PHYTOGEOMORPHOLOGY OF UPPER PART OF THE UMIAM BASIN (MEGHALAYA)

By

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Dissertation

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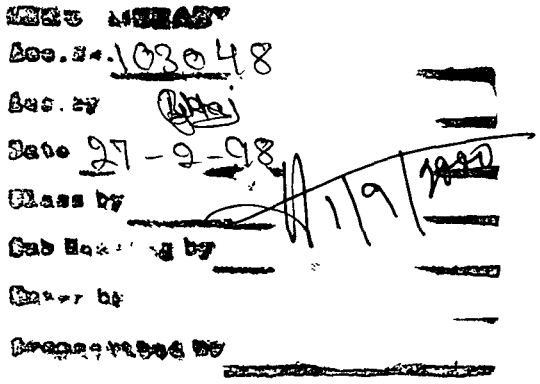

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CERTIFICATE

This is to certify that the dissertation entitled "Phytogeomorphology of Upper Part of the Umiam Basin", Meghalaya, submitted by Shri Laitpharlang Cajee, in partial fulfilment for the degree of Master of Philosophy in Geography.

This is a bonafide work to the best of my knowledge and may be placed before the examiner for evaluation.

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Dated Shillong
the 7th November,1994.

(Laitpharlang Cajee)

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CHAPTER I

INTRODUCTION

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INTRODUCTION

1.1 Preface

Phytogeomorphology offers a broad based synthesis of the important relationships between plants and landforms in studies related to the surface of the earth. Whereas the present landforms equally predate history, plant communities reflects interaction of current environmental factors.

Excluding those creatures that live wholly on the produce of the seas, all life depends directly or indirectly on a very thin mantle of the earth's surface. This is closely associated with landscape, form of the land and soil, which in turn reflects the operation of climate on the vegetation and the physical materials of the earth's surface[1].

1.2 Statement of the Problem

The term phytogeomorphology emphasises the importance of combining plants and landforms in studies related to the land surface of the earth and in recognition of their interdependence. Thus, in combination, the two form a powerful tool for the survey,management and planning of our environment. However there are more specific discipline-oriented studies that can benefit directly or indirectly from a phyto-geomorphic approach. It is observed that a balance between landforms and vegetation varies greatly. Thus an integral concept of

geomorphology and vegetation to landuse planning though is relatively new, can highlight a number of aspects of renewing this world to a better place to live in[2].

The whole mass of plant species is in a certain proportion to the different latitudes of the earth's surface. The proportion increases as we approach to the equator and decreases as we move away from it[3].

Civilization has been defined as man's gradual conquest of his environment, but how far this process, in sober facts gave, is a matter for careful thought. In some way, containing man's masterly over nature is complete enough where he exploited the resources of the mineral world to a remarkable degree but has been less successful in establishing a relationship with the plant world which is the time basis of human economy. Naturally enough vegetation is as susceptible to man's destructive propensities as any other part of nature and in many respects it can be as easily exploited by him, but unlike the rest he cannot entirely bind it to his own will[4].

In addition world wide vegetation distributions clearly mirror variations of climate-induced topography and topographically induced climate and also that plant communities influences local climate to a great extent. As a result vegetation modifies landforms though its effect on soil by penetrating through rock cracks and converting the parent rock material into the mantle of unconsolidated surface material

called regolith. Thus their total effect is increasing soil depth and diminishing its movement[5].

However, it can be seen that plant landforms relationship where studies on soil characteristics and parent rock material can throw a lot of light not only on many present - day questions and in lessening the limitations under which man labours, his inability to see into the future ?

Thus in the light of the above discussions the present study - **"Phyto-Geomorphology of Upper part of the Umiam Basin", Meghalaya,** has been chosen.

1.3 Aims And Objectives

Landforms and vegetation influences the development of the natural landscape. Therefore landform characteristics of the concerned area is an important aspect to be understood. So also is the distribution and characteristics of flora in relation to soil characteristics would require adequate consideration. However in other circumstances climatic differences may predominate. Thus the study focuses particularly on the study of landforms, soil and special attention is given to the dominating tree species. This therefore gives the following objectives:

i) to study the geomorphic attributes and landform characteristics of the area.

ii) to describe the physical and chemical characteristics of the soil.

iii) to describe the morphological characteristics the major tree species.

iv) to establish a relationship of the different parameters like landform, soil and morphological characteristics of the major tree species.

1.4 Research Questions

On attempting this study, a number of questions are set in the mind of the researcher.

(1) What are the geomorphic attributes of the study area ?

(2) How these attributes influence the major plant species of the area ?

(3) What are the physical and chemical characteristics of the soil and the role they play in the distribution of major plant species ?

(4) What are the other factors besides the above mentioned that affect the development of the species considered ?

1.5 The Study Area

Location: The area studied is found in Survey of India, Toposheet No.78 0/14 with a scale of 2 cms = 1 km. (ie. RF 1 : 50,000) which was surveyed in the year 1966-67. The study area covers an area of about 117 km^2 and the whole area is within the Umiam Drainage Basin. The area approximately lies between $25^{o}31'N - 25^{o}42'N$ latitudes of $91^{o}47'E - 91^{o}55'E$ longitudes. The

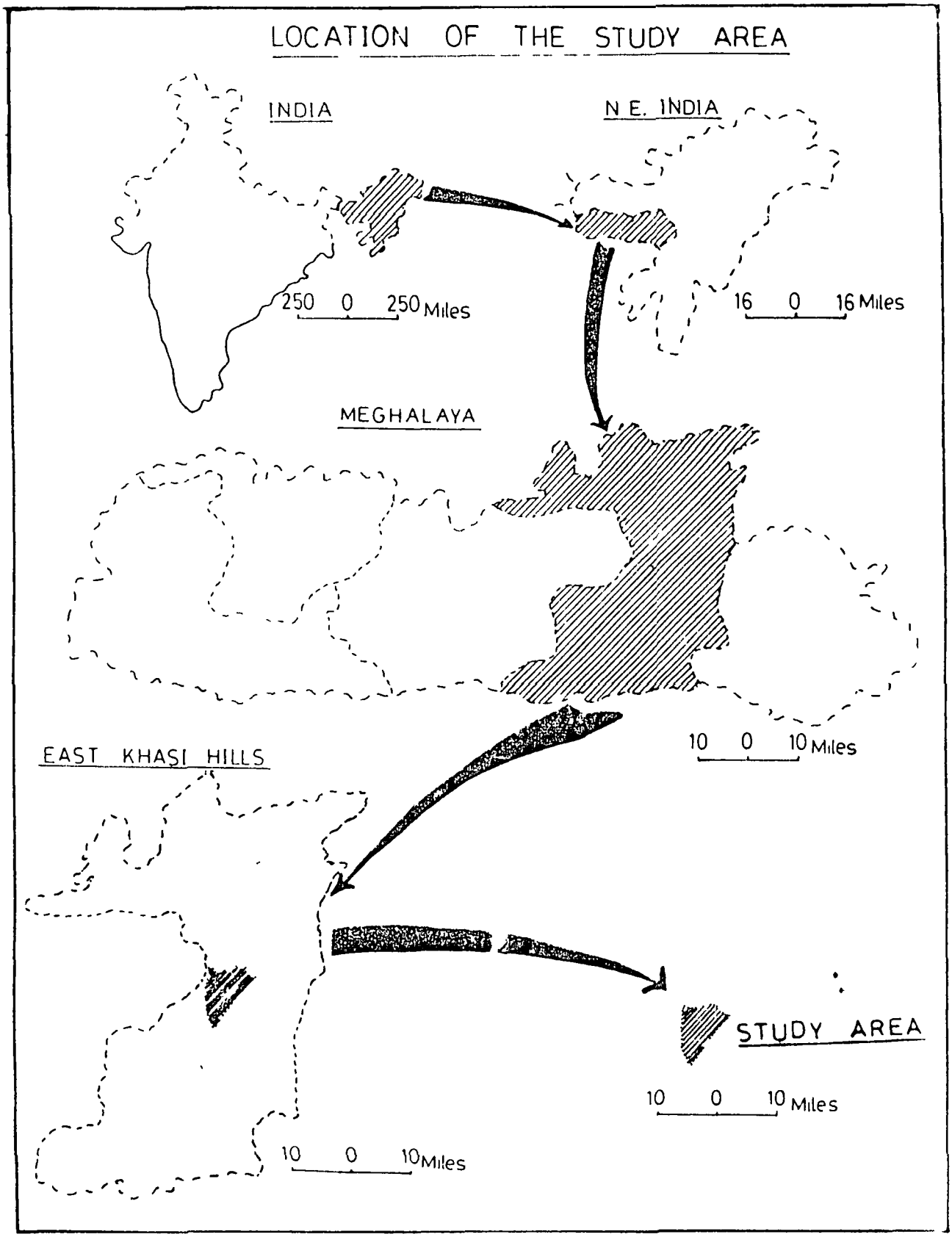

LOCATION OF THE STUDY AREA
INDIA
250 0 250 Miles
N E. INDIA
16 0 16 Miles
MEGHALAYA
10 0 10 Miles
EAST KHASI HILLS
10 0 10 Miles
STUDY AREA
10 0 10 Miles

FIG – 1

area studied is part of the East Khasi Hills District and a very small portion of the study area falls within the Ri-Bhoi District. The study area traverses right across Shillong town extending from around Upper Shillong area to the Umiam Lake. However the study area can be classed under 4 zones depending upon the altitude of the place where micro areal study has been done particularly with regard to the major tree species found and the physical characteristics of the soil and also some of the general physical features of these areal units, which includes the Upper Shillong area, Riat Khwan Area, the Barapani Lake Area and that of Umbir Village. The area is bounded by Ri-Bhoi District in the North, Bangladesh in the South, Jaintia Hills in the East and West Khasi Hills in the West.

1.6 Physical Setting

The study area has diverse and varied topography and consist mostly of rolling uplands intersected by streams. The area is formed by contours ranging from 900 -1950 metres. The 4 zones mentioned earlier can be termed "Uplands" and which are broadly categorized into 4 divisions where each micro areal unit study falls under each of these categories.

(i) High-Uplands (above 1800 metres a.s.l.) - Upper Shillong Area

(ii) Mid-Central Uplands (1400-1800 metres a.s.l.) - Riat Khwan Area.

(iii) Mid-Lower Uplands (1000-1400 metres a.s.l.) - Umbir Village

(iv) Low-Uplands (below 1000 metres a.s.l.) - Barapani Lake Area

The High-Upland area has got a hilly and rugged terrain which is also steeply sloping. Small streams are seen to start arising from this areal unit. The streams cut through the rugged topography carving through the exposed rock surfaces. This areal unit also has peaks which are above 1900 metres in height i.e. Shillong Peak & Laitkor Peak and is also dotted by rounded hills.

