Integrated Approach of Risk Sensitive Land Use Zoning: A Case Study of Banepa Municipality

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KEYWORDS

Risk Land use zoning, Multi-criteria analysis, GIS, Integrated approach,

ABSTRACT

Land is a basic source of livelihood for most of the Nepalese. Land fragmentation, improper use of land, rapid urbanization and lack of formal plan has created serious problems mostly in urban areas including study area. So proper Land use planning is necessary for getting optimum benefit from land resource in sustainable way. Risk factor has to be considered in land use planning process. Since Expert driven (Top down) approach has not gained satisfactory achievement, Participatory (Bottom up) approach has emerged to ensure public participation in land use planning. Participatory approach has also some limitations.

So the study seeks to implement integration of both expert driven and participatory approach to identify low risk land use zones in study area. Study targeted to identify risk areas from participatory approach before land use zoning. The case study was carried out in Banepa Municipality. The research was completed by following integrated approach using both primary and secondary data. Both desk study and case study method has been applied. Questionnaire, focus group discussion, interview techniques has been used in the study for collecting primary information where as high resolution satellite imagery, municipal GIS database, Census data etc. were used as secondary data. GIS application was used for Multi-criteria Analysis (MCA). To determine corresponding weight for each factor for land use zoning AHP (Analytical Hierarchy process) has been implemented.

Different risk zones in the study area are identified using participatory approach. Final risk free land use zoning map of the study area is prepared. Study concludes that integrated approach is useful for effective land use zoning and risk should also be considered in this process. Different kinds of risk like landslide, flooding, industrial hazard etc. are dominant in the study area. Legal, organizational and technical improvement is required for effective implementation of land use zoning .

1.Introduction

Land is basic resource of livelihood for more than 75 % of Nepalese. Most of the parcels are fragmented due to population growth and other causes. The issues of slums, land less, tenants etc. are also increasing. Nepal has a severe threat of facing problem of food insecurity and hunger in future. Similarly, unplanned settlement, detrimental habitat, rapid Population growth, lack of urban infrastructure, natural disaster, and environmental degradation are other serious challenges to be faced in near future. Mostly population growth takes places in urban areas dramatically (Schmandt, 1961).

According to Basyal and Khanal (2001),urbanization in most cities of Nepal is taking place due to migration of people from rural to urban areas in search of employment, for commercial activities and in seek of education and other opportunities. Land use planning offer many opportunities and options to reduce human, economic, and physical losses due to natural disasters (UN-HABITAT ,2015).

Land use zoning, i.e. the delimitation of homogenous zones in regard to their characteristics (topography, soil, vegetation, land cover, forest classification, ecological system etc.) or functions (current land use, land use potential, agricultural potential, conservation values, ecosystem services etc.), should be part of any land use analysis. The categories for zoning should be derived from the key problems, major challenges and/or main potentials of the planning area or if already identified from the planning objectives (Pickardt, 2011).Land use zones are micro level of planning which has to be prepared mandatorily by each Municipality or VDC through community participation (KVDA, 2015).

Dhakal (2012) has concluded that the public participation in decision making, implementation, monitoring and evaluation, and benefit sharing of urban planning is well taken by the community itself. Conventional (top-down) planning approaches have had very little achievement due to a lack of dialogue and coordination among implementing bodies and local stakeholders Hence, participation has been identified as key factor for a successful land use planning. The old expert driven approach resulting in one way communication still exists here and there. Risk mapping, for instance, can be done in a participatory way together with the local population during a normal land use planning workshop (Pickardt, 2011).

Rapid Urbanization is a major problem for most of the cities in Nepal. According to Building bylaws of Banepa Municipality, Banepa is one of the rapid growing city with increasing population and urbanization. Lack of formal planning increases the adoption of informal ways of planning, which may or may not be effective. So it is necessary to develop land use plan for optimum benefit in sustainable way. Since city is suffering from different hazards like land slide, flooding ,industrial hazard etc, we have to consider those risk in proposed land use plan. Many countries have failed to address natural disaster like flood in land use planning though it provides the missing basis for taking precautions against catastrophes (Sudmeier-rieux & Jaboyedoff ,2015).

