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HYDROLOGICAL SOIL CLASSIFICATION IN SHER-UMAR RIVER DOAB IN NARMADA BASIN

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1.0 INTRODUCTION

The study and classification of soil has in the past been undertaken by engineers and agriculturists who have confined themselves to those soil properties and materials in which they have a special interest. The soils have also been studied by geologists, but the geological description of an area does not include the information required by soil users. The appreciation of soil made in this way has been restricted by the limited standpoint from which it has been investigated. A classification designed by one soil user has tended to be of limited value to others because, it has been designed to serve a specific and limited purpose. Soil classification is largely a 20th century concept, although, work in this area started in the preceding century. Numerous systems of soil classification have been developed and many are in use in various parts of the world.

Hydrologic soil classification refers to a group of soil series that can be considered homogeneous in respect of soil characteristics that influence the runoff. Soil characteristics of watershed play an important role in its runoff potential. The surface runoff, soil moisture storage and deep percolation due to infiltration from a storm are influenced by the soil characteristics of the watershed. Such response is affected by the characteristics of soils both on the surface and sub-surface horizons. The characteristic of the soil on the surface is the infiltration capacity and characteristic of the soil in the sub surface is the percolation or transmission rate. Hydrologic soil classification is useful for estimation of runoff. The soil characteristics of watershed play am important role in the hydrologic soil Classification. Viewing the importance of Hydrologic soil classification role in the estimation of runoff of a watersheds a model area under comprehensive hydrological study of a sub-basin in Narmada has been taken up.

In this report, an attempt has been made with emphasis on systematic determination of hydrological properties of soils, such as, infiltration rate, saturated hydraulic conductivity, soil samples and their physical properties analysis and then its classification, based on prevailing Soil Conservation Services(SCS) Criteria. It is difficult to get all hydrologic soil parameters falling in one group mentioned under Soil Conservation Services of USA. Facing such problem, it has been presumed that infiltration rate is going to be affected by other parameters i.e effective depth of soil, clay content, soil drainability and ground water table. In other way, it can be said that infiltration rate is by product of other parameters. Hence, for

classification of hydrologic soil group, infiltration rate has been considered a guiding factor that include an overall effect of particle size, its distribution, compaction, topography along with other several parameters. Thus, the hydrological soil map has been prepared for the study area, keeping in view the infiltration rates observed in the field.

2.0 STUDY AREA

The Bargi multi-purpose project, renamed as Rani Avanti Bai Sagar Project, is one of the major river valley project on Narmada river by the Govt. of Madhya Pradesh as a part of the Narmada Valley Development Plan. On completion of the project, irrigation facilities will be available for 157,000 hectares in Jabalpur and Narsinghpur districts through Left Bank Canal system and 46,000 hectares in Jabalpur district through Right Bank Canal system.

The study area is a part of the Left Bank Canal Command of Bargi Multi-purpose Project. The canal is 132.2 kilometer long and has a discharge capacity of 124.65 cumecs. This canal has Culturable Command Area of 95,000 hectares

2.1 LOCATION

The study area is a part of Narsinghpur tehsil of Narsimhapur District, Madhya Pradesh and occupies the central part of Bargi Dam Command area in Narmada river basin (Fig. 1). The area lies between latitudes 22^0 53′ N to 23^0 03′ N and longitudes 79^0 10′ E to 79^0 32′ E and falls under Survey of India toposheets no. 55M/4, 55M/8 and 55M/9. The area is bound by the Sher river in west, by the Umar river in east and north, and by the Bargi Left Bank Canal in South (under construction). This is one of the most fertile and populus part of Narsinghpur.

The study area lies in the East of Narsinghpur town and is traversed by State Highway No. 22 from Jabalpur to Hoshangabad. The main broadgauge railway line from Hawrah to Bombay also passes though the study area.

2.2 PHYSIOGRAPHY

The study area occupies a part of the southern part of the Narmada Valley which is most fertile and populus part of Narsinghpur district. The general level of the study area lies between 338m to 360m above MSL. The general topography of the area appears to be flat except in the vicinity of the rivers, where deep gullies and ravines have formed giving rise to undulating to rolling topography. At few places, gravel mounds are also present.

