

Soil Quality Index and Nutrient in Badekhola and Brindaban Catchments, Nepal

Research Article

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Received: October 26, 2017 | **Published:** February 19, 2018**Abstract**

Soil quality index is the indicator of soil health, physical and chemical properties. However such type of research was not done yet in catchments of Nepal. Thus this research was objectively carried out to assess the soil N, P, K and pH, soil texture and soil quality index. Badekhola and Brindaban catchments of Doti and Baitadi districts, Nepal were selected for the study site. Altogether 60 soil samples 30 from each catchment were gathered randomly from 0-10 and 10-30 cm soil pits. The collected soil samples were carried out in the lab for analysis. The result showed that silt content was the highest 66.35 ± 1.47 at 0-10 cm in Badekhola catchment and it was the lowest 58.25 ± 2.74 at 10-30 cm in Brindaban catchment. The highest C was nearly 191.27 ± 9.89 t ha⁻¹ at 0-10 cm in Badekhola which was the least 25.82 ± 5.7 t ha⁻¹ at 10-30 cm in Brindaban catchment. The N, P and K were the highest 92.55 ± 12.34 , 43.33 ± 2.98 and 435.7 ± 98.9 kg/ha at 0-10 cm depth in Badekhola catchment. The highest pH was recorded 6.11 ± 0.17 at 0-10 cm depth in Brindaban catchment. Two tailed independent t-test showed that there were significance differences in mean value of soil C, N, P and K at 0-10 cm soil depth at 95% confidence level between two Badekhola and Brindaban catchments. The calculated soil quality index was the best in both catchments which was slightly higher 1.39 in Badekhola than 1.3 in Brindaban catchment at 0-10 cm soil depth. The research will be useful for policy maker and scientific community.

Keywords: Soil quality index; Nutrient status; Variation of soil properties; Catchments; UNFCCC

Introduction

Most of the issues regarding desertification are always related to soil fertility and water quality [1,2]. Hence United Nation Framework Convention on Climate Change (UNFCCC) seriously globalized the issues of desertification in 1992. The developed and developing including hilly mountainous countries are the conference of the parties and so as Nepal [3]. The catchments in hill and Himalayan regions in the world are huge source of water [4]. The people's livelihood depends up on the regular circulation of water. Thus the soil and water health depend upon the health of Himalaya and hills in mountainous countries like India, Bhutan, Afghanistan and obviously Nepal. River, stream, canal, glaciers, river tributaries always flow from upstream to downstream [5].

The upstream and downstream are most likely related to the catchment which is defined as any area of land where precipitation collects and drains off into a common outlet. If the upstream is healthy apparently the water flowing in river, stream and river tributaries is fresh. The fresh water is base of several terrestrial, water, wetland and air ecosystem. The health of the catchment depends up on the quality of the soil it contains. In fact, several countries assess the soil quality index, physical and chemical properties of soil so that the several policy and mechanical measures can be applied to protect, improve and restore the catchment [6,7]. The management practices are applied in same

way [8,9] since soil physical and chemical properties are the dominant factors to determine the soil quality. Soil quality index is an integrative indicator of environmental quality, food security and economic potentiality [10].

Few decades, rapid depletion of natural resources is an emerging issue especially in the developing countries like Nepal. Agricultural intensification, conversion of marginal land into agriculture and intensive use of the forests have been identified as soil fertility problems in Nepal [11]. The leaching of nitrogen, runoff and erosion may increase nitrogen and phosphorus levels in surface water, which can lead to eutrophication and degradation of water quality. The dynamics of soil quality, physical and chemical properties cannot show without assessing the baseline status. Generally, the soil quality index was not considered to evaluate the quality of the catchments in Nepal. The soil quality index is the significant dimension to indicate the characteristics of the soil. It showed how the soil nutrients specifically N, P, K, pH and C were varied. Though, the vegetation is one of the best indicators of the soil nutrient and fertility, physical and chemical properties of soil and soil quality index are precise parameter to assess the quality of catchment. Such type of research was not done in Nepal. Thus this research was importantly carried out to answer the research questions like what is the status of N, P, K, pH and C, how the soil texture vary in Badekhola and Brindaban catchments and where the soil quality index is higher?

Materials and Methods

Study area

Catchments lie in the south western part of Doti and Baitadi districts which are located in the far western development region of Nepal. Badekhola lies in the southern part of Doti district approximately at 29° 17' 23.20" N and 80° 46' 16.86" E whereas the Brindaban catchment of Baitadi district lies approximately at 29° 33' 09.32" N and 80° 43' 13.60" E. The elevation of Banlekh VDC of Doti district is 700 m and the elevation of Shikharpur VDC of Baitadi district is 2100 m (Figure 1).

Broadly, the catchment area can be divided into forest and cultivated land. The dominant species are *Shorea robusta* (Sal), *Pinus roxburghii* (Salla), *Quercus spp* (Banjh) in the respective fields.

