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WATER INFILTRATION UNDER DESERT CONDITIONS

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ABSTRACT

Space-time variability in the hydrologic characteristics of the five major soil series represented in the Silverbell Validation Site (Tucson Basin, Arizona) was investigated by sampling the infiltration characteristics, at randomly selected locations, under several vegetative covers within each series. The experimental data were the time distributions of infiltration which, for each sampled location, were fitted by least squares to the Philip's infiltration equation. The parameters of this equation have physical interpretation and therefore were used as measures of the infiltration characteristics. Analysis of variance was used to investigate the spatial variability in the parameters. Also, the mean values of the parameters for each soil-vegetation combination were used to simulate water yield (runoff) due to a rainfall event over a desert catchment "containing" the given combination. Bounds on the runoff volume due to a one standard deviation spread in the infiltration parameters were obtained. Statistical tests show that there is no significant difference among the infiltration characteristics of all the soil-vegetation combinations. However, the statistically insignificant variations in the infiltration parameters produce significant variations in simulated runoff volumes.

INTRODUCTION

Knowledge of the water balance of desert ecosystems is important to the understanding and subsequent modeling of the entire system. One of the major processes in determining the water balance for an area is the infiltration of water at the soil surface. This is because the rate of infiltration determines the amount of water penetrating the subsurface soil and also the amount of overland flow which will form over the surface.

The rate of infiltration depends on the rainfall intensity and duration, canopy characteristics and near-surface soil properties. Because of the wide variability in these biotic and soil properties under natural conditions, the characterization of infiltration properties and, subsequently, the water balance of the desert ecosystem is by no means a trivial task.

OBJECTIVES

This study has as its goal to use the infiltration characteristics of representative desert soils under varying vegetative cover, as proxy information, to infer the hydrologic properties of the soils. Specifically, the objectives are to:

1. Sample infiltration characteristics of the major soil series found in a typical Sonoran Desert environment as exemplified by the Silverbell Validation Site near Tucson, Arizona.
2. Investigate the variability of these characteristics under various vegetative cover.
3. Obtain bounds on water yield (runoff) from a rainfall event over a desert catchment using estimated infiltration characteristics of the various soil series and the interception characteristics of the different vegetative cover.

The third objective, as stated above, is a slight modification of that given in the original proposal. The original objective was to improve model prediction using measured data on soil and vegetative properties. The latter objective investigates the effect of various soil-vegetation combinations on water yield from a desert catchment; it is broader in scope and is more in keeping with the overall goals of the IBP.

PREVIOUS STUDIES

Studies pertaining to the desert ecosystem, germane to the present study, have been carried out at the Silverbell site and elsewhere under the auspices of the IBP. Principal among these was the delineation of the soils at the Silverbell site into soil series (DSCODE A3UHD01) as reported by Thames et al. (1973). The resulting soil map provided a natural basis for establishing the sampling units for infiltration measurements performed in the current study. The report also contains a rather extensive description of the types, distribution and density of the vegetation found on the site (A3UTC21-26). Mehuys et al. (1974) have measured hydraulic conductivity and soil water diffusivity for desert soils from the Santa Rita Experimental Range near Tucson, Arizona, the Silverbell site near Tucson (A3UST03) and the Rock Valley site in Nevada (A3UST01-02). Measurements were carried out in the laboratory over a wide range (0 to -50 bars) of water pressure using a transient outflow method.

Lyford and Qashu (1969) used a double ring infiltrometer, as opposed to the sprinkler type, to evaluate the influence of two desert plants (paloverde and creosotebush) on infiltration rates of two desert soils (Rillito gravelly-sandy loam and Continental sandy loam) at radial distances from the plant centers. They found that the final infiltration capacities near the base of the plant were, on the average, nearly three times those in the interplant areas. No significant difference in rates was found between the two vegetation types.

Kincaid et al. (1964), using an F-type infiltrometer on plots in southern Arizona, showed how certain soil and vegetation characteristics affect infiltration. They concluded that the crown spread (coverage) of shrubs was the most important vegetative parameter affecting infiltration.

SAMPLED SOIL SERIES

A detailed description of the soil series within the Silverbell site has been documented by Thames et al. (1973). A common characteristic of these soil series is that they are gravelly sandy loams with moderately coarse to very coarse textured surfaces. For example, about 70% of the surface of the Rillito gravelly-sandy loam is covered by gravel.

The major soil series sampled are shown in Table 1, which also contains the abbreviations used to represent these soils in this report as well as those used by Thames et al. (1973).

EXPERIMENTAL DESIGN

A variety of sampling plans exist by which infiltration run locations may be selected. In choosing a plan for this study, we have been guided by the prevailing experimental conditions within the project area. The soils of and the vegetation on the site are heterogeneous, five major soil series and five major vegetation species being represented. The heterogeneity in the soil and vegetation types motivated our adoption of a stratified sampling plan. Stratification was based on the five soil series identified in Table 1. Thus each series corresponded to a sampling unit. The sampled variables are the soil sorptivity and the final infiltration capacity.

Bursage (*Ambrosia deltoidea*) is the most abundant plant species on the Silverbell site with an average density of about 6,000 plants/ha. It is followed by the creosotebush plant (*Larrea tridentata*) which has a density of about 190 plants/ha. However, in terms of plant cover, which has been described as the most important vegetative characteristic affecting infiltration (Kincaid et al. 1964), the creosotebush covers almost twice as much area as does the bursage bush. Estimates by Thames et al. (1973) show that 87% of the total area has no vegetative cover, about 4.6% is under creosotebush and about 2.6% is under bursage. Given that infiltration measurements are to be made within each unit at randomly selected locations, the sampling urn should contain ballots with markings of no-cover, creosotebush and bursage in a proportion of 33:2:1. Sampling was not done as described above since it is most probable that not enough creosotebush- and bursage-marked ballots would be sampled to obtain statistically significant results.

