Pertti Seuna: Influence of physiographic factors on maximum runoff
Tiivistelmä: Aluetekijöiden vaikutus pienten alueiden ylivalumiin 5

Pertti Seuna: Infiltration and its dependence on some physiographic factors
Tiivistelmä: Infilaatio ja sen riippuvuus eräistä aluetekijöistä 29

VESIHALLITUS—NATIONAL BOARD OF WATERS, FINLAND
Helsinki 1983
The author is responsible for the contents of the publication. It may not be referred to as the official view or policy of the National Board of Waters.

ISBN 951-46-6723-9
ISSN 0355-0982

Helsinki 1983. Valtion painatuskeskus
INfiltration AND ITS DEPENDENCE ON SOME PHYSIOGRAPHIC FACTORS

Pertti Seuna


Infiltration measurements using a modified double ring infiltrometer were carried out at Vihti, in southern Finland in 1973 to 1981. Infiltration equations of Philip, Horton and a logarithmic one, were fitted to 214 measurements. The suitability of the Horton and the logarithmic equations was good; in two thirds of the cases the degree of determination (R²) exceeded 0.90. The fit of the Philip equation was weaker in this data. Infiltration capacity was best explained by the finest fractions of soil and the amount of organic matter. The application of ring infiltrometer values to the basin scale needs much for calibration, due to different order of their magnitude compared with natural basin and due to large scatter of ring measurements; a successful measurement of infiltration would undoubtedly improve possibilities to synthetically develop physically-based models for drainage basins.

Index words: infiltration, ring infiltrometer, small basin.

1. INTRODUCTION

Infiltration is usually defined as the penetration of water through soil surface (Horton 1933). It is then to be separated from percolation, which means water movement inside the soil. Infiltration and percolation are, however, closely involved, because percolation provides pore space for the continuation of infiltration.

The theory of infiltration has been generally accepted as the interpretation presented by Sherman (1944). Accordingly, in the soil there are large pores or gravity-water channels, and small capillary pores, which have greater affinity for water than for air. The force of capillarity acts in all directions and often exceeds the force of gravity. Capillary water moves from wet to dry soil. In a dry soil infiltration into the surface layer takes place, not only through gravity channels, but also through the entire soil surface as a capillary action. The capillary intake decreases, as water penetrates deeper. The water in gravity channels, however, continues to penetrate deeper to the smallest resistance at a rather uniform rate. The gravity water thus serves as a storage for lateral capillary
absorption into the soil. Consequently the general wetting of soil penetrates still deeper, and continues until the capillary pores are filled or until the gravity storage is depleted.

Infiltration plays an important role in the hydrological cycle by separating direct runoff from interflow and baseflow. In most conditions of the continents, the major part of precipitation moves into the soil (Schulz 1973). The proportion of infiltration greatly varies, however, depending on soil structure, grain size distribution and antecedent moisture conditions. For example, a 20 mm rainfall may produce runoff peak higher than 100 l s\(^{-1}\) km\(^{-2}\) or no notable runoff at all from the same drainage basin in Finnish conditions.

Areal infiltration could be determined from hydrograph analysis. Other methods have to be employed, such as infiltrometers or rainfall simulators, if such data are not available.

From 1973 on, infiltration measurements were carried out in the Kylmänoja basin at Vihti, in southern Finland (Fig. 1). These measurements are discussed in the following.

### 2. METHOD

In these measurements a modified double ring infiltrometer was used with the diameter of the inner ring equal to 22.8 cm and that of the outer ring equal to 35.6 cm and with the height of the both rings being equal to 15 cm. The cylinders were driven into the soil about 10 cm deep. Water depth inside the cylinders averaged 1.5 cm. A burette with valves was installed above the inner ring in order to maintain a constant water table in the inner ring (Fig. 2). The intention was to adjust the water table by means of the Mariotte’s vessel, but sufficient accuracy could not be achieved mainly due to the surface tension of water. For this reason a manual adjustment and sharp nibs were used in the both rings to maintain the desired water table.

