THE JOURNAL OF RESEARCH REVIEW

P-ISSN: 3006-2632	E-ISSN: 3006-2640
Vol. 2. No. 02 (April-June) 2025	Page 444-460

Impact Of Population Growth On Forest Cover In District Orakzai Between 1985 To 2020

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Abstract: *The present study is focused on District Orakzai; it is located on the north western part of the Khyber Pakhtunkhwa. The main objective of this research is to analyze the impact of population growth on forest cover in District Orakzai. Satellite images are downloaded from the USGS Earth Explorer. The images were classified using supervised classification methods. The Population data is collected from census reports. Due to unavailability, the 1985 population data is projected based on 1981 data. Similarly, the 2010 population data is projected based on 1998 data, which was also used to estimate the 2000 population. The 2017 population data is estimated based on 2020 data, as the actual data for 2017 is not available. The classification is divided into three periods: 1985 to 2000, 2000 to 2010, and 2010 to 2020. The overall images are classified into five different classes, showing the various land use and land cover in the region. In the first period, 1985, there was a rapid decrease in forest cover. The land use and land cover classification of 1985 showed barren land covering 55.30% of the region, built-up areas at 1%, agricultural land at 6.82%, forest cover at 8.56%, and water bodies covering 28.72%. Moving on to the year 2000, barren land comprised 11.2% of the area, agricultural land at 3.34%, built-up areas at 4%, forest cover at 11.27%, and water bodies covering 4.1%. The classified image from 2000 showed a significant loss of forest cover due to population growth. In the third period, 2010, the forest cover began to increase compared to the other periods. The total area covered by forest was 45.8%, built-up areas at 10.25%, barren land at 16.32%, agricultural land at 16.32%, and water bodies at 3.37%. During this time, people from District Orakzai migrated to other districts due to military operations by Pakistan. Some tribes living in the area were also displaced, leading to the slow cutting of forests. However, in the last period, 2020, the population continued to migrate to District Orakzai. The forest cover decreased with barren land occupying 4.71% of the area, agricultural land at 5.8%, built-up areas at 76%, forest cover at 3.32%, and water bodies covering 11%.*

Keywords: Pakistan,

1 Introduction:

The general disturbance of a forest ecosystem brought on by extensive tree cutting is known as deforestation. It also describes any procedure that changes the original tree cover, such as clearing a site of all trees, thinning a forest, and burning bushes. People take down trees for a variety of reasons. For instance, they may cut down trees to make charcoal, which is used as fuel, or they may use them to build homes and settlements or to provide pastures for livestock. Scientists and researchers worldwide have issued numerous warnings about the persistent environmental threat of deforestation. (Oladipo, 2015).

Human activities such as mining, horticulture, and logging have impacted six million hectares of forest areas globally. (Verburg et al., 2006). Every year, almost 13 million hectares of forest are lost globally. (Kricher, 1989). The primary cause of deforestation, according to the United Nations Framework Convention on Climate Change (UNFCCC), is agribusiness. Agriculture and subsistence farming account for 48% of deforestation. Deforestation is caused by logging in 14% of scenarios, dependable fuel forests in 32% of circumstances, and forest accumulation in 5% of events. (UNFCCC, 2007) as indicated by Siddiqui et al., (2006).

A worldwide environmental problem, deforestation, is reducing and shrinking forest areas. Humans or other factors may cause deforestation, which is the transition from forests to other land use types. (Ali et al., 2024a; FAO, 2022) Numerous factors contribute to deforestation, but in many areas, agricultural practices and urbanization are the main causes. Habitat loss, fragmentation, and ecological process disruption result from the conversion of wooded regions into urban landscapes or agricultural land. These human-caused activities have a major impact on ecosystem functioning, biodiversity conservation, and sustainable land use. Because of its significant effects on biodiversity and the global climate, deforestation in the Amazon rainforest has been the subject of much research. The ecological, economic, and social significance of forests in other areas must be acknowledged. But there are also natural factors that contribute to the loss of forests and plants, such as fire patterns and browning brought on by extreme and protracted droughts. (Fuentes I, et al., 2024).

One of the nations with the highest rates of deforestation is Pakistan. Pakistan has 4.8 million hectares of forest. (GOP, 2005; Lubna, 2001). The second-largest and most established juniper forests in the world are found in Pakistan. The nation's northwest is dominated by evergreen woods, which make up 42% of Khyber Pakhtunkhwa. Logging, horticulture, mining, and other human activities alter six million hectares of forest areas worldwide (Ali et al., 2024b; verburg et al., 2006). Globally, almost 13 million hectares of forest are lost annually.(Kricher, 1989). According to the United Nations Framework Convention on Climate Change (UNFCCC), agribusiness is the primary cause of deforestation. Subsistence farming accounts for 48% of deforestation. Deforestation is caused by logging in 14% of cases, dependable fuel forests in 32% of cases, and forest accumulation in 5% of cases. (UNFCCC, 2007) as indicated by Siddiqui et al., (2006).

With an annual deforestation rate of 4.6%, Pakistan is the second most deforested country in the world. (Verburg et al., 2006) shown that logging, mining, agriculture, and other human activities have altered the overall six-million-hectare forest terrains. Naqi and Khan According to reports, forests and trees play a significant role in Khyber Pakhtunkhwa's rural economy. The majority of people depend on forests for fuel, housing, and lumber. Additionally, forest people collect many non-timber forest products for both monetary compensation and household use. according to the UNFCCC, the United Nations Framework Convention on Climate Change. Deforestation is directly related to human activities, particularly agriculture, as is the case with most environmental issues. R.R(Chowdhury, 2010).

Deforestation has been researched locally and internationally over the past few decades. The studies are now more exact and accurate thanks to the use of satellite imagery. Using satellite imagery, several strategies have been developed. The majority of studies have decided to categorize the images. For example. To identify deforestation hotspots in Venezuela, a decision tree model was trained using random samples selected from MODIS satellite imaginaries from 2005 to 2010 (Pacheco, 2014).

