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*Full Length Research Paper*

# **Public open spaces in Crisis: Appraisal and observation from metropolitan Kathmandu, Nepal**

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**There is an emerging debate in the literature of urbanism that public open space is in crisis in the cities of developing countries due to the increasing trends of urbanization and in-migration. With the significant growth of the urban population and rapid expansion of the city, the land demand for housing and other infrastructure development is very high. The high rate of urbanization due to which encroachment, high speculation, use change, etc. are the major reasons for decreasing public open spaces. There are many inferences that public open spaces are decreasing in Kathmandu Metropolitan City (KMC) as Tundikhel; an important public open space located in the heart of Kathmandu is decreasing in its size and has changed in its use over time. At present, KMC does not have a sizable public open space for emergency uses such as evacuation, relief, recovery, and reconstruction during the catastrophic hazards. Analysis of historical imagery and the changing patterns of land use reveal that the decreasing trends of open spaces may lead more vulnerable to the city as it does not have public open space for disaster management in an emergency need. Moreover, it may have adverse impacts on sociability and well-being as people do not get space for public life activities.**

**Key words:** Urbanization, migration, land use change, public open space, sociability.

## **INTRODUCTION**

Public open space is a place that is not closed or blocked up and provides access to people for enjoyment, social gatherings, organizing political events, religious, sports, commercial activities, and is controlled and managed for the public interest (Madanipour, 2003; Wooley, 2003). There is a clear distinction between public open space and open space. Open space can be accounted for all types of open spaces including private and public open areas, whereas public open space is the open space that is accessible to all people without any restrictions. It means all public open areas are open space but all open areas may not be the public open space. In the urban contexts, open spaces contribute to the urban residence

that underpins many social, ecological, and economic activities, and are essential to the healthy functioning of urban life and environment (RECPHEC, 2016; UN-Habitat, 2018). These spaces are valuable for urban residence as it provides commonplace for recreation, health enhancement, developing social networking, and enhancing peoples' well-being. There is increasing debate among the academicians that public open spaces are the essential assets of urban life. But with a rapidly increasing population causing a high growth rate of urbanization has been demanding more land for housing, infrastructure development in the cities of developing countries which has led to decreasing public open

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spaces. Evidence reveals that public open spaces in the cities of developing countries are very limited which may result in limiting public life as people do not get space for public interactions, recreations, and organizing public events (UN-Habitat, 2018). Cities in developing countries are facing a public/open space crisis. High population growth and in-migration leading to urbanization in the cities like KMC are the major causes of decreasing the public/open space. So discussions about urbanization and land-use trend are pertinent to present how these impact in diminishing public/open space in KMC.

Urbanization refers to the process of growth in the proportion of the population living in urban areas with the structural shift in employment from agriculture to non-agriculture pursuits (Sharma, 2003). The structural shift which is expected in urbanization is always in question in the contexts of Nepal's urbanization process. As the government declared 293 municipalities in the process of the promulgation of the new federal constitution in 2015, most of these municipalities are still having a reliant base of an agricultural economy. Rural areas are converted into urban areas which are lacking not only the basic infrastructures but are lacking employment in other sectors and heavily dependent on agriculture. Due to which migration still exists between towns and regions from the less potential towns to high potential towns and cities (Devkota, 2018; Suwal, 2014). Kathmandu Valley (KV) is still a potential destination of migrants as it poses a high opportunity for employment, education, and better services there. Due to this, potential cultivable lands are converting into built-up forms leaving no proper public open spaces for recreation and sociability. Furthermore, such a scenario has posed many implications associated with the society linking it with well-being, disaster risk reduction, and the environment.

Kathmandu valley is one of the highest populated, and it has been rapidly expanding its settlement areas from the core to its fringes. Valley's urbanization is highly dynamic in its spatial pattern, complex in its nature, and expanding built-up areas from the core to its fringes converting agriculture land use into urban use (Thapa, 2009). Development in the valley was taking place with uncontrolled infill development and individual housing in the past. Some planned development initiatives have been ongoing in the later stages to make cities reasonably healthy and sustainable with some provisions of open spaces. However, with increasing population inflow in the valley, land value is highly increasing due to which there is high pressure on open space including the agriculture field (KVDA, 2015; Thapa, 2009). Due to its rapid urban expansion, public/open spaces are decreasing in such a way that the government now does not get public land for public infrastructure development in the city. It has also been corroborated that in case of a catastrophic disaster hit, the government would not get essential open space for treatment, emergency relief, rescue, and recovery in Kathmandu.

Despite the conversion of agriculture land into built-up form, there is a trend of decreasing available public land for different uses in Kathmandu. Studies show that Tundikel, a public open space of the heart of Kathmandu has been decreased almost half in the past 60 years in the name of different uses (Shrestha, 2018). Evidence shows that use change, uses transformation, encroachment, etc. are the major reasons for the loss in public open space. Similarly, the encroachment of river corridors and some public open spaces in the inner part of KMC is due to the increasing trends of squatter settlements (DUDBC, 2010). Increasing squatter settlements may cause of decreasing public open spaces in Kathmandu. This paper explores urbanization trends and rapid urban expansion in the valley and in KMC to assess how these processes affect to decreasing public/open space and its implications.

## MATERIALS AND METHODS

This research paper is based on a review of existing literature on open space, urban development, migration, and urbanization of Kathmandu Valley and KMC. Population censuses from 1981 to 2011 and other published secondary data were collected through different sources. Some map data were collected from published and unpublished articles and theses. Data from various institutions such as National Society for Earthquake Technology (NSET), Kathmandu Valley Development Authority (KVDA), Kathmandu Metropolitan City (KMC) were collected, and reviewed and found out the urban expansion pattern in the valley and KMC. Historical images were collected by Google Earth's historical images and archive data of secondary sources. Similarly, the latest, land use map of KMC was prepared by using the latest Google Earth images in the GIS environment and then further analyzed with image interpretation methods. The GIS data then overlaid with KMC's previous GIS dataset, 2011 to get changes in urban development trends and patterns to see how changes are occurring to threaten the public/open space. Likewise, empirical data such as research findings and excerpts were used to interpret on encroachment, uses change and transformation of the open area into built-up form. All the data were thoroughly categorized, interpreted, and then analyzed to get the intended objectives. The details of the methods for collecting data and analysis are presented in Figure 1.

### Kathmandu Valley and KMC: Brief overview

Kathmandu Valley comprises three districts namely Kathmandu, Lalitpur, and Bhaktapur together which cover an area of 899 km<sup>2</sup>, whereas the area of the Valley is 721.87 km<sup>2</sup>. The Valley encloses the entire area of Kathmandu and Bhaktapur districts and 50% of Lalitpur district. Geographically, the valley is situated between 27°31'55" to 27°48'56" North Latitude and 85°11'11" to 85°31'52" East Longitude. The valley comprises 18 units of municipalities (2 Metropolitan Cities and 16 Municipalities) with some portion of Bagmati and Konjyoson Rural Municipalities of Lalitpur district. The valley extends from 1,425 m in its lowest height to 2,732 m highest height. Kathmandu Metropolitan City is the federal capital city of Nepal which is located in the central part of the valley. It is not only the capital of the Federal Democratic Republic of Nepal but it is the historic, political, commercial, cultural, and tourist center of the country (EMI, 2010). The city is the urban core of the Kathmandu Valley with a total area of 50.67km<sup>2</sup>. It is situated at an average altitude of 1,350m above sea level. The city is located at 85°19'14"

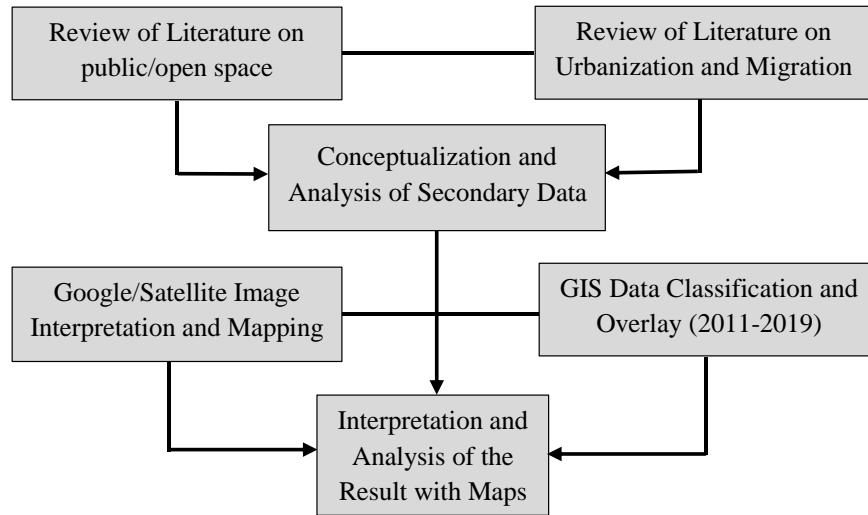


Figure 1. Methods of data collection and analysis.