Soil sampling

The stratified random sampling was applied to collect the sample. Firstly, the catchment area was divided into two strata based on catchments. Altogether 60 samples 30 from each catchment were gathered [12]. Specifically sample were taken from 0-10, 10-30 cm using the soil corer. About 500 gm of soil excavated and bagged in polythene bag, and transported to the soil lab.

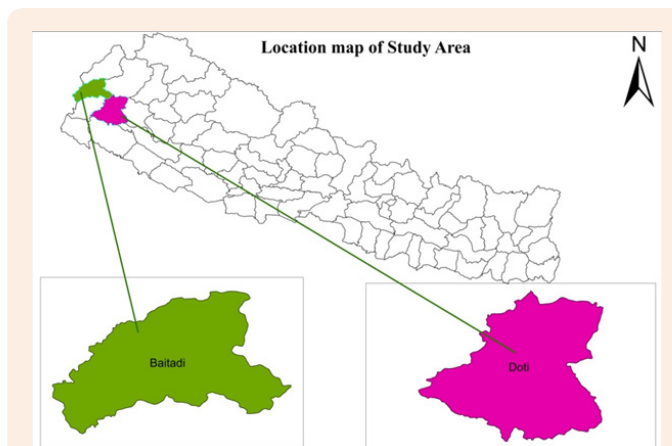


Figure 1: Map of the study area.

Lab analysis

Collected soil samples were analyzed in the lab.

Carbon content in the soil was analyzed by using dry combustion method [13].

$$\text{Bulk Density (BD g / cc)} = \left(\frac{\text{oven dry weight of soil}}{\text{volume of soil in the core}} \right)$$

$$\text{SOC} = \text{Organic Carbon Content \%} \times \text{Soil Bulk Density (Kg / cc)} \times \text{thickness of horizon}$$

The N was analyzed using the [14] method; soil texture and Phosphorous using [15] method, Potash using flame photometric method [16]; K and pH were analyzed using pH meter [17].

Statistical Analysis

The descriptive and inferential analysis was carried out to find the mean and compare the soil carbon, N, P, K and pH of Badekhola and Brindaban catchments. At the same time, distribution of data was evaluated using Kolmogorov-Smirnov and Shapiro-Wilk tests to examine the normality of the data. Next, the t-test was applied to compare the soil C, N, P, K and pH between Badekhola and Brindaban catchments [12].

Soil quality index

Soil Quality Index values calculated by using the following equation [18,19].

$$\text{SOI} = \left[(a \times \text{RSTC}) + (b \times \text{RpH}) + (c \times \text{ROC}) + (d \times \text{RNPK}) \right]$$

Where,

RSTC= assigned ranking values for soil textural class

RpH = assigned ranking values for soil pH

ROC=assigned ranking values for soil organic carbon

RN=assigned ranking values for nitrogen,

RP=assigned ranking values phosphorus

RK=assigned ranking values for potassium

And a=0.2 b=0.1 c=0.4 and d=0.3 are weighted values corresponding to each of the parameters.

Scoring method

The scoring method developed by NARC is used to interpret SQI (Table 1).

Table 1: Commonly used soil parameters in Nepal.

Parameters	Ranking Values				
	0.2	0.4	0.6	0.8	1
Soil textural class	C,S	CL, SC, SiC	Si, LS	L, SiL, SL	SiCL
Soil pH	<4	4.1 -4.9	5-5.9	6-6.4	6.5-7.5
Fertility (NPK)	Low	Mod low	Moderate	Moderate High	High
SOI	Very Poor	Poor	Fair	Good	Best

C- Clay, S-Sand, CL-Clay loam, SC- Sandy Clay, SiC- Silty Clay, Si-Silt, LS-Loamy sand, SiL- Silty loam, SL-Sandy loam, LS Loamy Sand, SiL-Silty loam, SL-Sandy loam, SiCL-Silty clay loam, SCL- Sandy Clay loam, SQI-Soil Quality Index .

Results and Discussions

Physical properties of soil at Badekhola and Brindaban catchments, Nepal

The physical properties of soil indicated that the soil was silt in both catchments at both soil depths. In fact, the silt content was the highest 66.35 ± 1.47 at 0-10 cm in Badekhola catchment but it was the lowest nearly 58.25 ± 2.74 at 10-30 cm in Brindaban catchment (Table 2).

Chemical properties of soil in Badekhola and Brindaban catchments, Nepal

The result showed the chemical properties were differed in the catchments. The C was the highest about 191.27 ± 9.89 t ha⁻¹ at 0-10 cm in Badekhola but it was the least 25.82 ± 5.7 t ha⁻¹ at 10-30 cm in Brindaban catchment (Table 3). About similar trend was found in case of N, P, K and pH in the catchments.

Table 2: Physical properties of soil.

Catchments	Soil Depth cm	Soil Textures (%)			Textural Class
		Sand	Silt	Clay	
Badekhola	0-10	26.4±2.06	66.35±1.47	8.1±0.95	SILT
Brindaban	30-Oct	28.2±5.46	62.6±4.4	9.2±1.6	SILT
Badekhola		31.64±4.55	61.47±3.99	6.9±1.29	SILT
Brindaban		37.5±3.24	58.25±2.74	3.55±0.79	SILT

Table 3: Chemical properties of soil.

