LAND USE PLANNING IN MOUNTAIN AREA

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ABSTRACT:

Urbanization creates high demand of land mainly for residential, commercial, industrial and other this growth associated with increasing pressure on land for settlement. The suitable areas are identifying for urban development to establish the industrial, commercial and residential areas. Land use planning is one of the critical issues for urban planning in hilly areas. There are different problems which are arises at the time of research. The rises problems are lack of suitable land in a particular area and lack of transportation and other infrastructure facility like as water and electricity. The Rampur municipality lies on two major fault zone along with Kaligandaki River. The land slide or avalanches are also problems of development of infrastructures and urban development. The research work is basically spatial map preparation from the high resolution satellite image using digitalization and visual interpretation method in ArcGIS software. The suitable areas of urban development are very useful to local people as well as urban planners for the appropriate plans of land use planning in sustainable urban development. This research helps to control the fragmentation of land and haphazard urbanization, to enhance the efficient use of natural resources with minimum impact on environment future generations, and to develop a plan for efficient, equality and sustainability. In this article it is briefly describe the method of selection of suitable land for urban development in mountain area in land use planning process.

1. INTRODUCTION

Land is one of the important and precious natural resources of the earth surface. The demands for arable land, grazing, forestry, wild-life, tourism and urban development are greater than land resources available. In the developing countries, these demands become more pressing every year and the population dependent on the land for food, fuel and employment will double within the next 25 to 50 years (FAO, 1993). The economic and social lifestyles of most of the Nepalese are intimately related to land. Hence, urban planning for making the best use of the limited land resources is inevitable. However, space science technology known as satellite remote sensing (RS) and the Geographic Information System (GIS) can be helpful in acquiring spatial/temporal data, and preparing digital data base. These spatial databases together with data on different land characteristics that could be collected from field survey certainly will be helpful in decision making support system for an efficient management of resources in municipality level.

On the April 16, 2012, the Government of Nepal has approved the National Land Use Policy, 2012 with an intention to manage land use according to land use zoning policy of the Government of Nepal and outlined six zones such as Agricultural area, Residential area, Commercial area, Industrial area, Forest area and Public use area. The policy has defined the respective zones as per the land characteristics, capability and requirement of the lands. The VDCs and municipality of Nepal lack proper base map. They are mostly dependent on 1:25,000 or 1:50,000 scale topographic maps, Land resources maps or other available analogue maps which is not sufficient or too coarse to use for municipality level planning. The available maps are also not much useful for proper decision making process of the municipal development activities. The lacking of digital geographic information in Nepal, particularly large scale, has resulted ineffective and inefficient planning activities in urban development. Thus, this result playing the vital role of the planning activities.

2. STUDY AREA

Rampur Municipality is located in northern part of Palpa district, western Nepal. It covers the area of 123.34 sq. km. The municipality is surrounded by Kali Gandaki River in the north and east and Mahabharat mountain range in the south and west. It is situated at the altitude 250m to 1850m and 27^0 48' 9.84" to 27^0 55' 38.32" N latitude and $83^0$39' 23.73" to 84^0 0' 8.57" E longitude. The location map of study area is shown on Figure 1 as below.

