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HYDROLOGICAL SOIL CLASSIFICATION OF SHER-BARUREWA RIVER DOAB

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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 an important role in the hydrologic soil Classification. Viewing the importance of Hydrologic soil classification 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 to classify the soils of Sher-Barurewa doab into hydrologic soil groups. Emphasis has been given on systematic determination of hydrological properties of soils, such as, infiltration rate, saturated hydraulic conductivity, effective soil depth, physical properties of soil and water table depth. It is difficult to get all hydrologic soil parameters falling in one group mentioned under Soil Conservation Services method. 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 the by-product of other

soil 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, keeping in view the infiltration rates observed in the field, a hydrological soil map has been prepared for the Sher-Barurewa doab in Bargi Left Bank Canal command area.

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. Two main canals i.e., Right Bank Canal and Left Bank Canal will carry water from the reservoir for irrigation of 203,000 hectare of land.

The study area is a part of the left bank canal command of Bargi Multi-purpose Project.

2.1 Location

The study area lies between latitude 22^0 50′ 30″ N to 23^0 0′ 30″0 N and longitude 79^0 6′ 30″ E to 79^0 23′ 15″ E and is located in the Narsinghpur district of Madhya Pradesh. This area is a doab, encompassed by Sher river in the east and the north, Barurewa river in the west and Bargi left bank canal in the south, having an area of 250 sq. km. The study area is a part of Bargi Dam left bank canal and is a part of Narmada Basin. Location of the area is shown in FIG.-1.

The study area lies around Narsinghpur town, the headquarters of Narsinghpur district and is well connected by the National Highway No. 26 from Jhansi to Nagpur and 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 Topography

The elevation above mean sea level of the study area varies from 325m to 380m. 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. As such, the entire area is a broad plain of low relief. Local difference in elevation is small due to adaptations of "Haveli system" of cultivation, which has checked the erosion. "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

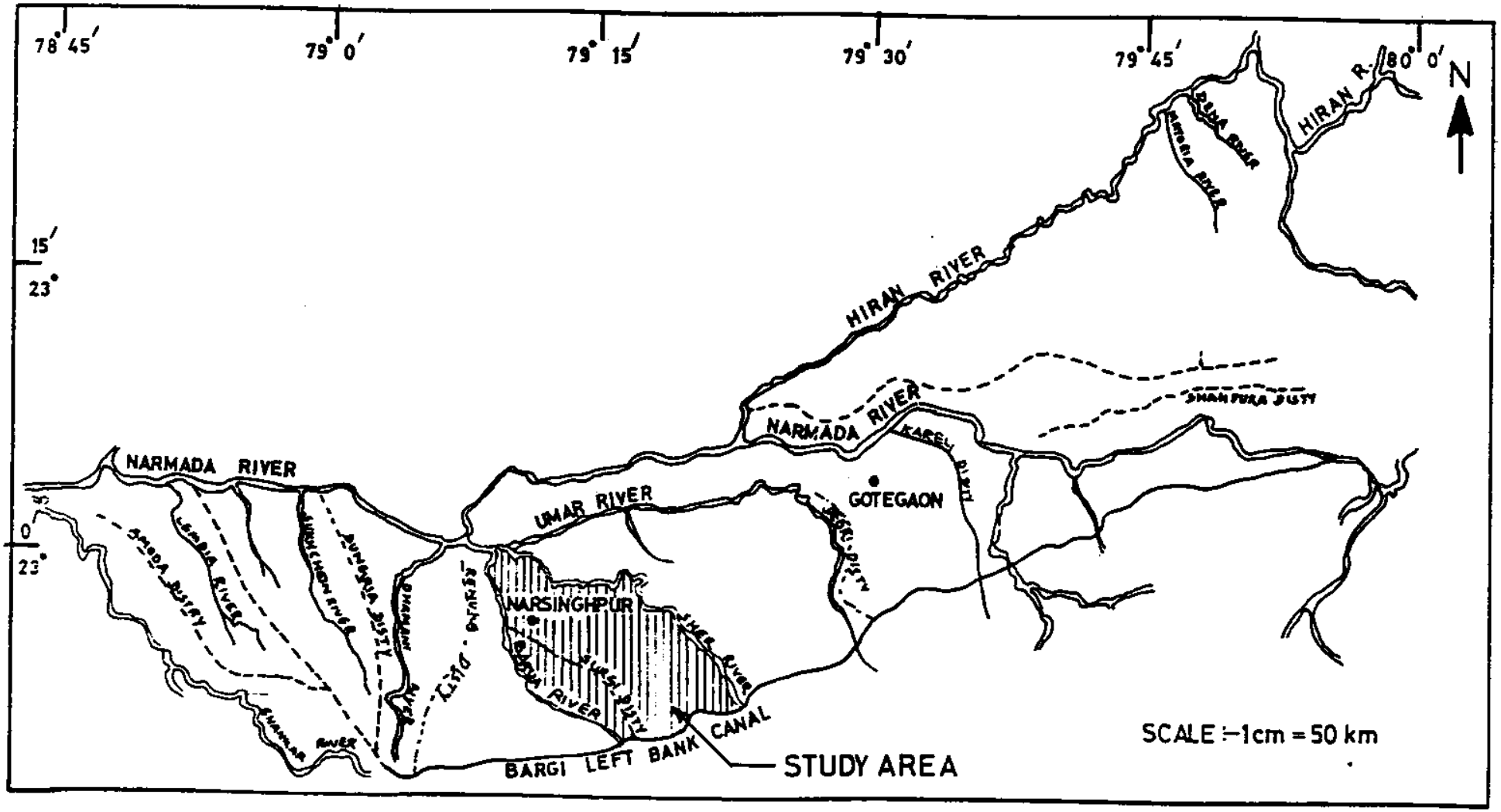

Fig.1 : Location map of the study area.