The Mid-Central Uplands cover mainly the proper Shillong Town area and extends upto Mawlai. Here the streams are wider and fast flowing through the dissected topography. The drainage pattern within this areal unit is mainly dendritic in nature and a rolling type of topography showing the true nature of a plateau . Scarps, cliffs and water falls are dotted at certain parts of this areal unit.

The Mid-Lower Uplands cover the major portion of the study area. Here the streams are very fast flowing and have tributaries passing from the High and the Mid-Central Uplands. Waterfalls, cliffs and scarps are notable features and hills with rounded tops are prominent.

The Lower-Uplands are mainly the Barapani Lake Area and its surroundings. The slopes are gentle and the streams are almost parallel. Rounded hill tops, scarps with Valleys and ridges are notable.

Thus in general we can say that the main physical features of the study area are the presence of rounded hill tops, escarpments, cliffs, waterfalls, ridges, valleys and a smooth undulating skyline showing the true nature of a plateau with a rolling topography.

1.7 Geological Investigations

The first geological study on the region was made by T.Oldnam (1859)[6]. H.B. Medlicott (1869)[7], Godwin Austin (1869)[8], La Touche (1883, 1889)[9] and F.R. Mallet (1876)[10]. They carried out detail work with regard to a systematic Geological mapping. Later workers namely R.W. Palmer (1923)[11], C.B. Fox (1936-38)[12], V.R. Khedkar and P.N. Mukherji (1938-39) [13] and A.M.N. Ghosh (1936-39)[14] led establishment of stratigraphic sequence of different rock suits of the region.

The self sediments of the southern parts of the plateau have been mapped by A.C.Bhattacharya, G.Barman, B.K.Duara, C.Chakravarti, B.D.Adhikari, K.K.Sen and S.K.Srivastava during the field seasons from 1961-62 to 1972-73.[15] . Their work led to the delineation of different litho-stratigraphic units of the Tertiary Self Sediments.

1.8 Geology

The Upper part of the Umiam Basin is an integral part of the Shillong Plateau. So before going to discuss about

GEOLOGICAL MAP OF MEGHALAYA

(BASED ON " KNOW YOUR DISTRICT " PUBLICATIONS–1976, GEOLOGICAL SURVEY OF INDIA)

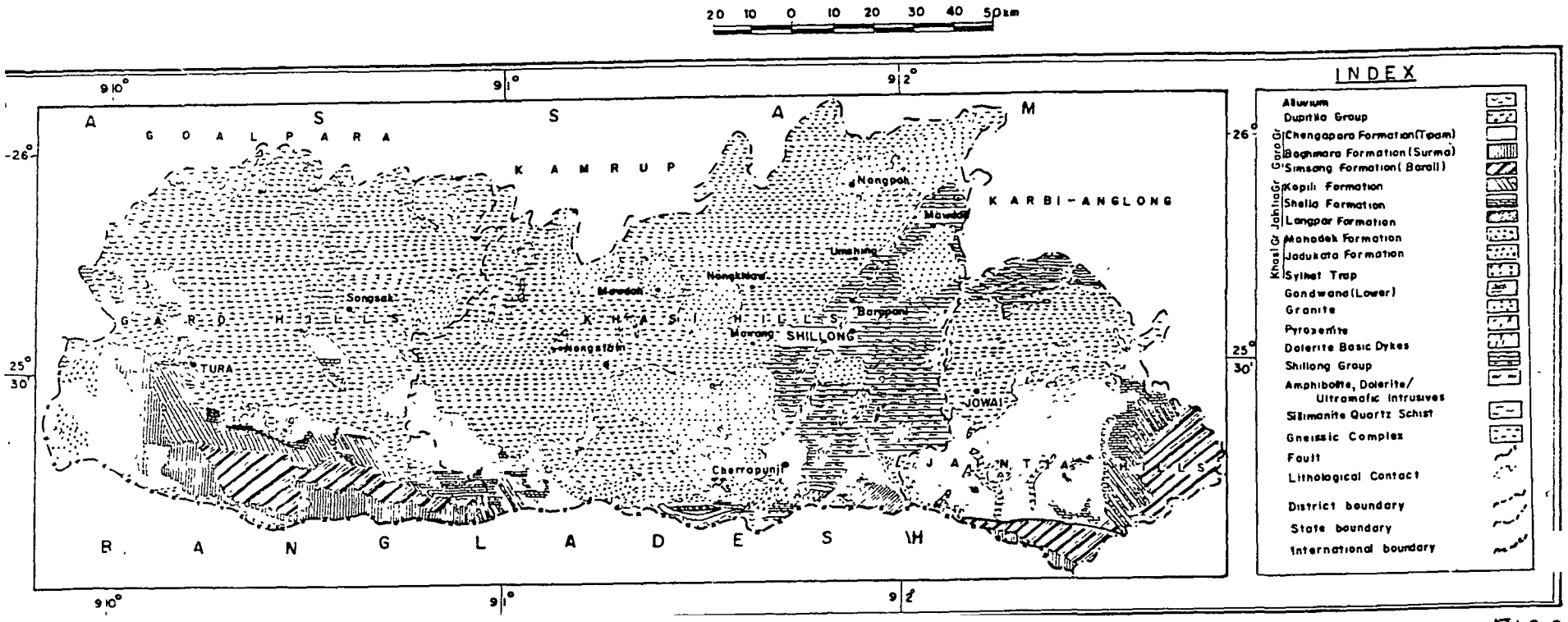


FIG-2

the geology, of the area under study, it is very much essential to give a brief geological account of the Shillong Plateau. The Shillong Plateau is composed of rocks of the Precambrian age acutely folded and steeply dipping with an over-turned fringe of Mesozoic and Tertiary Sediments[16]. Geologically it is a part of the Indian Peninsula being cut off from the intervening spread of the Ganges and the Brahmaputra alluvium and chronologically have similarity with that of the Chotanagpur Plateau including the Rajmahal Hills. Further resemblance is seen in marine transgression which affected the Southern shores of the plateau in Cretaceous times and has left deposits which lie undisturbed upon older rocks, as do similar deposits along the Corammandel coast of the Peninsula[17].

The plateau contains the ancient (Precambrian) peneplaned surface, with marks of the different cycles of denudation. In the central and northern part, it is hidden beneath the Sylhet traps along the central southern fringe and Cretaceous Tertiary and Post Tertiary Sediments over the southern, south-eastern and south-western parts. The plateau stands as a watershed between the Surma Valley of Bangladesh in the south and the Brahmaputra valley in the north.

The whole of Meghalaya is occupied,if one looks at the geological map (Fig.2) by the following groups of different geological periods:

(a) Recent-Newer Alluvium

(b) Pleistocene-Older Allulvium

(c) Mio-Pliocene-Dupti Tila Group.

(d) Oligo-Miocene-Garo Group.

(e) Eocene-Jaintia Group.

(f) Upper Cretaceous-Khasi Group.

(g) Jurrasic-Sylhet Trap.

(h) Precambrian-Shillong Group

(i) Archaean-Genissic Complex

1.9 Geology of the Study Area

The study area forms part of the Shillong Plateau, by and large exposing the Shillong group of rocks (Fig. 3). The generalised Litho-stratigraphic sequence is given in (Table 1).

1.10 The Gneissic Complex:

The gnessisc complex forms the basement for the Shillong Group. The complex is represented by quartzite, biotite-gneiss, hornblende, biotite, mica, quartz, schist etc. The rocks are migmatised to varying extent and are mostly aligned concordant to the flora.

The gnessic complex occurs in the N.W. corner of the study area confined to N.W of Sumer ridge. The contact between the genessic complex and the overlying Shillong Group of rocks runs mostly N.E.-S.W.

Geological Map Of The Upper-Umïam Basin

(Based: Geological Survey Of India)

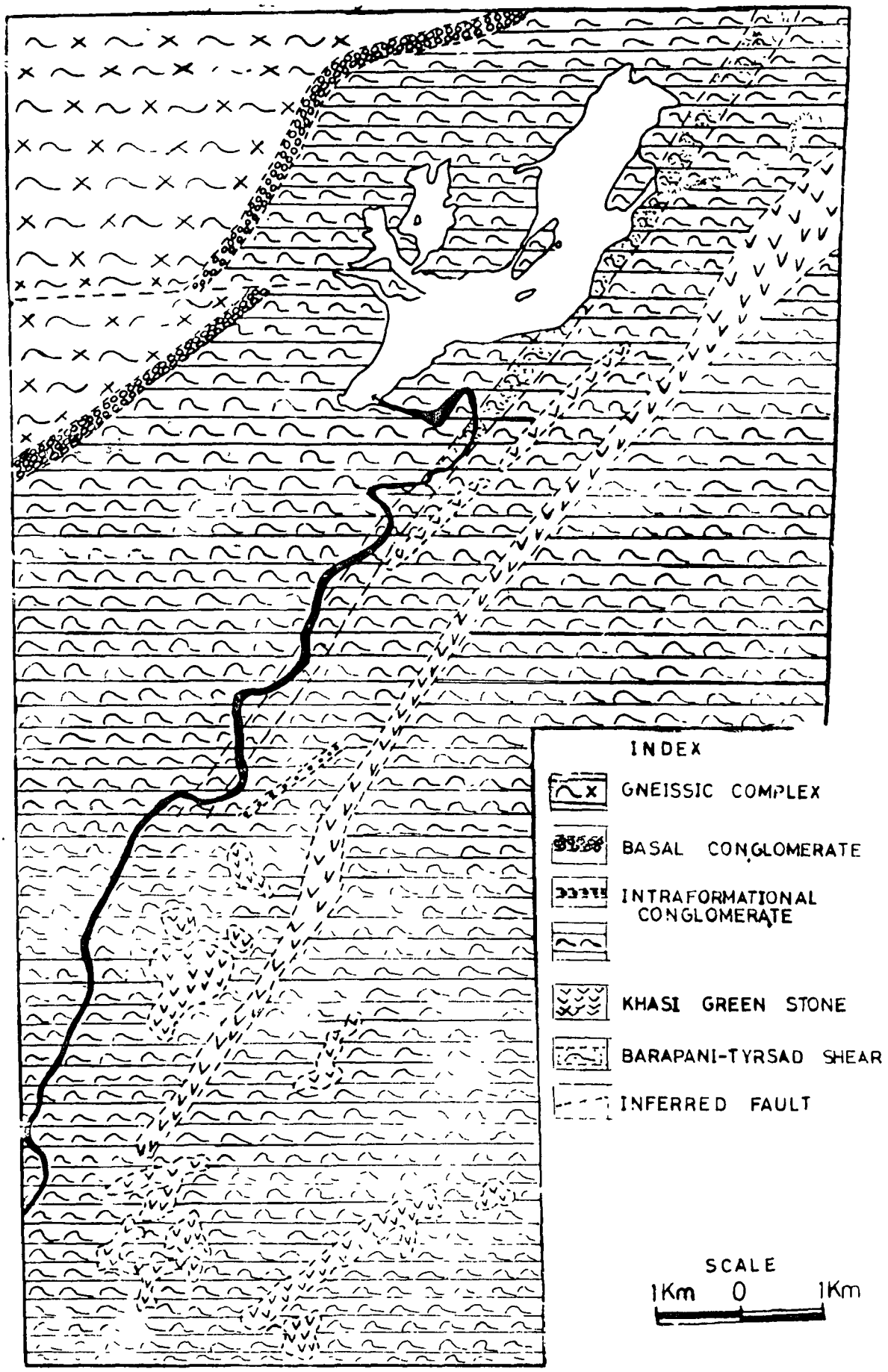


FIG: 3

1.11 The Shillong Group

The Shillong Group of rocks occupy the major portion of the study area. It is composed of subordinate phyllite facies which are weakly metamorphosed. These metasedimentary rocks occur as N.E.-S.W. tending linear bases represented by basal conglomerate, and an association of sandstone/quartzite/arkoses, siltstone-shale-slate-phyllite locally carbonaceous and rarely mica schist. The rocks show heterogeneous nature and variation along as well as across strikes.