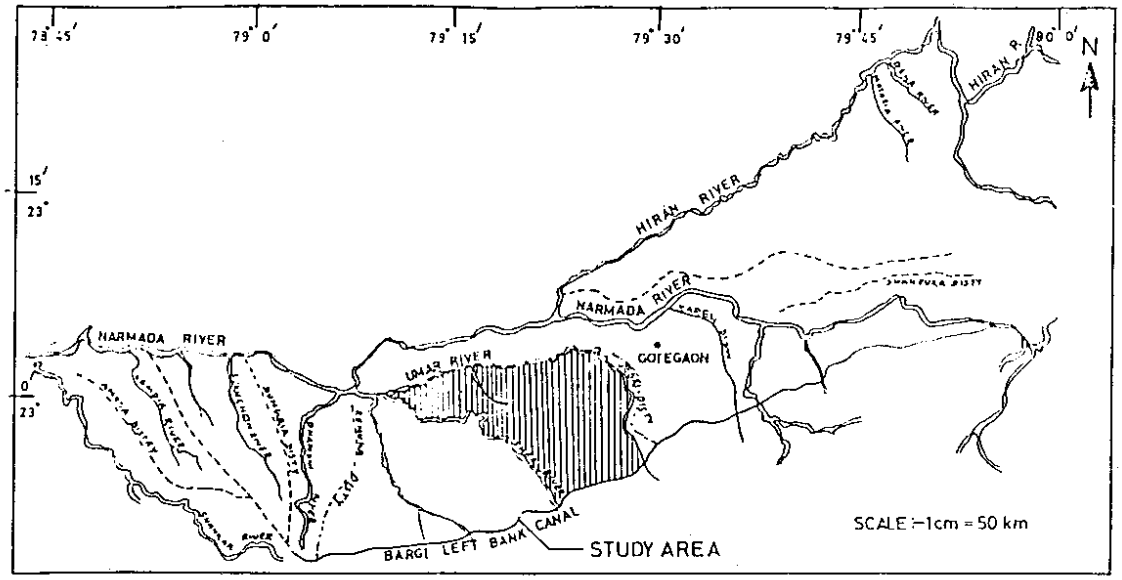

FIG.1 : Location map of the Sher-Umar river doab.

The general slope of the area is towards north and northwest. In the plain areas, the slope is upto 3 %, whereas in the undulating areas the slope is upto 15 %. The drainage pattern in the area is dendritic type. Small rivulets are confined to the southern and northern part of the study area (FIG.2). In southern area, the drainage is mainly in the hilly area and in the northern part it is along the two major rivers, i.e., Sher and Umar. The landscape of the area is such that most of the surplus rain water drains through rivers and streams, but poor to moderate drainage conditions occur in the flat areas creating drainage problem in the central part of the doab.

2.3 CLIMATE

The study area falls in sub-zone-2c based on hydrometeorological classification of the country (Kaushal & Chaudhary, 1975; WAPCOS, 1986). The climate in the region is sub-tropical.

The rainy season extends from June to October under the influence of south-west monsoon. Normally the rainfall ceases by the end of September, but in quite a large number of years, the area receives good rainfall during October. The area also receives some rainfall during January and February. There is considerable variation in rainfall from year to year. As per the rainfall data of Narsinghpur meterological station, annual rainfall varied from 563.3 mm (1965) to 1893.6 mm (1977), with average annual rainfall of 1162 mm (1965-89). Mean monthly rainfall of Narsinghpur meteorological station is given in TABLE-1.

The temperature in the area varies from 45^0 C in summers to 2^0 C in the winters. The temperature begins to rise rapidly from March till May, which is generally the hottest month of the year. With the onset of the monsoon in the second week of June, there is an appreciable drop in the day temperature. From mid-November onwards, both day and night temperature decreases rapidly. December and January are the coldest months of the year.

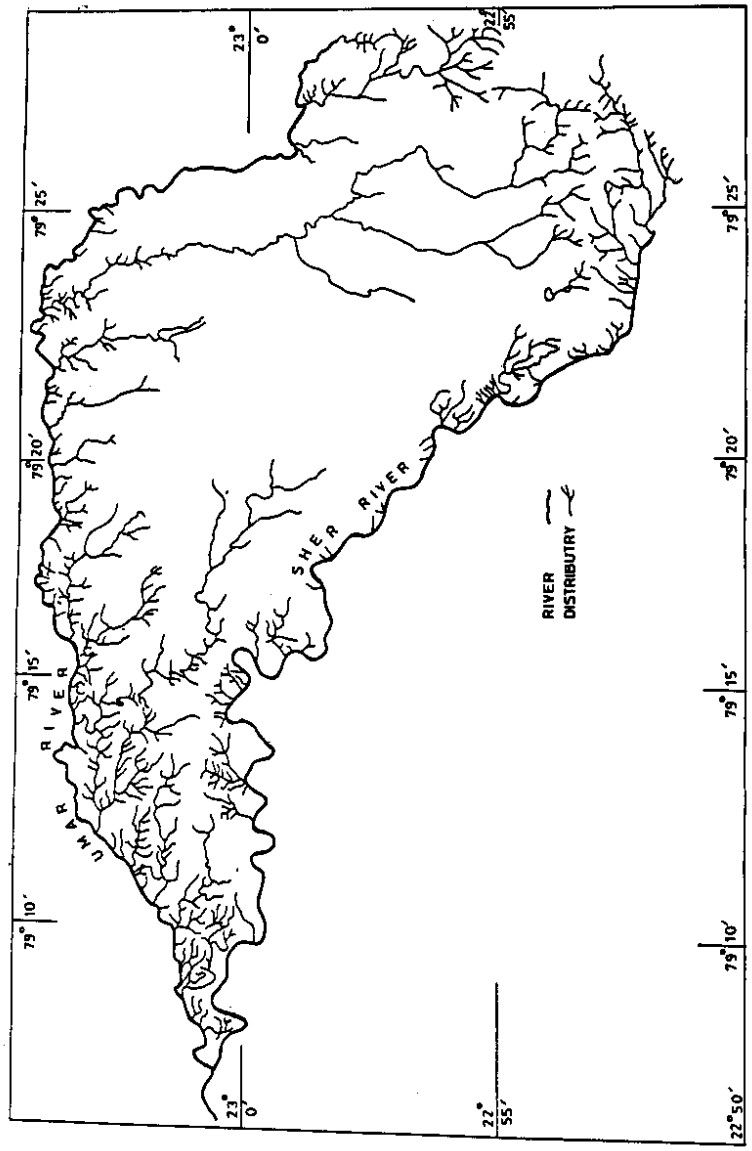

FIG. 2 : Drainage map of the Sher-Umar river doab.

