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Characterization, classification and physiography of Zari-NAAM river watershed of Parbhani district by using GIS, GPS and remote sensing

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Abstract
The present investigation "Characterization, Classification, Evaluation and Physiography of Soils of Zari-Naam River Watershed of Parbhani District By Using GIS, GPS and Remote Sensing" was carried out during the year 2015-16. The total Length of watershed was 4.2 km and it is divided into seven compartments and three Parts viz. Part I, Part II and Parts III. These three parts were surveyed and fifty representative soil samples were drawn by grid survey using topographic map, remote sensing imagery and GPS. These 50 soil samples were drawn to study the soil properties. Further three representative soil profiles were excavated on the basis of soil depth and behavior of cracks**.**The thematic maps of all important soil parameters were generated.
The results emerged out from the present investigation revealed that soils of Naam River Watershed (part-1*)* are Typic Haplusterts and Vertic Haplusterts. These soils are brown to black in colour and clayey in texture. These are slightly to moderately alkaline in nature, safe in total soluble salt concentration, calcareous to highly calcareous and low in organic carbon. Typic Haplusterts have higher alkalinity than Vertic Haplusterts. Two pedons of Naam River Watershed representing Typic Haplusterts and Vertic Haplusterts. This pedon are highly to moderately suitable for growing the crops with little modification in pH. These soils support soybean, mug, jowar, Tur and cotton.

Keywords: Zari-Naam river watershed, GIS, GPS and remote sensing, typic haplusterts, vertic haplusterts

Introduction
The demand for land, water and food has increased manifolds with population explosion. In its efforts to meet the basic needs, humankind is degrading these natural resources through unscientific exploitation, causing environmental problems like land degradation, drought and floods and calls for a scientific approach in development and management of these resources at various levels. A soil resource inventory provides an insight into the potentialities and limitations of soils for its effective exploitation. It also provides adequate information in terms of landforms, terrain, vegetation as well as characteristics of soils which can be utilized for land resources management and development.
Soil and water are the basic resources essential for the survival of humankind on the earth. Generally speaking, very few people realize the importance of conserving and judiciously utilizing the soil. "Soil without water is desert and water without soil is useless". In old days ground water was thought of only as a source of household use but today, it is used for great variety of purpose and therefore its judicious utilization has become almost necessary. The socio-economic growth of the country, particularly in respect of rural area depends primarily, on the continuous preservation and effective utilization of our water resources. The pattern of water resources development for various beneficial use, however, differs from area to area depending upon its climatic and physiographic condition and socio-economic development.
The recent technologies like RS, GPS and GIS have much to offer for preparing soil fertility maps. Global positioning system (GPS) is a space based navigation and positioning system, which helps to determine the exact position of an object on the earth surface in terms of geographical co-ordinates.

Geographical information system (GIS) is a computer system for capturing, storing, querying and displaying geographical data.

Remote sensing data provide multi-spectral, multi-temporal and multi-sensor information of the earth surface with greater accuracy and economy, and is more efficient in data collection and precise mapping of land resources than the conventional method. It also provides up to date baseline information on crop, soil and water resources. Geographic information system (GIS) has proved as powerful tool for integrated resource analysis and generating map information combining data from remotely sensed imagery, existing topographic and other maps and ground survey for more precise and timely information for natural resources management.

Material and Methods

The present investigation on "Characterization, classification and evaluation of physiography of soils of Zari-Naam river watershed (Part-1) of Parbhani district by using GIS, GPS and remote sensing" was carried out by using topographic maps, remote sensing imagery and GPS locations. On the basis of toposheet and satellite imageries, detail survey was carried out by escavating three soil profiles and collecting fifty surface soil samples.

In this chapter, details regarding the location of Zari-Naam river in Parbhani district, selection of the typifying pedons, surface soil sample collection and characterizations, classification and evaluation of the soils, and collection of water samples for budgeting and characterization and classification are given:

Location

Geographically, the Naam river watershed in Zari, Parbhani Tahsil, District Parbhani is situated at 455 m above mean sea level between $76^{0}70"32^{'}$ East longitude and $19^{0}62^{'}"12'$North latitude.

Geology and parent material

The area is covered by the basaltic lava flows, some layers of the lava flow are hard and compact while others are soft. These basalt flows are the result of intense volcanic activity during cretaceous-eocene period (almost seventy million year ago).When the lava flows were ejected through long narrow fissures on the earth surface. This area has shallow cover of gravelly sediments over a hard basaltic Lithic or Paralithic contact within 50 to 90 cm surface.

