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Spatial Analysis for identification of suitable areas to promote dense settlements in the case of Kageshwori Manohara Municipality

By

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A THESIS REPORT

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Certificate of Thesis Approval

This is to certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis report titled **"Spatial Analysis for Identification of Suitable Areas to Promote Dense Settlement : A Case of Kageshwari-Manohara Municipality"** submitted by **Mr. Krishna Hari Pudasaini (078-MSURP-006)** in the partial fulfillment of the requirements for the degree of **Master of Science in Urban Planning**.

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Krishna Hari Pudasaini

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ACRONYMS

AD: Anno Domini

ADSS: All Dilated Support System

AHP: Analytical Hierarchical Process

BC: Before Christ

CBD: Central Business District

CBS: Central Bureau of Statistics

DUDBC: Department of Urban Development and Building Construction

EBPS: Electronic Building Permit system

E.D: Executive Director

FAR: Floor Area Ratio

GIS: Geographic Information System

MCA: Multi Criteria Analysis

MCDM: Multi Criteria Decision Making

MCE: Multi-Criteria Evaluation

M.D: Managing Director

SMC: Sub Metropolitan City

UN DESA: United Nations Department of Economic and Social Affairs

UGF: Under Ground Fiber

VDC: Village Development Committee

KVDA: Kathmandu Valley Development authority

GCR: Ground Coverage Ratio

NUP: Nepal Urban Policy

LTDP: Long Term Development Plan

JICA: Japan International Corporation Agency

VDC: Village Development Committee

LUA: Land Use Act

KMC: Kathmandu Metropolitan City

MoUD: Ministry of Urban Development

NUDS: National Urban Development Strategies

PPHA: Person per Hectare

DUPHa: Dwelling Unit per Hectare

MOFAGA: Ministry of Foreign Affairs and General Administration

MOFA: Ministry of Foreign Affairs

NBC: Nepal Building Code

MOUD: Ministry Of Urban Development

LUP: Land Use Policy

SDG: Sustainable Development Goal

LTDP: Long Term Development Plan

KV: Kathmandu Valley

GLD: Guided Land development.

ToDR: Transfer of Development Rights

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1. INTRODUCTION

1.1.Background

The constitution of Nepal 2015 stated the three tiers of government increasing the number of municipalities thus increasing the number of urban space classification. Municipality is taken as a starting point for urban development acting as a growth center point. The change of rural to urban space is very high in rural areas. The national census 2021 data has shown that the urban population reached 66.2 percent in Nepal. (CBS:2021) Not only in the case of Nepal, also the world data also shows that the urban population is increasing rapidly. It is due to changes in space use or change of space for use to urban kind. The change of spaces and shifting of large mass of population is very challenging. The infrastructure and services the previous space provides can be limited to new and larger populations. The efficient use of resources for large mass can be a challenge.

Urbanization is gaining pace in other cities of Nepal. However, Kathmandu Valley continues to be the "hub" of urban development in Nepal (MoUD, 2017). Various plans for urban development of Kathmandu Valley have been formulated at different times. Implementation of these, however, has largely been poor (KVDA, 2015). Unplanned urbanization in the valley continued engulfing the agricultural lands, adding several physical, social, and environmental problems in the Kathmandu Valley, and significantly increasing vulnerability to disasters, including earthquakes (Muzzini and Aparicio, 2013; Khanal et al., 2017). Urban disasters are rising due to poor planning practices. Planning practices and studies also hasn't been effective in implementation of proper policies and intervention.

Due to this, urban sprawl is increasing in the valley and its peripheral areas also in various developing parts of the country. The city is growing with low densities and at the cost of important lands and open space. This low density consumes more land and more costly infrastructures. This kind of low-density settlement may lead to various problems and disasters in the city. The city cannot function efficiently if there are problems of infrastructure, economy, and hygiene. The sprawl can cost more to the people and government itself, resulting in vulnerable, inefficient, and unsustainable cities.

Thus, the planning process is required for efficient use of space in new emerging urban space and populations. The challenging ratio of rural to urban area growth has made it compulsory for planners and associates to look for new emerging ideas which can do well to face these rapid changes. The expansion of built-up urban areas leads to a loss of agricultural land and

green spaces. The concept of densification of settlements comes up when there is a limited resource available and must be shared with maximum economic benefit (Foley et al. 2005).

Cities play an indisputable and crucial role today, serving as focal points for population, economic activities, and infrastructure. However, cities also bear the brunt of numerous pressing social issues such as depopulation and population aging, environmental concerns like escalating pollution, and spatial challenges such as the expanding issue of unplanned suburbanization. To address the mounting problems associated with urbanization, there is a concerted effort to promote and adopt various sustainable urban development concepts and models.

Urban densification is the process of making cities more compact by using land more intensively. It involves increasing the population and the number of dwellings within the city boundary. Densification has been supported since the 1990s and is a widely applied planning policy globally. Land-use planning plays a crucial role in shaping densification, as it determines how land is utilized and building densities. The planning system regulates land uses and building densities, rather than relying on occupancy rates of buildings (Abdrabo et al., 2021).

Urban densification comes into action as one of the major strategies to create sustainable and Resilient planning. Urban densification practiced has the characteristics of compact settlements, walkability, transit-oriented development, and the sustainability features comes off with all the measures. Urban densification targets to improve urban life and infrastructure while also promoting natural ecosystem. This also gives us the advantage of conservation of natural resources, open space, cultural heritage and so on.

The process of densification can typically be observed through two variables, i.e., through the increase of population and jobs or through the increase of built floor area within a defined area. These two 2 variables are obviously related but may present divergences over time and space(Teller, 2021).Urban Densification comes up with the dark side too which if unregulated and not monitored can create a huge impact on humans, sociological, economical, and physical dimensions. These impacts can be disastrous.

Kageshwori Manohara Municipality is also a representative local body for the Northeast Belt of Kathmandu, formed in 2015 along with the rise in Federal System of Nepal. It has a boundary of area of 27.38 square kilometers. Total Population of 102,235 residing in 26,66

households. The population density 3734 per square kilometers (37.33/hector), According the population census 2021.

The declaration of municipalities in Nepal in 2015, created a pressure for rural area in terms of socio economic and physical infrastructure. The minimum requirements that an area must have to be become a municipality was missing in most of the area. However, the exercise for the minimum requirements of urban space is growing but the missing population exercising the secondary and tertiary economic activities is absent. The scarce and scattered population distribution has created a lot more vacant space between the growth centers and the place of living. This has become costlier for local bodies to implement the needs and rights of people.

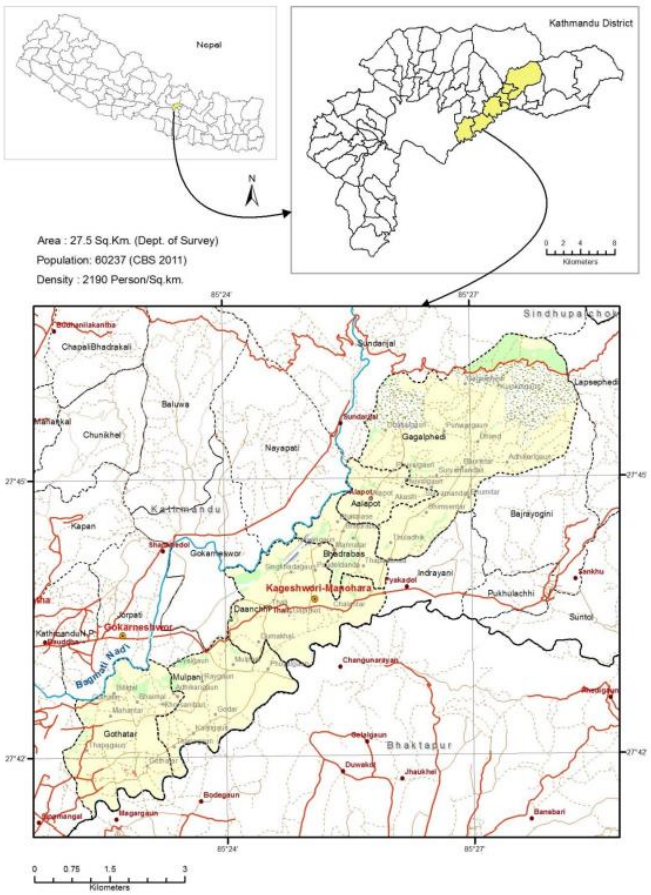


Figure 1 Location of Municipality. (Source: KMM, MTMP)

1.2 Case Area

Kathmandu valley consists of three districts namely Kathmandu, Bhaktapur and Lalitpur. Kathmandu Valley basically is an urban agglomeration that epitomizes the extraordinary urban growth (Ishtiaque, et al., 2017) due to its political and economic importance. Kathmandu Valley with its core, Kathmandu district has a population of 20,17,532 (CBS,2021) distributed unevenly at a total administrative boundary of 413.69 sq.km. This city's core is experiencing various urban issues because of the enormous population development, including traffic congestion, housing shortages, deterioration of public areas, pollution, and decreased safety. Thus, the urbanization of the periphery of Kathmandu city started primarily to address the problems with unplanned urban growth.

The case area of the research lies inside the Kathmandu Valley, Kathmandu district. Kageshwori Manohara Municipality is taken as a case area for this research. Kageshwori

Manohara Municipality is in northeast of the Kathmandu valley with an administrative boundary area of 27.38 square kilometers (Kageshwori Manohara Municipality,2018). The municipality was formed in 2071 B.S by merging 6 former VDC of Gothatar, Mulpani, Danchi, Bhadrawas, Alapot and Gagalphedi. The municipality has its own identity from Kageshwori mandir and Manohara River basin. The municipality boundary is differentiated by Manohara River in the east and Bagmati river in the west sharing it boundary with Gokarneshwor Municipality in west and Shankarapur Municipality in the east. The municipality also has various landmarks such as Gokarna Forest, International Cricket Stadium, Bagmati and Manohara River and so on. The municipality consists of 9 wards allocated north to south accordingly to ward 1 to ward 9. The current Population data statics shows that the total population of the municipality is 1,33,326 (CBS,2021)

The significance of selecting the specified site for the thesis topic "Spatial Analysis for Densification of Settlements and Policy in Case Kageshwori Manohara Municipality" is underscored by several compelling reasons. Firstly, the site experiences an extraordinary population surge, surpassing 116% over the past decade—a stark contrast to the trend observed across the other 18 local bodies in Kathmandu Valley. This remarkable demographic change presents an invaluable opportunity to delve into the dynamics of urban growth and its implications.

Furthermore, the substantial presence of virgin land within the area emphasizes the need to preserve these natural expanses from encroachment as a means to maximize their potential for productivity rather than immediate built-up development. This aspect aligns seamlessly with the exploration of spatial analysis techniques to facilitate smart and sustainable land allocation.

Addressing the pressing issue of encroachment is another pivotal reason for the selection of this site. The encroachment observed in resource areas bears the potential to deplete essential resources for future generations. This serves as a compelling backdrop to delve into the policy interventions required to curb unsustainable development and ensure the long-term well-being of the region.

Lastly, the encroachment in forest areas and riverbanks not only raises environmental concerns but also poses hazards to both the ecosystem and residents. Investigating how densification and strategic settlement planning can mitigate these risks is integral to the thesis's central theme.

1.3 Problem Statement.

In the most rapid developing nation like Nepal, the growth trend of urban population is very high. In additional, the government of Nepal declared the addition of Municipalities as urban space which led to the increase of urban population to 62.2 % (CBS,2021).

Kageshwori Manohara is one of those newly formed municipalities of Kathmandu Valley that is facing the challenge of development versus environment. (Munankarmi,2020). A decade back, the dominant area of the Kageshwori Manohara Municipality was rural and population density was less. More Agricultural land was found in the river basin of Manohara and Bagmati river and other areas too. More Green vegetation and forest area was found. Data shows that the annual population growth rate of Kageshwori Manohara Municipality is 9.57% per year. This increment of population growth is very high in KMC. The population has more than doubled in the last 10 years. At this rate more population is projected and expected to settle and service in KMM.

The rapid increase in population has led to the huge change in land use, environmental degradations, and other socio-cultural factors. The growth of built-up area is very haphazard and uncontrolled. Implementation of various plans and multiple approaches to it has been largely ineffective. (KVDA,2015). Since there has been lack in space and services inside the Kathmandu center, people are going out in a distant place like kageshwori Manohara municipality. It is possibly due to immigration inside the valley. The landcover of KMC is changing very rapidly due to such immigration. The central problems faced by the municipality due to haphazard growth of populations and built-up area are:

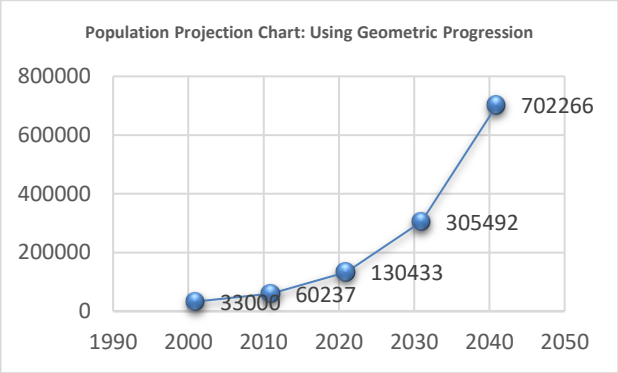


Figure 2 Population Growth Chart

- High Population growth with low density settlements.
- Huge change in land cover: Loss of agricultural lands and natural environment.
- Rise in sprawl and development which makes infrastructure costlier and ineffective.

1.4 Need

Settlement densification is a need for developing urban areas in context of developing country like Nepal. Various densification measures are adopted by governments and suggested by scholars which have not been implemented and practiced due to various microsmatic issues which need to be addressed and analyzed. Before any growing place would turn into a sprawl, there is a need to access, study, and implement better strategies to develop settlement in a suitable area, or risk-free area. A city born, live and die, while the challenge is to make it livable longer and effectively. (Jacob,2021)

Densification in urban settlement can play a vital role in the conservation of natural ecosystems, increase economy, promote sustainability, and make city resilient if monitored properly. From a perspective of spatial justice, it is crucial to consider the various factors associated with higher densities, as they can give rise to new vulnerabilities that diminish urban resilience. It is essential to strike a balance that accounts for both the individual and collective costs and benefits of densification. (Teller, 2021).

1.5 Importance

The clear study or space compactness can help us grow ideas and strategies to the next possible problems and provides solution to the problems. A better approach to densification at suitable areas can cost the city much less and live more in harmony with nature. The increase in need of housing and opportunities in Kathmandu valley is due to rise in population pulled through internal migration in seeking of opportunities.

Growing cities worldwide face the challenge of balancing the provision of adequate housing with the need to limit urban sprawl. To tackle this issue, experts and professionals in urban planning concur that higher densities in cities offer numerous benefits. Increased densities can lead to positive sustainability outcomes by preserving undeveloped land, protecting biodiversity, and reducing CO2 emissions through compact development. Moreover, densification projects can expand the housing supply, potentially making housing more affordable. Additionally, densification has the potential to foster urban diversity by mitigating socio-economic and racial segregation that can arise from restrictive land use regulations. Consequently, policymakers globally are implementing measures to optimize land use, with a specific focus on housing densification projects (Wicki, 2022)

1.6 Research Gap

While there has been substantial research conducted on urban compactness in cities including the approaches and strategies implemented such as housings, land pooling and development, high rise apartments etc. there still exist a significant research gap of how a (non-generalized spatial area) should hold an urban character with proper degree of density measures to perform well, resilient, and sustainable.

Figure 3 research Gap

Furthermore, major research has a general study to apply and practice on large scale cases. The research objective will include the following objectives.

1.7 Research Objectives

- **To conduct comprehensive spatial analysis to identify suitable areas for promoting optimum dense settlements and carry out required policy interventions in the case of Kageshwori Manohara Municipality.**

For the objectives and study, I would also be exploring in further research question such as:

1. What are the suitable areas for urban densification?
2. How do we decide the optimum density required for the area?
3. Why it is necessary to enforce policy interventions to get desired density)
4. What policy interventions can be done to encourage desired density in suitable identified area?

1.8 Scope and Limitations

The scope of this research is to explore densification ideas and practices in new growing urban areas. It will involve a study about current practices and approaches for the management of Urban Population in city. The study would look forward to the densification of services orientation and the densification of population to balance the investment, urban ecology, and its functions.

The scope of the research encompasses a comprehensive examination of multiple dimensions related to urban development. It focuses specifically on the neighborhood of Kageshwori and aims to provide insights and recommendations tailored to its unique characteristics. The

research will cover a range of topics, including urban planning and design, infrastructure development, community engagement, socio-economic considerations, environmental impact, policy and governance aspects, and data analysis and modeling. By delving into these diverse areas, the research aims to offer a holistic understanding of urban densification in Kageshwori and provide actionable guidance for sustainable and effective urban development in the neighborhood.

The research scope is confined to Kageshwori, which may limit the generalizability of the results to other urban areas. The unique context, cultural factors, and governance structures specific to Kageshwori may restrict the applicability of the recommendations to different settings. Moreover, the research is subject to time and resource constraints, potentially limiting the depth and breadth of the investigation. The level of stakeholder engagement may also be influenced by factors such as stakeholder availability and willingness to participate, potentially impacting the diversity and representativeness of perspectives. Lastly, the dynamic nature of urban development introduces future uncertainties, as changes in policies, socio-economic conditions, or environmental factors could impact the relevance and effectiveness of the research outcomes over time. Despite these limitations, the research aims to provide valuable insights and guidance within the defined scope of the study area.

2. Conceptual Framework and Methodology

The foundation of this study rests on a relativistic perspective, which emphasizes viewing the research problem as a distinct and intricate entity (Ponterotto, 2005). The investigation primarily aims to comprehend the research issue from this specific viewpoint. The paradigms in place significantly shape how information is explored and understood. The selected paradigm dictates the research's objectives, driving forces, and anticipated outcomes. To proceed with decisions regarding techniques, methodologies, literature references, and research structure, it is imperative to first identify and define the underlying paradigm.

2.1. Research Methodology:

In its initial phases, the research primarily adhered to the positivist paradigm, which perceived truth as an external entity independent of the mind. Presently, this domain has expanded due to the emergence of various alternative research paradigms over time. According to Merriam-Webster, a paradigm signifies a theoretical framework within a scientific field, encompassing theories, laws, generalizations, and associated experiments.

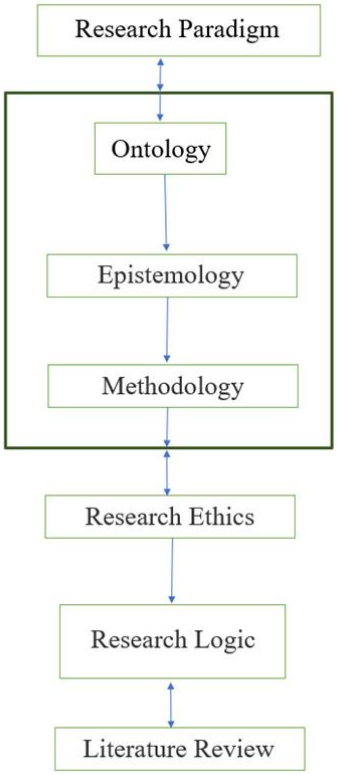


Figure 4 Research Diagram

During its early stages, research methodologies predominantly aligned with the positivist model, which regarded reality as existing outside of cognitive processes. However, with the gradual introduction of diverse research paradigms, the landscape of this field has evolved considerably.

As per the definition provided by the Merriam-Webster Dictionary, a paradigm is described as "a philosophical and theoretical framework of a scientific school or discipline within which theories, laws, generalizations, and the experiments performed in support of them are formulated." In the context of research, a research paradigm represents a broader perspective or philosophical framework that encompasses concepts, convictions, and predispositions, all of which direct the trajectory of the research process. The chosen research paradigm essentially influences how the research is designed and carried out.

A paradigm serves as a conceptual structure that aids in comprehending and interpreting the social environment. This framework comprises four fundamental elements: ontology, epistemology, methodology, and methods. Ontology involves the exploration of the types of entities that exist and their presence in the universe. It forms the foundational aspect of any research endeavor. Conversely, epistemology delves into the origins of knowledge, encompassing the possibilities, nature, sources, and constraints associated with understanding within the field of study. It deals with how the knower's relationship with the known is characterized. Paradigm is Basic Belief Systems Based on Ontological,
Epistemological, and Methodological assumptions *(Guba & Lincoln, 2013)*.

Kuhn defines a research paradigm as the set of common beliefs and agreements shared between

scientists about how problems should be understood and addressed *(Kuhn, 2020)*. Research paradigm is a way of describing a worldview guided by certain philosophical assumptions about
the nature of social reality (ontology), ways of knowing (epistemology) and the science of obtaining that knowledge (methodology). Paradigm governs a belief about the nature of knowledge, a methodology and criteria for validity *(Mackenzie & Knipe, 2006)*. The research paradigm is selected considering the following three factors i.e.

- Assumptions about the nature of reality and knowledge
- Theoretical framework, literature, and research practice
- Value systems and ethical principles.

2.2. Ontological Position

Kageshwori Manohara is an emerging town experiencing a rapid and haphazard growth in its development. Established as a municipality in 2017, the town has been undergoing substantial expansion without proper planning. The availability of land for both residential and economic purposes has attracted a significant influx of people, causing the population to double with each passing decade. This trend is fueled by a noticeable migration of individuals from neighboring districts, who are seeking better living conditions in urban settings.

However, this swift urbanization has given rise to pressing challenges, primarily the increasing demand for land and housing, accompanied by the necessary infrastructure. The uncontrolled growth has led to significant alterations in land usage patterns, notably the conversion of agricultural land into built-up areas. This transformation has resulted in the depletion of open spaces, green areas, water bodies, and other invaluable natural resources.

Given this scenario, it becomes imperative to address the management of the burgeoning population within the confines of well-planned spaces. This forms the core premise of the study's focus, wherein the aim is to investigate and understand the intricacies of urban development and population dynamics in Kageshwori Manohara.

2.3. Epistemology

Examining the site is essential to gather data on its current land utilization and overall condition. It is crucial to comprehensively scrutinize the primary factors compelling individuals to gravitate towards this location and predict their upcoming requirements. This undertaking necessitates conducting a thorough survey of the area and establishing direct

communication with influential figures within the city, encompassing both government entities and other relevant organizations. Additionally, gaining insights into the historical spatial patterns of urban expansion is imperative.

To facilitate this research approach, the utilization of specialized software, such as Geographic Information Systems (GIS), becomes pivotal. GIS will serve as a tool for analyzing spatial data, aiding in the identification of viable solutions. Consequently, these outlined steps constitute the fundamental framework guiding the epistemology of this research endeavor.

2.4. Research Paradigm.

The research topic and objectives inherently align with the Pragmatic paradigm, which underscores the pursuit of practical solutions and problem-solving within real-world contexts. In the context of urban densification, the pragmatic paradigm takes center stage by directing attention towards the identification and implementation of effective strategies that enhance and streamline densification practices in tangible and applicable ways.

Within the pragmatic paradigm, the research's primary focus revolves around addressing the pressing challenges related to urban densification and settlement patterns. This approach acknowledges that urban areas are undergoing rapid changes, and that the practical application of research findings is crucial for achieving sustainable and impactful outcomes. The emphasis on real-world solutions underscores the need to bridge the gap between theoretical insights and their practical implementation on the ground.

By adopting the pragmatic paradigm, the research strives to provide actionable recommendations that can be directly applied to the case of Kageshwori Manohara Municipality. It seeks to offer guidance that not only aligns with theoretical concepts but also resonates with the municipality's practical needs and aspirations. This paradigm places a premium on creating a positive impact in the immediate context, where the application of findings can lead to tangible improvements in densification practices, settlement patterns, and overall urban development.

In essence, the pragmatic paradigm empowers the research to transcend theoretical boundaries and venture into the realm of practicality, relevance, and utility. It underscores the importance of research that translates into meaningful outcomes, benefiting both the municipality and its residents by offering feasible and implementable strategies for addressing urban densification challenges and shaping sustainable urban landscapes.

2.5. Methods

The methods employed in a study are intricately shaped by the underlying philosophical foundations of ontology, epistemology, and the chosen paradigm that underpins the research. These philosophical perspectives collectively guide the researcher's approach to understanding reality (ontology), the means through which knowledge is acquired (epistemology), and the overall framework within which the study is conducted (paradigm). Consequently, the methods selected serve as a structured pathway for gathering data and conducting an in-depth investigation aligned with these philosophical principles. These methods can encompass a diverse range of techniques, each tailored to provide a systematic and coherent approach to data collection, analysis, and interpretation. The careful alignment of methods with the ontology, epistemology, and paradigm ensures that the research is conducted in a manner that not only adheres to established principles but also yields meaningful and reliable insights into the subject under study.

2.5.1. Research methods

Research methods refer to the systematic approaches, procedures, or techniques employed to gather data or evidence for analysis, with the aim of discovering new information or enhancing comprehension of a particular subject. Following methods will be adopted for this research:

- **Case Studies as Literature**: A diverse range of Urban areas and their transformation to compact and resilient city practice contexts will be selected. Case studies to investigate the proper approach to the area and context.
- **Interviews and Surveys:** The research will approach multiple governmental organizations including the experts, urban planners, Municipal bodies to study the various aspects and opinions on the research. The experiences and knowledge would be very important for researchers to understand the ground reality of the approach to urban densification. Multiple citizens and users committee in different level of organizations as stakeholders to the plans and practices would be considered.
- **Comparative Analysis:** the comparative study of urban topography, ecosystem, human population and services, economy, of various regional and national cases with the selected case can be done and similar strategies can be studied, test in a simulated model and enhance with what more can be done.

- **Field Visits and Documentation:** The research includes the visit of selected site to visually document and analyze the status of urban growth patterns, the existing issues within the boundary due to the growth of urban area, the existing condition of similar research and the actual needs of the site.
- **Modeling and Simulation:** Spatial analysis and modeling techniques will be employed to simulate and evaluate different scenarios of urban densification in Kageshwori. This may include the use of Geographic Information Systems (GIS) to analyze spatial data, develop land use models, and assess the potential impact of different densification strategies.
- **Synthesis and Recommendations:** The findings from the data analysis will be synthesized to draw conclusions and generate recommendations for better practices and processes for urban densification in Kageshwori. The recommendations will be based on a combination of empirical evidence, theoretical insights, and stakeholder input, aiming to provide actionable guidance for sustainable urban development.

Literature review.

A comprehensive review of literature concerning the research topic and its objectives has been conducted. This encompassed a thorough examination of scholarly articles, books, maps, journals, and diverse documents directly relevant to the research area. Furthermore, a comprehensive analysis of analogous cases and their corresponding problem-solving strategies was undertaken to gain insights into effective approaches. Through an exhaustive desk-based investigation, which involved scrutinizing books, articles, and online journals, the problem statement was refined, thus facilitating a more systematic approach to the subsequent study. The primary research involved a detailed analysis of land utilization patterns, settlement distributions, and the evolution of urban regions, augmented by supplementary data from Google Timelines.

2.6. Data collection:

Data collection includes both primary and secondary data. This data is collected through various methods and approaches with an individual and an organization. The primary data collection is done through interviews with key informants who are experts in similar fields. The informants were from the government, non-governmental organizations, private stakeholders involved in land development and housing development in the city. The data collected with site visits and physical observations is also considered as primary data sources.

Secondary data is collected in the form of printed books, journals, articles, newspapers and more. These were collected from various organizations like Municipality office, KVDA, DUDBC, Department of Survey for maps and GIS files. Data is mainly in the form of hard and soft copy which is scanned and digitalized to work in.

2.7. Data Analysis and results:

The data analysis part contains how the data is processed into the system for an expected output. To get the objective of the study, the development pattern and settlements are analyzed using maps and field data verification. The data collected during the visit and discussion was added to the input. Constraints and development factors are listed out and verified with experts to work on certain criteria for the study. The method of multi-criteria decision-making problem and MCA method is used for the identification of solution for a given problem. The criteria have some weightage through which suitable area is accessed. The important portion of the data analysis consists of the opinion and insights from the expert's interview. Spatial analysis tool is used to identify areas and work in for further. The steps include.

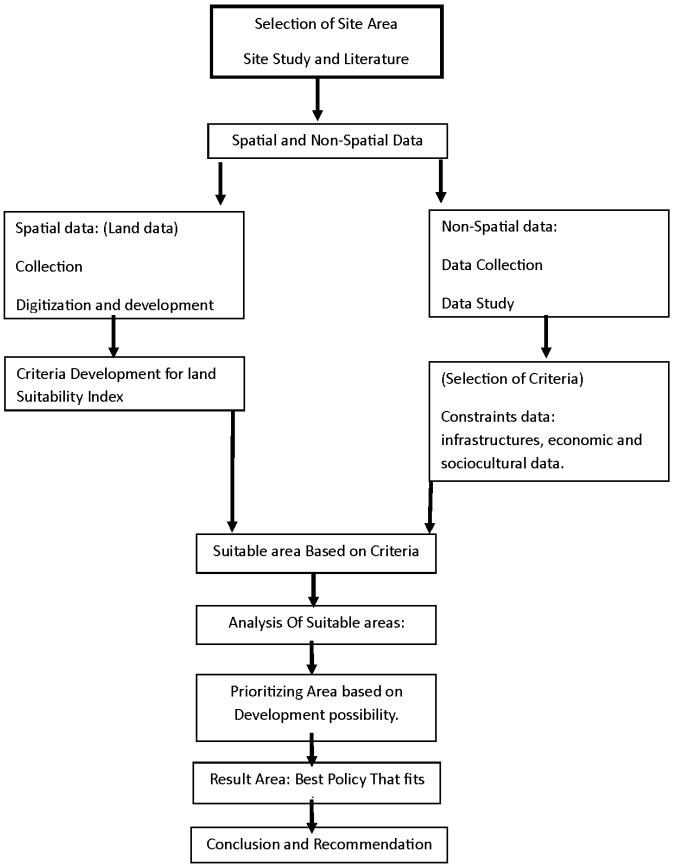


Figure 5 Flowchart Showing Research process.

3. LITREATURE REVIEW

3.1. Urban densification of Settlements

Urban densification is a method of Increasing natural density of an urban area. Densification can be increasing density of Urban Dwellers, Dwellings and Services in an urban area. Urban Densification plays an important role in the development of compact cities and hence can promote sustainable development in an urban area. Urban density can be an influential factor for a city to grow compact. This can save more area in return for other useful purposes.

Many regions experience densification, particularly rapidly expanding cities when a combination of demographic change, economic pressure, and significant transportation infrastructure investments is at play. In order to prevent additional urban area growth and the ensuing artificialization of open/green spaces, several cities and regions have developed planning strategies that encourage urban densification through in-fill development and urban consolidation (Teller, 2021).

Urban densification has received significant attention due to its benefits, such as reduced land consumption, improved public transport, and vibrant neighborhoods. However, we must not overlook its potential negative effects. These include physical and mental health implications due to reduced living space, increased traffic congestion and air pollution, loss of access to public amenities, rising housing prices, lack of privacy, and environmental impacts like increased energy demand and greenhouse gas emissions. The impact of densification on Sustainable Development Goals, climate change, and public health, including mental health and exposure to traffic pollution, needs further study. Densification's costs may not be evenly distributed among the population and cities, leading to housing affordability issues, displacement, and longer commuting distances.(Teller, 2020)

Densification can be observed through two variables: the increase in population and jobs or the increase in built floor area within a defined area. These two variables may not always align over time and space. Subdivision and subletting of buildings can lead to a faster increase in population densities compared to build areas. On the other hand, the commodification of housing may result in more buildings being constructed without a proportional increase in inhabitants or occupants, leading to fewer people in larger dwellings. Monitoring the divergence between built and occupational densification is crucial to understand urbanization dynamics. These indicators should be compared with variables like quality of life and economic

development to assess the effectiveness of compact city/in-fill development policies implemented by cities and regions.(Teller, 2020)

3.2 Origin of City

Early cities emerged in various regions, spanning from Mesopotamia to Asia and the Americas. These ancient urban centers exhibited both geographical and functional diversity. Some served as sparsely populated political capitals, while others functioned as bustling trade hubs. Certain cities had a predominant religious focus. Therefore, it would be unfair to explain ancient urbanism with a single factor, given the multifaceted nature of these settlements.

Prominent examples of influential ancient cities include Alexandria and Antioch of the Hellenistic civilization, Carthage, ancient Rome, and its later eastern successor, Constantinople (now Istanbul). These cities grew into powerful capital cities, acting as vital centers of commerce and industry, strategically positioned at the hearts of burgeoning ancient empires.

Among the Sumerians of Assyria, city kingdoms developed as a combination of fortresses and marketplaces for the agricultural produce of the surrounding lands. Additionally, these cities engaged in light manufacturing and craft making, characteristic of the Bronze Age. The study of early urban sites demonstrates the varied and dynamic nature of ancient cities, showcasing their significance as centers of governance, trade, and cultural expression throughout history.

According to theorists, agriculture is considered a crucial requirement for the formation of cities. Cities play a vital role in preserving surplus agricultural production and facilitating economies of scale (Lumen, 2014). Vere Gordon Childe proposed that a settlement can be classified as a city if it possesses a substantial surplus of raw materials to support trade and sustains a relatively large population (Wikipedia, 2020).

Before the advent of farming, human societies relied on hunting and gathering for sustenance. Their lifestyle was nomadic, as they constantly moved from one location to another in search of wild fruits and vegetables, adapting to the changing seasons and food availability. Due to their mobile lifestyle, they possessed very few possessions and had little concept of private ownership. Social and communal life among these early societies was minimal or non-existent.

Around 1000-1200 years ago, hunter-gatherer societies transitioned to agriculture as they discovered the benefits of cultivating and harvesting crops instead of solely relying on gathering. This shift led to the formation of settled agricultural communities. Additionally, the

domestication of animals such as cows, sheep, and buffalo for dairy products further contributed to agricultural practices. As both plants and animals required specific resources, the communities engaged in farming and trade, leading to the exchange of goods.

This exchange of surplus food played a crucial role in fostering dense populations and promoting the growth of settlements. The success of these settlements was founded on a conducive environment and robust social organization. Cities offered numerous advantages, including reduced transportation costs for goods, people, and ideas by bringing them together in one central location. This proximity decreased transaction costs, ultimately contributing to higher worker productivity. Moreover, cities provided protection for people and their valuable possessions, which were accumulating as societies progressed.

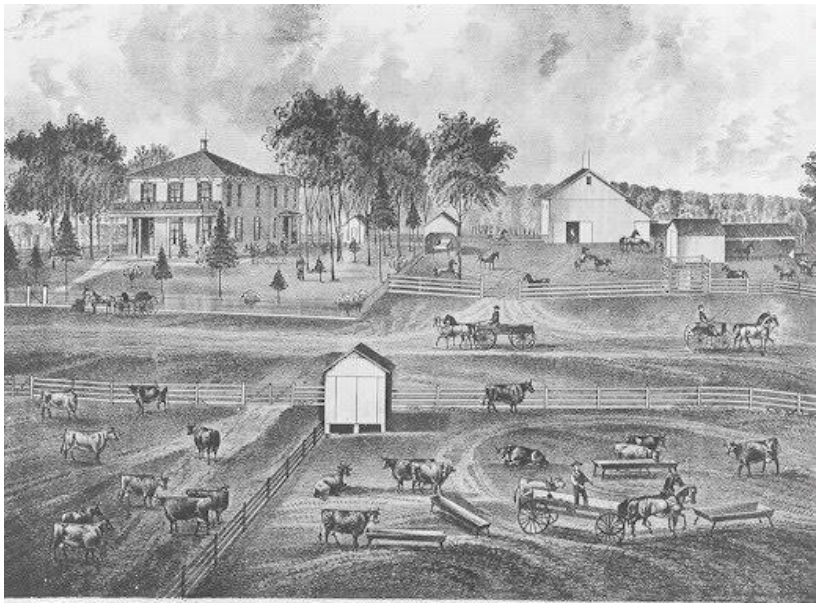


Figure 6 Pre industrialization Society(Source:UCPS)

Many ancient cities were consciously planned by rulers or groups of merchants, with some displaying geometric regularity in their layout. This indicates that cities were established due to their efficiency over dispersed settlements in various aspects of life. The development of cities was a significant milestone in human history, marking a shift from nomadic lifestyles to organized communities that contributed to the advancement of societies.

3.3. Pre and Post Industrialization Stages of urban density and Study

3.3.1 Pre-Industrialization settlements.

During the pre-industrial era, powerful empires focused on expanding their territories through conquest and colonization, gaining access to valuable resources, and increasing their influence. Advancements in agriculture, such as improved irrigation techniques and tools, led to higher food production, with surplus food stored in towns. This was made possible by improved transport systems that facilitated the efficient distribution of goods and resources. Consequently, new institutions emerged to manage the storage, exchange, and redistribution of

commodities within these towns. (Shrestha,2018) As towns grew and trade routes were established, long-distance trade flourished, becoming a significant aspect of this period. Specialization in various occupations became prevalent, with people focusing on specific crafts and skills, resulting in increased productivity and a diverse range of goods. This specialization contributed to the expansion of trade, as regions with unique products met demands in other areas. The flourishing trade not only brought economic prosperity to empires but also fostered cultural exchange, sharing ideas, cultures, and technologies, leading to cultural diffusion and progress. In summary, the pre-industrial stage was characterized by expansionist empires, agricultural progress, town development, and thriving long-distance trade, setting the groundwork for the growth of complex and interconnected societies.

3.3.2 Post Industrialization settlements

The industrial revolution, spanning from 1750 to 1850 in western Europe, sparked remarkable technological and societal advancements. Innovations in agriculture, transportation, and communication revolutionized the way people lived and worked. Agricultural implements and farming technologies boosted productivity, while improved food preservation methods ensured a stable food supply. The development of more effective water supply systems improved living conditions in urban areas, contributing to the growth of cities.

Figure 7 Post Industrialization (source: history.com)

During this period, a significant transformation occurred in the relationship between towns and hinterlands. Cities increasingly relied on villages for raw materials to sustain their industrial activities. However, as urban centers evolved, they became less dependent on investments in rural regions, thanks to breakthroughs in transportation and refrigeration. These innovations enabled the transportation of goods, including food, from distant areas to industrial cities, leading to the emergence of a globalized economy.

The rapid urbanization and industrialization also brought about complex socio-economic dynamics, especially in the context of colonial relationships. Cities, acting as hubs of economic and political power, exploited the resources of their colonial territories without providing fair returns. This exploitative pattern created an urban-rural divide, with the urban centers benefiting disproportionately. The concept of parasitism gained prominence in discussions, with proponents of dependency theory highlighting the unequal distribution of resources and opportunities between urban and rural regions.

Overall, the industrial revolution was a period of profound change, bringing progress and prosperity but also giving rise to socio-economic disparities. The impact of this era continues to shape the trajectory of societies, emphasizing the importance of understanding historical developments to address present-day challenges.

3.3.3 Modern urban Settlements

The rise of industrial cities brought about significant challenges in terms of urban ecology degradation, and little effort was initially made to improve the conditions. However, as population and economic growth continued, cities expanded further. Until the 1860s, population densities increased within a radius of about 4.8 kilometers from the city center. While these areas lacked gardens and public parks, they were within a 20-minute walking distance from open fields. Nonetheless, a notable shift occurred after 1870, as British and American cities underwent significant changes, marked by the adoption of cheap and efficient transportation systems like motor buses and commuter trains.

The growth of cities became evident through a series of maps depicting their transformation over time. Public transportation played a profound role in this process, with early steam trains accelerating urban expansion. Cities began spreading in all directions, with inner areas maintaining higher densities. The reliance on trains was limited due to poor reliability, necessitating the use of feeder services like horse buses or trams, which were not well-developed. This led to a form of urban growth known as suburbanization, where residents started moving to adjacent communities outside the city. Suburbs became automobile-dependent, and the process of suburban growth and decentralization accelerated between the two world wars, reshaping the cities.

This suburbanization trend, however, raised concerns among intellectuals, planners, conservationists, and those worried about the urban environment. They feared the consumption of agricultural land at an alarming rate and the increased commuting distances resulting from decentralized urbanization. These issues prompted a movement led by professional planners and conservationists, advocating for limitations on urban growth and the preservation of valuable green spaces. Various organizations were formed to address these concerns and promote sustainable urban development.

Figure 8 Old/ New town (source: medium.com)

3.4. Theories of Urban Growth and Densification.

Urban areas are determined first by the diverse economic activities rather than agriculture as a primary economic activity. This area offers a large variety of services and infrastructure for socio-economic development. The process of urbanization in developing countries is characterized by extensive concentration of resources and activities in one or few urban centers i.e the existence of the primate city phenomenon.(Dimou & Schaffar, 2011).We can find the density of people, services, and infrastructure in urban areas in high scale. The large accumulation of people resulting demand in service and infrastructure. There has been a huge challenge in maintaining adequate services for people. The physical shape of a city or urban area and ways it expands directly affect the severity of these issues (Alghais & Pullar, 2018). Population growth of cities is economically important as extremely large investments in

building new housing and infrastructure must be made to accommodate the demographic growth of the cities (Gilles & Diego, 2013). It is seen that there is large increment of population growth (10.7%) between 2000-100 in US metropolitan areas exceeding the average growth of 5.3%. similarly vast difference can be seen in Europe large cities and peripheral areas.

Urban growth is driven by several factors, including the deterioration of environmental quality in densely built city centers, resulting in issues like traffic congestion, pollution, and the degradation of public spaces and safety. Changing lifestyles, driven by increased incomes, lead people to prefer more spacious decentralized housing options. This shift is further propelled by the conversion of city center residential areas into tertiary activities, such as commercial and service sectors, while housing improvement costs in the city center exceed those of new constructions outside the city. Real estate agents' housing supply strategies also contribute to urban growth, as they encounter less opposition in promoting developments in more spacious out-of-town areas. Moreover, the influx of human capital and entrepreneurship plays a significant role in the expansion and development of cities.

Growth in urban areas and cities follows more models of development patterns. These patterns and models have been identified, analyzed, and proposed in various theories which shall be discussed in the following.

3.4.1 Sector Growth Model

In the 1930s, Homer Hoyt published another variation of the concentric circle growth model called the sector growth model. The sector model recognized that growth tends to extend outward from the city center primarily along transportation lines and that specific types of development tend to cluster together in patterns (Goodwill, 2018). Many European cities, particularly British cities, exhibit this development pattern.

