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Correlation of Tree Diameter, Height and Biodiversity with Soil N, P and K

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Abstract: This research was done to assess effect of soil nutrients (N, P and K) on diameter at breast height (DBH), height and biodiversity. Three transect lines according to altitudinal gradient were established to systematically allocate the plot. Total 45 samples having 20m×25m were established to collect the biophysical data and soil samples. DBH and height of trees were recorded and soil samples were carried out in the lab. The Shannon –Weiner Index, Simpson Index and Evenness Index were analyzed. Nitrogen (N), Phosphorous (P) and Potash (K) was analyzed using Kjeldahl, Olsen's and Somers and Flame photometric methods respectively. The Pearson's correlation was performed to show the relation of DBH, height and biodiversity indexes with N, P and K. Descriptive statistics showed that the highest Mean±SE DBH (cm) was 50.75±4.61 in altitude<200m while this was the least 34.92±1.35 cm in altitude 200-400 m. The highest value of Shannon –Weiner index was 0.95 at altitude of <200m and lowest value was 0.47 at altitude of 200-400m. R square values of DBH vs. Nitrogen% at 10-20 cm depth was 0.033. Similarly, R square value of DBH vs. Phosphorous was more about 0.102 and 0.323 at 0-10 and 10-20 cm depth respectively. This R square value of Height vs. Phosphorus was 0.024 and 0.117 respectively. R square of height vs. Potash was 0.034 and 0.001 at 0-10 and 10-20 cm depths respectively. F-test showed that the correlation between Soil nutrient (N, P, K) and tree structures (DBH and Height) was insignificant at 95% confidence level since the p>0.05. However, t-test showed that, the intercept used in the equation was significant at 95% confidence level. R square value of H' and N% was 0.001 and 0.008 at 0-10 and 10-20 cm soil depth respectively. Similarly, the R square value of H' vs. P (kg/ha) was 0.38 and 0.42 at 0-10 and 10-20 cm soil depth respectively. Moreover, the R square value of H' vs. K (kg/ha) was 0.36 and 0.01 respectively. This research will be useful to understand the effect of soil nutrients on DBH, height and soil nutrient in the forest according to altitudinal gradient.

Keywords: Altitude, Soil Nutrients, DBH, Height, Biodiversity

1. Introduction

The soil characteristics are the very good indicators of vegetation types in the forest and at the same time, soil health is the indicator of forest health as well. Healthy soil means healthy forest. The health is commonly determined by Nitrogen (N), Phosphorous (P), Potash (K) and other matters. Healthy soil means mainly rich in N, P and K. The soil health helps to determine the structure and composition of the forest and its condition. Thus, it is considered that the condition of the soil is useful tool to understand the structure and composition of the forest as well [1, 2]. The species and growth parameter like diameter, height and crown of the vegetation are affected by the availability of nutrients. The richer the soil nutrients, the healthier the forest and its better growth will be [3, 4]. On the other hand, the degradation of soil affects negatively the structure of tree and its biodiversity.

Soil characteristic is determined by the climate, topography, and slope and their condition [5]. Especially, lower mountain zone is highly vulnerable due to soil degradation [6]. The lower mountain zone is the good example of subtropical climatic zone where the forest vegetation and soil types are different than the temperate and alpine zone [7]. The top of hills is considered as the rich in soil nutrients than side hill where there is high chance of soil erosion [8]. Similarly, steeply sloppy area is more prone to soil erosion and less fertile. The obvious effect is on the establishment of the forest vegetation and its growth.

There is intrinsic relation between soil and vegetation [8, 9]. The subtropical forest is generally expanded in Pakistan, India, Nepal and Bhutan [10]. The subtropical forest is very valuable ecologically and socio-economically as well but because of soil degradation this forest types are being degraded. The Chure region is the best example of youngest Mountain [11] having fragile and disturbed soil. This degradation of soil influences the composition of the forest stand and ground cover, rate of tree growth and vigor of natural reproduction [12]. The soil is influenced by several factors like altitude, vegetation diversity and its structure and composition in this region [13]. However, the response of soil characteristics and vegetation structure, composition and biodiversity according to altitudinal gradient has not so far been studied yet. Thus, this research was objectively conducted to assess the response of diameter at breast height and height as well as biodiversity to the soil nutrients (N, P and K).

