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ARTICLE

Soil Health and Sustainable Land Resource Management Practices at Municipal Level: A Case from Bheri Nagarpalika (Municipality), Jajorkot District, Nepal

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ABSTRACT

The increasing challenges of pressure and ever-growing demands on limited resources in Nepal by diverse actors, land degradation, biodiversity loss and climate change require the rational use of land resources to sustain and enhance productivity and maintain resilient ecosystems for achieving the sustainable and efficient use of resources, taking into account biophysical and socioeconomic dimensions. Regarding this, Nepal Government has realized and taken initiation of scientific and sustainable land use zoning following the National Land Use Act 2019 (2076 B.S.) to use land resources in practicable and sustainable manner. Using spatial information techniques such asZ-3 satellite image, remote sensing (RS), global positioning system (GPS) and geographic information system (GIS). Multicriteria decision making (MCDM) methods for acquiring spatial/temporal data, through expert judgment techniques based on field observation as well as laboratory analysis result, it was found that the soil nutrient status of, the municipality varied spatially and has pH with very high acidic to slightly alkaline but most of the soils are slightly acidic (39.58%). Majority of the soil are loam and sandy loam type with very low to high level of organic matter. Most of the municipal area is under medium range of organic matter. Nitrogen content ranges from very low to very high level as to same ranges of phosphorous (37.69%). Potassium level is also in very high to low as 37 percent land area has high level of potassium. Reclamation of acidic soil mainly in leachable soil is recommended with the proper management of Nitrogen with addition of organic matter is needed to manage for improving crop production.

1. Introduction

The increasing and juxtaposed challenges of ever-growing demands on limited resources in Nepal by diverse actors, land degradation, biodiversity loss and climate change require the rational use of resources to sustain and enhance productivity and maintain resilient ecosystems. Land-use planning and, more broadly, land resource planning (LRP), are tools for achieving the sustainable and efficient use of resources, taking into account biophysical and socioeconomic dimensions. The availability of suitable tools and information to support

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and satisfy the needs of decision-makers at different scales, across sectors and among stakeholders is limited, however. The needs of decision-makers to address the challenges and drivers of change and promote effective and sustainable responses calls for an updated set of tools and approaches for participatory LRP. Such a set of tools should take into account biophysical, economic, socio-cultural and governance dimensions, and it should promote integrated landscape management as a means to satisfy the needs of multiple stakeholders and implement diverse national strategies and commitments [1]. It is proposed that a consultation process involving a wide range of stakeholders operating at different scales be undertaken to bring together lessons and experiences in tools and approaches for LRP and to identify the main gaps and opportunities [2]. This consultation process should lead to the formulation, with partners, of a strategy for the development, testing and validation of updated LRP tools in pilot countries with stakeholders and decision-makers, from the scale of local landscapes to the subnational, national and transboundary scales.

There has been a loss of interest in the discipline of land-use planning in recent decades, largely because little unused and unexplored land remains; moreover, scientists have realized that the relationship between land productivity and ecological/edaphic factors is dependent not only on land or soil potential but also on social and economic factors. On the other hand, management and inputs are still dependent on natural resources such as soil quality, water availability, biodiversity and climate, as well as on infrastructure, access to services and labor, and knowledge. For example, less-healthy or less-suitable soils involve a higher cost (e.g. in terms of soil and water conservation measures, irrigation, fertilizers and adapted seeds or other germplasm) to attain the same yield as suitable soils, where suitability involves the ability not only to produce but also to store, process and sell surplus products. Consequently, suitability evaluations that address only land resource potential have declined in importance, while the matching of management options (technologies and approaches) with land uses and socio-economic determinants (e.g. knowledge, inputs, costs and benefits)– as proposed, for example, in Land Degradation Assessment in Dryland Areas (LADA) and the World Overview of Conservation Approaches and Technologies (WOCAT) have gained in importance [3].

Modern approaches to land-use planning not only determine appropriate land-use types but also provide decision-makers with sustainable land resource management scenarios that improve productivity and sustainability [4]. The scarcity of land and water increases competition for these resources and forces users to intensify production to meet escalating demand. Decision-makers need assistance in determining and putting into practice the best land-use management options for sustaining production. In most cases, management options are under continuous development. Broad consideration of natural resources and ecosystems is required in the planning process to identify and promote the most suitable and sustainable production systems over time [5].

Land-use plan, the systematic assessment of the potential of land resource is the multi criteria evaluation of alternatives for land use aiming at sustainability, improved land management and improved economic and social conditions in the specific location context. Its purpose is to select and put into practice those land uses that will best meet the needs of the national economy and the people while safeguarding resources for the future. It is carried out in a series of steps and is based on dialogue and a balance of interests among all parties involved [6].

