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INFILTRATION STUDIES IN BAIRA NALLA SUB-CATCHMENT H.P.

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ABSTRACT

The phenomenon of infiltration, that is the process of water entry into the soil deserves a special place in hydrologic studies. In the present study an attempt has been made to develop infiltration curves for Baira nalla sub-catchment in the district of Chamba, H.P. For the purpose double ring cylinder infiltrometer tests were conducted at 30 places within the basin under different land uses on different dates

The regression analysis was performed between field observations for Kostiakov (1932) type infiltration function ($Y = a t^b$) using multiple linear regression . The results showed that the average initial infiltration rates were higher for forest lands (42.45 cm/hr) than barren(26.4 cm/hr), grass (24.4 cm/hr), agriculture(36.0 cm/hr) and mixed forest (39.6 cm/hr) lands. The correlation coefficients of regression equation ($\log y = b \log t + \log a$) ranged from 0.97 to 0.99 in most cases confirming a good fit of the infiltration function.

1.0 INTRODUCTION:

Infiltration is the downward movement of water from precipitation, through soil surface due to the combined forces of the capillarity and gravity contributing to replenishment of soil moisture, recharge of aquifers and ultimately augmenting the stream flows during dry periods. This is an important parameter for hydrologists and watershed managers. Knowledge of infiltration characteristics of the basin helps in estimating the quantity of rainfall excess resulting from a stream. Infiltration is one of the basic parameters for developing an integrated crop , soil and water management plan and often used in on-farm irrigation water management practices. Hydrologic importance of the process is to be seen from the fact that it marks the transition from fast moving surface water to slow moving soil and ground water.

Infiltration characteristics are very useful to the agronomists and ecologists who are concerned with the availability of soil moisture in the root zone of crops and plants. The plant growth may be affected in the conditions of water logging or moisture stress. Therefore, the infiltration is very important for assessing the soil moisture deficits and accordingly planning irrigation and drainage systems.The knowledge of infiltration is also useful to soil conservationist for planning devices to dissipate the energy of flowing water to minimise soil erosion. He may suitably plan engineering and forestry measures to induce infiltration through the land surface depending upon the soil infiltration characteristics. A geomorphologist may be interested in the magnitude, frequency and spatial characteristics of infiltration related to rainfall intensity for preventing land slips due to overland flow.

Computer models of runoff processes of a hydrologic system have been devised to simulate annual hydrograph and to estimate the frequency and magnitude of high and low flows in rivers with little or no hydrologic records. Such models reflect varying views of how the source areas generate stream flow. Traditional engineering models are mostly infiltration based.

Keeping in view the importance of infiltration characteristics in hydrology and watershed management practices it is attempted to determine infiltration characteristics of Baira-nalla sub catchment in HP state. To the extent possible, the exhaustive numbers of field tests were carried out under forests, barren, grasses, agriculture and mixed forest lands etc. to accomplish objectives of long term hydrologic studies of mountainous representative basins. The results obtained through analysis of various field data have been carafully examined and presented through tabular as well as graphical form in the present report.

2.0 REVIEW:

2.1 General :

The term infiltration was used in the United States by Goerge P.Marsh, a careful observer of natural phenomena, and he published the edition "Man and Nature" in 1864. Ivan Houk (1921), in connection with the studies leading to the development of the Miami conservancy District in Ohio, under Arthur E. Morgan, reported the results of measurements of " soil absorption" for several conditions in the vicinity of the Miami River. This term was used in reference to the difference between rainfall and runoff of small areas while formulating the plans for the Miami flood control Project. In the mid of 1930, the American Geophysical union established a research committee on infiltration, a process which was regarded as of having significant role on water resources planning.

Infiltration may be defined as the process of water entry into the soil, generally by downward flow through all or part of the soil surface. Water may enter the soil through the entire surface uniformly as under ponding or rain, or it may enter the soil through furrows. Infiltration rate is the volume of water entering the soil profile per unit of soil surface area and time. The maximum rate at which a given soil in a given condition can absorb water is known as **infiltration capacity** or infiltrability of the soil.

2.2 Factors Affecting Infiltration :

The factors which mostly affect the infiltration capacity are intensity and duration of rainfall, soil characteristics, condition of soil (Soil moisture content), vegetal cover, land use, entrapped air, depth of the ground water and weather (temperature) etc.

Infiltration rate is a function of both rainfall rate and soil conditions. If the rainfall rate is less than infiltration capacity rate, infiltration may continue indefinitely at a rate equal to the rainfall rate without ponding at the surface. When rainfall rate is more than the infiltration capacity, the infiltration rate is limited by the capacity of the soil to absorb water. This results in surface ponding and water becomes available for run-off.

The soil texture controls the infiltration rate until the soil behind the wetting front reaches saturation. As soon as the water content of the soil reaches saturation, the hydraulic conductivity begins to control the infiltration rate. The depth of the soil profile and its initial moisture content determines the amount of infiltrated water which can be stored in the soil before saturation is reached. Higher the initial moisture content, lower will be the infiltration capacity. Organic matter content promotes soil aggregation and ultimately that will cause rapid infiltration and drainage.

Vegetal cover and land use are very important factors for affecting the infiltration rates. The vegetal cover provides protection against rain drop impact which reduces the soil erosion. Vegetal cover facilitates high rate of infiltration which in turn reduces the surface run-off. Mulching greatly improves the infiltration rates by absorbing the raindrop impact and prevents the formation of impervious surface layer.

The entrapment of soil air builds up air pressure, which reduces the infiltration rate. Besides these factors, the depth of ground water table, weather (temperature) and man's activities also affect the process of infiltration.

2.3 Theory of Infiltration :

Green and Ampt (1911) developed infiltration equation from a ponded surface in deep homogeneous soil with uniform initial water content based on Darcy type water flux. Infiltration has to be proportional to the total gradient, including suction effect. Therefore,

$$f = \frac{Ks(H + £ + Lf)}{Lf} \qquad (1)$$

Where, f is infiltration rate or capacity (units of velocity), H is a some level of ponding on the surface, £ is a suction effect due to dryness at lower levels, Lf is the increasing depth of the water front and Ks is saturated hydraulic conductivity. It is assumed that the wet front moves as piston. If H is assumed small , eqn. 1 can be expressed as

$$f = Ks + \frac{Ks\ S\ £}{y} \qquad (2)$$

Where y is the total infiltrated water given by (Qs-Qi).Lf = SLf, and S is the initial moisture (as a fraction volume) deficit of the soil column. Haan et al. (1982) have also provided a good summary of results to the Green and Ampt model.

