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State of Urbanization in Nepal: The Official Definition and Reality

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Abstract

Nepali government's official delineation of several human settlements as new urban areas has been questionable because many important criteria such as urban infrastructure and services, open space, population density and economic viability are not thoroughly analyzed while defining what is urban. Many settlements in Nepal officially defined as urban, often driven by political considerations, are operating in the rural framework forming ruralopolises. This paper analyzes various criteria needed for defining urbanization that are internationally accepted to assess Nepal's official definition of urban settlements. Urban areas have been expanding in Nepal at the cost of agricultural, forest, and shrubland land uses. We found that using road as the main variable but keeping agriculture, forest and shrubland constant, one percent increase in road length will lead to an increase in the geographical area of urban settlements by 0.47 percent. Spatial visualization of urban expansion and road network clearly indicate that new urban areas that are radiating from the established large urban centers are expanding along the road network on land that are relatively flat with less than 15° slope to the horizontal plane. Undulated landscape, low density population, and lack of road infrastructure, among other factors, have limited the expansion of urban areas in the mountainous region. To develop a sustainable urban development plan, this paper did detail land use and land cover analyses. Using 10 x 10 m sentinel satellite imagery, the paper presents detailed analyses of land use and cover changes from 2017 to 2021. These years are chosen because after the promulgation of the new constitution in 2015, rapid urbanization started, but its implementation state restructuring began only after 2017. The urban areas, as defined by the government, expanded rapidly in the Tarai and mid Hills regions from 23% in 2014 to 66% in 2017 and is expanding further.

Keywords: *Nepal, urbanization, municipalities, spatial visualization, land-use.*

Introduction

After 2015, Nepal became one of the fastest urbanizing countries in Asia where the percentage of classified urban dwellers increased from 23% in 2011 to 66% in 2021 (CBS, 2021) with an increase in the number of municipalities from 217 to 293 along the promulgation of new constitution (Bhattarai and Conway, 2021). An increase in officially defined urban area has created several fuzzy boundaries between the growing areas of urban and areas of decreasing rural settlements. This research identifies the major driving forces that promote spatial expansion of urban areas in Nepal.

Ambiguous boundaries between rural and urban areas are creating several mini-regions that have mixed characteristics of both urban and rural environments, which can be called “*ruralo-urbano-polises*” or simply “*rurban areas*.” A *rurban* area refers to a geographic landscape which possesses the economic characteristics and lifestyles of an urban area while retaining its original features of rural settlement or rural municipality or rural community (herein after referred to as rural jurisdiction). Relatively, highly populated rural jurisdictions are rapidly being captured within the areas defined as urban. Such areas are receiving capital flows from the Nepali remitters who aspire to live in built-in urban environment when they return but may not be able to afford a residential structure in well-established urban area. Buildings are being built-in in fuzzy areas that emulate the urban environment. Similar trends have been a common occurrence globally mostly in Latin American countries (Coq-Hueva and Asian-Chaves, 2019) where nearby rural jurisdictions and suburbs are often annexed by adjacent cities thereby expanding their spatial extents.

We utilize spatial and aspatial data to identify factors leading to urbanization in three geographic regions - mountain, hills, and Tarai - of Nepal's seven provinces and 77 administrative districts between 2017 and 2021.

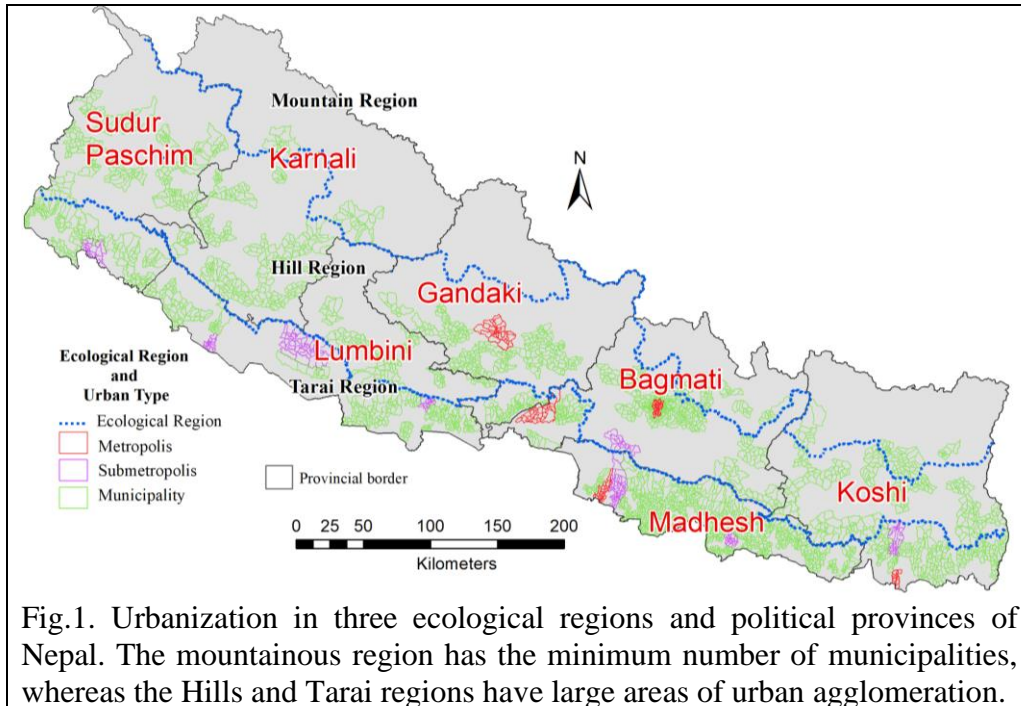
As the state restructuring was completed in 2017, local political units comprising of 3,374 (3157 village development committees and 217 municipalities) from the previous political structure were combined to create the 753 units. Of the 753 local political units, 450 rural jurisdictions and 293 municipalities of various hierarchies were created. To achieve this goal, many rural hamlets were annexed to the existing 217 municipalities to meet the urban thresholds and to promote such areas into municipalities of various levels such as municipalities, sub-metropolises, and metropolises. Robert Redfield (1930) termed such phenomenon of fuzzy urban-rural boundaries as rural-urban conundrum. As these conundrums are created, many areas that are classified as urban still retain attributes of rural jurisdictions, a distinct legal definition that is different from rural jurisdictions. These distinctions are made for tax and amenities purposes, despite having rural characteristics in terms of infrastructure, residential density, public facilities, and services.

Like in its neighbors India and China, rural jurisdictions in Nepal are sparsely populated, while municipalities are relatively densely populated. However, rural jurisdiction and municipalities do not exist in isolation from each other. They are linked through administration, education, employment, and exchanges of labor, agriculture, and factory products, which include basic and non-basic economic activities, which in geographic term is called the functional relationship. In a functional relationship, even the non-contiguous areas may be closely linked together for various reasons. A review of literature on the rural-urban conundrum for developed countries such as USA, Canada (US Census Bureau, 2022) often shows a clear distinction between farmhouses in the rural areas and mid-rises and skyscrapers in the urban areas (Liao and Wang, 2019; Rees, 2001). However, in Nepal, such clear distinctions are not always visible. Nepal's urbanization conditions are similar to the conditions of developing countries like India (Biswas et al., 2017), Brazil (Fix and Arantes, 2022), Kenya (Forster and Ammann, 2018), and Egypt (Verme et al., 2014; Zinkina and Kororayes, 2013) to name a few. Many rural areas in Nepal that are officially defined as municipalities still have no clear-cut urban characteristics. Simply put, except for some large cities such as Biratnagar, Dharan, Janakpur, Birgunj, Kathmandu, Bharatpur, Pokhara, Butwal, Tulsipur, Nepalgunj, and Kanchanpur, there are no meaningful distinctions between rural and urban areas. However, by definition, there are distinctions between those two in financial and environmental regulatory policies designed for investment and tax collection purposes.

The municipal areas in Nepal are expanding fast, and some areas are even turning into slum or slum-like settlements (Adhikari, 1998) like in many developing countries (Akaku, 2014) because of the formation of rural-urban conundrum. In developed countries like the United States, counter migration started in the 1940s creating a trend of horizontal disintegration. In this counter migration, wealthier families first left cities as the federal government expanded highways and freeways and granted loans at low interest rates for families to buy automobiles to facilitate rural-urban commuting. In Nepal however, high-income families started raising families in urban areas and building large buildings as urbanization started in Nepal in the early 1950s. Families able to afford buy well-facilitated buildings within the urban areas, and low-income families started living in the urban areas along with the high-income families but occupying spaces that have limited amenities such as outside facing windows, cooking spaces, and close bathroom facilities. Such spaces are in the basements or at the top floor without elevator (lift) facilities. The well-to-do families may occupy the more comfortable spaces in the same building. This way in Nepal, there are both vertical and horizontal segregation of families by income. Horizontal urban segregation is observed because of the formation of *rubran* areas with low-income families still living in rural like environment within the legal territory of municipalities while high-income families live in places with greater amenities. Hence, Nepali urban spaces are characterized both by North American city models with horizontal segregation and Latin America and European city models with vertical segregation. The vertical segregation is attributed to the lack of reliable transportation from rural to urban areas where some types of jobs are available. Theoretically, a functional relationship exists between urban core and rural jurisdiction. However, overtime, such functional relationships have been weakened because core urban dwellers started consuming imported goods from long distances. Covid-19 pandemic has alerted urban planners that the weakening supply chain indeed is not a sustainable path of urban management (Bhattarai and Adhikari, 2023).

Since 2007, at the global scale, over 50 percent of the total population has been living in urban areas, mostly concentrated in large metropolitan centers to enjoy the opportunities offered by the cities (The World Bank, 2018). Like the global urbanization trends, Nepal has been urbanizing rapidly by annexing rural areas into

urban jurisdiction since the process of state restructuring (Fig. 1) started in 2015. Many rural areas were classified urban despite the need of people there to travel longer distances for services, schools, health, and access to jobs within the urban areas like the rural jurisdiction.



Many semiurban areas that provide only limited urban facilities have been annexed into municipalities creating several rural-urban corridors (Fig. 1). These rural-urban corridors are connecting large urban centers passing through rural areas. For examples, Janakpur to Dhalkebar in Dhanusha district in Madhesh Province, Bhairahwa and Butwal in Rupandehi district of Lumbini Province are rural-urban corridors.