The approach followed was to sample from urns, each of which contained ballots of the same type (i.e., vegetative cover). On each ballot was marked a number corresponding to a potential sampling location. Sampling from each urn was done at random and without replacement. Figure 1 shows the sampling locations. The sample size was determined more by manpower and time limitations than by any sampling theoretic methods. Nevertheless we consider the above procedure to be practical in the sense that it was possible to carry through according to specifications. A precision level, ρ of 30% of the mean of the sampled variables was considered sufficient considering the field experimental conditions.

Table 1. Sampled soil series

Soil Series	Representation This report	Thames
Anthony-Tres Hermanos Complex	ANTTHC	A-TH
Rillito Gravelly Sandy Loam	RILGSL	R
Tres Hermanos Gravelly Sandy Loam	TRHGSL	TH1/TH2
Tubac Gravelly Sandy Loam	TUBGSL	Tu1/Tu2
Tubac Rillito Complex	TUBRIC	Tu-R

In order to be consistent and to compensate for the nonscientific manner in which the sample size was arrived at, significant levels (a) were computed from ρ, the sample mean (y), the standard deviation (s) and the sample size (n), for each soil-vegetation combination sampled. Confidence levels which should be equal for a given sampling plan were defined as

$$L\rho = (\rho y/100) \text{ and } La = Z_a s/\sqrt{n}$$

so that

$$Za = (\sqrt{n}\, \rho y/s) \qquad (1)$$

where Za is the test statistic for a normally distributed random variable. Thus given Za, for a given combination and using a table of standard normal distribution to read off the probability, Pa corresponding to Za, a may be obtained from $a = 2(1 - Pa)$. The values of a obtained were then used as guidelines for selecting a level of significance, commensurate to the range of sample sizes, for subsequent statistical tests.

EXPERIMENTAL METHOD

DATA COLLECTION

A rainfall simulator of the sprinkler type (Fig. 2) was used to apply a steady rate (0.4 cm/min) of artificial rainfall over a 1,000 cm² delimiter placed over each sampling location. The rainfall was applied through a grid of 0.1-cm diameter nozzles covering a total area of 45 x 45 cm. Nozzle spacing was 2 cm. The uniformity of the application depth over the area was expressed in terms of Christiansen's uniformity coefficient, Cu defined below:

$$Cu = [1 - (\sum_{i=1}^{n} |X_i - X_m)/X_m] \qquad (2)$$

where X_i is the depth observed in the i'th spray can in centimeters, X_m is the mean depth of water in centimeters and n is the number of spray cans. Cu was computed for the first run and at random intervals; the nozzles of the simulator being flushed after each determination. Cu varied between 89 and 95% for all determinations.

It was originally planned that the rainfall simulator should stand at a height of 3.05 m above the ground from the nozzle. At this height, however, the simulator was unstable due to wind and gravity effects. The simulator stood at 1.53 m above the ground for all runs except one trial run when it was kept at 0.91 m. The 1.53-m height was obtained, by trial and error, as the height at which the wind and gravity effects were acceptable.

Uninfiltrated water was pumped out from within the delimiter into a container sitting on a transducer (strain gauge) weighing balance. The pump was a variable discharge pump. The strain gauge was connected to an automatic chart recorder through a voltmeter. The operation of the unit was such that the weight of the pumped water in the container induced a voltage difference in the gauge which was amplified by the voltmeter and then recorded on the chart. The voltage from the gauge varied between 0 and 1.5 mv and was amplified to between 0 and 10 mv. Figure 3 shows the pump and measuring equipment.

A linear relationship (1 mv ≡ 300 cm^3) was obtained between the voltage recorded on the chart and the amount of water in the container from calibration experiments. The reading on the chart was therefore multiplied by a factor of 300 to obtain the cumulative pumpage in cubic centimeters. The difference between the cumulative application and the corresponding pumpage is the cumulative infiltration up to that time. The experimental data per sampled location were the cumulative infiltration versus time. Duration of test runs varied between 20 and 55 min with an average of 35 min. A run was terminated when the infiltration rate appeared to reach a constant value which may be observed from when the infiltration curve becomes approximately a straight line.