Table-1 : Mean monthly rainfall at Narsinghpur meterological station.
(Period 1965-89)

Sl. No.	Month	Mean monthly rainfall (mm)	Year 1989
1.	January	18.74	0.00
2.	February	19.40	0.00
3.	March	10.36	38.00
4.	April	1.68	0.00
5.	May	7.05	0.00
6.	June	166.70	231.80
7.	July	314.95	93.40
8.	August	422.50	603.60
9.	September	155.58	120.80
10.	October	22.30	0.00
11.	November	11.30	0.00
12.	December	11.40	0.00
	TOTAL	1161.96	1087.60

2.4 SOILS

The soils of the area are alluvial in nature. The thickness of alluvium increases towards north. Rocks are exposed on the southern periphery of the study area. Kankars have been observed at a depth of 80 cm to 150 cm.

The top soils of the area are normally heavy and dark coloured and are derived from Deccan Trap rocks. The top black soil is variable in thickness with average thickness of about 1 meter and overall soil thickness is more than 9 meters except in southern fringe of the study area. This soil is clayey in texture and has high moisture retaining capacity. The black soil is underlain by light textured yellow soil. This yellow soil has low water retaining capacity as compared to black soil.

In some places, the soils have been formed from sand stone parent material in which a lot of textural variation is found. It varies from sandy loam to clay. The soil crust is deep and has a fair amount of gravel or Kankar (impure form of nodular calcium carbonate) along the depth of profile.

The soil survey of the area had been carried out by Soil Survey Unit, Jabalpur under Department of Agriculture, Govt. of Madhya Pradesh. In study area, there are only three types of soil i.e. clay, clay loam, silty clay loam, in which clay and silty clay loam are predominant (FIG.3).

Towards the banks of river, the texture of the soil changes from heavier to lighter grade i,e from clay to clay loam, loam, sandy loam and finally sandy. The colour of the soil also changes from dark greyish brown to brown, yellowish brown and finally yellow grey.

2.5 GROUNDWATER

The entire study area is covered with alluvium of recent age. Alluvium consists mainly of clay and fine to medium grained sand. The thickness of alluvium varies from place to place ranging from 15 to 180m. Groundwater is mostly present under confined conditions and gives yield of 75-150 m^3/hr for 6m drawdown.

Water table is a guiding factor which controls the movement of water through soil, though by physical character, a soil may have different drainability.

2.6 AGRICULTURE AND IRRIGATION

The study area is normally agricultural area with no forest land. Forested area lies beyond Bargi canal in the south. The main crops grown in the area are Soyabean, Gram, Arhar, Masoor, Moong, Jwar, Wheat and Sugar Cane. In some low lying areas, rice is also cultivated. Fruit bearing trees are Mango and Jamun.

