Development and Application of Land Cover Map for Urban Planning and Development Using Geographic Information System and Remote Sensing

Tahir Ali Akbar[1], Maheen Ahmad Khan[2], Syed Usama Meraj[2], Haris Bin Mukhtar[2] and Qasim Umar[2].

1. Corresponding Author. Associate Professor, Department of Civil Engineering, COMSATS University Islamabad, Abbottabad Campus, University Road, 22060 Abbottabad, KPK, Pakistan.
   Email: drtahir@cuiatd.edu.pk

2. BSc student, Department of Civil Engineering, COMSATS University Islamabad, Abbottabad Campus, University Road, 22060 Abbottabad, KPK, Pakistan.
   Email: khanmak0001@gmail.com (M.A.K)
3. Email: usamameraj16@gmail.com (S.U.M)
4. Email: harismukhtar97@gmail.com (H.B.M)
5. Email: qasimumar77@gmail.com(Q.U)

Abstract

The urban land of Abbottabad city is constantly changing due to population growth and migration of people from other regions. It causes major problems of depletion of natural land resources. The main objective of this research work was to study the urban land change in the past 17 years. The other objectives were to quantify landcover classes transformed from one type into other.

The methodology includes: (i) acquisition of satellite images from Google Earth; (ii) digitization of land covers classes for both years of 2001 and 2018 using the satellite images and (iii) GIS analysis for quantifying the land cover changes. The result indicated 40.02% increase in built-up area, 51.65% increase in forestation, 28.46% increase in open land and 120.93% increase in recreational area in the last seventeen years. There were 40.02% decrease in barren land and 69.33% decrease in agriculture. This study could be utilized for urban planning development and management of urban land of district Abbottabad.

Keywords: Geographic Information System (GIS); Remote Sensing (RS); Urban Land Change; Google Earth Pro; urban sprawl; transformation of classes; landscape study.

1. INTRODUCTION:

Land use suitability assessment is a key factor in any urban and suburban planning and decision-making processes. The assessment is evaluated by a series of criteria involving socio-economic needs. Land use (LU) change is a major issue of concern with regards to change in the global environment. The rapid growth and expansion of urban centers, rapid population growth, scarcity of land, the need for more production, changing technologies are among the many drivers of LU in the world today(Cheruto et al, 2017).

The study area was district Abbottabad. This small city acts as a transit point between the northern regions of Pakistan with the rest of the country. Due to this reason, this area attracts a great number of people to settle in it. The other attractions include good weather, high literacy rate, and peace as compared to other cities. The increase in population also gives rise to increase in urban problems and causes urban sprawl. This sprawl results in unplanned settlement, traffic congestion and depletion of natural resources and land resources.

Research work previously conducted using GIS and RS included investigation of the spatial distribution and modeling of existing and future land changes(Akbar et al, 2019); urban green space development using GIS based multi-criteria analysis(Abebe et al, 2017); spatial and temporal land use/land cover assessment is also done using GIS and RS(Foresman et al, 1997); land use change analysis of District Abbottabad using GIS and Land-sat models (Raza et al, 2011); assessment of land use pattern in the district of Abbottabad(Ali et al, 2017).

This research work was conducted to observe the trend of land cover changes occurred in the past 17 years, which couldhelp the planners for urban planning of this city.

1.2. Objectives:
The objectives of this research work are to:
1. Study the urban land changes in the past 17 years;
2. Quantify Urban land areafor land use/land cover changes;

1.3. Research Significance:
The purpose of this study was to study the changes occurred in the urban land of the city of Abbottabad. The land use/land cover changes (LULC)in the various classes were observed. These classes were: built up area, forestation, agricultural land, barren land, recreational area and open land. The pattern of LULC was observed and causative factors were identified. It was also studied that how these changes impacted the city over the period of seventeen year. This research could be helpful in urban planning of the city in future.