The infiltration rate \( (f, \text{ mm min}^{-1}) \) vs. time \( (t, \text{ min}) \) curves were fitted to each measurement using the formulae of Philip (1954) and Horton (1940), and a logarithmic equation, as follows:

**Philip equation**

\[
S_1 t^{-1/2} + A_1, \tag{1}
\]

where

- \( S_1 \) = measure indicating sorptivity
- \( A_1 \) = constant

**Horton equation**

\[
f = f_c + (f_0 - f_c) e^{-kt}, \tag{2}
\]

where

- \( f_0 \) = initial infiltration
- \( f_c \) = infiltration capacity
- \( k \) = constant

**Logarithmic equation**

\[
f = \frac{K}{\log(t + 1)} + B \log(t + 1) + A, \tag{3}
\]

where \( K, B, A \) coefficients to be determined

The equations (1) and (3) were fitted using a normal regression analysis, for the equation (2) an iterative method was employed. In eq. (3) \( t + 1 \) was used as a time factor instead of \( t \), in order to avoid \( t \)-values smaller than one, because minute was chosen for time unit.

In order to visualize the phenomenon of infiltration, a separate experiment using tracers was made. Rhodamin B liquid was diluted in the inner cylinder, while Methyl violet was used in the outer cylinder. After two hours of infiltration it could be noticed from the excavation that the penetration of water was concentrated almost entirely in big pores, fissures or holes. No even distribution of the colour existed. This was probably due to the fact that the capillary movement of water to the micropores is much slower than the percolation of water to even relatively deep layers.

Macropores act as small pipes; the intake of water to the upper part results in a respective outflow. This is demonstrated as a rise in ground water table, but not necessarily as an increase in soil moisture of intermediate soil (Seuna 1977). The macropores thus have a significant effect on infiltration especially during heavy and short-duration rainstorms.

### 3. FITTING OF THE INFILTRATION EQUATIONS

The equations mentioned above, were fitted to 214 infiltration measurements each of them having some forty values. In general all these equations could be fitted rather well to the measured data (Table 1).

The Philip equation could be fitted reasonably well to the data; in 22 per cent of the measurements the correlation coefficient exceeded 0.95 and in 44 per cent it was higher than 0.90. The risk limit of 0.1
Fig. 1. A map showing the Kylmänoja basin, the types of surface soil, and the measuring sites K1-K7.
Table 1. Distribution of the correlation coefficients of the 214 fittings using the infiltration equations of Philip (1954), Horton (1940) and a logarithmic modification (equation 3).

<table>
<thead>
<tr>
<th>Range of correlation coefficient</th>
<th>Percentage of the fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Philip</td>
</tr>
<tr>
<td>&gt;0.99</td>
<td>3</td>
</tr>
<tr>
<td>0.950—0.99</td>
<td>19</td>
</tr>
<tr>
<td>0.900—0.949</td>
<td>22</td>
</tr>
<tr>
<td>0.850—0.899</td>
<td>16</td>
</tr>
<tr>
<td>0.800—0.849</td>
<td>14</td>
</tr>
<tr>
<td>0.700—0.799</td>
<td>13</td>
</tr>
<tr>
<td>&lt;0.700</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Square sum of residuals was minimized. The fit of the Horton equation was good; in 63 per cent of the measurements the correlation coefficient exceeded 0.95 and in 82 per cent it was higher than 0.90. Infiltration capacity given by the Horton equation, corresponded well to the graphical value of the infiltration capacity. However, a rather general tendency to produce too high values for infiltration capacity, was noticed. In almost half of the measurements the computed infiltration capacity exceeded the measured one by more than 20 per cent. Respectively, too steep a curve was easily obtained by the Horton equation in the beginning of a measurement.

In the fitting of the logarithmic equation (3) the parameters to be optimized were K, B and A. In general the fit was good; in 67 per cent of the cases the correlation coefficient was higher than 0.95 and in 86 per cent it exceeded 0.90. The fit was thus still slightly better than that of the Horton equation.

In Figs. 3—5 some fittings of these equations are shown.

Fig. 2. Infiltration measurement with a modified double ring infiltrometer.
Fig. 3. A plot of infiltration rate at the site K1 in dry (a) and in wet (b) conditions.

Fig. 4. A plot of infiltration rate at the site K5 in dry (a) and in wet (b) conditions.

