Present Land Use and Land Use Zoning of Kushma Municipality: A Comparative Assessment with Cadastral Superimpose

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KEYWORDS

Present Land Use, Land Use Zoning, Cadastral Superimpose, Multi-Criteria Analysis

ABSTRACT

Rapid urbanization and unplanned expansion in Nepal have necessitated a structured land use planning to balance economic growth, environmental sustainability and disaster resilience. This study conducts a comparative assessment of present land use and land use zoning in Kushma Municipality integrating cadastral data to evaluate alignment with the national land use policy. Using Geographic Information System (GIS), high-resolution satellite image and multi-criteria analysis, the research maps current land use patterns and land use zoning framework in the municipality. Results reveal agricultural dominance in present land use with 60.81% of total area followed by forest cover. Land use zoning indicates a 13.23% reduction in agricultural land, offset by substantial expansions in residential area by 10.65%. Cadastral superimposition highlights discrepancies, with agricultural parcels decreasing from 51.90% to 41.78%, while commercial areas triple in allocated space. The study underscores the need for adaptive land use policies, periodic zoning revisions and community engagement to ensure sustainable development. By integrating GIS-driven insights with participatory planning, Kushma Municipality can navigate urbanization challenges while safeguarding ecological and agricultural assets. This research contributes a replicable framework for municipalities in developing regions aiming to harmonize cadastral data, land use planning and policy implementation.

1. INTRODUCTION

Land is a fundamental and invaluable natural resource that plays a crucial role in sustaining life and supporting various human activities. However, the increasing demands for arable land, grazing areas, forestry, wildlife conservation, tourism, and urban expansion have outpaced the availability of land resources. This growing pressure on land highlights the challenges associated with its sustainable management and equitable distribution. In Nepal, land use has been recognized as a critical sector in national development, as evidenced by various government policies, strategic plans, and official documents (Sharma, 2012). The Nepalese government has prioritized land use planning to balance competing demands while ensuring environmental sustainability and economic growth.

The use of land and its resource has been considered as one of the integral parts of sustainable development (United Nations, 2024). There is widespread agreement that sustainable agriculture plays a crucial role in achieving global sustainable development, with the need for sustainable agricultural production systems being increasingly recognized. In Nepal, however, urban centers are expanding haphazardly due to inadequate planning, despite the preparation of extensive urban development planning documents in the past (Acharya & Halden, 2018; GoN, 2015). A key focus of these plans was the management of urban areas through effective land use zoning, yet their implementation has been largely ineffective. As a result, urban growth has been disorderly and unregulated. In light of this, there is an urgent need to establish structured land use planning and zoning mechanisms to guide urban development (Dahal, 2023). A modernized land use policy is essential to ensure food security, promote environmental sustainability, create safe human settlements and foster planned urbanization alongside inclusive economic growth. While the existing policy prioritizes the protection of arable land to safeguard food security, the catastrophic earthquake of 2015 and its aftershocks have highlighted the necessity for a secure, disaster-resilient human settlement. Consequently, a comprehensive review of the current land use policy has become imperative (MoLRM, 2015).

Effective land use planning is essential for optimizing the utilization of limited land resources. It involves a systematic evaluation of land and water potential, exploration of alternative land use options, and consideration of economic and social factors to identify and implement the most suitable land use strategies (FAO, 1993). While Nepal has made sporadic efforts to implement land use planning in urban areas (GoN, 2002), comprehensive land use planning at the national level remains largely absent. Past initiatives have focused on achieving a balanced use of natural resources through various policies and national planning endeavors. Additionally, Nepal has recently begun incorporating risk-sensitive land use planning at the municipal and rural municipal levels. However, these efforts often overlook the underlying causes and specific characteristics of geo-disasters, raising concerns about their effectiveness (Thapa, 2018).

Land use planning is typically implemented at three broad levels: national, district and local. At the local level, planning focuses on the practical execution of land-related activities, determining what actions will be undertaken, their specific locations and timing, and the entities responsible for their implementation. This process necessitates comprehensive and detailed information regarding land characteristics, population dynamics, and available services within a given locality (Oli, 2018). However, in Nepal, land use data had historically been available only at a regional scale, primarily through the Land Resource Mapping Project conducted in 1980s, which provided insights into land use, land systems, and land capability (Carson et al., 1986). Recognizing the limitations of these datasets, the Government of Nepal, through the Ministry of Land Reform and Management, established the National Land Use Project (NLUP) in the fiscal year 2057/58 with the objective of developing a comprehensive database on the country's land resources at the local level. This comprehensive digital database encompasses various spatial and thematic datasets, including current municipal land use, soil characteristics, land capability classifications, and land use zoning. Additionally, it integrates cadastral layers alongside a detailed municipal profile, which encapsulates both biophysical attributes and socio-economic parameters (Oli, 2018).

The National Land Use Policy of 2013 was formulated with a primary focus on safeguarding arable land to ensure national food security. However, the devastating earthquake of April 25, 2015 underscored the urgent need for a more comprehensive approach to land use planning, particularly in disaster-prone areas. This disaster highlighted the necessity of enforcing regulated activities within zones susceptible to natural hazards to mitigate risks and enhance resilience. The construction of physical infrastructure henceforth must incorporate considerations of newly emerging hazards. Recognizing the evolving challenges posed by natural disasters, the Land Use Policy of 2015 was introduced as an updated framework, following a critical reassessment of the 2013 policy. This revised policy aims to address contemporary land use issues in a long-term and sustainable manner, integrating disaster risk reduction principles into national land management strategies (MoLRM, 2015).

Nepal aims to regulate land use in accordance with the Land Use Policy established by the Government of Nepal. This policy classifies land into ten distinct zones: Agricultural, Residential, Commercial, Industrial, Mines and Minerals, Cultural and Archaeological, River and Riverine, Forest, Public Use and Open Space, and Others. The delineation of these zones is based on land characteristics, capability, and requirements of the land for sustainable utilization and management (MoLRM, 2015). In order to facilitate the effective implementation of these zoning regulations, the National Land Use Policy mandates a structured institutional framework, establishing a Land Use Council at the national level, with corresponding bodies extending down to the district and municipal levels (NLUP, 2016).