2. EXPERIMENTAL PROCEDURES:
2.1. Study Area and Data Acquisition:
2.1.1. Study Area:
In the Hazara region of Khyber Pakhtunkhwa, Pakistan, the city Abbottabad is located about 120 kilometers north of Islamabad and 150 kilometers east of Peshawar at an altitude of 1,260 meters(SMEDA). Muzaffarabad lies 77 kilometers to the east of Abbottabad (SMEDA).It is the transit point to the Northern tourist areas. This city is alsoheadquarter of the Hazara division of the KPK province of Pakistan. It has beautiful landscape features along with great climatic conditions and high literacy rate due to

which this is preferred and popular city for settlement.

There is increase in population due to which there is intense pressure on available land resources. It caused numerous land cover changes which affected overall scenario of Abbottabad. The location of study area is given in Figure 1.

Figure 1. Location of study area

2.1.2. Data and Method:
The images of the study area were obtained using the Google Earth. The acquisition dates for these images are April 23ʳᵈ, 2018 and March 23ʳᵈ, 2001. The spatial resolution of these images vary from 0.5m to 2.5m.This resolution is sufficient enough to produce high quality landcover map for urban planning and development of a city.

3. RESULTS AND DISCUSSION:
The polygons for all theclasses of study area were digitized in Google Earth and then these were exported to the Q-GIS software for analysis. The files imported into the Q-GIS were first converted into files that were compatible with this software and then a single map of the study areawas prepared which had all land cover sub-classes.

The land cover sub-classes obtained in Q-GIS were merged together to obtain final classes. After merging classes shape file was produced. This shape file is then converted into a map of 2018 using Q-GIS. Another map of the year 2001 is also made using the same methodology. The areas of all land cover classes were obtained for year 2018. These maps were used for obtaining the areas of different classes for the last 17 years.

The calculation shows that the total area of the Abbottabad city is 24.46 sq. miles. In this area, for the year 2001, the calculations showed that built-up area consisted of 26.11% of the total area of the city; barren land was 19.11%; open land comprised of 16.10% of the

area; forestation covered 14.72%; crop area used 22.61% of the land available and the remaining 1.34% was taken up by recreational area.Whereas for the year 2018, the area calculated for the different classes were; built-up areawas36.78%; barren land was10.05%; open land was20.80%; forestation covered22.39%; crop area comprised of 6.99% and the remaining 2.98%was covered by recreational area.These results can also be seen in Figure 2.
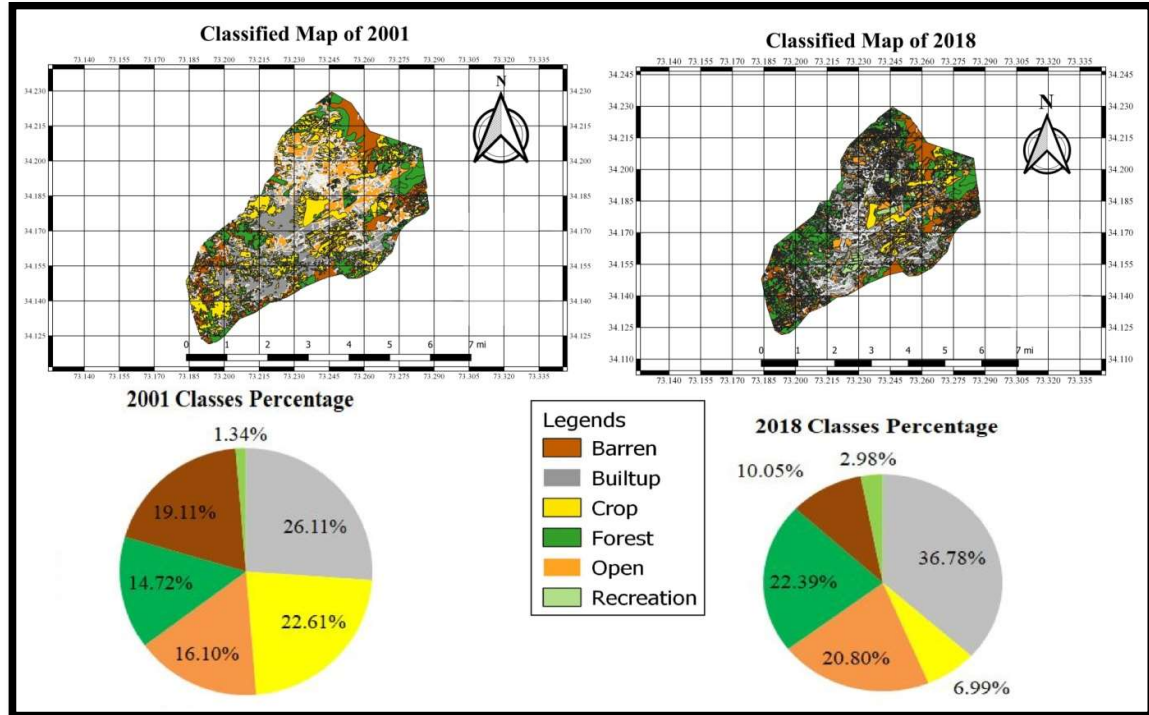

