Sri Lanka Journal of South Asian Studies No : 1 (New series)1986/87 pp. 43- 58

GEOMORPHOLOGY OF THE VALUKKAI ARU *DRAINAGE BASIN*

PATHMADEVY PUVANESWARAN

This article is based on a survey carriedout in the Valukkai Aru drainage basin to determine the important Geomorphological aspects of the basin. The study investigated the soil, water and proximity to the sea, stream and ponds of the Valukkai aru drainage basin. The Valukkai, though only a seasonal stream, is the only stream in the Jaffna peninsula. It was found that these characteristics of the region contributed to the drying up of the Valukkai stream.

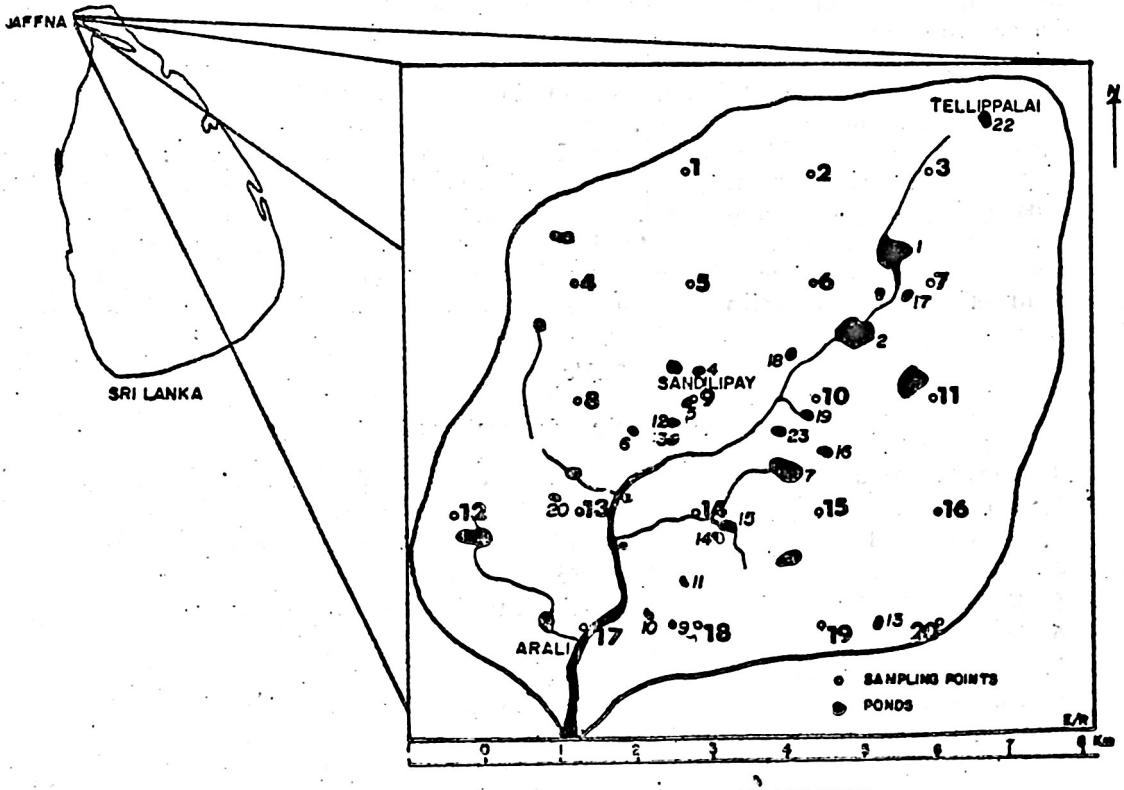


Fig: 1. LOCATION OF THE VALUKKAI ARU BASIN

Study Area:

The Valukkai (Fig.1) is the only natural stream in the Jaffna Peninsula which lies like a crown at the top of Sri Lanka. It arises at Ampanni in Thellipalai which is at an elevation of about 10.67 Metres above sea-level and runs through Alaveddi, Uduvil and Manipay for a distance of 12.87 Kilometres and reaches the sea at Arali. On the basis of the gathering ground of the Valukkai stream system, and on the basis of a contour map of the area it was estimated that the Valukkai drainage basin consists of roughly 56.98 square Kilometres and encompasses Peria Vilan, Makiyappitty, Mallakam, Sithankerni, Alaveddy, Sandilipay, Sanguveli, Kantharodai, Vaddukodai, Kaddudai, Manipay, Suthumalai, Navali, Uduvil and Arali either in part or full.

Besides the few natural tributaries which swell the Valukkai artificial canals are also linked to the Valukkai at two places. These are the canal from Navindy through Jaffna town and the one from Palali through Mayliddi. Furthermore, numerous small ponds are also to be seen in this drainage basin. Examples are the Periathambiran and the Panaka ponds in Alaveddi, the Kuruccual Kovil and the Uthirikai, ponds in Kantharodai, the Alangulai, the Vauvil the Vithanaka, the Kumba ponds, and Sandilipay pond in Sandilipay, the Inchilankai pond in Chankanai, the Kelangamam and the Sanguveli, ponds in Sanguveli, the Thickarai pond in Vaddukoddai the Sangarathai and the Ordakarai ponds in Sangarathai, the Kulavi, the Veduvankandy and the Navali ponds in Navali, the Indikundu pond in Manipay, the paravai pond in Suthumalai the Uduvil pond in Uduvil. Figure No. 1 shows the detail of the ponds which are numbered in Table 1.

Table 1

Ponds in the Valukkai basin

1. Panaka Pond
2. Kovil pond
3. Vauvil pond
4. Vithanaka Pond
5. Kumba Pond
6. Inchilankai Pond
7. Kelangamam Pond
8. Thickarai
9. Kulavi Pond
10. Veduvankandy
11. Navali Pond
12. Sandilipay Pond
13. Paravai pond
14. Idikundu Pond
15. Kuruccal Kovil Pond
16. Uduvil Pond
17. Uthirikai Pond
18. Alangulai Pond
19. Sanguveli Pond
20. Sangarathai Pond
21. Ordakari Pond
22. Periathamiran Pond
23. Karapittiyar Kovil Pond

Though this drainage basin appears flat the source of the stream is 10.67 Metres above sea level and the mouth of the stream at Arali is 1.52 Metres above sea level.