During the Roman period in Europe, many peri-urban areas were developed as regions with local functional specialization such as agricultural and industrial products to sustain the regional economies. This practice has been common even in the modern circular economy (Cerisola and Capello, 2019). Emerged in the 1970s, the concept of circular economy aims in reducing the consumption of inputs for industrial production, but potentially applicable for sharing, leasing, reusing, repairing, and refurbishing resources (Arruda et al. 2021). Many urban areas which have nodal connections are sharing their resources (Gautam, 2006). The rural-urban corridors in Nepal often have distinctive microclimates that are suitable for horticultural and agricultural farming. In 1826, German geographer and economist Von Thunen developed the location theory with reference to the city of Chicago and nearby region where several agricultural activities were confined in and around the cities when many areas were remained disconnected, like an isolated state, by a reliable transportation network (Horvath, 2010). Though the concept of isolated state was coined by von Thunen has become obsolete with the development of modern transportation for agricultural products, Covid-19 disrupted the supply chain of food making- urban farming more attractive (Bhattarai and Adhikari, 2023). Promoting local functional specializations with advance technology can help create circular economies and strengthen connections between rural jurisdictions and urban areas (Minnesota History, 2021).

In Nepal, after 2015, many peri-urban areas are connected to each other resulting into urban agglomeration (Fig. 1) with the conversion of farming areas into urban environments (Fig. 2). Urban corridor between Biratnagar and Inarwa in Koshi Province, Janakpur to Dhalkebar in Madhesh Province, Lalitpur-Kathmandu-Banepa in Bagmati Province, Lekhnath-Khairani in Gandaki Province, Butwal-Bhairahwa, Krishna Nagar- Suraikanaka, and Ghorahi-Tulsipur, Nepalgunj-Kohalpur-Chisapani in Lumbini Province, Birendranagar in Karnali Province, and Dhangadhi-Godavari in Sudur Pashim Province have seen the conversion of several farming lands into urban development. While Nepali urban planners have been struggling to provide urban services to these corridors, these accelerating land use changes have created a rural-urban conundrum making it difficult to delineate boundaries between rural jurisdiction and urban municipalities. Amidst this confusion, many communities which

have limited urban facilities but are living within the officially defined urban territories are paying high taxes to government like those in the more established cities.

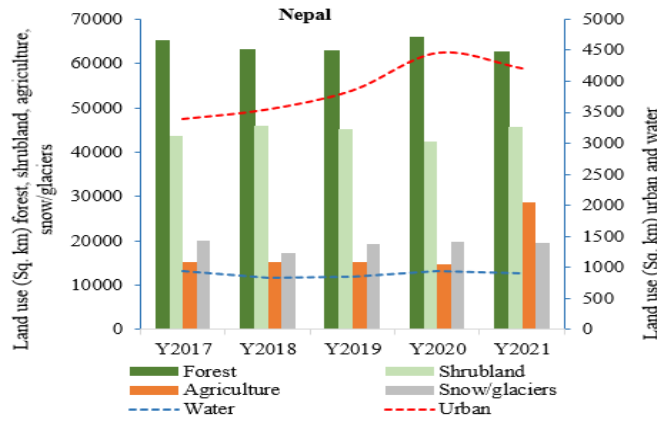


Fig. 2. Land use in Nepal between 2017 and 2021. Officially defined urban area is rapidly increasing since 2017 except for the year 2021 due to Covid-19.

The objective of this paper is to assess the main drivers of urbanization in various ecological regions of Nepal’s seven provinces belonging to 77 administrative districts between 2017 and 2021. To achieve this goal, this paper is divided into two parts. Part I is descriptive and Part II is quantitative. To lay the foundation for Parts I and II, first the paper presents the study area followed by materials and methods. Part I provides explanation on how urbanization process has evolved in Nepal and the current state of urbanization. Since cities are inextricably interwoven with economic life that involves a portion of the economic effort “supported by non-local demands” but brings money to city (basic economy) and city also requires local services (non-basic) (Alexander, 1954), it also assesses basic and non-basic economic activities in various provinces and derive multiplying factors these basic and non-basic economic activities generate. Part II presents quantitative techniques based on the land use and cover and population changes from 2018 to 2021. Finally, it presents concluding remarks with some suggestions for policy instrumentation on how the information presented here can be used to develop sustainable cities in Nepal.

2. STUDY AREA

For the study, we include the entire geography of Nepal covering 14.8 million hectares located between China in the north and India in south, east, and west. There are six metropolises, 11 sub-metropolises, and 276 municipalities within three geographic (ecological) regions, seven provinces, covering 77 administrative districts in the country(Fig. 3).

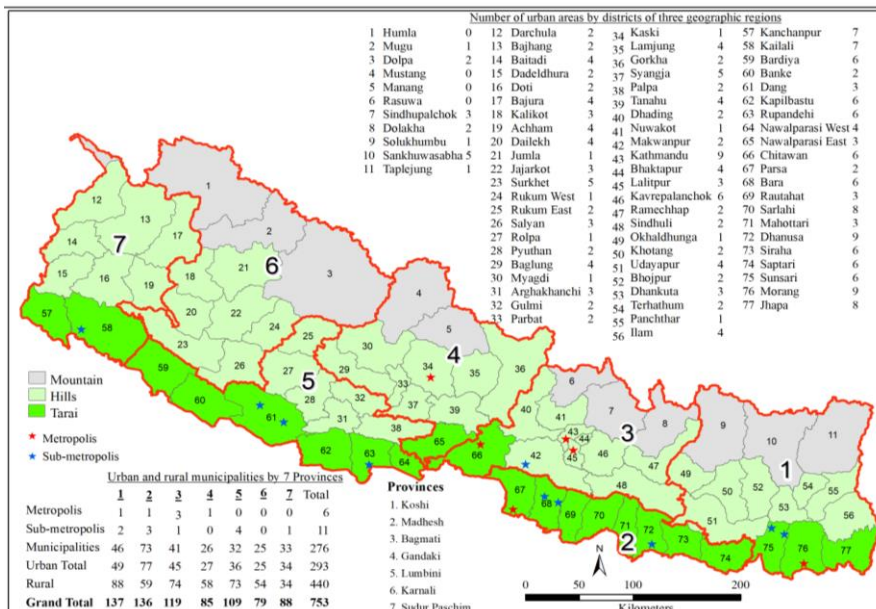


Fig. 3. Distribution of the three tiers of municipalities (Metropolitan, sub-metropolitan, and municipal), and rural jurisdictions. Urban centers are listed by administrative districts spread over three ecological regions of seven provinces. [Adapted and modified from Bhattarai and Conway, 2021].

As per the new constitution of Nepal (2015), local political units from the old Panchayat system comprising 3,374 (3157 village development committees and 217 municipalities) were reduced to 753 units. In doing so, many rural jurisdictions were annexed to the nearest urban units making the total urban population 66% of the total population, a jump from just 15% of the population as urban in 2015. New rural settlements were appended to adjacent urban areas to meet the population and income thresholds of municipality, sub-metropolitan, and metropolitan units. However, many of these urban areas so classified are characterized by *rubrans* where people living in rural settings within the legally defined urban areas are competing with the limited facilities of the urban cores. Despite such competition for limited resources/facilities, many of the *rubrans* are aspiring to becoming “smart cities.” However, political leaders and urban planners responsible for the planning of these *rubrans* have been struggling to have real time geospatial data to promote them into “smart cities.” This research explores in detail what factors contributed to the conversion of many rural jurisdictions into municipalities and looks at the sustainability aspects of the various urban areas where the annual population growth rate is between 4.5 and 5% (CBS, 2021).

3. MATERIALS AND METHODS

3.1 MATERIALS

We gathered aspatial data such as demography and other socioeconomic information from the Central Bureau of Statistics (CBS). We also gathered spatial land use and land cover data at 10 m x 10 m pixel levels extracted from the global land cover Sentinel-2 surface reflectance obtained from [Esri website](#) for [UTM Zones 44 and 45 N](#) to cover the entire geographic area of Nepal. These satellite images were classified using a deep learning model that used over five billion hand-labeled Sentinel-2 pixels sampled from over 20,000 sites distributed across all major biomes of the world. Using a shapefile, only portions of Nepal’s land use and cover datasets were extracted for 2017, 2018, 2020, and 2021. Seven land use classes were identified that include: 1) forest with over 30 percent crown coverage; 2) shrubland having scattered trees with less than 29.99 percent tree crown coverage (crown cover were obtained from global tree cover dataset) along with bush and shrub; 3) agricultural land having different crops; 4) areas with snow/ice cover; 5) glacier covered areas (these include glacier rivers); 6) urban settlements; and 7) water (both stagnant and non-stagnant water bodies). Our major focus is to investigate the shift in land uses and cover into the urban areas and the factors associated with the conversion processes in all three ecological regions.

3.2 METHODS:

We first present qualitative assessment on what led certain areas to be officially classified as urban in the different geographic /ecological regions in various periods. Then, we look at the population distribution in different geographic regions and the number of urban units and types in seven provinces. We also analyzed the basic-and non-basic economic activities and the multiplier effects that these economic activities generate. Generating multiplier factors help us understand whether these multiplier factors also have contributed to the development of urban areas. Land use and land cover information is used to examine which factors significantly contribute to the formation of urban areas.

PART I: DESCRIPTIVE ANALYSES

4.1 Defining an Urban Area

There is no single universally accepted definition for urban areas. However, each country uses its own criteria to define what are urban and rural areas. A combination of the following criteria is generally regarded as good indicators for defining an urban area. For a human settlement to be considered urban, it must meet most of these criteria.

- Population density over 300 persons/km².
- More than 5,000 total population in a contiguous urban area.

- Availability of basic urban infrastructure and services (e.g., roads, water supply, stormwater, wastewater systems, and electricity).
- Availability of services and amenities, such as recreational parks, open space, transit, communication services, institutions of higher education, government services, financial services, hospitality services, public and private services, and health services.
- Employment opportunities in primary sectors such as service, manufacturing, trade, export.
- The area covered by the footprint of buildings as the percentage of the total geographic area of the settlement (e.g., it should be generally more than 50%).
- Intensity of development in the area, often measured by the Floor Area Ratio (FAR). FAR is the total floor area of a building divided by the total site area on which it is built in. The higher the FAR, the more intense is the level of urbanization. For example, the FAR in city centers may be 1 to 10 or even more; and in the suburban areas, it could be around 1 to 3 or less).
- How many of these criteria are met by a human settlement can indicate the degree of urbanization, such as city center, dense urban, suburban, and peri urban.

4.2 Internationally applicable definition for urban areas

The most comprehensive definition of “urban” was created by the European Union in collaboration with International Labor Organization (ILO), Food and Agricultural Organization of the United Nations (FAO), Organization for Economic Co-operation and Development (OECD), UN Habitat, and the World Bank. The European Union (2021) defines a continuum of urban areas ranging from urban center, dense urban cluster, semi dense urban cluster, rural cluster, to suburban. The definitions use the criteria of population density in contiguous areas of one square kilometer grids, and the total population within the contiguous areas of the identified human settlement. The European Commission methodology uses geographical grids and superimposes such grids over the geographical units (European Union 2021).