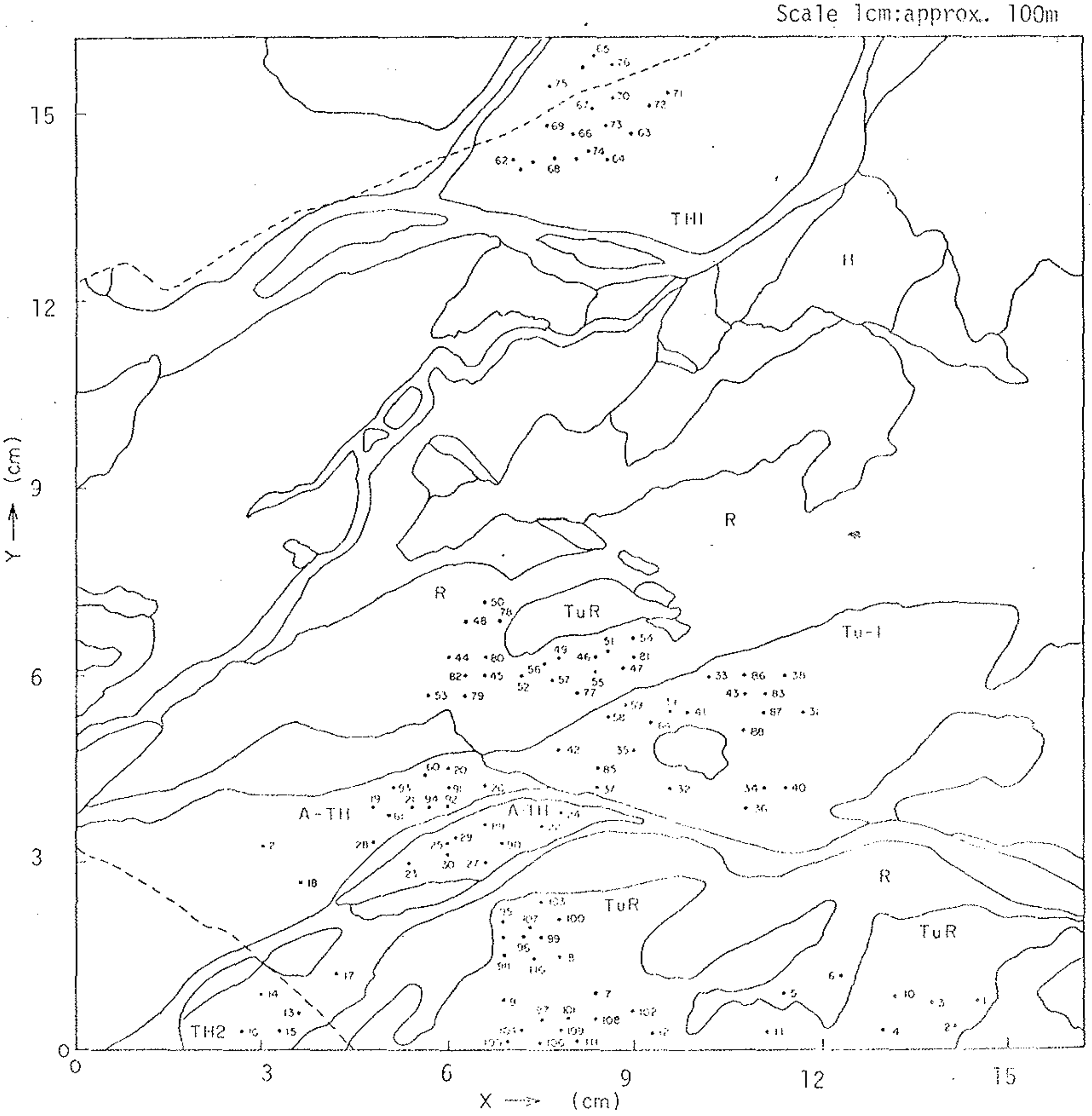

Figure 1. Soil survey map of the Silverbell Validation Site showing sampling locations.

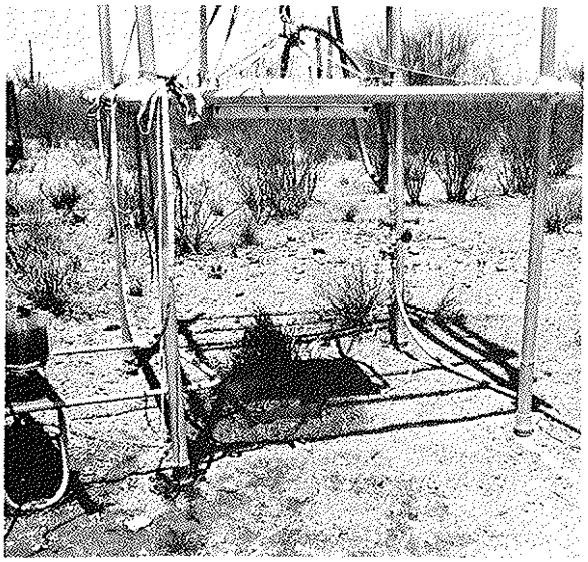

Figure 2. Positioning of rainfall simulator and delimiter.

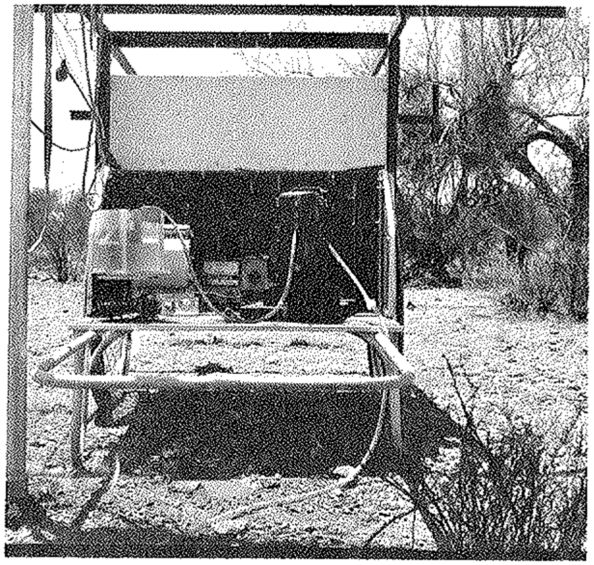

Figure 3. Pump and measurement equipment.