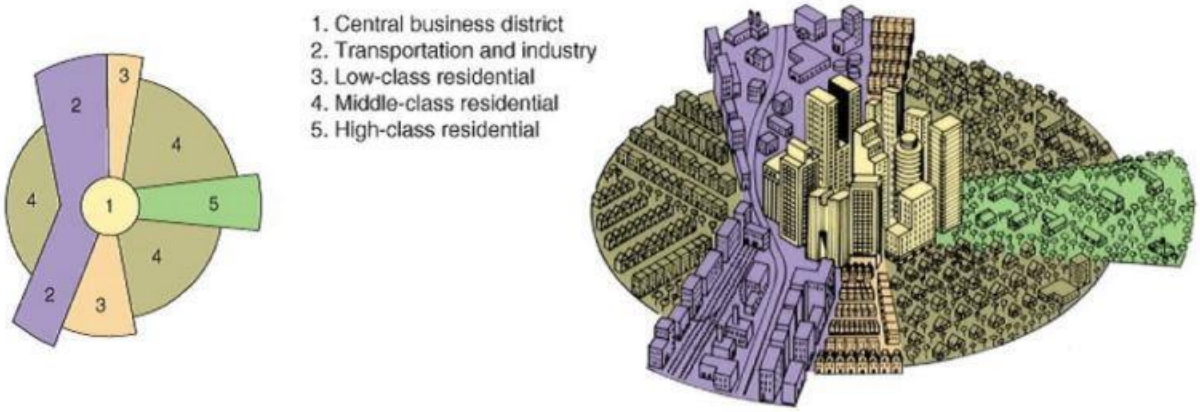


Figure 9 Sector Growth model. (Source:)

In contrast to the concentric circle model, the sector growth model depicts residential units forming a wedge shape emanating from the central business district. Low-income worker settlements are strategically located along major transportation corridors to facilitate their daily commutes to work. Next to them, middle-income workers reside in less congested areas, as they can afford the transportation needed for their daily work trips. A small number of affluent individuals live far away from the central business district, representing the wealthiest segment of the city's population.

The sector growth model can be visualized as a cluster-based development with outward progression. It can be considered a modified version of the concentric model, allowing for expansion in specific sectors. This model has been observed in British cities like New Castle and London, as well as in modern cities such as Calgary in Canada and Chicago in the United States.

3.4.2 Concentric Circular Model

The concentric circular model urban development also called CCD model was probably first theory proposed on urban growth pattern. It was developed in 1925 by a sociologist, Ernest Burgess from the inspiration of development of Chicago (Goodwill, 2018). In this model, the growth starts with a central business district at the center of the city. It is the major economic hub of the city. The rent of living in this central area is highest and goes on decreasing upon moving away from the center but the transportation time and costs are added. Though the automobile friendly cities facilitate the development of economy outside city core at present times, it held true in the case of early cities and is still standing still in case of many cities.

Another important thing to be noted is that the geographic nature can restrict the growth of cities. This kind of urban growth mostly occurred until 1930, because railway being the major source of transportation, factories needed to be located near downtown railway station and likewise the factory workers because of high living cost at core preferred to live far away in lesser dense areas.

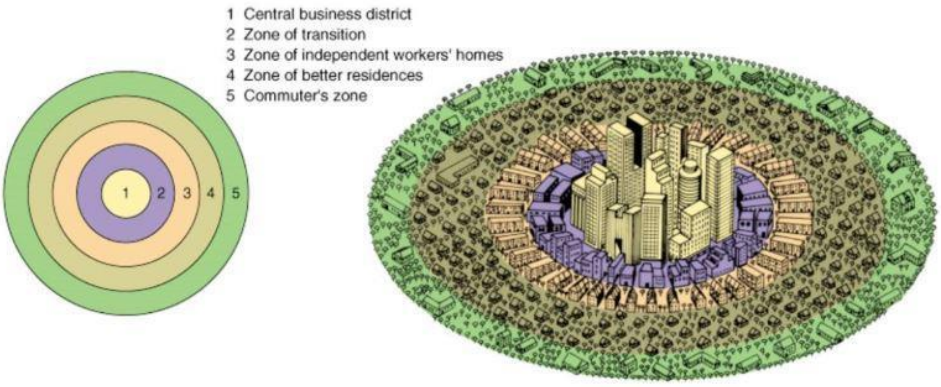


Figure 10 concentric circular model: (source)

3.4.3 Axial Growth Model

The significance of transportation in influencing urban growth is evident from the study of cities' historical development. The axial growth model, developed around the same time as the sectoral growth model, proposes that urban development occurs primarily along the transportation lines leading out from the city center (Goodwill, 2018). Areas located near the transportation system experience the most rapid development, while those farther away gradually become less developed, resulting in a belt-like pattern of growth and development.

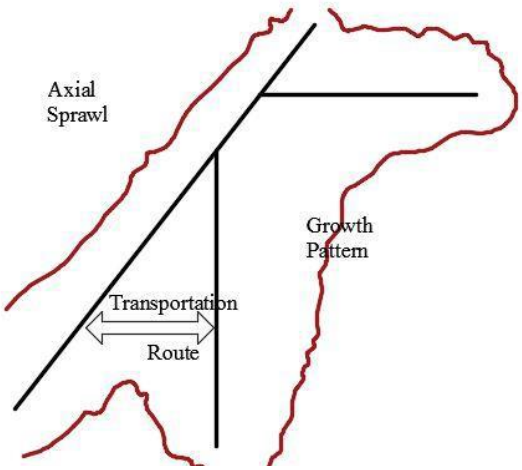


Figure 11Axial growth Model:

This axial growth model is observed in many developing countries, including Nepal. In Nepal, areas situated along major highways such as the East-West highway and Arani Ko Highway are witnessing organic growth primarily due to their strategic locations along the major transportation routes. Emerging urban areas like Muglin and Khurkot serve as examples of

urban growth and development following this model. The accessibility and connectivity provided by the transportation lines play a crucial role in shaping the spatial distribution and expansion of cities in such regions.

The pattern any city follows during its growth is subjected to be affected by social, economic, and technological aspects. Before, rich and wealthy people wanted to live in more open spaces, in bigger houses away from the congestion of the city core. A self-owned automobile was a necessity, and they could afford it. But, coming to this age, where sustainability is an issue because of resources being scarce, this phenomenon is a subject of question. The revere phenomenon is seen nowadays in many of the large cities because moving outwards demanded longer time and effort. Urban planners and designers are trying to develop a more efficient and sustainable model for planned urban growth to happen.

3.5. Spatial analysis

3.5.1 Spatial analysis in Planning.

Spatial analysis entails the investigation and assessment of entities by examining their spatial data features, such as locations, attributes, and relationships, which reveal their geographic and geometric properties. It employs various computational models, analytical methods, and algorithms to assimilate geographic information and determine its appropriateness for a particular system.

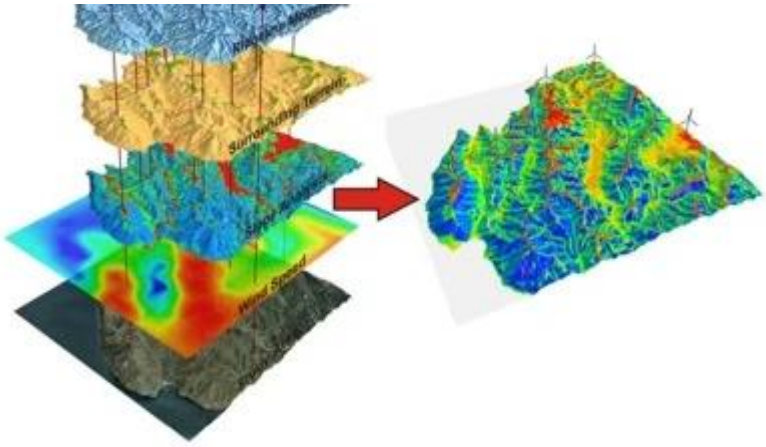


Figure 12 GIS Application in study (source: IS wordpress.com)

To better understand and plan future urban development, the use of remote sensing, geographical information sciences (GIS), and related techniques has become increasingly common. These technologies provide rich and diverse data sources, including modern satellite imagery and traditional aerial photos, allowing for large-scale studies of urban development processes. However, urban development is a complex and dynamic process influenced by various physical, social, and economic factors. The intricacy arises from the unknown quantity of factors involved, the multi-scale interactions among them, and the unpredictable dynamics, which exceed the capabilities of current GIS theory and methods. The relationship between

urban development patterns and processes is also scale-dependent, making it essential to identify determinant factors at various scales. To address this complexity, the integration of remote sensing, GIS, and other modeling techniques is crucial for understanding the interaction between urban development patterns and processes.

3.5.2 Analysis Approaches and Ideas.

3.5.2.1 Multi Criteria Decision Making (MCDM)

Multiple-criteria decision analysis (MCDA) is a collection of methods that support decision makers in structuring and evaluating complex decisions with multiple factors and alternatives. Over the past two decades, MCDA has been successfully integrated with geographic information systems (GIS) to address spatial problems. (Greene et al., 2011)

Multi-Criteria Decision Analysis (MCDA) is an essential tool that assists in resolving complex decision-making challenges by systematically considering multiple criteria and their relative importance. This method enables decision-makers to effectively compare various alternatives and objectively rank them based on their performance across the identified criteria. By using MCDA, decision-makers can gain a comprehensive understanding of how different options fare against one another, leading to informed and well-balanced decisions.

One of the significant strengths of MCDA lies in its ability to address situations where there are conflicting objectives or trade-offs between criteria. Decision-makers can assign weights to each criterion based on their priorities, allowing them to incorporate their preferences into the analysis. The systematic approach of MCDA ensures transparency in the decision-making process, as the criteria and their weights are openly discussed and agreed upon by stakeholders. This fosters a collaborative environment and enhances confidence in the final decision.

MCDA techniques find broad applications in a diverse range of fields. In business, it aids in investment decisions, product development, and supplier selection. Environmental managers can use MCDA to evaluate various pollution control strategies or choose optimal sites for sustainable development. Healthcare professionals employ MCDA to assess treatment options based on multiple medical and economic criteria. Overall, MCDA serves as a valuable tool for informed decision-making, enabling stakeholders to make better choices in complex and uncertain scenarios while considering multiple objectives and constraints. *(Majumder & Saha, 2016).*

At its core MCDA is helpful for:

- Dividing the decision into smaller, more understandable parts.
- Analyzing each part.
- Integrating the parts to produce a meaningful solution (*MCDA, 2011.*)

In essence, MCDA / MCDM involves the following four elements:

- Alternatives (or individuals) to be ranked or chosen from
- Criteria by which the alternatives are evaluated and compared.
- Weights representing the relative importance of the criteria.
- Decision-makers and potentially other stakeholders whose preferences are to be. represented *(What Is MCDA / MCDM? | 1000minds, n.d.)*

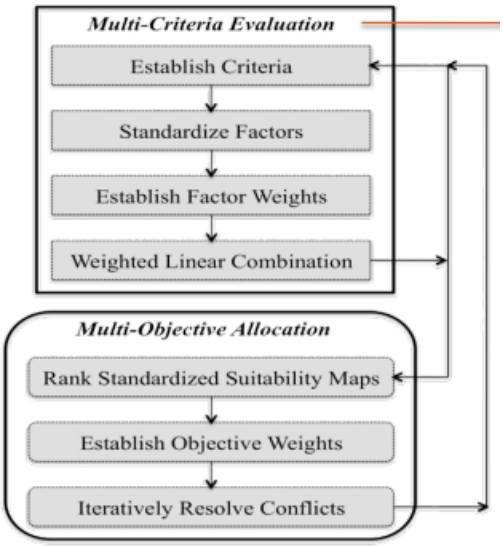
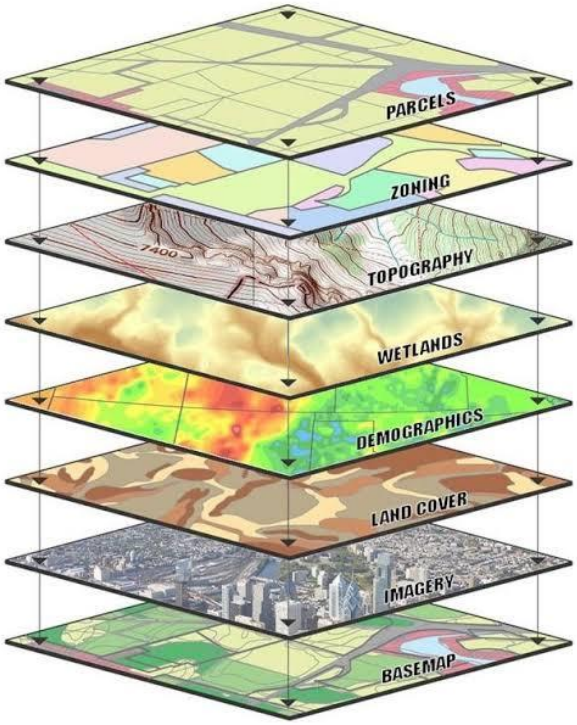


Figure 13 MCDA APPROACH

3.5.2.2 GIS-Based MCA.

Geographic Information Systems (GIS) are a set of techniques and procedures that hold a crucial role in analyzing decision problems, particularly those involving spatial components. GIS is acknowledged as a powerful decision support system that facilitates problem-solving by integrating data with spatial references. It enables decision-makers to examine and understand the relationships between geographical features and various factors, contributing to more informed and effective decision-making processes.

In the context of GIS-based Multi-Criteria Analysis (MCA), the methodology can be seen as a transformative process that combines geographical data with decision-makers' value judgments or preferences. The integration of these two components results in valuable information that aids decision-makers in their evaluations. By incorporating spatial data, such as maps, satellite imagery, and location-based information, GIS-MCA provides a comprehensive understanding of the geographical context in which the decision problem exists. This spatial dimension enhances the analysis and allows decision-makers to account for location-specific factors and visualize the potential impacts of different alternatives.



GIS-based MCA is particularly useful when dealing with complex decision problems that involve multiple criteria and spatial considerations. It helps decision-makers to systematically compare various alternatives and evaluate their performance against the identified criteria. By merging spatial data and value judgments, GIS-MCA assists in generating a comprehensive and rational basis for decision-making, thereby improving the quality and robustness of the chosen solutions. Additionally, GIS-MCA offers a visual and intuitive representation of the decision problem, making it easier for stakeholders to comprehend the implications of their choices and promoting more participatory decision-making processes.

Spatial applications of Multiple-Criteria Decision Analysis (MCDA) aim to enhance traditional decision-making by incorporating spatial considerations, addressing not only "what" to choose but also "where." By integrating MCDA with Geographic Information Systems (GIS), spatial criteria such as distance, travel time, and slope can be analyzed, making it applicable to a wide range of spatial problems. However, certain MCDA methods are limited in dealing with spatially continuous problems that involve numerous alternatives, due to computational constraints or practical considerations. To overcome these limitations, researchers have explored approaches like converting continuous problems into discrete alternatives or classifying study areas into homogeneous zones based on criteria values. Despite the breadth of methods and applications, GIS-based MCDA remains a niche field, but it has seen growing

research activity since the early 1990s, especially in areas such as environment, transportation, urban planning, and agriculture.(Greene et al., 2011)

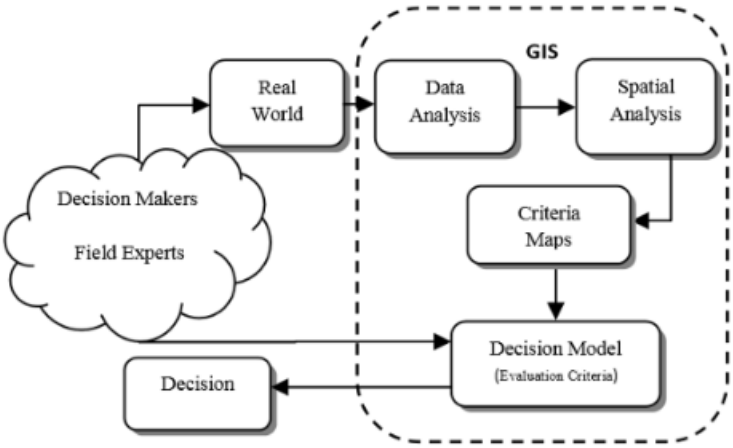


Figure 15 MCDA process (source: (Greene et al., 2011))

In the context of Multi-Criteria Decision Analysis (MCDA), Geographic Information Systems (GIS) serve as a powerful tool that combines and transforms geographic data, representing input criteria, along with decision-makers' value judgments. This process leads to a comprehensive assessment used to select the best alternative actions or prioritize suitable lands for proposed land uses (Velasquez & Hester, 2013). In recent times, GIS-based MCDA has found widespread applications in various domains, including site suitability analysis for natural resource management (Eastman et al., 1991), solar energy plants (Majumder & Saha, 2016), industrial site selection (Rikalovic et al., 2014), and agricultural land use (Özkan et al., 2020). Notably, this study highlights the specific use of GIS and MCDA methods to create maps of settlement development priorities in Kageshwori Manohara municipality.

The Suitable Settlement is mapped using the weighted sum overlay analysis in the QGIS software. A suitable settlement Suitability map is created after the predicted Weight were Assigned to the relevant layers and the maps were layered on top of one another. For Suitability Map, it needs,

4. Suitable Factor for the analysis
5. Development of suitability Map for dense Settlement.

3.6 Historical Urban Growth and approach In Nepal

Nepal history is dated back from Kirati, who were known as the first rulers of the valley. (Valley named Nepal). There is very little information and data about that era. Lichhavi came into power after the dawn of Kirati. They brought and developed the concept of art and architecture (MOFA, 2020). It is believed that there were many concentrated and compact settlements existing in various parts of Kathmandu valley. They were centers for commercial and residential development. These centers later evolved into urban settlements and then referred to as capital towns. There were urban settlements inside and outside the valley. People used to live close by agricultural lands but occupied minimum area for living and all.

Figure 16(source: Nepal times)

In 1200 AD Malla rulers Succeeded Lichhavi and started a wealthy age called Golden Age. They built temples and squares. People use to live close by temples and squares due to the society shared common goals, values, and gods. The Malla developed Kathmandu as an administrative route between India and China, thus market center growth and there was an increase in population for living, economy, and trade.

While the Kathmandu Valley's natural surroundings provided some protection, the disturbances in northern India prompted the necessity for defending towns within the region. Consequently, this led to the emergence of compact settlements characterized by narrow streets and crowded courtyards. (KVDA, 2015)These settlements were strategically situated on elevated terraces, flanked by fields on both sides. Examples include the Thimi and Nagadesh settlements, strategically positioned along the route connecting Bhaktapur and Kathmandu. Bhaktapur, a prominent trade hub by the mid-13th century, was shaped in a distinctive conch-shell configuration, resembling the hand of Lord Vishnu. The heart of the town was the King's palace, from which streets radiated in various directions. The city was divided into different areas known as "Toles," each of which included communal spaces called "Nanis" or "Bahals."(KVDA, 2015)

A social hierarchy played a role in shaping the town's layout. Different castes were organized in concentric circles within the town. Those at the lowest social strata, such as sweepers, resided on the outskirts of the town. Cultivators lived in the next ring, situated close to their fields.

Artisans and craftsmen were settled in the innermost ring, reflecting the spatial organization based on social and economic roles.

In essence, the need for defense and strategic positioning drove the development of compact settlements with specific social and functional layouts in the Kathmandu Valley. These arrangements were shaped by both the geographic and socio-cultural dynamics of the region.

Palaces and Temple were built as a part of kingdom and people have their settlement close by, together performing similar collaborative activities. They built their houses in high or raised lands and performed agricultural activities in low and fertile lands. They avoided using agricultural and farmlands for residential or other purposes because agriculture was the primary source of bread and butter.

3.7 Contemporary Growth and Approach

3.7.1 Current Urban Scenario of Nepal

The constitution of Nepal 2015 defines Nepal as 'Federal Democratic Republic'. As per the constitution, Nepal has three tiers of Government: Local, Provincial and Federal in ascending order of authority. Since the last democratic election held in 2017, Nepal consists of 753 local Governments (293 Municipalities *(Nagarpalikas)* and 460 Rural Municipalities *(Gaunpalikas)*) under 7 provincial Governments under a single federal Government. The local election that took place after twenty long years finally provided citizens to exercise their right to choose their own representatives. Each local government has its own chairperson. All the provincial Government has its own Planning Commission with the National Planning Commission being a part of federal Government. The change in political and governance system is for the transfer of power from federal to provincial and local Government to ensure healthy and balanced growth all over Nepal.

These 293 municipalities are what the Government recognizes as urban areas in the current scenario. The municipalities are further stratified as: Municipality, Sub-Metropolitan City and Metropolitan City. The designated local body must fulfil certain criteria to be declared as so. The criteria have been listed below:

3.7.2. Densification in Kathmandu

Figure 17 Urban growth in Kathmandu (source: THE RECORD NEPAL)

Kathmandu Valley is a rapidly urbanizing mountain basin in the Himalayas surrounded by the Himalayan Mountain range and expanding in an area of 899 square kilometer (Ishtiaque, et al., 2017). The cities within the valley rank among the oldest human settlements in the central Himalayas. It shares the characteristics with many other rapidly urbanizing cities in the region including unregulated urban development, inadequate enforcement of land use policies, poorly maintained city infrastructures, the massive influx of people from surrounding rural areas and hinterlands, land speculation, excessive pressure of commercial activities and gaps in supply and demand for basic services (Ishtiaque, et al., 2017). Till 2014, Kathmandu Valley had five municipalities (urban centers) namely Kathmandu, Lalitpur, Bhaktapur, Madhyapur Thimi and Kritipur's. After the nation's restructuring, the addition of 13 new municipalities in the valley indicates the trend of urbanization is high in the valley. The research by Ishtiaque et al suggests that in the last three decades, built-up areas of Kathmandu Valley has increased by 412% while agricultural land lost at the rate of 31%. It has become important to study the dynamics of urbanization and its sustainability in the valley to prevent further deterioration of urban environment.

3.7.3. (Urban Growth) in Nepal

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 percent.

Urbanization in Nepal is dominated by a few large and medium cities with an excessive population concentration in the Kathmandu Valley.

High urban growth 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 (MoUD, 2015; Muzzini & Apericio, 2013).

The urban population distribution is uneven across the country. 33.5 per cent of the urban population is concentrated in 16 urban centers that each have a population of over 100,000 people (MoUD, 2015). The Central Development Region has the highest proportion of the urban population, followed by the Eastern and Western Development Regions. The distribution of the urban population is relatively low in the Mid-Western and Far Western Development Regions (MoUD, 2015).

The average urban population density in Nepal in 2011 was 1,381 per square kilometer, which compares to the total population density of 180 per square kilometer (CBS, 2011). The last Census data 2021 shows that the urban population has grown from 17.11% in 2011 to 66.2% in 2021. (CBS,2021)

3.8 Criteria Study

Urban densification for settlement encompasses a comprehensive range of strategies aimed at increasing population and infrastructure within existing urban areas in response to urban expansion, population growth, and limited land availability. These criteria involve optimizing existing resources to create efficient, vibrant, and sustainable communities. Key factors include proximity to infrastructure, efficient land use, mixed land uses, sustainable infrastructure, green spaces, and pedestrian-friendly design. Additionally, the strategy addresses affordable housing needs, preserves cultural identity, and considers environmental impacts. Guided by long-term city planning goals and community engagement, urban densification aims to create balanced, connected, and environmentally conscious urban environments. From the planning perspectives the suitable criteria should be based on some planning and measures, and which would include,

Planning criteria:

- **Dense and Compact Area.**
- **Promoting clean Urban Greenery and Forest.**
- **Effective connectivity for all. (Transportation, communication)**
- **Easy access to basic health and education for all.**

- **Geographically, naturally, safe from disasters and Hazards.**
- **Promoting open parks, recreational area, Sports arena etc.…**

a. **Dense and compact area:**

A dense and compact urban area is characterized by its intentional design to curb urban sprawl and fringe development, while simultaneously promoting efficient land use and sustainable growth. This approach to urban planning focuses on optimizing available resources and infrastructure to create a more livable and cohesive environment. Several key points underscore the importance of a dense and compact urban area:

- Halting Urban Sprawl and Fringe Development: Dense and compact urban development is an effective strategy to counter the detrimental effects of urban sprawl. By concentrating growth within well-defined boundaries, it prevents the haphazard expansion of urban areas into surrounding rural or undeveloped regions. This containment ensures that valuable agricultural land, natural habitats, and open spaces are preserved and not consumed by unchecked growth.
- Encouraging Infill Development: A key principle of dense and compact urban areas is the encouragement of infill development. This entails making use of underutilized or vacant spaces within the existing urban fabric, such as abandoned buildings or vacant lots. By revitalizing these areas, the need for outward expansion is diminished, fostering a more sustainable and efficient land use pattern.
- Promoting Affordable Housing: A dense and compact urban environment often leads to increased land values, making housing affordability a concern. However, when planned thoughtfully, it can also present opportunities for affordable housing. By utilizing vertical development and mixed-use spaces, developers can create a range of housing options that cater to diverse income groups. This reduces the need for long commutes and promotes equitable access to urban amenities.
- Enhancing Accessibility and Mobility: Concentrating development within a compact area supports the development of well-connected transportation networks. This includes efficient public transit systems, pedestrian-friendly infrastructure, and cycling lanes. These measures not only reduce traffic congestion but also improve accessibility, making it easier for residents to access employment centers, services, and recreational areas.

- Fostering Community Interaction: Compact urban environments encourage social interaction and a sense of community. With people living in closer proximity, public spaces, parks, and community centers become focal points for gathering, enhancing the quality of life for residents. This cohesive environment fosters a strong sense of identity and belonging.
- Efficient Infrastructure and Services: Compact urban development optimizes the utilization of infrastructure and utilities. Concentrating housing, businesses, and services reduces the costs associated with providing amenities such as water, sewage, electricity, and telecommunications. This, in turn, enables municipalities to allocate resources more effectively and maintain a higher level of service provision.

Embracing a dense and compact urban development approach offers multifaceted benefits. It curtails urban sprawl, encourages the revitalization of underused areas, supports affordable housing options, and promotes sustainable mobility and community engagement. By strategically planning for growth within well-defined boundaries, cities can create vibrant, inclusive, and efficient urban spaces that address the challenges of modern urbanization.

b. **Promoting clean Urban Greenery and Forest.**

Promoting clean urban greenery and forests within urban areas is essential for fostering a balanced and sustainable environment. This approach offers a multitude of benefits, ranging from safeguarding forests and wildlife to enhancing the quality of life for urban residents. The following points highlight the significance of these efforts:

- Protection of Forest and Wildlife: Integrating green spaces and forests into urban areas serves as a protective measure for both local forests and wildlife. By creating designated areas within the urban landscape, natural habitats are preserved and conserved, contributing to the overall biodiversity of the region. This safeguards native plants and animals, maintaining the delicate ecological balance.
- Promotion of Green Space and Forests within Urban Areas: Incorporating green spaces and forests into the urban fabric improves the aesthetic appeal of the city while offering recreational and leisure opportunities for residents. Urban forests, parks, and gardens provide a retreat from the bustling urban environment, allowing people to reconnect with nature, relax, and engage in outdoor activities.
- Harmony between Built Environment and Nature: Integrating clean urban greenery and forests helps establish a harmonious relationship between the built environment and the

natural world. It counteracts the negative impacts of concrete-dominated landscapes, mitigating pollution, noise, and heat, which are common in urban areas. This balance supports the physical and mental well-being of urban dwellers.

- Air Quality and Climate Regulation: Urban greenery and forests play a vital role in improving air quality by absorbing pollutants and releasing oxygen. They also aid in regulating local climate conditions by providing shade and reducing the urban heat island effect. This cooling effect helps to combat rising temperatures and contributes to a healthier urban environment.
- Natural Stormwater Management: Forests and green spaces act as natural stormwater management systems, absorbing excess rainwater and reducing the risk of flooding and erosion. This is particularly important in urban areas where impervious surfaces can lead to water runoff issues.
- Enhancement of Biodiversity: Creating urban green spaces and forests offers opportunities for native plant species to thrive and supports the growth of diverse ecosystems. These areas attract various bird and insect species, contributing to urban biodiversity.
- Educational and Community Benefits: Green spaces and urban forests serve as educational resources, providing opportunities for environmental education and awareness programs. These areas also foster a sense of community by offering gathering spaces for events, picnics, and social interactions.

c. **Effective connectivity for all. (Transportation, communication)**

"Enhancing Urban Connectivity: Strategic Steps for Transportation and Communication"

Identification of Crucial Connecting Points: In the pursuit of inclusive urban development, pinpointing key connecting points is essential. These pivotal locations, often transport hubs and communication centers, act as lifelines for the city. Identifying them allows for targeted investments, fostering smoother mobility and information exchange. By strategically investing in these nodes, cities can optimize resources for maximum impact, creating a well-connected urban fabric that facilitates efficient movement and communication.

Promotion, Widening, and Maintenance of Road Networks: A robust road network is the backbone of urban mobility. Promoting its growth through strategic expansion, regular

maintenance, and comprehensive planning ensures efficient transportation flow. Widened roadways accommodate increasing traffic demands, while well-maintained infrastructure enhances safety and longevity. This approach not only eases congestion but also supports sustainable urban development, fostering economic growth and enhancing residents' daily lives.

d. **Easy access to basic health and education for all.**

Easy Access to Basic Health and Education for All: Ensuring effortless access to fundamental healthcare and education is pivotal for thriving communities. By strategically locating clinics, hospitals, schools, and educational institutions, cities prioritize the well-being and development of every resident. This approach lays the foundation for a healthy, educated populace, fostering long-term prosperity and social cohesion.

Equal Access and Opportunities for Everyone: Empowering all members of society requires eradicating barriers and inequities. Cities that provide uniform access to resources, amenities, and opportunities foster inclusivity and diversity. Such environments enable residents to unleash their full potential, contributing to a vibrant and innovative community fabric that transcends social and economic boundaries.

Proximity Is Important: Recognizing the significance of proximity in urban planning yields efficient and interconnected living spaces. Placing essential services, recreation, and daily necessities close to residences minimizes travel time, enhances convenience, and strengthens social bonds. Proximity-driven planning promotes sustainable living and enriches the urban experience for all.

e. **Geographically, naturally, safe from disasters and Hazards.**

Optimal settlement locations should prioritize geographical and natural safety, avoiding disaster-prone areas and environmental constraints. By selecting sites removed from natural hazards and human-made limitations, cities can proactively mitigate risks. Through careful identification and implementation of safety measures, these areas can provide secure living environments while minimizing vulnerability to disasters, fostering resilient and sustainable communities.

f. **Promoting open parks, recreational area, Sports arena etc…**

Encouraging the creation of open parks, recreational zones, and sports arenas enhances urban livability. Identifying spaces for future open areas allows for long-term planning that accommodates urban growth. Allocating and preserving these spaces ensures their availability in the face of development. Providing easy access to such areas fosters community well-being, physical activity, and social interaction, contributing to a healthier and more vibrant urban environment.

3.9. Suitability Criteria for Urban dense Settlements.

To identify the proper area for dense settlement in urban areas, it is important to find out the area which is appropriate for settlement. For this there must be a suitable criterion that defines how to form balanced urban environment and population distribution. The criteria depend upon humans, geography, climates, economy, politics and so on. It is important that the best criteria must be selected based on the individual case area and data availability of the area. The criteria also depend upon the human psychological way of perceiving the suitable or danger area.

The initial step in determining the optimal area for any intended use involves the selection of suitable and pertinent criteria. The ultimate selection of these criteria is also contingent upon the available data. Researchers employ varied criteria to identify appropriate sites for urban expansion, yet all these criteria can be categorized into four primary groups: accessibility, physical attributes, socioeconomic factors, and environmental considerations. While most scholars take these categories into account, the most crucial determinants are typically accessibility and physical characteristics, followed by environmental and socioeconomic considerations. In the context of identifying a suitable location for a residential development, this study has focused on one accessibility factor (proximity to roads), two environmental factors (land use and land cover types, and distance from a river), one physical factor (slope), and one socioeconomic factor (population density).(Guragain & Bajracharya, 2022)

Different scholars have identified various criteria depending upon the location, scope of research and the targeted outcomes. The criteria might not become valid if it is not contextual and relevant to the context area. The parameters may depends on Physical setting, physical infrastructures,economic and livelihood oppurtunitunities,social development, institutional development and environmental.(Pokhrel et al., 2018). The parameter defines the type of criteria to be selected suitable for study. Slope Rating, landcover, elevation rating, drainage and water bodies, geological rating is taken as suitability parameter in Site Suitability Analysis for urban development for Bajura district, Nepal.(Subedi & Bajracharya, 2015).

A study of Spatial Pattern and Influencing Factors of Rural Settlements in Qinba Mountains, Shaanxi Province, China has taken criteria such as Geomorphic slope and location data, Demographic and Economy, Infrastructure proximity, Buffer from rivers and roads are taken into consideration for finding suitable area for settlements. (Peng, 2015)

Thus, after study of various approaches for suitability of settlements, it can also be the suitable criteria for urban densification approaches. So analyzing the study area we can conclude some major suitability criteria for this study which are listed below.

1. **Topography/Geological factors**
   - Terrain elevation
   - Slope
   - Geological hazards
2. **Socio-economic Factors**
   - Proximity to urban built-up area.
   - Proximity to highway and major roads
   - Land use type.
3. **Ecological Factors**
   - Soil erosion
   - Desertification
   - Importance of water
   - Importance of biodiversity Conservation
4. **Prohibitive factors.**
   - Earthquake Fault Zone
   - Surface Water
   - Special protection area.

After finding a suitable area for promoting urban densification, the criteria are listed out and analysis of each factor is done. The method of multi-criteria Assessment tool is used for analysis of data. Before this each criteria analysis is done and assigned suitability value based on its degree of suitability. After this weightage is calculated for each criterion which later contributes to the whole calculation. Based on this calculation, overlaying all the criteria and their weight will provide data, which would represent the most suitable area based on the score they get.

To identify suitable areas for such densification, a thorough analysis of various factors is essential. These factors can be categorized into different criteria, as you've outlined:

Topography/Geological factors, Socio-economic Factors, Ecological Factors, and Prohibitive factors.

Here's a step-by-step breakdown of the process:

1. Identification of Criteria: The first step is to determine the criteria that will influence the suitability of an area for urban densification. These criteria are based on various aspects of the study area that can affect the feasibility and sustainability of densification.
2. Criteria Analysis and Suitability Values: For each criterion, a detailed analysis is conducted to evaluate its suitability for urban densification. Suitability values are assigned to different levels or categories within each criterion. For example, in the "Terrain Elevation" criterion, lower elevation areas might be more suitable for densification due to easier construction and accessibility.
3. Weightage Assignment: Each criterion is then assigned a weight based on its relative importance in the context of urban densification. Some criteria might have a more significant impact on the overall suitability than others. Weightage reflects this importance.
4. Multi-Criteria Assessment: The multi-criteria assessment involves calculating a suitability score for each area within the study zone based on the assigned suitability values and weighted criteria. This is done for all criteria, resulting in a set of suitability scores for each area.
5. Overlay and Final Suitability Map: The suitability scores from each criterion are combined through overlay analysis. This process involves combining the scores spatially using GIS (Geographic Information System) software or similar tools. The overlay generates a comprehensive suitability map where each area is represented by an overall suitability score.

Identification of Most Suitable Areas: Based on the final suitability map, areas with the highest scores are considered the most suitable for urban densification. These areas have the best combination of factors that align with the criteria and weightage.

In summary, the process involves evaluating various factors through assigned suitability values, applying weights to criteria based on importance, calculating suitability scores, and combining these scores to create a final suitability map. This map then guides decision-makers toward areas that are most suitable for urban densification based on the comprehensive analysis of multiple criteria.

By considering a holistic approach that encompasses geological, socio-economic, ecological, and prohibitive factors, this method helps urban planners and policymakers make informed decisions about where to focus efforts for sustainable and effective urban densification.

3.10 Desired density for Urban area:

In any urban area, town or city, the development principle may vary, and they tend to lean towards their own desired and favorable ideas for the infrastructure and other development. There is no mention of the global standard of human density that must reside in a certain area. Despite this, any urban area could be targeted for such optimum density so that it can match and balance the urban economy, infrastructure development and facilities that the population gets. Sources are limited and thus must be optimized use of them. Maximum benefit can be through the optimum use of resources at the cost of less destruction to the environment and the future any space holds. This research also searches for the optimum desired density of any growing town so that they can prosper and facilitate well for the Population residing in them.

Any area could be less, medium, or high dense, there is no such standard that needs to be enforced globally. Principles have been developed by many theorists and researchers to suggest some ideas to identify the growth trend of population and economy, thus helping to build a balanced population distribution of density and infrastructures.

Despite these, during development various cities around the world it is seen that they have adopted social, cultural, economic strategies to identify for the population limit they can bear according to the availability of resources and development they have for now and in the future. To study about the desired population density, we need to look over various national and international cases which have defined the desired density for their own cases.

3.10.1 International cases:

Population density varies significantly around the world due to factors such as geography, urbanization, economic development, and cultural trends. Here's an overview of population density in different countries and regions:

Monaco: As the most densely populated country, Monaco is an extreme case with a population density of around 26,337 people per square kilometer. Its small size and status as a luxury destination contribute to this high density.

Singapore: Known for its efficient urban planning, Singapore has a population density of around 8,109 people per square kilometer. The city-state's limited land area has led to vertical development and innovative housing solutions.

Bangladesh: This South Asian country has one of the highest population densities globally, with around 1,265 people per square kilometer. A combination of a large population and limited arable land leads to this density.

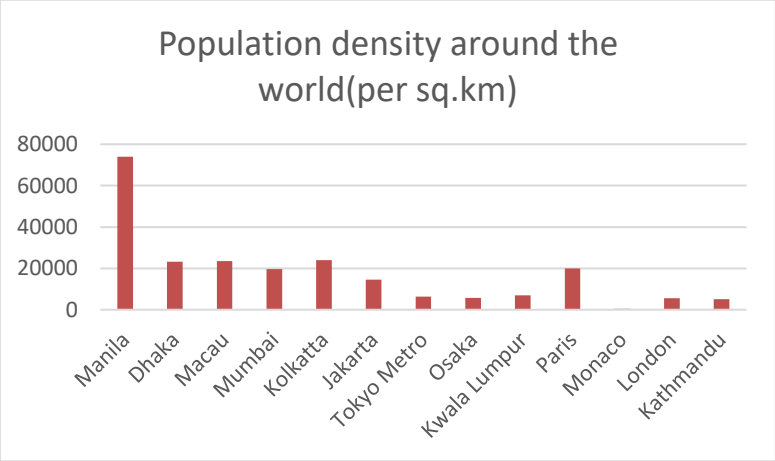


Figure 18 Population Density Comparison

India: With over 1.3 billion people, India's population density is about 455 people per square kilometer. Urban centers like Mumbai and Delhi exhibit much higher densities compared to rural areas.

Netherlands: The Netherlands is densely populated, with around 521 people per square kilometer. Urban planning and efficient land use contribute to this density.

South Korea: With a population density of approximately 525 people per square kilometer, South Korea's industrialization and urbanization have concentrated its population in urban centers.

Hong Kong: This special administrative region of China has a population density of about 6,782 people per square kilometer. Limited land availability and a vertical cityscape contribute to this high density.

Japan: Japan's population density is around 334 people per square kilometer. Urban areas like Tokyo and Yokohama are densely populated, while rural areas have lower densities.

United Kingdom: The UK's population density is about 281 people per square kilometer. While it has urbanized areas like London, it also includes rural regions.

China: With a population of over 1.4 billion, China's population density is approximately 153 people per square kilometer. While its overall density is moderate, it varies widely between densely populated cities and sparsely populated rural areas.

United States: The US has a diverse population density ranging from less than 1 person per square kilometer in some rural areas to over 12,000 people per square kilometer in cities like New York.

Canada: Canada's population density is relatively low at around 4 people per square kilometer due to its vast land area and concentration of population in select urban regions.

These examples illustrate the diverse ways in which population density is influenced by factors such as urbanization, geographical constraints, and economic development. While some countries exhibit incredibly high densities due to their small size and concentrated urban areas, others maintain lower densities due to expansive landscapes and more dispersed populations.

Cases in India

In the realm of Indian urban development and housing standards, various guidelines and plans have been established to address population density and housing in different contexts. The adoption of specific population density metrics has been integral to shaping urban landscapes.

COUNTRY	ACT/LAW NAME	PROPOSED AREA	POPULATION DENSITY	REMARKS
India	Standard for Low-income Housing	Low-income Housing	120-150 DPHa	
India	NBC:2005	All India	130-260 PPHa	
India	Master Plan of Delhi	Slum Housing	155-500 DPHa	
India	Rajiv Awas Yojana (2013-2022)		300-500 DPHa	
India	Greater Hyderabaad:	Plan for Slum	600 DPHa	
India	LIG plan	Low-income Group Plan	500 DPHa	
India	BIS for Low Income Group	Low-income Group Plan	300DPHa	

India	Resettlement and Jhuggi Jhonpri (JJ) in-situ upgradation		250 PPHa	
India	Model Bye law, MOUD	for educational residents	400 PPHa	
India	Model Bye law, MOUD,2016		500 DUPHa	
India	Bangalore Planning,2015	Peripheral Road development	200-600 DUPHa	

Figure 19 (Plans and Policies in India)

For instance, in metropolitan areas, the Indian standard for low-income housing suggests a range of 125-150 dwellings per hectare. NBC-2005 echoes this sentiment, proposing a broader range of 130-260 persons per hectare as a reference for optimal population density. Meanwhile, the master plan devised for Delhi's slum housing emphasizes a varied density of 175-500 dwelling units per hectare, allowing for adaptable urban planning.

The Rajiv Awas Yojana (2013-2022) further refines these numbers, promoting a range of 300-500 dwelling units per hectare to accommodate the housing needs of vulnerable communities. This aligns with the perspective of Greater Hyderabad's slum housing plan, which suggests a density of 600 dwelling units per hectare.

Beyond the slum context, considerations for low-income group (LIG) housing include the suggestion of 500 dwelling units per hectare. However, BIS norms advocate for a net density of 300 dwelling units per hectare for LIG housing, reflecting a balance between population density and sustainable urban living.

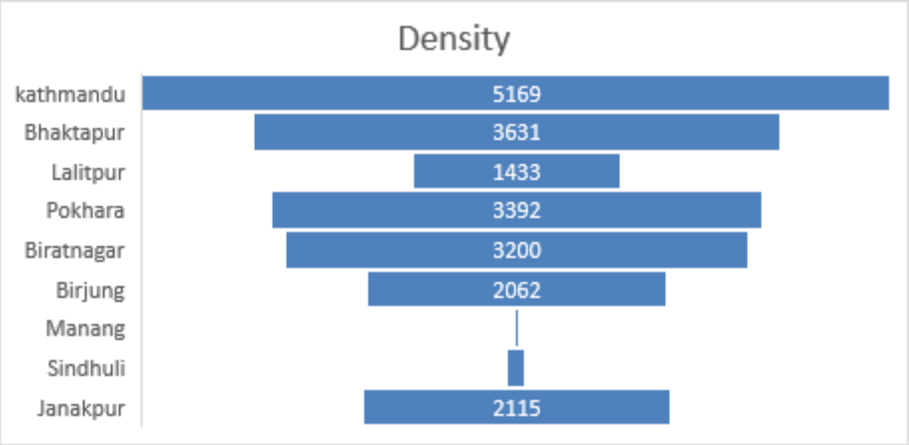
In situations involving resettlement and in-situ upgradation of slums, guidelines propose a maximum of 250 persons per hectare, ensuring an optimal living environment for these communities. Notably, the Model Building Bye laws from the Ministry of Urban Development (MOUD) in India highlight the importance of accommodating educational facilities, with a recommendation of 400 persons per hectare for residents and 200 persons per hectare for organizations.