Natural vegetation and present land use

The most of the area is under soybean (*Glycine max*), pigeon pea (*Cajanus cajan*), sorghum (*Sorghum bicolor*), cotton (*Gossypium* spp.) and sugarcane (*Sacchharum officinarum*) in *kharif* season whereas sorghum (*Sorghum bicolor*), wheat (*Triticum austivum*) and gram (*Cicer arietinum*) in *rabi* season, field bunds and banks of nalas are covered under dry deciduous plant species and grasses. Commonly occurring species of trees and grasses are babul (*Acacia arabica*), ber (*Ziziphus jujube*), neem (*Azadirachta indica*), mango (*Mangifera indica*), tamarind (*Tamarindus indica*), papaya (*Carica papaya*), jambhul (*Syzygium cumini*), guava (*Spidium guajava*), hariyali (*Cynodon dactylon*).

Experimental details

By using topographic maps, remote sensing imagery (Plate:1) FCC (false colour composition) and GPS locations, detail study of physiographic units of Naam River watershed was carried out. On the basis of toposheet FCC-satellite image, detail survey was carried out. Simultaneously 3 soil profiles were escavated and 50 surface soil samples and water sample were collected as per standard outlined procedure.

Table 1: Locations of surface soil samples

Sr. No.	GPS Location	Name of farmer	Previous crops			Irrigated/ Rainfed
			kharif	Rabi	kharif	
1.	EL-1323' N-19^{0}25"46' E$_{0}$-76^{0}46"28'	Dhiraj Gautam	Soybean	Jowar	Cotton	R
2.	EL-1330' N-19^{0}25"40' E$_{0}$-76^{0}46".16'	Bhanudas Jagade	Mung	Cotton	Soybean	R
3.	EL-1316' N-19^{0}25"40' E$_{0}$-76^{0}46".25'	Yogesh Gautam	Turmeric	Cotton	Soybean	R
4.	EL-1331' N-19^{0}25"25' E$_{0}$-76^{0}46".26'	Anand Vatare	Jowar	Jowar	Turmeric	R
5.	EL-1330' N-19^{0}25"32' E$_{0}$-76^{0}46".30'	Prasad Vatare	Soybean	Jowar	Soybean	R
6.	EL-1308' N-19^{0}25"14' E$_{0}$-76^{0}46"33.'	Prashant Deshmukh	Soybean	Jowar	Cotton	R
7.	EL-1316' N-19^{0}25"04' E$_{0}$-76^{0}46".41'	Jayprakash Mundhada	Tur	Cotton	Soybean	R
8.	EL-1288' N-19^{0}24"99' E$_{0}$-76^{0}46".50'	Appa Pandit	Soybean	Cotton	Cotton	R
9.	EL-1320' N-19^{0}24"92' E$_{0}$-76^{0}46".55'	Ambadas Deshmukh	Jowar	Maize	Soybean	R
10.	EL-1319'	Ashok Bhusare	Cotton	Cotton	Soybean	R