The contact between the Gneissic complex to overlapping Shillong Group has variable nature in different places. South of Sumer ridge, a distinct unconformity demarcation between the two groups with commencement of basal conglomerate.[18]

The members of the Shillong group are described below:

Basal Conglomerate unit

This is a thickly bedded unit and occurs as detached lensoid beds from near Barapani (Sumer Ridge) in N.E. to Diengiei peak 1851 m.In composition, the clusters are of vein quality and rarely quartzite. The pebbles lie with thin long axes aligned parallel to bedding and short axes lying perpendicular to bedding.

The Sandstone-Phyllitic quartzite Unit:

This is a dominant lithotype in the area. Basically it has two varieties (1) coarse grained and (2) fine-grained.

TABLE No. 1

Litho-stratigraphic Succession of the upper part of the Umiam Basin

	Recent Terraces	
----------	Unconformity	----------
	Quarternary Terraces	
----------	Unconformity	----------
	Khasi Green Stone	
----------	Intrusive Contact	----------
Late Proterozoic	SHILLONG GROUP	Cyclothem of arenaceous and pelitic meta-sedimentary facies represented by an association of sandstone/phyllitic quartzite and siltstone-shale-slate-phyllite with basal conglomerate. Locally mica, schist, and ferrogenous quartzite. Basal conglomerate.
----------	Unconformity	----------
Late Proterozoic to Archean	GNEISSIC COMPLEX	Quartz biotite, gneiss, hornblende, biotite gneiss, mica, quartz, schist often magmatised.

SOURCE: GEOLOGICAL SURVEY OF INDIA, MEGHALAYA.

However the quartizite of its allied variants mostly occur in area south of Mawlai and the phyllitic variants occur north of Mawlai.

The Siltstone-slate-phyllite Unit:

These have been labeled together for description purpose as they occur in association and represent the argillaceous facies of the Shillong Group. In composition, it is similar to sandstone particularly to siltstone members and its allied variants.

At places where the argillaceous components in the rocks have increased, the grain size has decreased.The rocks appear as slate and phyllite particularly north of Mawiong and before Barapani dam. The phyllite show various shades and colour namely yellow, grey and light green. The characteristic member of this association is Carbonaceous slate/phyllite which is exposed along G.S.Road cutting before Barapani dam.It is persistent and continues SW upto Mawphlang (De,1981).

A remarkable feature of the association is the presence of impersistent lenses of autoclastic conglomerate which is metamorphosed. One such exposure can be seen on G.S.Road near Shillong "Goo Shala".

The Khasi Green stone unit:

It is a metamorphosed concordant basic intrusive confined within the Shillong group. Along the G.S.Road good sections are exposed near Mawiong and in Phud Umshing.

Tyrsad Barapani Shear Zone:

Tyrsad Barapani Shear Zone is a prominent structural trend in the area. This zone accompanies the shearing of rocks. This zone is exposed in the G.S.Road cuttings between Mawiong and Barapani Dam.

1.12 Climate

The area experiences a tropical monsoon type of climate where maximum rainfall is received during the months of June to October accounting to about 85% of the total annual rainfall. However there is a lot of temperature variations where the high altitudinal areas differ greatly from the low altitudinal areas. January and February are the coldest months of the year where the average mean mminum varies from $4^{o}C$ - $9^{o}C$ depending on altitude and the hottest months being June to August where the average mean maximum varies from $21^{o}C$ - $27^{o}C$.

1.13 Soil

The most dominant types of soil of the study area are that of Red Loamy Soils and Laterite Soils which are a result of the weathering of the exposed parent rock material such as granites, gnessis, quartzites, schist, conglomerates and dolerites which are rich in clay forming minerals, iron and aluminium. They vary from loamy to sandy clay loamy soils which are brown to dark brown in colour.

1.14 Vegetation

It is observed that the natural vegetation varies from a mixed tropical evergreen forests to that of temperate forests. The main tree species that of pines (Pinus khasyana), shorea species and schima species are found in the study area.

1.15 Data Base

For morphometric analysis, data was extracted from Survey of India, topographical sheet No. 78 O/14, surveyed in the year 1966 - 67.

The soil samples which have been collected from the field have been analysed at the Research Laboratory, Department of Agriculture, Meghalaya. The results of the physical (textural composition) and chemical characteristics of the soils are being ascertained.

1.16 Methodology

In the present study 2(two) major methods are being used, i.e., (1) Field study (2) Laboratory study.

Field Study:

Field observations play a very important role in the present study where a general geographical personality can be accounted particularly to the various landscapes, the major tree species of the area and certain physical properties of the soils.

In addition a field survey of the morphological characteristics of the major tree species with regard to the height, girth, leaf pattern etc. is taken into account and also the selection of the 4 different types of micro-areas particularly on the basis of altitude.

Laboratory Study

In this study, morphometric analysis have been applied to understand the landforms of the basin.

Some statistical methods like correlation analysis, have been used to correlate the physical and chemical characteristics of the soil and the T-test is applied to obtain the level of confidence of the preceding analysis. Correlation is obtained through the formula:

$$r = \frac{\Sigma xy - \Sigma xy/n}{\sqrt{\{\Sigma x^2 - (\Sigma x)^2/n\}} \quad \sqrt{\{\Sigma y^2 - (\Sigma y)^2/n\}}}$$

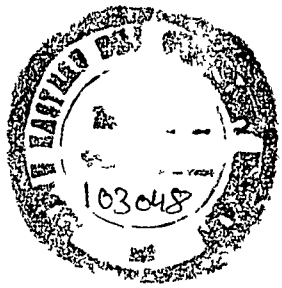
and to test the correlation, we use the "t" statistics as

$$t = r\sqrt{(n-2)/(1-r^2)} \quad \text{with } (n-2) \text{ degrees of freedom.}$$

1.17 Design of Study

The entire work is divided into 6 chapters..

(1) In the first chapter an introduction of the conceptual background of the study, methodology and design of study has been outlined.



(2) The second chapter deals with the general geographical personality of the study area.

(3)Chapter three describes the physical and chemical characteristics of the soils.

(4)Chapter four describes the morphological characteristics of the major tree species of the sample areas .

(5) Chapter five deals with the relationship between the geomorphic attributes, soil characteristics and that of the morphological characteristics of the major tree species.

(6) Chapter six includes the findings and suggestions synthesised from the study area.

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CHAPTER II

MORPHOMETRIC ANALYSIS

AND

GEOMORPHIC LANDFORMS

CHAPTER II

MORPHOMETRIC ANALYSIS AND GEOMORPHIC LANDFORMS

2.1 Morphometric Techniques

The measurement and mathematical analysis of the configuration of the earth's surface and of the slopes and dimensions of its landforms provide the base of investigation of maps for gemorphological analysis. This is known as "Morphometry".

The basis of investigation are related to area, altitude, volume, slope, profile and texture of the land. Some of the methods were devised in the last century and a large number were the results of demands of quantification of the present day which are aimed for the sake of an articulate description of landscape configuration.

However, morphometric analysis includes various techniques but only some of the most common techniques have been used in this work. Thus, only relief, slope analysis, drainage density and drainage frequency has been analysed and the prime source of information is derived from the survey of India. Topographical sheet No.78 O/14 having an R.F.1:50,000.

2.2 Methodology

Field observations play a very important role in the present study and the topographic sheet was inevitable for the extraction of vital information regarding relief, slope and drainage which is analysed in this study.

To prepare a relief map, a contour map is used with

100 metres interval where four categories are shown in accordance to the relative height given in the original sheet.

To calculate the average slope, Wentwort's method has been used. According to this method the number of contour crossings are being counted and averaged for every kilometre (since the scale of the topographical sheet is 2 cms = 1 km; therefore grids for the study area are prepared having 2x2 cms which will represent 1 km^2).The result derived from each grid is substituted by the formula:

$$\tan\Theta = N \times I/636.6$$

where N = Average no. of Contour Crossings.

I = Contour Interval and 636.6 is the standard value.

To calculate the drainage density, Horton's method, has been used. For the measurement of the drainage density the length of the stream channel are being measured for every km^2 through preparation of 2x2 cms grids. The results thus obtained are substituted by the following formula so as to indicate the density per km^2.

$$\text{Drainage Density} = \frac{\text{Total length of streams}}{\text{Total area}}$$

For determining the drainage frequency, the same procedure is used but now the number of streams are counted occurring in each grid and is divided by the unit area considered