The trajectory of urban development also incorporates regional specificity, such as the Bangalore Planning 2015, which envisions concentric circles guided by peripheral road development. This approach proposes a dynamic range of 200-600 dwelling units per hectare, adapting to the city's unique spatial demands.

In summary, India's urban development landscape is marked by diverse benchmarks for population density and housing, with considerations spanning low-income housing, slum redevelopment, and educational infrastructure. These guidelines underscore the complexity of achieving harmonious urban growth while prioritizing the needs and well-being of its citizens.

3.10.2 In Nepal.

Nepal's population density exhibits contrast between urban and rural areas. Cities like Kathmandu are densely populated, while rural regions have lower densities due to challenging terrain. The average density is approximately 204 people per square kilometer as of 2021, reflecting both urbanization trends and geographical diversity.



The population data of Nepal 2021 shows that there are varying population densities across the different part of the country. Kathmandu being the capital city of Nepal holds about 9.1% of total population of Nepal. Kathmandu has population density about 5169 per sq.km which is highest among other area in Nepal. Manag has the lowest population density of 2.51 per sq.km. Bhaktapur, Pokhara, Biratnagar have moderate densities about 3000 per sq.km and above. Besides this there is fewer actual data about the net density of any area, it could be much higher.

In Kathmandu,

The population data for the year 2021 AD presents a snapshot of the demographic distribution across various areas in Nepal, providing insights into population density trends and projections. The figures are as follows:

Kathmandu: 2,041,587
Bhaktapur: 78,854
Lalitpur: 551,667
Total: 2,916,4578

Notably, Kathmandu houses approximately 9.1 percent of Nepal's entire population, signifying its role as a significant urban center in the country's demographic landscape.

Looking forward to the year 2035, projections indicate that Kathmandu Metropolitan City's population density is anticipated to be 367 persons per hectare (PPHa). This projection suggests an intensified urban environment and underscores the ongoing urbanization trend in the region.

Furthermore, a general trend is observed across all municipalities, where population density is expected to surpass 100 PPHa. This trend signifies a broader demographic shift towards more concentrated urban living.

In line with these projections, a JICA (Japan International Cooperation Agency) report highlights gross and net density benchmarks for urban planning. The report suggests that the gross population density is projected to be 300 PPHa, while the net density could reach 600 PPHa. These figures provide planning authorities with guidelines to manage urban growth and infrastructure development.

Examining the population density within the Kathmandu Ring Road area, distinct patterns emerge:

Core Area: The central core of the city, as defined by the Ring Road, is projected to reach a high population density of 1000 PPHa. This concentration reflects the intense urbanization and demographic pressure experienced in the heart of Kathmandu.

Surrounding Area: The regions surrounding the core area are expected to maintain a population density of 600 PPHa. This density level captures the transition from the densely packed core to the slightly more dispersed surroundings.

Density in Kathmandu Valley

The KVDA Development Plan of 2020 introduces a gross population density target of 300 persons per hectare (PPHa). This metric serves as a key reference point for guiding urban growth while accommodating the needs of the population.

COUNTRY	ACT/LAW NAME	PROPOSED AREA	POPULATION DENSITY	REMARKS
Nepal	Kuleshwor Planning	KTM, Kuleshwor	159 PPHa	
Nepal	Gongabu Planning	KTM, Gongabu	143 PPHa	
Nepal	KVDA,2020	Kathmandu Valley	300 PPHa	
Nepal	Kamerotar Planning	Bhaktapur	<300 PPHa	
Nepal	KVDA, LTDP 2002	Kathamndu valley	300 PPHa	max: 500 PPHa
Nepal	Harisiddhi Town development Program	Lalitpur	210 PPHa	

Figure 20 Population density In various Project

Moving to specific areas:

- Kuleshwor planning exhibits a population density of 159 PPHA, reflecting a moderately concentrated urban environment.(Faust et al., 2020)
- Gongabu Planning showcases a slightly lower density of 143 PPHA, suggesting a relatively less dense but still urbanized locality.(Faust et al., 2020)
- LTDP 2002 recommends a population density of 300 PPHA, with an optimal density of 500 PPHA. This recommendation underscores the balance between accommodating residents and maintaining a sustainable urban fabric.(KVDA, 2015)
- Harsiddhi Town Development Program is designed with a population density of 210 PPHA, aimed at accommodating around 1.5 lakh people in a 14000 ropany area.
- In the year 2020, KVDA data presents varying population densities across different wards: Ward 24 experiences a density of 442 PPHA, while Ward 8 records a lower density of 75 PPHA. Ward 13 in LMC registers a density of 194 PPHA, while Ward 15 has a lower density of 25 PPHA. In contrast, Ward 21 demonstrates a relatively high density of 704 PPHA.

- Bhaktapur Metropolitan's Ward 9 displays a notably high population density of 1039 PPHA, suggesting a concentrated urban living environment. Meanwhile, Ward 17 has a lower density of 72 PPHA.
- Madhyapur Thimi, as of 2020, exhibits a population density of 76 PPHA, reflecting a moderate urban environment.
- Kritipur's Ward 10 stands out with a high population density of 919 PPHA, emphasizing the intensity of urban living. Conversely, Ward 19 demonstrates a lower density of 12 PPHA.

Collectively, this data pattern emphasizes the diversity of urban planning approaches and population density trends across various localities. It underscores the need for balanced planning strategies to accommodate varying degrees of urbanization, while considering the balance between population growth, livability, and sustainable development.

3.11. Plans and Policy Review for Densification Through spatial Analysis.

To Plan, execute, develop, and monitor any plan, it must have some guiding principles and boundary it should be managed within. To address the change in Population, dynamics of urban area, use of land, settlement of people, infrastructural growth, there are various plans and policies developed by government of Nepal. These policies, act and directives are important aspects that should be studied and analyzed to acknowledge what we can do and what we can't. In this concern, the following acts, regulations, policies etc. reviewed for study have been listed below:

2.12.1 National Urban Policy 2007

The policy is expected to be a landmark towards farming positive directions in a planned, integrated and coordinated way in solving unplanned urbanization process and its challenges. It is the outcome of concerned intellectuals, experts and Government in written suggestions and ideas for the balanced urban growth of Nepal. By the decade of 1970 urbanization process added challenges to the city population. The haphazard urbanization would be a problem was learnt from the western pattern of urbanization. The national urban structure was shaky with almost all physical, social, and economic infrastructures centered in Kathmandu Valley. The National Urban Policy of 2007 was formulated in such context with a vision to promote balanced growth.

NUP 2007 objective supports for densification approaches which is needed in that time and now in 2023. The strategies to develop cities with balanced infrastructure development, improving quality of life and to involve local agencies and people for sustainability and conduct proper city management.

3.11.1 Nepal Urban Development Strategy (NUDS),2017

The national urban development strategy has been designed for a 15-year period and aims to achieve positive outcomes in key areas such as infrastructure, environment, economy, and finance. Within the urban sector, the overarching goal is to bolster both the national and sub-national urban systems. Specifically, the strategy addresses various factor of urban development:

Infrastructure: The strategy places emphasis on enhancing urban infrastructure. This involves allocating more national resources to urban infrastructure development. It also seeks to encourage private sector investment in both essential services and more advanced forms of infrastructure. Strategic investments are directed towards shared infrastructure within urban regions, adopting a cluster city approach. Furthermore, the strategy aims to strengthen the institutional capabilities at both the national and local levels, enhancing their abilities to facilitate infrastructure development and efficient service delivery.

Urban Economy: The strategies in this realm are directed at increasing the contribution of urban areas to the country's Gross Domestic Product (GDP). This encompasses strengthening the economic foundations of urban regions, covering aspects like economic growth, investment opportunities, and financial aspects.

Urban Finance: The ultimate objective here is to establish financially self-sufficient and stable urban areas. The strategies seek to achieve this by addressing financial aspects in urban development. This could involve efficient financial planning, resource management, and mechanisms to generate revenue within urban areas.

Overall, the strategy aims to create a comprehensive framework for urban development that promotes sustainability, economic growth, and financial stability. It envisions stronger urban systems at both national and sub-national levels, with well-developed infrastructure, thriving economies, and prudent financial management. The focus is on achieving a balanced and prosperous urban landscape that contributes positively to the overall growth and development of the country.

3.11.2 Planning Norms and Standard,2015

The Department of Urban Development and Building Construction has developed a comprehensive set of Planning Norms and Standards aimed at standardizing the planning process for urban development projects. This document categorizes urban areas into five classes: Metro City, Sub Metro City, City, Sub City, and Market Centers. The Planning Norms and Standards, established in 2015, are structured under three main categories: infrastructure norms and standards, land use norms and standards, and urban form norms and standards.

The urban infrastructure norms and standards are further divided into three categories: Physical, Economic, and Social Infrastructures. Likewise, the land use norms and standards encompass two areas: the promotion of natural resources and the promotion of settlements. Specific standards have been defined under each of these categories.

The primary goal of this initiative is to provide a practical tool that urban designers, planners, and policymakers can utilize. This tool aids in recognizing and predicting the essential requirements for various types of urban areas. By establishing standardized norms and standards, the department seeks to streamline the planning process for urban development projects, ensuring that vital aspects such as infrastructure, land use, and urban design are comprehensively addressed in a consistent manner.

Land use Policy, 2015

The policy identifies land as a scarce resource and aims towards optimum use and protection of land from rampant fragmentation. It has tried to ensure a hygienic, beautiful, well-facilitated and safe human settlement for a planned and sustainable urban development.

3.11.3 Land use act 2019.

The Land Use Act of 2019 in Nepal grants the government the authority to formulate land use plans to ensure appropriate land utilization through prior public notification. Land is categorized into various areas for specific purposes as outlined below:

Agricultural Area: Land designated for farming and agricultural activities.

Residential Area: Land designated for housing and residential purposes.

Commercial Area: Land allocated for commercial and business activities.

Industrial Area: Land set aside for industrial and manufacturing purposes.

Mineral and Mine Area: Land designated for mining and mineral extraction activities.

Forest Area: Land reserved for forestry and conservation efforts.

Stream, River, Lake, Marshy Area: Land around water bodies and wetlands.

Public Land Area: Land intended for public facilities and services.

Cultural and Archeological Area: Land with cultural or archaeological significance.

Other Areas: Any areas designated by the Nepal Government for specific uses.

Under this act, the Ministry of Land Management, Cooperatives, and Poverty Alleviation is responsible for preparing land-use area plans for local governments. These plans need to be handed over within a year of the act's implementation. The plans must identify disaster-prone and risky areas. Local governments have the authority to create separate land use area plans for both rural and urban areas. Additionally, landowners will be provided with a land ownership certificate indicating their allocated land use area. If a landowner is dissatisfied with the allocation, they can file a complaint with the District Court within 35 days of receiving notice.

Furthermore, the act establishes various councils for land use:

Local Land Use Council: Deals with land use matters at the local level.

Provincial Land Use Council: Responsible for land use management at the provincial level.

Federal Land Use Council: Manages land use issues on the federal level.

3.11.4. Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development, a universal initiative adopted by all United Nations Member States in 2015, outlines a collective framework for promoting peace, prosperity, and sustainability for people and the planet, both now and in the future. Central to this agenda are the 17 Sustainable Development Goals (SDGs), comprising 169 targets. These goals serve as a pressing call to action for all countries, regardless of their development status, to engage in a collaborative global partnership.

Nepal has actively embraced the SDGs, becoming a participant in this global endeavor. The eleventh SDG focuses on Sustainable Cities and Communities. Its objective is to rejuvenate and design cities and human settlements in a manner that provides equal opportunities for everyone, ensuring access to essential services, energy, housing, transportation, and

environmentally friendly public spaces. This is achieved while concurrently reducing resource consumption and negative environmental impacts.

The foundation of sustainable cities hinges on harmonizing three fundamental aspects: Economic Growth, Social Inclusion, and Environmental Protection. By striking a balance between these elements, cities can achieve true sustainability. A holistic approach that considers economic progress, inclusivity in society, and safeguarding the environment is essential.

Numerous national and international organizations are actively collaborating to facilitate the attainment of these goals within Nepal. Their concerted efforts are aimed at ensuring the successful realization of the SDGs, fostering sustainable urban development, and creating a future that aligns with the principles of sustainability and well-being for all.

3.12.5 KVDTC and KVDA and Its contribution to Urban development.

The Kathmandu Valley Development Authority (KVDA) plays a significant role in urban development and management within the Kathmandu Valley region in Nepal. Its role encompasses various responsibilities aimed at promoting sustainable urban growth, efficient resource management, and improved living conditions for residents of the valley.

From 1969 to today there has been an active involvement of various government bodies, experts in making development plans and policies to make this valley better for today and tomorrow. Continuous studies and research have been conducted by national and international agencies to address the growing urban problem, address them, conserve traditional settlements and culture, preservation of cultural heritages and significant environmental resources. Various plans and studies that have been done, a page long and vast studies have been conducted for resource management and sharing and primarily save the cultural city from devastation. Plans and efforts can be listed as.

A. Physical development plan of Kathmandu valley,1969

This plan recommended an intervention for extension of settlement is west and south part of KV, to address the growing demand of people and to solve the urban issue regarding rapid population and urban growth.

B. Kathmandu Valley Physical development Plan 1972.

It recommended the development of settlement in the arable land area (tar - टार) and maintenance of greenery in wetland area as per the geographical structure of the Valley.

C. Land Use Plan of Kathmandu Valley 1976 (2033 BS)

Development of inner and outer ring road, various residential and protection zones were proposed in the plan. The plan recommended the land use zoning and regulations for coordinated development of Kathmandu Valley. For physical development planning it divided the area of Kathmandu Valley into broadly three different categories in which inner core settlement of Kathmandu and Lalitpur belonged to category “Ka”, the settlements adjacent to the existing core settlements of Kathmandu and Lalitpur was termed as category “Kha” and the spread and sparse settlements of Kathmandu Valley which has to be compacted were termed as category “Ga”.

D. Kathmandu Development Authority Act 1988

This Act concerns the establishment of the Kathmandu Valley Development Authority, whose functions shall pertain to land use planning, development in land-use areas and the prescription of methods of construction works, formulation and implementation for the development and maintenance of cultural heritage, and protection and conservation of the environment and natural resources.

E. Urban Development and Conservation Scheme 1988 (2045 BS)

Under the leadership of Ministry of Housing and Physical Planning, the plan launched programs such as conservation of wetlands and riverbanks of the Kathmandu Valley. Similarly, the Land Pooling and the Guided Land Development programs were launched under this Scheme.

F. Kathmandu Valley Urban Development Plan and Program 1991 (2048 BS)

The proposal suggested that the Kathmandu Valley (KV) should be recognized as the main hub for administration, culture, tourism, and the preservation of historical monuments. Additionally, it emphasized the idea of considering KV as an extension of Kathmandu City rather than making it a center for industrial operations. The plan had the objective of increasing the population density in Kathmandu and Lalitpur settlements, which would consequently limit the urban expansion in the valley. This approach was aimed at safeguarding the valley's ecology and agricultural lands by promoting agricultural activities and rural economic growth.

G. Town Development Act 1998: The legislation establishes the legal framework for urban planning within specified "Town planning areas." Urban planning is directed toward achieving

a specific outcome in a defined region, either through land pooling or directed land development. Consequently, the Act empowers a Town Development Committee to execute the task of "town planning" within the designated area. However, it is not intended to facilitate the broader process of urban planning applicable to larger regions like the Kathmandu Valley

H. Long Term Development Concept Plan of Kathmandu Valley 2002 (2059 BS)

The Long-Term Development Concept Plan for Kathmandu Valley was formulated by the Kathmandu Valley Town Development Committee in July 2000 and approved by the Government of Nepal (GoN) in 2002. This plan aimed to guide the development of Kathmandu Valley up to the year 2020. It analyzed the shortcomings of past policies while aiming to position the valley as a historical, cultural, tourism, and capital region of the country.

Two key strategies were proposed by the plan:

Decentralization of Economic Opportunities: With the valley's population growth posing threats to land use, the plan recognized the need to distribute economic opportunities and capital investments to other promising regions of the country. The plan aimed to relocate polluting industries such as cement, bricks, and carpets outside the valley, and prevent new ones from being established within its boundaries.

Expansion and Carrying Capacity: Due to rapid urbanization and the conversion of agricultural land into built-up areas, the plan identified areas for expansion based on projected population growth and carrying capacity. It highlighted the urgency of introducing policy measures to prevent the conversion of potential agricultural land into urban sprawl, which could occur within decades without timely interventions.

Despite its potential, the plan faced challenges in implementation due to its conceptual nature and the absence of an operational plan.

I. 20 Years Strategic Development Master Plan (2015 - 2035) for Kathmandu Valley.

The "2035 A.D. Scenario of Kathmandu Valley" embodies a realized aspiration led by capable political leadership, guided by modern technological advancements, and fueled by a development-oriented outlook. This vision is rooted in the collective determination and solutions of the people. The associated Strategic Work Plan outlines concrete steps to transform this vision into reality. This is plan as a comprehensive agenda for urban development planning in the Kathmandu Valley. It not only outlines a developmental roadmap for the Valley itself but

also recognizes its significance in contributing to the progress of Nepal as a whole. Furthermore, it aims to attract global investors by spotlighting the potential opportunities within the Kathmandu Valley.

Main Extract from the vision is:

1. Four percent of the total area of the new town would be urban forest and parks.
2. There will no conversion of public land into built up area.
3. Planning for 7 satellite town development. An initiative to stop Sprawl.
4. It aims to regain forest area at 40% of valley.
5. Aim of regaining 56% agricultural area and reduce built up area to 12 percent, which is challenging.
6. Increase road density to 12 km/sq.km
7. High-capacity vehicle planning.
8. Intercity bus terminal with BRT system
9. Neighborhood Park for each square km housing area.
10. Preserving core areas, art, and architecture. Economy and culture.
11. Development of Affordable housing (institutional) 10 percent of urban core.
12. There is a plan to maintain at least 300 PPHA population density with optimal 500 PPHA.

These are the visions that should be addressed with studying the space selection and development of Dense area settlements in new growing and old towns.

4. Study area:

4.1. Introduction.

Kageshwori Manohara Municipality is positioned in the northern region of the Kathmandu Valley within the Bagmati Province. It stands as one of the recently established 13 municipalities within the valley. Geographically, the municipality shares its borders with Gokarneshwor Municipality to the west, the Sindhupalchowk District to the north, Shankharapur Municipality and Bhaktapur District to the east, and the Kathmandu Metropolitan City to the south.

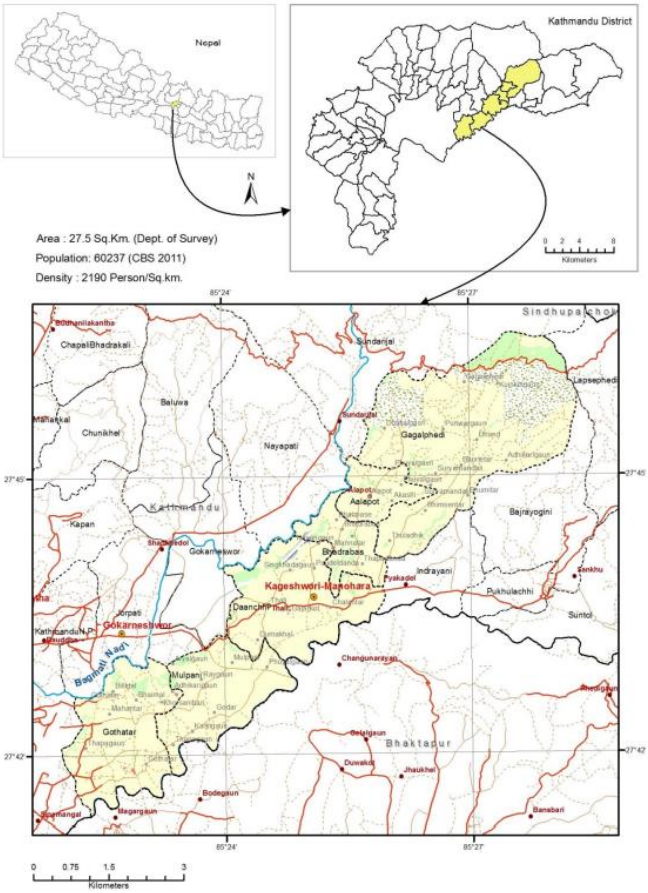


Figure 21 Location Map (source: Kageshworimun MTMP)

4.2. Administrations:

Kageshwori Manohara was declared as municipality in December 2014 by merging six former VDCs namely Gothatar, Mulpani, Danchhi, Bhadrawas, Alapot and Gagalphedi. The municipality covers an area of 27.364 sq.km. (Municipal Profile, 2076). Administratively, it has been divided into nine different wards with its administrative center i.e., Office of Municipal Executive located at Danchhi that lies in Ward-5. The place can be referred to as the geographical center of the Municipality as well. The division of wards is numbered as 1 to 9 from North to South, each ward having its own independent ward offices. It has set its office in a rented building and its own building is proposed and the construction is supposed to commence soon.

4.3. Regional Context

Broadly, in a regional context, Kageshwori Manohara is a part of Kathmandu Valley located towards the South-Eastern side of the valley. It lies between two major ancient historical urban and economic centers of Nepal, Kathmandu and Bhaktapur. The Municipality has linkage roads via Bagmati Corridor, Jadibuti, Chabahil and Bode from these urban centers. Chabahil-Lapsiphedi-Bhotechaur Road Section is also proposed that will directly link to

Sindhupalchowk district. The boundary is well defined by two major rivers Bagmati in the West and Manohara in the East. The development works can be seen ongoing along the Bagmati corridor which is considered as a milestone in improving the connectivity among various places of Kathmandu Valley and also to ease the traffic congestion.

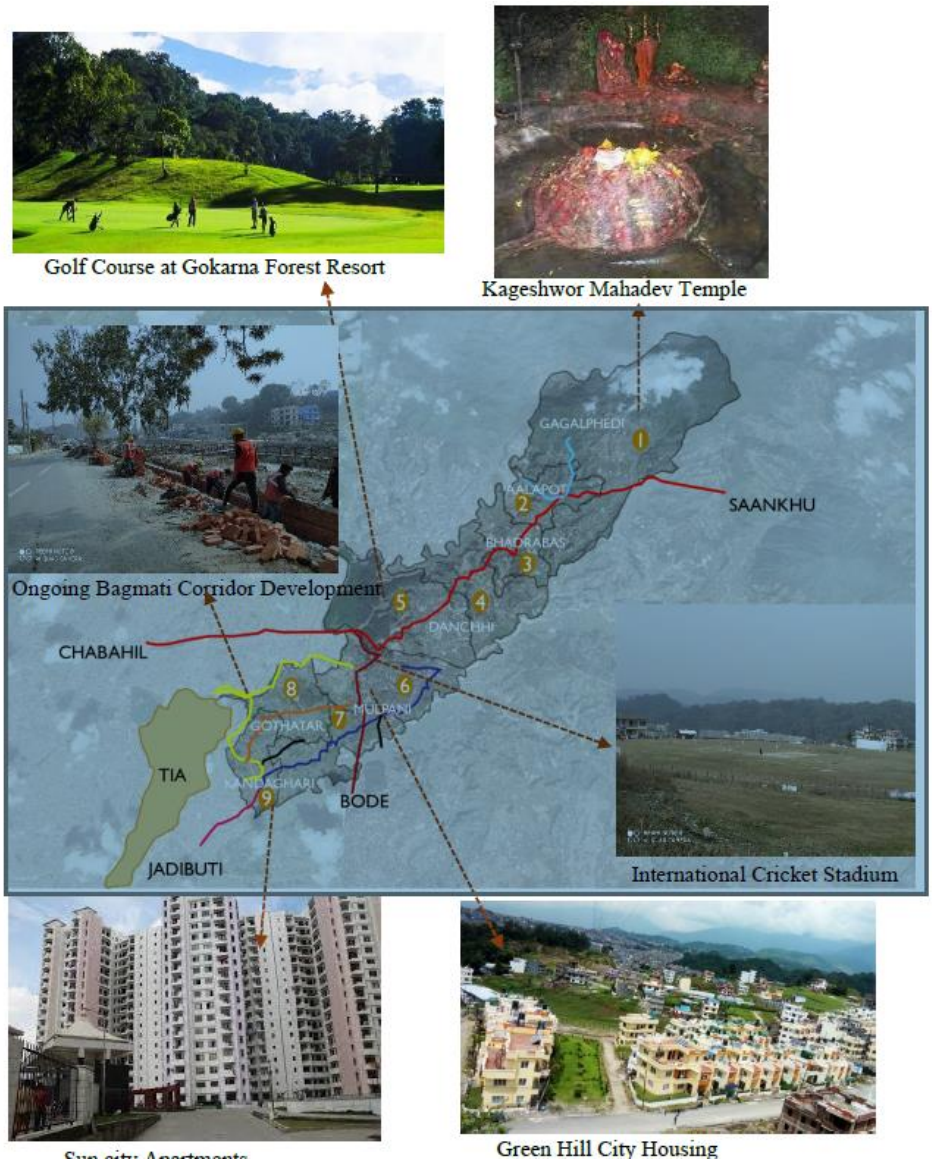


Figure 22 Various Locations in Kageshwori

Another major regional context of the municipality is its shared boundary with Tribhuwan International Airport. Due to this proximity, the Municipality though does not have its own airport, is not distant to access the service. But the spread of Airport in a larger area also restricts the linkage to Kathmandu.

The temple of Kageshwori Mahadev that lies in Ward 1, Gagalphedi attracts religious tourists and visitors. Another important religious place Salinadi, that lies in Saankhu is also accessed via this Municipality. Gokarna Forest Resort that lies in Ward-5 is also mostly occupied by

national and international tourists as it has the Golf Course Site. The construction of the International Cricket Stadium is also ongoing in the Ward-6 of the Municipality.

4.4.**Historical background**:

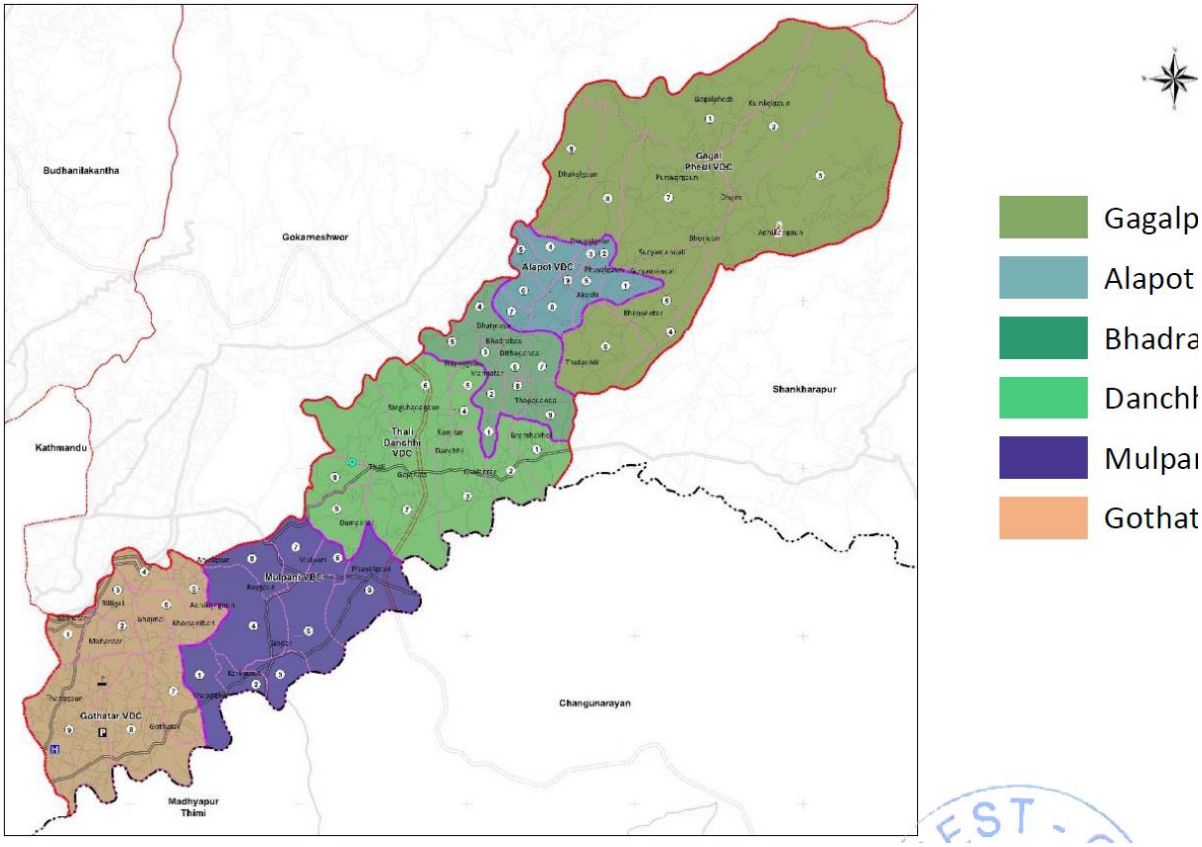


Figure 23 Sabik Ward Map of Kageshwori MM. (source: NEST, GEOCOM 2019)

The municipality derives its name from the renowned temple 'Kageshwori Mahadev,' situated in Ward-01, Gagalphedi, and the prominent 'Manohara' river. In the 20th chapter of the Nepal Mahatmya katha, the tale of the Kageshwori temple is narrated. According to this legend, during the distribution of the elixir of immortality, Lord Shiva assumed the form of a crow to safeguard the elixir from malevolent entities in the hills of Kageshwori Manohara. This event led to the establishment of the Kageshwori temple in that region. The name 'Manohara' is believed to have originated when King Manichud lost his Naagmani (snake gem) in the hills of Gagalphedi North-East. These stories are thought to be the origin of the name 'Kageshwori Manohara' for the municipality. Archaeological excavations in certain parts of the municipality have revealed Lichchavi-era bricks and coins, underscoring the historical significance of the region during that period (ERMC; NEST; GEOCOM INTERNATIONAL, 2019). It is a tradition that individuals who encounter or are touched by crows must pay a visit to the temple. An annual fair takes place at the Kageshwori temple during the Bhadra Shukla Ashtami period.

4.5. Geography

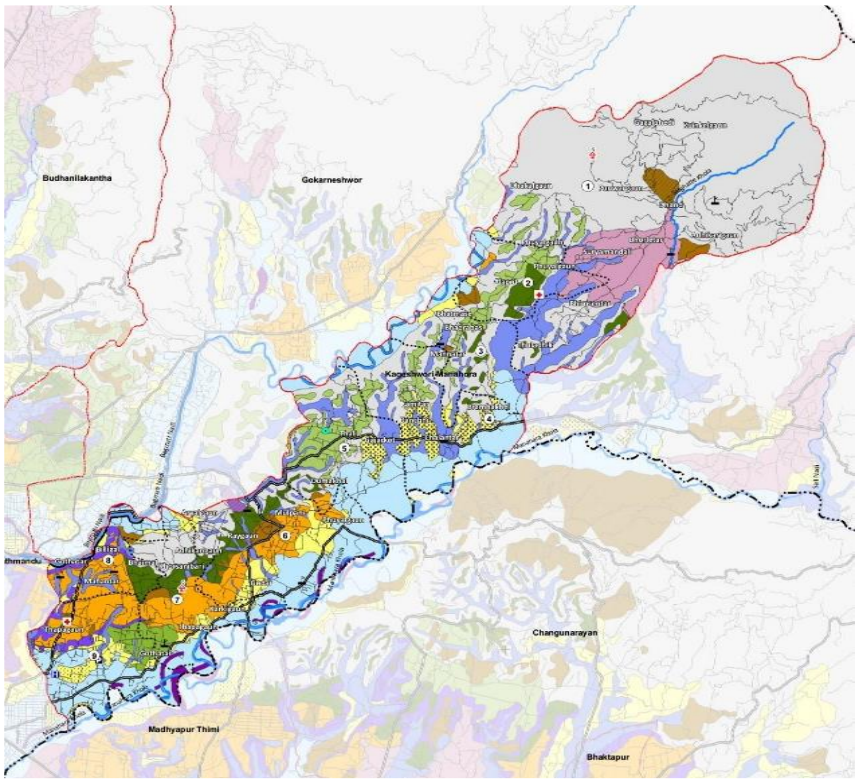
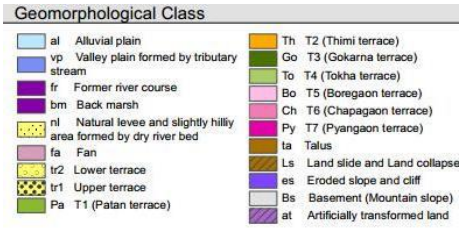


Figure 24 Geomorphology Map (source: NEST, GEOCOM 2019)



Kageshwori Manohara Municipality is located about 13 Km southeast of Kathmandu and lies between 85°36'E and 85° 46' 48"E longitude and 27° 41' 24" and 27° 52' 12"N. latitude. The highest altitude of the municipality is 2200 meters and lowest level is 1310 meters.

Geology:

Kageshwori Manohara has a mild climate and fertile land as it is in Kathmandu valley basin of Midland Region. It is tectonic basins of the sub-Himalayas. Geologically, the Kathmandu basin lies on the Kathmandu Nappe which consists of metamorphic nappe and the overlying fossiliferous Tethyan sediments, both belongs to Kathmandu Complex. The Kathmandu Nappe is composed of Shivpuri gneiss and granite injection complex and schistose rocks and marbles of the Bhimphedi Group.

Kathmandu Valley is divided into 3 ground water divisions namely, Northern groundwater zone, Central groundwater zone and southern groundwater zone by JICA in 1990. Kageshwori Manohara Municipality lies in Northern Groundwater Zone. This zone is the principal source

of groundwater. It is generally composed of unconsolidated highly permeable materials and coarse sediments which are interbedded with fine impermeable sediments forming the main aquifer. The total area of NGD is 157 km2 of which 59 km2 is its recharge area. The deposits are composed of unconsolidated highly permeable materials of micaceous sand and gravel. Aquifer transmissivity ranges from 83 to 1963 m2/day. Water quality is characterized by low electrical conductivity of 100-200 µS/cm according to Dixit and Upadhya (2005).

4.6. Watershed and Water Bodies

Major rivers flowing through Kageshwori Manohara Municipality is Bagmati River and Manohara River flowing at the western and eastern boundary. The name Kageshwori Manohara was given by the name of the river Manohara. Besides these two main rivers, the other rivers flowing within the municipality are Kavre khola, Maruwa khola, Dhakal Khola, Kageshwori khola, ghatte khola, Mahadev khola. Besides these rivers there are various streams at various regions of the municipality – Kageshwori chaago(stream), Manilingeswor chango (stream),

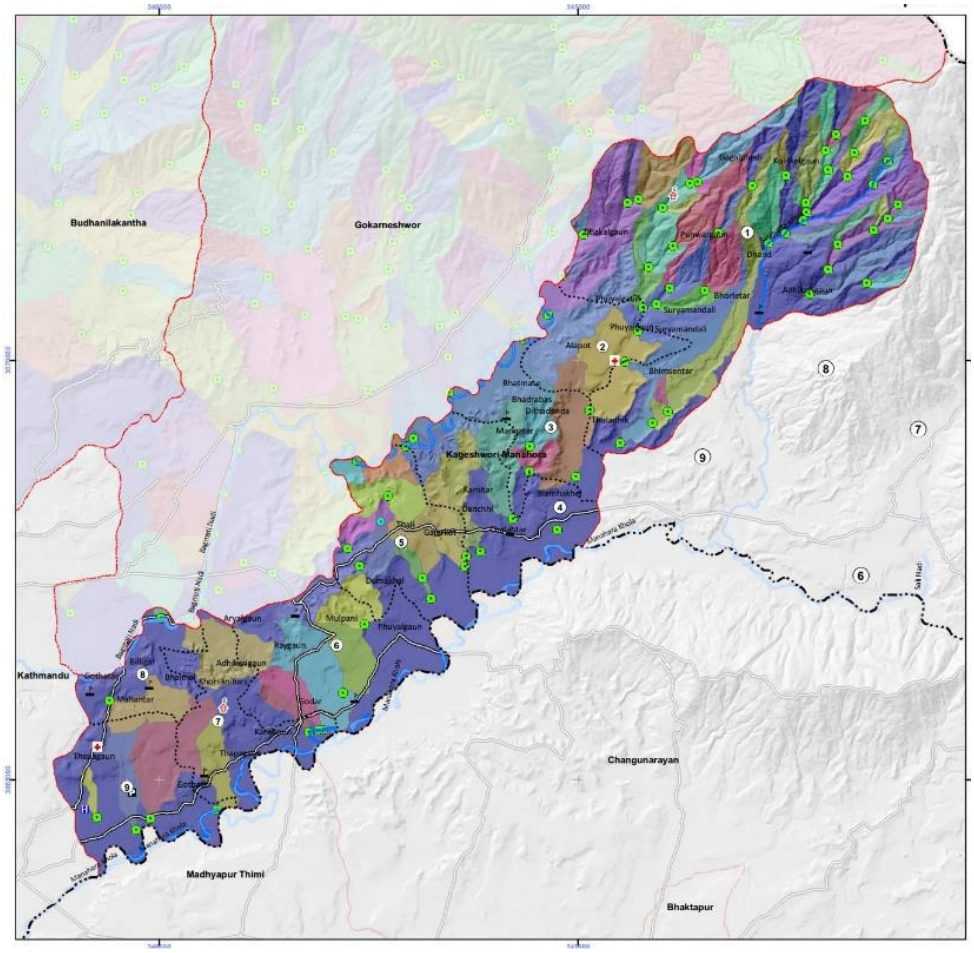
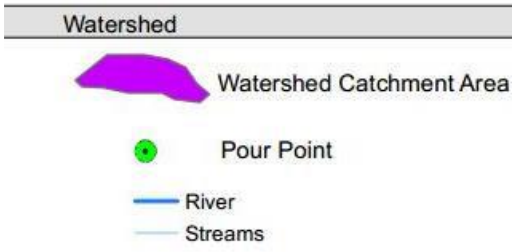


Figure 25 Watershed Map (source: NEST, GEOCOM 2019)



4.7. Climate:

Kageshwori Manohara Municipality lies in subtropical climate zone (1000 to 2000 meters) and Deciduous Monsoon Forest Zone (altitude range of 1,200–2,100 meters), one of five vegetation zones defined for Nepal.

In Kathmandu valley, during summer the average maximum temperature during the months of July, August is 29.1o C and during winter average minimum temperature during December and January is 2.4o C. The average minimum winter temperature in Kageshwori Manohara municipality is 4.2 o C and during summer the average maximum temperature is 27.7 o C. The average annual rainfall in Kathmandu valley is 1400 mm, three-fourth of which falls in June, July and August. The wettest month is July with average rainfall 325.3 mm.

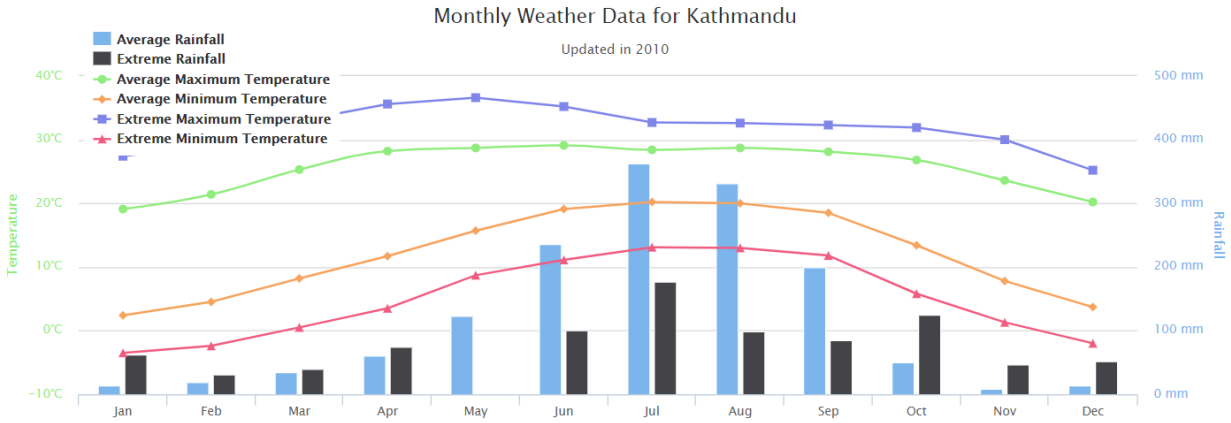


Figure 26 Climate data(source: NEST, GEOCOM 2019)

4.8. Natural Resources:

Forest

The total forest area covered in Kathmandu district is 152 sq. km. The total forest cover in Kageshwori Municipality is 1.56 sq. km. There are 16 community forest and 2 religious' forest in Kageshwori Manohara.

Mines and natural resources

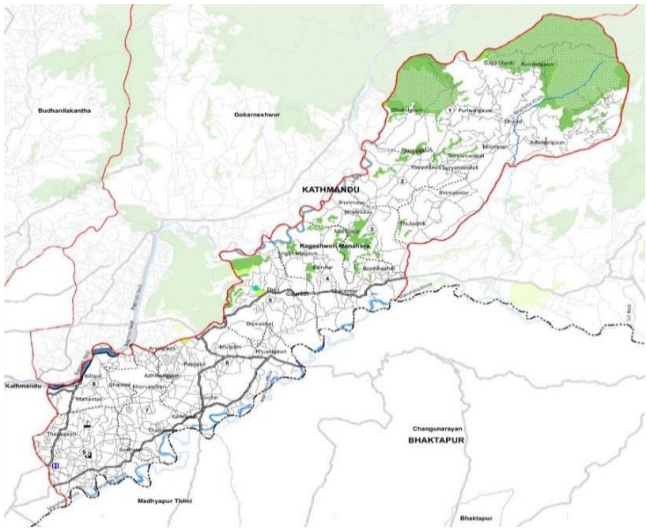


Figure 27 Forest and Mines(source :IUDP 2020)

Mines and natural resources available in the Kageshwori Manohara are sand, stone and silica sand. Currently, there are 6 registered Silica Sand quarries and 1 sand quarries in operation. Besides there are several sand and stone mines that are in operation in the municipality without liscense. According to department of mines and geology there are few deposits of Uranium in Gagalphedi area along with Shivpuri area in Kathmandu Valley.

5. Data collection:

For this research, a study of primary and secondary data must be carried out. To meet the requirements of the study and the objectives various data collection methods and approaches have been used. Despite two types of data having been collected, secondary data has been verified with professional, personal and professionals. The data collection methods use is:

1. Primary data collection.
2. Secondary data collection.

5.1. Primary Data collection:

The primary data collection is conducted through visits of various government offices, local bodies, private and public stakeholders. This data have been directly used for research purposes while thinking it is valid and verified data. Survey and filed visit helped in collection of these data along with some verification on site. Various important places is visited along with the study of important data needed for the study.