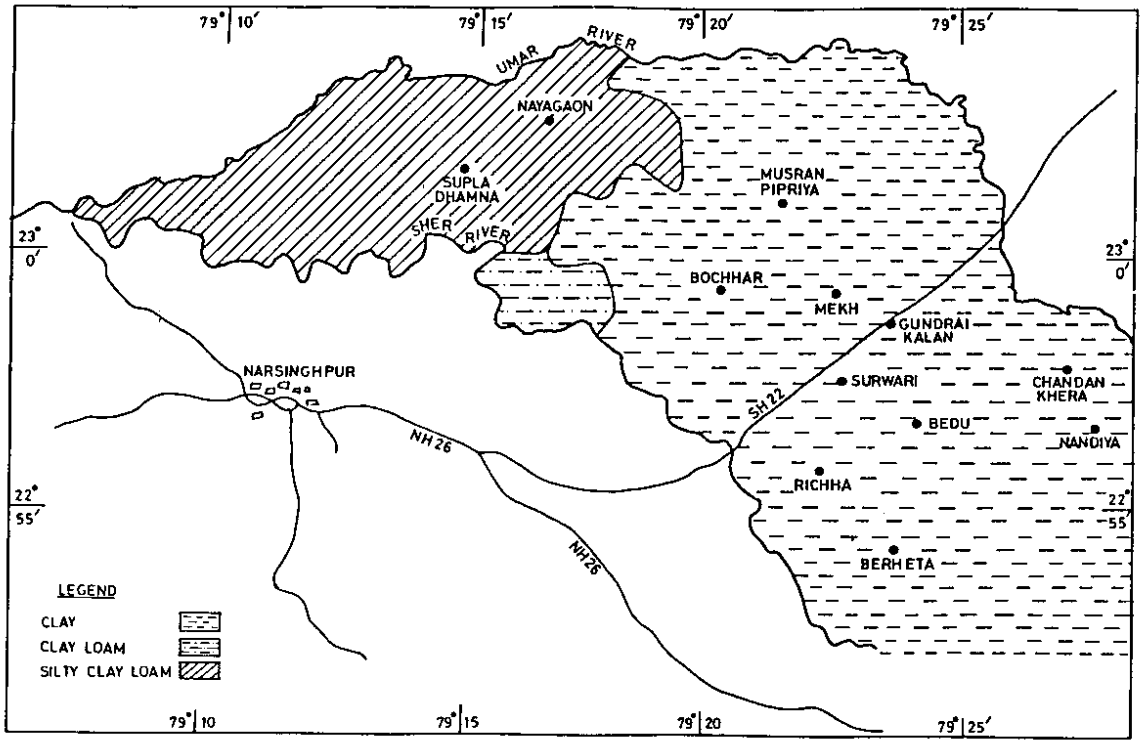

FIG. 3 : Soil type map of the Sher-Umar river doab

As the general topography of the area under study is somewhat irregular, soil is highly impermeable due to its high clay content, both surface/sub-surface method of irrigation are not efficient for the study area. Therefore, Sprinkler method of irrigation is in general practice to irrigate the fields located in the study area.

"The old Haveli" system of cultivation is practised in rabi. The preference to rabi cultivation is due to the high clay content of the soil which is difficult to work in rainy season. Broadly speaking, under Haveli system a large area is bunded and utilised for collecting rain water during the monsoon and is left fallow during Kharif season. The rain water stored as soil moisture helps to grow rabi crops.

3.0 METHODOLOGY

The first systematic soil survey was launched in 1899 in the United States before any method for classification of soil was developed. The kinds of soil shown on earliest maps were called soil types and so effort was made at first to relate the types of one survey area to those of another. Within the first ten years of the programme, a classification consisting of three categories namely physiographic region, the soil series and soil type were proposed. The second system of soil classification was based on a proposal by Marbut in the U.S.A. The emphasis has been given to soil profile characteristics. In 1950, efforts were begun to revise the entire system rather than try to improve individual segments. The work of revising the classification system was carried forward through a sequence of approximations.

3.1 HYDROLOGIC SOIL CLASSIFICATION

Hydrologic soil classification is essential for the evaluation of runoff. The main parameters used commonly in hydrologic soil classification are:

- Effective soil depth,
- Soil texture/average clay content in the surface and sub surface layers
- Soil structure in the surface and sub surface layers
- Infiltration rate, and
- Soil permeability and drainability

Effective depth of soil

The depth of soil that can be effectively exploited by the plant roots is an important criterion in selecting land for irrigation. Effective depth includes the solum thickness plus adjusted or corrected thickness of the disintegrated and weathered permeable rock material where the soil rests on such a material. In case of soils with hard pan, the effective depth is the thickness of soil overlying such a layer. When the soils are lying over disintegrated and weathered sub-stratum. The adjusted and corrected thickness for such a disintegrated layer can be calculated by multiplying thickness of this layer with the percent soil material contained in it.

Soil texture / average clay content

Soil texture refers to relative proportion of various soil separates in a soil material and is related to soil water inter-relationships. On the basis of relative proportion of sand, silt and clay, various soil textural groups are recognised. Clay, being the most active and reactive fraction, is used as a single factor index in deciding hydrologic group of a series. Clay content of the surface layer and the average clay content of the whole profile are considered for this purpose. In order to compute average clay content of the profile, the clay content of each of the soil horizon is multiplied by its respective thickness and the summation of these is divided by the total thickness of the profile.

Soil structure

Soil structure refers to the arrangement of soil particles in the soil profile. Soil structure governs the moisture and air regimes in the soil. The movement of water in the soil and its transmission is affected by soil structure and texture. The runoff potential of the different soil structures is Low (single grain); Moderately low to low for Granular & Crumb; Moderately low to Moderately high for Subangular blocky & columnar; Moderately high to high for Strong angular blocky and prismatic; and High for Strong platy, compact, massive structures

Infiltration rate

Infiltration characteristics of a soil is an important parameter required for many hydrological studies and simulation of flow process. Quantitavely, infiltration rate is defined as the volume of water passing into soil per unit area per unit time and has the dimension of velocity. The maximum rate at which the soil can absorb water through the soil surface is termed as infiltration capacity. This is a function of soil moisture condition. At saturation, infiltration capacity is minimum and is the characteristics of the soil i.e. texture, structure, organic matter, type of clay mineral, antecedent soil moisture etc. This plays an important role in hydrological soil classification.

Soil Permeability

Soil permeability refers to the ease with which water can move in the soil profile. Its a measure of drainability of the soil in cm/ hour or cm/ day. Soil properties such as texture, structure, management practices, landcover, landuse etc. all control the total water intake in a soil profile at a given time.

3.2 HYDROLOGIC SOIL GROUPS BASED ON SCS

Soil conservation services of the U.S. Department of Agriculture has classified the soils into four hydrologic soil groups, namely, Group A, B, C and Group D respectively in the increasing order of runoff potential.

Group A — Soils having high infiltration rate even when thoroughly wetted and consisting chiefly of deep to very deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B — Soils having moderate infiltration rate when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C — Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have slow water transmissibility rate.