The drainage basin consists mainly of limestone which is covered for the greater part by Grey loam and to a small extent by Red soil. According to the soil analysis done by Joachim in 1945, this drainage basin falls within the Geological division "terra rossa" but according to the analysis of Moorman and Panabokke (1961) it belongs to the "red yellow latosol division".

The Valukkai is a seasonal stream which appears when this drainage basin receives rainfall during the northeast monsoon. Because of this, climate plays a large part in determining the Geomorphology of this region. According to the climatic classification of Ceylon (Sri Lanka) prepared by Thambiapillai (1952) this region is part of the "Northern coastal Area" which is denoted by I1 am.

Aim :

Because seasonal stream water in the Valukkai drainage region rapidly dries up, this water is not useful for economic development. Since the Geomorphology of the region is responsible for the drying up of this stream water, is of great significance. Important aspects of the Geomorphology of the Velukkai region are its soil, water, proximity to the sea, stream and ponds. The climate and land usage have left their mark on the Geomorphology of the place. From a detailed study of all this a clear picture of the Geomorphology of the place emerges.

Method :

The soil and water samples taken from the region were examined in the laboratory, and from the soil samples.

1. The grain size of the soil particles through mechanical analysis,
2. The permeability on the basis of Darcy's laws using a Permeameter, were measured.

And from the water samples,

1. The electrical conductivity of the water in order to determine its salinity.
2. The PH of the water were measured.

These measurements contribute to our understanding of the Geomorphology of the Valukkai stream region. Some relevant hydrological aspects such as water table etc. were also measured by the present author — by Puvaneswaran (1974), but not discused here.

Results and discussion:

Using the hydrometer and applying the formula :

$$Dmm = 1.3555 \frac{U}{ew(Gs-1)} \cdot \frac{HR}{t}$$

Where, Dmm is Diameter of equivalent spherical particle (mm).
U is Viscosity of water at T°C (Poise).
ew is Density of water T°C (in c.g.s. units).
Gs is Specific Gravity of soil.
HR is Effective depth of immersion of hydrometer.
t is Time (seconds).

and also by the method certain data were obtained. From this data graphs were made and the average diameters of soil particle in different soil samples and the nature of the soil were obtained. These are given in table II. The graphs of soil samples are annexed. (see appendix 1,2,3,4.)

Looking at the figure (Fig.2) which was drawn using the information in table II the nature of the soil in this drainage basin is evident.

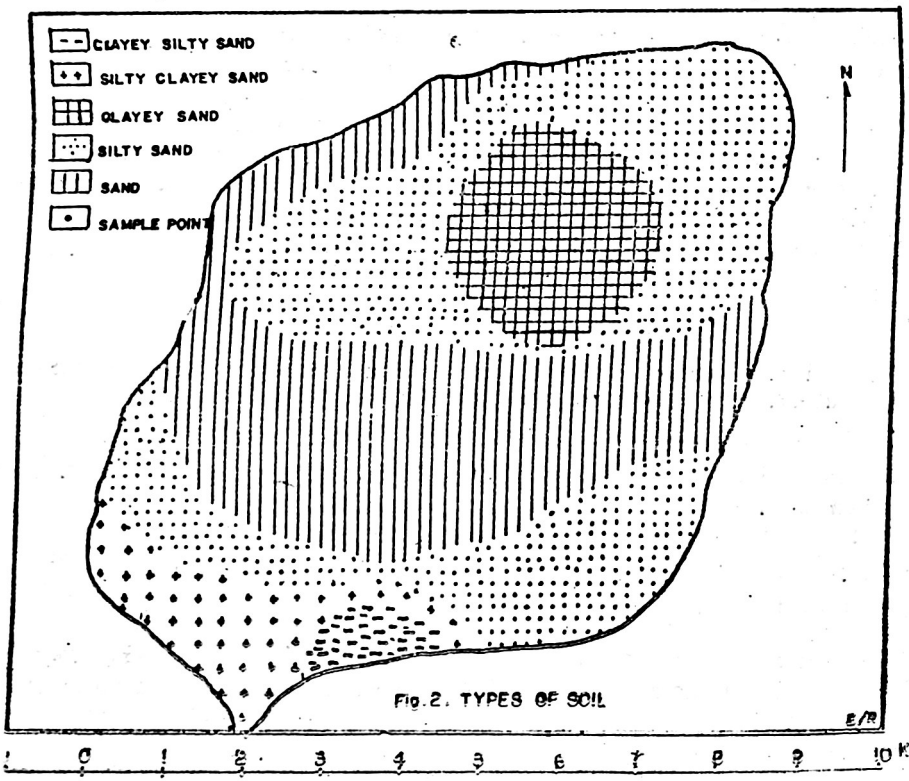


Fig.2. TYPES OF SOIL

In places where there is stagnant water and in the drainage region of the stream clayey sand is to be seen. Because this stream and the depressions where water collects do not receive water throughout the year, but only during the north-east monsoon, the above places do not consist completely of clay but are made up of clayey sand. The average diameter of the soil particles in the whole region under investigation was found to be 0.17 mm.

Permeabilities are obtained using Permeameters which are either sand using constant head Permeameters or clay using falling head Permeameters The choice of the type of Permeameter depends on soil texture. For the first type of Permeameter the formula.

$$Q = \frac{KA.H}{L}$$

is applied to obtain the permeability and for the second type the formula.

$$T = \frac{LA}{KA} (\text{Log}_e H - \text{Log}_e Ho)$$

is used. The permeabilities obtained are given in Table II. This can be seen in Figure 3 which is a map of permeability.

