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Spatio-temporal residential land-use changes in District Abbottabad from 1990 to 2018

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Abstract

Land is one of the most important natural resources because it is a source of materials, all human activities are performed on land by using existing natural resources with the intention to get benefits from the land which is called *Land use*. Physical and biological cover includes water, vegetation, bare soil, artificial structures over the surface, or the land serves for a specific purpose such as recreation it refers to *Land cover* but it does not discuss surface cover on the ground. The purpose of the current study is monitoring land use land cover changes in Abbottabad during the period 1990 to 2018. The changes were detected by means of the *supervised classification*, using ArcGIS. The land classified into four major categories; built-up, barren, water, vegetation area. Resultant land cover land use overlay maps are generated in ArcMap to indicate the significant shift from Vegetation to Settlement. Vegetation area has been also improved due to afforestation through a billion tsunami projects. Therefore, reduction in a barren area, water almost remains stable. Mostly settlement was in the centrality, the barren area was in the east, south, and northeast mostly. The urbanization is causing adverse impacts on the forest area, agricultural land, water bodies, soil fertility; the ruination of vegetal land cover is the reason for the loss of biodiversity and cause human health problems. Therefore, proper land-use management is required; otherwise, this fruitful land will be lost and will no longer be able to play their role in the socio-economic development of the area.

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Introduction

In the 20th century when the development of machines occurred land cover of the earth has been changed due to ecological, physical and socio-economical activities of human beings. Relationship between the Population and Natural Resources has also been discussed by Malthus (Land, Division, & Planning, 1995) population growth will eventually cause catastrophic pressure on natural resources. (Roy & Roy, 2012). After the earthquake of 2005 in Neelum Valley, Kashmir, people migrated from earthquake affected areas to Abbottabad due to which tremendous changes occur in land use of Abbottabad. The current study is an effort to provide justification of population burden and improper use of natural resources. Sustainable development is required to maintain the available facilities for a better future. Although international and national level support was provided to the residents of the whole affected areas but peaceful environment attract population to this region. Abbottabad possesses the charming climate and full with beauty that's why population migrate from all districts and put pressure on urbanization. Low Infrastructure, unemployment and lack of health facilities create more problems for residents of the area.

Land is regarded as the most important natural resource because it is the source of materials and all human activities are performed on land. The activities performed by human beings by using existing natural resources with the intention to get benefits from the land are called Land use. (Land *et al*., 1995) (Dewan & Yamaguchi, 2009) It includes the alteration of natural land surfaces by anthropogenic activities. Basically, it is the way in which humans are using land which varies with the reason for which the land is being used i.e. to produce food, acquire shelter, extraction, and recreation etc. The two factors that are most influencing the land are Human Needs (socio-economical) and Environmental Process. (Halder, 2013):(Song *et al*., 2018) In the developing countries like Pakistan due to increasing population land is not used with its potential, to gain the maximum output from the available resources in a short period of time human used the land over its potential, these Inappropriate agriculture practices impact in the form of land degradation, which leads towards the deforestation, desertification, salinity, water logging, depletion of soil fertility, soil erosion and negative nutrient balances. Degradation also having adverse impacts on land cover of the area. Pakistan now-a-days due to absence of monitoring and coordinating the use of land, is severely facing these challenges. (Anjum, Zada, & Tareen, 2016).

The physical and biological cover including water, vegetation, bare soil, and artificial structures over the surface of the land is referred to as Landcover. (Zhang *et al*., 2019) (Rounsevell *et al*., 2014) Land use and land cover have some basic differences. If the land serves for a specific purpose such as recreation, wildlife habitat or agriculture etc., It refers to land cover it does not discuss the surface cover on the ground. For example, recreational land use could occur in a forest, shrub-land, and grasslands or on manicured lawns. Land cover describes the surface cover on the ground, whether it is bare soil, urban infrastructure, water or vegetation, not illustrates the purpose for which the is used and lands with the same cover type may have a different use of land. For example, a land cover type of forest may be used for timber production and wildlife management or recreation it may be private land, a protected watershed or a popular state park. In short, land use indicates how people are using the land, on the other hand land cover indicates the physical land type. (Teshome, de Graaff, Ritsema, & Kassie, 2016) (J. Liu *et al*., 2013).

Spatial distribution of the different land cover classes on the earth's surface, indicates land cover, while land that is using human and performing various activities on the same piece of land we describe this land according to its use with the help of natural and social scientific methods. (Fasona *et al*., 2018) (Zubair, 2006) Technically, increase or decrease in the areal extent is termed as LULC, it is obvious that LULC is formed by both anthropogenic and environmental forces. (M. Liu, Hu, Chang, He, & Zhang, 2009) (Tariq & Ali, 2017). LULC is possibly the most

obvious form of global environmental change which occur spatially and temporally and immediately relevant to our daily existence (Mahoney *et al*., 2003) (Voinov *et al*., 2016).

Remote sensing plays a very important role in estimate the land use and land cover at a particular location in a specific time. Land use and land cover information are very significant, Anderson 1971 used several knowledge-based approaches for LULC classification make use of additional geographical data beside satellite images. The framework of national land use and land cover classification system was presented by Anderson, to use with remote sensor data. (Anderson, 1976) (Kassawmar, Eckert, Hurni, Zeleke, & Hurni, 2018). It has already been widely accepted that the LULC plays a very important role at local to global scales on ecosystem functioning, ecosystem services, and biophysical and human variables like climate and government policies. (Turner & Gardner, 2015) (Meyer, Meyer, & BL Turner, 1994).

