

Urban Spatial Transformation: A case study of Pokhara Metropolitan City

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Abstract

This article analyses the spatial distribution of different land use types. The article utilizes land use/land cover (hereafter LULC) data based on time-series Landsat images, remote sensing images which were obtained from earthexplorer portal. Additional statistical data were collected from earlier research papers, municipal and district reports as well as references were taken from Google historical time-line and open street map. Although the data may deviate from actual data due to various reason, however, the aim of this article is to establish the trend of spatial transformation which is useful to indicate the pattern of urban growth and land use/ land cover of the Pokhara metropolitan city (hereafter PMC). The result indicates that PMC has been spatially transforming with rising built up space at the expense of decreasing agricultural land and open space which challenges the already vulnerable and risk hazard geology of the region. The main reason cited were high rate of migration, lack of land use and zoning maps and inadequate development control.

Keywords

urbanization, spatial transformation, land use/land cover, spatial orientation

1. Introduction

Urbanization is defined as the accumulation of the population and activities at a region or location to take the benefits or the advantages of shared function like economic, social and political progress. The urban transformation is the outcome of increase in built up environment and socio-economic activities and taking the advantages of shared facilities by humans in space and in time. In urban areas, land use/change is a continuous process which also challenges the urban guidelines and policies meant for managing the growth within given location or region. However, urbanisation also invites the serious issue for sustainable urban development. In general, land use or land cover (LULC) represents the transformation or modifications of land by the humans to take the advantages of resources and location for various activities. Through land use, humans transform the natural landscapes especially to trigger the economic functions. Thus, urban growth is a key indicator of economic development. In urban area, land use or land cover is a continuous and inevitable process due to economic development, exploitation of natural resources and rapid population growth. Especially in

developing countries, urban growth poses serious issues for sustainable development due to insufficient guidelines and policies because developing countries are in continuous transition. Among other indicators like socio-economic functions, land use or land cover studies provides information about the transitions of a region from rural to urban. Thus, land use or land cover provides information about the management and modifications of natural environment for example, changes in land use categories helps understand the rate or trend of urban transformation. In this case, it is important that we analyse the trends in spatial distribution based on land use or land cover categories.

Spatial distribution refers to the arrangement which depicts the characteristics or phenomena of earth surface usually represented in graphical display like a map. It can be obtained by choosing the variable pertaining to the phenomena and displaying the occurrence of variable on a map or a graph. The data representing the variables can be obtained by simply summarizing of raw data or may be obtained from sophisticated analysis of data. Such study can include the distribution of physical objects, population, temperature, climate and so on. More specifically, to

study the land use or land cover, such analysis includes the investigation into various land use categories which take up the space in a region and their influencing factors. Such distribution includes the arrangement of human population and their built up environment and natural resources. the factors influencing such distribution include migration, location of resources and services, location of habitat etc. In this background, this study analyses the spatial distribution of different land use types in Pokhara Metropolitan City region. For the purpose of the study, the land use category described in section 2 outlines the incident of spatial transformation of PMC region and hence forms the variables of the study.

2. Materials and Methods

2.1 Study area

The location of this research is the Pokhara Metropolitan City (PMC) as shown in figure 1. After the state restructuring in 2015, Pokhara sub-metropolitan city and Lekhnath sub metropolitan city along with other 14 small VDCs were merged to form Pokhara metropolitan city (PMC). With total area of 464.24 square kilometer, PMC is the largest city of Nepal in terms of administrative boundary [1]. It is the regional center of the western part of Nepal, the headquarters of Kaski district as well as the capital of Gandaki province. PMC is a bowl shaped valley centrally divided by deep lying seti river and surrounded by popular hills and lies in the lap of Annapurna Himalayan Range. The geographical specification of PMC is different from other urban areas in Nepal with sharp rise in altitude in close range. In terms of its spatial character, use and in current development intensity, the geographical feature presents itself a unique characteristics. The rhetoric surrounding the description of PMC boasts the spectacular mountain view, beautiful lakes and abundant adventure activities which makes it the most beautiful places in Nepal and an important gateway town for mountaineers. The city region of PMC was originally dominated by trade and market service centers along the gateways and subsequently by the agrarian communities. Furthermore, the spatial structures and spatial patterns in the PMC region underwent a very significant change due to the development of several new activities namely, tourism, trade and markets, settlements, education, and transportation during the 60s and 70s. For the reason cited above, PMC is taken for case study.

