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Status of Land use Land cover Change and its Causes at Hemja, Pokhara Metropolitan City, Nepal

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Abstract

The terms "land use" and "land cover" pertain to two related ideas about how the earth's surface is covered. While land use refers to the socioeconomic framework and purpose that enable human activity on the land. Land cover refers to the natural or ecological state of the land. Since land is a valuable and limited resource, knowledge of changes in land cover and use is crucial for determining how human activity affects the ecosystem. This study examined the state of land cover change and land use at Hemja, a location within the Pokhara Metropolitan City, over a 20-year period. Direct observation, topographic map verification, surveys, focus group discussions, and interviews were the methods used to gather primary data. Through a variety of governmental and non-governmental sources, secondary data were gathered. The results of the study were obtained by statistical and geographical analysis of this data. The conversion of agricultural, woodland, bush, and sandy areas into built-up areas was one of the study area's most noticeable changes. Various issues related to infrastructure, economy, and demography have been proposed as the reasons behind this shift in the study area across the historical period. Additional research micro level could be useful in examining the specific effects of the causes and estimating the potential effects of such changes in land use and land cover.

Keywords: *Land use land cover, environment, accessibility, economic opportunity.*

Introduction

Land cover refers to the natural and man-made layers of flora, water, bare soil, and human constructions that cover the surface of the world (Ellis, 2007). The

social and economic goals and procedures that direct land management are another way to define land use (Poudel, 2008). Despite the frequent confusion between the words, there is a discernible difference between land use and land cover. Although remote sensing, which shows the spatial distribution of various land cover types on the surface of the Earth, can be used to precisely determine land cover, agricultural activities and its transformations require the inclusion of both natural and social processes in order to define human activities. It can even be found as a land cover in several parts of the nation (Lambin et al., 2001).

According to Vitousek (1997), land cover change is thought to be the single most significant factor influencing ecological systems globally, having an effect on the environment that is at least as great as that of climate change. It is especially connected to population growth and intensive farming (Awasthi et al., 2002). An even more significant and ostensibly readily quantifiable indication for sustainable management of natural resources is the shift in the forest cover. The world's forests are changing, both positively and negatively, in terms of quantity and quality (FAO, 2000). Social, economic, and environmental elements are involved in this process. In general, the conversion of forest cover has detrimental long-term effects on the ecosystem and socioeconomics both locally and worldwide. These effects include habitat fragmentation, global climate change, and land degradation, species extinction and so on. Even more susceptible to forest conversion are mountainous nations like Nepal, where hills and mountains make approximately 86% of the entire land area. Despite the importance of these crucial environmental factors, there hasn't been much research done in Nepal on the dynamics of land cover and the impact of geomorphometric features on watershed quality (Awasthi et al., 2002). Between 1978-1979 and 1994, the area covered by forests and shrubs dropped at an annual rate of 0.5%, whilst the country's overall forest area declined at a 1.7% annual rate (Parajuli, 2005). High rates of deforestation within a country are most often linked to poverty and population growth. Population growth increases the demand for resources such as fuel, water, food, lumber, and other requirements, which puts a heavy burden on the environment (Phong, 2004). In spite of these issues, Nepal was among the first developing nations to launch innovative programs for managing forests that included local populations (Agrawal and Ostrom, 2001).

Resources on land are scarce and limited. In roughly 60 years, there will be twice as many people on the planet if human population growth continues at its current rate. In order to maximize sustainable production and meet the many requirements of society while also protecting delicate ecosystems and our genetic heritage, it is consequently becoming more and more important to match land types and land uses in the most sensible way (FAO/UNDP, 2003).

Bhusal (2010) conducted a study on the changes in land use and land cover in Madhyapur Thimi Municipality between 1978 and 2008. The findings indicate a decline in agricultural land due to the expansion of built-up areas. The significant increase in built-up areas highlights the need for effective regulations related to land management. To prevent the uncontrolled growth of built-up areas and mitigate the adverse effects of land use changes, the researcher suggested the proper enforcement of land use policies and revisions to the existing laws and regulations. Similarly, Rimal (2010) observed rapid changes in land use within Kathmandu Metropolis due to urbanization. Population pressure has led to the conversion of agricultural land and open spaces into urban areas. The study effectively utilized remote sensing satellite data from 1976 to 2009 to analyze land use changes, providing valuable insights.

