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Physical and Chemical Properties of Soil: Indicator of Forest Health and Ecosystem of Mathwad range

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Abstract: **Generally soil characteristics made up of two properties namely physical like soil moisture, soil texture and chemical like soil organic carbon, soil pH, nitrogen, available phosphorus and micronutrients (trace elements Cu, Fe, Mn & Zn) to be important to forest productivity. This study was aimed to investigate soil health analysis for wildlife habitat improvement like shelter and food, forest productivity, appropriate plantation, grassland and describe the forest soil of Mathwad forest range Alirajpur District Madhya Pradesh India. A total of 30 soil samples were collected from different forest compartments of the study area with their GPS coordinates and analyzed physical and chemical properties according to standard procedures. Results shows that organic carbon soil varies from 0.96 to 2.38 which was medium to high and equivalent to 1.66 to 4.10 per cent organic matter and nitrogen, phosphorous contents all the soil samples were in optimum level. The soil pH optimal for the health of most plants N, P, and K were in adequately quality for the growth and development of forest plants. Although the soil contains high quality of micro nutrients, the availability will not be in toxic level because of the natural pH.**

Keywords: **Mathwad, Tribals, Soil, NPK, Vegetation pH, Organic carbon, soil texture, Micronutrient.**

I. INTRODUCTION

Vegetation one of the most important factors contributing to soil origin. Soil health play important role of plant productivity for forest ecosystem. Soil natural body developed by natural force which differs from the parent material, morphology physical chemical properties and its constitution. Basically, soil is a porous material made up of (depending on soil type) 40-60% mineral matter, 20-50% water, 10-25% air and 2-10% organic matter. Soil organic carbon (SOC) play a very important role in global C cycle, as it largest terrestrial C pool [7],[13],[9]. Soil organic matter (SOM) is the end product of microbial breakdown of animal and plant material added to soil and it plays a vital role in soil 'health'. SOM the simple and complex plants and animals that live within it and around it, and which produce it, are integral to soil fertility and its ability to support efficient plant growth. The microbial processes that lie behind plant nutrient cycling, soil fertility and plant growth are largely dependent on the SOM. Soil quality, like site quality or forest productivity, value-based concept related to the objectives of ecosystem management, and hence will be management and ecosystem-dependent. Many studies have shown the effects of individual tree species on soil chemical and physical properties [16], [4], [5], [1], [2], [11]. Although woody species may affect soil properties by redistributing nutrients within the rooting zone [2]. The aim of this study how soil health role play for habitat improvement in the study site.

II. MATERIALS AND METHODS

A. *Soil sampling*

Study site was Mathwad Range of Alirajpur Forest Division situated in Alirajpur district Madhya Pradesh geographically located between, 21055'34.449" N and 2202'21.127" N parallels of latitude and between 7408'14.736" E and 74020'39.076" E meridians of longitude (Site map-1). Total 30 soil samples were collected from different forest compartments (Table-1) of the study area with their GPS coordinates (Map-1). Collection of soil samples was the most important step; tools should be clean, auger free of rust, and stored away from fertilizer materials. Other tools include sample buckets, shovel or spade, sample bags and permanent marker pen for identifying samples on sample bags. The soil samples were collected by using auger from 30 cm depth soil layers. The soil samples were mixed thoroughly, air dried and passed through a 2 mm mesh sieve to remove the stone pieces and large root particles. The composite soil sample was used for detail analysis.

Laboratory and Statistical Analyses

Laboratory analysis was carried out at the Soil lab Silviculture Branch, State Forest Research Institute, Jabalpur Madhya Pradesh India. Descriptive statistics was used to describe the Laboratory results.

B. Soil analysis

Water holding capacity

Water holding capacity of soil was determined by Keen's method by using copper cup of 5.6 cm internal diameter and 1.6 cm height [12].

Soil pH

Soil pH was measured by mixing 10 gram of freshly soil sample and 50 ml of distilled water and stirred for 20 minutes in a 100 ml beaker using magnetic stirrer. The soil-water mixture was kept overnight and taken the reading with the help of Digital pH meter.

Soil organic carbon

Soil organic carbon was determined by rapid dichromate oxidation technique [14]. The organic matters in the soil were oxidized by chromic acid (Potassium dichromate plus conc. H_2SO_4) utilizing the heat of dilution of H_2SO_4. The unreacted dichromate was determined by back titration with ferrous sulphate [8].

