Aplinkos tyrimai, inžinerija ir vadyba, 2011. Nr. 1(55), P. 5-13
Environmental Research, Engineering and Management, 2011. No. 1(55), P. 5-13
http://erem.ktu.lt

ISSN 2029-2139
(On-line)

An Assessment of Soil Properties under Different Landuse Types of the Kallada River Basin, Kerala, India

M. Suma[1], A. V. George[2], V. B. Rekha[1], J. Leenamma[3]

[1] *School of Environmental Science, Mahatma Gandhi University, Kottayam, Kerala, India*
[2] *Department of Geology and Environmental Sciences. Christ College, Irinjalakkuda, Thrissur, Kerala, India*
[3] *Department of Zoology and Environmental Sciences, St.John's College, Anchal, Kollam, Kerala, India*

(received in February, 2011, accepted in March, 2011)

A thin layer of soil covers most of the earth's land surface. This layer varying from a few centimeters to 2 or 3 meters in thickness might appear insignificant relative to the bulk of the earth. On the basis of morphological features and physico chemical properties, the soils of the Kallada basin can be classified into broad six groups (1) Coastal alluviam 2) Riverine alluviam 3) Brown hydromorphic 4) Greyish Onattukara soil 5) Laterite soil and 6)Forest loam (GSI Map). Twenty four soil profiles were collected from the Kallada river basin for analysis, whose 12 profiles are in one cluster distributed adjoining the Western Ghats crest. As many as 12 profiles were under forest, three under grasslands, three under teak plantations, two under mixed tree crops, two under tea plantation and one each from eucalyptus and rubber plantations. Soil is a rich but fragile ecosystem. It is a three-phase system, composed of solid, liquid and gaseous phases. In most soils, the solid phase makes up the vast majority of the soil mass, and over half of its volume. It consists of mineral matter derived from the weathering of rocks and organic matter from the decomposition of plants and animals. The liquid phase is composed predominantly of water, enriched with dissolved solids, the gaseous phase of air, enriched with carbon dioxide from the respiration of soil animals and plant roots. Physical properties of the soil are determined by the character of solid particles and the way in which they are packed together. (Das et al. 1981; Jain et al. 2001)

Key words: *landuse, soil, property, Kallada river basin, India.*

1. Introduction

A thin layer of soil covers most of the earth's land surface. This layer varying from a few centimeters to 2 or 3 meters in thickness might appear insignificant relative to the bulk of the earth. Yet it is in this thin layer of soil that plant and animal kingdoms meet the mineral world and established a dynamic relationship (Glacken 1967). Soils are next to water man's most vital natural resource. Hence from an economic point of view, the production of soils is the most significant result of rock weathering (Thorn bury 1990). Soils are more correctly interpreted as a function of various environmental factors rather than a product of interaction of these factors. Development of soils depends primarily on parent material, climate, topography, soil biota and time. Climate is important as it affects the types and intensity of the weathering processes, the amount and types of soil organisms, soil temperature and moisture, and the rate of decay of organic material.

The Kallada river is a 7th order stream. It has a major irrigation project at Thenmala (Parappar) and is presently beset with many environmental problems. Drainage pattern is dendritic and in most cases, structural control is amplified by trellis pattern and straightness of the stream course. The basin is elongated in shape. The origin of the Kallada is Karimalai Kodakkal at an elevation of 1524 m. The river is formed by the confluence of three small streams, i.e. the Kulathupuzha, the Chendurni and the Palaruvi at Parappar (Themala) on the upper forest catchment. Thenmala dam onwards the river flow north-west and the west ward where it is joined by an important tributary the Chitar Ar. Thereafter the river follows a meandering course through gentle to moderately undulated terrain and flows in a south westerly course till it debouches in to the Ashtamudi estuary.

2. Soil Profile of the Kallada River Basin

On the basis of morphological features and physico chemical properties, the soils of the basin can be classified into broad six groups (1) Coastal alluviam 2) Riverine alluviam 3) Brown hydromorphic 4) Greyish Onattukara soil 5) Laterite soil and 6)Forest loam (GSI Map). Lateritic soil covers a major portion of the midland and coastal belt. Forest loam found in the eastern part of the basin is the product of weathering of crystalline rock under forest cover. Deep forest loam soils are especially seen in the areas with thick canopy. These soils are dark reddish brown to black in colour with loamy to silt texture. The dark colour of the surface horizon is due to the presence of organic matter derived from vegetation. River alluvium occurs mostly along banks of the river and its tributaries. These are very deep soils with surface texture ranging from sandy loam to clayey loam. Greyish onattukara soils are purely marine deposits extending to the interior. These soils are in general coarse textured. The fertility status of these soils is very poor, as they are low in organic matter and nutrients. Brown hydromorphic soils are mostly confined to valley bottoms in the midland and low lying areas of the coastal belt.