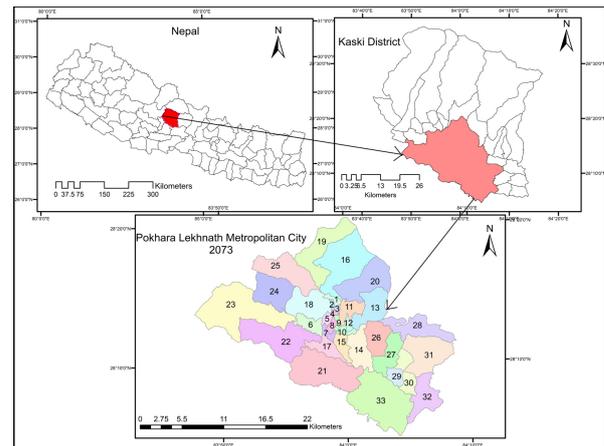


Figure 1: Location map of the study area PMC

2.2 Data sources and methods

The data set for this study is based on Landsat images available from Earthexplorer portal. The LULC representation presented in the study utilizes a total of eight views of Landsat images which are: Landsat 4-5, Thematic Mapper (TM) with path/row 142/040, May 18, 1990; Landsat 7, Enhanced Thematic Mapper (ETM) with path/row 142/041, April 3, 2000; Landsat 7, Enhanced Thematic Mapper (ETM) with path/row 142/040, March 14, 2010 and Landsat 8, Operational Land Imager (OLI) with path/row 142/40, October 11, 2020. In order to achieve more clear and accurate imagery, additional criteria like Land Cloud Cover (<90 %) and Scene Cloud Cover (<90 %) were also utilized. The Landsat image set for respective year were compiled in QGIS using semi-automatic classification plugin (SCP). For the purpose of this study, the band number from 1-7 were used from respective Landsat images.

2.3 Spatial distribution: Types and descriptions

The phenomena of spatial distribution can be obtained by analysing the various LULC types and graphically displaying them in a map of the study area. The LULC characteristics is widely considered as significant for the purpose of planning and management. In order to define the land use/land cover (LULC) classification system for this study, references were taken from similar kind of land use studies, such as the land cover classification used in Kaski district [2], LULC modeling of phewa watershed [3] and Satellite image based monitoring of land use in Pokhara [4]. The land use types for the purpose of this study is illustrated as below:

Built-up areas Commercial buildings, industrial areas, residential area, roads and utilities

Agricultural land Croplands, arable land, irrigation land

Water body Lakes, reservoirs, ponds, rivers, streams and canals, and wetlands

Open space Protected open areas, including playgrounds and airports and barren land

Forest Evergreen and deciduous forest, scattered forest, sparse, mixed and degraded forest

Sand/gravel River banks, sandy and gravel areas

Grassland Grass field (dense, moderate or low coverage of grass)

Table 1: Land cover statistics between 1990 and 2020 in Pokhara MC

Land-use types	1990 (km ²)	2000 (km ²)	2010 (km ²)	2020 (km ²)
Built-up areas	15.78	17.54	26.15	37.3
Agricultural land	223.23	235.07	226.8	213.85
Water body	11.59	9.73	12.46	13.71
Open space	3.15	1.2	1.46	1.1
Forest	202.91	197.66	189.43	191.33
Sand/gravel	0.99	2.09	5.34	4.4
Grassland	5.59	0.95	2.6	2.55
Total area	464.24	464.24	464.24	464.24

3. Results

3.1 LULC Statistics

The result is based on the analysis and comparisons of land use data between 1990 to 2020. The research utilizes the remote sensing and Landsat images for the year mentioned which were obtained online from the earthexplorer portal. The resulting LULC image maps were created using QGIS software. The land use images from previous researches on land use/land cover (LULC) were selected for cross reference. Quantitative data was used for comparisons and as well as Open Street map and google satellite data were integrated in QGIS to create the Land use images. The data obtained from QGIS are tabulated in table 1. Although there remains the possibility of slightest of errors, however it is likely to have any effect in our discussion because we are observing the trend over a period of time. The data was collected and compared to analyse the trend of LULC over the past 30 years. Result indicated that there have been significant changes in LULC in PMC region. Most importantly, result indicates that built up area in particular have increased drastically. The compared data and the result can be divided into number of clear inferences.