Forests provide various ecological, economic, and social services in life, including water supply, soil conservation, nutrient cycling, species and genetic diversity, and greenhouse gas management. The overall productivity of ecosystems working at regional and global scales is threatened by growing anthropogenic pressures such as loss of biological variety, pollution of the air, water, and soil, changes in land use and land cover, and degradation of soil quality. The significance of forest cover and the negative effects of forest cover loss in district Orakzai will be made clearer to the local population and

line agencies by this study. Because of the increased detail, segmentation performance may become an issue for high resolution satellite photos. Skill applied Random Forest classification on overlay in another investigation. Landset-7 has eight bands: Blue, Red, Near-infrared1, Near-infrared2, Thermal, Mid-infrared, panchromatic. With the exception of thermal, which has 60 matters of resolution, and panchromatic, which has 15 matters; all of the bands have a resolution of 30 meters. (GIS Geography, 2017, USGS, 2017). The satellites Sentinel 1 and 2 have a much higher spatial resolution (10M). They were not selected since they were only introduced in 2014, which precludes a longer length of time for scrutiny. Images of June, July, and August were obtained. Due to the region's high levels of cloud cover and snow, the winter, spring, and fall seasons are not recommended. District Orakzai, which is situated in the northwest of Khyber Pakhtunkhwa, is part of the current study. People cut down trees for building materials, timber, and firewood. Timber and firewood have been transported to the nearby plain areas in addition to being used locally. Ruthless cutting of trees leads to forest cover depletion which magnifies soil erosion and environmental degradation. This study will determine how the forest cover has changed and contribute to maintaining it for the sustainable management of the green spaces in the Orakzai district. This study's primary goal is to examine the spatiotemporal pattern of forest cover change in the study area as well as the effects of population increase on the forest cover in the Orakzai district.

1.1 Study Area:

Orakzai is a hilly region with fertile valleys. In the west, the hills are above 3,000 meters high, whereas in the east, they are less than 2,000 meters. The Karagh Ghar Range's mountains dominate these hills. Among the lozaka pass's most important passes. The geographic location of District Orakzai are 33°33' to 33°54' N and 70°36' to 71°22' E. According to the 1998 census, this agency's overall geographic area is 1,538 km² (GOP 1998). There were 358,751 people living in the district as of the 1981 census. Of all the Tribal Districts, Orakzai had the most population. With over 233 people per square kilometer, the density was likewise among the highest in FATA.The rate of population growth is undefined. Suppose a 2.8% average growth rate (the interdental yearly average growth between 1972 and 1981), (GOP 1998). District Orakzai is located in the North- western region of Khyber Pakhtunkhwa. After Khyber Pakhtunkhwa's FATA merger. Orakzai Agency's administrative status was converted to that of a district. It is separated administratively into four sub-divisions: Ismail Zai Orakzai, Central Orakzai, Lower Orakzai, and Upper Orakzai (www.Almanaccom).

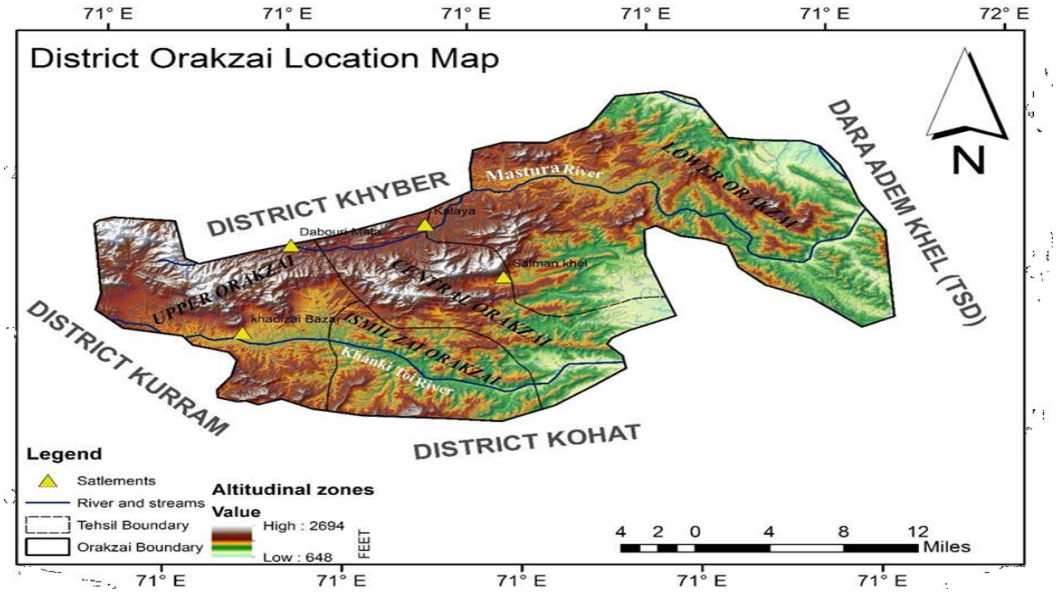

Figure 1.1: Location map of district Orakzai.

Source: Digital Elevation Model was downloaded from USGS and prepared in ArcGIS10.8.

2 RESEARCH METHODOLOGY

2.1 The Aim of the Study:

The main aim of the current study is to find out the patio-temporal change of forest cover in the study area during the period 1985-2020 and to analyze the impact of population growth on the natural vegetation cover in the study area.

2.2 Data Acquisition:

The satellite imagery was downloaded from the USGS Earth Explorer, launched by the USA. The duration of time was divided into three periods: 1985 to 2000, 2000 to 2010, and 2010 to 2020. After that, these images were processed in ArcGIS 10.8 using supervised classification. Each period was divided into five different classes: Forest cover, Built-up Area, Barren land, water bodies, and Agriculture land, showing the land use and land cover of the region. The population data acquired from the DCR in 1981 was projected onto the 1985 data, the 1998 data was projected onto 2000, and the 2017 data was projected onto 2020. The rapid increase in population caused a loss of forest cover in district Orakzai. The data was presented in the form of maps, tables, and graphs.

1.1 Processing and Analyzing the Imageries:

The satellite images were processed through ArcGIS 10.8. The area of the District Orakzai map is taken from the Pakistan shape file that was collected from DIVAGIS by overlapping the seven spectral bands for each image. The district censes report (DCR) was used to extract the subdivisions of Upper Orakzai, Lower Orakzai, and Central Orakzai. A comparison research study was conducted, and accurate results were obtained. By applying standard deviation stretch to the histograms, the images' visibility was improved. (Qamer et al. 2012). Using the usual land use/land cover categories from public sources, classification procedures were conducted using the false color Infra-Red (4, 3, 2 bands combination). A computer was trained to create signature files for each of the five LULC classes that were produced. For every class, over a hundred training samples were collected, and ARCGIS signature files were created. Images were classified using the Maximum Likelihood supervised Classification Algorithm and a field calculator were used to determine the area for each class. The area was computed using "calculate geometry," and digital land use classes were created.