2. Materials and Methods

Study Area: The study was carried out in Chure forest areas of Arghakhanchi District. Arghakhanchi lies between 27'45"N and 28'6" N latitude, and 80'45"E to 83'23"E longitude. It covers 1193 km^2 area. The altitude of the district varies from 305 to 2515 meters above sea level. The Chure forest of Arghakhanchi district lies in Sitganga municipality, which is declared as the biggest municipality in Nepal. The area of Chure in Arghakhanchi district covers 55,754.91 ha (557.5491 km^2) which is equivalent to 46.74% of the total district area. It consists of hills, steep land slopes, gorges, and large spans of temporary streams. The forest of Chure is mostly deciduous, semi-deciduous, and sub-tropical Sal forest mixed with broad leaves and lower mountain hardwood mixed forest (figure 1).

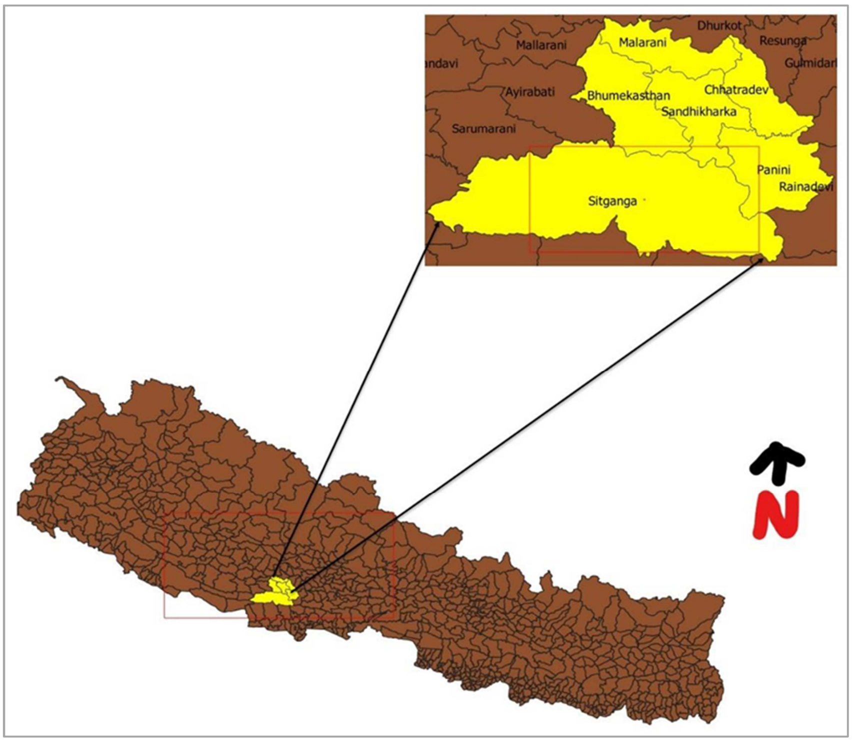

Figure 1. *Map of Study Area.*

2.1. Sampling Technique and Data Collection

The study was carried out in Chure areas of Arghakhanchi District. Three transect lines were drawn to establish the plot. Transects were divided into two altitudinal gradients namely elevation<200m and 200-400m. The transect 1, 2 and 3 was passing through Dhirikhola, Majhure and Lahari CFs respectively. Altogether 45 sample plots having 20m* 25m were established to collect sample from the field. Soil samples were collected within these sample plots from 0-10 and 10-20 cm depths. The diameter at breast height (DBH) and height were measured and their number species were recorded.

Data analysis: Mainly three types of analysis were done for the field data. (1) Quantitative Analysis (2) Lab Analysis and (3) Statistical Analysis.

2.2. Quantative Analysis

Shannon-Wiener index (H') = -∑Pi Log Pi, where Pi = n / N Whereas,

N=Total no of species, n= no. of individuals of species and Pi= n/N [14].

Index of Dominance (C) = - ∑ (n /N) ^{2}, Whereas, n = number of individuals of each species N = total number of individuals [15].

Evenness (e) = H'/ log S, Whereas H' = Shannon -Wiener Index & S = numbers of species [16].

2.3. Lab Analysis

Total Nitrogen (N), Available Phosphorus (P) and Potash (K) using Kjeldahl method, Olsen's and Somers method and Flame photometric method [17-19].