Koirala (2010) examined land use changes, urban growth, and their environmental impact in Banepa Municipality, Kavrepalanchok. He emphasized the importance of formulating an effective land use policy based on a thorough analysis of historical land use changes. Understanding these changes at different intervals is crucial for developing a sound land use planning policy. He also highlighted the need for more precise studies of land use changes at shorter intervals, such as every five years, due to the limitations and accuracy of available land use data.

Poudel (2003) used GIS tools and techniques to study spatial and temporal changes over a 22-year period. His research found that although cultivated land remained the predominant land use, it saw a slight decline of 5.26%. In contrast, forested areas, representing greenbelts, increased by 3.94%. Urban land uses, such as transportation, commercial-residential, institutional, and residential areas, grew significantly, with increases of 267.57%, 249.33%, 128.90%, and 150.18%, respectively. There was a sharp decline in open spaces by 90.03%, while water bodies and sandy areas expanded by 22.80%. These shifts highlight significant land use changes in Lekhanath Municipality, influenced by factors such as the Prithivi Highway, improved urban amenities, and rural-to-urban migration.

Similarly, Rimal (2011) explored urban growth and changes in land use and land cover in Pokhara Sub-Metropolitan City, Nepal. The study showed a notable expansion in urban areas, largely due to increased urban accessibility. Over the past five decades, Pokhara's population has grown 41.62 times (1952/54-2001), leading to rapid land use changes.

Land use involves a wide range of human, natural, and physical activities, including residential, industrial, commercial, and recreational uses. All types of development have environmental impacts, with the extent of these impacts depending on the nature of the use, development intensity, and the physical characteristics of the

site. In developed countries, urban areas are intensively used, while non-commercial activities are typically located on the outskirts. In developing countries like Nepal, agricultural activities are still common in urban centers, making the urban economy heavily dependent on agriculture. However, urban land use patterns in Nepal's towns are changing rapidly, posing a significant challenge due to the lack of planned urban development.

Rapid and unplanned urbanization, seen both globally and in Nepal, is influenced by various factors, including geographic location, population growth, access to public services, economic opportunities, government policies, land markets, globalization, tourism, and political activities. In Nepal, this rapid urban expansion is evident in cities and nearby semi-urban areas, where people migrate from rural regions in search of better opportunities, education, and living conditions. Government policies and urban categorization (urban, metropolis, sub-metropolis, rural) also play a role in the distribution of resources and population movement. This process results in significant changes in land use and land cover, with numerous ecological, physical, and socio-economic implications.

For example, agricultural expansion can help meet the food demands of a growing population, but converting natural vegetation into agricultural land and settlements can alter the environment, causing increases in temperature, decreases in air quality, and reduced soil water retention. Hemja, for instance, has experienced considerable development, with new buildings, roads, and market centers, leading to increased land consumption and changes in land use over time. The rising population in Hemja, driven by migration from rural areas, highlights the need for comprehensive studies on land use and land cover changes to develop effective land use planning and management policies.

This study aims to fill the gap in understanding the dynamics of urbanization and agricultural land use, along with their causes and impacts, to support the development of effective policies and management plans. The main objective is to assess current land use and land cover patterns and identify the potential causes of these changes.