Fig. 5. A plot of infiltration rate at the site K6 in dry (a) and in moist (b) conditions.
4. DEPENDENCE OF INFILTRATION ON SOME PHYSIOGRAPHIC AND METEOROLOGIC FACTORS

The dependence of infiltration on soil characteristics, but also on other factors, was studied using the measurements from seven fixed sites, from where soil samples were taken. Grain size distribution and the thickness of organic matter were determined in 10 cm surface soil. At each site (K1-K7) soil samples were taken after 4 to 5 infiltration measurements.

4.1 Soil characteristics

The average grain size distributions of the soil samples from the sites K1-K7 are presented in Fig. 6 and soil characteristics used in regression analyses are given in Table 2.

In Table 2 the symbols are as follows:

\[ \begin{align*}
G_c &= \text{percentage of soil by weight, finer than 0.002 mm in grain size} \\
G_i &= \text{percentage of soil by weight, finer than 0.06 mm in grain size} \\
G_s &= \text{percentage of soil by weight, coarser than 0.2 mm in grain size} \\
G_g &= \text{percentage of soil by weight, coarser than 2 mm in grain size} \\
d_{10} &= \text{grain size in mm, 10 per cent finer by weight} \\
d_{50} &= \text{grain size in mm, 50 per cent finer by weight} \\
d_{90} &= \text{grain size in mm, 90 per cent finer by weight} \\
d_{60} &= \text{coefficient of uniformity, indicating if the soil is graded soil (d_{60}/d_{10} < 5) or moraine (d_{60}/d_{10} > 5)} \\
O_t &= \text{thickness of organic layer in cm}
\end{align*} \]

Soil was defined as graded soil, if the ratio of \( d_{60} \) (= grain size, 60 per cent finer by weight) and \( d_{10} \) (= grain size, 10 per cent finer by weight) was less than five.

In comparison with the agrogeological map in

Table 2. Soil characteristics of the measuring sites K1-K7 at Vihti.

<table>
<thead>
<tr>
<th>Observation site</th>
<th>Soil characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>( G_c % ) 10.3</td>
</tr>
<tr>
<td>K2</td>
<td>0</td>
</tr>
<tr>
<td>K3</td>
<td>0</td>
</tr>
<tr>
<td>K4</td>
<td>10.6</td>
</tr>
<tr>
<td>K5</td>
<td>25.0</td>
</tr>
<tr>
<td>K6</td>
<td>32.0</td>
</tr>
<tr>
<td>K7</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 6. Grain size distribution of 10 cm surface soil of the measuring sites K1-K7.
scale 1:20 000 these classifications of soil did not fully agree in more than three sites of the seven ones.

4.2 Antecedent precipitation index

As a measure of moisture conditions the antecedent precipitation index (4) was used.

\[ \text{API}_n = k \cdot \text{API}_{n-1} + P_{n-1}, \]

where

- \( \text{API}_n \) = antecedent precipitation index of the \( n \)th day in mm
- \( \text{API}_{n-1} \) = the index of preceding day \((n-1)\) in mm
- \( P_{n-1} \) = precipitation of \((n-1)\)th day in mm
- \( k \) = coefficient of the month

The antecedent precipitation index can be interpreted to represent fluctuations of soil moisture in an active soil layer. On this basis the coefficient \( k \) was calculated in such a way that soil moisture of a certain soil layer corresponded to API. In 1967 to 1971 a great number of soil moisture measurements were carried out at Vihti in connection with an irrigation experiment (Seuna 1977). Using these measurements, the average soil water storage of the 43 cm top soil layer was calculated (Fig. 7). The temporal distribution of soil water in 25 cm layer was assumed to approximately follow the distribution of 43 cm layer, although being slightly steeper.

For calculating water balance of the 25 cm layer, long-term averages of precipitation (1931—1960) and runoff (1961—1975) were used. For the correction of precipitation values, an increase of 7 per cent was used (Lemmelä and Solantie 1977); runoff was taken from the Kylmänoja basin. Table 3 shows the water balance calculations, when corrected average precipitation, the soil water storage from Fig. 7, and the Kylmänoja runoff are used. Evaporation, including percolation, is obtained as a residual term.

The 311 mm for evaporation added by percolation is 64 mm smaller than the long-term average of the period from 1953 to 1967 of potential evapotranspiration at Vihti, computed using the USWB-lake evaporation formula (Mustonen and Seuna 1969).