2. Methodology

This study has adopted methods, approaches and techniques following National Land Use Act 2020(2076B. S.) of Nepal initiated to manage land resources by maintaining accuracy and uniformity of the preparation of land resources maps at the municipal level for the safe and secure settlement along with the environmental protection and ensuring of food security. The task concentrated to identify and classify the land utilization aspects and dimensions based on geospatial characteristics, soil quality, land capability, land suitability, and the state-of- art- of the technology to maximize the level of land resources utilization that reflect on livelihood improvement, income generation and employment in cash crops, horticulture or herbal and aromatic plant cultivation, production and marketing with sustainability of soil fertility. The assessment has also devoted to classify land for residential, public usages, industrial corridor, special economic zone, commercial activities, sensitive area for national security, cultural and religious importance area, environmental and disaster sensitive area, river/stream/wetland/lake area and other specific area identified by the government among the existing settlement locations. Proposed land use (zoning) has to be carried out in sustainable way which could balance the environment, ecology, and economy at the municipal level and meet the national policy of land utilization [7].

This attempt has been undertaken to map out the current land use pattern with potential land use zoning in order to categorize and assess land based on the optimal suitability for sustainable management of land resources

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using spatial information techniques such as satellite image, remote sensing (RS),global positioning system(GPS) and geographic information system (GIS). Multicriteria decision making (MCDM) method is applying for acquiring spatial/temporal data, through expert judgment techniques based on field observation as well as laboratory analysis result [8,9]. To analyze the land resource management practices at municipal level an attempt has been made to formulize national land policy for effective utilization of land according to its productive capacity and usefulness. Soil survey by fixing pits through satellite imagery several measures and techniques were applied to classify land that reflects a soil quality indicator. A preliminary reconnaissance survey was carried out during the pre-field activities to get the insight of ground situation of the municipality regarding the association of landform and soil which assessed to systematic land use planning in an effective way. This field based assessment further helped to identify several observed and measured parameters. Soil classification was taken as one of the important parameters to classify land that reflects a soil quality indicator to get the insight of ground situation of the municipal area regarding the association of landform and soil in identification of soil mapping units and designing the soil sample pit collection. Field work was carried out to study the physiography, landform and their associated soils based on the soil pit. A total of 61 soil pits were taken in the field representing varied micro topography. Soil Sample pits covering all the units were dug based on the interpreted soil map, topographical map, ZY-3 Satellite imagery for determination of soil profile. Soil classification of the area was done based on the USDA soil taxonomy and soil orders.

2.1 Study Area

Bheri Nagarpalika (Municipality), Jajorkot district is located in Mahabharata range and mountainous area. The region is geologically fragile and geomorphologically unstable and highly sensitive in terms of natural hazards like landslides, soil erosion and watershed degradation. The lower parts of Nagarpalika area is however, accessible in terms of physical infrastructure like accessibility of transportation, market and health and education services. Concerning to naming of Bheri Nagarpalika, it is named by covering the watershed area of Bheri River where all the gads, streams and rivulets of the district are confluence into Bheri River in the south western direction. So that the name of the Nagarpalika has named based on the watershed area of Bheri River drainage system and named as Bheri Nagarpalika as shown drainage system of the Nagarpalika (Figure 1).

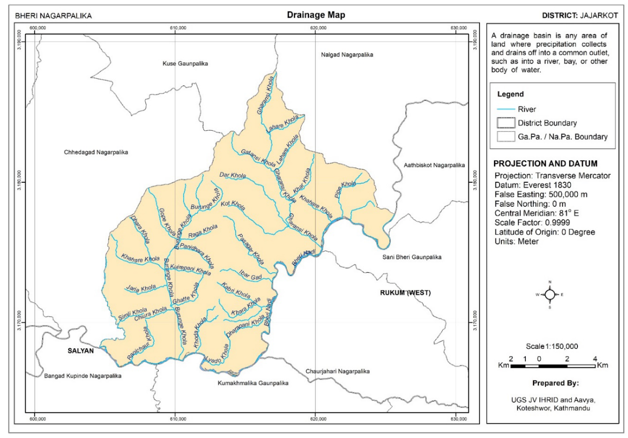

Figure 1. Watershed and drainage network

By the Geographical location this Nagarpalika is located at the south west part of the district which is surrounded by Nalgad Nagarpalika of Jajorkot district, Sani Bheri Gaupalika and Chaurjhari Nagarpalika of Rukkum district and Bheri River from the east, Bangad Kupinde Nagarpalika and Kumakhmalika Gaupalika of Salyan district and Bheri River from the south, Kushe Gaupalika of Jajorkot district from the north, and Chhedagad Nagarpalika of Jajorkot district from the west. This Nagarpalika is extended from 82˚4'13.147" east to 82˚17'4.819" eastern longitudes and 28 36'35.449" north to 28.48'32.108" northern with having an area of 221.40 sqkm with 22.71 km north-south length and 23.39.24 km east-west width. Its elevation ranges from 593-2697 meter. Geographically it extends from 82˚4'13.147" east to 82˚17'4.819" eastern longitudes and 28 36'35.449" north to 28.48'32.108 northern with having an area of 221.40 sqkm with 22.71 km north-south length and 23.39.24 km east-west width (Figure 2).