2.4. Statistical Analysis

The descriptive statistics was performed to find the mean, standard error, maximum and minimum of the raw data from the field study whereas regression statistics was performed to find the multiple R, R square, adjusted R square, F-statistics (p- value), t-statistics intercept (p-value) and X variable of the two dependent vs. independent variables [20].

3. Results

3.1. Descriptive Statistics of DBH and Height of Trees

The descriptive statistics showed that Mean±SE, Maximum and Minimum value of DBH and height in different transects. The Mean±SE, Maximum and Minimum values of DBH (cm) in Transect 2 of altitude<200m were 44.07±3.38, 51.83 and 33.39 respectively while these values of height (m) of this transect were 22.04±0.78, 34 and 13.1 respectively. The highest Mean±SE DBH (cm) was 50.75±4.61 in Transect 3 (altitude<200m), while this was the least 34.92±1.35 cm in Transect in altitude 200-400 m. The Mean±SE height (m) was 22.04±0.78 in Transect 2 (altitude<200m) (Table 1).

Table 1. *Structure of tree in Chure forest according to altitude.*

Descriptive statistics of DBH & Height							
Altitude	**Transects**	**DBH cm**			**HEIGHT m**		
		Mean±SE	**MAX**	**MIN**	**Mean±SE**	**MAX**	**MIN**
<200	Transect 2	44.07±3.38	51.83	33.39	22.04±0.78	34	13.1
	Transect 3	50.75±4.61	55.37	46.14	22.01±2.29	24.31	19.71
200-400	Transect 1	49.33±2.16	69	37.88	19.96±0.87	29	16
	Transect 2	34.92±1.35	39.79	29.92	15.75±2.49	27.5	7.36
	Transect 3	47.75±2.52	64.2	37.25	20.54±0.90	26.2	15.74

3.2. Species Composition at Pole and Tree Staged According to Altitude

There are several species in the forest but these were varying according to altitudes. Major tree species are *Shorea robusta, Terminelia tomentosa, Syszygium cumini, Schleichera oleosa, Anogeisus latifolia, Garuga pinnata, Semecarpus anacardium, Lagerstroemia parviflora, Adina cardifolia, Diospyros embryopteris, Dalbirgia sissoo, Buchaniana latifolia, Careya arborea, Mallotus philippensis, Melia azedarach, Wendlandla exserta, Gaultheria fragrantissima, Euphorbia thymifolia* and *Terminalia bellirica*. *Shorea robusta* and *Terminelia tomentosa* are dominating in all transects while *Wendlandla exserta, Gaultheria fragrantissima* and *Euphorbia thymifolia* were found only in altitude <200m (Table 2).

Table 2. *List of Major tree species in different altitudes.*

Transects	**Transect 1**	**Transect 2**		**Transect 3**	
Spp/Altitude	**200-400**	**<200**	**200-400**	**<200**	**200-400**
Shorea robusta	✓	✓	✓	✓	✓
Terminelia tomentosa	✓	✓	✓	✓	✓
Syszygium cumini		✓			✓
Schleichera oleosa	✓	✓	✓	✓	✓
Anogeisus latifolia	✓	✓	✓	✓	✓
Garuga pinnata		✓	✓	✓	
Semecarpus anacardium	✓			✓	✓
Lagerstroemia parviflora	✓		✓		
Adina cardifolia	✓	✓	✓		
Diospyros embryopteris		✓	✓		
Dalbirgia sissoo		✓			
Buchaniana latifolia	✓	✓	✓		✓
Careya arborea	✓		✓	✓	
Mallotus philippensis	✓		✓		
Melia azedarach	✓	✓			
Wendlandla exserta		✓			
Gaultheria fragrantissima		✓			
Euphorbia thymifolia		✓			
Terminalia bellirica		✓	✓	✓	

3.3. Biodiversity Index of Tree Staged Spp in Chure Forest According to Altitude

The biodiversity index of tree spp was varying according to altitude. The result showed that, the highest value of Shannon

Weiner index was 0.95 at altitude of <200m in Transect-3 (Lahari CF) and lowest value was 0.47 at altitude of 200-400m in Dhirikhola CF (Transect-1) (Table 3).