Materials and Methods

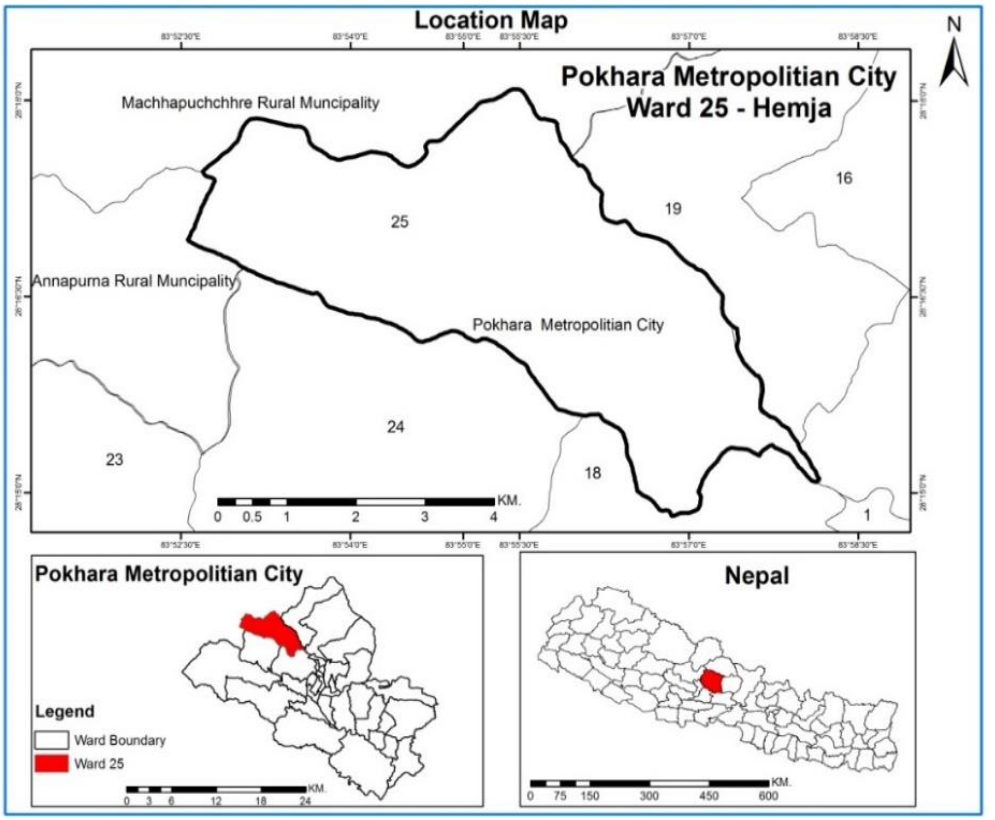
Study Area

Pokhara Metropolitan City is situated in the Kaski district of Gandaki province, which is situated on the lap of the Annapurna range. The main part of the metropolis is located in the south of the Kaski district. Hemja, the study area

comprising ward No. 25 of Pokhara Metropolitan City (Figure 1). The study area is surrounded by Lumle in the west; Dhital in the north; and Kaskikot in the south.

Figure 1

Location Map of Study Area of Hemja in Pokhara Metropolitan City



The study area is bordered by Yamdi Khola in the south and the Seti River forms the Eastern border of Hemja. The absolute location of the study area is between 83^0 52' 48" and 83^0 58'18" east longitude and 28^0 14' 48" and 28^0 18' 05" north latitude. The average east-west breadth is about 8 km and north to south length is about 10.78 km. The elevation ranges from 950 m to 1786 m above the mean sea level. Hemja has a unique physical feature mostly has flat to gently slope from West to East. It has gravel deposition by Seti River and Yamdi Khola. Other notable features include the sub-tropical climatic zone covering both urban and rural sectors. The surface composition includes soil, sand, salty, muddy, and loam. The population is largely Hindu, with some Tibetan refugees. The ethnic composition is Brahmin, Chhetri, Dalit, and Janajati. The total population has been recorded as 12,262 consisting of 6,620 females and 5,633 males (SO Kaski, 2074 B.S.).

Source of Data

This study utilizes both primary and secondary data sources. Primary data were gathered through household surveys, field observations using GPS, field verification of topographic maps, focus group discussions, and interviews with knowledgeable local individuals. Out of the 625 households situated linearly along the Baglung Highway and extending from Tibetan Camp to Jay Buddha Oil Store, from Milan Chowk to Gaurishankar Secondary School, and from Milan Chowk northwards to Dhital Astham Road, a purposive sampling method was employed to select 20% of these households for the study. Efforts were made to understand the environmental impacts of land use and land cover changes over the past two decades through group discussions and key informant interviews with community leaders, professionals, farmers, employees, and teachers. Additionally, secondary data were collected from topographical maps, a 1998 satellite image, and a 2019 Google satellite image. Socio-economic data were obtained from the 2011 Nepal population census, the Pokhara Metropolitan Profile, and various government records.