Kostiakov (1932) proposed an empirical equation and is generally known as Kostiakov equation (Lewis, 1937, Criddle et al., 1956, Haise et al.,1956). The equation is given as :

$$y = a\,t^{b} \qquad (t \text{ is not } = 0) \qquad (3)$$

Where y is cumulative depth of water infiltered (cm); t is time elapsed from start of the ponding of the water (hr), a and b are empirical constants.

Horton (1933) defined infiltration as the process involved when water soaks into the ground. The rate at which water can enter the soil is called the infiltration capacity. (Horton, 1940 Fleming et al 1975). After a period of 1-2 hours water infiltrates at a slow steady rate. This is called the **basic infiltration rate**. The proposed Horton's equation for infiltration capacity (cm/hr) at time t is :

$$f = fe + (fo - fe)\,e^{-kt} \qquad (4)$$

Where k is a constant representing the rate of decrease in infiltration f; fe is final or equilibrium capacity (cm/hr) ; and fo is initial infiltration.

Klute (1952) defined infiltration into unsaturated soil by differential equation as given under:

$$\frac{dQ}{dt} = \frac{d}{dz}\left(K\frac{dO}{dz}\right) + \frac{d}{dz}(K.g) \qquad (5)$$

(<u>N.B.: d denotes partial differentiation</u>)

Where, Q is the moisture content in volume of water per unit volume of soil, K is the unsaturated hydraulic conductivity (L/T), O is the capillary potential (L) , g is gravitational constant (L/T^2) and z is the vertical co-ordinate (L).

Philip (1957) suggested the following theoretical infiltration equation based on physical properties of soil and analysis of water penetration into a uniform soil.

$$y = Sp\ t^{0.5} + a\ t \qquad (6)$$

Where , y is cumulative infiltration (cm) at time t , Sp is 'sorptivity' parameter that relates to capillarity or soil matrix forces, and a is soil parameter relating to transmission of water through the soil or gravity force.

Soil Conservation Service (1968) empirically obtained run-off over finite areas for various regions in the United States. The equation is:

$$P - y - Ia = Rs = \frac{(P-Ia)^2}{(P - Ia + S)} \qquad (7)$$

$$P \geq Ia$$

$$S \geq Ia + y$$

Where, P is volume of total precipitation, y is volume of total infiltration, Ia is an initial retention volume and S is the potential maximum surface retention. The initial abstraction Ia is commonly taken as Ia = 0.2 S . The retention volume is given by:

$$S\ (\text{inches}) = \frac{1000}{CN} - 10 \qquad (8)$$

Where CN is called curve number , a parameter dependent on soil type , use , and antecedent moisture conditions.

Holton (1971) proposed the following equation for infiltration capacity (cm/hr) at time t,

$$f = ci\ Sa^{n} + t\ fe \tag{9}$$

Where, i is infiltration capacity per unit of available storage ; Sa is available storage which is the difference between the potential soil moisture storage and the cumulative (cm), n is a coefficient that relates to soil texture ; fe is constant rate of infiltration after prolonged wetting of soil (cm/hr) and the value of c is given as 0.69 for cm (1.0 for inches).

2.4 Infiltration Studies Abroad :

Duley (1939) showed in his experiments on infiltration that infiltration decreases rapidly during rainfall because of formation of thin compact layer on soil surface. Browning (1939) observed that soil swells at the expense of soil pores. He generalized that factors responsible for pore size distribution in soil shall influence the rate of infiltration.Christiansen (1944) showed that entrapped air in the soil decreases infiltration considerably.

Kittredge (1948) concluded that the difference in infiltration between forested and cropped soils may be in the ratio of 100 to 2. Annon (1962) also reported that the infiltration rate was highest in the forest land in comparison to grass or bare and agricultural soils.

Musgrave (1955) concluded from his study on infiltration that the various factors such as surface condition and cover , internal soil characters and profile, soil moisture status duration of rainfall and application of water , season of the year, temperature of soil water etc. affect soil intake of water

Hay and Subramanyam (1955) found that generally field infiltration rates become constant after three hours. Infiltration rates were increasing in the order of bare land, scrub forest and ploughed land respectively.

Wood (1977) conducted infiltration studies on various vegetal covers adjacent to agricultural areas. He observed that the water infiltration rates were higher on 14 out of 15 forest sites than in the adjacent sites used for agriculture. Lee (1980) concluded in his study that forest fires may decrease infiltration rates significantly.

Walfe et al. (1988) have formulated three layer infiltration model using the Green and Ampt approach (1911) The characteristics of the surface and tilled are transient being subject to surface sealing and consolidation respectively.

2.5 Infiltration Studies in India :

Mistry and Chatterjee (1965) conducted infiltration studies in Bihar and recorded average infiltration rates as 26,12 and 9 cm/hr under forests , grasslands and croplands respectively.

Tejwani et al. (1975) reported average infiltration rates under different types of site conditions. They found infiltration rates 1.0,2.60 and 17.0 cm/hr for agricultural land, grass land and wood land respectively in Bellary. The infiltration rates in Ootacamund under Shola forest , Broom and Grazed grass land were recorded 12.50, 11.25 and 6.25 cm/hr respectively.

Mathur et al. (1982) found higher infiltration rate in the forest soils than in adjacent agricultural soil subject to continued cultivation. He also showed that infiltration capacity of forest land may decrease abruptly as a result of forest fires that destroy organic layer (litter and humus) as well as vegetation at the forest floor and compact the soil.

Dhruvanarayana and Shastri (1983), conducted a comparative study on different forest covers in Dehradun (North Western Himalayan Region) and recorded initial infiltration rates as 54.0, 21.4, 12.0,9.6 , 9.6 and 7.6 cm/hr under Eucalyptus, sal , chir,teak, Bamboo and grass land respectively . In the same study effects of the fire on infiltration in chir plantation was studied and infiltration was reduced to a value of 3.6 cm/hr. The analysis of infiltration data from small forests and agriculture watershed in Doon Valley indicated that the rate of infiltration was twice in forest watershed (shorea Robusta) as compared to agriculture watershed.

Soni et al. (1985), have conducted infiltration studies in the experimental plantations of Forest Research Institute & College, Dehradun under Pinus Roxburghii plantation, Sal plantation, Teak plantation, Bamboo plantation, Eucalyptus plantation and ungrazed grassland . The infiltration rates were found to be highest in Eucalyptus and lowest in Pinus (after burning) . Infiltration capacities under different vegetation covers were found positively correlated with soil porosity and negatively with bulk density.

