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Assessment of land use land cover changes through remote sensing data in Multan Tahsil

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Abstract

Land use land cover (LULC) changes are fundamental aspects of our evolving environment, reflecting the dynamic interplay between human activities and natural processes. Current study, executed to estimate LULC changes in seasonal intervals 2000, 2010 and 2020 to generate an accurate database on LULC changes from 2000 to 2020 in Multan tahsil (Pakistan) using RS data. Data were preprocessed in Arc GIS 10.1 and ERDAS IMAGINE software's for layer stacking, mosaicking, and sub setting. After pre-proceed, the iterative self-organized supervised clustering algorism (ISODATA) of ERDAS IMAGINE software was used to perform the supervised classification. 'Built-up area' in 2000 occupied 15.54 % of all the classes. But in 2020, build-up area increased (911.92 %) as compare to 2020. 'Vegetation area' in 2000 occupied the class with 72.312 %, but in 2020 vegetation area decreased (5.06 %) as compare to 2020 and similarly 'bare soil' decreased (5.77 %). The study shows that building area is increasing from 2000 to 2020. Increase in building area indicates increase in population in this tahsil. Our results about LULC changes are an essential tool for informed decision-making and sustainable land management.

1. Introduction

Land use land cover (LULC) is two terms for describing land. Land use (LU) defines the utilization of any piece of land by humans for one or more purposes (Huet al. 2023). While Land cover (LC) is the bodily matter on the outside of any part of ground which cover the land. LC shows the outside cover on the land, water, vegetation, built-up roads, soil and other. Classification of LC establish the baseline as of which monitor activities able to be perform, and provide the land cover knowledge for baseline thematic map (Hussain et al. 2020a). LU refers to idea about the land supply e.g., recreation, natural environment, or cultivation. LU purposes involve mutually baseline mapping and successive watching. The LULC changes refer to the transformation of the Earth's surface over time, reflecting shifts in how we utilize and occupy land (Karuppasamy et al. 2022). These changes encompass a wide spectrum of alterations, from natural processes like forest succession to the expansion of urban areas and agricultural development driven by human activities (Hussain and Karuppannan, 2023). Remote sensing technology, such as satellite imagery and aerial photography, plays a pivotal role in tracking and analyzing these changes. By classifying and comparing land cover types over different time periods, researchers and policymakers can make informed decisions regarding land management, conservation efforts, and sustainable development strategies (Khaliq et al. 2022; Hussain et al. 2021).

Pakistan is generally an agricultural and sixth most populous country where urban area is very high. Major population in Pakistan is related to agriculture, mainly southern Punjab areas (Majeed et al. 2022). The first challenge is that in temporal LULC change in the region of Mulan. Other challenge is identifying the LULC changes from 2000 to 2020 and its impact of citizen. Using RS data, this study delivers complete LULC changes of the Multan tahsil from 2000 to 2020 to detect changes in LULC. Current study, executed to estimate LULC changes in seasonal intervals 2000, 2010 and 2020 to generate an accurate database on LULC changes from 2000 to 2020 in Multan tahsil (Pakistan) using RS data.

2. Method

2.1. Study Area

The study area is Multan tahsil which lies in Punjab, Pakistan (Fig. 1). It lies approximately between latitude 30.0442° N, 30.6682° N and longitude 72.3441° E, 73.1114° E respectively. Multan District, located in the heart of Pakistan's Punjab province, boasts a unique climate and diverse land characteristics that contribute to its significance in the region. The district's climate is primarily classified as arid to semi-arid, strongly

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influenced by its geographical location and proximity to the Thar Desert. Multan District experiences a hot desert climate, characterized by scorching summers and relatively mild winters. The climate can be divided into three distinct seasons. Summers season (April to September) in Multan are exceptionally hot and dry. Daytime temperatures often soar above 40°C (104°F), with occasional heat waves pushing the mercury even higher.

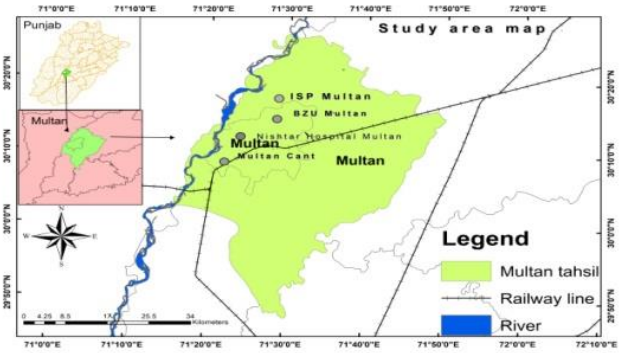

Figure 1. Study area map

2.2. Data Collection

Satellite data and Ancillary data are used in this research. The Landsat data was downloaded freely from official Earth Explorer USGS acquired by National Aeronautics and Space Administration (NASA) website (earthexplorer.usgs.gov). Ancillary data comprised of ground truth data for the LULC classes, topographic maps, aerial images of watershed and its adjacent areas. Ground truth data were collected as data control points using GPS (Geographical Positioning System), used for image analysis and classification, as well as for assessing the accuracy of classification results (Hussain et al., 2022a). Additionally, satellite data comprised of multi-spectral data obtained by Landsat 7 and Landsat 8 OLI (Operational Land Imager) satellite for the month of September (Table 1).

