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VEGETATION AND SOIL STRUCTURE AROUND BAGMATI RIVER NEAR SUNDARIJAL

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ABSTRACT

Vegetation samples in the form of herbarium and soil samples were collected from three stations of Bagmati river near the sundarijal. Vegetations were identified in Central Department of Botany. Frequency and relative frequency, density and relative density, dominance and relative dominance, important value index and biomass production of ground vegetation were determined. *Castanopsis tribuloides* was found dominant tree species. Soil samples of different stations were analyzed for different physical and chemical characters. in laboratory of Nepal Agriculture Research Council (NARC), in Khumaltar. The soil of study area was found acidic in nature. All collected soil samples were investigated

KEYWORDS. biomass, density, dominance, herbarium

INTRODUCTION

Environment is a complex of many things like light, temperature, soil, water etc. with all organisms. The relation of soil and vegetation has been a great interest to ecologists and several works have been carried out on soil and plant relationships. Vegetation distribution is influenced by the climatic factors and the edaphic factors i.e. soil. From the ecological point of view, the soil may be defined as the earth's crust which serve as a substratum for plant life. Soil is the weathered superficial layer of earth's crust which is mixed with living organisms and products of their decay (Daubenmire, 1959).

A true soil has five constituents: 1) the mineral particles of various sizes and in different stages of chemical decomposition; 2) organic matter in various stages of decomposition ranging from raw little to well decomposed humus; 3) the soil solution of various inorganic salts; 4) the soil air occupying interspaces not filled with soil solution and 5) micro-organisms, both plants and animals.(Weaver and Clements, 1938).

A definite relationship exists between the physical and chemical nature of the soil and vegetation distribution. Young (1934) suggested that heterogeneity in plant distribution is related to soil heterogeneity. Wild (1993) had shown that though climatic factors are responsible to a great extent for the boundaries of distribution of plant species, the main composition of forest stand is determined by nature of soil.

The physical characters determine the exact nature of the soil as a substratum of plants. The rigidity and supporting power, drainage and moisture storage capacity, plasticity, case of penetration by roots, aeration and reaction of plant nutrients are also intimately connected with the physical conditions of the soil (Forth 1984). The main objective of the current research is to analyze the vegetation and soil structure around Bagmati river, near Sundarijal, Kathmandu.

MATERIELS AND METHODS

Study Area

Bagmati river originates in the southern strip of Shivapuri hill of Baghdwar, northern part of Kathmandu valley at an altitude of 2650 m. The study area was selected at the surrounding of Sundarijal, which is the main feeding stream of Bagmati River. The study area was divided into main three stations.

Station S_1: The Station S_1 was selected at the upper hill of Sundarijal. The station is situated near by Okhareni Gaun, at the height of 1900m.

Station S_2: The Station S_2 was selected near the Mahankal Gaun and Army Camp at the height of 1700m. This station is situated near the reservoir and it is about 1.5 km far from station S_1.

Station S_3: The Station S_3 was selected below the hill of Sundarijal and Army Camp at the height of 1500m and about 1.5 km far from station S_2.

The field work of present study was carried out between March 1999 to August 1999.

1. Vegetation Analysis

For the analysis of vegetation, a quadrat method was adopted. Five plots were taken at each station for random sampling and a quadrat size of 10m × 10m was used. The tree species (>10 cbh) were recorded and their total counts were noted and kept for herbarium. The tree species were identified by consulting the Herbarium of Central Department of Botany, (TUCH) T.U. and National Herbarium Godavri (Kathmandu).

i. Density and Relative Density

Density is the number of individuals of a species per unit area or volume. By definition, density requires actual counts of individuals in a definite space. Density was calculated by using following equation.

$$\text{Density of sps. A (tree ha}^{-1}) = \frac{\text{Total number of sp.A in all quadrats}}{\text{Total number of quadrat studied} \times \text{Area in one plot}} \times 10{,}000$$

Relative density is the numerical strength of a species in relation to the total number of species.

$$\text{Relative Density of species A} = \frac{\text{Number of individual of sp.}}{\text{Total numbers of all species}} \times 100$$

ii. Frequency and Relative Frequency

It is defined as the percentage of occurrence of a species in a series of samples of uniform size and contained in a single stand, the number and size of plants in each being ignored. Frequency was calculated by using formula;

$$\text{Frequency \% of sp. A} = \frac{\text{Number of plots with sp. A}}{\text{Total numbers of plots}} \times 100$$

Relative frequency is the frequency of a species in relation to total frequencies of all species of that community. The formula is,

$$\text{Relative frequency} = \frac{\text{Frequency of sp. A}}{\text{Sum of frequencies of all species}} \times 100$$

iii. Dominance and Relative Dominance

Dominance or coverage indicates the amount of surface occupied by a plant in a community.