Expert driven approach of land use planning has not gain satisfactory achievement in land use planning. Public participation in every step of land use planning should also be ensured (Pickardt, 2011).

The main objective of the study is to identify risk sensitive land use zones in Banepa Municipality from integrated approach of expert driven and participatory.

2. Study Area

Banepa Municipality, a small valley lies in the north-west part of Kavre District, Bagmati zone of Nepal. It lies 26 km east from the capital city Kathmandu. Its geographical limits are latitude 27^0 37' 1" to 27^0 39' 2" north and longitude 85^o 30' 55" to 85^o 32' 59" east. The elevation varies from about 1400 meter to 1800 meter from mean sea level. The political boundaries of this Municipality are: Rabiopi VDC in the north, Panauti Municipality in the south, Dhulikhel Municipality in the east and Ugratara and

Ugrachandi VDCs in the west. Study area is lacking of formal land use zoning .

3. Methodology

The research starts from Data preparation phase. After that present land use was analyzed and updated using high resolution Geo I image. Risk was analyzed using participatory approach. Both spatial and Socio-economic data were analyzed using Multi-criteria and Subjective approach. Finally different land use zones were declared in final risk sensitive land use zone map. Following two approaches has been applied for this study .

3.1 Multi-criteria Analysis

Land use zoning is carried out by considering various criteria collected from literature review and key informants interview. Those criteria are translated in GIS software and analysis is done. This is a scientific process and individual judgments cannot be made while applying the process. The suitability of certain use is judged by the software based on the provided criteria.

3.2 Subjective Analysis

Subjective analysis on the basis of requirement and expert's opinion is carried out. As an example, although, if a small piece of land is found suitable for agricultural use, however, it is surrounded by residential area, then it is located in the residential area.The conceptual framework of overall research methodology is presented in the following figure 1.

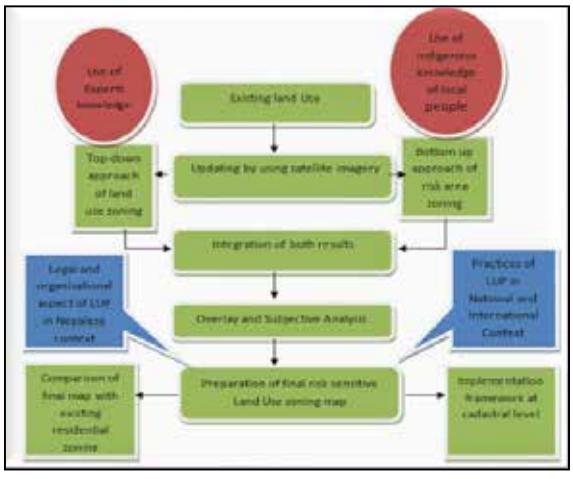


Figure 1: Conceptual framework

4. Result and Discussion

Results from the analysis of the collected data and discussion are presented below.

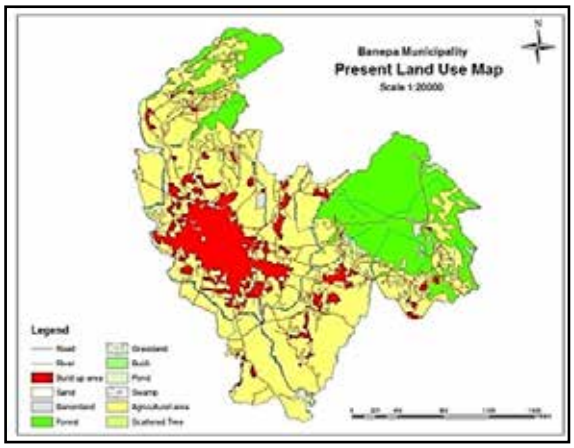
4.1 Population of Banepa Municipality

Banepa Municipality has 12597 populations according to 2048 Census. This increased up to 24764 in 2068 B.S. Population growth rate is 4.83.(Population of 2068 -Populationof2048)/ Populationof 2068*100/20=4.83).