to grow rabi crops. In the plain area, the slope ranges from 0 to 3%, but in area having undulating topography, the steeper slopes even up to 15% are noticed.

The drainage in the area is dendritic in nature. 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 Barurewa. In the central part of the doab, the drainage is poor.

2.3 Climate

The study area broadly falls in sub-zone-2c based on hydrometeorological similarity of the country. The tract enjoys a sub-tropical climate. There are considerable variations in rainfall, temperature and humidity. The area has three distinct seasons in a year, (i) rainy season, (ii) winter season, and (iii) summer season.

The rainy season in area extends from June to October under the influence of south-west monsoon. The area also receives some rainfall during January and February from North-East monsoon. July and August are the heaviest rainy-months. Normally, the rainfall ceases by the end of September. However, inquiet a large number of years, October receives good rainfall. There is considerable variation in rainfall from year to year as well as month to month in a 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 begins to rise rapidly from about March till May which is generally hottest month. With the on-set of the monsoon in the second week of June, there is an appreciable drop in day temperature. From mid-November on wards, both day and night temperature decreases rapidly. December and January are the coldest months of the year.

In winter, cold waves affect the area in the wake of western disturbances passing across North India. Normally, the annual temperature varies from 2^0C to 45^0C. On the whole, the days are warm and nights are cooler.

