IMPACT OF URBAN GROWTH
A STUDY OF SHUKLAGANDAKI MUNICIPALITY

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The thesis entitled **“IMPACT OF URBAN GROWTH" A STUDY IN SHUKLAGANDAKI MUNICIPALITY** has been prepared by Mr. Rabindra Poudel under my supervision in partial fulfilment of the requirements for the Master’s Degree in Geography. I hereby recommend this thesis for the evaluation by the Thesis Committee.

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ABSTRACT

This thesis examines the patterns and drivers of urban growth in Shuklagandaki Municipality, a rapidly urbanizing region in Nepal. The study employs a mixed-methods research design, including both quantitative and qualitative data sources. Quantitative data were collected from government statistics, census data, and published reports, and were used to analyze trends in population and economic development in the municipality over the last two decades. Qualitative data were collected through in-depth interviews with key stakeholders in the municipality, including government officials, business owners, and community leaders. Data analysis techniques included both descriptive statistics and inferential statistics, such as regression analysis.

The results of the study show that Shuklagandaki Municipality has experienced significant growth in both population and economic indicators over the last two decades. Economic development and population growth were the most significant drivers of urban growth in the municipality, while infrastructure improvements played a smaller, but still important, role. The rapid pace of urbanization in the municipality has brought both challenges and opportunities, and policy and planning efforts should aim to promote sustainable urban growth that takes into account the needs and well-being of both current and future residents.

The conclusion of the thesis summarizes the main findings of the study and discusses the limitations of the research. It also suggests directions for future research on urban growth in Shuklagandaki Municipality, considering the gaps in the current literature and the questions that remain unanswered.

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ABBREVIATIONS

CBS	Central Bureau of Statistics
CEDA	Centre for economic development and administration
GIS	Geographical Information System
GPS	Global Positioning System
GON	Government of Nepal
ICIMOD	International Centre for Integrated Mountain Development
LULC	Land use and land cover change
ERDAS	Earth Resources Data Analysis System
NPC	National Planning Commission
RS	Remote Sensing
TIRS	Thermal Infrared Sensor
ADS	Agriculture Development Strategy
APP	Agriculture Perspective Plan
CBS	Central Bureau of Statistics
DOS	Department of Survey
EIA	Environmental Impact Assessment
FINIDA	Finnish International Development Agency
GDP	Gross Domestic Product
GON	Government of Nepal
LRMP	Land Resource Mapping Project
NGIID	National Geographic Information Infrastructure
NLUP	National Land Use Project
P.N.C.	Prithvi Narayan Campus
USGS	United States Geological Survey
LandsatETM+	Landsat Enhanced Thematic Mapper Plus

CHAPTER I
INTRODUCTION

1.1. Background

The migration of people from rural to urban regions is known as urbanization. It derives from the Latin word "Urbs," which the Romans used to refer to a city. The study of group dynamics, interpersonal relationships, and urban social situations is known as urban sociology. the transfer of people from villages whose activities are largely or exclusively focused on agriculture to other, often bigger places with activities that are primarily focused on government, trade, manufacturing, or related interests.(Nottridge, 2013)

As the world's cities grow both physically and economically, they must make many important decisions to influence how this growth occurs. The concept of urban sprawl and its negative impact on many municipalities is a looming threat that highlights how uncontrolled city growth will bring serious consequences with it (Gurin, 2003). How sprawl works, the impact it has, and how to combat it are crucial things to understand for development decision-makers and the stakeholders that their projects affect alike. Sprawl is an extremely complex issue, which is highlighted by the fact that it occurs in substantially different patterns in different locations around the world (Nechyba and Walsh, 2004).

Urban growth and increasing concentration of people in urban areas are creating societal problems world-wide. Population is nearly 50% of the world's population in urban areas and in the last 200 years, world population has increased six times, stressing ecological and social systems. The result of population growth and migration from rural to urban areas, urbanization has been recognized as a critical socioeconomic process in metropolitan areas of Nepal.

Urban sprawl has a variety of impacts on the totality of the human environment. The impacts can be principally positive or negative depending on the adequacy of plans and strategies in anticipation of it, because it may not be welcome but it must arise under normal economic circumstances (Dewees etal. 2020). It is one of the factors

noticeable under population and economic growth where business attractions, social life improvement and a lot of other factors are activated with time.

Land resource is the backbone of the economy of a nation and important basic natural resource for human survival. It comprises the physical environment including climate, relief, soils, water and vegetation, all of which have influence on Land-use potential. Land resources play a strategic role in determination of man's economic, social and cultural progress as is evident from the economic history of different nations. Among the land resources, agricultural land resource has played a vital role since time immemorial engaging the largest percentage of inhabitants of the world. Owing to increasing pressure of population on land and ever growing demands of food and raw materials, there is a dire need to use every piece of land properly, which calls for scientific, rational and economic planning for the use of land resource. Development of land resource has very often been left in the past entirely to trial and error methods. This naturally has led to improper use of land in many parts of the world, with the result that an important basic resource has gradually deteriorated. In countries where efforts are being made to modernize agriculture through the adoption of scientific methods, there is an excellent opportunity for correcting past errors in Land-use and to get rid of further errors through detailed mapping and classification of land. When man-land ratio is under decreasing trend, land is being treated as capital as well as product of nature. The role of land in the economy of each nation is not always obvious, but is of great significance. Without secure land rights there can be no sustainable development. Land and its use may be examined from many different points of view. Some measures put in place to regulate this phenomenon have been met by resistance and inertial factors. In some jurisdictional domains the government normally puts some constraints on land use giving reservation order in some areas to allocate them for agricultural, industrial and games purposes. Often some of these uses for which those areas were reserved have been reversed with some other interests often based on housing needs (Sivakumar, 2005).

Urbanization has become a major trend worldwide in recent years. In 1920, the urban population made up 14% of the world, and reached 25% in 1950 (Weber et al, 2003). Currently, 50% (3.3 billion) of the world population lives in urban areas (UN, 2008). Usually, urbanization refers to the proportion of the population of a country that lives

in cities. In some studies, however, it has been referred to as a process of spatial diffusion. The concept of urbanization may vary from discipline to discipline, author to author and region to region; hence, in this study, I have defined urbanization as a territorial and socioeconomic process that causes a general transformation of landscape patterns over time. More precisely, the spatial process of urbanization can be considered as the observable transformation of the spatial pattern of land use and land cover, such as the transformation of agricultural and forest land uses into built-up surfaces or the gradual transformation of rural landscape into urban landforms. The time-space relationship plays an important role in understanding the spatial process of urbanization. The world's population is growing at an alarming rate, with predictions that it will double in just 60 years. This presents a pressing need to carefully consider land use and match it with land types in the most rational way possible. Doing so can maximize sustainable production and meet society's diverse needs while conserving fragile ecosystems and genetic heritage. Land use encompasses human, natural, and physical activities, including residential, industrial, commercial, and recreational activities. However, any physical development will inevitably have some environmental impact, with the extent of that impact depending on factors such as the category of use, intensity of development, and site characteristics (Weber and Puissant, 2003).

Currently, the global urban population outnumbers the rural population, and this trend is projected to continue with 70% of the total population residing in urban areas by 2050. Although Nepal's urban growth rate is high, its population distribution across urban areas remains uneven, with Kathmandu Valley serving as the hub of the country's urbanization. According to a recent report by the Ministry of Urban Development, Kathmandu city recorded the highest population density of 19,726 persons per km2 in 2011, with over 1 million people living there. (CBS,2011).The report highlights the challenges faced by municipalities in managing population growth with limited resources due to an imbalance in population distribution across ecological and development regions. Urbanization is most prominent in the hill region, with a level of 21.7%, compared to 15.1% in Tarai and 2.8% in the mountains. The Central Bureau of Statistics reports a steady increase in the urban population, from 4% in 1971 to 17% in 2011, while the rural population decreased from 86% in 2001 to 83% in 2011. Furthermore, the urban growth rate was 7%, compared to only

2% in rural areas in 2011. As a result, 72 out of the 77 districts in Nepal now have municipal areas, and the urban population has increased from 0.23 million to 4.5 million. (CBS,2011).

These demographic changes have a significant impact on land use, and it is crucial to carefully consider and plan for sustainable land use to ensure that resources are used efficiently and effectively. Failure to do so can result in adverse environmental impacts and may lead to social and economic instability. As a research paper writer, it is important to emphasize the need for sustainable land use planning and to explore possible solutions to the challenges posed by urbanization and population growth. This can include developing policies and strategies that promote sustainable land use practices, investing in infrastructure, and encouraging public participation in decision-making processes.

The first official census in Nepal was held in 1952-1954. Data on urbanization are available since that time. The study of urban areas is sometimes made more difficult by the frequent alterations of definitions and urban political regions, as well as the integration of new ones in Nepal. In order to achieve full economic development and promote the agglomeration of the economy, the regional development strategy was adopted in the 1970s, and a number of north-south growth corridors and growth centers were identified. This concentration of development efforts had a significant impact on urbanization. With an urban population of nearly 14%, Nepal is one of the least urbanized countries in the world by the year 2004 (Rijal, et al, 2020).

Knowing the many elements that might impact a city's size and, therefore, its short-term dynamics, is essential to comprehending urbanization and economic growth. These all contribute to the fundamental factors that produce the actual and monetary externalities that urban agglomeration and the congestion that results from agglomeration both exploit. In Shuklagandaki, three fundamental types of agglomeration factors have been utilized to explain why urban agglomerations form; each of them was first presented (Marshall 1920). Knowledge spillovers, or the idea that a new research lab will be more productive the more biomedical research is conducted in an urban area; dense markets for specialized inputs; the idea that the more companies that hire specialized programmers, the larger the pool from which another company can hire when the other may be laying off workers; and backward

and forward linkages. Local conveniences and public resources may be effective agglomeration forces in and of themselves (Ioannides et at, 2010).

The research in “Urbanization in Nepal” by Basyal (2000) has highlighted the trends of urbanization, demographic and socio-economic characteristics of urban population and population density of urban area in his report. The conclusion of the studies on relevant topic was that Nepal has been experiencing considerable rise of population and rural to urban migration. The rapid rate of urbanization was the major cause for the better way of life, increased economy and improved facilities and services in the cities and on the other hand, for challenges like pollution, urban poverty, crowd crime etc. as well.

High urbangrowth is occurring in the Kathmandu Valley, the Pokhara Valley, the Inner Tarai valleys, and in market and border towns located on highway junctures between the east-west highway and the five main north-south corridors. Urban growth centers are also emerging close to the border with India (Muzzini & Apericio, 2013).Nepal is one of the ten least urbanized countries in the world. However, it is also one of the top ten fastest urbanizing countries. In 2014, the level of urbanization was 18.2 per cent, with an urban population of 5,130,000, and a rate of urbanization of 3 per cent (UN DESA, 2014). For the period 2014-2050, Nepal will remain amongst the top ten fastest urbanizing countries in the world with a projected annual urbanization rate of 1.9 per cent. The size of urban agglomerations is the result of a tradeoff between the relevant agglomeration and congestion forces (Ellison et al, 1999).Urban expansion can thus be the outcome of any economy-wide or city-specific shift that increases the power or breadth of agglomeration forces or decreases the significance of congestion pressures. A reduction in commuting expenses, which results in larger cities in terms of size, population, and in most models, production, is one illustration that has been often used in the literature. (Chatterjee et.al, 1999). Few years back Shuklagandaki is a small market center which was a linkage with nearby cities Pokhara and Damauli. Now with the increment of demography and infrastructure it is being a huge trade centre.Shuklagandaki is a rapidly developing as an urban center located in the Tanahun district of Nepal. It has become a hub for trade and commerce for various rural areas in the region, such as Thaprek, Kotre, Bankiya, Dhorphirdi, Raipur, Firfire, and more. The town is experiencing a significant

transformation in terms of infrastructure, economy, and urbanization, making it a prime example of a growing urban center.

Despite the urbanization in the Shuklagandaki it remains connected to its rural fringes. The town serves as a market center for the surrounding rural areas, providing access to various goods and services. Additionally, many people from the rural areas commute to Shuklagandaki for employment opportunities, contributing to the town's economic growth. Thus, the linkage between the town and the rural fringes is symbiotic, with both benefiting from each other's resources and opportunities.

The present study aims at interpreting ‘IMPACT OF URBAN GROWTH' A STUDY OF SHUKLAGANDAKI MUNICIPALITY as it is rapidly growing as an urban center along the Prithvi Highway in linear pattern. The present study has also attempted to trace out the trend of urban development and to analyze the changing land use pattern based on the methods adopted by different researchers. Here, an attempt is made to measure the growth of the contemporary rate of changes by reviewing the trend of urban growth in the past according the images of the various years.

1.2.Statement of the problem

Urbanization is a common phenomenon that has been observed in many countries around the world. As the population grows, urbanization becomes inevitable, and with it comes a series of changes to the landscape, environment, and socio-economic conditions of the area. Shuklagandaki municipality, with a population of about 45,456 people, is no exception to this trend. Urbanization is driven by socio-economic and biophysical factors, which include the functioning of local and national markets, policy, demographic conditions, and economic activities. These factors interact in complex ways, leading to unexpected urban sprawl and changes in land use and landcover. The intensification of economic activities and the increasing population coupled with global market pressures have led to an extensive transformation of the municipality's hydrological, ecological, and socioeconomic systems.

As a finite and potentially productive natural resource, land is crucial for food production and other economic activities. Therefore, the changes in land use and landcover need to be carefully monitored and managed to ensure that the ecological

and hydrological systems are not negatively impacted. Urban planning and decision-making play a crucial role in mitigating the negative impacts of urbanization.

Continuous assessment and monitoring of urban development are required to ensure that the changes that occur do not have adverse effects on the environment and the residents' quality of life. The research paper that focuses on the changes in the municipality's infrastructure, linkage between other cities, demography, and land use and landcover could help the plan makers in the municipality make informed decisions for sustainable development.

In conclusion, urbanization is an inevitable process that must be managed carefully to ensure that the environment and socio-economic systems are not negatively impacted. Shuklagandaki municipality, with its rich diversity of people, languages, and culture, is a prime example of the need for sustainable urban development. Continuous monitoring and assessment of the changes that occur in the municipality are required to ensure that the municipality's resources are utilized sustainably and to ensure that the residents' quality of life is not compromised.

1.3. Objectives of the Study

The main objective of this study is to analyse urban growth of the Shukla Gandaki municipality between twenty years period since 1999 to 2019.The objectives of the present study are as follows:

a) To show the trend of organization in the study area.
b) To analyse the causes and impact of urban growth.

1.4 Study Area

Shuklagandaki is a municipality located in the Tanahun district of the Gandaki Province in Nepal. It was formed on May 18, 2014, by merging three previous village development committees, namely Dhorphirdi, Dulegauda, and Khairanitar. Later, on March 5, 2017, Thaprek, Raipur, and Phirphire VDCs were also merged into the municipality (Fig. 1.1).

The municipality is located along the Prithivi Highwayin between 28° 04' 12"N- 28^0 04'42"N latitude and $84^0$05'24"-$84^0$11'40" E longitudes,which connects it to other

major cities and towns in the region, such as Dulegaunda, Khairenitar, and Kotre. The addition of these new areas to the municipality has increased its population significantly. According to the 2011 Nepal Census, the population of Shuklagandaki was 37,109, but after the merger, the population has increased to 48,456.

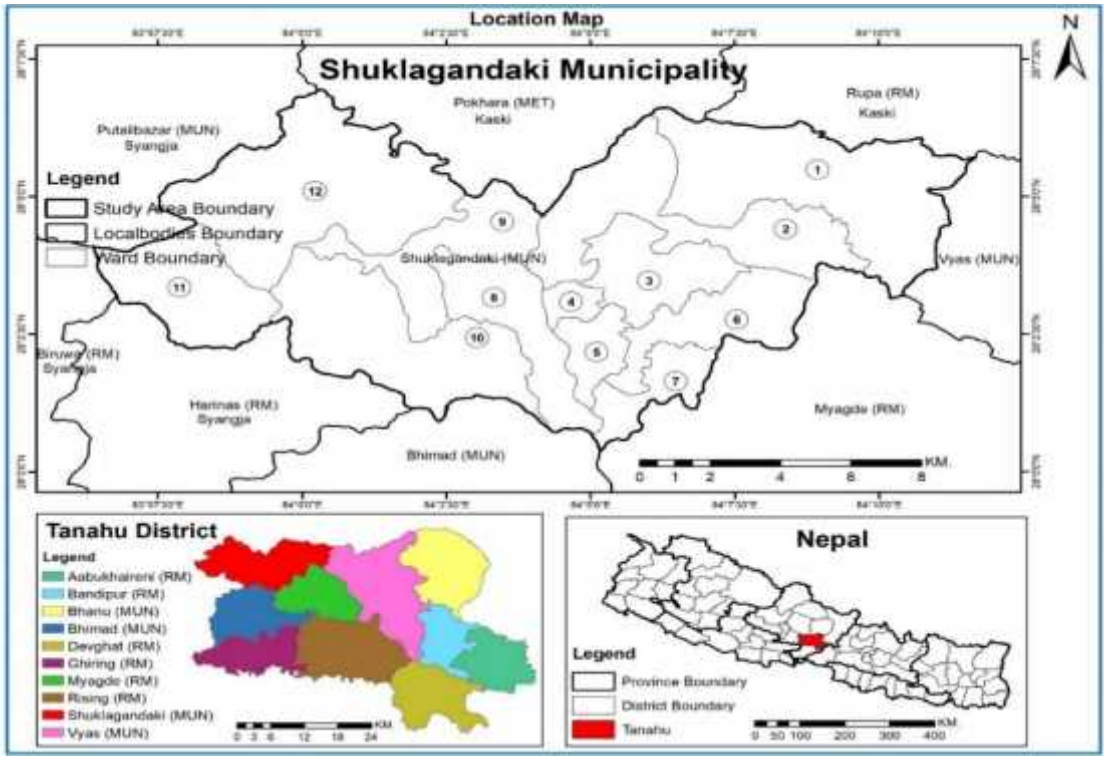


Figure 1.1. Location Map of the Study Area

1.5.Significance of the Study

Urban sprawl is a term used to describe the unplanned and uncontrolled expansion of urban areas into surrounding rural or undeveloped areas. It is a major issue in many developing countries, including Nepal, where rapid population growth and urbanization have led to increased demand for housing, infrastructure, and services. This has resulted in the conversion of agricultural land and natural habitats into built-up areas, which can have negative environmental, social, and economic impacts.

To address this issue, the study proposes to use GIS (Geographic Information System) and remote sensing techniques to analyze changes in the built-up areas of Suklagandaki Municipality over time. GIS is a computer-based tool that allows researchers to analyze and visualize spatial data, while remote sensing involves the use of satellite imagery to gather information about the Earth's surface.

By combining these two techniques, the study aims to identify patterns and trends in urban sprawl in Suklagandaki Municipality, and to understand the driving factors behind these changes. This information can be important to urban and development planners and to formulate policies for sustainable growth and development.

The study's findings will be relevant not only to Suklagandaki Municipality, but to other urban areas in Nepal and other developing countries facing similar challenges. In addition, the research can serve as a starting point for future studies on urbanization and its impacts on the environment, economy, and society.

1.6.Limitation of the Study

Cultural and linguistic diversity is a significant challenge for any research conducted in Nepal, as the country is home to over 100 ethnic groups, each with its own culture, language, and traditions. This diversity can make it difficult to accurately capture the unique perspectives and experiences of different communities within a given area, particularly for a student researcher with limited time and resources.

Furthermore, as a Master's student, the researcher may have limitations in terms of access to funding, equipment, and time. This may result in the study being limited in scope or lacking the ability to collect data from a wide range of sources. The use of selective social science research tools, such as surveys or interviews, may also have limitations in terms of their ability to capture complex social, economic, and cultural issues related to urban growth.

Despite these challenges, the study of Suklagandaki Municipality is still important and relevant, as it provides insights into the effects of urban growth on the area and the driving factors behind it. The study's findings can be used to inform local government policies and planning processes and provide a starting point for future research on this topic.