	N-19^{0}24”96’ E$_0$-76^{0}46”.67’					
11.	EL-1321’ N-19^{0}25”03’ E$_0$-76^{0}46”71.	Ramchndra Mule	Tur	Tur	Cotton	R
12.	EL-1335’ N-19^{0}25”27’ E$_0$-76^{0}46”.77’	Kashinath Fullare	Turmeric	Jowar	Soybean	R
13.	EL-1330’ N-19^{0}25”31’ E$_0$-76^{0}46”79’	Gajanan Gaikwad	Cotton	Safflower	Soybean	R
14.	EL-1335’ N-19^{0}24”17’ E$_0$-76^{0}46”.73’	Pralad Jadhav	Cotton	Cotton	Soybean	R
15.	EL-1339’ N-19^{0}25”30’ E$_0$-76^{0}46”.65’	Shekh Ismail	Cotton	Cotton	Cotton	R
16.	EL-1338’ N-19^{0}25”38’ E$_0$-76^{0}46”.61’	Gupalsing Gautm	Cotton	Cotton	Soybean	R
17.	EL-1355’ N-19^{0}25”53’ E$_0$-76^{0}46”.64’	Jaysing Gautam	Cotton	Cotton	Soybean	R
18.	EL-1346’ N-19^{0}25”57’ E$_0$-76^{0}46”.55’	Dipak Rajput	Soybean	Tur	Cotton	R
19.	EL-1342’ N-19^{0}25”60’ E$_0$-76^{0}46”.58’	Dipak Rajput	Mung	Jowar	Soybean	R
20.	EL-1338’ N-19^{0}25”81’ E$_0$-76^{0}46”.47’	Limbaji Vadkar	Cotton	Cotton	Soybean	R
21.	EL-1368’ N-19^{0}25”83’ E$_0$-76^{0}46”.27’	Haribhau Sonvane	Soybean	Jowar	Soybean	R
22.	EL-1335’ N-19^{0}25”54’ E$_0$-76^{0}46”.45’	Dipaksing Gautm	Tur	Jowar	Soybean	R
23.	EL-1296’ N-19^{0}25”49’ E$_0$-76^{0}46”.38’	Santoba Tithe	Cotton	Tur	Soybean	R
24.	EL-1307’ N-19^{0}25”42’ E$_0$-76^{0}46”.41’	Maruti Jagade	Cotton	Jowar	Cotton	R
25.	EL-1329’ N-19^{0}25”42’ E$_0$-76^{0}46”.44’	Mujaji Jagade	Cotton	Cotton	Tur	R
26.	EL-1337’ N-19^{0}25”35’ E$_0$-76^{0}46”.47’	Bhaskar Sonvane	Cotton	Gram	Soybean	R
27.	EL-1309’ N-19^{0}25”28’ E$_0$-76^{0}46”.53’	Sopan Sonvane	Soybean	Jowar	Cotton	R
28.	EL-1297’ N-19^{0}25”36’ E$_0$-76^{0}46”.47’	Shivaji Sonvane	Soybean	Gram	Tur	R
29.	EL-1322’ N-19^{0}25”18’ E$_0$-76^{0}46”.52’	Sopan Shinde	Jowar	Tur	Jowar	R
30.	EL-1354’ N-19^{0}25”02’ E$_0$-76^{0}46”.54’	Dhondiba Borkar	Soybean	Safflower	Soybean	R
31.	EL-1316’ N-19^{0}25”03’ E$_0$-76^{0}46”.59’	Pralad Deshmukh	Soybean	Jowar	Soybean	R
32.	EL-1334’ N-19^{0}24”99’ E$_0$-76^{0}46”.96’	Rekha Raghuvanshi	Cotton	Cotton	Cotton	R
33.	EL-1267’ N-19^{0}25”13’ E$_0$-76^{0}47”.10’	Hamidbhai Shekh	Soybean	Maize	Soybean	R

34.	EL-1323’ N-19^{0}25”07’ E$_0$-76^{0}47”.14’	Uttam Tithe	Cotton	Maize	Cotton	R
35.	EL-1316’ N-19^{0}25”48’ E$_0$-76^{0}46”.03’	Bahudim Khatip	Chilli	Jowar	Maize	R
36.	EL-1312’ N-19^{0}25”45’ E$_0$-76^{0}46”.06’	Sopan Bhusari	Soybean	Jowar	Soybean	R
37.	EL-1326’ N-19^{0}25”37’ E$_0$-76^{0}45”.94’	Vinod Gaikwad	Cotton	Maize	Soybean	R
38.	EL-1310’ N-19^{0}25”41’ E$_0$-76^{0}45”.95’	Pralad Busari	Cotton	Maize	Cotton	R
39.	EL-1310’ N-19^{0}25”44’ E$_0$-76^{0}45”.88’	Gangadhar Joshi	Cotton	Cotton	Spinach	R
40.	EL-1308’ N-19^{0}25”45’ E$_0$-76^{0}47”.09’	Nilesh Gautam	Cotton	Cotton	Spinach	R
41.	EL-1331’ N-19^{0}25”42’ E$_0$-76^{0}46”.17’	NItin Gautam	Soybean	Jowar	Spinach	R
42.	EL-1320’ N-19^{0}25”27’ E$_0$-76^{0}46”.17’	Devidas Bhusari	Cotton	Tur	Cotton	R
43.	EL-1306’ N-19^{0}25”20’ E$_0$-76^{0}46”.08’	Navanit Deshmukh	Soybean	Jowar	Soybean	R
44.	EL-1319’ N-19^{0}25”13’ E$_0$-76^{0}46”.06’	Sundarao Deshmukh	Cotton	Tur	Cotton	R
45.	EL-1323’ N-19^{0}25”04’ E$_0$-76^{0}46”.18’	Subas Deshmukh	Tur	Tur	Maize	R
46.	EL-1311’ N-19^{0}25”02’ E$_0$-76^{0}46”.17’	Vilas Deshmukh	Cotton	Cotton	Jowar	R
47.	EL-1315’ N-19^{0}25”05’ E$_0$-76^{0}46”.04’	Gauru Deshmukh	Cotton	Jowar	Soybean	R
48.	EL-1323’ N-19^{0}25”01’ E$_0$-76^{0}46”.06’	Somnath Sawant	Soybean	Cotton	Soybean	R
49.	EL-1315’ N-19^{0}24”95’ E$_0$-76^{0}46”.08’	Kamlkar Deshmukh	Jowar	Cotton	Soybean	R
50.	EL-1322’ N-19^{0}24”97’ E$_0$-76^{0}46”.09’	Dipakrao Deshmukh	Cotton	Cotton	Jowar	R

