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STUDY ON SOIL WATER DYNAMICS FOR SHIRLA NEMANE WATERSHED

V. P. PANDAGALE[1], G. U. SATPUTE[2]

1. M. Tech Student, Department of Soil & Water Conservation Engineering, Dr. PDKV, Akola-444104
2. Associate Professor, Department of Soil & Water Conservation Engineering, Dr. PDKV Akola-444104

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Abstract: *Water on the earth is in motion through the hydrological cycle. The utilization of water for most of users i.e. human, animal or plant involve moment of water. The dynamic and renewable nature of water resources and recurrent need for its utilization requires that water resources are measured. The demands of fresh water all over the world is increasing every year due to population growth, increase of water use, increase of water demand by industry and agriculture. Under changing scenario, it is pertinent to study soil-water dynamics in detail for managing rainfed as well as irrigated agriculture. The study related to soil water dynamics needs an input of the important soil hydraulic properties. In this context; present study was carried out for acquisition of basic soil properties data to estimate available water capacity of soils of the Shirla Nemane watershed. The geographical area of this watershed is 22,400 ha in Buldhana district of Maharashtra state. Sixty sampling points were marked at a grid of 2 km x 2 km using Geographical Positioning System. Soil samples were collected from each sampling point at a depth range from 0-30 cm. Results revealed that nine different soil textural classes were observed in watershed. Measured available water capacities for Sandy, Loamy and Clay soils was ranging from 2.7 to 15.65%, 11.88 to 23.45% and 2.57 to 31.26% respectively.*

Keywords: *Available water capacity, Bulk density, Organic carbon etc.*

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Corresponding Author: MR. V. P. PANDAGALE

Co Author: MR. G. U. SATPUTE

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INTRODUCTION

World oceans cover about three fourth of earth's surface. The fresh water constitutes a very small proportion of this enormous quantity. About 2.7 per cent of the total water available on the earth is fresh water of which 75.2 per cent lies frozen in polar regions and another 22.6 per cent is per cent is present as ground water. The demand of fresh water all over the world is increasing every year due to population growth, increase of water use, increase of water demand by industry and agriculture. On the other hand, its depletion is intensifying because of over exploitation and reduced ground water recharge and contamination of fresh water from expansion of Industry and local residential area in the developing world. More than 98% of the available fresh water is groundwater which by far exceeds the volume of surface water (Fetter, 2001).

In an agrarian based economy, in India, management of natural resources like soil and water plays a critical role in food production. Current per capita land availability (2011) at 0.30 ha makes India one of the poorest in the world in terms of land resource. Water resources of the country vastly and it is expected that India will be a water scare country in near future with per capita water availability of around 1545 m3.

Infiltration and evaporation are the most significant hydrological processes determining soil water storage in the rainfed ecosystem. There has been a growing interest in understanding the mechanisms involved in surface and groundwater interactions since these interactions play a crucial role in the behavior of surface runoff as well as ground water movement. The soil hydraulic properties determine the behavior of soil water within the soil system under specified conditions.

Under changing scenario, it is pertinent to study soil-water dynamics in detail for managing rainfed as well as irrigated agriculture. The study related to soil water dynamics needs an input of two important soil hydraulic properties – viz., saturated hydraulic conductivity and soil water retention characteristics of which the data are however rarely available.

2. MATERIAL AND METHODS

2.1 Location, topography and climate of the study areas

Shirala Nemane watershed is located between 76019'23.72''E- 76042'55.32''E longitude and 20017'32.48'' N – 20030'23.42'' N latitude with catchment area of about 224 km2. The survey of India Topo-sheet number 55D/11 and 55D/7 contains the physiographical features of this

watershed. Map of Shirla Nemane Watershed in Buldhana District Fig. 2.1.Also Grid Map of ShirlaNemane Watershed in Fig. 2.2.

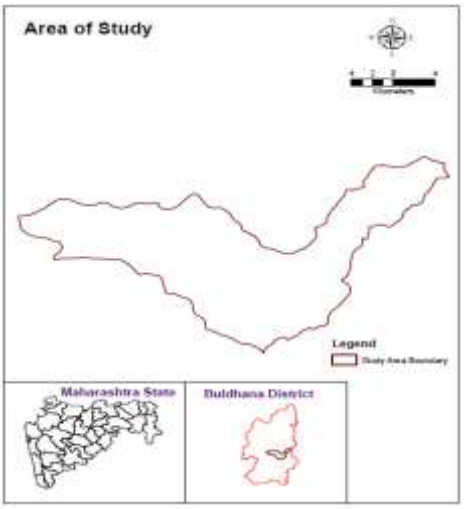

Figure. 2.1 Map of ShirlaNemane Watershed Watershed in Buldhana district.