COLLATION AND ANALYSIS OF DATA

The experimental data as obtained from the continuous recording chart were extracted, for the purposes of analysis, in 15-sec intervals. We consider this as the sampling interval. Data edition was made to correct for reading errors or instrument malfunction and to delete erroneous data. Thus, of the 111 runs made, three were used as test runs and hence not included. Of the remaining 108, six were deleted due to instrument malfunction and seven were corrected for mild instrument malfunction. The latter have been noted as possible erroneous data in the data sent to the Desert Biome Central Data Bank (DSCODE A3UDI01).

The time distribution of infiltration obtained for each sampling location was fitted, by least squares, to the Philip's infiltration equation:

$$F = At^{0.5} + Bt \qquad (3)$$

where F = cumulative infiltration in centimeters, t is time in minutes, A is soil sorptivity and B is the final infiltration capacity of the soil. The values of B from the least squares fit were, in some cases, unrealistic (negative) even though the experimental data show a positive constant slope at later time intervals. In these cases, which were relatively few, the value of B determined from experimental data was used. In most cases, however, the values of B from the experimental data and those obtained by least squares fit were within 10%. Table 2 shows the values of the parameters as obtained for each sampled location. The mean values and the corresponding standard deviation are also shown for each cell (soil-vegetation combination) as well as the α values. The data of Table 2 were used in subsequent analyses to investigate the spatial variability in the infiltration characteristics and the effect of such variability on water yield for various combinations using a watershed model.

Table 2. Infiltration characteristics at sampled locations

Cover / Soil Series	No Cover			Creosote			Bursage		
	L*	A	B	L	A	B	L	A	B
ANTTHL	15	.90	.14	17	1.13	.07	21	1.28	.10
	16	.99	.08	18	1.84	.08	22	.88	.06
	19	1.28	.08	20	1.14	.15	85	1.08	.11
	23	.96	.08	24	1.51	.07	86	1.44	.08
	25	1.01	.08	27	.66	.15			
	26	1.22	.08	56	.81	.14			
	83	1.01	.11	57	1.05	.06			
	84	1.22	.06	87	1.13	.02			
Mean		1.07	.09		1.20	.09		1.17	.09
Std.Dev.		.14	.03		.37	.05		.24	.02
α		**	**		**	.10		**	**
RILGSL	2	1.15	.09	49	1.36	.05	45	1.19	.09
	3	.68	.15	50	1.24	.05	46	1.02	.04
	41	.73	.06	51	.66	.11	47	1.05	.09
	42	1.35	.11	52	1.17	.13	53	1.41	.08
	43	.92	.07	76	1.74	.04	74	1.45	.01
	44	.90	.15	77	1.72	.05	75	1.20	.06
	48	1.04	.02						
	72	1.56	.01						
	73	1.12	.03						
Mean		1.05	.08		1.32	.07		1.22	.06
Std.Dev.		.28	.05		.40	.04		.18	.03
α		**	.20		**	.24		**	.24
TRHGSL	10	.60	.09	11	1.21	.10	61	1.17	.09
	12	.99	.27	13	.70	.17	62	.97	.08
	14	.42	.15	64	1.31	.02	63	.89	.02
	58	1.18	.06	65	.42	.13	70	1.13	.03
	59	1.05	.06	68	.81	.11			
	60	1.26	.04						
	66	1.40	.01						
Mean		.99	.10		.89	.11		1.04	.06
Std.Dev.		.36	.08		.37	.06		.13	.04
α		**	.38		.10	.20		**	.34
TUBGSL	29	1.37	--	28	1.48	.06	30	1.46	.07
	31	.43	.04	32	.97	.03	33	1.43	.12
	34	.26	.01	36	1.37	.03	38	.91	.13
	35	1.18	.07	54	.63	.12	40	1.19	.04
	37	1.19	.05	55	.97	.10	80	1.18	--
	39	.45	.06	81	.92	.10			
				82	1.06	.11			
Mean		.81	.05		1.06	.08		1.23	.09
Std.Dev.		.48	.02		.29	.04		.22	.04
α		.22	.10		**	.10		**	.10

* L = sampling location, see Figure 1.
A = soil sorptivity
F = cumulative infiltration (cm)
= $At^{0.5} + Bt$ (Philip's equation)
** = significance level less than 0.02
B = final infiltration capacity
t = time (minutes)
α = computed significance level

ANALYSIS OF VARIANCE

The analysis of variance technique was used to determine if the different soil-vegetation combinations have significantly different infiltration characteristics. In the process, a two-way analysis of variance was performed on the response variables; soil sorptivity (A) and final infiltration capacity (B). The two factors were the vegetative cover (three types) and the soil series (four of them). The sample size of the soil-vegetation combinations (cells) was not necessarily equal.

It was assumed that both the vegetative covers and the soil series are random effects sampled from infinite populations with not necessarily equal variances. The sources of variance were identified then as the cover, C, the soil type, S, and the interaction between these two, CS. The tests of significance for the null hypothesis, using the F-test, were made from the column of mean squares in Table 3.

In addition to the above, which are overall tests, the value of the t-statistic (T) and the corresponding degree of freedom (f) for all possible cell pairs have been computed (see Appendix). Since we do not assume that the individual cell contents were drawn from populations with the same variance, Fisher's approximation was used to compute f for each of the cell pairs.

Not all the cell pairs are relevant to the current investigation, as for example, the pair (7,5) or (5,7) which represents TRHGSL (no cover [7]) and RILGSL (creosotebush [5]) combinations. The 30 relevant pairs have been underlined in the Appendix. It is therefore an easy matter to determine if any two pairs are statistically different at a desired level of significance.