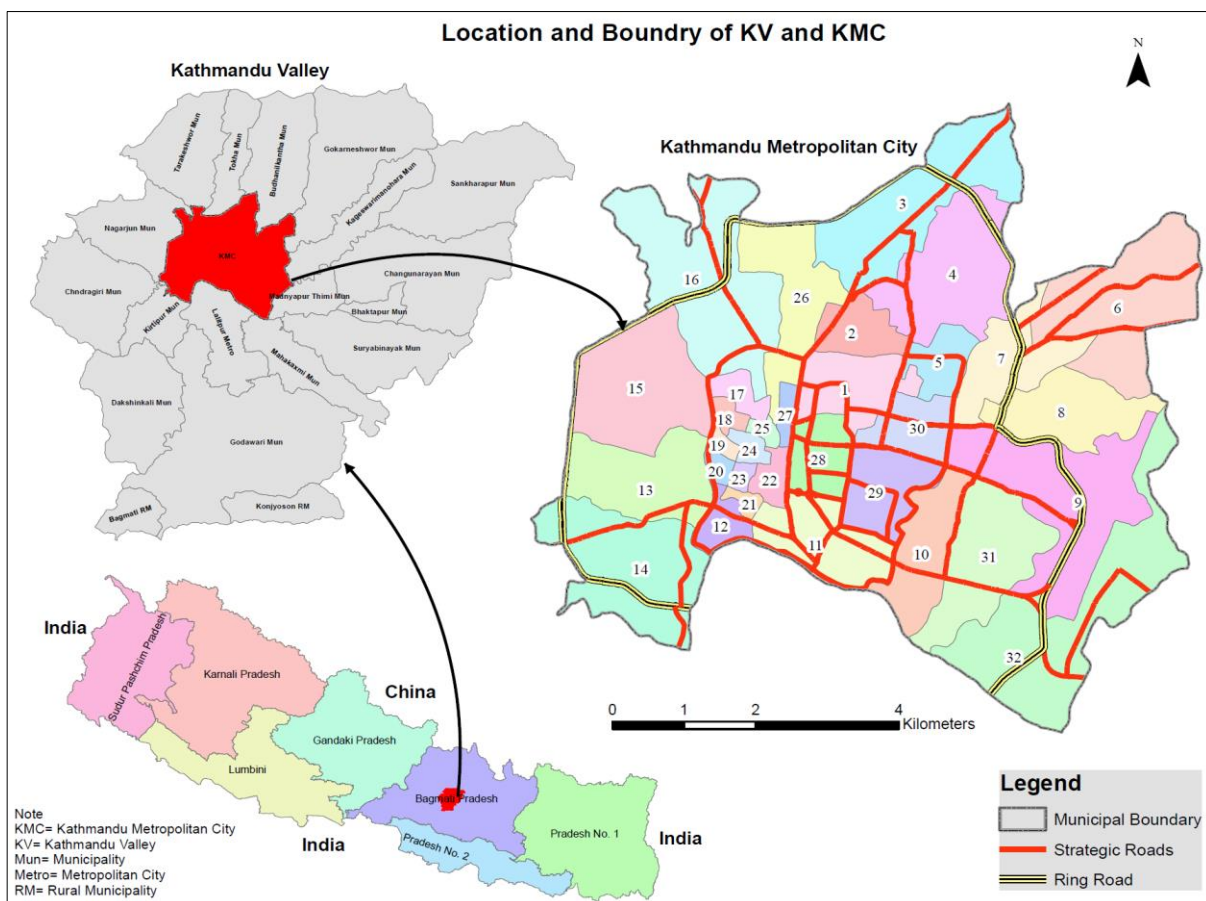


Figure 2. Location and Boundary of Kathmandu Valley and KMC.

East longitude and 27°42'06" North latitude. Divided into 32 wards, KMC is bordered with Lalitpur Metropolitan City and Kiritipur Municipality in the South, Nagarjun Municipality in the West,

Tarkeshwor, Tokha and Budhanilkantha Municipalities in the North and Gokarneshwor, Kageshwari Manohara and Bhaktapur Municipalities in the East (Figure 2).

## RESULTS AND DISCUSSION

### Urbanization trends in Kathmandu Valley

Urbanization is taking place rapidly with a share of 62.6% of the urban population in the total population of Nepal (MoFAGA, 2017) that has been found to increase from 4.88% in 1991 to 62.6% in 2015. The Kathmandu Valley is the most populated urban region and one of the fastest-growing urban agglomerations in South Asia (Muzzini and Apericio, 2013) which has a huge impact on the social and economic pattern in the valley. At present, the Valley accounts for 24.11% of the total urban population of Nepal with a share of 36.06 in KMC (MoFAGA, 2017) alone in the Valley's urban population. Table 1 shows the urbanization trend and urban growth rate of the KV. In 1981, there were only 3 municipalities with 77,038 population in the valley. After 10 years in 1991, the total number of municipalities in the valley reached 5 with a total of 1,105,379 population. The population of the valley increased by 871,932 with an annual growth rate of 5.3% in 2011 even though the number of municipalities was only 5. The growth rate increased by 5.89% in 2019/2020. During the state restructuring in 2015, the number of municipalities in the valley increased by almost four times with a total of 18 municipalities (including two metropolitan Cities). In-migration is one of the reasons for the increasing population trend in the valley as it is the most common destination of inter-district current migrants as nearly 38% of current migrants go to the central hill, out of which 34% are based in the three districts of KV (Suwal, 2014).

### Urbanization trends in KMC with compare to other urban areas

The population of KMC has been increasing rapidly over the past ten years. In-migration towards the city is increasing due to the income and employment opportunities, available urban facilities and services, and of course being the Federal Capital City of Nepal. Likewise, boundary readjustments at different times also played a role in the increase of the city's population. KMC is one of the major destinations of migrants as it has several potentialities to cater to migrants' populations here in different economic sectors. As a result, KMC's population has grown by about 48% over ten years (2011-2019), from 975,453 people in 2011 to 1,442,271 people in 2019 (CBS, 2011; World Population Atlas, 2020). Historically known as *Newar* settlement (Slusser, 1982; Malla, 1978; Kirkpatrick, 1969; cited in Subedi, 2010), KMC is the most densely populated city in Nepal with a density of 132.34 person per hectare which is higher compared to the aggregate urban population density of all the cities of Nepal recorded at only 3.77 persons per hectare (Subedi, 2010; Muzzini and Apericio, 2013).

Historical trends of population growth in KMC have been observed comparing it with KV and the overall urban population of Nepal. The highest growth rate among the censuses 1952/1954 to 2011, census 1991 poses the highest one with 7.91% of the annual growth rate. After 2001, the growth rate is slightly dropping down but its share in the valley's population is also shrinking from 67.5% in 2001 to 39.2% in 2011 which implies population concentration is slightly shifted towards nearby towns of KMC. However, after state reconstruction during the implementation of the Federal Constitution of Nepal, there were drastic changes in local government bodies, and the number of municipalities in Nepal reached 293. Now the share of the urban population in the country reached 62.7% and its share in the population of the valley decreased to 24.11%. The demographic situation and trends of population growth of KMC is presented in Table 2.

The unprecedented population increase in Kathmandu over the last few decades is not only due to a higher rate of natural increase but also due to a high level of in-migration and immigration in the valley (Subedi, 2010) and KMC. Being Federal Capital, KMC is the central attraction for services and economic opportunities that contributed to in-migration. Expansion of built-up areas (Ishtiaque et al., 2017). KMC experiences a high rate of and rapid conversion of agriculture land into built-up is caused by massive rural-to-urban migration (Rimal, 2011; in-migration with people coming from municipalities and districts outside of the valley (EMI, 2010). As there was 975,453 population in the 2011 census, it has now reached to 1,442,271 and it is projected to be 1,855,000 by 2030 (Muzzini and Apericio, 2013). Among the major causes of increasing rural-to-urban migration in the valley in general and in KMC in particular, are job searching, easy lifestyle, education/training, natural disaster family reasons, political reason in the area of origin. This is obvious that such external migrants are mainly concentrated in KMC as the migrants mainly choose to work and livelihoods (Timalsina, 2011), business, schooling, and diplomatic purposes. Though there is an increasing trend of migrants' priority at nearby towns of KMC in the later years (Subedi, 2010), there is still a huge bulge of migrants who choose to migrate because of the high probability of getting jobs.

### Land use change in KMC

The scenario of land use changes over 40 years reveals that the built-up area in KMC has been increasing tremendously. Evidence shows that there has been a significant land-use change in KMC, converting agriculture and open spaces into the built-up form. This significant urban growth and rapid urban expansion coupled with unmanaged settlement development which has led to various socio-environmental challenges (Thapa, 2009;

**Table 1.** Increase of population in Kathmandu Valley.

Year	No of municipalities	Total population	Population growth	Growth rate (%)
1981	3	770,389	-	-
1991	3	1,105,379	334,990	4.88
2001	5	1,645,091	539,721	4.34
2011	5	2,517,023	871,932	5.30
2019	18	4,000,000*	1,500,000*	5.89

Source: Sharma, 2003; Dong and Karmacharya, 2018 and MoFAGA, 2017.

\*Approximate (estimated in 2019/2020).

**Table 2.** Trends of urban population growth.

Year	Kathmandu Metropolitan City (KMC)			Kathmandu Valley (KV)		Nepal	
	Population size	As % of KV	Growth rate	Population size	As % of urban Nepal	Population size	% of urban population
1952/54	106,579	54.2	-	196,777 (5)	82.6	238,275	2.9
1961	121,019	55.5	1.35	218,092 (5)	64.9	336,222	3.6
1971	150,402	60.3	2.43	249,563 (3)	54.0	461,938	4.0
1981	235,160	64.7	5.63	363,507 (3)	38.0	956,721	6.4
1991	421,258	70.4	7.91	598,528 (3)	35.3	1,695,719	9.2
2001	671,846	67.5	5.95	995,966 (5)	30.9	3,227,879	13.9
2011	975,453	39.2	4.67	2,517,023 (5)	55.6	4,523,820	17.1
1919	1,442,271*	36.06	5.32	4,000,000 (18) ***	24.11	16,587,625**	62.6*

Number in the parenthesis is the total number of municipalities in the respective year; \*Population data were taken from World Population Atlas and World Population Review 2020. \*\* Considering 2015 restructured 293 municipalities of population 2011.\*\*\*Valley's estimated population).

Source: Subedi, 2010; Population Census, 2011; Population Monograph, 2014; World Population Atlas, 2020.

Rimal, 2011; Ishtiaque et al., 2017) including increase informal settlements, ineffectiveness in implementation of land use zoning, decreasing public resources and poor governance and service delivery (MoUD, 2013; KVDA, 2015). The land-use change from 1980 to 2019 in KMC is observed that within 40 years' time period, cultivable land is almost disappeared and a significant decrease in open areas (Figure 3). Such changes in land use are the result of rapid in-migration which has resulted in encroachment, depletion of public open spaces, and resulting in its associated consequences.

Land-use changes of KMC comparing with the land use data of 1980, 2011, and 2019 is presented in Table 3. It reveals that in 2019 KMC occupies 58.77% area as mixed-use (residential, commercial) whereas only 5.47% area is under cultivation. Similarly, 8.5% area as road, 7.74% area as institutional, 3.22% area as a recreational area. Changes in land use/cover from 1980 to 2019 reveal a huge change with 40% growth in the built-up area whereas cultivation decreased by almost 53%. Changes have also occurred in an open space which decreased by 1.76% in the same period.