Table 1. Detail of Landsat satellite images

No.	Satellite/ Sensor	Band used	Path/Row	Date
1	Landsat 5	1,2,3,4,56,7	149/039	2000
2	Landsat 7	1,2,3,4,56,7	149/039	2010
3	Landsat 8	1,2,3,4,56,7,9	149/039	2020

2.3. Image classification

Reprocessing satellite images before detecting changes is extremely important and has a unique goal to start a direct connection among the data obtained and biophysical experiences. The data was processed for georeferencing, layer stackin, mosaicking and sub setting of the image in ERDAS IMAGINE 15. All satellite data was investigated by allocating per-pixel signatures and distinguishing five classes based on the definite DN (Digital Number) value of various elements (Hussain et al. 2022 b, c). Digital processing of satellite image provides tools for analyzing the image using various mathematical indices and algorithms. The iterative self-organized supervised clustering algorism (ISODATA) of ERDAS IMAGINE software was used to perform the supervised classification (Hussain et al. 2022d). To create classified LULC maps with a predetermined number of classes (5-24), supervised classifications runs were created on satellite images for 2000, 2010 ad 2020 with step 1 at each subsequent stage, maximum number iterations will be set up to 50% with 0.97 convergence threshold. The signatures were analyzed to acquire minimum and average divergence statistical indicators.

3. Results

A new layer was generating because of all the analysis made on LULC maps. Single layer was generated using weighted overlay tool of spatial analysis. The resulting layer shows the areas of LULC classes in study area. Land Use/Land Cover classes, patterns as well as change over time in the study area were mapped with unsupervised classification methods. Initial level was LC type, 2nd level was LU type and last level was the LULC classes. Final LULC images were used to evaluate areas employed by different LULC classes which were analyzed for variations between and within LULC classes (Table 2). In year 2000 vegetation area was 72.31 % followed by water bodies (1.46 %); the area covered by built-up area was 15.54 % while bare soil covered about 10.69 %. During the year 2020, vegetation area was 67.25 % followed by water bodies (0.36 %); the area covered by built up area was 27.47 % while bare soil covered about 4.92 %.

Change detection plays a pivotal role in understanding the dynamic transformation of landscapes over time. It involves the systematic comparison of satellite or aerial imagery from different time periods to identify and quantify alterations in urban development and natural or cultivated vegetation. 'Built-up area' in 200 occupied 15.54 % of all the classes. But in 2020 build-up area increased (911.92 %) as compare to 2020 (Table 3). However, there is a large increase in 'building area' has experienced a significant increase during 2000 to 2020 (Fig. 2, 3, 4 and 5). 'Vegetation area' in 2000 occupied the class with 72.312 %, but in 2020 vegetation area decreased (5.06 %) as compare to 2020 and similarly 'bare soil' decreased (5.77 %). This result showed that vegetation area converted to residential, commercial area and Road.

4. Discussion

Current study, executed to estimate LULC changes in seasonal intervals 2000, 2010 and 2020 to generate an accurate database on LULC changes from 2000 to 2020 in Multan tahsil (Pakistan) using RS data. The LULC changes are central to addressing some of the most pressing environmental and societal challenges of our time. These changes, driven by a complex interplay of natural processes and human activities, have far-

reaching implications that necessitate careful consideration and action. LULC changes are emblematic of the profound impact of human activities on our planet. The expansion of urban areas, agricultural intensification, deforestation, and industrialization has reshaped landscapes, often at the expense of natural ecosystems. These changes are inextricably linked to issues such as habitat loss, biodiversity decline, and alterations in hydrological cycles, posing significant threats to ecological integrity (Hussain et al. 2023a).