AVERAGE INFILTRATION CHARACTERISTICS

The average values of the parameters shown in Table 2 were plugged into the Philip's equation so as to generate infiltration rate curves for each cell. Selected curves are shown in Figures 4 and 5 to illustrate the spatial variability of the infiltration functions. Figure 4 shows the effect of vegetative cover for two soil types, the Anthony Tres Hermanos complex and Tubac gravelly-sandy loam. Figure 5 shows the effect of the different soil series on the infiltration characteristics.

RUNOFF SIMULATION

Runoff hydrographs using the average values of the parameters in Table 2 were simulated for selected soil-vegetation combinations. The runoff simulation model used was developed by Nnaji et al. (1974). The model simulates runoff on an event basis and has features that reflect the special hydrologic characteristics exhibited by semiarid environments.

In particular, a reductionist approach in which the entire catchment (including channel reaches) was subdivided into a finite number of meshes was used in developing the model. The various components of the runoff phenomenon were delineated within each mesh as independent functions of the

Table 3. Analysis of variance for soil-vegetation combinations

Response Variable	Source of Variance	Degree of Freedom	Mean Squares	Grand Mean	Variance Ratio
SOIL SORPTIVITY (A)	C	2	0.0357		3.01
	S	3	0.0298		2.52
	CS	6	0.0118		
	Total	11	0.0210	1.08	
*Lower bound				0.94	
Upper bound				1.23	
FINAL INFILTRATION CAPACITY (B)	C	2	0.000199		0.54
	S	3	0.000295		0.80
	CS	6	0.000371		
	Total	11	0.000320	0.08	
Lower bound				0.06	
Upper bound				0.10	

* The lower and upper bounds are at one standard deviation from the grand mean.

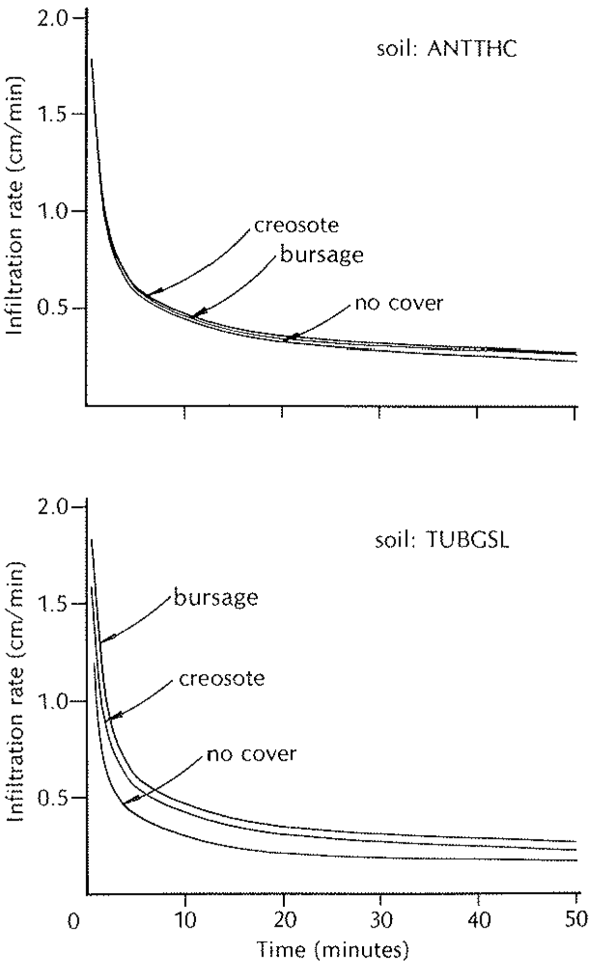

Figure 4. Effect of vegetative cover on the infiltration characteristics of two soils.

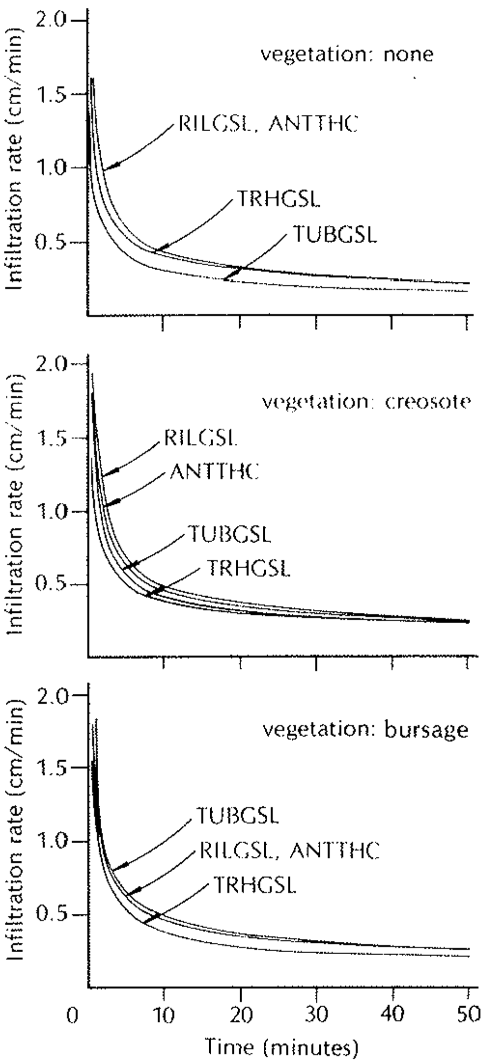

Figure 5. Effect of soil types on the infiltration characteristics under various cover.

catchment. Simplified forms of the hydrodynamic equations of flow were used to route flow generated from each mesh to obtain a complete hydrograph at the outlet point.