Group D — Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow water transmissibility rate.

The soil characteristics associated with each group are presented in TABLE-2.

Table-2 : Hydrologic soil classification based on SCS method.

Soil Characteristic	Hydrologic soil group			
	A	B	C	D
Effective depth (cm)	> 100	51 - 100	26 - 50	< 25
Texture	S, LS	SL, SiL, L	Si, SCL, CL, SiCL	SC, SiC, C
Clay (%)	0 - 8	9 - 25	26 - 40	> 40
Structure	Single grained, granular crumb	granular crumb, Sub-angular blocky	Sub-angular blocky, columnar prismatic	Platy, massive
Infiltration rate (cm/hr)	> 8.0	5.1 - 8.0	1.6 - 5.0	< 1.6
Permeability (cm/hr)	High (> 13)	Mod. High (2 - 13)	Mod. Low to Mod. High (0.5 - 2)	Low (< 0.5)
Depth to Groundwater (m)	>5	3 - 5	1.5 - 3	< 1.5

S- Sand LS-Loamy Sand SL-Sandy Loam SiL-Silty Loam L-Loam Si-Silt SCL-Sandy Clay Loam
CL-Clay Loam SiC-Silty Clay C-Clay SiCL-Silty Clay Loam

3.3 HYDROLOGIC SOIL GROUPING BY ALL INDIA SOIL AND LAND USE SURVEY ORGANISATION.

All India Soil and Land Use Survey (AIS&LUS) has been carrying out soil survey since 1958 in various parts of the country. The survey includes, the broad landscape, physiography, erosion, slope gradient, physical soil characteristics and land use. The AIS&LUS has also carried out the classification of the soil series into hydrologic soil groups.

The important soil characteristics parameters i.e. effective depth, average clay in profile, soil structure, infiltration rate and permeability were considered in soil classification.

3.4 ADOPTED CRITERIA FOR HYDROLOGICAL SOIL CLASSIFICATION

As discussed above that hydrological soil groups can be identified using the following soil parameters, i.e., effective soil depth, soil texture/average clay content in the surface and sub surface layers, soil structure in the surface and sub surface layers, infiltration rate, and soil permeability and drainability. All these soil parameters seldom lead to a single hydrological soil group, therefore, hydrological soil groups can be identified by any one of the three ways i.e., soil characteristics (texture/clay percentage), soil survey (effective depth, soil structure) and infiltration capacity.

The infiltration capacity is affected by most of the soil propreties and other related parameters, such as, water level. Therefore, the knowledge of infiltration capacity or saturated hydraulic conductivity provides an overall picture of hydrological response of the soil to a hydrological event. Keeping these aspects in view, it was decided to classify the soils on the basis of infiltration capacity.

4.0 FIELD AND LABORATORY STUDIES

To determine various soil parameters for Hydrological soil classification, field survey and laboratory analysis was carried out. Field work was carried out in first and second week of October 1995. Before carrying out the actual field survey, testing points were selected based on the soil map and topographic maps. In the field, infiltration rate, saturated hydraulic conductivity, effective depth of soil and water levels were measured. After the field work the soil samples were analysed for particle size distribution in the laboratory.

4.1 SELECTION OF TESTING POINTS

A rapid reconnaissance survey of the Bargi left bank canal project was carried out in the year 1963-64. The grids adopted were too large to represent the area. The study was not based on morphological description and the information about the soil was limited, hence, a fresh reconnaissance survey of the entire Bargi left bank canal command was carried out by the soil survey unit, Jabalpur, Department of Agriculture, Government of Madhya Pradesh in 1974-75. This survey of command area was conducted on 1:145,000 scale by using tahsil and village maps as the base maps. The whole area was divided into 350 grids, and normally a grid represents 1025 hectare.

As the study area is a part of Bargi left bank canal command area, a grid map of doab area was prepared having the same scale and assigning same grid number as that of soil survey conducted in 1974-75.

The test points were marked at alternate grid, but keeping in view the easy approach of the sites, open well for watertable measurement. By this method, only twelve sites could be selected. It has been tried to take atleast two test points in one soil series for comparison of the test results.

4.2 FIELD SURVEY

During the field surveys, the following experiments/observations were conducted in the field.

Soil sampling and effective depth

The objectives of this measurement were to determine the physical properties of soil; to know the soil moisture conditions; and to judge the effective depth of soil.

At each site, first of all auguring was done for a trial to see the homogeneity of soil in vertical space up to 2 m. This was also helpful in the determination of effective depth of soil. At eleven sites, it was observed that effective soil depth was more than 2 m. At the twelveth site, i.e., at Pachauri, the soil depth was shallow and was about 80 cm. Here, weathered marble was encountered below soil cover.

For determination of physical properties of soil of each site, soil samples of nearly 2 kg were collected from each type of soil up to maximum depth of 2m. Usually two types of soil were encountered up to this depth at each site, i.e., black clayey soil (black cotton soil) and yellow clayey soil. The samples were collected in polythene bags and sealed tightly to preserve naturality.

