the LULC types that have expanded. From 1.74 percent in 2010 to 5.72 percent, the proportion of land covered by buildings has more than doubled. The volume of water, however, has decreased from 2.17 percent to 1.26 percent. Table 2 provides specifics on the area covered by LULCs and the percentage of various LULC categories. Additionally, the data shows that the amount of land that is actually built on has grown by a substantial 3.98 percentage points.

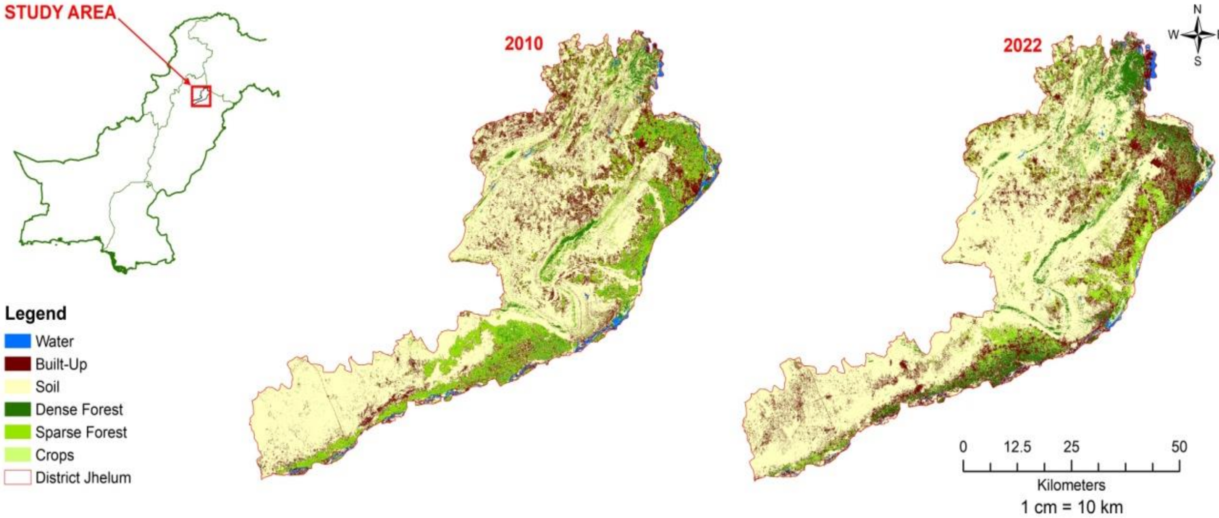

Figure 2: A Temporal decline to agriculture

Similarly, horticulture has seen an expansion of 3.29 percent in terms of land use. Refer to Table 2 for geographic data on the remaining LULC groups. Over the study period, the watershed has experienced a significant change in LULC types, specifically the conversion of agricultural land to settlements and of forested area to agricultural land to suit the needs of an ever-increasing population [9]. We draw spectral signatures of existing landues classes in Figure 3.

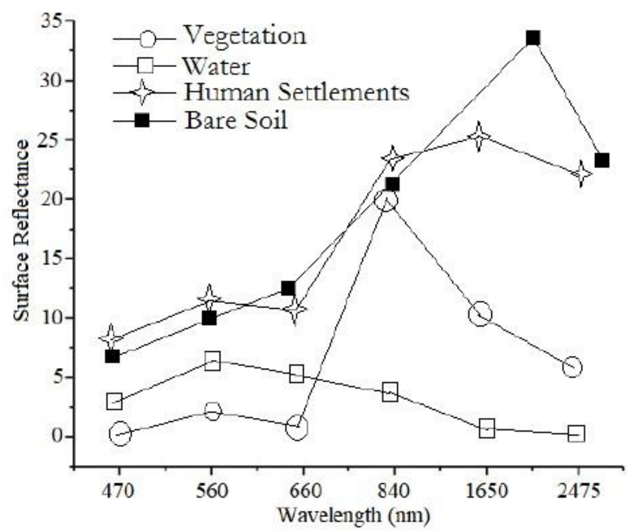

Figure 3. Spectral Signature of various Landuse Classes computed through Satellite Imagery