Note: R = Rainfed

Soil analysis

Soil samples were collected before sowing, i.e. in the month of May from surface layer (0-20 cm).Soils were air dried, ground with wooden mortar and pestle and passed through 2 mm sieve. The sieved samples were stored in polythene bags with proper labeling for further analysis.

Result and Discussion-

Physical properties of Soil

Important physical properties of soil viz. soil colour, bulk density and Porosity of the soils of Zari-NAAM river (part-1) watershed are evaluated and presented in Table 2.

Soil colour

The munsell colours of soils from Zari-NAAM river watershed area, from varied 7.5YR and 10YR Hue. There was little variation in value and chroma. The value varied between 3 to 5 while purity of colour i.e. chroma fluctuate between 1 to 2. So according to Munsell colour system these soils are brown to dark gray in colour. Very dark grey, brown to black colour dominate in Inceptisol, very dark brown to brown noticed in Entisol. In Vertisol soil colour was very dark grayish brown to very dark gray to black (Table 2). This variation in colour value and chroma may be because of assemblage of minerals derived from basaltic trap rock. Its dark brown to black colour is associated with Titaniferrous composition and humus content.

Bulk density

The data pertaining to bulk density are presented in Table 2. The bulk density of soil ranged from 1.20 to 1.81 Mg m^{-3} with an average value of 1.20 Mg m^{-3}. The soil sample collected from latitude 19025”18’ and longitude 76046”.52 GPS location showed lowest value of bulk density, while highest

bulk density value 1.81 Mg m^{-3} was noticed in soil sample collected from latitude 19025”32’ and longitude 76046”30’. The bulk density of soil showed wide variations. The wide variations in bulk density may be due to the differences in texture, depth, compactness and changes in cropping pattern. These results are in compliance with the findings of Bharambe and Ghonsikar (1985) [1] and Balpande *et al.* (2007) [2].

Porosity

The data on porosity of soil collected from NAAM river watershed (Part-1) is reported in Table- 2 showed that the porosity of soil ranged from 39 to 58 per cent. The soil collected from latitude 19024”92’ and longitude 76046”55’ GPS location showed lowest porosity of 39 per cent while maximum porosity 58 per cent was recorded in soil sample collected from latitude 19025”45’ and longitude 76060”64’ GPS location. The variation in porosity may be due to variation in bulk density and organic carbon content in the soil. The variation in porosity of soils confirm the results recorded by Malavath and Mani (2015) [3, 8] and Kantharaj *et al.* (2015) [4].

Table 2: Physical properties of soils of Zari-NAAM river watershed (part-1)

Sr. No.	GPS Location of soil sample	Soil colour	Munsell colour notation	Bulk density (Mg m^{-3})	Porosity (%)
1.	EL-1323’ N-19^{0}25”46’ E$_0$-76^{0}46”28’	Grayish brown	10YR 5/2	1.49	44
2.	EL-1330’ N-19^{0}25”40’ E$_0$-76^{0}46”.16’	Grayish brown	10YR 5/2	1.21	55
3.	EL-1316’ N-19^{0}25”40’ E$_0$-76^{0}46”.25’	Brown	10YR 5/2	1.28	52
4.	EL-1331’ N-19^{0}25”25’ E$_0$-76^{0}46”.26’	Brown	10YR 5/2	1.26	53
5.	EL-1330’ N-19^{0}25”32’ E$_0$-76^{0}46”.30’	Brown	10YR 5/2	1.81	32
6.	EL-1308’ N-19^{0}25”14’ E$_0$-76^{0}46”33.’	Dark gray	10YR 4/1	1.43	47
7.	EL-1316’ N-19^{0}25”04’ E$_0$-76^{0}46”.41’	Grayish brown	10YR 5/2	1.39	48
8.	EL-1288’ N-19^{0}24”99’ E$_0$-76^{0}46”.50’	Dark gray	10YR 4/1	1.52	43
9.	EL-1320’ N-19^{0}24”92’ E$_0$-76^{0}46”.55’	Grayish brown	10YR 5/2	1.63	39
10.	EL-1319’ N-19^{0}24”96’ E$_0$-76^{0}46”.67’	Grayish brown	10YR 5/2	1.41	47
11.	EL-1321’ N-19^{0}25”03’ E$_0$-76^{0}46”71.	Dark grayish brown	7.5YR 4/1	1.29	52
12.	EL-1335’ N-19^{0}25”27’ E$_0$-76^{0}46”.77’	Dark gray	10YR 4/2	1.23	54
13.	EL-1330’ N-19^{0}25”31’ E$_0$-76^{0}46”79’	Grayish brown	10YR 5/1	1.52	43
14.	EL-1335’ N-19^{0}24”17’ E$_0$-76^{0}46”.73’	Grayish brown	10YR 5/1	1.46	45
15.	EL-1339’ N-19^{0}25”30’ E$_0$-76^{0}46”.65’	Dark gray	10YR 4/2	1.63	39
16.	EL-1338’ N-19^{0}25”38’ E$_0$-76^{0}46”.61’	Dark gray	10YR 4/2	1.21	55
17.	EL-1355’ N-19^{0}25”53’ E$_0$-76^{0}46”.64’	Dark grayish brown	7.5YR 4/1	1.29	52
18.	EL-1346’ N-19^{0}25”57’ E$_0$-76^{0}46”.55’	Grayish brown	10YR 5/2	1.34	50