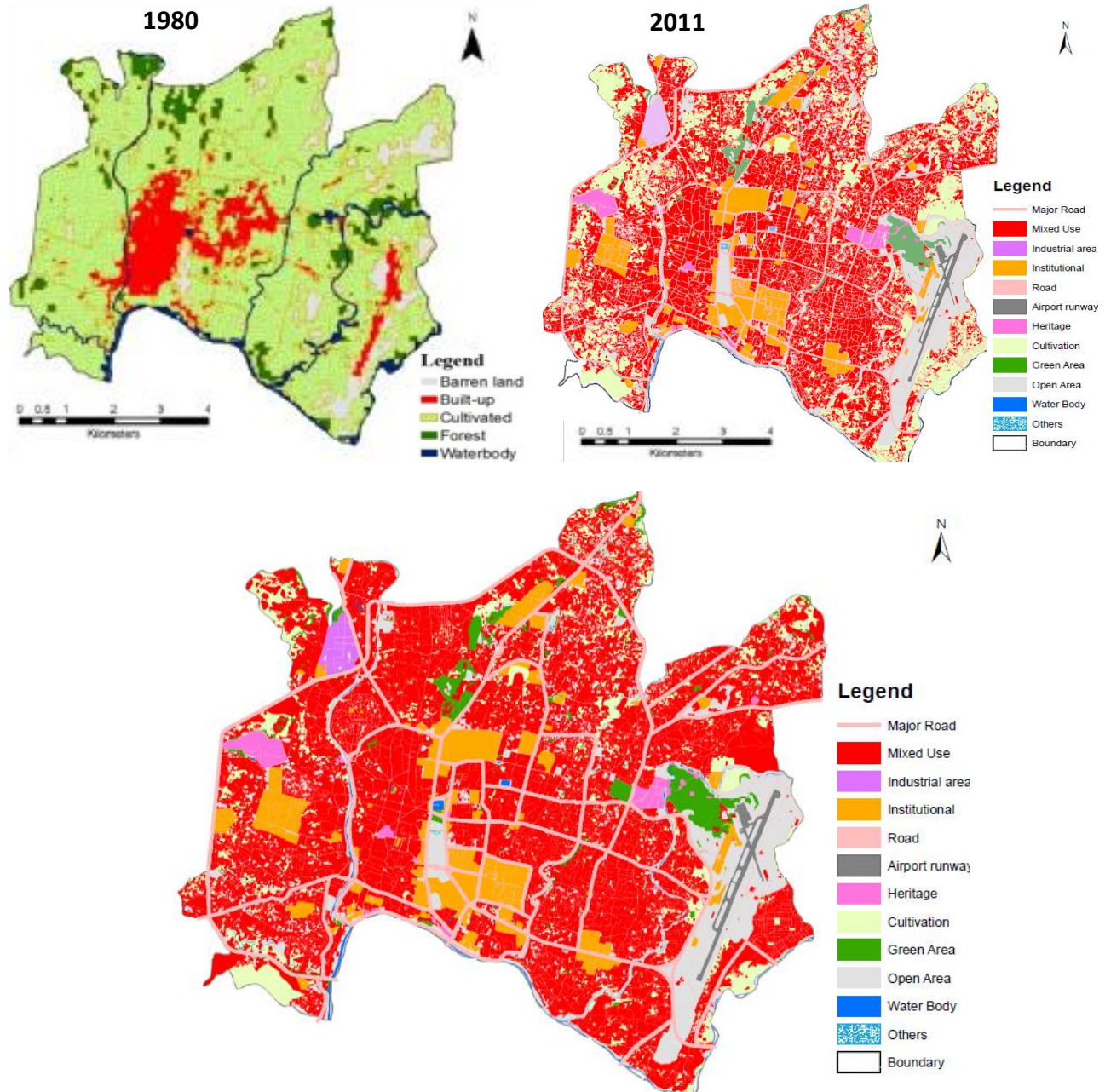
One of the tools for regulating urban growth is by implementing land-use zoning by-laws. However, the land-use zone as prescribed by building by-laws of KVTDC (2007) with 9 zones such as: 1) Old city zone, 2)

Residential zone, 3) Institutional zone, 4) Industrial zone, 5) Protected zone/recreational zone, 6) City expansion zone, 7) Surface transport zone, 8) Airport zone, 9) Sports zone has not been translated into implementations so that the development and urban expansion is haphazard (KMC, 2011; MoUD, 2015). Present land use in KMC is predominantly mixed land use which comprises mostly of combined residential and commercial land uses and there is no specific zone that could be viewed in the ground but poses messy urban growth. Reviewing the urban development and growth trends, it reveals that both the agriculture area and open spaces are decreased both in the valley and in KMC. On the one hand, the land use picture of KMC is a kind of messy that has not been regulated by the proposed land-use zoning, on the other hand, open areas have been converting into built-up forms heading to haphazard urban development that ruins the remaining public open space in the days to come.

### Trends of increasing built-up area

Looking at the trends of change in the built-up area of Kathmandu, it is apparent that the growth trend is increasing in the later decades. The different points of





**Figure 3.** Land use change in KMC: 1980-2019.  
Source: Pradhan-Salike and Pokhrel (2017); KMC (2011) and Google Earth Image, 2019.).

time historic data reveal the growth of the built-up area in KMC is witnessed an unprecedented increase in recent decades. As discussed earlier, decreasing open spaces is the result of increasing in-migration and urbanization in Kathmandu Valley in general and KMC in particular which is justified that urbanization growth in KMC in 1990 was the highest with 7.91. But the decades of 1990 and 2000 also show a significant increase in the built-up areas with a high concentration in the fringe areas (KVDA, 2015) such as *Sitapaila, Gongabu, Balaju, Nayabazar, Pepsicola, Sinamangal, Buddhanagar Kapan, Baudha*, etc. These

decades received a large flow of in-migrants due to political unrest affecting mainly in rural areas of Nepal.

Historical images of different areas of KMC reveals a tremendous growth converting agricultural land into the built-up area. This scenario illustrates to the researcher and urban authorities that open space in KMC will no longer be available due to such unprecedented urban growth. The following figures show how urban growth from some historical point of time taking place resulting in decreasing open spaces in KMC. Figures 4 to 6 reveal different areas of changing built-up form in Kathmandu

**Table 3.** Land use change scenario of KMC.

Major land use type	1980		2011		2019*		Percentage point change (1980-2019)
	Area (km <sup>2</sup> )**	%	Area (km <sup>2</sup> )	%	Area (km <sup>2</sup> )	%	
Cultivation	29.55	58.32	5.56	10.97	2.77	5.47	-52.85
Mixed use (residential and commercial) Area	9.5	18.75	26.68	52.65	29.78	58.77	40.02
Open Area	6.6	13.03	5.86	11.57	5.71	11.27	-1.76
Institutional Area	-	-	3.86	7.62	3.92	7.74	-
Road	-	-	4.17	8.23	4.31	8.51	-
Heritage Conservation Area	-	-	0.64	1.26	0.63	1.24	-
Industrial Area	-	-	0.32	0.63	0.33	0.65	-
Airport Runway	-	-	0.33	0.65	0.33	0.65	-
Recreational and Green Area (Forest, Park, Plantation)	-	-	2	3.95	1.63	3.22	-
Water Body	0.69	1.36	0.67	1.32	0.67	1.32	-0.04
Other (sandy area, waste body, etc.)	-	-	0.59	1.16	0.59	1.16	-
<b>Total</b>	<b>50.67</b>	<b>100.00</b>	<b>50.67</b>	<b>100.00</b>	<b>50.67</b>	<b>100.00</b>	

\* The data is derived from the proposed land use plan of 5 years periodic plan of KMC and map overlaid on the Google-based image, 2019.

\*\* Data acquired from Salike and Pokhrel, 2017, and KVDA, 2015 in which broad land use category is defined as baren land, cultivation, build-up (including airport ground), forest and water body. So data on other categories for that year is not available.

Source: KMC (2012) and Periodic Plan of KMC (2011).



**Figure 4.** Increasing scenario of converting open space into built-up form around Boudhanath area. Source: Google Earth Archived Image, 2003 and 2019 and Thapa, 2009

over time and give a picture of how the urban expansion is taking its pace leading to higher densities in the city causing decreasing open areas. Archive images of different periods reveal that the open agriculture fields have changed into a built-up form with an increasing trend of building construction. Settlement development is taking place with a high concentration in the fringe areas as the city core already became very dense. These scenarios present rapid urban expansion with changing agriculture/open field into built-up that leads to public

open space crisis in KMC.

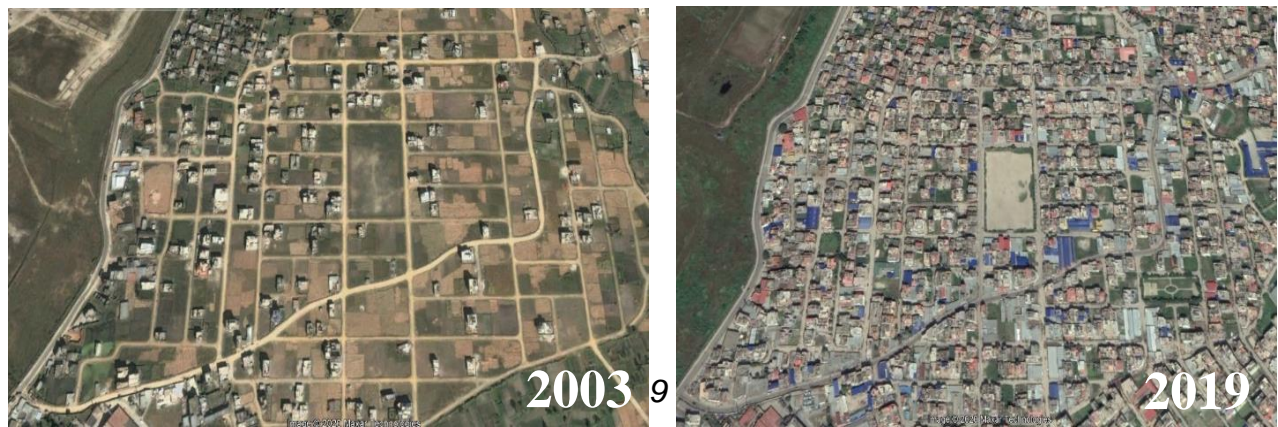
### Loss of public open spaces: Ruin to all

As defined above, public spaces are all places publicly owned or of public use, accessible and enjoyable by all for free and without a profit motive (Amanda, 2017; UN-Habitat, 2018), and it contributes to urban residence a place for social interactions and well-being. Public





**Figure 5.** Increasing scenario of building construction trend at Gangabu area.  
Source: Google Earth archived Image, 2003 and 2019.



**Figure 6.** Increasing scenario of building construction trends at Pepsicola planning area (Ward no 32).  
Source: Google Earth Image Archived, 2003 and 2019.

squares, parks, gardens, courtyards, *Chautara*, barren lands, ponds and lakes, roads, etc. are considered public spaces. There is a growing interest in looking at various implications of public open spaces in the urbanism.