5.1.1. Interview with experts and Questionnaire Survey.

A discussion and questionnaire survey were conducted with various officials concerned with this context of municipality. Interview interview as key informant was taken with experts such as urban planners, head of concerned authorities like municipalities and other governing bodies.

The interview and discussion taken with officials are listed below.

Person Name	Institution	Position	Interview date	Time
Shanta Thapa	Kageshwori Manohara Municipality	Deputy Mayor	July 22nd 2023	11:30 AM
Shreeram Chaulagain	Kageshwori Manohara Municipality	Building Permit head Engineer	July 19th 2023	11:15 AM
Sandesh Kumar Dhakal	Kageshwori Manohara Municipality	Ex. Planning department head	July 20th 2023	12:00 PM
Mukunda Prasad Gajurel	Ward No 1.	Ward President	July 25th 2023	2:00 PM
Ram mani Pudasaini	Ward No 3.	Ward President	July 18th 2023	12:00 PM
Prakash Phuyal	Ward No 6.	Ward President	July 17th 2023	1:00 PM
Hari bhakta Pudasaini	Ward No 8.	Ward President	July 24th 2023	3:00 PM
Anil Thapa	Ward No 9.	Ward President	July 24th 2023	4:30 PM
Dipa Karki	Ward 8 Technical	Civil Engineer	July 24th 2023	1:00 PM
Shekhar Khanal	Ward 6 Technical	Civil Engineer	July 17th 2023	11:00 AM
Yogesh Purna Shrestha	Picaso Consultant Pvt.Ltd	Urban Planner	July 10th 2023	5:00 PM
Parasar Ghimire	Eastern Kathmandu New Township	Urban Planner	July 29th 2023	1:00 PM
Sugam Gautam	Freelancer	Urban Planner	July 20th 2023	3:00 PM
Kapil Pudasaini	Freelancer	Industrial Engineer	July 20th 2023	5:30 PM

Interview with deputy Mayor of Kageshwori Manohara.

On July 22nd, 2023, in a interview with Deputy Mayor Shanta Thapa, a several question was asked about the urban density, infrastructure development and vision of the municipality. She with all her knowledge, was kind to know about the research and all she could add was a vision for a green environment and people enjoying the infrastructure that municipality wants to serve people with. She agrees with the idea of urban densification, and she added that we could do a lot more if people stay together in a small area and leave other areas open. She said that if it is

given a chance do that that option of staying together, we could all benefit from it. She told that kageshwori Manohara has initiated an approach to conserve forest area and water bodies. She said that there has not been any open space and public land identification till now but is planning to do that very soon. After the study of this research proposal, she said that she is positive about the planning method that would benefit all of us. She added that there are a lot of problems we might face during the densification planning. She insists on conducting similar research and sees the possibility of compact settlement design in the area. She is glad about how people benefit from urban infrastructure despite paying low taxes on everything that would contribute so little in revenue collection. She explained about the possibility of urban growth due to availability of lands for future populations, but the problem lies within the current infrastructure if that could hold further population. She is positive about the development in infrastructure for the near future as they have invested more in infrastructure. Despite her expertise in this area of study, she wishes the best of luck for this study and expected that it would help somehow in identifying problems and suggest some practical solution that the municipality can afford at least cost.

Inferences from the Interview with Deputy Mayor Shanta Thapa:

- Vision of Green Environment and Enjoyable Infrastructure: Deputy Mayor Thapa envisions a municipality marked by a green environment and infrastructure that enhances the quality of life for residents.
- Support for Urban Densification: Thapa is in favor of urban densification, highlighting the potential benefits of compact living and resource management.
- Conservation Initiatives: The municipality has initiated efforts to conserve forests and water bodies, indicating a commitment to sustainable development.
- Future for Open Spaces and Public Lands: Thapa mentions upcoming plans for identifying open spaces and public lands, emphasizing a holistic approach to urban planning.
- Positive Reception of Research Proposal: Thapa expresses optimism about the research proposal's value and its potential to benefit the municipality.
- Challenges in Densification Planning: While positive, Thapa acknowledges potential challenges in densification planning, indicating an awareness of complexities involved.
- Importance of Research and Compact Settlements: Thapa sees the value of similar research and compact settlement designs, underlining research's role in future urban growth planning.

Interview with Er. Shreeram Chaulagain.

Shreeram Chaulagain is a Civil engineer who has been involved in this municipality for seven years. He is now the head of the building permit section and is involved in contributing suggestions and plans to better the building permit system, bye laws and further plans of the municipality. He was asked with questions like the understanding of urban settlements with increasing density for future use. He was asked for the planning norms and bye laws that have been enforced into the local bodies. The question of how many buildings is permitted in a certain period. He was also asked to verify the densification of settlement criteria and if the listed criteria is contextual or not.

He said that he has only been involved in the building permit system and has been regulating the bye laws that the municipality has passed in recent years. He gave information about the high trend of people that are willing to build houses and commercial spaces. He thinks that the municipality is expanding in a rapid way and there is no regulation for people not to build buildings and spaces beside the restricted areas like forest and conserved area. He added that everyone has the right to build their homes and we are not restricting them location wise. He said that there are simple measures taken for urban expansion of highways and their proper use. He said that the far for main highway touched plot ahs been increased from 1.75 to 3.5 which can contribute to dense area development. Either its commercial or residential, the FAR for other buildings is increased to 3. The ground coverage for buildings has been increased from 60 to 70 percent for residential and 50 to 60 for commercial areas. This can add a lot to the densification of settlements. Only plots that have been planned for land pooling and smart cities are blocked for construction of houses. Despite this, people in need have to build houses for them. He added that the most influencing population comes from ward no 9 that is Gothatar area. At first people came and built houses for them. Location being near to metropolitan city, people found it comfortable to

build houses. There was no building regulation at that time and haphazard construction of houses can be seen.

From 2073 B.S the practice of building ye laws came to existence and ahs been modified according to the needs of settlement and space. For Criteria of selection of suitable areas, he added that there are some liquefaction areas near the river which should not be missed during the study. He is concerned about this area where people are rapidly building houses, where the municipality doesn't have proper rules and measures for that kind of construction. He recommends that there should be study and active enforcement of laws so that people would be aware of risk and save themselves in near future.

Key Points from Shreeram Chaulagain Interview:

- Understanding of Urban Density: Chaulagain was queried about comprehending urban settlements with increasing density for future needs.
- Enforced Planning Norms and Bye Laws: He was questioned about the existing planning norms and bye laws implemented by the local bodies.
- Involvement and Regulations: Chaulagain specified his involvement in the building permit system and the regulation of recently passed by laws.
- Trends in Building Spaces: He discussed the high trend of individuals willing to build houses and commercial spaces.
- Municipality Expansion and Regulations: Chaulagain noted the rapid municipality expansion and the absence of strict regulations on building within restricted areas, except for forests and conserved regions.
- Urban Expansion Measures: He mentioned measures taken for urban expansion, such as increased Floor Area Ratio (FAR) and ground coverage percentages.
- Plot Blocking and Construction: Chaulagain highlighted that plots designated for land pooling and smart cities are blocked for construction, but people in need still build houses.
- Influential Population and Haphazard Construction: He discussed the influence of population from Ward No. 9, particularly the Gothatar area, and the haphazard construction practices seen due to the absence of regulations in the past.
- Evolution of Building Bye Laws: Chaulagain explained the evolution of building bye laws from 2073 B.S and their modifications according to settlement needs.

- Criteria for Suitable Areas: He emphasized considering liquefaction-prone areas near the river while selecting suitable areas for construction.
- Concerns and Recommendations: Chaulagain expressed concern about unregulated construction in certain areas and recommended conducting studies and enforcing laws to increase awareness of risks and ensure safety in the future.

Interview with Mukund Prasad Gajurel.

Mr. Mukund Prasad Gajurel is selected as ward president for Ward no 1 in recent election. He also has been actively involved in society and development since she young age. He has always been a sincere person regarding rural and urban development. As a ward chairperson he was asked to simplify the population trend, housing demands, migration of people, real estate development, infrastructure condition and demand and huge change in landcovers. He was asked about the change of occupation of people, their living conditions, the economic growth people have felt and also about the environmental changes. He was with many other concerned people who were interested in people. He allowed everyone to express their thoughts with them. All of them had similar voices and opinions towards the question forwarded to them.

Ward no 1 being the most rural Part of the municipality has high constraints factors for development such as slope and Shivpuri Forest area. The base of the Shivpuri area is still a highly cultivated land. But now these lands are sold and bought repeatedly. He added that the municipality has higher potential for people settlement due to large availability of land and resources. Many people are still fascinated with natural resources like water, tress and mines. But now due to mismanagement or lack of a way to do it properly there is a vast change in land use. Migration of people has been increased in recent times due to the best natural environment this ward offers. People are migrating here also due to reasonable price of land which is huge in supply. The main reason is the change in the basic occupation of people from agriculture to

service based. People are more dependent on valley center for service and economical activities. They are selling their lands and making houses for themselves. The sale and purchase of land happen anywhere in. He talks about the land pooling which is delayed by years which has compelled to not to wait but build buildings.

He said there used to be greener a few years back but now people are deviating from farmlands. Only a few people from outside are involved in collective farming. People have become money-minded and are willing to give anything for its sake. There is no sensitization for people to conserve these lands for future use and it has resulted in haphazard growth of people. He adds that there is still a chance to maintain planned development growth which might include protection of forest and greens.

Major Key points are.

- Migration and Real Estate Development: Gajurel addressed the migration of people, real estate development, and the implications for the ward.
- Infrastructure and Land Cover Changes: Infrastructure conditions, changing land covers, and associated challenges were discussed.
- Change of Occupation and Economic Growth: Shifts in occupation from agriculture to service-based activities were noted, impacting economic growth and livelihoods.
- Environmental and Living Condition Changes: Gajurel shared insights on changing environmental conditions and evolving living standards.
- Role of Concerned People and Voices: He highlighted collaborative efforts and engagement of concerned individuals who shared similar opinions and perspectives.
- Development Constraints: Ward No. 1 faces developmental constraints like slope and the presence of Shivpuri Forest area, impacting planning and growth.
- Land Use Changes and Migration Factors: The municipality's potential for settlement due to land availability and resources was discussed, alongside the impact of migration due to natural environment and reasonable land prices.
- Transition from Agriculture to Services: The transition of the local economy from agriculture to service-based activities, as well as its influence on land use and real estate, was emphasized.
- Land Pooling and Haphazard Growth: Delays in land pooling prompted individuals to build rather than wait, contributing to unplanned growth. A decline in collective farming was noted, attributed to changing priorities.

- Conservation and Planned Growth: The need for sensitization and planned development, including forest and green space protection, was highlighted. Maintaining green areas and planned growth remains feasible.

Similarly other ward presidents and professionals and urban planners were participated in discussion. And the discussion and finding has been included in the another part of the report

5.1.2 Site observation, Transect walk, Field Observation.,

Site observation, transect walks, and field observations are essential methods in environmental research. Site observation involves initial visits to record key features, transect walks offer systematic insights into ecosystem changes along defined paths, and field observations provide in-depth understanding of species behavior and interactions. These approaches collectively yield diverse data, help detect ecosystem shifts, and inform conservation efforts. However, challenges related to subjectivity, resource requirements, and environmental dynamics must be addressed for optimal results. In sum, these techniques are indispensable for holistic environmental comprehension and effective management strategies.

Figure 28 Site observation in Ward 1

Figure 29 Site Observation in ward 6

5.2. Secondary Data collection

Secondary data is collected in the form of hard and soft copy. These data were collected from various digital means such as internet websites of concerned authority. Data such as land use maps, road maps, landcover maps, building maps, water bodies maps. Most of the maps are in the GIS file Format and Some are in the hard copy. GIS file format can be easily used in the analysis of study. The hard copy map is scanned and digitalized into softcopy geo-referenced to form required shapefile format. There maps and hardcopies are collected from various sources like Survey Department Min Bhawan, DUBDC Babar mahal, Municipality Office Thali. And many other individuals like experts and urban planners have contributed their skills and ideas to develop these maps. GIS maps are better than Hard copy Maps because of the easiness to use files and the attribute table containing various fields of data. The sources of various files and data is listed in the table below.

SN	Secondary data	Type/ Format	Source
1	Municipal and Ward Map	GIS Shape file	Survey department, Kathmandu
2	Land use map	Hardcopy	IUDP,2020 Kageshwori
3	Existing Built-up Maps,	GIS Shape file,	Digitalized from Goole earth
4	Slope Map	GIS Shape file,	Open topography.org
5	Road Maps	GIS Shape file	Survey department, Kathmandu
6	Electricity	GIS Shape file	IUDP,2020 Kageshwori
7	Water Supply	GIS Shape file	IUDP,2020 Kageshwori
8	Network and tele	GIS Shape file	IUDP,2020 Kageshwori
9	Health Institution	GIS Shape file	Digitalized from Goole earth
10	Educational institution	GIS Shape file	Digitalized from Goole earth

11	Market Centers	GIS Shape file	Digitalized from Goole earth
12	Protected forest	GIS Shape file	IUDP,2020 Kageshwori
13	Water Bodies	GIS Shape file	IUDP,2020 Kageshwori
14	Soil Erosion	GIS Shape file	IUDP,2020 Kageshwori

Various non-spatial secondary data required for the study has been collected like:

- Demographic data
- Socio economic data.
- Culture and tradition.
- Municipal plans and Program.

The maps collected from the secondary source are listed below.

Land use map.

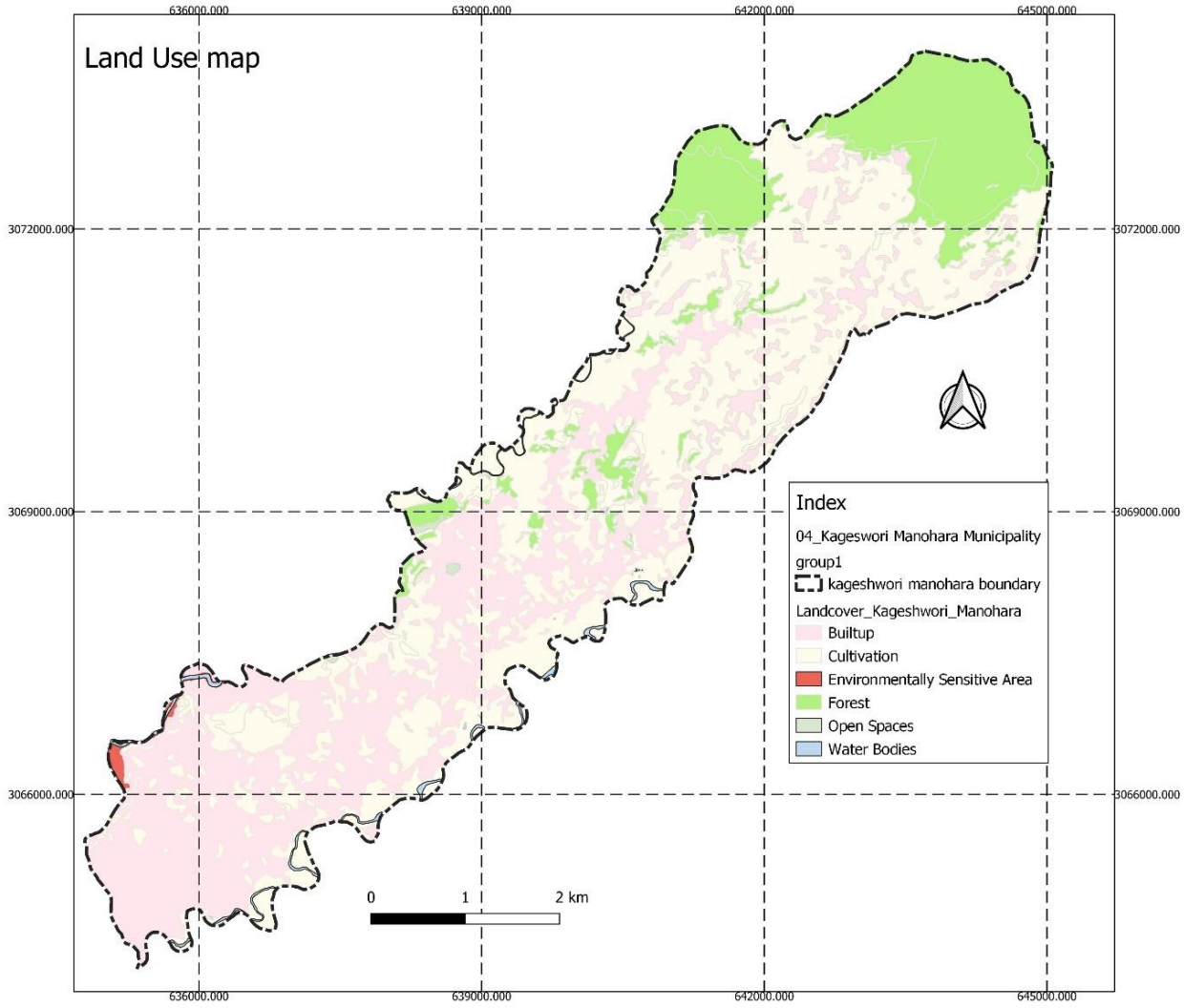


Figure 30 Land Use Map (source: NEST, GEOCOM 2019)

Road network map

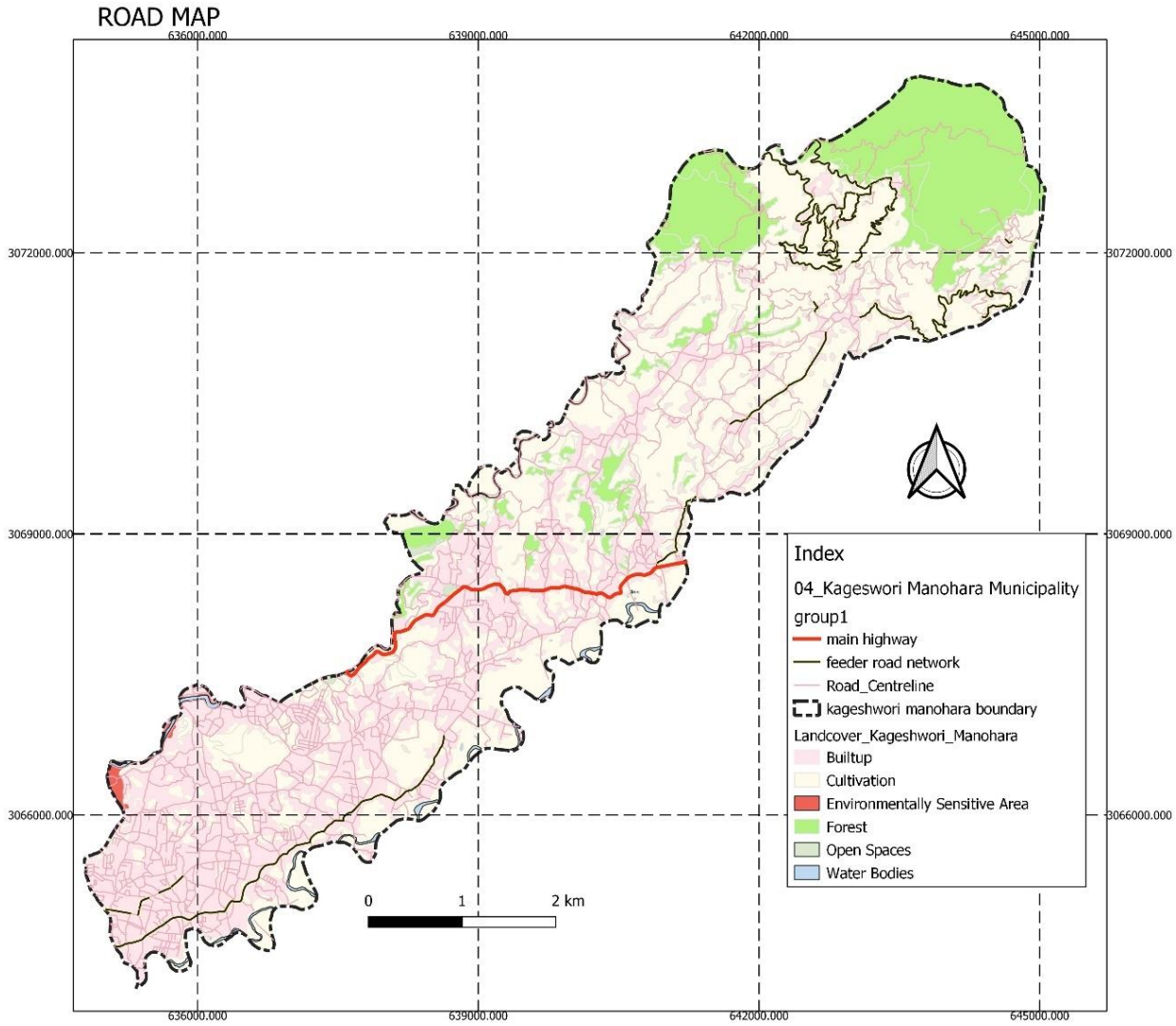


Figure 31 Road Map (source: NEST, GEOCOM 2019)

Educational institute maps

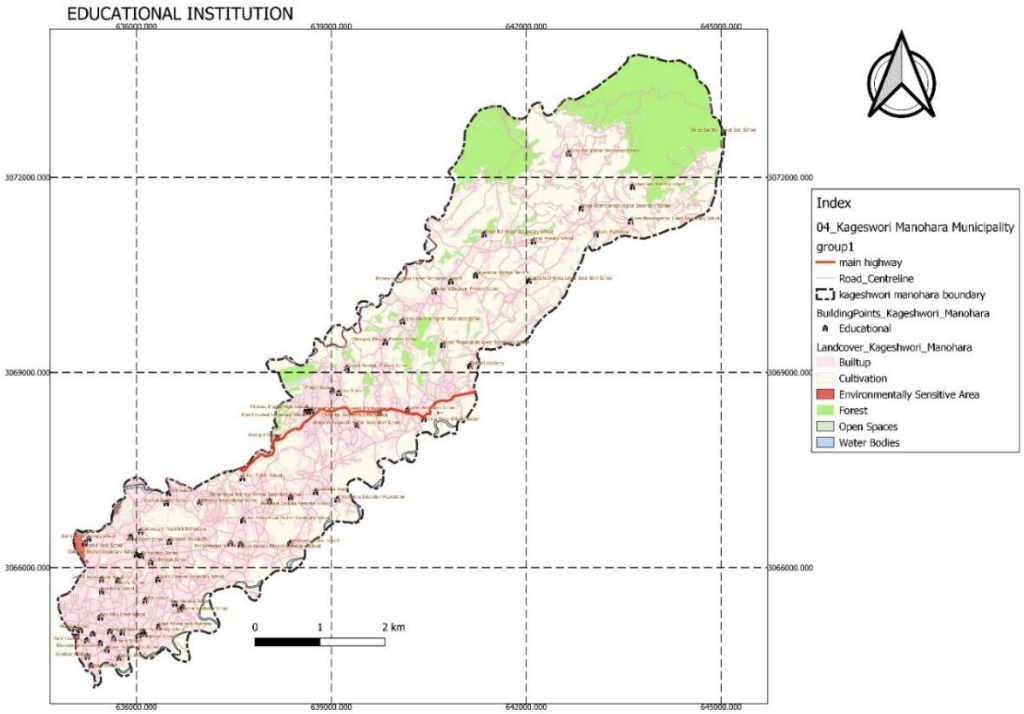


Figure 32 Educational Institute Map (source: NEST, GEOCOM 2019)

Health institute maps

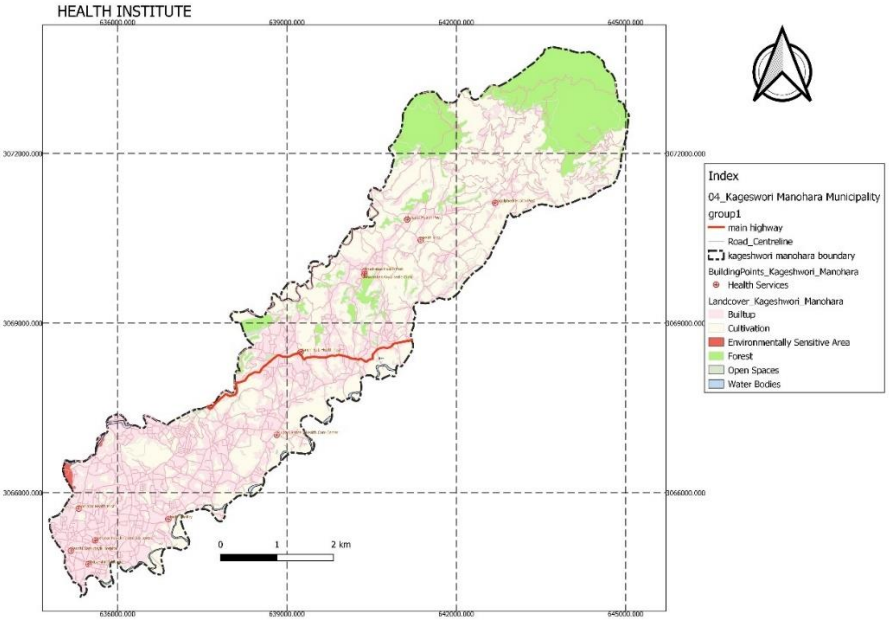


Figure 33 Health Institute Map(source: NEST, GEOCOM 2019)

Cultural and Religious Spaces

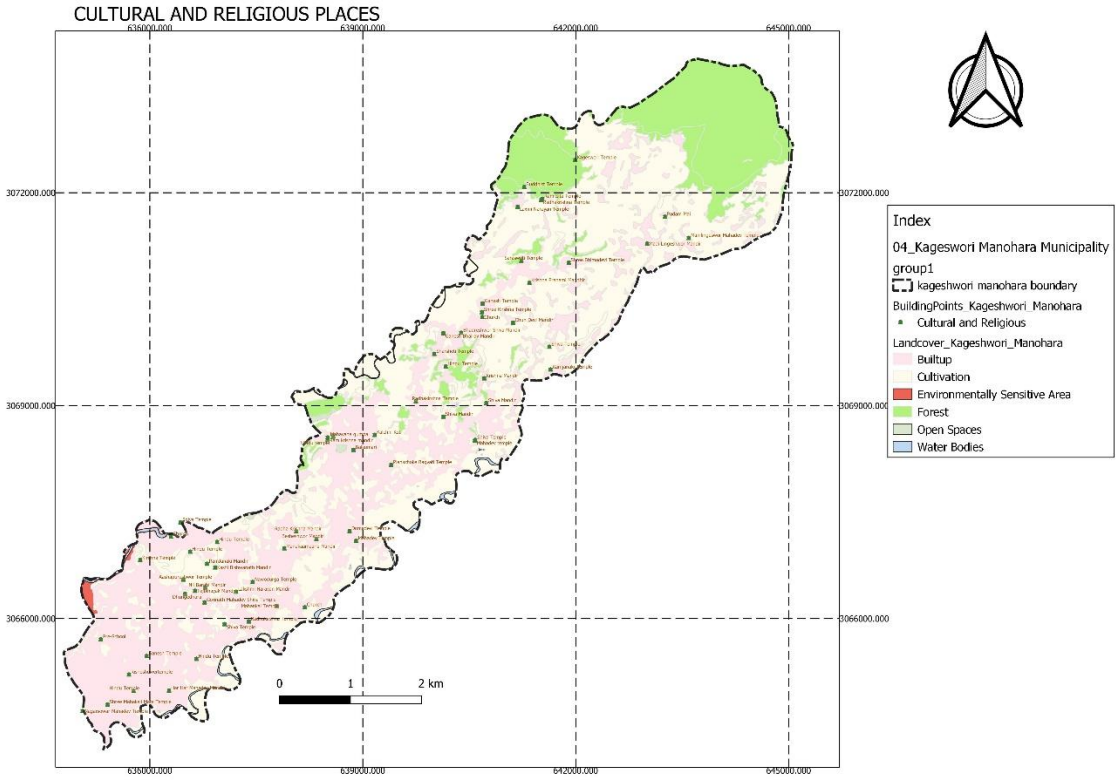


Figure 34 Religious and Cultural Maps (source: NEST, GEOCOM 2019)

Electricity distribution maps

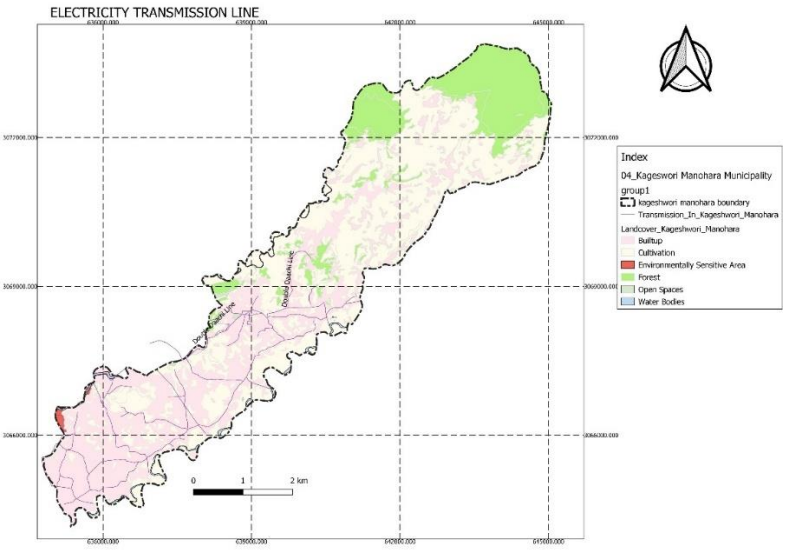


Figure 35 Electricity Distribution Maps

6. Analysis and Findings

6.1. Population Growth

The total population of the municipality as per the census 2078 B.S. is 130433. Kageshwori municipality holds 4.44 % of the population of Kathmandu valley. Kathmandu Metropolitan city has the greatest contribution around 29.35%. The CBS data shows that there is the highest percentage growth of population from 2068 to 2078 among all the 18 Local bodies inside the valley. Dakshinkali Contributes the Least population percentage of 0.89 percent. It is also found that the population is doubling in each decade in kageshwori Manohara municipality from 2058 to 2078. This is due to the internal migration from neighboring districts in search of opportunities.

	Local Bodies	Population Data 2021	Population Contribution
1	Kageshwori	130433	4.440329781
2	Shankharapur	29318	0.998072486
3	Tarakeshwor	151479	5.156798624
4	Chandargiri	136860	4.659124101
5	Nagarjun	115437	3.92982105
6	Dakshinkali	26372	0.897781827
7	Gokarneshwor	149366	5.084865779
8	Kathmandu Metropolitan City	862400	29.35867766
9	Budhanilkantha	177557	6.044571811
10	Kritipur	81578	2.77715933
11	Tokha	133755	4.553420606
12	lalitpur metropolitan city	294098	10.01197633
13	Mahalaxmi	123116	4.191237197
14	Godawari	98633	3.357762586
15	changu narayan	88083	2.998609003
16	Suryabinayak	140085	4.768912755
17	Bhaktapur	79136	2.69402634
18	Madhyapur thimi	119756	4.076852739

		2937462	100

Figure 36 Kathmandu valley Population Data (CBS,2021)

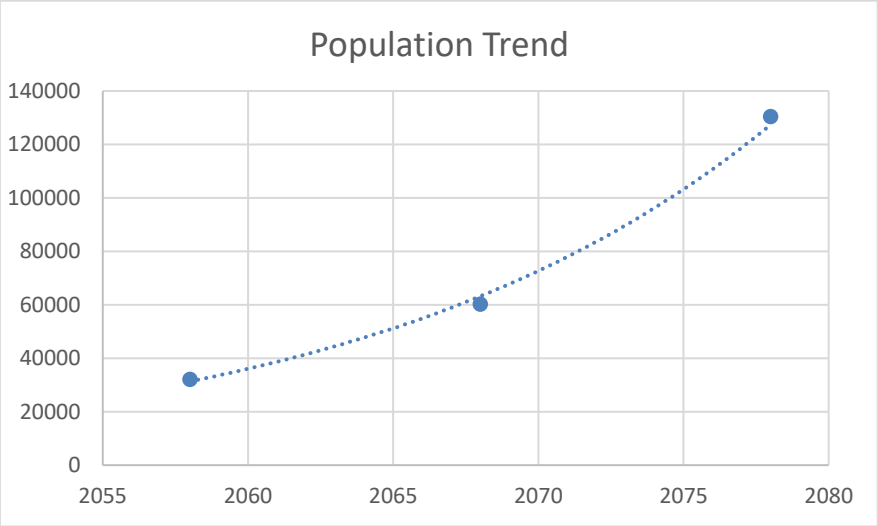


Figure 37 Population Growth Graph Of Kageshwori Manohara Municipality

Census Year	2,048	2,058	2068	2078
Population	25,848	32,077	60237	130433
Number of HH		6351	14329	33764
Household Per Hectare		5.050701	4.203852	3.86307902
Density (PPHA)		11.71549	22.00037	47.638057

Figure 38 Population Growth 2048-2078 (kageshwori manohara)

5.1.1 Ward Wise population density.

Ward	Pop	Area	in HA	Density
1	6795	10.76435	1076.435	6.312504
2	3440	1.470396	147.0396	23.39506
3	3196	1.670991	167.0991	19.12637
4	9501	2.58603	258.603	36.73971
5	12847	2.408314	240.8314	53.34438
6	25345	3.021066	302.1066	83.89422
7	21500	1.9707	197.07	109.0983
8	**16664**	**1.161904**	**116.1904**	**143.4198**
9	31145	2.323437	232.3437	134.0471

Figure 39 Ward Wise Population Density

Despite ward 9 having a large volume of population, ward 8 has the highest density of 143.4 PPHA and ward 1 has the least population density of 6.31 PPHA. Ward 7 density is followed by ward 6,5,4 respectively.

5.2. Population distribution:

The population distribution within Kageshwori Manohara Municipality is likely characterized by a mix of urban and rural settlements, common to many areas in the Kathmandu Valley. Being a part of the Kathmandu metropolitan area, the municipality could experience higher population densities, particularly in urbanized areas.

The municipality's population distribution may show concentrations around economic centers, transportation hubs, and government facilities, often accompanied by a blend of residential, commercial, and industrial activities. The outskirts of the municipality might have a more dispersed population due to agricultural and traditional livelihood practices.

The density also changes from high to low densely populated area when we move from southern part of the municipality to north part. The northern part of the municipality main consists of forest area and hills which are less suitable for human settlement in terms of land suitability and infrastructure.

Ward wise Population distribution

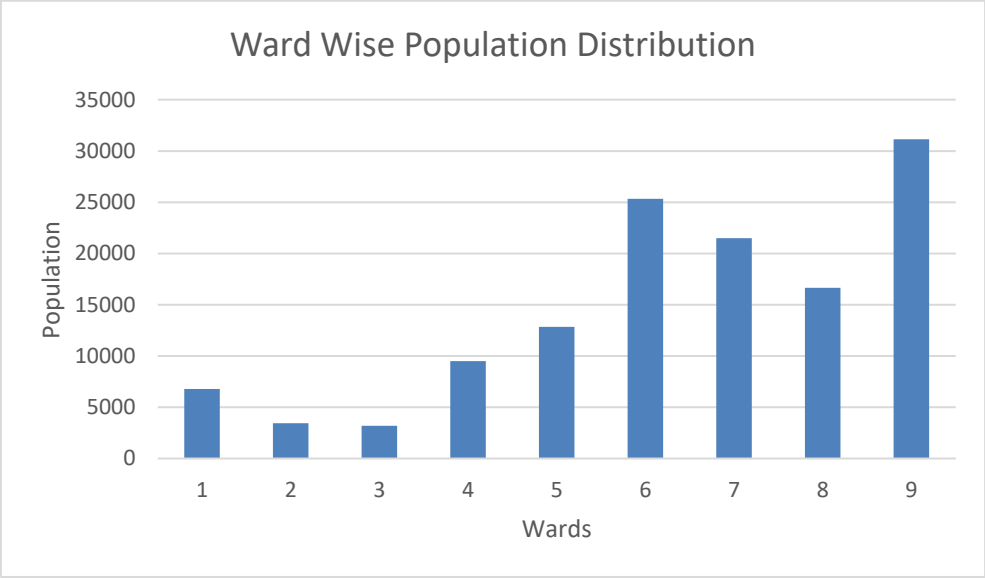


Figure 40 Ward Wise Population Distribution

It was found that the major contribution to population is through ward 9 which is in Gothatar area, while Ward 3 has the least population contribution. The Gross Population density of ward 8 is highest and the population density of ward 1 is 6.31 PPHA.

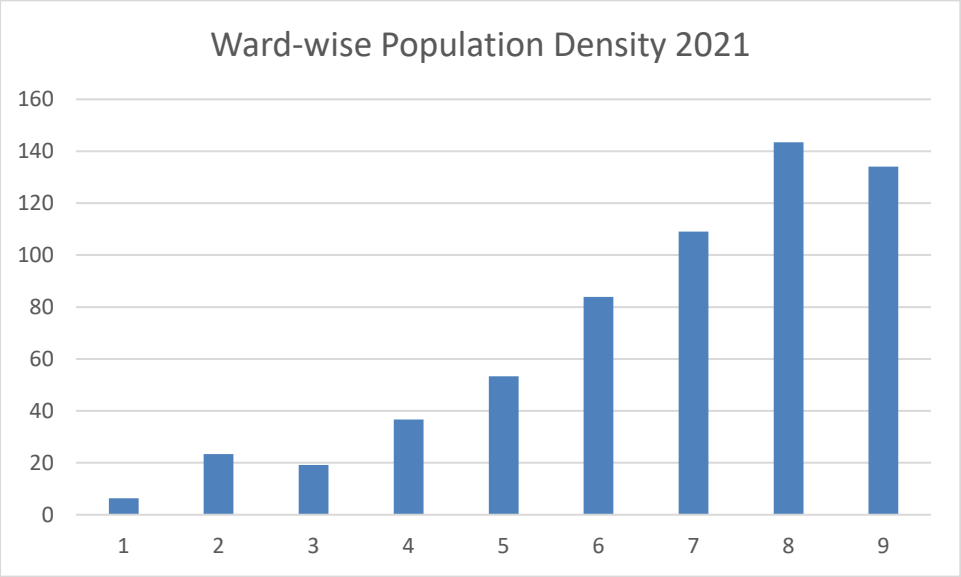


Figure 41 Ward Wise Population density 2021

Analyzing the pattern of development, population and density, the municipality ca be divided into clusters of 3 categories to make the study easier.

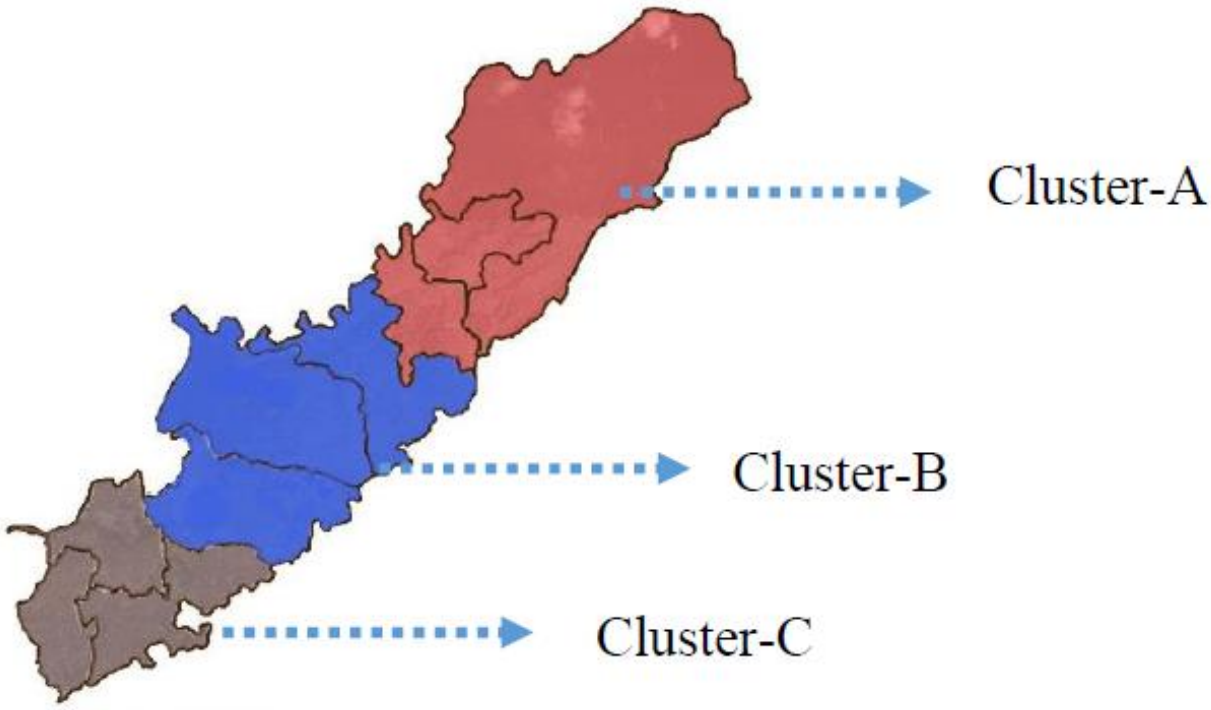


Figure 42 Density Cluster

Dividing the municipality into three clusters, namely A comprising wards 1, 2, and 3, B encompassing wards 4, 5, and 6, and C consisting of wards 7, 8, and 9, it becomes evident that cluster C situated in the southern region of the municipality and neighboring the Kathmandu Metropolitan City holds the highest population distribution. Cluster B exhibits a lower concentration of inhabitants, while cluster A demonstrates the least population concentration.