19.	EL-1342’ N-19^{0}25”60’ E$_0$-76^{0}46”.58’	Dark grayish brown	7.5YR 4/1	1.39	48
20.	EL-1338’ N-19^{0}25”81’ E$_0$-76^{0}46”.47’	Grayish brown	10YR 5/2	1.41	47
21.	EL-1368’ N-19^{0}25”83’ E$_0$-76^{0}46”.27’	Dark grayish brown	7.5YR 4/1	1.50	44
22.	EL-1335’ N-19^{0}25”54’ E$_0$-76^{0}46”.45’	Dark gray	10YR 4/1	1.64	39
23.	EL-1296’ N-19^{0}25”49’ E$_0$-76^{0}46”.38’	Grayish brown	10YR 5/2	1.61	40
24.	EL-1307’ N-19^{0}25”42’ E$_0$-76^{0}46”.41’	Grayish brown	10YR 5/2	1.30	51
25.	EL-1329’ N-19^{0}25”42’ E$_0$-76^{0}46”.44’	Dark grayish brown	7.5YR 4/1	1.45	46
26.	EL-1337’ N-19^{0}25”35’ E$_0$-76^{0}46”.47’	Gray	10YR 5/1	1.41	47
27.	EL-1309’ N-19^{0}25”28’ E$_0$-76^{0}46”.53’	Grayish brown	10YR 5/2	1.29	52
28.	EL-1297’ N-19^{0}25”36’ E$_0$-76^{0}46”.47’	Dark grayish brown	10YR 4/2	1.25	53
29.	EL-1322’ N-19^{0}25”18’ E$_0$-76^{0}46”.52’	Very dark gray	10YR 4/2	1.20	55
30.	EL-1354’ N-19^{0}25”02’ E$_0$-76^{0}46”.54’	Gray	10YR 5/1	1.43	56
31.	EL-1316’ N-19^{0}25”03’ E$_0$-76^{0}46”.59’	Gray	10YR 5/1	1.39	47
32.	EL-1334’ N-19^{0}24”99’ E$_0$-76^{0}46”.96’	Gray	10YR 5/1	1.37	48
33.	EL-1267’ N-19^{0}25”13’ E$_0$-76^{0}47”.10’	Dark gray	10YR 5/2	1.26	49
34.	EL-1323’ N-19^{0}25”07’ E$_0$-76^{0}47”.14’	Dark gray	10YR 5/2	1.32	53
35.	EL-1316’ N-19^{0}25”48’ E$_0$-76^{0}46”.03’	Dark gray	10YR 5/1	1.29	51
36.	EL-1312’ N-19^{0}25”45’ E$_0$-76^{0}46”.06’	Very dark gray	10YR 3/1	1.31	58
37.	EL-1326’ N-19^{0}25”37’ E$_0$-76^{0}45”.94’	Very dark gray	10YR 3/1	1.44	51
38.	EL-1310’ N-19^{0}25”41’ E$_0$-76^{0}45”.95’	Dark gray	10YR 4/1	1.43	46
39.	EL-1310’ N-19^{0}25”44’ E$_0$-76^{0}45”.88’	Very dark gray	10YR 3/1	1.28	47
40.	EL-1308’ N-19^{0}25”45’ E$_0$-76^{0}47”.09’	Dark gray	10YR 4/1	1.27	52
41.	EL-1331’ N-19^{0}25”42’ E$_0$-76^{0}46”.17’	Dark gray	10YR 4/1	1.47	53
42.	EL-1320’ N-19^{0}25”27’	Very dark gray	10YR 3/1	1.36	45