EC (Electrical conductivity- Electrical conductivity (E.C.)

The EC was measured by using a conductivity meter which contained a source of electric current, a Wheatstone Bridge and a galvanometer. The conductivity was measured in dS/m-1 (deci Siemens per meter).

Nitrogen

Nitrogen was determined by Kjeldahl method [3]. The air-dried soil sample were digested in a block digestor in the presence of 10 – 15 ml of conc. H_2SO_4 and 5 – 7 g of salt mixture i.e., mixture of 250g K_2SO_4, 50g $CuSO_4.5H_2O$ and 5 g metallic Selenium as catalyst at the temperature between 360oC and 410oC. Distillation was done with the help of 'Kel Plus Nitrogen Estimation System' by adding 40 ml of 40% NaOH. The distillated sample was collected in a 250 ml conical flask containing 4% boric acid and three drops of bromocresol green and methyl orange, and then the colour appeared transparent. The sample was then titrated against 0.1N HCl.

Phosphorus

Available phosphorus was determined after extracting soil phosphorus in 0.5 M sodium bicarbonate solution by Olsen's method. The extract was prepared by adding 2.5 g of soil sample in the 250 ml conical flask containing 50 ml of extracting solution ($NaHCO_3$), shaken for 30 minutes and the suspension was filtered through a Whatman No. 40 paper. Then 5 ml of the extract was taken into a 25 ml conical flask, to which 5 ml of Dickman and Bray's reagent was added drop by drop till the effervescence ceased. The content was diluted to 22 ml, adjusted the pH to 5.0 and added 1ml of diluted $SnCl_2$. Then the optical density was measured just after 10 minutes with the help of Spectrophotometer 119 at 660 nm [8].

Potassium

Potassium of soil was determined by using flame photometer after extracting with 1N ammonium acetate solution. 5 g of soil sample was shaken with 25 ml of 1N ammonium acetate solution for 5 minutes and filtered through Whatman No. 1. Then the potassium concentration was determined by flame photometer by using K-filter) [6], [8].

III. RESULTS AND DISCUSSION

A. Acidity

Result shows that the all soil samples pH was in the range 6.03 to 6.79, only one soil sample No. 11 compartment No. 472 was very slightly acidic. Thus, the soil was almost neutral. The pH range 6.0-7.0 was optimum for the health of most of the plant species, although plants can survive and grow in a wiser pH range also. The diversity in natural vegetation grown on soils with on varying range of pH was the best evidence. However, different species do have preferences for a specific range of soil reaction. Soil reaction and plant growth inter-related. Soil pH makes a significant impact on the availability various nutrients elements. It may result in increase or decrease of contain elements. The concentration of certain metallic elements, such as Ac^{3+}, Fe^{3+}, or Mn^{2+} may rise to toxic levels in acidic soils with pH less than 6.0 pH value beyond the recommended range of 6.0-7.0 generally lowers the availability of all nutrients except molybdenum and boron. The pH range (6.03 to 6.79) shown in (Table No. I.) of the study area was suitable for availability of most of the nutrients elements. Neutral soils have a pH of 7.0 (6.5-7.5), acid soils have a pH $\leq$ 6.5 and basic soils have a soil pH $\geq$ 7.5. Most foresters believe that hardwoods prefer slightly acidic to neutral soils. Most tree species well grow over a broad range of pH values (5.5 to 7.0) [15].

B. Organic Carbon

All soil samples were found to vary between 0.96% and 2.38% which was equivalent to 1.66 to 4.10 percent organic matter (Table No. I.). except two soil samples No-21 and sample No-22 compartments 476 and 477 were slightly low organic carbon. Thus, the organic matter content in the study area was medium to high despite low density of stocking. Soil organic matter plays a very and sometimes spectacular role in the maintenance and improvement of soil properties.

C. NPK

Nitrogen and phosphorus contents were almost all the soil samples in the optimum range level (Table No. I.). Nitrogen essential constituent of metabolically active compounds such as amino acid, proteins, enzymes and some non-proteins compounds. Whereas nitrogen limiting factor, the rate and extend of protein synthesis was depressed resulting in adverse impact on the plant growth. The plants get stunted and chlorosis development.

Potassium content in almost all the soil samples were also found at an optimum level for the growth and development of plants. Potassium plays an important role in the maintenance of cellular organizations by regulating permeability of cell membranes and keeping the protoplasm in a proper degree of hydration

Phosphorus structural component of cell membranes, chloroplasts and mitochondria and a constituent of sugar phosphates, viz. ADP and ATP, nucleic acid, etc, phospholipids and phosphatides.