Additionally, the study's limitations may provide opportunities for future research to address gaps in knowledge or explore new research methods that are better suited to capture the diverse perspectives and experiences of different communities within Nepal. This can lead to more comprehensive and inclusive research methods that can provide a more accurate representation of the issues related to urban growth and their impacts on local communities.

1.7. Organization of the Study

The whole research study will be organized in the following six chapters:

Chapter I basically deal with introductory part of the study consisting background of the study, statement of the problems, objective of the study, significance of the study and limitations of the study organization of the study.

Chapter II mainly focuses on the data collection and research methodology that will include different techniques, tools and methods used for the research study.

Chapter III provides comprehensive study of different literatures. This chapter contains conceptual review of relevant studies from books, magazines, previous writings, and review of journals etc.

Chapter IV deal with the geographical and socio-economic condition of the study area.

Chapter V will concentrate on Land use pattern and Land use change for different era of Shuklagandaki Municipality and discuss about the causes and impacts of urban growth.

Chapter VI deals with summary of the main findings, conclusions made ultimately and recommendations. Finally, appendices contain list of bibliography, figures.

CHAPTER II

METHODOLOGY

This study is based on primary and secondary sources of data. The primary information was collected from field survey and secondary information from various sources such as different sites as CBS, local newspaper, website of Tanahun district, website of the Shuklagandaki Municipality.

2.1. Source

2.1.1. Primary source

Structured interviews, questionnaire method, observations, and photographs were taken to generate information for this study. Establishing a checklist of things, documenting the location, conducting a Focal Group discussion, and engaging knowledgeable people as key informants all aid in exploring the factors and implications of land use change. Similarly, for the ground verification of land use, a Global Positioning System (GPS) Garmin 24 Channel navigation gadget was selected to analyze ground truths as primary data. The following tools and techniques are being used to collect the data:

a) Field observation

The land cover change confirmation was confirmed using spatial analysis. The unclear land use change in the photograph was verified with field observations in the field using this approach.

b) Questionnaire

Questionnaire survey is one of the important techniques in research field which helped gather both quantitative and qualitative data and information. It was considered in this research to gather baseline data, socioeconomic conditions, and changes in the study area. (Appendices)

c) Focal group discussion

The main goal of the focus group discussion was to learn more about the settlement's history, previous and present urban growth patterns, land use patterns, infrastructural facilities, social structures, environmental factors, benefits and drawbacks of the settlement, and institutional and legislative policies toward the people who are living

in the study area. It was held in a working environment, with individuals of different sex and age in attendance.

d) Local government views

Local government views have been obtained through various means, such as interviews with local government officials, analysis of government reports and planning documents, and review of public meeting minutes and other government communications.

e) Photographs

Photographs were utilized to record information that would later be used in data analysis. This provides as proof of the circumstances and conditions in the research region.

2.1.2. Secondary source

Most of the secondary information is available from maps, image and Physical, socio–economic records from the reliable source. Two types of secondary information are used in the study namely satellite data and ancillary data (table 2.1).

a. Satellite data

The used satellite data is on the below table:

Table 2.1 Satellite data

Data Use	Path/Rows	Spatial Resolution	Swath Wide (km)	Date of Acquisition
Land sat 8 OLI/TIRS C1 Level-1	142/041	30	185	11/10/2020
Land sat 7 ETM+ C1 Level-1	142/041	30	185	12/11/2010

Source: glovis.usgs.gov.

b. Ancillary data

To find out the changes on urban growth ancillary data is used on the basis of satellite data

a. Topographical sheet
b. District Profile
c. Landform Map from Department of Survey, Government of Nepal
d. Demographic data of the Central Bureau of Statistics 2018, Nepal.
e. Others –Research Report, Journal books and Documents

2.3.Methods of analysis

One of the crucial and vital phases of any study is the data analysis. The work's core is found there. Depending on the kind of data, multiple pre-processing techniques were used in this study. Statistics were used to assess attribute data from the main and secondary sources. Data analysis and the creation of graphs, charts, and indexes employed statistical software, such as Microsoft Excel and Word. The creation of maps illustrating changes in urban growth was done using the ArcGIS program.

Using supervised classification, the gathered map from Land sat images from 2000, 2010, and 2020 was examined independently. Spectral signatures were created from certain regions in the picture for supervised categorization. The user designated these specific places, which were given the general label "training sites." The raster scene was typically digitally scanned over by a vector overlay. A variety of polygons covering diverse land-use kinds make up the vector layer. For mapping classes, supervised classification was significantly more accurate. The method was straightforward: based on prior knowledge of the scene's contents or, more broadly, the region it is located in, through familiarity with thematic maps, or by on-site inspections, recognize conventional classes (actual and known) or relevant (but somewhat contrived) classes in the scene. This familiarity made it possible to create distinct classes, choose them (thus controlling the selection), and then give them category names.

After that, the analysis of the changes in land use and land cover between 2000 and 2010, 2010 and 2020 reveals how urbanization has changed throughout the time period. ArcGIS Imagine tools were used for post-analysis after the spatial data had been examined using supervised and visual classification. Urbanization issues and problems are based on social analysis as well as certain data that is now accessible from various sources.

The analysis of urban growth using the regression is a statistical method that allows for the examination of the relationship between two categorical variables. This method involves the collection of data on the frequency of each category for each variable, the calculation of expected frequencies based on the assumption of no relationship between the variables, and the calculation of observed frequencies based on the actual counts in the data.

2.4. Conceptual Framework of the Study

The flow chart of the research is given below:

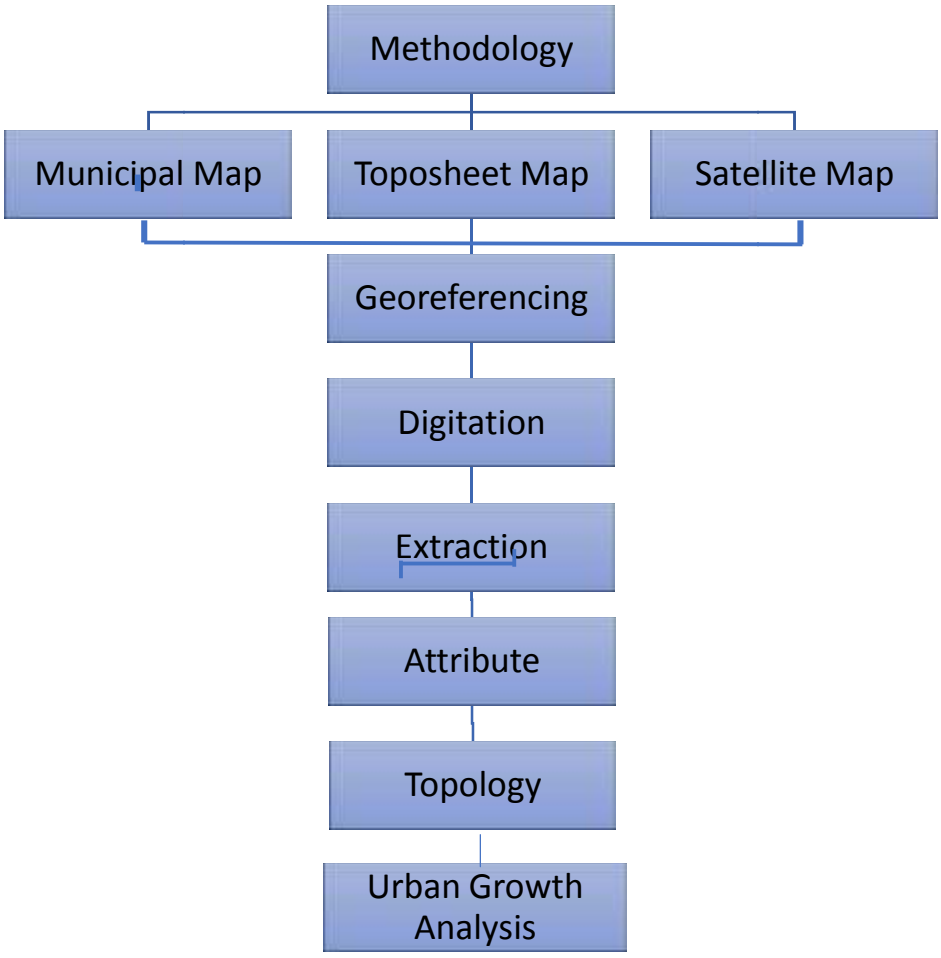


Figure 2.1 Conceptual Frame Work of the Study

2.5. Classification of the Land Cover

Based on the field verification, the visual interpretation of the satellite data and the topo sheet, the following land cover classes for land use classification are identified in the study area:

1. **Barren Land** - This is a place where there is little vegetation, no water, and no other living things. These places can be found in deserts, rocky areas, or other types of barren land. They can be difficult to get to and explore because of their rugged terrain.
2. **Bush** - There are areas of dense vegetation covered by small trees, shrubs, and other plants. These areas are often found in grasslands and savannas, and can provide habitat for a variety of wildlife. Bushes can also be used for firewood, medicine, and other purposes.
3. **Cliff/Cutting** - This type of land cover is found in areas with steep vertical slopes or sharp changes in elevation. These areas can be found along riverbanks, in mountainous regions, or along roads where cuts have been made through hills and other elevated terrain. Cliff/cutting areas can be dangerous to navigate and can pose a risk of landslides or rock falls.
4. **Cultivated Land** - This refers to farmland or agricultural areas. These areas can include fields where crops are grown or pastures where livestock is raised. Cultivated land is important for providing food and other resources for humans and animals, and is a key part of many economies.
5. **Edge of Water body** - The edge of a body of water can refer to the interface between a body of water and the surrounding land. This can include beaches, riverbanks, and lake shores. The edge of a body of water can provide habitat for a variety of wildlife and can also be used for recreational activities such as swimming and fishing.
6. **Forest**-Forest is an area dominated by trees and other shrubs. Forests can take many forms, including tropical rainforests, temperate forests, and boreal forests. They are important for providing habitat for wildlife, absorbing carbon dioxide from the atmosphere and producing oxygen.
7. **Grass Area** - This refers to grassy areas where livestock can graze. These areas provide important habitat for many animals, as well as helping to store carbon.
8. **Pond**-Pond can be a small body of water that is often created artificially for irrigation or other purposes. Ponds can provide habitat for a variety of aquatic plants and animals, and can also be used for recreational activities such as fishing and swimming.
9. **Sandy Area** - Sandy areas are areas covered by sand or other loose sediments. They can take many forms, including sand dunes, beachfronts, and deserts, and

are important for providing habitat for a variety of specialized plant and animal species.

10. **Built up** - This refers to areas with a high concentration of man-made structures, such as buildings, roads, and other infrastructure. These areas can have many benefits, such as providing space for human activities and supporting the economy, but they can also have negative impacts on the environment. For example, air pollution, habitat destruction, and water pollution can all increase in these areas.

CHAPTER III
LITERATURE REVIEW

3.1. Literature Review

Urbanization is a global phenomenon, with more people living in urban areas than ever before (United Nations, 2018). Urbanization has been driven by a range of factors, including population growth, rural-urban migration, and economic opportunities (Angel et al., 2011). As a result, cities have become the engines of economic growth and development, but they also pose significant challenges such as increased demand for housing, infrastructure, and services, which can strain already limited resources and lead to social, economic, and environmental issues (UN-Habitat, 2016). This literature review will examine the key factors driving urban change and the challenges associated with it, with a focus on the case of Nepal.

Urban growth is also referred as irresponsible, and often poorly planned development that destroys green space, increases traffic, contributes to air pollution, leads to congestion with crowding and does not contribute significantly to revenue, a major concern. Increasingly, the impact of population growth on urban sprawl has become a topic of discussion and debate. Typically, conditions in environmental systems with gross measures of urbanization are correlated such as population density with built-up area (Smart Growth America, 2000; The Regionalist, 1997). The relation of population growth and urban sprawl is that the population growth is a key driver of urban sprawl.

Recently, emerging nations like China (Yeh and Li, 2001; Cheng and Masser, 2003) and India (Barnes et al., 2001, Hurd et al., 2001; Epstein et al., 2002) have undertaken the research on urban sprawl (The Regionalist, 1997) (Jothimani, 1997 and Lata et al., 2001). Nowadays, 17% of people reside in urban areas in Nepal alone (Census of Nepal, 2011), while it is projected that in the next 20 years about 50% would be living in urban centers. This rapid urbanization presents a significant challenge for the country, as it strains existing infrastructure, puts pressure on limited land resources, and creates social and economic disparities between urban and rural areas. The impacts of this urban growth on the environment, public health, and quality of life for

urban residents are also major concerns that need to be addressed. Therefore, understanding the driving factors behind urban growth and its impacts is crucial for effective urban planning and management in Nepal. The spatial patterns of urban sprawl over different time periods, can be systematically mapped, monitored and accurately assessed from satellite data along with conventional ground data. The physical expressions and patterns of sprawl on landscapes can be detected, mapped, and analyzed using remote sensing and geographical information system (GIS) technologies. The patterns of sprawl are being described using a variety of metrics, through visual interpretation techniques, all with the aid of software and other application programs. The earth scientists with the Northeast Applications of Useable Technology in Land Use Planning for Urban Sprawl (NAUTILUS) program are using techniques of statistical software to characterize urbanizing landscapes over time and to calculate spatial indices that measure dimensions such as contagion, the patchiness of landscapes, fractal dimension, and patch shape complexity (Hurd et al., 2001; NAUTILUS 2001). Hurd et al. (2001) concentrated on a technique to produce graphics showing the pattern of urban growth and forest fragmentation from the deduced classifications of satellite data.

The effects of urban patterns on ecosystem dynamics should concentrate on how physical changes, such as patch structure, on an urban to rural gradient affect ecological circumstances (such as species composition). Although existing applications do not discriminate between various urban patterns, gradient analysis might be used to analyze the urban-to-rural gradient of land-use intensity to explain the continuum of forest change from city centers to non-urban locations (Alberti et al., 1999). Most studies on the consequences of urbanization do not differentiate between various urban designs. Planners must have a thorough grasp of ecology in order to make decisions that will mitigate the impacts of inevitable urban growth. Governments, businesses, developers, and urban people all make decisions that affect patterns. The spatial pattern is one of these environmental factors (among a very small number) that can be partially modified by land-use planning. Urban ecological research will struggle to understand and implement design solutions for reducing ecological repercussions if spatial pattern issues are not addressed.

The vast majority of studies on the negative impacts of urbanization do not differentiate between various urban designs. To make decisions that will lessen the

impacts of inevitable urban growth, planners need to have a thorough grasp of ecology. Decisions are made that affect patterns by urban people, businesses, developers, and governments. The spatial pattern is one of these environmental factors that can be partially impacted by land-use planning (among a very small number)(Claremont and Jiang, 2001). Urban ecology research will continue to be limited in its understanding of and ability to apply design solutions for reducing ecological repercussions if spatial pattern issues are not addressed(Lo and Yang, 2002). Rural settlement has a linkage with the urban environment; it has its own complex entity of the distribution of buildings by which people attach themselves to the land for the purpose of primary production (Stone, 1965).

Population growth is one of the main factors driving urban change. The rapid growth of the world's population has led to an increase in the number of people living in cities, particularly in developing countries (Cohen, 2006). Rural-urban migration is another key factor, as people move from rural areas to urban centers in search of better economic opportunities and access to services (Angel et al., 2011). Economic growth and globalization have also contributed to urbanization, as cities become hubs of trade, investment, and innovation (Jacobs, 1961).

The world is undergoing the largest wave of urban growth in history. According to the United Nations Population Fund (UNFPA, 2013), rapid population growth has been concentrated in towns and cities of the world. The report also projected that by the year 2030 the vast majority of this growth will be observed in the developing world of Africa and Asia where urban growth is highly concentrated. Because cities offer a lot of opportunities such as jobs and sources of income than the corresponding rural areas, they attracted a lot of people.

Koirala (2010) has shown the trend of land use has showed significant decline in forest area, remarkable increase in urban area and a slight decline of agricultural area in Kathmandu valley. The urban area including residential and industrial area have increased significantly from 3096 hectors in 1984 to 12367 hectors in 1998. This increase has been mainly at the expense of the agricultural land mostly in the valley floors, flood plain area, tars and level terraces. He has further showed that if all the factors remain constant, the trend of urbanization will continue, most of the crop land will be lost and covered by the urban area in 2020.

Meyer and Turner (1994) Land use affects land cover and changes in land cover affect land use. A change in either however is not necessarily the product of the other. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere.

Land use and land cover changes became prominent as a research topic on the global environmental change several decades ago with the idea of processes in the earth's surface influence climate. In early 1980's the significance impact of land use and land cover change on the global climate via carbon cycle was understood where terrestrial ecosystems acted as a source and sinks due to the changes. Following this, the forthcoming volume of the 1991 Global Change Institute of the Office of Interdisciplinary Earth Studies (OIES) dedicated to land use and land cover changes at global level by explaining the major recent trends of changes, their consequences in environment, human causes on it as well as data and modeling of changes (Meyer and Turner, 1992).

Urban change can have both positive and negative impacts on society, the economy, and the environment. One of the key challenges associated with urban change is the demand for housing, as more people move into cities and compete for limited resources (UN-Habitat, 2016). This can lead to informal settlements and slums, which often lack basic services such as water, sanitation, and electricity (Roy, 2011). The provision of infrastructure and services is another challenge, as cities struggle to keep pace with the growing demand (Angel et al., 2011). Urban change can also have negative environmental impacts, including air and water pollution, deforestation, and the loss of biodiversity (Grimm et al., 2008).

Later, under the support of land use and land cover change project of the International Geo sphere and Biosphere Program (IGBP) and International Human Dimensions Program on Global Environmental Change (IHDP), the research community has identified three basic issues. These understood the causes of land use and land cover changes, how to quantify it and how to apply models of predicting the changes (Lambin et al, 2003).

In Nepal, urbanization is a relatively recent phenomenon, with only around 17% of the population living in urban areas (Census of Nepal, 2011). However, the pace of urbanization has accelerated in recent years, with an annual urban growth rate of 5.5% (UN-Habitat, 2016). This rapid urbanization has led to a range of challenges, including the proliferation of informal settlements and slums, inadequate provision of basic services, and environmental degradation (Karki & Nishimura, 2019). Urban planning and management have been identified as key areas for intervention to address these challenges (UN-Habitat, 2016).

Changes in land use and land cover caused through direct and indirect consequences of human activities on the environment for the purpose of having better life. One of the direct impacts of humans is population growth where its increase and decrease have effects on land use especially in developing world at longer time scales. According to Lambin et al (2003), it can also be caused by the mutual interactions between environmental and social factors at different spatial and temporal scales as land use and land cover change is a complex process.

Urban change is a complex and multifaceted phenomenon, driven by a range of factors and associated with a variety of challenges. Understanding the drivers and impacts of urban change is crucial for developing effective policies and strategies to manage it sustainably. The case of Nepal provides an interesting example of the challenges associated with rapid urbanization in a developing country, and highlights the need for effective urban planning and management to address these challenges.

CHAPTER IV
ENVIRONMENTAL SETTINGS

4.1. Physical Environment

4.1.1. Location

Nepal is a small, landlocked country situated in the southern part of Asia. The country is approximately 147,181 square kilometers in size and is located between India in the south, east, and west, and the Tibetan region of the People's Republic of China in the north. The country is known for its diverse geography, which includes mountains, hills, and valleys.

Shuklagandaki, located in the Tanahun district of Gandaki province, is a small municipality in the hilly region of Nepal. The municipality is approximately 8 km in length and 25 km in breadth, covering a total area of 124 sq. km. The geographic location of Shuklagandaki municipality falls between 28° 04' 12"N- 28^0 04'42"N latitude and $84^0$05'24"-$84^0$11'40" E longitudes. (Fig 3.1).

The hilly terrain of Shuklagandaki municipality presents various opportunities and challenges for its inhabitants. The municipality is home to a diverse range of flora and fauna, including many endangered species. However, due to the increasing urbanization and population growth, there is a growing concern for the sustainability of the municipality's natural resources. Additionally, the municipality's hilly terrain and limited access to resources make it difficult for the local government to provide basic services such as healthcare, education, and transportation to its residents.