Soil Depth	Catchment	pH Value	C t ha ⁻¹	N(kg/ha)	P(kg/ha)	K(kg/ha)
0-10	Badekhola	5.73±0.17	191.27±9.89	92.55±12.34	43.33±2.98	435.7±98.9
30-Oct	Brindaban	6.11±0.17	121.62±11.93	81.34±9.12	10.67±2.49	370.24±81.35
	Badekhola	5.95±0.16	77.21±6.21	37.8±6.17	16.4±2.28	268.97±79.19
	Brindaban	5.98±0.14	25.82±5.7	31±4.44	8.39±2.12	310.9±82.14

Table 4: Statistical comparison.

Soil Depth cm	Two Tailed T-Test (P-Value)				
	pH	C	N	P	K
0-10	0.23	0.02	0.03	0.01	0
30-Oct	0.31	0	0.02	0.07	0.06

Table 5: Soil quality index of different land use in its depth at different catchment.

Catchments	Soil Depth cm	Soil Quality Index	Quality of Catchment
Badekhola	0-10	1.39	Best
Brindaban	30-Oct	1.3	Best
Badekhola		1.06	Best
Brindaban		1.03	Best

Statistical comparison of differences in chemical soil properties

Two tailed independent t-test showed that there were significance differences in mean value of soil C, N, P and K at 0-10 cm soil depth at 95% confidence level between two Badekhola and Brindaban Catchments. However, there were no significance differences in pH values in these catchments and it was also insignificant differences in P and K at 10-30 cm soil depth at 95% confidence level (Table 4).

Soil Quality Index at Badekhola and Brindaban catchments, Nepal

The estimated soil quality index showed that the soil quality was the best in both catchments. Specifically, the estimated soil quality index was slightly higher 1.39 in Badekhola than nearly 1.3 in Brindaban catchment at 0-10 cm soil depth. The soil quality index was lower at 10-30 cm depth (Table 5).

Discussion

The physical properties, chemical properties and soil quality index are the indicator of soil quality in the catchment. The high values of these properties and soil quality index indicated that the soil were silt in both catchments at both soil depths. The soil C, N, P, K and soil quality index were decreased according to increase in soil depth [20,21], same pattern was recorded in our study. The soil quality depends upon various biotic and abiotic factors such as micro-climate, faunal diversity, land use, and management [22]. The soil quality index was higher at 0-10 cm soil depth in both catchments. The higher value was observed in Badekhola than Brindaban catchment. The forest vegetation is working as the indicator of soil fertility [23] which was observed better in Badekhola catchment. Thus the C, N, P, K and soil quality index were higher in Badekhola catchment. The soil texture was quite similar in both catchments.

The mean carbon of soil was the highest nearly 23.62 t ha⁻¹ at root zone of *Emblia officinalis* stratum [24] this was about

to similar with our research, the C value at 10-30 cm soil depths of Brindaban catchment. N in Bisbitty public plantation in Mahottary Nepal was nearly 42.00 Kg/ha in 0-0.1m depth [25] which was close to the N value (37.8 ± 6.17) at 10-30 cm soil depth of Badekhola. The soil having very less N % is considered as the very low fertile soil [26].

In fact, the silt content was the highest 66.35 ± 1.47 at 0-10 cm in Badekhola catchment but it was the lowest nearly 58.25 ± 2.74 at 10-30 cm in Brindaban catchment. The soil texture at the bank of the river and ocean is dominated by sandy soil but it is silt or loamy texture in the forest [27]. Similar research carried out in forest in Dailekh district Nepal showed that soil was silt [28] which is supportive finding to our research.

The study done by [29] showed that the N, P and K were 453.24, 25.46 and 340.62 kg/ha respectively in plantation of *Leucaena leucocephala*. In addition, [30] showed that the values of N, P and K were 843, 61 and 310 kg/ha in mixed Schima- Castonopsis forest of Gaukhureshwar Community Forest, Nepal. On the other hand, [31] reported that phosphorus and potassium in the soil of the pure *Shorea robusta* forest were 76.64 and 267.73 kg/ha respectively. Some of these values are similar and some of them are contradicted with the values of our research.

Conclusion

The physical, chemical properties and soil quality index were differed in Badekhola and Brindaban catchments. Soil chemical properties like pH, C, N, K and P were significantly varied in the catchments at 0-10 and 10-30 cm soil depths. The values of physical and chemical properties of soil were higher in Badekhola than Brindaban catchments. Moreover, the soil quality was the best in both catchments. Further studies are required to explore the soil quality of the catchment so that policy can be made accordingly to manage it.

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Conflict of Interest

The authors are agreed to publish the paper through MOJ Ecology and Environmental Science. This paper is not submitted anywhere else and not published in any journal. There is no conflict of interest.

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