Because the soil samples consisted mainly of sand, plastic limit, Liquid

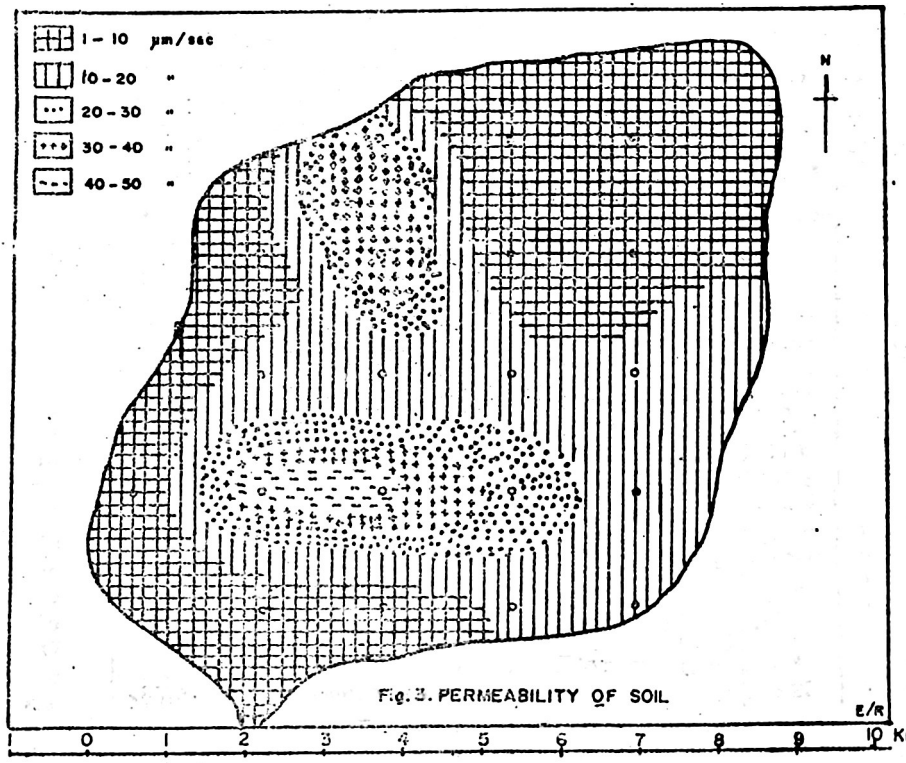


Fig. 3. PERMEABILITY OF SOIL

limit and plasticity Index were not present to any appreciable extent and therefore the attempt to determine these was abandoned.

The Electrical conductivity and PH of the water samples and their proximity to the sea are given in Table II.

The Electrical conductivity of the water samples is an indicator of their salinity. A high value for Electrical conductivity generally means a high degree of salinity and a low value shows that the salinity is low. (But if ionization is high, this also can increase the Electrical conductivity depends on ionization; the ionization of pure water is very low, so is its electrical conductivity. When an Alkaline or an acid is added to water ionization increases. Because the ionization of strong acids and strong alkalines is high the Electrical conductivity is also high. If we consider a solution of Sodium chloride (common salt) the solution will be completely or almost completely ionized.

$$NaCl \longrightarrow Na^{+} + Cl^{-}$$
$$H_2O \longrightarrow H^{+} + OH^{-}$$

Rain water combines with the carbon dioxide in the atmosphere and forms carbonic acid. (Therefore on reaching the ground its PH) is less than 7. The Valukkai stream region is made up mainly of limestone. When rain water seeps through the soil salts such as calcium carbonate

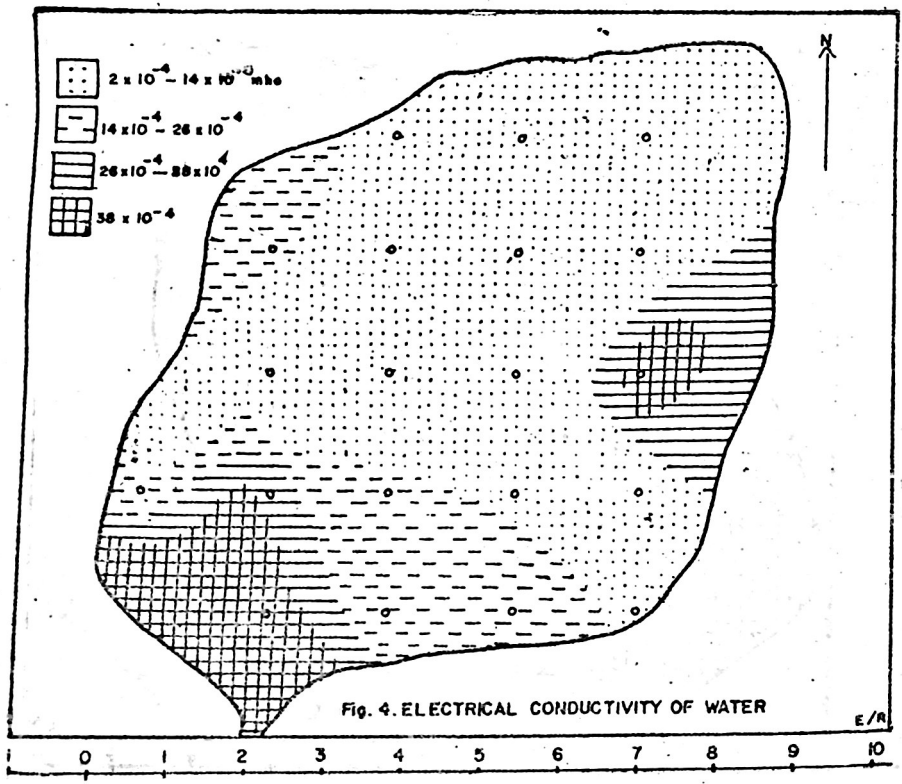


Fig. 4. ELECTRICAL CONDUCTIVITY OF WATER

and calcium sulphate dissolve in it and a salt solution results. Because of this the PH of the water in this region is greater than 7. The salinity of the well-water samples taken from the Valukkai region varies as shown by the various values for the electrical conductivity. In places where the water has a low electrical conductivity the salinity is low and in places close to the sea such as Vaddukoddai East and Arali North where the water has a high electrical conductivity, the salinity is high. This can be seen in Figure 4, which is a map of electrical conductivity.