Understanding the geography and location of Shuklagandaki municipality is essential for analyzing the impact of urbanization and population growth on its natural resources and infrastructure. The geographic data and information collected can help urban planners and decision-makers develop effective policies and strategies to ensure the sustainable development of the municipality.

4.1.2. Relief Feature

Shuklagandaki municipality is located in the hilly region of Nepal, which is known for its diverse and unique biodiversity. The municipality stretches from an elevation of 550 meters above sea level to 1542 meters above sea level (Fig. 3.2,). The diversity in altitude and climate results in a variety of vegetation and wildlife. The weather in Shuklagandaki is influenced by the monsoon, which brings rainfall from the end of June until September. In addition, rainfall also occurs due to western winds from *Poush* to *Magh*. The temperature varies throughout the year, with summer temperatures reaching up to 38 degrees Celsius and winter temperatures dropping to a minimum of 5 degrees Celsius. On average, the temperature throughout the year is around 18 degrees Celsius. The winter days are characterized by thick fog, while summer days are sunny and hot. The unique biodiversity of Shuklagandaki municipality can be attributed to its location in the hilly region of Nepal, which is characterized by steep slopes deep valleys, and rugged terrain (Fig. 3.3, 3.4). The vegetation in the area varies from tropical forests to temperate forests, and subalpine forests with rhododendron, oak, and pine trees. The area is also home to a variety of wildlife, including deer, wild boar, monkeys, and different species of birds. The region has also been designated as an Important Bird and Biodiversity Area (IBA), due to the presence of threatened bird species such as the Himalayan monal and cheer pheasant.

The weather in Shuklagandaki municipality is greatly influenced by the monsoon, which brings heavy rainfall to the region. The heavy rainfall can cause landslides, flash floods, and other natural disasters, which can have a significant impact on the local communities. The temperature in the region is relatively moderate throughout the year, making it suitable for agriculture and other economic activities. The region is known for its production of rice, wheat, maize, and other crops.

Overall, the unique biodiversity, climate, and geography of Shuklagandaki municipality make it an important area for ecological research and conservation. It also provides opportunities for ecotourism, which can contribute to the local economy while promoting conservation efforts. However, it is important to manage the natural resources in the area in a sustainable manner to ensure their long-term viability and the well-being of local communities.

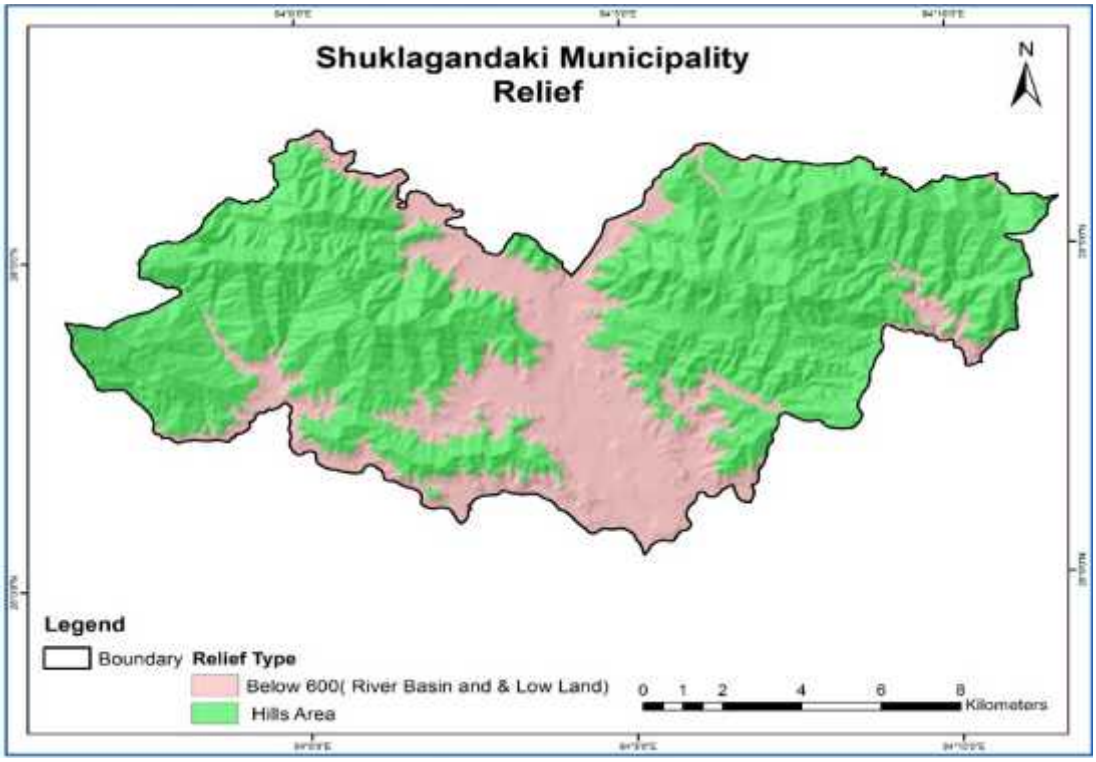


Figure 4. 1 Relief map of the study area

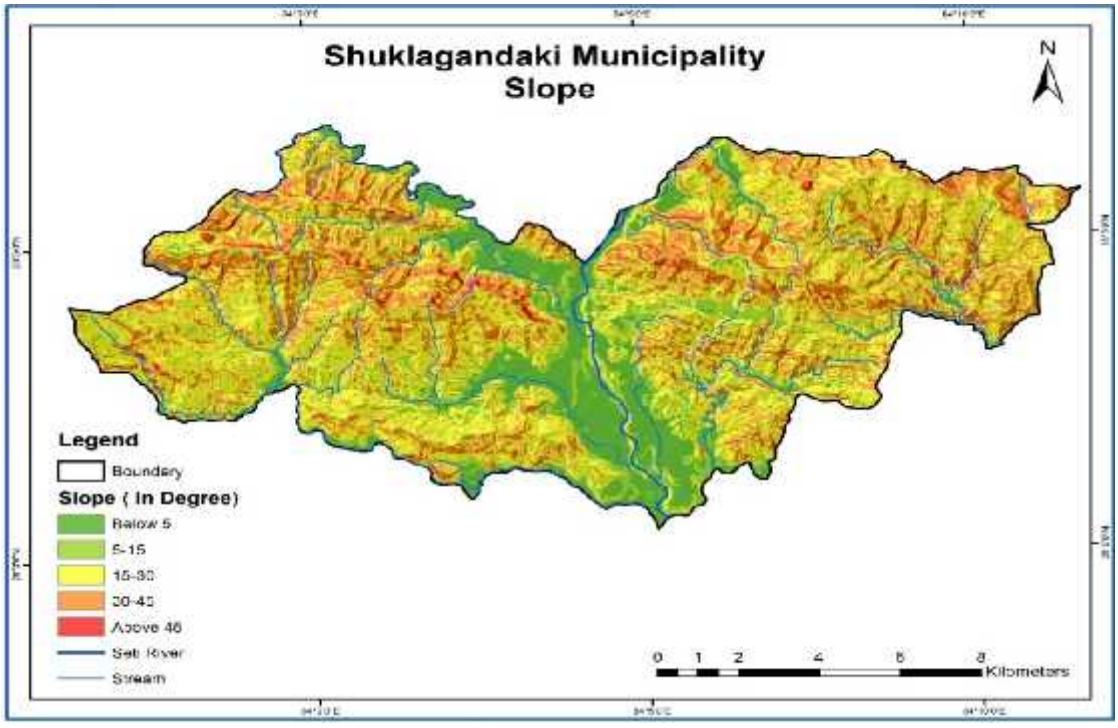


Figure 4. 2 Slope Map of the Study Area

4.1.3. Drainage Pattern

The Shuklagandaki municipality is blessed with an abundant supply of natural water resources such as rivers, ponds, lakes and mountains. The Seti River and its tributaries are the major sources of water in the region. The Seti River enters from the

northern portion of the municipality and dissects the area into two parts. The major tributaries of Seti River, such as Suraudi, Kotre, Dhorbharai, Kumle, and Kangdi Khola, are important water resources in the region.

Apart from the Seti River, other rivers such as Myagde Khola, Syangdi Khola, Baraha Khola and Suraudi Khola also flow into this river (Fig. 3.5). Additionally, three rivers, namely Kotre river, Haledhi river, Gachyepani, Kumle, and other rivers, are also major water resources in the region. These rivers play a significant role in providing water for irrigating fields and as a source of drinking water.

Water resources are essential for human life and are the basis of human civilization. The centers of human civilization are the places with water resources. Therefore, water resources are a hallmark of human development and an indispensable necessity of life. The municipality of Shuklagandaki has received assistance to maintain the required supply of water from the above-mentioned water resources, environmental cleanliness and beauty.

Overall, the natural water resources of the Shuklagandaki municipality play a crucial role in the development and growth of the region. They provide essential resources for agriculture, industry, and other human activities. It is important to protect and conserve these resources for the sustainable development of the region.

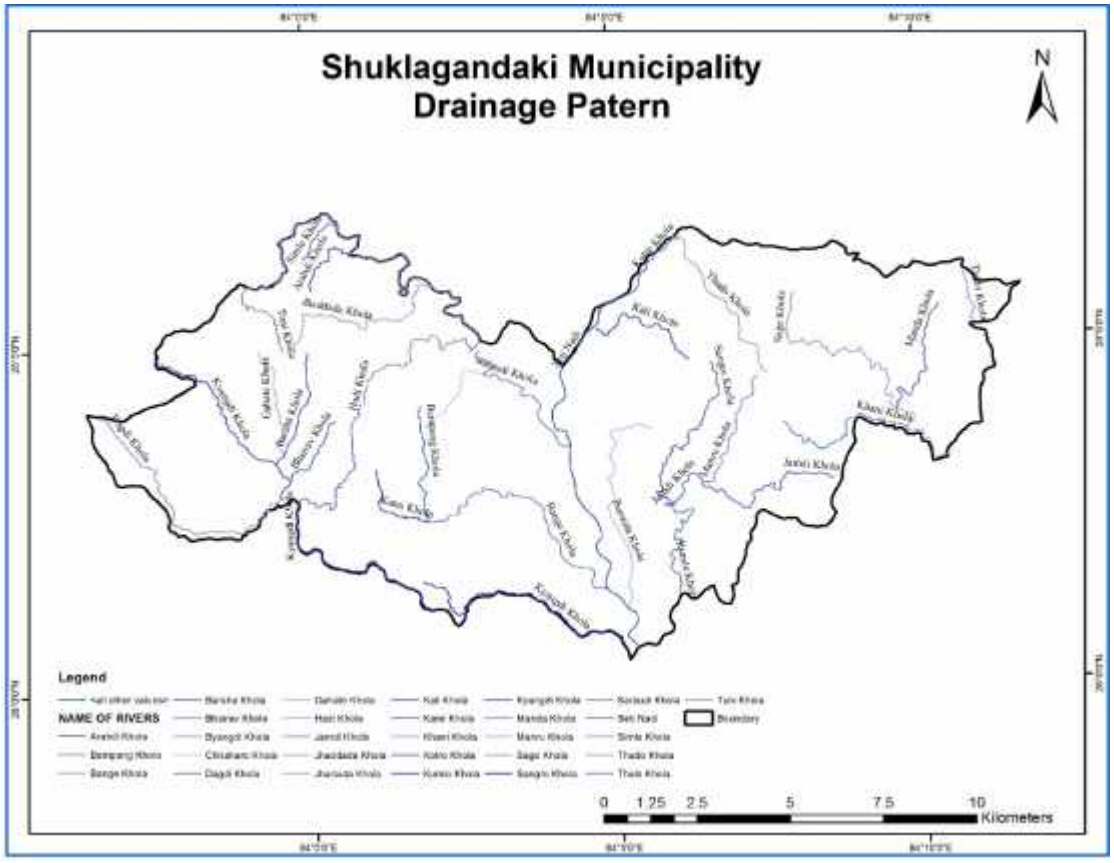


Figure 4. 3 Drainage Pattern Map of the Study Area

4.1.4. Climate

The climate of Shuklagandaki and nearby areas can be broadly classified as sub-tropical monsoon and cool temperate types. The region experiences four seasons: summer, monsoon, autumn, and winter. The summer season starts from June and lasts until August. During this season, the temperature is high, ranging from 25 to 35 °C. The climate is hot and wet, and the humidity level is high. The hot weather during the summer season can sometimes cause discomfort, and people prefer to stay indoors during the day.

The monsoon season starts from July and lasts until September. During this season, the region receives a high amount of rainfall. The precipitation level is much higher in Shuklagandaki and nearby areas as compared to other parts of Nepal. Lumle, a place located 23 kilometers away from the boundary of the study area, receives the highest amount of rainfall (> 5600 mm/year or 222 inches/year) in the country. The monsoon season brings much-needed relief from the scorching summer heat, and the temperature drops down to a comfortable level.The autumn season starts from

October and lasts until November. During this season, the climate is mild and pleasant. The sky is clear, and the air is dry. The temperature during this season ranges from 15 to 25 °C (Table 5.1). This is the best time to visit Shuklagandaki and nearby areas for trekking and hiking activities.

The winter season starts from December and lasts until February. During this season, the temperature drops down to as low as 5 °C. The climate is generally cold and dry, and the skies are clear and sunny. The winter season brings a unique charm to the region, and the snow-capped mountains look stunning. The winter season is also the time for various festivals and cultural activities in Nepal.

In conclusion, the climate of the study area is an essential factor that shapes the natural environment, water resources, and human activities in the region. The sub-tropical monsoon and cool temperate climate types bring a unique set of challenges and opportunities for the people living in the area. Understanding the climate patterns and their effects on the region can help policymakers, researchers, and other stakeholders make informed decisions regarding sustainable development and adaptation to climate change.

Table 4. 1: Year wise Maximum Minimum Temperature data around Shuklagandaki (2009-2021)

Years	Maximum Temperature		Minimum Temperature	
	°C	Month Day	°C	Month Day
2009	33.5	25-Apr	5.2	3-Jan
2010	34	21-Apr	3.5	30-Dec
2011	34.5	31-May	4.6	14-Jan
2012	34.5	23-Jun	4.8	22-Jan
2013	34	30-May	4.5	15-Jan
2014	33.6	9-Apr	3.2	1-Feb
2015	35	24-Apr	5.5	1-Jan
2016	33.8	21-Apr	5.5	25-Dec
2017	33	23-Jun	2.8	27-Dec
2018	34.2	30-May	0.5	12-Jan
2019	34.2	12-Apr	2.4	11-Jan
2020	35.4	14- Jun	5.5	23-Dec
2021	38.5	18- Jun	5.6	21- Jan

Source: Hydrology and Meteorology Office, Pokhara 2022

Table 4.1provides the maximum and minimum temperature data for the years 2009 to 2021 around Shuklagandaki municipality. The data is based on the observations made at the local weather stations, and it gives us an idea of the temperature patterns in the area over the past decade.

The table shows that the maximum temperature in the region ranges from 33°C to 38.5°C, with the highest recorded temperature being in June 2021. The minimum temperature ranges from 0.5°C to 5.6°C, with the lowest recorded temperature being in January 2018. The maximum temperature generally occurs in the months of April to June, while the minimum temperature generally occurs in December and January.

From the data, it is clear that the temperature in the study area varies considerably from year to year, with no clear trend over the past decade. The highest maximum temperature was recorded in 2021, while the lowest minimum temperature was recorded in 2018. These fluctuations could be due to a range of factors, including variations in weather patterns, changes in land use, and human activity.

It is important to note that the temperature data presented in the table is only for the Shuklagandaki municipality and its surrounding areas. Other parts of Nepal may experience different temperature patterns depending on their location and altitude.

Overall, the temperature data presented in Table provides useful information for understanding the climate of the study area. It can be used to inform decision-making and planning related to agriculture, tourism, and other sectors that are affected by temperature patterns.

Table 4. 2: Temperature and Precipitation data 2021 around Shuklagandaki

Month	Max. Temperature °C	Min. Temperature °C	Precipitation inches
Jan	18.3	10.2	10.6
Feb	24.9	12	54.4
Mar	28.1	15.8	30.1
Apr	30.2	16	114.3
May	31	19.6	277.3
Jun	38.5	24	623.1
Jul	30.9	22.7	773.9
Aug	31.1	22.5	420
Sep	31	21.3	289.2
Oct	27.7	18.5	183.4
Nov	24.3	11.4	12.3
Dec	20.5	5.5	1.3
Total			**2789.9**

Source:http://www.mfd.gov.np/city (2022)

The Table 4.2 presents temperature and precipitation data for the year 2021 around Shuklagandaki. The data has been collected on a monthly basis, starting from January and ending in December.

The maximum and minimum temperatures vary throughout the year. In January, the maximum temperature was recorded as 18.3 °C, while the minimum temperature was 10.2 °C. The highest maximum temperature was recorded in June, which was 38.5

°C, while the lowest minimum temperature was recorded in December at 5.5 °C. Overall, the temperature range in the study area was between 5.5 °C to 38.5 °C.

The precipitation data for the region is also provided in the table. Precipitation is measured in inches and the data indicates that the area receives a significant amount of rainfall throughout the year. The highest amount of precipitation was recorded in July, which was 773.9 inches, while the lowest amount was recorded in December at 1.3 inches.

The data suggests that the monsoon season (June - September) brings a significant amount of rainfall to the region, with June receiving the highest amount of rainfall (623.1 inches). May and July also received a significant amount of rainfall, with 277.3 inches and 420 inches, respectively. The dry season starts from October and lasts until April, with December being the driest month with only 1.3 inches of precipitation.

In conclusion, the temperature and precipitation data for 2021 around Shuklagandaki indicate that the region has a varied climate throughout the year, with a hot and wet summer and a cold and dry winter. The area receives a significant amount of rainfall, especially during the monsoon season. The data provided can be useful for understanding the climate patterns of the region and planning for various activities.

4.1.5. Vegetation

The study area is characterized by sub-tropical forests and thatched grasses as the dominant natural vegetation. Various plant species are found in this region, including Chilaune (Schima wallichii), Katus (Castanopsis indica), Tooni (Cedrela spp.), Sisoo (Dalbergia sissoo), Pipal (Ficus religiosa), Simal (Bombax ceiba), Bamboo (Dendrocalamus strictus), and Laligurans (Rhododendron arboreum). However, due to urban expansion, natural vegetation has been significantly encroached upon. To maintain the environmental balance and meet the wood demand of the city area, Sisoo is being afforested in some barren lands (Fig. 3.5). The river terraces are covered by thatched grass, kans, and siru. The scientific names of the plant species indicate the diverse flora found in the study area, which is a significant aspect of the natural environment of the region.