Data from both primary and secondary sources were organized into standardized formats, including tables and figures. Statistical analyses were conducted using MS Excel, and spatial data were processed using various GIS software tools. Based on field verification, visual interpretation of satellite imagery, and topographic maps, the study identified different land use categories such as agricultural land with settlements, barren land, shrubland, forest area, built-up areas, grassland, sandy areas, and water bodies for classification purposes within the study area.

Findings and Discussion

Status of Land use Land cover of 1998 and 2019 and its change

Based on a 1996 aerial photo released in 1:50000 scale by the Topographical Survey Branch of Nepalese government and field verification in 1998, the land use and land cover pattern of Hemja in 1998 has been evaluated. In a similar vein, the 2019 land use and land cover map has been examined using Arc GIS 10.3 and field verification using the Google Earth Pro Image. In this area, there are primarily eight types of land cover and land use. These include populated agricultural areas, forested areas, marshlands, water features, sandy areas, built-up areas, grasslands, and barren areas.

Table 1

Land Use and Land Cover Change 1998 and 2019

LULC types	1998, Area (sq.km.)	Percent	2019, Area (sq.km.)	Percent	Change Area (sq.km.)	Change Percent
Agriculture land	10.521	46.862	8.902	39.647	-1.62	-15.39
Barren land	0.01	0.045	0.055	0.244	0.05	450.00
Built up area	0.183	0.815	1.751	7.791	1.57	856.83
Bush area	0.629	2.802	0.527	2.347	-0.10	-16.22
Forest area	10.114	45.049	10.310	45.918	0.20	1.94
Grass land	0.029	0.129	0.019	0.084	-0.01	-34.48
Sandy	0.348	1.550	0.309	1.376	-0.04	-11.21
Water bodies	0.617	2.748	0.580	2.583	-0.04	-6.00
Total	22.451	100	22.451	100	0.00	100

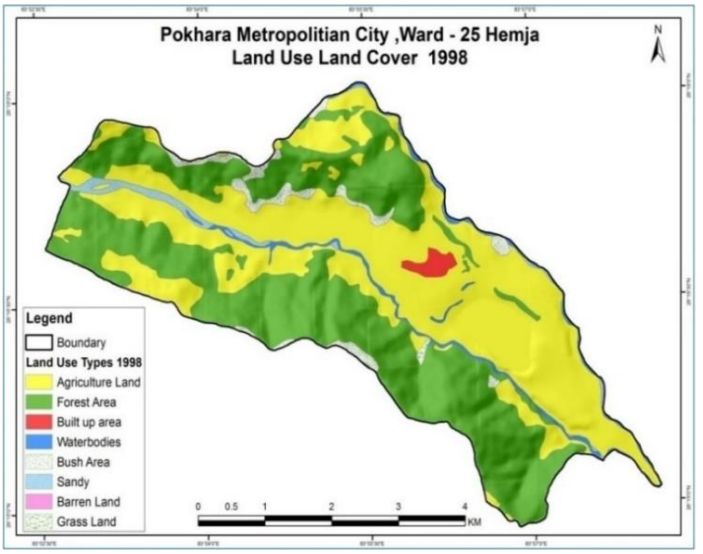
Source: *Topographical map published by survey department of Nepal (1998), Google Earth pro Image (2019).*

The total area of Hemja is 22.451 sq.km. In 1998, table 1 shows 46.813 percent (10.521 sq.km) area is under agriculture with settlement. It is followed by forest land which is the second most dominant land use type in this area. It covers 45.049 percent (10.114 sq.km). These agriculture and forest area. has dominated the land use type at present. Similarly, bush area, water bodies, sandy area, built up area, grassland, barren land cover are 6.43, 2.74, 1.55, 0.815, 0.129 and 0.04 percent respectively. Likewise in 2019 Out of 22.451 sq. km of land 45.918 percent (10.312 sq.km) under forest area.

It is followed by agriculture with settlement which is the second most land use type in this area. It covers 39.647 percent (8.902 sq.km). The forest and agriculture area is still the most dominant land use type. Similarly, built up area, water bodies, bush area, sandy area, barren land and grassland, cover 7.79, 2.58, 2.34, 1.37, 2.24 and 0.084 percent respectively.