A. Geographic grids

- **An urban center** with contiguous grid cells of human settlements with a density of minimum 1,500 persons/km², and a total population of at least 50,000.
 - Contiguous grid cells that have at least 50% built-up areas in footprint can be added to the urban center.
- **An urban cluster** has contiguous grid cells with a minimum population density of 300 persons/km² and a total population of at least 5,000.
- **Rural** grid cells are those areas which do not meet the above criteria.

B. Geographical units

- **Cities:** local units that have at least 50% of their population in urban centers.
- **Towns and semi-dense areas:** local units that have less than 50% of their population in urban centers, and less than 50% of their population in rural grid cells.
- **Rural areas** local units that have at least 50% of their population in rural grid cells.

The above two factors can be combined to develop a matrix to identify urban and rural areas (Table 1).

Table 1. Urban-rural matrix

		Population size thresholds of the cluster of cells (settlement size)			No population size criterion (not a settlement)
		>=50,000	5,000-49,999	500-4,999	
Urban	Center				
Urban	Cluster				
Rural					

	>=1500	Urban Center	Dense urban cluster		
	>=300		Semi-urban cluster*	Rural cluster	Sub-urban or peri-urban grid cells
	>=50				Low density rural grid cells
	<50				Very low-density rural grid cells
<ul style="list-style-type: none"> Semi-dense urban clusters can have a population more than 49,999 					

Source: European Union (2021), and European Commission (2020). Under Creative Commons License.

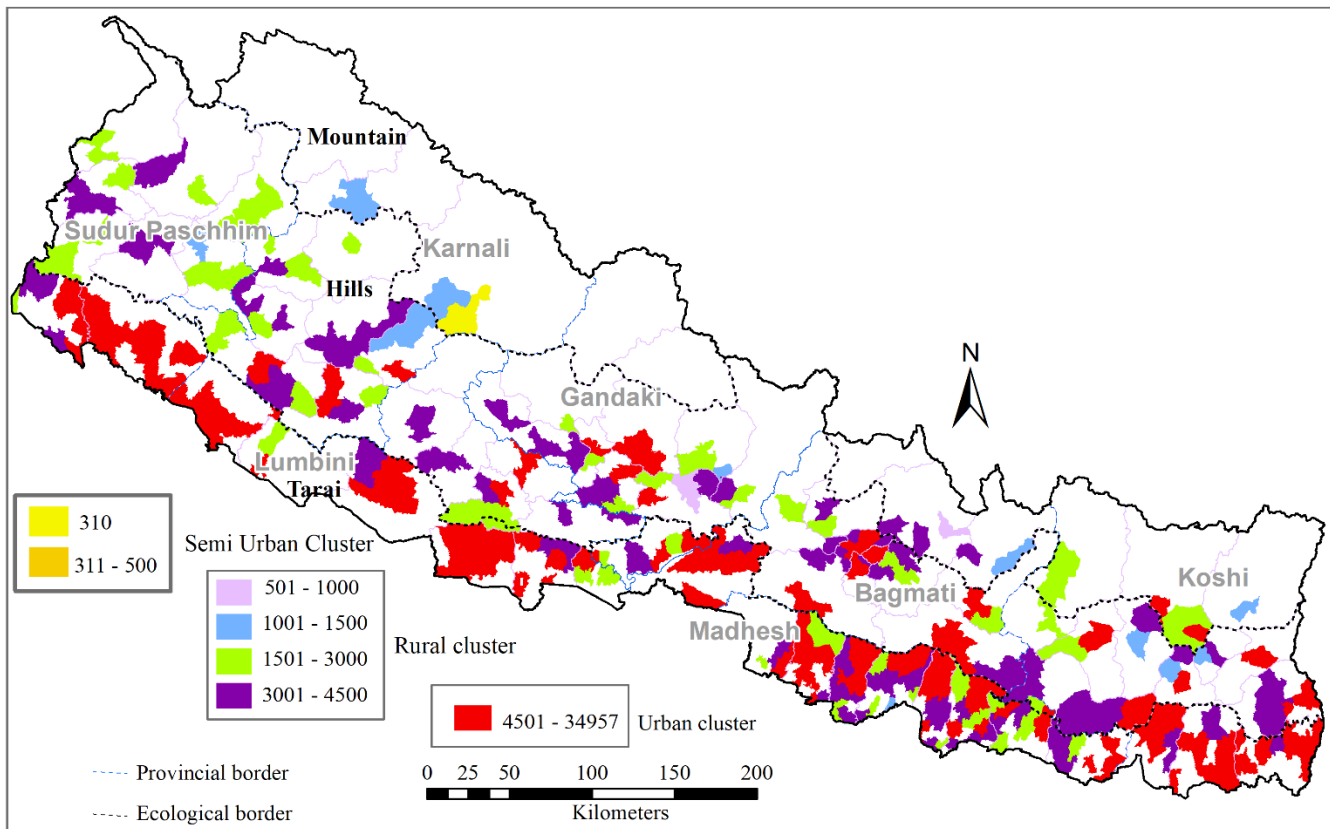


Fig. 4 Urban area according to the European Union methods of classification based on 2021 census. Most of the urban clusters are formed at in the Tarai region of all the provinces followed by mid-Hills of the Bagmati and Gandaki provinces. In the mid-Hills several rural areas are annexed to existing urban areas that are forming *rubran areas*. Mountainous region has the minimum number of semi-urban clusters.

4.3 Definition of urban areas for Nepal

In Nepal, the definition of what is urban has frequently changed in the past six decades. To be classified as an urban area, there are different requirements in different geographic (ecological) regions of Nepal. Table 2 provides a glimpse of criteria the government used for defining urban areas from 1952 to 1999.

Table 2 Changing definition for urban in Nepal 1952-1999

Years	Criteria	Remarks
1952/54	<ul style="list-style-type: none"> Population over 5,000 	Unclear criteria 'Prominent' settlement'
1961: Census	<ul style="list-style-type: none"> Population over 500 Urban environment 	'Sahar'
1962: Nagar Panchayat Act	<ul style="list-style-type: none"> Population at least 10,000 Local urban administrative unit Local government unit 	'Nagarpalika'

1976	<ul style="list-style-type: none"> Population size at least 9,000 	'Nagar panchayat'
1992: Municipal Act	<ul style="list-style-type: none"> Population size at least 9,000 	'Nagarpalika'
1992 Municipality Act	<ul style="list-style-type: none"> Population size 20,000 Basic urban infrastructures Minimum one million annual revenue Semi- urban environment 	'Nagarpalika'
1999: Local Self Governance Act	Redefined the Urban Area <ul style="list-style-type: none"> Population size 300,000 Rs. 400 million annual revenues Urban environment High education facilities 	'Mahanagarpalika' (Metropolitan City)
	<ul style="list-style-type: none"> Population size 100,000 Rs. 100 million annual revenues Urban environment Already received 'Municipality status' 	'Upa-Mahanagarpalika' (Sub- Metropolitan City)
	<ul style="list-style-type: none"> Population with 20,000 in Tarai and 10,000 in mountain and hill area (Fig. 1). Rs. 5 million annual revenues in Tarai and 500,000 in hill and mountain. Minimum urban facilities. 	

Source: Chapagain (2018)

A more comprehensive definition for the different levels of municipalities was provided by the Nepali government's Local Government Operation Act of 2074 BS (2017). Accordingly, different areas have been classified as urban in different periods and new urban areas are added (Table 3) through the annexation of rural jurisdictions. This annexation helped Nepal's urban population to jump from 17% to 65.91% (Table 4) leading to the increase in official urban population in three geographic regions of six province. The Madhesh Pradesh has only Tarai and mid-hill ecological regions (Table 6).

Table 3. Number of municipalities, and urban population as percentage of national population in selected years

Duration	Year of enactment	Number of new municipalities	Total number of urban municipalities	Urban population as percentage of total population of Nepal
Before 1980	Until 1981	-	23	6.2
1981-1990	1991	10	33	9.2
2001	2001	25	58	13.9
Political restructuring	2011	0	58	17.1
	2014 May	72	130	27.2
	2014 (Dec)	61	191	38.2
	2015 (Sept)	25	217	41.6
Nepal Federated with 7 provinces	2017 (Feb)	76	293	62.4

Source: Agergaard et al. (2022); Bhattarai and Conway (2021); Center Bureau of Statistics (CBS, 2003, 2012). Ministry of Federal Affairs and Local Development (2014, 2015 and 2017).

Table 4. Nepal: Rural-Urban population (2011-2021)

	Census Year	
	2011	2021

Geographic region	Population	Percent	Population adjustment after state restructure	Percent	Gender Ratio	Population	Percent	Gender Ratio
Urban	4,523,820	17.03	16,740,732	65.19	95.89	19,291,039	66.08	96.35
Rural	21,970,684	82.93	9,753,772	36.81	91.27	9,901,449	33.92	95.05
Nepal	26,494,504	100	26,494,504	100	94.16	29,192,480	100.00	95.91

Source: Central Bureau of Statistics (CBS, 2021, Table 7: page 18)

We looked at the total share of national population in different provinces based on 2011 and 2021 censuses. In 2021, Karnali Province contributes 5.81% of the national population but within the province, 52.10% of the population is living in urban area. Likewise, Gandaki province has 8.49% of the total national population and 65.71% of its population is classified as urban. Koshi Province has 17.09% of the national population and it has round 17% of its population listed as urban. The Sudur Paschhim province accounts for 9.29% of the total national population, whereas its urban population is 6.22% of the total provincial population. These urban demographic figures prompted us to assess the criteria for defining urban areas in different ecological regions. Since Karnali, Gandaki, and Sudur Paschhim have large areas of Mid-Hills and Mountainous areas, we are assessing whether their urban areas are defined more leniently in the Mid-Hills and Mountainous area as compared to the inner Tarai, outer Tarai, and the Kathmandu Valley. Then we explore the contemporary urban definition in different geographic regions (Table 6). In Nepal, as the countrywide insurgency started due to Maoist movement from 1996 that lasted till 2006, many families moved to urban areas for security reasons. Since there are not many manufacturing job opportunities available in the urban areas (basic economic activities), a large number of young working age population have been emigrating to many foreign countries as mostly temporary workers. Indeed, there have been the waves of daily exodus of mostly working age males, which persists in large number even today. As a result, in almost all the households in all geographic regions, the female population is higher than the male population. We have provided the number of households and population by gender in each local political units such as rural municipalities and three tiers of municipalities (municipality, sub-metropolis, and metropolis). Information provided in Table 6 clearly depicts that many Nepali households have been female headed. In a patriarchal society like Nepal, males make most major investment decisions. Though these males often remit their incomes from foreign countries, these incomes are rarely used in capital investment. Almost 80% of the remittance income is used in daily consumptions, 2.5% in capital investment, and rest is used in other purposes such as medical expenses, education, transportation, and others (Bhattarai and Conway, 2021). As a result, the multiplier factors that each province generate from urban areas are low because many manufacturing industries are missing in urban areas of Nepal.