2. STUDY AREA

Kushma Municipality was officially established in 2017 (2074 BS) as a local administrative unit in Nepal. It serves as the administrative center of Parbat district within Gandaki Province, with its headquarter located in the city of Kushma. The municipality shares its eastern boundary with Modi Rural Municipality and the districts of Kaski and Syangja, while it is bordered to the west by Baglung District. To the north, it is surrounded by Jaljala Rural Municipality, Modi Rural Municipality and Phalewas Municipality, whereas Phalewas Municipality and Syangja District form its southern boundary (Kushma Municipality, 2024).

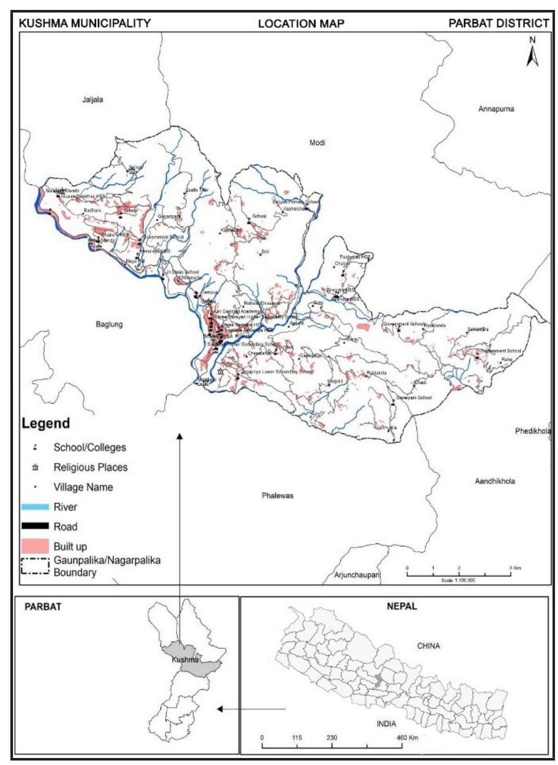

Figure 1: Location Map of Study Area

The geographical coordinates of Kushma Municipality extend from 83°36’40” to 83°48’33” east longitude and from 28°12’05” to 28°16’22” north latitude. Covering a total area of 93.18 square kilometers (36.00 square miles), the municipality recorded a population of 38,101 in the 2021 (2078 BS) Nepal Census, with a population density of approximately 409 individuals per square kilometer (CBS, 2021). Administratively, Kushma Municipality is divided into 14 wards.

3. METHODOLOGY

3.1 Preparation of Present Land Use Map

The specific approaches and methods adopted to generate the Municipality level present land use map in the project area is explained briefly with the overall work flow diagram (Figure 2). The stepwise procedure adopted to generate the present land use map of the area is the following:

3.1.1 Pan-sharpening (Image Fusion)

Pan-sharpening (resolution merge or image fusion) technique has been applied on the ZY-3 images covering the study area. This is basically done through the fusion process of high-resolution panchromatic data with lower resolution multispectral data in order to create a high-resolution multispectral data set. In this study, pan-sharpening was done using Brovey transform technique. The pan-sharpening using Brovey transform was applied to visually increase contrast in the low and high ends of the image's histogram (i.e. to provide contrast in shadows, water and high reflectance areas such as urban features).

3.1.2 Visual Image Interpretation and Classification

The desired categories of land use/ land cover were to be extracted as thematic information from the pan-sharpened ZY-3 image. In this study, knowledge-based visual interpretation was carried out. Ground reference data collected were employed in preparation of classification system.

Prior to undertaking the task of image interpretation for the identification and delineation of land use classes, two critical issues must be addressed. The first step involves establishing necessary criteria to distinguish the various feature categories present in the image. To accomplish this, the specific characteristics that define and separate the appropriate land use classes were determined as per the classification hierarchy outlined in the Land Use Act, 2076 and the Land Use Regulation, 2079. The second key issue pertains to the selection of the minimum mapping unit (MMU) for delineating discrete areal units on photographs. In this project, the MMU for land use classification was set as one fourth of a hectare in accordance with the land use specifications for mapping at scale of 1:10,000 (NLUP, 2016). However, smaller yet significant features, particularly buildings were also mapped even if they fell below the MMU threshold.

3.1.3 Accuracy Assessment

In this study, validation of the classification result was done for the quantification and evaluation of error using a confusion matrix. A total of 457 samples points in study area were collected using GPS to be taken for the confusion matrix generation. The confusion matrix was generated based on the comparison between the classified image and the existing ground i.e. the matrix depicted the land cover classification categories in the image versus the field observed land cover types.

The error/confusion matrix was evaluated by computing the user accuracy, producer accuracy and overall accuracy which was tested statistically using the Kappa statistics. The Kappa Index of Agreement (KIA) was calculated with the following formula (Congalton 1991).

$$K = \frac{N \sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} \cdot x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} \cdot x_{+i})}$$

Where:

K = Kappa coefficient

N = Total number of observations

r = Total number of classes

x_{ii} = Number of observations correctly classified for class i (diagonal elements of the confusion matrix)

x_{i+} = Total number of observations in row i (sum of row i)

x_{+i} = Total number of observations in column i (sum of column i)

3.1.4 Land Use Geo-Database Creation and Mapping

Once the classification was completed and validated, a comprehensive geo-database was created in GIS environment to store and manage the land use data. Finally, a present land use map was produced to represent the current spatial distribution of each land use category within the study area.

