



Driving Factors behind the Land Use Land Cover Change in Hilly Region in Gorkha Municipality, Nepal

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Abstract

Land is considered a principal source of human existence and a major type of property that has undergone changes over many years. This paper attempts to study the Land Use Land Cover (LULC) change and identify the driving factors for these changes in hilly region in Gorkha Municipality, Nepal. This study is based on spatial and attribute data acquired through both primary and secondary sources, including field studies, Google images, and topographic maps. The data was prepared using GIS tools for analysis. Key informant interviews and field observations were also conducted to assess the changes and identify the driving forces behind land use and land cover (LULC) changes from 1998 to 2020. The study reveals that LULC change is influenced by a combination of numerous driving factors, including biophysical, economic, technological, demographic, institutional, and cultural/social factors. Major driving factors of LULC change include rapid population growth, immigration, road facilities, infrastructure development, land fragmentation, expanding income dimensions, migration, deforestation, natural factors (landslides, seismic movements, and soil erosion), poor farming practices, and crops destroyed by wild animals). The study shows that the built-up area and forest area have increased while the cultivation area is decreased over the twenty two years. Hence, appropriate measures are needed to protect cultivation land to ensure sustainable conservation for human livelihood

Key words: *Built-up area, change, driving factors, land use land cover*

Introduction

Land cover refers to the observed physical cover on the earth's surface, while land use refers to the arrangements, activities, and inputs that people impose on a particular type of land cover based on their interests (Neupane, 2016; Koirala, 2010,

Zhai, et al., 2020). Land use and its cover change is a complex subject, caused by many biological, physical, social, economic and institutional factors (Yetnayet et al., 2017). Land use is defined as the observed bio-physical cover of the watershed, whereas land cover is defined as the extent of human activities directly tied to the land and the utilization of its resources (Khatiwada, 2019). The land cover refers to the physical state of the land surface, such as forests, grassland, agricultural land, barren land, etc., whereas land use refers to how people utilize the land and its resources for various purposes. This includes the rights to buy, sell, and modify land, leading to changes in land use and land cover over time. Land use refers to how humans utilize the terrain, whether for development, conservation, or a combination of both. Different forms of land cover can be managed or used in various ways (US Department of Commerce, 2015). Several empirical studies have found that urban development is caused by various and diverse factors that change land use (Nagy & Lockaby, 2011; Hasan et al., 2019; Colsaet et al., 2018).

Changes in land use and land cover have become a crucial aspect of studying global environmental change, as they present a locally pervasive and globally significant ecological challenge (Lambin et al., 2001). Land use change is directly influenced by infrastructure development, which aggregates all types of human facilities (Poudel, 2008). Factors such as migration, globalization, government plans and programs, and political situations also affect urban development and land use changes (Rimal, 2010). Understanding these changes is vital for managing and monitoring natural resources and development. Changes that assist planners in achieving sustainability are linked to a loss of ecosystem services, which can adversely affect human well-being in cities. Ecosystem-based adaptation and mitigation should be integrated into urban designs, supported by strong policies and funding (Wang et al., 2020). Environmental pressures are increasing due to abandonment and underutilization of agricultural land, increase in invasive species, increase in crop damage by wildlife, and other negative factors (KC & Race, 2019). Land cover change is a dynamic process in which natural and geological activities are always active (Lambin et al., 2003). Land cover statistics indicate how much of a region is covered by forests, wetlands, impervious surfaces, agricultural areas, and other types of land and water.

In the context of Nepal, there is diversity in land use and land cover across the nation. The land use pattern has been changing in various ways; thus, this study aims to explore the major driving factors of land use change in the hilly regions of Nepal. Due to rapid population growth, internal migration, unmanaged and rapid urbanization, and other factors, encroachment on arable lands, forests, government

and public lands, and various natural resources is rampant, posing significant challenges to their protection. Land use is related to human natural and physical activities. The range of land use activities covers residential, industrial, commercial, agricultural, and recreational activities. Land is a basic resource for life and is used for various purposes, leading to changes in LULC when people change their purposes. This study seeks to answer how land use land cover has changed and what driving factors have contributed to these changes in hilly region located Gorkha Municipality. Hence, the focus is on exploring the driving factors of land use land cover change between 1998 and 2020 in the study area.