	E0-76^{0}46".17'				
43.	EL-1306' N-19^{0}25"20' E0-76^{0}46".08'	Dark gray	10YR 4/1	1.41	49
44.	EL-1319' N-19^{0}25"13' E0-76^{0}46".06'	Dark gray	10YR 4/1	1.29	47
45.	EL-1323' N-19^{0}25"04' E0-76^{0}46".18'	Dark gray	10YR 4/1	1.29	53
46.	EL-1311' N-19^{0}25"02' E0-76^{0}46".17'	Dark gray	10YR 4/1	1.43	47
47.	EL-1315' N-19^{0}25"05' E0-76^{0}46".04'	Very dark gray	10YR 3/1	1.46	45
48.	EL-1323' N-19^{0}25"01' E0-76^{0}46".06'	Dark gray	10YR 4/1	1.49	44
49.	EL-1315' N-19^{0}24"95' E0-76^{0}46".08'	Dark gray	10YR 4/1	1.30	51
50.	EL-1322' N-19^{0}24"97' E0-76^{0}46".09'	Dark gray	10YR 4/1	1.35	50
	Range			1.20-1.81	32-58
	Average			1.38	48.28

Physico-chemical properties of soil

Soil pH

The data regarding pH of soils are narrated in Table 3. The soil sample collected from latitude 19^0"25"03'and longitude 76^0"46"71' GPS location showed lowest pH value 8.0, while the highest pH value 8.7 was recorded in soil sample collected from latitude 19^0"25"45' and longitude 76^0"46"73' GPS location. It is seen from the data (Table 2) that the pH ranged from 8.0 to 8.7 with an average value 8.26. It is revealed from the data that, out of 50 samples, the pH of 45 samples (90%) are moderately alkaline, 05 samples (10%) showed strongly alkaline pH. Thus pH of the soils was recorded in more or less similar range. These values of pH indicate that all the soils under study were neutral to alkaline in reaction. The alkaline reaction of soil is probably due to the presence of sufficient lime content (Kaushal, *et al*. 1986) and basaltic alluvium parent material rich in alluminosilicates and alkaline earth from which these soils are derived (Challa, *et al*. 1995) [5]. Similar types of findings were also reported by Mali and Raut (2001) [6] and Malewar *et al*. (2004) and Chandrasekhar *et al*. (2014) [14].

Electrical conductivity

The low EC was observed in soil 0.12 dSm^{-1} from soil sample collected from latitude 19^0"25"14' and longitude 76^0"46"71' GPS location and maximum EC was observed in soil 0.98 dSm^{-1} from latitude 19^0"25"04' and longitude 76^0"46"18'GPS location with an average value of 0.24 dSm^{-1} (Table 3). Thus all the soil samples collected from NAAM river watershed (part-1) were in safe limit. The values of EC obtained in the investigation were found within desirable range as proposed by Richard and Cambell (1948). When EC exceeds 4 dSm^{-1}, the salt present become harmful to the growth of the crop. However, EC below 1.0 dSm^{-1} was considering as normal. The low EC of soil might be due to free drainage condition which favored the removal of released bases by percolation and drainage concluded by Chandrasekhar *et al.* (2014) [7].

Organic carbon content

Regarding the organic carbon (Table 3) the lowest organic carbon 1.20 g kg^{-1}, was observed in soil sample collected from latitude 19^0"25"27' and longitude 76^0"47"67'GPS location and the maximum organic carbon content 5.4 g kg^{-1} in soil collected from latitude 19^0"25"04' and longitude 76^0"46"18' GPS location. The soil sample collected from NAAM river watershed also showed the content of organic carbon in the range of 1.20 to 5.40 g kg^{-1} with an average value 3.26 g kg^{-1}. The soil under study on the basis of organic carbon were categorized in (Table 3) out of 50 samples 12 samples (24%) were very low in organic carbon content , 21samples (42%) were low in organic carbon content and 17 samples (34%) were moderate in organic carbon content. From the values of organic carbon, it is clearly depicted that the majority of soil samples are low to moderate in range of organic carbon content. The agro-climate and agro-ecological unit is very important from stand point of soil fertility and plant growth. The content of organic carbon in soils depends on the range of precipitation within the experimental area, considerable variation in precipitation is observed. The differences in the level of organic carbon in these soils are largely attributed to the pattern of rainfall in the area. In addition, hot and dry climate is directly related with the temperature variation in the region or ecological unit. Low to moderate content of organic carbon is also attributed to the variation in decomposition rate. Similar results were also reported by Malvath and Mani (2009) and Thangasamy *et al*. (2005) [9].