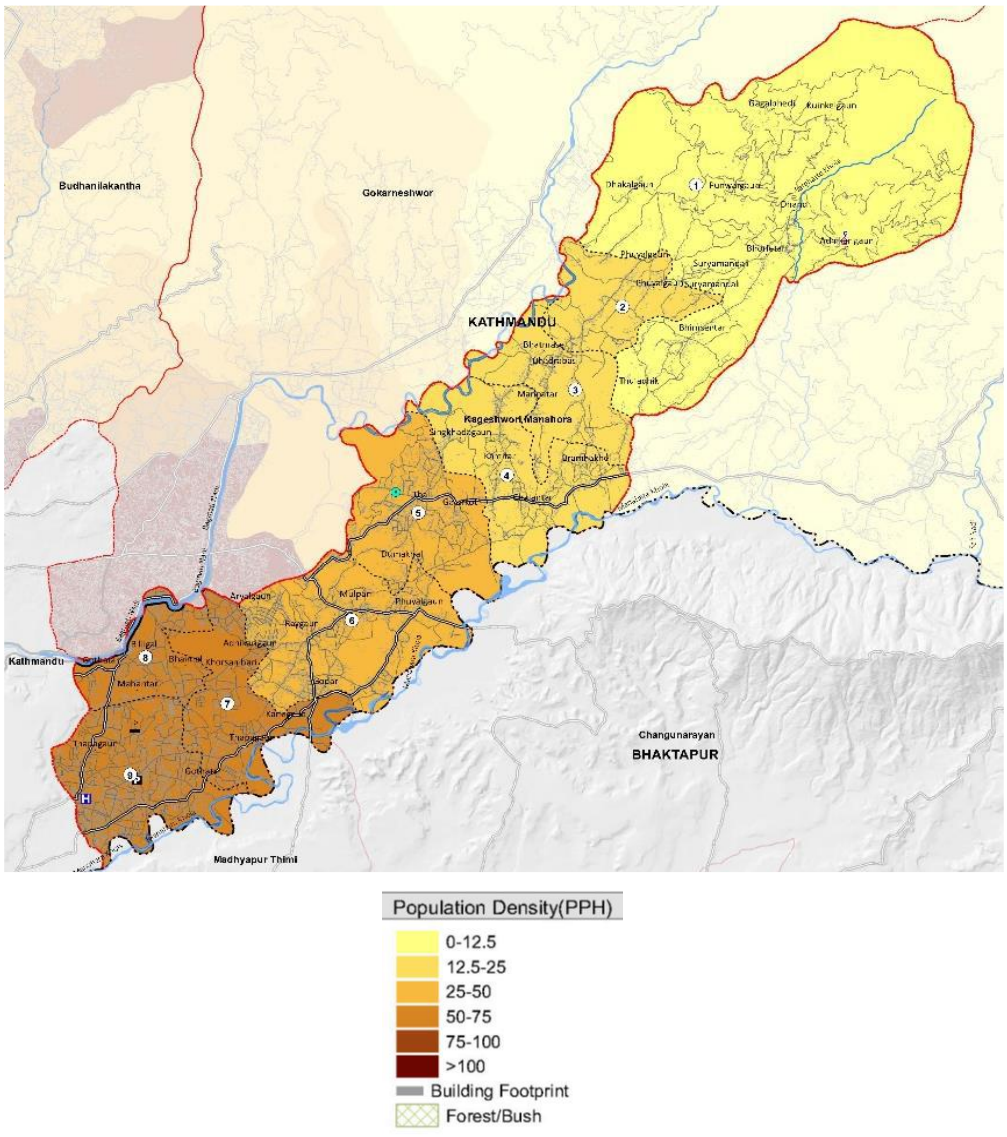


Figure 43 Density Map

5.3. Migration Trend.

Migration has far-reaching effects on a city's social, economic, and political landscape. Therefore, a crucial aspect of achieving sustainable development involves ensuring a harmonious coexistence between the local population and those who have migrated. Managing the consequences of growth driven by migration presents both challenges and potential advantages. The National Housing and Population Census gauges the migration rate by analyzing the number of people absent from their usual residence within the country.

According to the Household Survey conducted in 2019, approximately 69.4% of all households have relocated to the Municipality. In the timeframe between April 1, 2073, and November 4, 2076, the Vital Registration Record of the Municipality documents a total of 3658 individuals who have moved to Kageshwori Manohara, while 406 people have moved away from the area. Following the establishment of the Municipality, for every individual who has migrated from this location, a significant number of 9 individuals have chosen to relocate to this area. The rise in the population is not solely attributed to organic growth within the Municipality; instead, it is largely influenced by the substantial influx of people migrating from various districts across Nepal.

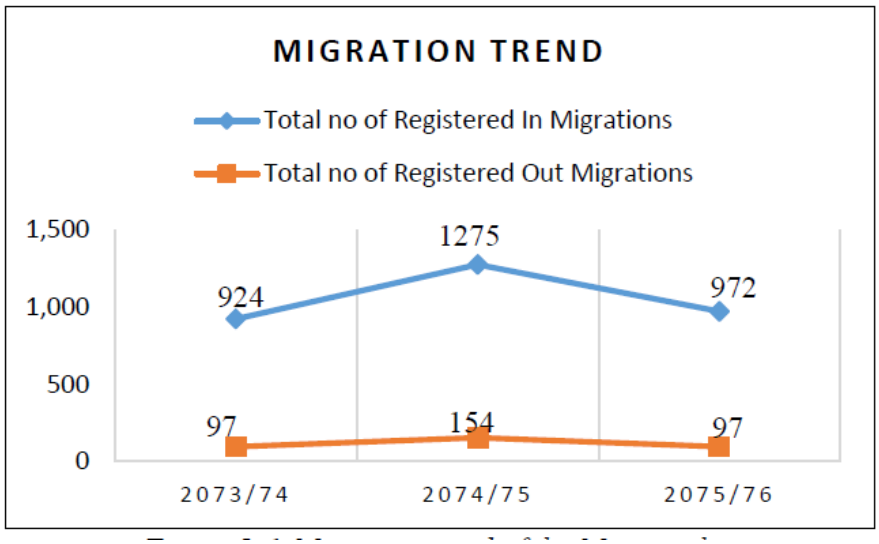


Figure 44 Migration Trend (source: NEST, GEOCOM 2020)

Reasons for in and Out Migration

People have migrated to the Municipality for better living opportunities. The majority of the migrated households (49%) accept better economic opportunities as the driving factor. The migration occurs in different stages. Firstly, people migrate to the bigger cities like Kathmandu

for benefits mentioned above and with the increment in their economic status, they tend to move out to the fringe areas due to the relatively cheaper land and housing prices.

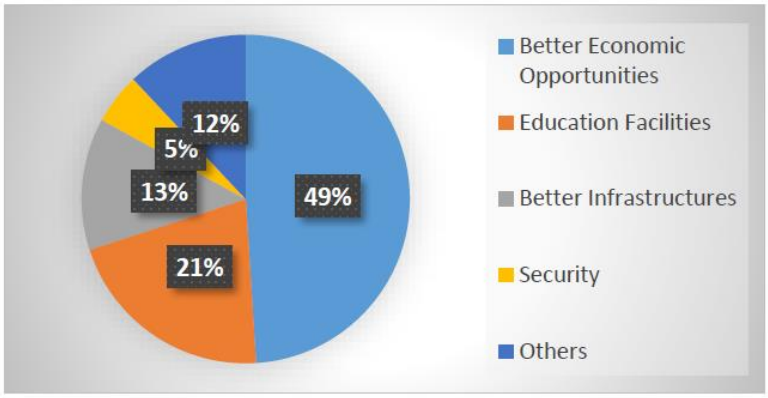


Figure 45 Migration Factors

Similarly, total 18.9 % of the Households had absent family members out which 30% went for higher studies and remaining 70% for foreign employment . (*Cbs Data.Pdf*, n.d.)

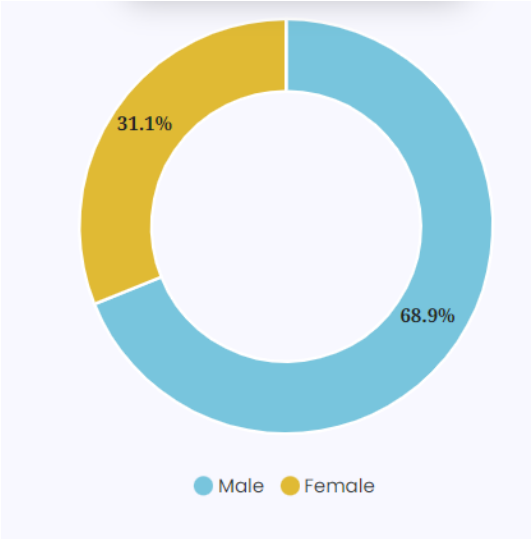


Figure 46 Sex ratio

The data clearly indicates the rise in population is majorly due to inter municipal migration rather than its natural internal growth. It also establishes the relation of rural-urban migration between two or different municipalities as well as two or more countries. The wards closer to Kathmandu was and still is densely populated with a higher number of people migrating to the place even today. The Survey showed that in each Wards 7, 8 and 9 almost 85% of total Households have migrated from other places. So, it indicates towards the Municipality as urbanizing and likely to receive more migrants soon.

5.4. Land use and change:

It is found the with urbanization and growth there is a vast change in land use. There is huge change in open space and agricultural land followed by increasing in built up area for residential and commercial. There is no doubt about kageshwori Manohara municipality being an extension of Kathmandu. People have migrated from commercial centers to the municipality for comfortable housing and a peaceful environment. Kageshwori Manohara being located near and connected to Kathmandu core, people feel comfortable being near to the urban center and have affordable housing.

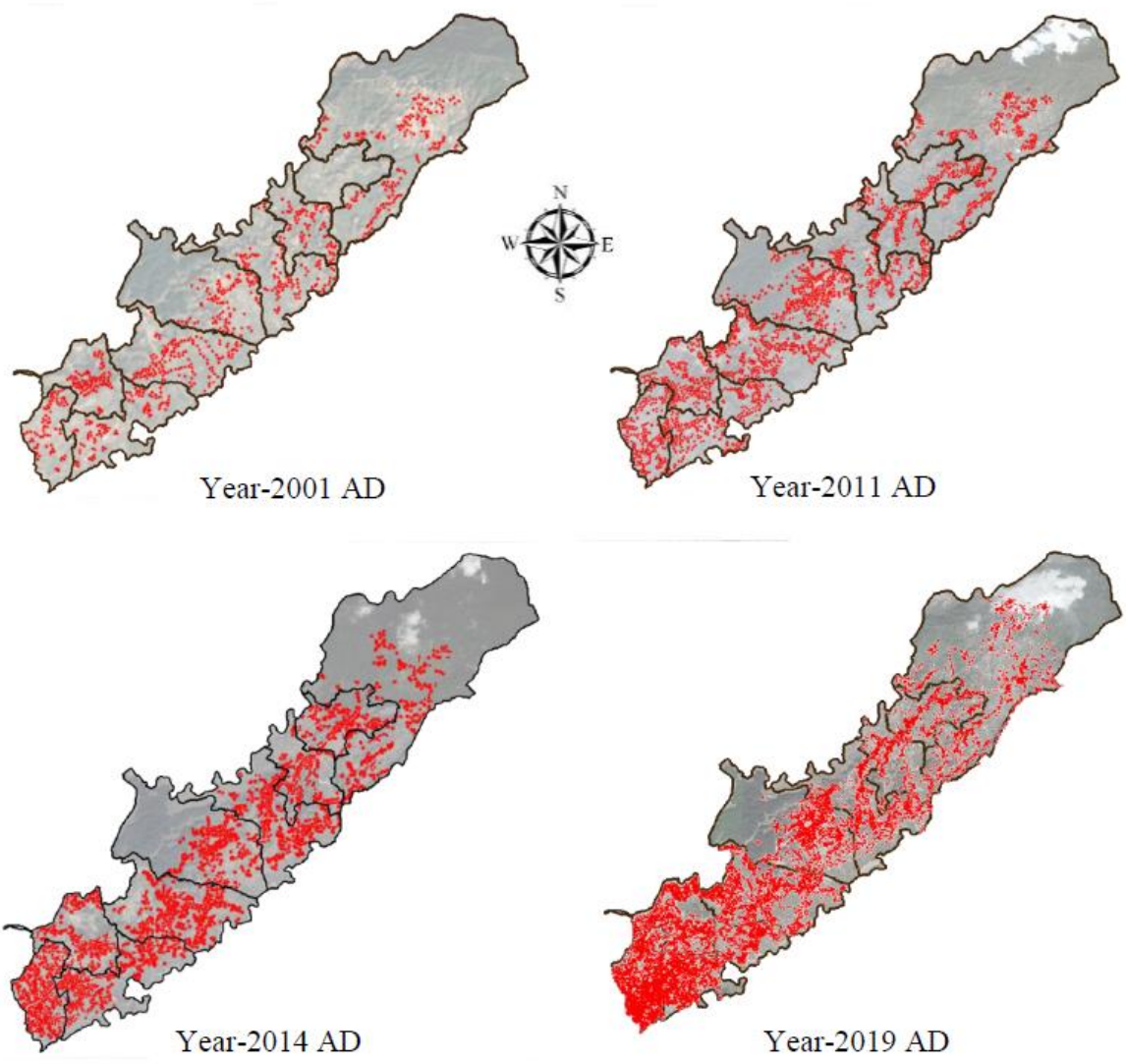


Figure 47 Increase in Built Up areas over last two decade

Existing land use.

Present composition of land use of the municipality shows that out of 2735.42 Hectares 34.43% land is built-up while 46.94% is cultivated land and 11.28% of land is protected area under Shivpuri National Park.(*EMRC,NEST,2020*)

Category	Area (Ha)	Percent
Agriculture	1284.38	46.94%
Built-up	942.19	34.43%
Bush	7.2	0.26%
Forest	156.35	5.71%
Institutional	3.05	0.11%
Others	9.76	0.36%
Pond	1.28	0.05%
Protected Area	308.7	11.28%
Recreational/Open space	5.23	0.19%
River	18.28	0.67%
Total	**2736.42**	100.00%
		Source: Base Map, Field Verification

Source: Base Map, Field verification

Figure 48 Land use Area Table

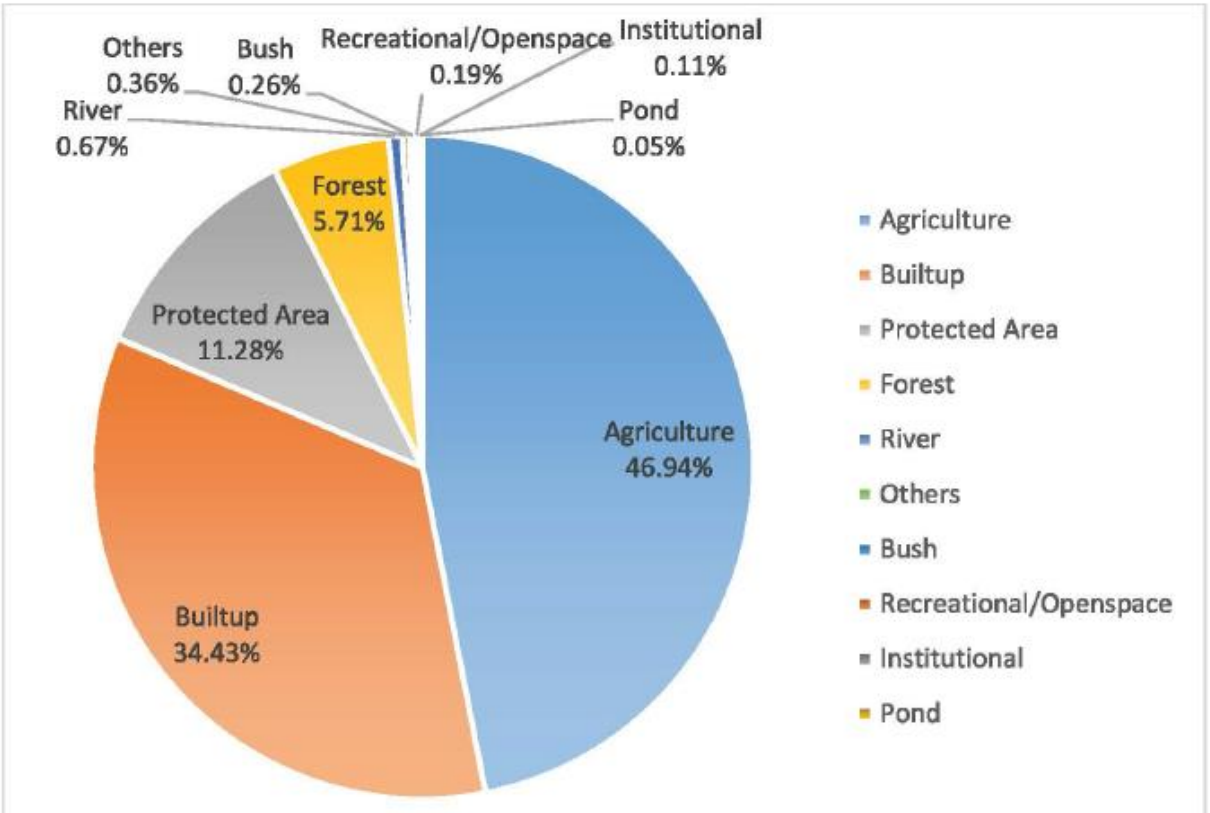


Figure 49 Land use area Chart

Land use change Scenario

The analysis primarily focuses on changes in the built-up area from 1990 to the present, with overlays in a GIS platform to track land use changes and anticipate future trends. The shift in land use gained momentum after 1990 due to rural-urban migration into Kathmandu, driven by economic prospects in the city compared to rural areas. Push factors from rural regions also contribute to this migration, including extreme poverty, limited economic opportunities, subpar living conditions, and lack of basic amenities. Recent decades have seen an escalation due to civil conflict. Analysis reveals a remarkable shift: from 1990 to 2000, the built-up area quadrupled from 36 to 138 hectares, and from 2000 to 2012, it tripled to 406 hectares. The subsequent years up to 2018 saw a doubling of the built-up area. This period also witnessed the densification of sparsely settled areas in wards 7, 8, and 9.

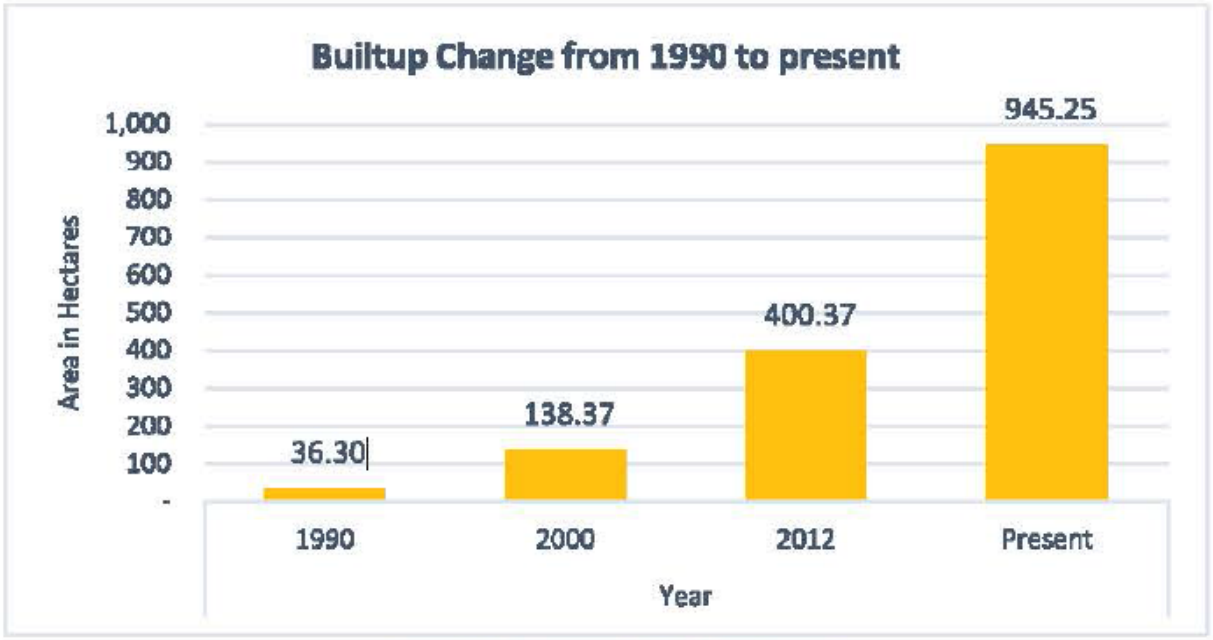


Figure 50 Builtup Change

Using GIS, land use maps of 1990, 2000, 2012, and the present depict a rapid urban sprawl, expanding built-up areas by 26 times from 1990 to 2018. This expansion comes at the expense of agricultural land degradation in the municipality. The agricultural area decreased by 5% from 1990 to 2000, 13% from 2000 to 2012, and 30% from 2012 to the present. Analyzing the shift between built-up and farmland, the overall proportion of farmland decreased significantly, dropping from 80% to 47% of the municipality's total area from 1990 to 2018.

	Decadal Change of Land use area			
Land use	**1990**	**2000**	**2012**	**Present**
Built up	36.30	138.37	400.37	945.24
Cultivation	2198.55	2096.48	1829.25	1284.37
Barren Land	9.756	9.75	9.75	9.75
Bush	7.19	7.19	7.19	7.19
Forest	156.34	156.34	156.34	156.34
Protected Forest	308.70	308.70	308.70	308.70
Pond	1.28	1.28	1.28	1.28
Recreational	0	0	5.23	5.23
River	18.27	18.27	18.27	18.27
Total	**2736.41**	**2736.41**	**2736.41**	**2736.41**

Figure 51 Decadal change of land use area

5.5. Land and Housing

Housing provision in the country involves four sectors: informal private, public, organized private, and institutional. However, the organized/formal private housing sector remains underdeveloped, with a few exceptions in land development schemes. The government's public sector initiatives for housing are limited to three models: Site and Services (S&S), Guided Land Development (GLD), and Land Pooling (LP), aimed at addressing the growing housing needs. So far, twelve land pooling projects have been completed, with ten ongoing projects in cooperation with private landowners. (JICA,2017) In Nepal, constructing a house is primarily an individual or family responsibility, with over 90 percent of houses being informally built on an individual basis. This trend is driven by the understanding that housing serves as a valuable asset with appreciating value, generating rental income, and having both use and exchange value.

In the context of housing in Kathmandu Valley, the National Living Standards Survey (NLSS) classifies ownership into four types: Owner, Rented, Rent-free, and Others. A comparison between NLSS 2004 and NLSS 2010/11 reveals a decline in owner households from 62.5% to 48.1%, alongside an increase in rental households from 33.1% to 49.5% (CBS 2004, CBS 2010). This signifies a rising trend of households choosing to rent in the present scenario. According to NLSS 2010, the average dwelling size in Kathmandu Valley is 555 sq. ft, while the average area of housing plots is 1223.7 sq. ft.

The Kageshwori Manohara Municipality serves as an extension of Kathmandu Metropolitan City. In this area, most of the housing needs are fulfilled by the informal private sector, with some contribution from the formal private sector. There are sixteen land and housing development projects, with ten being housing projects and six focusing on land development, all from the private sector. These projects cover approximately 27.05 hectares of land and include 2751 units, mainly in Gothatar and Mulpani. Land development projects are concentrated in wards 9, 8, 7, and 6, with a few land pooling initiatives emerging in rural wards like 1 and 3. Government intervention in housing demand is primarily through land pooling schemes that offer planned plots for construction. Notable projects like Sinamangal Land Pooling in Kathmandu Metropolitan City have encouraged private sector involvement in land development within Kageshwori Manohara. ((*EMRC,NEST,2020*))

5.6. Population Projection.

Population projection holds significant importance in this study due to its ability to provide a forward-looking understanding of demographic changes in Kageshwori Manohara Municipality. These projections offer insights into future population growth, distribution, and composition, which are crucial for effective urban planning and policy formulation. By anticipating housing demands, infrastructure needs, and service requirements, population projections guide decisions on land use allocation and development strategies. They also aid in assessing the capacity of existing infrastructure to accommodate projected growth, addressing potential bottlenecks or gaps. Moreover, population projections facilitate the integration of sustainability and environmental considerations into urban planning, ensuring that growth aligns with resource conservation goals. In essence, population projections serve as a fundamental basis for your thesis, enabling informed spatial analysis and policy recommendations that cater to the municipality's evolving demographic landscape.

Ward NO	Total Population							Projected Population Growth		
	2058	Increment percent		2068	Increase		2078		2088	2098	3008
1	5229	304	5.81	5533	1262	22.81	6795	11.52	7577.47	8450.039	9423.09
2	2884	275	9.54	3159	281	8.90	3440	9.21	3756.81	4102.807	4480.67
3	2139	249	11.64	2388	808	33.84	3196	19.85	3830.29	4590.47	5501.51
4	4316	671	15.55	4987	4514	90.52	9501	37.51	13065.11	17966.22	24705.89
5	3360	2899	86.28	6259	6588	105.26	12847	95.30	25089.79	48999.59	95694.68
6	4263	4267	100.09	8530	16815	197.13	25345	140.47	60946.63	146557.2	352423.19
7	3663	6368	173.85	10031	11469	114.34	21500	140.99	51811.83	124858.9	300891.51
8	3254	2496	76.71	5750	10914	189.81	16664	120.66	36771.16	81140.09	179045.59
9	2969	10631	358.07	13600	17545	129.01	31145	214.93	98083.74	308891.3	972779.41
total	**32077**	**28160**		**60237**	**70196**		**130433**		**300932.8**	**745556.6**	**1944945.5**

5.6.1 Arithmetic:

Ward NO	Total Population							Projected Population Growth		
	2058	Increase	2068	Increase	2078	Avg.Inc./Decade		2088	2098	3008
1	5229	304	5533	1262	6795	783		7578	8361	9144
2	2884	275	3159	281	3440	278		3718	3996	4274
3	2139	249	2388	808	3196	528.5		3724.5	4253	4781.5
4	4316	671	4987	4514	9501	2592.5		12093.5	14686	17278.5
5	3360	2899	6259	6588	12847	4743.5		17590.5	22334	27077.5
6	4263	4267	8530	16815	25345	10541		35886	46427	56968
7	3663	6368	10031	11469	21500	8918.5		30418.5	39337	48255.5
8	3254	2496	5750	10914	16664	6705		23369	30074	36779
9	2969	10631	13600	17545	31145	14088		45233	59321	73409
Total	**32077**		**60,237**		**130433**			**179611**	**228789**	**277967**

Figure 52 Population Projection: Arithmetic

5.6.2 Geometric Population Growth

Figure 53 Geometric Projection

5.6.3 Exponential Projection

Ward NO	**Total Population**						**Projected Population Growth**		
	2058	**Increase**	**2068**	**Increase**	**2078**	**Rate ®**	**2088**	**2098**	**3008**
1	5229	304	5533	1262	6795	0.21	8344.84	10248.19	12585.66
2	2884	275	3159	281	3440	0.09	3746.00	4079.21	4442.065
3	2139	249	2388	808	3196	0.29	4277.39	5724.686	7661.682
4	4316	671	4987	4514	9501	0.64	18100.86	34484.92	65699.06
5	3360	2899	6259	6588	12847	0.72	26369.29	54124.67	111094.4
6	4263	4267	8530	16815	25345	1.09	75307.04	223758.1	664847.6
7	3663	6368	10031	11469	21500	0.76	46082.15	98770.42	211700.1
8	3254	2496	5750	10914	16664	1.06	48293.72	139959.4	405614.5
9	2969	10631	13600	17545	31145	0.83	71324.34	163338	374056
Total	**32077**		**60,237**		**1E+05**		**301845.6**	**734487.6**	**1857701**

For this study exponential population growth is taken as valid because of the population trend and pattern being developed in Kageshwori Manohara Municipality.

5.7. Calculation for housing demand:

A housing demand calculation is necessary while identifying areas suitable for dense population. It allows us to accommodate total population in a designed and planned area. Various data is collected which is necessary for recognizing required urban population, density and required area. To conduct the calculation, policy and bye laws has to be aligned and be supported.

For housing demand calculation:

Area required for each person = 20 sq.m (adopted from IUDP 2020, Kageshwori)

Housing demand calculation	Year	Population	
Population	2078	130433	
	2088	301845	
	2098	734487	
Additional Population	2088	171412	
	2098	432642	
		Area(sq.m)	
Minimum plot size area		143.08	4.5 anna
Max coverage (65%)		93.002	
floor area (far=3)		429.24	
No of tenant per house (20sq.m per person)		21.462	
No of house	2088	7986.76731	
	2098	20158.51272	
Additional development area in	2088	1142746.667	114.2746667 ha
	2098	2884280	288.428 ha

Figure 54 Housing Demand calculation

Average Ground Coverage: 65% (building bye law 2075, kageshwori)

Floor area ratio: 3 (adopted from Municipal Bye law)

The population of Kageshwori Manohara is 130433 as of 2021 (CBS,2021), and projected population is 301845 in 2031 and 734487 in 2041 AD.

The projected population and minimum space required for everyone is taken and then calculated for the total built up area. In this direct calculation, we found that the population density would be around 10000 people per hectare, and this is a very high density to obtain. To maintain this density, we would have to go vertical development of skyscrapers and tall buildings which is challenging and costlier for people to afford and regulate.

We aim to maintain a desirable density with aligning the plans and policies adopted by government of Nepal and Kathmandu valley development Authority. The density which we adopt in kageshwori Manohara municipality would be 300 people per hectare. The development of infrastructure service will be propagated to this density of population. In Nepal the density of 300 PPHa is taken as a medium density. The density of 400 PPHa is taken as high density in an urban area while 200 and below is taken as low density. (IUDP Kageshwori,2020)

Now taking 300 PPHa as a target Population density, we can calculate the area required for the future population, which is given as,

Total extra area required to maintain Net density of 300 PPHa = Total Increase in Population/ Total area

We have total additional population in 2088 is 171412, so the total area required is given by

171412/300= 571.37 hectare of area

Similarly in 2098 additional area will be required: 432642/300 = 1443 hectare

5.8. Criteria for suitable dense settlement development.

To identify the suitable area for dense settlements, it is important to finalize the criteria that is relevant to site and context. These parameters should be determined from various spatial, non-spatial, qualitative, and quantitative data. These criteria will guide where the suitability of urban dense settlement can be prioritized.

First relevant data is collected, and maps are generated based on the information collected. The data is divided into two major parts such as restriction and development factors. The restricted factors restrict the development, and the development factors is further analyzed deep for the suitability with degree of suitability with respect to others. The parameters and criteria are

developed from the study of various literature studies. The criteria are then expressed and consulted with academicians, experts' governmental bodies, related individuals, and stakeholders. With some addition and subtraction in criteria, A list of final criteria for study is made and detailed out. Before injecting the criteria, it is important to mention the governing planning criteria from government and experts, The planning criteria are derived and discussed from literature part of this report. The frame in which criteria would remain at are listed below:

- **Dense and Compact Area.**
- **Promoting clean Urban Greenery and Forest.**
- **Effective connectivity for all. (Transportation, communication)**
- **Easy access to basic health and education for all.**
- **Geographically, naturally, safe from disasters and Hazards.**
- **Promoting open parks, recreational area, Sports arena etc.**

5.8.1 Development of suitability Index:

The core criteria were determined from the literature, interview with experts and professionals and the suitability ranges is determined from literature and consultations. For example, (Rushemuka, 2020)(Guragain & Bajracharya, 2022)(Pokhrel et al., 2018)(Rashid, 2021)

Each criteria have a range of suitability values. Therefore, all the maps were converted to similar pixel values during GIS analysis so that they would all depict or function at the same scale. After the processing and overlaying of all the layers the value gained by pixel is accumulated and value ranges from 0 to 5 representing from high suitable to low suitable area and restricted area respectively.

The further analysis criteria are listed out:

- Site Slope
- Fault Line
- Forest area
- Water Bodies
- Landslide
- Soil erosion
- Liquefaction
- Airport Restricted areas.
- Proximity to Major Roads, Highway
- Proximity to water supply

- Proximity to Electricity line
- Proximity to telecommunication
- Proximity to School
- Proximity to college/university
- Proximity to Health post
- Proximity to Hospitals
- Proximity to market/urban center.

		CRITERIA		Source		SUITABILITY	
			HIGH =5	MODERATE=4	Low=3	VERY LOW=2	RESTRICTED =1
1	**Roadway Proximity**	(Pokhrel et al., 2018)	0-250	251-500	501-750	751-1000	>1000
2	**Water Supply**	(Pokhrel et al., 2018)	0-250	251-500	501-750	751-1000	>1000
3	**Electricity Line**	(Pokhrel et al., 2018)	0-250	251-500	501-750	751-1000	>1000
4	**Network /telecom**	(Pokhrel et al., 2018)	0-250	251-500	501-750	751-1000	>1000
5	**Health Post**		0-500	501-1000	1001-1500	1501-2000	2001-2500
6	**Hospital**		0-700	701-1400	1401-2100	2101-2800	>2800
7	**Primary School**		0-200	201-400	401-600	601-800	>800
8	**Secondary School**		0-500	501-1000	1001-1500	1501-2000	>2000

9	**College/University**		0-2000	2000-4000	4000-8000	8000-10000	>10000
10	**Administrations/Offices**	0-500	501-1000	1001-1500	1501-2000	>2000	
11	**Market centers/ BFI**	(Guragain & Bajracharya, 2022)	0-2000	2000-4000	4000-8000	8000-10000	>10000
12	**Urban centers**						
13	**forest/Green**				Restricted		
14	**Water Bodies**				Restricted		
15	**Slope**		Slope less than 30 degree: Suitable		Slope >30 degree: Restricted		
16	**Soil erosion**				Restricted		
17	**Fault Line**				Restricted		

Figure 55 Criteria Table

The criteria have been limited and listed down. All the criteria couldn't be included due to the limitations in data availability. The listed criteria in many ways can identify suitable area for

5.9. **5.9 Constraints map development:**

Slope Map of Kageshwori Manohara Municipality

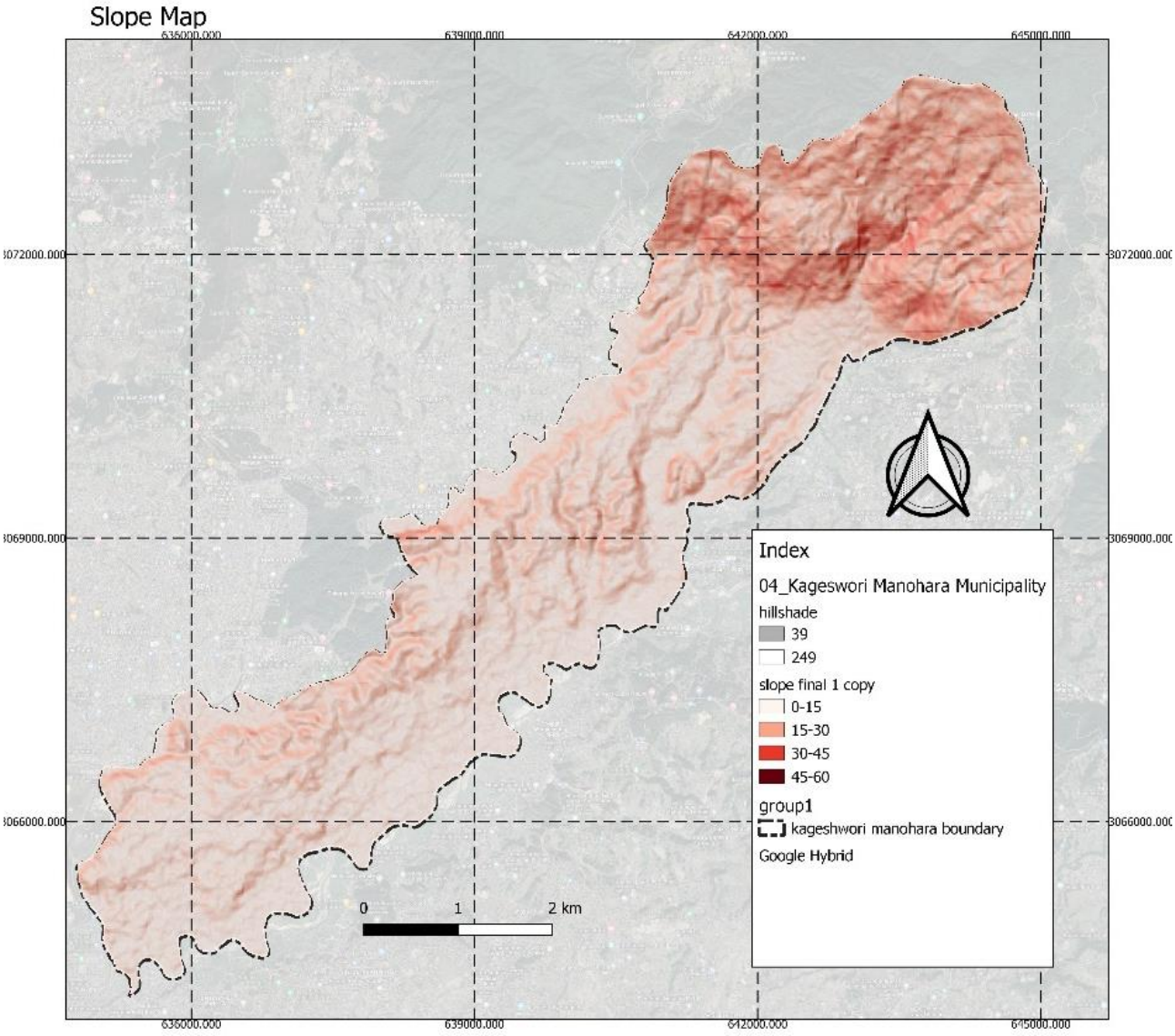
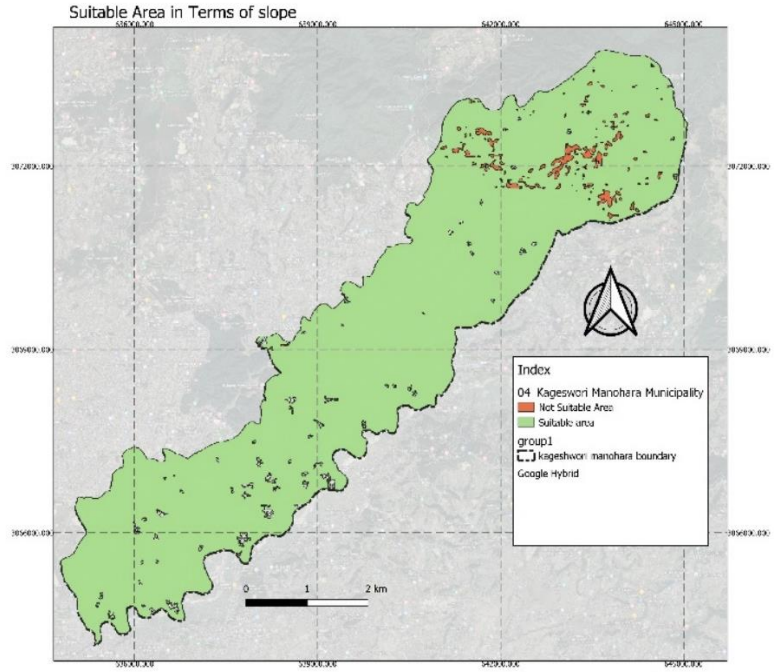
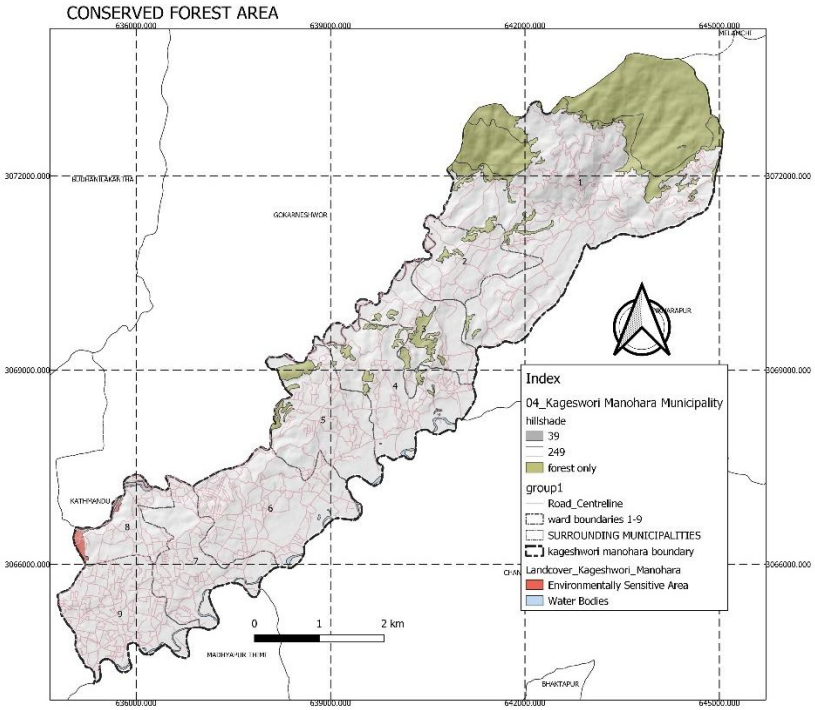


Figure 56 Slope Map

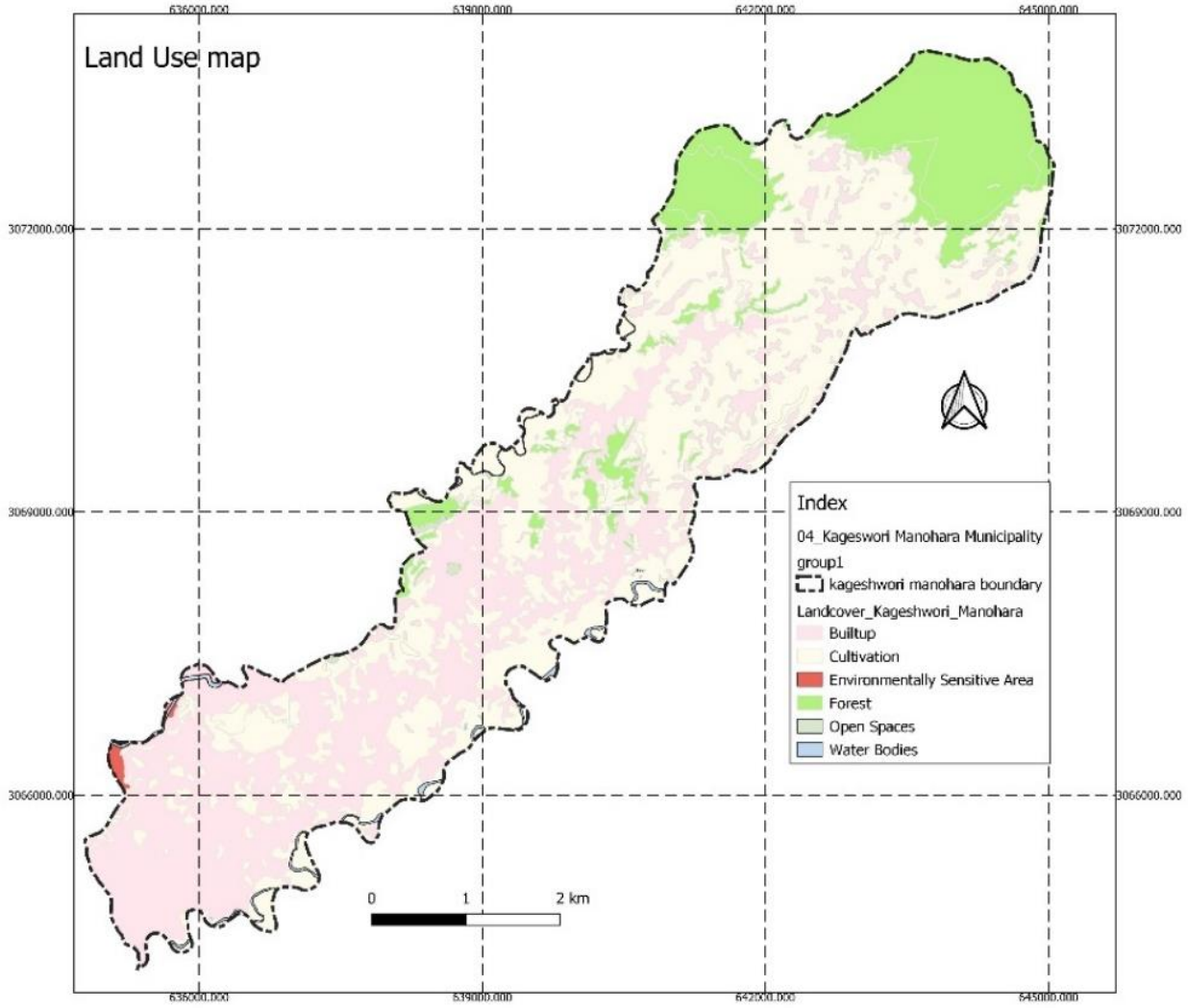
Land Suitability in terms of Slope



Conserved forest area.