To confirm the data obtained in this study 'r' test (Coefficient of correlation), was used. The correlation between mean diameter of soil particles and permeability plays a major role in determining the geomorpholoy of the region. For the Valukkai region the correlation between diameter of soil particle and permeability was found to be 0.46 (Regression line and Scatter plots were given in Graph 1.) which is between 0.05 and 0.02 level of significance. Obviously this shows that there is a significant relationship between the diameter of soil particle and permeability of soil. It is because there is a positive relationship between permeability and diameter of soil particle that there are small ponds in the Valukki region. However it should be mentioned that these ponds also depend on the seasonal rain for their water.

Table II

Mean diameter, Nature, Permeability of Soil, Proximity to the sea of Sample point and Electrical conductivity and PH of water.

Samples No.	Place	Mean diameter of soil (mm)	Nature of Soil	Permeability (um/Sec)	Proximity to the sea (K meter)	Elect. Conductivity (10^{-4}mho)	pH
1	Periyavilan	.25	Sand	39.50	3.22	3.50	8.10
2	Alaveddi West	.10	Clayey Sand	8.25	4.02	2.30	7.85
3	Alaveddi	.15	Silty Sand	8.09	.48	8.25	7.80
4	Chankanai West	.17	Silty Sand	3.95	4.02	14.00	7.55
5	Chankanai East	.18	Silty Sand	38.50	4.83	4.35	8.05
6	Makiyappiddy	.19	Clayey Sand	5.30	5.63	7.00	7.60
7	Mallakam	.03	Clayey Sand	5.68	5.63	8.00	7.05
8	Sittankerni	.15	Clayey Sand	10.10	.83	9.50	7.55
9	Sandilipay	.20	Sand	11.10	.83	6.50	8.20
10	Sankuveli	.17	Sand	16.90	5.63	5.50	7.70
11	Kantaroday	.14	Sand	18.90	6.44	2.70	7.35
12	Vaddukoddai	.15	Silty Sand	3.87	3.22	12.50	7.30
13	Vaddukoddai East	.22	Sand	41.50	3.22	41.00	7.75
14	Kaddudai	.15	Sand	43.10	4.02	14.40	7.65
15	Manipay	.25	Sand	28.90	4.83	8.50	7.75
16	Uduvil	.17	Silty Sand	16.40	4.83	6.00	7.30
17	Araly North	.11	Silty Clayey Sand	1.10	1.61	40.00	8.35
18	Navali	.18	Silty Sand	1.20	2.41	14.50	8.20
19	Manipay	.18	Silty Sand	11.80	3.22	23.50	8.30
20	Suthumali	.20	Sand	17.80	2.41	5.50	7.60

To find out whether the proximity of the sea brings about any changes in the geomorphology of the region statistical method was used to find out the correlation coefficient between salinity of the water in a particular place and the distance of this place from the sea. The results which is −·3. showed that there is a decline in salinity with distance from the sea. (Regression line and scatter plots were given in Graph 2). Even though the proximity to the sea may affect salinity in a small way other factors such as climate and the nature of soil affect is considerable as far as the Valukkai region is concerned. Using statistical methods for the rainfall data in the region, the year was divided into wet and dry seasons. Since evaporation is greater during dry spells there is a corresponding increase in the salinity of the soil.

Conclusion :

Because the Valukkai is a seasonal stream and the region through which it runs is not hilly or elevated but almost flat and the stream not flow from perennial springs, the land formations usually associated with a typical river are absent here. Water is found throughout the year in the area near the mouth of the river and almost throughout the year in the biggest pond in the region namely the Panaka pond. Here clayey sand is found. As for the rest of the region there is not much difference between soil found near the stream and elsewhere and this is explained by the fact that the stream does not contain water right throughout the year.

Almost half the Valukkai region is farmland devoted to paddy cultivation. The rest of the region is populated areas and small cultivated fields. This is evident from the aerial photographs (Fig. 5) which were examined and also the determination of land use through random sampling. Land use affects the geomorphology of any area. For example houses and large buildings built of cement are found in many parts of the Valukkai region and prevent the water provided by nature from seeping into the soil. Earlier sea water mixed with the stream water at the mouth of the river. But recently a cement barrier has been built here to prevent or reduce this mixing. This will obviously reduce the salinity of the water near the mouth of the river. Here as in all inhabited parts of the earth, man's activities are changing the geomorphology. Because of these geomorphologic characteristics the stream and ponds in this region run dry rapidly. These characteristics also enable the formation of ponds swallow holes, grikes and underground caves.