Calcium carbonate content

The soil collected from latitude 19^0"24"20'and longitude 76^0"46"08' GPS location showed lowest calcium carbonate of 28.0 g kg^{-1} while maximum calcium carbonate 208.0 g kg^{-1} was recorded in soil sample collected from latitude 19^0"25"40' and longitude 76^0"46"25' GPS location. Regarding the data on calcium carbonate, it is seen that the $CaCO_3$ ranged from 28.0 to 208.0 g kg^{-1} with an average value 139.90 g kg^{-1}. It is revealed from the data in Table 3

that 2 sample (4%) was non calcareous in nature, 9 samples (18%) were calcareous in nature and 39 samples (78%) were highly calcareous in nature. This showed that most of the soil samples are very calcareous in nature. Relative more accumulation of $CaCO_3$ in Vertisols and associated block soils may be partly associated with their recent origin with rich in alkali earth metals and partly due to calcification process prevalent in this region. Similar range of calcium carbonate was recorded by Malvath and Mani (2009) and Patil (2010) [10].

Table 3: Physico-chemical properties of soils of Zari-NAAM river watershed (part-1)

Sr.no.	GPS Location of soil sample	pH (1:2.5)	EC dSm^{-1}	Organic Carbon (g kg^{-1})	$CaCO_3$ (g kg^{-1})
1.	EL-1323' N-19^{0}25"46' E$_0$-76^{0}46"28'	8.4	0.17	3.4	136
2.	EL-1330' N-19^{0}25"40' E$_0$-76^{0}46".16'	8.3	0.26	2.7	170
3.	EL-1316' N-19^{0}25"40' E$_0$-76^{0}46".25'	8.3	0.20	1.5	208
4.	EL-1331' N-19^{0}25"25' E$_0$-76^{0}46".26'	8.2	0.25	2.2	154
5.	EL-1330' N-19^{0}25"32' E$_0$-76^{0}46".30'	8.5	0.26	1.5	112
6.	EL-1308' N-19^{0}25"14' E$_0$-76^{0}46"33.'	8.1	0.12	3.7	92.0
7.	EL-1316' N-19^{0}25"04' E$_0$-76^{0}46".41'	8.0	0.18	4.2	114
8.	EL-1288' N-19^{0}24"99' E$_0$-76^{0}46".50'	8.0	0.39	1.8	156
9.	EL-1320' N-19^{0}24"92' E$_0$-76^{0}46".55'	8.1	0.54	3.0	194
10.	EL-1319' N-19^{0}24"96' E$_0$-76^{0}46".67'	8.1	0.20	4.2	76.0
11.	EL-1321' N-19^{0}25"03' E$_0$-76^{0}46"71.	8.0	0.32	3.0	144
12.	EL-1335' N-19^{0}25"27' E$_0$-76^{0}46".77'	8.2	0.37	1.2	133
13.	EL-1330' N-19^{0}25"31' E$_0$-76^{0}46"79'	8.1	0.15	3.0	208
14.	EL-1335' N-19^{0}24"17' E$_0$-76^{0}46".73'	8.7	0.36	1.2	196
15.	EL-1339' N-19^{0}25"30' E$_0$-76^{0}46".65'	8.0	0.22	3.0	188
16.	EL-1338' N-19^{0}25"38' E$_0$-76^{0}46".61'	8.2	0.36	1.5	150
17.	EL-1355' N-19^{0}25"53' E$_0$-76^{0}46".64'	8.3	0.18	2.2	144
18.	EL-1346' N-19^{0}25"57' E$_0$-76^{0}46".55'	8.0	0.23	1.2	206
19.	EL-1342' N-19^{0}25"60' E$_0$-76^{0}46".58'	8.1	0.25	1.2	174
20.	EL-1338' N-19^{0}25"81' E$_0$-76^{0}46".47'	8.6	0.58	1.2	74.0
21.	EL-1368' N-19^{0}25"83'	8.2	0.21	4.6	80.0