Table 2: Changes in areal extent of LULC classes in study area from 2010-2022

LULC Types	Area				Change (Gain/ Loss)	
	2010		2022		2010 - 2022	
	sq km	% Age	sq km	% Age	sq km	% Age
Built Up	405.34	11.4	562.36	3.2	157.02	38.74
Soil	2191.35	61.9	2274.47	13.1	83.12	3.79
D Forest	146.97	4.2	316.48	1.8	169.51	115.34
S Forest	541.20	15.3	234.15	1.3	-307.05	-56.73
Crops	207.13	5.8	117.56	0.7	-89.57	-43.24
Water	49.13	1.4	36.10	0.2	-13.03	-26.52
Total	**3541.13**	**100**	**3541.13**	**20**		

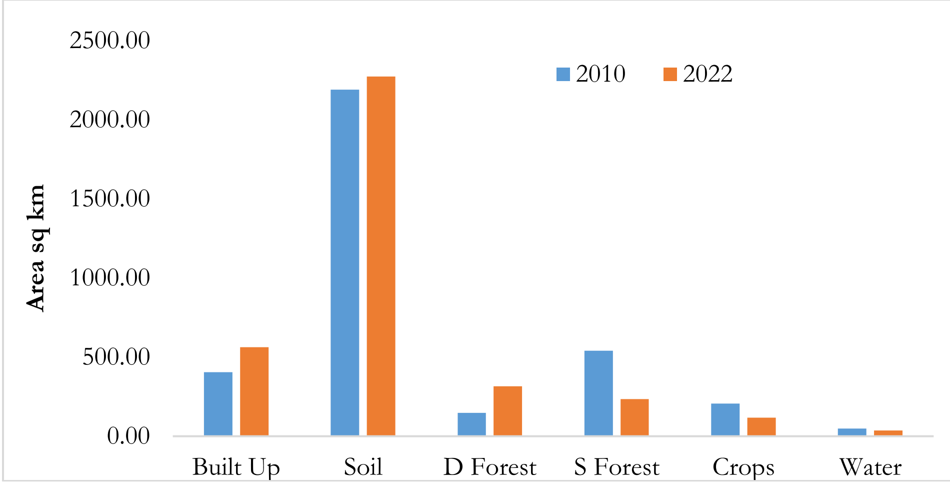

Figure 4: Bar diagram depicting change in LULC classes from 2010-2022

Figure 4 shows the variation in area over the investigation time period. Population expansion and urbanization both contribute to this, with the former stimulating structural changes via multiplier effects, and the latter causing an increase in the built-up category of practically every LULC classification system. The impacts of deforestation, together with any other anthropogenic influences within the watershed, have hastened the decline in watershed structure and function. This is especially true in terms of the growth of watershed infrastructure and horticulture. As can be seen from the output maps, most horticultural land is derived from agricultural land, and infrastructure development often takes place on farmland, indicating a downward trend in the total area devoted to agriculture. For this reason, less water-intensive horticultural land is becoming increasingly popular in the region. Deforestation, urbanization, and other well-known environmental concerns may be to blame for the shrinking amount of land covered by forests.