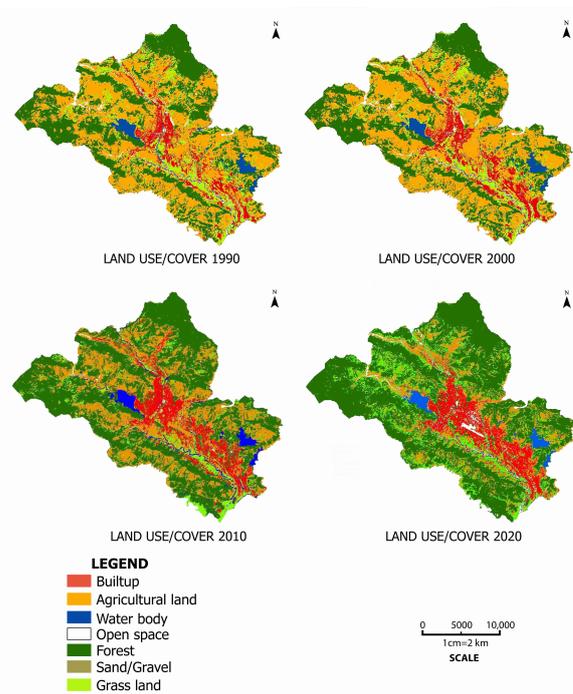


Figure 2: LULC map of PMC between 1990 and 2020

3.1.1 Built area

Comparing the data for each year throughout 1990 and 2020, it can be inferred that there is continuous rise in built up area. It increased by 1.76 square km, 8.61 square km and 11.15 square km through out study year respectively. Most of the built up area used up agricultural land, open space and forest cover. the reason for this according to City Planning Commission member Saroj Koiral is due to high rate of migration (6%) (personal communication, March 10, 2021). Analogously, Pokhrel and Khanal [5], points out that the physical infrastructure centered development and lack of consensus among planning

authorities and local people alike have not been able to control encroachment (p. 37).

3.1.2 Agricultural land

During the 1990 agricultural land increased mostly due to the conversion of grassland and forest into agricultural fields with the increasing agrarian society in the region. However, since 2000, the agricultural land decreased by 9.1 and 13 square km respectively over the years considered in this analysis mostly due to increasing built up area. In PMC, agricultural land decreased by 21.22 square km over the last 20 years as indicated in figure 3. According to Raut et al, the internal migration from rural to urban regions have caused agricultural land to forest especially in rural areas as there are lack of farmers [6].

3.1.3 Water body and Sand/gravel

The area of water bodies increased slightly over the period of 1990 to 2020 within the PMC. The sand/gravel area also increased slightly in PMC during this time. The change in Sand/Gravel might be due to the landslides and floods in around lake shore and on the upper hilly areas.

3.1.4 Forest cover

The overall forest cover decreased by 11.58 square km within Pokhara MC during 1990 - 2020 which can be attributed to the encroachment.

3.1.5 Grassland and Open space

The area of grassland decreased drastically during the period of 1990- 2000. This is due to the conversion of grassland to agricultural land mostly contributed by population growth and increasing agrarian society which resulted in conversion of grassland to agricultural land. Since 2000 to 2010 there was some increase in grass land mostly in the hilly area. This is because the people have migrated to city areas and their agriculture land was converted to grassland. Also, in suburban area, the deforestation was responsible for increase in grassland. Similarly, the open spaces in core city regions also decreased due to lack of knowledge regarding the importance of open space and government negligence to control development [5].