Table 3. *Biodiversity Index of tree spp in Chure forest according to altitude.*

Stage of plants	Tree staged diversity				
Altitude m	**<200**		**200-400**		
Transects	**Transect 1**	**Transect 3**	**Transect 1**	**Transect 2**	**Transect 3**
Shannon –Weiner Index	0.71	0.95	0.47	0.86	0.75
Simpson Index	0.8	0.71	0.84	0.55	0.81
Evenness Index	0.14	0.13	0.06	0.28	0.18

3.4. Status of Soil Characteristics (N. P and K in the Transect)

The descriptive statistics showed the Mean±SE, Maximum and Minimum values of Nitrogen (N), Phosphorous (P) and Potash (K) at altitude<200m and altitude between 200 and 400m in different Transects. The highest Mean±SE, Maximum and Minimum values of soil Nitrogen were 0.17±0.1%, 0.18% and 0.16% respectively in transect-3 (Lahari CF) in 0-10cm depth at altitude <200m and these values showed lowest soil nitrogen were 0.09±0.00%, 0.117% and 0.056%. Similarly, the Mean±SE, Maximum and Minimum values of highest phosphorous were 209.37±191.03 (kg/ha), 400.4 (kg/ha) and 18.34 (kg/ha) respectively in transect-3 (Lahari CF) at 0-10cm depth in altitude <200 altitude. However, the Mean±SE, Maximum and Minimum values of lowest phosphorous were 21.94±6.66 (kg/ha), 106.4 (kg/ha) and 1.12 (kg/ha) respectively in transect-1 (Dhirikhola CF) at 10-20cm depth in altitude 200-400m. Similarly, the Mean±SE, Maximum and Minimum values of the highest Potash were 56.45±7.93 (kg/ha), 120.96 (kg/ha) and 25.58 (kg/ha) respectively in transect-3 (Lahari CF) at 0-10cm depth in altitude 200-400m. Also these values were lowest 29.56±2.68 (kg/ha), 32.25 (kg/ha) and 26.88 (kg/ha) respectively in transect-3 (Lahari CF) at 10-20cm depth in altitude <200m (Table 4).

Table 4. *Status of soil Characteristics (N, P, K) according to altitude.*

TRANSECT 1 (DHIRIKHOLA CF)							
Altitude m	**Soil nutrients**	**N %**		**P (Kg/ha)**		**K (kg/ha)**	
	Soil depth	**0-10 cm**	**10-20 cm**	**0-10 cm**	**10-20 cm**	**0-10 cm**	**10-20 cm**
200-400	Mean±SE	0.12±0	0.12±0	27.88±6.55	21.94±6.67	50.08	39.71±2.9
	Max	0.18	0.15	93.1	106.4	61.8	110.2
	Min	0.09	0.09	2.8	1.12	26.9	26.9

TRANSECT 2 (MAJHURE CF)							
Altitude m	**Soil nutrients**	**N %**		**P (Kg/ha)**		**K (kg/ha)**	
	Soil depth	**0-10 cm**	**10-20 cm**	**0-10 cm**	**10-20 cm**	**0-10 cm**	**10-20 cm**
<200	MEAN	0.09±0	0.10±0	51.16±4.81	46.89±6.87	36.4±2.4	36.32±3.00
	Max	0.11	0.14	69.37	84	51.07	45.69
	Min	0.05	0.08	28.63	25.27	26.88	29.56
200-400	MEAN	0.09±0	0.11±0	52.51±4.60	41.57±4.88	36.69±1.34	36.08±1.84
	Max	0.11	0.13	72.38	65.52	45.69	43
	Min	0.06	0.09	37.66	21.35	29.56	32.25

TRANSECT 3 (LAHARI CF)							
Altitude m	**Soil nutrients**	**N %**		**P (Kg/ha)**		**K (kg/ha)**	
	Soil depth	**0-10 cm**	**10-20 cm**	**0-10 cm**	**10-20 cm**	**0-10 cm**	**10-20 cm**
<200	MEAN	0.17±0.01	0.10±0	209.37±191.03	44.27±17.1	41.66±6.72	29.56±2.68
	Max	0.18	0.1	400.4	61.39	48.38	32.25
	Min	0.16	0.1	18.34	27.16	34.94	26.88
200-400	MEAN	0.11±0	0.17±0.06	63.18±13.32	62.01±18.13	56.45±7.93	48.5±4.09
	Max	0.15	0.99	210.7	265.3	120.96	86.01
	Min	0.08	0.05	12.6	18.97	25.58	32.25