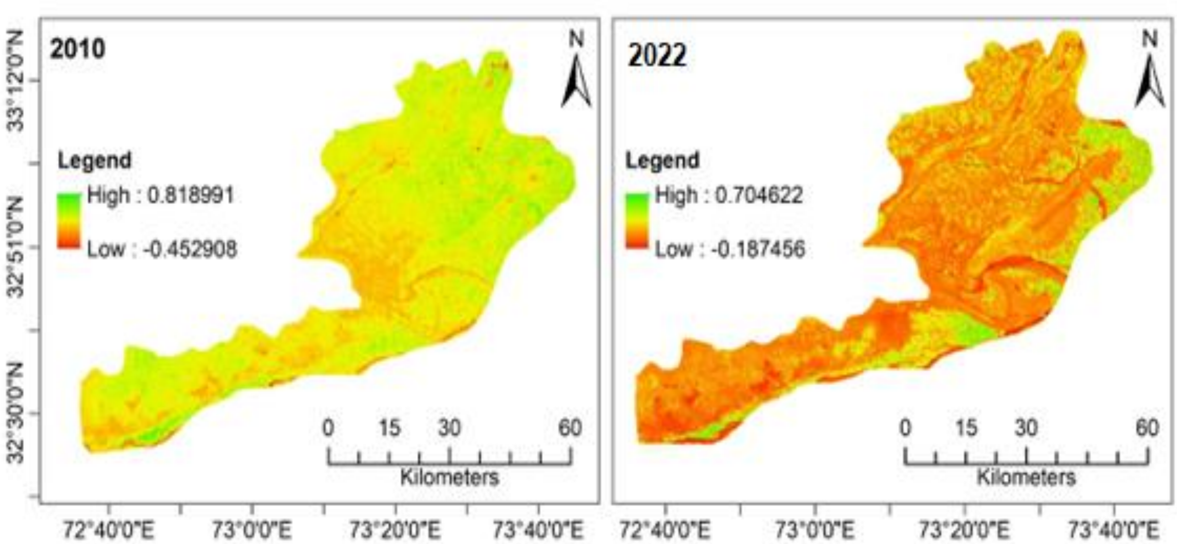

Figure 5. Temporal variations in NDVI

Figure 5 shows that NDVI values were high in 2010 that turned to low values in 2022

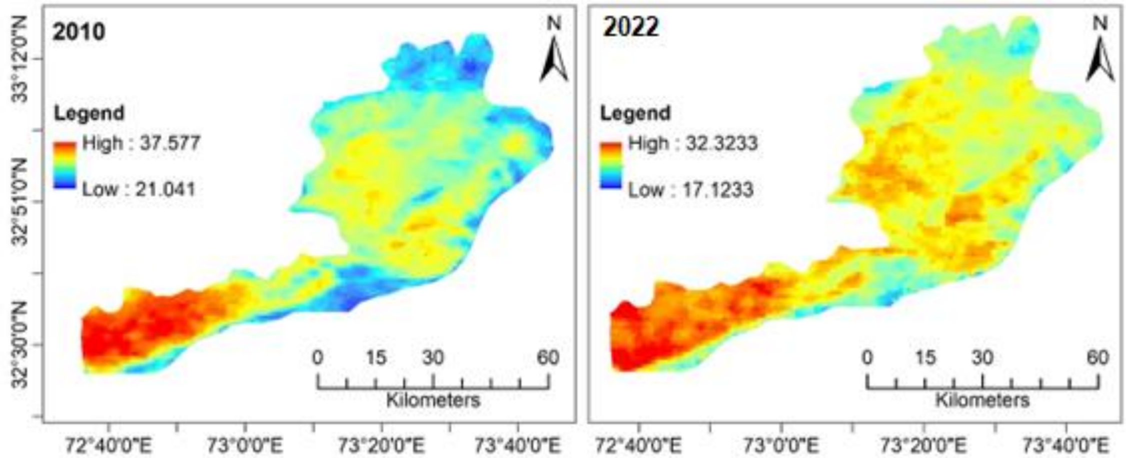

Figure 6. Variations in LST over the study period.

Figure 6 shows that high temperature values dispersed throughout the study region in 2022 as compared to 2010 due to decline in vegetation cover and increased urbanization.

We selected 25 sample points for accuracy evaluation, 15 for the vegetated classes and 10 for the non-vegetated classes. We identified two incorrectly marked classes out of a total of 25, including both vegetated and non-vegetated groups, and we determined the Kappa coefficient to be K=0.83. According to the methods section, this K number indicates a good degree of accuracy.

Discussion.