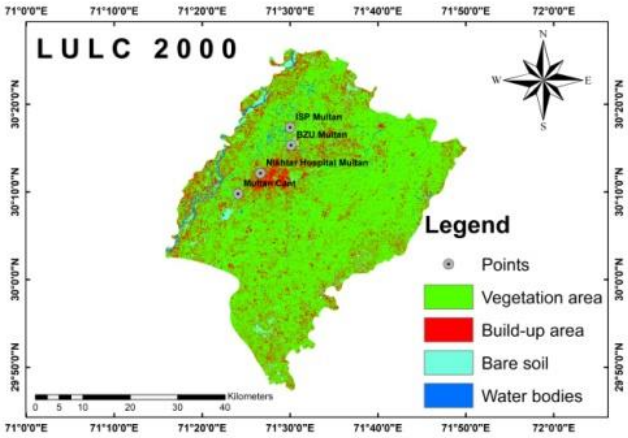

Figure 2. Land Use/Land Cover map for 2000

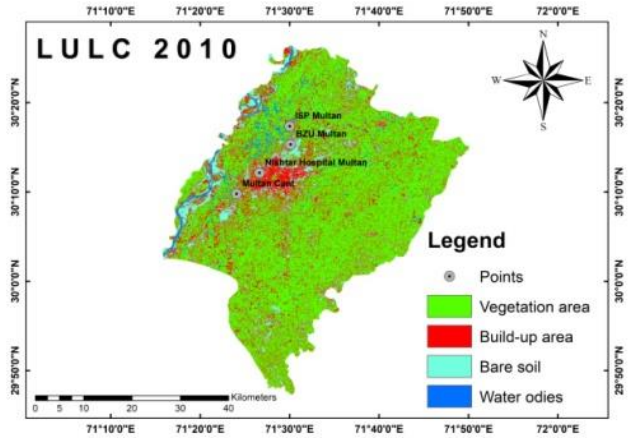

Figure 3. Land Use/Land Cover map for 2010

Moreover, the socio-economic dimension of these changes cannot be understated. Land use alterations directly affect livelihoods, food security, and access to resources for communities around the world. Understanding and mitigating the negative socio-economic consequences, especially for vulnerable populations, is an imperative aspect of addressing LULC changes. Climate change exacerbates the complexities surrounding LULC changes. Altered land cover, such as deforestation or changes in land management, can contribute to greenhouse gas emissions and influence regional climate patterns (Hussain et al. 2023b). Conversely, climate change itself influences land use through factors like altered precipitation patterns, which can impact agriculture and water resources. According to our study, 'Built-up area' in 200 occupied 15.54 % of all the classes. But in 2020 build-up area has increased (911.92 %) as compare to 2020. However, there is a large increase in 'building area' has experienced a significant increase during 2000 to 2020.

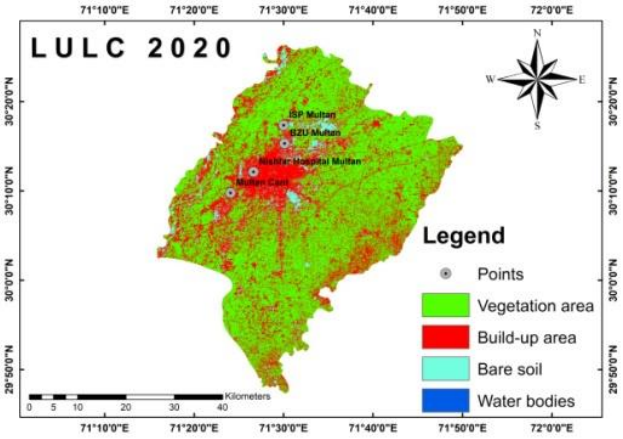

Figure 4. Land Use/Land Cover map for 2020

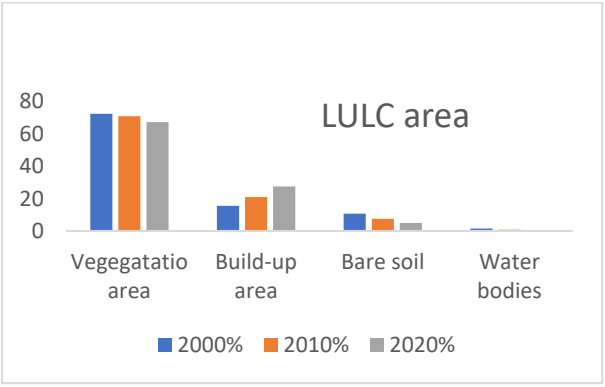

Figure 5. LULC area from 2000 to 2020

Effective policies and international cooperation are vital in addressing these issues on a global scale. Collaborative efforts are essential to conserving biodiversity, promoting sustainable development, and achieving climate goals outlined in international agreements like the Paris Agreement. The findings provide data that can be integrated into land management systems. In conclusion, discussions surrounding LULC changes underscore the intricate relationships between human society, the environment, and climate.

5. Conclusion

Study conducted on Multan tahsil shows that LULC has change over last 20 years. 'Built-up area' in 200 occupied 15.54 % of all the classes. But in 2020 build-up area has increased (911.92 %) as compare to 2020. 'Vegetation area' in 2000 occupied the class with 72.312 %, but in 2020 vegetation area decreased (5.06 %) as compare to 2020 and similarly 'bare soil' decreased (5.77 %). The vegetation trend is on average same from 2000 to 2020 the heavy venations is show in the area. Remarkable changes have shown in building area; it increases from last 20 years vigorously. It is not doubt that the fast population growth in these districts had a maximum effect on LULC. These changes, driven by a myriad of factors including urbanization, agriculture, deforestation, and climate change, have far-reaching

consequences that transcend geographical boundaries. In summary, the results of LULC change analyses offer a comprehensive view of how human activities and natural processes are altering our environment. These findings play a pivotal role in guiding sustainable development, conservation efforts, and informed decision-making to address the complex challenges facing in study area.

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