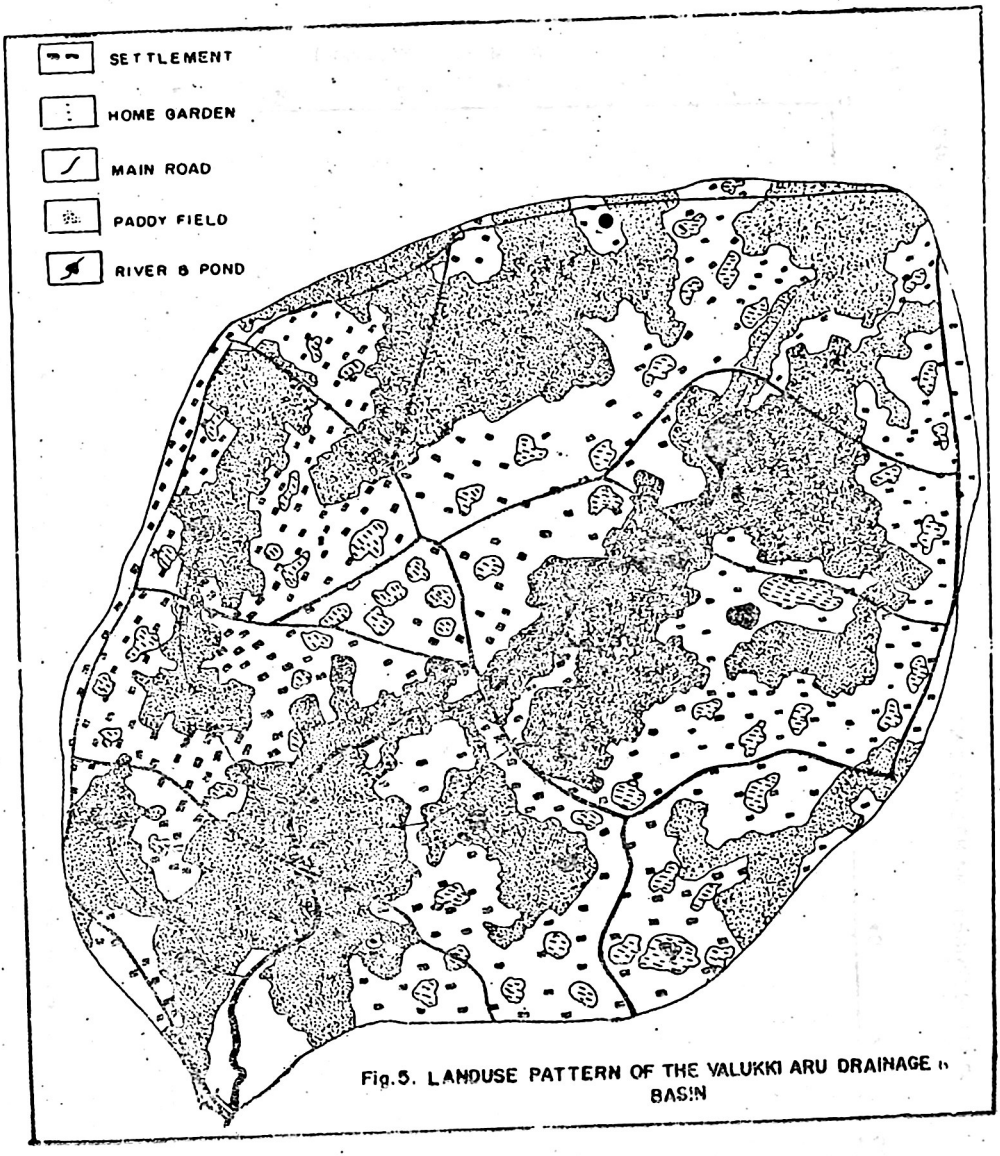
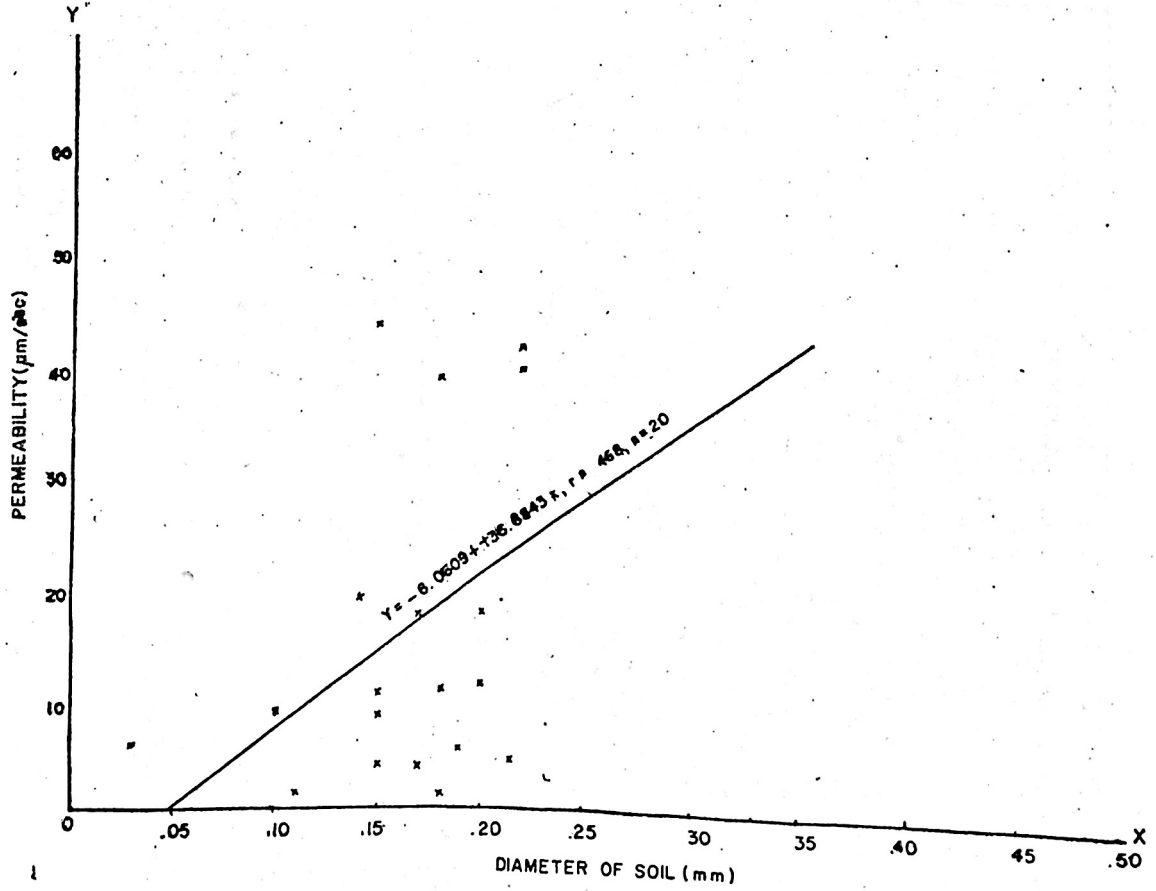