1.1 Image Classification:

The supervised classification approach was applied to map the research area's LULC. Land cover/land use characteristics are represented as grouped pixels in digital image classification methods. Since digital remote sensing data performed the supervised image classification process and the overall goal of image classification is to automatically classify all pixels in an image into land cover/land use classes, land use/land cover classes are typically charted. Forest, built-up area, agricultural land, wasteland/barren land, and water bodies were the five categories into which this region was divided.

1.2 Accuracy Assessment of the Images:

Any classification project needs to include accurate assessment, which means comparing the categorized image with a trustworthy reference dataset called ground truth data. Field collecting is a time-consuming and expensive method of obtaining ground truth data. Alternative approaches include examining high-resolution images, pre-existing categorized data, or GIS layers. Creating a random selection of points from the ground truth data and comparing them to the classified results in a confusion matrix is a popular method for evaluating the accuracy of a classified map. When ground truth data is unavailable and the same imagery is utilized for classification, this procedure may be used to assess how well various classification techniques or training sites perform. Google Earth is regarded as one of the most accurate sources of Earth data and is commonly used as a trustworthy source of ground truth information.

Population projection:

In Pakistan Census is conducted after each ten years. The first census was conducted in 1951 than in 1961, 1981, 1998, 2017 and 2023. In the current research study population data for the years 1985, 2000, 2010 and 2020 was projected using the following formula,

P1=Po (1+r/100) n

Were

P1=population of the current year Po= population of the base year r= Growth rate

n= means time interval between last censes and the year for which population data in Projected

1 DATA ANALYSIS

Population growth and socio-economic development bring about rapid changes in the surface features of an area. This phenomenon is most evident in developing countries. Pakistan has no exception. And an annual change of 1.9% in the population of Pakistan rapidly increases, and their impact on land use and land cover. After applying GIS techniques, all four images of the year 1985, 2000, 2010, and 2020 of District Orakzai were classified. For classification, five Land Use/Land Cover (LULC) classes named as Built-up area, Forest cover, Water bodies, Vegetation, and Barren land were used, as shown in Table 3.1.

Table 3.1: District Orakzai LULC Supervised Description

Classes	Description
Built- up Area	Human settlements, commercial and industrial buildings, and roads.
Water bodies	Water reserves, ponds, rivers, and lakes.
Agriculture	Crop fields and grazing lands with herbs and shrubs.
Forest	Vegetation cover, homestead vegetation, reserve and non-reserve forests, etc.
Barren Land	Exposed soil with no vegetation at all.

1 LAND USE AND LAND COVER OF DISTRICT ORAKZAI IN 1985:

The district's classification image reveals a notable reduction in forest coverage attributed to the increasing population. The land use breakdown indicates that barren land encompasses 55.30% of the region, built-up areas 1%, agricultural land 6.82%, forest cover 8.56%, and water bodies cover 28.72%. Table 3.2 depicts land use/land cover of District Orakzai in 1985 and figure

3.1,3.2 and 3.3 explain the above-mentioned biophysical phenomenon.

Table 3.2: Statistic of LULC classes from 1985 supervised classification.

Classes (1985)	Built up Area	Barren Land	Agriculture Land	Forest Cover	Water Bodies
Area (hac)	8498.7	808370.9	99784.89	125138.3	419877.8
Area Percentage	1%	55.30%	6.82%	8.56%	28.72%

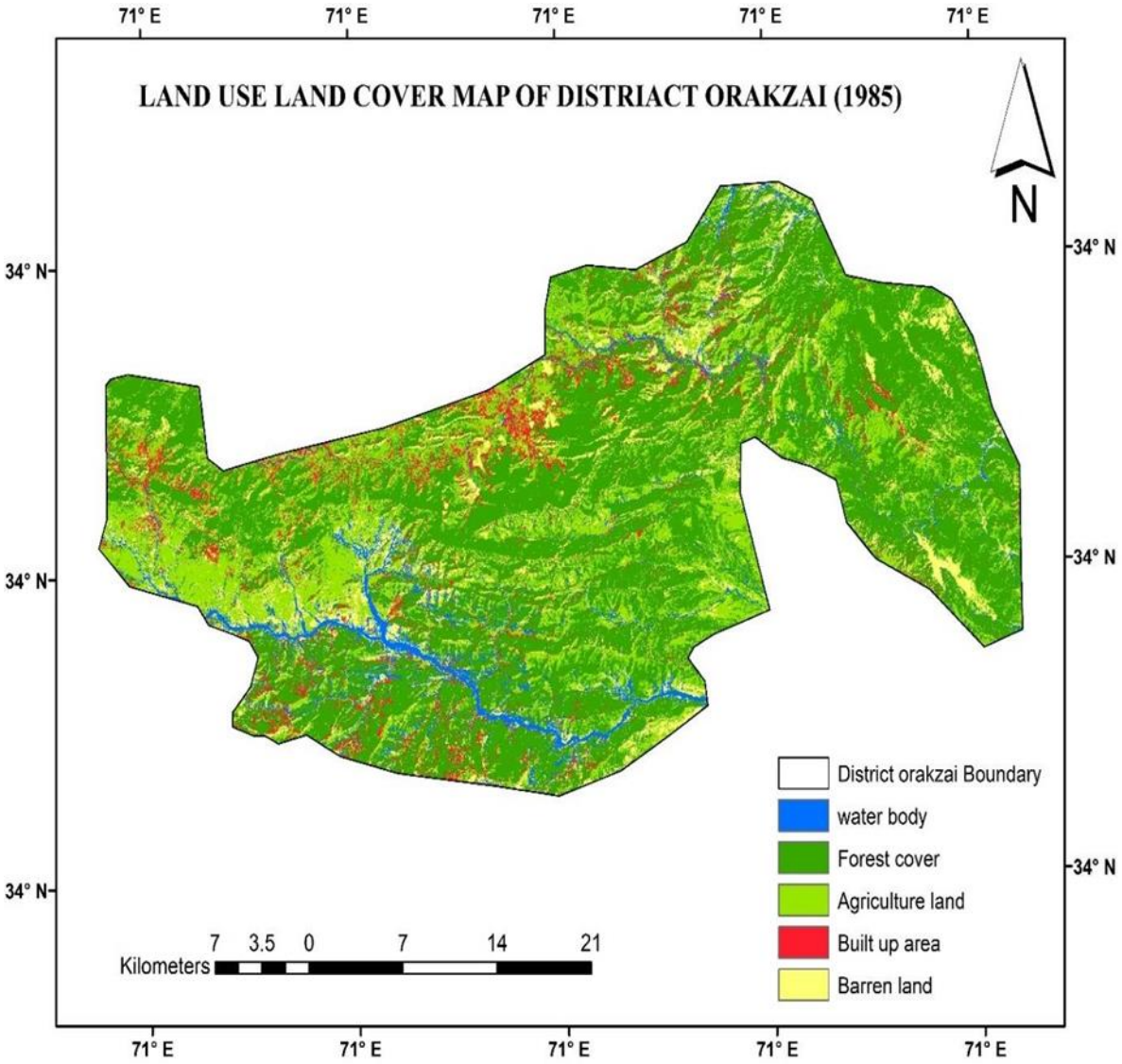

Figure: 2.1 show the land use land cover map of District Orakzai 1985

Source: Landsat images downloaded from USGS earth explorer and prepared in ArcGIS10.8