Figure 2: Present Land Use Workflow

3.2 Preparation of Land Use Zoning Map

3.2.1 Conceptual Basis

In this particular project, the land use zoning was carried out by adopting the following concept:

- Classifying land into Agricultural area, Residential area, Commercial area, Industrial area, Mining and Mineral area, Cultural and Archaeological area, River, Lake and Water bodies area, Forest area, Public Use area and Others as per the provision of Land Use Act, 2076 and Land Use Regulation, 2079.
- Identifying the potential zones for residential, commercial, industrial and public utility development while ensuring environmental sustainability.
- Classifying agricultural lands into sub-zones based on land quality, capability, and access to irrigation systems to optimize productivity.
- Ensuring the conservation of natural resources, including forests, shrublands, rivers, rivulets, and wetlands.
- Determining mine and mineral extraction zones with a comprehensive evaluation of their environmental and social impacts.
- Identifying public service areas, particularly open spaces to facilitate hazard mitigation strategies.
- Proposing the development of forested and public service areas in regions prone to natural hazards as a preventive measure.

The fundamental principles guiding the land use zoning of Kushma municipality are as follows:

a) Land Composition, Capability and Suitability

The primary criterion for determining land use zoning was the geographical and geological composition of the land, along with its capacity and appropriateness for specific uses.

b) Existing Land Use

Zoning decisions were based on the current land use of a given area, provided that its existing utilization aligned with its inherent composition, capability and suitability.

c) Functional Necessity

Land use zones were designated to ensure optimal utilization of land resources in accordance with the societal and economic needs.

3.2.2 General Guidelines

Based on the above criteria, the following guidelines were considered for the land use zoning:

Table 1: Guidelines for Land Use Zoning

S.N.	Zones	Guidelines
1	Agricultural Zone	a) Most agricultural areas are retained, but some land is allocated for residential, commercial, industrial, and public use. b) Priority is given to retaining highly arable land while using marginal lands for infrastructure. c) Agricultural land is classified based on land capability, system, temperature, irrigation, drainage, and soil parameters. d) Consultation with agricultural experts is conducted for further classification.
2	Forest Zone	a) Existing forests remain intact. b) New forests or plantations are established on: - Barren lands, wetlands, abandoned lands - Sloping land, watersheds, high mountains - Flood and erosion prone riverbanks - Marginally utilized lands - Roadside and canal areas where possible - Near industrial areas for pollution control - High and medium hazard risk lands - Suitable areas for agroforestry and timber production
3	Residential Zone	a) Existing residential areas remain intact if risk-free or low-risk. b) New settlements are proposed based on: - Low hazard risk land - Proximity to existing settlements - Availability of roads and infrastructure - Avoiding floodplains - Geological stability - Distance from dense forests and industrial areas - Preference for marginally productive agricultural land
4	Commercial Zone	a) Existing commercial areas remain intact. b) New commercial/business areas, including government institutions are planned based on: - Low hazard risk land - Proximity to residential areas and population centers - Availability of roads and infrastructure - Avoidance of floodplains - Geological stability - Distance from dense forests - Preference for marginally productive agricultural land

S.N.	Zones	Guidelines
5	Industrial Zone	a) Existing small, agriculture-based industries remain intact. b) Heavy industries affecting human settlements are relocated. c) Proposed industrial areas follow these criteria: - Low-hazard-risk land - Proximity to existing industrial areas (if suitable) - Distance from residential and commercial areas but accessible to markets and infrastructure - Availability of roads - Distance from rivers, ponds, and dense forests - Marginally productive agricultural land - Geological stability - Located near administrative borders for shared resources
6	Public Use Zone	a) Existing public utility and open spaces remain intact. b) New public use areas (health, education, open spaces) are placed near residential, commercial, and industrial areas. c) Planned based on local needs and participatory community discussions.
7	Mine and Minerals Zone	a) Existing mining and quarrying areas following the National Land Use Act, 2076 and Land Use Regulation, 2079. b) Potential future mining and quarrying areas are identified and prescribed.
8	Cultural and Archaeological Zone	a) Existing religious, cultural, and archaeological sites following the National Land Use Act, 2076 and Land Use Regulation, 2079. b) Cultural heritage areas are identified and planned according to master plans.
9	Riverine and Lake Zone	Existing rivers and water bodies following the National Land Use Act, 2076 and Land Use Regulation, 2079.
10	Other Zones	a) As prescribed by experts and decided by the Municipality. b) Includes land use types not covered in other categories.

3.2.3 Data

The main datasets used in land use zoning of the study area are as follows:

- Ortho-rectified High Resolution Satellite Image
- Present Land Use Map, Soil Map, Land System Map, Land Capability Map and Reports prepared by Survey Department
- Municipality Profile, Database and Reports
- Digital Topographical Datasets
- GIS Vector Data (shape file) of mainly Land Capability, Land System, Present Land Use, Administrative Boundary
- Socio-economic Data and Village Profile
- Hazard Data such as Seismicity Data, Flood Inundation Data, Industrial Risk Data, etc.

3.2.4 Methods

The specific methods used for land use zoning are the following:

3.2.4.1 Preparation

At first, a comprehensive literature review, requirement analysis and the development of a database comprising various criteria maps for land use zoning were undertaken to identify appropriate land use classifications. This process served as a foundation for generating insights into land use zoning and facilitating informed decision-making for sustainable utilization of land in the future.

3.2.4.2 Multi-criteria Analysis

Land use zoning was primarily conducted through GIS-based spatial analysis, which incorporated multiple criteria from various available datasets. The analysis utilized either GIS vector data (shapefiles) or raster data, focusing on factors like land capability, land systems, current land use and socio-economic data, which served as factor maps. A general rule for zoning was developed by applying multiple criteria derived from expert knowledge, gathered through focus group discussions with stakeholders or by using the Analytical Hierarchy Process (AHP) with pairwise comparisons. These criteria were employed to determine the most appropriate land use zones and to identify potential areas for future land use. The datasets included a range of parameters such as soil characteristics, landform, land type, arability, slope, drainage systems, topography, existing land use, crop patterns, population density and other relevant factors for zoning. A simplified rule-based approach was developed relying on expert knowledge and multiple criteria to classify land into specific zones. This approach was based on scientific principles, ensuring that the process was objective and free from individual biases.