Table 5: Minimum criteria for various types of urban areas in Nepal.

Types of Urban administrative unit	Mountain (Himalayan)			Mid-Hills			Inner Tarai			Tarai			Kathmandu Valley		
	Population	Annual Revenue (Rs.) US 1 = Rs. 130	Infrastructure /Services (examples)	Population	Annual Revenue (Rs.)	Infrastructure/ Services (examples)	Population	Annual Revenue (Rs.)	Infrastructure /Services (examples)	Population	Annual Revenue (Rs.)	Infra/Services (examples)	Population	Annual Revenue (Rs.)	Infrastructure /Services (examples)
Municipality	10,000	10 million	Roads, water supply, communication, solid waste management, parks, hospitals, banks, bus park, market, slaughterhouse, crematorium, sports field, master plan for the municipality	40,000	30 million	Roads, water supply, communication, solid waste management, parks, hospitals, banks, bus park, market, slaughterhouse, crematorium, sports field, master plan for the municipality	50,000	30 million	Roads, water supply, communication, solid waste management, parks, hospitals, banks, bus park, market, slaughterhouse, crematorium, sports field, master plan for the municipality	75,000	30 million	Roads, water supply, communication, solid waste management, parks, hospitals, banks, bus park, market, slaughterhouse, crematorium, sports field, master plan for the municipality	100,000	30 million	Roads, water supply, communication, solid waste management, parks, hospitals, banks, bus park, market, slaughterhouse, crematorium, sports field, master plan for the municipality
Sub-metropolitan city	200,000	250 million	Higher infrastructure, service levels than municipality, including larger hospitals, hotels, more paved roads etc.	200,000	250 million	Higher infrastructure, service levels than municipality, including larger hospitals, hotels, more paved roads etc.	200,000	250 million	Higher infrastructure, service levels than municipality, including larger hospitals, hotels, more paved roads etc.	200,000	250 million	Higher infrastructure, service levels than municipality, including larger hospitals, hotels, more paved roads etc.	200,000	250 million	Higher infrastructure, service levels than municipality, including larger hospitals, hotels, more paved roads etc.
Metropolitan city	500,000	1 billion	Higher infrastructure, service levels than sub-metropolitan city, including larger hospitals, universities, airports, world class hotels, museums etc.	500,000	1 billion	Higher infrastructure, service levels than sub-metropolitan city, including larger hospitals, universities, airports, world class hotels, museums etc.	500,000	1 billion	Higher infrastructure, service levels than sub-metropolitan city, including larger hospitals, universities, airports, world class hotels, museums etc.	500,000	1 billion	Higher infrastructure, service levels than sub-metropolitan city, including larger hospitals, universities, airports, world class hotels, museums etc.	500,000	1 billion	Higher infrastructure, service levels than sub-metropolitan city, including larger hospitals, universities, airports, world class hotels, museums etc.

Source: Redrawn and adapted by the authors based on the Local Government Operation Act (2017) document, Government of Nepal

The settlements identified as urban by the 2021 National Census in Nepal are not all urban if the more comprehensive and internationally accepted definition of urban areas as discussed above is applied. Many of the clusters of buildings and dwellings in Nepal defined as urban in the 2022 Census seem to include settlements that do not have the levels of density and urban services that are discussed earlier. Table 6 clearly depicted that there is leniency in the definition of urban population in some geographic regions. Then, we looked at the household and population distribution in different geographic regions belonging to rural jurisdictions and urban areas of various hierarchies based on 2021 census (Table 7).

Table 6. Total household, total population by gender distribution in various rural, urban, sub-metropolitan, and metropolitan units in three geographic regions of seven provinces

Province	Population distribution in various local political units (rural councils, municipalities, sub-metropolitan, and metropolitans) by seven provinces in three ecological zones in 2021											
	Mountain				Hills				Tarai			
	Rural	Municipality	Sub-metropolitan	Metropolitan	Rural	Municipality	Sub-metropolitan	Metropolitan	Rural	Municipality	Sub-metropolitan	Metropolitan
Koshi	HH: 49684 TP: 234273 M: 112287 F: 121986	HH: 35158 TP: 155516 M: 72630 F: 82886	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 181592 TP: 851417 M: 398776 F: 452641	HH: 465949 TP: 743166 M: 349007 F: 394159	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 162156 TP: 774256 M: 374417 F: 399839	HH: 296208 TP: 1290800 M: 609055 F: 681745	HH: 66487 TP: 278222 M: 131237 F: 146985	HH: 47798 TP: 214663 M: 108827 F: 105836
Madhesh	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 255387 TP: 1528921 M: 771172 F: 757749	HH: 564552 TP: 3209411 M: 1596377 F: 1613034	HH: 70948 TP: 402290 M: 206649 F: 195641	HH: 39286 TP: 240922 M: 127227 F: 113695
Bagmati	HH: 82313 TP: 346626 M: 164889 F: 181737	HH: 39721 TP: 166376 M: 78026 F: 88350	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 227648 TP: 1110329 M: 526512 F: 583817	HH: 428299 TP: 1827505 M: 899823 F: 927682	HH: 34270 TP: 152875 M: 74964 F: 77911	HH: 324548 TP: 1260375 M: 657765 F: 602610	HH: 4778 TP: 25002 M: 12460 F: 12542	HH: 58532 TP: 264228 M: 124154 F: 140074	HH: 0 TP: 0 M: 0 F: 0	HH: 69035 TP: 280502 M: 134001 F: 146501
Gandaki	HH: 4753 TP: 17420 M: 8786 F: 8634	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 197695 TP: 838270 M: 371268 F: 464906	HH: 206696 TP: 824006 M: 361537 F: 462469	HH: 0 TP: 0 M: 0 F: 0	HH: 108240 TP: 413619 M: 197797 F: 215822	HH: 16272 TP: 84957 M: 38149 F: 46808	HH: 51240 TP: 228854 M: 105338 F: 123516	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0
Lumbini	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 166972 TP: 767941 M: 334969 F: 432972	HH: 164956 TP: 693056 M: 320349 F: 372707	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 226736 TP: 1290904 M: 623138 F: 667766	HH: 283389 TP: 1436426 M: 690134 F: 746292	HH: 95380 TP: 433388 M: 206456 F: 226932	HH: 0 TP: 0 M: 0 F: 0
Karnali	HH: 14251 TP: 76888 M: 38102 F: 38786	HH: 5684 TP: 29096 M: 14416 F: 14680	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 109345 TP: 592736 M: 286560 F: 306176	HH: 165409 TP: 803999 M: 391752 F: 412247	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 7135 TP: 40687 M: 19853 F: 20834	HH: 2662 TP: 14486 M: 7140 F: 7346	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0
Sudur Paschim	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 141514 TP: 783206 M: 365356 F: 417850	HH: 131287 TP: 677699 M: 313879 F: 363820	HH: 0 TP: 0 M: 0 F: 0	HH: 0 TP: 0 M: 0 F: 0	HH: 48671 TP: 275517 M: 132821 F: 142696	HH: 232655 TP: 1166210 M: 562076 F: 604134	HH: 58995 TP: 272327 M: 139194 F: 133133	HH: 0 TP: 0 M: 0 F: 0

Source: Bhattarai and Conway (2021); Census Bureau of Statistics (2021), Provincial Statistics. HH→ refers to total number of households within the local political units in a province broken down by ecological regions. Likewise, TP→ is the total population within the local political unit; M→ is the total male population within the local political unit, F→ is the total female population within the local political unit of a province broken down by ecological regions.

4.4. Population distribution, state restructuring, and the formation of cities

The Hill region of Nepal (Fig. 1) was home to the large number of inhabitants until the 1950s. However, this situation altered as the Tarai region was opened in the late 1950s after malaria became controllable and the construction of the east-west national road network started in the Tarai region in the 1970s. Migrations to the Tarai from the hills started since then (Gurung, 1989). This led to the development of various urban centers in Nepal outside the Kathmandu Valley (Subedi, 2014). According to the Central Bureau of Statistics (CBS), Nepal's population increased at an average rate of nearly 2.0 percent between 1981 and 2001, while the number of municipalities rose from 23 to 58. The national population grew at the rate of 1.4 percent between 2001 and 2011, and it reached 26.5 million in 2011 (Table 4) (CBS, 2012). During this period, many urban areas were developed as per the Local Self-Governance Act (LSGA) of 1999 when population of a settlement was taken as a major criterion to declare an area as urban. For example, a threshold of 20,000 population was required to define a settlement as a municipality in the Tarai region and 10,000 in the Hills and Mountains (Muzzini & Aparicio, 2013). In 2015, the population of a settlement was considered as the main criteria to define an area as urban (Table 6). The process of delineating an area as urban was often rife with subjective and political consideration. This was often camouflaged under the rubric of creating a “New Nepal” that consisted of the restructuring the state into a federal system. This practice, which could even involve some gerrymandering, distorted the geopolitical and ecological balances of the country by ignoring the ecological linkages between the mountains, hills, and Tarai regions that was during the Panchayat System (1960-1990) (Fig. 5). It also disregarded the bionomics, how biotic and abiotic factors intricately interact with each other (Miles et al., 2019), and resource sharing principles among three ecological regions (Fig. 1) (Bhattarai and Conway, 2021). The new restructure of seven provinces from five development regions (Fig. 5) disconnected the Madhesh Province (Figs. 1 & 2) from the mountain region making it dependent on water resources that flow through the Bagmati and Koshi Provinces.

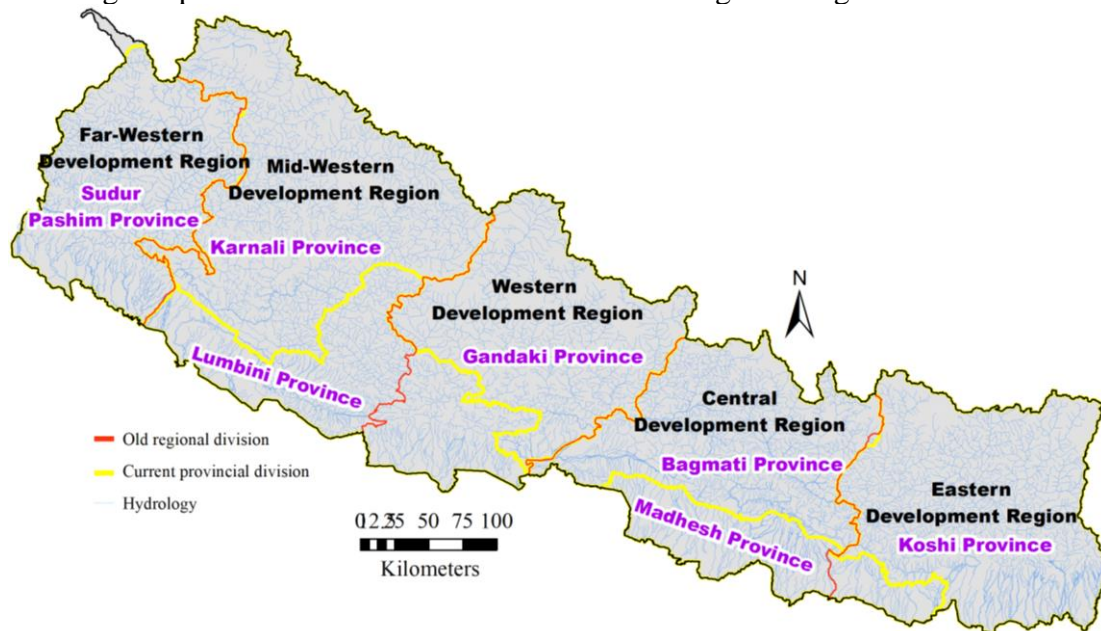


Fig. 5. Old and new structure of Nepal.