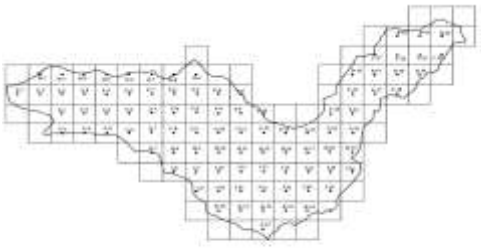

Figure. 2.2. Grid map of shirlaNemane In Buldhana district.

2.2 Collection of the soil samples

Seventy five sampling points were marked at a distance 2 km x2 km intervals using Geographical Positioning System (GPS). Soil samples were collected from each sampling point at a depth of 0-30 cm. Soil samples were air-dried and grounded to pass through a 2-mm sieve.

2.3 Soil analysis

Soil samples were then analysed for calculation of physical and chemical soil properties such as bulk density by clod method (1965), particle size distribution by Bouyoucos Hydrometer (1986), moisture retention parameter by pressure plate apparatus (1986) and organic carbon by Walkely and Black method (1967).

3. RESULT AND DISCUSSION

3.1 Determination of Basic Soil Properties

The laboratory measured basic soil properties and particle sizes of different soil samples collected from the study area are presented in Table 3.1. The textural classes of soil samples were categorised as per USDA textural classification.

Table 3.1 Laboratory measured basic soil properties

Sr. No.	Sample point	Particle size analysis			BD (g/cm3)	Organic carbon (%)	Textural Class
		Sand %	Silt %	Clay %			
1	B20	28.78	44.74	26.48	1.32	0.41	Loam
2	C19	41.72	44.4	13.88	1.34	0.80	Loam
3	D2	31.85	41.31	26.83	1.38	0.81	Loam
4	D3	11.7	31.65	56.65	1.46	0.97	Clay
5	D4	11.12	60.3	28.59	1.83	0.58	Silty Clay Loam
6	D5	61.73	20.45	17.82	1.67	0.58	Sandy loam
7	D6	16.97	60.16	22.87	1.88	0.70	Silt loam
8	D7	19.92	26.73	53.35	1.28	0.47	Clay
9	D8	69.59	3.74	26.68	1.79	0.09	Sandy clay loam
10	D9	16.67	50.54	32.8	1.51	0.46	Silty Clay Loam
11	D18	56.21	16.03	27.76	1.72	1.05	Sandy clay loam
12	D19	37.59	54.09	8.33	1.43	0.51	Silt Loam
13	E1	1.24	79.33	19.43	1.23	1.07	Silt Loam
14	E2	14.28	80.01	5.72	1.68	0.37	Silt
15	E3	16.96	41.3	41.74	1.98	0.51	Silt Clay
16	E4	3.45	66.02	30.53	1.55	0.65	Silty Clay Loam
17	E5	0.86	76.93	22.21	1.73	0.17	Silt Loam
18	E6	33.95	60.33	5.72	1.85	0.31	Silt Loam

19	E7	32.15	50.7	17.15	1.52	0.20	Loam
20	E9	54.07	31.02	14.91	1.73	0.63	Sandy loam
21	E16	61.31	31.3	7.39	1.90	0.16	Sandy Loam
22	E17	37.15	30.25	32.6	1.28	0.36	Clay loam
23	E18	45.11	37.66	17.23	1.62	0.51	Loam
24	F2	12.78	75.3	11.93	1.64	0.06	Silt Loam
25	F3	9.15	40.17	50.69	1.26	0.94	Silty Clay Loam
26	F4	18.69	50.78	30.53	1.88	0.24	Silty Clay Loam
27	F5	15.33	33.98	50.69	1.59	0.64	Clay
28	F6	7.36	30.39	62.24	1.85	0.36	Clay
29	F7	33.95	60.33	5.72	1.65	0.27	Silt Loam
30	F8	13.92	35.7	50.39	1.31	0.44	Clay
31	F16	29.28	40.19	30.53	1.42	0.04	Clay loam
32	G3	14.63	56.78	28.59	1.80	0.64	Silty Clay Loam
33	G4	9.9	36.75	53.35	1.65	0.73	Clay
34	G5	47.59	46.7	5.72	2.20	0.80	Sandy Loam
35	G6	15.84	58.70	25.46	1.69	0.78	Silt loam
36	G7	42.39	42.84	14.77	1.79	0.70	Loam
37	G8	14.3	52.91	32.8	1.84	0.65	Silty Clay Loam
38	G13	24.83	57.35	17.82	1.58	0.30	Silt loam
39	G14	17.39	57.15	24.46	1.83	0.09	Silt loam
40	G15	9.48	76.64	13.88	1.84	1.31	Silt Loam