3. Soil properties under different land use types

Twenty four soil profiles were collected from the Kallada river basin for analysis whose 12 profiles (1 to 12) are in one cluster distributed adjoining the Western Ghats crest. Sixty eight soil samples from 24 soil profiles have been examined in the Kallada basin. As many as 12 profiles were under forest, three under grasslands, three under teak plantations, two under mixed tree crops, two under tea plantation and one each from eucalyptus and rubber plantations.

According to benchmark soils of Kerala the area from where these samples were collected falls under the soil series of Kallar and Ponmudi of Thiruvananthapuram district and Karavaloor series of Kollam district. The associated series are Kottur and Edamulakkal. The rock types on which these soils have developed are charnockite, khondalite and gneisses. Soil textures of the representative sample considered for series description are sandy clay, sandy clay loam and gravelly sandy loam.

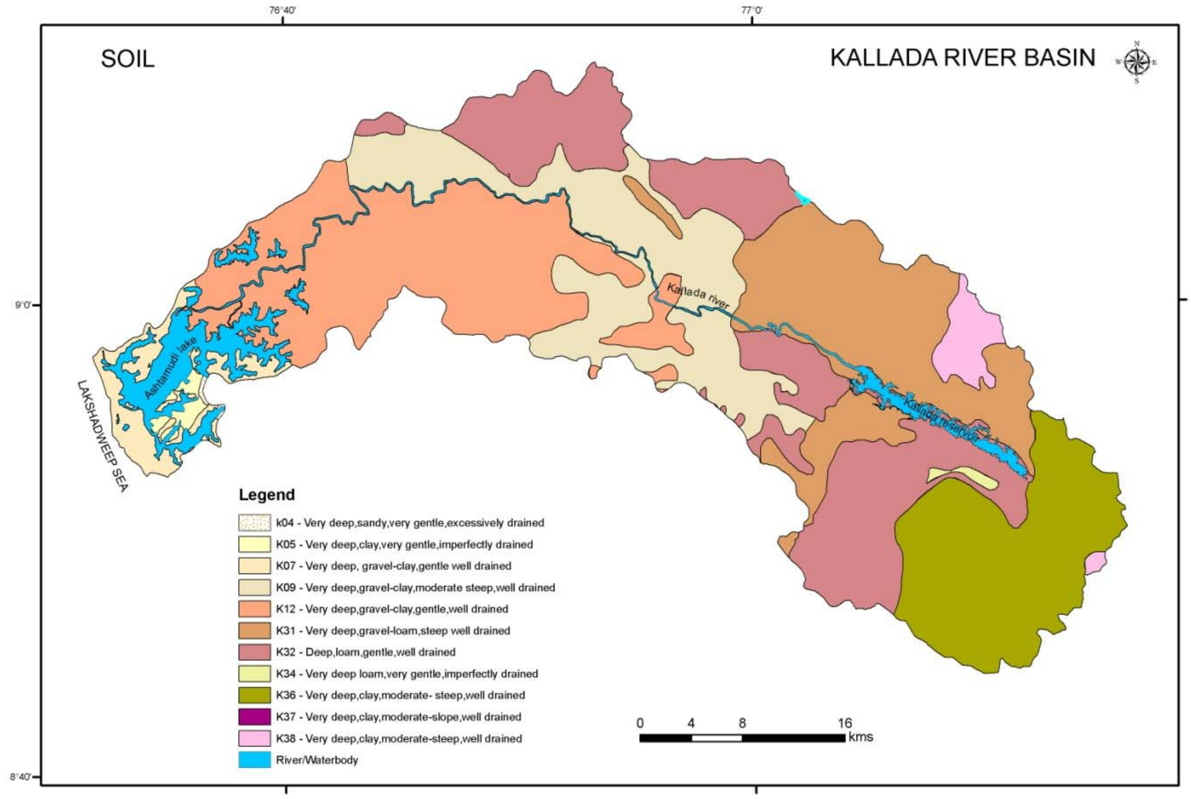

Fig. 1A. Map Showing Soil Profile of the Kallada River Basin

3.1. Mechanical composition

Gravel dominates mechanical composition of the soils. It varies from 0.64% in the bottom layer of profile No 24 under mixed tree crops to 67% in the bottom layer of profile No 18 under forest. Proportion of gravel decreases in six profiles, increases in another six profiles and record mixed trend, i.e. increases in the middle layer and decreases in the bottom layer or a decrease in the middle layer and an increase thereafter, in case 11 profiles. Only in one profile the proportion of gravel remains the same in all layers. Gravel proportion is within 4% in case of two profiles under settlement with mixed tree crops. There is no specific trend observed in gravel distribution under different land use types.

Considering the soil samples for the upper layer three textural classes are evident **(Fig. 1B)**. These are clay (profile Nos. 1, 7, 11, 19 & 21), sandy clay (2,3,8,9,10,12,13,14,17,18, 20 & 23) and sandy clay loam (4,5,6,15,16,22,& 24). Soils under settlement with mixed tree crops falls in the textural category of sandy clay loam, and soils under tea plantations are of clay and sandy clay in texture. Grass land soils are sandy clay loam and sandy loam in texture. Out of the 12 profiles examined under forest eight are of sandy clay texture. Location of all these eight profiles except two (Nos 3 and 9) are in lower altitudes. Other two high altitude forest locations (Nos 7 and 11) show clay texture.