3.2.4.3 Subjective Analysis

A subjective analysis combined with logical inference was employed for land use zoning in consultation with thematic experts and through focus group discussions with stakeholders in order to refine the land use zones derived from multi-criteria analysis. This process was based on specific requirements and expert opinions. For instance, if a small parcel of land was deemed suitable for agricultural use but was surrounded by residential area, it would be designated as part of the residential zone. Similarly, if land suitable for agriculture was located within a river floodplain with a high risk of flooding, it would be designated for forest and plantation use to mitigate the flooding risks.

After public auditing and demarcation of land use zoning by municipal officials, experts and specialists; land use zoning guidelines were prepared in each ward which were approved by the municipal land use council. The following schematic diagram illustrates the general approach and methodology adopted for land use zoning of Kushma municipality.

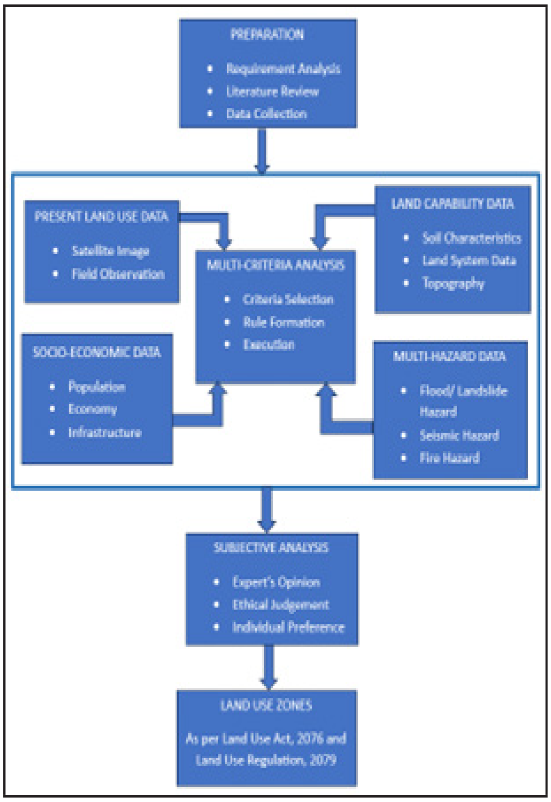

Figure 3: Land Use Zoning Workflow

3.3 Cadastral Data Superimpose

The superimpose of cadastral data was performed with both present land use and land use zoning layers for a comparative analysis in order to facilitate the effective implementation of land use policy. This process required two key components: a cadastral layer that served as the foundational dataset and a present land use/land use zoning layer to facilitate the policy enforcement. The overlay process of these data layers having same reference system led to the preparation of composite map and data. A new set of polygons with attributes were generated that explain the relations existing between the two inputs of spatial data.

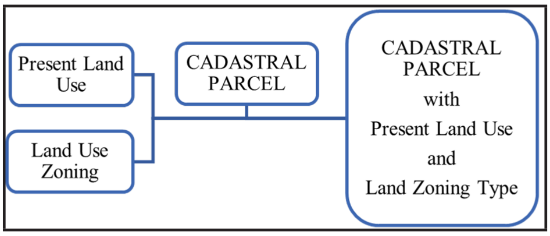

Figure 4: Cadastral Superimpose

The process of cadastral data superimpose on land use zoning was carried out in the following steps:

3.3.1 Acquisition of Cadastral Maps

The digital copies of cadastral maps of the study area were obtained from Survey Department in vector format. These maps were stored as sheet wise geodatabase with attribute database having schema as described in Table 2.

Table 2: Schema of Cadastral Parcel Feature Class

Field Name	Data Type	Description
ObjectID	Object ID	Unique object ID
Shape	Geometry (Polygon)	Geometric object type e. g. Point, Line, Polygon etc.
PARCELKEY	String (Length = 23)	Unique parcel key
PARCELNO	Integer	Parcel number as in cadastral map
DISTRICT	Integer	District ID
GAPA_NAPA	Integer	GAPA_NAPA Code
WARDNO	String (Length = 3)	Ward number
GRIDS1	String (Length = 9)	Grid sheet number in case of Trig sheets, and in case of island map sheet e. g. Ka, Kha etc.
PARCELTY	Integer	Parcel type code as specified by DOLIA (e.g. river, track, ravine, pine etc.)
Shape_Length	Double	Number representing perimeter of the polygon
Shape_Area	Double	Number representing area of the polygon
ParcelNote	String	

3.3.2 Scanning, Georeferencing and Digitizing

Due to the absence of certain digital cadastral maps in the database provided by Survey Department, the missing maps were obtained from Survey Office Parbat. First, the ammonia prints of these maps were acquired which were then scanned in 300 dpi using a high-quality scanner to convert into digital raster file. Then georeferencing of both digital cadastral database and scanned cadastral images were carried out with the help of ortho-rectified satellite image of the study area. This helped to establish a common geodetic framework for all related maps and data providing a common basis for overlay and other GIS operations. After georeferencing, the scanned maps were subsequently digitized to transform them to vector format, resulting in cadastral datasets stored as sheet-wise geodatabases in. gdb format.

3.3.3 Preparation of Municipality Level Seamless Cadastral Dataset

Seamless cadastral datasets at both the ward and municipality levels were created through spatial analysis in a GIS environment, involving the merging of various geo-referenced cadastral map sheets. During this process, some errors such as overlaps and gaps between individual cadastral map sheets were identified. However, these errors were rectified by establishing topology within predefined thresholds. In rare instances where significant gaps or overlaps occurred, they were addressed accordingly.

3.3.4 Superimpose of Seamless Cadastral Dataset on Land Use Zoning Map

The superimpose of cadastral dataset on land use zoning map of the same area, same scale and same georeferenced framework was performed functions in GIS environment. During the overlay procedure, careful attention was given to preserving topology by adhering to key principles such as preventing overlaps, avoiding intersections and ensuring that no topological function was entirely contained within another.