The coefficients \( k \) were determined in such a way that the API of each month corresponded to the average soil water content of the same month in the 25 cm topsoil of a cultivated land. For the initial value 100 mm in the beginning of May was chosen, which corresponds to the field capacity of this soil. The \( k \)-values of May, October and November were slightly decreased in order to take into account the rainfall excess removed by direct runoff, which did not even temporarily enter the soil water storage. On these basis the following \( k \)-values for various months were obtained:

<table>
<thead>
<tr>
<th>Month</th>
<th>Soil water storage in the beginning of the month</th>
<th>Precipitation</th>
<th>Runoff</th>
<th>Sum of evaporation and percolation</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>100</td>
<td>42</td>
<td>34</td>
<td>30</td>
</tr>
<tr>
<td>June</td>
<td>78</td>
<td>49</td>
<td>7</td>
<td>59</td>
</tr>
<tr>
<td>July</td>
<td>61</td>
<td>78</td>
<td>6</td>
<td>72</td>
</tr>
<tr>
<td>August</td>
<td>61</td>
<td>82</td>
<td>8</td>
<td>68</td>
</tr>
<tr>
<td>September</td>
<td>67</td>
<td>71</td>
<td>9</td>
<td>52</td>
</tr>
<tr>
<td>October</td>
<td>77</td>
<td>70</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>November</td>
<td>94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total May-October</td>
<td>392</td>
<td>87</td>
<td></td>
<td>311</td>
</tr>
</tbody>
</table>

Table 3. The average water balance (mm) of a 25 cm top soil in a cultivated land at Vihti, in southern Finland.

Fig. 7. Average soil water storage of agricultural land in 43 cm (solid line) and in 25 cm (dotted line) surface soil at Vihti in 1967 to 1971. Soil water value for field capacity FC approximately corresponds to 100 mm in 25 cm layer and 180 mm in 43 cm layer, and for wilting point WP to 40 mm and 80 mm, respectively.
These coefficients and average monthly soil water storages from Fig. 7 gave the monthly evaporation, including runoff from soil moisture storage, and percolation, as follows (mm):

<table>
<thead>
<tr>
<th>Month</th>
<th>Storage (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>53</td>
</tr>
<tr>
<td>June</td>
<td>66</td>
</tr>
<tr>
<td>July</td>
<td>81</td>
</tr>
<tr>
<td>August</td>
<td>76</td>
</tr>
<tr>
<td>September</td>
<td>60</td>
</tr>
<tr>
<td>October</td>
<td>43</td>
</tr>
<tr>
<td>May-October</td>
<td>379</td>
</tr>
</tbody>
</table>

4.3 Influence of soil characteristics and moisture conditions on infiltration capacity

In order to study relationships between the infiltration capacity and soil characteristics the infiltration measurements were classified according to the measuring site (K1-K7) and API (80-100 mm, 51-79 mm and 30-50 mm).

The infiltration capacity obtained from the individual measurements could differ considerably on the same plot, even in similar moisture conditions, due to some big fissures of the soil. For this reason group means (n = 21) were used in the regression analysis instead of the individual measurements, each group including some 8 measurements.

The best independent variables in the regression analysis were the thickness of organic layer ($O_t$, $r = 0.66$), the grain size of the finest 10 per cent of soil ($d_{10}$, $r = 0.64$), the percentage of clay ($G_c$, $r = -0.63$) and the percentage of soil coarser than 0.2 mm ($G_s$, $r = 0.62$) (Table 4). The combination of API and the gradedness of soil correlated well with infiltration capacity ($API/(d_{60}/d_{10})$, $r = 0.74$; $(API)^2/(d_{60}/d_{10})$, $r = 0.78$).

The equation (5) explained 71 per cent of the total variance of infiltration capacity $f_c$ (mm min$^{-1}$)

$$f_c = 0.38 O_t + 0.0021 \frac{API^2}{d_{60}/d_{10}} + 1.30, R = 0.845 \quad (5)$$

The effect of antecedent precipitation index varied in separate measuring sites. At the sites K2, K3, K6 and K7 the infiltration capacity was in dry soil usually smaller than in somewhat moister soil (Table 5).