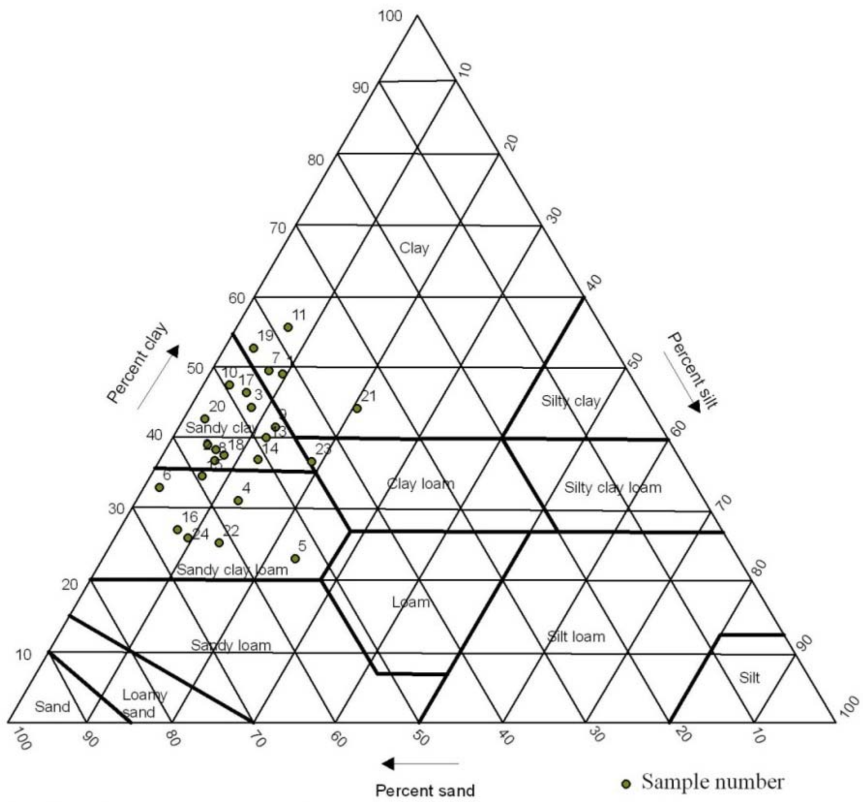

Fig. 1B. Textural Classes –the Kallada (Upper layer)

Comparing three samples one each under tea (No 2), forest (No 3) and grasslands (No 4) located side by side it emerges that sand content in the top layer is the highest (57.75%) in the sample under grassland, followed by tea (55.20%) and forest (48.40%). Conversely, clay content in soils under forest, tea and grasslands are 44.4%, 38.2% and 31.9% respectively. As there are sufficient base covers in all these cases soils are more or less protected. Mechanical composition of soil samples under different land use categories are given in the Figs. 2, 3, 4, 5, 6, 7, and 8.

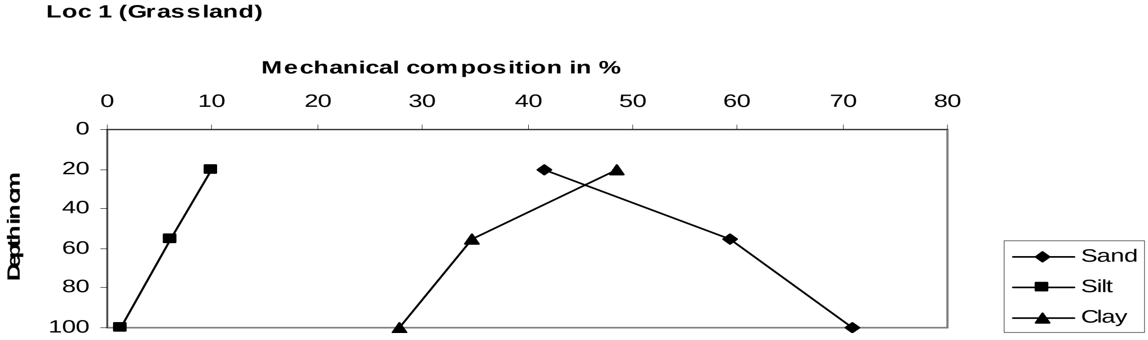

Fig. 2.

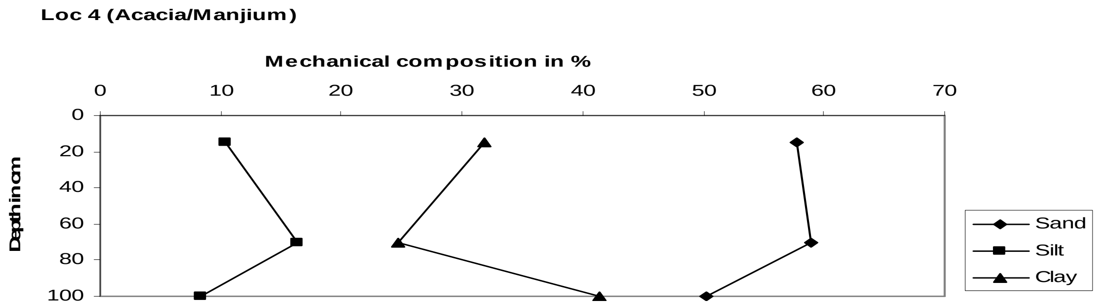

Fig. 3.