The soil parameter values used in the simulation are given in Table 4. They represent, as an example, the mean values for no-cover sampled locations only. The vegetation parameters used are shown in Table 5. Other parameters were estimated and kept constant for all runs.

The IBP maintains a number of rainfall gauges and a flume measuring runoff from a small catchment located within the Silverbell site. However, available data are poor and a topographical map of this catchment was not available. Under these conditions, the Atterbury subwatershed (W2), a 0.75 km² catchment located about 32 km southeast of Tucson, Arizona was used for the purposes of providing a catchment boundary and topography only. All parameter estimates were obtained from data available from the Silverbell site, including our sampling results. A map of the Atterbury subwatershed is shown in Figure 6. The solid lines within the catchment boundary represent lines dividing the catchment into meshes. Eleven meshes may be identified.

Table 4. Soil parameter values used in simulation

Soil	Parameter*		
	A	B	** Soil Moisture cm/cm
ANTTHL	1.07	0.09	0.18
RILGSL	1.05	0.08	0.14
TRHGSL	0.99	0.09	0.20
TUBGSL	0.81	0.05	0.14

* Mean values for no cover sampled locations only.
** Soil moisture near saturation, used as porosity.

Table 5. Vegetation parameter values used in simulation

Vegetative Cover	Parameter*		
	Coverage (m^2/ha)	Interception Capacity (cm)	Throughfall (fraction)
NO COVER	0.00	0.0	1.0
CREOSOTE	462	0.5	0.67
BURSAGE	261	1.8	0.23

* Coverage data after Thames (1973).
* Interception and Throughfall estimated from two rainfall events over Silverbell (Evans and Sammis, 1975).

The rainfall used was the storm of July 22, 1964, occurring over the Atterbury subwatershed as recorded in gauge R-32 maintained by the Arizona Water Resources Research Center at the University of Arizona, Tucson.

Table 6 gives simulated peak discharges in liters/sec and runoff volumes in m^3 from the catchment "containing" homogeneous soils under various vegetative cover. Selected hydrographs have been plotted in Figure 7 to show the effect of vegetative cover, through interception and water infiltration, on water yield of a typical semiarid catchment.

RESULTS AND DISCUSSION

Based on the a values obtained and given in Table 2, a significance level of 10% was used for tests involving the soil sorptivity, A, and 20% for tests involving the soil final infiltration capacity, B.

For the analysis of variance, tests of significance were performed using the empirical F-statistics (variance ratios) given in the last column of Table 3 for both sources of variance C and S. For response variable A, the theoretical F-statistics are 3.46 for C and 3.29 for S, while the corresponding empirical values as given in Table 3 are 3.01 and 2.52, respectively. For B, the theoretical F-statistics are

Table 6. Simulated water yield for soil-vegetation combinations

Soil Series	No Cover		Creosote		Bursage	
	Q* (lit/sec)	V* (m^3)	Q (lit/sec)	V (m^3)	Q (lit/sec)	V (m^3)
ANTTHL	4.1	1377	3.4	1133	3.2	1059
RILGSL	8.7	3066	7.9	2744	7.6	2659
TRHGSL	4.5	1520	3.7	1265	3.5	1177
TUBGSL	25.8	10149	24.8	9725	24.4	9591

Q* = Peak Discharge

V* = Runoff Volume

2.10 for C and 2.10 for S while the empirical values are 0.54 and 0.80.

These results show that the gross effect of the different soil series and vegetative cover on the infiltration characteristics of the soil-vegetation combinations sampled are not significantly different. Also when considered pairwise and using the same *a* levels as before, no pairs showed any statistically significant difference in soil sorptivity while only three of the 30 pairs showed such difference in final infiltration capacity.

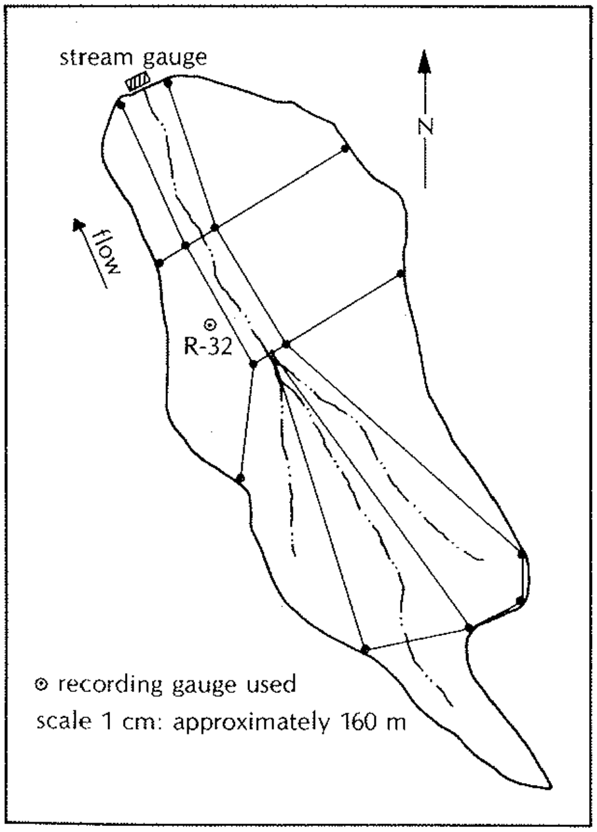

Figure 6. Atterbury subwatershed (W2) showing location of gauges.