CONTOUR MAP

1Km 0 1Km

FIG - 4

RELIEF MAP

1Km 0 1Km

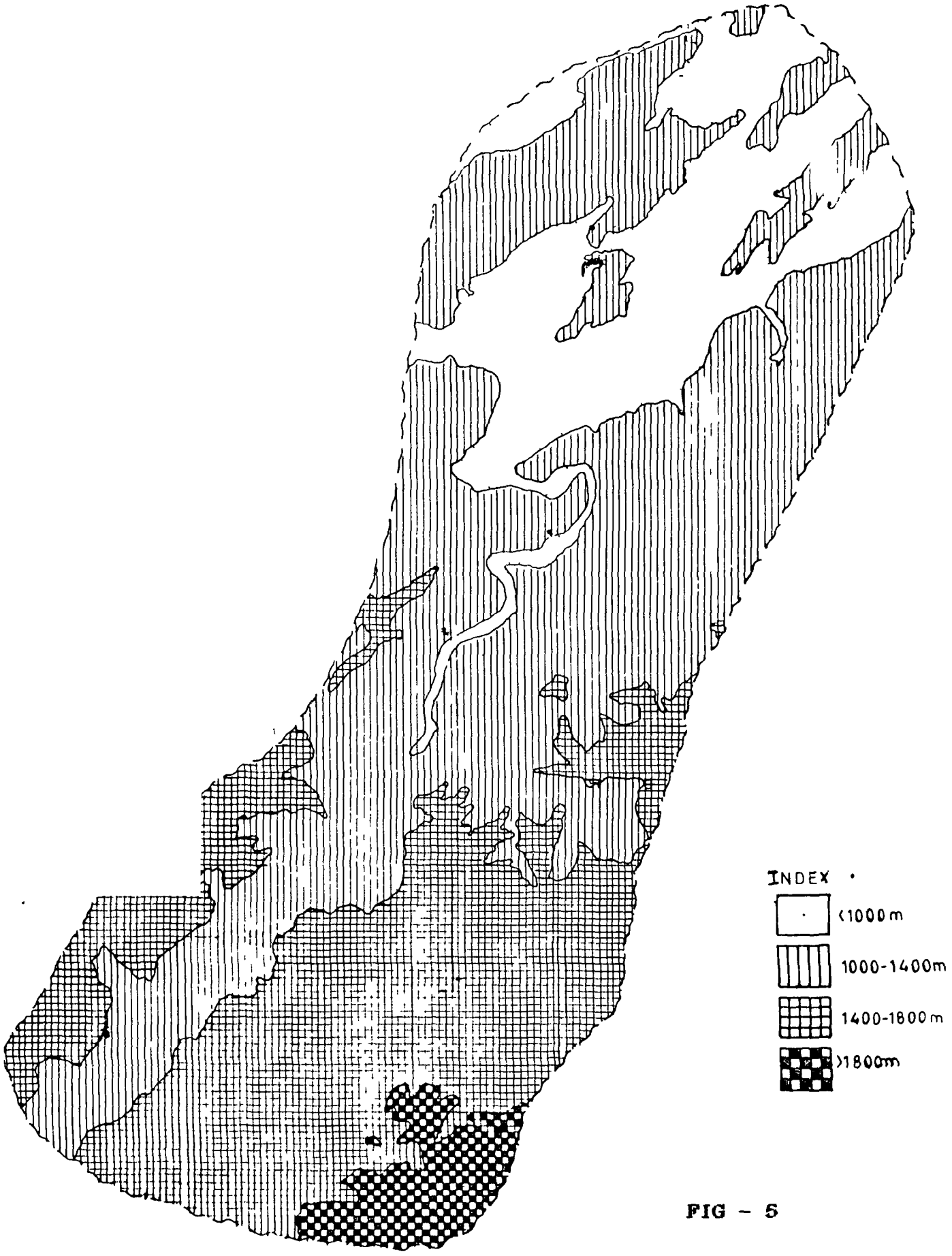

FIG - 5

which is $1km^2$ .It thus could be represented by the formula [1].

Stream frequency = No of streams per km/Unit Area.

2.3 Relief

From the prepared relief map (fig. 5) it broadly shows that the study also can be categorised into 4 main zones i.e. (i)the high uplands (> 1800 m above sea level) which covers the micro areal unit which was studied i.e. the Shillong Peak area occuring in the south-eastern part of the Umiam Basin. This high upland zone of the study area covers about 4 sq.kms.

(ii)The mid-central uplands (1400-1800m above sea level) which covers the micro areal unit studied i.e. the Riat Khwan area near Mawlai Gate occurs in the southern and south-Central parts of the basin .The mid-central uplands zone of the area covers about 37 sq.kms.

(ii)The lower mid-uplands (1000-1400m above sea level) covers the micro area unit studied i.e. the Umbir Village near Barapani Lake occurs in the central parts of the south-west and the north-eastern part of the basin. This zone of the basin covers an area of about 59 sq.km.

(iv) The lower uplands (<1000metres above sea level) which covers the micro areal unit i.e. the Barapani lake area occurs in the northern and the north central part of the study area. This low upland zone covers an area of about 17 sq.km. of the basin.

AVERAGE SLOPE

1Km 0 1Km

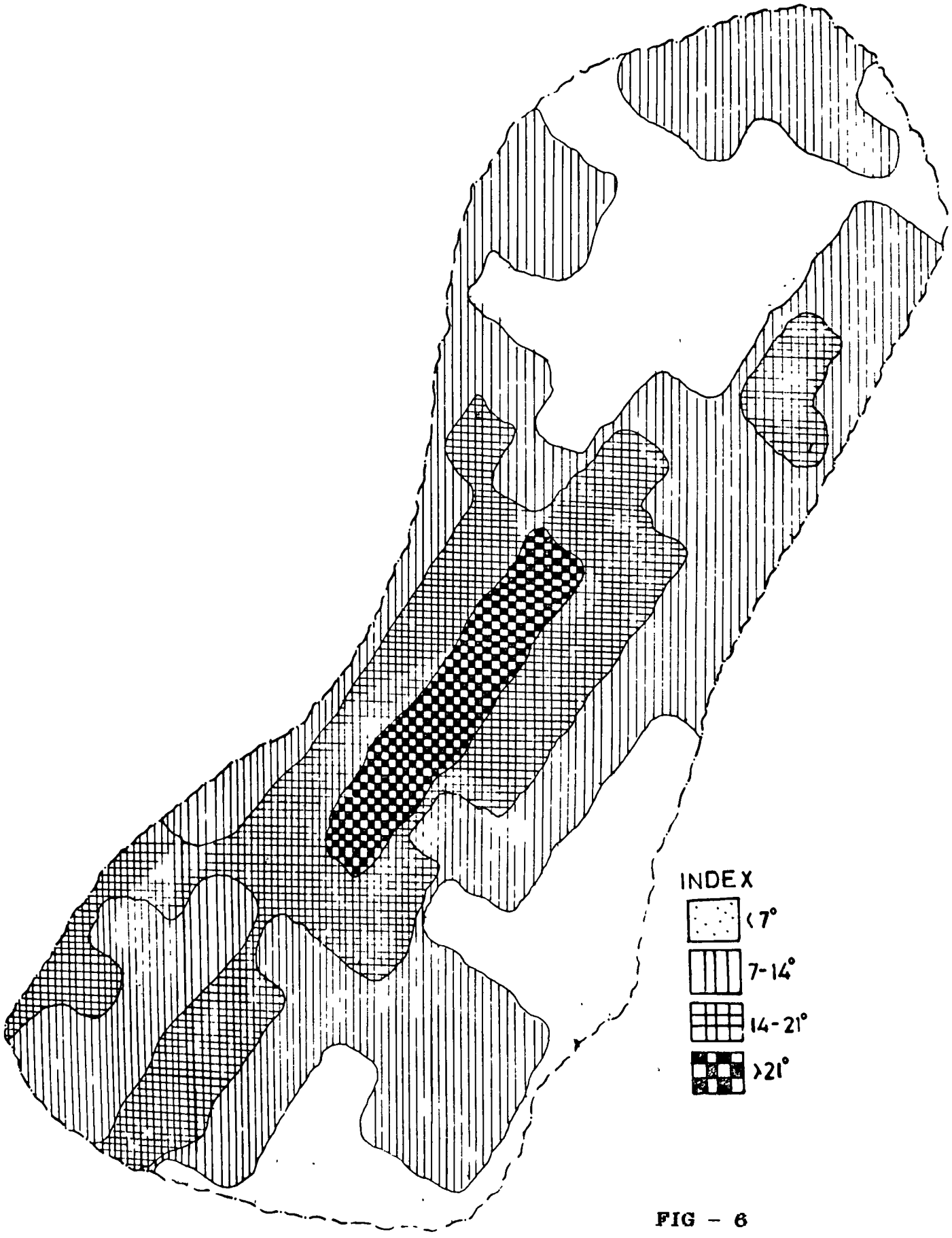

FIG - 6

2.4 Average Slope

The average slope map of the study area fig.6 shows the steepest slopes found in the lower mid-upland zone where slopes above 21^{o} are found in the south-western part and a small stretch in the central part of the study area. Slopes between 14^{o}-21^{o} are found in the central, the southern and a section of the north-eastern part of the basin. In general slopes above 14^{o} covers about half of the southern part, two-thirds of the central part and one-fifth of the north-eastern part of the basin. The steep slopes are found mainly in the portion where the relief is between 1000-1800 metres and not in the higher altitudinal areas which is above 1800 metres. It highlights that, it is mainly due to the break in the river profile indicates a possible rejuvenation of the upper part of the river basin [2]. However, these steep slopes cover and an area of about 47 $km.^{2}$.

Slopes which fall within the category between 7^{o}-14^{o} are found in the south-eastern, the central eastern, the northern, the north-eastern, the north-western and a stretch along the western part of the study area and slopes below 7^{o} is found mainly in the south-eastern part particularly in the Upper Shillong area, the central eastern part and the northern part of the basin. However slopes below 14^{o} cover the major portion of the study area espicially in the northern part of the basin. This is due to the presence of the Barapani Lake.