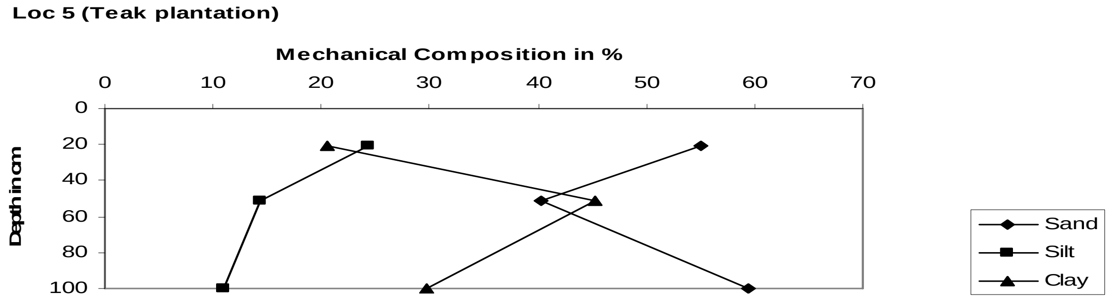

Fig. 4.

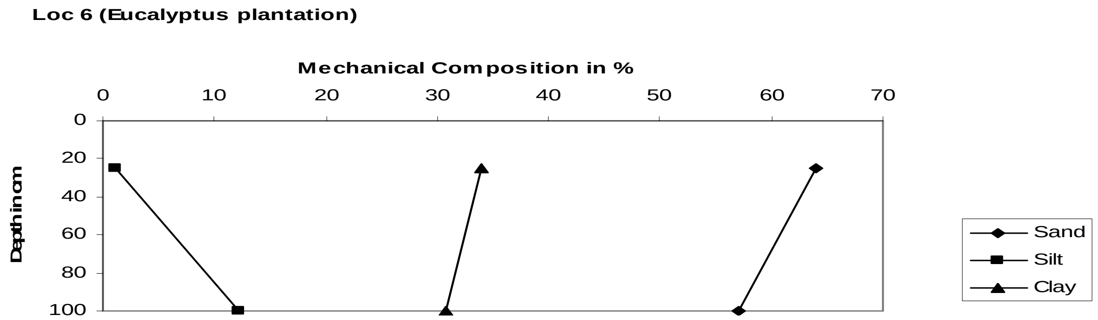

Fig. 5.

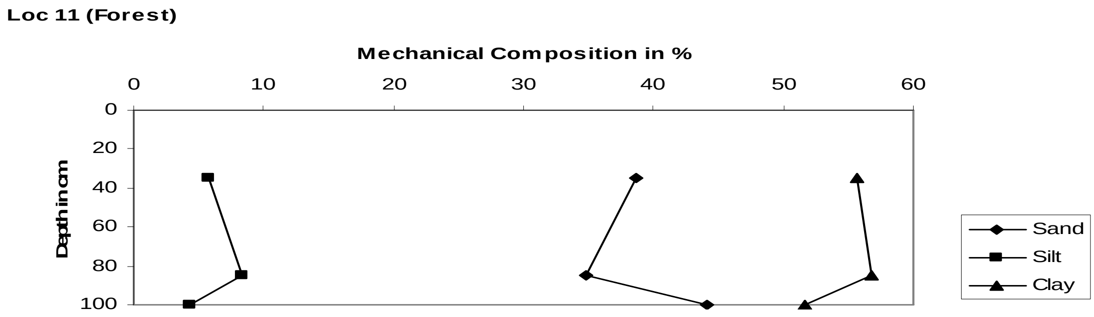

Fig. 6.

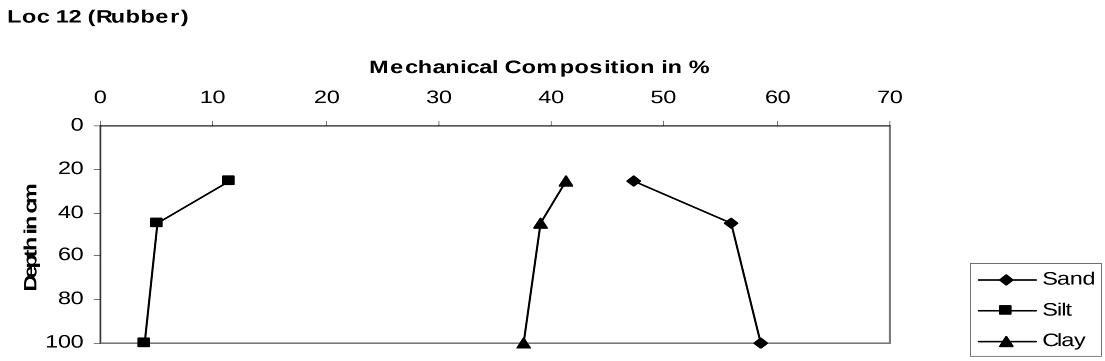

Fig. 7.