D. Micronutrients

The concentrations of micronutrients (Cu, Fe, Mn & Zn) were to some extent at higher level (Table No. I). Although the soils contain high quantity of nutrients it will not be at toxic level because of near neutral pH. The very fact that the micronutrient elements required by plant in very low concentration, suggests that they function as catalysts or with some catalytic processes in plant.

E. Soil texture

Soil texture in the study area, was red lateritic murrumy soil with pebbles and boulders ware a common sight. However, some patches of black soil (Comptt. No. 458, 471, 472), sandy loam soil (Comptt. No. 444, 460, 462, 463, 466, 469, 470, 471 and 474), and loamy soil (Comptt. No. 477) was also met with. The type of soil near the river was sandy alluvium. The soil classes and the percentage distribution of the study area can be seen in figure No. 1

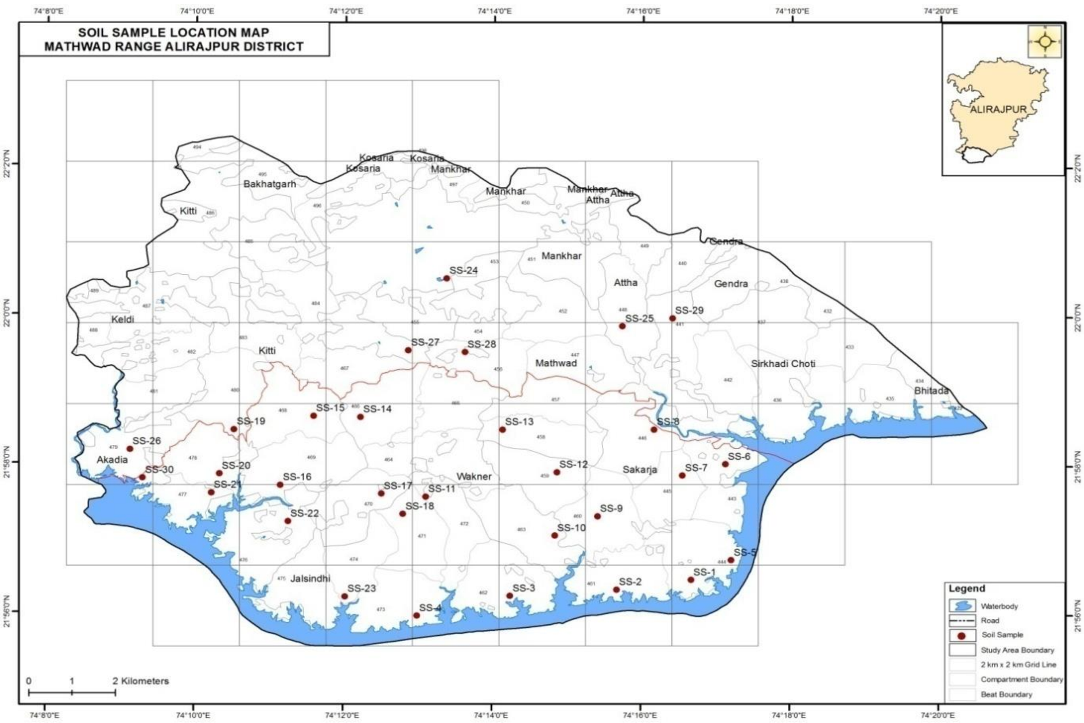
In study site for plantation and seed showing patches identified for habitat improvement with the help of their soil health results. On the basis of physio-chemical properties of the study site these species recommend for plantation and seed sowing like *Terminalia bellerica, Terminalia chebula, Madhuca latifolia, Buchnania lanzan, Hardwickia binata, Acacia catechu,* and *Tamarindus indica* in compartment No. 444, 460, 462, 463, 466, 469, 470, 471 and 474 soil was sandy loam and loamy soil which suitable for grassland development for ungulate, suitable soil in the compartment no. 458, 471, 472. This compartment soil texture were black and loamy soil and physio-chemical properties also favorable for grass species like *Dichanthium annulatum, Sorghom vulgare, Heteropogon contortus, Themeda quadrivalvis, Pennisetum pedicellatum* and *Pennisetum purpureum*. They also reported that teak can grow in soils having moderate to deep solum depth, slightly acidic, loamy texture and appreciable amount of organic carbon. [10]