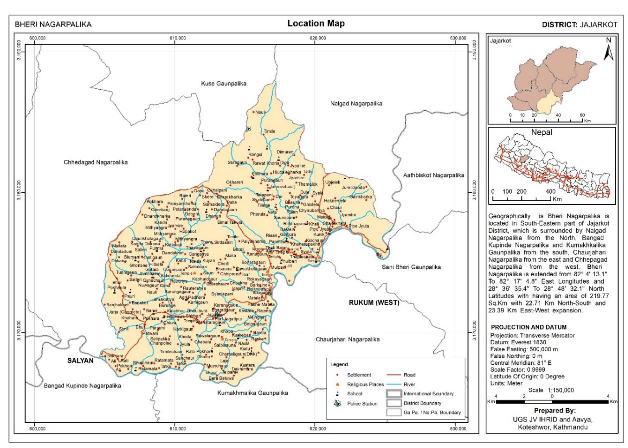

Figure 2. Location of Bheri Municipality

2.2 Land Use and Land Zoning

Using multi criteria analysis method different potential land use zones have been allocated under low risk. Among the prescribed 10 land use zone category in Land Use Act 2076, eight land use zones have been are allocated with maximum area for the forest (58.54%) followed by agriculture (31.54%), riverine and lake (4.08%), residential (3,24%), public use (2.50%), industrial (0.02%), commercial (0.07%), cultural (0.001%),and mining and extraction zones (0.003%)have been allocated. Agriculture land is further classified in to cereal crop (83%), cash crop (3%) and agroforestry. land use zoning assessment shows that most of the forest land is in the Nagarpalika [10].

The land capability assessment classified land into ten class as class I as the most suitable for the agriculture, forestry and grazing with few or no limitations of soil and erosion parameters. Around 2.51% land is under II land which has some degree of slope limitation and is moderately suitable for arable agriculture which can grow diverse crops. Class IIAu/5 land is not suitable for cultivation and subject to conservation. The land category with IIIAh can be cropped with different crop but due to slope, erosion is frequent. Class IIIAh/5 land is not suitable for cultivation. There is less choice of crops in IIIAh than IIAu. Class IVAh land is suitable for cultivation but there is severe limitation of climate and slope. Class 5 and IVAu/5 lands are not suitable for crop production suitable for forest, agro forestry, NTFPs and medicinal and herbal plant cultivation with drainage deficiency. The soil of the Nagarpalika is under nutrients and less developed. Organic matter, nitrogen, and phosphorous quantity in soil are also in low and medium range. Overall, 63.22percent land is above 30-degree slope which is not suitable for cultivation [11,12].

Two cultivation land system and four cultivation land units are identified in the Nagarpalika area where 72.31 percent cultivation land is H- hill cultivation and 27.69 percent under M-. mountain cultivation. Whereas 23.31 percent is level terraces upland cultivation, 55.49 percent level terraces, 16.83 percent sloppy terraces and 4.37 percent under sloppy upland cultivation units.

Nine land use classes were observed in the existing land use practices in the Nagarpalika area in which forest covers 63.14 percent (13980.49 ha) followed by agricultural 28.76 percent (6367.43ha), riverine and lake area 4.07 percent (901.42 ha), residential 3.11 percent (689.55 ha), public service 0.65 percent (144.34 ha),and commercial 0.01 percent (2.69ha). Present land use pattern reveals that the Nagarpalika has dominant forest area which is gradually decreasing day by day. The dominant cropping pattern of the municipal is maize-millet-wheat, Maize-rice- – vegetable. However, 15.70 ha (0.25%) land area is shrub from non -forest area and barren for cultivation.

After analysis of the land use zone and potential risks, the area is considered as a safe area for settlement, in general. There is no severe risk which may cause any loss of human life, goods or infrastructures. However, there are some risk of flooding, bank cutting, inundation and landslide during rainy season. To prevent from these risk, residential commercial areas are not proposed along those locations. Similarly, appropriate care is taken to plan new settlements. Geological studies should be carried out and proper building codes should be followed. Appropriate safety measures should be adopted and safe material should be used for infrastructure development and construction. The area is not a dense and crowded urban area and therefore excess of open spaces is available which may be considered as an asset for safety during any disaster such as earthquake, landslide, flood and fire. Open areas and area for business and services are also allocated nearby settlements clusters [13,14]. It was allocated in such a way that several nearby residential areas can be benefited by travelling minimum distance through the existing road networks.