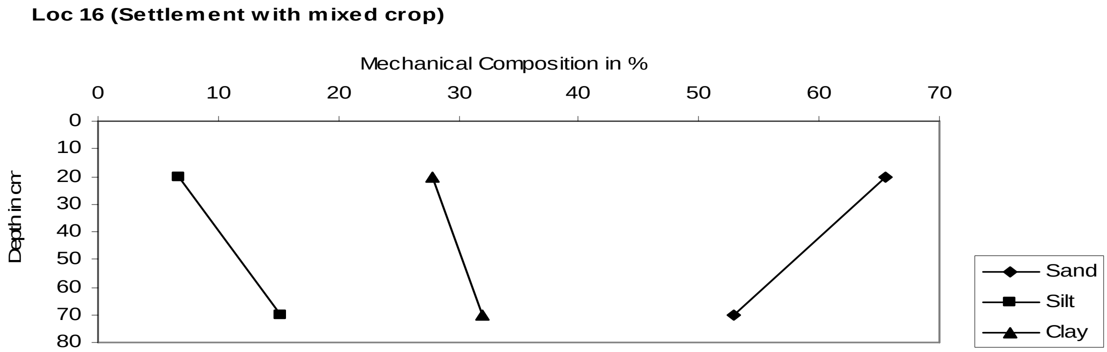

Fig. 8.

3.2. Organic carbon

Distribution of organic carbon varies from 0.24% in the bottom layer of profile No 3 under forest to 3.57% in the top layer of profile No 10 under teak plantation. Organic carbon is high in the top layer in general. It varies from 0.41% under tea plantation to 3.57% under teak. Organic carbon is low in the soil profiles under settlement with mixed tree crops. Among the soil samples under forest the variation is from 0.60% to 3.09%. Some of the well maintained teak plantations have good base cover contributing to a high concentration of organic carbon in the upper layer. Percentage of organic carbon reduces with depth in all profiles except profile No19 under tea plantation, where there is an increase in organic carbon in the middle layer and subsequent reduction in the bottom layer (Table 1).

Table 1. Distribution of Organic Carbon under different land use types along depth, the Kallada basin

Depth in cm	LAND USE TYPES							
	Forest	Grass land	Teak	Acacia-Mangium	Tea	Rubber	Eucalyptus	Settlement with mixed tree crops
<20	2.89	1.93	2.24	1.41	0.41	2.20	0.73	1.22
20-60	2.10	0.48	1.33	0.97	0.71	1.68	-	-
60-100	0.71	0.46	0.93	0.97	0.37	1.62	0.85	0.32

3.3. Nutrient status

According to the benchmark soils of Kerala the nutrient status of Kallar, Ponmudi and Karavallor series are given in Table 2. Nutrient status of soils in this area is relatively low.

In general potassium is low in the study area, therefore our discussion here will be limited to nitrogen and phosphorus only. Available nitrogen varies from 7.6 kg/ha in the upper layer of profile No 3 under high altitude forest to 72.0 kg/ha in the upper layer of profile No 8 under teak plantation and middle layer of profile no.12 under rubber plantation. Among the 12 profiles examined under forest available nitrogen content varied from 7.6 kg/ha to 63.5 kg/ha. Forests in the valleys and low altitude locations record comparatively higher nitrogen content. The highest concentration of nitrogen is reported from the profiles under teak plantations followed by grass lands (Table 3). The highest phosphorous content is recorded in the upper layer of Profile No 1 under grass lands, however considering the mean value the highest concentration is observed under teak plantation. Figs 9, 10, 11, 12, 13, 14, 15, 16 provide nitrogen and phosphorus content of soil profiles under different land use types.

Table 2. Nutrient status of soils in the Kallada basin according to benchmark soils

Soil series	**Nitrogen (kg/ha)**	**Phosphorus (kg/ha)**	**Potassium (Kg/ha)**
Kallar	Medium to high (134 -403)	Medium to high (12-52)	Low (20-80 kg/ha)
Ponmudi	Medium to high (134-403)	Medium to high (12-52)	Low (20-80 kg/ha)
Karavaloor	Low to medium (90-220)	Medium (10.1-24)	Low (15-45)

Source: benchmark soils of Kerala, 2007

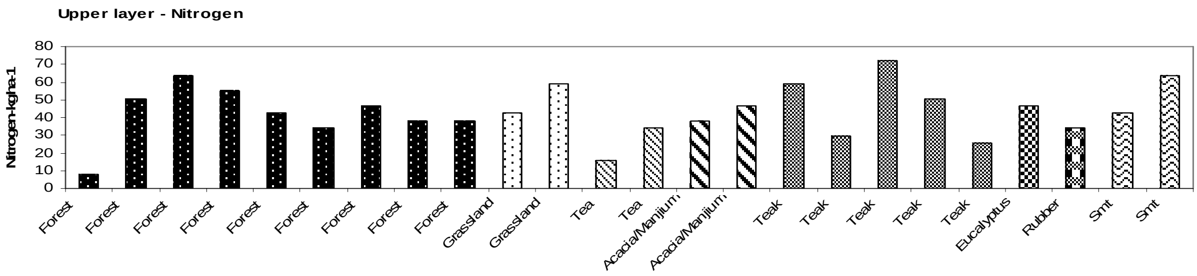

Fig. 9.