Decline to Agriculture

Housing needs are being supplied by expanding cities into agricultural regions as cities continue to grow due to a growing population and migration from rural to urban areas. Unplanned housing developments, shopping centers, hospitals, schools, and other settlements are quickly destroying the rural area that surrounds Pakistan's largest towns. By constructing new crops and educational facilities during the "green revolution" of the 1950s, the agriculture sector experienced great expansion [26]. However, the momentum was not maintained, and the industry suffered greatly as a result of bad policies and a lack of implementation. It is now common knowledge in all major cities to observe lax land-use regulation and the merging of urban activity on rural terrain. When Pakistan was created in 1947, just 17% of the nation could be classified as urban [27]. With a growth rate of 2.5% annually as of 2020, metropolitan cities will be home to 37% of the world's population [28]. With this enormous expansion, industry have also moved onto agricultural lands, causing degradation of the water sources needed for cultivation. Massive rural-to-urban migration has resulted in a shortage of resources for farmers because of the demand for labor in urban areas, workers for construction projects, and personnel in the transportation and services industries [29].

The importance of the agricultural sector has decreased as a result of rapid urbanization, while the value of urban industrial and manufacturing businesses has soared. Deforestation is destroying the natural environment on the edges of cities like Lahore and Karachi, just as urbanization has fueled expansion in the timber sector due to construction and housing needs. Future crops that require particular environmental conditions may suffer as a result of the decreased air quality and environmental harm [30]. Pakistan lacks vertical housing, which is leading to encroachments on pastures and agricultural land. The population's needs and preferences for food have altered as a result of urbanization. More and more people need to be fed as cities expand. Yet this is not altogether good for the agriculture industry because there is a huge increase in imports of goods and foods that cannot be produced locally. Urbanization causes ongoing agricultural land loss, which puts pressure on farmers and lowers the productivity and efficiency of the agricultural sector [31]. Due to a decline in physical activity, urbanization is also linked to dietary changes toward more processed and prepared foods. Large-scale agricultural producers will be able to fulfill supply and demand as supermarkets and wholesale marketplaces continue to expand in urban areas, while small- to medium-scale farmers run the risk of losing their land to more powerful competitors [32]. The employment structure of the food system will also change as a result, with fewer people employed in agriculture and more in the transportation, wholesale, retail, food processing, and vending industries.

Without solving the problems, the agriculture sector faces, Pakistan's dream of economic stability would never come true. In order to ensure that only arid land is utilized for the development of residential, commercial, and other types of infrastructure, correct laws must be implemented in areas surrounding cities where encroachments on agricultural fields are becoming more and more frequent. There are currently no rules that prohibit this process of urban sprawl, so as housing needs increase, cities must prioritize vertical growth above horizontal expansion [33]. Given the rising need for food both locally and worldwide, Pakistan's agriculture sector needs support and assistance from the appropriate authorities to guarantee that farmers have access to seeds and fertilizers to boost productivity and efficiency. The traditional crops of wheat, sugarcane, corn, and cotton are insufficient to provide the wide range of demand for agricultural products, hence crop diversification is fundamentally required [34].

Water should be used more wisely, and safeguards should be put in place to stop businesses and megacities from dumping contaminants into agricultural water streams. The consequences of climate change on various crops should be addressed with the help of biotechnology, a burgeoning subject [35]. It has been demonstrated that seeds made by genetic engineering yield better results. Low markup rates on loans should be made available to farmers as this will encourage urban youth and the general populace to view farming and agriculture as a viable economic option [36]. Finally, the inability to use energy to power equipment for crop handling and harvesting causes productivity issues for the majority of farmers. It's also necessary to subsidize electricity costs and offer affordable electricity to tube wells [37]. All parties, including research institutes, universities, and allied institutions, require a strong and comprehensive coordination structure. Pakistan can also learn from other nations, like China, which have successfully managed urbanization and agricultural productivity [38]. In order to increase the production of cultivated lands, modern approaches must be employed along with research and cutting-edge technologies [39]. Finally, land reforms must be taken into account, and all relevant parties must work together to develop a sound strategy for Pakistan's future agricultural resurgence.