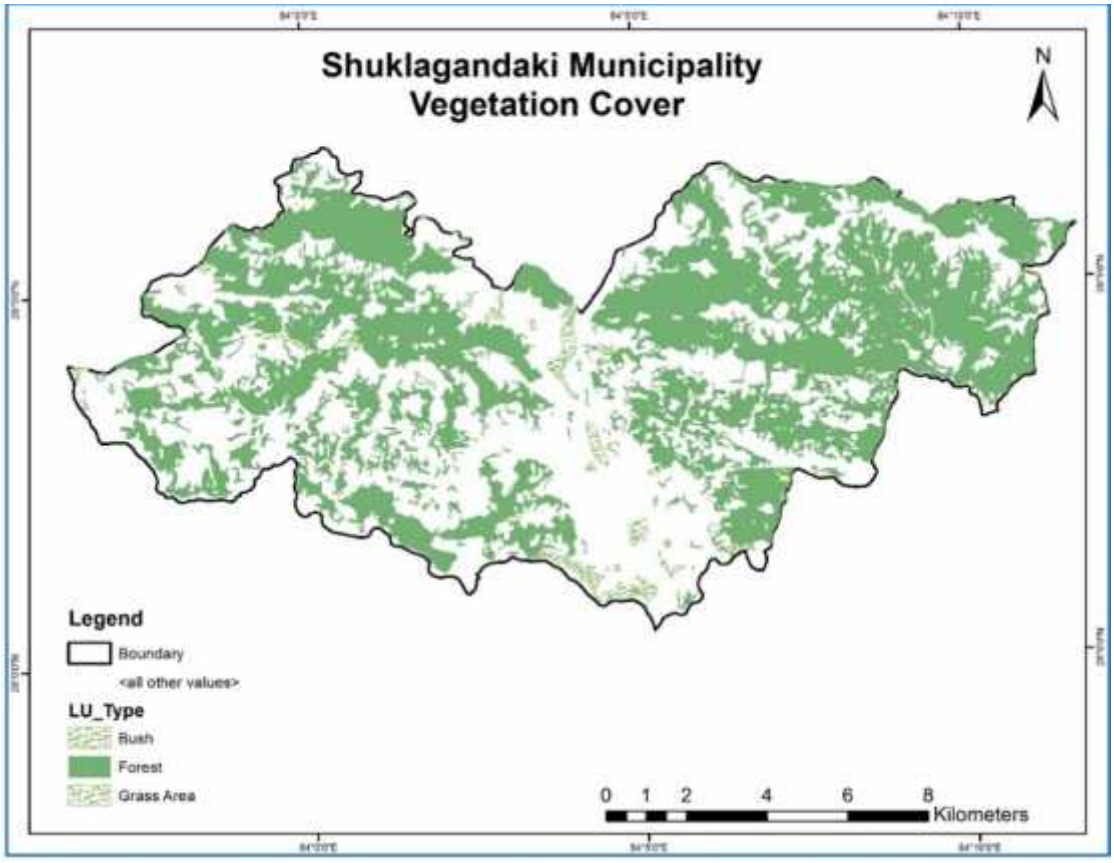


Figure 4. 1 Vegetation Cover map of the Study Area

4.2. Cultural Environment

Population is one of the most critical factors in the development of a municipality. Public participation is essential for the development of a municipality as it enables the government to understand the needs and requirements of the people living in the municipality. Shuklagandaki Municipality, located in the midland region of Nepal, has a total population of 48,456 according to the 2068 census. Out of which 43.94 percent are male and 56.06 percent are female.

The population density of Shuklagandaki Municipality is 4.02 persons per square kilometer, indicating that it is not densely populated. However, the population density has increased in some wards of the municipality, while it has decreased in others. This indicates that the population growth is not evenly distributed throughout the municipality, and some areas might face greater pressure for development and construction.

The development plan of the municipality must be expanded according to the size of the population, and the needs of the population must be addressed. The increasing population can be beneficial for the development of the municipality as it can lead to the growth of the economy and the creation of employment opportunities. However, it can also lead to the depletion of natural resources, pollution, and the degradation of the environment.

The municipality needs to ensure that the population growth is sustainable, and the development activities are carried out in an environmentally friendly manner. The government must take necessary steps to ensure that the population growth does not exceed the carrying capacity of the municipality. This can be achieved by implementing appropriate policies and regulations related to population growth and development activities.

The municipality must also involve the public in the decision-making process to ensure that the development activities are aligned with the needs and requirements of the people. The involvement of the public will help to identify the priorities for development and ensure that the development activities are carried out in a transparent and accountable manner.

In conclusion, the population situation of Shuklagandaki Municipality plays a critical role in its development. The government must take necessary steps to ensure that the population growth is sustainable and the development activities are carried out in an environmentally friendly manner. Public participation is essential for the development of the municipality, and the government must involve the public in the decision-making process to ensure that the development activities are aligned with the needs and requirements of the people.

4.2.1. Sex Structure

The age and sex characteristics of the population are dynamic. The social and economic characters of the places are determined by age - sex structure.

Table 4. 3: Age and sex structure

Age group	Female	Male	Total
Below 5 years	2033	2100	4133
5-9	2692	2774	5466
10-14	3165	3202	6367
15-18	2970	2740	5710
19-24	2641	1513	4154
25-25	7743	4024	11767
46-59	3261	2634	5895
60-69	1538	1301	2839
Above70	1101	1004	2105

Source : CBS 2011

This Table 4.3 shows how many people are in different age groups in the municipality. It is broken down by sex and totalled up. The table shows how many females, males, and total population there are in each age group.

The table shows that, overall, the municipality is slightly more populated by women than men. Out of the total population, 56.06% are female, while 43.94% are male. The highest number of people are in the age group of 25-45 years, with 11,767 individuals.

The data shows that in most age groups, there are about equal numbers of males and females. However, in the age group of 19-24 years, there are more females than males. And as people get older, the number of females continues to increase, while the number of males decreases.

The sex structure table provides information about the population in a municipality. This can help policymakers and researchers understand how the population is changing, what trends are happening, and what issues may be affecting people based on their sex or age. This information can be useful in planning and implementing policies to help the municipality grow and be successful.

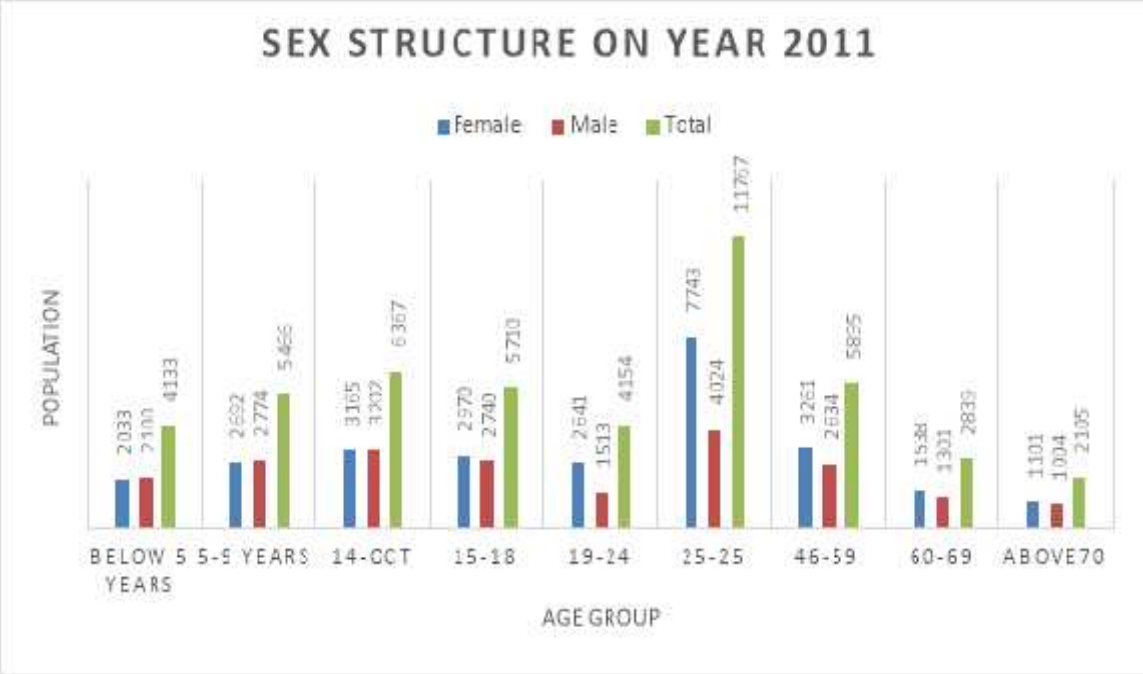


Figure 4. 2 Bar graph showing Sex structure in the study area

4.2.2. Ethnic Composition

Shuklagandaki municipality is a place where you can see a lot of different ethnic and cultural groups. This is because it is a mixture of both highland and lowland areas, which makes it very interesting. There are a lot of different castes living here, which shows how diverse the area is.

The majority of people in the municipality are from the Chhetri, Brahmin, Magar, Newar, Tharu, Tamang, Kami, Muslim, Rai, Gurung, Damai, Sunuwar, and other castes. The Magar caste is the most prevalent, followed by the Chhetri caste. This means that there are a lot of people from the Magar and Chhetri communities living in the municipality.

In the former Thaprek VDC, there are more Gurung people, Bahman people, and Tamang people. In the former Raipur VDC, the Bahman, Tamang, and Chhetri people are the most common. In the former Phirphare VDC, the Gurung, Kami, and Brahman people are the most common.

Castes in Shuklagandaki municipality come from different parts of India and have different customs and traditions too. This makes the municipality a rich cultural place where different people can live together in peace.

The municipality has a lot of cultural heritage and diversity, which makes it a popular tourist destination. There are many cultural festivals and events happening throughout the year, which celebrate the different traditions and customs of different groups of people.

The Shuklagandaki municipality is a great example of the diversity and richness of Nepal's culture and ethnic heritage. The mix of different castes and cultures here helps to create a sense of social harmony and integration, which helps to improve the region's overall development. The coexistence of different cultures is an important part of Nepal's cultural identity, and the Shuklagandaki municipality is a great example of this.

Table 4. 4: Ethnic Composition of the study area

Ethnic details	population	Ethnic details	population	Ethnic details	population	Ethnic details	population
Thaprek		Shuklagandaki		Raipur		Firfire	
Chhetri	139	Chhetri	5275	Chhetri	1548	Chhetri	90
Brahman	729	Brahman	6338	Brahman	4361	Brahman	301
Magar	151	Magar	7926	Magar	649	Magar	103
Muslim	342	Tamang	390	Tharu	173	Newar	36
Tamang	551	Newar	2911	Tamang	3461	Kami	382
kami	218	Muslim	494	Newar	1020	Rai	15
Gurung	823	kami	3984	Muslim	30	Gurung	1691
Damai	152	Rai	267	kami	547	Damai	167
Thakuri	124	Gurung	3806	Rai	34	Thakuri	217
Sarki	51	Damai	1270	Gurung	492	Sarki	51
Sanysi	140	Thakuri	1042	Damai	364	Gharti	159
Gharti	39	Sarki	1057	Kumal	961	Others	23
Sunuwar	34	Kumal	1665	Sunuwar	122		
Others	9	Gharti	842	Others	59		
		Others	181				
Total	2,951	Total	38,307	Total	14,324	Total	3,235

Source: Tanahun District profile, 2072 B.S.

4.2.3. Mother tongue Language status

Nepal is a country with a rich and diverse culture, and Shuklagandaki municipality is no exception. Nepali is the most commonly spoken language in the municipality, but there are also significant populations of Gurung and Magar speakers, reflecting the ethnic diversity of the region. Additionally, Newari and Urdu are spoken in the municipality, as these languages are not as widely spoken in other parts of Nepal.

The presence of multiple language communities in Shuklagandaki municipality underscores the importance of language in shaping the identity and culture of a place. Language is not just a means of communication, but it also reflects the history, traditions, and beliefs of a community. As such, it is important to recognize and celebrate the linguistic diversity of Nepal and ensure that all language communities are given equal opportunities to thrive.

Table 4.5: Mother tongue language spoken in the study area

Mother tongue language	Male	Female	Total	Total Percentage
Nepali	15813	20120	35933	74.16%
Maithaili	13	9	22	0.05%
Bhojpuri	136	46	182	0.38%
Tharu	47	27	74	0.15%
Tamang	74	81	155	0.32%
Newari	591	700	1291	2.66%
Magar	1774	2519	4293	8.86%
Gurung	2141	2906	5047	10.42%
Urdu	281	311	592	1.22%
Hindi	74	42	116	0.24%
Kumal	89	111	200	0.41%
Thakali	11	17	28	0.06%
Rai	67	42	109	0.22%
Kham	65	93	158	0.33%
Lowa	28	28	56	0.12%
Others	23	21	44	0.09%
Unknown	65	91	156	0.32%
Total	21292	27164	48456	100.00%

Source: Tanahun District profile 2072

The largest language group in the municipality is Nepali, which accounts for 74.16% of the total population. Magar and Gurung are the next two most common languages

spoken in the municipality, accounting for 8.86% and 10.42% of the population, respectively. It's worth noting that the data only includes male and female categories and does not account for any other gender identities. Additionally, the data only considers mother tongue language and does not account for individuals who may speak multiple languages or may not speak their mother tongue fluently. The given data represents the population distribution in Shuklagandaki municipality based on mother tongue language. The data includes the number of males, females, and the total population for each language group. The total percentage column represents the percentage of the population that speaks each language, calculated based on the total population of 48,456. Newari, Tamang, and Urdu are also spoken by a significant portion of the population, with each language accounting for more than 1% of the total population. The remaining language groups each account for less than 1% of the population.

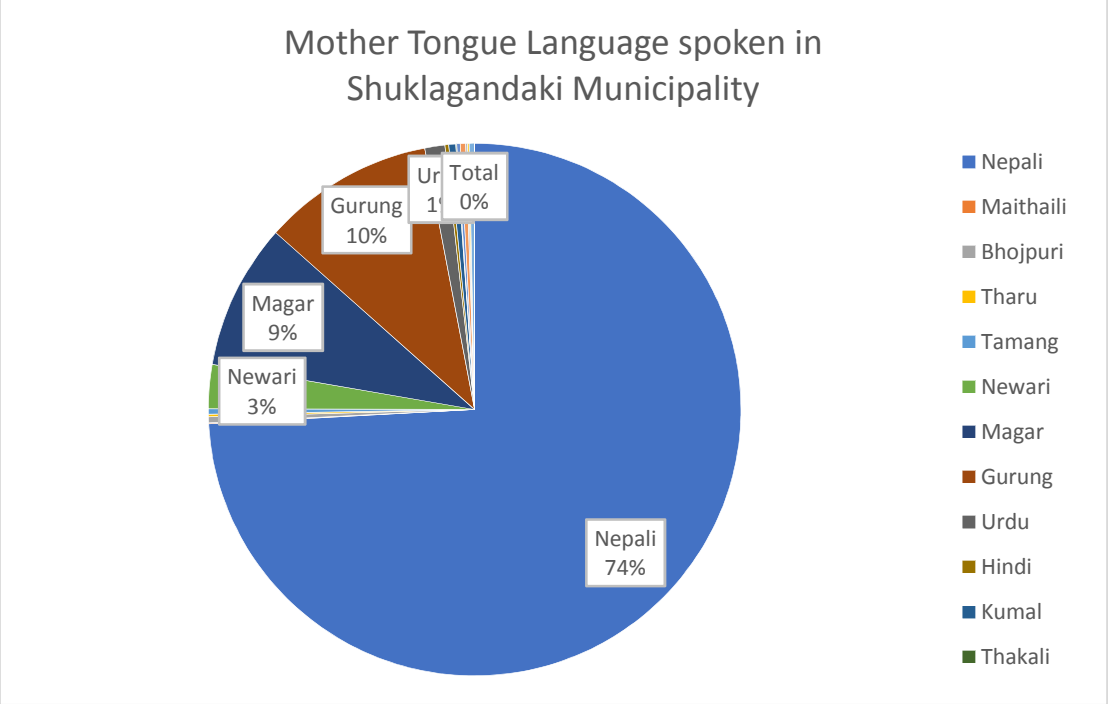


Figure 4.6. Mother tongue language spoken in the study area

4.2.4. Educational Status

The municipality of Shuklagandaki is considered to be one of the brightest educational lands in the country. It is also the identifying area of Tanahu district. As the birthplace of Adikavi Bhanubhakta's district and a municipality located in a

district which has developed in the language, adequate educational fields have been established and operated in this region. So far, 13 campuses are being operated for higher education in the region, but no world-class educational institution has been established. Educational details of the municipality:

Table 4. 6: Educational Institute in the study area

Details	Public	Community	Private	Total
Primary school		327	52	379
Basic level school		73	35	108
Secondary school		108	55	163
Campus		9	4	13
Child development center	254	93	149	496
Community study center		15		15

Source: CBS, 2011

The table includes data for Child Development Centers (CDCs) and Community Study Centers (CSCs), which are alternative education programs for children and adults, respectively. There are a total of 496 CDCs and 15 CSCs in the municipality.

In terms of ownership, the table shows that there are no public schools in the municipality, while there are 327 community-owned primary schools, 73 community-owned basic level schools, 108 community-owned secondary schools, and 9 community-owned campuses. Additionally, there are 52 privately-owned primary schools, 35 privately-owned basic level schools, 55 privately-owned secondary schools, and 4 privately-owned campuses.

Overall, the table indicates that the majority of educational institutes in Shuklagandaki Municipality are community-owned, with a smaller number of private institutions.

CHAPTER V
URBAN GROWTH AND LANDUSE CHANGE

Changes in the land cover have an impact on land usage, and the reverse is also true. Yet, a change in one does not always result from the other. Land degradation is not always implied by changes in land cover brought about by land use. Yet, a number of changing land-use patterns brought on by many societal factors lead to changes in land cover that have an impact on biodiversity, water and radiation budgets, trace gas emissions, and other processes that ultimately affect climate and the biosphere (Riebsame et. al 1994).

Nepal has low level of urbanization in terms of both urban population and number of towns. According to Census 2011, the urban population (population residing in 58 municipalities) constitutes 17 % (4,523,820) of the total population whilst it was 13.94% (3,227,879) according to census 2001. In the 18^{th} century, urban centers in Nepal were developed mainly in Kathmandu valley, Patan, Bhaktapur, Thimi and Kirtipur were the main urban centers in the Kathmandu valley. After the unification of Nepal, Butwal, Tansen Ilam, Bandipur, and different places connected to India and China (Tibet) were emerged as the trade centers outside Kathmandu valley. (Deubler, Stephanie, et al. 2013).

Although Nepal is very small on the world map, it is rich in biodiversity, natural beauty and eco-tourism. Shuklagandaki municipality of Tanahun district is also one of the major tourist destinations in Nepal. The area is famous for its tourism connoisseurs. The mountains and river channels of the remote area that can be seen from here are the heritage that attracts tourists to this region. The Dhorbharai temple on its own land, the temple of Tinkholoe Devi, the temple of Durga are the focal points of religious tourism in the region.

To study the temporal and geographical changes in land use and look at the processes that are causing those changes, it is vital to have access to land use statistics and transition matrices. The cartographic model was used to create a map of land usage. The areas occupied by each land use category were calculated and percentages were also determined; the results are displayed in tabular form in the figures for the three

land-use patterns maps for the years 2000, 2010, and 2020. These maps are based on photos that earth observation satellites have collected during the past three decades at various times. These graphs depict the usual LULC pattern in the research region, or, to put it another way, the urbanization process there.