Land use Map


Land Use map
636000.000
639000.000
642000.000
645000.000
3072000.000
3069000.000
3066000.000
Index
04_Kageswori Manohara Municipality
group1
kageshwori manohara boundary
Landcover_Kageshwori_Manohara
Builtup
Cultivation
Environmentally Sensitive Area
Forest
Open Spaces
Water Bodies
0
1
2 km

Final constraints map

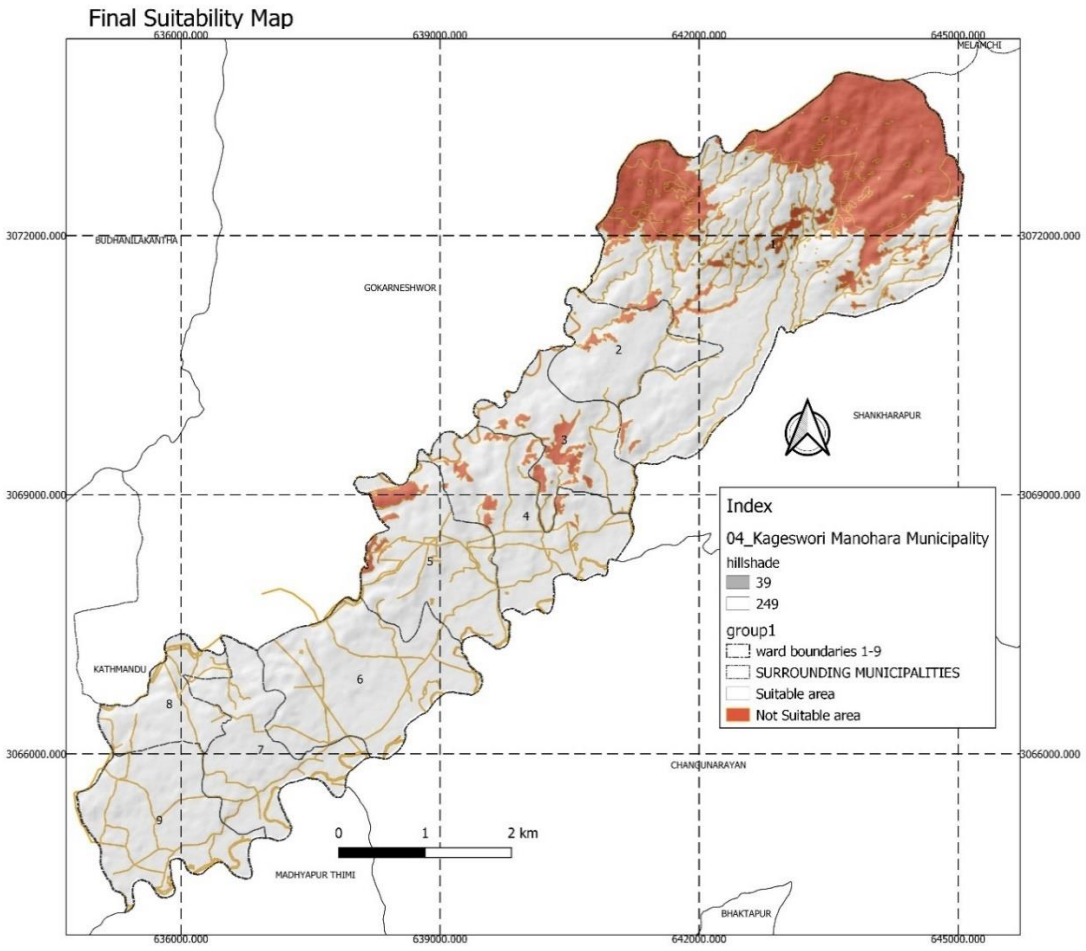


Figure 57 Final Constraints Maps

Suitable and non-suitable area calculation

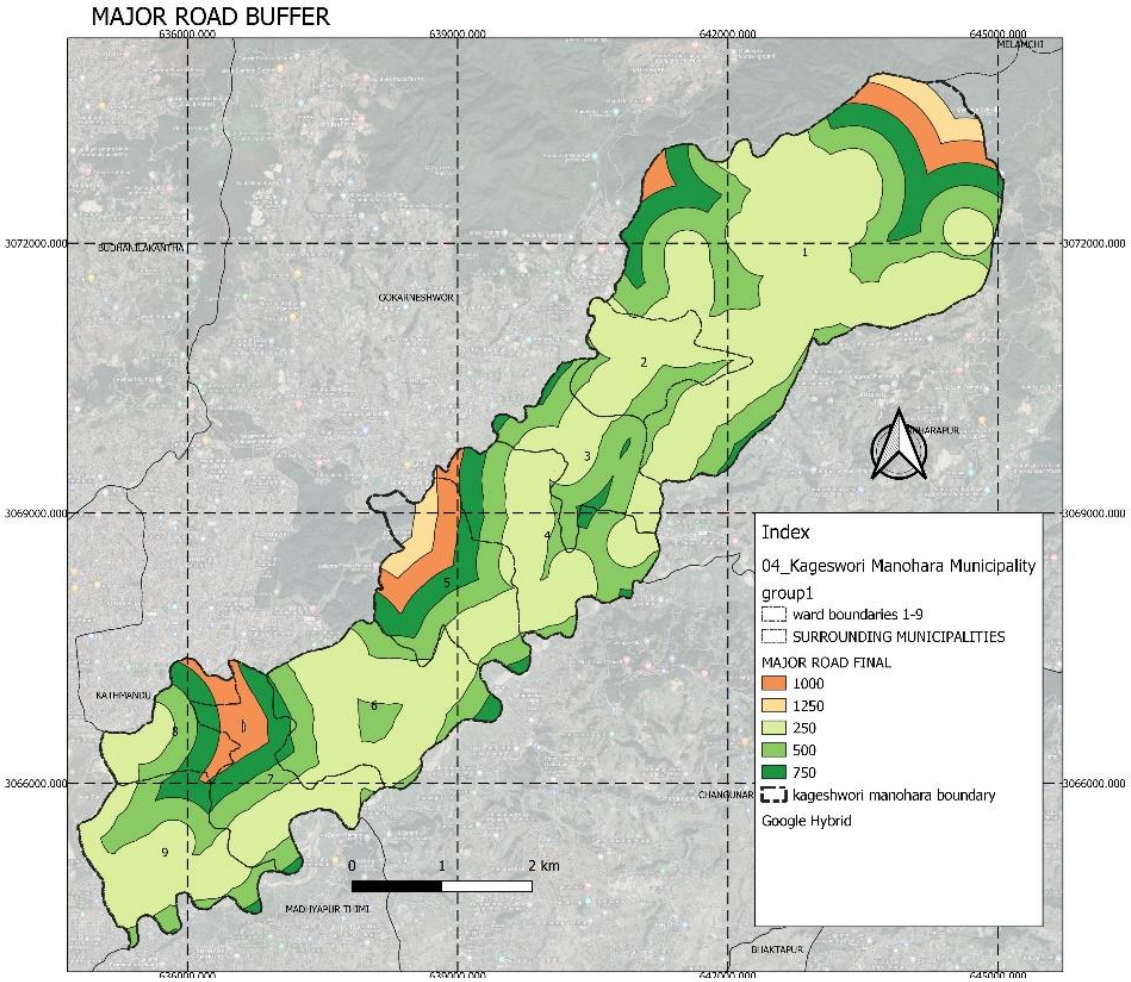
	Sq.km	Percent
Suitable Area	20.59	75.22560374
Not Suitable Area	6.781	24.77439626
Total	27.5	100

Figure 58 Suitable and Non suitable area calculation

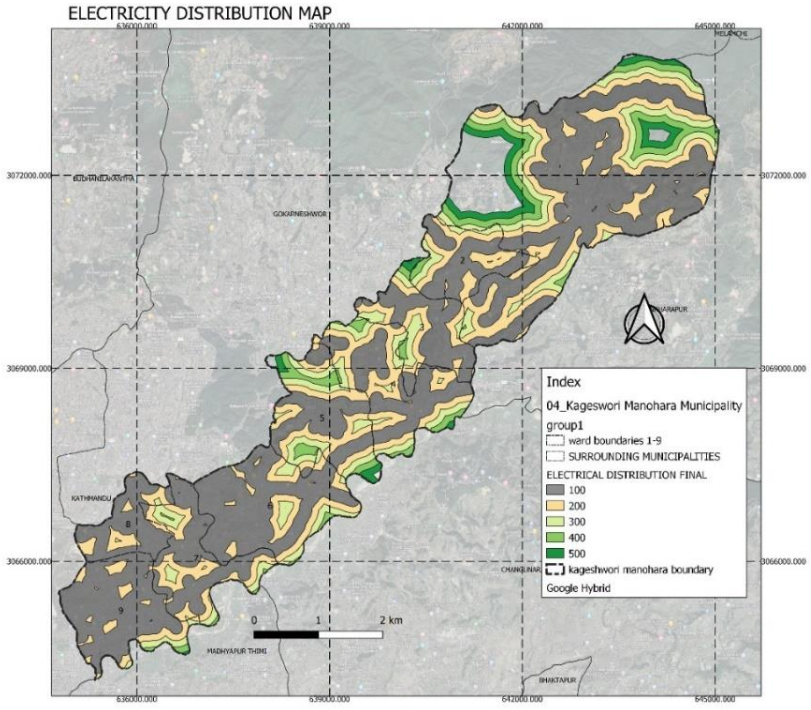
It is found that more than 75 percent of total land of Kageshwori Manohara is constraint free like Protected Forest area, slope area, Water bodies and rivers, transmission line area etc. This shows that there are more developable lands for settlements.

5.10 Map based on proximity to infrastructure and services.

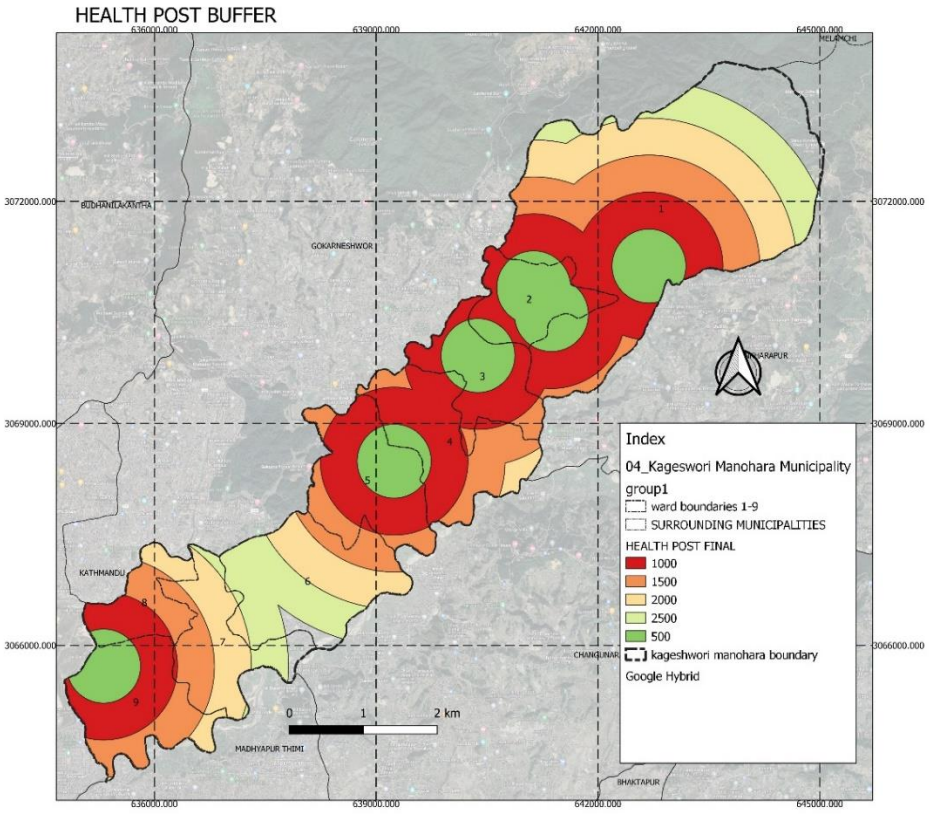
Major Roads Proximity Calculations.



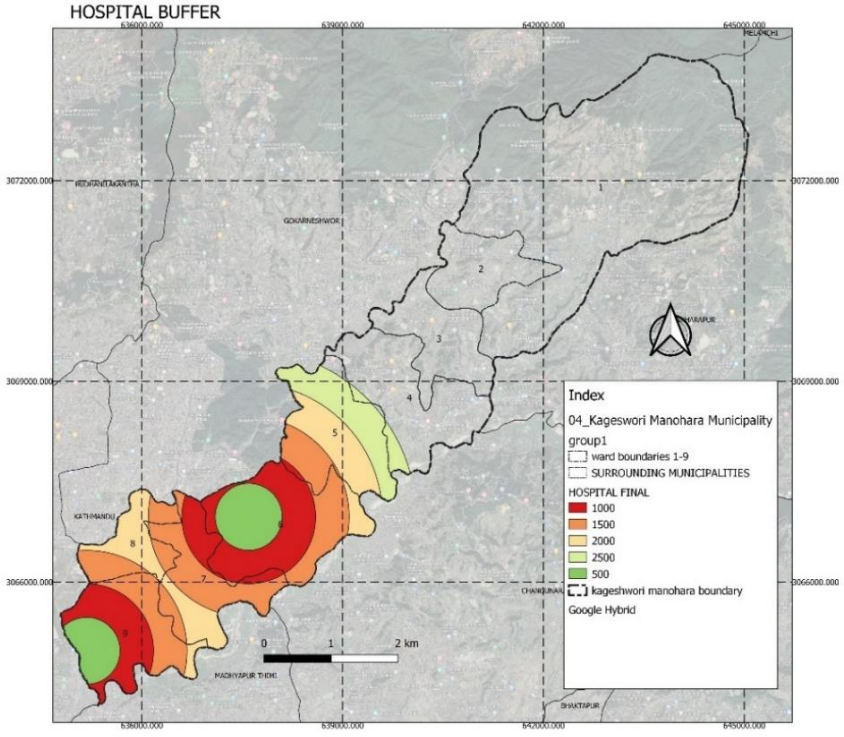
Electrical distribution line



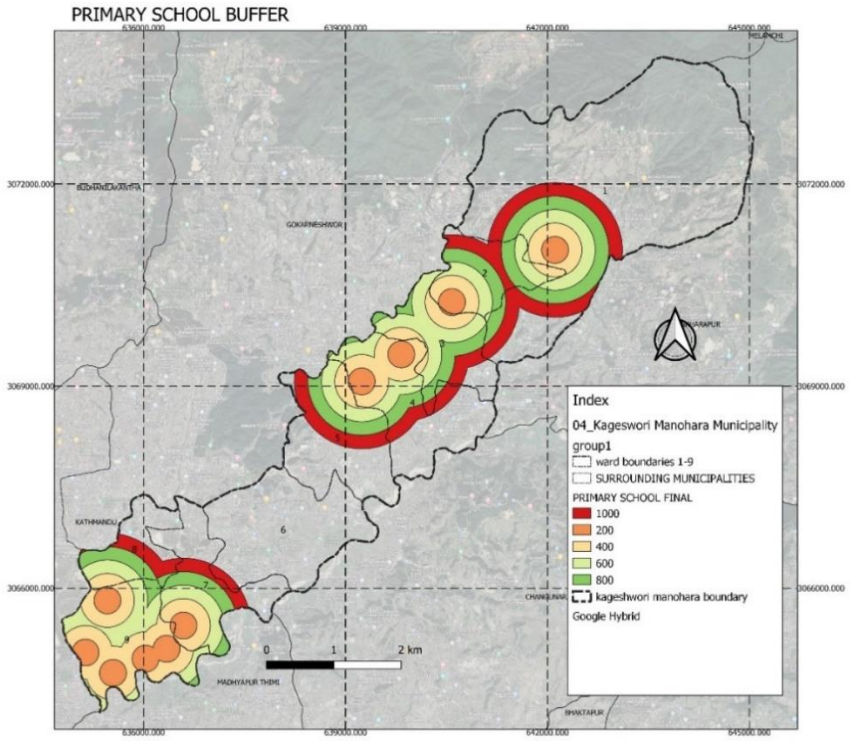
Health post



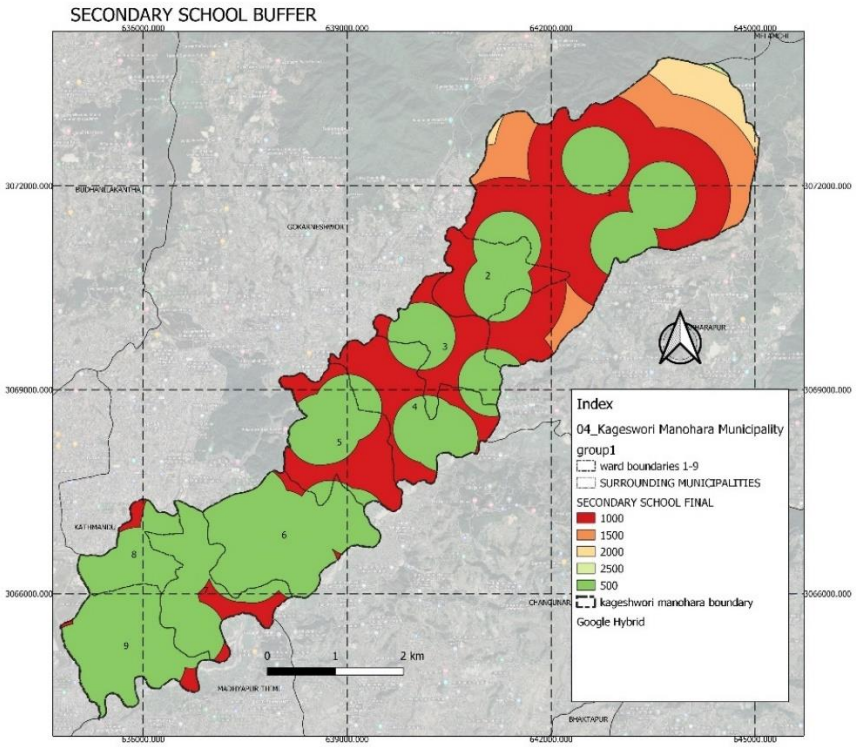
Hospitals



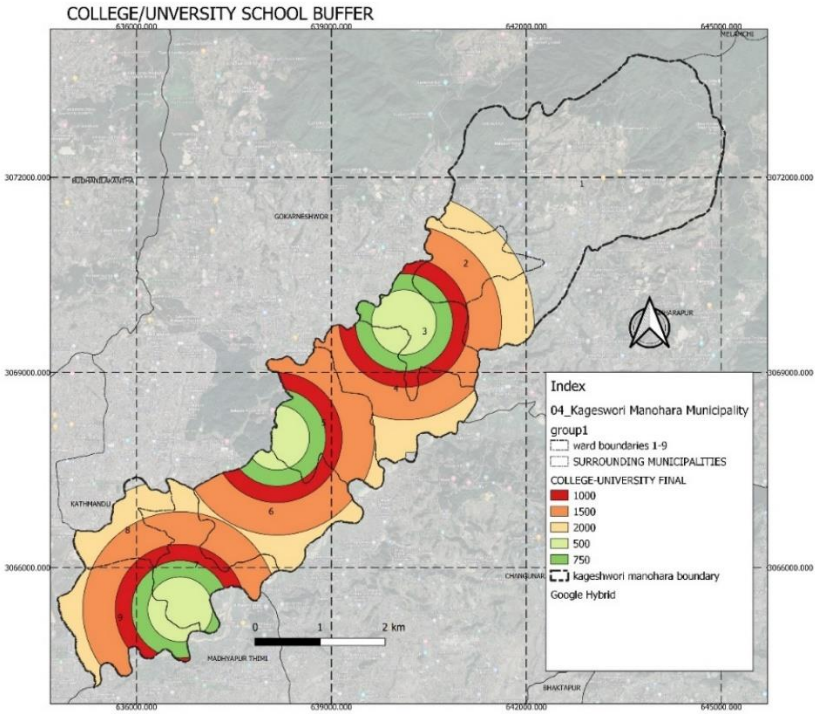
Primary School



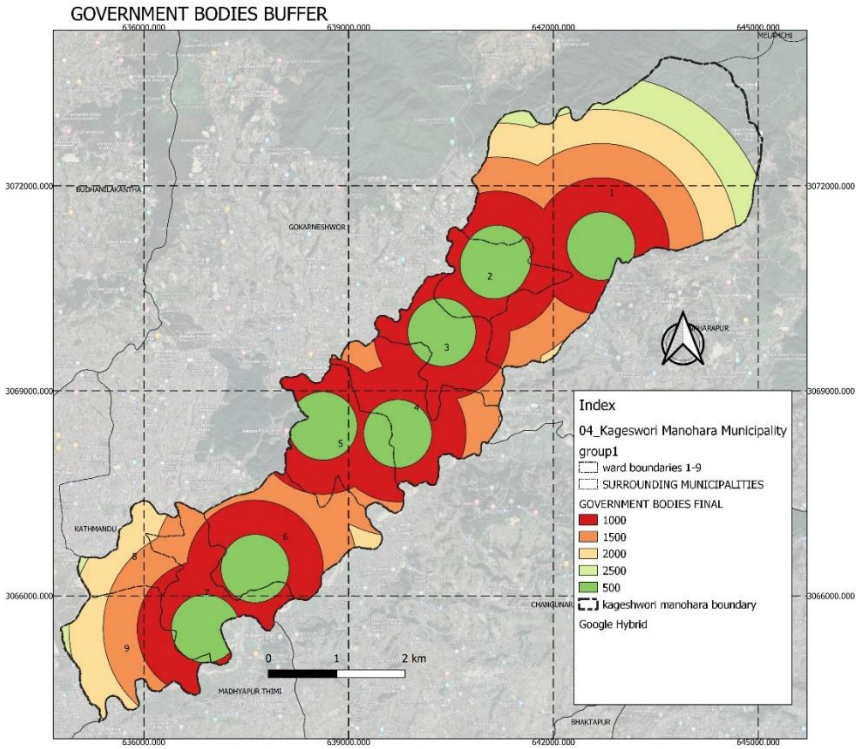
Secondary school



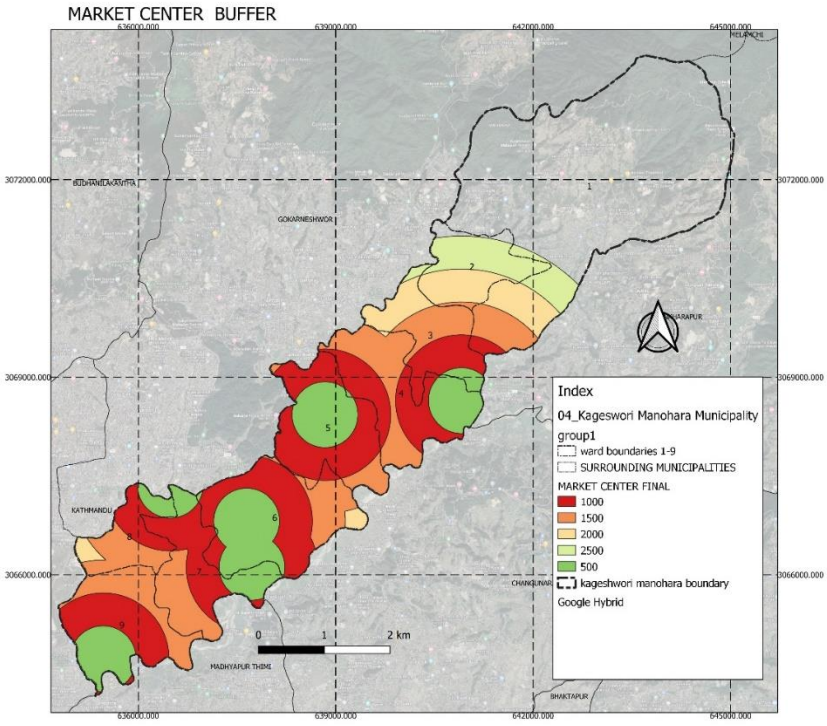
College/university



Public Administration



Market center



5.11 Final Suitability Map.

The final suitability map is the result of a comprehensive process that brings together several distinct maps, each focusing on different aspects of suitability and service proximity. These individual maps are integrated using Geographic Information System (GIS) technology, which allows for a balanced evaluation by giving equal importance to each criterion. To ensure a fair comparison, all values across different criteria have been standardized to a consistent scale.

This composite map represents a holistic overview of the most optimal areas for future urban expansion. By considering various factors and services, it provides a comprehensive perspective on which locations are best suited for development. This map holds significant value for urban planners and decision-makers, offering insights into where resources and infrastructure should be allocated to facilitate sustainable growth.

The process of creating the final suitability map using GIS technology underscores the sophisticated nature of spatial analysis. By combining various criteria, this map serves as a practical tool for making informed decisions about urban development. It ensures that growth is well-planned, considering factors such as accessibility to services, environmental impact, and community needs. In essence, the final suitability map acts as a roadmap for guiding the future development of the studied area in a manner that is both strategic and sustainable.

Raster Calculation.

Important Raster Attributes

1. Road and Infrastructure
2. Built Up Density
3. Educational Institutes
4. Health Institute
5. Market Center

Weight assigned.

	Weight Percentage
Road and infrastructure	20%
Built up Density	20%
Educational Institutes	20%
Health Institutes	20%
Market center	20%

Final Suitability Map (Composite Map)

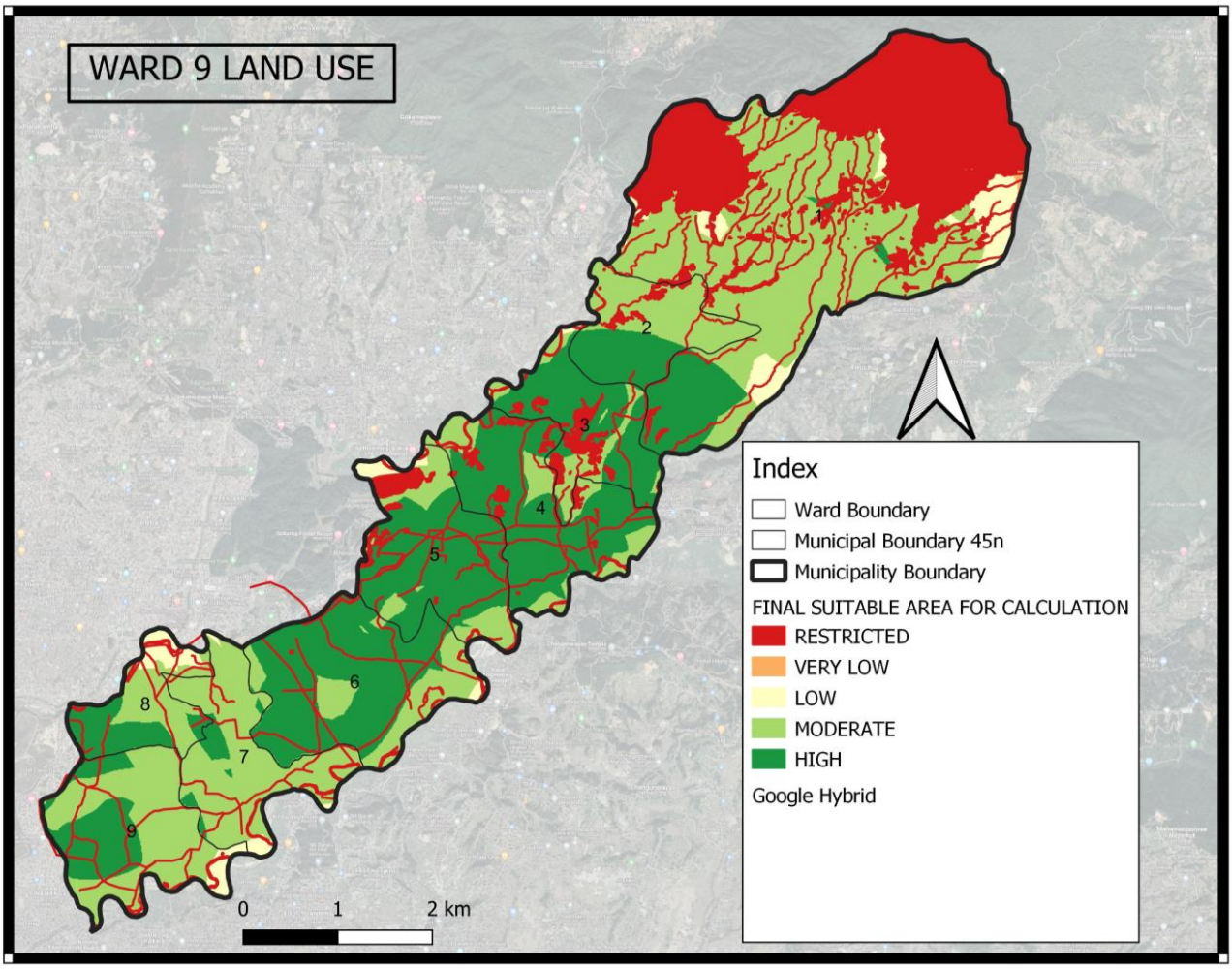


Figure 59 Suitability Map

Total Suitable Area Calculation:

SUITABILITY	Area (SQ.KM)	Percentage
VERY LOW SUITABLE/ RESTRICTED	7	25.45
VERY LOW	0.3	1.09
LOW	1.4	5.09
MODERATE	11	40
HIGH	7.8	28.36
	27.5	100

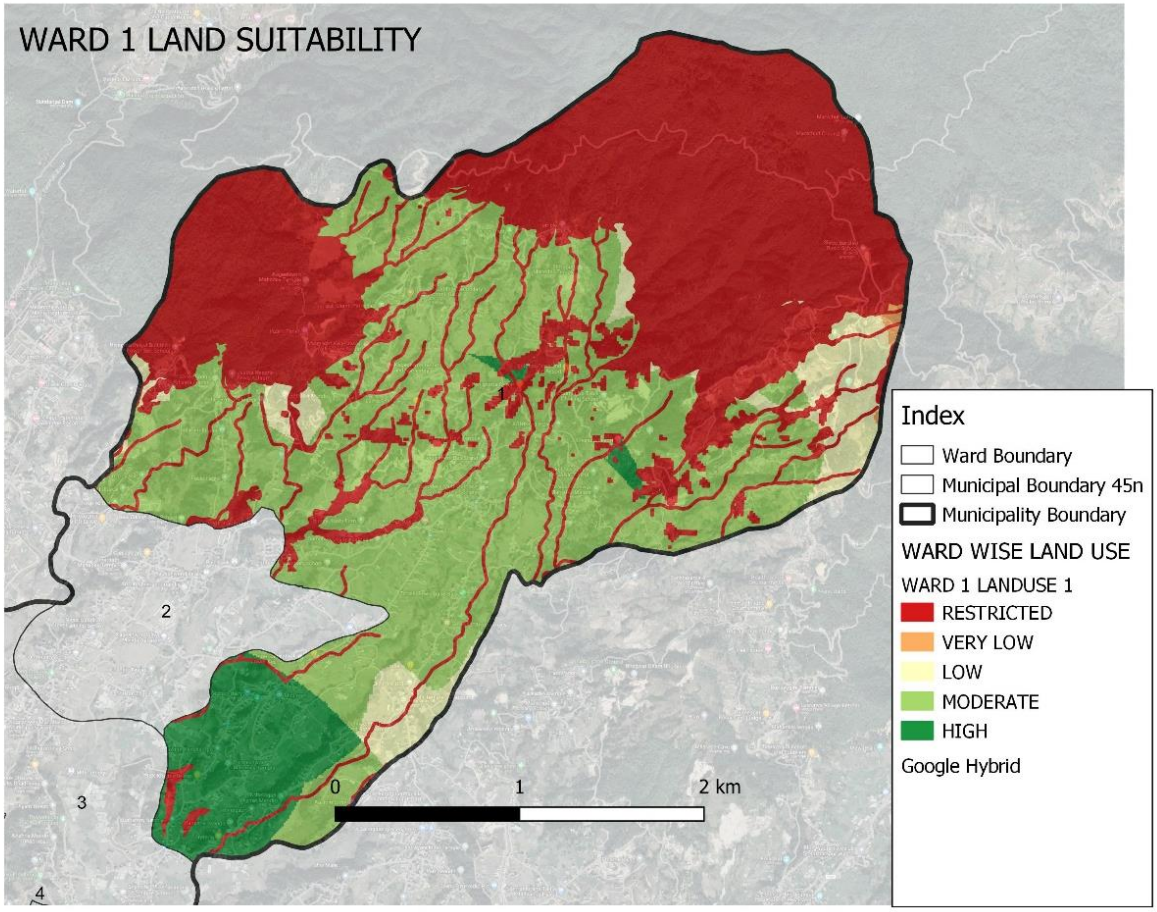
From the final suitability map it is found that there is a highly suitable area to promote dense settlements, with an area of 7.8 sq.km. These areas lie in fragmentation of ward 3, 4, 5 and 6.

Moderate suitability can be found mainly in between ward numbers from ward 1 to 9 in a good percentage of about 40%. This area covers most part of the Gagalphedi, Alapot and Gothatar area. Because this area is already in the pace of development and offers opportunity for residential and commercial development. There is suitable geography and less slope terrain along with the availability of infrastructure and services. Since this area also has an emerging population density, the identified can be developed and prioritized for making plans accordingly. The total area of 11 sq.km is moderately suitable.

A low suitable area consists of 0.3 sq.km area. These are lies mainly in ward 1,7 and 8. Among these some have high density population, and some have low, few have low infrastructure development, and some have good. For example, wards 7 and 8 are densely populated and is categorized in low suitable area. In ward 1 there is demand in density but less infrastructural growth.

Low suitable area is followed by very low suitable with only area of 1.3 square kilometers which is around 1 percent of the total area. About 25.45 square kilometers of land area is restricted for residential development inside the municipality boundary. This area consists of protected forest area, open space, ecologically important areas and so on.

Ward wise Land suitability.



SUITABILITY	WARD 1 (Area)	Percentage
VERY LOW SUITABLE/ RESTRICTED	4.759	43.5965555
VERY LOW	0.199	1.82301209
LOW	0.606	5.55148406
MODERATE	4.581	41.9659216
HIGH	0.771	7.06302675

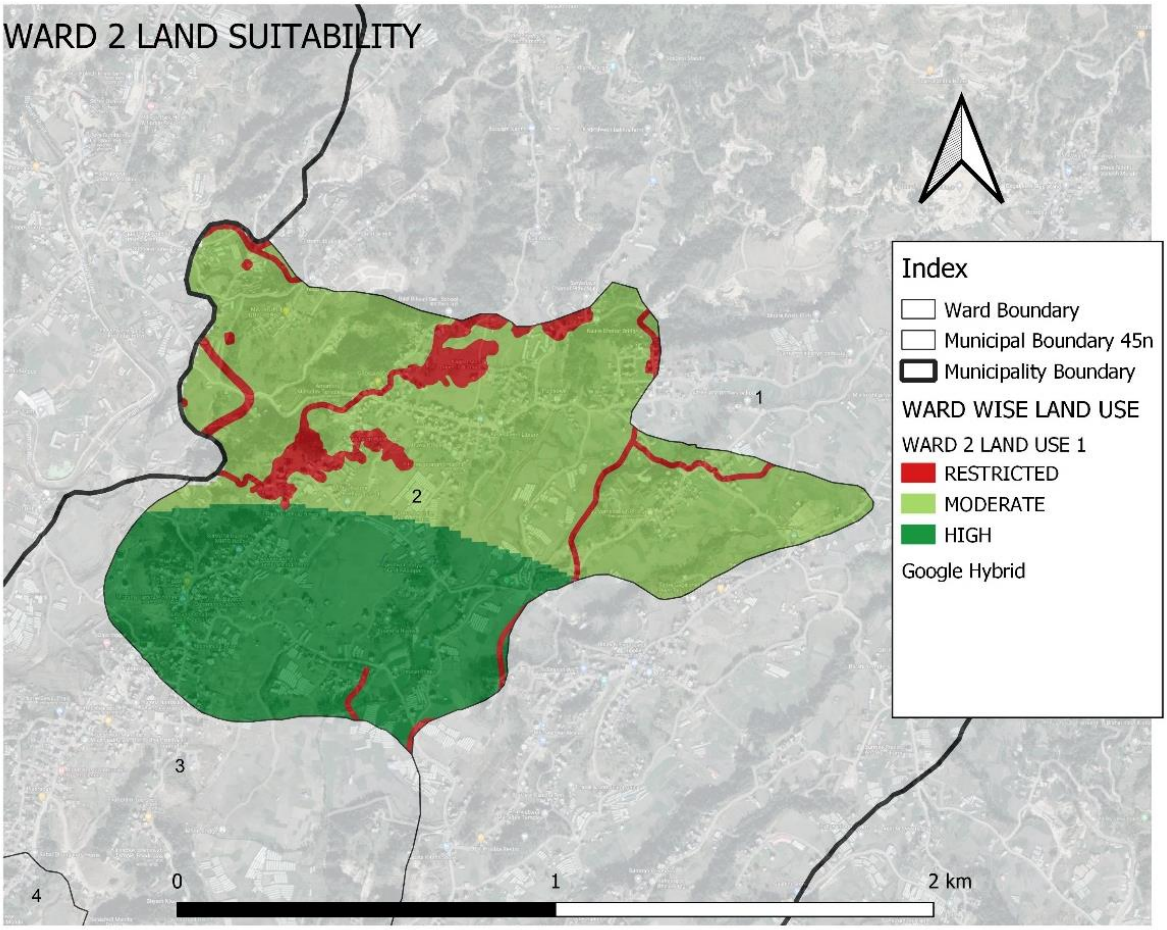
In Ward 1, the land suitability data provided outlines the distribution of various suitability categories across the area. Most of the land, accounting for 43.60%, falls into the category of "Very Low Suitable/Restricted," suggesting limitations or restrictions on its use. Following this, smaller proportions are attributed to "Very Low" (1.82%), "Low" (5.55%), and "High" (7.06%) suitability categories. Interestingly, a substantial portion, approximately 41.97%, is classified as "Moderate" suitability, indicating a moderate level of suitability for specific uses or developments. This breakdown offers insight into the distribution of land suitability within

Ward 1, essential for guiding decisions related to land utilization, development planning, and zoning regulations to ensure optimal and appropriate use of the available land resources.

Ward wise Policy Interventions.

Ward 1:

1. Settlement planning can be done in this area through land pooling and developments.
2. Bye law control over ground coverage and far to encourage growth in density as this area has lowest density of all.
3. Incentives for Building permit and tax should be promoted in this area.
4. Proper buffer distance should be maintained to preserve forest area and wildlife reserve.
5. Education and health facilities should be encouraged to promote density settlements in this area.
6. Promoting area through natural and local tourism plans.
7. Urban agro and farming culture should be promoted in order to utilize farmlands.

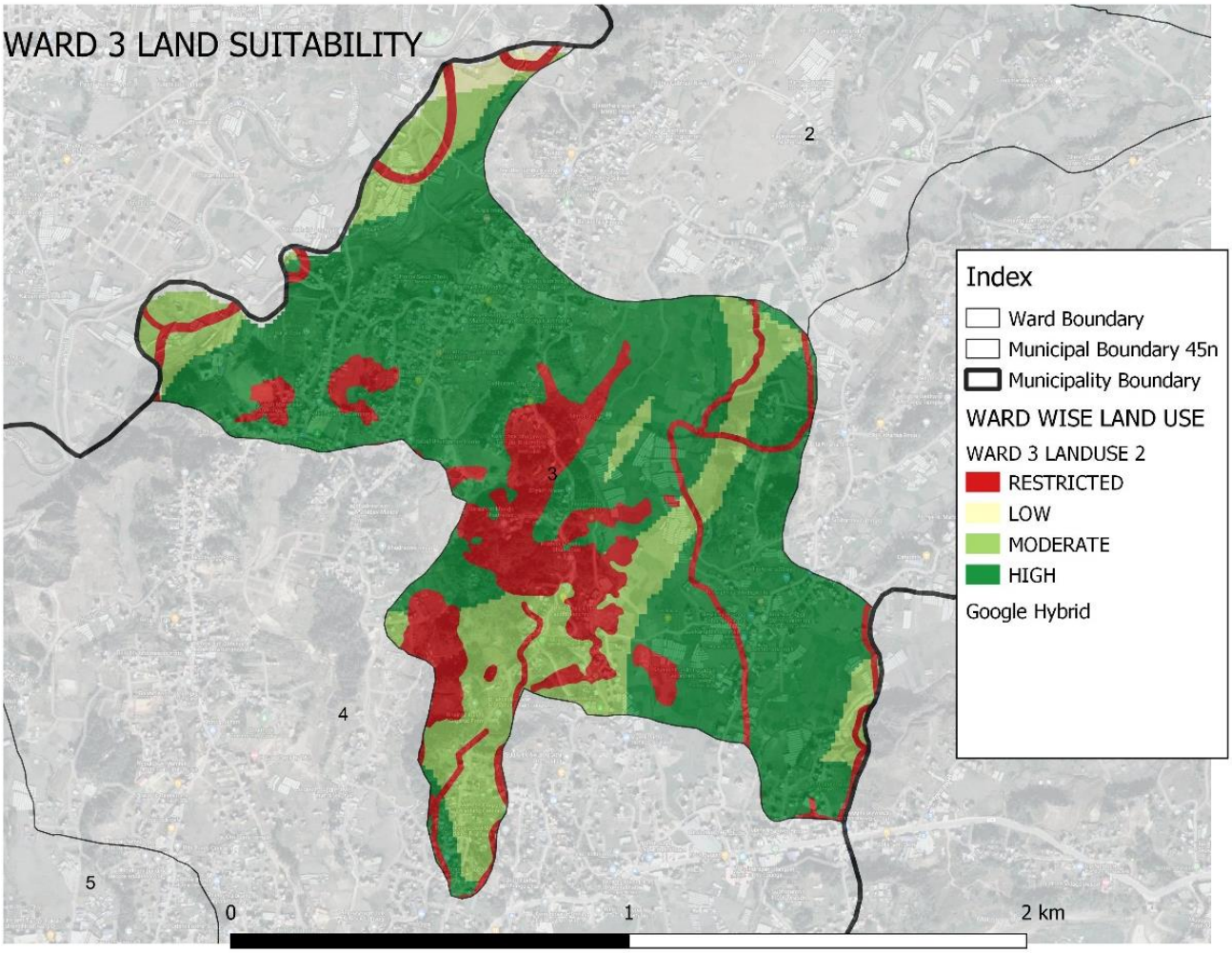


SUITABILITY	WARD 2(Area)	Percentage
VERY LOW SUITABLE/ RESTRICTED	0.102	6.971975393
VERY LOW	0	0
LOW	0	0
MODERATE	0.825	56.39097744
HIGH	0.536	78.4168

There's no land marked as "Very Low" or "Low" suitability. Most of the area, about 78.42%, is considered "High" suitability, meaning it's good for various things. Some land, around 56.39%, is seen as "Moderate" suitability, okay for certain uses. But a small part, 6.97%, is labeled as "Very Low Suitable/Restricted," meaning there might be limitations on what can be done there.