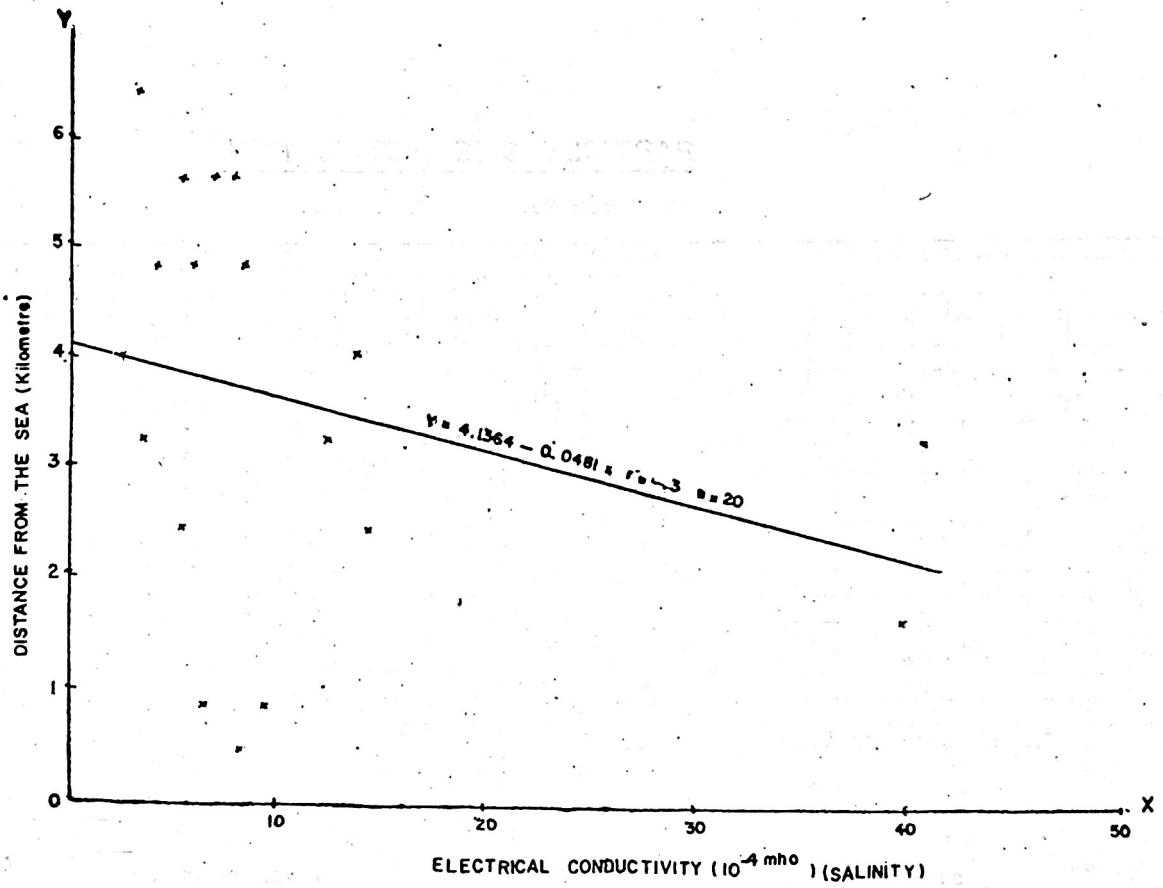