Soni and Singh (1988) developed a methodology for an average infiltration function from point infiltration measurements using cylinder infiltrometers. The natural logarithm of cumulative infiltration at 15,30,45,60,75,90,105,120,135,150,165,180,and 195 minutes elapsed time were found to be normally distributed. It was, therefore, concludec that geometric mean of cumulative infiltration observed at different locations should be taken to arrive at the average cumulative infiltration values for the entire field.

Om Kar and Pal (1990) conducted infiltration tests prior to irrigating wheat crop for evaluating performance of border irrigation system. Regression analysis was performed for Kostiakov (1932) infiltration model between cumulative depth of water (dependent variable) and elapsed time (independent variable). The constants a and b in Kostiakov (1932) infiltration function (Eq. 3) were found to be higher prior to first irrigation than second one. The correlation coefficients were found to be varied from 0.94 to 0.99 for all tests. It may be concluded that infiltration rates decreased prior to second irrigation due to surface sealing by smaller soil particles and rising of moisture level during first irrigation. The correlation co-efficients for the function ranged from 0.94 to 0.99 in all experiments.

Ranganna et al. (1991) carried out infiltration tests on different soils in Pavanje river basin in Dakshina Kannada district of Karnataka State. They observed that constant infiltration rates were highest in sandy soils . However, there were a few cases of constant infiltration rates quite high in lateritic soils . This may be due to other factors which affect infiltration viz., soil surface conditions, depth of surface detention, compaction , soil moisture content, macrostructures of soils etc.

3.0 STATEMENT OF THE PROBLEM:

Infiltration characteristics of a soil is an important parameter for hydrological modeling . It is essential to know the rates at which different soils will take in water under different conditions. Infiltration rates are affected by a number of factors of which soil moisture, soil texture and vegetal cover are most important. It is a basic parameter for developing an integrated crop, soil and water management plan. The knowledge of infiltration is of great importance to a hydrologist in estimating rate of run-off and peak flow with time, to a soil scientist / agronomist in estimating the availability of soil moisture, to irrigation and drainage engineers in planning and designing various water resources development projects.

Infiltration measurements in India have been made in a large number using different methods ranging from simple infiltrometer to rainfall simulator .Many agencies like AIS & LUS, CSWCRTI, Dehradun and various academic organizations have conducted studies to ascertain the infiltration characteristics of various river basins However, there are following reasonable gaps regarding infiltration studies conducted so far:

1. Infiltration data for many basins are not available.
2. Preparation of thematic maps for different basins have not been done.
3. Data availability and studies on infiltration at vegetated and snow covered soil surfaces are very limited.
4. The hydrological parameterizations of surface run-off and ground water have been well achieved , however, studies concerning with infiltration process still lag behind.

Keeping in view the various existing gaps, National

Institute of Hydrology proposed to conduct field infiltration tests on national level. The study aims to prepare an all India infiltration map and to determine average cumulative infiltration function from point infiltration measurements. In pursuit of these objectives, and also as component part of long term representative basin studies, the NIH Regional Centre, Jammu has carried out field tests in several places within Baira-nalla sub-catchment of HP state.

4.0 THE STUDY AREA:

The study area of Baira Nalla sub-catchment at Tissa in the district of Chamba, Himachal Pradesh, India has been selected as one of the areas within the Western Himalayan Region for representative basin studies. It is located between latitude 32^{o} - 02' N to longitude 75^{o}-57' to 76^{o}-23' E. The area exhibits some of the prominent features of the Western Himalayan Region. As part of the long term representative basin studies, the area has been selected for infiltration studies.

The Baira Nalla sub-catchment above Tissa (Fig.1) is of about 585 sq.km covered under Survey of India map 52 D/1, 52 D/5, 52 C/4 and 43 P/13 in scale 1:50,000 with its elevation varying from 1600m to 4400m above m.s.l. and basin slope from North to South. The area is within Tissa block in the district of Chamba.

The Forest covered area and types of forest as per record of forest range, Tissa shows that in addition to total forest area of 2781.60 hectares in general category, there are 1490 hectares of forest area under departmental protected forest area (DPF) notified during British period.

Baira nalla sub-catchment have steep slopes with 'V' shaped valleys. Area reconnaissance reveals that there are two types of soil . The upland soil is derived from quartzite parent material and is sandy, with moderately high infiltration rates. At lower elevations old river terraces contain more clay and have a lower infiltration rate. Soil depths on the upper slopes are shallow, approximately 18-24 inches apparantly.