Spatial data is necessary for obtaining information about qualitative and quantitative changes in LULC of an area. With the advancement of the latest technology in RS (Council, 2008) (Palmer, 2018) sensor efficiency is also enhanced in terms of spatial resolution, spectral variability and temporal frequency, which proves quite beneficial in the accurate and fair estimation of the little changes on surface of earth. Other than altering the terrestrial extent, LULC has many other subsidiary impacts which may ultimately direct towards the degradation of the earth (Dregne & Chou, 1992) (Nabiebakye, 2015) from which the principal impact is a reduction of vegetation cover. Vegetal loss itself head towards the number of detrimental consequences. Plants consume CO_2, when there were no plants then no consumption of CO_2 which will cause pollution, disturb water system, vegetation is also the house of many plants and animals by loss in vegetation biodiversity is also affected, eventually climate change and many other environmental stresses (Niyogi, Mahmood, & Adegoke, 2009) (Keesstra *et al*., 2016).

Many planning activities and management activities that are concerned with the surface of earth uses the information about land use and land cover, (Lillesand, Kiefer, & Chipman, 2015) as it is mandatory for acquiring scientific information regarding to the environment which will be quite helpful, in generating useful policies to manage the resources by limiting the human activities (Boakye, Odai, Adjei, & Annor, 2008). A precise understanding of the LULC is a vital component for the planning of even the specific piece of land. Thus, an extensive number of scientists, earth system researchers, scholars of urban planning are trying to gather information of the location, its distribution, type of changes in LULC and the pattern by which the land has been changed by using this spatial information policymaker can take appropriate decisions (Tran *et al*., 2017).

With the development and easy access to remote sensing is being helpful in map making and to measure LULC changes. Mapping by conventional procedures is excessively boring and a blind process, also with the passage of time information becomes visible to planners, it is already old-fashioned and unnecessary since the damage has already been done. (Manichander, 2016). For the collection and analyzation of required information, Geo-Informatics represent highly productive tools that even detect the minor changes in urban areas which could not be possible for conventional surveying technology. (Saleh & Al Rawashdeh, 2007) (Hegazy & Kaloop, 2015). Therefore the study undertaken to observe and measure land use, land cover changes over space and time for sustainability.

Materials and methods

Study Area

District Abbottabad is located in the Hazara division, situated in the eastern part of Khyber Pakhtunkhwa province. (Hegazy & Kaloop, 2015). It is located at the base of Himalaya's land, between 34° 9′ 21″ North and 73° 13′ 10″ East with total area about 1,967 square kilometers. Neighboring borders are Mansehra district to the north and Muzaffarabad district in the east, Haripur district is in west, and Islamabad to the south. (Raza, Raja, & Raza, 2012)

Abbottabad district famous for its good location, scenic landscape, variety of flora and fauna and Pleasant weather attracts people from all over Pakistan every year. Tourism is the major source of economy of Abbottabad. Some people just come here for tourism while, others to seek education in high-quality institutions (Pakistan, 2004). A large number of tourists come to Abbottabad in summers to enjoy its attractive climatic conditions and to avoid the combating heat, when temperatures in the plains of Pakistan rise above 45℃.

Emerging of high-quality educational institutes in this gorgeous location force people to roam from neighbor areas to this district, which results in rapid population growth in the city. Population expansion is affecting its environmental conditions and generate considerable land-use changes over the last few years. Once there was extensive land cover, forest area, and Biodiversity with a previous few decades by population pressure, the necessity and pressure of residential and commercial areas has increased, which usher deforestation and conversion of grassland, agricultural land, and forest into residential colonies and commercial areas (Radwan, Blackburn, Whyatt, & Atkinson, 2019), due which the price of lands that have been raised. In Abbottabad, the most remarkable reason for the land-use change was the 2005 earthquake. (Fujiwara *et al.*, 2006).