Land use zoning shows the forest and agriculture is the dominant land use zone followed by Riverine, Lake and Marsh, residential and public use zone. Commercial and cultural and archeological zones are in small scale. Industrial, Mine and mineral are not identified in this study area, however, sand and stone collection areas are operated informally in several locations. The description of land use zoning area is shown in the table 1.

Table 1. Area coverage of different Land Use Zones in Bheri Nagarpalika

SN	Land use Zone Class	Area Ha	Percent
1	Agriculture Zone	6983.00	31.54
2	Residential Zone	718.30	3.24
3	Commercial Zone	14.72	0.07
4	Industrial Zone	4.32	0.02
5	Forest Zone	12960.68	58.54
6	Public Service Zone	554.05	2.50
7	Mine and Minerals Zone	0.53	0.00
8	Cultural and Archeological Zone	0.61	0.00
9	Riverine, Lake and Marsh Area Zone	904.36	4.08
10	Other Zone	0.00	0.00
Total		22140.56	100.00

Source: TSLUMD,2019; Field Study, 2020

Among the prescribed 10 land use zone category eight land use zones are allocated in this Nagarpalika; forest zone dominates the land use zone which is followed by agriculture zone in this study area. Industry could identify in the

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study area during fieldtrip but this zone is purposed for future needs which is about 4.32ha (0.02%) beside this small agro based industries are potential which can be adjust in purpose commercial zone [15,16]. Agriculture predominantly is a driving force of the land and the people way ahead of the other category. Forest covers maximum area (58.5%) followed by Agricultural area (31.5%). Next significant land use is Riverine, Lake and Marsh Area (Figure 3)

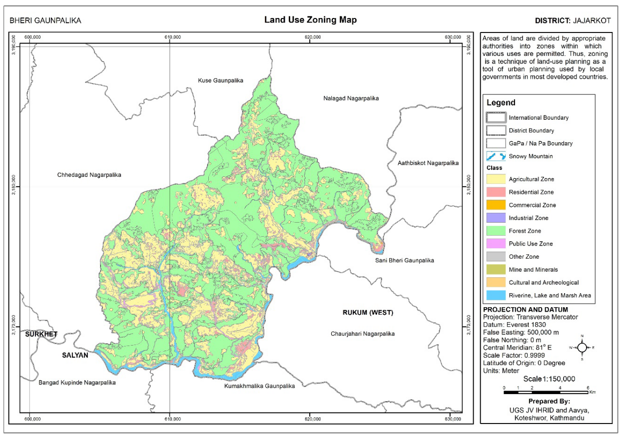

Figure 3. Land use zoning

2.3 Soil Type and Characteristics

Two soil orders, two sub-orders, four great groups and five sub great - group of soil types of the municipal area were identified based on the morphological, chemical and physical properties of soil acquired from the soil study by digging the soil pit and soil mapping unit level [17]. Considering genetic horizons and soil properties, loamy sand, sandy loam, sandy clay silty loam and sandy types soil found at the sub group level. Based on soil taxonomy system, the Entisols was 2.97 percent and Inceptisols 92.96percent. Based on soil properties such depth, genetic horizons, and fertility characteristics, organic matter on the top soil found medium to low which indicates poor nutrients in soil. Regarding the soil pH, Nagarpalika has pH with very high acidic to slightly alkaline but most of the soils is slightly acidic (39.58%). There is very low to high level of organic matter present with more proportion of land (40.03%) under medium range of organic matter. Nitrogen content ranges from very low to very high level with medium level of Nitrogen (32.13%) in major proportion followed by low level of nitrogen (28.25%). Very low to high level of phosphorous content was found the dominance of high level of phosphorous (37.69%) followed by low (20.09%) and medium (16.95%) level of phosphorus. Potassium level is very high to low. Around 37 percent land has high level of potassium, 29.53 percent land has medium level, and 24.9 percent has very high level of potassium and 4.74 percent has low level of potassium.

Soil profile of the Nagarpalika shows that most of the soil was acidic to slightly acidic and some neutral. The quantity of nitrogen and phosphorus in soil found low to medium while the amount of potassium fount medium to high. Over all the soil in the entire area of the Nagarpalika is less developed and marginally suitable for intensive agriculture and suit for forest and agro forestry practices. It shows that soil fertility assessment has to be the first priority of the local government to maximize the benefits from land resources. Soil Orders, Sub-Orders, Great Groups, and Sub-Groups. Bheri Nagarpalika presents in Table 2

Table 2. Soil Taxonomy Classification of Bheri, Nagarpalika

SN	Soil Order	Sub order	Great Group	Sub Great Group	Area Ha	Percent
1	**Entisols**	Orthents	Ustorthents	Lithic Ustorthents	659.28	2.98
2	**Inceptisols**	Ustepts	Dystrustepts	Lithic Dystrustepts	14645.03	66.15
				Typic Dystrustepts	4094.68	18.49
			Haplustepts	Lithic Haplustepts	1703.78	7.70
			Humustepts	Lithic Humustepts	138.55	0.63
3	**Waterbody**				**899.25**	4.06
Total					22140.56	100