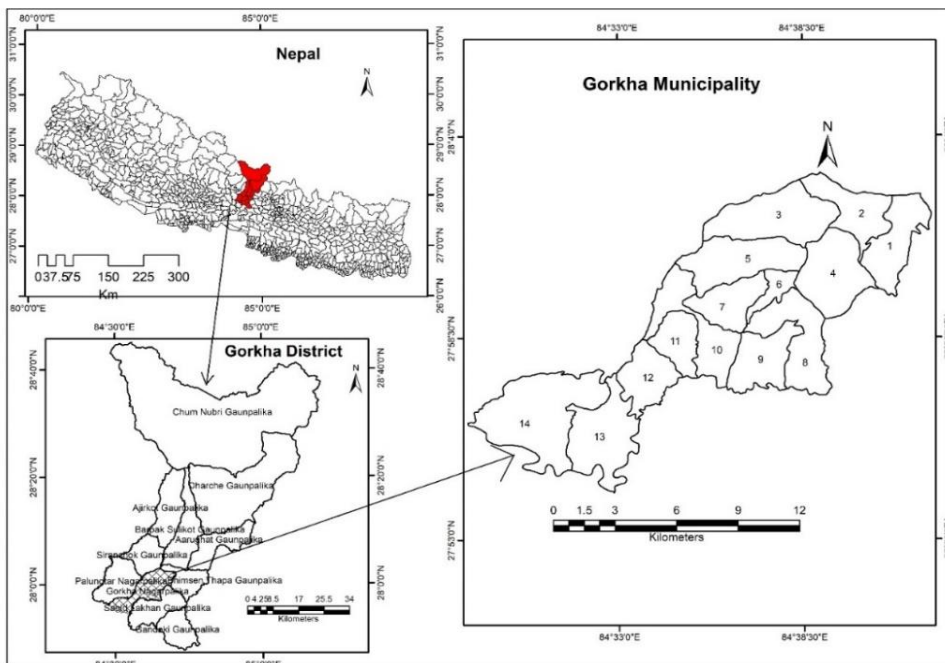
Methodology

Study Area

Gorkha Municipality, previously known as Prithvi Narayan Nagarpalika, is located in the Gorkha District of Gandaki Province, which is historically connected with the creation of modern Nepal. The municipality was established in January 1997 by combining Gorakhkali, Raniswara, and Taranagar VDCs. Later, Finam and Nareswor VDCs in 2015, and Taple and Deurali VDCs in 2017, were also merged into Gorkha Municipality (Figure 1).