3.3.5 Linking Attribute of Land Use Zoning with Cadastral Parcel

The process of connecting land use zoning map with seamless cadastral datasets involved querying the attribute table of cadastral datasets at the VDC level with the land use zoning class datasets. This linkage associated geographic objects in a vector map with one or more tables, specifying the driver database to be utilized. In a geometry file, each parcel category number was linked to a corresponding row in the attribute table. The system's practical functionality enabled the integration of thematically distinct yet topologically interconnected objects within a single map. Additionally, the table was linked to subsequent layers for further analysis and integration.

3.3.6 Production of Data, Map and Report

The process described in this section resulted in the creation of a composite data base, map and report. The overall method adopted for cadastral superimpose on land use zoning of Kushma municipality is illustrated in Figure 5.

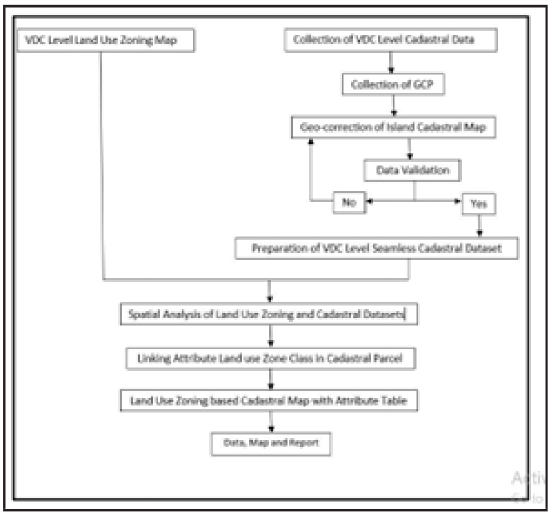

Figure 5: Method Adopted for Cadastral Superimpose

4. RESULTS AND DISCUSSION

4.1 Present Land Use

The present land use map of Kushma municipality demonstrates that agriculture land has dominated the land use class in this area. The present land use area in hectares for the municipality, broken down by wards, reveals varying distributions across different regions. In Ward 1, agricultural land dominates with 513.02 hectares, while Ward 2 has the highest agricultural area at 736.54 hectares. Ward 3 follows closely with 770.49 hectares allocated for agriculture. Commercial activities are limited across all wards, with Ward 5 having the highest commercial land use at 14.37 hectares. Cultural and archaeological sites are relatively small in all wards, with Ward 3 having the highest at 0.83 hectares. Forested areas vary significantly, with Ward 2 having the highest forest cover at 496.96 hectares, while Ward 6 has only

0.52 hectares. Industrial areas are minimal in most wards, with Ward 1 having the highest at 13.73 hectares. Mine and mineral areas are concentrated in Ward 13, accounting for 3.11 hectares. Public use spaces are distributed across wards, with Ward 10 having the largest area at 31.74 hectares. Residential areas are relatively consistent across wards, with Ward 5 having the highest at 28.17 hectares. Ward 1 has the most significant riverine, lake, and marsh area at 39.79 hectares, while Ward 5 has the lowest at 11.67 hectares. This detailed breakdown by wards offers insights into the unique land use patterns within each region of Kushma Municipality, aiding in localized planning and development initiatives.

The distribution of present land use pattern of Kushma municipality is presented Figure 6 and ward-wise details are provided in Table 3. Table 4 depicts the confusion matrix generated for the validation of classification results. The overall accuracy of present land use classification was 95.62% and the Kappa Coefficient was computed as 0.94.