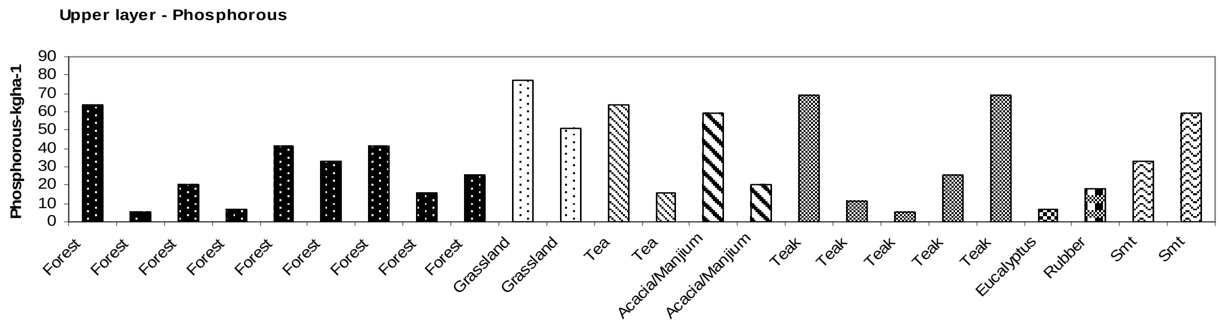

Fig. 10.

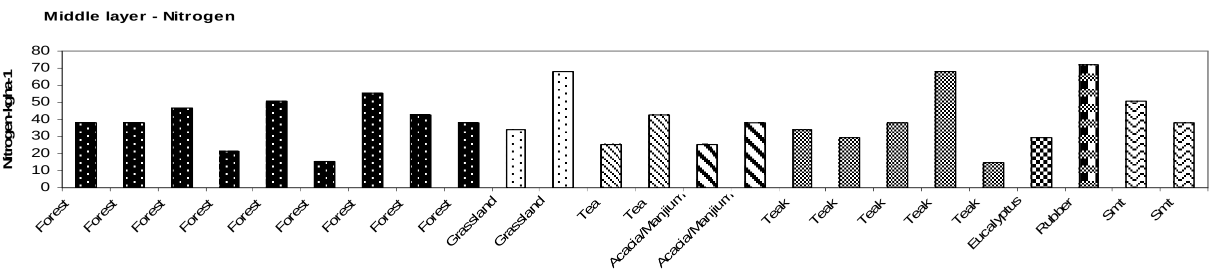

Fig. 11.

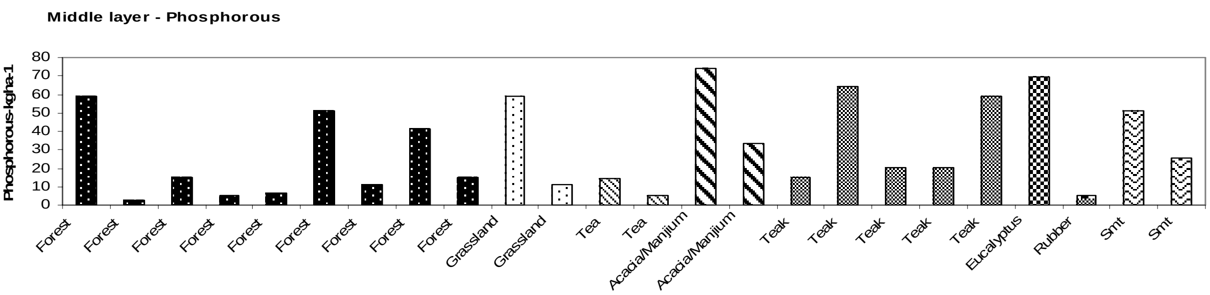

Fig. 12.