Figure 1

Location Map of the Study Area



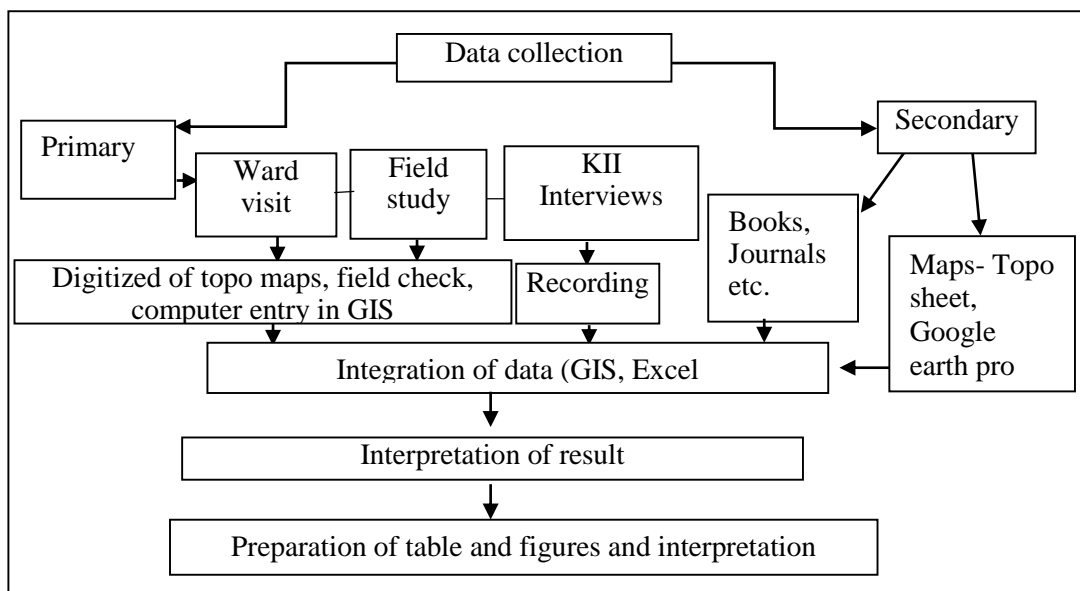
It is divided into 14 wards and consists 245 small entities known as Tole (settlements). It lies between latitudes 27.56' 03" and 28.13' 07" north and longitudes 84.23' and 84.38' east, with an altitude variation from 328 meters to 1522 meters above sea level. The municipality covers an area of 131.86 square kilometers. It is located 141 kilometers from the capital, Kathmandu, and 24 kilometers from Aanbu-Khaireni, Tanahun. It is bordered by Sahid Lakhan and Bhimsen Rural Municipality to the east, Palungtar Rural Municipality to the west, Siranchok Municipality to the north, and Sahid Lakhan and Aanbu-Khaireni Rural Municipality to the south. The total population of the municipality is 49272 across 13,127 households (Gorkha Municipality, 2021). Gorkha Municipality is rich in both geographical and historical aspects, with a wide range of mountains that enhance the beauty of the municipality.

Data Acquisition and Process

This study was primarily designed to assess the nature of land use land cover (LULC) change and its driving factors. It is based on both qualitative and quantitative information collected on spatial and non-spatial aspects from primary and secondary sources. The information collection and analysis processes used in the study are illustrated in figure 2.

Figure 2

Data collection and analysis process



Primary Data Sources

Primary data were collected through the check list and Key Informant Interviews (KII). In order to identify the driving factors for the change in land use in this area, information were collected with the help of a semi-structured questionnaire through the KII. At least one key informant (KI) was selected from each ward of the municipality for interviews to explore their views on the driving factors for LULC changes in their area. The key informants typically included ward chairmen, local social campaigners, and teachers. In this regard, the Key Informant Interview (KII) method was adopted. The interviews with experts and social campaigners as KIIs focused on two main issues: a) the history of land use and b) the major driving factors of LUC change. Similarly, field observation was done to primarily collect data on the driving factors of LULC change and other relevant phenomena.

Secondary data sources

The secondary data were collected from various relevant published and unpublished documents. The land use land cover situation in 1998 was obtained from a Topographic Map (1:25000) published by the Survey Department of Nepal is used as a base map. Similarly, Google Earth Pro 2020 was used superimposed as a base map and both scale to assess the existing land use land cover situation. Additional secondary data, such as maps, district profiles, municipality profiles, and related published documents, were used to gather information.

Data Analysis and Presentation

The collected data were analyzed using various processes. The initial phase of data analysis involved comparing the LULC changes from the base year 1998 to the current year 2020, utilizing ArcGIS 10.4 and Google Earth Pro (Image). Interviews with key informants were conducted with their consent, recorded, translated, and transcribed into English for analytical purposes. The data from different sources were analyzed and presented in map and tables to clarify the findings of the study.