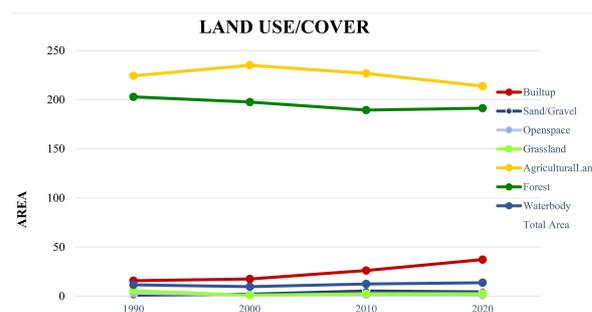


Figure 3: LULC transformation of PMC between 1990 and 2020

3.2 Spatial orientation

On analysing the trend of LULC transformation, the study also illustrates the spatial orientation of built up spaces, which indicates that built up area is mostly concentrated along the major highways and also inside the core area. The study found that urbanisation has mostly expanded towards south east, north east and north west along the three major highway viz: Siddharth highway, Prithvi highway and Baglung highway respectively (as indicated in figure 4, adopted from [4]). The location preference can also be found as rural people migrate towards the closest urban region. For example, migrants from Syangja (located to the south of PMC) settle mostly towards ward-17 region (located towards the south east of PMC or Siddharth highway); migrants from Baglung and Parbat (located to the west of PMC) settle mostly towards the Hemja, and Lamachour region (towards the north west region of PMC or Baglung highway) and migrants from Myagdi, Lamjung etc (located to the east of PMC) settle mostly towards the Lekhnath region (towards the north east of PMC or Prithvi highway). Also, along with the densification of core region, the urban growth mostly followed the major highways, rivers, and lake sides within cities as illustrated in figure 4. According to city planning commission member Saroj Koirala, the private plotting and housing in outer fringe areas as such illustrated above is due to the cheaper prices of land property. However, such built up space is occupied without following the local byelaws and guidelines and have presented the challenges in land management in the region. Similarly, built up have also expanded towards the hazard prone areas as there is no clear demarcation of hazard prone and risk sensitive areas violating the land use regulation and building bye-laws. This has made the settlement insecure and vulnerable towards natural hazards and disaster.

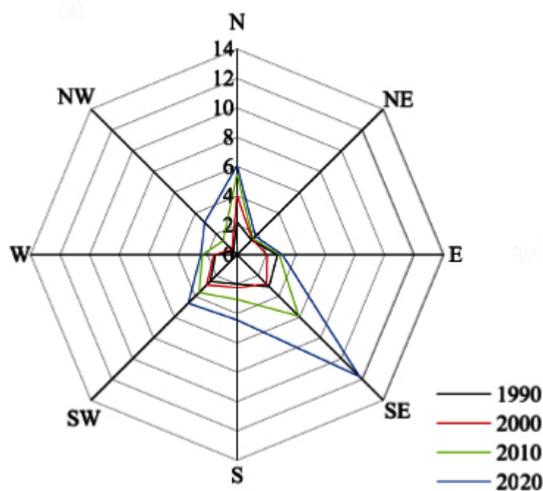


Figure 4: Built-up transformation and their orientations between 1990 and 2020 of PMC.

4. Conclusion

The study analysed the pattern of urbanisation through characteristics of LULC change in PMC region between the year 1990 and 2020. The trend indicates that urbanisation is expected to grow continuously in future years. Urbanisation is expanding mostly towards the major highways at the expense of prime farm lands which is clearly visible through urban sprawl in such areas. Also, urbanisation has seeped into hazard prone and risk sensitive areas and fertile and arable land. Despite the geographical and ecological sensitivity, urbanisation is taking place at a rapid pace. Due to inadequate bye-laws and land use zoning and regulation towards land management and also high rate of internal migration, urbanisation is expected to gain momentum. In such case, it has become very important that PMC formulate and implement strict bye laws. Also, the relocation of urban settle from hazard prone and risk sensitive areas is equally important. Thus, there is need for planned settlement in PMC region. For this, the current land use practices should be precisely studied keeping in mind the geographical and ecological vulnerability

and sensitivity. Hence, precise study of land use pattern is must to make good land use planning and management policy for guiding the sustainable development of PMC.

Acknowledgments

The authors are grateful to Institute of Engineering [IOE], Center for Applied Research and Development [CARD], and Pulchowk Campus for this wonderful opportunity in the standardization of Conference Paper Format.

Also, the author is thankful to the Bureau of Statistics, Pokhara Metropolitan City for providing statistical data required to the case study.

References

- [1] PMC. Resource map of pokhara lekhnath municipal corporation. 03 2018.
- [2] Bhagawat Rimal, Lifu Zhang, Hamidreza Keshtkar, Xuejian Sun, and Sushila Rijal. Quantifying the spatiotemporal pattern of urban expansion and hazard and risk area identification in the kaski district of nepal. *Land*, 7(1), 2018.
- [3] Ramesh Pant, Nandalal Adhikari, and Bhagawat Rimal. Land use and land cover change in western nepal: A case from phewa watershed -pokhara nepal. *Himalayan Scientific Journal*, 12 2019.
- [4] Raju Rai, Zhang Yili, Basanta Paudel, Narendra Raj Khanal, and Bipin Kumar Acharya. Satellite Image-Based Monitoring of Urban Land Use Change and Assessing the Driving Factors in Pokhara and Bharatpur Metropolitan Cities, Gandaki Basin, Nepal. *Journal of Resources and Ecology*, 11(1):87 – 99, 2020.
- [5] Ramjee Pokharel and Narendra Khanal. Open space: Typology and distribution in pokhara lekhnath metropolitan city. *Geographical Journal of Nepal*, 11:25, 04 2018.
- [6] Sanjeev Kumar Raut, Puran Chaudhary, and Laxmi Thapa. Land use/land cover change detection in pokhara metropolitan, nepal using remote sensing. *Journal of Geoscience and Environment Protection*, 7(08), 2020.