Source: Field Study,2020 and Soil labrotary Report, 2020

Table 2 shows that in Bheri Nagarpalika, two major orders of soil were found viz. Entisols and Inceptisols. The major of the soil is occupied by Inceptisols followed by Entisols. Lithic Dystrusteptsoccupied the largest area (66.15%) followed by Typic Dystrustepts, Lithic HaplusteptsLithic Ustorthents and Lithic Humulstepts. Intotal Inceptisols occupied 92.96% area and Entisols occupied 2.98% area (Figure 4).

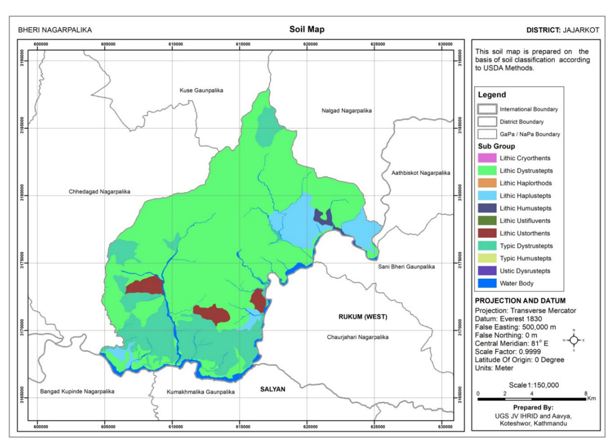

Figure 4. Soil map of Bheri Nagarpalika, Jajarkot

The major soils found in this Nagarpalika are discussed in following heads. Adverse environmental impact from their application. The nitrogen contain in soil is shown in Figure 5.

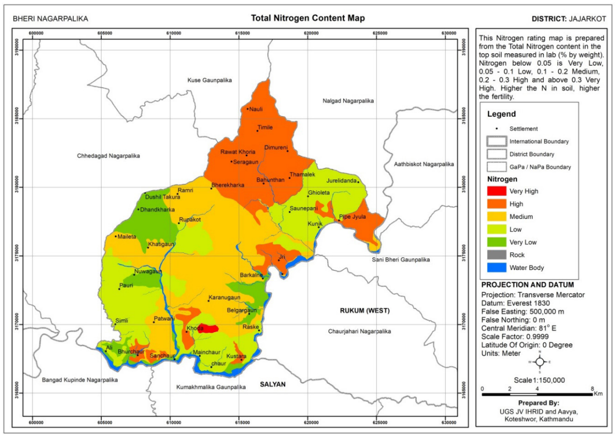

Figure 5. Nitrogen Map of Bheri Nagarpalika

The productive capacity of a soil depends on often complex and sometimes little understood interactions between the biological, chemical and physical properties of soil. Good farm practice aims to manage the various factors that make up each of these three properties to optimize the yields of crops in environmentally friendly ways. Although the focus is on plant nutrients, managing these properly is only one part of best soil management practice which also involves consideration of soil organic matter, soil structure, and the maintenance of a thriving soil microbial population. Soil analysis is an aid to managing soil nutrients efficiently to maintain soil fertility for those nutrients like phosphorus (P), potassium (K) and magnesium (Mg) that are retained in soil in plant available forms. If the amount of any of these nutrients in such forms in soil is too less then yield is jeopardized, but increasing reserves in agricultural soils to very high level is an unnecessary expense. Distribution of potassium of soil is presented in Figure 6.

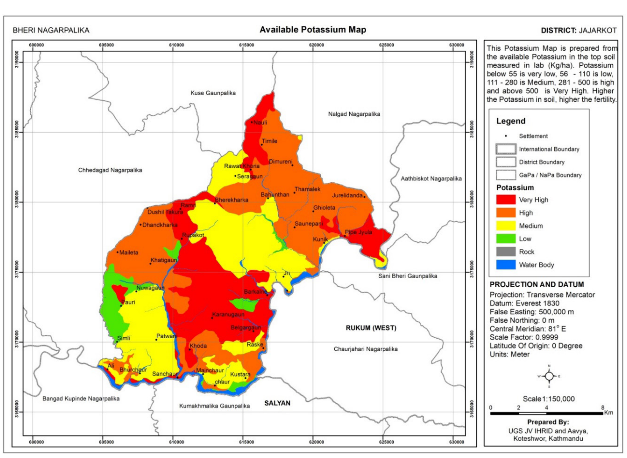

Figure 6. Potassium Map of Bheri Nagarpalika

The phosphorous contain in soil in Bheri Nagarpalika is shown in Figure 7.