During the process of state restructuring, ecological, environmental, and development potential criteria were not fully followed, as it was largely a political process. The state

restructuring committee stated that it followed several criteria such as population size, urban population density (Figs. 4 & 6), economy, and geographic areas while creating 293 urban municipalities and 460 rural jurisdictions based on population distribution (Table 6) in seven provinces that incorporates 77 administrative districts of Nepal (Fig. 1), but there were no consistencies in the delineation of urban territories. Madhesh province has the largest share of total population within relatively smaller geographic area, but the Karnali Province has large geographic area, but has the lowest share of urban population.

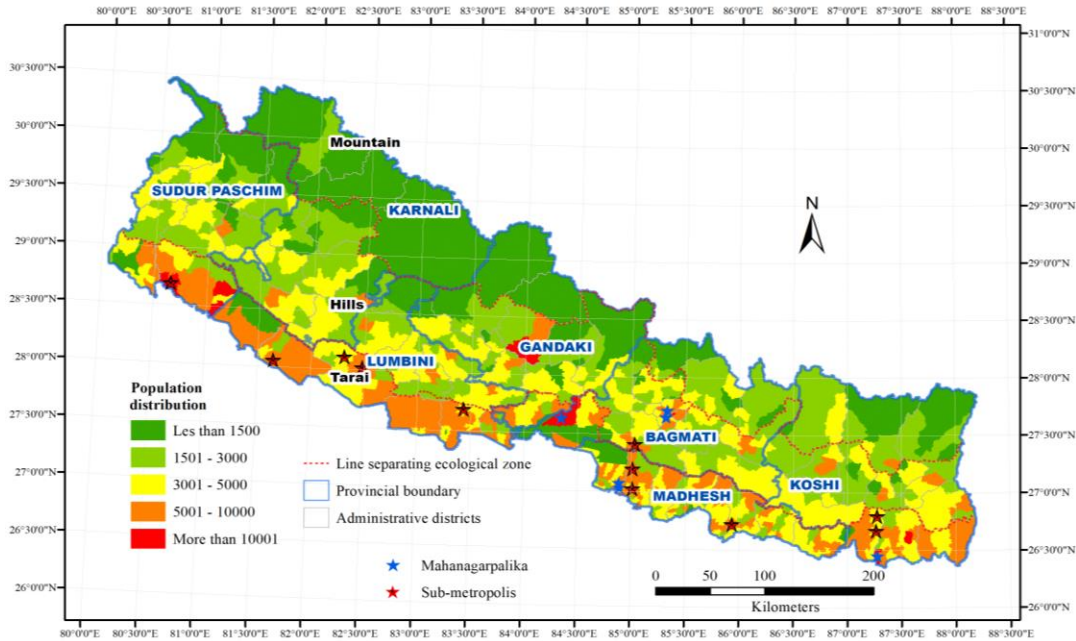


Fig. 6. Population density in Nepal within rural settlements and urban municipalities. Green colors (both dark and light) represent rural settlements. Light red color represents municipal boundaries.

The National Urban Development Plan (NUDP) (2017) aimed to achieve balance of political power and size of economy between geographical regions through urban development. It aimed to create several economic hubs by reorganizing the already-existing cities and urban corridors (Cox, 2012). The NUDP ended up creating new structure as given in Table 7 to shape the precise authorities, norms, and regulations and daily politics

Table 7: The distribution of rural and urban administrative units in Nepal’s seven provinces

Province	Local political organizations				Rural administrative units	Total municipal	Urban municipal as % of total municipality	Population density /Sq. km
	Metro	Sub-metro	Municipal	Total				
Koshi	1	2	46	49	88	137	35.8	175
Madhesh	1	3	73	77	59	136	56.6	559
Bagmati	3	1	41	45	74	119	37.8	272
Gandaki	1	0	26	27	58	85	31.8	112
Lumbini	0	4	32	36	73	109	33.0	219
Karnali	0	0	25	25	54	79	31.6	41
Sudur Paschim	0	1	33	34	34	88	38.6	130
Nepal	6	11	276	293	440	753	38.9	215.43

Source: Agergaard et al. (2022).

4.5 Economic activities

Urban growth in Nepal is mostly attributed mostly to the increased unemployment in rural areas due to lack of employment in traditional agriculture causing rural to urban migration, especially, during 1996-2006, which was a period of political turmoil caused by the Maoist violence. People also move to urban areas to earn higher incomes, to enjoy urban amenities, for better education to their children, and to connect more easily to the outside world. The rural-to-urban migration has supported both basic and non-basic economic sectors in the cities. Basic (B) economic activities include manufacturing, construction, wholesale, retail trade, repair of motor vehicles, transportation, and storage, public administration and defense, and compulsory social security. Non-basic (NB) economic activities include agriculture, forestry and fishing, mining, and quarrying, electricity, gas, steam, and air conditioning. The various businesses established in the urban centers have helped employ the rural migrants. Nepal National (Rastra) Bank (2012) estimated that the Kathmandu Valley alone contributed 31 percent of total national GDP with 630,000 jobs in various sectors, making it an attractive destination to many rural inhabitants. With the influx of additional people and buoyed by higher municipal revenues, the road network in the urban areas in general, and in the Kathmandu Valley in particular, grew rapidly. For example, the first motorable road was constructed in Kathmandu Valley in 1924. In the 1950s, the road length in the Valley was 376 km which was almost 80 percent of Nepal's total road network; in the 1970s, almost 62 percent of road length was in Kathmandu with the total length of just around 750 km; in the 1980s, the Kathmandu Valley had 50 percent of the road with a length of 1,000 km. "The road network increased dramatically in the 1990s by 154 percent and it slowed down between 2001 to 2012 with an average of 31 percent" (KVDA, 2016). Current total length of urban road in Nepal is just over 2,000 km. Throughout Nepal, by the end of 2022, the total road length is "33,871 km (16,939 km blacktopped and 8,821 km fair weather roads)" (Nepal Road Network, 2022; myRepublica, 2022). However, many of the transportation infrastructures, including urban roads, are poorly maintained.

With the increased road network throughout the country, many smaller urban areas were developed outside the capital city. However, economies of these urban centers are still mainly based on extractive activities as many of them are just in the rural clusters (Fig. 4). That means more primary and secondary activities are in operation than the tertiary, quaternary, and quinary activities which would have contributed more to basic economic activities in the urban sectors. The basic economy of urban is export-oriented (selling manufactured or agricultural goods or services); in contrast, the non-basic sector recycles corporate and individual incomes to satisfy local demand. The retail, lodging, food and beverage, real estate, and personal services industries (e.g., hair salons, lawyers, repair shops) are non-basic (NB) economic sectors. These activities essentially meet local needs. Considering economic base analysis, the non-basic sector plays a less significant role in determining the macro economy than the micro (local) economies. Other NB economic activities include water supply, sewerage, waste management and remediation activities, accommodation and food service activities, financial and insurance activities, real estate activities, professional, scientific, and technical activities, administrative and support service activities, education, human health and social work activities, arts, entertainment, and recreation. Also, service activities such as households' employment and undifferentiated goods- and services-producing activities of households for their own use also come under non-basic economic activities. It is hard to make a clear demarcation between basic and non-basic economic activities. However, the general rule of thumb is that a higher amount of non-basic economic activities than

basic suggests that an urban area has more rural environment than an urban setting (Fig. 4). Table 8a provides the breakdown of basic and non-basic economic activities in urban sectors of seven provinces for fiscal year 2018 to 2021.

Table 8a: Urban economic Activities in seven provinces

Province	Fiscal years	Economic activities		GDP (US \$) at base price of 2018/2019	Taxes minus subsidies products (US \$)
		Basic (US \$)	Non-basic (US \$)		
Koshi	2018/19	1761.317	3490.33	5284.953	707.4693
	2019/20	1602.977	3851.645	5488.602	635.0458
	2020/21	1755.431	4113.384	5903.399	732.5995
Madhesh	2018/19	1469.322	2938.714	4445.458	589.917
	2019/20	1340.493	3280.055	4658.727	529.5617
	2020/21	1481.548	3485.341	5005.747	610.8915
Bagmati	2018/19	5466.697	6865.876	12378.5	2250.403
	2019/20	5054.852	7463.99	12565.7	1982.055
	2020/21	5634.47	8085.979	13768.14	2308.364
Gandaki	2018/19	970.486	1976.567	2963.227	445.0474
	2019/20	900.3454	2131.177	3048.024	396.5377
	2020/21	969.482	2276.206	3262.483	459.1487
Lumbini	2018/19	1620.645	3071.723	4728.558	671.4608
	2019/20	1461.459	3402.287	4900.669	598.0476
	2020/21	1601.896	3623.647	5263.122	692.606
Karnali	2018/19	276.6935	1041.987	1329.793	189.1252
	2019/20	254.7653	1163.773	1429.876	175.9491
	2020/21	274.9389	1231.687	1518.165	199.4221
Sudur Pashhchim	2018/19	626.7529	1650.456	2294.315	311.0745
	2019/20	583.5407	1848.802	2449.795	288.4171
	2020/21	633.3241	1960.599	2611.685	327.4409
Total Gross Value Added (GVA)	2018/19	12191.91	21035.65	33424.81	5164.497
	2019/20	11198.43	23141.73	34541.4	4605.614
	2020/21	12351.09	24776.84	37332.74	5330.473

Source: Table 1: Provincial Annual Gross Value Added by Industrial Division: 2018-2020. Province level income: Central Bureau of Statistics (2017-2021)

There are no clear-cut boundaries between the basic and non-basic economic activities. When people visit cities to acquire certain goods and services, the cities export retail services. Also, services, such as legal services, may offer both basic and non-basic services (e.g., a law firm that handles both corporate mergers in another city and local divorces). Both basic and non-basic economic activities make up the economies of a city. Mathematically, it can be expressed as total employment (T) equals the sum of the basic and non-basic sectors (B + NB) (eq. i).

$$T = B + NB \dots\dots\dots(i)$$

When the multiplier effects associated with different economic activities are added, the size and structure of total economy of an urban area change as given by eqs. (ii) and (iii), and the total economy is influenced by the multiplier effect as given by eq (iv).

$$m = T/B \dots\dots\dots(ii)$$

$$m = \frac{(B+NB)}{B} = 1 + \frac{NB}{B} \dots\dots\dots(iii)$$

$$\Delta T = m\Delta B \dots\dots\dots(iv)$$

Table 8b provides the multiplier effects that urban centers generate in each province. The Karnali province has the largest share of the multiplier factors. This province is the least urbanized one followed by Sudur Paschim. Since many non-basic economic activities are more than basic economic activities, higher number of non-basic economic activities are contributing to higher multiplier factors.