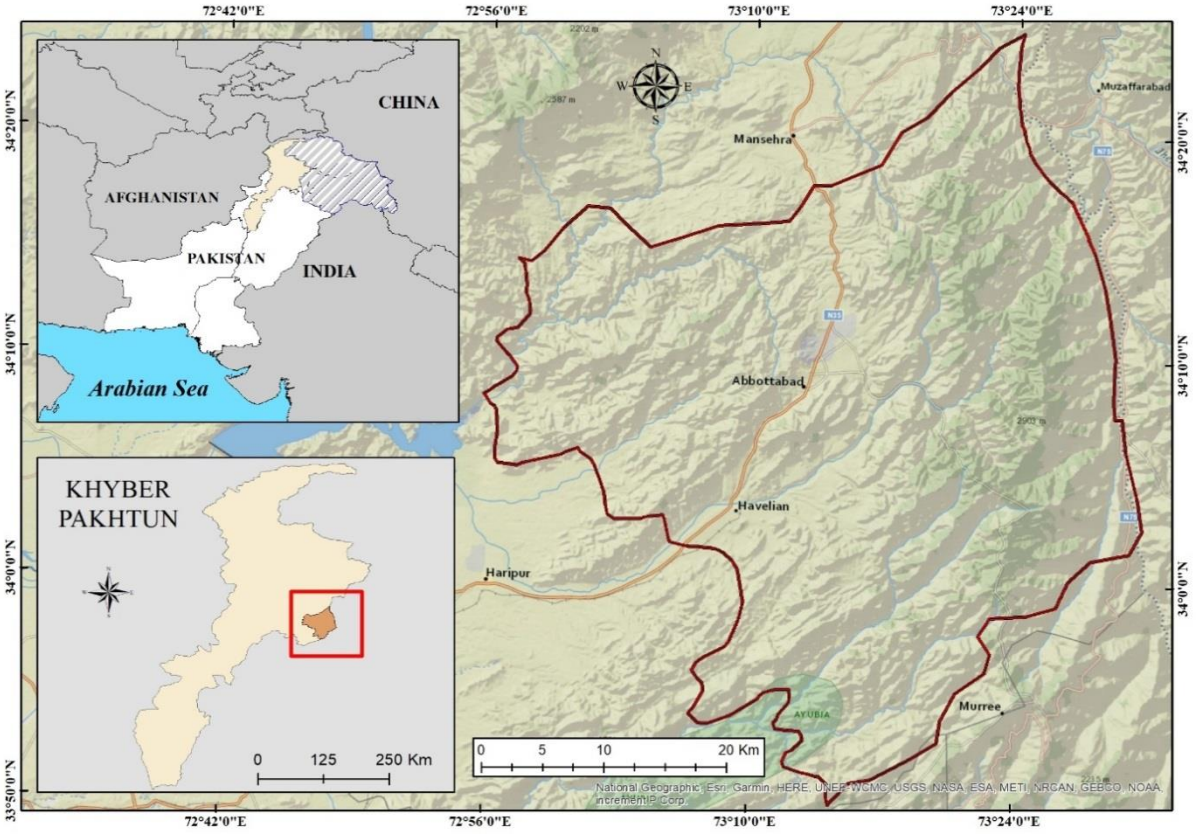

Fig. 1. Study Area Map.
Source: USGS (2019)

The lake of adequate land use planning and legislation is a main obstacle in the comfortable management of land resources. Land-use planning has never been high on Pakistan's priority. These establishment activities eventually led to lowering water-table, flood-like situations during heavy rains, contamination of drinking water sources, increasing vehicles, recurrent traffic congestion and air pollution problems, which never had been the attributes of Abbottabad. These land-use changes are threatening the sustainability of the environment. Before going to implement the LULC schemes one should thoroughly

study it for the purpose of planning, selection, and implementation. This study will also accommodate in examining the changes of LULC due to the population growth in this district. Geographic Information System (GIS) and Remote Sensing (RS) have been most beneficial and powerful tools, which are extensively used in the Spatial-Temporal changes detection of land use and land cover (Radwan *et al.*, 2019).

RS method cost-effectively provides abundant, multi-spectral, multi-temporal, and Real-time data and turns it into information valuable for understanding and monitoring land development patterns and processes and for building land-use data sets (Lu, Mausel, Brondizio, & Moran, 2004). GIS has been a powerful function of storing, analyzing, and displaying geo-referenced data necessary for change detection (Nazir & Ahmad, 2018) (Raza *et al.*, 2012). The Infinite advantages are received in the detection of dynamics in LULC by the combination of RS and GIS. The researchers can monitor the LULC processes and patterns by obtaining useful multi-temporal data form RS, then can analyze and make maps of these patterns by using GIS (Dewan & Yamaguchi, 2009) (Giri, 2016). In this study, the LULC changes have been analyzed in district Abbottabad cover 4 years 1990, 2000, 2010, 2018.

Data Acquisition and Analysis

The present study is based on the remote sensing spatial data as well as the non-spatial data available from the various sources for specific periods. The set of data sources used in the study comprises both primary and secondary data that was collected through relevant sources.

- Primary data was acquired

Data of satellite images of Abbottabad acquired from USGS, to access information on the physical characteristic of the area and analyzing impacts of change.

- Secondary data was acquired from: Published material from various sources like books, journals, reports, and thesis etc.

Publication

Satellite Images

The Landsat satellite series has continually observed Earth since 1972 and has accumulated an enormous number of time-series images (Sexton *et al.*, 2013). Landsat images have been widely used in land cover classification because of their stable imaging quality (Chen *et al.*, 2015, Gong *et al.*, 2013). In order to see the residential land-use the remotely sensed data is utilized. We used medium-scale Landsat thematic mapper (Land *et al.*), enhanced thematic mapper plus (ETM+) Operational Land Imager (McMichael, Powles, Butler, & Uauy), and the Thermal Infrared Sensor (TIRS) satellite images for the analysis. The study area, Abbottabad, is located at the position of Path 149 Row 37 of the Landsat Worldwide Reference System (WRS). Landsat time-series data from 1990 to 2018 with 10-year intervals were selected for extracting information on LULC changes. The three satellite images of Abbottabad were downloaded from the Earth Explorer-United States Geological Survey.

Table 1. Satellite Dataset used in this Study.