Infiltration rate

Infiltration tests were carried out at each site using Double Ring Infiltrometer, with inner ring of diameter 22.5 cm to 35 cm and the outer ring of diameter 37.5 cm to 50.0 cm. Constant head principle was used to determine the infiltration characteristics of the soils. The constant rate of each site has been taken as the final infiltration capacity. The results of the infiltraion tests are given in Table-3.

Table-3 : Infiltration rates in Sher-Umar river doab.

S.No.	Name of village	Infiltartion Capacity (cm/hr)
1.	Nayagaon	4.80
2.	Supla	2.40
3.	Bedu	0.40
4.	Gundrai Kalan	0.12
5.	Berheta	0.10
6.	Survari	0.60
7.	Bochhar	2.40
8.	Mekh	3.00
9.	Musran Piparia	0.20
10.	Pachauri (Nadiya)	1.80
11.	Chandankhera	0.20
12.	Richha	0.20

Hydraulic conductivity

Saturated hydraulic conductivity, also known as permeability, was determined in the field with the help of Guelph Permeameter. The Guelph Permeameter is essentially an "in hole" Mariotte bottle constructed of concentric transparent plastic tubes. The apparatus comprises of a Tripod Assembly, Support Tubes and lower air tube fittings, Reservoir Assembly, Well Head Scale and upper air tube fittings, Auxiliary tools.

The hydraulic conductivity values obtained from field measurements are tabulated in TABLE-4. There is large variation in values of saturated hydraulic conductivity (TABLE-4) as compared to infiltration capacity (TABLE-3), this may be due to presence of cracks and rat holes in the soils. Also the method of preparation of hole for measurement of saturated hydraulic conductivity by Guelph Permeameter in clayey soils, affects the conductivity values.

Table-4 : Saturated Hydraulic conductivity of the soils of Sher-Umar river doab.

S.No.	Name of village	Saturated Hydraulic Conductivity (cm/hr)
1.	Nayagaon	0.10
2.	Supla	0.05
3.	Bedu	0.12
4.	Gundrai Kalan	0.56
5.	Berheta	<0.01
6.	Survari	<0.01
7.	Bochhar	0.85
8.	Mekh	1.43
9.	Musran Piparia	<0.01
10.	Pachauri (Nadiya)	<0.01
11.	Chandankhera	<0.01
12.	Richha	<0.01

Water table

Water table is a guiding factor which controls the movement of water through soil, though by physical character, a soil may have better drainability. Depth to water table was recorded at each site from its nearby open well with the help of water table indicator. In the villages where dug wells were not present, the water level of nearby villages was considered. To get the actual level, the measurements were made in those open wells in which pumps were not operative for a few days. The water levels at all twelve sites are given in TABLE-5.

TABLE-5 shows that the water level varies from 1.3 to 20 meters. Generally, the water level is between 5 to 10 meters except at Pachauri (1.3 m). This site is located near to a pond and here soil thickness is about 1 m.

Table-5 : Groundwater table depth in Sher-Umar river doab in October 1996.

S.No.	Name of village	Depth to Water Table (m)
1.	Nayagaon	6.6
2.	Supla	6.8
3.	Bedu	9.6
4.	Gundrai Kalan	9.4
5.	Berheta	6.5
6.	Survari	7.8
7.	Bochhar	6.9
8.	Mekh	8.4
9.	Musran Piparia	9.2
10.	Pachauri (Nadiya)	1.3
11.	Chandankhera	7.4
12.	Richha	7.5

4.3 LABORATORY ANALYSIS

The samples collected from the field were tested in the Soil Water Laboratory, Nation Institute of Hydrology, Roorkee, for the particle size distribution. Particle size distribution of the soils was by sieve and sedimentation analysis. Soil samples were washed with distilled water to remove the soluble salts. The washed samples were separated into two fractions i.e., +75 micron and -75 micron through wet seiving. Sieve analysis was performed for the fraction of soil retained on 75 micron sieve (+75 micron). The portion passing through the 75 micron sieve (-75 micron) was analysed by sedimentation analysis using hydrometers. The test results of the analysis are given in TABLE-6.

Table-6 : Paricle size distribution in soils of Sher-Umar river doab

S. No.	Name of village	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Texture
1.	Nayagaon	4.9	5.4	62.1	27.6	silty clay loam
2.	Supla	0.0	8.9	61.7	29.4	silty clay loam
3.	Bedu	0.5	13.9	37.7	47.9	clay
4.	Gundrai Kalan	2.4	16.4	20.3	60.9	clay
5.	Berheta	2.4	20.2	24.8	52.6	clay
6.	Survari	0.0	6.0	26.8	67.2	clay
7.	Bochhar	1.6	10.3	34.7	53.4	clay
8.	Mekh	1.0	14.0	21.8	63.2	clay
9.	Musran Piparia	0.0	12.5	19.3	68.2	clay
10.	Pachauri (Nadiya)	0.6	24.3	26.0	49.1	clay
1.	Chandankhera	0.4	4.6	22.7	72.3	clay
12.	Richha	0.0	12.8	12.3	74.9	clay

5.0 RESULTS AND ANALYSIS

Hydrologic soil classification of an area is essential to estimate the runoff accurately, generated due to a storm, from that area. The main soil parameters generally considered for analysis are effective soil depth, soil texture, clay content in surface and subsurface layers, soil structure, infiltration rate, soil permeability and soil drainability.