Result and Discussion

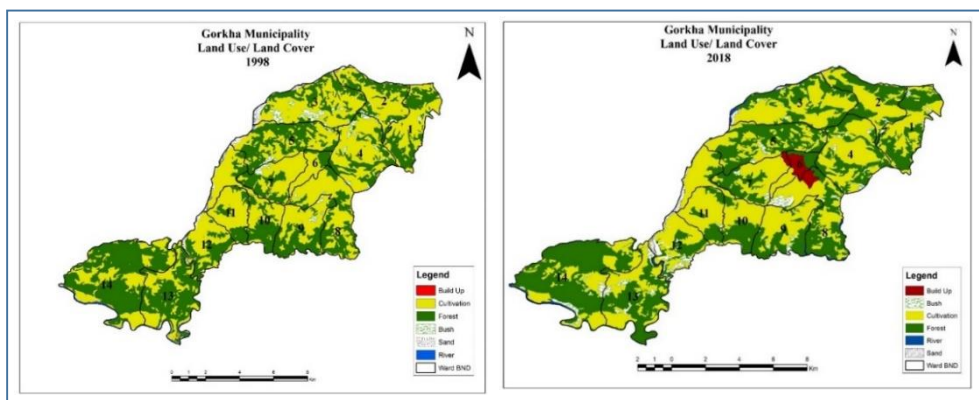
Land Use Land Cover of Gorkha Municipality in 1998 and 2020

Land is a resource, and 'land use' means 'resource use' in different types. A linkage exists between population and change of land use has been found in everywhere. Due to the spatial characteristics of land various types of land use practices has been found. Regarding the LULC of Gorkha Municipality in 1998, it was categorized mainly into six categories: cultivation, forest, bush, river/stream, sand, and built- up area.

In 1998, some areas such as Haramtari Chok, Ayurved Chok, Buspark Area, Dharapani Area, Thulo Aagan, Patechaur, and Hospital Area were urbanized. However, most parts of Gorkha Municipality, like Ranishwara, Mathillo Chhichhing Fant, and Tallo Chhichhing Fant, were dominated by cultivation. Forest areas included Damgade, Kharkopakha, and Suntale. Similarly, river/stream areas like Daraudi River, Bhaldhunga, Bokorlok, and Shirdi Khola have sandy areas in Gorkha municipality (Figure 3). Most people in Gorkha Municipality were farmers entirely dependent on agriculture for their livelihood. Therefore, there was very diminutive barren land in the municipality. Forest areas included Damgade, Kharkopakha, and Suntale. Similarly, river/stream areas like Daraudi River, Bhaldhunga, Bokorlok, and Shirdi Khola have sandy areas in Gorkha municipality (Figure 3). The majority of the study area is gradually transitioning from agriculture to built-up areas due to various driving factors. Population growth is a major influencing factor that directly or indirectly affects LULC change in the study area.

Figure 3

Land use land cover of 1998 and 2020



Sources: *Topographical Map, Survey Department of Nepal, 1998 and Google earth pro, 2020.*

Similarly, increases in built-up areas, road access, and the application of modern technology in agriculture, the establishment of industries, management of public recreation sites, educational opportunities, job opportunities, market facilities, and public awareness play vital roles in changing land use land cover. Additionally, the destruction of crops by wild animals (monkeys, hedgehogs) are also significant factors for land use change in Gorkha Municipality (Figure 3). Previous LULC has changed by rapidly urbanizing process. Easy access to roadways has created new

residential areas that were previously used for cultivation. Forest areas have expanded because they have been conserved managed as community forest. By the year 2020 the majority of the study area is gradually transitioning from agriculture to built-up areas due to various driving factors. Population growth is a major influencing factor that directly or indirectly affects LULC change in the study area. Previous LULC has gradually changed by increases in built-up areas, road access, establishment of industries, management of public recreation sites, educational opportunities, job opportunities, market facilities, and public awareness play vital roles in changing land use land cover. Easy access to roadways has created new residential areas that were previously used for cultivation. Forest areas have expanded because they have been conserved managed as community forest. Additionally, the destruction of crops by wild animals (monkeys, hedgehogs) are also significant driving factors for land use change in Gorkha Municipality.