DRAINAGE PATTERNS

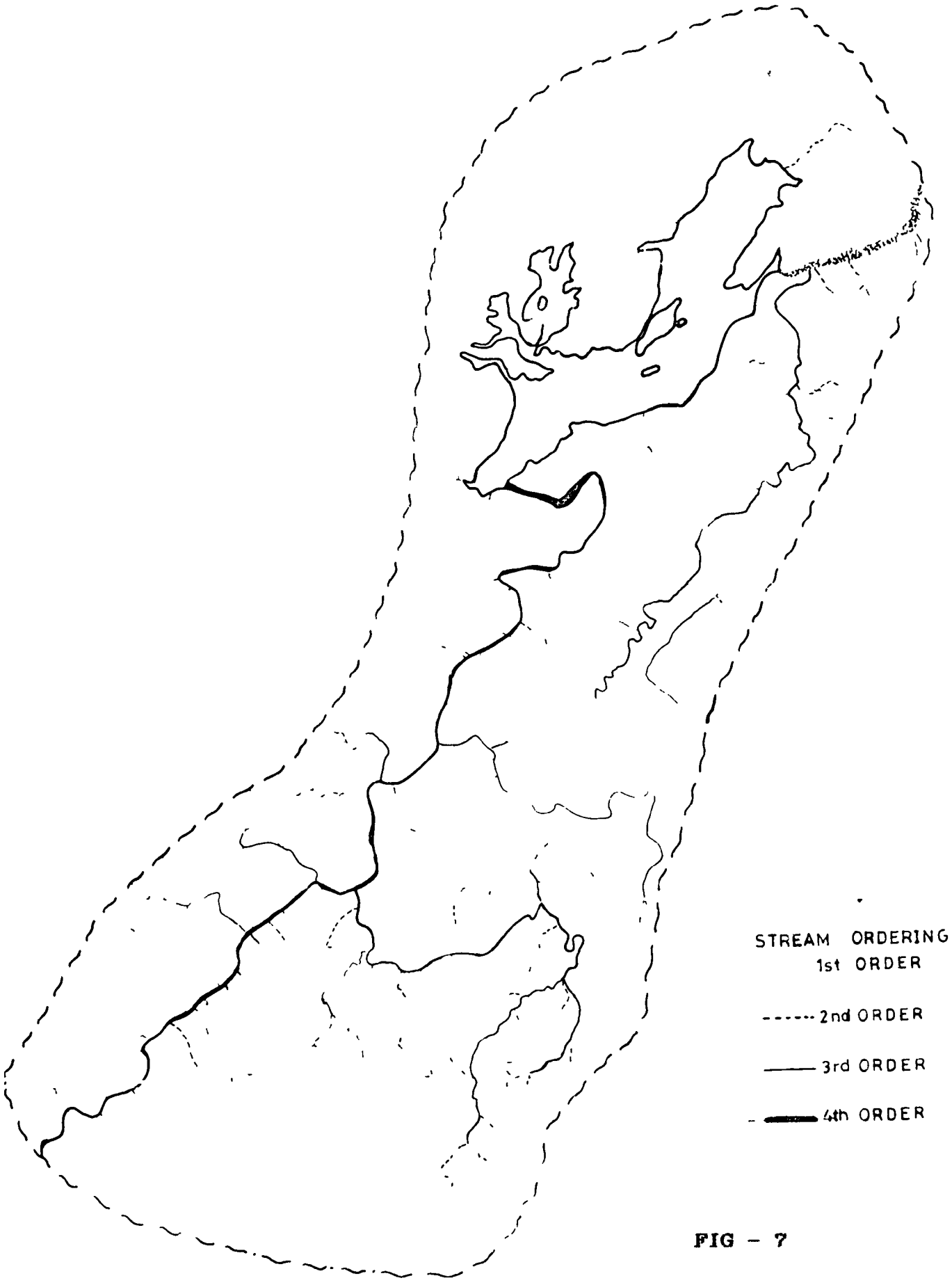

FIG - 7

DRAINAGE DENSITY

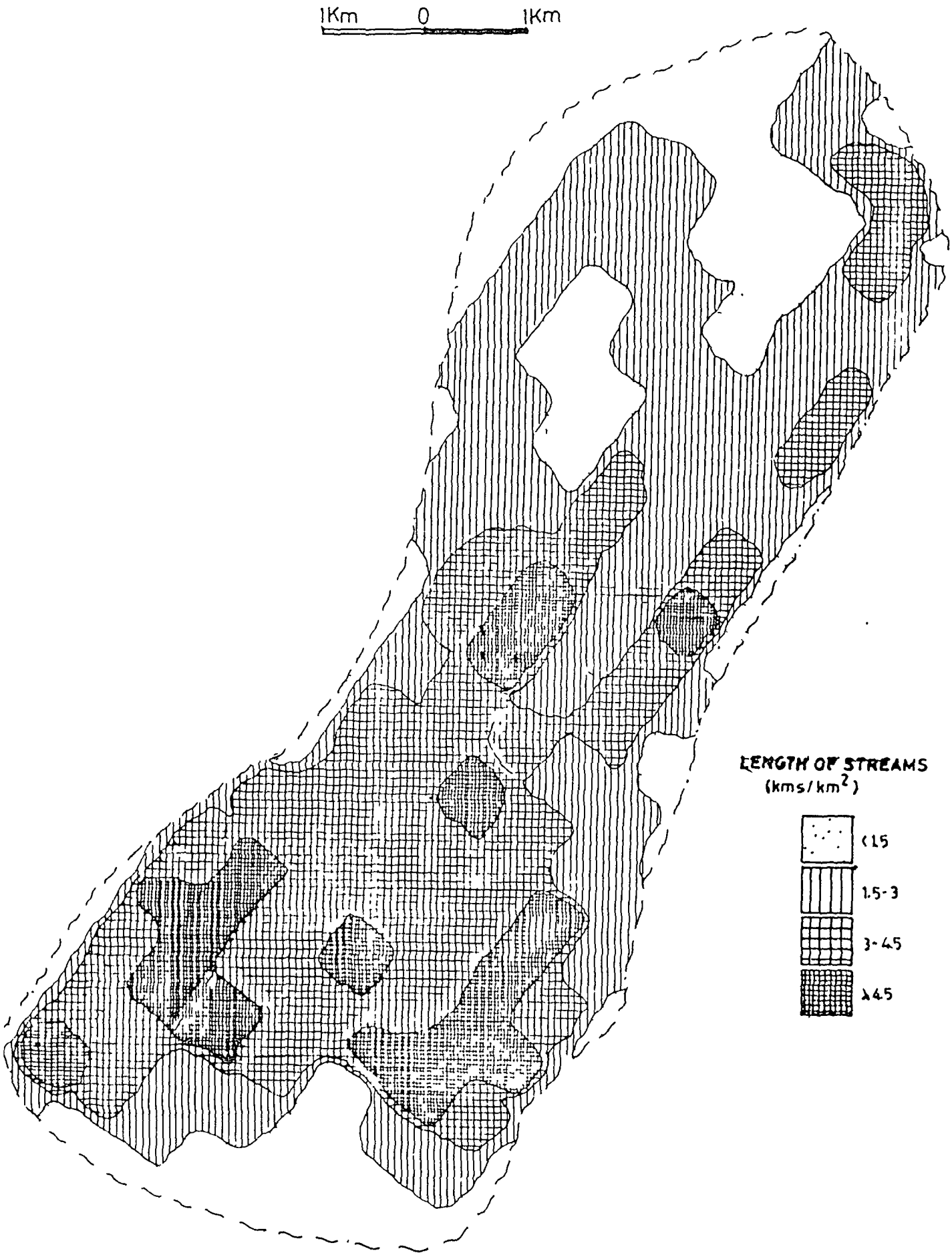

FIG - 8

2.5 Drainage Patterns

The drainage system as shown in the map (fig.7) differs much from the large scale maps. The drainage network of the upper part of the Umiam Basin shows different patterns between those of the northern and the southern parts. In the northern part and along the main drainage system, a parallel type of drainage pattern is observed. This is mainly because of the conformation of the river to the structure of the rocks as it carves its valley through the dissected topography resulting to a parallel pattern of drainage network.

However, in the southern part of the basin dendritic pattern can be observed particularly towards western part of the main drainage system. The main factor for this occurance is because of the nature of underlying rocks.

2.6 Drainage Density

Stream flowing over a surface are influenced by the structure of the rocks and one of the most important factor that determines the drainage density are the rock types over which the streams flow. The drainage density of the basin ranges from around 1-5 km/sq.km. It may be said that the slope and the general landscape plays a very important role in the drainage density. In general it can be observed as shown in Fig.8 that the central, the south-western and the south central part have drainage density above 2.5 - 5 km/sq.km. whereas the northern and the south eastern parts are dominated by somewhat low drainage density which

DRAINAGE FREQUENCY

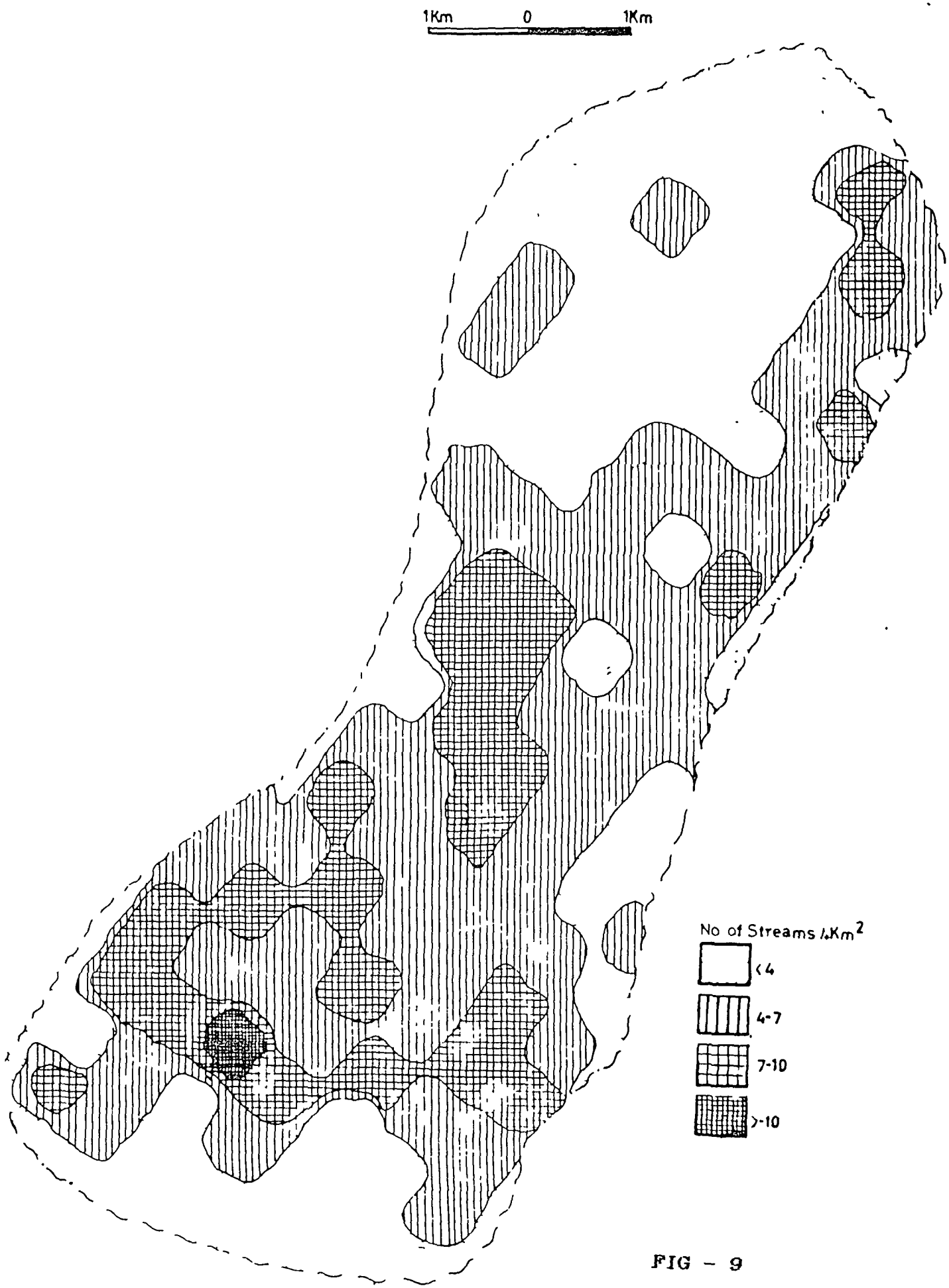

FIG - 9

ranges below 1 km-2.5km/km^2. Towards the margin of the basin, low drainage density is observed as a result it shows that where slopes are 7^o -14^o there is high drainage density i.e., 2.5 - 5 kms/km^2. This is however not true in the case of the Upper Shillong area where there is high relief, and the slopes are around 7^o - 14^o as it shows low drainage density because we find the origin of small streamlets which cannot be identified from the toposheet and also most of the streamlets are seasonal,thus resulting to low density of drainage in around this area. Similarly in the case of Barapani catchment area due to the presence of the lake drainage density is not accounted.