<table>
<thead>
<tr>
<th>API</th>
<th>Average infiltration capacity (mm min$^{-1}$) of the observation sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>80—100</td>
<td>1.14 8.53 5.40 2.40 0.52 3.22 5.82</td>
</tr>
<tr>
<td>51—79</td>
<td>2.47 3.59 3.67 3.06 1.84 1.76 3.55</td>
</tr>
<tr>
<td>30—50</td>
<td>2.99 2.22 2.85 2.95 1.39 0.50 4.24</td>
</tr>
</tbody>
</table>

In individual cases very low infiltration rates were observed in exceptionally dry soil. After the first rainfall infiltration generally increased remarkably, probably because of the softening of the soil surface. This procedure was followed in the sites, where the soil was highly graded. They were also rich in fine fractions. This could be demonstrated as notable runoff from a cultivated area in exceptionally dry conditions due to a rainstorm. In moraine areas, infiltration capacity of dry soil exceeded that of moist soil.

The relationship between the infiltration capacity and soil characteristics was also studied using each of the seven measuring point as one group. The API-means of the groups were almost identical and the group means could thus well be
Fig. 8. Typical infiltration curves for the measuring sites K1-K7.

compared. The infiltration capacity correlated significantly statistically (risk < 1 per cent) with the thickness of organic matter ($O_t$, $r = 0.95$), grain size of the 10 per cent fraction ($d_{10}$, $r = 0.91$), the percentage of clay ($G_c$, $r = -0.89$) and the percentage of material coarser than 0.2 mm ($G_{>0.2}$, $r = 0.88$) (Table 6).

The equations (6) and (7) explain more than 90 per cent of the variance of $f$ ($\text{mm min}^{-1}$):

\begin{align*}
f_c &= 0.69 O_t + 1.90, \quad R = 0.946 \quad (6) \\
f_c &= 0.47 O_t - 0.041 G_c + 2.7, \quad R = 0.976 \quad (7)
\end{align*}

Average curves of infiltration for the sites K1-K7 are presented in Fig. 8.

Table 6. Correlation coefficients between the independent variables and the dependent variable ($f_c$) for site averages ($n = 7$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_c$</td>
<td>-0.89</td>
</tr>
<tr>
<td>$G_t$</td>
<td>-0.83</td>
</tr>
<tr>
<td>$G_{&gt;0.2}$</td>
<td>0.88</td>
</tr>
<tr>
<td>$d_{10}$</td>
<td>0.86</td>
</tr>
<tr>
<td>$d_{50}$</td>
<td>0.91</td>
</tr>
<tr>
<td>$d_{90}$</td>
<td>0.71</td>
</tr>
<tr>
<td>$d_{60}/d_{10}$</td>
<td>0.78</td>
</tr>
<tr>
<td>$O_t$</td>
<td>0.95</td>
</tr>
</tbody>
</table>

5. DISCUSSION

Infiltration measured using a double ring infiltrometer could be presented satisfactorily with different infiltration equations, such as the two parameter Philip, but especially with the three parameter Horton and a logarithmic equation. The Philip equation has been recommended e.g. by Swartzendruber and Youngs (1974), but in this data the suitability was clearly weaker than those of the Horton and the logarithmic equations.

Infiltration curves, measured, were generally logical, but some comments are required (e.g. Table 5, Fig. 8). The measured infiltration capacity averaged 2.7 mm min$^{-1}$, which is obviously much greater than in the basin scale in nature. This difference was also pointed out earlier (e.g. Hills 1970, Scoging and Thornes 1979). Reasons for high infiltration rates could be lateral flows, hydrostatic pressure or disturbance of soil in connection with the measurement. The biggest difference between a basin and a ring infiltrometer has probably risen, however, from the fact that in a basin, water has access from the rainfall area to drainage network, but in the infiltrometer no access from the ring exists, except for the one downwards. Furthermore, in a basin permeable soils in Finland usually coincide with slopes, where time for infiltration is short. Lateral flows can be considered negligible judging from the experiment with dye dilution. This conclusion was presented also by e.g. Hills (1970).
Due to the measuring method, the initial infiltration has become too high in some cases, when water surface in the infiltrometer was not yet in balance after the first 15 seconds from the start.