No.	Satellite Image	Spatial Resolution	Acquisition Date	Bands	Remarks
1.	Landsat 4-5 TM	30m	03 May 1990	7	
2.	Landsat-7 ETM+	30m	13 Oct 2000	8	SLC-on
3.	Landsat-8 OLi/ TIRS	15m	15 Sep 2016	11	

Image Classification

Once the image downloaded, it was imported into ERDAS Imagine for land-use change detection and classification. The image has to be classified into appropriate classes first. Classification is the process of assorting the pixels into different classes on Land Use and Land Cover (LULC) based on characteristics of the light reflected from each of the LULC types in the area that this image covers.

The supervised classification method was principally used. Supervised classification methods require prior knowledge of the study area and the identification of training areas. For supervised classification, a false-color composite was prepared by combining all bands of download images.

The false-color composite was prepared by using option layer stacking. Then the prepared false-color composite was used for supervised classification to determine the change in residential land-use in Abbottabad.

Data Analysis

After primary data collection, it was entered into SPSS (Statistical Package for social science 21.0) for applying appropriate test and further analysis. Frequency distribution was used for descriptive statistics.

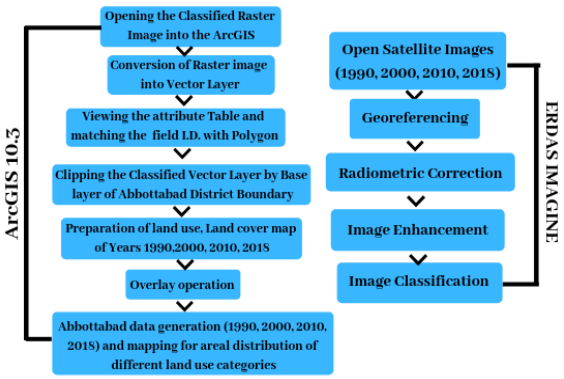

Fig. 1. Data Analysis Method.

This work can be summarized in the following steps:

- The image processed by using RS on Software ERDAS IMAGINE 9.2.
- LULC classification by applying supervised classification method.
- Used overlay operation for change detection analysis in ArcGIS 10.3 Software.

Land-use of Abbottabad 1990

Fig. 2 shows the land use of Abbottabad in 1990. According to analysis, 81% of the total area was consist of Vegetation. Barren land and water was 17% and 1.4% respectively. The built-up area was only 0.60%. So, till 1990 built-up area was not in large fraction. Mostly the area was vegetated in 1990 and a small proportion of the built-up area was present.

Fig. 3 indicates the land use of Abbottabad in 2000. 71% of the total area was consist of Vegetative land. Barren land consists of 27%, Water 0.7% area, and the rest of the 1.3% was Built-up area.

So, there is an increase in Barren land, and a decreased in vegetation has been observed. It means Deforestation occurs due to the consumption of wood as fuel and timber.

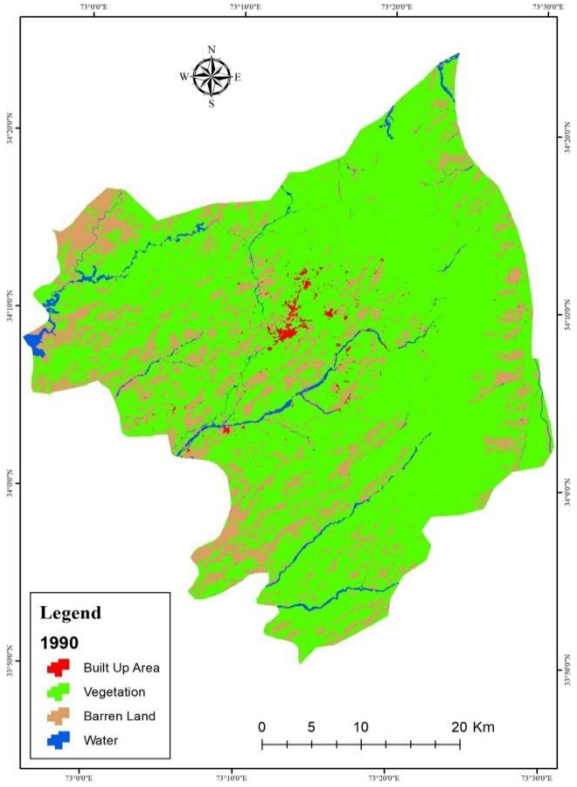

Fig. 2. Land use land cover Classification 1990.

Land-use of Abbottabad 2000

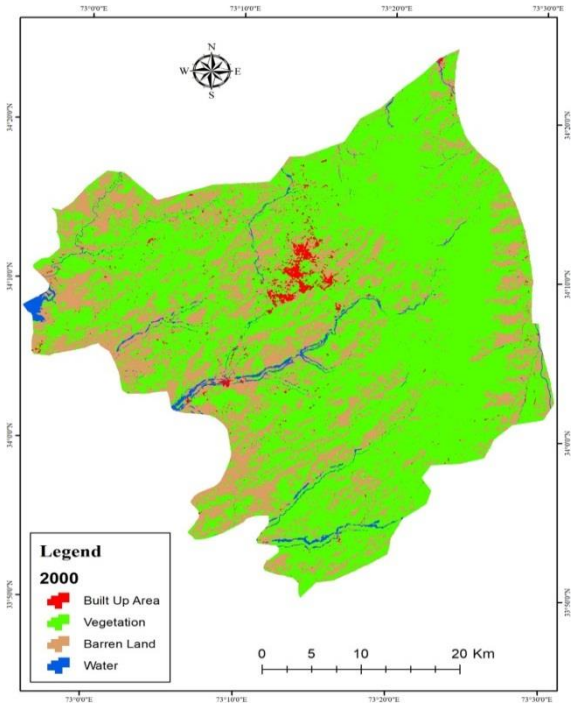

Fig. 1. Land use land cover Classification 2000.