5.1.Land use pattern of 2000

The land use pattern of year 2000 is expressed in the following table 4.1

Table 5.1: Land Use Pattern of Year 2000

LU Type	Area in Sq. Km	Percentage
Barren Land	0.010606	0.01%
Bush	2.093001	1.27%
Cliff/Cutting	0.262039	0.16%
Cultivated Land	76.92818	46.64%
Edge of Water body	1.353314	0.82%
Forest	77.87582	47.21%
Grass Area	1.485047	0.90%
Pond	0.002189	0.00%
Sandy Area	3.087056	1.87%
Urban	1.851341	1.12%
Total	164.9486	100.00%

Source: Land Sat Image 2000

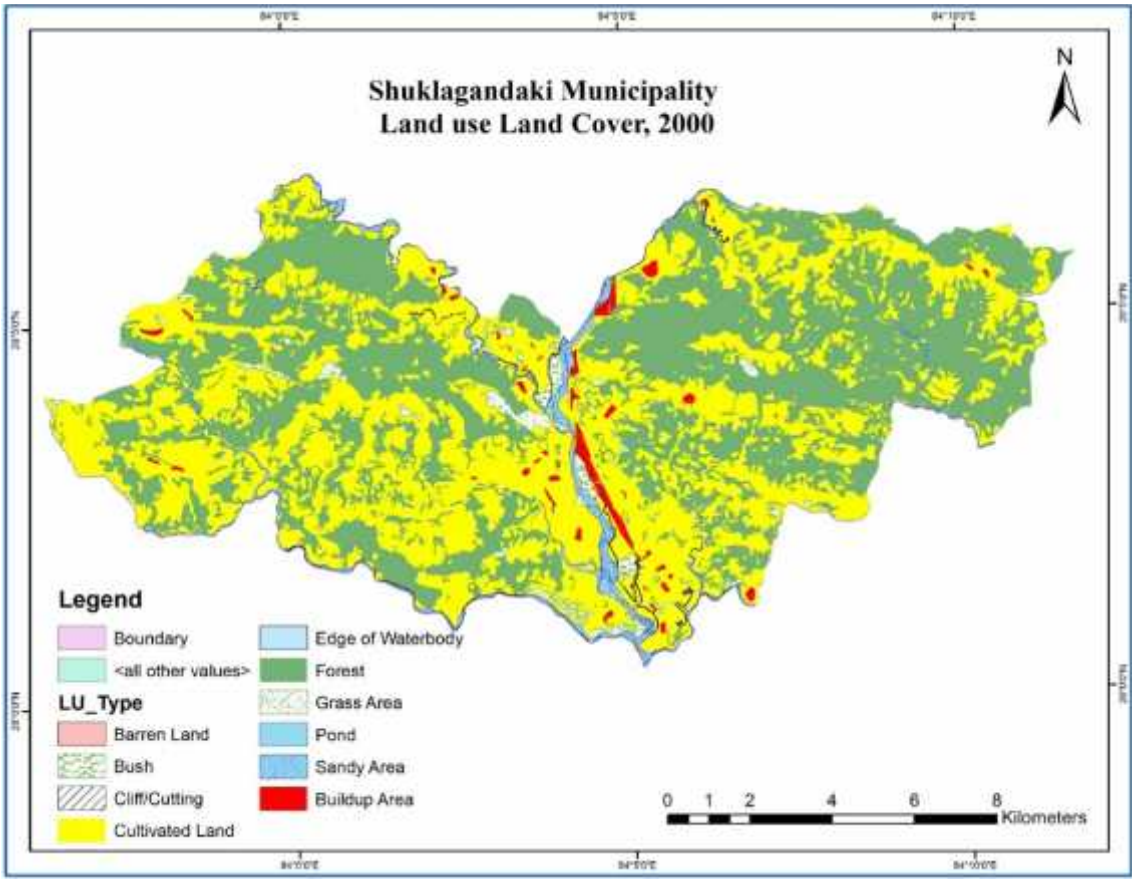


Figure 5.1 land use Land Cover of year 2000

Shuklagandaki municipality's land use pattern in the year 2000 can be analysed from the data presented in the table above. The total area of the municipality is 164.9485934 square units, and it comprises various types of land use, such as forest, cultivated land, urban areas, grass area, barren land, bush, cliff/cutting, edge of water body, pond, and sandy area.

The forest covers the largest area, with a percentage of 47.21% of the total land, while the cultivated land covers 46.64% of the land. This implies that the municipality has a significant amount of forest cover, which could contribute to the maintenance of the ecological balance in the area. The cultivated land also indicates the importance of agriculture as a primary source of livelihood for the people in the area.

The urban area covers only 1.12% of the total land, which indicates that the municipality is mostly rural. However, this may have changed over time due to urbanization and population growth, and it would be interesting to see the changes in land use pattern in the municipality in recent years.

Other land use types such as grass area, barren land, bush, cliff/cutting, edge of water body, pond, and sandy area cover a smaller percentage of the land. However, these areas may have significant ecological and environmental importance, and their preservation is essential for maintaining the overall ecological balance of the municipality.

In conclusion, the land use pattern of Shuklagandaki municipality in the year 2000 suggests the importance of forest and agriculture in the area, with a small percentage of urban areas. The study of land use patterns can help in understanding the dynamics of the environment and human activities in the area and can aid in the formulation of sustainable development plans.

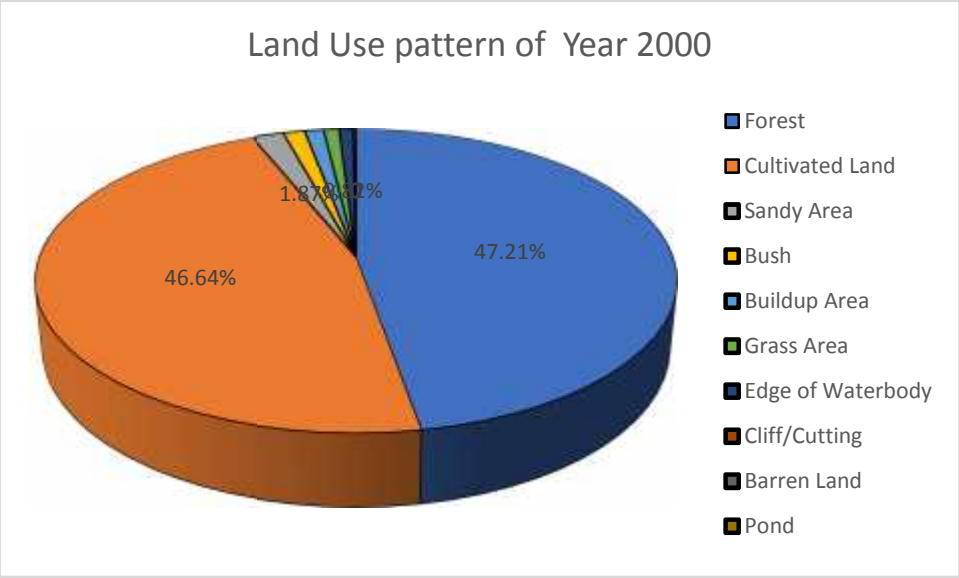


Figure 5. 2Land Use PatternoftheStudyAreain2000

5.2 Land use pattern of 2010

The land use pattern of year 2010 is expressed in the following table and the figure:

Table 5.2: Land Use Pattern of Year 2010

LU_Type	Area in Sq. KM	Percentage
Barren Land	0.0106058	0.01%
Bush	2.0930009	1.27%
Cliff/Cutting	0.2620395	0.16%
Cultivated Land	75.50394	45.77%
Edge of Waterbody	1.3504306	0.82%
Forest	77.845424	47.19%
Grass Area	1.4731968	0.89%
Pond	0.0021893	0.00%
Sandy Area	3.0475847	1.85%
Built Up	3.3601647	2.04%
Total	164.94859	100%

Source: Land Sat Image, 2010

The land use pattern of Suklagandaki municipality in the year 2010 can be described using data provided in the table. The municipality has a total area of 164.94859 square units, and it is characterized by different land use types. The most dominant land use types are forests and cultivated land, covering 47.19% and 45.77% of the area, respectively.

Forests are the largest land use type, covering almost half of the municipality's area. This indicates the importance of forests in the municipality, which could be for various reasons, such as providing ecological services, timber, and non-timber forest products. The cultivated land, covering 45.77% of the area, suggests that agriculture is a significant economic activity, in the municipality. The high percentage of cultivated land indicates that the municipality's residents rely on agriculture for their livelihoods.

Other land use types in the municipality include urban areas, grass areas, sandy areas, bushes, cliffs/cutting, barren lands, ponds, and edges of waterbodies. Urban areas and

sandy areas cover 2.04% and 1.85% of the area, respectively. This suggests that the municipality has some urban centers and that there are areas with sandy soils.

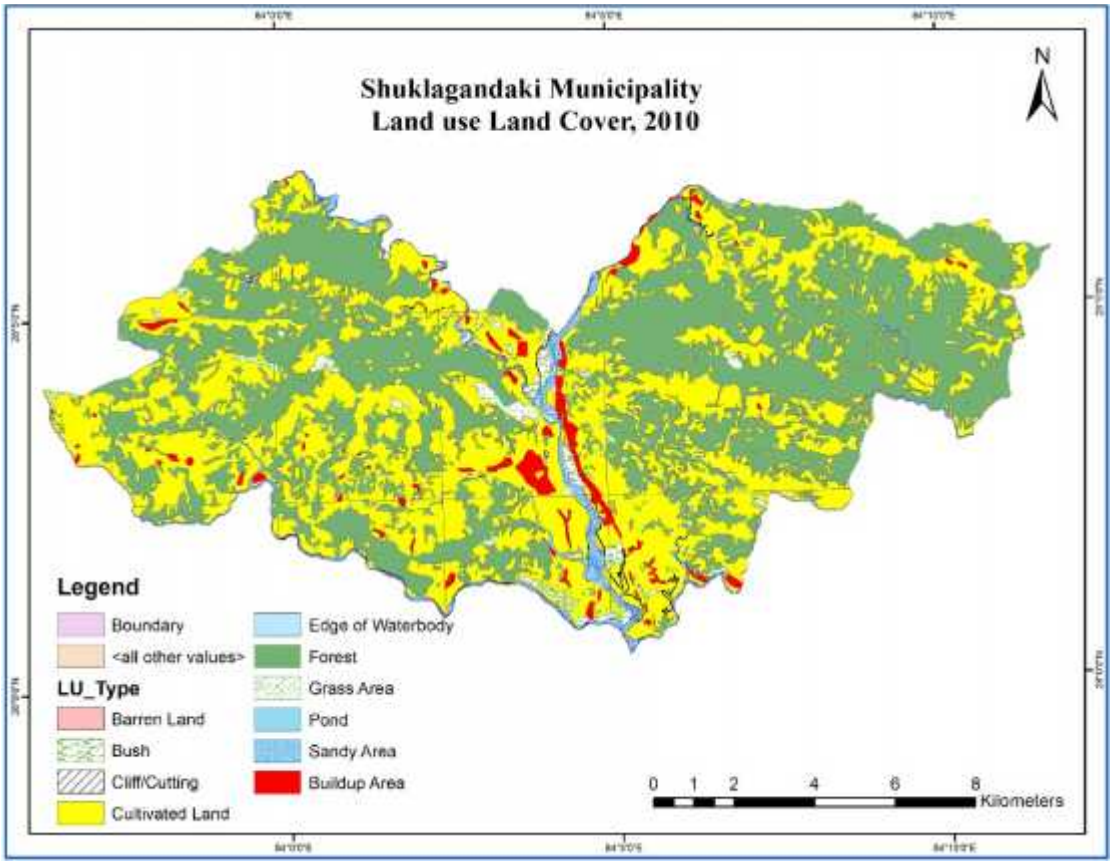


Figure 5. 3. Land use Land Cover Map of the study area 2010

Source : Land Sat Image 2010

Grass areas, bushes, cliffs/cutting, barren lands, ponds, and edges of waterbodies are less dominant land use types, covering less than 1.5% of the municipality's area. This suggests that these land use types have a limited impact on the municipality's overall land use pattern.

Understanding the land use pattern of Shuklagandaki municipality is crucial for policymakers and planners to develop appropriate land use policies and plans that promote sustainable land use practices, preserve ecological services, and enhance the livelihoods of the municipality's residents.

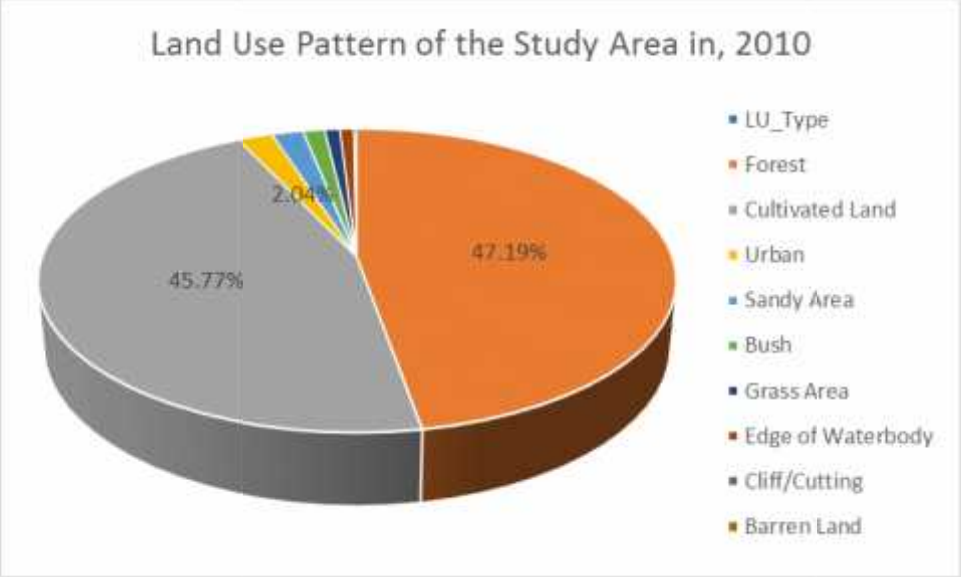


Figure 5. 4:Land Use PatternoftheStudyAreain, 2010

5.3 Land Use Pattern of year 2020

The land use pattern of year 2010 is expressed in the following table and the figure:

Table 5.3: Land use Pattern of 2020

LU_Type	Area in Sq. Km	Percentage
Barren Land	0.010606	0.01%
Bush	2.061786	1.25%
Cliff/Cutting	0.262039	0.16%
Cultivated Land	60.31932	36.57%
Edge of Waterbody	1.353314	0.82%
Forest	78.86548	47.81%
Grass Area	0.833283	0.51%
Pond	0.002189	0.00%
Sandy Area	2.93296	1.78%
Urban	18.30763	11.10%
Total	164.9486	100%

Source : Land Sat Image 2020

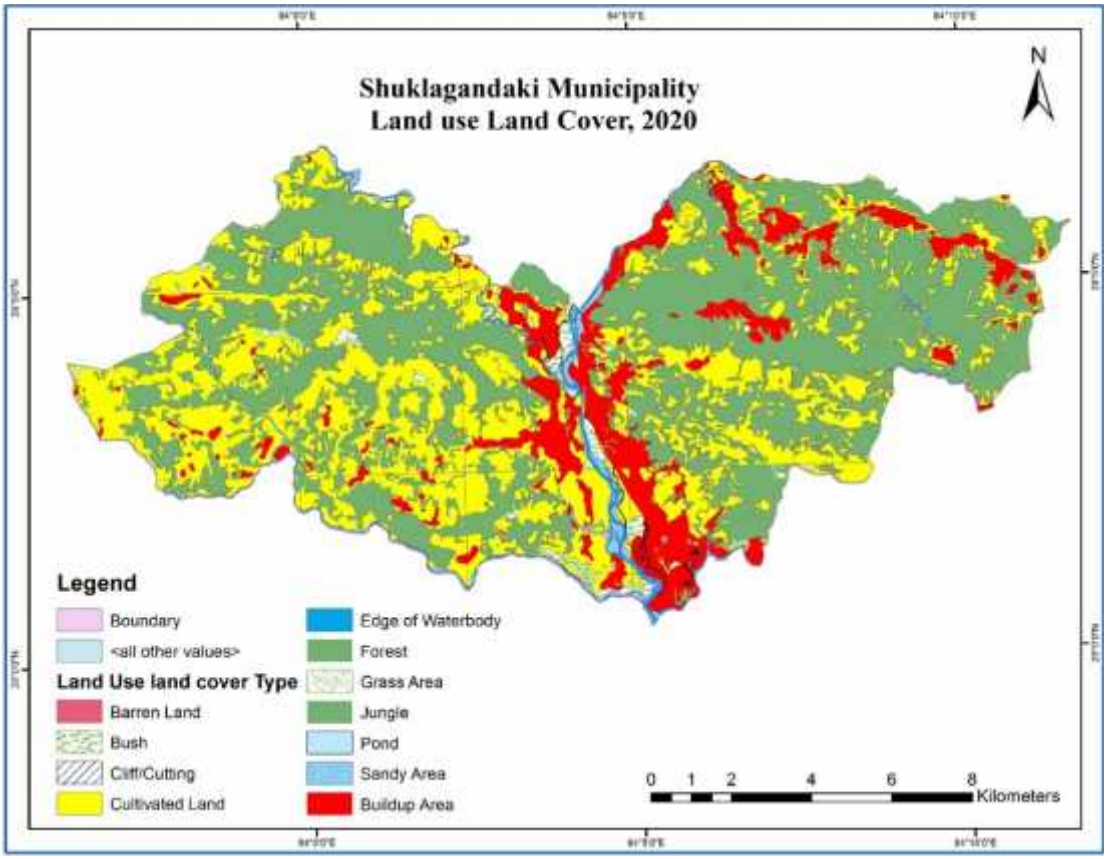


Figure 5. 5 Land use Land Cover 2020

Source : Land Sat image 2020

Land use pattern refers to the distribution of land use types in a particular area. Shuklagandaki municipality is a local administrative area in Nepal. The land use pattern of the municipality in 2020 was characterized by nine types of land uses, namely, Barren Land, Bush, Cliff/Cutting, Cultivated Land, Edge of Waterbody, Forest, Grass Area, Pond, Sandy Area, and Urban.

According to the data provided, the most dominant land use type in Shuklagandaki municipality in 2020 was Forest, which covered 47.81% of the total area. The second-largest land use type was Cultivated Land, covering 36.57% of the area, followed by Urban areas, which covered 11.10% of the area. Other land use types such as Bush, Cliff/Cutting, Edge of Waterbody, Grass Area, Pond, and Sandy Area covered less than 2% of the total area each.

Barren Land covered only 0.01% of the total area. Sandy Area covered 1.78% of the total area, and Grass Area covered 0.51%. Pond covered only 0.00% of the total area.

The land use pattern of Shuklagandaki municipality in 2020 suggests that the municipality is primarily covered by forests and cultivated land, with urban areas being developed in some parts. This information can be useful for policymakers, planners, and researchers to understand the distribution of land use types in the municipality and to plan for sustainable land use management and development.

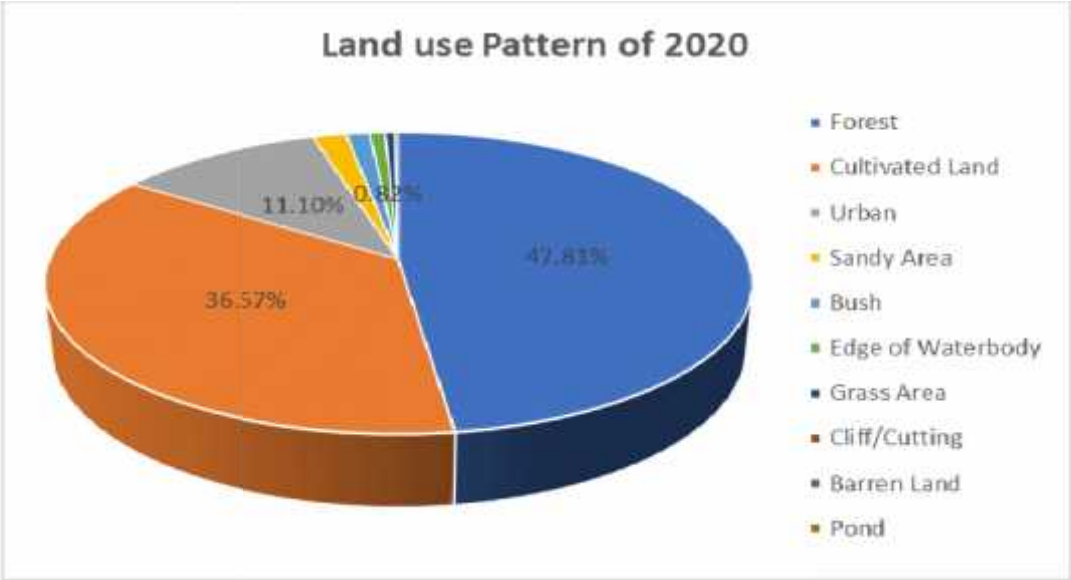


Figure 5.6 Land use pattern in year 2020

5.4 Landcoverchangeof Sandy Area from2000to2020

The land cover change from year 2000 -2020 is expressed in the following table and the figure:

Table 5.4: Land cover change of Sandy Area

Land Use Change of Sandy Area in Year	Area in Square K.M
2000	3.087056
2010	3.047585
2020	2.93296

Source : land Sat image

Based on the table 4.5, the sandy area in the Shuklagandaki Municipality has undergone significant land cover change from 2000 to 2020. The area has experienced a decrease in sandy land cover, with the area decreasing from 3.087056 square kilometers in 2000 to 2.93296 square kilometers in 2020.

The majority of the land cover change appears to be due to the conversion of sandy areas to built-up areas. Specifically, it has been reported that the sandy area in Ward Number 2 Kotre region has been converted to built-up areas.