Figure 2

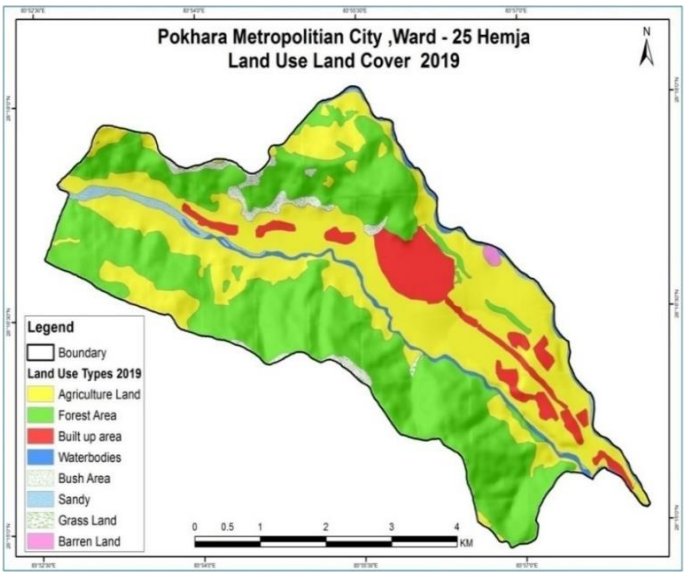
Land Use and Land Cover of 1998.. Source: Survey Dept, Topo Map of 1998.



The analysis of land use changes between 1998 and 2019 is presented in Table 1. This analysis is based on data from a 1998 topographic map and a 2019 Google satellite image. In 1998, agricultural land covered 46.862% of the area, which decreased to 39.647% in 2019, indicating a reduction of 1.62 sq. km. This decline is observed in regions such as Tallo Hemja, Upallo Hemja, Yamdi, Suinkhet, Basbot, and other lowland areas. The analysis of land use changes between 1998 and 2019 is presented in Table 1.

Figure 3

Land Use and Land Cover of 2019. Source: Google Earth pro Image, 2019.



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to 45.918% in 2019, an expansion of about 0.20 sq. km, notably in the Jhijirka and Shera areas of Hemja.

The built-up area saw significant growth, rising from 0.815% in 1998 to 7.791% in 2019, with a total increase of 1.57 sq. km. This expansion is primarily seen in the flat areas of Hemja, including Yamdi, Sapkotachowk, Suikhet, Milanchok, Mygditol, Basbot, and Suinkhet. Barren land also experienced a slight increase, growing from 0.04% in 1998 to 0.24% in 2019, amounting to an increase of 0.05 sq. km. The sandy area decreased from 1.55% in 1998 to 1.37% in 2019, a reduction of 0.04 sq. km. The analysis of land use changes between 1998 and 2019 is presented in Table 1, Figure 2, 3 & 4.