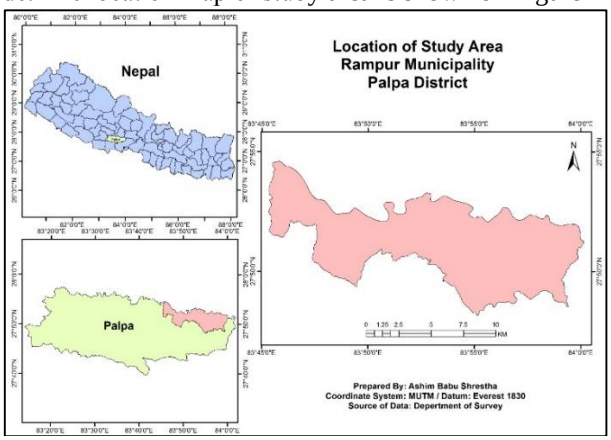

Figure 1: Location Map of Study Area

3. MATERIALS AND METHODS

The Topographical Maps of the Study area are covered under 2880 04D, 08A, 08B, 08C, 01C, 05A, 05C in the scale of 1:25,000 scale with supplementary contour of interval 10m. These maps are published in 1996 and are compiled from 1:50,000 scale aerial photography of December, 1990 and field verification done in December, 1991. The Topographical Maps were used for planning process of GCPs collection with DGPS survey and also used for feature extraction of dataset such as Municipality boundary, location name, and additional data for GIS based analysis. The list of data types and sources are shown as below in Table 1.

Table 1: Data Types and Sources

Data Type	**Year**	**Scale / Resolution**	**Source**
Topographical Maps	1996	1:25000	Department of Survey
Geology Map	1978/79	1:125000	Department of Survey
Digital Globe 4 Band Satellite Image, PAN & MSS	March 07, 2015	1m PAN and 2m MSS	National Land Use Project
Aster DEM	2011	PS. 30*30	Download from USGS Website
DGPS Survey for GCPs and field verification	2015	Boundary & Land Use	ERMC team including author

The research work is basically spatial data preparation from the high resolution satellite image by visual image interpretation method as it was difficult to remove the minute areas due to shadow and trees. The suitability analysis and weighted overlay analysis is the specific approaches and methods adopted to identify the suitable areas for urban development of the study area. The work flow diagram is shown in Figure 2 as below.

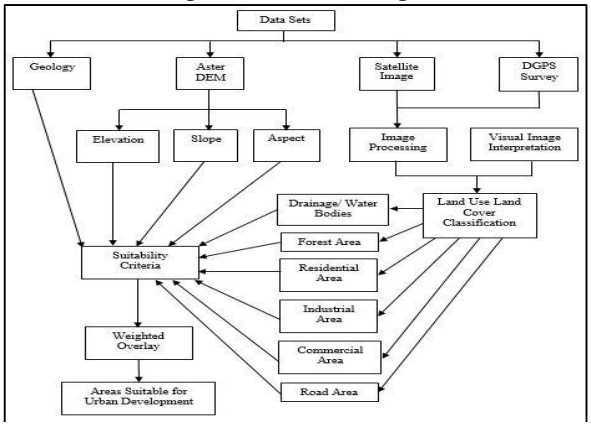

Figure 2: Workflow Diagram

Suitability Criteria for Urban Development

The urban development carried out on the basis of GIS based spatial analysis using weighted overlay analysis on several available data sets. The data files comprised the various parameters like geology, elevation, slope, aspect, and land use land cover parameters used for identifying the areas for suitable for urban development. A rule base was developed by using multiple-criteria on the basis of research knowledge for land use planning. These criteria were used to identifying suitable areas for urban development area. The ArcGIS 10.2 software was used for GIS analysis. The process for identifying the suitable areas map begins with ensuring all data are in the appropriate raster format. The polygon shape files such as geology buffer, forest area buffer, drainage/water bodies buffer, residential area buffer, commercial area buffer, industrial area buffer and road area buffer should be converted from vector to raster using Feature to raster tool. A slope raster was created using the elevation raster using spatial analyst tool. All raster files should be reclassified using reclassify tool. The appropriate distance values were binned into four classes based on Table 2 and favourability values were assigned. The all criteria types (1-4) elevation and slope raster were assigned to correct favourability classes, which is started were: 1= not suitable, 2= least suitable, 3= moderately suitable, and 4= highly suitable. All reclassified raster were added as inputs in the weighted overlay tool. This resulted in a final suitability raster for suitable areas for urban development final map production.