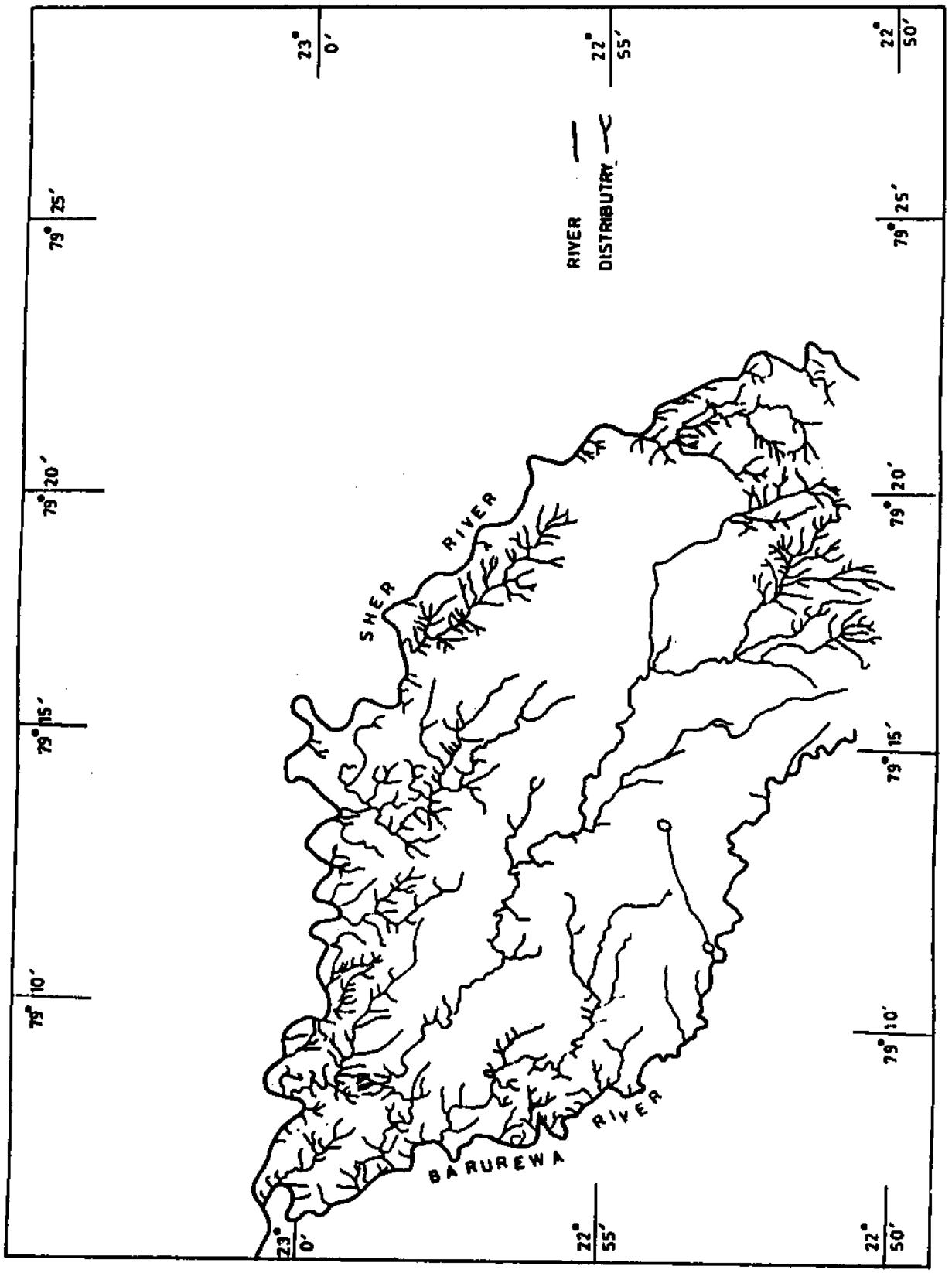

FIG. 2 : Drainage map of the Sher-Barurewa river doab.

Table-1 : Mean monthly rainfall at Narsinghpur meterological station for the 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

Broadly speaking, the soils of the area are in various shades of darkness and are derived from Deccan trap rocks. Generally, the soils are clayey in texture and its depth is more than 9 m. Mostly black soil constitute the top layer and is variable in thickness (about 1-2 meters). Below the dark brown soil, a yellowish layer is found. 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.

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 four types of soil i.e. clay, clay loam, sandy clay loam and loam, in which clay and clay loam are predominant (FIG.-3). Based on morphological and chemical characteristics of the soil profiles six soil series i.e. Beloda, Sanguraria, Sarol, Gopalpur, Amagaon and Kunda have been identified (FIG.-4). The types of soil and soil series of area are enlisted in TABLE-2 and TABLE-3 respectively.

Table-2 : Soil texture in Sher-Barurewa doab area.

Sl. No.	Textural class	Grid No.	Total no. of Grids
1.	Clay	229, 230, 231, 232, 234, 242, 245, 248, 249, 250, 252, 253, 260, 261, 262, 263, 265, 267, 269, 270, 280, 281, 282, 283, 284.	25
2.	Clay loam	233, 244, 246, 251, 266, 268, 277, 278.	8
3.	Loam	264.	1
4.	Sandy Clay loam	243, 247, 258, 259, 275, 276, 279, 287, 288.	9

Table-3 : Soil Series in Sher-Barurewa doab area.

Sl. No.	Soil Series	Grid No.	Total No. of Grids
1.	Amgaon	229, 230, 231, 232, 233, 234, 245, 249, 250, 251, 260, 262, 263, 266, 269, 270, 282, 284.	18
2.	Beloda	244, 248, 252, 267.	4
3.	Gopalpur	243, 246, 247, 259, 264, 279.	6
4.	Kunda	242, 258, 268, 275, 276, 277, 287, 288.	8
5.	Sarol	265, 280, 281, 283.	4
6.	Songuraria	253, 261, 278.	3