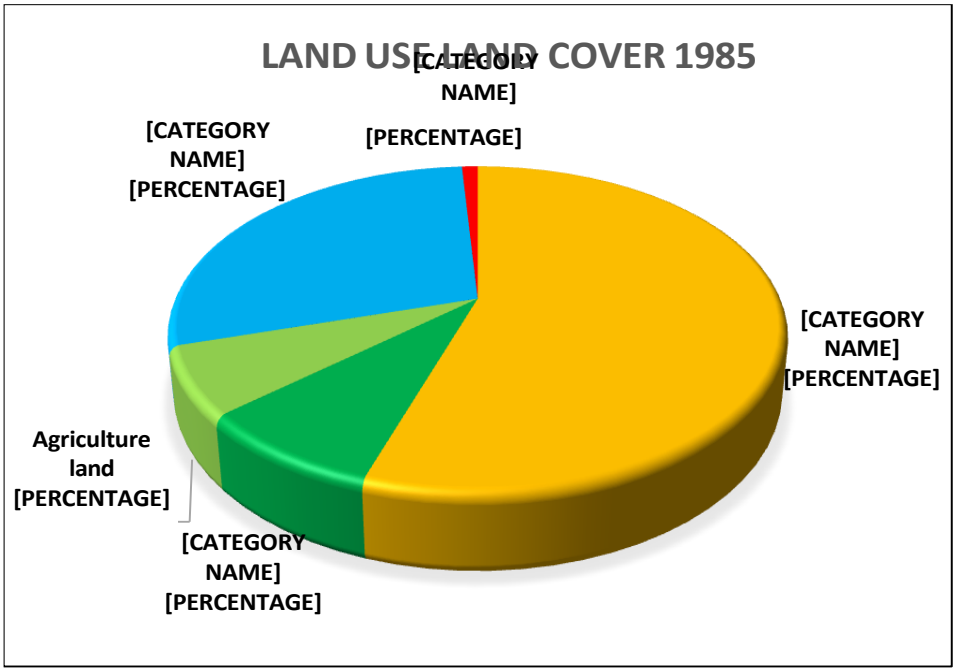

Figure: 3.3 District Orakzai, Area of LULC classes (1985)

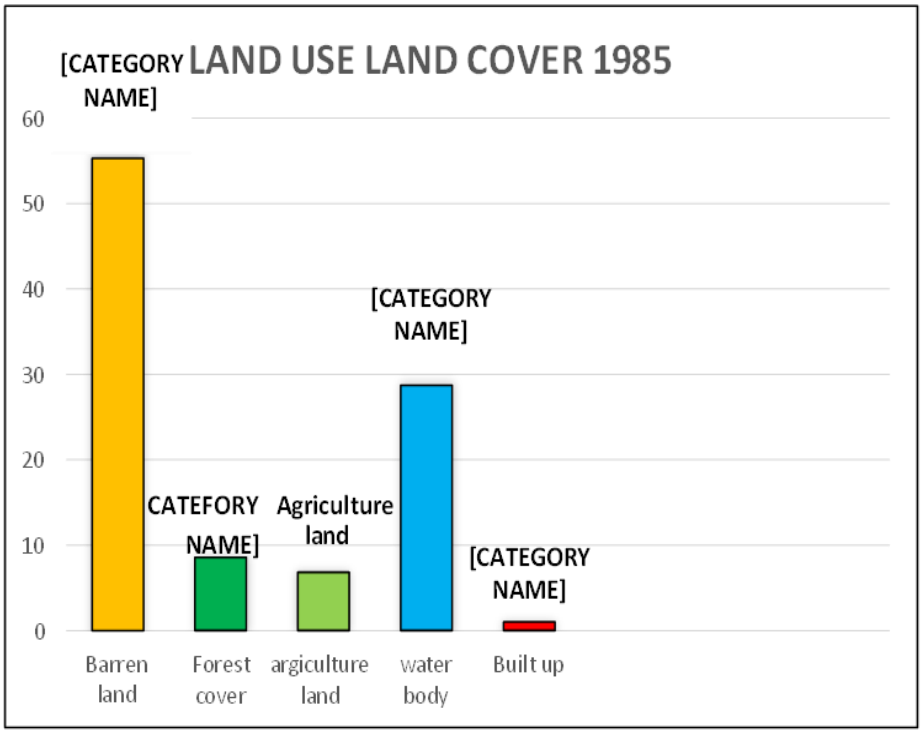

Figure: 3.4 District Orakzai, Area of LULC classes (1985)

2 LAND USE AND LAND COVER OF DISTRICT ORAKZAI IN 2000:

The district's classification image reveals a marked decline in forest cover attributed to population growth. The land use breakdown indicates that barren land comprises 11.2% of the area, agricultural land 3.34%, built-up areas 4%, forest cover 11.27%, and water bodies cover 4.1%.

Table 3.3 depicts land use/land cover of District Orakzai in 2000 and figure 3.3, 3.4 and 3.5 explain the above-mentioned biophysical phenomenon.