Figure 4

Land Use Land Cover Change analysis 1998-2019

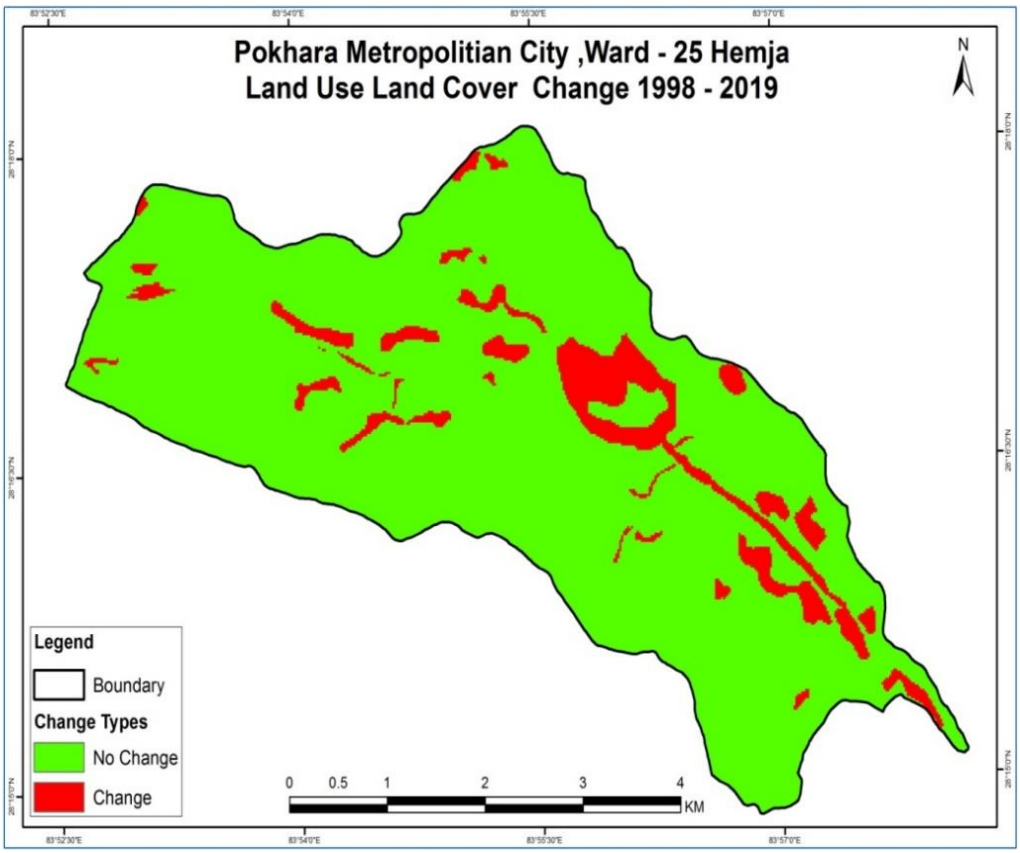

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Table 2

Land Use and Land Cover Change 1998-2019

LULC Types (From)	Change (To)	Change Area (Sqk.m)	Change Area (Hectare)	Percent
Agriculture Land	Agriculture Land	8.723	872.335	82.91
	Built up Area	1.563	156.275	14.85
	Bush Area	0.050	5.025	0.48
	Forest Area	0.173	17.284	1.64
	Sandy Area	0.012	1.186	0.11
	Waterbodies	0.000	0.026	0.00
Total		10.521	1052.132	100.00
Barren Land	Barren Land	0.012	1.165	100.00
Built up Area	Built up Area	0.184	18.378	100.00
Bush Area	Bush Area	0.479	47.881	76.04
	Barren Land	0.053	5.330	8.46
	Forest Area	0.098	9.754	15.49
Total		0.630	62.965	100.00