The residential area is 6862509Square meters and forecasted area required for 10 years Period is 1061179 square meters. So extra area required for 10 years for residential purpose is 344166 square meters.

4.2 Present land use of Banepa Municipality

Banepa Municipality has 11 land use types (however, all categories are not as adopted by NLUP) and their corresponding area is given in the Figure 2.



The area of different types of Present land use of study area are shown in the following table 1.

Table 1 : Present land use distribution

Land use Type	Present land use (Ha)
Buildup area	755031
Cultivation	3906118
Forest	1836761
Grass	42414
Bush	68673
Scattered Tree	183652

Swamp	1637
Sand	2477
Barren land	72756
River	27804
Pond	3199
Total	6862509

4.3 Risk zones in Study area

Risk zones in the study area were identified from participatory approach.GPS field survey was also conducted for data collection as well as validation of the result. Some types of risk found in the study area are:

- Flooding
- Forest fire
- Industrial Hazard
- Land Slide

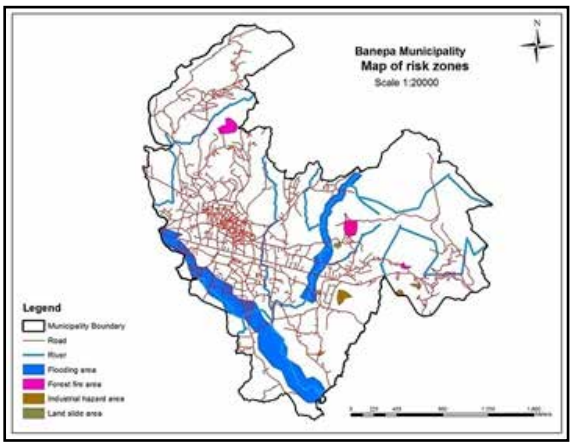


Figure 3: Risk map of Banepa Municipality

This study area is in moderate risk from earthquake perspective .So we haven't considered that risk in the study area.

4.4 Parameters and mapping of different land use zones

The land use zoning should be carried out on the basis of multi criteria analysis using present land use, land resource data sets and socio economic data sets. However, the present land use is also given due consideration in the issue of Cultural, forest, residential, commercial, Industrial as well as public use. According to the Land Use Policy 2072 BS, there must be following eleven land use zones. This research has also considered all specified zones in land use zoning process as far as possible by analyzing data and public requirements. Some of the criteria used for land use zoning of different categories are as follows:

A. Residential Zone

Residential zone means the land used by people for shelter or housing and the word also includes animal shed, food container, garage, stable, well, tap, orchard, backyard, courtyard or land with any other use whether joined with the house or separate. This word also denotes a collective housing or apartment built by a business company or institution, and also to a specific land declared by the government for housing purposes. The existing residential area is kept intact.Some of the criteria to identify appropriate land for these new settlements are:

i. The area should be in the neighborhood of the existing settlement
ii. Availability of Road and infrastructures if possible
iii. Not in the flood plain of any river
iv. Geologically stable
v. Not in the vicinity of dense forests and Industrial areas as much as possible
vi. The land should be of marginal utilization, i.e. the land should be less capable for agricultural crop production

According to LUP experts, factors like Risk, Accessibility, land capability etc. are responsible for residential zoning. Accessibility should be considered highly according to 17 respondents. Similarly other factors should also be considered. Table 2 describes about factors and their corresponding weights according to LUP experts.

Table 2: Factors for residential zoning

Parameters	No .of Respondents
Risk	13
Accessibility	17
Land Capability	12
Utility services	13
Social Sentiments	5
Geology	10

Topography	7
Existing Settlement	4
Land System	7

Following figure describes about factors and their corresponding weights for residential zoning according to Survey Measurement Act 1963.