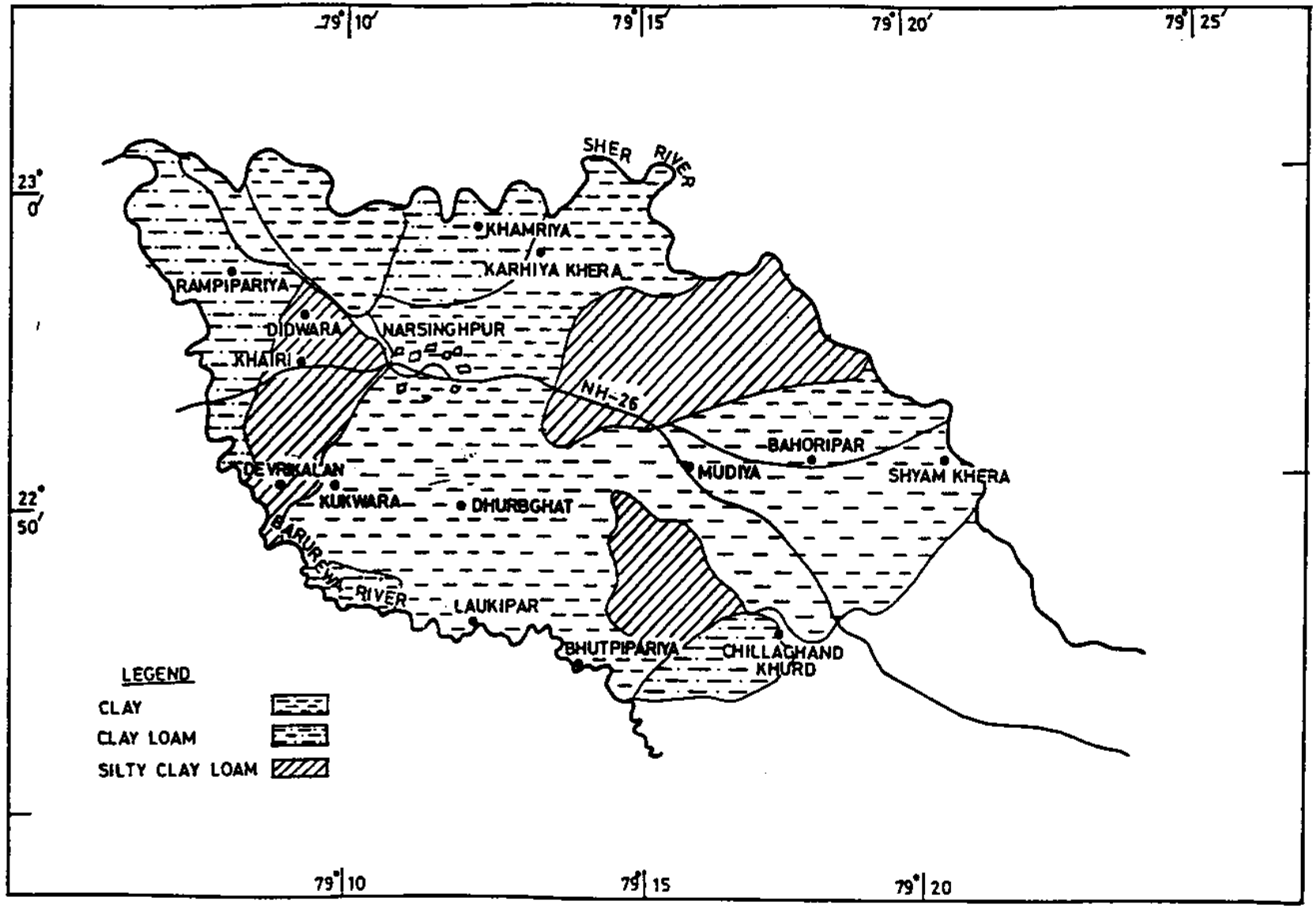

Fig. 3 : Soil type map of the Sher-Barurewa river doab

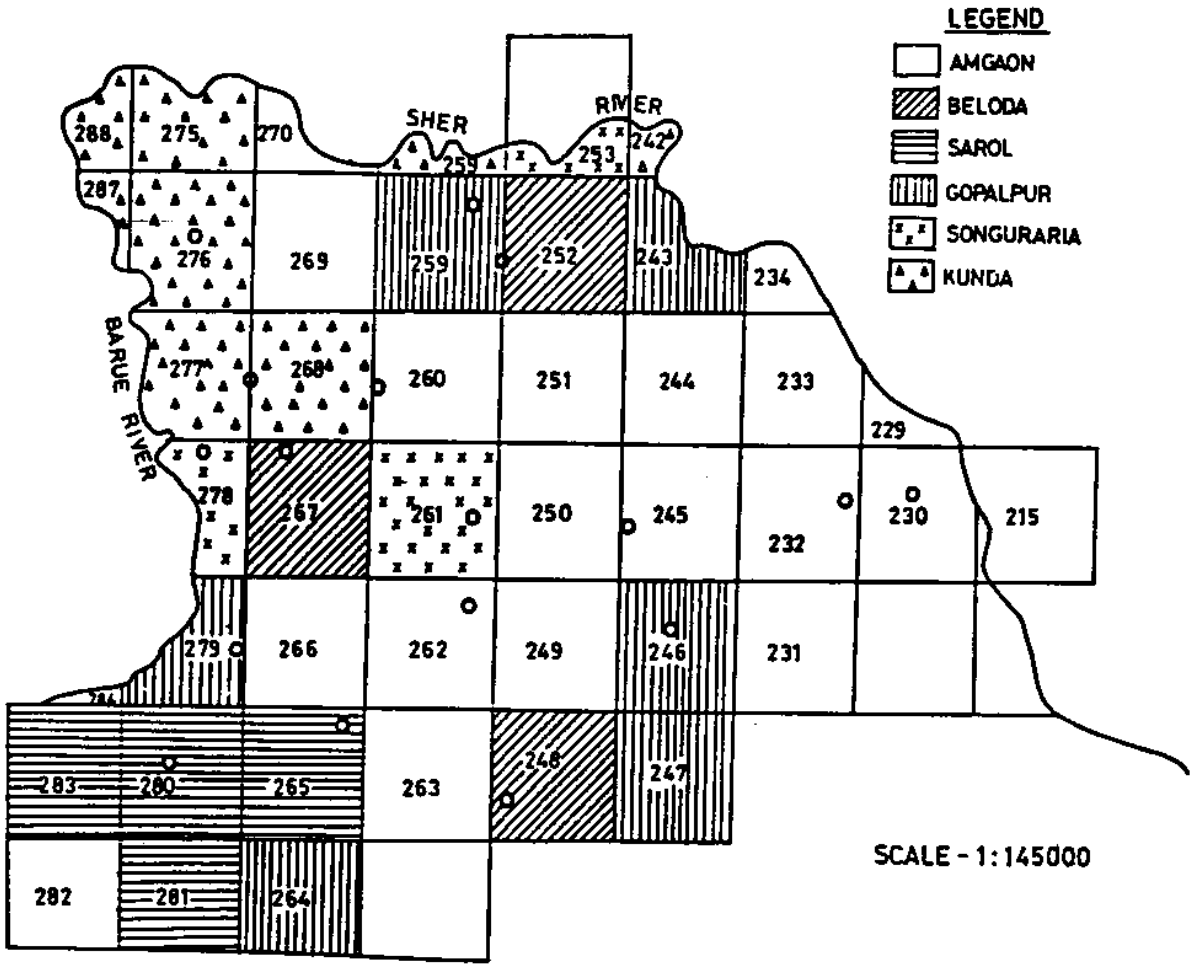

Fig. 4 : Soil series map of the Sher-Barurewa river doab

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. The water levels in different observation wells in 1989 are given in TABLE-4.