Table 2: Weight for Identifying the Areas Suitable for Urban Development

S. N.	Category	Criteria	Value	Suitability Level
1.	Geology	Unconsolidated Sediments	4	Highly Suitable
		Salyan Series	3	Moderately Suitable
		Midland Metasediments Group	2	Least Suitable
		Thrust Buffer 100m	1	Not suitable
2.	Elevation	< 500m	4	Highly Suitable
		500 – 750m	3	Moderately Suitable
		750 – 1000m	2	Least Suitable
		> 1000m	1	Not Suitable
3.	Slope	0 – 10 Degree	4	Highly Suitable
		10 – 20 Degree	3	Moderately Suitable
		20 – 30 Degree	2	Least Suitable
		> 30 Degrees	1	Not Suitable
4.	Aspect	157.5 – 202.5	4	Highly Suitable
		112.5 – 157.5 and 202.5 – 247.5	3	Moderately Suitable
		90 – 112.5 and 247.5 - 270	2	Least Suitable
		0 – 90 and 270 - 360	1	Not Suitable
5.	LULC	Agriculture	4	Highly Suitable
		Buffer of Forest 100m, River 40m, Stream 20m, Commercial 20m, Residential 20m, Public Use 20m, Industrial 20m and Road 20m	1	Not Suitable

Weighted Overlay Analysis

Weighted Overlay is a technique for applying a common measurement scale of values to diverse and dissimilar inputs to create an integrated analysis (ESRI, 2015). Weighted overlay only accepts raster input such as geology, elevation, slope, aspect, and LULC in this research. The raster is required reclassified before they can be used. The values of raster are grouped into ranges must be assigned a single value before it can be used in weighted overlay tool. The assign weights at the time of reclassifying the cells in the raster will already be set according to suitability. The output raster can be weighted by importance and added to produce an output raster using weighted overlay tool using in ArcGIS. The tool was used for to locate suitable areas, higher values generally indicate that a location is more suitable.

4. PROCESS

The weighted overlay analysis process used for identifying the suitable areas for urban development. In this research, the five subjective criteria ware used for urban development area selection. These five subjective criteria are geology, elevation, slope, aspect, and LULC description with map as below.

4.1 GEOLOGY

Rampur Municipality of Palpa district is mainly composed of red soil and clay in the Lesser Himalaya. Geologically, it has 1) recent and Pleistocene formation by alluvium, the work of water including river terraces. It also has 2 major fault along the Kaligandaki River and foot of the hills in the south 2) Southern Part of the area consists of Precambrian to

recent Cambrian with Jarbutta formation with shale and lime stones. In this research geological data has been used for the analysis of terrain and slop of study area which is helpful for the analysis of urban planning at present and future urban development. In the base of geological map study identified the suitable area of urbanization and other infrastructure development. According to the analysis thrust area is identified which is support for the development process. The Geology Figure 3 is shown as below.

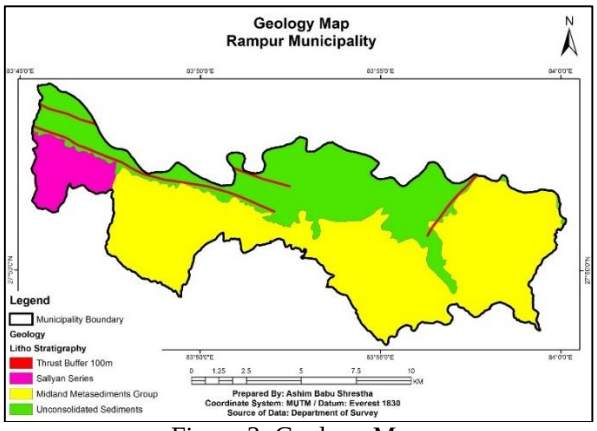

Figure 3: Geology Map

4.2 ELEVATION

The elevation will show the elevation situation of the Rampur municipality. Almost all the area of Rampur falls under the slopping land. Elevation of this municipality ranges at the altitude 250m to 1850m above mean sea level. There are four class of elevation i.e. < 500m, 500m – 750m, 750m – 1000m and > 1000m. The elevation of < 500m is useful for residential, commercial, and industrial suitable areas for urban development. The < 500m is highly suitable areas for urban development and it gives the high weight and > 1000m is not suitable for urban areas so it gives the low value for planning criteria. The elevation situation of Rampur municipality Elevation Figure 4 as below.