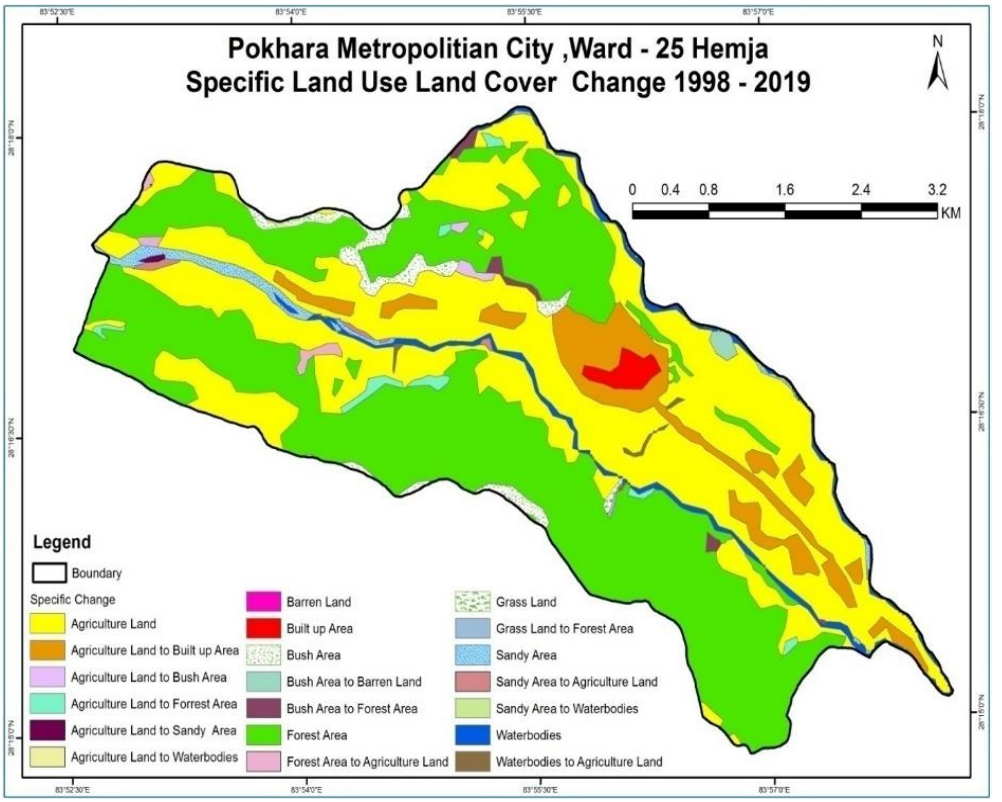
Forest Area	Forest Area	10.032	1002.864	99.18
	Agricultre Land	0.083	8.250	0.82
Total		10.114	1011.114	100.00
Grass Land	Grass Land	0.021	2.050	70.70
	Forest Area	0.008	0.850	29.30
Total		0.029	2.900	100.00
Sandy Area	Sandy Area	0.295	29.497	84.72
	Agriculture Land	0.052	5.201	14.94
	Waterbodies	0.001	0.120	0.34
Total		0.348	34.818	100.00
Waterbodies	Waterbodies	0.581	58.079	94.13
	Agriculture Land	0.036	3.621	5.87
Total		0.617	61.700	100.00

Source: *Topographical map published by survey department of Nepal (1998), Google Earth Pro Image (2019).*

Table 2 illustrates that 17.08% of agricultural land has been converted to other land uses, predominantly transitioning into built-up areas (14.85%), followed by a shift to forest land (1.64%), and minor changes to bush and sandy areas. The development of built-up areas is particularly noticeable in Yamdi, Tallo Hemja, and Mathillo Hemja. Meanwhile, 23.95% of bush land, equivalent to 0.098 sq. km, has been transformed into other land uses, with 15.49% being converted to forest and 8.46% to barren land. During the same period, forest land has experienced a minimal conversion to agricultural use, amounting to just 0.82%. Additionally, 29.30% of grassland has been converted to forest. Sandy areas have seen 15.28% converted to other land uses, with 14.94% transitioning to agricultural land and the remainder to water bodies. Water bodies themselves have been partially converted to agricultural land, accounting for 5.87% of the change.

Figure 5

Land Use and Land Cover of 2019. Source: Google Earth pro Image, 2019.



However, barren land and built-up areas have remained relatively unchanged during this period. The migration of people from higher elevations and other districts to the flatter regions of Hemja has contributed to this land use transformation. Following Hemja's incorporation into the Metropolitan City, areas along the Baglung Highway, including Yamdi, Milanchok, and Sapkota Chowk, have seen significant development and expansion of built-up areas.

Causes of Land Use and Land Cover Change

Several factors can be considered responsible for the land use and land cover changes that have taken place in Hemja over the years. Rapid population growth, along with urbanization and industrialization, has led to the expansion of business centers, significantly altering the land use and cover in the area. Additionally, the influx of people from nearby rural regions, accompanied by rising incomes, has fueled urban expansion in Hemja. The primary drivers of these changes can be broadly categorized into three main types:

Demographic Causes of Land Cover Change

The rise in population, driven by the in-migration of individuals from remote regions, has resulted in the expansion of built-up areas. This urban growth has led to an increased need for road construction, further reducing agricultural land. Notably, this trend accelerated following the peace agreement signed between the then Maoist party and the Government of Nepal in 2006. The return of peace acted as a catalyst for development, prompting many displaced individuals, who had lost their homes and loved ones, to seek community and support in more populated areas. Consequently, many left their rural homes in favor of compact urban communities. While this shift is not solely due to urbanization, the lack of opportunities in their original locales has compelled people to move towards urban settings.