Figure 2. LULC maps with percentages of classes

The increase and decrease in the different classes can be clearly seen from the following table:

Table.1 Difference observed in the different classes over a span of 17 years.

Classes	Percentage Area		Difference in Percentage	
	2001	2018	Increase	Decrease
Barren Land	19.11%	10.05%	-	47.78%
Built-up Area	26.11%	36.78%	40.02%	-
Crop Land	22.61%	6.99%	-	69.33%
Forestation	14.72%	22.39%	51.65%	-
Open Land	16.10%	20.80%	28.46%	-
Recreational Area	1.34%	2.98%	120.93%	-

4. CONCLUSIONS:

GIS and Remote Sensing technology was applied to develop land cover maps for urban planning of Abbottabad city of KPK province. The high-resolution satellite images from Google Earth were processed to produce land cover maps for 2001 and 2018. The classes of each land cover map were: (i) built-up area; (ii) barren land; (iii) open land; (iv) forestation; (v) crop area and (vi) recreational area.

The result indicated 40.02% increases in built-up area, 51.65% increase in forestation, 28.46% increase in open land and 120.93% increase in recreational area in the last seventeen years. There were 40.02% decrease in barren land and 69.33% decrease in agriculture. The results indicated the spread of urban sprawl at faster rate.

The land cover maps could be utilized for effective urban planning and management of the Abbottabad city. GIS and Remote Sensing were found very effective tools for obtaining urban land changes over theperiod of time. Such studies should be accomplished for other cities of Pakistan for town/city planning and development.

This research work can help in improving the state of the city, by controlling the urban sprawl and eliminating the further congestion of the built-up area. If the data used in this research work is used in preparing a master plan, then it can greatly help in the future development of this city. It is recommended that such studies should be carried out for other cities so that their condition can also be improved.

ACKNOWLEDGEMENTS:

REFERENCES:

1. Mercy C Cheruto, Matheaus K Kauti, Patrick D Kisangau and Patrick Kariuki, 2017.Assessment of Land Use and Land Cover Change Using GIS and Remote Sensing Techniques: A Case Study of Makueni County, Kenya.
2. Tahir Ali Akbar, Quazi K. Hassan, Sana Ishaq, Maleeha Batool, Hira Jannat Butt, Hira Jabbar, 2019. Investigative Spatial Distribution and Modelling of Existing and Future Urban Land Changes and Its Impact on Urbanization and Economy.
3. Mathias Tesfaye Abebe,Tebarek Lika Megento, 2017. Urban Green Space Development Using GIS Based Multi-Criteria Analysis in Addis Ababa Metropolis.
4. Timothy W. Foresman, Steward T. A. Pickett, Wayne C. Zipperer 1997.Methods for Spatial and Temporal Land Use and Land Cover Assessment for Urban Ecosystems and Application in the Greater Baltimore-Chesapeake Region.
5. Auriba Raza, Iftikhar A. Raja, Shahid Raza, Elisabet Lindgren, 2011. Land-Use Change Analysis of District Abbottabad, Pakistan: Taking Advantage of GIS And RS Analysis.
6. Sajjad Ali, Zia Ur Rahman, Salman Khan, Tariq Khan, Wajid Ali, Arshad Iqbal, 2017. Assessment of land use pattern in District Abbottabad through Geographic Information System and RS.
7. *SMEDA* (Small and Medium Enterprises Development Authority) *website,* https://smeda.org/index.php?option=com_content&view=article&id=103&catid=47&Itemid=258