Dense cities like KMC where per capita open space is about only 2 m<sup>2</sup> which is quite less than the 9m<sup>2</sup> per capita according to WHO standards (UN-Habitat, 2018). Public open space is more valuable in the dense cities of developing countries where individual households do not have open spaces and people use public open space as a place for enhancing social capital and well-being for social interactions and establishing relations in the society (Bordieu, 1986). However, looking at the nature of public open spaces, some open spaces are very limited to public access and some others are having more access to them (Low and Smith, 2006). Therefore, accessibility patterns of public open spaces vary

according to the types, functions, and uses of public open spaces in the urban contexts vary according to its location, urban forms, and the settlement structures.

Public spaces play a vital role in the social life of urban communities as these provide space for interactions and establishing relations. Society acts as a self-organizing public service with a shared space in which experiences and values are created, shared and interactions among the community people established (Wooley, 2003; Stavrides, 2016; Massey and Massey, 2005). The public places of different scales at the community level can be a place for sharing feelings, experiences, knowledge, physical exercise for improving their health. Moreover, public open spaces in the urban areas provide a place for economic earnings, livelihoods to urban poor in Kathmandu (Timalsina, 2011). Evidence shows that public open spaces are decreasing rapidly with increasing

**Table 4.** Open space provisions.

Cities/agencies	% of open space	Open space per capita (m <sup>2</sup> )	Distance to open space (m)
Bogota		10	
Hongkong		2	
Johannesburg		24	
London			400
New York		10	
Singapore			400
Sidney			400
Stockholm			200
Vancouver			5
Mumbai		2	
Kathmandu	5% of the metro city area	2.05	
UN-Habitat	15% of the city area		400
WHO		9	300
ECI			300
US EPA			500

Source: Un-Habitat (2018); MoUD (2015).

built-up areas in the valley which has now become a central concern of researches, academicians, urban planners, and urban authorities.

There is a tendency that various cities in the world, countries, and organizations have different practices of provisioning the open spaces in urban development and planning. High dense cities such as New York, Hongkong, Johannesburg, etc. use per capita; cities like London, Singapore, Sidney, Vancouver, Stockholm use distance from the residence to open space. Organizations like WHO use per capita whereas ECI (European Common Indicators), US EPA (US Environment Protection Agency) use distance to open spaces and Un-Habitat uses both per capita and distance to open spaces. Table 4 reveals the major provisions and practices in world towns and agencies to make open space functional in the cities.

The data reveals that Johannesburg seems the highest per capita open space then followed by New York among the developed countries. However, cities in developing countries like Mumbai and Kathmandu have the least open space availability. Mumbai has below 2 m<sup>2</sup> per capita open spaces whereas KMC has 2.05m<sup>2</sup> per capita (UN-Habitat, 2018; KMC, 2011). It implies that public open spaces are important for urban life as many developed countries are giving high attention to make the cities lived and functional with sufficient public open space provisions for healthy living.

Altogether 887 open spaces were identified by the Kathmandu Valley Development Authority (KVDA) in the Kathmandu Valley among which, 488 are in Kathmandu, 346 are in Lalitpur, and 53 are in Bhaktapur Districts, and out of 488 open spaces of Kathmandu district, 266 are located in Kathmandu Metropolitan City (KVDA, 2015).

These open spaces are of different sizes and types including institutional, government, private, educational institutions, religious, hospital, and others. Open spaces including private ownership are included in the identified open spaces. The types and status of open spaces in Kathmandu are presented in Table 5, which reveals that among the available 5.71 km<sup>2</sup> of total open area, 76.5% is occupied by the Nepal government ownership including the government office coverage areas. About 51.6% of total open spaces are identified as useable in case of emergency need. The distribution of open spaces is presented in Figure 7. There is evidence in Kathmandu that public land has been converted into built-up infrastructures as many public areas have encroached. River corridors; both Bagmati and Bishnumati rivers, Tundikhel, Koteshwor area have encroached for different uses. River corridors are mostly encroached by the informal settlements whereas the decrease of Tundikhel was mainly because of expansion of road, uses changes (Dasharath Rangasala, Army headquarter in the past and conversion *Khulla Manch* into buss park recently) whereas the decrease of Koteshwor temple area is due to encroachment by a school and government office (Tiwari, 1989; Poudel, 2017) There are other many examples that cause decreasing the public open spaces in Kathmandu (Box 1). Thus, the open spaces are shrinking by encroachment, development of infrastructures, sub-division of land for uses changes. Unprecedented urbanization, the rapid expansion of settlements are the major causes for tempting to loss of public open space in KMC.

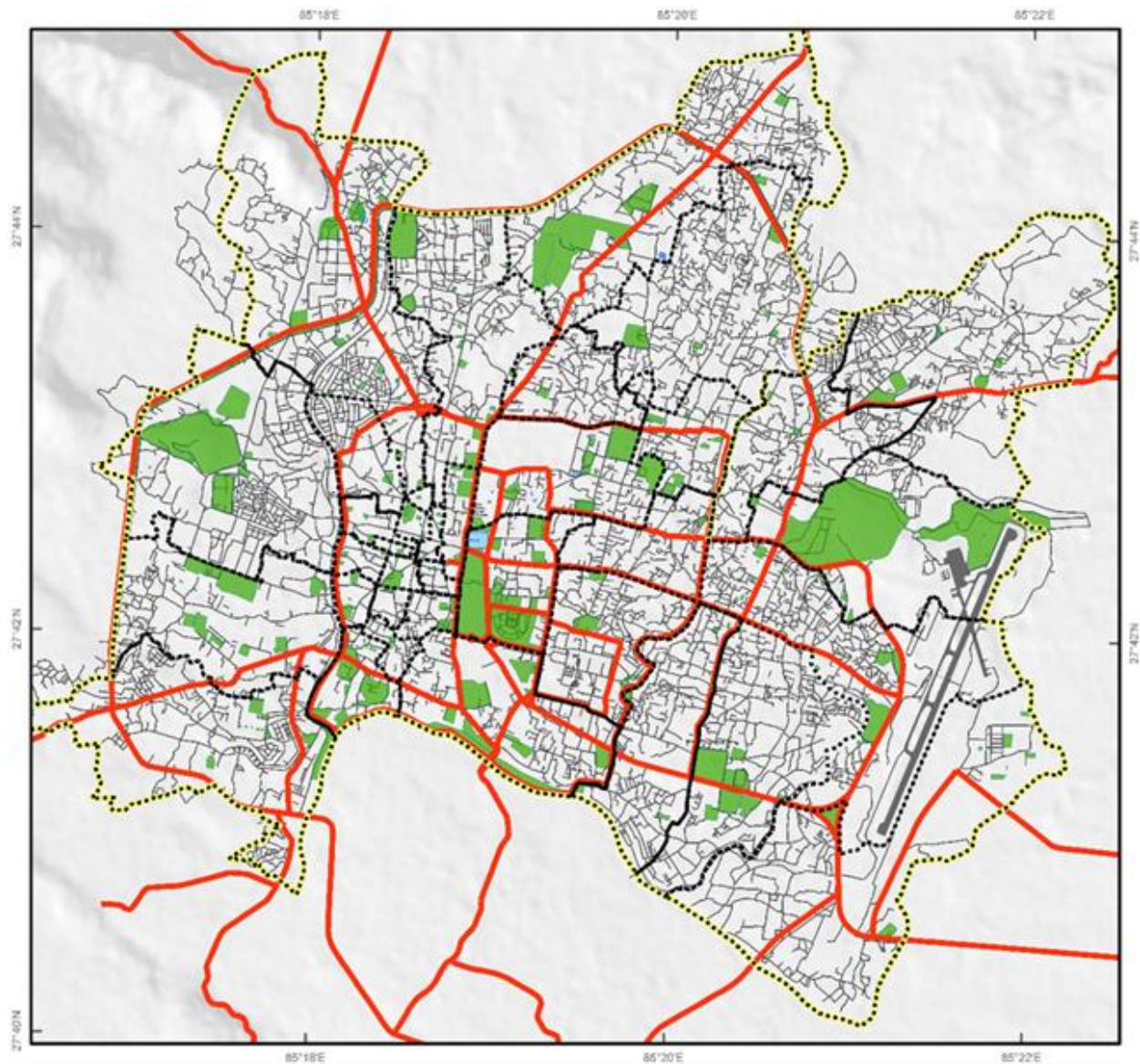
Data reveals that there are 2,333 squatter households with 11,473 population residing encroaching 183,495.96 m<sup>2</sup> public land in KMC (DUDBC, 2010) including river



**Table 5.** Types and status of open space in KMC.

S/N	Types	Total area (km <sup>2</sup> )	%	Useable area (km <sup>2</sup> )	% share of useable area
1	Campus	0.08	1.39	0.04	50.0
2	Guthi, temple, church, stupa, etc.	0.75	13.1	0.45	60.0
3	Hospital	0.05	0.87	0.02	40.0
4	Institutional	0.34	5.92	0.14	41.2
5	Nepal government (public)	4.39	76.5	2.24	51.0
6	Lease (privately owned land area with institutional use)	0.07	1.22	0.04	57.1
7	School	0.06	1.05	0.03	50.0
	<b>Total</b>	<b>5.74</b>	<b>100</b>	<b>2.96</b>	<b>51.6</b>

Source: KVDA, 2015.

**Figure 7.** Distribution of open spaces in KMC.  
Source: KVDA (2015).



**Figure 8.** Encroachment of public land along the Bagmati river corridor, Kupandol area (left: Satellite image visible open spaces without buildings along the river corridor in 2003; right: Satellite image showing increasing buildings in the same area in 2019).

corridors and other public lands. Some government-owned open spaces like river corridors are shrinking by the encroachment of informal settlements and squatters. The encroachment began in Kathmandu Valley in the name of landless squatters 26 years ago, but there was a spike in the numbers after the pro-republican movement of 2006 (Chitrakar, 2020) and there is an increasing trend of encroachment by the squatters. Figure 8 presents the encroachment of public land (open spaces) of *Bagmati* river corridor by the squatters and some inferences of decreasing open spaces in Kathmandu have also been presented in Box 1.

Hence, public spaces are the assets for cities to create sociality to give a feeling of togetherness among the community people through interaction, establish relations between space and people, recreation and well-being, people's health improvement, public gathering and social networking, safer place for sheltering during and after disasters (MoUD, 2015; KVDA, 2015). However, decreasing such invaluable open spaces may result a number of problems in Kathmandu making cities chaotic, disaggregated, less sociability, and environmentally vulnerable (Joshef Rountree Foundation-JFR, 2019). Social life in KMC is squeezing sociability as there has a decreasing trend of social gatherings, interactions, and networking among people. Decreasing the public realm is one of the causes as people have losing public spaces to gather, talk, and enjoy sharing a common information-sharing platform. Therefore, such a crisis of public open spaces may degrade the sociability and community well-being in dense cities like Kathmandu.