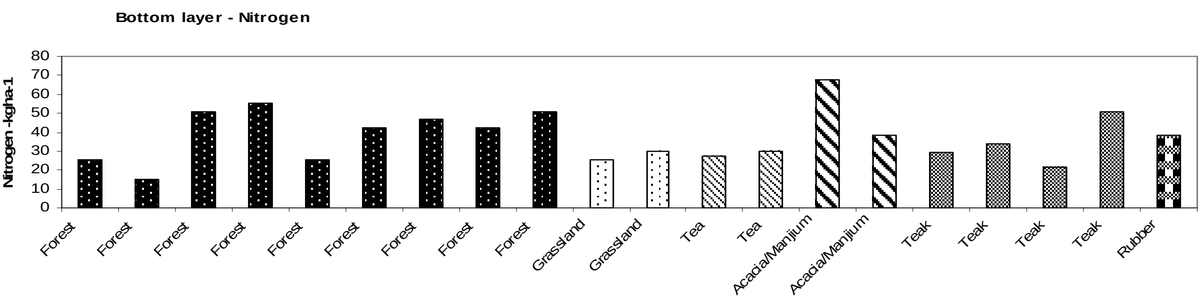

Fig. 13

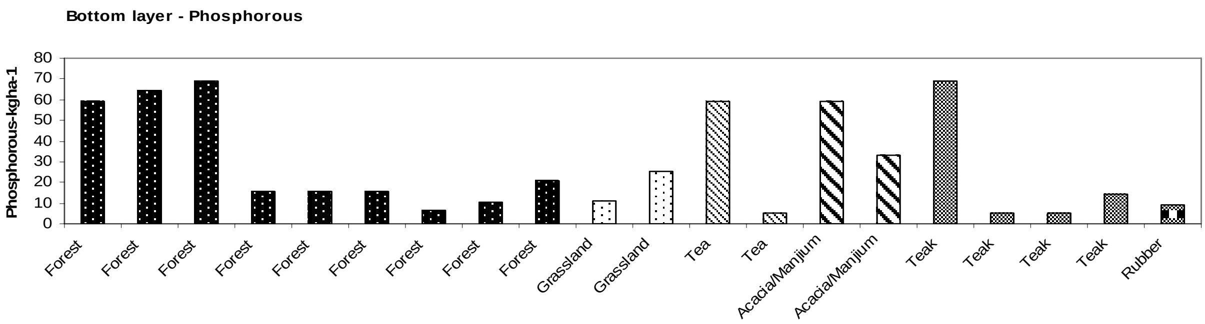

Fig.14

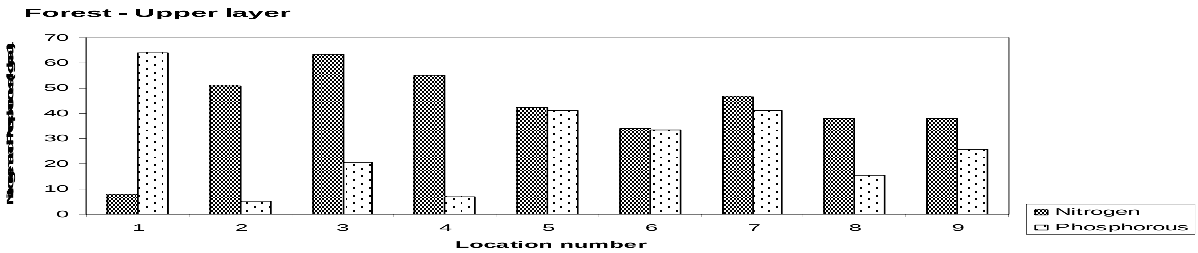

Fig. 15

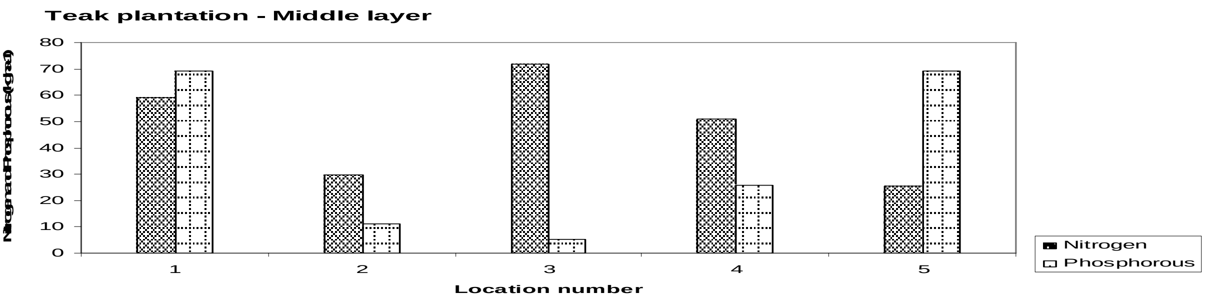

Fig. 16

Table 3. Available Nitrogen and Phosphorous content under different land use types, the Kallada basin

Land use	No. of observations	Nitrogen (kg/ha)	Phosphorous (kg/ha)
Forest	9	Mean: 41.8	Mean:28.09
		SD: 14.9	SD: 17.85
Teak plantation	5	Mean: 47.39	Mean: 54.49
		SD : 17.66	SD : 22.93
Grassland	2	Mean: 50.80	Mean: 64.12
		SD : 8.47	SD : 12.82
Acacia/ Manjium	2	Mean : 42.3	Mean: 39.8
		SD: 4.2	SD: 19.2
Tea	2	Mean: 29.1	Mean: 27.2
		SD: 6.2	SD: 18.7
Eucalyptus	1	46.6	6.7
Rubber	1	33.9	17.9
Settlement with mixed tree crops	1	42.3	33.3