The circumference data of trees at 1.3 m. height were used for calculating the basal area coverage by using the formula given by Zobel et al. (1987)

$$\text{Basal Area m}^2 = \frac{C^2}{4\pi}$$

Where C= Circumference

Pie = 3.141633

Dominance was calculated as;

$$\text{Dominance} = \frac{\text{Total basal area}}{\text{Area sampled}}$$

And Relative Dominance was calculated by using following formula;

$$\text{Relative Dominance} = \frac{\text{Dominance for sp.A}}{\text{Total dominance for all sps.}} \times 100$$

iv. Importance Value Index (IVI)

Since the quantitative values of frequency, density and cover was not sufficient for providing the total picture of the sociological characters of a species in a community, IVI was calculated for the individual sps. as;

IVI = Relative frequency + Relative density +

Relative dominance

v. Biomass Production of Ground Vegetation

For sampling of ground vegetation, a quadrate of size of 1m × 1m was used. At each station five samplings were taken and all the ground vegetation were cut down from each plot and kept in polythene bags. All the samples were brought to the Central Department of Zoology, then dried in the oven for 24 hours at 70^0C, then the dry weight of ground vegetation was taken.

The biomass of ground vegetation was estimated by following formula;

$$\text{Biomass} = \frac{\text{Mean dry weight}}{\text{Area}}$$

2. Soil

A general type of anger was used for sampling the soil. Five samples were collected at each station. Soil was taken from upper 20 cm of the soil surface . All the samples of single plot were kept separately in tightly closed polythene bags and taken to the laboratory for investigation.

The collected soil samples were investigated in laboratory of Nepal Agriculture Research Council (NARC), Soil Science Division, Agriculture Department, HMG, Khumaltar. Following chemical parameters of the soil were carried out;

Hydrogen ion concentration (pH), Organic matter (%), Nitrogen (%), Phosphorus (kg/ha), Potassium (kg/ha), Moisture content (%) and Water holding capacity (%)

RESULTS

1. Vegetation Analysis

A total of 19 tree species were recorded during study period. Among them, 118 individuals of sixteen tree species were recorded at station S_1, 116 individuals of thirteen tree species were recorded at station S_2 and 106 individuals of seven tree species were recorded at station S_3.

i. Frequency and Relative Frequency

Station S_1

The highest frequency and relative frequency 100% and 9.25 of *Quercus gluaca, Castonopsis tribuloids, Castanopsis indica, Rhododendron arboreum, Schima wallichi* were found while the lowest frequency and relative frequency of *Prunus cerrasoids* were found 20% and 1.85% respectively.

Station S_2

The highest frequency and relative frequency 100% and 10.63% of *Quercus glauca, Castanopsis tribuloids, Rhododendron arboreum, Schima wallichi* and *Castanopsis indica* were found while the lowest frequency and relative frequency were found 20% and 2.12% of *Machilus sps*. and *Myrica esculenta*.

Station S_3

The highest frequency and relative frequency 100% and 16.12 of *Rhododendron arboreum, Schima wallichi, Alnus nepalensi*s were found while the lowest frequency and relative frequency were found 40% and 6.65% of *Machilus sps.*

ii. Density and Relative Density

Station S_1

The highest density 500 no/ha of *Castanopsis tribuloids* was found which was followed by 280 no/ha of *Schima wallichi* ,240 no/ha of *Rhododendron arboreum* while lowest density was found 20 no/ha *Prunus cerrasoids*.

The highest relative density was 21.18% of *Castanopsis tribuloids* and lowest relative density was 0.84% of *Prunus cerrasoids* .

Station S_2

The highest density was 500no/ha of *Rhododendron arboreum* which was followed by 400no/ha of *Castanopsis tribuloids*. The lowest density was 20 no/ha of *Machilus spp*.

and *Myrica esculeneta*. The highest relative density was 21.18 of *Rhododendron arboretum* and lowest relative density was 0.84 of *Machilus spp.* and *Myrica esculeneta*.

Station S_3

The highest density was 460 no/ha of *Castanopsis tribuloids,* which was followed by 380 no/ ha of *Pinus roxburghii* and lowest density was 60 no/ ha of *Machilus spp*. The highest relative density was 21.69 of *Castanopsis tribuloids* and lowest relative density was 2.83 of *Machilus spp*.

iii. Dominance and Relative Dominance

Station S_1

The highest dominance was 9.7 m^2 of *Castanopsis tribuloids*, which was followed by 7.6 m^2 of *Quercus lamellose* and 7.3 m^2 of *Quercus glauca* and *Rhododendron arboreum*. The lowest dominance was 1.3 m^2 of *Lindera spp.*

The highest relative dominance was 13.41 of *Castanopsis tribuloids* and lowest relative dominance was 1.79 of *Lindera spp*.