Cities and towns expand as a result of urbanization, which sees people moving from rural to urban areas [40]. It may also be thought of as a general rise in both city and countryside populations. It is heavily influenced by the widespread belief that metropolitan areas have outperformed their rural counterparts in terms of economic, political, and social development. More and more individuals in both developing and developed nations are moving to urban areas in pursuit of the "privileged" social and economic services and benefits that can be found there. Advantages in housing, employment, transportation, health care, and sanitation are all examples of these social and economic benefits [41]. The term "urbanization" is used to describe the process through which individuals move from rural to urban areas, the decrease in the rural population, and the societal adjustments made to accommodate this trend (or urbanization) [42]. Cities and towns originate and expand as a result of people moving into metropolitan areas in search of employment and housing. Most people travel to urban regions because they believe that life in the country is difficult and that its inhabitants engage in backwards practices. Urbanization is caused by population movements from less developed to more developed locations (towns and cities). In most cases, this aids in the preparation of land for the construction of dwellings, community and economic infrastructure, and business establishments. The eventual result of these efforts is a slew of urbanization-related problems [43].

Industrialization, the transition from an agrarian to a non-agricultural economy, led to the emergence of the modern world we live in today. Many individuals have moved to cities during the Industrial Revolution because of the better job prospects available there. Industrialization has boosted employment prospects by opening up careers in prosperous new sectors of the economy.

Commerce and trade have significant effects on urbanization. Modern marketing structures and exchange networks, made possible by the widespread circulation of products and services, have sped up the development of urban areas significantly. The widespread notion that metropolitan places offer better economic possibilities and returns than rural areas has been helpful to commercialization and trade.

Living in a city or town has many positive effects on one's social life. There has been an overall uptick in the quality of life, with improvements in housing sanitation, medical treatment, entertainment options, and interpersonal connections. This has led to an increase in the number of people moving to urban regions in search of the myriad of social benefits and amenities not available in more remote locations.

Those from rural areas who are looking for greater economic prospects often make the move to urban areas. Most people relocate to cities in search of better job prospects because of the wide range of industries and businesses that contribute to the city's economic growth (such as healthcare, education, transportation, sports, and entertainment). More value-added employment is created by the expansion of the service and manufacturing sectors, which in turn increases the number of available positions.

The process of modernization is an essential stage in the development of cities. People feel they can live in peace in urban areas when they have access to modern forms of transportation, communication, healthcare, societal norms on appearance and behavior, and a more enlightened and liberal outlook on society in general. People in cities tend to be more open to trying new things, whether that's in terms of their routines, outlooks, wardrobes, diets, or worldviews. So, people go to the cities, and the cities prosper as a result of the constant influx of new residents.

As regions become more prosperous and wealthier as a result of the discovery of minerals, the exploitation of natural resources, or agricultural pursuits, cities begin to arise in once rural areas. Raising productivity results in a flourishing economy and more well-paying employment openings. Because of this, we need to invest in better transportation systems, schools, hospitals, banks, government agencies, public parks, and homes. Hence, rural areas begin to acquire metropolitan culture and evolve into urban hubs that continue to grow as more people come there in quest of a higher quality of life.

There are several advantages to urbanization if it stays within acceptable parameters. Jobs, better infrastructure and technology, better communication and transportation, better schools and hospitals, and higher living standards are only some of the benefits of urbanization. Nonetheless, there are often negative consequences to widespread urbanization. Several of them are presented down below.

Because of urbanization's allure, there has been a dramatic increase in the population of populated areas. Rising city populations exacerbate an already severe shortage of available dwellings. This is due to a number of factors, including poverty, unemployment, and the exorbitant cost of construction supplies that only a select few can afford.

Overcrowding occurs when too many individuals are crammed into a location that was not designed to accommodate so many. As more people, including immigrants, move to urban regions in quest of a better quality of life, congestion due to overcrowding becomes increasingly common. Most people in rural or economically depressed places long for city life and this constant yearning causes a swarming of people in a small area.