4. Conclusions

Soil is the natural unconsolidated mineral and organic material occurring above bed rock on the surface of the Earth (Oxford Dictionary of Earth Sciences 2003). Rock type, climate, topography, vegetation and the weathering processes all together control soil formation. There is a close link between morphogenesis and pedogenesis. Soil is a rich but fragile ecosystem. It is a three-phase system, composed of solid, liquid and gaseous phases. In most soils, the solid phase makes up the vast majority of the soil mass, and over half of its volume. It consists of mineral matter derived from the weathering of rocks and organic matter from the decomposition of plants and animals. The liquid phase is composed predominantly of water, enriched with dissolved solids, the gaseous phase of air, enriched with carbon dioxide from the respiration of soil animals and plant roots. Physical properties of the soil are determined by the character of solid particles and the way in which they are packed together.

References

Das DDC, Bali YP, Kaul RN (1981) Soil conservation in multipurpose river valley catchments. Problems, programme approaches and effectiveness. Indian Journal of Soil Conservation 9(1):5–26

Dillon,P.J and Kirchner, W.B., (1975), The effects of geology and landuse on the export of Phosphorus from watersheds. Water Research 9, 135-148.

Glacken, (1967), Preliminary assessment of the Land use and water quality changes in the Magens bay watershed, Water, Air and Soil Pollution, 45-49

Jain AK, Kothyari UC (1997) Sediment yield estimation using GIS. Hydrology Science Journal 45(5):771–786

Jain SK, Kumar S, Varghese J (2001) Estimation of soil erosion for a Himalayan watershed using GIS technique. Water Resource Management 15:41–54

Jain SK, Singh P, Saraf AK, Seth SM (2003) Estimation of sediment yield for a rain, snow and glacier fed river in the western Himalayan region. Water Resource Management 17:377–393

Kothyari UC, Jain SK (1997) Sediment yield estimation using GIS. Hydrology Science Journal 42(6):833–843

Narayana VVD, Babu R (1983) Estimation of soil loss in India. Journal of Irrigation, Drainage Engineering,109(4):419–433

Suresh, R. (2000), Soil and Water Conservation Engineering 3rd Ed. 24. Watershed Conservation and Management 785-813

Thornbury, W. D. (1990). Principle of Geomorphology (p. 594). New Delhi: Willey Eastern Limited.

Dr. M. Suma, Research Scholar at Center for Remote Sensing and GIS, School of Environmental Science, Mahatma Gandhi University.
Main research areas: environmental msnsgement, sustainable development, the management of logistics proceses.
Address: Kottayam, Kerala- 686 560
E-mail: sumachediath@gmail.com

Prof. Dr. A. V. George, Head of Department of Geology and Environmental Sciences, Christ College, Irinjalakkuda, Thrissur, Kerala, India.
Main research areas: Hydrology, Environmental degradation, GIS and Remote Sensing.

V. B. Rekha, Research Scholar at Center for Remote Sensing and GIS, School of Environmental Science, Mahatma Gandhi University.
Main research areas: Hydrological modeling, GIS and Remote Sensing

J. Leenamma, Department of Zoology and Environmental Sciences, St.John's College, Anchal Kollam, Kerala, India.
Main research areas: Ecology, Environmental quality, Soil characteristics and Microbes

Žemės naudojimo pobūdžio ir dirvožemio savybių priklausomybės vertinimas Kalada upės baseino teritorijoje, Indijoje

M. Suma[1], A. V. George[2], V. B. Rekha[1], J. Leenamma[3]
[1] *Aplinkos apsaugos mokslų mokykla, Mahatmos Gandžio universitetas, Indija*
[2] *Geologijos ir aplinkos apsaugos mokslų fakultetas, Kristaus kolegija, Irinjalakuda, Indija*
[3] *Zoologijos ir aplinkos apsaugos mokslų fakultetas, Švento Jono kolegija, Anchalas, Indija*

(gauta 2011 m. vasario mėn.; atiduota spaudai 2011 m. kovo mėn.)

Didžiąją Žemės paviršiaus dalį dengia plonas dirvožemio sluoksnis, svyruojantis nuo keleto centimetrų iki 2–3 metrų. Palyginti su visu Žemės tūriu, šis sluoksnis ypač menkas. Kalada upės baseino dirvožemis pagal morfologines bei fizikines ir chemines savybes skirstomas į šešias grupes: 1) pakrančių aliuvinis dirvožemis; 2) upių aliuvinis dirvožemis; 3) rudasis hidromorfinis dirvožemis; 4) pilkšvas Onatukara dirvožemis; 5) rausvasis dirvožemis; 6) miškų priemolis. Šiame straipsnyje aprašytas tyrimas, kurį atliekant tirti skirtingų Kalada upės baseino vietovių, pasižyminčių specifine augalija ir žemėnauda, 24 dirvos profiliai.