Geologically the Baira Nalla sub-catchment lies within

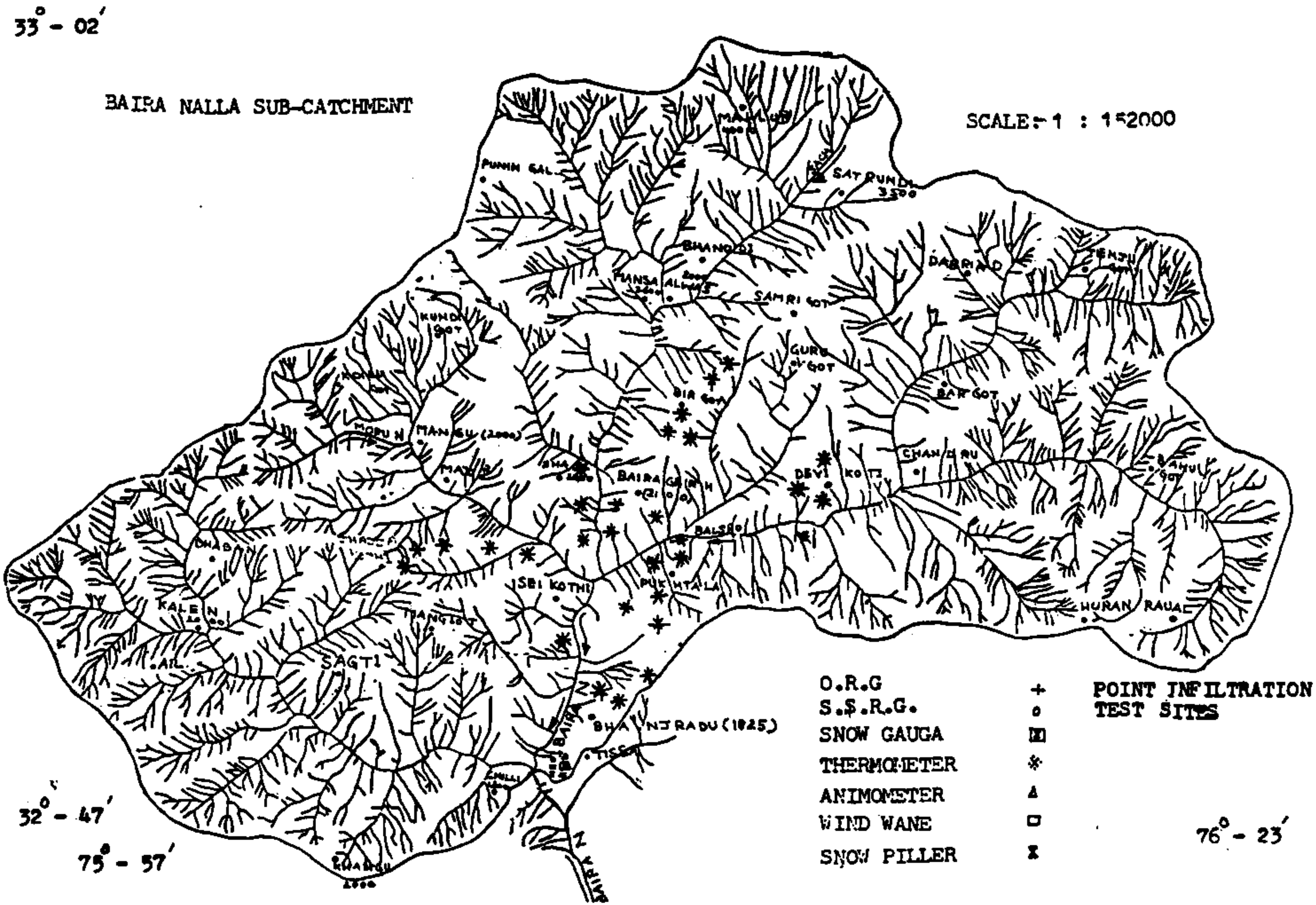

Fig.1. Index Map of Baira Nalla Sub-catchment

lesser Himalayas. Lesser Himalayas are separated from Siwalik rocks by main boundary thrust. The main rock types occuring in the area are dollomite, ,limestone, philates, Mica, Schist, Quartz (grey) etc. dipping towards south-west at the average of 30-50 degree, bearing three phases of folding. The lesser himalayas are separated from Higher Himalayas by main central thrust diping towards north-east.

There is unconfirmity in depositions of different layers. Rocks are highly fractured and planes are developing probably due to unstability. Because of the presence of Dollomite, Limestone etc. the area is very prone to erosion by process of chemical weathering when they come in contact with water . In phillates (low gravity metamorphic rock) and quartzites in the baren slopes water percolates along the fractures and ersion is caused due to biological weathering.

The river Baira Nalla has a total catchment of 585 sq.km of which some areas at higher elevation are under permanent snow cover. The basin is partially snow covered during winter from December to March with maximum snow cover of 70.22 % and minimum of 52.40% in Feburary and March as interpretated from Landsat imageries of five durations (Feb. 1984, Feb 85, Feb.89, March 90 and March 1992). Rain occurs mostly during July to August. Aannual, Rainfall of 1034 mm, 886 m, 1433 mm and 1136 mm in 1980, 1985, 1986 and 1987 respectively have been reported for the district of Chamba.

5.0 METHODOLOGY

Commonly used methods for determining infiltration capacity are hydrograph analysis and infiltrometer studies. Infiltrometers are usually classified as rainfall simulators or flooding devices. Flooding infiltrometers are usually rings or tubes inserted in the ground. Water is applied and maintained at a constant level and observations are made on the rate of the replenishment required. The present study has been conducted using a set of double ring cylinder infiltrometer discussed as follows:

5.1 Assembly:

In double ring cylinder infiltrometer, a small cylinder is placed concentrically inside another cylinder. Diameters were 30 cm for inner cylinder and 45 cm for outer cylinder. The height was 45 cm for both cylinders. The edge of cylinder should be beveled to reduce soil disturbance when the cylinder is pushed or driven into the soil. The diameter should be as large as practicable to get a true measure of the vertical infiltration.

5.2 Installation:

Cylinder infiltrometers should be installed with as little disturbance of the soil as possible. The soil surface should be in its natural condition and free from only woody stems, rocks, or other items that may get caught under the cylinder edge on inserting the device. The depth of penetration of the cylinder should be as small as possible to minimize soil disturbance, but large enough to prevent water from blowing out a hole under the cylinder wall. Penetration of about 5 - 10 cm is sufficient. If the soil surface is cracked, the cylinder should penetrate the soil at least as deep as the cracks, to prevent water from escaping laterally through cracks below the cylinder. If after installing the cylinder there is some separation between the soil inside the cylinder and the cylinder wall, the soil should be pushed or packed back against the cylinder.

5.3 Measurement of Infiltration:

The water used in infiltrometer tests must be of the same quality and composition as the water in the real systems for which the infiltration rate is to be estimated. Also, the water must be at about the same temperature as the soil. Equal water levels must be maintained in both cylinders (Bouwer, 1963) and the infiltration rate is measured on the inner cylinder only. The thought behind the double cylinder system was to let the outer annular space between the two rings absorb all the edge and divergence effects, so that the infiltration from the inner ring would be a true measure of the vertical infiltration rate of the soil.

Double ring cylinder infiltrometers could be effective only where there is a surface crust, an impeding layer on the surface, or other soil condition that makes it different to get a good bound between the undisturbed soil and the cylinder wall. Leakage along the cylinder wall can be minimized by placing another cylinder around the infiltrometer and maintaining the water level in there at exactly same height as in the inner cylinder.

6.0 RESULTS:

The infiltration studies for various sites were conducted using double ring cylinder infiltrometer. Multiple linear regression program MULTI.FOR was used to compute the coefficients of Kostiakov (1932) type infiltration function. The infiltration curves for different land uses and locations were developed. The results obtained are discussed as under:

6.1 Infiltration Rates Under Different Landuses:

The field tests were conducted for barren lands, agricultural lands, grass lands, forest and mixed forest lands. Table-1 gives the initial and final infiltration capacities for different land uses at various locations shown in Fig.1 and results are described through corresponding infiltration curves (Fig.2 to Fig.6). It was found that the initial infiltration capacities for barren lands, agricultural lands, grass lands, forest lands and mixed forest lands varied from 10.8 to 37.2, 14.4 to 73.2, 10.8 to 36.0, 22.8 to 70.8 and 24 to 54 cm/hr respectively. Whereas, the final infiltration capacities for same land uses were found to be varying from 1.2 to 2.4, 1.2 to 13.4, 1.0 to 9.6, 0.7 to 14.4 and 8.4 to 10.8 cm/hr respectively. The average initial infiltration rates decreased in order of forest lands, mixed forest lands, agricultural lands, barren lands and grass lands. Annon (1962) found infiltration rates highest in the forest lands and then in grass, bare and agricultural soils. Wood (1977), Mistry & chatterjee (1965) and Mathur et al. (1982) also supported these results.