Station S_2

The highest dominance was 10.5 m^2 of *Rhododendron arboreum,* which was followed by 7.8 m^2 of *Castanopsis tribuloids*. The lowest dominance was 0.6 m^2 of *Myrica esculeneta*.

The highest relative dominance was 15.06 of *Rhododendron arboreum* and lowest relative dominance was 0.86 of *Myrica esculeneta*.

Station S_3

The highest dominance was 13.5 m^2 of *Rhododendron arboreum,* which was followed by 13.3 m^2 of *Castanopsis tribuloids*. The lowest dominance was 3.5 m^2 of *Machilus spp*.

The highest relative dominance was 19.04 of *Rhododendron arboreum* and lowest relative dominance was 4.93 of *Machilus spp*.

iv. Important Value Index (IVI)

Station S_1

The highest IVI was 43.84 of *Castanopsis tribuloides* which is followed by 30.51 of *Schima wallichi*. The lowest value was 5.05 0f *Prunus cerrasoides.*

Station S_2

The highest IVI was 14.19 of *Rhododendron arboreum* ***which is followed by 39.19 of*** *Castanopsis tribuloides.* ***The lowest value was 4.03 of*** *Myrica esculeneta.*

Station S_3 The highest IVI was 56.56 of *Castanopsis tribuloides* which is followed by 50.25 of *Rhododendron arboreum*. The lowest value was 14.21 of *Machilus spp*.

v. Biomass Production of Ground Vegetation (gm/m^2)

The highest biomass production of ground vegetation was 270 gm/m^2 at station S_1 and lowest biomass production of ground vegetation was 150 gm/m^2 at station S_3. [Table-3].

2. Soil

Soil samples collected from different plots of three stations were analyzed for different physical and chemical characteristics.

In general the soil of the study area was sandy loam in nature. Composition of sand, silt and clay are shown in Table-4. In these plots of study area the percentage of sand alone covers more than 60%.

Soil showed variation in colour at different station. Majority of soil sample at station S_1 and S_2 were black in colour. The colour ranged from light black to brown black and grayish black. The soil at station S_3 was grayish black in colour. The highest moisture content of soil was 16% at station S_1 and lowest was 6.03% at station S_3. The water holding capacity of soil was maximum at station S_1 of 45,2% and minimum at station S_3

of 36.00%.

Chemical parameters of soil include pH, organic matter, nitrogen, phosphorus and potassium content.

Soil of study area was found acidic in nature. The highest pH of 6.7 was found at station S_1 and lowest of 4.5 was found at station S_2.

The organic matter content in soil was found increasing with the increase in altitude. It was maximum at station S_1 (9.7%) and minimum at station S_3 (1.932%).

Nitrogen content in soil of study area was maximum at station S_1 (0.325%) and minimum at station S_3 (0.180%). Phosphorus was found maximum at station S_1 (32.5kg/ha) and minimum at station S_3 (21.72kg/ha). Similarly Potassium was found maximum at station S_1 (200.80kg/ha) and minimum at station S_3 (122.00kg/ha).

Table-1. Total tree species of the Bagmati Watershed Area during study period.

Name of tree sps.	Local name	Family	Station		
			S_1	S_2	S_3
Quercus lanata (Smith)	Banjh	Fagaceae	+	-	-
Quercus glauca (Thunb)	Musure falant	Fagaceae	+	+	-
Quercus lamaellosa (Smith in Rees)	Banse falant	Fagaceae	+	+	-
Quercus semecarpifolia (Smith)	Kharsu	Fagaceae	+	-	-
Castonopsis tribuloids (Sm) A.DC.	Masure katus	Fagaceae	+	+	+
Castonopsis indica (Roxb)A.DC.	Dhale katus	Fagaceae	+	+	+
Rhodendron arboreum		Ericaceae	+	+	+
Lyonia ovalifolia (Wallich) Drude in Engl.	Angeri	Ericaceae	+	+	-
Schima wallichi (D.C.)	Chilaune	Theaceae	+	+	+
Cinnamomum sps.	Masala	Lauraceae	+	-	-
Prunus cerrasoids (D.Don)	Paiyu	Betulaceae	+	-	-
Myrica esculanata (D.Don)	Hande kafal	Myricaceae	+	+	-
Myrsine capitellata (Wall)	Seti kath	Myricaceae	+	-	-
Linder sps.		Lauraceae	+	-	-
Pinus roxburghii (Sagent)	Ram sallo	Pinaceae	+	+	+
Litsea oblonga (Wall)	Paheli	Lauraceae	-	+	-
Machilus sps.		Lauraceae	-	+	+
Lindera pulcherima (Nees)	Phusure	Lauraceae	-	+	-
Alnus nepalensis (D.Don)	Utis	Betulaceae	-	+	+