41	G16	56.22	10.98	32.8	1.58	0.94	Sandy clay loam
42	H7	22.94	35.21	41.85	1.36	0.27	Clay
43	H8	22.69	44.0	33.31	1.45	0.90	Clay loam
44	H9	18.44	30.87	50.69	1.83	0.51	Clay
45	H10	19.63	43.44	36.93	1.25	3.00	Silt Clay Loam
46	H16	17.68	40.47	41.85	2.04	0.73	Silty Clay
47	I8	28.59	62.46	8.94	1.76	1.08	Silt Loam
48	I9	6.45	41.85	51.7	1.66	0.44	Silty Clay
49	I10	33.67	39.25	27.08	1.71	0.04	Clay Loam
50	I15	11.83	41.39	46.77	1.56	0.14	Silt Loam
51	J9	30.56	36.84	32.6	1.46	0.04	Clay loam
52	J14	36.3	42.95	20.75	1.25	0.87	Loam
53	J15	15.28	28.41	56.31	1.18	0.23	Clay
54	K10	24.4	38.67	36.93	1.51	3.00	Clay loam
55	K11	33.79	24.36	41.85	1.30	3.00	Clay loam
56	K12	17.68	35.55	46.77	1.67	3.00	Clay
57	K13	17.68	40.47	41.85	1.52	3.00	clay loam
58	K14	9.3	53.78	36.93	1.74	0.30	Silty Clay Loam
59	K15	9.94	36.71	53.35	1.69	0.55	Clay
60	L12	32.11	35.89	32.0	1.46	3.00	clay loam

It is revealed that from Table 3.1 the textural classes of different soil samples were found to be varying in 9 different classes as sandy loam, sandy clay loam, loam, silt loam, silt clay loam, silt,

clay loam and clay. The bulk density of different soil samples vary from 1.20 to 2.20 g/cc3. Organic carbon was found to vary from 0.04 to 3.00 % in different soil samples of the study area.

Table 3.2 Range of basic soil properties in different textural classes

Sr. No.	Textural Class	Particle size analysis			B.D. (g/cm3)	Organic carbon (%)
		Sand %	Silt %	Clay %		
1	Sandy loam	54.03-61.73	20.45-31.3	7.39-17.82	1.67-1.90	0.16-0.58
2	Sandy clay loam	56.21-69.59	3.74-16.03	26.68-32.8	1.58-1.79	0.09-1.05
3	Loam	28.78-45.11	37.66-50.7	13.88-26.83	1.25-1.79	0.20-0.87
4	Silt loam	0.86-37.59	41.39-79.33	5.72-46.77	1.23-1.88	0.06-1.31
5	Silt clay loam	3.45-19.63	40.17-60.3	28.59-36.93	1.25-1.88	0.06-1.31
6	Silty clay	6.45-17.68	40.47-41.85	41.74-51.7	1.66-2.04	0.51-0.73
7	Silt	14.28	80.01	5.72	1.68	0.37
8	Clay loam	22.69-37.15	24.36-40.19	27.08-41.85	1.28-1.51	0.04-3.00
9	Clay	9.9-19.92	26.73-36.75	41.85-62.24	1.28-1.83	0.23-3.00

The range of particle sizes, bulk density and organic matter in different textural classes of the samples is presented in Table 3.2. The sand content in sandy clay loam soil greatly varied from 56.21 to 69.59 %. Silt content in silt soil and silt loam soil also varied from 41.39 to 79.33 % and 80.01% respectively. Similarly, clay content in the clay soil varied from 41.85 to 62.24%. The bulk density in different textural classes varies from 1.23 to 2.04 gm/cm^3. The silt clay soil was having maximum bulk density in the range of 1.66 to 2.04 gm/cm^3. The organic content of clay and clay loam soils was found to be highest, followed by silt loam, silt clay loam, sandy clay loam, loam, silty clay and sandy soil. The organic carbon of the clay and clay loam soil was varying from 0.23 to 3.00 and 0.04 to 3.00 respectively.