Table - 1

Infiltration Rates under Different Landuses of Baira Nalla Sub-catchment

Land use	Tests	Infiltration Rates (cm/hr)			Locations
		Initial	Average	Final	
Barren	1	33.6		2.4	Khushnagari
	2	37.2	26.4	1.2	near Gudesh
	3	10.8		1.44	Devikoti Mor
	4	24.0		1.2	Jajarkoti
Grass	1	36.0		2.4	Tissa Coloney
	2	30.0		6.0	Dhershean
	3	31.2	24.4	9.60	near Dhearshean
	4	16.8		0.6	Devikoti
	5	21.6		0.4	Pukhtala
	6	10.8		1.0	Jajarkoti
Agricul.	1	30.0		1.20	Jatheri
	2	14.40		2.40	Gudesh
	3	18.0		3.6	Tarwai/Puktala
	4	49.2	36.0	2.0	Devikoti
	* 5	109.2		20.6	Pukhtala *
	6	73.2		13.4	Jajarkoti
	7	31.2		2.1	Alwas
Forest	1	30.0		14.4	Ranikot/Bairagar
	2	39.6		13.20	Jatheri
	3	43.20		12.0	Gudesh
	4	55.20		13.2	Dind Forest
	5	46.80	42.45	14.0	Dind Forest
	6	70.8		2.8	Devikoti
	7	22.8		0.7	Pukhtala
	8	31.2		3.2	Jajarkoti
Mixed forest	1	54.0		12.6	Bairagar
	2	42.0		9.60	Bhanjuraddu
	3	30.0	39.6	10.80	Gudesh
	4	24.0		8.40	Dhabuas
	5	48.0		12.0	Dind Forest

N.B.:- Tests were conducted in Oct. & Nov. 1993

* This test showing abnormal result is not considered.