By following all sources of parameters given, Some of the parameters considered as a factor for residential zoning are as follows:

- Slope- slope up to 30 degree is better
- Aspect-East west slope is better
- Present land use-Built-up area, barren land are better, Forest, water body are restricted
- Land Capability-Warm, temperate, humid and moisture regime is suitable.
- Land System-Less than 30 degree mountain sloppy area are suitable
- Accessibility- Near to road is preferable
- Nearness to river-Far from road is preferable

Making comparison matrix (reciprocal matrix)

Based on the value obtained from pair wise comparison, comparison matrix was developed. Since factors are taken as parameters for pair wise comparison, the matrix size is 7×7. To fill the lower triangular matrix, the reciprocal values of the upper diagonal were used. If a_{ij} is the element of row i column j of the matrix, then the lower diagonal is filled using this formula: $a_{ji} = 1 / a_{ij}$

Eigen value (λ)

After determining the relative weights, the consistency of output was checked... This is iterative process. Principal Eigen Value is obtained from the summation of products between each elements of Eigen vector and the sum of column of reciprocal matrix. The Eigen value is in second iteration is 8.08.

Consistency Index (CI) and Consistency Ratio (CR)

Prof. Saaty proved that for consistent reciprocal matrix, the largest Eigen value is equal to the size of comparison matrix, or λ max = n. Then he gave a measure of consistency, called Consistency Index as deviation or degree of consistency using the following formula.

$CI = (\lambda max - n)/(n-1)$

Principal Eigen Vector calculated in our result was found to be 8.08. Since the value of λmax is 8.39 and the size of comparison matrix is 7, thus the consistency index (CI) is

$CI = (\lambda max - n)/(n-1) = (8.08-7)/(7-1) = 0.18$

Now, our objective is to find Consistency Ratio (CR) which is ratio of Consistency Index (CI) to Random Consistency Index (RI).

$CR = CI / RI$,$CR=0.18/1.32$,$CR=0.136$

Therefore, consistency Ratio= 13.6 %

So after testing the final consistency ratio of AHP parameters, using Weightage of each parameter, the weighted overlay operation in model builder was carried out.After all process weight of each parameter has been calculated as shown in the following table 3.

Table 3: Weightage of each parameter

Parameters	HP Values		Principal Eigen Vector (%)
1	Slope	0.07	7
2	Aspect	0.02	2
3	Road	0.33	33
4	Nearness to river	0.05	5
5	Land cover	0.15	15
6	land capability	0.24	24
7	Land System	0.14	14
		Total	100

Using those principal Eigen vector as a percentage value of weight of each parameter, weighted overlay was prepared and run.Then final residential zoning rating map is prepared after running model. It describes about suitable and unsuitable areas for different land use zoning which is shown in Figure 4.

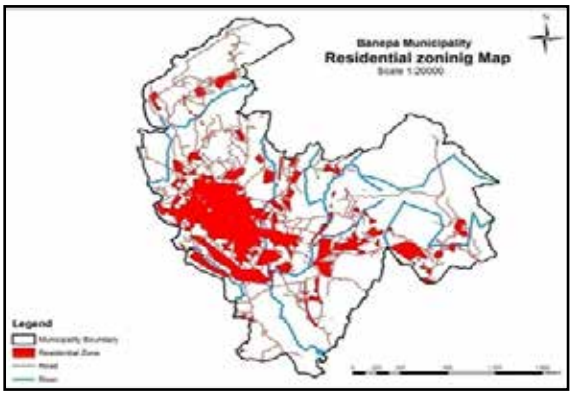


Figure 4: Residential zoning map

Similar approach has been applied to find suitable areas for different zones.Some of them are:

B. Agricultural Zone

The agricultural zone means the area where there is a presence of agro products (food grains, cash crops, horticulture, etc.), animal husbandry, fisheries, agro and forest products or orchards in a private land. .