Fig. 4 shows the land use of Abbottabad in 2010. According to this Fig. 4, 87% of the total area was covered by vegetative land. Barren land consisted of a 10% area. Water 1% and the rest of the 2% was Built-up area. So, there was an increase in agriculture and built-up area. There was a decrease in the barren land. It means that the Barren land was decreasing and Residential land, as well as Vegetative land, was increasing during the period of 2000 to 2010.

Fig. 5 shows the land use of Abbottabad during the period of 2010 to 2018. According to this fig., 87% of the total area was covered by Vegetative land. Barren land was consist of a 10% area. Water 1% and the rest of the 2% was Built-up area. So, there is an increase in agriculture and built-up area. There is a decrease in the barren land. It means that the Barren area is on the decrease and Residential land, as well as Vegetative land, is on increase.

Land-use of Abbottabad 2010

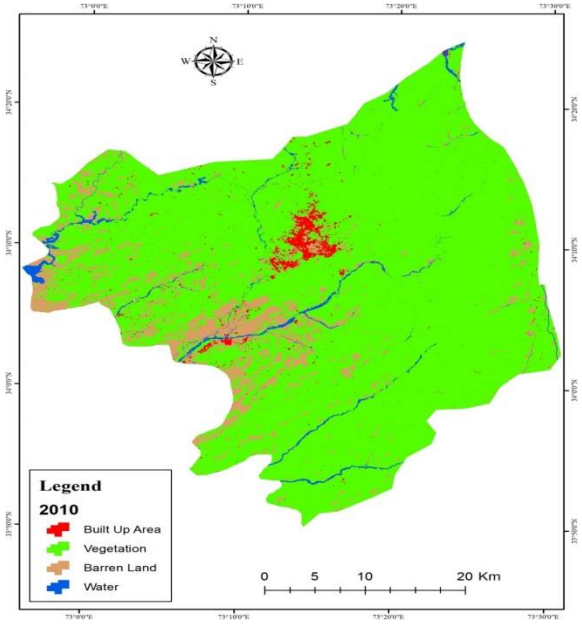

Fig. 2. Land use land cover Classification 2010.

Land-use of Abbottabad 2018

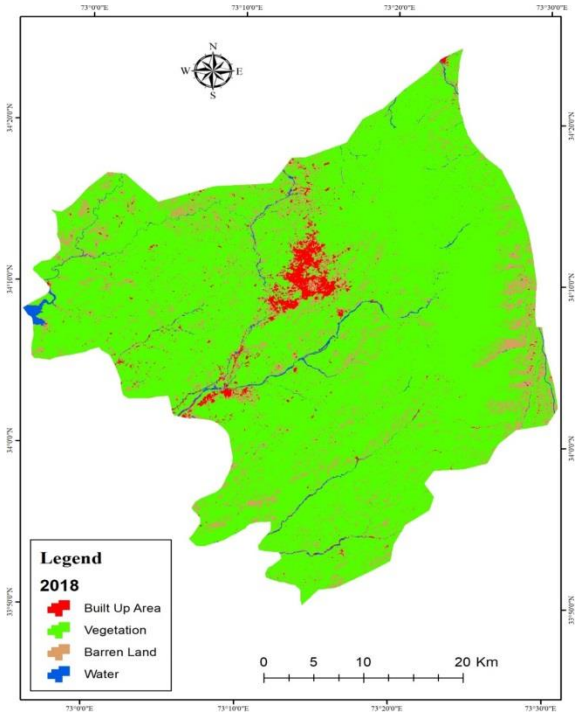

Fig. 3. Land use land cover Classification 2018.

Results and discussion

Land Use Distribution of 1999, 2000, 2010 and 2018

RS and GIS analysis were used for the assessment of LULC change detection, which proven highly valuable in gathering unique information for decision making. Accuracy depends upon the skill of using software and decision power, supervised classification was done, then that classified image was used to take classes. Four land use classes were identified built-up, vegetation, water, and barren land.

Table 2 clearly reveals an increase in the Built-up area (settlement) in year 2000, 2010 and 2018, which occur due to Educational, health, beautiful weather conditions and transportation facilities in this gorgeous location.

Table 2. Area (Km²) and percentage for different land use classes for the years 1999, 2000, 2010, and 2018.