IV. CONCLUSION

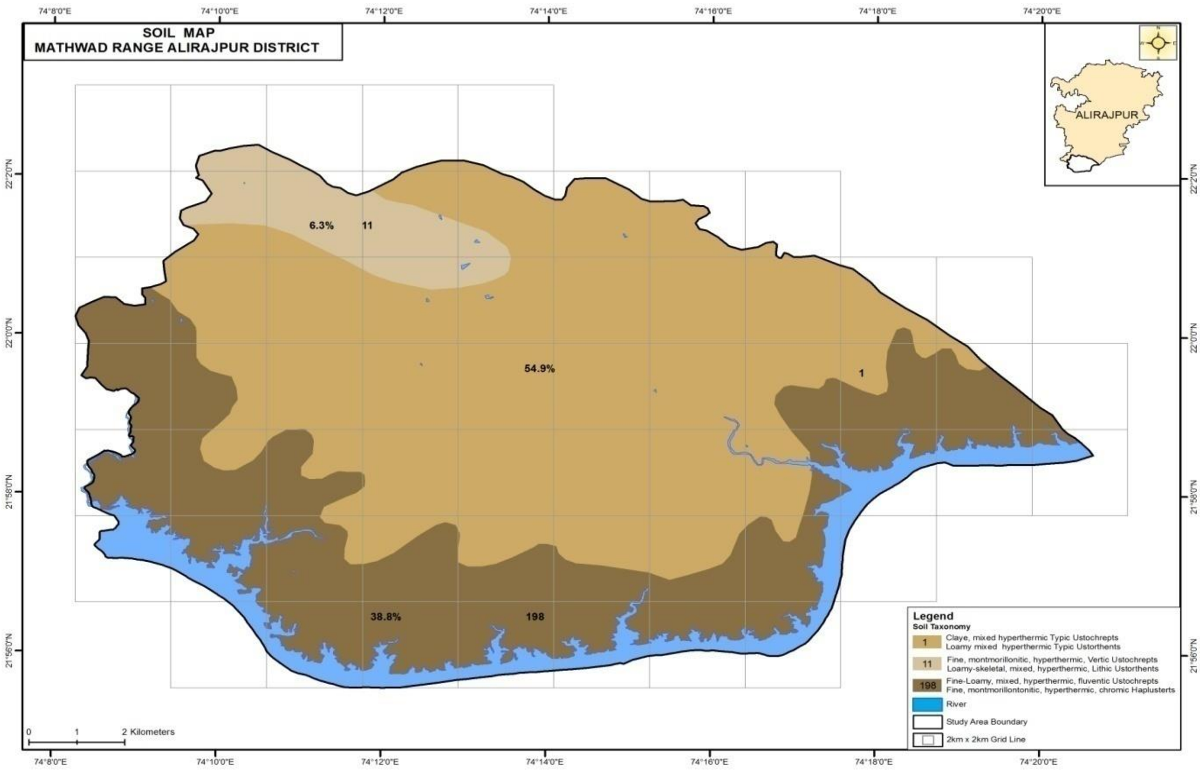
The study has revealed to determine the physio-chemical properties to describe the soil of Mathwad range area for wildlife habitat improvement with the help of appropriate plantation and grassland development according their soil health results. The investigation has shown from laboratory analysis that some of the trace elements such as Zinc, Copper, magneze and Iron concentration were some extent in higher level in the soil of the study area. The very fact that the micronutrient elements were required by plants in very low concentration suggests that they all function as catalysts or with some catalytic processes in plants. From the present analysis, at was obvious that the soil in the study area was of very good quality with near neutral pH, sufficient organic carbon and macronutrients. Although the concentration of micronutrients was a bit higher, it was not expected to attain toxic proportions. Soil texture greatly influences its moisture, retention, electrical conductivity, aeration, workability and availability of nutrients for plants. Sandy soil has excellent aeration and water drainage but poor water holding capacity. Percentage of clay in the soil, its water holding capacity increases but very little soil moisture was available to the plants. Best soils for the growth of plants was loams, sandy loams and clay loams soil. Thus, the soils of the study area were suitable to support most of the species.