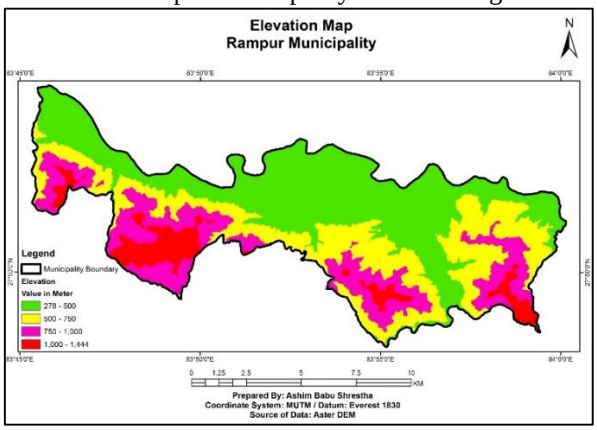

Figure 4: Elevation Map

4.3 SLOPE

The terrain of middle hill of Rampur municipality is flat to very steep. The slope degree (°) of this municipality is 0° to 84°. There are four class of slope i.e. 0° – 10°, 10° – 20°, 20° – 30° and the maximum gradient is 30° and above. The slope of 0° – 10° is more useful for residential, commercial and industrial areas suitable for urban development. The > 30° slope is not suitable for planning. The suitable area slope is high weight value and not suitable areas for low weight value. The Slope is shown in Figure 5 as below.

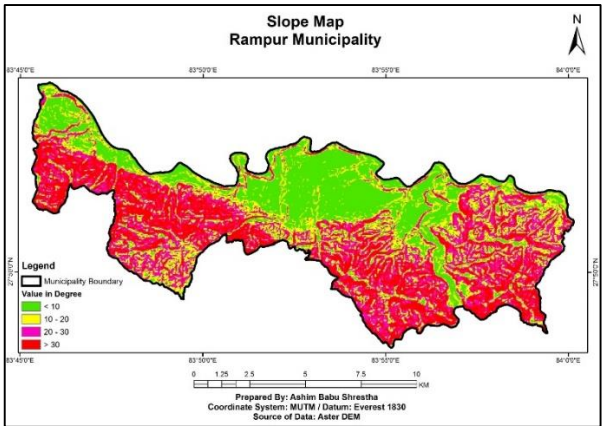

Figure 5: Slope Map

4.4 ASPECT

Aspect identifiers are the down slope direction of the maximum rate of change in value from each cell to its neighbours. Aspect can be thought of as the slope direction. The values of the output raster will be the compass direction of the aspect (ArcGIS ESRI, 2016). Aspect is better for urban development as a face of East or South direction according to sun light direction. Sun always rise from East direction and set in West direction. According to the sun light direction East and South face sufficient light for winter season. North face very poor light so it is always cold. So, South direction is highly suitable i.e. high weight and North direction not suitable i.e. less weight. The Aspect is shown in Figure 6 as below.

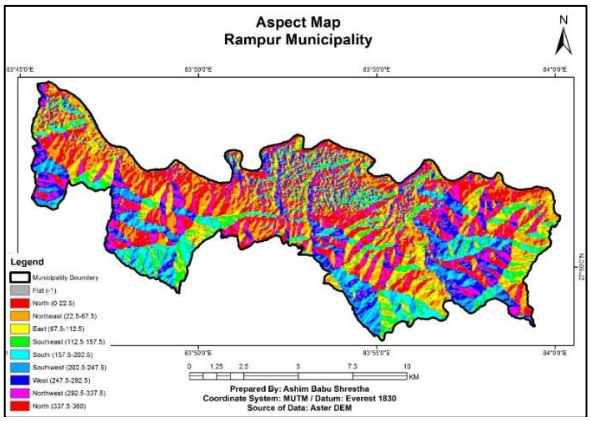

Figure 6: Aspect Map

4.5 LAND USE LAND COVER

The land use /land cover map is the basic criteria for identifying suitable areas for urban development. The criteria parameters as geology buffer, forest area buffer, drainage/ water bodies buffer, existing residential area buffer, existing commercial area buffer, existing industrial area buffer and existing road area buffer are not suitable for urban development. The Land Use Land Cover is shown in Figure 7 as below.