A visual inspection of the curves in Figure 4 would indicate some variations, albeit nonstatistically significant. One may observe that Tubac gravelly-sandy loam (TUBGSL) shows a greater variability in the infiltration function due to vegetative cover than does the Anthony Tres Hermanos complex. On the same token, by comparing the curves in Figure 5, it appears that the variability is least in the different soils under no cover and greatest under the bursage bush.

The same trend is observed when we compare the hydrographs simulated from varying the vegetative cover over a given soil series as shown in Figure 7. However, the effect of the soil series under any one vegetative cover appears to be significant as can be seen from Figure 8. The runoff volume due to Tubac gravelly-sandy loam and the Tres Hermanos gravelly-sandy loam was 3.6 times and 8 times as large as those due to the Rillito gravelly-sandy loam and the Tres Hermanos gravelly-sandy loam, respectively. The hydrographs of Figure 8 were obtained for no vegetative cover.

All told, we hasten to note that the observations of the last two paragraphs should be taken with caution because only the mean values of the response variables have been used both in generating the infiltration functions of Figures 4 and 5 and in simulating the hydrographs of Figures 7 and 8. That

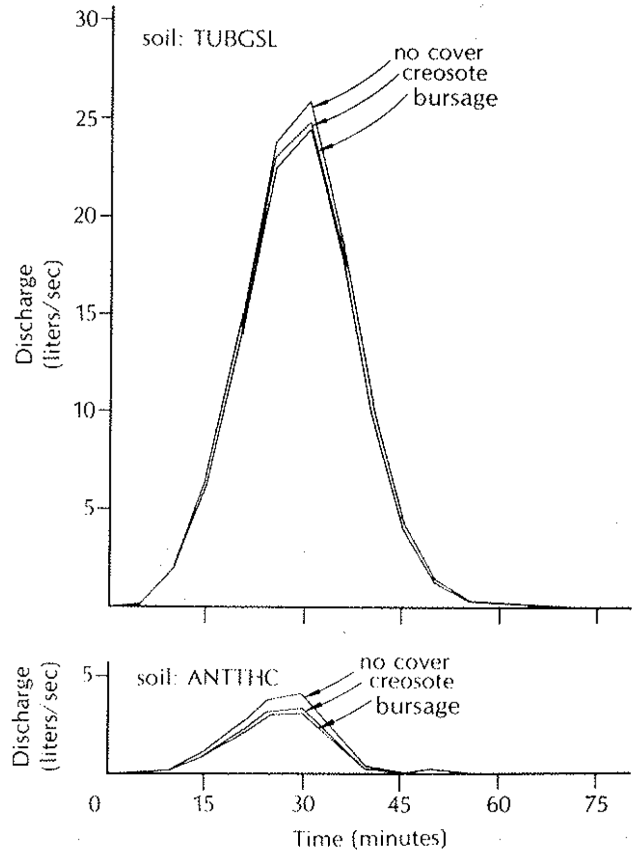

Figure 7. Simulated hydrographs showing the effect of vegetative cover.

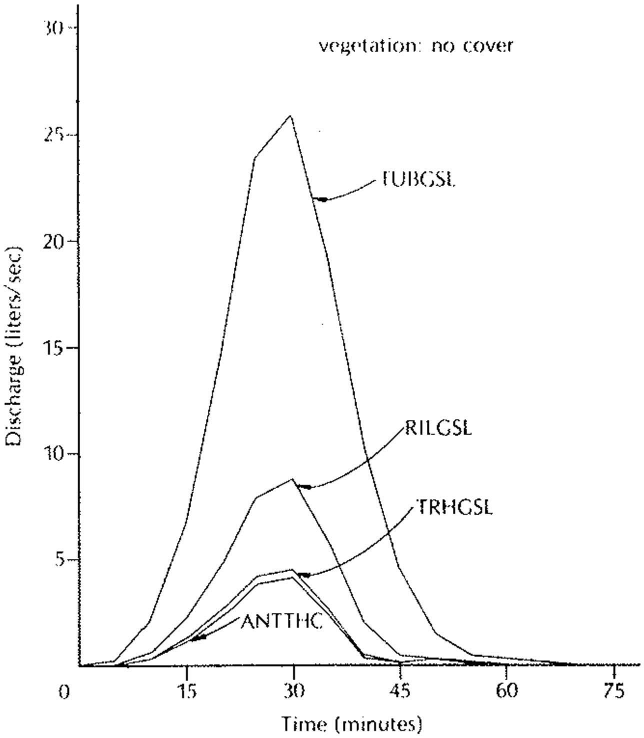

Figure 8. Soil series effect on simulated water yield.

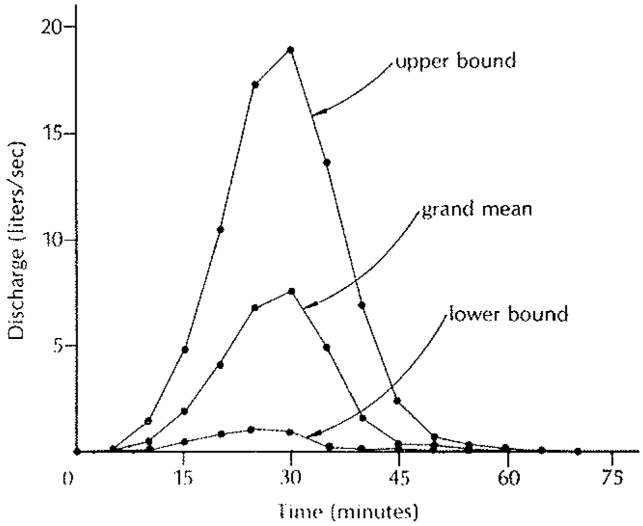

Figure 9. Runoff hydrographs for one standard deviation spread in the average infiltration parameters.

is, no considerations have been made for the individual sample variances in obtaining the above figures.