Policy Interventions.

1. Tax intensives during building permits. For example. Low tax rates on square foot of built-up area.
2. More allowance on building coverage and floor area ratio should be maintained to increase the density and meet the demand of future area.
3. Priority on infrastructure development is much needed.
4. Density Bonuses for Affordable Housing:
5. Adaptive Reuse Policy.

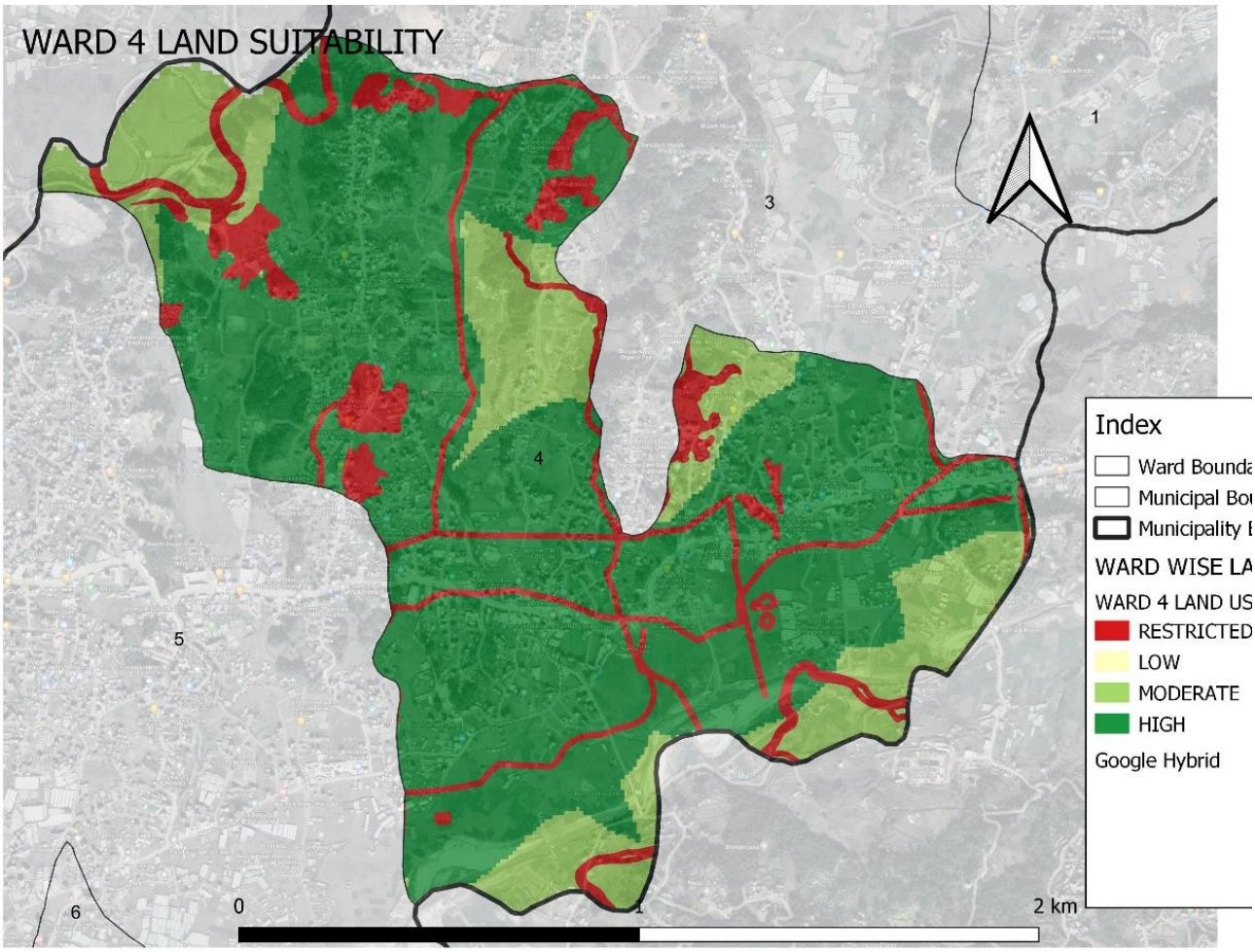


SUITABILITY	WARD 3 (Area)	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.281	15.94778661
VERY LOW	0	0
LOW	0.124	7.037457435
MODERATE	0.339	19.23950057
HIGH	1.018	57.77525539
	1.762	100

. None of the land is labeled as "Very Low" suitability. A small amount, about 7.04%, falls into the "Low" suitability category, indicating some limitations. Around 19.24% is considered "Moderate" suitability, meaning it's okay for certain things. A significant part, roughly 57.78%, is marked as "High" suitability, indicating it's good for various uses. Interestingly, the total percentages add up to 100%, showing that all the land in Ward 3 falls into these suitability categories.

Policy Interventions.

1. Encourage medium density and low-rise buildings.
2. High suitability area is present which can be strength for dense settlement development.
3. Need of economic growth point and center.
4. Promoting mixed use of buildings in the road frontline.
5. Minimum allocation of 5 to 10 percent of open area for public use.

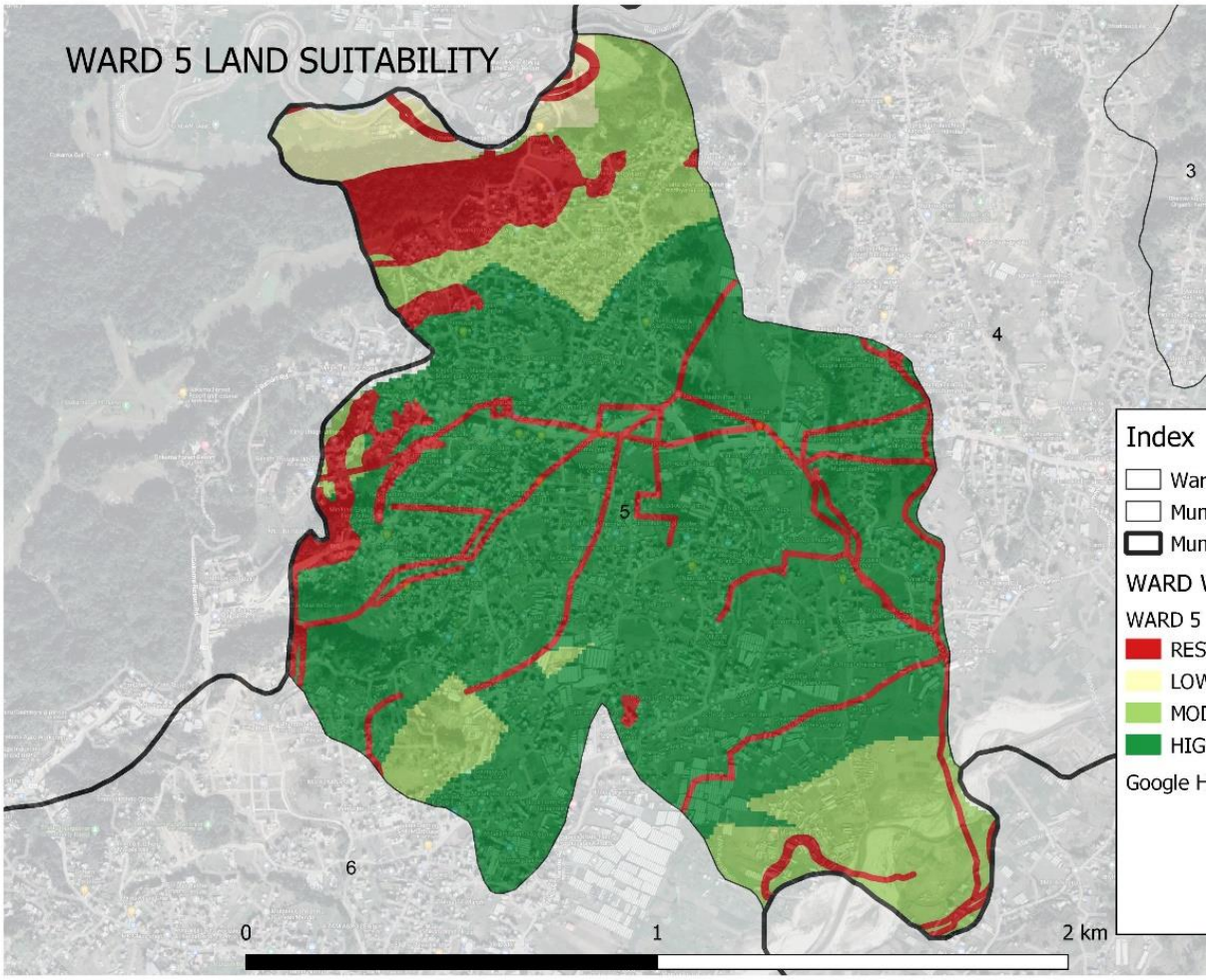


SUITABILITY	WARD 4 (Area)	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.279	10.8436685
VERY LOW	0	0
LOW	0.00593	0.230476538
MODERATE	0.529	20.56021734
HIGH	1.759	68.36563762
	2.57293	100

None of the land is labeled as "Very Low" or "Very Low Suitable/Restricted." A tiny part, about 0.23%, falls into the "Low" suitability category, suggesting some limitations. Around 20.56% is considered "Moderate" suitability, meaning it's okay for certain uses. A significant portion, roughly 68.37%, is marked as "High" suitability, showing it's good for dense settlements.

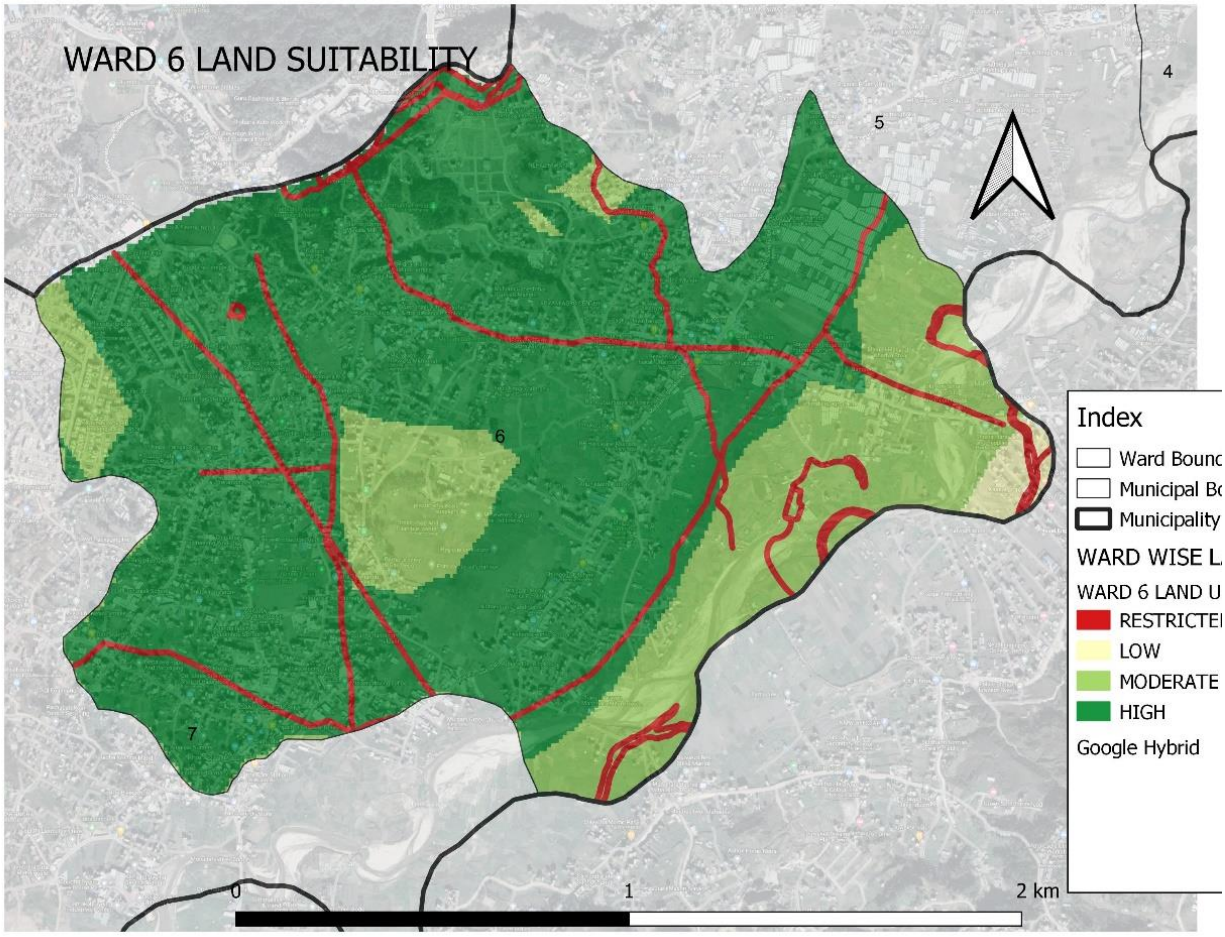
Policy Interventions.

1. Focus on increasing the quality of infrastructure and development.
2. Generation of growth pole such as central market area.
3. Increase in floor area ratio.
4. Subsides for infill developments.
5. Promoting flat renting through increase in FAR and coverage conserving open space and agricultural area.



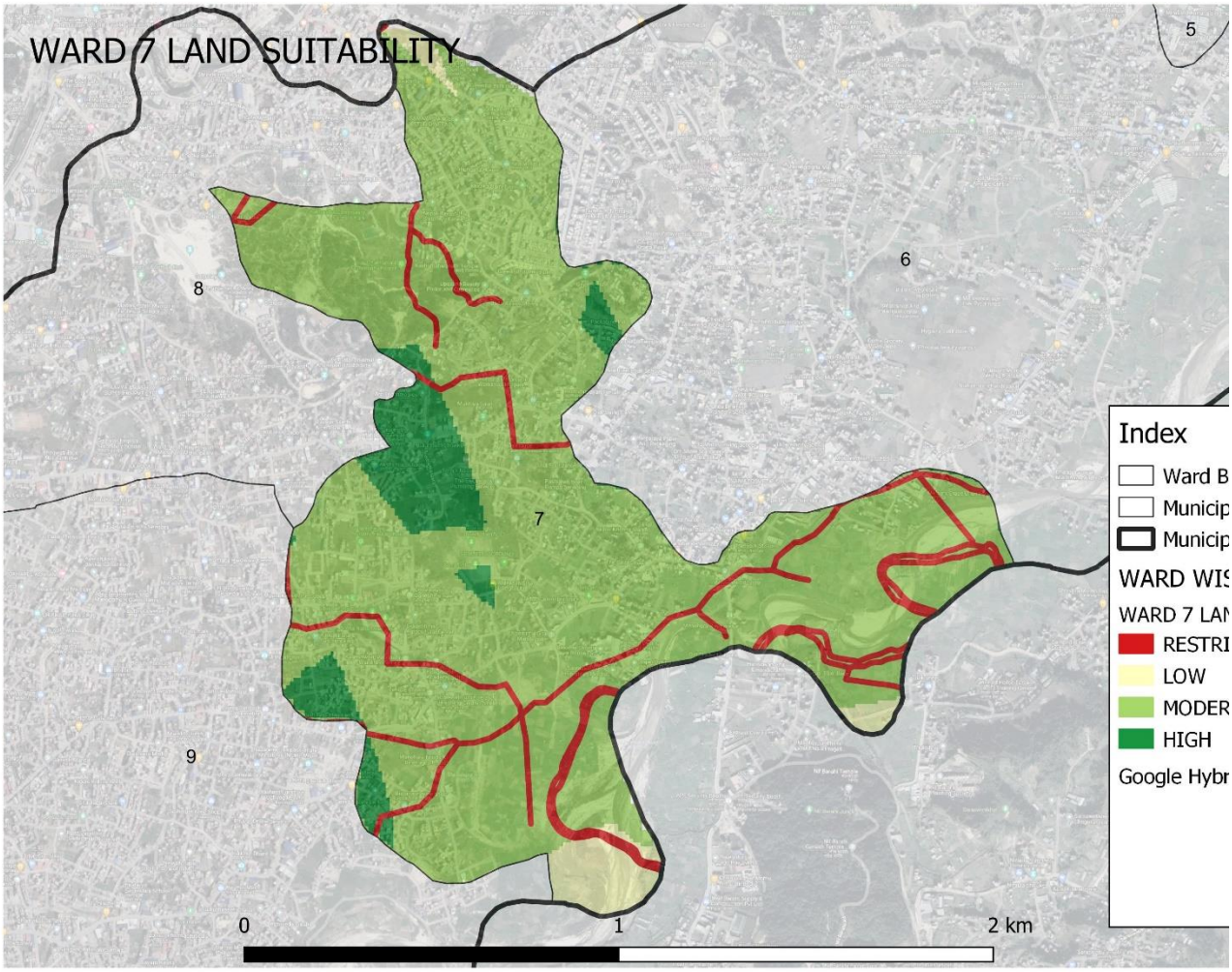
SUITABILITY	WARD 5	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.325	32.30616302
VERY LOW	0	0
LOW	0.074	7.355864811
MODERATE	0.454	45.12922465
HIGH	0.153	15.20874751
	1.006	100

None of the land is labeled as "Very Low" except for "Very Low Suitable/Restricted," which covers about 32.31% and might have some restrictions on its use. There's a small portion, around 7.36%, marked as "Low" suitability, suggesting some limitations as well. About 45.13% falls into the "Moderate" suitability category, meaning it's okay for certain things. Lastly, 15.21% is considered "High" suitability, indicating it's good for settlements planning.



SUITABILITY	WARD 6	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.162	4.976958525
VERY LOW	0	0
LOW	0.288	8.847926267
MODERATE	0.688	21.13671275
HIGH	2.117	65.03840246
	3.255	100

"Very Low Suitable/Restricted" covers a small portion, approximately 4.98%, suggesting some limitations or restrictions on its use. There's another small fraction, around 8.85%, marked as "Low" suitability, indicating certain limitations as well. About 21.14% falls into the "Moderate" suitability category, meaning it's okay for certain uses. The majority, around 65.04%, is categorized as "High" suitability, suggesting it's good for settlements planning.



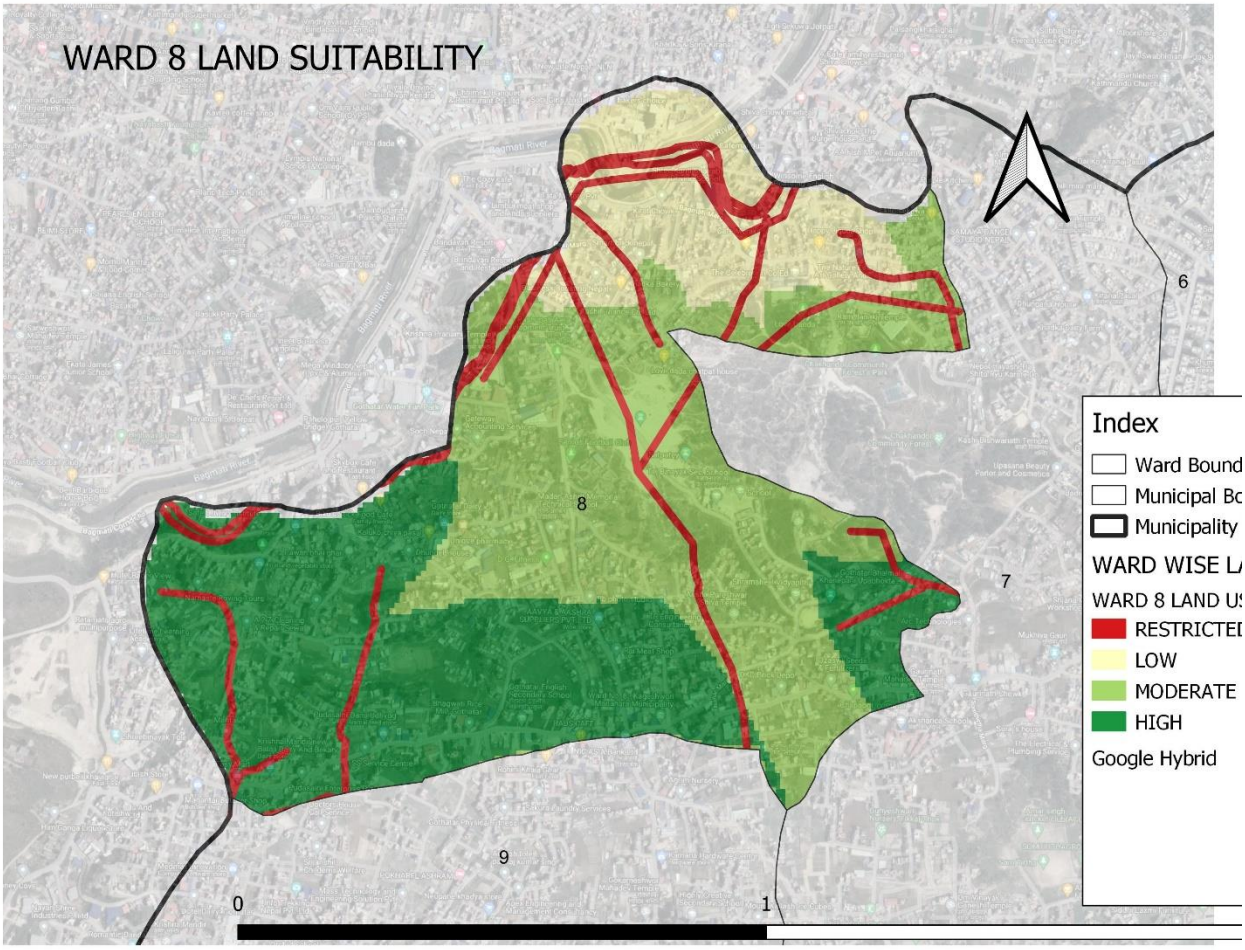
SUITABILITY	WARD 7	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.11	5.626598465
VERY LOW	0	0
LOW	0.069	3.529411765
MODERATE	1.616	82.65984655
HIGH	0.16	8.184143223
	1.955	100

There's a small portion, approximately 5.63%, labeled as "Very Low Suitable/Restricted," indicating some limitations or restrictions on its use. Another small fraction, about 3.53%, falls into the "Low" suitability category, suggesting some limitations as well. The largest portion, around 82.66%, is categorized as "Moderate" suitability, signifying it's okay for certain uses.

Additionally, 8.18% is marked as "High" suitability, indicating it's good for settlements planning.

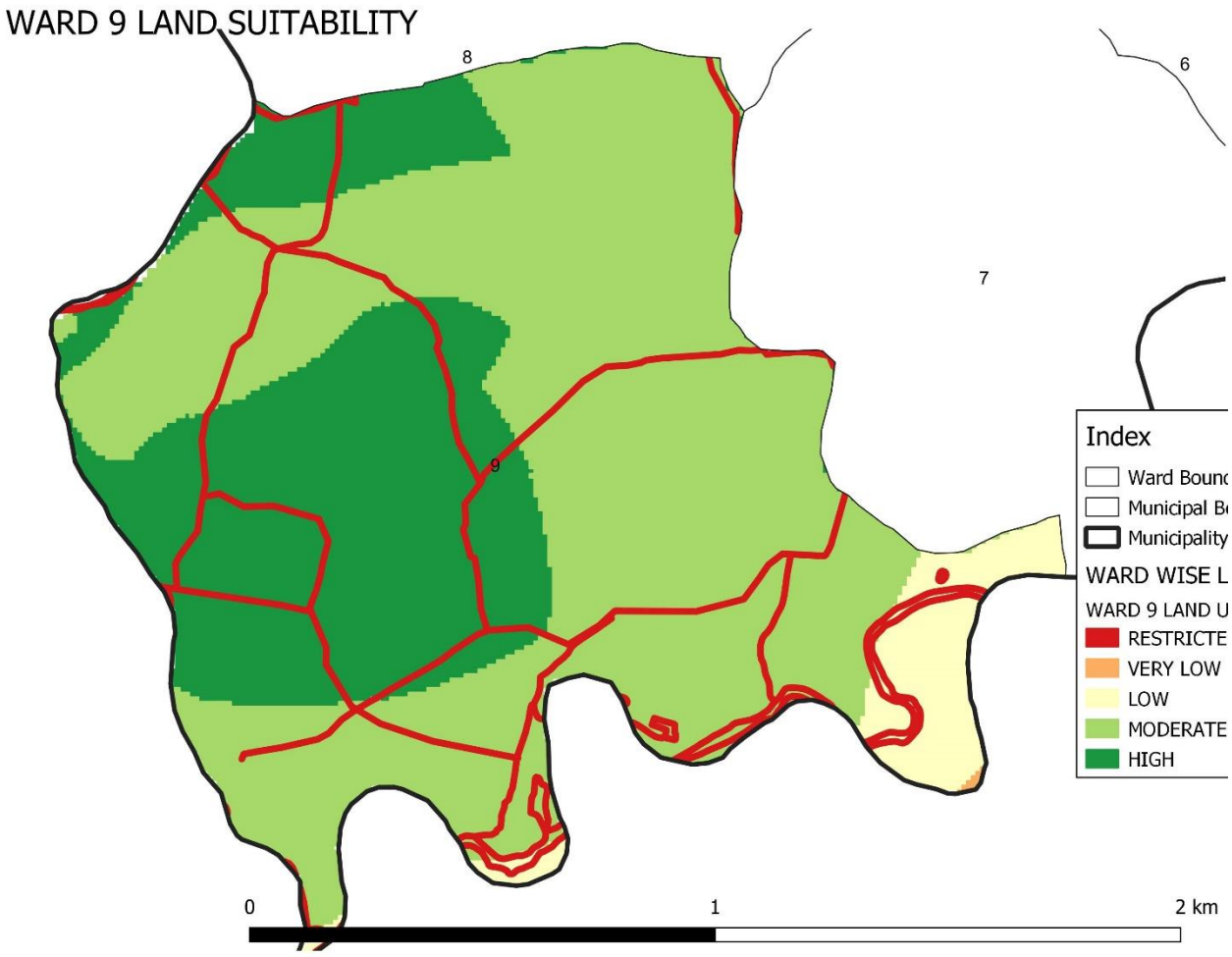
Policy Interventions for Ward Six and Seven

1. Restriction of settlements in the red zone, especially that in the conserved forest and close river basin. High taxation and low coverage of buildings in those areas can discourage settlement development.
2. Increasing floor area ratio for potential areas including business and residences.
3. Promoting protection and allocation of public open spaces.
4. Discourage settlements close with Manohara and Bagmati river basin.
5. Higher density incentives.



SUITABILITY	WARD 8	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.0861	45.07853403
VERY LOW	0	0
LOW	0.156	8.167539267
MODERATE	0.442	23.14136126
HIGH	0.451	23.61256545
	1.91	100

A significant portion, about 45.08%, falls under "Very Low Suitable/Restricted," indicating considerable limitations or restrictions on its use. There's also a small fraction, approximately 8.17%, labeled as "Low" suitability, suggesting some limitations as well. Around 23.14% is categorized as "Moderate" suitability, indicating it's okay for certain uses. Similarly, another 23.61% falls into the "High" suitability category, showing it's good for settlements planning.



SUITABILITY	WARD 9	PERCENTAGE
VERY LOW SUITABLE/ RESTRICTED	0.136	5.872193437
VERY LOW	0.011	0.474956822
LOW	0.116	5.008635579
MODERATE	1.351	58.33333333
HIGH	0.702	30.31088083
	2.316	100

A small portion, around 5.87%, falls under "Very Low Suitable/Restricted," indicating some limitations or restrictions on its use. Additionally, about 0.47% is categorized as "Very Low" suitability. Another fraction, approximately 5.01%, is labeled as "Low" suitability, suggesting some limitations as well. A significant part, roughly 58.33%, is categorized as "Moderate" suitability, meaning it's okay for certain uses. Additionally, about 30.31% falls into the "High" suitability category, showing it's good for settlements.

Policy Interventions

1. Improve infrastructure quality.
2. Promoting Infill development.
3. Introducing Transfer of development rights.

6. DISCUSSION.

Multiple criteria have been studied to find out the most suitable area for urban densification in kageshwori Manohara Municipality. Firstly, constraints were identified such as water bodies, slope and conserved areas and development factors were analyzed. It is obvious that a more suitable area would form towards the main highways and major roads due to the accessibility of resources near to them. Proximity of roads, water networks, electricity, education, health, and market centers always attract people, and this area will always be a priority for people to live in.

There has been vast change in land cover in the municipality due to growth in population and housing need. So proper identification of suitable space is most important to reduce development cost in unnecessary areas. This can also help to reduce hazard and disaster when settlement is built only in suitable area. It is seen that there is a huge portion of land which is suitable for further urban expansion and to meet the housing need of the growing population.

It is estimated that in the coming first decade an additional population would need 571 hectares to build the area to maintain the proper estimated density. The second decade would need about an additional 1400 hectares of built-up area. That will cause a lot of trouble if the planning is not performed in the proper way. We would not be able to see open or usable areas if the same sprawl goes on in future.

For the optimum density required for the given area, various demographics of Kathmandu valley and neighboring areas are studied. It was very important to know about the natural and human-induced density throughout the area. However, the literature proposes various density according to the requirements of physical, social, and economic condition of people, it is important to identify the type of density development in the study area.

Since the municipality has diverse range of population density i.e., high to low in different wards, the study aims to find suitable area among all the wards based on infrastructure built. The optimum density of 300 PPHa is a target for future population. The density is found out through various literature studies and moreover have been targeting to practice in our own context. For example, land pooling projects have also adopted this density while planning and development of the project. It is also recommended by KVDA in its long-term development plan.

The density of 300 PPHa might require low rise medium density method of planning in which there should be an impressive amount of open space and urban forest. These can create a balance between the built environment and ecology. There are various obstacles to growing high density and high-rise buildings, due to expensive built, geolocation not feasible and lack in policy.

There are various challenges even if a suitable area is identified and recommended as the best location for settlements. It is a basic right of people to go and live anywhere within a country. They can own a piece of land and make a house. In this scenario the government must look for the best solution that would allow participation of people to develop the best area for them. There should be a win-win situation between citizens and government. It is the duty of the government to make people understand about the hazard and risk due to haphazard development. Sensitization among people of urban areas to make their place better with minimum possible problems is important.

The best way to enforce proper planning method is to develop a policy that would encourage low investment in development for government and normal people. For example, it would not be beneficial for one to build a house in an area in urban where there is no basic infrastructure and facilities. It's hard to afford the service for just one or couple number of families. It is important to encourage one for the compact settlement as it has numerous advantages for him/her instead of isolated settlements.

This study is carried out to identify suitable geographic location, that would adopt optimum desired density with progressive policy interventions. It is found that GIS has made this study easier and has offered flexible and precise assessment techniques. In the urban setting, to study the multiple criteria under various layers of data GIS is the best tool. Similar tasks were done by planners and researchers with manual calculations in the past, this method could help researchers to adopt in other decision-making processes for land use plan, suitability analysis.

This analysis and its findings hold substantial potential for guiding the sustainable and appropriate future urban expansion of Kageshwori Manohara Municipality. For urban planners, the decision of whether to immediately develop land or preserve it for future growth is of paramount importance. This evaluation can serve as a pivotal tool for city planners and policymakers in formulating effective urban growth strategies.

The technique offers a means to closely monitor the progression of urban land development. As the rate of urbanization surges, the urgency to strike a balance between immediate development and long-term preservation becomes increasingly evident. The prevailing belief in the promising and secure nature of land investments has led to a rapid increase in such transactions, fueled by the escalating value of land. Large-scale transactions for buying and selling land have become commonplace. However, this burgeoning trend has not necessarily translated into a corresponding increase in government revenue.

This discrepancy sheds light on a noteworthy disparity between the government's established guidelines and the actual transaction prices that dominate the market. In essence, the current scenario highlights the misalignment between official regulations and the prevalent market dynamics.

7. Further Policy interventions for desired density implementation in suitable area of Kageshwori Manohara Municipality.

Kageshwori Manohara Municipality is a new growing town in the outskirts of Kathmandu metropolitan city. The town is connected to the main city through multi-large road networks. Since the municipality offers a large portion of unused lands for different purposes and due to availability of infrastructure, there is a large portion of population migrating to this region. This has created unmanaged urbanization resulting in problems due to lack in suitable infrastructure. This can be addressed through proper implementation of plans and policies from central to local level governance.

7.1 Municipal level Plan:

From the suitability analysis it is found that there is a large portion of land suitable for settlement and its growth. Since the projected population growth is even higher than expected, more area is needed in future to accommodate and facilitate large number of dwellings and services with people. For this municipality can direct its plans and programs through wise investment in the suitable areas. Since calculated suitable areas are not enough for the future, it is important to develop more suitable areas through wise investment in infrastructure.

Current Positive Efforts of Municipality for dense settlement development.

Kageshwori Manohara municipality has enforced its municipal building bye laws to ensure and promote higher density population through,

- Minimum Plot size
- Increase in FAR (Floor area ratio)
- Increase in Ground coverage. (from 60% to 70 % for residential and 50% to 60% of the total plot size for commercial Building)

Since this study analysis suggests that Kageshwori Manohara should target low rise and medium density development, Municipality must enforce more laws targeting the minute aspect of development and conservation, either for the built or open space.

Municipal Policy intervention plays a pivotal role in maintaining optimum urban density within Kageshwori Manohara Municipality for several compelling reasons. As the municipality experiences growth and transformation, policies are necessary to ensure a harmonious balance between urban expansion and the preservation of natural and social resources. These

interventions guide the distribution of development across suitable areas, preventing congestion and sprawl while promoting efficient land use. Moreover, policies facilitate the provision of essential infrastructure and services, such as transportation networks, utilities, schools, and healthcare facilities, in proportion to the population. By strategically managing urban density, these policies contribute to minimizing the ecological footprint, reducing energy consumption, and curbing pollution. Additionally, they encourage vibrant, pedestrian-friendly neighborhoods where residents can easily access amenities and cultural attractions, fostering a sense of community and enhancing overall well-being. Through initiatives promoting mixed-use development, policies not only ensure convenience but also stimulate economic growth by attracting businesses and investment. Importantly, policy-driven urban density management contributes to disaster resilience by discouraging construction in high-risk areas and prioritizing safety. By maintaining affordable housing options, policies address potential inequalities, ensuring that diverse socio-economic groups can access the benefits of urban living. Ultimately, these interventions guide the municipality towards a sustainable, inclusive, and prosperous urban future.

1. **Zoning and Land Use Regulations**: Implement zoning regulations that encourage compact and mixed-use development within the selected suitable areas. Enforce land use regulations that promote higher-density construction, ensuring that developments are aligned with the targeted density of 300 persons per hectare (PPHa).
2. **Incentives for Higher Density:** Introduce incentives for developers and builders to create higher-density projects. This could include reduced permit fees, faster approval processes, or tax benefits for projects that meet or exceed the optimal density target.
3. **Transfer of Development Rights (ToDR):** Establish a TDR program that allows landowners in less suitable areas to transfer their development rights to more suitable areas. This encourages development in locations that can accommodate higher density while preserving ecologically sensitive or historically significant areas.
4. **Floor Area Ratio (FAR) Bonuses**: Offer increased floor area ratios (FAR) to developers who incorporate public amenities, green spaces, affordable housing, or other community benefits within their projects. This encourages denser development while enhancing the quality of life in the municipality.
5. **Infrastructure Investment:** Develop policies that tie infrastructure development to higher density areas. Prioritize the provision of essential services such as transportation,

utilities, schools, and healthcare facilities in these selected areas to support population growth.

6. **Density Bonuses for Affordable Housing:** Offer density bonuses to developers who include a certain percentage of affordable housing units in their projects. This not only addresses housing affordability but also contributes to achieving optimal density levels.
7. **Community Engagement and Education:** Engage local communities in the planning process to ensure their input and address concerns. Educate residents about the benefits of higher density, including improved access to services, reduced urban sprawl, and enhanced public spaces.
8. **Phased Development:** Implement policies that promote phased development, encouraging developers to build in stages to gradually achieve the targeted density. This approach can prevent sudden spikes in population density that might overwhelm.
9. **Urban Growth Boundaries**: Establish urban growth boundaries to prevent urban sprawl and concentrate development within the selected suitable areas. This encourages efficient land use and infrastructure utilization.
10. **Density Transfer Programs:** Introduce programs that allow developers to transfer unused density rights from one area to another, ensuring that optimal density is achieved across the municipality.
11. **Public Spaces and Parks:** Develop policies that mandate the inclusion of public spaces, parks, and green areas within higher-density developments, enhancing the overall livability of the selected areas.
12. **Design Review Boards:** Establish design review boards to ensure that higher-density projects adhere to aesthetic and architectural standards, promoting a cohesive and visually appealing urban landscape.
13. **Infrastructure Financing Districts:** Create financing districts where a portion of property tax revenue generated from higher-density developments is earmarked for infrastructure improvements in the same area.
14. **Smart Growth Principles:** Integrate smart growth principles into policies, emphasizing mixed land uses, walkability, connectivity, and sustainable transportation options to achieve optimum density.
15. **Adaptive Reuse Policies:** Encourage the adaptive reuse of existing buildings and underutilized sites for higher-density development, minimizing land consumption while revitalizing older areas.

16. **Community Land Trusts:** Establish community land trusts that hold and manage land for the benefit of the community, ensuring that higher-density developments remain affordable and aligned with local needs.
17. **Mixed-Income Housing Policies**: Promote policies that encourage a mix of income levels within higher-density developments, fostering socio-economic diversity and inclusivity.
18. **Performance-Based Zoning:** Shift from prescriptive zoning to performance-based zoning, focusing on desired outcomes like density, open space, and environmental sustainability.
19. **Incremental Density Increase:** Develop policies that gradually increase density over time, allowing communities to adapt to changes and ensuring a smooth transition to higher density living.
20. **Energy Efficiency Standards:** Enforce energy-efficient building standards for higher-density developments, reducing their environmental footprint and promoting sustainability.
21. **Mixed-Generational Housing:** Encourage the integration of housing types suitable for different age groups, fostering a sense of community and providing for diverse needs.
22. **Monitoring and Evaluation:** Establish mechanisms to continuously monitor and evaluate the effectiveness of density policies, adjusting based on actual outcomes.

By implementing a combination of these policy interventions, Kageshwori Manohara Municipality can effectively work towards achieving optimum density in the selected suitable areas, fostering sustainable urban growth, and enhancing the quality of life for residents.

8. Recommendations from the study.

There are many ways to identify suitable areas for dense development which is an important aspect during development in the case where there is maximum increase in Population. The multi criteria decision making (MCDM) is an easy and popular way to find solution for the given problems. Likewise, here to find suitable areas, we take different effective factors that influence the most and analyze for the best possible option favored by the factors. Any contextual factors could be used to decide. It is totally based on the site, criteria, and stakeholders themselves.

This analysis has proven a highly effective and simple procedure displaying results in informative and in the form of digital maps. The favored areas can be categorized and

calculated for their use in an appropriate way. The use can be enhanced and changed, changing the value of the factors.

Referring to the output map, municipality can plan a way of development activities and investment schemes in future. It can make bold decisions for the appropriate use of lands and space available. First all the incoming population should be encouraged to settle in a highly suitable area, and then moderately suitable areas. This can prove wise investment of local government to full fill the basic infrastructural needs of the people. Similarly, there is large proportion of low suitable areas consisting of agricultural fields, population saturated Ares, open areas and so on which can be used for other useful purposes and development like parks, conserved forest, urban agricultural fields. Or low suitable areas can be enhanced to moderate suitable or highly suitable areas if needed for settlements. This can be done by investing in appropriate infrastructure and development works. Suitable areas should be encouraged for infill development and initiatives should be started.

Recommendations for Further Study.

This study uses the MCDM method to identify suitable areas for further development. This method is simple and easy to understand about the suitable cases for suitable development of settlements and markets. Combining more and more suitable criteria one can predict the suitable area. However, there are more complications when we get in-depth study about the minute criteria and character of settlement developments. There are more obstacles and errors when we rationally choose out the criteria and evaluation methods. More suitable evaluation methods have been developed for considering and mitigating errors. There are more accurate and detailed methods such as AHP method for MCDM which calculates using more error mitigating calculations. Further studies can be done with more advanced criteria and decision-making process.

The study involves less criteria while developing suitability maps. So, this cannot be suitable for any more areas, but can be for areas having suitable and favorable conditions. For different places criteria can be prioritized and taken into consideration. Criteria can be chosen, and weighted methods can be adopted. More priority criteria can be given more weight during raster calculations.

Identification of optimum density as a numerical number for any area depends upon the various physical, cultural, and socio-economic factors along with the environmental factors. The study

must be conducted for various similar cases, with the generated output result, taken into evaluation. So, this variable factor can be anything with low, medium, and high-density development. More study can be done for different locations and developing regions.

Municipal level planning can play a huge role in the implementation of balanced and sustainable planning principles. The identification of suitable areas and the optimum density for any required area can help to formulate plans and programs for municipalities and other levels of government. More study can be for providing effective and rigid municipal plans with effective development planning and goals.

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Annex. A

QUESTIONAIRES FOR GENERAL AND EXPERT PEOPLE REVIEW

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
PULCHOWK CAMPUS

Checklist and Interview with the Experts and Officials

This checklist questionnaire has been developed as a requirement during the master's thesis study in urban planning under the Department of Architecture and Urban Planning, Pulchowk Campus, Lalitpur, I.O.E., T.U.

Title of the Thesis: **Spatial Analysis for Densification of Settlements and Policy intervention in the case of Kageshwori Manohara Municipality.**

- **Objective:** To conduct comprehensive spatial analysis to identify suitable areas for promoting desired densification practices/policies in the case of Kageshwori Manohara Municipality.

For the objectives and study, I would also be exploring in further **research question** such as:

5. What are the suitable areas for urban densification?
6. How can we obtain the optimum target density standard for those suitable areas?
7. What measure/policies can be enforced to meet the targets?