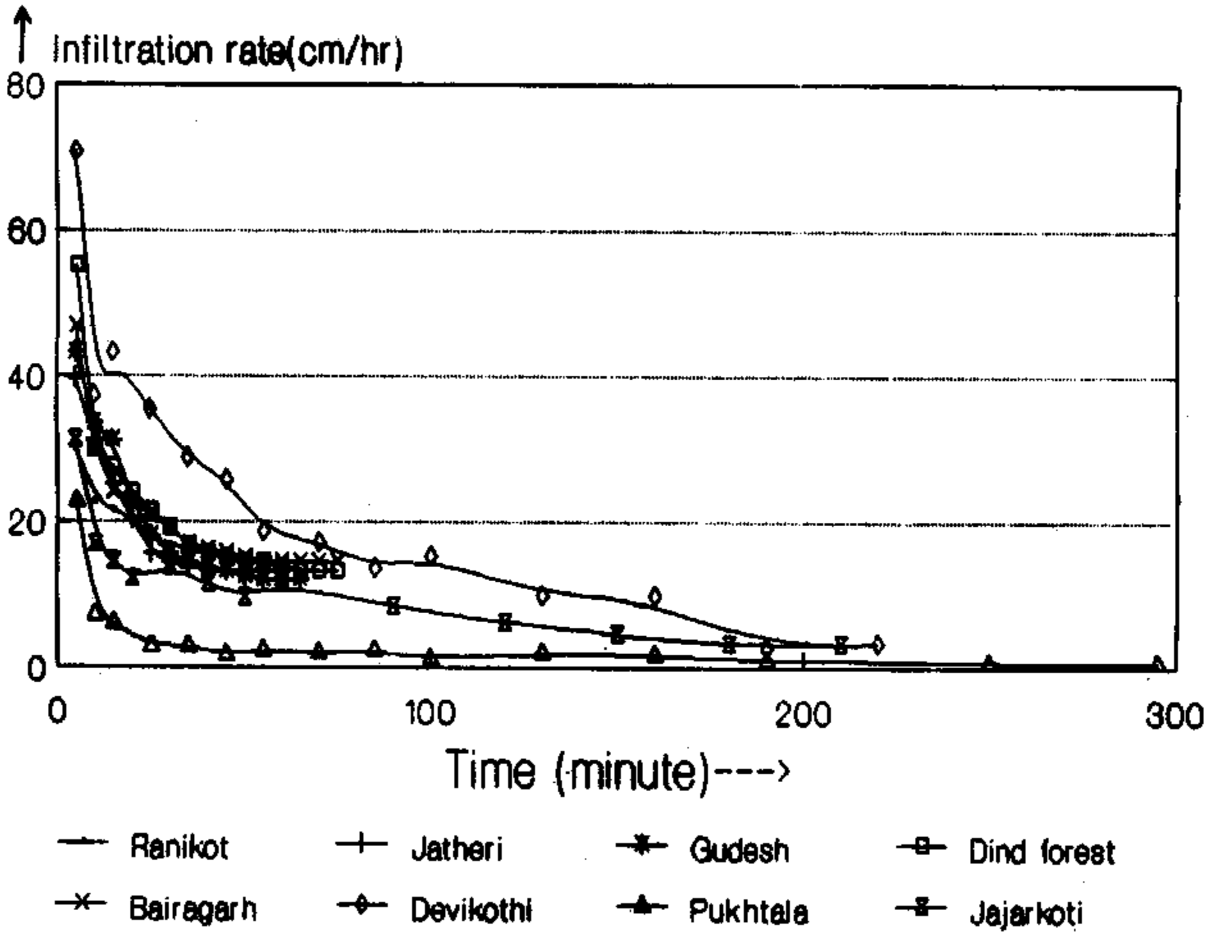

Fig.2 : Infiltration characteristics for forest land

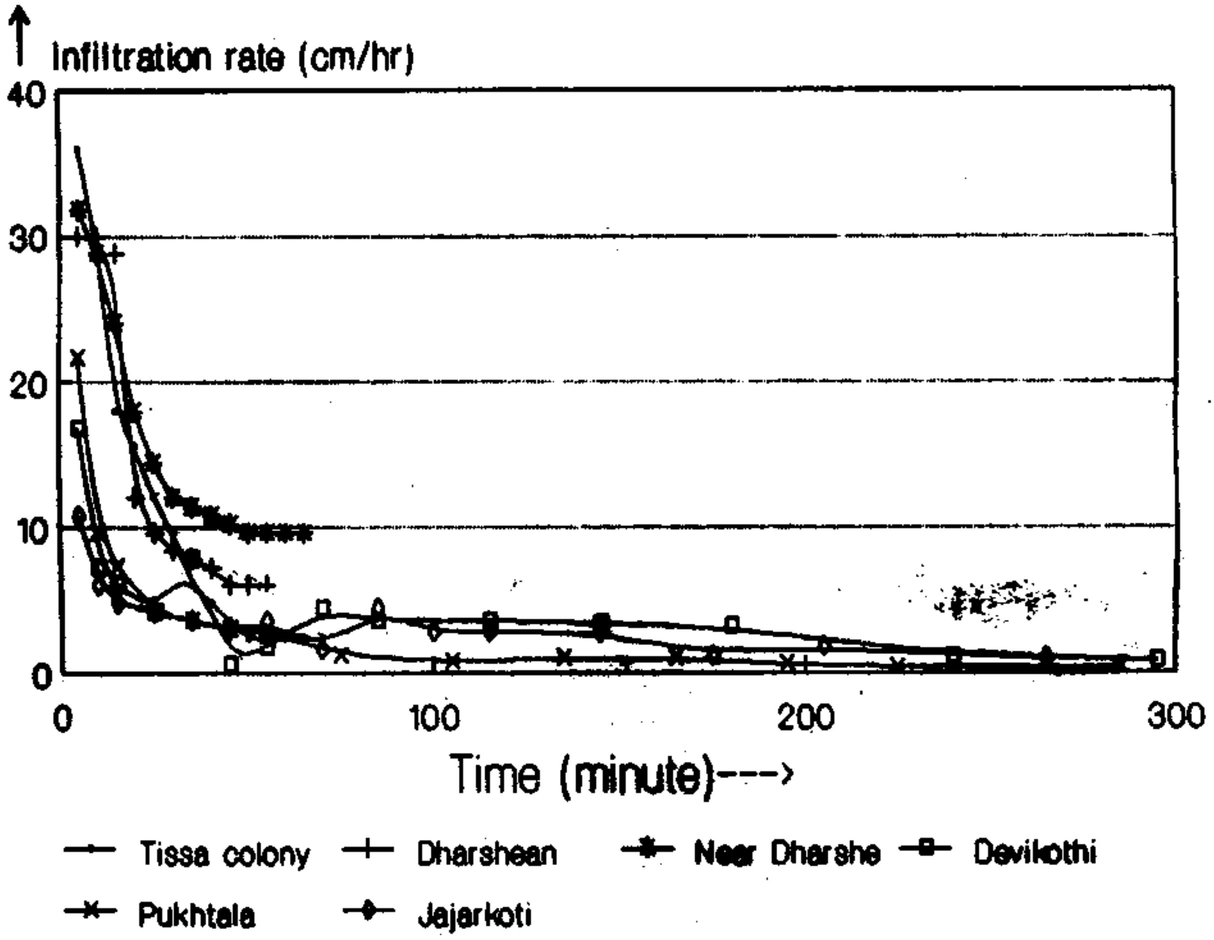

Fig.3 - Infiltration characteristics for grassland

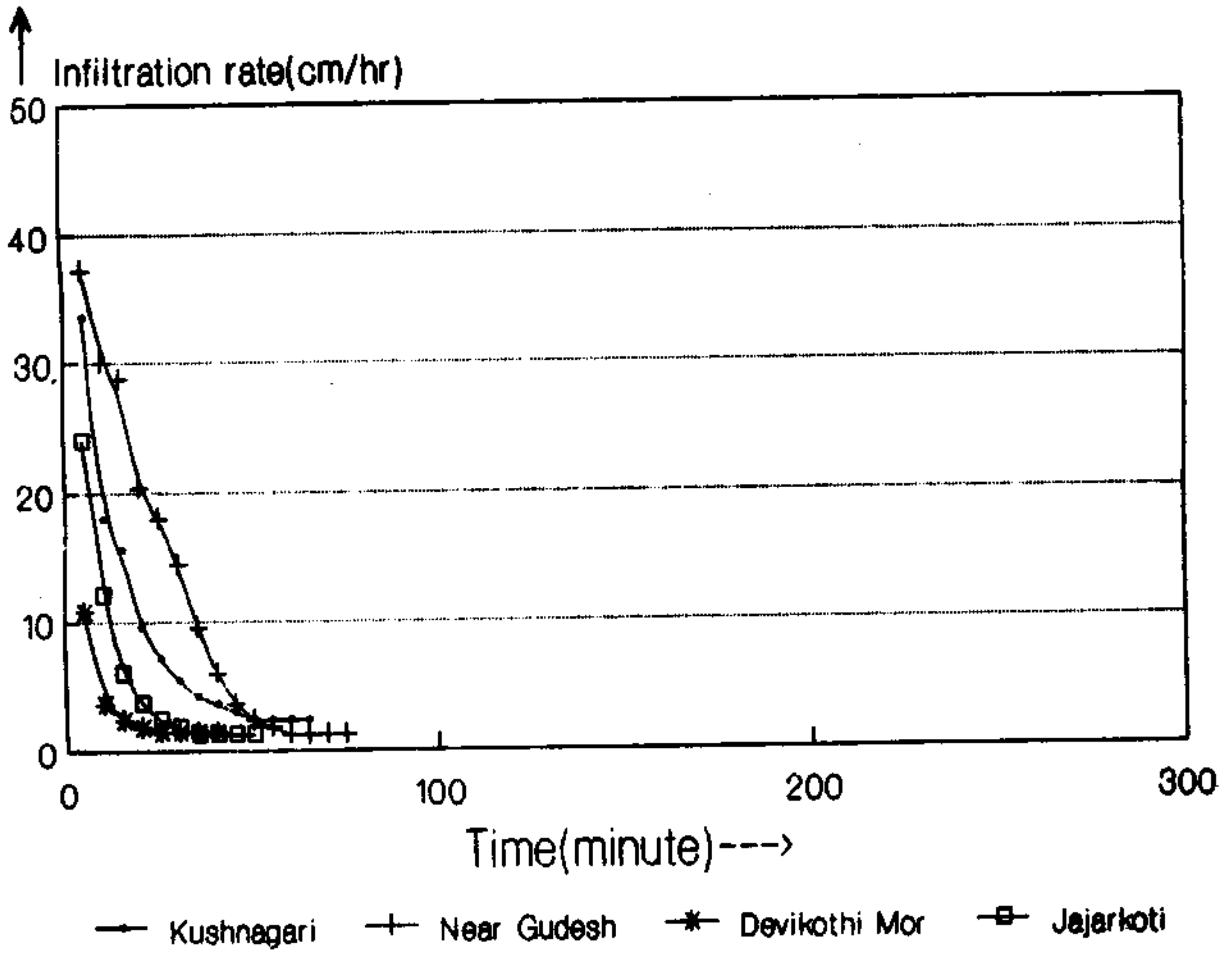

Fig.4 - Infiltration Characteristics for barren land

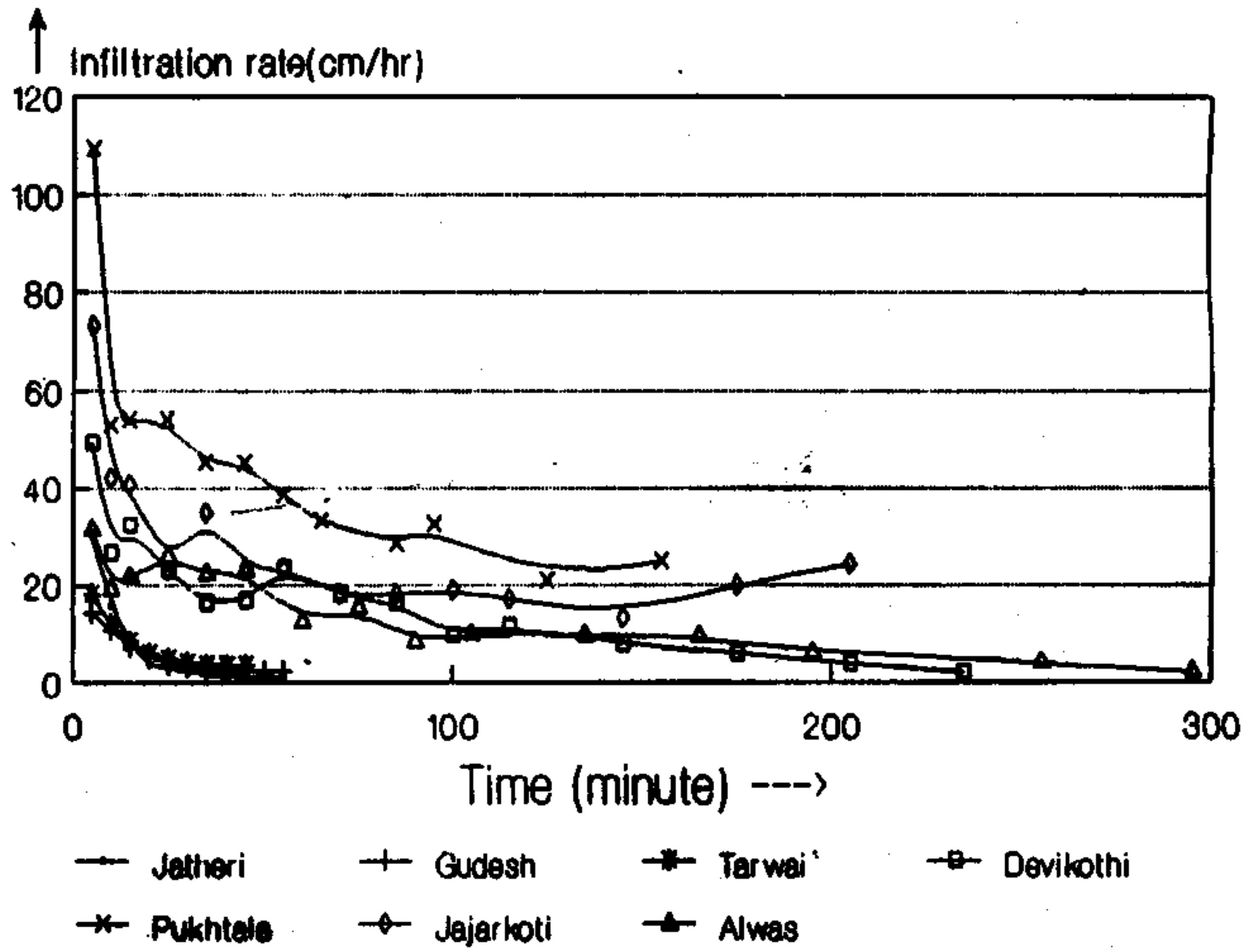

Fig.5 : Infiltration Characteristics for agricultural land

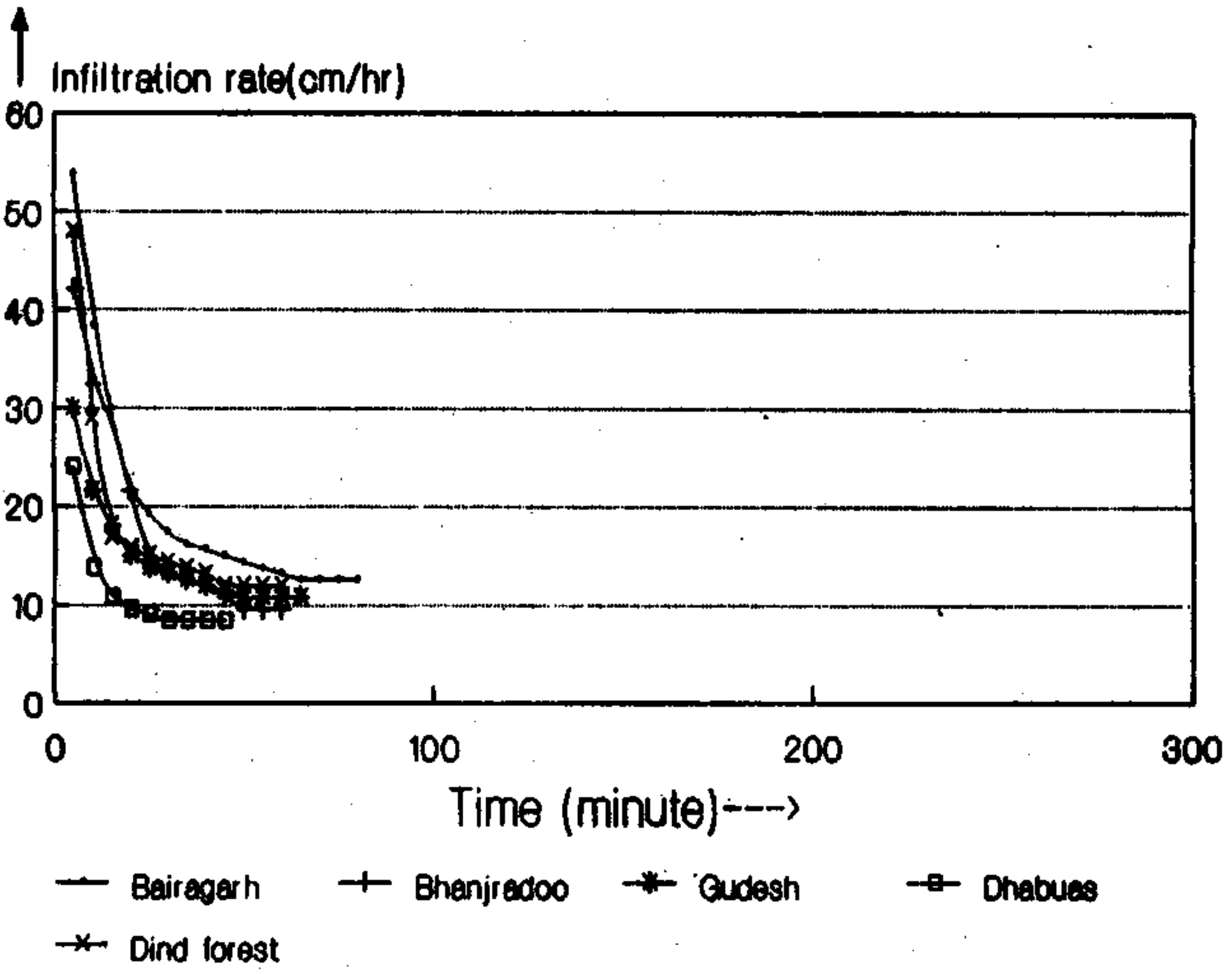

Fig.6 : Infiltration characteristics for mixed land

6.2 Relationships between Cumulative Infiltration(cm) and Elapsed Time(min) :

The relationships between cumulative depth of infiltrated water (dependent variable) and elapsed time (independent variable) were developed for Kostiakov (1932) type infiltration function ($Y = a t^b$). The two coefficients a and b were obtained using multiple linear regression program MULTI.FOR after transforming the function into the linear form through logarithmic transformation. The results are presented in the form of linear equation **$\log Y = b \log t + \log a$** (Table-2). It is evident from the Table-2 that the correlation coefficients varied from 0.97 to 0.99 in most cases indicating a satisfactory fit.

Table-2

Regression Equations with Correlation coefficients for Different Sites

Regression Equation, $y = a t^b$, or $\log y = b \log t + \log a$