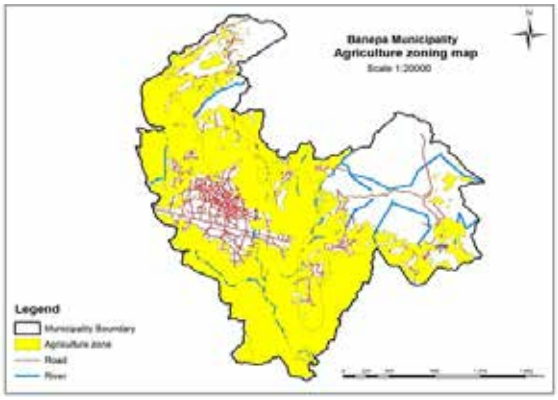


Figure 5: Agriculture zoning map

C. Commercial Zone

Commercial zone means the land occupied by or allocated for shops, hotels, exhibition stalls, petrol pumps, warehouses, health and information facilities, commodities trade centre, an organization providing any literary, scientific or technical service or advice, fair venues, discos, clubs, etc. Different parameters like Existing settlement; Accessibility, geology topography etc. are responsible for commercial zoning according to the LUP experts. Area suitable for the commercial purpose are shown on the map in red color.

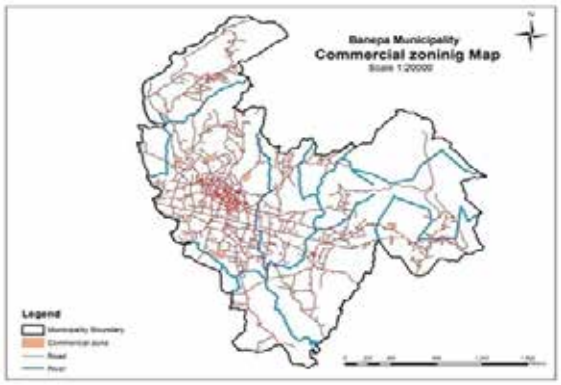


Figure 6: Commercial zoning map

D. Industrial Zone

Industrial zone means the land occupied by or allocated for any workshop, goods manufacturing industry, the associated buildings and sheds. This word also denotes an industrial corridor, industrial village, cluster, special export zone and special economic zone declared by the government for industrial promotion in a definite geographical region. Different parameters like Existing settlement; Accessibility, geology topography etc. are responsible for commercial zoning according to the LUP experts.Areas suitable for industrial purpose are shown on the map in black color.

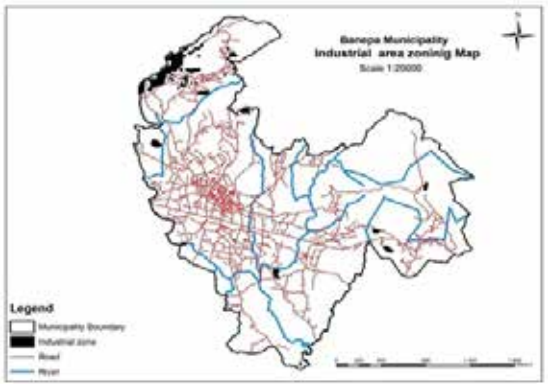


Figure 7: Industrial zoning Map

E. Public use Zone

Public utilities and open zone means land occupied by schools, colleges, vocational educational centers, academic institutions

including the universities, security agencies, health centers, health posts, private or community hospitals, telecom, drinking water, government agencies involved in providing electricityetc. Areas suitable for the Public use purpose are shown on the map in purple color.

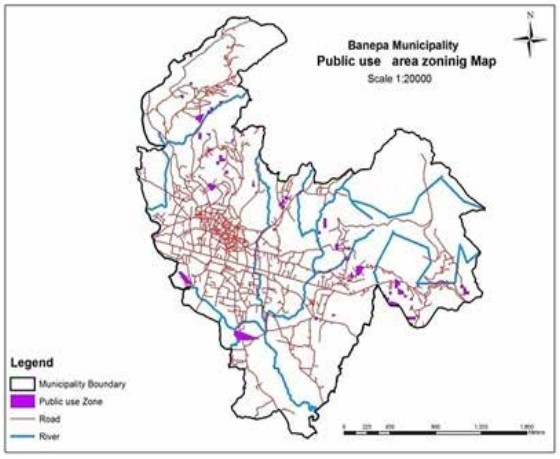


Figure 8: Public use zoning map

F. Forest Zone

Forest zone means an areas being covered with public, community, leasehold forests in part or entirety, national parks, wildlife reserves, conservation areas, bushes, shrubs, plains, all types of jungles and places designated by the government as a forest regardless of whether there are trees or not.