Overall, the land cover change in the Sandy Area of Shuklagandaki Municipality from 2000 to 2020 highlights the impact of urbanization and development on natural environments. It is important to carefully manage land use and ensure that development is sustainable to minimize negative impacts on ecosystems and maintain biodiversity.

Table 5.5: Change of Sandy Area from 2000-2020

S.N	Change Type	Area in Sq. Km
1.	Sandy Area -Cultivated Land	0.008116596
2.	Sandy Area -Forest	0.000865641
3.	Sandy Area -Sandy Area	2.93295958
4.	Sandy Area -Built up area	0.156466228

Source: Land Sat Image

The changes are categorized into four types: Sandy Area-Cultivated Land, Sandy Area-Forest, Sandy Area-Sandy Area, and Sandy Area-Built up area.

Sandy Area-Cultivated Land: This category represents the change in land cover from sandy areas to cultivated land. From 2000 to 2020, there has been an increase in the area of sandy land that has been converted into cultivated land. Specifically, the area of Sandy Area-Cultivated Land has increased by 0.008116596 square kilometers.

Sandy Area-Forest: This category represents the change in land cover from sandy areas to forested areas. From 2000 to 2020, there has been a very small increase in the area of sandy land that has been converted into forested areas. Specifically, the area of Sandy Area-Forest has increased by 0.000865641 square kilometers.

Sandy Area-Sandy Area: This category represents the area that has remained as sandy areas without any land cover change. From 2000 to 2020, there has been a decrease in the area of sandy land that has remained as sandy areas without any change. Specifically, the area of Sandy Area-Sandy Area has decreased from 3.087056 square kilometers in 2000 to 2.93295958 square kilometers in 2020.

Sandy Area-Built up area: This category represents the change in land cover from sandy areas to Built up area areas. From 2000 to 2020, there has been a significant increase in the area of sandy land that has been converted into Built up area areas. Specifically, the area of Sandy Area-Built up area has increased by 0.156466228 square kilometers.

5.5 Land cover change of Forest and Grass Area from2000to2020

The land cover changes from year 2000 -2020is expressed in the following table and the figure:

Table 5.6Land cover changes in forest and grass area

Land Use Change of Forest Area in Year	Area in Square K.M
2000	77.87581826
2010	77.84542381
2020	78.8654752

Source: Land sat image

The table5.5 shows the land cover change in Forest and Grass areas from 2000 to 2020.Forest Area: The table shows that the forest area has undergone a slight increase from 77.87581826 square kilometers in 2000 to 78.8654752 square kilometers in 2020. This suggests that there has been a net gain in forest cover over the 20-year period, though the increase is relatively small.

Grass Area: The table also shows that the grass area has undergone a significant decrease from 1.485046568 square kilometers in 2000 to 0.833282708 square kilometers in 2020. This suggests that there has been a significant loss of grassland over the 20-year period.

Overall, the table highlights the importance of monitoring land cover changes in different areas over time.

Table 5.7.Land Cover Change in Vegetation

S.N	Change Type	Area in Sq.km
1.	Forest -Cultivated Land	0.049027101
2.	Forest -Forest	77.52612759
3.	Forest -Built up area	0.33630389
4.	Grass Area -Cultivated Land	0.187011489
5.	Grass Area -Grass Area	0.833282704
6.	Grass Area -Built up area	0.465604966

Source: Land Sat Image

The table shows the land cover change in Forest and Grass areas from 2000 to 2020, categorized into six types:

Forest-Cultivated Land: This category represents the change in land cover from forested areas to cultivated land. From 2000 to 2020, there has been an increase in the area of forested land that has been converted into cultivated land. Specifically, the area of Forest-Cultivated Land has increased by 0.049027101 square kilometers.

Forest-Forest: This category represents the area that has remained as forested areas without any land cover change. From 2000 to 2020, there has been a slight increase in the area of forested land that has remained as forested areas without any change. Specifically, the area of Forest-Forest has increased from 77.87581826 square kilometers in 2000 to 77.52612759 square kilometers in 2020.

Forest-Built up area: This category represents the change in land cover from forested areas to Built up area areas. From 2000 to 2020, there has been an increase in the area of forested land that has been converted into Built up area areas. Specifically, the area of Forest-Built up area has increased by 0.33630389 square kilometers.

Grass Area-Cultivated Land: This category represents the change in land cover from grass areas to cultivated land. From 2000 to 2020, there has been an increase in the area of grassland that has been converted into cultivated land. Specifically, the area of Grass Area-Cultivated Land has increased by 0.187011489 square kilometers.

Grass Area-Grass Area: This category represents the area that has remained as grassland without any land cover change. From 2000 to 2020, there has been a decrease in the area of grassland that has remained as grassland without any change.

Specifically, the area of Grass Area-Grass Area has decreased from 1.485046568 square kilometers in 2000 to 0.833282704 square kilometers in 2020.

Grass Area-Built up area: This category represents the change in land cover from grass areas to Built up area areas. From 2000 to 2020, there has been an increase in the area of grassland that has been converted into Built up area areas. Specifically, the area of Grass Area-Built up area has increased by 0.465604966 square kilometers.

Overall, the land cover change in Forest and Grass areas from 2000 to 2020 suggests the impact of urbanization and agricultural expansion on natural environments. The slight decrease in forested areas and the significant loss of grassland over the 20-year period highlights the importance of careful land management and sustainable development practices.

5.6Landcoverchangeof Cultivated Area from2000to2020

The land cover change from year 2000 -2020 is expressed in the following table and the figure:

Table 5.8: Land cover change of Cultivated Area

Land Use Change of Cultivated Area in Year	Area in Square K.M
2000	76.92818252
2010	75.50393995
2020	60.31931515

Source: Land Sat Image

The table provided shows the land use change in Cultivated Area in Shuklagandaki Municipality from the year 2000 to 2020. It categorizes the area of cultivated land in square kilometers for each year.From the table, the area of cultivated land in the municipality was 76.92818252 square kilometers in the year 2000. However, over the next 10 years, there was a decrease in the area of cultivated land, and it reduced to 75.50393995 square kilometers by 2010. The data shows that there has been a more significant decrease in the area of cultivated land from 2010 to 2020, as it decreased to 60.31931515 square kilometers

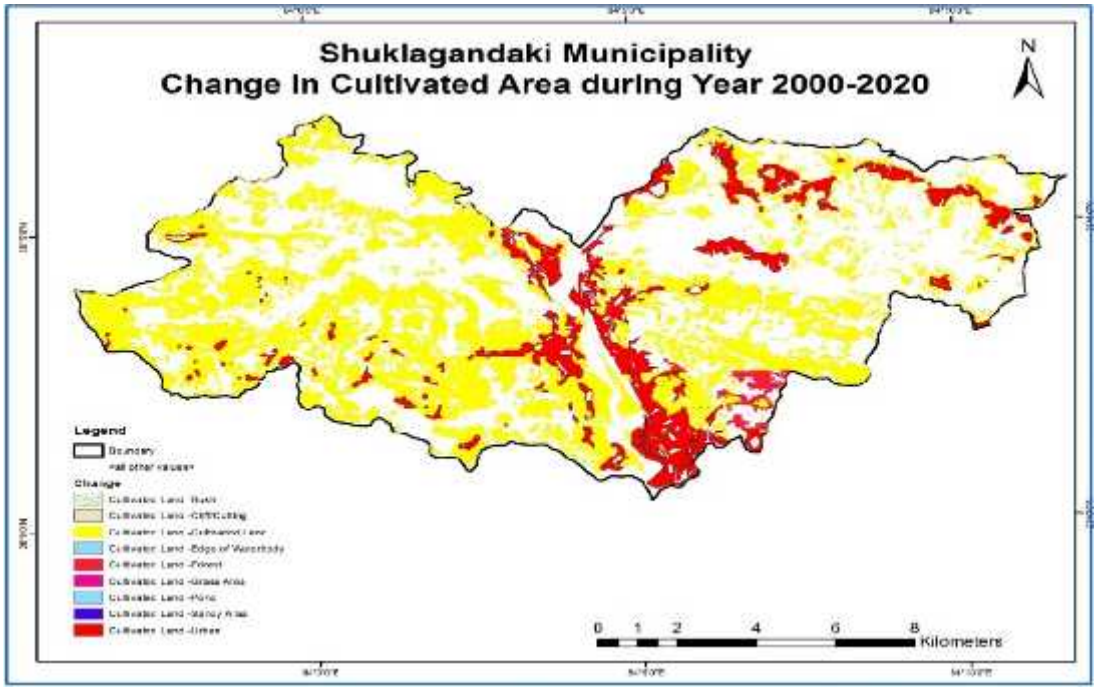


Figure 5. 7. Land cover change of Cultivated Area

Source : Land Sat Image

Table 5.9 Land cover change type from Cultivated Area

S. N	Change Type	Area in Sq. Km
1.	Cultivated Land -Bush	0.007306302
2.	Cultivated Land -Cliff/Cutting	0.009341528
3	Cultivated Land -Cultivated Land	60.07504334
4	Cultivated Land -Edge of Waterbody	0.001535853
5	Cultivated Land -Forest	1.342185461
6	Cultivated Land -Grass Area	0.000773834
7	Cultivated Land -Sandy Area	0.004766227
8	Cultivated Land -Built up area	15.47323844

Source : Land Sat Image

The table shows the land use change of cultivated land in Shuklagandaki Municipality from the year 2000 to 2020. It shows the area of cultivated land in square kilometers and the different types of land use changes that have occurred over the years.

From the table, there has been a significant change in land use from cultivated land to other land uses. The largest change occurred in the conversion of cultivated land to built-up areas, which increased from 0 square kilometers in 2000 to 15.47323844 square kilometers in 2020. This indicates that the urbanization process has been

significant in the municipality, with more land being converted to built-up areas for housing, commercial, and industrial purposes.

Other significant changes include the conversion of cultivated land to forest, which increased from 0 square kilometers in 2000 to 1.342185461 square kilometers in 2020, and the conversion of cultivated land to sandy areas, which increased from 0 square kilometers in 2000 to 0.004766227 square kilometers in 2020.

There were also minor changes in the conversion of cultivated land to bush, cliff/cutting, grass area, and edge of water body. However, these changes were relatively small compared to the conversion to built-up areas, forest, and sandy areas.

Finally, the majority of the changes occurred in wards 2, 4, 5, 6, and 8. These wards may have experienced more rapid urbanization or other forms of land use changes compared to other wards in the municipality. Understanding these land use changes is essential for informed decision-making related to land use planning and management in the municipality.

5.7Land cover change of Built Up Area from 2000 to 2020

The land cover changes from year 2000 -2020 is expressed in the following table and the figure:

Table 5.10: Land Use Change of Built-Up Area

Land Use Change of Built-Up Area in Year	Area in Square K.M
2000	1.85134082
2010	3.360164708
2020	18.307625772

Source: Land Sat Image

The data on table4.11 shows a significant increase in the Built-Up Area of Shuklagandaki municipality from 2000 to 2020. The area has increased from 1.85134082 square kilometres in 2000 to 18.307625772 square kilometres in 2020. This indicates a massive increase of about 16.46 square kilometres over 20 years.

It is also mentioned that the majority of changes in the Built-Up Area occurred in wards 2, 4, 5, 7, and 8. This information could be useful for further analysis and

planning purposes. It is essential to understand the reason behind such changes and their impact on the environment, society, and the economy.

Further analysis could involve identifying the drivers of land cover change, such as population growth, economic development, or infrastructure expansion. It could also involve assessing the environmental impacts of the change, such as loss of vegetation cover and wildlife habitat and increased air and water pollution.

Table 5.11.Land Use Change Type from Built-Up Area

S.N.	Change type	Area in Sq. Km
1.	Built up area -Bush	0.000247788
2.	Built up area -Cliff/Cutting	0.000421987
3.	Built up area -Cultivated Land	0.000481178
4.	Built up area -Forest	0.000270876
5.	Built up area -Built up area	1.858645681

Source: Land Sat Image

Based on the table 4.11, the land cover change in the Built up Area of Shuklagandaki municipality from 2000 to 2020 is primarily characterized by an increase in the Built Up Area itself, as well as smaller changes in other land cover types such as Bush, Cliff/Cutting, Cultivated Land, and Forest.

Specifically, the data shows that the Built-Up Area has increased by 1.858645681 sq. km over the time period in question. The other changes in land cover types are relatively minor in comparison, with Bush showing a decrease of 0.000247788 sq. km, Cliff/Cutting showing an increase of 0.000421987 sq. km, Cultivated Land showing an increase of 0.000481178 sq. km, and Forest showing a decrease of 0.000270876 sq. km.

The data also suggests that the majority of these changes in land cover have occurred in wards 2, 4, 5, 7, and 8.

5.8Land cover change from year 2000 to 2010

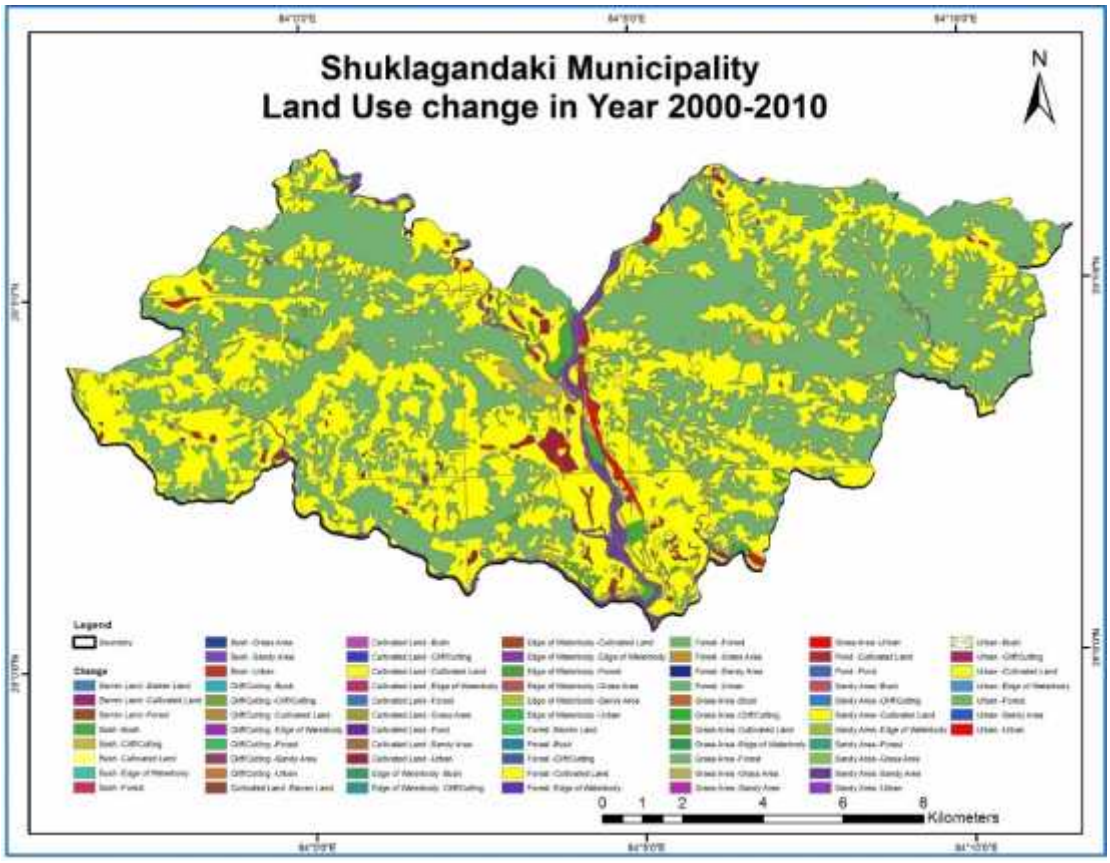


Figure 5. 8 Land cover change from year 2000 to 2010

Table 5.12. shows the land use types in an area in the years 2000 and 2010, along with their respective areas in square units and percentage of the total area, as well as the difference in percentage between the two years.

The land use types include Barren Land, Bush, Cliff/Cutting, Cultivated Land, Edge of Waterbody, Forest, Grass Area, Pond, Sandy Area, and Urban.

In 2000, the total area of the land was 164.9485934 square units. The land use types with the largest areas were Forest and Cultivated Land, which together made up more than 93% of the total area. In 2010, the total area remained the same, but there were changes in the areas of some land use types.

The areas of Cultivated Land and Urban changed the most between 2000 and 2010. Cultivated Land decreased by 0.86% while Urban increased by 0.91%. The other land use types remained relatively stable in terms of their areas, with differences in percentage of less than 0.02%.

Table 5.12.Land Cover Change from Year 2000 to 2010

LU Type	Area 2000		Area 2010		Difference in Percentage
Barren Land	0.010605788	0.01%	0.0106058	0.01%	0.00%
Bush	2.093000886	1.27%	2.0930009	1.27%	0.00%
Cliff/Cutting	0.262039463	0.16%	0.2620395	0.16%	0.00%
Cultivated Land	76.92818252	46.64%	75.50394	45.77%	-0.86%
Edge of Waterbody	1.35331413	0.82%	1.3504306	0.82%	0.00%
Forest	77.87581826	47.21%	77.845424	47.19%	-0.02%
Grass Area	1.485046568	0.90%	1.4731968	0.89%	-0.01%
Pond	0.00218928	0.00%	0.0021893	0.00%	0.00%
Sandy Area	3.087055644	1.87%	3.0475847	1.85%	-0.02%
Urban	1.85134082	1.12%	3.3601647	2.04%	0.91%
Total	164.9485934	100%	164.94859	100%	

Source: Land Sat Image 2000 and 2010

5.9Land cover change from year 2010 to 2020

The land cover changes from year 2010 -2020 is expressed in the following table and the figure:

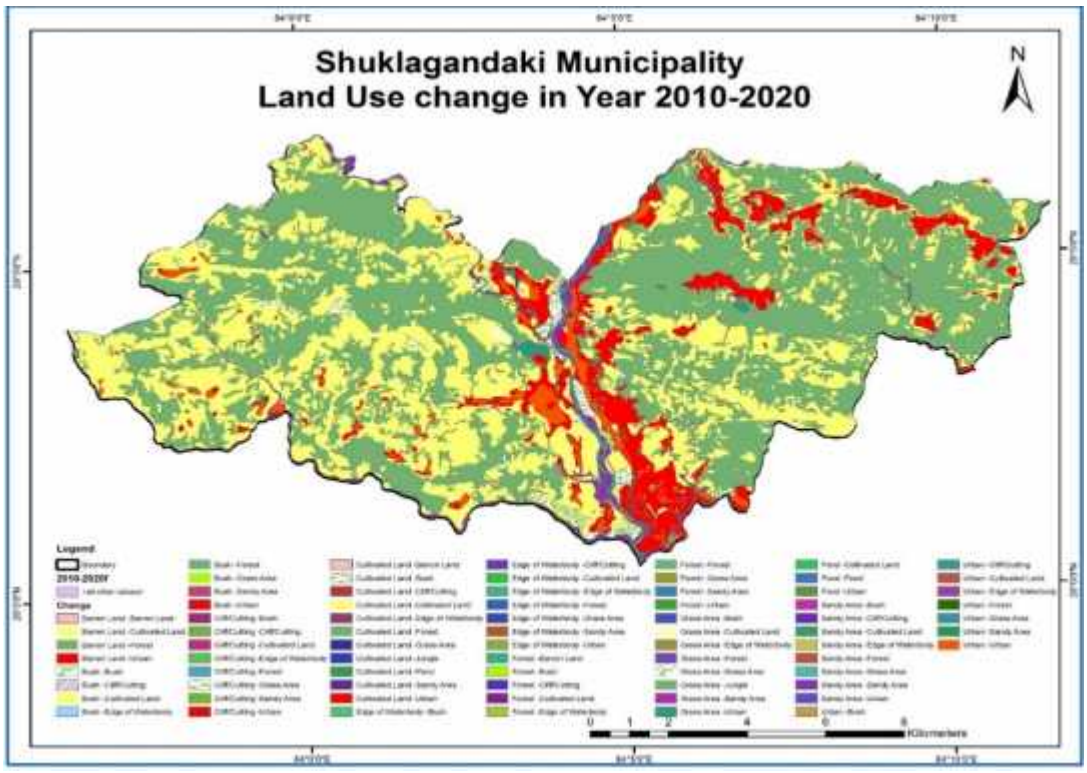


Figure 5. 9 Land cover change from year 2010 to 2020

Table 5. 13. Land cover change from year 2010 to 2020

LU_Type	Area 2010	Percentage	Area 2020	Percentage	percentage difference
Barren Land	0.0106058	0.01%	0.010606	0.01%	0.00%
Bush	2.0930009	1.27%	2.061786	1.25%	-0.02%
Cliff/Cutting	0.2620395	0.16%	0.262039	0.16%	0.00%
Cultivated Land	75.50394	45.77%	60.31932	36.57%	-9.21%
Edge of Waterbody	1.3504306	0.82%	1.353314	0.82%	0.00%
Forest	77.845424	47.19%	78.86548	47.81%	0.62%
Grass Area	1.4731968	0.89%	0.833283	0.51%	-0.39%
Pond	0.0021893	0.00%	0.002189	0.00%	0.00%
Sandy Area	3.0475847	1.85%	2.93296	1.78%	-0.07%
Urban	3.3601647	2.04%	18.30763	11.10%	9.06%
Total	164.9486	100%	164.9486	100%	

Source: Land Sat Image

The Table 5.13 shows the land use types and their respective areas for the years 2010 and 2020, as well as the percentage difference between the two years.