Table 8b. Multiplier effects (based on Table 8a)

Province	Fiscal years	Economic activities		Multiplier effects for various years
		Basic	Nonbiased	
		(US \$)	(US \$)	
Koshi	2018/19	1761.317	3490.33	2.98
	2019/20	1602.977	3851.645	3.40
	2020/21	1755.431	4113.384	3.34
Madhesh	2018/19	1469.322	2938.714	3.00
	2019/20	1340.493	3280.055	3.45
	2020/21	1481.548	3485.341	3.35
Bagmati	2018/19	5466.697	6865.876	2.26
	2019/20	5054.852	7463.99	2.48
	2020/21	5634.47	8085.979	2.44
Gandaki	2018/19	970.486	1976.567	3.04
	2019/20	900.3454	2131.177	3.37
	2020/21	969.482	2276.206	3.35
Lumbini	2018/19	1620.645	3071.723	2.90
	2019/20	1461.459	3402.287	3.33
	2020/21	1601.896	3623.647	3.26
Karnali	2018/19	276.6935	1041.987	4.77
	2019/20	254.7653	1163.773	5.57
	2020/21	274.9389	1231.687	5.48
Sudur Pashhhim	2018/19	626.7529	1650.456	3.63
	2019/20	583.5407	1848.802	4.17
	2020/21	633.3241	1960.599	4.10
Total Gross Value Added (GVA)	2018/19	12191.91	21035.65	2.73
	2019/20	11198.43	23141.73	3.07
	2020/21	12351.09	24776.84	3.01

According to the economic base model, when the basic sector grows or shrinks, those changes ripple through the local economy. Consumer spending in interconnected urban corridors also creates multiplier effects within the circular economy and help in the spatial extension of urban areas. Road connectivity, geographic proximity, and nature of the landscape also contribute to the spatial expansion of urban areas (Fig. 7).

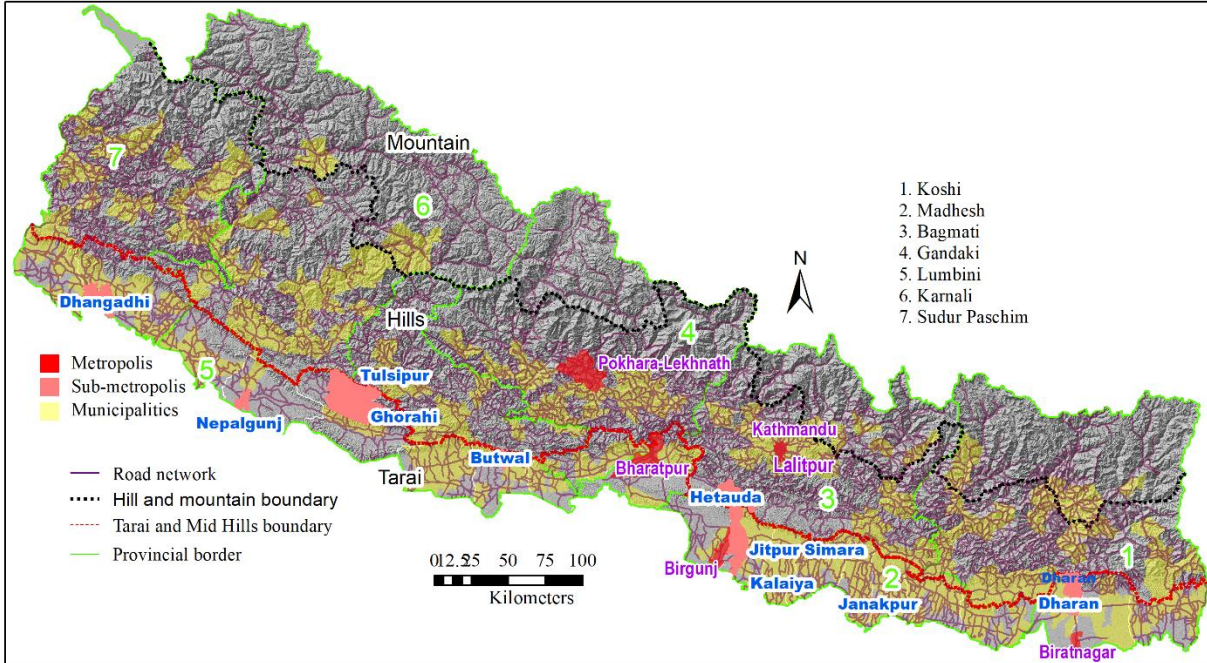


Fig. 7. Formation of *rubran* areas in Nepal with reference to topography, transportation network, and geographic proximities. Contiguous urban corridors are the byproducts of road network, topological association in physical term, but mainly derived by the political motives.

The descriptive analysis presented above suggest that in Nepal urban expansion from 15% in 2014 to 66% in 2015 was guided by political factor irrespective of whether other qualifying criteria were met. Criteria such as transportation, water and wastewater facilities, parks, open space, and existence of master planning seem to have been given less importance (Liu et al., 2021) in defining urban areas. Since other than political motives, no specific criteria were found for delineating urban areas in Nepal, we are assessing if there are any other reasons for the rapid urban classification of Nepal rural jurisdictions.

PART II: EMPIRICAL ANALYSES

5.1 Land use and cover analysis

To assess the basis of urban classification, we used spatial analyst in ArcGIS 10.8.2 to extract classified images for different provinces and tabulate information for different land use classes. We undertook this approach because despite rapid urbanization process, a detailed spatial-temporal dynamics of land use land cover (LULC) remains unavailable for Nepal. This article itself is the first study that uses a 10 m x 10 m resolution land use and cover image to identify the land use trends between 2017 and 2021 and uses statistical model to identify what factors have contributed to the expansion of urban areas. We limited our study on the spatial data for 2017 and

2021 because the rapid urbanization process started in 2015 and it got into full swing through rapid land conversion from 2017. Unfortunately, we could not get and use urbanization data for 2022. Thus, we have limited our approach to the date up to 2021 only. We investigated the LULC at the provincial levels (Figs. 8 a-g1). We have observed that population concentration has increased in metropolitan areas between 2017 and 2020, especially in the mid-hills and Tarai regions. However, due to Covid-19 pandemic, the urban growth slowed down during 2019-2021.

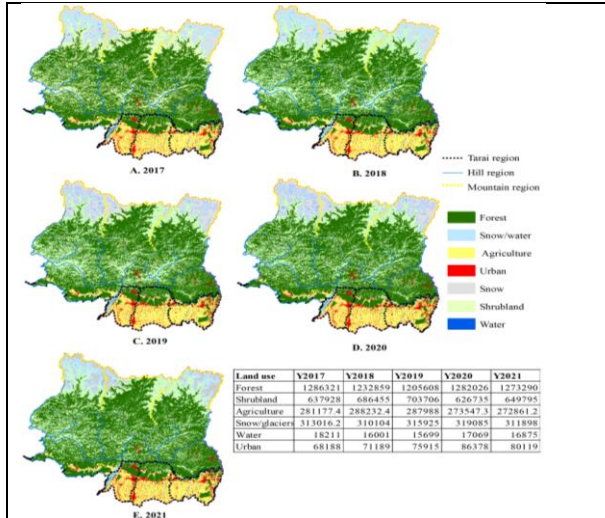


Fig. 8a: Land use and cover Koshi Province (2017-2021)

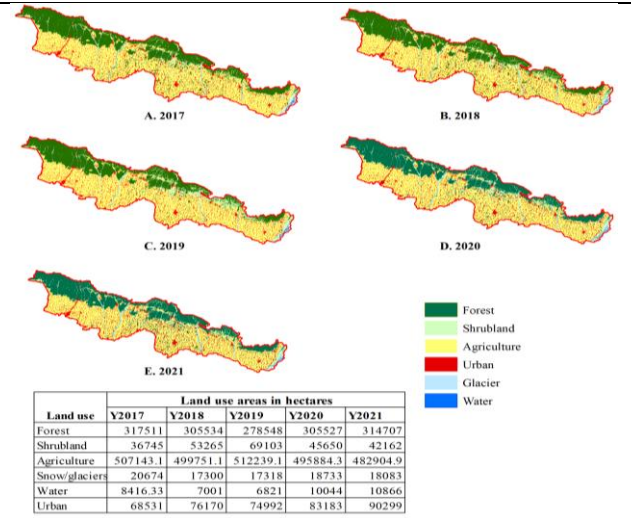


Fig. 8b: Land use and cover Madhesh Province (2017-2021)

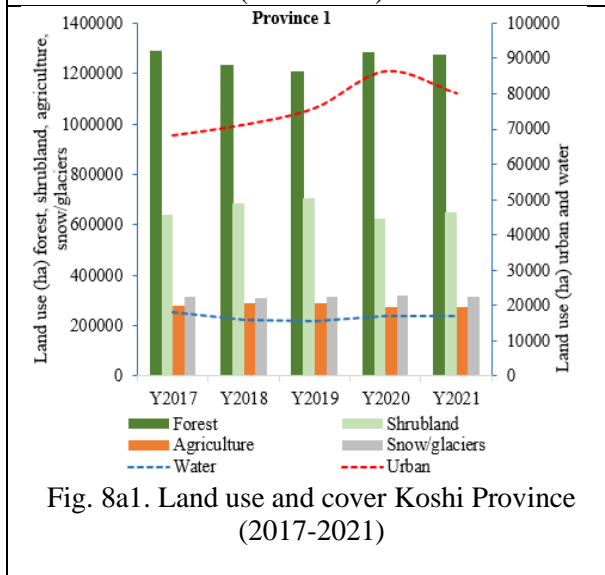


Fig. 8a1. Land use and cover Koshi Province (2017-2021)