Year	1990		2000		2010		2018 Total	
Land-use Classes	Area Km²	%	Area Km²	%	Area Km²	%	Area Km²	%
Built-up Area	10.6132	0.58	23.965	1.33	28.9931	1.609	53.8541	2.98
Vegetation	1457.55	80.92	1280.38	71.08	1578.88	87.66	1543.25	85.68
Barren Land	311.658	17.303	484.613	26.903	175.954	9.76	185.602	10.304
Water	21.2952	1.182	12.3524	0.68	17.29523	0.96	18.4544	1.024
Total	1801.11	100	1801.31	100	1801.1223	100	1801.160	100

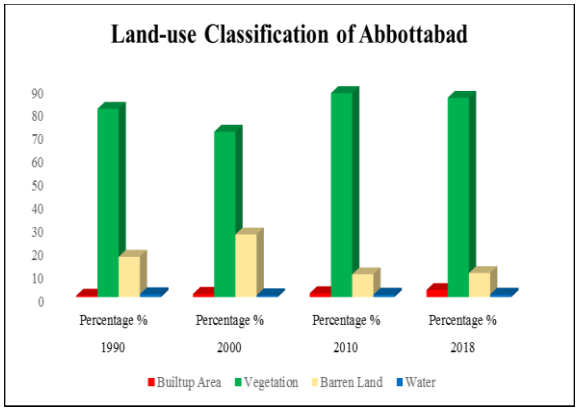

Fig. 6. Land-use Classification of Abbottabad% Area.

Fig. 6 shows that the population increased in 2010 and 2018 it was because of new emerging health care facilities side by side with the advancement of educational institutes (Medical colleges, Engineering and Information Technology universities and many quality standards branches of schools). Migration of 2005 also one of leading cause of increasing population of the city, in 2005 although earthquake hit the Abbottabad but there was very few loss as compare to Muzaffarabad or other areas that why people migrated towards Abbottabad.

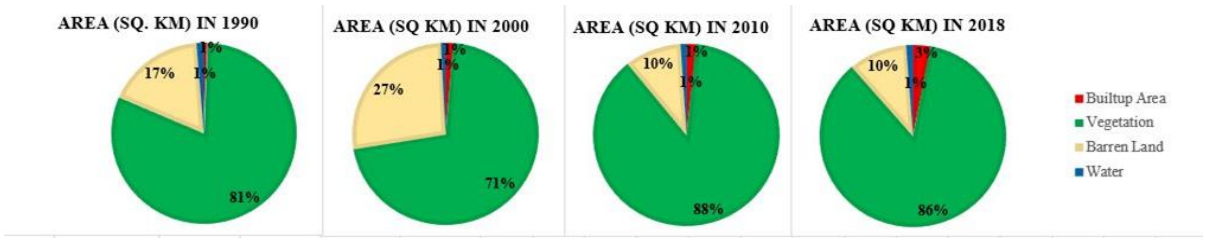

Fig. 7. Land-use Classification of Abbottabad Area (sq.km).

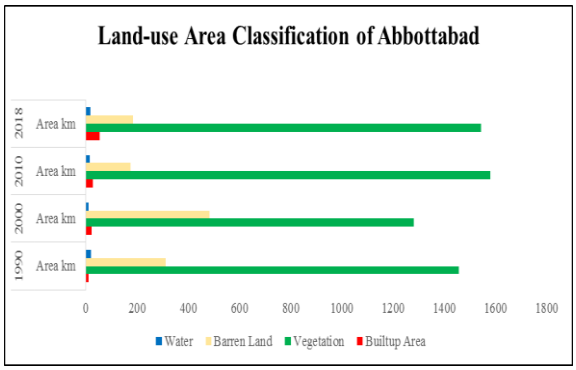

Fig. 8. Land-use Classification of Abbottabad Area (sq.km).

To compensate for the loss of earthquake and land-sliding the vegetal cover has been gradually increased due to plantation schemes and billion tree tsunami projects implemented by the Provincial Government of Khyber Pakhtunkhwa, Pakistan in 2014 and successfully completed in 2017. Due to the increasing vegetation barren area has been starting reducing, the water remained almost the same.

Accuracy Assessment for land-use changes

Accuracy assessment is a tool that can test overall fitness and data capacity for a particular person. According to the United States Geological Survey, estimating accuracy is "proximity". The result of observation, counting, or estimating the correct values or estimated. In the services of information extraction by analysis of image, accuracy measures the agreement between a standard assumed to be correct and a classified image an unknown quality. Precision tells the level of detail found in the classification. We can decrease the amount of detail in the image, it will increase the accuracy of classification.

Example: There is a scheme having trees vs crops. In this case, there is less opportunity for errors in the classification. If we have many types of trees and many types of crops then we must have to face errors during classification in this case lower precision gives us higher accuracy. However, the user of the map who has only general classes can not able to point on the map due to fewer classes or generalized classes.

Accuracy Assessment of 1990

Table 3 shows the accurate matrix for the classification of land cover maps of Abbottabad in 1990. It shows all over the classification of this region and also shows the kappa classification of Abbottabad. If we talk about the range of overall classification and kappa classification, then it is 173

and 0.82% respectively. The accuracy pattern total samples are 200 and each class has 50 sample sites. There are four classes that are built-up area vegetation land barren land and water. If we check the numbers of output, then there are 45 samples of built-up area out of 50 sample sites.39 samples of vegetation land out 50 sample sites. Barren land samples are 43 out of 50 sample sites. Water samples are 46 out of 50 sample sites. In this way, this table represents the overall classification accuracy and kappa classification. Besides this, if we talk about the area covered by these classes in sq. km and percentage then it will that built-up area in sq. km is 10.61 and 0.5%, vegetation is 1457 in sq. km and 80%, barren land is 329 in sq. km and 17%, water is 21 in sq. km and 1%.