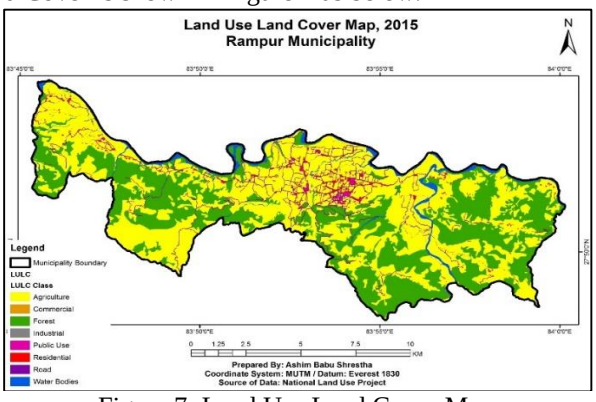

Figure 7: Land Use Land Cover Map

5. RESULT AND DISCUSSION

The weighted was provided to the criteria on the value of 1 to 4 based on the research knowledge. 1 is being assigned to completely restrict for weighted overlay analysis. The suitability level and values of identifying suitable areas for urban development Suitability Level and Value Table 3 as below.

Table 3: Suitability Level and value

S. N.	Value	Suitability Level
1.	4	Highly Suitable
2.	3	Moderately Suitable
3.	2	Least Suitable
4.	1	Not Suitable

5.1 GEOLOGY

The geological categories with weighted value are shown in as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. are not suitable to highly suitable. The presented Criteria for Geology Weighted Value are shown in Table 4 and Suitability Classification of Geology Figure 8 as below.

Table 4: Criteria for Geology Weighted Value

S. N.	Category Geology	Value	Suitability Level	Occupied Area in Sq. KM.
1.	Unconsolidated Sediments	4	Highly Suitable	38.77
2.	Salyan Series	3	Moderately Suitable	74.21
3.	Midland Metasediments Group	2	Least Suitable	8.28
4.	Thrust Buffer 100m	1	Not Suitable	2.09

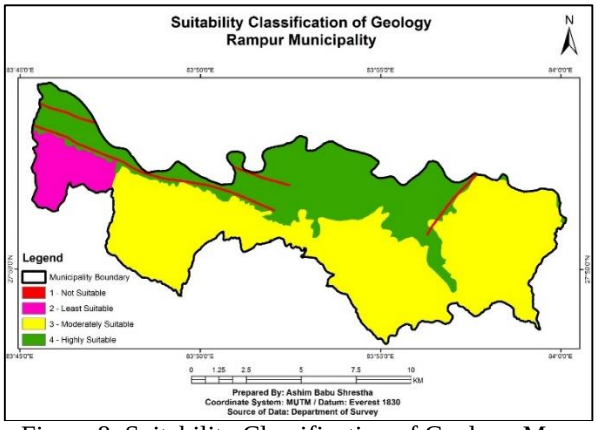

Figure 8: Suitability Classification of Geology Map

5.2 ELEVATION

The elevation categories with weighted value are shown in as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. is shown in not suitable to highly suitable. The presented Criteria for Elevation Weighted Value Table 5 and Suitability Classification of Elevation Figure 9 are shown in as below.