Fig.5. LANDUSE PATTERN OF THE VALUKKI ARU DRAINAGE BASIN



GRAPH. I REGRESSION LINE AND SCATTER PLOTS BETWEEN DIAMETER AND PERMEABILITY OF SOIL

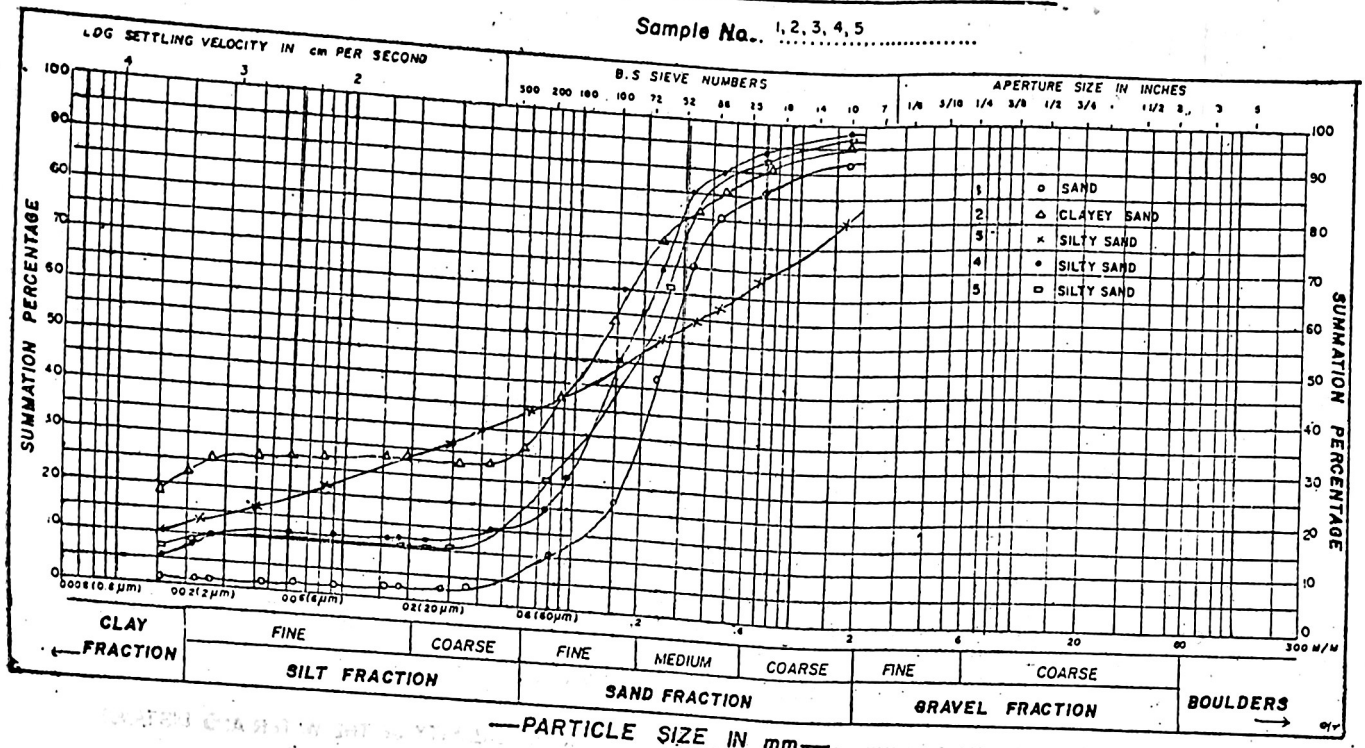


GRAPH 2. REGRESSION LINE AND SCATTER PLOTS BETWEEN SALINITY OF THE WATER AND DISTANCE FROM THE SEA

APPENDIX - I

PARTICLE SIZE DISTRIBUTION

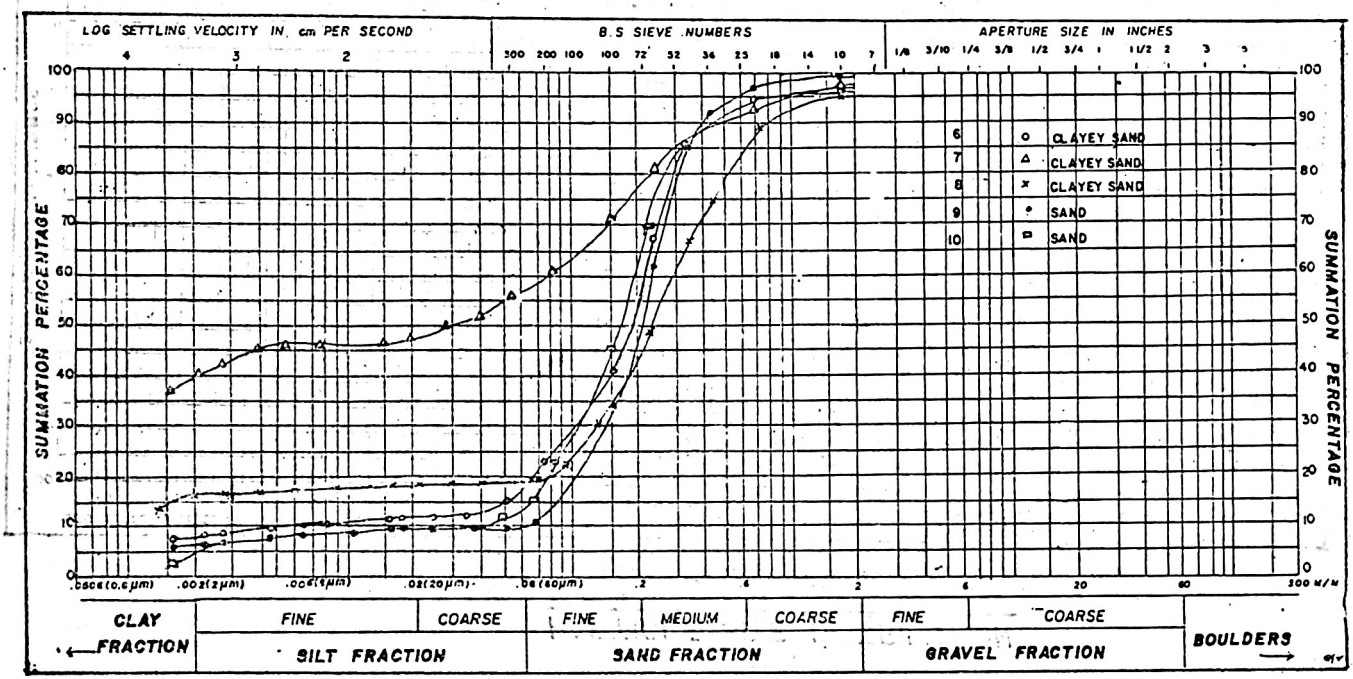
Sample No. 1, 2, 3, 4, 5 .....