+ Present - Absent

Table-2. Density, Relative Density, Frequency, Relative Frequency, Dominance, Relative Dominance, and Important Value Index of tree species found in Study Area.

Station S_1

Name of the plants	Density/ha	RD	F%	RF	Dominance/m^2	RD	IVI
Quercus lanata	140	5.93	80	7.40	6.9	9.54	22.87
Quercus glauca	240	10.16	100	9.25	7.3	10.09	29.5
Quercus lamellosa	140	5.93	80	7.40	7.6	10.51	23.84
Quercus semecarpifollia	80	3.38	60	5.55	5.2	7.19	16.12
Castonopsis semecarpifolia	500	21.18	100	9.25	9.7	13.41	43.84
Castonopsis indica	160	6.77	100	9.25	5.2	7.19	23.21
Rhododendron arboreum	240	10.16	100	9.25	7.3	10.09	29.5
Lyonia ovalifolia	180	7.62	80	7.40	4.5	6.22	21.94
Schima wallichi	280	11.86	100	9.25	6.8	9.40	30.51
Cinnamomum sps.	100	4.23	60	5.55	2.6	3.59	13.37
Prunus cerassoids	20	0.84	20	1.85	1.7	2.35	5.05
Myrica esculenta	60	2.54	40	3.70	1.9	2.62	8.86
Myrsine capitellata	100	4.23	60	5.55	2.2	3.04	12.82
Linder sps.	40	1.69	40	3.70	1.3	1.79	7.18
Pinus roxburghii	80	3.38	60	5.55	2.1	2.90	11.83

Station S_2

Name of the plants	Density/ha	RD	F%	RF	Dominance/m^2	RD	IVI
Quercus glauca	180	7.62	100	10.63	6.2	8.89	26.63
Quercus lamellosa	140	5.93	80	8.51	6.3	9.03	23.02
Castonopsis tribuloids	400	16.94	100	10.63	7.8	11.19	38.19
Rhododendron arboreum	500	21.18	100	10.63	10.5	15.06	46.19
Lyonia ovalifolia	160	6.77	80	8.51	7.5	10.76	25.53
Schima wallichi	220	9.32	100	1063	7.2	10.32	29.74
Machilus sps.	20	0.84	20	2.12	1.7	2.43	5.28
Litsea oblonga	40	1.69	40	4.25	1.3	1.86	7.67
Lindera pulcherima	60	2.54	40	4.25	2.1	3.01	9.64
Castonopsis indica	180	7.62	100	1063	6.3	9.07	26.79
Alnus nepalensis	200	8.47	80	8.51	6.1	8.75	25.28
Myrica esculenta	20	0.84	10	2.12	0.6	0.86	4.03
Pinus roxburghii	200	8.47	80	8.51	6.1	8.75	25.97

Station S_3

Name of the plants	Density/ha	RD	F%	RF	Dominance/m^2	RD	IVI
Rhododendron arboreum	320	15.09	100	16.12	13.5	19.04	50.25
Schima wallichi	300	14.15	100	16.12	12.2	17.20	47.47
Castonopsis tribuloids	460	21.69	100	16.12	13.3	18.75	56.56
Castonopsis indica	200	9.43	80	12.90	8.6	12.12	34.45
Alnus nepalensis	400	18.86	100	16.12	9.7	13.68	48.66
Machilus sps.	60	2.86	40	6.45	3.5	4.93	14.21
Pinus roxburghii	380	17.92	100	16.12	10.1	14.24	48.28

Table-3. Biomass production of ground vegetation

Stations	Biomass production gm/m^2
S_1	270
S_2	256
S_3	150

Table-4. Physical properties of soil of study area

Station S_1

Sand %	Silt %	Clay %	Silt+ Clay %	Moisture Content %
69	21	13	34	16
76	24	12	36	15
66	27	9	36	12.2
70	23	8	31	12.01
72	23	10	33	11.0

Station S_2

Sand %	Silt %	Clay %	Silt+ Clay %	Moisture Content %
65	24	13	37	11.2
63	25	15	40	11.5
68	26	10	36	12.0
69	29	11	40	10.02
74	21	9	30	9.8