3.5. Correlation Between Soil Nutrient (N, P, and K) and DBH and Height

The result showed the correlation between Soil nutrient (N, P, and K) and tree structures (DBH and Height) in the transect 1 (in Dhirikhola CF). The values R square of DBH vs. Nitrogen% at 0-10 cm depth was 0.009 while this value of DBH vs. Nitrogen% at 10-20 cm depth was 0.033. Similarly, the R square value of DBH vs Phosphorous was more about 0.102 and 0.323 at 0-10 and 10-20 cm depths respectively. Moreover, the correlation between height vs. Nitrogen was 0.001 and 0.066 at 0-10 and 10-20 cm depth respectively. In addition, this R square value of Height vs. Phosphorus was 0.024 and 0.117 respectively. The R square of height vs. Potash was 0.034 and 0.001 at 0-10 and 10-20 cm depths respectively. The F-statistics showed that the correlation between Soil nutrient (N, P, K at 0-10 and 10-20 cm depths) and tree structures (DBH and Height) was non-significant at 95% confidence level since the p>0.05 (0.72 & 0.5164 at 0-10 and 10-20 cm depths respectively). However, t-test showed that, the intercept used in the equation was significant at 95% confidence level since the p<0.05 (0.001 and 0.0165 at 0-10 and 10- 20 cm depths respectively) while in case of the variable in the equation it was non- significant at 95% confidence level since the p>0.05 (0.725 & 0.516 at 0-10 and 10-20 cm depths respectively). Similar results were found in other transects 2 and 3 (Majhure and Lahari CFs). The correlation showed how N, P and K with the tree structure especially DBH and Height (Table 5).

Table 5. *Correlation between soil nutrient (N, P, and K) and tree structures (DBH and Height).*

TRANSECT 1 (DHIRIKHOLA CF)												
Regression	**DBH vs. Nitrogen%**		**DBH vs. P (kg/ha)**		**DBH vs. K (kg/ha)**		**Height vs. Nitrogen%**		**Height vs. P (kg/ha)**		**Height vs. K (kg/ha)**	
Soil depth cm	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20
R square	0.009	0.033	0.102	0.323	0.009	0.001	0.001	0.066	0.024	0.117	0.034	0.001
F-Stat (p-value)	0.72	0.516	0.243	0.026	0.738	0.907	0.947	0.353	0.575	0.21	0.507	0.95
Intercept (t-test, p-value)	0.001	0.016	0.001	0.001	0.001	0.001	0.001	0.0254	0.001	0.001	0.001	0.001
x -variable (t-test, pvalue)	0.725	0.516	0.243	0.026	0.738	0.907	0.947	0.353	0.575	0.21	0.507	0.957

TRANSECT 2 (MAJHURE CF)												
Regression	**DBH vs. Nitrogen%**		**DBH vs. P (kg/ha)**		**DBH vs. K (kg/ha)**		**Height vs. Nitrogen%**		**Height vs. P (kg/ha)**		**Height vs. K (kg/ha)**	
R square	0.002	0.105	0.017	0.015	0.011	0.001	0	0.119	0.025	0.029	0.001	0.058
F-Stat (p-value)	0.87	0.257	0.651	0.666	0.711	0.884	0.961	0.225	0.584	0.554	0.976	0.405
Intercept (t-test, p-value)	0	0	0	0	0.001	0.001	0.031	0.013	0.009	0.035	0.001	0.001
x -variable (t-test, pvalue)	0.87	0.257	0.651	0.666	0.711	0.884	0.961	0.225	0.584	0.554	0.976	0.405

TRANSECT 3 (LAHARI CF)												
Regression	**DBH vs. Nitrogen%**		**DBH vs. P (kg/ha)**		**DBH vs. K (kg/ha)**		**Height vs. Nitrogen%**		**Height vs. P (kg/ha)**		**Height vs. K (kg/ha)**	
R square	0.019	0.29	0.011	0.11	0.001	0.001	0.07	0.009	0.103	0.007	0.285	0.001
F-Stat (p-value)	0.72	0.13	0.819	0.381	0.801	0.994	0.479	0.805	0.398	0.819	0.138	0.985
Intercept (t-test, p-value)	0.01	0	0.001	0.006	0.001	0	0.011	0.002	0.005	0.009	0.001	0.001
x -variable (t-test, pvalue)	0.72	0.13	0.819	0.381	0.801	0.994	0.479	0.805	0.398	0.819	0.138	0.985