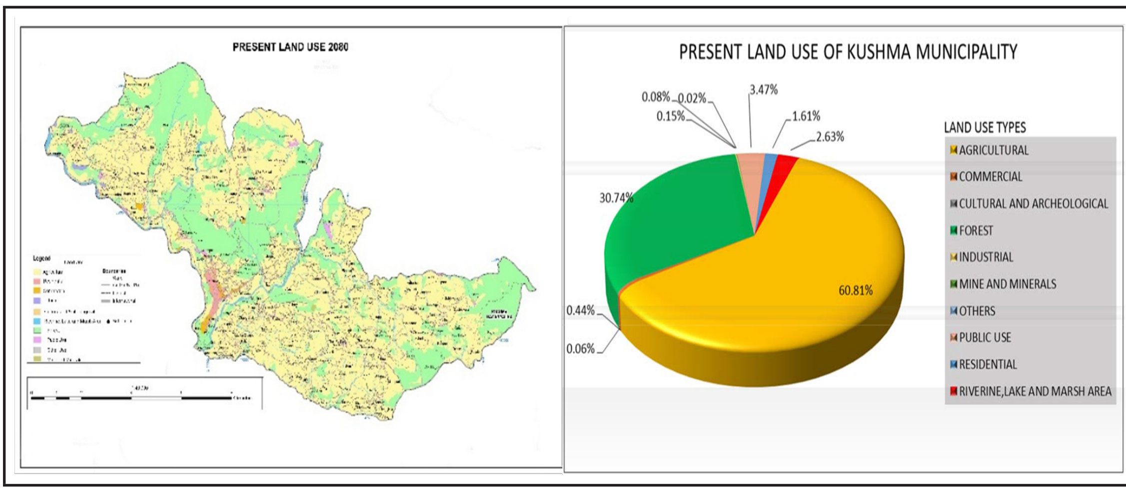

Figure 6: Present Land Use 2080

Table 3: Present Land Use 2080

LAND USE TYPE	PRESENT LAND USE 2080 (AREA IN HECTARES)														Grand Total
	WARD NO.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
AGRICULTURAL	513.02	736.54	770.49	162.42	36.54	14.70	104.02	173.57	239.33	637.91	522.56	533.31	484.56	737.17	**5666.14**
COMMERCIAL	0.64	5.56	2.74	6.75	14.37	4.51	3.93	1.16	0.17	0.04	0.03	0.39	0.04	0.31	**40.66**
CULTURAL AND ARCHEOLOGICAL	1.37	0.32	0.49	0.49	0.81	0.25	0.05	0.11	0.20	0.17	0.17	0.07	0.53	0.83	**5.86**
FOREST	253.38	496.96	401.02	255.10	49.31	0.52	78.29	295.20	20.51	61.80	171.75	72.28	104.12	603.55	**2863.77**
INDUSTRIAL	13.73	0.05	0.00	0.05	0.00	0.00	0.00	0.52	0.00	0.03	0.00	0.00	0.00	0.00	**14.38**
MINE AND MINERALS	0.20	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.11	0.00	3.69	**7.03**
OTHERS	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.01	0.04	0.78	**2.05**
PUBLIC USE	30.94	39.96	34.02	26.21	11.39	5.16	11.96	17.04	13.65	28.60	31.74	24.79	20.44	27.23	**323.14**
RESIDENTIAL	13.49	14.46	17.16	9.66	28.17	9.32	4.16	6.78	9.05	8.14	8.39	6.78	5.55	8.84	**149.94**
RIVERINE, LAKE AND MARSH AREA	39.79	34.46	22.98	14.36	11.67	3.84	9.31	24.82	11.51	17.27	20.54	7.70	11.77	14.61	**244.63**
Grand Total	**866.57**	**1328.55**	**1248.93**	**475.04**	**152.26**	**38.30**	**211.72**	**519.21**	**294.42**	**755.02**	**755.19**	**648.45**	**627.04**	**1397.00**	**9317.69**

Table 4: Accuracy Assessment of Present Land Use 2080

	Land Use Categories	GROUND VERIFICATION: Agriculture	Forest	Residential	Commercial	Industrial	Public	Minerals	Cultural and Archeological	River, Lake and Marsh	Other	Total	User's Accuracy
Classification	Agriculture	98	0	1	0	0	1	0	1	0	1	**102**	96.08%
	Forest	1	53	0	0	0	1	0	1	0	0	**56**	94.64%
	Residential	0	0	55	2	0	0	0	1	0	0	**58**	94.83%
	Commercial	0	0	0	33	1	0	0	0	0	0	**34**	97.06%
	Industrial	1	0	0	0	22	0	0	0	0	0	**23**	95.65%
	Public	0	0	1	0	0	80	0	2	0	0	**83**	96.39%
	Minerals	0	0	0	0	0	1	15	0	0	0	**16**	93.75%
	Cultural and Archeological	0	0	1	0	0	0	0	35	0	0	**36**	97.22%
	River, Lake and Marsh	1	1	0	0	0	0	0	0	34	0	**36**	94.44%
	Other	1	0	0	0	0	0	0	0	0	12	**13**	92.31%
Total		**102**	**54**	**58**	**35**	**23**	**83**	**15**	**40**	**34**	**13**	**457**	
Producer's Accuracy		96.08%	98.15%	94.83%	94.29%	95.65%	96.39%	100.00%	87.50%	100.00%	92.31%		

4.2 Land Use Zones

Across Kushma Municipality, agricultural zones dominate the land use, spanning a total 4433.05 hectares, indicating a strong emphasis on farming and cultivation activities. Significant forest cover of 2832.94 hectares in the municipality highlights conservation efforts, while residential zones covering 1142.46 hectares suggest the areas designated for housing and habitation. The commercial zones occupy 136.46 hectares, cultural and archaeological zones encompass 5.86 hectares, and public use zones provide recreational spaces over 503.04 hectares. Industrial and mine/minerals zones are relatively small, covering 14.09 hectares and 6.90 hectares, respectively. Riverine, lake, and marsh areas contribute 242.88 hectares to the overall landscape, reflecting the diverse natural features within the municipality.

The distribution pattern of land use zoning in Kushma municipality is presented in Figure 7 and ward-wise details are provided in Table 5.