Date and Time of Interview: _____

Name of the Student/Interviewer: Krishna Pudasaini

Name of the Supervisor: Dr. Ajay Chandra Lal

Name of the Key Informant/Expert to be interviewed: _____

Working Profession/Field of the Expert: _____

Name of the Office: _____

Address: _____

PART-I: VERIFICATION OF DEVELOPED CRITERIA FOR URBAN SETTLEMENT DENSIFICATIONS

After the thorough study of literature, following suitability criteria for densification of settlements in Kageshwori Manohara city has been developed, which area as follows.

1.1 Constraints

- Forest
- River (flood prone)
- Risk Sensitive Areas (conserved, streams and ponds)

Then For the selection of densification area, Proximity to

- Health (Hospital, health center)
- Education (School, college)
- Culture (Religious places, community center)
- Recreation (Open spaces, parks, sport arena)
- economic /Market center
- Proximity to Highway/Major Roads.
    - Administration office:

- Open Space:

.

KII FOR GOVERNMENT BODIES

Name:

Organization:

Position:

1. **What is the trend of urban pattern in Kageshwori Manohara?**

(Urban sprawl/ Ribbon development/Pocket development)

2. **What are the factors that are driving the development pattern?**

(Road, infrastructures, land price, proximity to services)

Validate what happens first.

3. **In the current scenario, where are people buying land and settling?**

(Land fragmentation: where and frequency) Why are they buying in that area?

4. **Are there any policies (Municipal) regarding the development of new densification policies or area? (Upcoming/Pipeline)**

5. **What criteria should be taken into consideration for development of new residential settlement?**

(Risk sensitive areas, Proximity to services/urban amenities)

6. **What could be the issues/ challenges for densification development?**

7. **What interventions can be taken to make people go to the selected area?**

For General people

Informant:

Profession/involvement:

a) What is your age?
b) What is your occupation?
c) How long have you lived in this town?
d) Do you own or rent your current residence?
e) How long have you been in this area as a resident?
f) Describe your Place in a few words.

2. Knowledge and Perceptions of Urban Densifications.

a. How would you describe the current level of urban densification in the town?

b. In your opinion, what are the positive effects of urban densification?

c. In your opinion, what are the negative effects of urban densification?

d. How important is it for the town to implement measures for urban densification?

3. Housing and Living Conditions.

a. What type of housing do you currently reside in (e.g., single-family home, apartment, condominium)?

b. Are you satisfied with your current housing situation?

c. Are you experiencing any issues related to overcrowding or lack of space in your living environment?

4. Transportation and Mobility:

a. How do you typically commute within the town (e.g., walking, cycling, public transport, private car)?

b. Do you feel that the town's infrastructure supports sustainable transportation options?

c. Would you be willing to use public transportation or non-motorized modes of transport more frequently if they were improved?

5. Green Spaces and Public Amenities:

a. How accessible are green spaces (parks, recreational areas) in your neighborhood?

b. Are there enough public amenities (e.g., schools, healthcare facilities, community centers) to support the population?

c. Do you think there is a need for more green spaces and public amenities in the town?

6. Community Engagement and Involvement:

a. Are you aware of any urban densification initiatives or projects undertaken by the town's authorities?

b. Have you participated in any community discussions or consultations regarding urban densification measures?

c. Do you believe that the community's opinions and concerns are considered when planning urban densification?

7. Sustainability and Environmental Impact:

a. How do you perceive the environmental impact of urban densification in the town?

b. Would you support urban densification measures that prioritize sustainability and energy efficiency?

8. Future Expectations and Preferences: (policies and Interventions)

a. What changes would you like to see in the town's urban densification policies?

b. How do you envision the town's development in the next 5-10 years regarding urban densification?

ANNEX V - Time Schedule

S.No.	Proposed Activities	Timeline																			
		Jestha				Ashad				Shrawan				Bhadra				Ashwin			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Literature Review and Conceptualization																				
2	Thesis Proposal Submission																				
3	Presentation of Thesis Proposal																				
4	Further Literature Review and Discussion after consulting with the Supervisor																				
5	Revised Thesis Proposal Submission																				
6	Preliminary Thesis Presentation																				
7	Literature Review - Case Study: National and International																				
8	Consultation with Resource persons and Stakeholders																				
9	Field Visit: Data Collection																				
11	Preliminary Analysis of Data Collected from Multiple Sources																				
12	Cross Case Analysis and Findings																				
13	Mid Term Thesis Report Submission																				
14	Mid Term Thesis Presentation																				
15	Consultation with Experts																				
15	Data Compilation, Filtering, Screening and Analysis; Consultation with the supervisor and experts																				
16	Draft Final Report Submission																				

17	Final Thesis Defense																			
18	Final Thesis Report Submission																			

– IOE GC Acceptance Letter and Paper

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Date: November 26, 2023

To Whom It May Concern:

This is to certify that the paper titled "***Spatial Analysis for identification of suitable areas to promote dense settlements in the case of Kageshwori Manohara Municipality***" (Submission# **598**) submitted by **Krishna Hari Pudasaini** as the first author has been accepted after the peer-review process for presentation in the 14th IOE Graduate Conference being held during Nov 29 to Dec 1, 2023. Kindly note that the publication of the conference proceedings is still underway and hence inclusion of the accepted manuscript in the conference proceedings is contingent upon the author's presence for presentation during the conference and timely response to further edits during the publication process.

Bhim Kumar Dahal, PhD
Convener,
14th IOE Graduate Conference

IOE Graduate Conference
[Placeholder for Publication Information]

Spatial Analysis for identification of suitable areas to promote dense settlements in the case of Kageshwori Manohara Municipality

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Abstract
This research looks out for the identification of a suitable area to deploy optimum density in human settlement and planning in Kageshwori Manohara Municipality. Analyzing the global, national, and regional trend of urban population growth, this research also seeks for optimum density required for the case area. To address the problem of rapid urbanization in Municipality this research looks for the interventions in development approach based on sustainable and economical ways. For this spatial analysis is done for determining the suitable area for dense settlement development. GIS based; MCA is used for suitability analysis. Literature and discussion helped in determining restriction and development criteria for selection of suitable area for dense settlements. Final maps from both criteria are developed in GIS as maps. A final map was created based on the restriction criteria. Each development criterion was initially transformed into a GIS map and then standardized into raster maps, using a scale where values of 5,4,3,2 and represent highly suitable, moderately suitable, low suitability, very low suitability, and unsuitability, respectively. Final Raster weighted overlay was done in GIS using multiple layers of developable and restricted criteria, which gave the final suitable area in the form of map. Further required density for this suitable area is studied with future population projection.
Area required for the future is calculated maintaining the desired density. Thus, divided area with various degree of suitability, are recommended for priority development and order. Various policy interventions, incentive distribution, tax exemption could be deployed to encourage people to follow the guided development plan, which maximizes profitability for people and the country.

Keywords
Densification, Spatial Analysis Compact settlements, Land Suitability, Density, GIS based MCA.

1. Introduction

A human way of living could be urban or rural. Urban areas consist of more secondary and tertiary activities rather than an agricultural economy. A surplus economy, dense urban dwellings and services, more infrastructural services, and high people density are common characteristics of urban areas. In the context where the world urban population exceeds half, Nepal also recorded an urban population of more than 66% [1]. The formation of more municipalities resulted in growth in urban areas and population in many parts of the country. Urbanization is gaining pace in other cities of Nepal. However, Kathmandu Valley continues to be the "hub" of urban development in Nepal [2]. Unplanned urbanization in the valley continued engulfing the agricultural lands, adding several physical, social, and environmental problems in the Kathmandu Valley, and significantly increasing vulnerability to disasters, including earthquakes [3]. The increase in urban hazards is directly proportional to the increase in populations and is more hazardous when there are fewer or no preparations. So, population growth has challenged new and developing towns to accommodate the population with additional infrastructure and services.

Similarly, unplanned, and non-uniform urban density has created gaps in development for developing areas. Less or high density creates an imbalance in urban ecosystems. So, there is a need to balance urban density and available resources. The concept of densification of settlements comes up when there is a limited resource available and it must be shared with maximum economic benefit.[4]

Urban densification is a way to create cities compact to use land more intensively. It comes as a major strategy for sustainable and resilient planning consisting of compact settlements, walkability, TOD, and more. As

per [5] densification process can be observed through increase in population/ jobs and through increase of built floor area. These two 2 variables are obviously related but may present divergences over time and space. Urban densification can bring disastrous effects when not regulated or monitored overtime.

With the rise in urban population throughout the country, Kathmandu valley still contributing to 9 percent of total population of Nepal. [1] which was 10 percent in 2011. The urban area in the valley is expanding along with fringe development. The case for the study is taken among 18 local administrations inside the valley contributing to accommodate the high increase of population and demands. The case area for the study is Kageshwori Manohara located in the northeast part of the valley. This area can represent a similar case and scenario which is occurring in the valley.

Kageshwori Manohara Municipality has an administrative boundary of 27.38 sq.km formed through the merge of 6 former VDC of the area. (Kageshwori Manohara Municipality,2018) and municipal boundary differentiated by Manohara River on East and Bagmati on the west. Currently there are 9 wards with a total population of 1,30,433. [1]

It is seen that the municipality is facing population growth of more than 100 percent in just a decade. The trend has been the same for more than two decades. This growth trend has resulted in huge changes in landcover and an increase in fringe development. The high land price in central Kathmandu has pushed huge population to shift towards the outskirts of the valley, because of which a major number of outskirt municipality have faced the consequences for more than two decades. Therefore, the population of Kathmandu Metro is decreasing where other outer areas are getting populated. The study area consists of a substantial volume of virgin land and resources which are used for farming and agriculture. But due to unplanned land management and preparation, the population growth has resulted sprawl development with rise in urban hazards and loss of natural resources. Optimum use of resources and proper planning could be achieved if the population is managed within the designated area.

1.1 Problem Statement

In Nepal, rapid urbanization is driving a significant increase in the urban population, reaching 62.2% due to the government's declaration of municipalities as urban areas. Kageshwori Manohara Municipality in the Kathmandu Valley is grappling with the challenge of balancing development and environmental concerns. A decade ago, this area was predominantly rural with ample agricultural land, green vegetation, and forests. However, Kageshwori Manohara Municipality now faces an annual population growth rate of 9.57%, resulting in a doubling of the population over the past decade, with further increases projected. This population surge has led to extensive changes in land use, environmental degradation, and socio-cultural issues, characterized by haphazard and uncontrolled urban growth. Despite various planning efforts, implementation has proven largely ineffective.[6].The influx of people to Kageshwori Manohara Municipality is likely driven by the shortage of space and services in Kathmandu's city center. Consequently, the land cover in Kageshwori Manohara Municipality is rapidly transforming due to this migration, necessitating urgent attention to sustainable urban planning and development. The main problems can be listed as.

- High Population growth with low density settlements.
- Huge change in land cover: Loss of agricultural lands and natural environment.
- Rise in sprawl and development which makes infrastructure costlier and ineffective.

1.2 Objective of the Study

Analyzing the problems of the case area, the study has a main objective which is:

- To conduct comprehensive spatial analysis to identify suitable areas for promoting optimum dense settlements, carrying out required policy interventions in the case of Kageshwori Manohara Municipality.

To address the study objective, further research questions are developed which are listed below:

1. How do we identify suitable areas for promoting dense settlements?
2. What is the optimum density for such a developing area?
3. What policy interventions can be done to encourage desired density in suitable identified area?

1.3 Rationale of the study

Increasing the density of cities, especially in places like Nepal, is essential for making cities more sustainable. It has its challenges, but if we do it right, it can help protect nature, boost the economy, and make cities stronger. We need to find a balance between what's good for individuals and what's good for everyone. Planning cities in a compact way can be cost-effective and better for the environment. In Kageshwori Manohara where more people are moving in, we really need to plan how

we build things carefully. This idea of denser cities is recognized worldwide because it helps save land, protect nature, reduce pollution, and create more housing. According to [7],policymakers are starting to focus on making housing denser to use land wisely and create diverse and vibrant cities.

Need of the study:

- Kageshwori Manohara is a swiftly growing urban center among the valley's 18 municipalities.
- Protecting open spaces and optimizing natural resources is crucial.
- Tackling sprawl and fringe development in the municipality is vital.

Importance of the Study:

- Identification of Area that needs to be promoted or discouraged.
- Regulating optimum density could help in resource optimization.
- To recommend concerned authority/organization conduct/invest in potential development area.

1.4 Scope and Limitation

This research primarily focuses on Kageshwori Manohara municipality, and the criteria used for spatial analysis are tailored to its specific context. However, it's worth noting that the insights gained from this study could potentially be valuable for similar regions facing similar challenges and sharing comparable characteristics. Therefore, while the analysis is context-specific, its findings and methodology could potentially have broader applicability to other areas with analogous conditions.

2. Conceptual Framework and Methodology

This research delves into the intricacies of urban development and population growth in Kageshwori Manohara, a rapidly expanding town. The study approach follows a pragmatic paradigm, emphasizing practical problem-solving within the context of urban densification.

The research paradigm selection considers three key factors: assumptions regarding reality and knowledge, theoretical frameworks, literature, and research practices, as well as ethical principles and value systems. This research adopts the Pragmatic paradigm, focusing on the application of research findings to address urban densification challenges effectively.

Ontological Position: Kageshwori Manohara has witnessed substantial, unplanned urban growth, primarily driven by an influx of people from neighboring areas seeking improved living conditions. This has resulted in the conversion of agricultural land into urban areas, depleting natural resources. Our study concentrates on the well-planned management of this growing population.

Epistemology: To gain insights into the area, this study employs comprehensive surveys, establish communication with key stakeholders, and utilize Geographic Information Systems (GIS) to analyze historical spatial patterns. These steps guide data gathering and knowledge acquisition.

Research Paradigm: This research aligns with the Pragmatic paradigm, emphasizing practical solutions and real-world problem-solving in the realm of urban densification. It aims to offer actionable recommendations that bridge the gap between theory and practice, addressing the actual challenges faced by Kageshwori Manohara Municipality. This paradigm prioritizes tangible enhancements in suitable space identification for densification practices, finding optimal density and urban development.

In summary, this research methodology combines the pragmatic paradigm with robust data collection and analysis techniques to effectively address space identification for urban densification practice and challenges in Kageshwori Manohara while maintaining originality and integrity in natural and social ecosystems.

Methodological approach

The main aim is to produce a suitable area map eligible for optimum density development and contribute to local level planning policy. This will be carried out with major steps such as

- Literature Review for Contextual study of applicable criteria for optimum density development.
- Data Collection in the form of primary or secondary to work in software for analysis of the quantitate and qualitative collected data.
- Spatial analysis using Raster Overlay for identification of most suitable raster which represents developable or non-developable area.

3. Literature Review

Urban densification is a way to create compact city development with optimum utilization of space and resources. Densification can be done where it is beforehand or after. The concentration of people inside the CBD, or the less density out the fringe area, both are not acceptable in terms of sustainability, resource optimization and durability. Densification observed through two variables: increase in population and increases in built up area which may not align overtime. Monitoring the divergence between built and occupational densification is crucial to understand urbanization dynamics. These indicators should be compared with variables like quality of life and economic development to assess the effectiveness of compact city/in-fill development policies implemented by cities and regions. [8].

To identify suitable area for compact settlement, there must be some suitability features and criteria that allows

for an easy and economical development practice. It is also important to note the pattern and hierarchy of settlements that people are willing to adopt. From the historic to modern era, it is found that humans are social animals which form society and groups to live together sharing and caring for each other. Modern urban areas are more engaged in-service industry rather than physical good production. Here industries are located far away from the settlements and working area. The main concept is to optimum use of space and resource which can be done through proximity design of space within a walkable distance or less time consuming.

Urban growth follows some theoretical patterns such as Sector Model, Concentric Model and Axial Growth model based on the natural setting of human population, economy, socio-cultural aspects, and environment. These models are studied and observed in the case area while searching for the appropriate pattern of development. In Nepal, the developing area is mostly following Axial pattern. The axial growth model, developed around the same time as the sectoral growth model, proposes that urban development occurs primarily along the transportation lines leading out from the city center (Goodwill, 2018).

3.1Spatial Analysis using MCDM.

GIS-Based Spatial Analysis and Multiple-Criteria Decision Making (MCDA) is a way to use maps and data to help make smart decisions about places. [9]. It looks at things like where things are, what they're like, and how they're connected to each other. By using maps and numbers, it helps people decide what's best, considering many different things [3]. This is useful for picking the right spot for something or making choices about the environment or transportation. It also makes sure that people work together and understand why a decision was made.

3.2Criteria Development for Spatial Analysis.

Urban densification means making cities more crowded in a smart and sustainable way because cities are getting bigger, and land is limited. This involves things like using land efficiently, having good transportation, green spaces, and friendly places to walk. It also means making sure everyone can easily access things like healthcare and education, and that cities are safe from natural disasters. Densification plans should be based on factors like making areas more compact, having green spaces, good transportation, and promoting parks and sports areas. These are some heading the for criteria development.

Selecting the right criteria is essential when identifying suitable areas for urban expansion. These criteria depend on factors like geography, climate, and human preferences. The specific choice of criteria should match the location and available data. In general, criteria can be grouped into four categories: accessibility, physical characteristics, socioeconomic factors, and environmental considerations. For residential development, typical criteria include proximity to roads, land use, distance from rivers, slope, and population density[10].

Different studies adopt various criteria depending on their research focus and location. It's important that these criteria align with the specific context. For example, when assessing suitability for urban development in Bajura district, Nepal, factors like slope rating, land cover, elevation rating, drainage, and geological conditions are considered [11]. Likewise, a study in Shaanxi Province, China, looked at criteria such as slope, demographics, infrastructure proximity, and buffer zones from rivers and roads to identify suitable areas for settlements [12]. These diverse approaches can help determine appropriate criteria for urban densification. Moreover, criteria can be categorized into two groups of constraints and development factors.

Development factors can be proximity to transportation, health, education, water supply, market centers and administration whereas constraints can be Forest and conserved area, river, and water bodies, site slope and other constraints.

3.3Desired Density of a City.

Urban areas have their own unique approaches to development and population density. There's no global standard, but it's important for each place to find an optimal density that balances economic growth, infrastructure, and environmental sustainability. This research explores how different cities worldwide have determined suitable population densities based on their available resources and development goals.

Globally it is found that cities around the world hold varied population densities based on their planning and development policy or it could be the natural growth of people. According to (Philippine Statics Authority,2023). Manila, Philippines has the largest population density of more than 42,857 person per sq.km Many south Asian country has their gross density of around 500 Person per sq.km, while the net density of core urban area exceeds 20000 persons per sq.km (World Population Review,2023)

In India, many development plans have adopted a density of around 400-500 PPHa. Despite this, the Housing Plan for Low-income group includes 500 DU per hectare which is high and could be planned in minimum dwelling unit size and vertical expansion is required. For In Situ upgradation of slums, guidelines propose a maximum of 250 PPHa. [13].

In Nepal, some places are very crowded, like Kathmandu, while others, especially in the countryside, are less crowded because of the tough terrain. On

average, there are about 204 people living in each square kilometer in Nepal as of 2021. Kathmandu is the most crowded, with around 5,169 people in each square kilometer, while places like Manang have only 2.51 people in the same space. Some other cities, like Bhaktapur, Pokhara, and Biratnagar, are also moderately crowded, and some areas might be even more crowded.

In 2021, Kathmandu had about 9.1% of Nepal's population, and it's getting even more crowded by 2035, with a projected population density of 367 people per hectare. Across Nepal, cities and towns are becoming more densely populated, with most places expected to have over 100 people per hectare. This shows a trend toward more concentrated urban living.
A report by JICA sets guidelines for urban planning, suggesting a gross population density of 300 people per hectare and a net density of 600 people per hectare to manage urban growth. Within Kathmandu's Ring Road, the central core will be very crowded with around 1000 people per hectare, while the surrounding areas will be a bit less crowded at 600 people per hectare.

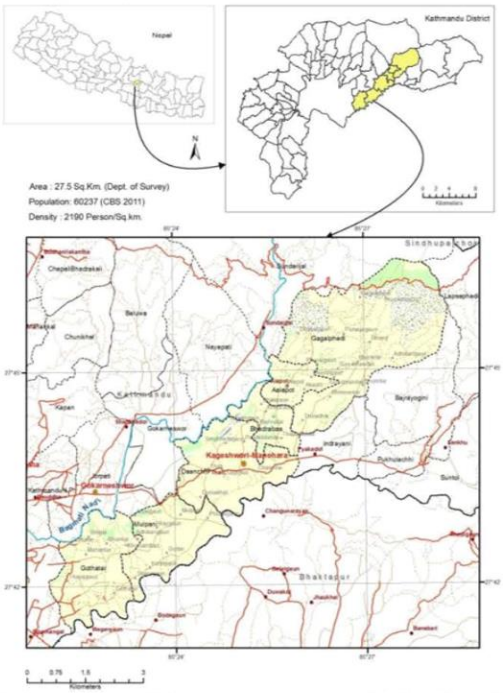
The KVDA Development Plan of 2020 has introduced a target population density of 300 people per hectare (PPHa) to guide urban growth [14]. Specific areas exhibit various population densities, such as Kuleshwor with 159 PPHA and Gongabu with 143 PPHA [15].The LTDP 2002 recommends a population density of 300 PPHA, with an optimal density of 500 PPHA to balance resident needs and urban sustainability[6]. Harsiddhi Town Development Program is designed with a population density of 210 PPHA. KVDA data from 2020 presents different densities across ward, like Ward 24 with 442 PPHA and Ward 8 with 75 PPHA. Bhaktapur Metropolitan's Ward 9 has a notably high population density of 1039 PPHA, while Ward 17 has 72 PPHA. Madhyapur Thimi shows a density of 76 PPHA. Kritipur's Ward 10 stands out with 919 PPHA, while Ward 19 has a lower density of 12 PPHA. This data pattern underscores the diversity of urban planning approaches and population density trends It emphasizes the importance of balanced strategies to accommodate varying degrees of urbanization while considering livability and sustainable development[14].

Nepal's urban development strategies revolve around sustainable, balanced growth. The 2007 National Urban Policy (NUP) prioritizes densification and local involvement. The 2017 Nepal Urban Development Strategy (NUDS) outlines a 15-year plan focusing on infrastructure and finance. The 2015 Planning Norms and Standards simplify urban development planning. The Land Use Policy of 2015 safeguards land use. The 2019 Land Use Act empowers government intervention. Nepal actively supports SDG 11 for sustainable cities. The Kathmandu Valley Development Authority (KVDA) addresses urbanization challenges, striving for sustainable growth. The "2035 A.D. Scenario of Kathmandu Valley" envisions urban forests, greenery, and cultural preservation. Nepal's urban policies prioritize sustainability, balance, and infrastructure while aligning with global goals.

4.Study Area

Kageshwori Manohara Municipality is a recently established municipality in the Kathmandu Valley, situated in the Bagmati Province of Nepal. It shares borders with Gokarneshwor Municipality to the west, Sindhupalchowk District to the north, Shankharapur Municipality and Bhaktapur District to the east, and Kathmandu Metropolitan City to the south. The municipality was formed by merging six former VDCs (Gothatar, Mulpani, Danchhi, Bhadrawas, Alapot, and Gagalphedi) in December 2014, covering an area of 27.364 sq.km. It is divided into nine wards, with its administrative center located in Danchhi, Ward-5.

Geographically, Kageshwori Manohara connects



Kathmandu and Bhaktapur and has road links through Bagmati Corridor, Jadibuti, Chabahil, and Bode. It also

Figure 1 Location Map of Kageshwori Manohara Municipality

shares its boundary with Tribhuvan International Airport. The municipality is home to religious sites like Kageshwori Mahadev Temple and Sali Nadi. It also attracts tourists with places like Gokarna Forest Resort

and the ongoing construction of an International Cricket Stadium in Ward-6.

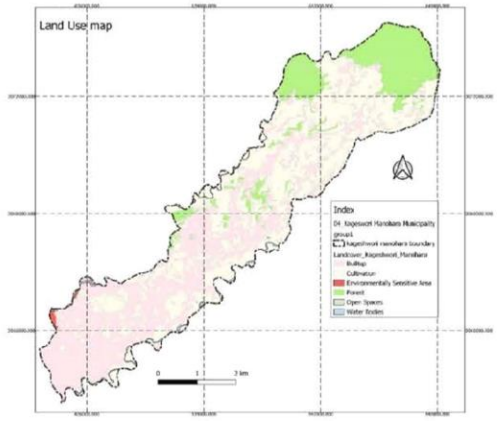


Figure 2 Landcover Map

The municipality is rich in natural resources and a green environment. Shivpuri Forest and Gokarna Forest area contribute natural greenery to the municipality. The large flat agricultural area is cultivated through natural streams and mainly by Bagmati and Manohara River. These assets also do provide mines and minerals with them. The municipality has large stream water sources which are drinkable. The north Ground water Zone also lies in this region, where water gets stored in natural form.

5. Analysis and Findings

Existing Urban Expansion and Pattern

Kageshwori Manohara Municipality is growing at a faster rate for human settlements and market area. The market area has been developed in old chowks(nodes) in many parts of the municipality. Ribbon development is seen along the roadside of the maximum area. Infrastructure development is also seen along the different road hierarchy connecting to the major roads. It is found that the municipality has a road network connected to every part of the site. The development is seen wherever there is presence of road. Despite the quality of roads, people are attracted towards the road for either residential or commercial purposes. The settlement along the road is mixed type housing supporting local business and housing demand at the same time.

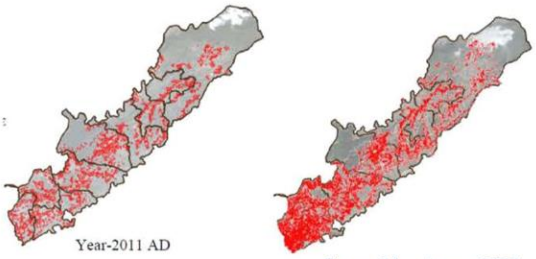
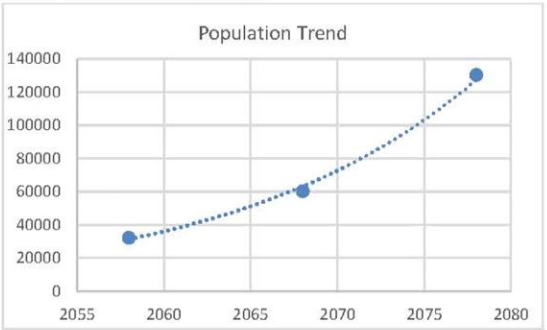


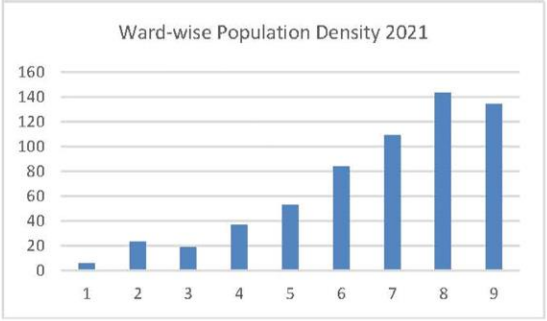
Figure 3 Landcover 2021

In a decade there has been a lot of change in landcovers from open to build areas from 2011 to 2021. Along with growth in population there is a vast increase in built up area for residential and commercial purposes. Similarly, strip/ribbon development patterns can be witnessed along the major roads as well as urban roads. There is loss in Agricultural Land and open space. Population is increasing rapidly such that there is less density at the cost of loss of more precious lands.

5.1 Population Growth and Distribution.

In the 2078 B.S. census, Kageshwori Manohara Municipality had a total population of 130,433, accounting for 4.44% of the Kathmandu Valley's population. Kathmandu Metropolitan City had the highest share at 29.35%, while Dakshinkali contributed the least at 0.89%. The municipality saw the highest population growth from 2068 to 2078 among all 18 local bodies in the valley, mainly due to internal migration. The population in Kageshwori Manohara doubled each decade from 2058 to 2078.





Despite Ward 9 having a large population, Ward 8 had the highest population density at 143.4 people per hectare (PPHA), while Ward 1 had the lowest density at 6.31 PPHA. Ward 9 had the second-highest density, followed by Wards 7, 6, 5, and 4.

The municipality's population distribution reflects a mix of urban and rural settlements typical of the Kathmandu Valley. Urban areas have higher population densities, especially around economic centers, transport hubs, and government facilities. The outskirts have a more dispersed population due to agriculture and traditional livelihoods. Population density decreases from the

southern to the northern part, where forested hills limit human settlement due to land suitability and infrastructure constraints.

5.2 Migration trend

Migration significantly impacts a city's social, economic, and political landscape, requiring a balance between locals and newcomers for sustainable development. In Kageshwori Manohara Municipality, data from 2019 households reveals that 69.4% have moved there. Between April 2073 and November 2076, 3,658 individuals migrated in while 406 left. For every person leaving, nine others chose to settle here. The influx of people from various Nepali districts drives population growth, primarily due to better economic prospects. Migration stages often involve moving from larger cities like Kathmandu to suburban areas with cheaper housing. About 18.9% of households had absent members, with 30% pursuing higher education and 70% seeking foreign employment. This migration trend emphasizes inter-municipal and rural-urban migration, especially in wards close to Kathmandu, indicating ongoing urbanization and potential for more migration.

5.3 Existing Land use and change

Land use in Kageshwori Manohara Municipality has undergone significant changes due to urbanization and growth. The municipality, closely linked to Kathmandu, has attracted people seeking comfortable housing and a peaceful environment. Presently, out of the municipality's 2,735.42 hectares, 34.43% is built-up, 46.94% is cultivated land, and 11.28% is protected area under Shivpuri National Park.[16]

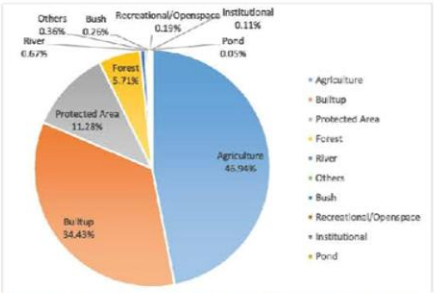


Figure 4 Existing Land use Chart (Source: IUDP 2018, NEST)

Analysis of land use change focuses on the expansion of the built-up area since 1990. Rural-urban migration, driven by economic opportunities and push factors from rural regions, has led to rapid urbanization. From 1990 to 2018, the built-up area increased 26 times, while agricultural land decreased significantly, dropping from 80% to 47% of the total area.

This shift highlights the municipality's transformation from predominantly rural to urban, with significant implications for its landscape and development.

5.4 Land and housing

Housing provision in Nepal involves informal private, public, organized private, and institutional sectors, with limited development in the formal private housing sector. The government focuses on three housing models: Site and Services, Guided Land Development, and Land Pooling. Twelve land pooling projects have been completed, and ten are ongoing in partnership with private landowners (JICA, 2017).

In Kathmandu Valley, the shift from ownership to renting is noticeable, with owner households declining from 62.5% to 48.1%, and rental households increasing from 33.1% to 49.5% between 2004 and 2010/11 (CBS 2004, CBS 2010). The average dwelling size is 555 sq. ft, and housing plots average 1223.7 sq. ft (NLSS 2010). Kageshwori Manohara Municipality, an extension of Kathmandu, primarily relies on the informal private sector for housing, with some input from the formal private sector. Sixteen private sector projects, covering 27.05 hectares, provide around 2751 units, mainly in Gothatar and Mulpani. Land development projects are concentrated in wards 9, 8, 7, and 6, with emerging land pooling initiatives in rural wards like 1 and 3. Government intervention involves land pooling schemes, encouraging private sector participation .[16]

5.5 Population Projection and Housing Demand

For housing demand calculation, we'll need to consider population projections for specific years, such as 2078, 2088, and 2098. Additional population growth is anticipated for 2088 and 2098. We'll also need to account for various factors like minimum lot size area, maximum coverage (65%), floor area (FAR=3), and the number of tenants per house (20 sq.m per person).

First gathering population data for different years, such as 2078 (130,433), 2088 (301,845), and 2098 (734,487). Calculating additional population growth for 2088 (171,412) and 2098 (432,642). Considering the minimum lot size area (143.08 sq.m per house), maximum coverage (65%), floor area ratio (FAR=3), and the number of tenants per house (20 sq.m per person). Calculating the number of houses needed for each year: 2088: 7986.77 houses 2098: 20,158.51 houses Determining additional development areas required for 2088 (114.27 hectares) and 2098 (288.43 hectares). To maintain a desirable population density of 300 people per hectare, we need calculate the area needed for future populations: For 2088: 171,412 / 300 = 571.37 hectares for 2098: 432,642 / 300 = 1,443 hectares. Looking at the situation, if these rational calculations claim for more built-up area, the target density could reach 500 person per hectare. These calculations aim to strike a balance between accommodating population growth and maintaining a sustainable and manageable density, considering the policies and plans of the government and local authorities.

5.6 Final criteria for dense settlement Development

To identify the suitable area for dense settlements, it is

important to finalize the criteria that is relevant to site and context. These parameters should be determined from various spatial, non-spatial, qualitative, and quantitative data. These criteria will guide where the suitability of urban dense settlement can be prioritized. First relevant data is collected, and maps are generated based on the information collected. The data is divided into two major parts such as restriction and development factors.

The restricted factors restrict the development, and the development factors are further analyzed deeply for the suitability with degree of suitability with respect to others. The parameters and criteria are developed from the study of various literature studies. The criteria are then expressed and consulted with academicians, experts' governmental bodies, related individuals, and stakeholders. With some addition and subtraction in criteria, A list of final criteria for study is made and detailed out. Before injecting the criteria, it is important to mention the governing planning criteria from government and experts, The planning criteria are derived and discussed from literature part of this report. The frame in which criteria would remain at are listed below:

- Dense and Compact Area.
- Promoting clean Urban Greenery and Forest.
- Effective connectivity for all. (Transportation, communication)
- Easy access to basic health and education for all.
- Geographically, naturally, safe from disasters and Hazards.
- Promoting open parks, recreational area, Sports arena etc.

The core criteria were derived from a mix of literature, expert interviews, and professional input. Suitability ranges for these criteria were determined using sources like (Rushemuka, 2020)[17], (Guragain & Bajracharya, 2022)[10], (Pokhrel et al., 2018)[18], and (Rashid, 2021)[19].To ensure consistency, all maps were adjusted to have uniform pixel values during GIS analysis, allowing for a standardized scale. After processing and layer overlay, pixel values were combined, ranging from 5 (high suitability) to 1(restricted suitability).

Analysis Criteria selected are:

Constraints factors: Site Slope, Conserved Forest, Conserved Water Sources and Rivers, Landslide and Soil erosion Area and Flooding area.

Development Factors: Proximity to Major Roads, Water Supply, Sanitation, Electricity, Telecommunications, Public Administration, Health Services, Education and Market Centers.

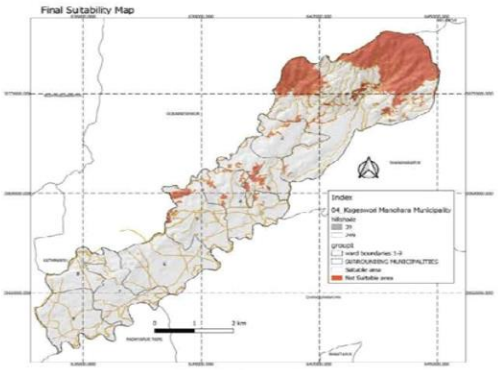
Scoring based of Constraints and Development Factors

	CRITERIA	SUITABILITY				
		HIGH=1	MODERATE=2	Low=3	VERY LOW=4	RESTRICTED=5
1	Roadway Proximity	0-250	251-500	501-750	751-1000	>1000
2	Water Supply	0-250	251-500	501-750	751-1000	>1000
3	Electricity Line	0-250	251-500	501-750	751-1000	>1000
4	Network /telecom	0-250	251-500	501-750	751-1000	>1000
5	Health Post	0-500	501-1000	1001-1500	1501-2000	2001-2500
6	Hospital	0-700	701-1400	1401-2100	2101-2800	>2800
7	Primary School	0-200	201-400	401-600	601-800	>800
8	Secondary School	0-500	501-1000	1001-1500	1501-2000	>2000
9	College/University	0-2000	2000-4000	4000-8000	8000-10000	>10000
10	Administrations	0-500	501-1000	1001-1500	1501-2000	>2000
11	Market centers/ BFI	0-2000	2000-4000	4000-8000	8000-10000	>10000
13	forest/Green	Restricted				
14	Water Bodies	Restricted				
15	Slope	Slope less than 30 degree: Suitable			Slope >30 degree: Restricted	
16	Soil erosion	Restricted				
17	Fault Line	Restricted				

Suitability Score Table

5.7 Final Constraints Map based on Suitability Score.

The constraints such as Site Slope, Conserved Forest, Conserved Water Sources and Rivers, Landslide and Soil erosion Area, Flooding areas data is collected and put into frame of maps. All the constraints layers are overlaid in maps to get the final suitability maps which are constraints free.



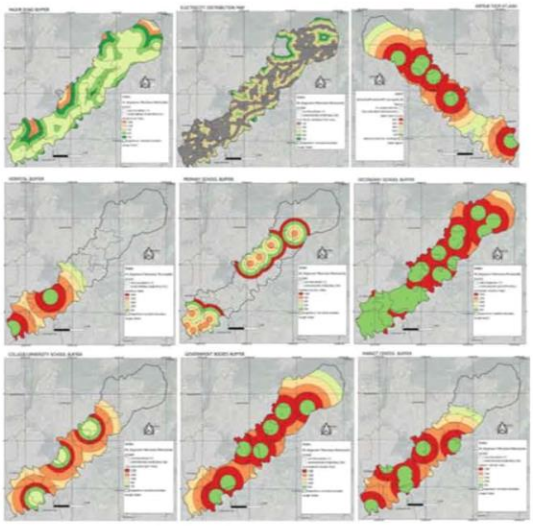
Final constraint Suitability Map

Area	Sq.km	Percent
Suitable Area	20.59	75.22560374
Not Suitable Area	6.781	24.77439626
Total	27.371	100

5.8 Maps for Development factors using the scores,

Individual maps are created based on the criteria scoring, converting them into raster format. These maps are then prepared for the final weighted overlay process, where multiple raster layers are combined to pinpoint the most suitable areas that should take priority for development.

Since economic and sustainable development is crucial for developing nation like Nepal, this scoring can add up the priority area to taken into consideration for development.



Above are the individual development factor maps based on proximity and the score provided to them.

5.9 Final Suitability Map

The ultimate suitability map is the result of an intricate procedure that amalgamates multiple distinct maps, each focusing on different aspect of suitability like slope and proximity to services like road services. Utilizing Geographic Information System (GIS) technology, these individual maps are harmoniously integrated, giving equal weight to every criterion to ensure an equitable assessment. To facilitate a fair comparison, all values across diverse criteria have been standardized to a consistent scale.

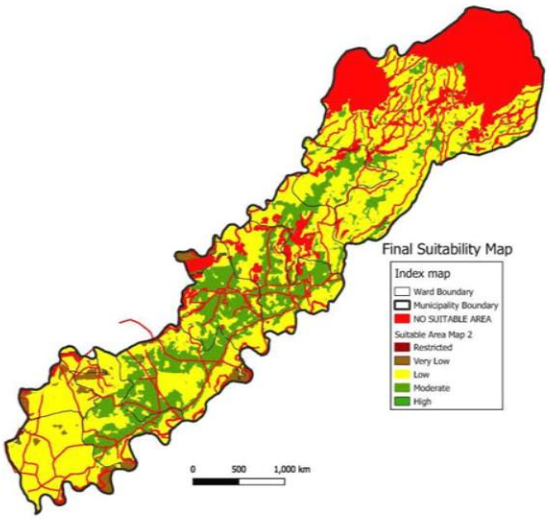


Figure 5 Final Suitability Map

POINTS	SUITABILITY	AREA(Sq.km)	PERCENTAGE
Less Than 3	Restricted	6.23	22.65
3 to 4	Very Low	1.3	4.72
4 to 5	Low	9.43	34.29
5 to 6	Moderate	10.29	37.41
6 to 8	High	0.25	0.90
	Total	**27.38**	**100**

Less than 1% highly suitable area in wards 4, 5, and 6 for dense settlements. Moderately suitable (9.43 sq.km) in Danchi, Mulpani, and Gothatar, already in development with infrastructure. Low suitability (9.43 sq.km) in wards 1, 2, 8, and 9, with varying population density and infrastructure. Very low suitability (1.3 sq.km), about 4% of the total area, mainly comprising protected forests and ecologically vital zones. Approximately 6.23 sq.km restricted for residential development due to ecological importance.

6. Discussion and Conclusion

In the pursuit of identifying ideal areas for urban densification in Kageshwori Manohara Municipality, various criteria were considered. Initially, constraints like water bodies, slopes, and conserved areas were identified, while development factors were assessed. It's evident that areas near main highways and major roads are more suitable due to their resource accessibility. Proximity to roads, utilities, education, healthcare, and markets is attractive to residents, making these areas a priority for habitation.

Given the substantial changes in land cover due to population growth, pinpointing suitable spaces becomes crucial to minimize development costs and reduce disaster risks. A significant portion of land is identified as suitable for urban expansion to meet the rising population's housing needs. Over the next decade, approximately 571 hectares will be needed to maintain the desired population density, followed by an additional 1,400 hectares in the second decade. Proper planning is imperative to avoid sprawl-related issues.

The study aims to find suitable areas across different wards based on infrastructure, targeting an optimal density of 300 people per hectare. This density encourages low-rise, medium density planning with ample open spaces and urban forests, creating a balance between development and ecology.

Challenges arise even after identifying suitable areas. It's a citizen's right to live anywhere, making it crucial for the government to educate and involve citizens in planned development to mitigate hazards and risks.

Encouraging proper planning through policies that promote compact settlements and discourage isolated ones is essential. GIS technology has significantly facilitated this study, offering precise and flexible assessment techniques. This analysis has the potential to guide sustainable urban expansion in Kageshwori

Manohara Municipality, aiding urban planners and policymakers in decision-making. It monitors urban land development, highlighting the need to align government regulations with market dynamics for effective land management.

7. Policy Intervention and Recommendation

This study explores various criteria to identify the most suitable areas for urban development in Kageshwori Manohara Municipality. It underscores the critical importance of thoughtful space selection, considering factors like water bodies and terrain steepness to minimize unnecessary costs and potential risks. The Municipal policies are a roadmap for shaping the growth of Kageshwori Manohara in a positive direction. They encompass various strategies to ensure the city expands thoughtfully. For instance, there are guidelines dictating where different types of buildings can be constructed, encouraging a mix of businesses, homes, and services in the same area. Additionally, there are incentives in place to encourage developers to build more homes and buildings in smaller spaces, making the city more densely populated.

Furthermore, these policies introduce methods like Transfer of Development Rights (TDR), which allow people to move their building rights from less suitable areas to better-suited spots. They aim to involve and educate the local community, explaining why it's crucial to build in specific zones.

The plans also focus on providing essential facilities like roads, schools, and parks in areas where more people live, improving the quality of life for residents. Ensuring affordable housing for everyone is a priority, and these policies are designed to monitor how well they work and adjust if necessary to ensure the city grows sustainably and equitably.

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