3.6. Correlation Between Soil Nutrient (N, P, K) and Biodiversity Index (Shannon- Weiner and Simpson Index) of Tree-Staged Spp in Three CFs of Chure Area

The result showed that the correlation between tree diversity and soil nutrients to understand the response of biodiversity with respect to N, P and K. The R square value of H' and N% was 0.001 and 0.008 at 0-10 and 10-20 cm soil depth respectively in Transect 1 (Dhirikhola CF). Similarly, the R square value of H' vs. P (kg/ha) was 0.38 and 0.42 at 0-10 and 10-20 cm soil depth respectively in this transect. Moreover, the R square value of H' vs. K (kg/ha) was 0.36 and 0.01 respectively. Similar types of results were found in the relation between Simpson index vs. soil nutrients (Table 6).

Table 6. *Correlation between Tree diversity and Soil nutrients.*

TRANSECT 1 (DHIRIKHOLA CF)												
Regression	**H' vs. N%**		**H' vs. P (kg/ha)**		**H' vs. K (kg/ha)**		**Simpson vs. Nitrogen%**		**Simpson vs. P (kg/ha)**		**Simpson vs. K (kg/ha)**	
Soil depth cm	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20	0-10	10-20
R square	0.001	0.008	0.38	0.42	0.36	0.01	0.08	0.015	0.05	0.25	0.1	0.09
F-Stat (p-value)	0.94	0.81	0.07	0.05	0.083	0.79	0.28	0.65	0.4	0.05	0.23	0.27
Intercept (t-tes p value)	0.352	0.217	0.002	0.001	0	0.004	0.05	0.05	0.002	0.001	0	0.001
x variable (t-est p value)	0.94	0.81	0.07	0.05	0.083	0.791	0.28	0.65	0.4	0.05	0.23	0.27

TRANSECT 2 (MAJHURE CF)												
Regression	**H' vs. N%**		**H' vs. P (kg/ha)**		**H' vs. K (kg/ha)**		**Simpson vs. Nitrogen%**		**Simpson vs. P (kg/ha)**		**Simpson vs. K (kg/ha)**	
R square	0.72	0.08	0.71	0.06	0.08	0.01	0.003	0.01	0.04	0.26	0.03	0.002
F-Stat (p-value)	0.06	0.64	0.07	0.69	0.64	0.84	0.83	0.73	0.47	0.06	0.54	0.87
Intercept (t-tes p value)	0.34	0.93	0.001	0.002	0.002	0.002	0.024	0.269	0.001	0.003	0.002	0.001
x variable (t-est p value)	0.06	0.64	0.07	0.69	0.64	0.84	0.83	0.73	0.47	0.06	0.54	0.87

TRANSECT 3 (LAHARI CF)												
Regression	**H' vs. N%**		**H' vs. P (kg/ha)**		**H' vs. K (kg/ha)**		**Simpson vs. Nitrogen%**		**Simpson vs. P (kg/ha)**		**Simpson vs. K (kg/ha)**	
R square	0.01	0.04	0.04	0.04	0.05	0.01	0.02	0.02	0.29	0.01	0	0.03
F-Stat (p-value)	0.69	0.49	0.48	0.48	0.45	0.74	0.54	0.56	0.03	0.68	0.95	0.53
Intercept (t-test p value)	0.13	0	0.001	0.003	0.002	0	0.14	0.001	0.002	0.002	0.001	0.001
x variable (t-test p value)	0.69	0.49	0.48	0.48	0.45	0.74	0.54	0.56	0.03	0.68	0.95	0.53

4. Discussion

The Mean±SE, Maximum and Minimum values of DBH (cm) in Transect 2 of altitude<200m were 44.07±3.38, 51.83 and 33.39 respectively while these values of height (m) of this transect were 22.04±0.78, 34 and 13.1 respectively but the DBH and height of trees were varying according to altitude [21, 22]. Small variation in elevation can affect the structure of tree (DBH and height) [23, 24].