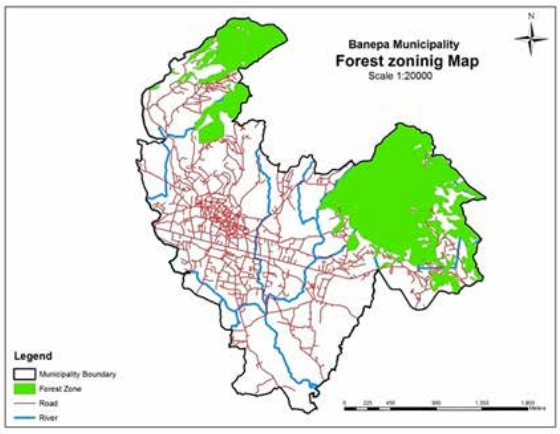


Figure 9: Forest zone map

K. Other Zone prescribed as required

Other Zones prescribed as required mean the areas that do not fall under any of the above land use zones but which need to be mentioned as an exclusive land use zone..

4.5 Final Risk Sensitive land use zoning map

Final risk sensitive land use zoning map with 10 different land use classes was prepared after identification of risk area. Four types of risk were identified in the studyarea Tourist zone was added to the previous map approach.

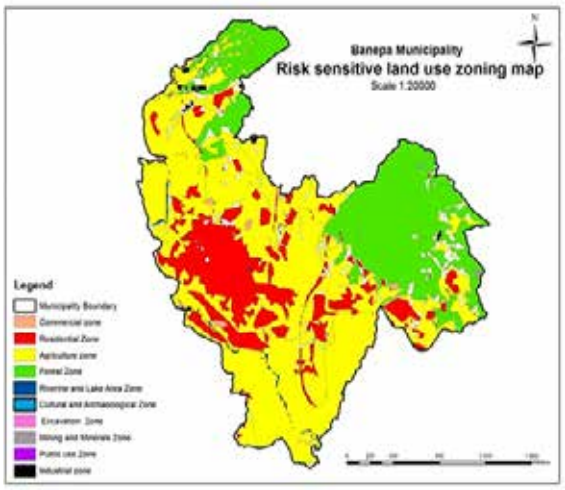


Figure 10: Risk sensitive land use zoning map

4.5 Verification (accuracy assessment) of Land Use Zoning Maps

The final proposed risk sensitive land use zoning map is verified by field visit and observation. All proposed land use zones are visited and also interaction with local people was held. The real situation and map was compared and analyzed whether proposed zones are implementable or not in the study area. There was a work shop organized in Banepa Municipality with Municipality representative to approve and verify final map. According to the suggestions from that discussion, some minor changes were done in the risk areas as well as proposed zones. Municipality and local people were agreed upon proposed zoning map and willing to accept implementation of the proposed zones at cadastral level. The 80 different random points are generated on the zoning map and are assessed on the ground with public participation to analyze feasibility of the proposed land use class in the real field. Following results are found and overall accuracy was calculated in the error matrix.

Result from Expert Driven approach:

Land use zoning from expert driven approach was analyzed and overall accuracy was calculated as shown in Table 4.

Table 4: Result from Expert Driven approach

	Ground data				
Expert driven data					
	Resi-dential	Agriculture	Forest	Road	
Residential	20	5	0	0	20
Agriculture	5	30	0	5	30
Forest	0	0	15	0	15
Road	0	0	0	0	0
Total	25	35	15	5	80

Overall Accuracy: 81.25

Result from Participatory approach:

Land use zoning from participatory approach was analyzed and overall accuracy was calculated as shown in Table 5.