The empirical research findings as excerpts on decreasing public open space in KMC have been cited in Box 1. It reveals that Tundikhel, one of the important public open spaces located in the heart of KMC is reduced by almost half as the spaces have been

converted into institutional uses for Nepal Army and event management (Sharma, 2019; Chitrakar, 2020 and Chhetri, 2020). Similarly, a part of Tundikhel (Khulamanch) now has been converted into a bus park operation as another uses. Previously the old Buspark, located nearby Tundikhel is now has been going to convert into a modern multi-story building that is now under construction by Kathmandu Metropolitan City. It means KMC itself is converting the public open spaces into various uses. These open spaces would be useful to accommodate the whole population in the past but today all these open spaces have been converting into the built-up form or have been changed into other forms which indicate public open space diminishing in KMC. This will ruin public life activities in KMC by limiting people in daily public life activities.

## Conclusion

The significant growth of the urban population in KV and KMC leads to diminishing the public open space. The rapid expansion of the cities in the Kathmandu Valley is high due to the high demand of land for housing and infrastructure development to increased population. Now, there are all the local bodies within the valley as urban areas with 18 municipalities including two metropolitan cities that cover almost 24.11% of the total urban population of Nepal. KMC, being the Federal Capital of Nepal, has been attracting the migrant's population for employment, education, and other diplomatic purposes to live in. The increasing population on the one hand has led to converting the open area into built-up forms and on the other hand, it has been increasing pressure on the available public open spaces for different uses. As a result, the public open space is in the stage of vanishing

in KMC.

The high rate of in-migration and urbanization due to which encroachment, high speculation, use change, etc. are the major reasons for decreasing public open spaces in Kathmandu. Tundikhel; an important public open space located in the heart of Kathmandu is decreasing in its size and has changed in its use over time. Data shows that in 2019 KMC occupies 58.77% area as mixed-use (residential, commercial) whereas only 5.47% area is under cultivation. Changes in land use/cover from 1980 to 2019 reveal a huge change with 40% growth in the built-up area whereas the cultivation area decreased by almost 53%. The lost cultivated land is converted into a built-up form. Changes have also occurred in the public open space which decreased by 1.76% in the same period. At present, KMC does not have a sizable public open space for emergency uses such as evacuation, relief, and recovery during the catastrophic hazards. Moreover, it may have another dimension of impact at the community level that decreasing public open space has adverse impacts on sociability and well-being. Hence, the growth trends of KMC suggests that open spaces exist today will no more available for future generations. Encroachment by the squatters, use of changes (institutional and other uses), increasing demand for open land for infrastructure development are the major causes of the loss of public/open spaces in KMC. Besides, there is no proper management plan of the existing open spaces which again drives to open space crisis in KMC. Therefore, it is recommended that concerned authorities need to plan effectively to protect the available public open spaces not only for protecting the city environment but for better management of risk and disaster and create public life activities in the society.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

## REFERENCES

- Amanda H (2017). Theorizing the urban commons: New thoughts, tensions and paths forward. *Urban Studies* 54(4):1062-1069.
- Bordieu P (1986). The forms of capital. In: Richardson JG (ed.), *Handbook of Theory and Research for the Sociology of Education*. Greenwood Press New York pp. 241-258.
- Central Bureau of Statistics (CBS) (2011). *Population Census of Nepal*. CBS: Kathmandu.
- Chhetri S (2020). Wide, open spaces: the state of public land in Kathmandu. *Kathmandu Post*, 27 Feb. 2020. Available at: <https://kathmandupost.com/valley/2020/02/27/wide-open-spaces-the-state-of-public-land-in-kathmandu>
- Chitrakar RM (2020). Space and the city. *Kathmandu post*, 20 Jan, 2020. Available at: <https://kathmandupost.com/columns/2020/01/20/space-and-the-city-1579434046>
- Devkota K (2018). Challenges of inclusive urbanization in the face of political transition in Nepal. In Makerere JM, Mesharch WK (eds.), *Handbook of Research on Urban Governance and Management in the Developing World*. South Asia Institute of Advanced Studies: Global Information Science Reference, USA.
- Dong PJ, Karmacharya T (2018). Impact of Urbanization on Public Health in Kathmandu Valley, Nepal-A Review. *Juniper Online Journal of Public Health* 3(4):001-0011.
- Department of Urban Development and Building Construction (DUDBC) (2010). Physical mapping of the squatter settlements in the Kathmandu Valley. Department of Urban Development and Building Construction (DUDBC), Babarmahal.
- EMI (2010). Risk sensitive land use plan of Kathmandu Metropolitan City: Mainstreaming disaster risk reduction in megacities. EMI: Philippines.
- Google Earth Image (2019). How to Get Old satellite Images on Google Maps. Available at: <https://medium.com/@thegeospatialnews/how-to-get-old-satellite-images-on-google-maps-f11b2fad17b4>
- Google Earth Image (2003). Medium Resolution Imaging Spectrometer (MERIS) image. Available at [https://www.esa.int/ESA\\_Multimedia/Images/2004/05/Jakarta\\_-\\_MERIS\\_-\\_23\\_October\\_2003](https://www.esa.int/ESA_Multimedia/Images/2004/05/Jakarta_-_MERIS_-_23_October_2003)
- Ishtiaque A, Shrestha M, Chhetri N (2017). Rapid urban growth in the Kathmandu Valley, Nepal: Monitoring land use land cover dynamics of a Himalayan city with landsat imageries. *Environments* 4(4):1-16.
- Joshef Rountree Foundation (JRF) (2019). Social value of public space. JRF:UK. Available at: <https://www.jrf.org.uk/sites/default/files/jrf/migrated/files/2050-public-space-community.pdf>
- Kathmandu Metropolitan City (KMC) (2011). Periodic plan of Kathmandu Metropolitan City. Department of Urban Development and Building Construction, Kathmandu.
- KVDA (2015). Kathmandu valley 2035 and beyond: 20 years strategic development master plan (2015–2035). Kathmandu: GOVN. Available at: [http://www.kvda.gov.np/documents/Document\\_201603060220.pdf](http://www.kvda.gov.np/documents/Document_201603060220.pdf)
- KVTDC (2007). Building and planning by-laws of Kathmandu. KVTDC, Government of Nepal, Kathmandu.
- Low S, Smith N (2005). Introduction: The imperative of public space. Low S, Smith N (eds.), *The politics of public space*. Routledge: New York and London.
- Madanipour A (2003). *Public and private spaces of the city*. Routledge.
- Massey D, Massey DB (2005). *For space*. Sage.
- MoFAGA (2017). GIS maps and population data of Nepal. Available at: <https://sthaniya.gov.np/gis/>
- MoUD (2013). Planning norms and standards. Department of Urban Development and Building Construction. Available at: <https://dudbc.gov.np/uploads/default/files/11fc96caa8c2194ab728796d5e9144cd.pdf>
- MoUD (2015). National urban development strategy (NUDS). DUDBC, Government of Nepal. Available at: <https://khub.niua.org/national-urban-development-strategy-nuds-of-nepal/>
- Muzzini C, Apericio D (2013). *Rethinking and urban transition of Nepal*. World Bank: Washington DC.
- Poudel K (2017). Open space vanishing fast. *New spotlight magazine*. Available at: <https://www.spotlightnepal.com/2017/11/11/open-spaces-vanishing-fast/>
- Pradhan-Salike I, Pokharel JR (2017). Impact of urbanization and climate change on urban flooding: A case of the Kathmandu Valley. *Journal of Natural Resources and Development* 7:56-66.
- Resource Centre for Primary Health Care (RECPHEC) (2016). A study on public spaces of Kathmandu Metropolitan City for policy revision. RECPHEC: Kathmandu. Available at: [https://healthbridge.ca/images/uploads/library/Study\\_report\\_Public\\_Space\\_Policy\\_Review.pdf](https://healthbridge.ca/images/uploads/library/Study_report_Public_Space_Policy_Review.pdf)
- Rimal B (2011). Application of remote sensing and GIS, Land use/land cover change. *Journal of Theoretical and Applied Information Technology* 23:80-86.
- Sharma B (2019). Open space advocacy. In Mishra P (ed), *New Spotlight, New Spotlight: Kathmandu*. Available at: <https://www.spotlightnepal.com/2019/03/27/bharat-sharma-and-his-open-space-advocacy/>
- Sharma P (2003). *Population monograph of Nepal*. Urbanization and development, Government of Nepal, Central Bureau of Statistics, Kathmandu, Nepal. pp. 375-412.
- Shrestha M (2018). How open spaces in Kathmandu Valley are shrinking? Available at: <https://cijnepal.org.np/open-spaces->

- kathmandu-valley-shrinking/
- Stavrides S (2016). *Commons space: The city as commons*. London: ZED Books.
- Subedi BP (2010). Ethnic/caste diversification in Kathmandu metropolitan: Changing social landscape of a capital city. *Journal of Geography and Regional Planning* 3(8):185-199.
- Suwal BR (2014). Internal migration in Nepal. *Population Monograph of Nepal* 1:241-276.
- Thapa R (2009). *Spatial process of urbanization in Kathmandu Valley, Nepal* (Unpublished Ph.D. Thesis).
- Thapa RB, Murayama Y (2010). Drivers of urban growth in the Kathmandu valley, Nepal: Examining the efficacy of the analytic hierarchy process. *Applied Geography* 30(1):70-83.
- Timalsina KP (2011). *Struggling for livelihood: making a living in the urban informal sector*. Germany: VDM Verlag Publisher.
- Tiwari SR (1989). *Tiered temples of Nepal*. Sunita Tiwari Publication: Kathmandu.
- UN-Habitat (2018). *Developing public space and land values in cities and Neighborhoods* (discussion paper). Kathmandu: UN-Habitat.
- Wooley H (2003). *Urban open space*. London and New York: Taylor and Francis.



**Appendix 1****Box 1: Some inferences of decreasing public open spaces in KMC**

Tundikhel, one of the largest and most important of the Valley's open spaces, once spanned nearly four kilometres, all the way from Rani Pokhari to Dashrath Stadium now has been shrunk almost half (Tiwari, 1989 and 1990 and Poudel, 2017).