S.No.	Site	Landuse	Regression Coefficients		Correlation Coefficients
1	Khushnagari	Barren	a = 1.54	b = 0.45	0.98
2	Near Gudesh	-do-	a = 1.65	b = 0.55	0.96
3	Devikoti Mor	-do-	a =-2.01	b = 0.38	0.99
4	Jajarkoti	-do-	a = 1.30	b = 0.34	0.97
5	Tissa Col.	Grass	a = 1.68	b = 0.49	0.97
6	Dharshean	-do-	a = 1.12	b = 0.63	0.97
7	Near Dharsh.	-do-	a =-1.01	b = 0.69	0.99
8	Devikoti	-do-	a =-1.95	b = 0.59	0.99
9	Pukhtala	-do-	a = 1.17	b = 0.36	0.98
10	Jajarkoti	-do-	a =-3.22	b = 0.65	0.99
11	Jatheri	Agri.	a = 1.68	b = 0.33	0.97
12	Gudesh	-do-	a =-1.77	b = 0.55	0.98
13	Tarwai	-do-	a =-1.54	b = 0.57	0.99
14	Devikoti	-do-	a = 1.51	b = 0.66	0.99
15	Pukhtala	-do-	a = 2.61	b = 0.73	0.99

contd.

Table-2 Contd.

16	Jajarkoti	-do-	a = 2.05	b = 0.67	0.99
17	Alwas	-do-	a =-1.11	b = 0.73	0.98
18	Ranikot	Forest	a =-1.42	b = 0.80	0.99
19	Jatheri	-do-	a = 1.20	b = 0.68	0.99
20	Gudesh	-do-	a = 1.42	b = 0.65	0.99
21	Dind forest	-do-	a = 1.68	b = 0.63	0.99
22	Bairagarh	-do-	a = 1.32	b = 0.68	0.99
23	Devikoti	-do-	a = 2.46	b = 0.61	0.99
24	Pukhtala	-do-	a =-1.04	b = 0.41	0.99
25	Jajarkoti	-do-	a =-1.45	b = 0.70	0.99
26	Bairagarh	Mixed	a = 1.79	b = 0.62	0.99
27	Bhanjradoo	-do-	a = 1.40	b = 0.64	0.99
28	Gudesh	-do-	a =-1.23	b = 0.72	0.99
29	Dhabuas	-do-	a = 1.05	b = 0.48	0.79
30	Dind Forest	-do-	a = 1.57	b = 0.59	0.99

7.0 CONCLUDING REMARKS:

The field tests were carried out for Baira nalla sub-catchment using double ring cylinder infiltrometer . It is a part of infiltration study being undertaken by National Institute of Hydrology on national level. The study was conducted for agriculture, barren, grass mixed forest and forest lands.

The forest lands resulted higher infiltration rates and then infiltration rates were lower and lower for mixed forest, agriculture, barren and grass lands. The correlation coefficients of linear equation ($\log y = b \log t + \log a$) ranged from 0.97 to 0.99 in most cases confirming a good fit of Kostiakov type infiltration function.

All the tests under different land uses were carried out in October and November months in dry weather. This resulted in higher rate of infiltration at initial stage varying from 39.6 cm/hr to 24.4 cm/hr. Because of the old nature of soil and humus present in almost all the land uses even final infiltration rates in some cases were of the order of 14.4 cm.

There is no existing informations about infiltration characteristics for Baira nalla sub-catchment. The results brought out in the report will be useful in long term representative basin studies in the sub-catchment.

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