Table 5: Criteria for Elevation Weighted Value

S. N.	Category Elevation	Value	Suitability Level	Occupied Area in Sq. KM.
1.	< 500m	4	Highly Suitable	53.25
2.	500 – 750m	3	Moderately Suitable	29.52
3.	750 – 1000m	2	Least Suitable	30.34
4.	> 1000m	1	Not Suitable	10.23

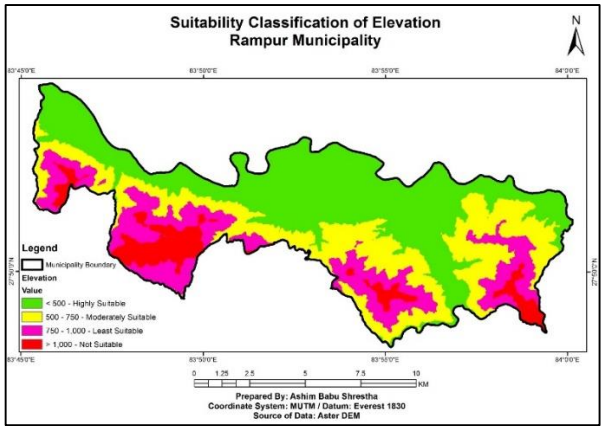

Figure 9: Suitability Classification of Elevation Map

5.3 SLOPE

The slope categories with weighted value is shown as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. are not suitable to highly suitable. The presented Criteria for Slope Weighted Value are shown in Table 6 and Suitability Classification of Slope Figure 10 as below.

Table 6: Criteria for Slope Weighted Value

S. N.	Category Slope	Value	Suitability Level	Occupied Area in Sq. KM.
1.	0 – 10 Degree	4	Highly Suitable	35.90
2.	10 – 20 Degree	3	Moderately Suitable	17.58
3.	20 – 30 Degree	2	Least Suitable	28.13
4.	> 30 Degrees	1	Not Suitable	41.74

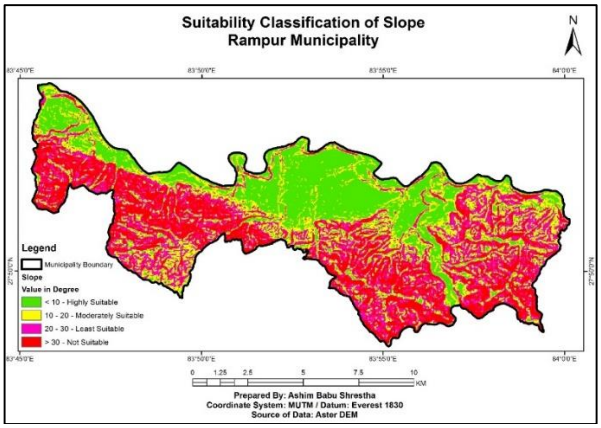

Figure 10: Suitability Classification of Slope Map

5.4 ASPECT

The aspect categories with weighted value are shown in as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. are not suitable to highly suitable. The presented Criteria for Aspect Weighted Value is shown in is shown in Table 7 and Suitability Classification of Aspect Figure 11 as below.

Table 7: Criteria for Aspect Weighted Value

S. N.	Category Aspect Direction	Value	Suitability Level	Occupied Area in Sq. KM.
1.	157.5-202.5	4	Highly Suitable	11.57
2.	112.5-157.5 & 202.5-247.5	3	Moderately Suitable	14.83
3.	90-112.5 & 247.5-270	2	Least Suitable	10.51
4.	0-90 & 270-360	1	Not Suitable	86.43

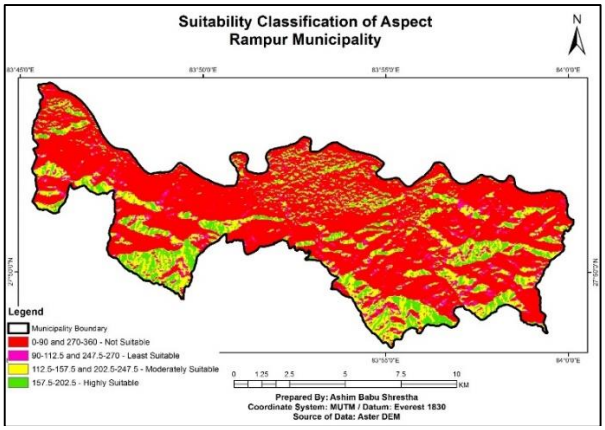

Figure 11: Suitability Classification of Aspect Map

5.5 LULC

The LULC categories with weighted value is shown as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. are suitable to highly suitable. The presented Criteria for LULC Weighted Value are shown in Table 8 and Suitability Classification of LULC Figure 12 as below.