Land Use Land Covers Change and its Driving Factors

Land use and land cover change and its driving factors are influenced by a various biophysical and societal factors operating on several spatial and temporal levels.

Natural factors

Some areas of this municipality have experienced changes in land use due to natural factors. According to KII due to the hilly terrain there are several landslides and flood etc which destroy the farmland. Similarly, wild animals have destroyed the crops so farmer left the cultivated land. The Landslides in Taple, Phinam, Dhungade, Aahale, Mathillo Thingureshwara, Dadelavir, Daraudi, Sirdi, 10 and 12 Kilo have altered land use patterns. Due to wild animals like hedgehogs and monkey destroying the crops, the previously cultivated land is now left barren in wards 3, 5, 7, 8, 9, and 14. Similarly, the seismic trigger in 2015 devastated various parts of Gorkha Municipality.

Socio-economic Factors

There are several socio-economic driving factors play vital role to change the land use. KII have pointed out the driving factors that change the state of land use, such as migration, low production, lack of irrigation, land fragmentation, lack of agriculture labor, expand built up area, repeated forest fire, construction motor able road, traditional framing practice, lack of modern technology etc. The primary drivers of urbanization in the study area are population growth and migration from remote areas therefore expand the built up area. The growth of tourism and other infrastructure is another factor driving urbanization in Gorkha Municipality. Most

people have diversified their sources of income, engaging in wage labor, business (e.g., hotels, restaurants), foreign employment, and civil services. The manpower migration also main cause to land use change. These factors attract rural people to urban areas, leading to previously cultivated rural areas being left as barren. Due to rural to urban migration rural area area's farmland seem fallow.

KI reported that, people who are economically stronger show less interest in agriculture, moving to other business or services, which indirectly changes the agricultural land use. Therefore, along roadsides, cultivated land has been transformed into settlement areas such as Kafalghari, Nareashwor, Gorkha Campus, Gorkhkali Darbar, Baraha, Aahale, Dhungade, Deragau, Kokhe Aahale, Dumri Dada, Kattel Dada, and Shikgar areas. Thus, previous cultivation areas have gradually transitioned into bush and forest.

Land Use Land Cover Change Patterns between 1998-2020

There are some differences in land use patterns between 1998 and 2020 in Gorkha Municipality. Data shows that the present built-up area has expanded significantly compared to the built-up area in 1998. The cultivation land has decreased due to rapid unplanned urbanization, crop diversification, and road construction. River strip and sandy area have decreased due to landslides. However, forest and bush areas, as well as built-up areas, have increased table 1 and figure 4.

In 1998, a nominal area or only 0.02 percent area was occupied by the built-up area in eight wards (6, 7, 8, 9, 10, 11, 12 & 13), and the remaining wards (1, 2, 3, 4, 5, and 14) were covered by cultivation. The rivers Marsyangdi, Daraudi, Sirdi, Ludi, Gangate, Karne, Jyadul, and Beni cover 1.22 percent of the area.

Table 1

Change pattern in land use land cover between 1998-2020

Land use types	1998		2020		Change Percent
	Area (km ²)	Percent	Area (km ²)	Percent	
Cultivation	70.05	53.12	63.17	47.93	-9.82
Forest	55.34	41.97	59.79	45.37	7.46
Built Up	0.03	0.02	1.70	1.29	97.64
Bush	2.82	2.14	4.80	3.64	61.33
River	1.62	1.23	1.31	0.99	-19.14
Sand	2.01	1.52	1.08	0.82	-45.77
Total	131.87	100.00	131.85	100.04	

Sources: Topographical Map, Survey dept of Nepal, 1998 and Google earth, 2020.