The land use types listed in the table include barren land, bush, cliff/cutting, cultivated land, edge of waterbody, forest, grass area, pond, sandy area, and urban. The area is reported in hectares or square meters. The total area for both years is 164.9486 hectares.

Comparing the land use areas in 2010 and 2020, it can be observed that there have been changes in some land use types. For example, the area of cultivated land has decreased by 9.21%, while the area of urban land has increased by 9.06%. On the other hand, the areas of barren land, bush, cliff/cutting, edge of waterbody, forest, grass area, pond, and sandy area have remained relatively stable over the ten-year period.

The percentage difference column indicates the change in the area of each land use type between the two years, expressed as a percentage of the 2010 area. A positive value in this column indicates an increase in area, while a negative value indicates a decrease. For example, the percentage difference for urban land is 9.06%, which means that the area of urban land in 2020 is 9.06% higher than the area in 2010.

Conversely, the percentage difference for cultivated land is -9.21%, which means that the area of cultivated land in 2020 is 9.21% lower than the area in 2010.

5.10Land cover change from year 2000 to 2020

The land cover change from year 2000 -2020 is expressed in the following table and the figure:

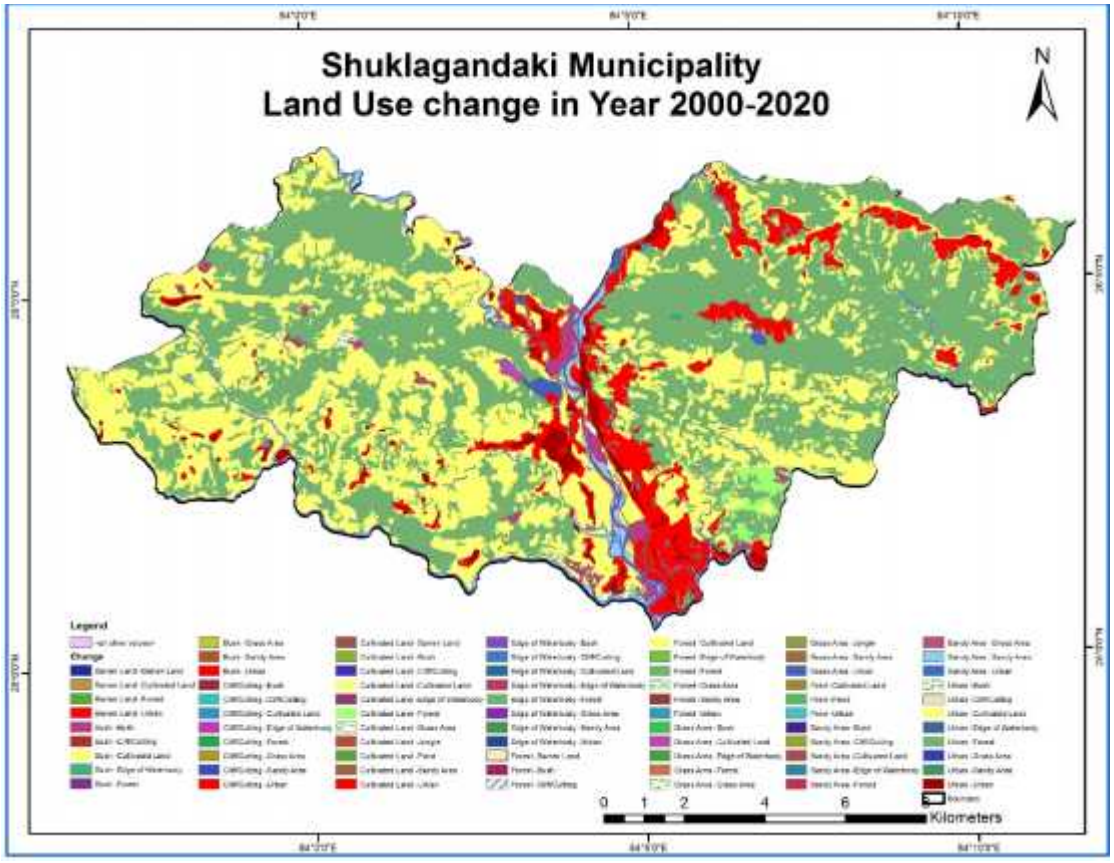


Figure 4. 10 Land cover change from year 2000 to 2020

Table 5.14: Land cover change from year 2000 to 2020

LU_Type	Area 2000		Area 2020		percentage difference
Barren Land	0.010606	0.01%	0.010606	0.01%	0.00%
Bush	2.093001	1.27%	2.061786	1.25%	-0.02%
Cliff/Cutting	0.262039	0.16%	0.262039	0.16%	0.00%
Cultivated Land	76.92818	46.64%	60.31932	36.57%	-10.07%
Edge of waterbody	1.353314	0.82%	1.353314	0.82%	0.00%
Forest	77.87582	47.21%	78.86548	47.81%	0.60%
Grass Area	1.485047	0.90%	0.833283	0.51%	-0.40%
Pond	0.002189	0.00%	0.002189	0.00%	0.00%
Sandy Area	3.087056	1.87%	2.93296	1.78%	-0.09%
Urban	1.851341	1.12%	18.30763	11.10%	9.98%
Total	164.9486	100%	164.9486	100%	

Source : Land Sat Image

The Table 5.14 represents land use data for two different years (2000 and 2020) in a particular area, along with the percentage difference in the area covered by each land use category between the years.

The Land Use categories include Barren Land, Bush, Cliff/Cutting, Cultivated Land, Edge of Waterbody, Forest, Grass Area, Pond, Sandy Area, and Urban. The table shows the area covered by each Land Use category in square kilometers (km^2) for both 2000 and 2020 A.D.

The Cultivated Land category has decreased in area from 76.92818 km^2 in 2000 to 60.31932 km^2 in 2020, which represents a percentage difference of -10.07%. This suggests that there has been a decrease in the amount of land used for agriculture in the area over the past 20 years.

On the other hand, the Urban category has increased in area from 1.851341 km^2 in 2000 to 18.30763 km^2 in 2020, which represents a percentage difference of 9.98%. This suggests that there has been an increase in urbanization in the area over the past 20 years.

Overall, the total area covered by all the Land Use categories remains the same between 2000 and 2020, which is 164.9486 km². However, there have been changes in the distribution of different Land Use categories, as some have increased in area while others have decreased. The percentage difference column gives an indication of the extent and direction of these changes.

5.11 Comparison of ward wise population from year 1991 to 2011

The ward wise population from 1991 to 2011 isshown in the table below:

Table 5. 15.Ward wise population from year 1991 to 2011

Ward	Year 1991	Year 2001	Year 2011
1.	3844	3674	2,951
2.	2470	3457	4640
3.	1264	1743	2927
4.	3678	5173	4215
5.	2674	3251	5400
6.	2049	2534	4615
7.	1904	2889	4516
8.	2690	3468	4855
9.	1344	1733	2535
10.	2689	3467	4604
11.	4581	4908	3963
12.	4130	4273	3235
Total	33317	40570	48456

Source: District profile , Tanahun 2072

From the data, it is observed that the population of the municipality has increased over the years. In 1991, the total population was 33317 which increased to 40570 in 2001 and further increased to 48456 in 2011.

Ward 5 has seen the highest growth in population, with an increase from 2674 in 1991 to 3251 in 2001 and 5400 in 2011. Ward 2 and 10 have also seen significant growth in population, with an increase from 2470 to 4640 and 2689 to 4604 respectively.

On the other hand, ward 11 has seen a decline in population, with a decrease from 4581 in 1991 to 4908 in 2001 and further decrease to 3963 in 2011. Ward 12 has also seen a decrease in population, with a decrease from 4130 in 1991 to 4273 in 2001 and further decrease to 3235 in 2011.

Overall, the data shows that the population growth in the municipality has been unevenly distributed among the wards.

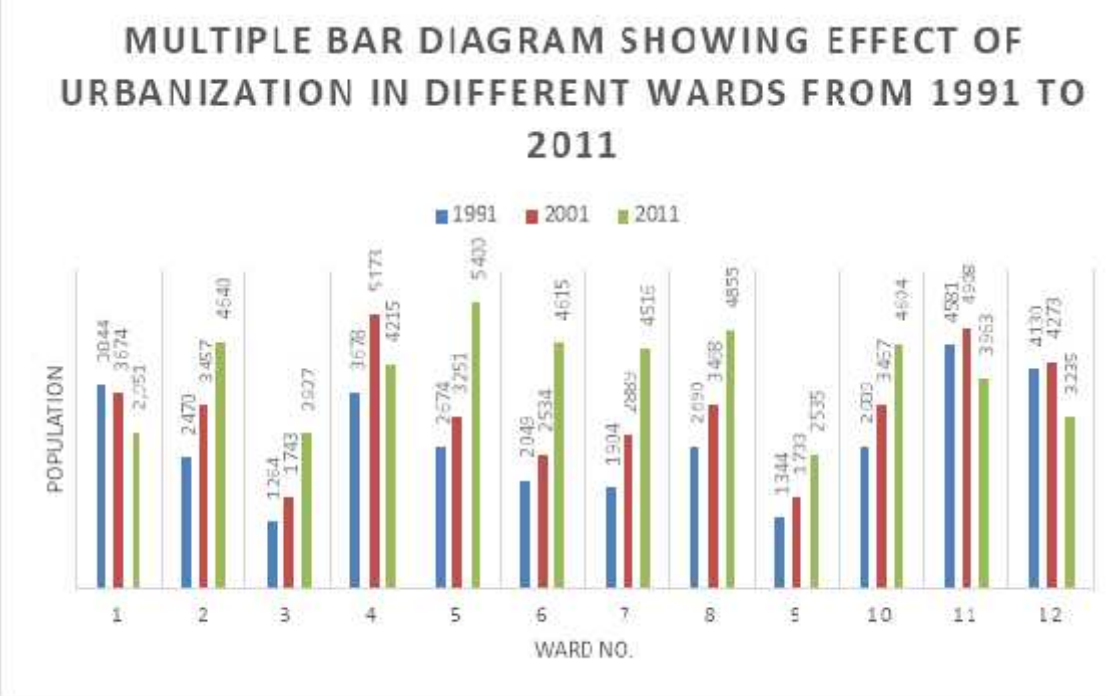


Figure 5. 11 Bar graph of population from 1991 to 2011

5.12Statistical analysis (Regression)

Table 5.16.Population and land use data from 2000 to 2020

Year	Population (X)	Built up Area (Y)	X×Y	X^2
2000	40570	1851.34	75108904.37	1645924900
2010	48456	3360.16	162820106.8	2347983936
2020	55749	18307.6	1020632065	3107951001
Total	144775	23519.14	1258561076	7101859837

We can use the following formulas to calculate the slope (m) and y-intercept (b) of the regression line:

m = (nΣxy - ΣxΣy) / (nΣx^2 - (Σx)^2)

b = (Σy - mΣx) / n

where n is the number of data points, Σxy is the sum of the products of each x-value and its corresponding y-value, Σx and Σy are the sums of the x-values and y-values, respectively, and Σx^2 is the sum of the squares of the x-values.

Using the given values, we can calculate:

n = 3 Σx = 144775 Σy = 23519.14 Σxy = 1258561076

Σx^2 = 7101859837

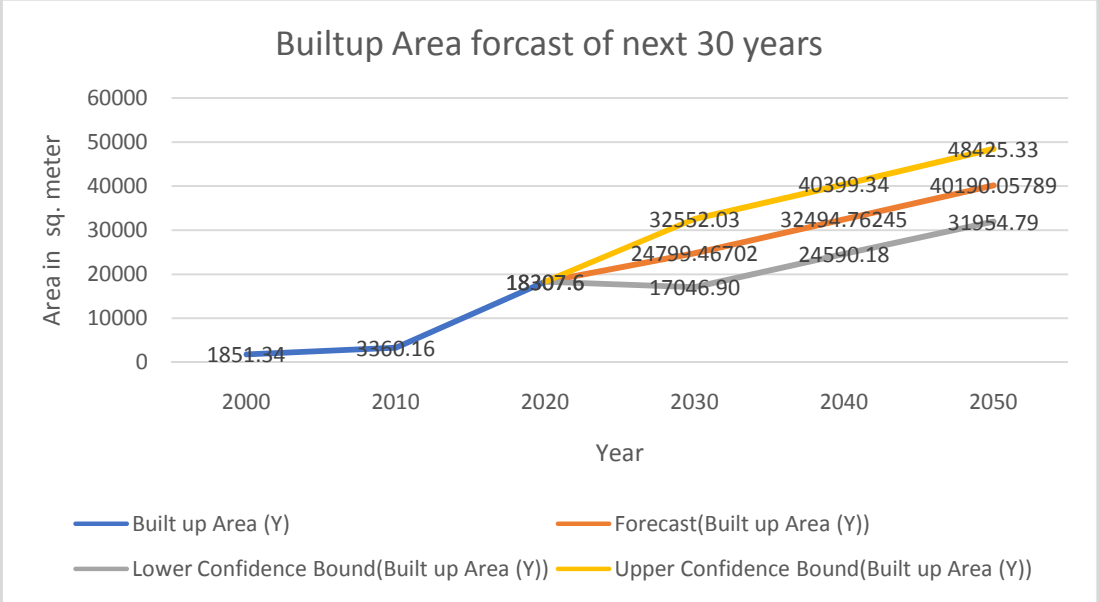
Now we can plug these values into the formulas to find the slope and y-intercept:

m = (nΣxy - ΣxΣy) / (nΣx^2 - (Σx) ^2)= (3775683228- 3404982770) / (3*7101859837 - (144775) ^2) = 1.072

b = (Σy - mΣx) / n= (23519.14 – 1.072*144775) / 3 = -43893.27

Therefore, the regression line is:y = 1.072x -43893.27

This line can be used to predict the value of y (the dependent variable) for any given value of x (the independent variable) within the range of the data.



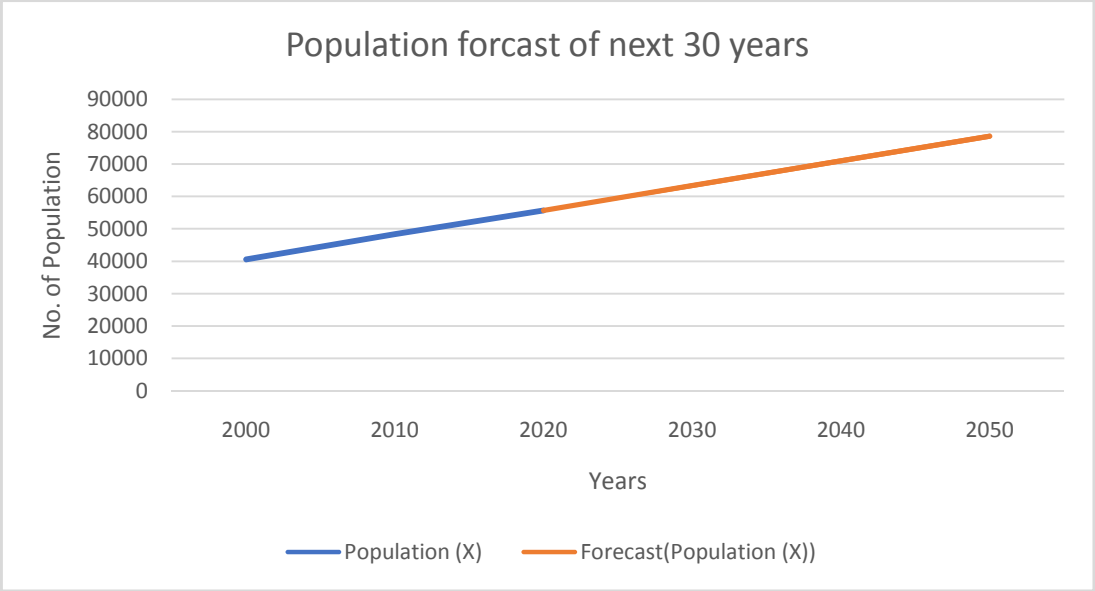


Figure 5.17: Prediction obtained from Regression analysis

5.13Causes of land use change and Urban Growth

Land use is a complex and multifaceted subject that is influenced by a wide range of physical, natural, and human factors. There are numerous factors that contribute to changes in land use, including both external and internal factors. External factors include technological advancements, migration patterns, market availability, infrastructure development, governmental policies, and natural disasters, while internal factors include regional economies, socio-economic and cultural trends, demographics, geographical conditions, and road accessibility, site and ecology. These factors interact with each other and lead to changes in land use patterns.

Land-use changes have significant impacts on climate at both local and global scales. Changes in land cover can lead to changes in surface albedo, evapotranspiration, and the exchange of heat and moisture between the land and atmosphere, which in turn can influence regional and global climate patterns. It is essential to understand the causes of land-use change and to monitor its effects on the environment in order to develop effective policies for sustainable land management. Such policies should consider both external and internal factors that contribute to land-use change and aim to mitigate their negative impacts on the environment while supporting sustainable economic development.

Shuklagandaki Municipality has experienced significant land-use change over the past few decades. Various factors, including economic, demographic, institutional, and development environment, have contributed to these changes. In this response, we will explain each of these factors in detail and how they have influenced land use change and urban growth in Shuklagandaki Municipality.

Economic factors: Economic factors have played a significant role in land use change in Shuklagandaki Municipality. The municipality is an essential center for trade, and its economy has been growing rapidly in recent years. The increasing demand for land for industrial and commercial purposes has led to a conversion of agricultural land to urban land, resulting in a significant land-use change. The construction of new roads, bridges, and other infrastructures has led to an increase in land prices, making it attractive for developers to purchase agricultural land and convert it into commercial and residential land.

Demographic factors: Demographic factors have also played a significant role in land-use change in Shuklagandaki Municipality. The population of the municipality has been growing rapidly over the past few decades due to migration from rural areas. The increasing population has led to an increase in demand for housing, which has resulted in the conversion of agricultural land to urban land. Additionally, the growing population has put pressure on natural resources such as water and forests, leading to a decline in their quality and quantity.

Institutional factors: Institutional factors have also contributed to land-use change in Shuklagandaki Municipality. The local government's policies and regulations have not always been effective in controlling land use change, resulting in haphazard urbanization and a lack of proper land-use planning. Additionally, the lack of proper enforcement of laws and regulations has led to illegal land-use changes, further exacerbating the problem.

Development environment: The development environment of the municipality has also played a significant role in land-use change. The availability of infrastructure, such as roads, electricity, and water supply, has made it easier for developers to convert agricultural land into urban land. The availability of jobs in urban areas has also led to a migration of people from rural areas to urban areas, further contributing to land-use change.