Table: 3.3 Statistic of LULC classes from 2000 supervised classification

Classes (2000)	Built Up Area	Barren Land	Agriculture Land	Forest Cover	Water Bodies
Area (hac)	98741.79	1027548	82445.02	278262.3	987417900
Area Percentage	12%	33%	10%	33%	12%

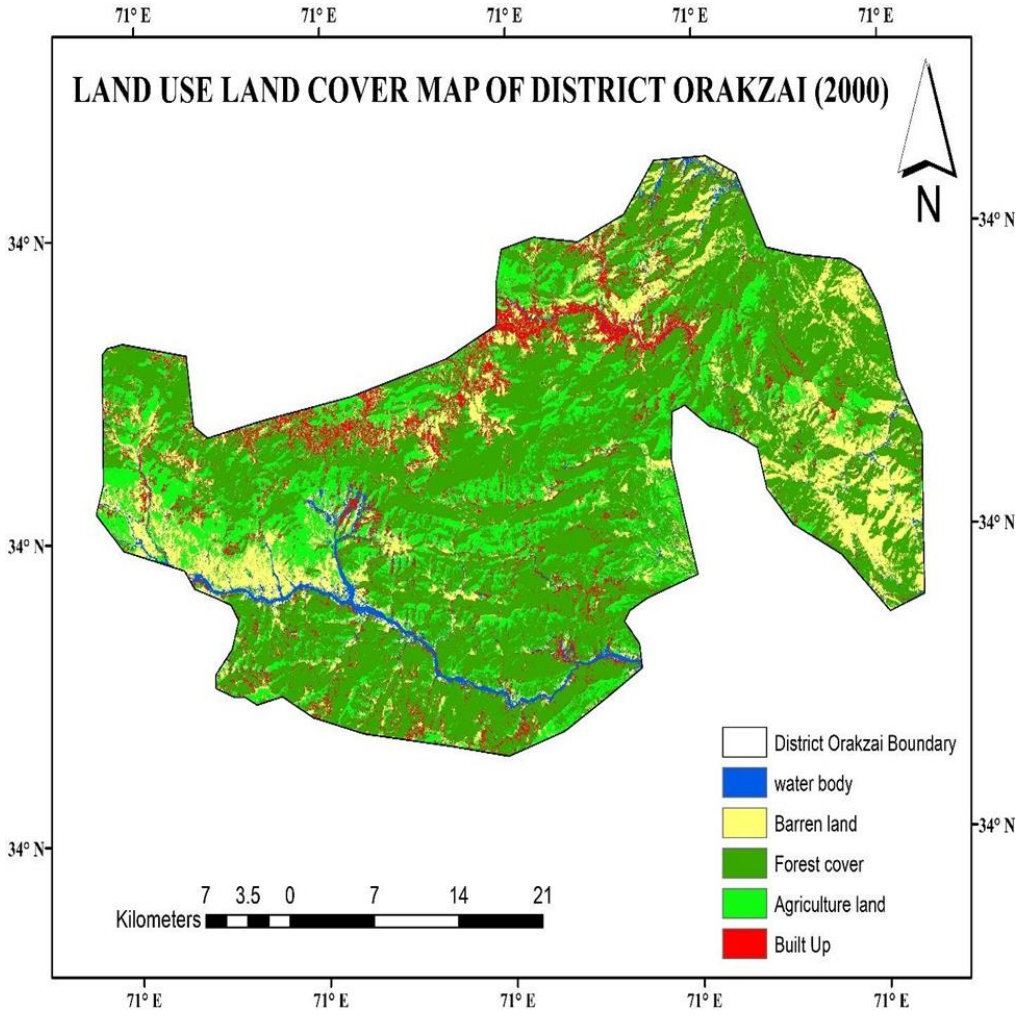

Figure:3.3 show the land use land cover map of District Orakzai 2000.

Source: Landsat image downloaded from USGS earth explorer and prepared in ArcGIS10.8

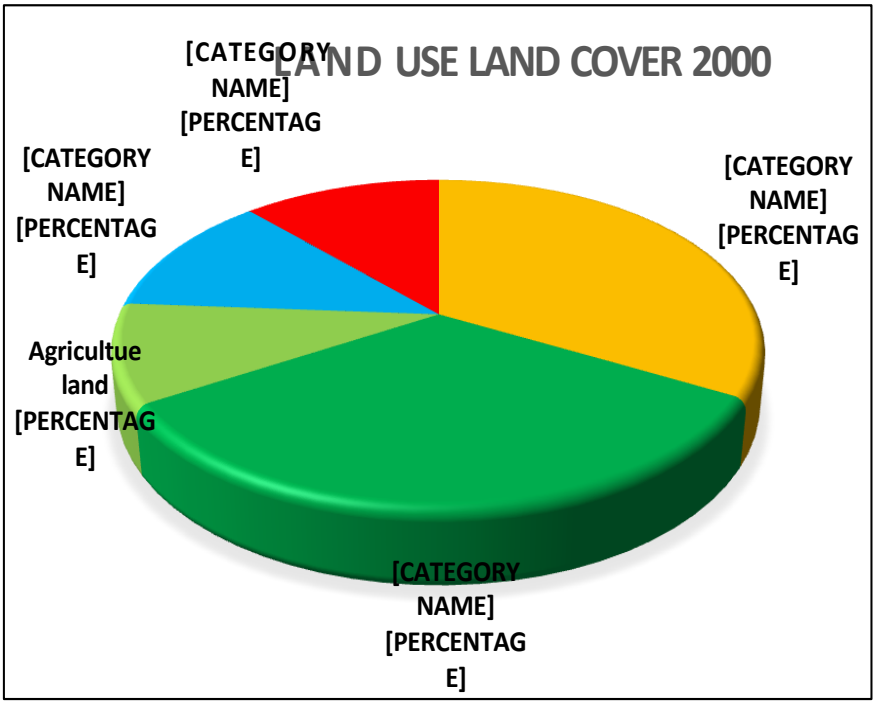

Figure: 3.4 District Orakzai, Area of LULC classes (2000)

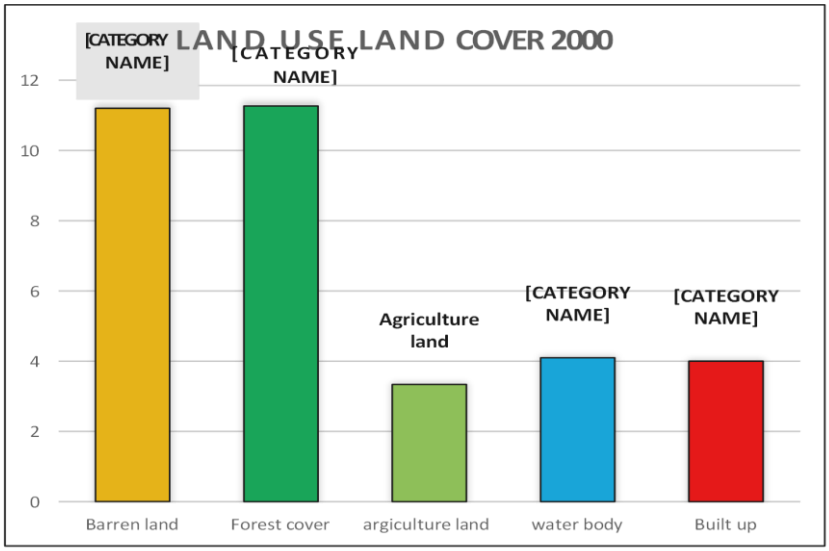

Figure:3.5 District Orakzai, Area of LULC classes (2000)