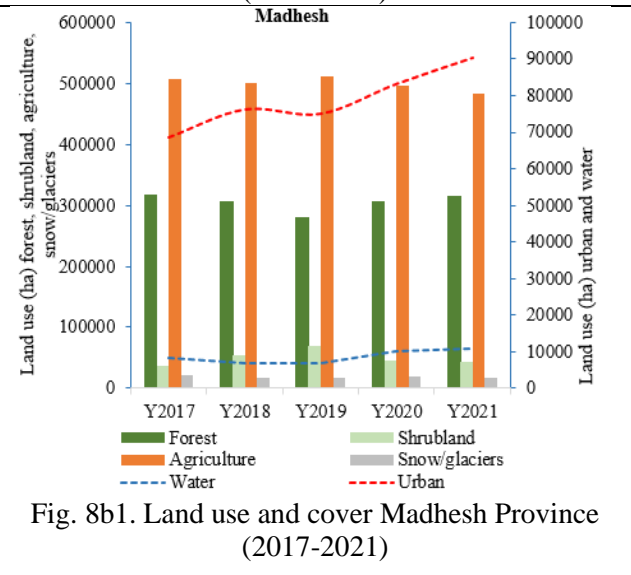


Fig. 8b1. Land use and cover Madhesh Province (2017-2021)

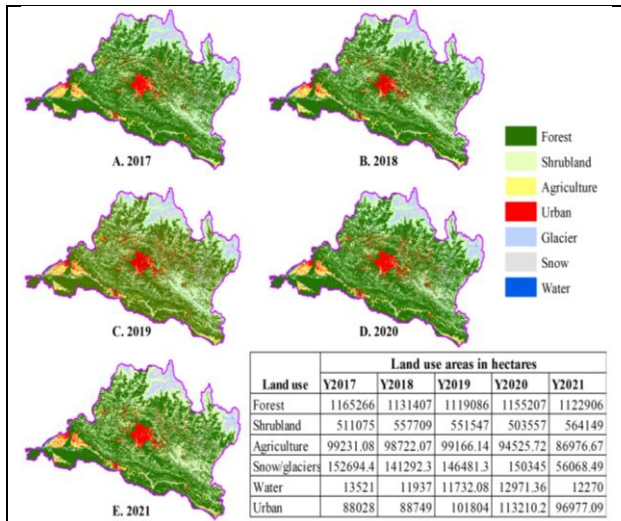


Fig. 8c. Land use and cover Bagmati Province (2017-2021)

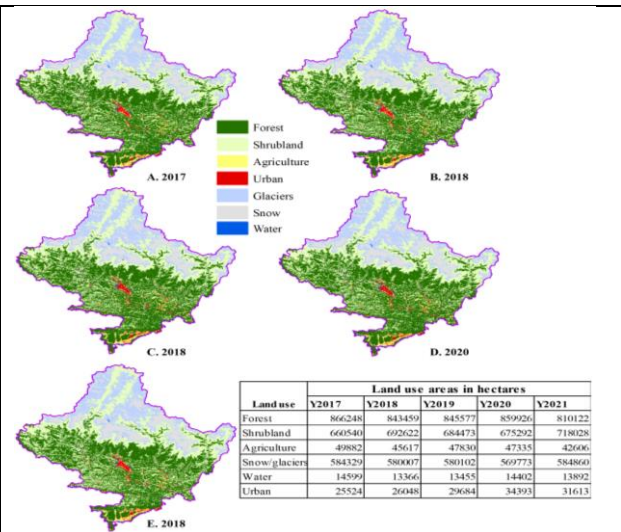


Fig. 8d. Land use and cover Gandaki Province (2017-2021)

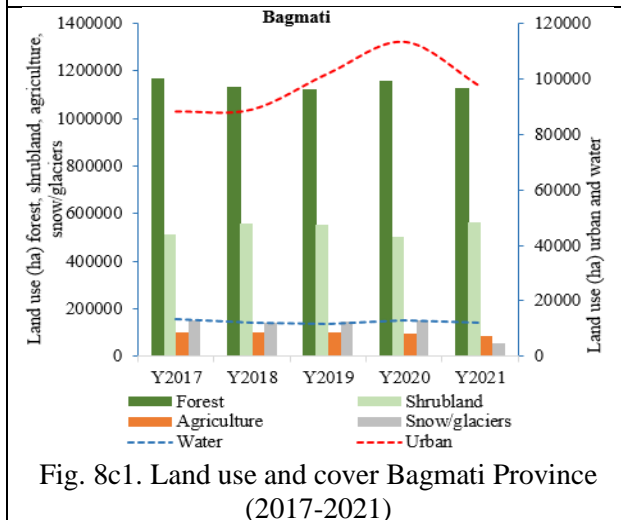


Fig. 8c1. Land use and cover Bagmati Province (2017-2021)

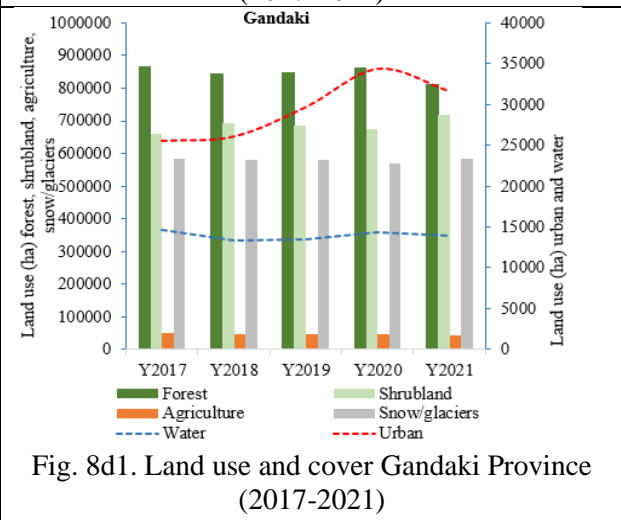


Fig. 8d1. Land use and cover Gandaki Province (2017-2021)

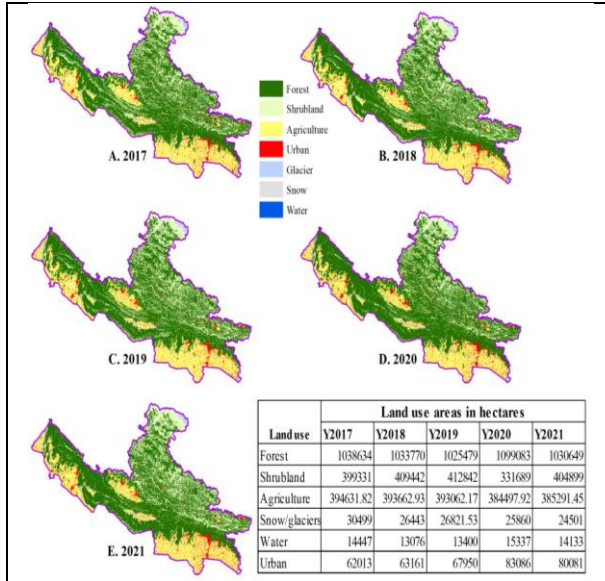


Fig. 8e. Land use and cover Lumbini Province (2017-2021)

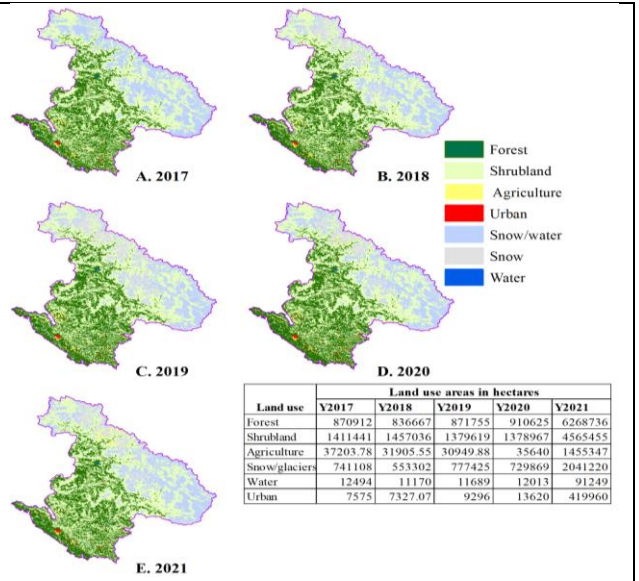


Fig. 8f. Land use and cover Karnali Province (2017 -2021)

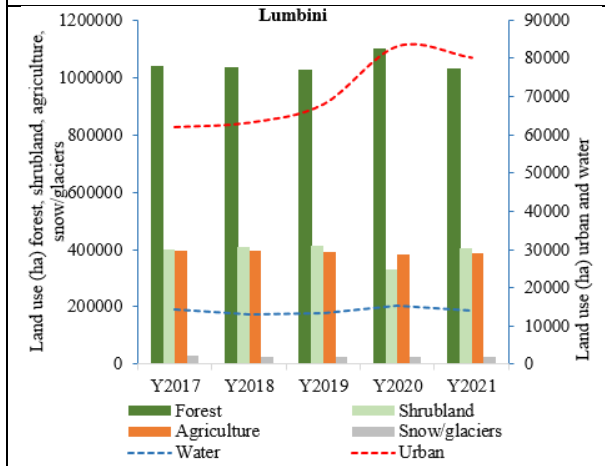


Fig. 8e1. Land use and cover Lumbini Province (2017-2021)

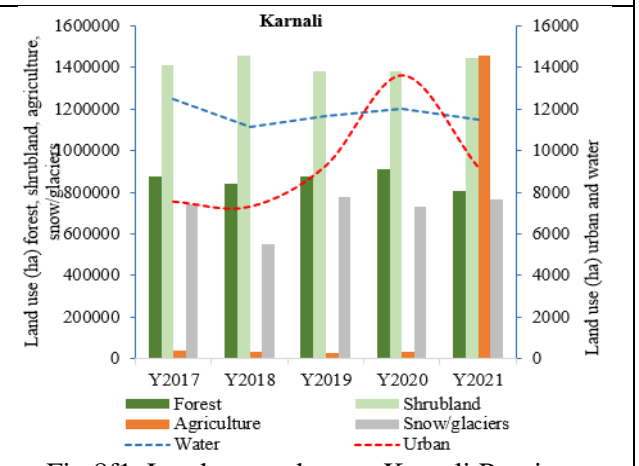


Fig.8f1. Land use and cover Karnali Province (2017-2021)

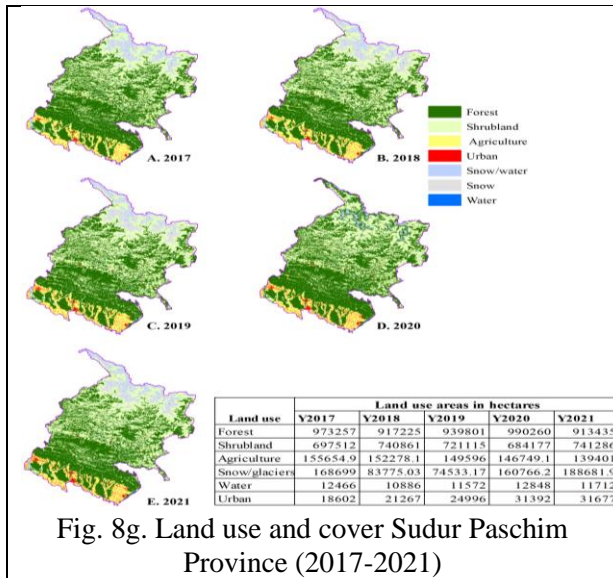


Fig. 8g. Land use and cover Sudur Paschim Province (2017-2021)