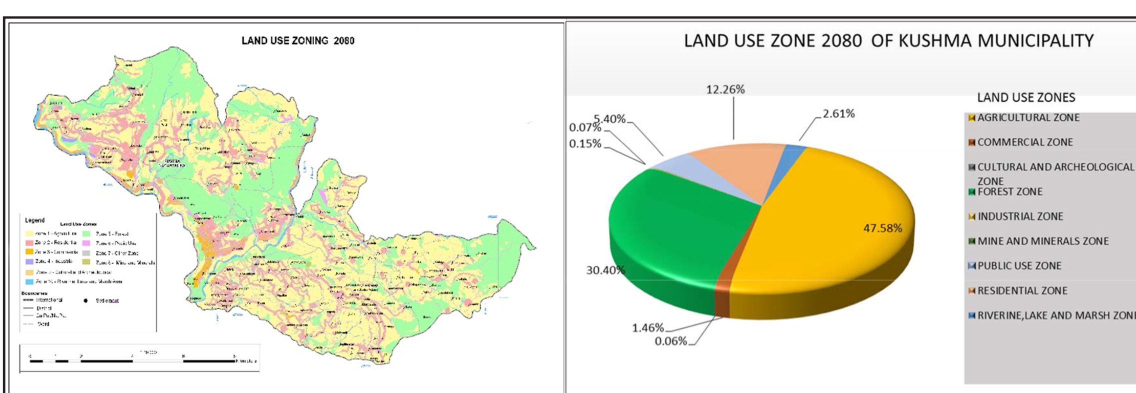

Figure 7: Land Use Zoning 2080

Table 5: Land Use Zoning 2080

LAND USE ZONES	LAND USE ZONE 2080 (AREA IN HECTARES)														Grand Total
	WARD NO.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
AGRICULTURAL ZONE	338.52	526.27	655.20	90.12	32.41	11.69	60.69	90.57	155.56	495.64	448.98	452.00	406.69	668.70	4433.05
COMMERCIAL ZONE	18.07	14.61	5.22	21.16	38.49	11.26	7.56	12.32	1.76	3.61	0.03	0.39	0.04	1.95	136.46
CULTURAL AND ARCHEOLOGICAL ZONE	1.37	0.32	0.49	0.49	0.81	0.25	0.05	0.11	0.20	0.17	0.17	0.07	0.53	0.83	5.86
FOREST ZONE	248.52	494.44	396.88	251.11	47.37	0.52	76.45	292.90	20.27	60.45	170.17	71.07	103.22	599.57	2832.94
INDUSTRIAL ZONE	13.47	0.05	0.00	0.05	0.00	0.00	0.00	0.51	0.00	0.01	0.00	0.00	0.00	0.00	14.09
MINE AND MINERALS ZONE	0.20	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.11	0.00	3.56	6.90
PUBLIC USE ZONE	57.66	60.72	49.59	40.24	19.55	7.34	19.87	33.67	22.53	42.32	43.35	35.80	29.04	41.35	503.04
RESIDENTIAL ZONE	148.61	197.94	118.72	57.73	1.95	3.41	37.85	64.82	82.75	135.76	72.05	78.49	75.93	66.45	1142.46
RIVERINE,LAKE AND MARSH AREA	40.15	34.20	22.79	14.14	11.67	3.83	9.25	24.29	11.36	17.07	20.43	7.52	11.59	14.59	242.88
GRAND TOTAL	866.57	1328.55	1248.93	475.04	152.26	38.30	211.72	519.21	294.42	755.02	755.19	648.44	627.04	1397.00	9317.69

4.3 Comparison Between Present Land Use 2080 and Land Use Zone 2080

Comparing the data between Present Land Use 2080 and Land Use Zoning 2080 for Kushma Municipality reveals significant shifts in land allocation across various categories. Presently, agricultural land spans 5666.14 hectares, constituting 60.81% of total land use, yet it is projected to decrease by 13.23% to 4433.05 hectares in Land Use Zoning 2080. Conversely, commercial areas, currently occupying 40.66 hectares (0.44%), are slated to expand by 1.03% to 136.46 hectares. Forested areas, accounting for 2863.77 hectares (30.74%), are projected to shrink by 0.33% to 2832.94 hectares. While industrial and mine areas remain stable at 14.38 hectares (0.15%) and 7.03 hectares (0.08%) respectively, residential zones are expected to surge by 10.65% from 149.94 hectares (1.61%) to 1142.46 hectares (12.26%). Public use areas are set to rise by 1.93% from 323.14 hectares (3.47%) to 503.04 hectares (5.40%). However, riverine, lake, and marsh areas may experience a slight reduction from 244.63 hectares (2.63%) to 242.88 hectares (2.61%), underscoring the complex interplay of urban development and environmental conservation in Kushma Municipality's future land use planning.

Table 6: Comparison Between Present Land Use 2080 and Land Use Zone 2080

LAND USE TYPES	Present Land Use 2080		Land Use Zoning 2080		Change in Area (hectare)	Rate of Change (Percentage)
	Area (Hectare)	Percentage	Area (Hectare)	Percentage		
Agricultural	5666.14	60.81 %	4432.33	47.58 %	**-1233.81**	**-13.23%**
Commercial	40.66	0.44 %	137.09	1.46 %	**96.43**	**1.03%**
Cultural And Archeological	5.86	0.06 %	5.86	0.06 %	**0**	**0.00%**
Forest	2863.77	30.74 %	2832.94	30.40 %	**-30.83**	**-0.33%**
Industrial	14.38	0.15 %	14.09	0.15 %	**-0.29**	**0.00%**
Mine And Minerals	7.03	0.08 %	6.90	0.07 %	**-0.13**	**0.00%**
Others	2.05	0.02 %	0.00	0.00 %	**-2.05**	**-0.02%**
Public Use	323.14	3.47 %	503.04	5.40 %	**179.9**	**1.93%**
Residential	149.94	1.61 %	1142.55	12.26%	**992.61**	**10.65%**
Riverine, Lake and Marsh Area	244.63	2.63 %	242.88	2.61 %	**-1.75**	**-0.02%**
TOTAL	**9317.69**	**100.00 %**	**9317.69**	**100.00%**		

4.4 Comparison between Cadastral Parcel Superimpose on Present Land Use and Cadastral Parcel Superimpose on Land Use Zone

A comparison between the Cadastral Superimposed on Present Land Use 2080 and Cadastral Superimposed on Land Use Zone 2080 data reveals notable shifts in land utilization within Kushma Municipality. In terms of agriculture, there's a notable decrease in parcel count from 88,550 to 65,634 and in area from 4,747.36 to 3,821.62 hectares, resulting a decline in percentage from 51.90% to 41.78%. Conversely, commercial land use experiences a substantial increase, with parcel count rising from 1,599 to 5,516 and area expanding from 65.48 to 209.65 hectares, leading to an increase in percentage from 0.72% to 2.29%. Cultural and archeological sites witness a decrease in parcel count from 140 to 115 and in area from 18.73 to 8.98 hectares, with a corresponding decline in percentage from 0.20% to 0.10%. Forest areas show a slight reduction in both parcel count, from 501 to 487, and area, from 2,823.90 to 2,769.57 hectares, resulting in a decrease in percentage from 30.87% to 30.28%. Industrial areas experience a decrease in parcel count from 125 to 114 and in area from 19.10 to 9.23 hectares, leading to a decrease in percentage from 0.21% to 0.10%. Notably, the "Others" category undergoes complete elimination in the land use zone scenario, with parcel count dropping from 50 to 0 and area from 11.64 to 0 hectares. These changes underscore a significant alteration in land use allocation patterns, with some categories exhibiting minor fluctuations while others undergo more substantial shifts within the municipality.