Table-4 : Groundwater conditions in the study area in 1989.

S. No.	Village	Ground Level (m)	Pre-monsoon (m)	Post-Monsoon (m)
1.	Devakachh	340.00	322.00	323.85
2.	Nandwara	351.00	345.55	347.28
3.	Narsinghpur	352.50	338.28	343.52
4.	Singhpur	359.50	345.40	350.00
5.	Khamaria	341.50	335.70	337.95
6.	Dangidhan	369.90	359.40	365.15
7.	Bachai	385.00	378.40	381.55
8.	Mainawari	355.00	349.09	352.77
9.	Ghatpidar	363.20	356.25	357.60
10.	Rathotia	349.00	339.70	341.00
11.	Umaria	345.00	326.90	328.05
12.	Kalyanpur	375.00	368.90	372.15
13.	Niwari	349.00	349.45	353.65
14.	Navalgaon	366.70	361.05	365.15

(Source : Groundwater Survey Unit, Narsinghpur)

2.6 Landuse and vegetation

The study area is normally agricultural area with no forest land. Forested area lies beyond Bergi 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.

2.7 Irrigation Practices

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.

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 Parameters for Hydrologic Soil Classification

Hydrologic soil classification is essential for the evaluation of runoff. The main parameters used commonly in hydrologic soil classification are (i) Effective soil depth, (ii) Soil texture/average clay content in the surface and sub surface layers, (iii) Soil structure in the surface and sub surface layers, (iv) Infiltration rate, and (v) Soil permeability.

3.1.1 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.

3.1.2 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.

3.1.3 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

3.1.4 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.

3.1.5 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-5.

Table-5 : 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)

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

From the above discussion it is clear 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. But it has been observed that 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 minimum infiltration rate.

The infiltration rate is affected by most of the soil and other related parameters. Therefore, the knowledge of constant infiltration rate 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 constant infiltration rate, as most of the parameters are going to affect this rate in the present study.

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

For determination of physical as well as hydrologic properties of soil, the following experiments were conducted in the field.

4.2.1 Soil sampling and effective depth

The objectives of this measurement were to determine the physical properties of soil; to know the antecedent soil moisture 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. It was difficult to go deeper by hand auger beyond 2 m. This was also helpful in the determination of effective depth of soil and sample collection for particle size distribution. For each site, it was observed that effective depth was more than 2 m. From available literatures, it was known that generally soil cover is more than 9 m in the area. 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 2 m depth. Usually two types of soil were encountered at each site. The top soils of the area are mostly dark coloured and are clayey in texture. These soils normally form a layer of about 1-2 meter thickness. At few places, underlying coarse calcareous yellow coloured soil are also exposed. Black clayey soils have been derived from Deccan Trap rocks, which are abundant in the nearby areas.

The samples were collected in polythene bags and sealed tightly to preserve naturality.

4.2.2 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. Both the black clayey soils and yellow calcareous soils have low infiltration rate, ranging from 0.24 cm/hr to 1.2 cm/hr. In the initial period of water application the infiltration rate is very high which reduces very rapidly with time. The results of the infiltration tests are given in TABLE-6.

The infiltration map of the area is shown in FIG.5.