Station S_3

Sand %	Silt %	Clay %	Silt+ Clay %	Moisture Content %
61	25	6	31	7.5
67	13	9	22	8.6
68	17	11	28	9.0
71	20	7	27	7.2
70	22	8	30	6.03

DISCUSSION

Present study showed that diversity of tree species was comparatively higher at station S1 than at other stations. *Castanopsis tribuloides* was found dominant tree species, and other dominant species were *Rhododendron arboreum* and *Schima wallichi* . So *Schima-Castanopsis* type of forest was found in the study area. The range of density of individual species were found between 200-500. At station S_1, the dominance of tree species was found in decreasing order as *Castanopsis tribuloids* > *Schima wallichi* > *Rhododendron arboreum.* At station S_2, it was *Rhododendron arboreum* > *Castanopsis tribuloids* > *Machillus species* and at station S_3, it was *Castonopsis tribuloids* > *Pinus roxburghii* > *Machillus spp.*

Frequency analysis gives the uniformity of the species. The frequency wa 100% of *Quercus glauca* , *Castonopsis tribuloides, Castanopsis indica*, *Rhododendron* species and *Schima*

wallichi at station S_1. The frequency was 100% of *Quercus glauca, Rhododendron* species, *Schima wallichi* and , *Castanopsis indica* at station S_2. *Castanopsis tribuliodes* and *Alnus nepalensis* showed 100% frequency at station S_3. (Table-2). The forest was found sparse type at station S_3 but it was comparatively dense at stations S_1 and S_2, it may be due to the deforestation and grazing at station S_3.

The moisture showed its influence on the nutrient content of the soil. The increase in soil moisture causes the dilution of H^+ ions in the soil solution which in turn rises the pH. The nutrient content in the organic matter is released by the microbial activities, for which moisture is necessary. As moisture increases, there is increment in the nutrient content of the soil. Moisture content in soil was low at station S_3 and high at station S_1. (Table-4)

The soil of study area was found acidic in nature. The pH of soil was comparatively low at station S_3 than at S_2 and S_1 (Table 5), it may be due to low moisture content.

Prajapati (1976) made an analytical study on the effect of nutrition (N,P,K), temperature and light on the growth and development of chir-pine seedlings. Shrestha (1979 made on ecological study on ground vegetation of Sallaghari hill in relation to its soil. Comparison of floristic composition at ground level of the northern and southern portion of hill and the analysis of soil characters (texture, pH, moisture content and nutrient content) revealed that such differences in the vegetation distribution were attributable to the variations in edaphic factors.

Manandhar and Bajracharya (1992) analyzed the surface soil characteristics in different ecological stand of mixed hard wood forest of Nagarjun hill. They observed that soils from *Quercus* dominated stand possessed low moisture, pH and nitrogen but high organic matter content compared to the stands possessing *Machilus* species.

Rana Chhetri (1981) analyzed the woody vegetation in relation to altitude, slope and soil factors in Chandragiri. In this study within the altitudinal range from 1380 m to 2510 m, four distinct kinds of forests were found on the basis of species composition. He reported that, the distribution of the forest types were governed by soil characters, such as texture, pH, organic matter content etc. along with the topographic features.

Young (1934) made a complete analysis of soil and vegetation in certain area of Cranberry lake region which included climax forest and other natural vegetation. The soil in climax forest habitats were richer in soil parameters, compared to the habitats supporting less developed vegetation. The result of analysis showed that a high degree of heterogeneity prevailed from habitat to habitat and similarly vegetation composition also varied. On the basis of this result, he concluded that soil heterogeneity is correlated with the plant heterogeneity.

Gazizullin (1997) studied the inter-relationship between soil topography and forest vegetation within the zone of mixed broad leaved forests of the middle Volga region. They showed the forest composition and productivity are influenced by the nature of the soil.

As the content of organic matter in the soil increases, the content of nitrogen and phosphorus also increases. The nitrogen and phosphorus content of soil low at station S_3 than at S_2 and S_1; it may be due to low organic matter content in soil at station S_3. The potassium content of soil in the study area was higher at station S1 and lower at station S_3, it may be due to the higher organic matter content and moisture content at station S_1.

The biomass of ground vegetation was highest

at station S1, it may be due to the high quantity of nitrogen, phosphorus, moisture and organic matter content in the soil of that area. Jha and Upadhaya (1982) showed the chemical composition of the soil, were directly related with climatic conditions. The low biomass production of ground vegetation at station S_3 may be due to grazing of cattle and human exploitation in that area.

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