In the present study, effective soil depth, texture, constant infiltration rate and saturated hydraulic conductivity have been determined through field tests and laboratory analysis. The results of all twelve sites related to effective soil depth, texture, constant infiltration rate and saturated hydraulic conductivity, against soil series of the sites are tabulated in TABLE-7.

Table-7 : Hydrologic Soil properties of the soils of Sher-Umar river doab

S. No.	Name of village	Effective Depth (m)	Clay content / Texture (%)	Infiltration Capacity (cm/hr)	Permeability (cm/hr)	Depth to Water table (m)
1.	Nayagaon	>100	27.6 (SiCL)	4.8	0.10	6.6
2.	Supla	>100	29.4 (SiCL)	2.4	0.05	6.8
3.	Bedu	>100	47.9 (C)	0.4	0.12	9.6
4.	Gundrai Kalan	>100	60.9 (C)	0.12	0.56	9.4
5.	Berheta	>100	52.6 (C)	0.1	<0.01	6.5
6.	Survari	>100	67.2 (C)	0.6	<0.01	7.8
7.	Bochhar	>100	53.4 (C)	2.4	0.85	6.9
8.	Mekh	>100	63.2 (C)	3.0	1.43	8.4
9.	Musran Piparia	>100	68.2 (C)	0.2	<0.01	9.2
10.	Pachauri (Nadiya)	>80	49.1 (C)	1.8	<0.01	1.3
11.	Chandankhera	>100	72.3 (C)	0.2	<0.01	7.4
12.	Richha	>100	74.9 (C)	0.2	<0.01	7.5

Based on the individual soil properties, the soils of the Sher-Umar river can be classified into various hydrological soil groups (Table-8).

Table-8 : Hydrologic Soil Groups based on individual soil properties in Sher-Umar river doab

S. No.	Name of village	Effective Depth	Clay content / Texture	Infiltration Capacity	Permeability	Depth to Water table
1.	Nayagaon	A	C	C	D	A
2.	Supla	A	C	C	D	A
3.	Bedu	A	D	D	D	A
4.	Gundrai Kalan	A	D	D	C	A
5.	Berheta	A	D	D	D	A
6.	Survari	A	D	D	D	A
7.	Bochhar	A	D	C	C	A
8.	Mekh	A	D	C	C	A
9.	Musran Piparia	A	D	D	D	A
10.	Pachauri (Nadiya)	B	D	C	D	D
11.	Chandankhera	A	D	D	D	A
12.	Richha	A	D	D	D	A

It can be seen from the Table-8, that based on effective depth the soils of Sher-Umar doab can be classified into Group-A, except at Pachauri where the hydrologic soil group is B. Similar is the case with groundwater table postion. Since the top soil in the area is mostly clayey or silty clay, it will restrict downward movement (infiltration and percolation) of water and will generate high surface runoff, therefore, effective depth may not give correct hydrological soil group for the area. Similarly, the groundwater table which is generally under confined conditions (due to the presence of top clay layer) may not be useful for the classification of hydrological soil groups in Sher-Umar doab.

Based of other properties like texture, clay content, infiltration rate and hydraulic conductivity, the soils can be classified into Group-C to D at all the locations. Both infiltration capacity and permeability are the function of soil texture and clay content. Hydraulic conductivity (permeability) and infiltration capacity are mostly close to each other. But TABLE-7 shows large variation in values of infiltration capacity and saturated hydraulic conductivity, this may be due to presence of cracks and rat holes in the soils. Moreover, during preparation of hole for determination of saturated hydraulic conductivity by Guelph in clayey soils, the soil gets disturbed and a smooth layer is formed around the inner wall of

the hole reducing the hydraulic conductivity. Therefore, in the present study infiltration rate has been taken as the criteria for the hydrologic soil classification grouping. Infiltration map of the area is given at Fig.4.

Based on this crieteia, soils of the Sher-Umar doab have been classified into hydrologic soil groups (Table-9).

Table-9 : Hydrologic Soil Groups in Sher-Umar river doab

S.No.	Name of village	Infiltration Capacity
1.	Nayagaon	C
2.	Supla	C
3.	Bedu	D
4.	Gundrai Kalan	D
5.	Berheta	D
6.	Survari	D
7.	Bochhar	D
8.	Mekh	C
9.	Musran Piparia	D
10.	Pachauri (Nadiya)	C
11.	Chandankhera	D
12.	Richha	D

TABLE-9 shows that there are two hydrologic soil groups in the area, i.e., Group-C and Group,-D. The silty clay loam soils in the north have Group-C type of soils, whereas, clayey soils also fall under Group-C as well as Group-D. Hydrologic soil map prepared from above soil groups is shown in Fig.5.