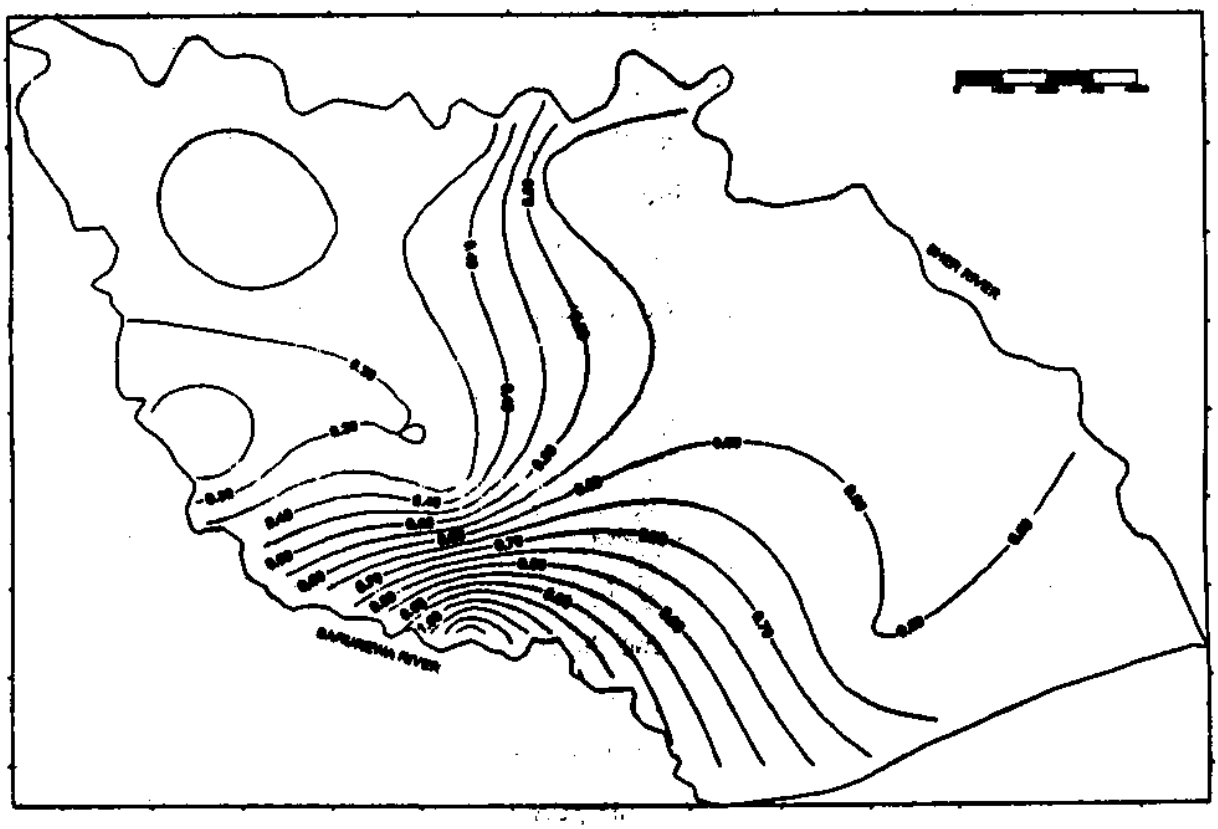

Fig. 5 : Infiltration capacity map of the Sher-Barurewa river doab.

Table-6 : Infiltration capacity in Sher-Barurewa doab.

S.No.	Name of village	Infiltration Capacity (cm/hr)
1.	Chilichawk Khurd	0.60
2.	Karhiyakhera	0.40
3.	Devri Kalan	0.20
4.	Kukwara	0.30
5.	Niwari	0.24
6.	Mudia	0.60
7.	Shyamkhera	0.60
8.	Khandhrapur	0.80
9.	Laukipar	1.20
10.	Khamariya	0.30
11.	Dhrubghat	0.30
12.	Didwara	0.40

4.2.3 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-7. The Table shows that the hydraulic conductivity of the soils is very low.

The large difference in infiltration capacity and saturated hydraulic conductivity at some locations may be due to the presence of rat holes and other type of heterogeneities present in the soil.

Table-7 : Saturated Hydraulic conductivity of the soils of Sher-Barurewa doab.

S.No.	Name of village	Saturated Hydraulic Conductivity (cm/hr)
1.	Chilichawk Khurd	0.15
2.	Karhiyakhera	NF
3.	Devri Kalan	0.18
4.	Kukwara	0.003
5.	Niwari	NF
6.	Mudia	0.38
7.	Shyamkhera	0.04
8.	Khandhrapur	0.84
9.	Laukipar	4.60
10.	Khamariya	4.01
11.	Dhrubghat	0.21
12.	Didwara	0.31

4.2.4 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 near by open well with the help of water table indicator. 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 table, at all the twelve places, was measured in the lst-2nd week of October'95. The water level measured in the area are given in TABLE-8.

Though the water table in the area is shallow, it has not shown any effect on the infiltration rate, because the rates of infiltration are firstly affected by paticle size and type of minerals present and then by water table. Since the soils in the area are mainly clayey (see next section) and also the clays are swelling type, therefore, infiltration rate is mainly affected by soil type rather than water table position.

Table-8 : Groundwater table depth in Sher-Barurewa doab in October 1995.

S.No.	Name of village	Depth to Water Table (m)
1.	Chilichawk Khurd	2.50
2.	Karhiyakhera	6.50
3.	Devri Kalan	2.20
4.	Kukwara	7.70
5.	Niwari	4.80
6.	Mudia	4.90
7.	Shyamkhera	24.60
8.	Khandhrapur	2.25
9.	Laukipar	4.20
10.	Khamariya	3.20
11.	Dhrubghat	7.10
12.	Didwara	4.50

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 sieving. 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-9.

Table-9 : Particle size distribution in soils of Sher-Barurewa doab.