Economic Causes of Land Cover Change

Hemja, a rapidly expanding urban and commercial hub in Kaski district and Gandaki Province, has experienced significant growth, creating numerous employment and business opportunities. Its fertile, flat terrain makes it ideal for settlements, agriculture, and infrastructure development. As infrastructure improves, an increasing number of people from nearby areas are influx to Hemja, a trend mirrored in other parts of Pokhara. The availability of more services and facilities compared to rural areas also attracts migrants. However, as agriculture becomes less profitable, the economy is shifting towards service-based industries. This transformation leads to a rise in urbanized areas, reducing the emphasis on agriculture. Evidence of this can be seen in maps and tables that highlight the conversion of agricultural land into built-up and forested areas. Additionally, the decline in sandy regions reflects the growing demand for construction materials, as sand is being extracted for building purposes.

Infrastructural Causes of Land Cover Change

As a business hub, Hemja is home to small and cottage industries, offices, health centers, and educational institutions, offering more services and amenities than remote areas. This influx of people from rural areas has contributed to the expansion of built-up areas. One of the key drivers of land use and land cover change is the improvement of transportation. The Bhupi Sherchan Highway, which passes through Pokhara Metropolitan City, is the main route connecting Pokhara to Baglung and other districts in Gandaki Province. Upgrades to this highway have increased traffic through Hemja, boosting commerce. A similar trend occurred with the construction of the Madhya Pahadi Lokmarga in western Nepal, where the development of highways led to an expansion in urban areas. As a result, agricultural and forested lands are increasingly being converted into spaces for infrastructure. In addition to

transportation, other factors such as better access to education, healthcare, and services in Pokhara have also motivated migration and land use changes in Hemja. These factors collectively drive the transformation of land use and cover in the area.

Conclusions

Hemja, a rapidly developing locality within the expansive Pokhara Metropolitan City, has witnessed substantial transformations in land use and land cover, reflecting the broader urbanization trends seen in Nepal's growing cities. While certain pre-urbanized regions may display minimal changes over time, Hemja stands out as a prime example of dynamic shifts in land usage driven by a combination of factors. The most evident change in the area has been the conversion of natural landscapes and agricultural land, including forests, shrublands, and sandy areas, into zones meant for human habitation and other urban purposes. Several key factors contribute to this transformation. Demographic growth, alongside improvements in the local economy, has led to an increase in population, which in turn drives the demand for housing, infrastructure, and public services. As the standard of living rises, there is a growing need for more land to accommodate residential, commercial, and industrial development. This often results in natural and agricultural lands being repurposed for construction, reducing the area available for farming, forest cover, and other ecological uses. In addition to these demographic and economic pressures, large-scale infrastructure projects-such as highways, roads, and public facilities-have significantly impacted land use and cover in Hemja. These projects are essential for the region's development, enabling better connectivity, transportation, and access to services. However, they also contribute to the irreversible transformation of natural environments into built-up areas. Infrastructure development often requires clearing forests, excavating land, and modifying the landscape to make way for roads, buildings, and other constructions.

As the study conducted on Hemja's land use and cover changes spanned two decades, it underscores the importance of continuous and more detailed monitoring of these patterns. Such data can provide invaluable insights to policymakers, urban planners, and other stakeholders, helping them make more informed decisions about future development. The ability to track land use changes with greater accuracy allows for better management of resources and the potential to balance urban growth with environmental sustainability. The long-term implications of land use change are particularly critical, as many alterations-such as deforestation, soil excavation, and the reduction of agricultural space-are often difficult or impossible to reverse in the short term. These changes can lead to environmental degradation, loss of biodiversity, and reduced agricultural productivity, which may, in turn, create challenges for local food security and the region's ecological health.

Therefore, it is essential that proactive measures have to take manage land use effectively, ensuring that development is sustainable and does not come at the expense of the environment. By addressing these issues now, policymakers can help mitigate future problems, such as soil erosion, habitat loss, and the negative impacts of rapid urbanization on local ecosystems. Careful planning and sustainable development practices will be crucial in balancing Hemja's growth with the need to preserve its natural and agricultural landscapes for future generations.

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