2.7 Drainage Frequency

Drainage frequency is simply the total number of streams per sq.km. Thus higher frequency implies large number of streams present as shown in Fig. 9. Stream frequency have a very close and positive relationship with stream density. In the upper part of the Umiam basin the highest frequency is above 10 streams per sq.km and lowest frequency is below 4 streams per sq.km.In general it can be observed that high frequency which ranges from 7 to 10 streams per sq.km the drainage density ranges from 2.5 - 4 streams per sq.km and where there is low frequency which ranges from 4 - 7 streams/sq.km. the drainage density ranges from 1 - 2.5 km/sq.km.

2.8 Relationship between landforms and Drainage Characteristics

A generalised study of the relief, slope, drainage density and drainage frequency brings about a relationship between landforms and drainage characteristics as shown in the Table No.2.

From the Table No. 2 a relationship between landforms and drainage characteristics highlights that the area can be broadly categorised in 4 main zones, that is, the low uplands where the relief is below 1000 metres having an average slope of $< 7^{o}$ in a major portion of the zone and a small portion of the zone has an average slope ranging from 7^{o} -14^{o} with a drainage density < 1km/sq.km in a major portion of the zone and a small portion of the zone has a drainage density of 1 - 2.5km^2 and a drainage frequency having a positive relationship of > 4 streams/Km^2 and 4-7 streams/Km^2 respectively.

In the mid-lower uplands where the relief is ranging between 1000-1400 metres above sea level, having an average slope of 14^{o} - 21^{o} in a major portion of the zone and a small portion of the zone has an average slope of more than 21^{o} with a drainage density of 1 - 2.5 kms/km^2 in a small portion of the zone, 2.5 - 4 kms^2 in a major portion of the zone and more than 4 kms/km^2 in another small portion of the zone and a drainage frequency having a positive relationship of 4-7 steams/km^2, 7-10 streams/km^2 and more than10 streams/km^2 respectively.

TABLE NO.2

RELATIONSHIP BETWEEN LANDFORMS & DRAINAGE CHARACTERISTICS

RELIEF IN METRES (a.s.l)	<1000	1000-1400	1400-1800	>1800
SLOPE IN DEGREES	<7; 7-14	14-21; >21	<7; 7-14	<7; 7-14
DRAINAGE DENSITY Km / Km^2	<1; 1-2.5	1-2.5; 2.5-4; >4	1-2.5; 2.5-4; >4	<1; 1-2.5
DRAINAGE FREQUENCY No. OF STREAMS/KM^2	<4; 4-7	4-7; 7-10; >10	4-7; 7-10; >10	<4; 4-7

In the mid-central uplands where the relief is ranging between 1400 - 1800 metres, having an average slope of <7° in a small portion of the zone and slopes ranging between 7° -14° in a major of the zone with a drainage density of 1 - 2.5 kms/km^2 in another small portion the zone 2.5 - 4 kms/km^2 and above 4 kms/sq.km in a major portion of the zone and a drainage frequency having a positive relationship of 4-7 streams/km^2 ,7-10 streams/km^2 and more than 10 streams/km^2 respectively.

The high uplands where the relief is above 1800 metres having an average slope below 7° in a major portion of the zone and a small portion of the zone has an average slope ranging from 7° - 14° with a drainage density below 1 km/km^2 in a major portion of the zone and a small portion of the zone has a drainage density ranging between 1 - 2.5 kms/km^2 and a drainage frequency having a positive relationship of below 4 streams/km^2 and 4-7 streams/km^2 respectively.

It may be accounted that the drainage density and frequency are low in the low uplands and the high uplands though the average slope is comparatively low because of the presence of the Barapani lake in the low uplands and the presence of Upper Shillong Area in the high uplands where the streamlets which becomes water sources arises here and which are seasonal in nature and are thus not being depicted in the base topographical map. In addition we see a diverse kind of drainage system on the other

hand in the mid-lower uplands and the mid-central uplands showing great tendencies of geomorphic processes taking place in these zones.

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CHAPTER III

SOIL CHARACTERISTICS

CHAPTER III

SOIL CHARACTERISTICS

3.1 Origin of Soils

Soils are formed from hard (solid) rock masses, loose unconsolidated transported materials and organic residue. Originally, even the loose materials are formed by the weathering of rock masses to stones, gravels, sands, silts, clays and soluble ions[1]. It is derived from the Latin word "solum". According to soil scientists, soil means that part of the earth's crust which has been changed as a result of soil forming processes.

Soils as such can be defined in a number of ways depending on the type of study it relates with. However, the two most common and simple definitions of soil are as follows:

It is derived as the unconsolidated mineral material as the immediate surface of the earth that serves as a natural medium for the growth of plants[2].

Dokuchayev defines soil as a body subjected to a natural and historical development, which came into being on the surface of the earth as a result of a complex combination of the inter-action of rocks, the organic macro and micro-organisms of vegetable and animal worlds, climate, local relief and the production activities of man[3].

3.2 Soil Analysis:

The only way to gain a thorough understanding of

soils is to carry out investigations both in the field and in the laboratory particularly the former, therefore frequent visits should be made to the field to see the various types of soils, factors helpful in soil formation and its utilisation. For this specific study the samples are taken from hilly woodland areas where soil samples are collected from below a particular chosen dominant tree species. However, it can be said that "the analysis can be no better than the sample"[4].

Thus a varied range of soil samples have been collected and certain methods have been followed regarding the determination of the colour and the structure of the soils. The other physical properties such as the texture of the soil and the Chemical properties of the soils have been analysed at the Research Laboratory, Department of Agriculture, Government of Meghalaya, Shillong.

3.3 Methodology

(a) Collection of Soil Samples :

The various requirements are a spade, small polythene bags and a soil auger.

(b) Procedure:

The ground is first dug by a soil auger to about a depth of 15-20 cms and the soil which lies between this range of 15-20 cms is being collected in the polythene bags with the help

of a spade. The amount of soil collected is about 500 gms. Thus in this way 18 sites have been chosen and the soils are collected below the dominant tree species studied.

(c) Soil Colour:

For this purpose the "Munsel"[5] soil Colour Chart had been used in which three simple variables of Colours are followed, ie. "Hue" - the dominant spectral colour, "Value" - the brilliance on total quality of light and "Chroma" - the relative purity on saturation of the dominant Spectral Colour.

(d) Soil Structure:

Sand, silt and clay which are the primary soil particles when grouped together into stable conditions, forming a definite pattern known as soil structure. The soil structure of the study area is studied in the field under the basis of tree structural categories, that is,

Structural Types:

(1) Angular Blocks

(2) Sub-Angular Blocks

(3) Crumb

(4) Granular

(5) Columnar

(6) Prismatic

(7) Plate-like

Structural Classes

(1) Very fine or very thin; < 1mm

(2) Fine or thin; 1-2 mm

(3) Medium; 2-5 mm

(4) Coarse or thick; 5-10 mm

(5) Very coarse or very thick; > 10 mm

Structural Grades

(1) Strong

(2) Moderate

(3) Weak

(4) Structureless

However, as said earlier the textural classification of soil and its chemical characteristics has been analysed by the Research Laboratory, Department of Agriculture, Meghalaya which is given in the Table No. 3.

3.4 Physical Characteristics of the Soils

The physical properties of the soils include texture, structure, density, porosity, consistency, temperature, colour and moisture content of which only a few major physical attributes have been studied and analysed in the present work. These attributes are colour, structure and the textural composition of the soil.

3.5 Soil Colour

The soil samples collected from the field show

varied ranges of soil colour which was determined from the Munsel Soil Colour Chart. However, the colour ranges from brown to dark brown showing that the soils have certain iron oxide contents. Since the soil samples have been collected from below the major tree species surveyed, there are certain variations in colour, where a mixture of the brown colour with a dark grayish colour and a light reddish stain showing that there is a certain percentage of humus present along with the iron oxides.

3.6 Soil Structure

The soil structure was studied in the field which show varied structure depending on the location of the sample taken as shown in Table No. 3.

The soils of the Barapani Lake Area are of fine, sub-angular and of crumb form with a size of 1 - 2 mm and a moderately weak grading signifying that the peds are visible in place though they break while handling.

Soils of Umbir Village are fine, sub-angular and of granular form with a size between 1 - 2 mm and weak grading as they break easily while handling which signifies that the soils are loose mainly due to the presence of pine trees.

The soils of Riat Khwan Area (near Mawlai Gate) show two major structural types. In the patches where Eucalyptus and Pine trees are present the soil are medium and of granular form with a size ranging from 2 - 5 mm and a weak grading breaking off very easily while handling. On the other hand, where other

TABLE NO:3

CLASSES AND TYPES OF SOIL STRUCTURE

CLASS	PLATELIKE	PRISMATIC	COLUMNAR	ANGULAR BLOCK	SUB-ANGULAR BLOCK	GRANULAR	CRUMB
Very fine or very thin	Below 1 mm	Below 10 mm	Below 10 mm	Below 5 mm	Below 5mm	Below 1 mm	Below 1 mm
Fine or thin	1-2 mm	10-20 mm	10-20 mm	5-10 mm	5-10 mm	1-2 mm	1-2 mm
Medium	2-5 mm	20-50 mm	20-50 mm	10-20 mm	10-20 mm	2-5 mm	2-5 mm
Coarse or thick	5-10 mm	50-100 mm	50-100 mm	20-50 mm	20-50 mm	5-10mm	------
Very coarse or very thick	above 10 mm	above 100 mm	above 100 mm	above 50 mm	above 50 mm	above 10 mm	------

Source: Soil Survey staff, Soil Taxonomy: A Basic System of Soil Classification for making and interpreting Soil Surveys, U.S.D.A. - Soil Conservation Service, Agriculture Handbook 436, Dec 1975 Pg. 475

indigenous trees are present the soils are fine and of crumb form having a size of 1 - 2 mm with a moderately weak grading signifying that the peds are visible, though they break while handling.

The soils in Upper Shillong are medium sized, that is 2-5 mm sub-angular to angular and are of crumb form with a structural grading which is moderately weak signifying that the pads are visible in place though they break easily while handling.

3.7 Soil Texture

Natural soils are comprised of soil particles of varying sizes. The soil particle-size groups called soil separates, are sands (the coarsest), silts and clays (the finest). The relative proportions of soil separates in a particular soil determine its texture[6] where twelve classes have been created and presented in the form of a triangular diagram by using only three size limits as shown in Fig.10.

The soils separates i.e. sand, silt and clay have been analysed in the laboratory in which the various percentages of each soil separate have been found as shown in Table No.4.