Table 3.3 Basic soil moisture retention properties

Sr. No.	Sample point	Textural Class	FC (%)	PWP (%)	AWC (%)
1	B20	Loam	33.61	14.85	18.76
2	C19	Loam	31.25	14.73	16.52
3	D2	Loam	29.64	17.76	11.88
4	D3	Clay	51.56	20.3	31.26
5	D4	Silty Clay Loam	36.25	11.74	24.51
6	D5	Sandy loam	14.52	11.82	2.7
7	D6	Silt loam	31.2	10.5	20.7
8	D7	Clay	48.26	19.44	28.82
9	D8	Sandy clay loam	13.4	10.93	2.47
10	D9	Silty Clay Loam	37.27	15.53	21.74
11	D18	Sandy clay loam	22.2	6.55	15.65
12	D19	Silt Loam	31.52	10.38	21.14
13	E1	Silt Loam	37.84	11.27	26.57
14	E2	Silt	29.71	6.26	23.45
15	E3	Silt Clay	31.52	15.36	16.16
16	E4	Silty Clay Loam	34.2	10.62	23.58
17	E5	Silt Loam	31.62	11.18	20.44
18	E6	Silt Loam	32.71	12.13	20.58
19	E7	Loam	30.26	14.54	15.72
20	E9	Sandy loam	18.03	8.25	9.78

21	E16	Sandy Loam	18.4	8.61	9.79
22	E17	Clay loam	27.69	19.91	7.78
23	E18	Loam	26.22	11.6	14.62
24	F2	Silt Loam	35.75	12.18	23.57
25	F3	Silty Clay Loam	31.23	10.87	20.36
26	F4	Silty Clay Loam	29.8	10.05	19.75
27	F5	Clay	34.82	20.1	14.72
28	F6	Clay	38.1	21.7	16.4
29	F7	Silt Loam	36.1	11.83	24.27
30	F8	Clay	31.7	14.91	16.79
31	F16	Clay loam	24.13	10.25	13.88
32	G3	Silty Clay Loam	34.83	12.85	21.98
33	G4	Clay	48.3	18.51	29.79
34	G5	Sandy Loam	37.41	14.91	22.50
35	G6	Silt loam	31.52	11.65	19.87
36	G7	Loam	24.0	10.82	13.18
37	G8	Silty Clay Loam	34.24	13.51	20.73
38	G13	Silt loam	30.44	11.21	19.23
39	G14	Silt loam	32.59	13.24	19.35
40	G15	Silt Loam	34.87	10.02	24.85
41	G16	Sandy clay loam	21.7	8.2	13.5
42	H7	Clay	43.3	15.5	27.8

43	H8	Clay loam	26.53	14.25	26.5
44	H9	Clay	34.0	16.5	17.5
45	H10	Silt Clay Loam	33.0	11.41	21.59
46	H16	Silty Clay	26.78	14.25	12.53
47	I8	Silt Loam	36.16	12.39	23.77
48	I9	Silty Clay	35.29	15.6	19.69
49	I10	Clay Loam	21.48	12.23	9.25
50	I15	Silt Loam	39.81	10.77	29.04
51	J9	Clay loam	23.98	14.23	9.75
52	J14	Loam	31.5	13.6	17.9
53	J15	Clay	37.94	21.1	16.84
54	K10	Clay loam	26.72	14.73	11.99
55	K11	Clay loam	30.61	14.49	16.12
56	K12	Clay	38.5	19.6	18.9
57	K13	clay loam	29.42	14.9	14.52
58	K14	Silty Clay Loam	31.41	10.81	20.6
59	K15	Clay	39.23	18.49	20.74
60	L12	clay loam	22.64	14.97	7.67

The basic soil moisture retention properties of the collected soil samples are presented in Table 3.3.

Table 3.4 Range of soil water retention characteristics of different soil textural classes

Textural classes	FC (%)	PWP (%)	AWC (%)
Sandy loam	18.0-21.5	8.0-9.75	8.0-10.66
Sandy clay loam	24.0-26.0	13.4-16.66	8.0-12.38
Loam	25.0-27.0	10-17.76	13.0-16.0
Silt loam	25.0-28.76	9.0-18.5	16.0-17.76
Silty clay loam	33.0-35.88	16.0-20.0	16.0-18
Silty clay	31.52-36.0	17.5-22.0	14.0-19.69
Silt	34.0	17.0	17.0
Clay loam	30.0-37.5	15.0-22.5	14.0-20
Clay	38.0-43.88	29.0-31.0	14.0-27.8

The ranges of measured of soil water retention characteristics data of different soil textural classes are presented in Table 3.4. From Table 3.4 it is revealed that there is great variation in soil water retention characteristics of the soil groups.

CONCLUSIONS

Based on the results obtained from the study, following conclusions are drawn.

1) Nine different soil textural classes were observed in Shirla Nemane watershed of 22400 ha area indicating wide variation in textural composition of the study area.

2) Available water capacities of Sandy, Loamy and Clayey soils are ranging from 2.7 to 15.65%, 11.88 to 23.45% and 2.57 to 31.26% respectively.

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