TABLE I. Result of physio-chemical properties of soil analysis (30cm depth) in study area Mathwad forest range

S. No.	Compartment No.	Latitude	Longitude	Water holding capacity	Organic carbon (%)	pH	ECs (ds/m^{-1})	Available macro nutrients (kg/ha)			Available trace elements (ppm)		
								Nitrogen	Phosphorus	Potassium	Cu	Fe	Zn
1.	444	21°56'27.6"	74°16'40.44"	33.17	1.03	6.61	0.434	230	230	230	1.082	7.086	0.342
2.	461	21°56'19.68"	74°15'40.68"	32.10	1.16	6.57	0.311	227	227	227	1.266	7.532	0.314
3.	460	21°56'14.28"	74°14'14.64"	29.35	1.32	6.79	0.218	360	360	360	1.838	3.846	0.244
4.	473	21°55'58.08	74°12'59.76"	30.11	1.55	6.63	0.352	226	226	226	1.838	5.668	0.474
5.	444	21°56'43.8"	74°17'12.84"	41.06	1.27	6.51	0.374	238	238	238	0.816	1.942	0.188
6.	443	21°58'0.84"	74°17'7.8"	33.76	1.45	6.60	0.427	251	251	251	2.982	4.088	1.754
7.	445	21°57'51.48"	74°16'33.24"	31.98	1.22	6.77	0.277	237	237	237	2.410	7.814	0.334
8.	446	21°58'28.56"	74°16'10.2"	31.71	1.01	6.60	0.212	237	237	237	0.754	2.184	0.516
9.	460	21°57'18.36"	74°15'25.2"	34.51	1.09	6.19	0.328	232	232	232	1.510	6.114	0.322
10.	463	21°57'2.88"	74°14'50.64"	35.74	2.22	6.33	0.361	352	352	352	2.328	3.966	0.216
11.	472	21°57'33.84"	74°13'6.24"	29.52	1.14	5.94	0.372	231	231	231	4.780	8.382	0.384
12.	459	21°57'54"	74°14'52.08"	31.61	0.96	6.11	0.311	227	227	227	2.736	5.992	0.300
13.	458	21°58'27.84"	74°14'8.16"	31.69	1.45	6.45	0.334	227	227	227	2.226	6.518	0.516
14.	466	21°58'37.56"	74°12'13.68"	30.25	2.38	6.72	0.482	360	360	360	6.334	8.504	0.544
15.	468	21°58'38.28"	74°11'35.52"	35.04	2.22	6.03	0.427	355	355	355	1.000	3.238	0.412
16.	469	21°57'42.84"	74°11'9.24"	34.26	1.53	6.51	0.501	351	351	351	0.836	2.468	0.370
17.	470	21°57'36"	74°12'30.6"	31.87	2.38	6.22	0.433	355	355	355	0.714	4.290	0.572
18.	471	21°57'19.8"	74°12'48.24"	35.47	1.73	6.65	0.491	289	289	289	1.654	5.870	0.640
19.	480	21°58'27.48"	74°10'31.44"	35.41	0.96	6.67	0.507	263	263	263	2.226	13.77	1.246
20.	478	21°57'51.84"	74°10'19.92"	35.74	0.96	6.55	0.372	238	238	238	1.736	3.480	0.294
21.	477	21°57'36.36"	74°10'13.44"	34.15	0.59	6.39	0.351	213	213	213	2.022	7.976	0.738
22.	476	21°57'13.32"	74°11'15.36"	41.83	0.59	6.51	0.239	213	213	213	2.390	11.18	0.536
23.	474	21°56'13.2"	74°12'1.44"	33.79	1.01	6.46	0.431	276	276	276	2.512	11.78	0.488
24.	453	22°0'29.52"	74°13'22.44"	36.66	0.67	6.17	0.511	225	225	225	2.634	12.07	0.398
25.	479	21°58'11.28"	74°9'7.56"	30.97	1.01	6.35	0.519	230	230	230	3.390	16.32	0.558
26.	456	21°59'31.56"	74°12'51.84"	31.86	1.78	6.60	0.438	276	276	276	0.856	6.032	0.300
27.	454	21°59'30.56"	74°13'37.56"	31.29	1.14	6.55	0.333	232	232	232	0.530	2.428	0.120
28.	478	21°57'48.24"	74°9'18"	33.11	1.22	6.53	0.215	238	238	238	2.962	14.82	0.446
29.	441	21°59'58.2"	74°16'24.6"	35.43	1.09	6.58	0.427	238	238	238	1.920	9.434	0.370
30.	448	21°59'51.72"	74°15'44.28"	33.80	0.91	6.13	0.471	225	225	225	3.064	14.86	0.426



Map 1. Location shown in the map soil sample collected from the different compartments in study area with their GPS coordinate



Map 2. Soil classes and the percentages of the study area

TABLE 4. Distribution of different soil classes, properties and percentage of area in the study site.