TABLE NO.4

TEXTURAL CLASSES OF SOILS OF UPPER PART OF UMIAM BASIN

SOIL SAMPLES	SAND %	SILT %	CLAY %
BARAPANI LAKE AREA			
1	38.81	32.50	23.00
2	41.82	32.00	20.50
3	37.50	32.00	27.00
4	43.56	30.00	24.50
5	39.10	34.50	23.50
6	39.53	33.00	24.10
MEAN	40.04	32.33	23.77
UMBIR VILLAGE			
1	40.59	37.50	15.00
2	47.97	30.00	19.00
MEAN	44.28	33.75	17.00
RIAT KHWAN AREA (Near Mawlai Gate)			
1	52.14	13.00	30.50
2	44.50	23.00	27.50
3	38.33	20.20	35.30
4	38.70	32.00	24.50
5	37.82	22.00	36.50
MEAN	42.30	22.04	30.86
UPPER SHILLONG AREA			
1	40.59	23.50	30.00
2	47.97	20.00	29.00
3	54.19	22.50	23.50
4	46.99	18.00	33.00
5	54.84	18.50	24.30
MEAN	48.92	20.50	27.96

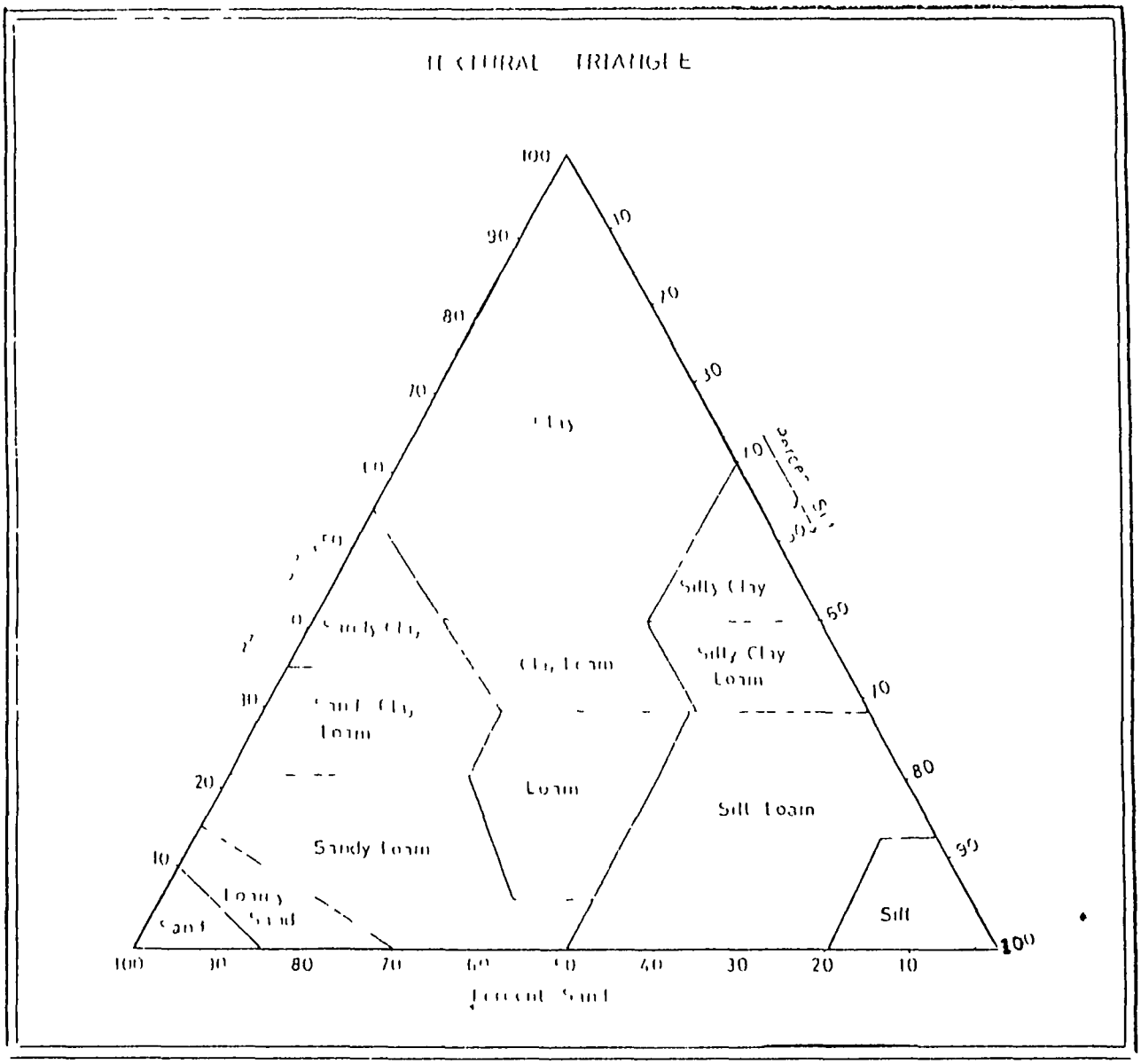
TEXTURAL TRIANGLE
Clay
Silty Clay
Silty Clay Loam
Clay Loam
Loam
Silt Loam
Silt
Sandy Clay
Sandy Clay Loam
Sandy Loam
Loamy Sand
Sand
Percent Sand

FIG: 10

In the Barapani Lake area and Umbir Village loamy soils are found whereas in the Riat Khwan area near Mawlai Gate and from Upper Shillong area sandy clay loamy soils are found signifying that geomorphic processes are taking place of which the action in the upper reaches differs greatly with that of the lower reaches. Thus from the above results we see that the upper part of the Umiam Basin have soils ranging from loamy to sandy clay loamy soils. To conclude, the soils of the lower reaches particularly those having loamy soils are the newly formed alluvial soils also known as "Khaddar"where new layers are deposited year after year during the "monsoons".

3.8 Chemical Characteristics of the Soils

The various chemical properties of soils covered in present study are the pH value, Organic Carbon %, Phosphorus Pentoxide(P_2O_5) content in Kg./ha. and Potassium Oxide (K_2O) content also in Kg/ha. The soil samples collected are analysed in the Research Laboratory Department of Agriculture, Government of Meghalaya, Shillong of which the various inferences are given in Table No.5.

From the above table it can be clearly said that all the soils are acidic in nature particularly because of the nature of the parent rock material and also largely influenced by the nature of vegetation where higher acidity of soils are realized in the pine forest and also in portions where eucalyptus

TABLE NO:4

CHEMICAL CHARACTERISTICS OF SOILS OF UPPER PART OF UMIAM BASIN

SOIL SAMPLES	pH	O.C% (Kg/ha)	P_2O_5 Kg/ha	K_2O Kg/ha
BARAPANI LAKE AREA				
1	4.4	2.57	3.14	235.20
2	4.55	1.42	3.14	313.60
3	4.00	0.28	2.24	117.60
4	4.00	2.57	2.24	162.40
5	4.25	1.88	2.24	162.40
6	4.3	1.42	0.45	224.00
MEAN	4.25	1.69	2.24	202.53
UMBIR VILLAGE				
1	3.85	1.42	0.45	50.40
2	4.00	2.54	2.24	112.00
MEAN	3.93	1.98	1.35	81.20
RIAT KHWAN AREA (Near Mawlai Gate)				
1	4.05	1.40	3.14	347.20
2	5.20	1.77	0.00	235.20
3	4.55	2.57	2.24	257.60
4	3.60	2.00	4.04	112.00
5	4.00	2.57	2.24	201.60
MEAN	4.28	2.16	2.33	230.70
UPPER SHILLONG AREA				
1	4.10	2.57	2.24	201.60
2	3.80	3.14	2.24	112.00
3	4.00	2.00	2.24	291.20
4	4.20	2.00	2.24	156.80
5	4.00	2.00	2.24	218.40
MEAN	4.02	2.34	2.24	196.00

trees are present, the pH value can go as low as 3.60, indicating very high acidity of the soil. However the pH value of the soil ranges from 3.60 to 5.20.

The other chemical characteristics of the soils i.e. organic carbon percentage (O.C %), phosphorus pentoxide (P2O5), and potassium Oxide (K2O) content is given in Table No.5. The following discussion can be made with the help of the Soil Rating Chart given in Table No. 6.

3.9 Soil Rating Status

The soils collected from Barapani Lake Area show a high percentage of organic carbon which is the Nitrogen Equivalent is present having an average percentage of 1.69 % (Kg./ha). The phosphorus content on the other hand is very low having an average of only 2.24 Kg./ha. with a moderate amount of potassium oxide content of 202.53 kg/ha.

Soils of Umbir village indicate a high percentage of organic carbon having an average percentage of 1.98% (Kg/ha), critically low amount of phosphorus content with an average of only 1.35 Kg/ha, and also low potassium oxide content having an average of 81.20 kg/ha.

From the Riat Khwan Area near Mawlai Gate the chemical characteristics of the soils indicate a high percentage of organic carbon present with an average of 2.16 % (Kg/ha) with very low phosphorus pentoxide content average to only 2.33 Kg/ha.

and a medium amount of potassium oxide content averaging to 230.7 kg/ha.

However, soils from Upper Shillong area indicate again high percentage of organic carbon content averaging to 2.34 % (Kg/ha) with a low phosphate content of 2.24 Kg/ha and medium amount of potassium content of 196 kg/ha .

TABLE NO.6

SOIL RATING CHART

	LOW	MEDIUM	HIGH
ORGANIC CARBON % (Kg/Ha	< 0.5	0.5-0.75	> 0.75
P_2O_5 Kg/Ha	< 28.03	28.03-56.05	> 56.05
K_2O Kg/Ha	< 134.5	134.5-336.3	> 336.3
T.S.S.	Critical	Non-Critical	

Source: Research Laboratory, Department of Agriculture, Govt. of Meghalaya, Shillong.

Thus in general we see that the soils have a high percentage of organic carbon which is the Nitrogen Equivalent, very low phosphate content and medium to low amount of potash content. This confirms that the original soil has high content of iron oxides in which Cation exchange takes place resulting to acidity of the soils. Secondly as the area is hilly

and under the influence of monsoons the soil cover is washed away leaving a bit of the fertility behind and as a result lowers the phosphate content and control the high potash content bringing it to a moderate level.

3.10. Correlation Matrix of the Textural Composition

An analysis of the inter-correlation of the textural composition show that the correlation between sand and silt and sand and clay are negative Table No. 7.

TABLE NO.7

CORRELATION MATRIX OF THE TEXTURAL COMPOSITION

	SAND	SILT	CLAY
SAND	1.000		
SILT	- 0.6098	1.000	
CLAY	- 0.0827	- 0.7122	1.000

An analysis of correlation of the textural composition so that the correlation between sand and silt and clay are negative. This signifies that sand, silt and clay are different components. The negative relationship of sand and silt being significant and 1% and 5% level of confidence and that between sand and clay is insignificant. From the correlation we

see that sand, silt and clay does not vary with each other. On the other hand it is seen that correlation between silt and clay is significant at 1% and 5% level of confidence.