4 LAND USE AND LAND COVER OF DISTRICT ORAKZAI IN 2010:

The classified image of the District Orakzai in 2010, show an increase in forest cover compared to other periods we have classified. In the 2010 classification, forest cover accounts for 45.8%, built-up areas for 10.25%, barren land for 16.32%, agriculture land for 16.32%, and water bodies for 3.37%. Table 3.3 show the land use/ land cover of district Orakzai in 2010 and figure 3.4,3.5, and 3.6 explain the above mention phenomenon.

Table: 3.4 Statistic of LULC classes from 2010 supervised classification.

Classes (2010)	Built Up Area	Barren Land	Agriculture Land	Forest Cover	Water Bodies
Area (hac)	13834.98	22027.5	82445.02	61676.01	4555.8
Area Percentage	10.25%	16.32%	16.32%	45.8%	3.37%

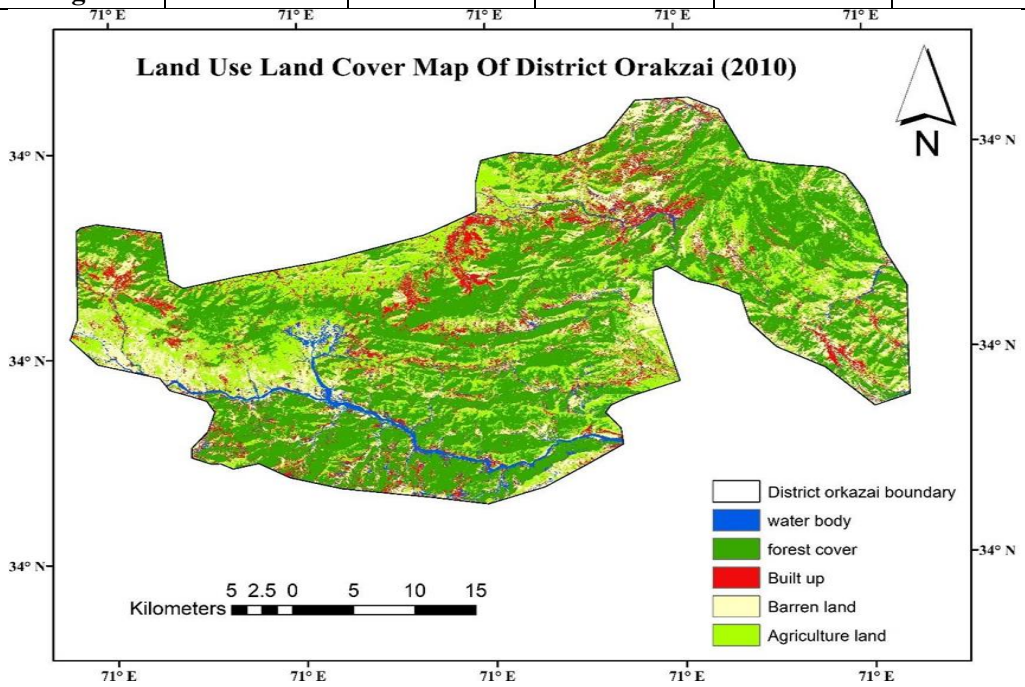

Figure: 3.4 show the land use land cover map of District Orakzai 2010.

Source: Landsat images downloaded from USGS earth explorer and prepared in ArcGIS10.8

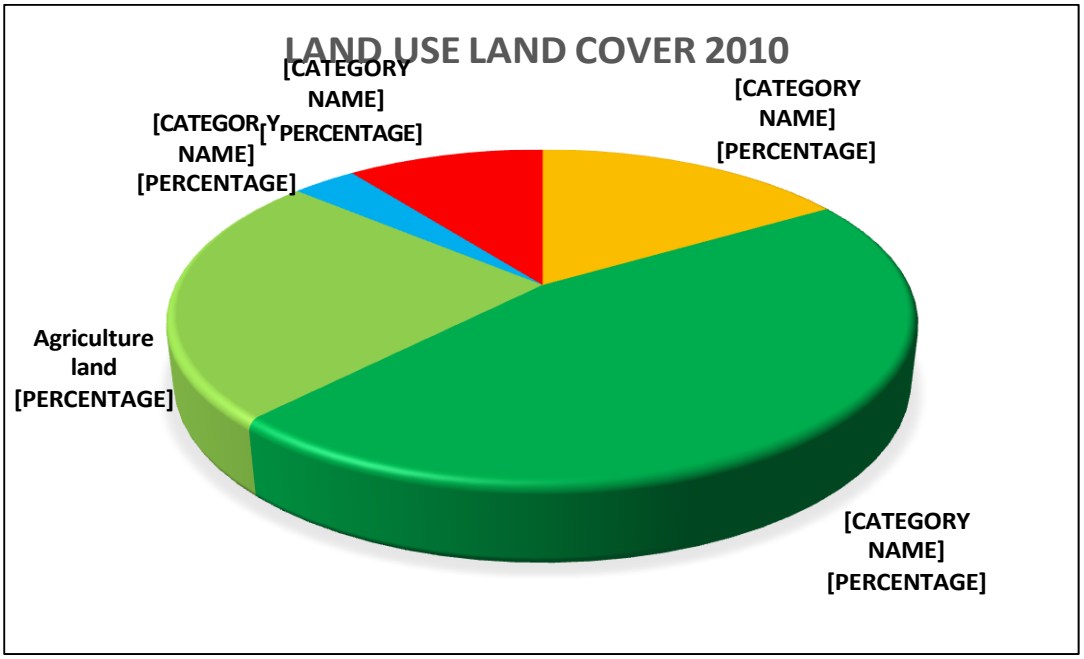

Figure: 3.5 District Orakzai, Area of LULC classes (2010)