Beginning in the 1960s, Ratna Park and Khula Manch were separated, as was Dashrath Stadium and successive governments have consistently chipped away at this prime land, cordoning off portions for private parks, roads, and for the exclusive use of the Nepal Army which occupies a significant portion of Tundikhel now. The army has also encroached upon the portion south of Shahid Gate for its headquarters and what started off as a recreation space for army officers morphed into a banquet hall for private events. (Chitrakar, 2020 and Chhetri, 2020).

In 2016, Kathmandu Metropolitan City had contracted Jaleswor Swachhanda Bkoi Builders to build a view tower in the old bus park, leading the bus park to move to Khula Manch. The theatre space is now a parking lot for buses and an informal dump for construction materials which has been continuous encroachment of public open spaces in the heart of Kathmandu (Poudel, 2017).

A report published by the Centre for Investigative Journalism in 2018 stated that the grounds belonging to the Pulchowk-based Madan Smarak Secondary School, which was designated as a public open space by the government in 2013, was leased to two separate construction companies to build a business complex (Chitrakar, 2020 and Chhetri, 2020).

In an urban context 10 to 15% of the total habituated area is a must to be designated as open space. In the Nepalese context, there are religious open spaces like the Bahal and Bahil in Kathmandu and also secular open spaces like Tundikhel. In the past, these spaces could easily accommodate the whole population. today we are in an open space crisis (Sharam, 2019).

**Box 1.** Some inferences of decreasing public open spaces in KMC.

*Full Length Research Paper*

# **Contemporary land suitability analysis for urban expansion in Welkite town, Gurage zone, Ethiopia**

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**Urban expansion through identifying most suitable sites for urban sprawl plays vital role in alleviating various socio-economic problems. The objective of this study is to identify potentially suitable sites of Welkite town, Ethiopia. Geographical Information System (GIS) was integrated with remote sensing data to conduct multi criteria overlay analysis by determining principal parameters. DEM data was used to produce elevation and slope map of the study site, whereas, land use and land cover classification was conducted by Landsat 7 image. The influence and weight of each factor was given as, 30% for land use, 25% for elevation, 25% for slope, 10% for ground water and road 10% for accessibility. Rate values for each criteria class were given based on their impact from 9 to 1, higher value for more suitable class value and lower values for unsuitable class values. Finally by employing multi criteria overlay analysis, suitability map of Welkite town was generated. As a result about 1750 hectare of land was founded from highly suitable to moderately suitable for urban sprawl which is located North-eastern parts of Welkite whereas, only southern part of the town exhibits from slightly suitable to unsuitable for further expansion with an area of 1039ha. Hence, decision makers and urban planners of the town are highly recommended to adjust their master plan and sprawl of Welkite town to its north-eastern part based on the identified suitability result of this study.**

**Key words:** GIS, remote sensing, land suitability.

## **INTRODUCTION**

Nowadays both horizontal and vertical urban growth have vital role in socio-economic aspects of a given town in particular and a nation in general. This is particularly true for developing countries like Ethiopia where a number of urban centers are increasing with time (Anwar and Bhalli, 2012). In Ethiopia it is clear that, the rate of urbanization is increasing in an alarming rate especially in the past decade. The reasons for this rapid urbanization center on population growth, rural-urban migration, improvement in the standard of living, unemployment in rural areas and

others. In the absence of proper urban management practice, uncontrolled and rapid increase in population pose enormous challenges to governments in providing adequate shelter to people in urban areas. This prompt increase of urban population and the transforming urban economy lead to an ever-increasing load on the urban environment in terms of urban capture structure of the cities, creating many problems, such as unplanned sprawl, inadequate housing facilities, traffic congestion, insufficient drainage, sewerage facilities and lack of other

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amenities (Liu, 1998).

Land suitability mapping and analysis is a prerequisite to achieve optimum utilization of the available land which is becoming increasingly scarce resources (Ayalew and Selassie, 2015). Hence, suitability analysis for urban growth is considered one of the most important and effective techniques for identifying the best locations for urban growth by employing different types of criteria and weights (Javadian, et al., 2011; Alexander et al., 2012). It involves the selection of suitable locations of development by mapping the suitability index of a specific area (Joerin et al., 2001). Moreover, land use suitability analysis for urban development is necessary to overcome the problem with limited land availability against astronomical growth of urbanization.

Though, geographic information system integrated with remote sensing techniques is a powerful tool for determining suitable sites for ever increasing urbanization. Geographic Information System help users to view, understand, question, interpret and visualize spatial and non-spatial data in many ways that reveals relationships, patterns and trends in the form of maps, reports and charts (Babu and Sivasankar, 2015).

The GIS based maps provide the most important sources for spatial analysis. Remote sensing data provide temporal and spatial accurate maps, when used in the GIS environment, and they are integrated. Also, the attribute data attached in the database provide great help to the urban planners and decision makers (Hauser et al., 1982). GIS-based land suitability analysis using the multi-criteria evaluation (MCE) approach is therefore the most suitable method for solving complex problems related to land-use planning and development (Malczewski, 2004).

In Ethiopia, the construction of settlement over time has witnessed unplanned and uncontrolled sprawl such that the urbanization process in most town reveal largely illegal growth pattern, without identifying potential suitable lands for urbanization. In the same way, the trend of urbanization in Welkite town exhibited unplanned and uncontrolled way deprived of considering potential suitable sites. This tendency creates a problem for urban planning in an efficient way and various land use conflicts between users each other and with the government to supply land for urban dwellers. The reason for this problem might be many and complex but one might be less attention was given to suitability identification. But, the future success of economic growth policies depends on a lot on the infrastructural planning and development through identifying the most suitable sites for urbanization. It is universally established that remote sensing and GIS tools play a major role in various infrastructure planning and development as well. Several decisions taken by different planning agencies require spatial analysis of maps involving many parameters (Shan, 1999; Liu, 1998).

Hence, identifying most suitable sites enables urban planners to plan their urban expansion and infrastructural

development to most suitable sites, decision makers to plan other development plans like investment on areas outside the residential areas and to attract investors by identifying potential areas. To this edge, this study tries to identify potential suitable sites for further expansion of Welkite town using multi-criteria evaluation techniques by employing GIS and remote sensing techniques together.

## Objectives

The general objective of this study is to identify and map potentially suitable areas for further expansion of Welkite town whereas, the specific objectives meet by this research are; to employ land use/cover map of Welkite town from remotely sensed data; to determine important parameters for urban suitability analysis and to classify Welkite town based on different suitability classes

## MATERIALS AND METHODS

### Description of the study area

#### Location

Welkite is a town and the administrative center of the Gurage Zone for the Southern Nations, Nationalities and Peoples' Region (SNNPR), of Ethiopia. Geographically Welkite town lies 37° 44'35" E to 37°48'45" E and 8°15'50"N to 8° 20' 00" N. The town is located on the main road from Addis Ababa to Jimma with a distance of 148 km from the country capital Addis Ababa. This town lies in a latitude and longitude of 8°17'N 37°47'E and an elevation between 1718 and 1909 m above sea level. It is surrounded by Kebena woreda (Figure 1).

#### Infrastructural development

According to the Gurage Zone Administrative government, Welkite is one of the 12 towns with electrical power, one of 11 towns with telephone service and one of the nine towns that have postal service. Welkite also had a bank branch and other financial institutions, as well as an all-weather road was built in 1963 which connects Welkite to Addis Ababa.

#### Economic activity

Since the town is in the midway on the road between Addis and Jima, trade is the major economic activity employed in the town, which most passengers who passes through the town use it as a transit and involved in various transactions. Hence, the residents of the town are primarily depend on retail and whole sale trade.

#### Demographic characteristics

Based on the Central Statistical Agency (2007) report, this town has a total population of 28,866, of whom 15,074 are men and 13,792 women. The plurality of the inhabitants practiced Ethiopian Orthodox Christianity, with 48.17% of the population reporting that belief, while 42.31% were Muslim, 7.86% were Protestants, and 1.34% were Catholic.

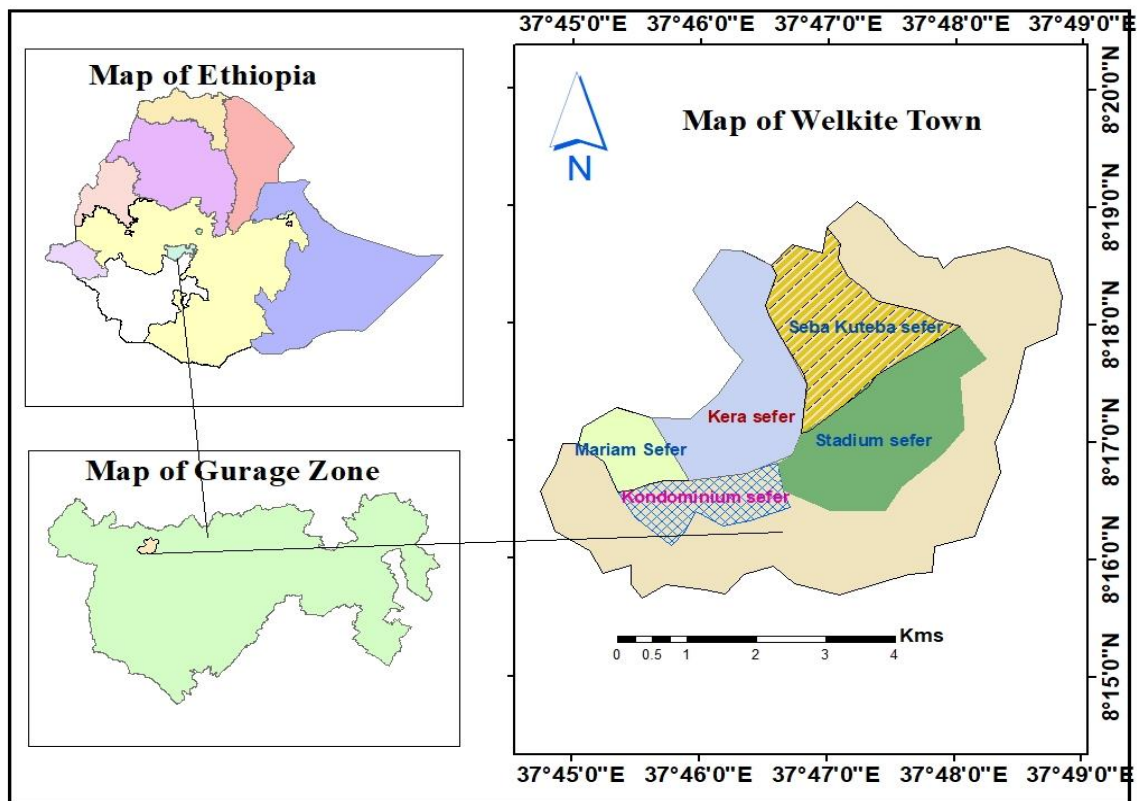


Figure 1. Location map of Welkite town.