S. No.	Name of village	Depth (cm)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Texture
1.	Chilichawk Khurd	10-35	0.50	27.00	15.50	57.00	Clay
2.	Karhiya khera	20-50	5.30	6.50	12.20	76.00	Clay
3.	Devri Kalan	25-50	5.20	11.30	13.50	70.00	Clay
4.	Kukwara	25-50	4.40	5.60	11.00	79.00	Clay
5.	Niwari	25-50	7.00	17.50	9.50	66.00	Clay
6.	Mudia	25-50	0.80	2.80	14.90	81.50	Clay
7.	Shyamkhera	20-40	0.10	5.40	11.50	83.00	Clay
8.	Khandhrapur	20-50	2.10	11.67	10.73	75.50	Clay
9.	Laukipar	20-50	0.10	36.31	14.59	49.00	Sandy clay
10.	Khamariya	25-50	2.60	34.65	10.75	52.00	Sandy clay
11.	Dhrubghat	15-50	1.10	2.60	11.30	85.00	Clay
12.	Didwara	25-50	2.20	7.70	12.60	77.50	Clay

The Table-9 shows that the soils are mostly clayey in texture, except at two places, i.e., Khamariya and Laukipar, where sand percentage is a bit higher and the soils are sandy clay in texture. The soil textue taken from the map of Soil Survey Unit, Jabalpur, Department of Agriculture, Madhya Pradesh does not exactly match with the above Table. This may be due to the fact that the above soil textures are of the soils which are 20-50 cm below the surface..

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-10 .

Table-10 : Hydrologic Soil properties of the soils of Sher-Barurewa doab.

S. No.	Name of village	Soil Series	Effective Depth (cm)	Texture / Clay content (%)	Infiltration Capacity (cm/hr)	Permeability (cm/hr)	Depth to Water table (m)
1.	Chilichawk Khurd	Gopalpur	>100	Clay (57.0)	1.20	0.15	2.50
2.	Karhiya khera	Beloda	>100	Clay (76.00)	0.40	NF	6.50
3.	Devri Kalan	Songuraria	>100	Clay (70.00)	0.20	0.18	2.20
4.	Kukwara	Beloda	>100	Clay (79.00)	0.30	0.003	7.70
5.	Niwari	Sarol	>100	Clay (66.00)	0.24	NF	4.80
6.	Mudia	Amagaon	>100	Clay (81.50)	0.60	0.38	4.90
7.	Shyamkhera	Amagaon	>100	Clay (83.00)	0.60	0.04	24.60
8.	Khandhrapur	Gopalpur	>100	Clay (75.50)	1.20	0.84	2.25
9.	Laukipar	Amagaon	>100	Clay (49.00)	1.20	4.60	4.20
10.	Khamariya	Gopalpur	>100	Sandy Clay (22.00)	0.30	4.01	3.20
11.	Dhrubghat	Songuraria	>100	Sandy clay loam (85.00)	0.30	0.21	7.10
12.	Didwara	Amagaon	>100	Clay (77.50)	0.40	0.31	4.50

Based on the individual soil properties, the soils of the Sher-Barurewa river can be classified into various hydrological soil groups (Table-11).

Table-11 : Hydrologic Soil Groups based on individual soil properties in Sher-Barurewa doab using SCS method.

S. No.	Name of village	Soil Series	Hydrological soil Groups based on					
			Effective Depth	Clay content	Texture	Infiltration Capacity	Permeability	Water table
1.	Chilichawk Khurd	Gopalpur	A	D	C	D	D	C
2.	Karhiya khera	Beloda	A	D	D	D	D	A
3.	Devri Kalan	Songuraria	A	D	C	D	D	C
4.	Kukwara	Beloda	A	D	D	D	D	A
5.	Niwari	Sarol	A	D	D	D	D	B
6.	Mudia	Amagaon	A	D	D	D	D	B
7.	Shyamkhera	Amagaon	A	D	D	D	D	A
8.	Khandhrapur	Gopalpur	A	D	C	D	D	C
9.	Laukipar	Amagaon	A	D	D	D	D	B
10.	Khamariya	Gopalpur	A	D	D	D	D	B
11.	Dhrubghat	Songuraria	A	D	D	D	D	A
12.	Didwara	Amagaon	A	D	D	D	D	B

It can be seen from the Table-11, that based on effective depth and groundwater table position, the soils of the area falls under Groups-A to C. Whereas, based of other properties like texture, clay content, infiltration rate and hydraulic conductivity, the soils can be classified into Group-B to D. Since the top soil in the area is mostly clayey, it will restrict downward movement (infiltration and percolation) of water and will generate high surface, therefore, effective depth may not give correct hydrological soil group for the area. Similarly, the groundwater table which is shallow and under confined conditions (due to the presence of top clay layer) may not be useful for the classification of hydrological soil groups in Sher-Barurewa doab.

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. Therefore, in the present study infiltration rate has been taken as the criteria for the hydrologic soil classification grouping.

Based on this criteria, soils of the Sher-Barurewa doab have been classified into hydrologic soil groups (Table-12).

Table-12 : Hydrologic Soil Groups assigned to soils of Sher-Barurewa doab.