Table 1 shows that in 2020 almost half of the total land area is still used for cultivation in Gorkha Municipality, whereas forest cover has increased to 45.34 percent, and bush area covers 3.64 percent area, 0.82 percent by the sand area, and 0.99 percent by rivers or streams. The remaining 1.29 percent of land is covered by the built-up area. The major built up sites such as Haramtari Chok, Ayurved Chok, Buspark Area, Dharapani Area, Satipipal, Thulo Aagan, Patechaur, Hospital area, Ahle, Dhungade Bhanjyang, Dera Gaun, Kokhe Aale, Laxmi Bazar, Biren Chok, 12 Kilo Bazaar, and 10 and 11 Kilo Bazaar are expanded.

Figure 4

Land Use Land Cover Change

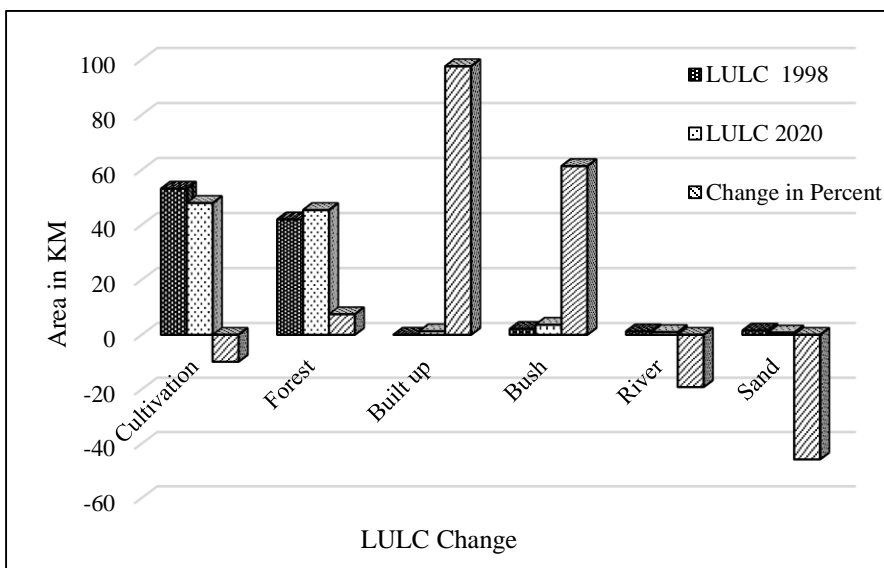


Table 1 and figure 5 show that some areas have undergone minor changes, whereas other areas have experienced significant changes in LULC. The cultivation area has decreased by 9.82 percent due to rapid unplanned urbanization and road construction. The river cover area has decreased by 19.14 percent and the sand area has also decreased by 45.77 percent due to soil erosion and landslides. Conversely, the forest area has increased by 7.46 percent. Similarly, the bush area has increased by 61.33 percent, and the built-up area has increased by 97.64 percent during the last 22 years.

Conclusion

This research has contributed to understanding the present condition of LULC in the Gorkha Municipality by comparing 22 years of data. Land use change is a

continuous process, but the driving factors can vary at the pace of change. Due to subsistence farming and labor out-migration, many young people are shifting away from agriculture to other occupations. As a result, fallow land has increased, allowing natural forests to grow, with forest cover expanding by more than seven percent. Major factors driving land use change in the study area include limited job opportunities, inadequate access to quality education and healthcare, insufficient irrigation, a shortage of agricultural labor and crops destruction by wild animals, and natural disasters like landslides and floods. The core area of Gorkha Municipality has expanded haphazardly, with unplanned urbanization that threatens the esthetic beauty of the place. Therefore, Gorkha Municipality should be taken steps to conserve agricultural land by promoting agriculture through various relevant programs like modern farming techniques, irrigation facilities, and concessions on tools, fertilizers, and seeds. Therefore, concerned authorities, such as local, province and federal governments, need to take this issue seriously and implement proper urbanization planning norms. This will support the sustainable development of land resource in Gorkha Municipality as well as hilly area of Nepal.

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