#### Data sources and method of collection

The most important thing in doing a GIS research is source of data. Reliable data is necessary to realize the designed purpose and objectives. This research used both primary and secondary data's which are collected from different sources. Secondary data such as, Shapfile GIS data's and others were collected from different Ethio-GIS. Landsat-7 satellite image with spatial resolution of 30 m from row 169 and path 54 was freely downloaded from United States Geological Survey [www.earthexplorer.usgs.gov](http://www.earthexplorer.usgs.gov). also SRTM with cell size of 30\*30 m data was also freely downloaded from [www.gisgeography.com/srtm-shuttle-radar-topography-mission/](http://www.gisgeography.com/srtm-shuttle-radar-topography-mission/). In addition to these data's observation and reconnaissance survey of the area through transect walk was conducted to recognize the biophysical components of the land. It was conducted to characterize each parameters such as land use/cover, slope, topography, road access and water point further enabled to determine the weighted values and scores based on their significance.

#### Data analysis

The town under study was clipped from Ethio-GIS shape file by using Arc map tools to delineate the boundary of Welkite town. Then important thematic layers for suitability analysis was created such as, land use/class map, elevation, slope, road network and water sources and weighed values were assigned based on their relevance. The procedures followed during the production of these thematic layers are clearly depicted as follows.

#### Land use/ cover and land cover classification

Digital image classification is the process of sorting pixels into a finite number of individual classes or thematic layers based on their reflectance values. Firstly image preprocessing methods such as image correction and enhancement techniques were employed to increase the transparency of image data. Supervised image classifications technique were applied after, assigning (creating) the signature editor, a maximum likelihood parameter was also used. Finally, the different land use/land cover classes were classified and maps were analyzed using ERDAS IMAGINE 2010 and ArcGIS 10.3.1 software.

#### Other parameters

Additional parameters for suitability analysis such as elevation map and slope was generated from a 30 m DEM, road map and water sources was extracted from Ethio-GIS shapefile by using ArcGIS 10.3.1 software for further suitability analysis.

#### Weighted overlay suitability model

Weighted overlay Suitability Model was used with GIS techniques for locations suitable for urban expansion. Each individual raster cell was reclassified into units of suitability and multiplied by a weight to assign relative importance to each and finally add them together for the final weight to obtain a suitability value for every location on the map; this can be interpreted by the following equation (Eastman, 2006):

**Table 1.** The area coverage of each land use/cover classes in Welkite town.

S/N	Land use Type	Area coverage(ha)	Percentage (%)
1	Cultivated land	766.97	27.5
2	Bare land	718.16	25.75
3	Open Bush land	648.44	23.25
4	Built-up Area	516	18.5
5	Eucalyptus forest land	139.45	5

**Table 2.** Land use/cover classes and assigned values.

Parameter	Given weight (%)	Class	Scale value
Land use	25	Bare/open land	9
		Open bush land	8
		Cultivated land	7
		Eucalyptus/forest land	5
		Built up area	Restricted

$$S = \sum w_i x_i$$

Where,  $w_i$  is the weight of  $i^{\text{th}}$  factor map;  $x_i$  is the criteria score of class of factor  $I$  and  $S$  is the suitability index for each pixel in the map.

All the thematic layers were integrated in ArcGIS 10.3.1 platform in order to prepare a map depicting suitable areas. The total weights of each pixel of the final integrated layer were derived from the following equation:

$$S = (SL_f SL_c + LE_f LE_c + LU_f LU_c + DR_f DR_c + DG_f DG_c)$$

Where,  $SL$  is Land slope;  $LE$  is land elevation;  $LU$  is land uses;  $DR$  is the distance to Road;  $DG$  is the distance to ground water potential areas. The subscript letter "f" represents the weight of each factor, while "c" represents the weight of each class of the individual factor.

Therefore, Suitable sites for expansion of Welkite town was estimated using the above equation for each pixel in the final integration layer and was regrouped into different classes with equal class interval to divide the entire study area into different suitable zones.

## RESULTS AND DISCUSSION

### Land use/cover classes

The major land use/land cover classes of the study town which was identified by supervised image classification during the year 2018 were forest land, cultivated land, open bush and shrub land, built up, and bare/open land as indicated in the Table 2 and Figure 2.

The area coverage of each class is depicted in Table 1.

### Land elevation

The elevation of the study town was generated from a 30 m resolution DEM and ranges from 1718 to 1909 m

above sea level as depicted in Figure 3.

Since the vertical elevation difference with in the town is about 191 m and the highest elevation is below 2000 m above sea level, all elevation classes were considered as suited for urbanization, but their scale values were assigned (highest value for lower elevation and lowest value for higher elevation classes) as indicated in the Table 3. The reason that high elevation slopes is given lower scale value is that, as the elevation increases, suitability for constructing infrastructures decreases, availability of ground water decreases and finally its suitability for urbanization will decrease.

### The land slope

The slope map of the study town was also produced from a 30m resolution DEM using arc hydro tools, and the slope values ranges from the minimum 0% to the maximum 47.9% as shown in the Figure 4. Most northern and eastern as well as south-western part of the town has a minimum slope value which is less than 10%, but only the central and north –western part of the town have highest slope values in between 15-30% values. This implies of that most parts of the town are with level topography.

In this study, slope areas with slope values greater than 20% are considered as unsuitable for house and other infrastructural construction, consequently unsuitable for urbanization and their values are restricted whereas areas with low slope value given highest scale values (as shown in the Table 4), because as slope decreases the land is level and there will be ease of construction of buildings, infrastructures, ease of transportation etc. as a result the suitability of a given land for urbanization increases.

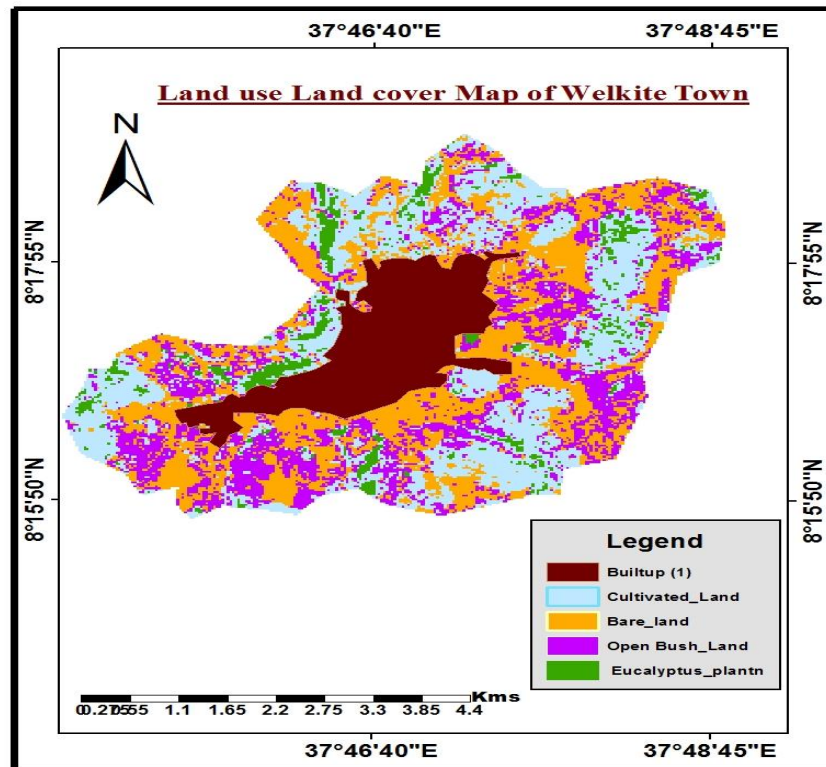


Figure 2. Land use/cover class map of Welkite town.

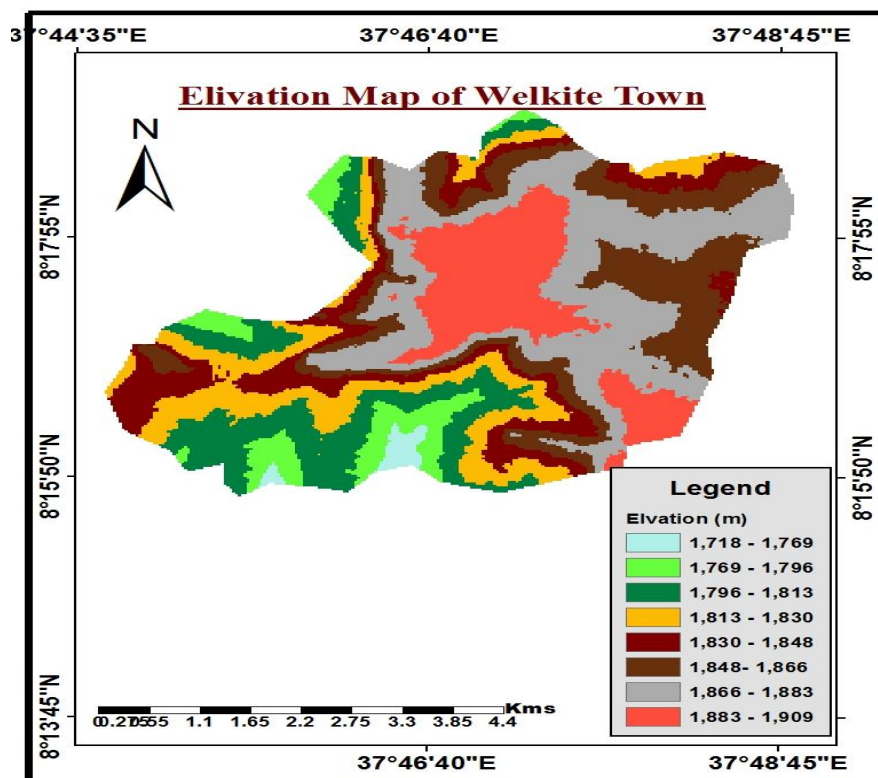
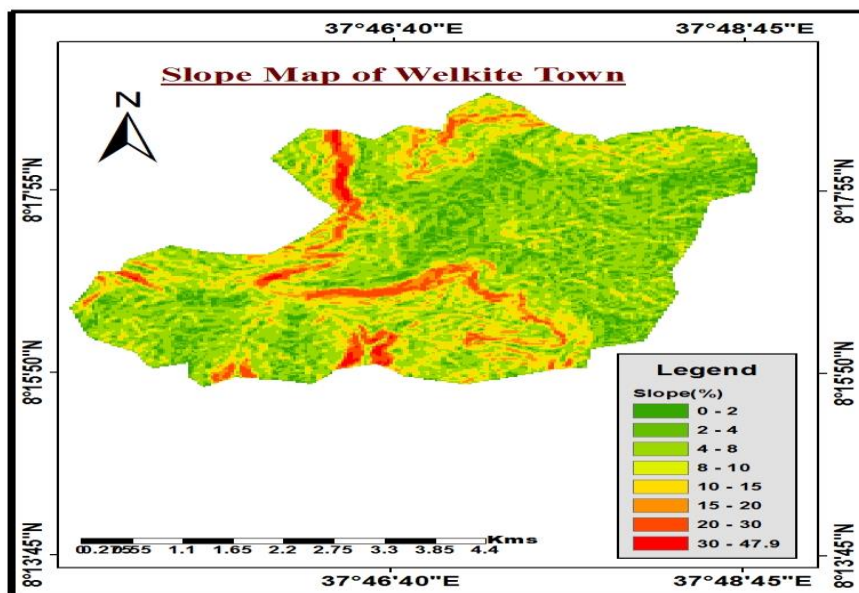


Figure 3. Elevation map of Welkite town.