5.14. Impact of Urban Growth

Shuklagandaki Municipality is a rapidly growing urban area located in Tanahun District. Like many other urban areas around the world, urban growth in Shuklagandaki Municipality has had both positive and negative impacts on the area.

i. Positive impacts of urban growth:

a. Improved access to services:

As the population of the Shuklagandaki Municipality grows, there has been an increase in the availability of public services, such as health care facilities, schools, and public transportation. These services are critical for the overall well-being of the residents of the municipality. For example, with the increase in the number of health care facilities, residents have better access to medical services, leading to a reduction in mortality rates and improved quality of life. Similarly, the growth of educational

institutions has improved the literacy rate, leading to more educated citizens and better economic opportunities.

Table 5.17.Increase in Public Services in Shuklagandaki Municipality

Type of Service	Number before 2000	Number after 2000
Health Care centers	≥10	110
Educational centers	15	1174
Public Transport route	1	5

Source: Focal group and district profile 2072

b. Economic development:

Urban growth has led to the establishment of new businesses and industries, providing job opportunities and economic growth in the Shuklagandaki Municipality. The increase in economic activities has led to an increase in the number of employment opportunities, particularly in the service sector. As a result, the population of the municipality has become more self-sufficient, with increased economic activities, leading to a reduction in poverty levels.

Table 5.18.Economic Development in Shuklagandaki Municipality

Economic Indicator	Before 2000	After Urban Growth
Number of Businesses	≥100	≤500
Number of Jobs	1,000	2,500
Poverty Rate	20%	10%

Source: Focal group

c. Increased social interaction:

Urban growth has led to an increase in social interaction between people from different backgrounds in the Shuklagandaki Municipality. With more people living in the municipality, there are more opportunities for socialization and interaction, which can lead to the creation of social networks and stronger community bonds. The diversity of the population has also led to the emergence of new cultural and social practices, contributing to a more vibrant and inclusive community.

Table 5.19.Increased Social Interaction in Shuklagandaki Municipality

Social Indicator	Before 2000	After Urban 2000
Diversity of Population	Homogeneous Population	Diverse Population
Number of Community Events	2	10
Number of Social Networks	3	7

Source: Focal group

ii. Negative impacts of urban growth:

a. Environmental degradation:

Urban growth often leads to environmental degradation in the Shuklagandaki Municipality. With the increase in population, there has been an increase in waste generation, air and water pollution, and deforestation. The increase in waste generation has led to an increase in the amount of garbage that needs to be collected and disposed of, leading to increased environmental pollution. Air and water pollution have also increased due to increased industrial activities, traffic congestion, and the release of untreated sewage into water bodies. Deforestation is another significant environmental concern resulting from urban growth, leading to soil erosion, loss of biodiversity, and an increase in the risk of landslides.

Table 5.20.Environmental Impact of Urban Growth in Shuklagandaki Municipality

Environmental Indicator	Before 2000	After 2000
Amount of Garbage Generated	10 tons/day	30 tons/day
Air Pollution	Low	High

Source: Focal group

Population of the Shuklagandaki Municipality has grown, there has been an increase Increased traffic congestion:

As the in the number of private vehicles on the roads, leading to traffic congestion. This has resulted in longer commute times, increased air pollution, and decreased quality of life. In addition, traffic congestion can have a negative impact on the economy by increasing transportation costs and reducing productivity.

Table 5.21.Traffic Impact of Urban Growth in Shuklagandaki Municipality

Traffic Indicator	Before 2000	After 2000
Number of Private Vehicles	500	<15,000
Commute Time	20 minutes	45 minutes
Economic Loss	Low	High

Source: Focal group

b. Housing issues:

Urban growth can lead to a shortage of affordable housing in the Shuklagandaki Municipality. As the population grows, there may not be enough housing to accommodate everyone, leading to issues such as homelessness and overcrowding. The lack of affordable housing can also lead to social inequality, as wealthier residents may have access to better housing options, while lower-income residents are forced to live in substandard conditions.

Table 5.22.Housing Issues in Shuklagandaki Municipality

Housing Indicator	Before 2000	After 2000
Number of Houses	≥2,000	<15,000
Homelessness Rate	5%	10%
Overcrowding Rate	15%	25%

Source: Focal group

c. Social inequality:

Urban growth can exacerbate existing social inequalities in the Shuklagandaki Municipality. As the population grows, there may be an unequal distribution of resources, with wealthier residents having access to better services and amenities than those with lower incomes. This can lead to social exclusion, with marginalized groups unable to access essential services or participate fully in the community.

Table 5.23.Social Inequality in Shuklagandaki Municipality

Social Indicator	Before 2000	After 2000
Income Inequality	Low	High
Access to Services	Equal	Unequal
Social Exclusion	Low	High

Source: Focal group

In summary, the impact of urban growth in Shuklagandaki Municipality is both positive and negative. While it has brought about economic development, increased access to services, and improved social interaction, it has also led to environmental degradation, traffic congestion, housing issues, and social inequality. Policymakers and urban planners must take these factors into account when planning for future growth in the municipality, to ensure that development is sustainable and equitable.

d. Decrease in agricultural land:

As urban growth continues in Shuklagandaki Municipality, there is an increased demand for land to accommodate the growing population. This has led to the conversion of agricultural land into residential or commercial areas. As a result, the amount of land available for farming has decreased, potentially leading to food insecurity and economic hardship for farmers.

Table 5.24.Agricultural Land Decrease in Shuklagandaki Municipality

Agricultural Indicator	Before 2000	After 2000
Agricultural Land	≤60%	36.57%
Food Security	High	Low
Economic Hardship	Low	High

Source: Focal group

e. Increase in criminal activities:

Urban growth in Shuklagandaki Municipality has also led to an increase in criminal activities, such as theft, vandalism, and drug trafficking. As the population grows, there may be a higher demand for goods and services, leading to an increase in theft and vandalism. In addition, the presence of drug traffickers may increase as the population and demand for drugs increases.

Table 5.25.Criminal Activity in Shuklagandaki Municipality

Criminal Indicator	Before 2000	After 2000
Theft	Low	High
Vandalism	Low	High
Drug Trafficking	Low	High

Source: Focal group

f. Unemployment:

While urban growth in Shuklagandaki Municipality may create new job opportunities, it can also lead to unemployment. As the population grows, there may be an oversupply of labor, leading to a decrease in wages and an increase in unemployment. In addition, some residents may not have the necessary skills or qualifications to compete for new jobs created by urban growth.

Table 5.26.Unemployment in Shuklagandaki Municipality

Employment Indicator	Before 2000	After 2000
Unemployment Rate	5%	10%
Wage Level	High	Low

Source: Focal group

g. Squatter Settlement problem:

As urban growth continues in Shuklagandaki Municipality, there may be an increase in squatter settlements. Squatter settlements are typically informal housing developments that are built on land that is not legally owned by the residents. These settlements often lack basic services such as water and sanitation, and residents may be at risk of eviction.

Table 5.27.Squatter Settlement Problem in Shuklagandaki Municipality

Squatter Settlement Indicator	Before 2000	After 2000
Number of Squatter Settlements	2	5
Lack of Basic Services	Low	High
Risk of Eviction	Low	High

Source: Focal group

h. Management problem:

As the population of Shuklagandaki Municipality grows, there may be challenges in managing urban growth effectively. These challenges may include inadequate infrastructure, such as roads and public transportation, and insufficient resources to provide essential services such as healthcare and education.

Table 5.28.Management Problem in Shuklagandaki Municipality

Management Indicator	Before 2000	After 2000
Infrastructure	Adequate	Inadequate
Essential Services	High	Low

Source: Focal group

In conclusion, while urban growth in Shuklagandaki Municipality may bring about positive changes, it can also lead to negative impacts such as a decrease in agricultural land, an increase in criminal activities, unemployment, squatter settlement problems, and management problems. It is important

CHAPTER VI
CONCLUSION AND SUGGESTION

Nepal has been experiencing rapid urbanization in recent years due to the invasion of people from rural areas, coupled with a growing economy and better employment opportunities in urban centres. While urbanization has brought about positive changes such as improved access to education, healthcare, and modern amenities, it has also created challenges such as inadequate housing, pollution and inadequate infrastructure. The government of Nepal as recognized these challenges and has been implementing policies to address them, such as the National Urban Policy 2016 and the Urban Development Strategy 2017.

Based on the data, it can be concluded that the Suklagandaki municipality has experienced significant urban growth over the past few decades. The population has increased from 33,317 in 1991 to 48,456 in 2011, with uneven distribution across the different wards. Ward 5 has seen the highest growth in population, followed by Ward 2 and 10. On the other hand, Ward 11 and 12 have seen a decline in population.

The land use data shows that the built-up area has increased over the years, from 1.85 km^2 in 2000 to 18.31 km^2 in 2020, while the non-built-up area has decreased. However, the chi-square test conducted to determine the association between population increase and increase in built-up area did not show a significant association.

Overall, the data suggests that the municipality has undergone significant urbanization and growth, with a corresponding increase in population and built-up area. However, the growth has not been evenly distributed across the different wards, and there may be factors other than population increase that contribute to the increase in built-up area. Further analysis may be necessary to understand the factors contributing to the urban growth in the municipality.

Suggestions

1. To develop a comprehensive urban planning strategy: Given the significant population growth and uneven distribution of urbanization, the municipality

should develop a comprehensive urban planning strategy to ensure sustainable development. This should include measures such as zoning regulations, land-use planning, and infrastructure development.

2. Sustainable drinking water system: Though the municipality covers more of hilly regions except very low plain terrain, the area is still facing drinking water, which are being fetched by the nearby streams. As the urban population in the town is increasing a long-term plan need to be made by the municipality by providing regular and fresh drinking water.
3. Health Facilities: This municipality is lacking in better health facilities, most of the wards of this municipality falls on rugged terrain, difficulties of road networks, problems in the communication system, even though the municipality lies along the national highway, which have access to the capital city of the country, which is nearly 170 km east ward and 30 km north to the capital city of Gandaki province.
4. Promote integrated development system: To encourage more sustainable development and reduce the reliance on private vehicles, the municipality should promote mixed-use development, where residential, commercial, and recreational spaces are located in close proximity. This can help reduce commute times, encourage walking and biking, and reduce carbon emissions.
5. Invest in public transportation: With the population increasing rapidly, investing in public transportation infrastructure should be a priority. This can include expanding existing bus routes, developing a light rail system, and improving pedestrian and cycling infrastructure.
6. Encourage green development: The municipality should encourage green development practices, such as the use of renewable energy sources, green building materials, and sustainable water management practices. This can help reduce the environmental impact of urbanization and contribute to a more sustainable future.
7. Increase community participation: To ensure that the development process is inclusive and meets the needs of all community members, the municipality should increase community participation in the decision-making process. This can include public meetings, surveys, and community workshops.
8. Strengthen disaster preparedness: As the population increases, so does the risk of natural disasters. The municipality should take steps to strengthen disaster

preparedness and response, including developing emergency plans, investing in early warning systems, and increasing community awareness and education.

Overall, the municipality should take a proactive approach to urban development that prioritizes sustainability, community participation, and disaster preparedness. By taking these steps, the municipality can ensure a more resilient and livable future for all residents.

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APPENDIX I

PHOTO PLATE I

Potographs i: Lalim, Ganapati , laharepipal (ward 8) 2021

Potographs ii: Lalim (ward 8) 2021

Photo Plates II

Potographs iii: Bhujikot (Ward 1) 2019

Potographs iv: Dulegauda bazar (Ward 4) 2017

Photo Plates III

Potographs v: Gachaepani (ward 3) 2021

APPENDIX II

Questionnaire For local People

1. Introduction:

a. Name and Ethnicity: _____. b. Age: _____.

c. V.D.C/ Municipality: _____. d. Ward. No.Tole:_____.

e. Permanent address: _____.

f. Family status: Single [ ] Joint [ ] Nuclear [ ]

g. Family members: Male [ ] Female [ ]

h. Head of the family: _____.

2. House hold Information (details of the family)

S.No	Age	Sex M F	Marital Status	Education M F	Occupation M F	Monthly Income
01	**0-14**					
02	**15-29**					
03	**30-44**					
04	**45-59**					
05	**0ver 59**					

3. . Are you local or Migrant? Migrant [ ] Local [ ]

4. Who migrated here? You or your ancestor?

   Myself [ ] Father [ ] Grandfather [ ] Forefather [ ]

5. When and where did you migrate from?

   _____.

6. What was the main purpose of migration?

   a. To gain the cheap land [ ]

   b. For employment [ ]

   c. Others [ ]

7. How and when did you get the ownership of the land?

   a. Bought _____ Year _____ Amount _____

   b. Inherited _____ Year _____

   c. Barren land _____ Year _____

d. Forested land _____ Year _____

e. Others _____ Year _____

8. Which are the major castes of this area?

_____.

9. Who are the aboriginal castes of this area?

_____.

10. When did you construct your house?

_____.

11. How many settlements and shops were there 50/30/20/10 years ago?

_____.

12. Are there any industrial units located in the village/city?

Name: _____.

13. Do you feel any necessity of environmental management?

Air [ ] Sewage disposal [ ] Water [ ]

Noise [ ] Soil pollution [ ] Garbage [ ]

14. Do you feel any necessity of environmental management?

Community participation [ ] Local administration [ ]

NGO's [ ] Individual [ ]

15. How are you adjusting with the problem?

a. Environmental _____

_____.

b. Socio- cultural _____

_____.

c. Economic _____

_____.

16. What kind of planning is necessary in your village/city?

Park, stadium [ ] Communication & transportation planning[ ]

Conservation and tourism planning [ ] Educational [ ] Others [ ]

Appendix III

Meta data of Year 2010

S.No	Parameters	Value
1	Landsat	LE07_L1TP_142041_20101211
2	Landsat	LE71420412010345PFS00
3	Date	12/11/2010
4	Scan Line	OFF
5	Collection	T1
6	Collection	2
7	Sensor	BUMPER
8	WRS Path	142
9	WRS Row	41
10	Full Partial	FULL
11	Date	9/10/2020
12	Start Time	47:17.9
13	Stop Time	47:44.6
14	Station	PFS
15	Day/Night	DAY
16	Land Cloud	5
17	Scene	5
18	Ground	568
19	Ground	5
20	Geometric	4.519
21	Geometric	3.139
22	Geometric	3.251
23	Image	9
24	Gain	N
25	Processing	LPGS_15.3.1c
26	Sun	35.04517525
27	Sun	154.33338
28	Gap Phase	DE
29	Gap Phase	-12.704133
30	Data Type	ETM_L1TP
31	Sensor	ETM
32	Satellite	7
33	Ephemeris	DEFINITIVE
34	Panchromat	13841
35	Panchromat	15841
36	Reflective	6921
37	Reflective	7921
38	Thermal Lines	6921
39	Thermal	7921
40	Product Map	UTM
41	UTM Zone	44
42	Datum	WGS84
43	Ellipsoid	WGS84
44	Grid Cell Size	15
45	Grid Cell Size	30
46	Grid Cell Size	30
47	Calibration Parameter File	LE07CPF_20101001_20101231_02.01
48	Scan Gap	2
49	Scene Center	27°25'36.37"N
50	Scene Center	83°44'22.88"E
51	Corner Upper	28°22'03.18"N
52	Corner Upper	82°58'59.52"E
53	Corner Upper	28°05'19"N
54	Corner Upper	84°54'07.20"E
55	Corner Lower	26°45'20.48"N
56	Corner Lower	82°35'26.99"E
57	Corner Lower	26°28'50.56"N
58	Corner Lower	84°28'55.88"E
59	Scene Center	27.42677
60	Scene Center	83.73969
61	Corner Upper	28.36755
62	Corner Upper	82.9832
63	Corner Upper	28.08861
64	Corner Upper	84.902
65	Corner Lower	26.75569
66	Corner Lower	82.59083
67	Corner Lower	26.48071
68	Corner Lower	84.48219

Meta data of year 2020

S. N	Parameters	Value
1	Landsat Product Identifier L1	LC08_L1TP_142041_20201011_20201016_02_T1
2	Landsat Scene Identifier	LC81420412020285LGN00
3	Date Acquired	10/11/2020
4	Collection Category	T1
5	Collection Number	2
6	WRS Path	142
7	WRS Row	41
8	Nadir/Off Nadir	NADIR
9	Roll Angle	0
10	Date Product Generated L1	10/16/2020
11	Land Cloud Cover	3.05
12	Scene Cloud Cover L1	3.05
13	Start Time	54:35.8
14	Stop Time	55:07.6
15	Station Identifier	LGN
16	Day/Night Indicator	DAY
17	Ground Control Points Model	656
18	Ground Control Points Version	5
19	Geometric RMSE Model	5.515
20	Geometric RMSE Model X	3.724
21	Geometric RMSE Model Y	4.068
22	Image Quality	9
23	Processing Software Version	LPGS_15.3.1
24	Sun Elevation L0RA	50.70037424
25	Sun Azimuth L0RA	148.9537472
26	TIRS SSM Model	FINAL
27	Data Type L1	OLI_TIRS_L1TP
28	Sensor Identifier	OLI_TIRS
29	Satellite	8
30	Panchromatic Lines	15381
31	Panchromatic Samples	15061
32	Reflective Lines	7691
33	Reflective Samples	7531
34	Thermal Lines	7691
35	Thermal Samples	7531
36	Product Map Projection L1	UTM
37	UTM Zone	44
38	Datum	WGS84
39	Ellipsoid	WGS84
40	Grid Cell Size Panchromatic	15
41	Grid Cell Size Reflective	30
42	Grid Cell Size Thermal	30
43	Bias Parameter File Name OLI	LO8BPF20201011044017_20201011061822.01
44	Bias Parameter File Name TIRS	LT8BPF20201002093800_20201011213831.01
45	Calibration Parameter File	LC08CPF_20201001_20201231_02.01
46	RLUT File Name	LC08RLUT_20150303_20431231_02_01.h5
47	Scene Center Lat DMS	27°25'53.72"N
48	Scene Center Long DMS	83°43'52.79"E
49	Corner Upper Left Lat DMS	28°29'09.96"N
50	Corner Upper Left Long DMS	82°36'14.15"E
51	Corner Upper Right Lat DMS	28°26'21.70"N
52	Corner Upper Right Long DMS	84°54'31.07"E
53	Corner Lower Left Lat DMS	26°24'14.90"N
54	Corner Lower Left Long DMS	82°34'26.72"E
55	Corner Lower Right Lat DMS	26°21'40.90"N
56	Corner Lower Right Long DMS	84°50'09.96"E
57	Scene Center Latitude	27.43159
58	Scene Center Longitude	83.73133
59	Corner Upper Left Latitude	28.4861
60	Corner Upper Left Longitude	82.60393
61	Corner Upper Right Latitude	28.43936
62	Corner Upper Right Longitude	84.90863
63	Corner Lower Left Latitude	26.40414
64	Corner Lower Left Longitude	82.57409
65	Corner Lower Right Latitude	26.36136
66	Corner Lower Right Longitude	84.8361

APPENDIX IV

Calculation of Regression

We can use the following formulas to calculate the slope (m) and y-intercept (b) of the regression line:

$m = (n\Sigma xy - \Sigma x\Sigma y) / (n\Sigma x^2 - (\Sigma x)^2)$

$b = (\Sigma y - m\Sigma x) / n$

where n is the number of data points, Σxy is the sum of the products of each x-value and its corresponding y-value, Σx and Σy are the sums of the x-values and y-values, respectively, and Σx^2 is the sum of the squares of the x-values.

Using the given values, we can calculate:

n = 3 Σx = 144775 Σy = 23519.14 Σxy = 1258561076

$\Sigma x^2 = 7101859837$

Now we can plug these values into the formulas to find the slope and y-intercept:

$m = (n\Sigma xy - \Sigma x\Sigma y) / (n\Sigma x^2 - (\Sigma x)^2)$

= (3775683228- 3404982770) / (3*7101859837 - (144775) ^2)

= 1.072

$b = (\Sigma y - m\Sigma x) / n$

= (23519.14 – 1.072*144775) / 3 = -43893.27

Therefore, the regression line is:

y = 1.072x -43893.27

This line can be used to predict the value of y (the dependent variable) for any given value of x (the independent variable) within the range of the data.