Table 8: Criteria for LULC Weighted Value

S. N.	Category LULC	Value	Suitability Level	Occupied Area in Sq. KM.
1.	Agriculture	4	Highly Suitable	45.99
2.	Buffer of Forest 100m, River 40m, Stream 20m, Commercial 20m, Industrial 20m and Road 20m	1	Not Suitable	77.35

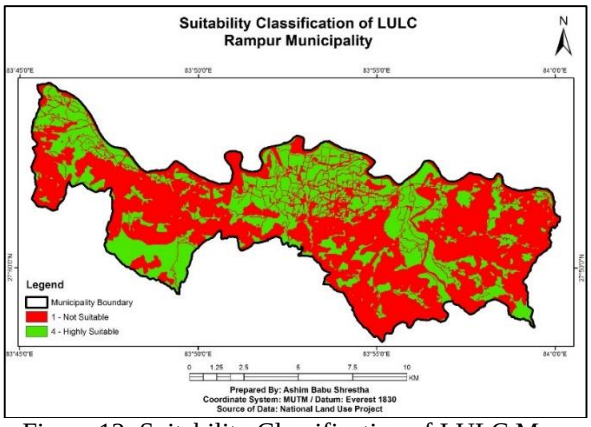

Figure 12: Suitability Classification of LULC Map

Suitable Areas for Urban Development

The suitable areas for urban development map was prepared on the basis of geology, elevation, slope, aspect and LULC with weighted value 1 to 4 i.e. not suitable to highly suitable where 1 is restricted value with weighted overlay analysis in ArcGIS software. The suitable areas for urban development map shown as below Figure 14.

The Figure 14 is the final resulting map which shows that 5.54 sq. km. areas within the Rampur municipality are highly suitable areas for urban development. There are many areas which are not suitable and few areas are least suitable. The weighted overlay analysis and equal influence 20 in each raster as in Figure 13 as below.

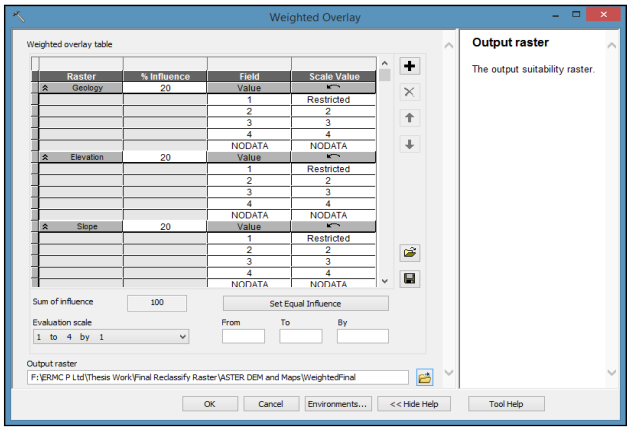

Figure 13: Weighted Overlay Analysis with Equal Influence

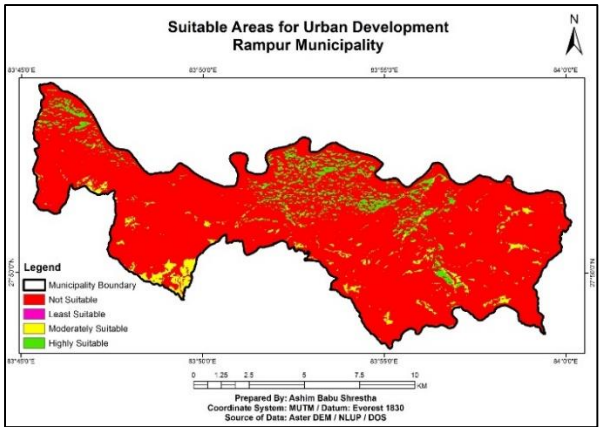

Figure 14: Suitable Areas for Urban Development

Result Analysis

The summary of total area and percentage of suitable areas for urban development map of study area is shown as below table. The result analysis of suitable areas for urban development as below Table 9, pie chart and bar chart Figure 15 and Figure 16 as below.