Table 1. Accuracy Assessment for the year of 1990.

	Classes on Ground				
Class on Map	Built-up	Vegetation	Barren	Water	Total Selected Sites
Built-up	45	2	2	1	50
Vegetation	3	39	8	-	50
Barren	-	4	43	3	50
Water	-	-	4	46	50
Total Selected Sites	48	45	57	50	200

In 1990

$$d = 45 + 39 + 43 + 46 = 173$$

$$q = \frac{\sum_{i=1}^{n}\left(\sum_{j=1}^{n} a_{i,j} \sum_{j=1}^{n} a_{j,i}\right)}{N}$$

$$= \frac{50 \times 48 + 50 \times 45 + 50 \times 57 + 50 \times 50}{200} = 50$$

$$\kappa = \frac{d - q}{N - q} = \frac{173 - 50}{200 - 50} = 0.82$$

Accuracy Assessment of 2000

Table 4 shows the accurate matrix for the classification of land cover maps of Abbottabad in 2000.it shows all over the classification of this region and also shows the kappa classification of Abbottabad. If we talk about the range of overall classification and kappa classification, then it is 171 and 0.81% respectively. The accuracy pattern total samples are 200 and each class has 50 sample sites. There are four classes that are built-up area vegetation land barren land and water. If we check the numbers of output, then there are 44 samples of built-up area out of 50 sample sites.45 samples of vegetation land out 50 sample sites. Barren land samples are 40 out of 50 sample sites. Water samples are 42 out of 50 sample sites. In this way, this table represent the overall classification accuracy and kappa classification. Besides this, if we talk about the area covered by these classes in sq. km and percentage then it will that built-up area in sq. km is 23 and 1%, vegetation is 1298 in sq. km and 71%, barren land is 484 in sq. km and 26%, water is 12 in sq. km and 0.6%.

Table 2. Accuracy Assessment for the year of 2000.

	Classes on Ground				
Class on Map	Built-up	Vegetation	Barren	Water	Total Selected Sites
Built-up	44	1	-	5	50
Vegetation	1	45	3	1	50
Barren	-	8	40	2	50
Water	4	1	3	42	50
Total Selected Sites	49	55	46	50	200

In 2000

$$d = 44 + 45 + 40 + 42 = 171$$

$$q = \frac{\sum_{i=1}^{n}\left(\sum_{j=1}^{n} a_{i,j} \sum_{j=1}^{n} a_{j,i}\right)}{N}$$

$$= \frac{50 \times 49 + 50 \times 55 + 50 \times 47 + 50 \times 50}{200} = 50$$

$$\kappa = \frac{d - q}{N - q} = \frac{171 - 50}{200 - 50} = 0.81$$

Accuracy Assessment of 2010

Table 5 shows the accurate matrix for the classification of land cover maps of Abbottabad in 2010.it shows all over the classification of this region and also shows the kappa classification of Abbottabad. If we talk about the range of overall classification and kappa classification, then it is 174 and 0.83% respectively. The accuracy pattern total samples are 200 and each class has 50 sample sites. There are four classes that are built-up area, vegetation land, barren land, and water. If we check the numbers of output, then there are 45 samples of built-up area out of 50 sample sites.41 samples of vegetation land out 50 sample sites. Barren land samples are 43 out of 50 sample sites.

Water samples are 45 out of 50 sample sites. In this way, this table represent the overall classification accuracy and kappa classification. Besides this, if we talk about the area covered by these classes in sq. km and percentage then it will that built-up area in sq. km is 28 and 1%, vegetation is 1587 in sq. km and 87%, barren land is 179 in sq. km and 9%, water is 22 in sq. km and 1%.

Table 3. Accuracy Assessment for the year of 2010.

	Classes on Ground				
Class on Map	Built-up	Vegetation	Barren	Water	Total Selected Sites
Built-up	45	-	2	3	50
Vegetation	2	41	7	-	50
Barren	2	5	43	-	50
Water	-	-	5	45	50
Total Selected Sites	49	46	57	48	200

In 2010

$$d = 45 + 41 + 43 + 45 = 174$$

$$q = \frac{\sum_{i=1}^{n}\left(\sum_{j=1}^{n} a_{i,j} \sum_{j=1}^{n} a_{j,i}\right)}{N}$$

$$= \frac{50 \times 49 + 50 \times 46 + 50 \times 57 + 50 \times 48}{200} = 50$$

$$\kappa = \frac{d - q}{N - q} = \frac{174 - 50}{200 - 50} = 0.83$$

Accuracy Assessment of 2018

Table 6 shows the accurate matrix for the classification of land cover maps of Abbottabad in 2018. shows all over the classification of this region and also shows the kappa classification of Abbottabad. If we talk about the range of overall classification and kappa classification, then it is 178 and 0.853% respectively. The accuracy pattern total samples are 200 and each class has 50 sample sites. There are four classes that are built-up area vegetation land barren land and water. If we check the numbers of output, then there are 42 samples of built-up area out of 50 sample sites.46 samples of vegetation land out 50 sample sites. Barren land samples are 44 out of 50 sample sites. Water samples are 46 out of 50 sample sites. In this way, this table represent the overall classification accuracy and kappa classification. Besides this, if we area in sq. km is 53 and 2%, vegetation is 1563 in sq. km and 85%, barren land is 189 in sq. km and 10%, water is 18 in sq. km and 1%.talk about the area covered by these classes in sq. km and percentage then it will that built-up.