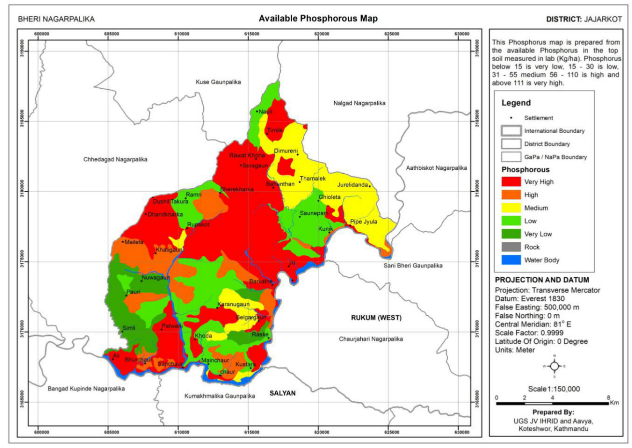

Figure 7. Phosphorous Map of Bheri Nagarpalika

Soil pH value is presented in Figure 8.

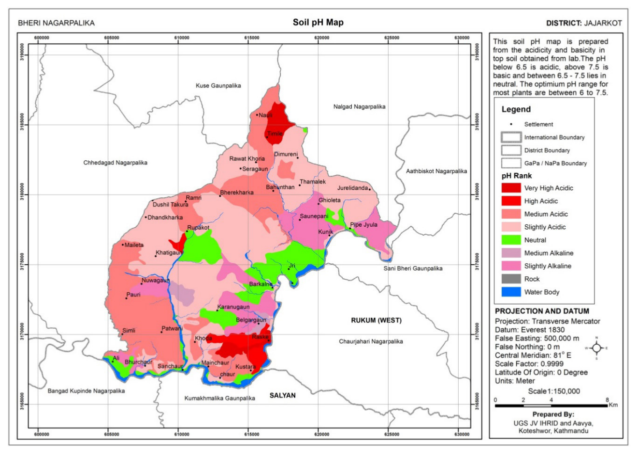

Figure 8. Soil pH map of Bheri Nagarpalika

Figure 42,5,.6 and 7 show that soil nutrient status of the study area has pH with very high acidic to slightly alkaline but most of the soils of Bheri Nagarpalika are slightly acidic (39.58%). Majority of the soil are loam and sandy loam type. There is very low to high level of organic matter present in the study area with more proportion of land (40.03%) under medium range of organic matter. Nitrogen content in the study area ranges from very low to very high level with medium level of Nitrogen (32.13%) in major proportion followed by low level of nitrogen (28.25%) of the area. Very low to high level of phosphorous content was found in the study area with the dominance of high level of phosphorous (37.69%) followed by low (20.09%) and medium (16.95%) level of phosphorus. Potassium level in the study area is very high to low. Around 37% land have high level of potassium, (29.53%) land have medium level, (24.9%) have very high level of potassium and (4.74%) have low level of potassium (Figure 9).

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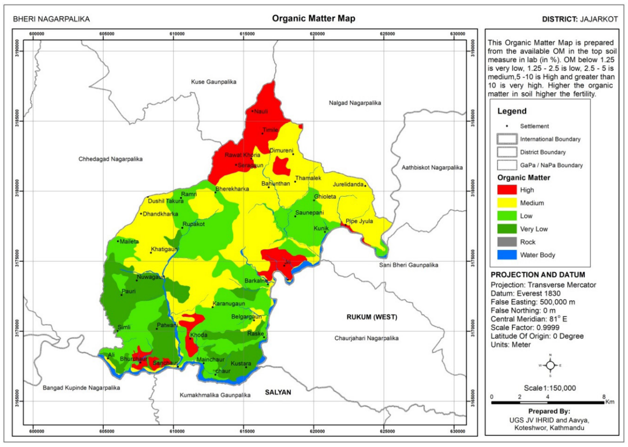

Figure 9. Soil organic matter map of Bheri Nagarpalika

The soil texture of the Nagarpalika is presented in Figure 10.

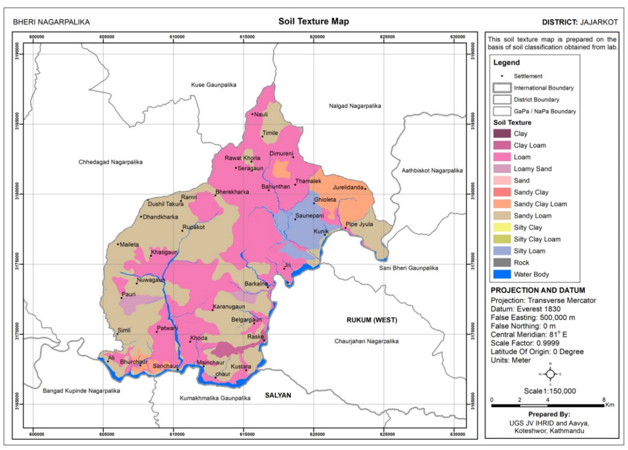

Figure 10. Soil texture map of Bheri Nagarpalika

Pit wise soil nutrient pH, organic matter and soil texture of Bheri Nagarpalika present in table 3.