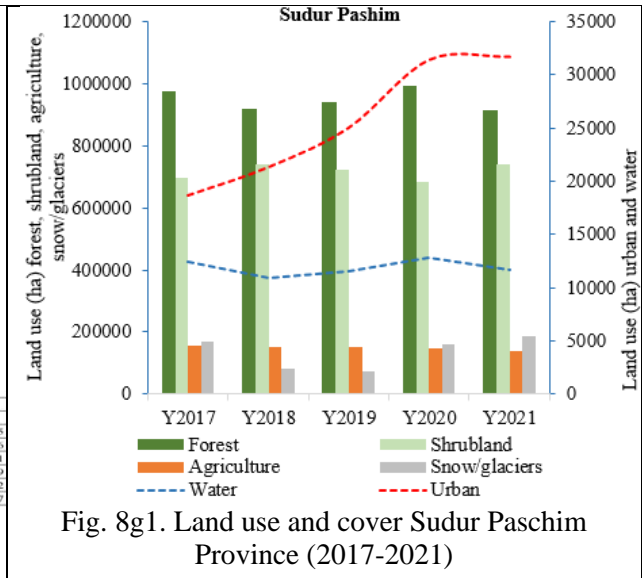


Fig. 8g1. Land use and cover Sudur Paschim Province (2017-2021)

Fig. 8. Land use and cover analyses at the provincial levels (2017-2021)

Our analysis of detailed land use and land cover changes from 2017 to 2021 reveals that before the Covid-19 pandemic, urban areas were growing in all provinces of Nepal. All these expansions occurred mainly along the road network on relatively topographically flat lands (Fig. 7). There are no urban expansions in the mountainous region (Figs. 9a-e).

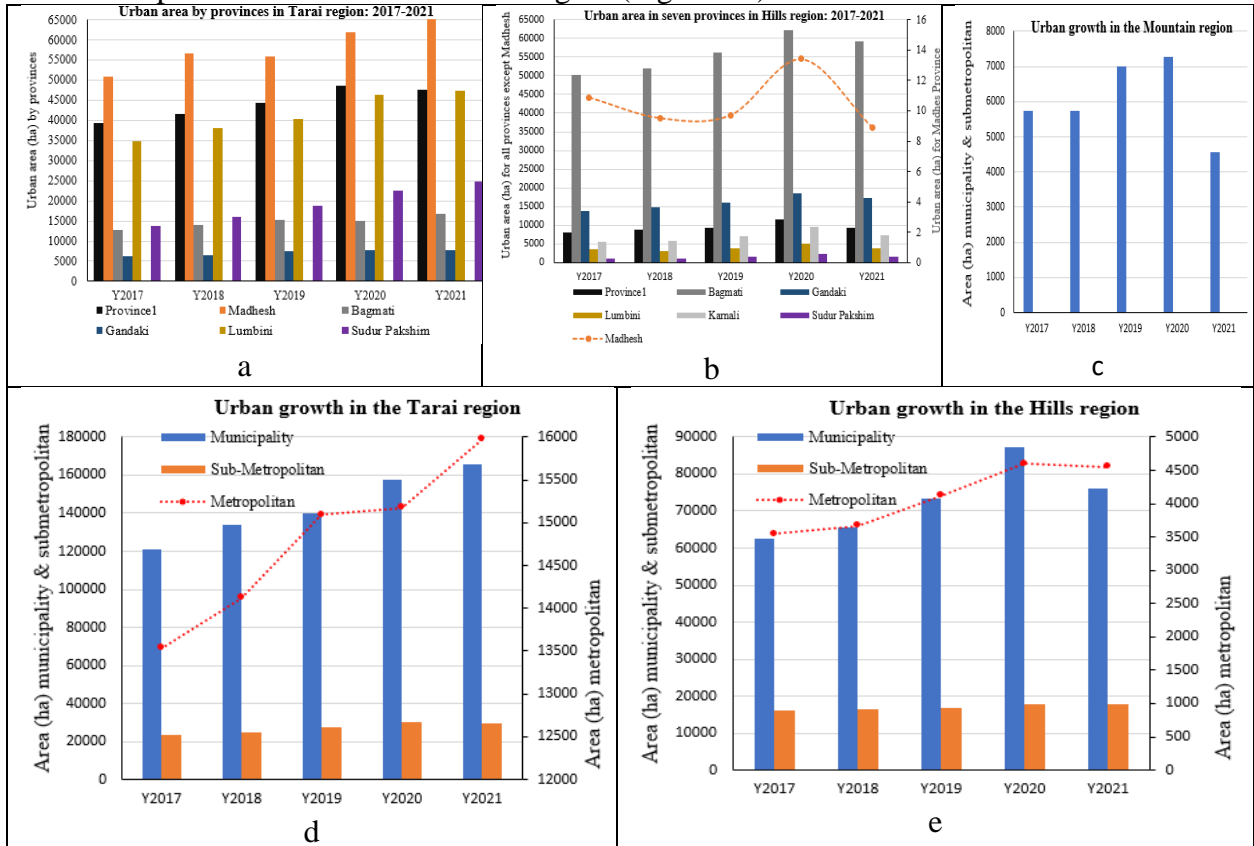


Fig. 9. Urban growth in Nepal by geographic regions (2017-2021): a) Tarai; b) Hills; c) Mountains; d) growth of municipality, sub-metropolis, and metropolis in the Tarai region; and e) growth of

municipality, sub-metropolis, and metropolis in the hill region. The mountain region has very few municipalities, and there are no sub-metropolis and metropolises.

5.2 Statistical modeling

We analyzed spatial expansion of urban areas in Nepal and visualized different growth scenarios. To assess the annual rate of growth of urban areas in different provinces, we regressed the percentages of urban growth as the dependent variable for the years 2017, 2018, 2019, 2020, and 2021 with independent variables such as forest, agriculture, shrubland, and road surface areas of the human settlements. We took 2017 as a base year and calculated the annual rate of urban growth for each province. Bagmati Province, which includes Nepal’s capital region, tops the list as the most urbanized province. This is followed by Lumbini, Madhesh, Koshi, Gandaki, Sudur Paschim, and Karnali Provinces, respectively.

Table 9: Urban areas as the percentage of total provincial population in 2017 and the average annual change rate of urban growth in Nepal

Urban changes from 2017 (base year), change rate, t-value, and p-significance				
Province	Urban (%) 2017	Change (± se) Per year (%)	t-value	p-significant
Bagmati	12.45	0.65 ± 0.28	2.28	0.0229
Madhesh	7.57	0.56 ± 0.10	5.55	<0.0001
Lumbini	5.75	0.54 ± 0.17	3.26	0.0011
Koshi	5.75	0.35 ± 0.16	3.26	0.0011
Gandaki	5.00	0.36 ± 0.21	1.74	0.0813
Sudur Pakshim	2.23	0.47 ± 0.12	3.89	0.0001
Karnali	0.91	0.13 ± 0.07	1.76	0.0788
NEPAL	5.6	0.44 ± 0.07	6.5	<0.0001

We ran the simple linear regression model to see the effect of urbanization on the conversion of various land use and cover and presented the regression outcomes in Table 10. Regression analysis reveals that one percent increase in road area/length would accelerate the formation of urban areas by 7 percent per year. Conversely, one percent increase in urban land area would lead to the decrease in 0.42 percent of forest land cover, 0.51 percent of shrub land, and 0.10 percent of agricultural land. These parameters suggest that there is a direct relationship between the road construction and urban formation whereas a negative correlation exists between the increase of urban areas with the forest, shrubland, and agricultural land area.

Table 9. Estimated effects of some variables on urban area formation

Variable	Estimate (%)	Standard Error	t Value	Pr > t	R-square
Road	7.00	0.07	107.34	<.0001	0.40
Forest	-0.42	0.01	-70.27	<.0001	0.22
Shrub	-0.51	0.01	-56.07	<.0001	0.15
Agri	-0.10	0.01	-17.04	<.0001	0.02

Finally, we ran another multiple regression model using the road surface area as the main variable while keeping forest, urban and agricultural land areas as constant. Parameter estimates are presented in table 10. Results suggest that one percent increase in road surface area would lead to 0.47 percent increase in the urban area. This suggests that merely expanding road length /area does not contribute to the expansion of urban areas unless land conversions occur from forest, shrub land, and agricultural lands to urban areas. Thus, it can be concluded that urban area is the byproduct of the conversion of forest, shrubland and agricultural areas and is aided by increase in road length and surface area.

Table 10. Relationship between urban formation and forest, shrubland and agricultural land conversion using road as the main variable. (R-square: 0.967)

Variable	Estimate (%)	Standard Error	t	p
Intercept	91.37	0.21	429.65	<.0001
Road	0.47	0.02	23.9	<.0001
Forest	-0.95	0.002	-467.24	<.0001
Shrub	-0.97	0.002	-416.39	<.0001
Agri	-0.95	0.002	-465.6	<.0001

6. Concluding remarks

We looked at the fundamental causes of urban expansion in Nepal between 2017 and 2021. Our analysis reveals that though several factors should have been taken into consideration to define a human settlement as urban, political interest seems to have unduly influenced the decision-making process in creating and the boundaries for cities/towns. Although there is no universally accepted definition for what is urban, Nepal government’s new urban definition is not consistent with the internationally accepted criteria. Nepal’s newly delineated urban areas often do not meet the generally accepted criteria for urban settlements such as transportation, water and wastewater services, parks and recreation, population density, services and economic basis for urban areas. The authors feel that the data in the 2022 Nepal national census showing that 66 percent of the Nepali population perhaps exaggerates the number of people that live in truly urban environments.

To help better understand how urbanization might be accomplished in a balanced manner by creating economic corridors, we presented descriptive analysis from population distribution and economic activities. Since we did not find that the government had followed any internationally recognized method of urban classification, we focused our analysis on land use and cover situation from 2017 to 2021. Understanding the specifics of land use planning is crucial for sustainable urbanization. Our analyses shed light on the status of different land uses such as agriculture, forest, shrubland, waters, and roads. Our analysis shows that agricultural land is decreasing and some districts, such as Bhaktapur has already been declared as a district that is rapidly losing its agricultural land. Covid-19 has taught us that the preservation of agricultural lands in urban areas is important to strengthen the local food supply chain, and for cooling the planet through green spaces. We expect that our land use analysis will help policymakers, city planners, and local government authorities develop sustainable urban development strategies.

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