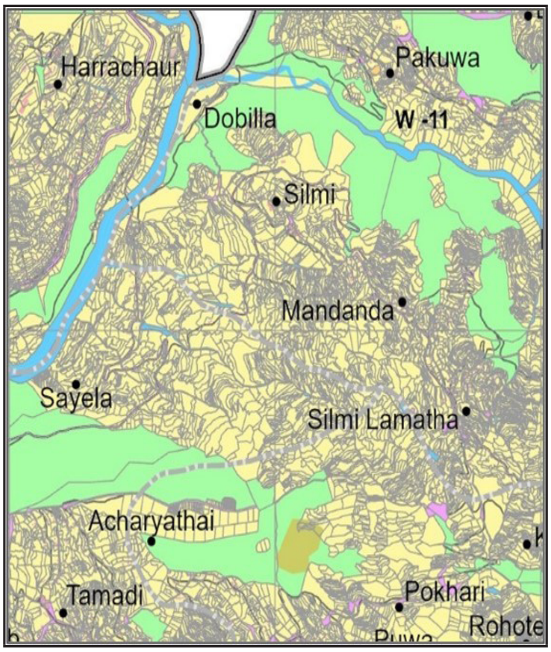

Figure 8: Cadastral Superimpose on Present Land Use

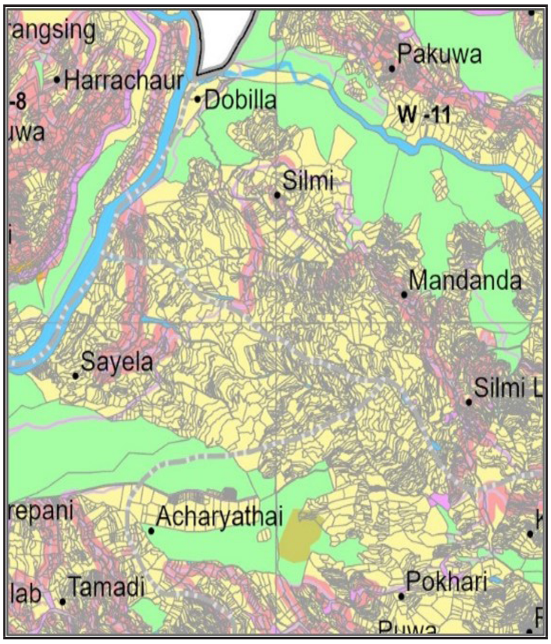

Figure 9: Cadastral Superimpose on Land use Zone

Table 7: Cadastral Parcel Superimpose on Present Land Use Vs Cadastral Parcel Superimpose on Land Use Zone

LAND USE TYPES	CADASTRAL SUPERIMPOSED ON PRESENT LAND USE 2080			CADASTRAL SUPERIMPOSED ON LAND USE ZONE 2080			RATE OF CHANGE
	No. of Parcel	Area (Hectare)	Percentage	No. of Parcel	Area (Hectare)	Percentage	
Agriculture	**88550**	4747.36	51.90%	**65634**	3821.62	41.78%	**-10.12%**
Commercial	**1599**	65.48	0.72%	**5516**	209.65	2.29%	**1.57%**
Cultural & Archeological	**140**	18.73	0.20%	**115**	8.98	0.10%	**-0.10%**
Forest	**501**	2823.90	30.87%	**487**	2769.57	30.28%	**-0.59%**
Industrial	**125**	19.10	0.21%	**114**	9.23	0.10%	**-0.11%**
Mine and Minerals	**21**	3.15	0.03%	**22**	3.54	0.04%	**0.01%**
Others	**50**	11.64	0.13%	**0**	0	0.00%	**-0.13%**
Public Use	**3072**	262.29	2.87%	**3608**	294.11	3.22%	**0.35%**
Residential	**16061**	1074.82	11.75%	**34489**	1829.7	20.0%	**8.25%**
Riverine, Lake & Marsh	**434**	120.05	1.31%	**568**	200.12	2.19%	**0.88%**
Grand Total	**110553**	9146.51	100.00%	**110553**	9146.51	100.00%	

5. CONCLUSION AND RECOMMENDATION

In conclusion, the land use zone mapping in Kushma municipality reflects a purposeful and community-centric urban development strategy. Overall, there is a clear trend towards urbanization and residential expansion, as evidenced by the notable increase in parcel count and area for residential land use. Commercial development also sees substantial growth, with an increase in both parcel count and area. However, this growth is accompanied by a decrease in agricultural land use, indicating a shift away from agricultural activities. Furthermore, while some land use categories, such as cultural and archeological sites, forest, industrial areas, and mine and minerals show minor fluctuations, others like the "Others" category witness complete elimination in the land use zone scenario. This suggests a notable restructuring of land use allocation, potentially reflecting changes in societal needs, economic priorities and environmental conservation efforts. Overall, these findings emphasize the dynamic nature of land use planning and the importance of adaptive strategies to address evolving societal and environmental challenges in urban and rural landscapes. These comparisons underscore dynamic shifts in land use patterns within Kushma Municipality, reflecting evolving urbanization, economic activities, and environmental considerations.

To realize the goals of land use policy, several key recommendations can be proposed based on land use zoning of Kushma municipality. Firstly, zoning refinement should be conducted periodically to adapt to the evolving needs. Sustainable development must be prioritized particularly in agricultural and forest zones. Infrastructure planning should be strategically aligned with residential and commercial expansion and cultural preservation efforts must safeguard significant archaeological and heritage sites. Additionally, industrial zone management should focus on eco-friendly practices through periodic assessment and revision of zoning regulations. Active community engagement is essential for inclusive decision-making and a structured monitoring and evaluation framework should be established to assess and refine land use policies regularly. Furthermore, water resource management should emphasize conservation efforts in riverine, lake, and marsh areas. An adaptive planning approach is crucial for enhancing resilience to environmental and socio-economic changes while data-driven decision-making should be supported by investments in advanced data collection tools to enable evidence-based planning. Lastly, collaboration and partnerships with key stakeholders must be fostered to ensure a holistic and well-coordinated approach to development. These recommendations collectively aim to guide Kushma Municipality toward sustainable, resilient, and community-centered growth.

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