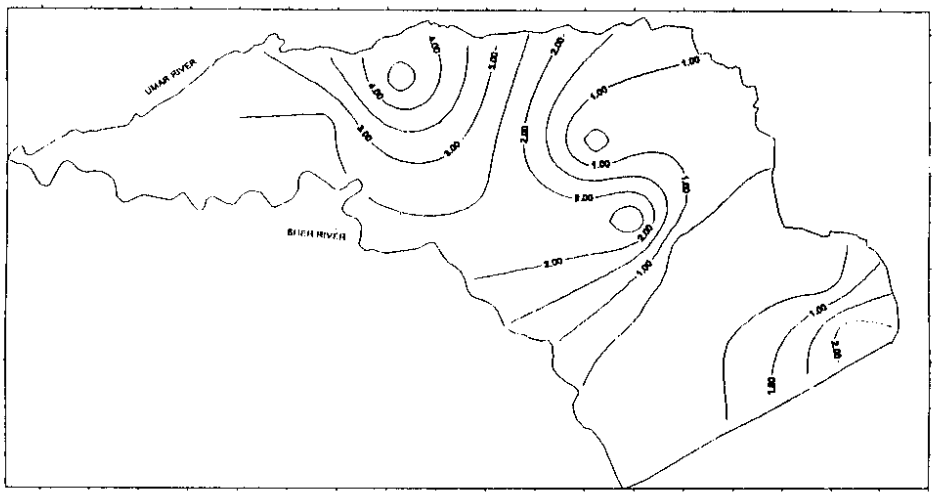

Fig. 4 : Infiltration capacity map of Sher-Umar river doab area.

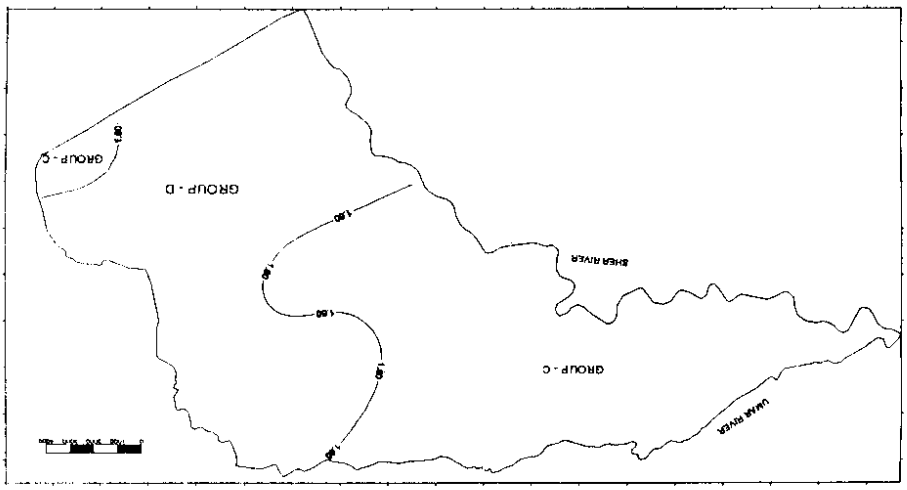

Fig. 5 : Hydrologic soil map of Sher-Umar river doab area.

6.0 CONCLUSIONS

Following conclusions can be drawn from the present study :

- None of the existing hydrologic soil classification schemes are robust enough to accommodate the all the soil properties into a particular group.

- Soil texture alone cannot be taken as a single parameter for classification of hydrologic soil groups, as same soil texture can give rise to different soil groups.

Infiltration rate may be adopted as main parameter for hydrologic soil classification, as infiltration rate is affected by all other soil characteristics.

REFERENCES

Arkley, R.J. (1971). proc. American society of soil science, vol. 35: 312-315

Averry, B.W. (1968). Trans. International congress of soil science, vol: 169 - 176.

Brooks, R.H. and A.T. Corey (1964) . Hydraulic properties of porous media Colorado State University Hydrol. paper no.3, pp. 27.

Campbell, G.S. (1974). A simple methid for determining unsaturated conductivity from moisture retention data. Soil sci. 117, pp. 311-314.

Kausal G.S., and G.K. Chaudhary, (1974-75). Reconnaissance soil survey report of Bargi Command Area, Report No.41, Department of Agriculture, Govt. of Madhya Pradesh, Adhartal, Jabalpur.

Rawls, W.J., D.L. Brakensiek and B.soni. (1983). Agricultural management effects on soil water processes : part I Soil Water Retention and Green Ampt Parameters. Transactios Asae 26 (6) pp. 1747-1752.

Rawls, W.J. and D.I. Brakensiek (1985). Prediction of soil water properties for hydrologic modelling. pp.293-299. In E.B. Jones and T.J. Ward (eds.) Watershed management in the Eighties Proc. of symposium sponsored by comm. On Watershed management, I & D Division, ASCE . ASCE convetion, Denver, Co., April 30- May 1.

Rawls, W.J. and D.L. Brakensiek (1989). Estimation of soil water Retention and Hydraulic properties in H.J. Modelling, Theory and Practice: Published by M/S Kluwer Academic Publishers pp 275-300.

SCS (1965). National Engineering Hand book', a publication of the Soil Conservation Services of United States of Department of Agriculture.

Soni, B. and G.C. Mishra (1985-86). "Hydrologic Soil Classification ", RN-6, National Institute of Hydrlogy, Roorkee.

WAPCOS (1986). Bargi Left Bank Canal Project, Feasibility Report , Vol-I, Water and Power Consultancy Services (INDIA) Ltd., New Delhi.

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