Table 3. Summary of soil nutrients, pH, organic matter and soil texture status of Bheri Nagarpalika

PIT NO	OM (%)	PH	TOTAL N (%)	Available P_2O_5 (kg/ha)	Exchangeable K_2O (kg/ha)	SOIL TEXTURE
BH-01	1.45	6.26	0.09	144.52	406.8	LOAM
BH-02	0.66	6.94	0.1	140.83	118.8	SANDY LOAM
Bh-03	1.52	5.89	0.08	13.57	244.8	SANDY LOAM
BH-04	5.68	6.43	0.39	78.12	217.2	SANDY LOAM
Bh-05	4.44	7	0.02	403.99	528	SANDY LOAM
BH-06	0.9	5.8	0.07	94.84	147.6	SANDY LOAM
BH-07	2.14	6.49	0.1	27.95	351.6	LOAM
BH-08	1.45	7.68	0.05	113.66	411.6	LOAM
BH-09	0.96	5.67	0.35	20.84	247.2	LOAM
BH-10	0.99	5.17	0.12	8.09	140.4	SANDY LOAM
BH-11	1.76	4.86	0.07	10.31	402	CLAY LOAM
BH-12	0.98	5.08	0.41	31.09	313.2	SANDY LOAM
BH-13	0.82	5.33	0.08	118.88	402	SANDY LOAM
BH-14	2.57	8.7	0.04	1031.14	1596	LOAM
BH-15	1.43	5.96	0.07	7.05	243.6	SANDY LOAM
BH-16	6.02	5.9	0.3	519.24	568.8	LOAM
BH-17	1.32	6.5	0.12	84.39	841.2	LOAM
BH-18	0.7	5.98	0.18	307.02	128.4	LOAM
BH-19	1.53	6.83	0.11	115.75	721.2	SANDY LOAM
BH-20	1.21	5.87	0.08	18.54	159.6	SANDY LOAM
BH-21	2.3	7.5	0.02	77.95	751.2	SANDY LOAM
BH-22	1.91	7.42	0.12	33.18	610.8	SANDY LOAM
BH-23	2.51	6.35	0.01	633.46	741.6	LOAM
BH-24	0.49	7.27	0.03	9.14	87.6	LOAMY SAND
BH-25	2.43	5.71	0.09	25.56	622.8	LOAM
BH-26	0.91	7.87	0.08	108.43	358.8	SANDY LOAM
BH-27	1.91	6.67	0.13	233.86	726	SANDY LOAM
BH-28	3.54	6.48	0.17	21.68	819.6	LOAM
BH-29	3.5	6.64	0.2	221.31	558	SANDY LOAM
BH-30	3.11	6.34	0.15	58.26	380.4	LOAM
BH-31	2.12	7.75	0.13	100.07	663.6	SNDY LOAM
BH-32	2.91	7.23	0.2	320.04	478.8	SANDY LOAM
BH-33	5.44	7.06	0.26	543.12	256.8	LOAM
BH-34	1.86	6.99	0.09	191.13	590.4	SANDY LOAM
BH-35	1.77	5.78	0.11	62.14	416.4	SANDY LOAM
BH-36	1.6	7.3	0.1	25.86	162	SILT LOAM
BH-37	0.89	5.22	0.05	47.84	98.4	SANDY LOAM
BH-38	1.84	6.06	0.09	77.95	172.8	SANDY LOAM
BH-39	3.12	6.72	0.14	102.16	183.6	LOAM
BH-40	1.67	5.52	0.11	10.18	70.8	SILT LOAM
BH-41	3.64	6.12	0.16	178.46	267.6	LOAM
BH-42	2.25	6.41	0.12	251.07	222	SANDY LOAM
BH-43	5.13	7.27	0.28	222.36	718.8	LOAM