S. No.	Name of village	Soil Series	Hydrologic soil group
1.	Chilichawk Khurd	Gopalpur	D
2.	Karhiyakhera	Beloda	D
3.	Devri Kalan	Songuraria	D
4.	Kukwara	Beloda	D
5.	Niwari	Sarol	D
6.	Mudia	Amagaon	D
7.	Shyamkhera	Amagaon	D
8.	Khandhrapur	Gopalpur	D
9.	Laukipar	Amagaon	D
10.	Khamariya	Gopalpur	D
11.	Dhrubghat	Songuraria	D
12.	Didwara	Amagaon	D

There are six soil series in the area and each soil series has some varying infiltration capacity. But still all the soils of the area fall under one hydrological soil group, i.e., Group-D. Hydrologic soil group of the Sher-Barurewa river doab is shown in Fig.6.

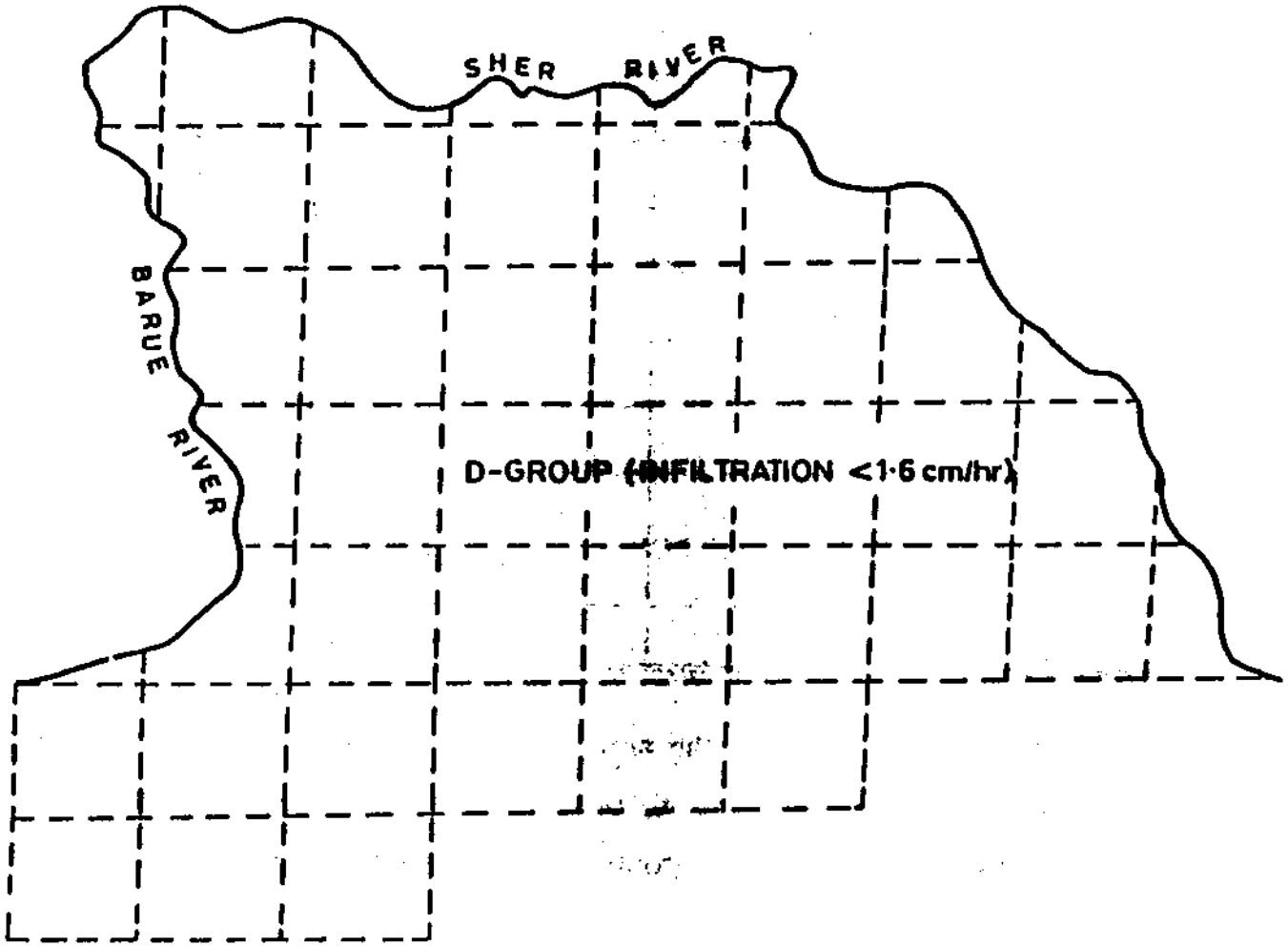

Fig. 6 : Hydrologic soil group in Sher-Barurewa river doab.

5.0 CONCLUSIONS

Following conclusions can be drawn from the above study:

1. None of the existing hydrologic soil classification schemes are robust enough to accommodate the all the soil properties into a particular group. Further research is needed through component, cluster, regression approaches to establish inter-relationship amongst parameters of hydrologic soil classification and to assess optimum or their relative merits to invoke upon the problem.

2. Infiltration rate may be adopted as main parameter for hydrologic soil classification, as other parameters are going to affect it.

3. For drawing the thematic map for hydrological soil classification, the major hydrological soil group of the same soil series at different locations may be taken as representative soil group.

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