Table 4. Accuracy Assessment for the year of 2018.

	Classes on Ground				
Class on Map	Built-up	Vegetation	Barren	Water	Total Selected Sites
Built-up	42	1	3	4	50
Vegetation	1	46	3	-	50
Barren	1	3	44	2	50
Water	-	1	3	46	50
Total Selected Sites	44	51	53	52	200

In our

$$d = 42 + 46 + 44 + 46 = 178$$

$$q = \frac{\sum_{i=1}^{n}\left(\sum_{j=1}^{n} a_{i,j} \sum_{j=1}^{n} a_{j,i}\right)}{N}$$

$$= \frac{50 \times 44 + 50 \times 51 + 50 \times 53 + 50 \times 52}{200} = 50$$

$$\kappa = \frac{d - q}{N - q} = \frac{178 - 50}{200 - 50} = 0.85$$

Reasons of change in land-use

Urbanization

Urbanization is the movement of people from the town to the main city of Abbottabad for the sake of more opportunities which is expanding the main city by increasing its growth and development it is not a new phenomenon it has been going on since 20th century from the industrial revolution. According to the UN more than half (55%) of the population now living in the cities.

Causes to Migrate

There are many factors which attracts population towards urban areas, such as: Better health care facilities, Education, Transportation, Sanitation, Employment, Communication, Infrastructure and better standards of living.

Deforestation

Deforestation can be defined as the removal of trees or vegetation to use the land for other activities e.g. housing, commercial, agriculture.

Deforestation is one of the major keys to the Greenhouse effect and desertification. Deforestation occurs to use the land for housing, commercial use, agriculture and use timber for furniture.

Degradation

The process through which the quality of land is being destroyed. Deforestation, landslides, soil erosion, mining, fossil fuels, pollution, overgrazing and poor agriculture practices.

Mining

The process of extracting useful minerals from inside the ground e.g. diamond, gold, coal, etc. Abbottabad famous mining materials are: (Kureshi, Mann, Khan, & Qureshi, 2009) e.g. Barite, dolomite , granite, gypsum, limestone, magnesite, marble, phosphate, red Ochre, and red Oxide

Impacts Of Land-Use Change

Natural

Abbottabad is a mountainous area there are many chances of "Land-sliding" and "Earthquake" naturally, 2005's earthquake is one of the devastating event that has been changed LULC of Abbottabad by increasing population through migration from different areas, even it generated a lake which was not present earlier. Landslide can blot out the forest cover which ultimately destroys the wildlife of forest, erode the fertile soil, in some cases landslide can cause flood, which will LULC of the area.

Anthropogenic activities

By the destruction of forest cover "Deforestation" occur which is the most important contributor to the emission of greenhouse gases (GHG) that contributes to global warming which is rapidly changing our climate. (McMichael *et al.*, 2007). Carbon dioxide is the leading pollutant of GHG which is warming the Earth. It is not only emitting human beings through breathing activities but industries, planes, vehicles, burning of fossil fuels, mining, and other anthropogenic activities are also emitting it on daily bases. When trees were present then Carbon dioxide can be easily consumed but due to deforestation it is not absorbed and a greater amount of CO_2 remains in an environment which causes Pollution (Air, Water, Soil).

Another important anthropogenic cause of changing LULC is "Population Pressure" which has been started increasing after 2005 in Abbottabad and still continues moreover it has increased more rapidly now. When the more people will demand more resources, their first demand will shelter to live. More population means more vehicles, more mining, more fossils fuel burning, then more GHSs and more Pollution to demolish the environment. This pollution will have adverse impacts on human health such as it can cause asthma, typhoid fever, much other air, and water-borne diseases.

Conclusion

In the present study, spatial-temporal analysis has been done for the assessment of LULC of Abbottabad by using the satellite images of four different years, by using GIS and RS techniques which very helpful in decision making. It is revealed from the analysis that the built-up area (settlement) has increased from 1999-2018. Vegetation area has been also improved due to afforestation through billion tsunami project, therefore, reduction in a barren area, water almost remain stable. Mostly settlement was in the centrality, barren area was in east, south, and northeast mostly. Urbanization is causing adverse impacts on forest area, agricultural land, water bodies, soil fertility, the ruination of vegetal land cover is the reason for the loss of biodiversity and cause human health problems., with also having negative impacts on the environment, which eventually leads towards climate change. Therefore, land-use planning is necessary, to use the land in an efficient way.

It is an efficient tool in determining the socioeconomic development of an area. Abbottabad is enriched with fertile land, rivers and mountains with a wealth of minerals thus it is vital to regulate its land. Unfortunately, in Pakistan land-use planning does not exist at any (national, provincial, district, tehsil or local) level. There is a need to be a mandatory Land Use plan to strictly follow the land use regulation strategies that will help out to stop the uneven expansion of settlement. Population expansion due to educational, health care facilities in this beautiful landscape are the main causes

of changing in LULC. This study highlights the need for sustainable land use planning by researching of land use planners, policymakers to make firm legislation to implement. There is a need to establish a GIS-based system of land information because proper LULC planning will be helpful in the social and economic betterment of an area.

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