Unemployment is especially perilous for college graduates in urban areas. It is believed that in major metropolitan areas, more than half of all young people without jobs are located. Even if wages are higher than average in a city, the high cost of living can make even a middle-class salary feel inadequate. Unemployment in major cities is primarily caused by people moving away from rural or developing areas.

In most cities, the cost of living is extremely expensive. Consequently, examples of unauthorized resident settlements like slums and squatter communities are on the rise due to factors including uncontrolled expansion and high unemployment rates. Rapid industrialization, a dearth of developed land for housing, a big influx of rural immigrants seeking a better life, and excessive land costs that are out of reach for the urban poor all contribute to the prevalence of slums and squatters in metropolitan regions.

Most cities have inadequate sewage infrastructure due to high population density and fast urbanization. When it comes to sewage facility management, municipalities and local governments are severely hampered by a lack of resources. The outcome is an unknown amount of sewage running off into the surrounding waterways. Typhoid, dysentery, the plague, and diarrhea are all examples of highly contagious diseases that can cause severe illness and even death if they are not contained quickly. Overpopulation significantly affects water deficit since supply cannot meet demand.

Social, economic, and housing factors all have a role in determining who in densely populated metropolitan regions has access to and makes use of public health care services. Slum dwellers are more likely to contract infectious diseases than the general population because of the lack of access to clean water and inadequate sanitation. Pollution in metropolitan areas has been linked to an array of health issues, including but not limited to allergies, asthma, infertility, food poisoning, cancer, and premature death.

As more people move to urban areas, congestion has become one of the biggest challenges facing the transportation network. When there are more people, there are more cars on the road, leading to gridlock and pollution. During peak hours, traffic congestion can be unbearable in densely populated cities. However, as cities expand, more people will flock there to find employment and fulfill their social requirements and wants, which can lead to increased traffic and other inconveniences.

In many cases, societal issues like violence, drug misuse, and crime may be traced back to a deficiency in resources, overpopulation, unemployment, poverty, and social services. Violence such as homicide, rape, kidnapping, riots, assault, theft, robbery, and hijacking are said to be more common in densely populated urban areas. The incidence of poverty-related crimes is higher in cities that are experiencing fast population increase. These types of crimes commonly disrupt city and town life.

Because no one should have to live in unsafe or polluted communities, governments should institute policies that encourage and facilitate the development of ecologically sustainable cities and smart growth practices. The goal is to create sustainable urban areas that place a premium on making sure all city dwellers feel secure. Governments can promote efficient use of urban resources and an economy based on green principles by funding initiatives like green public transportation, green industries, recycling and environmental campaigns, pollution control, and renewable energy.

Food, technology, clean water, sanitation, and education are all necessities that all citizens must have access to. Stakeholders in urban areas should be responsible for this. There needs to be a focus on creating opportunities for people to make money and get jobs so that

they can pay for the upkeep of the services. Government subsidies can lower the cost of utilities, schools, public transit, technology, and even basic healthcare and education.
Private investments should be encouraged to exploit natural resources and generate job possibilities in order to lessen the negative effects of rising urbanization and protect natural ecosystems. More jobs for city dwellers may be generated as a result of sustainable tourism development and responsible resource extraction. Subsidies and incentives for private and international investment in sustainable development projects that create jobs may also be available.

Leaders in urban areas need to promote accessible healthcare and family planning services through public awareness campaigns and counseling services. In order to curb the spread of disease and slow the rate of urbanization, medical centers with a focus on family planning need to be located all across the metropolitan area.

Conclusion

The results show that there were substantial shifts in the study area's LULC classes. There were regional and temporal differences in the character and intensity of these shifts. The causes of these shifts have been identified as a combination of social, economic, environmental, and other factors. Overall, the region's environmental and natural systems are under greater threat than they were before because of the development in urbanization, the decrease in agricultural land, and the expansion of water bodies. One other fascinating result concern planned infrastructure construction in the area under investigation. If this is not addressed with the haste it requires, it will undermine the carrying capacity of an already vulnerable ecosystem and present huge problems to environmental and natural resource managers and policy makers in the region.

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