There are several species in the forest but these were varying according to altitudes. Major tree species are *Shorea robusta, Terminelia tomentosa, Syszygium cumini, Schleichera oleosa, Anogeisus latifolia, Garuga pinnata, Semecarpus anacardium, Lagerstroemia parviflora, Adina cardifolia, Diospyros embryopteris, Dalbirgia sissoo, Buchaniana latifolia, Careya arborea, Mallotus philippensis, Melia azedarach, Wendlandla exserta, Gaultheria fragrantissima, Euphorbia thymifolia* and *Terminalia bellirica*. *Shorea robusta* and *Terminelia tomentosa* are dominating all transect while *Wendlandla exserta, Gaultheria fragrantissima* and *Euphorbia thymifolia* were found only in altitude <200m. This finding is quite similar to the report of Chure area which showed that:

Shorea robusta, Terminalia alata, Pinus roxburghii, Anogeissus latifolius, Lagerstroemia parviflora, Adina cordifolia, Buchanania latifolia Syzygium cumini, Schima wallichii, Desmodium oojenense are the dominat species in this area [25]. Sal (*Shorea robusta*), Asna (*Terminalia elliptica*) Saj (*Terminalia tomentosa*), Botdhairo (*Lagerstroemia parviflora*), Sissoo (*Dalbergia sissoo*),) Banjhi (anogeissus latifolia), Katus (*Castonopsis indica*), Pyari (*Buchanania latifilia*), Karma (*Adina cordifolia*), Harro (*Termenalia chebula*), Amala (*Phylanthus emblica*), Simal (*Bombax ceiba*), etc are the major tree species in foothills of Chure in Rupendehi district [26].

The biodiversity index of tree spp was varying according to altitude. The result showed that, the highest value of Shannon- Weiner index was 0.95 at altitude of <200m in Transect-3 (Lahari CF) and lowest value was 0.47 at altitude of 200-400m in Dhirikhola CF (Transect-1). Another study done in lower altitude showed that Shannon-Weaver Biodiversity Index was ranging from 2.34 to 2.52 at Kushmari plantation in Mahottary district [27]. Study done in collaborative forests in lowland area, Nepal showed that, the value of Shannon-Wiener Biodiversity Index ranging from 2.21 to 2.33 as well as Simpson's index from 0.39 to 0.44 [28]. The lower Shannon -Weiner index in the study site may be because of managing the community forest. The users are interest to keep the socially and economically valuable tree species and they remove other species through management practice [29, 30].

Not so much variation in N% but it was slightly more in altitude<200 m altitude with 0.17%. Similarly, P was the highest also in altitude<200m with 209.37 kg/ha and K was the highest 56.45 kg/ha in same altitude. The reason behind this may more microbial activities in the upper layer and lower altitude. The soil is more degraded in Chure area than its foothills [31-33].

There was high correlation between P with the Shannon – Weinner Index and Simpson Index in comparison to N% vs biodiversity indices and K vs biodiversity indices. Though, the statistically, ANOVA and t-test showed insignificant correlation in some exception. The intercepts in equation were significant. Proportion of soil nutrients are one of the important determining factors of biodiversity in natural forest [34, 35].

5. Conclusion and Recommendation

The mean value of DBH and height of trees were varying according to altitude. Major tree species are *Shorea robusta, Terminelia tomentosa, Syszygium cumini, Schleichera oleosa, Anogeisus latifolia, Garuga pinnata, Semecarpus anacardium, Lagerstroemia parviflora, Adina cardifolia, Diospyros embryopteris, Dalbirgia sissoo, Buchaniana latifolia, Careya arborea, Mallotus philippensis, Melia azedarach, Wendlandla exserta, Gaultheria fragrantissima, Euphorbia thymifolia* and *Terminalia bellirica*. *Shorea robusta* and *Terminelia tomentosa* are dominating all transect while *Wendlandla exserta, Gaultheria fragrantissima* and *Euphorbia thymifolia* were found only in altitude <200m.

The highest value of Shannon Weiner index was found at altitude of <200m but this was lowest at altitude of 200-400m in. The values of N%, P (kg/ha) and K (kg/ha) were slightly higher in altitude 200-400 m.

The correlation of tree DBH and height with N%, P (kg/ha) and K (kg/ha) was positive but very weak.

In addition, the correlation between tree diversity and soil nutrients was positive but very weak. This study will provide the knowledge to understand the correlation of soil nutrients with the tree structure and diversity. However, further researches are essential to understand the effect of altitude on the correlation of tree structure, biodiversity and soil nutrients.

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