Code	Soil class	Properties	Area in %
1.	• Shallow, slightly stony, well drained soil on moderately sloping hills and hill ranges with moderate erosion. **Associated with:** • Very shallow, somewhat excessively drained soils on steeply sloping hills and hill ranges with severe erosion.	• Clay, mixed, hyperthermic, Typic ustockrepts • Loamy mixed hyperthermic Typic ustorthents.	54.9
11	• Moderately deep, well drained soils on gently sloping hills with escarpments and with severe erosion. **Associated with:** • Extremely shallow, somewhat excessively drained soils on moderately sloping hills with very severe erosion.	• Fine clayey, montmorillonitic, hyperthermic, vertsic Ustochrepts. • Loamy-skeletal, mixed hyperthermic, Lithic ustothrents.	6.3
198	• Deep, well drained soils on very gently sloping flood plains with left out channels (moderately dissected) with moderate erosion. **Associated with:** • Deep, moderately well drained, soils on very gently sloping flood plains with moderate erosion.	• Fine loamy, calcareous, hyperthermic Fluventic ustochrepts. • Fine motmorillonitic hperthermic, chromic, Haplusterts.	38.8

Sources- (National Bureau of Soil Survey and Land Utilization Planning, ICAR-Nagpur**)**

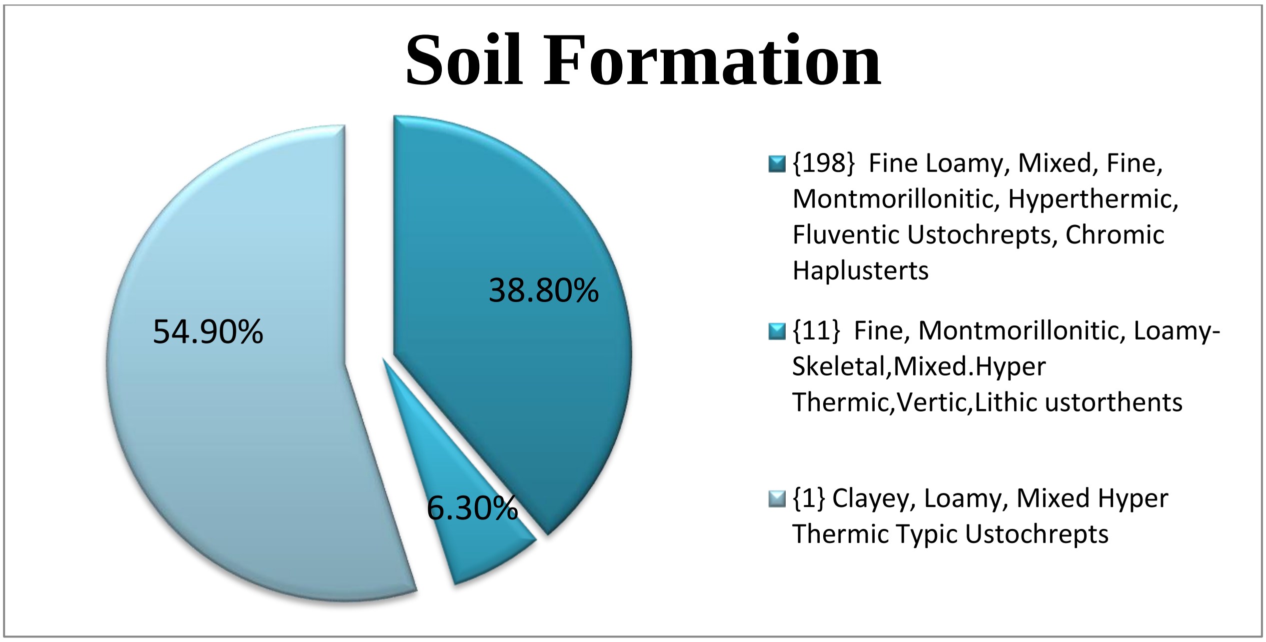


Fig 1. Description of soil formation, properties and percentage in study site of Mathwad range.

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