PIT NO	OM (%)	PH	TOTAL N (%)	Available P_2O_5 (kg/ha)	Exchangeable K_2O (kg/ha)	SOIL TEXTURE
BH-44	1.97	7.5	0.1	23.96	484.8	SILT LOAM
BH-45	4.99	7.1	0.25	645.92	686.4	LOAM
BH-46	1.87	5.87	0.14	23.77	663.6	SANDY LOAM
BH-47	3.55	6.19	0.05	127.79	393.6	SANDY LOAM
BH-48	2.58	6.36	0.14	81.48	178.8	LOAM
BH-49	4.63	5.95	0.25	360.32	195.6	LOAM
BH-50	4.7	7.4	0.22	46.76	742.8	SANDY LOAM
BH-51	4.83	5.7	0.25	489.93	411.6	LOAM
BH-52	4.86	6.09	0.24	32.13	303.6	LOAM
BH-53	5.67	6.01	0.26	413.01	274.8	LOAM
BH-54	5.61	5.89	0.29	475.30	447.6	SANDY CLAY LOAM
BH-55	6.22	6.02	0.34	133.52	901.2	SANDY LOAM
BH-56	6.34	5.87	0.34	33.18	704.4	LOAM
BH-57	5.65	5.66	0.27	22.72	584.4	LOAM
BH-58	0.8	5.56	0.07	0.78	87.6	SANDY LOAM
BH-59	0.86	5.65	0.06	107.56	136.8	LOAMY SAND
BH-60	0.34	7.57	0.04	2.87	186	SANDY LOAM
BH-61	0.44	6.75	0.042021	40.14	92.4	LOAM
Mean	2.64	6.41	0.15	162.39	420.07	-

Source: TSLUM,2019, Field study, 2020, Soil Laboratory report, 2020

Table 3 shows the spatial distribution of different soil nutrients, and clearly indicates the nitrogen content in soil is not sufficient which further triggered by the prevalence of nitrogen leaching, soil erosion and poor mineralization of organic matters. Phosphorus and potassium content in soil are in medium to high level. Organic matter in the soil ranges from low to medium and majority of soil pH varies from medium acidic to neutral. Farmers' must emphasize soil reclamation which may further improve nitrogen and phosphorous availability. Majority of the soil have loam to sandy loam texture which are consider as good soil and suitable for crop production. External input either organic or inorganic sources of nitrogen and phosphorous is required in the study area for improving crop production.

Soil taxonomy hierarchy as sub-order, great group, sub-group, and family. In the context of soil available nutrients, organic matter content in the soil was found to be within the range of low to high and Nitrogen were found to be within the range of very low to very high with medium level in major proportions, available phosphorus was found to be in very low to high range and Potassium content in the soil were also found to be in low to very high range. Soils of Bheri Nagarpalika are dominated by Inceptisols characterized by moderate fertility status from agriculture prospective [18].

Detail study of various endopedons and epipedons with their observable physico-chemical properties (pH, texture, color, structure, mottles, roots, and boundary) has been made for soil classification. Laboratory analysis (NPK, pH, texture and OM) of upper 30 cm depth soil further strengthen the soil classification procedure. However, some important parameters like CEC, texture, mineralogy, organic carbon and pH of subsoil is very necessary to characterize the sub-order, great groups and family of each order which is to be done in this process. Organic matter should be enriched in low level region. Reclamation of acidic soil is strongly recommended for acidic soil type in the Bheri Nagarpalika with the management of Nitrogen and Phosphorus. Addition of organic matter is further recommended. Potassium is dominant in most parts and limiting only in few parts of Nagarpalika where full dose of potassic fertilizer according to crop type is recommended. Nitrogen in soil is lost through leaching, erosion and poor management and necessary to manage in most part of the Nagarpalika. Major nutrients status in soil were found to be good but integrated land management practices should be encouraged that include agroforestry, animal husbandry, sloping agricultural land technology and other sustainable soil management technology for improving land productivity. This study is not sufficient for proper crop zoning should be used for further crop zoning initiative and policy intervention in agricultural commercialization in the Nagarpalika.

3. Conclusion

At the municipal level, land resources degradation leads the decreasing of soil fertility leading to declining and stagnating soil productivity, and low crop yields which is apparent in the degradation of soil physical properties and soil structure such as high bulk density, low porosity, high soil compaction, destruction of soil aggregates, water stability aggregates are destroyed and moisture holding capacity of soil decreases and water infiltration in to the soil becomes low. In consequence, the surface water runoff and erosion increase. However, land resource (Soil) is everything more than life of the municipal populace where all people are totally dependent on land resources for their livelihood. Soil is the store-house for all nutrients or it is the medium from which plants derive all the essential elements required for them and convert it to economic part as cereals, fruits, fire-wood, timber and even petroleum products. The importance of the land resource found manifold in Bheri Municipality. The land use zoning and soil

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characteristics of the municipality have been discussed by following the guidelines provided by Topographic Survey and Land Use management Division (TSLUMD) based on the National Land Use Act 2019 (2076 B.S.) and has categorized land zones into agricultural area, residential area, commercial area, industrial area, forest area, public use, mine and mirror, cultural and archeological, riverine and lake and others area as per local suitability and need assessment using spatial information techniques. The field based as well as lab based empirical assessment indicates that the municipal area has pH with very high acidic to slightly alkaline but most of the soils are slightly acidic with very low to high level of organic matter. Reclamation of acidic soil mainly in leachable soil is suggested with the proper management of Nitrogen, organic matter Phosphorus in most part of Nagarpalika for improving crop production.

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