At the site K3 the infiltration curve appeared to be rising except for the first ten minutes. At the other sites this shape was not observed. The soil of the site K3 was graded fine sand. It was compared with the site K2, the soil of which best resembled that of the site K3. A detailed soil sampling in 5 cm intervals showed that the layers at the same depth well corresponded to each other. Also the thickness and the structure of organic soil were quite similar. At the depth of 50 cm a stony till was located at the site K3. Respectively, the bottom soil at the site K2 was slightly finer at the depth of 50-60 cm than in the upper layers. The main reason for the rising curves thus appeared to be the stony bottom soil. This is in agreement with a statement by Meeuwig (1971, p. 7) that in case of slowly-wettable surface soil and more absorbent soil below, a rising curve is often formed.

The influence of soil characteristics on the rate of infiltration was clear in grouped data and it corresponded to results obtained in some other measurements (e.g. Free, Browning and Musgrave 1940). The finest fractions and the organic matter, especially, explained infiltration capacity very well. On the other hand moisture conditions appeared to affect in two ways. In moraines infiltration capacity of dry soil was higher than for moist soil, as could be expected. On the contrary, in graded soil with plenty of fine fractions the infiltration capacity of moist, but not thoroughly wet soil, was higher than that of a very dry soil. The first mild rainfall appeared to strongly rise the infiltration capacity. All the observational data logically followed this procedure, but more measurements in different soils would be needed to bear this out. This has to be especially studied in future, together with the application of the measurements to the basin scale.

The date of summer seemed to affect in such a way that infiltration was higher in spring than in late summer in respective conditions. This has been stated also by Schumm and Lusby (1963). On the other hand, infiltration capacity was not fully irrespective in preceding moisture conditions as reported by Papadakis and Preul (1973).

Considering the utilization of infiltration measurements with a ring infiltrometer, the transfer of the results to the basin scale requires much research and could even turn out to be impossible in the variable soil complex of Finland. On the other hand the average infiltration index evidently can be estimated from some soil characteristics and also relative differences of various soils or conditions could be determined using the infiltrometer. All these estimations, however, require several replicates of measurements in order to eliminate the influence of scatter caused by large pores and fissures of soil.

From a practical point of view information on the permeability of soil measured in situ would also serve agricultural objectives, especially, considering the impact of modern agriculture on soil.

ACKNOWLEDGEMENTS

Field measurements of this study have been started at Vihhti in 1973. Since then these measurements have mainly been carried out by Mr. Veikko Salmipuro, Ms. Marja-Leena Salmipuro and Mr. Sakari Wäre. The processing of data and in part also field measurements have been performed by Messrs. Timo Nieminen, Ilpo Savitie, Heikki Susimaa, Teppo Järvi and Ms. Marja-Leena Ruha. Mr. Teppo Järvi and Mr. Juhani Eloranta attended computational tasks.

The manuscript has been commented by Prof. Seppo E. Mustonen.

The typing of the manuscript was carried out by Ms. Eeva-Liisa Alanne, the illustrations were drawn by Ms. Terttu Halme and the layout was made by Ms. Raili Malinen.

I wish to express my sincere thanks to all, who contributed to the study.

Tuusula October 1982

Pertti Seuna

TIIVISTELMÄ

Vuosina 1973—1981 suoritettiin Vihdissä imetytöitä muunnetulla kaksoisrengasinfiltrometrilla. Näihin 214 mittaukseen sovittiin Philipin ja Hortonin infiitraatioyhtälöitä sekä kolmiparametrista logaritmiyhtälöä. Mittaukseista 63 %:ssä korrelaatiokerroin ylitti 0.95 ja 82 %:ssä 0.90. Logaritmifunktion sovituksesta 67 %:ssä korrelaatiokerroin ylitti 0.95 ja 86 %:ssä 0.90. Philipin yhtälön sovituksesta 63 %:ssä tapauksista korrelaatiokerroin ylitti 0.95 ja 82 %:ssä tapauksista 0.90. Logaritmfunktion sovituksesta 67 %:ssä korrelaatiokerroin ylitti 0.95 ja 86 %:ssä 0.90. Philipin yhtälön sovituus oli selvästi heikompi, vain 22 %:ssä tapauksista korrelaatiokerroin ylitti 0.95 ja 44 %:ssä tapauksista 0.90.

REFERENCES

Scoging, H.M. & Thones, J. 1979. Infiltration
characteristics in a semiarid environment. (A manuscript).