Table 5: Result from Participatory approach:

	Ground Data				
Participatory data					
	Residen-tial	Agricul-ture	Forest	Road	
Residential	15	5	0	0	15
Agriculture	10	25	0	0	25
Forest	0	5	20	0	20
Road	0	0	0	0	0
Total	25	35	20	0	80

Overall Accuracy: 68.75

Result from Integrated approach:

Land use zoning from integrated approach was analyzed and overall accuracy was calculated as shown in Table 6.

Table 6: Result from Integrated approach

	Ground Data				
Integrated data					
	Resi-dential	Agricul-ture	Forest	Road	
Residential	20	5	0	0	20
Agriculture	0	30	0	0	30
Forest	5	0	20	0	15
Road	0	0	0	0	0
Total	25	35	20	0	80

Overall Accuracy: 87.5

For overall accuracy assessment, 80 random points are generated through software and those points are assessed on the ground. The land use of those points are analyzed on land use zones from participatory approach, Expert Driven approach and Mixed approach. The overall accuracy or the result was found to be 81.25% for Top Down approach where as 68.75% for Participatory approach and 87.5% for integrated approach. From this analysis we can suggest for implementation of integrated approach for land use zoning rather than top down and bottom up approach.

4.6 Implementation Strategy of land Use Zoning

For effective implementation of proposed land use zoning, LUP professionals and experts have suggested different facts to be improved. To implement land use zoning at cadastral level, Strong political commitment is necessary. Public should be involved in land use zoning and implementation process .So government should ensure public participation. Similarly public should get compensation for their loss during the land use zoning implementation process. Land use policy is not sufficient for implementation of the proposed land use zoning. Acts, laws, guidelines and procedures should be prepared for effective implementation. All legal documents should be clear so that people can understand the process. But laws

and policies and their strong implementation are necessary. Regular monitoring mechanism of implementation process is suggested. Our organizational structure is not favorable for land use zoning implementation.

5 .Conclusion

Land use zoning is necessary for getting optimum benefit from land in a sustainable way. Risk factor should also be considered in land use zoning process. The Banepa Municipality has dominant risk factors like Flooding, forest fire, industrial hazard and land slide. Those risk zones are not suitable for any kinds of land use activities.

Banepa Municipality has prepared land use zoning map and approved it from Municipal Council but most of the residents of Banepa Municipality don't know about that zoning process. So considering different factors as suggested by land use planning experts, Survey and Measurement Act 1963 and Building Bylaws of Banepa Municipality, which are necessary for land use zoning, risk sensitive land use zoning map is proposed. The existing land use zones are compared with proposed risk sensitive land use zoning map and found that land use zones are not consistent in both map. Since Present land use zoning map is not prepared from participatory process and hasn't considered risk factor, people are not willing to accept this and are agreed to follow new land use zoning map.

6 . Recommendations

Due to lack of proper land use zoning practices, we are not getting optimum benefit from land resources. Although NLUP has started land use zoning at District level, it is not implemented. So it is highly recommend following both expert driven and participatory approach in an integrated way for finding suitable zones for different land uses. Risk factors should also be studies and considered in this process. Since present land use zoning map of the study area is not scientific and hasn't follow participatory approach, it is recommended to follow proposed risk sensitive land use zoning map.

Existing data for land use zoning is not accurate enough to superimpose it at cadastral level. So data of high accuracy is required. For effective implementation of proposed zones, public awareness program should be launched as soon as possible and our current laws and policies should be reviewed. Since local bodies like Municipality and VDC are responsible for implementation, it is better to empower those agencies to make them able to handle this process effectively.

Further research is necessary to follow scientific approach for risk mapping and look after land use planning at local level. High accurate data are recommended for the study and impact assessment of land use planning from National land use project can also be assessed. Another research is required for assessing practical aspect of implementation of land use plan prepared by National Land Use Project.

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