Further simulations were carried out in order to obtain bounds on runoff from the catchment due to a one standard deviation variation in the grand mean of the infiltration parameters. The values used in these latter simulations are given in Table 3. Figure 9 shows the runoff hydrographs for one standard deviation spread in the average infiltration parameters for all soil-vegetation combinations. It is apparent from the figure that the differences are appreciable.

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APPENDIX

t-STATISTIC AND DEGREE OF FREEDOM FOR SOIL-VEGETATION COMBINATION PAIRS

Response variable	Cell	ANTTHC						RILGSL						TRHGSL						TUBGSL					
		no cover 1		creosote 2		bursage 3		no cover 4		creosote 5		bursage 6		no cover 7		creosote 8		bursage 9		no cover 10		creosote 11		bursage 12	
		T	f	T	f	T	f	T	f	T	f	T	f	T	f	T	f	T	f	T	f	T	f	T	f
A	1	0.00	0	.56	9	.79	4	.20	13	1.46	6	1.57	10	.60	8	1.17	5	.36	7	1.33	5	.13	9	1.05	6
	2	.56	9	0.00	0	.05	10	.64	14	.70	12	.39	11	.85	14	1.17	10	.56	11	1.40	10	.55	14	.38	12
	3	.79	4	.05	10	0.00	0	.68	8	.50	9	.39	6	.83	10	1.16	8	.81	5	1.22	9	.60	9	.36	7
	4	.20	13	.64	14	.68	8	0.00	0	1.40	9	1.22	14	.38	12	.80	7	.06	12	1.11	8	.05	14	1.16	12
	5	1.46	6	.70	12	.50	9	1.40	9	0.00	0	.48	7	1.44	11	1.69	10	1.19	7	1.79	11	1.24	10	.36	9
	6	1.57	10	.39	11	.39	6	1.22	14	.48	7	0.00	0	1.35	10	1.75	6	1.54	9	1.76	6	1.11	11	.10	9
	7	.60	8	.85	14	.83	10	.38	12	1.44	11	1.35	10	0.00	0	.41	10	.27	9	.48	10	.38	13	1.26	11
	8	1.17	5	1.17	10	1.16	8	.80	7	1.69	10	1.75	6	.41	10	0.00	0	.68	5	.26	10	.81	8	1.60	7
	9	.36	7	.56	11	.81	5	.06	12	1.19	7	1.54	9	.27	9	.68	5	0.00	0	.82	6	.10	10	1.35	8
	10	1.33	5	1.40	10	1.22	9	1.11	8	1.79	11	1.76	6	.48	10	.26	10	.82	6	0.00	0	1.03	8	1.62	8
	11	.13	9	.55	14	.60	9	.05	14	1.24	10	1.11	11	.38	13	.81	8	.10	10	1.03	8	0.00	0	1.05	11
	12	1.05	6	.38	12	.36	7	1.16	12	.36	9	.10	9	1.26	11	1.60	7	1.35	8	1.62	8	1.05	11	0.00	0
B	1	0.00	0	.18	11	.08	6	.56	12	.94	9	1.66	10	.24	7	.71	5	1.76	5	3.13	13	.58	11	.07	7
	2	.18	11	0.00	0	.18	11	.60	16	.81	13	1.26	13	.12	9	.03	9	1.26	10	2.02	11	.57	14	.09	12
	3	.08	6	.18	11	0.00	0	.36	12	.67	9	1.26	9	.19	7	.54	6	1.36	6	2.66	7	.39	10	.11	8
	4	.55	12	.60	16	.36	12	0.00	0	.19	14	.58	14	.54	10	.91	9	.69	10	1.24	12	.08	15	.46	13
	5	.94	9	.81	13	.67	9	.19	14	0.00	0	.45	11	.61	9	1.10	8	.62	8	1.29	8	.38	12	.73	10
	6	1.66	10	1.26	13	1.26	9	.58	14	.45	11	0.00	0	.86	8	1.51	7	.28	7	.88	9	.79	12	1.24	9
	7	.24	7	.12	9	.19	7	.54	10	.61	9	.86	8	0.00	0	.18	11	.83	9	1.26	7	.48	8	.16	9
	8	.71	5	.03	9	.54	6	.91	9	1.10	8	1.51	7	.18	11	0.00	0	1.02	8	2.21	5	.93	7	.48	8
	9	1.76	5	1.26	10	1.36	6	.69	10	.62	8	.28	7	.83	9	1.42	8	0.00	0	.42	5	.92	8	1.28	8
	10	3.13	13	2.02	11	2.66	7	1.24	12	1.29	8	.88	9	1.26	7	2.21	5	.42	5	0.00	0	1.69	10	2.23	6
	11	.56	11	.57	14	.39	10	.08	15	.39	12	.79	12	.48	8	.93	7	.92	8	1.69	10	0.00	0	.48	10
	12	.07	7	.29	12	.11	8	.46	13	.73	10	1.24	9	.16	9	.48	8	1.28	8	2.23	6	.43	10	0.00	0