Table 9: Urban Development suitable Areas and Percentages

Level of Suitability	**Range of Score**	**Colour**	**Area in Sq. Km.**	**Percentage (%)**
Not Suitable	Class 1	Red	113.71	92.19
Least Suitable	Class 2	Pink	0.10	0.08
Moderately Suitable	Class 3	Yellow	3.99	3.24
Highly Suitable	Class 4	Green	5.54	4.49
Total			**123.34**	**100.0**

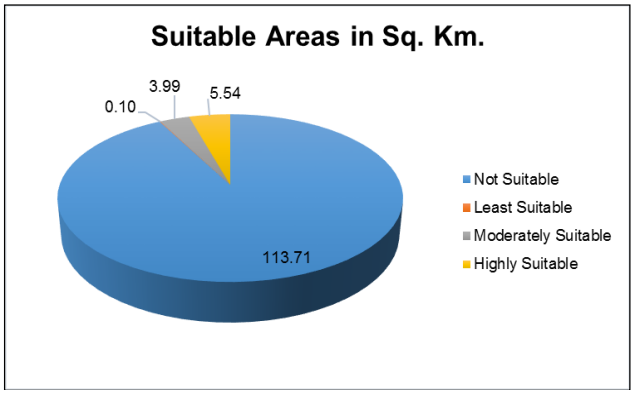

Figure 15: Urban Development Suitable Areas in Pie Chart

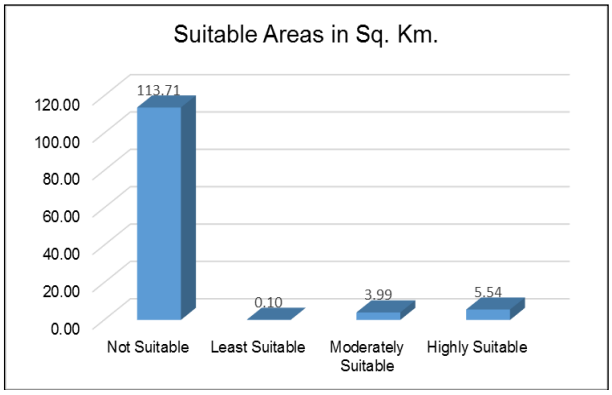

Figure 16: Urban Development Suitable Areas in Bar Chart

6. CONCLUSION

Urban growth and land use study is very useful in local government as well as in urban planners for the appropriate plans of land use planning in sustainable urban development. Urban development provides the knowledge for the planners and decision makers, the required information about the current state of development and the nature of changes that have occurred, physical conditions, public service accessibility, economic opportunities, local market, population growth, and government plans and policies are the driving forces of planning process. GIS and Remote Sensing provides spatial analysis tools which can be applied at the municipality, city and district level urban development planning. The present land use pattern of the municipality under study is classified by using remotely sensed image with the help of ground based information.

Lack of clear guidelines on the classification system has posed a level of difficulty in assigning the classes of different hierarchy in land use categories. Hierarchical classification system helped in incorporation of complex land use pattern of this municipality. NLUP specification and research knowledge classification system used in the study attribute to standardization in the land use land cover result among this municipality. Digitization and visual image interpretation

incorporated with extensive field visit and use of ancillary data such as geology map, and topographical map. The land use classes yield better accuracy because the classes are designated manually based on ground knowledge and visual interpretation rather than automatic classification.

The total areas cover by the not suitable i.e. 113.71 Sq. km. in Rampur municipality that is 92.19% of municipality area. The least suitable area cover of 0.10 Sq. Km. and total percentage is 0.08%. The total moderately suitable area is 3.99 Sq. Km. and its cover 3.24% of the area. The total highly suitable areas of Rampur municipality is 5.54 Sq. Km. and it covers 4.49% for suitable areas for urban development.

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8. ACKNOWLEDGEMENTS

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