	E_0-76^{0}46”.27’				
22.	EL-1335’ N-19^{0}25”54’ E_0-76^{0}46”.45’	8.4	0.24	3.3	110
23.	EL-1296’ N-19^{0}25”49’ E_0-76^{0}46”.38’	8.2	0.30	5.2	124
24.	EL-1307’ N-19^{0}25”42’ E_0-76^{0}46”.41’	8.3	0.32	1.6	130
25.	EL-1329’ N-19^{0}25”42’ E_0-76^{0}46”.44’	8.5	0.19	5.1	138
26.	EL-1337’ N-19^{0}25”35’ E_0-76^{0}46”.47’	8.6	0.17	5.1	182
27.	EL-1309’ N-19^{0}25”28’ E_0-76^{0}46”.53’	8.3	0.32	2.8	168
28.	EL-1297’ N-19^{0}25”36’ E_0-76^{0}46”.47’	8.1	0.26	5.2	138
29.	EL-1322’ N-19^{0}25”18’ E_0-76^{0}46”.52’	8.3	0.28	3.1	112
30.	EL-1354’ N-19^{0}25”02’ E_0-76^{0}46”.54’	8.0	0.25	3.1	200
31.	EL-1316’ N-19^{0}25”03’ E_0-76^{0}46”.59’	8.1	0.16	5.4	170
32.	EL-1334’ N-19^{0}24”99’ E_0-76^{0}46”.96’	8.0	0.55	5.1	9.00
33.	EL-1267’ N-19^{0}25”13’ E_0-76^{0}47”.10’	8.2	0.48	4.9	158
34.	EL-1323’ N-19^{0}25”07’ E_0-76^{0}47”.14’	8.0	0.46	4.8	126
35.	EL-1316’ N-19^{0}25”48’ E_0-76^{0}46”.03’	8.4	0.30	5.0	194
36.	EL-1312’ N-19^{0}25”45’ E_0-76^{0}46”.06’	8.2	0.42	4.9	208
37.	EL-1326’ N-19^{0}25”37’ E_0-76^{0}45”.94’	8.3	0.80	1.9	120
38.	EL-1310’ N-19^{0}25”41’ E_0-76^{0}45”.95’	8.4	0.43	4.4	130
39.	EL-1310’ N-19^{0}25”44’ E_0-76^{0}45”.88’	8.2	0.32	5.1	204
40.	EL-1308’ N-19^{0}25”45’ E_0-76^{0}47”.09’	8.7	0.38	3.4	186
41.	EL-1331’ N-19^{0}25”42’ E_0-76^{0}46”.17’	8.3	0.41	3.7	124
42.	EL-1320’ N-19^{0}25”27’ E_0-76^{0}46”.17’	8.2	0.23	1.3	118
43.	EL-1306’ N-19^{0}25”20’ E_0-76^{0}46”.08’	8.4	0.22	4.2	28.0
44.	EL-1319’ N-19^{0}25”13’ E_0-76^{0}46”.06’	8.2	0.27	3.9	60.0
45.	EL-1323’	8.3	0.98	5.4	48.0

	N-19^{0}25”04’ E$_0$-76^{0}46”.18’				
46.	EL-1311’ N-19^{0}25”02’ E$_0$-76^{0}46”.17’	8.6	0.22	2.4	18.0
47.	EL-1315’ N-19^{0}25”05’ E$_0$-76^{0}46”.04’	8.3	0.30	2.4	13.0
48.	EL-1323’ N-19^{0}25”01’ E$_0$-76^{0}46”.06’	8.5	0.24	3.9	126.0
49.	EL-1315’ N-19^{0}24”95’ E$_0$-76^{0}46”.08’	8.4	0.26	3.1	90.0
50.	EL-1322’ N-19^{0}24”97’ E$_0$-76^{0}46”.09’	8.2	0.23	2.2	94.0
	Range	8.0-8.7	0.12-0.98	1.2-5.4	28.0-208.0
	Average	8.2	0.31	3.26	139.9

Conclusion

The soil resource having importance due to its information which plays a vital role for soils management and crop production on sustainable basis. The study area geographically is situated at 455 m above mean sea level extending between 19^{0}62$^{'}$ N latitude and 76^{0}70$^{'}$ $^{'}$E longitude, comes under assured rainfall zone with semiarid and tropical climate. The soils are formed from basaltic alluvium rich in smectite group of minerals particularly montmorillonite. The soils are shallow to deep, clayey, dark brown to black in colour. The watershed soils are moderately alkaline to strongly alkaline in reaction and safe in salt concentration, moderately calcareous to highly calcareous in nature. These parameters are increased with depth of soil profile. The Variations were seen in the organic carbon content in soils of Naam River Watershed.

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