**Table 3.** Elevation ranges and assigned scale values.

Parameter	Weight (%)	Class	Scale value
Elevation	15	1718-1769	9
		1769-1796	8
		1796-1813	7
		1813-1830	6
		1830-1848	5
		1848-1866	4
		1866-1883	3
		1883-1909	2



**Figure 4.** Slope map of the Welkite town.

**Table 4.** Slope classes and assigned scale values

Parameter	Weight (%)	Class	Scale value
Land slope	25	0-2	9
		2-4	8
		4-8	7
		8-10	6
		10-15	5
		15-20	4
		20-30	Restricted
30-47.9	Restricted		

**The ground water source**

Source of water for drinking as well as other domestic activities is vital for the given town dweller. Hence, in this

study, the proximity of wells to expansion areas is considered as an advantage because wells will be used as a source for water. Areas lying close to the wells are considered the best suited and are assigned a higher class value as indicated in the Table 5.

**Distance from main roads**

Road plays a vital role in every daily social, economic and political issues in the inhabitants of a given town. In this study, the distances of each places from the main nearby road was calculated and those places with lower distance were considered to be suitable for urban expansion and assigned higher class values, as well as those places with higher distances were considered as less suited for urban expansion and assigned lower class values as portrayed in the Table 6.

**Table 5.** Distance from ground water and assigned class values.

Parameter	Weight	Classes (m)	Scale value
Distance from Ground water	20	0-250	9
		250-500	8
		500-1000	7
		1000-1500	6
		1500-2000	5
		2000-2500	Restricted
		>2500	Restricted

**Table 6.** Distance from main road and assigned class values.

Parameter	Weight	Classes	Scale value
Distance from main Road	15	1000-1200	9
		1200-1500	8
		1500-2000	7
		2000-2500	6
		2500-3000	5
		3000-4000	4
		>40000	Restricted

### Suitability analysis for urban expansion

After determining prominent parameters, urban suitability analysis was done by using weighted overlay technique through multi-criteria evaluation. Integrated GIS based method for site selection can advocate technically selecting land for sustainable urban development. The advance Analytical Hierarchy Process method is selected to assign the weightages for thematic layers and weighted overlay method is used for integration. An integrated layer was generated from highly suitable, moderately suitable, slightly suitable and unsuitable land based on the provided weights for each parameter. Finally, suitability class was extracted from integrated layer as depicted in the Figure 5.

The results of this suitability analysis showed that most North-eastern parts of Welkite town are from highly to moderately suitable lands and covers an area about 1750 hectares whereas, only southern part of the town is slightly suitable to unsuitable for further expansion due to various reasons.

Generally as clearly depicted in Figure 5, places represented with deep green color are identified as highly suitable for urban sprawl which possess an area of 780 ha, and spatially located in the northern and eastern part of the town. In addition, those places represented by light green color are identified as moderately suitable for urban sprawl which possess an area of 390 ha of land and those places represented by gray color are identified as slightly suitable for urban sprawl, possess an area of 580 ha of land. Even though, level of suitability varied, all

these classes of suitability area are considered as good for urban sprawl from the total of 2789 ha of land whereas the remaining part which was indicated by red color on identified as unsuitable for urban sprawl with an area of 1039 ha of land.

The possible reasons are, those parts of the town which was identified as suitable areas, possess lower elevation values, flat topographic nature, accessible to road, water point and with lower slope class values while most unsuitable areas exhibited higher elevation values, undulating topography, and higher slope classes. Similarly, the study of Şatir (2016), found that, the weights of slope and topography were the most significant factors for urban sprawl.

### Conclusion and Recommendation

Generally this study identifies suitable sites for further sprawl of Welkite town by applying multi criteria overlay analysis using determinant parameters as impute factors. Each selected parameter was considered as a significant impact during the expansion of the town. On the study GIS integrated with remote sensing was identified as a power full tool for conducting suitability analysis. Hence, the research found that most North-eastern parts of the study town was highly suitable for further expansion. Using this result decision makers and urbane planners area highly recommended to prepare their urban sprawl master plan based on suitability result found in this study, for holistic development of the own. But inured to make



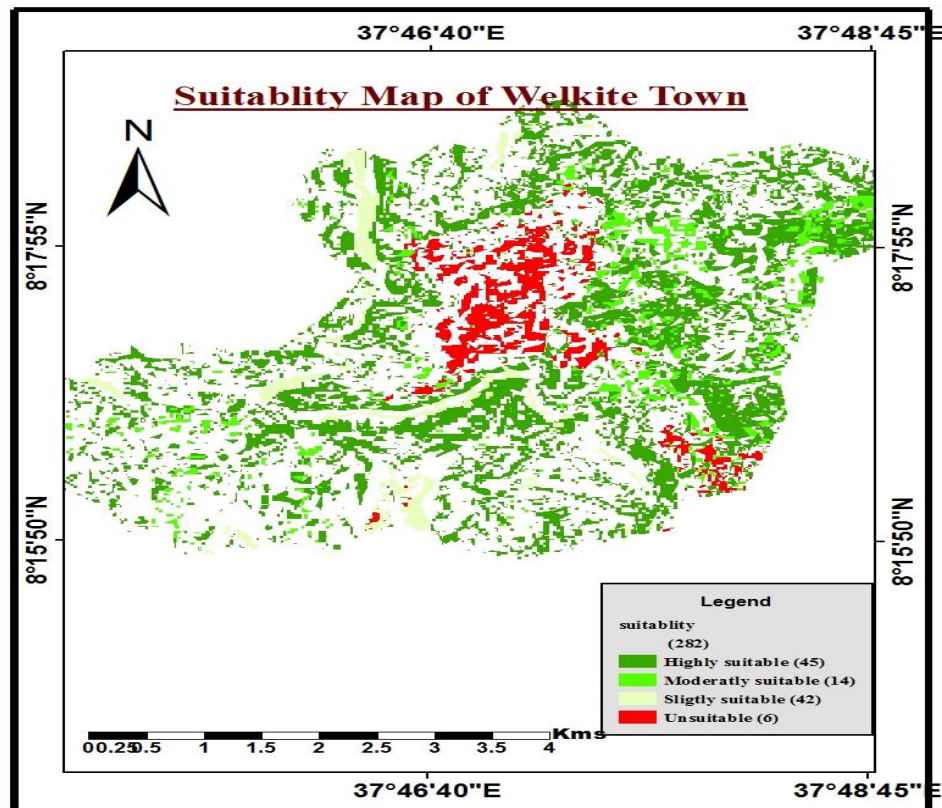


Figure 5. Suitability map of Welkite town.

the expansion of the town in both directions concerned body should do some site treatment mechanism. Additionally it is also warmly recommended that further researches should be conducted by including more parameters in addition to the parameters which were applied in this research to get more truthful urban sprawl suitability result.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

## REFERENCES

- Alexander KW, Benjamin M, Grephas OP (2012). Urban land use suitability assessment using geofomation techniques for Kisumu municipality in Kenya. *International Journal of Research and Reviews in Applied Sciences* 13(2):522-530.
- Anwar M, Bhalli M (2012). Urban population growth monitoring and land use classification by using GIS and Remote Sensing techniques: A case study of Faisalabad city. *Asian Journal of Social Sciences and Humanities* 1(1):5-13.
- Ayalew G, Selassie YG (2015). Evaluation of land suitability for cash and perennial crops using geographical information system in east Amhara region, Ethiopia. *International Journal of Remote Sensing and GIS* 4(1):1-7.
- Babu SS, Sivasankar S (2015). GIS and remote sensing in urban waste disposal and management: A case study of Usilampatti municipality, India. *International Journal of Applied Research* 1(9):1047-1051.
- Central Statistical Agency (CSA) (2007). National Population Census of Ethiopia. Available at : <http://www.csa.gov.et/census-report/complete-report/census-2007>
- Eastman JR (2006). *IDRISI Andes guide to GIS and image processing*. Clark University, Worcester P 328.
- Hauser PN, Gardener RW, Laquian AA, Shakhs P (1982). *Population and the Urban Future*.
- Javadian M, Shamskooski H, Momeni M (2011). Application of sustainable urban development in environmental suitability analysis of educational land use by using AHP and GIS in Tehran. *Procedia Engineering* 21:72-80.
- Joerin F, Thériault M, Musy A (2001). Using GIS and outranking multicriteria analysis for land-use suitability assessment. *International Journal of Geographical Information Science* 15(2):153-174.
- Liu Y (1998). Visualizing the urban development of Sydney (1971-1996) in GIS. In *Proceedings of the 10<sup>th</sup> Annual Colloquium of the Spatial Information Research Centre*. Dunedin: The University of Otago pp. 189-198.
- Malczewski J (2004). GIS-based land-use suitability analysis: a critical overview. *Progress in Planning* 62(1):3-65.
- Şatir O (2016). Mapping the Land-Use Suitability for Urban Sprawl Using Remote Sensing and GIS under Different Scenarios. In *Tech: Horwich, UK* pp. 205-226.
- Shan Z (1999). Remote sensing and GIS as a tool in exploring the dynamics of urban spatial structure: The case study of Shanghai city. In *Proceedings of the 20<sup>th</sup> Asian Conference on Remote Sensing was held on November* pp. 22-25.

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