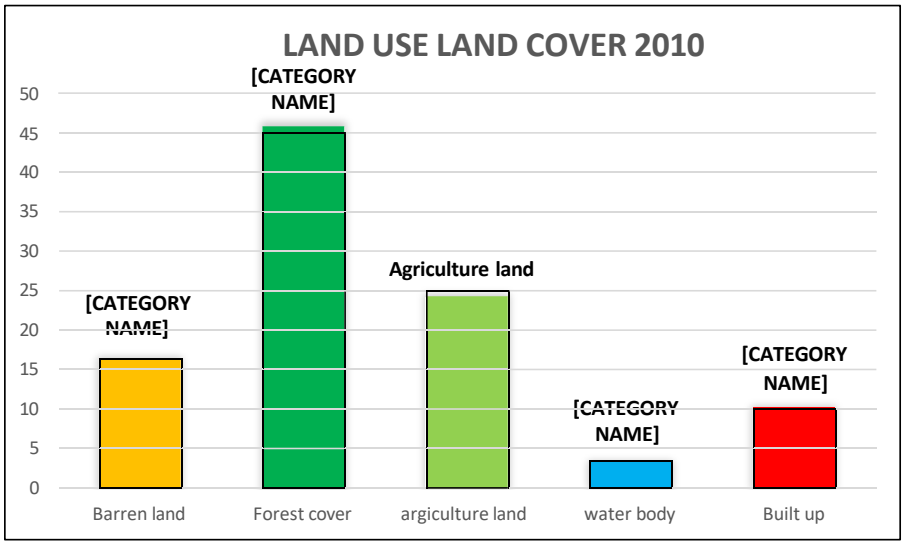

Figure: 3.6 District Orakzai, Area of LULC classes (2010)

5 LAND USE AND LAND COVER OF DISTRICT ORAKZAI IN 2020:

The classification image of the district indicates a significant decrease in forest cover due to the rising population. The breakdown of land use shows that barren land occupies 4.71% of the area, agriculture land 5.8%, built up area 76% forest cover 3.32, and water bodies cover 11%.

Table 4.5 show the land use/ land cover of district Orakzai in 2020 and figures 4.6,4.7, and 4.8 explain the above mention phenomenon.

Table: 3.5 Statistics of LULC classes from 2020 supervised classification.

Classes (2020)	Built Up Area	Barren Land	Agriculture Land	Forest Cover	Water Bodies
Area (hac)	2042029	127620	148076.3	89845.56	296808
Area Percentage	76%	4.71%	5.8%	3.32%	11%

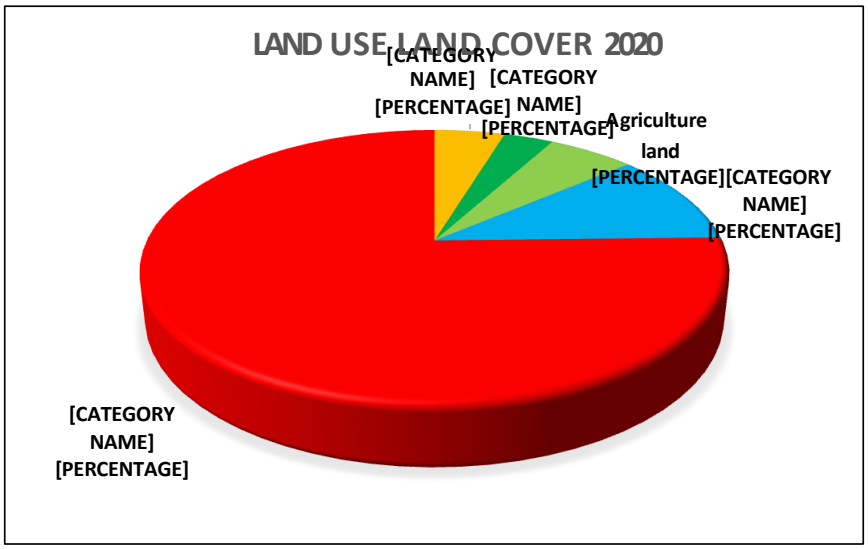

Figure:3.7 District Orakzai, Area of LULC classes (2020)

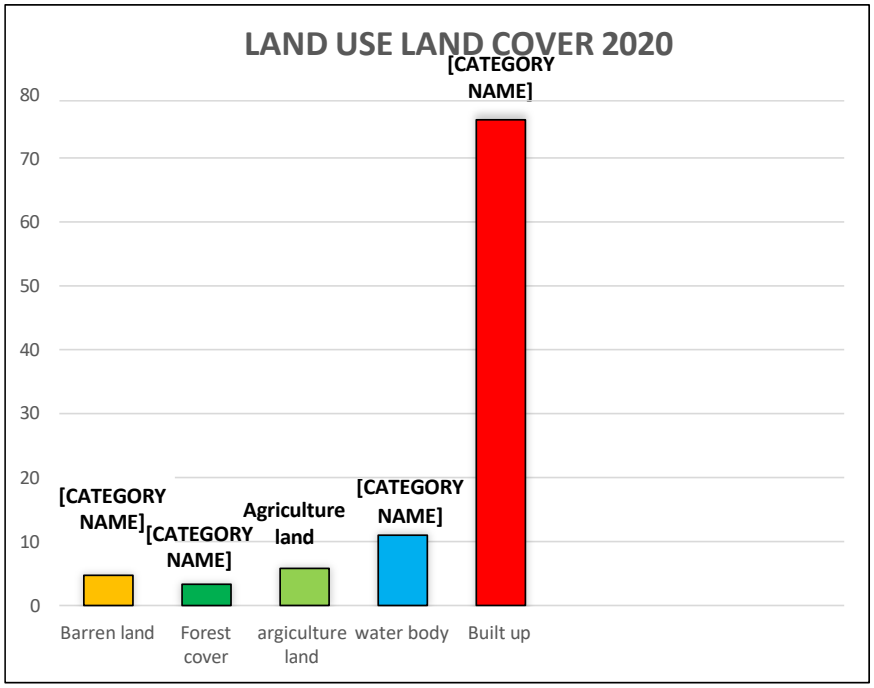

Figure: 3.8 District Orakzai, Area of LULC classes (2020)

DISCUSSION:

Satellite images are downloaded from the USGS Earth Explorer's free database Earth Explorer is a website provided by USGS that offers free access to a vast collection of satellite images and data. The images were classified using supervised classification methods: Classification is a process in remote sensing and image analysis where images are categorized into different themes or classes based on their characteristics. Population data is collected from census reports Population data refers to the information collected about the number of people living in a particular area, their demographics, and other relevant details. Due to unavailability, the 1985 population data is estimated based on 1981 data. Similarly, the 2010 population data is estimated based on 1998 data, which was also used to estimate the 2000 population. The 2017 population data is estimated based on 2020 data, as the actual data for 2017 is not available. The classification is divided into three periods: 1985 to 2000, 2000 to 2010, and 2010 to 2020. The overall images are classified into five different classes, showing the various land use and land cover in the region. In the first period, 1985, there was a rapid decrease in forest cover. The

land use and land cover classification of 1985 showed barren land covering 55.30% of the region, built-up areas at 1%, agricultural land at 6.82%, forest cover at 8.56%, and water bodies covering 28.72%. Moving on to the year 2000, barren land comprised 11.2% of the area, agricultural land at 3.34%, built-up areas at 4%, forest cover at 11.27%, and water bodies covering 4.1%. The classified image from 2000 showed a significant loss of forest cover due to population growth. In the third period, 2010, the forest cover began to increase compared to the other periods. The total area covered by forest was 45.8%, built-up areas at 10.25%, barren land at 16.32%, agricultural land at 16.32%, and water bodies at 3.37%. During this time, people from District Orakzai migrated to other districts due to military operations by Pakistan. Some tribes living in the area were also displaced, leading to the slow cutting of forests. However, in the last period, 2020, the population continued to migrate to District Orakzai. The forest cover decreased with barren land occupying 4.71% of the area, agricultural land at 5.8%, built-up areas at 76%, forest cover at 3.32%, and water bodies covering 11%.

It is concluded that the results above clearly demonstrate a decrease in forest cover over time, as well as an increase in population in the region. The majority of people are using firewood, which is not only being used but also transported to different areas.

Figure 3.9: During their visit to District Orakzai and tour of different tehsils, the inhabitants of Orakzai had been cutting down trees, this photo shows the transformation of the trees into furniture.

Figure 3.10: The people of the District Orakzai sealed the trees into different shops and used them for

different purposes.

Figure 3.11: The picture taken during a tour of District Orakzai showed the degration of forest.

Figure 3.12: The picture showed trees being cut for construction purposes according to the local people of district orakzai.

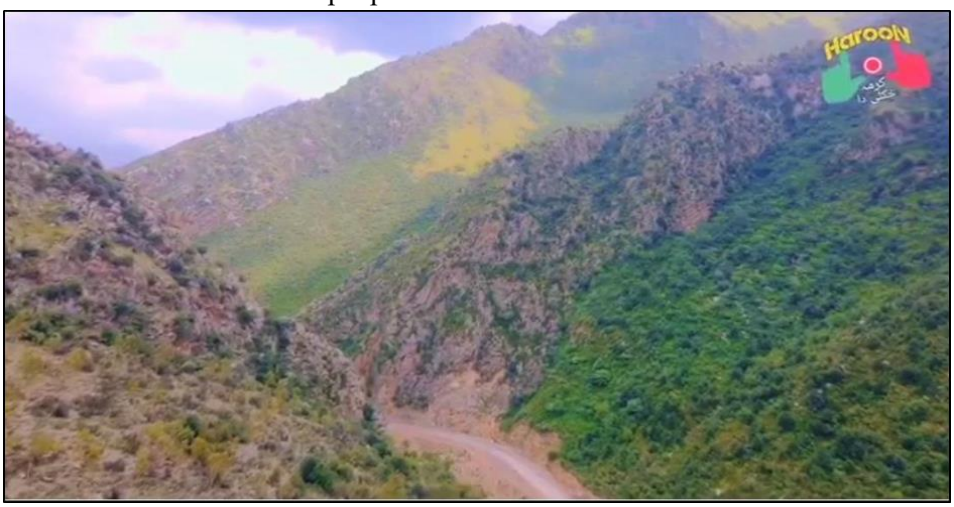

Figure 3.13: This picture shows deforestation at upper orakzai.
Source: haroon vlog

Figure 3.14 This picture shows deforestation in central orakzai.
Source: haroon vlog

LAND USE/ LAND COVER CHANGE FROM 1985-2020

LULC Classes	1985	2000	2010	2020	changes
	Area (Hectare)	Area (Hectare)	Area (Hectare)	Area (Hectare)	Area (Hectare)
Built up area	8498. 7 hac	98741.7 9 hac	13834.98 Hac	2042029 Hac	+2033530.3
Barren land	808370.9 Hac	1027548 hac	22027.5 Hac	127620 Hac	-680750 .9
Agricultural land	99784.89 Hac	82445.02 hac	32827.59hac	148076.3 Hac	+48291.41
Forest cover	125138.3 Hac	278262.3 hac	61676.01 Hac	89845.56 Hac	-35292. 74
Water bodies	419877.8 Hac	9874179 00hac	4555.8 Hac	296808 Hac	-12306 9.8

Table 4.7: District Orakzai, Population Growth Change Analysis (1985-2020)

Population growth 1985 -2020			
Year	**Population**	**Population Change**	**Population percentage change (%)**
1985	**403777.41109**	45,026.41109	12.54%
2000	**237316.33011**	166,461.08098	−41.26%
2010	**310368.92025**	73,052.59014	30.75%
2020	**273856.51660**	-36,512.40365	−11.75%

CONCLUSION:

This study investigates the impact of population on the vegetation cover in district Orakzai. The district has undergone significant transformations over the past three decades, with notable changes in its population, land use, and forest cover. The district's population has been steadily increasing over time, driven by a combination of natural growth and migration.

The district's landscape has undergone a profound transformation, with a shift from a predominantly barren landscape to one with more developed areas and forests. In 1985, barren land dominated the landscape, accounting for over 55% of the area. However, by 2000, barren land accounted for around 33% of the area, while built-up areas had expanded to cover around 12% of the district. Forests covered

around 33% of the area in 2000, but unfortunately, by 2000, the forest cover had decreased, with only 33% of the region remaining. In 2010, the forest cover showed a significant increase, with around 45.8% of the area covered in forest. This increase was likely driven by efforts to reforest and rehabilitate the area. However, by 2020, the forest cover had decreased again, to around 3.32% of the total area. Despite this decline, the district's agricultural land has expanded to cover around 16.32% of the total area in 2010.In conclusion, the Orakzai district has undergone significant changes over the past three decades, driven by a combination of demographic, economic, and environmental factors. While the district's population has continued to grow, its landscape has undergone a profound transformation, with a shift from a predominantly barren landscape to one with more developed areas and forests.

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