APPENDIX - 2

PARTICLE SIZE DISTRIBUTION

Sample No. 6, 7, 8, 9, 10

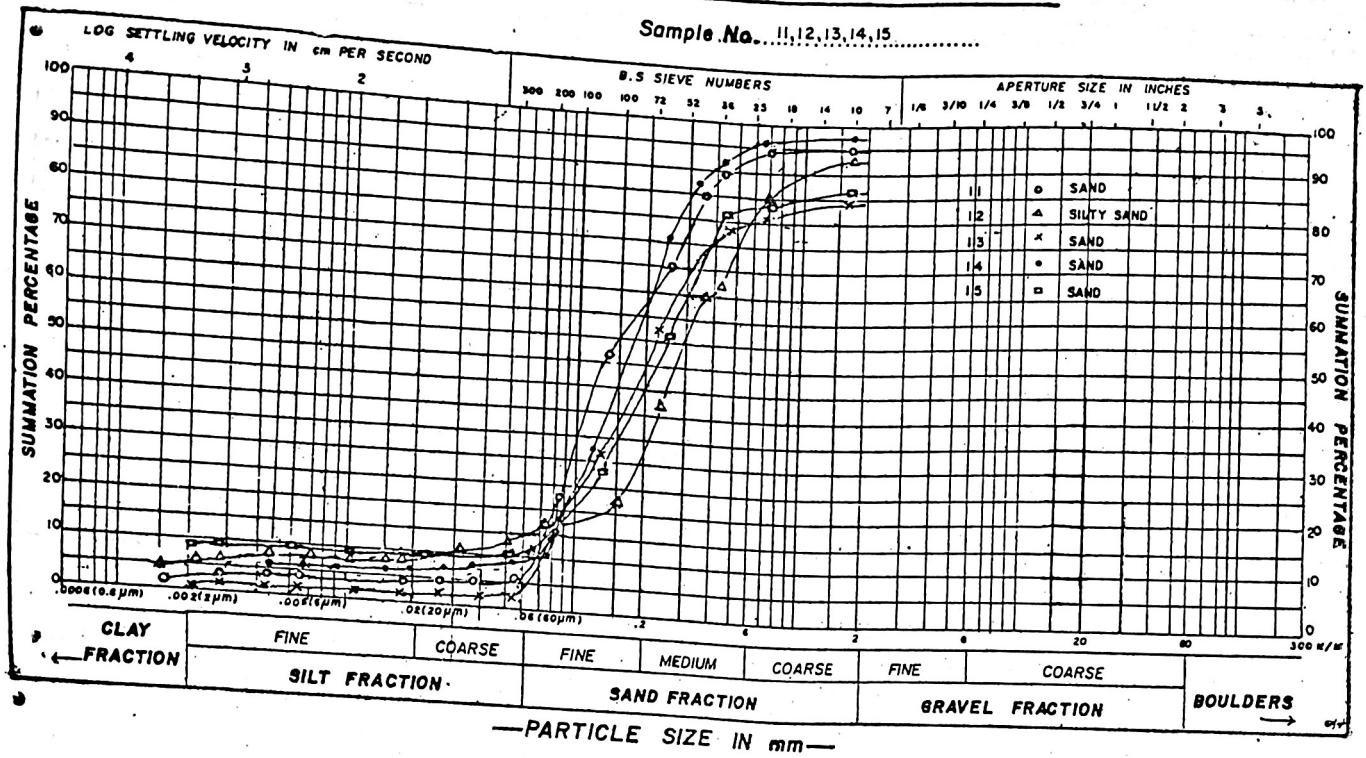


—PARTICLE SIZE IN mm—

APPENDIX - 3

PARTICLE SIZE DISTRIBUTION

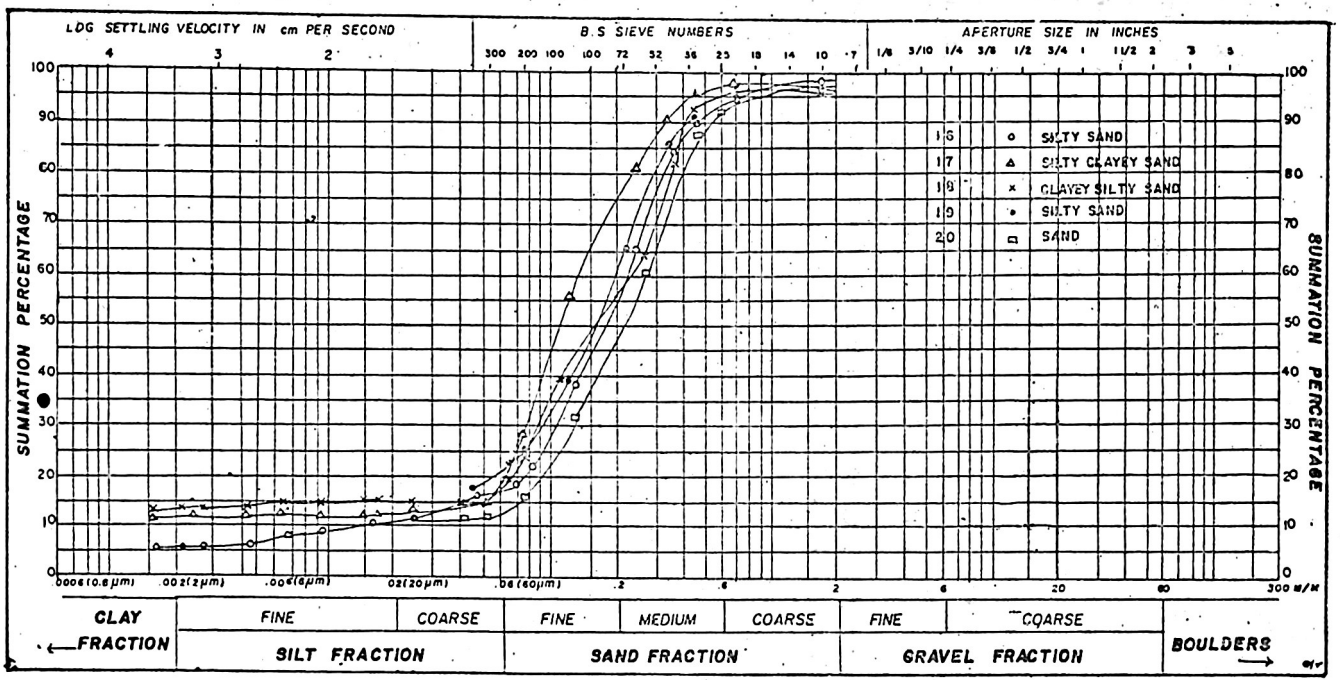
Sample No. 11,12,13,14,15



APPENDIX - 4

PARTICLE SIZE DISTRIBUTION

Sample No. 16, 17, 18, 19, 20



REFERENCES

1. British Standard Survey 1377 (1961): Methods of testing soil for civil Engineering purposes.

2. Joachim, A. W. (1947): The soils of Ceylon B.C.G.S. Vol. 2

3. Lambe, W. T. and Whitman, R. V. (1969): "Soil" Mechanics

4. Moorman, F. R. and Panabokke, C. R. (1961): A new approach to the identification and classification of the most important soil groups of Ceylon. Tropical Agriculture, Volume 117, No. 1

5. Puvaneswaran, P. (Miss P. Shanmugam) (1974): Geomorphology of the Region through which the Valukkai stream runs. Unpublished Hon's thesis, University of Peradeniya.

6. Thambiapillai, G. (1952): Climates of Ceylon, Unpublished M. A. Thesis, University of California, Los Angeles.