TABLE NO:8

CORRELATION MATRIX OF THE CHEMICAL CHARACTERISTICS

	pH	ORGANIC CARBON	P_2O_5	K_2O
pH	1.000			
OC	- .0958	1.000		
P_2O_5	- .4216	.7804	1.000	
K_2O	.4911	- .0360	.1841	1.000

3.11 Correlation Matrix of the Chemical Characteristics

An analysis of the correlation matrix of a group of variables under chemical characteristics of the correlation coefficients between pH, organic carbon, P_2O_5 and K_2O indicates that pH with organic carbon and phosphate content is negatively related whereas with that of Potash content is positive and is significant at 5% level of confidence and with phosphate is significant at 5% level of confidence.

On the other hand organic carbon is positively related with phospate content, but its significance is negligible

and is negatively related with potash content. It is also observed that phosphate is positively related to potash content but its significance is negligible.

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5 : Munsel Soil Colour Chart, Munsel Colour Company Inc.Baltimore 2, Maryland,1975.

6 : c.f. 2.

CHAPTER IV

MORPHOLOGICAL CHARACTERISTICS OF THE DOMINANT TREE SPECIES

CHAPTER IV

MORPHOLOGICAL CHARACTERISTICS OF THE DOMINANT TREE SPECIES

Morphological studies of plants deals with the study of forms and features of different plant organs such as roots, stems, leaves, flowers, seed and fruits. However, in the present study only a few aspects are taken such as stems with regard to girth and height and the thickness and structure of the bark, and with leaf pattern, size etc. of which the trees are classified under specified family, genus and species.

4.1 Units of Classification

"Species" is a group of individual (plants or animals) of one and of the same kind. Evidently they resemble one another in almost all important morphological characteristics - both vegetative and reproductive - so closely that they may be regarded as having been derived from the same parents. However occasionally owing to variations in climatic or edaphic conditions, individuals of a species may show a certain amount of variation in form, size, colours and other minor characteristics forming varieties. A species may consist of one or more varieties[1]

"Genus" is a collection of species which bear a close resemblance to one another in the morphological characters of the floral or reproductive parts. Whereas a Family is a group of genera which show general structural resemblances with one another, mainly in their floral organs.

Nomenclature of the identified tree species is followed in accordance to Binomial Nomenclature which was first introduced by Linnaeus in 1735 which is the scientific method of naming species of plants or animals of which the first refers to the genus and the second to the species.

4.2 Morphological Characteristics

The various tree species studied along with their morphological attributes as specified in the early paragraphs are summarized as follows.

In the Barapani Lake area the dominant tree species along with morphological characteristics in a primary Indegeneous forest are:

(1 & 2) Family - Lauraceae

Genus - Schima

Species-*Schima khasyana*

The leaves of this particular species are simple and are arranged alternately. The leaves are also petiolate i.e. they have a petiole and are lanceolate. The apex of the leaves are finely acute. The averaged size of the leaves is (16x 16)cms.

The bark of this species is rough and has fine irritating hair when dried. The average thickness of the bark is 1 - 1.5 cms.

The main trunk has an average girth of 167 cms with an average height of about 19 metres.

(3) Family - Verbernaceae

Genus - Clerodendron

Species- *Clerodendron fistulacum*

The leaves are simple and are arranged on an opposite pattern. They are also petiolate, exstipulate and lanceolate. The leaves are also broad and ovate in shape. The apex of the leaves is acute and the midrib is powdery. The average size of the leaves is (27x 21)cms.

The bark of this tree species is very thin with an average thickness of about .1 to .15 cms.

The average girth of the main trunk of the tree is 187 cms with an average height of 14 metres.

(4) Family - Verbernaceae

Genus - Docinia

Species -*Docinia*

The leaves of this tree species are simple arranged in an opposite pattern. The leaves are acute, stipulate, petiolate and lanceolate. The average size of the leaves are (15 x 15) cms.

The bark is marked with irregular stripes and an average thickness of .9 - 1.2 cms.

The average girth of the main trunk is 67 cms with an average height of 14 metres.

(5) Family - Dipterocarpaceae

Genus - Shorea

Species- *Shorea robusta*

The leaves are arranged alternately, large and ovate with a round base. The leaves are stipulate and the apex of the leaves is acute. The average size of the leaves is (23 x 21)cms.

The bark is thin with an average thickness ranging between .3 to .8 cms.

The average girth of the main trunk is 70 cms with an average height of 14 metres.

(6) Family - Betulaceae

Genus - Betula

Species - *Betula alriodis*

The leaves are simple which are arranged alternately, exstipulate, sub-sessile, petiolate and is ob-ovate. The leaf margin is serrate with an acute apex . The average size of the leaves is (11x6) cms.

The bark peels off seasonally with average thickness of 1 to 2 cms.

The average girth of the main trunk is 37cms with an average height of 17 metres.

In the Umbir Village the forested areas are void of

anymore primary indegeneous forests but is overtaken by pine forest which is a secondary forest.

(7& 8)Family - Pinaceae

Genus - Pinus

Species - *Pinus insularis*

The leaves are needle-like, 3 in each fasicle, circular, trifolate. The pine needles are on the average 16 cms long and with spirally arranged spurs.

The bark is dry, corky having a shedding outer bark. The average thickness of the bark is 3-5 cms.

The average girth of the main trunk is 125 cms with an average height of 23 metres.

The Riat Khwan Area (near Mawlai Gate) are dominated by the following tree species:

(9) Family - Lauraceae

Genus - Schima

Species - *Schima wallichiana*

For morphological characteristics, refer to tree species No.(1 & 2) from Barapani Lake area.

However, the girth of the main trunk on the average is 170 cms and the average height being 17 metres.

(10) Common Name - Etna

The leaves are simple, alternately arranged,

petiolate - petiole is 1 cm, exstipulate, ob-lanceolate, shining. The average size of the leaf is (14x 5) cms.

The bark is mealy where the inside is smooth and outer bark is marked with white patches. The average thickness of the bark is .5 to 8 cms.

The average girth of the main trunk is 217 cms and the average height being 23 metres.

(11) Family - Rosaceae

Genus - Prunus

Species - *Prunus podum*

The leaves are simple, alternate, petiolate - petiole 7 cm, exstipulate and broadly lanceolate. The leaf margin is serrate, and the apex is acute. The average size of the leaves is (8 x 4) cms.

The bark is thin which peels off easily having an average thickness of .5 cms.

The average girth of the main trunk is 197 cms with an average height of 17 metres.

(12) Family - Myrtaceae

Genus - Eucalyptus

Species - *Eucalyptus globolosses* (not indigenous)

The leaves are alternately arranged, lanceolate, petiolate, exstipulate, and are acute. The average size of the leaves are (16x4) cms.

The bark peels off seasonally and the average thickness of the bark is 0.3 to 1 cm.

The average girth of the tree is 99 cms with an average height of 17 metres.

(13) Family - Piniaceae

Genus - Pinus

Species - *Pinus insularis*

For morphological characteristics refer to tree species no. 7 of Umbir village.

In the Upper Shillong area the dominant tree species with their morphological characteristics are given below:

(14) Family - Fagaceae

Genus - Quercus

Species - *Quercus montana*

The leaves are simple and alternately arranged, sub-sessile, exstipulate, petiolate - petiole is 0.7 cm, broad, lanceolate and the apex is acute. The average size of the leaves is (17x7) cms.

The bark is rough, longitudinally striated beneath into thread like structures. The average thickness of the bark is 0.8 - 1.2 cm.

The average girth of the main trunk is 167 cms and average height is 20 metres.

(15) Family - Myricaceae

Genus - Myrica

Species - *Myrica esculanta*

The leaves are simple, alternate, petiolate, ex-stipulate, spiral, slightly with pulvinus. The leaf blade is oblong, shining, entired, gradually narrow towards the base, broader towards the apex but apex is acute. The average size of the leaves is (12x3) cms.

The bark secretes a violet blue juice and the outer bark is rough. The average thickness of the bark is 1.5 - 2 cms.

The average girth of the main trunk is 187 cms with an average height of 23 metres.

(16) Family - Magnoliaceae

Genus - Michelia

Species - *Michelia champaca*

The leaves are simple, alternate, stipulate, petiolate - petiole 4 - 5 cms (pinkish), lanceolate and spiral in the flowering bud. The average size of the leaves is (17x4) cms.

The average thickness of the bark is 0.2 - 0.3 cms and the average girth of the main trunk is 97 cms with an average height being 15 metres.

(17) Family - Rosaceae

Genus - Prunus

Species - *Prunus podum*

TABLE NO.9

RELATIONSHIP BETWEEN RELIEF (in metres) AND THE DOMINANT TREE SPECIES :

	LEAF SIZE	STEM GIRTH	STEM HEIGHT	BARK THICKNESS
Barapani Lake Area (>1000 m)	(18x14)cms	106 cms	15 m	.7 - 1.1 cms
Umbir village (1000-1400 m)	(16x0.3)cms	125 cms	23 m	3 - 5 cms
Riat Khwan Area (1400-1800 m)	(14x7) cms	171 cms	19 m	.6 - .9 cms
Upper Shillong Area (<1800 m)	(14x4) cms	162 cms	19 m	.7 - 1 cms

For morphological characteristics refer to tree species no. 11 of Riat Khwan Area.

(18) Family - Piniaceae

Genus - Pinus

Species - *Pinus khasyana*

The average girth of the main trunk is 147 cms and the average height being 17 metres. For other morphological characteristics refer to tree species no. 7 of Umbir village.

From the above Table No.9 we can generalise that secondary forests at Umbir village is negatively related to the primary indigenous forests of the other areas. However on the other hand we see that from the other three areal units where primary forests are accounted, it is found that as we move higher in altitude the shape of the leaves gradually becomes acute highlighting that leaves of trees in the low uplands are broader thus having more canopy coverage rather than that in the high uplands. Secondly, we see also the tendency that the trees are wider in girth and taller and more erect in the high uplands than that in the low upland zone, though the thickness of the bark is more or less at a constant rate.

Plate No.3 - [illegible]

Plate No.4 - Shorea robusta

Plate No.1 - Schima khasyana

Plate No.7 - Quercus montana.

Plate No.8 - Myrica esculanta

Plate No.9

Plate No.12 - Pinus Khasyana.

CHAPTER V

GEOMORPHIC - PLANT - SOIL RELATIONSHIPS

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After completing the early chapters with regard to geomorphic landforms, plant morphology, physical and chemical characteristics of the soil along with a sight reference in geology and macro-climatic conditions of the study area it can be said that there is a very strong and close relationship between the three where all these closely knitted to each other Geomorphology and geology determines the physical and chemical characteristics of the soils and vegetation. The soil conditions along with climatic conditions determine the nature of natural vegetation and thus both soils and plants (along with climatic factor) play a very significant role in geomorphic processes of any region, especially in the humid tropics having a tropical and sub-tropical climate.

The tables prepared showing the various relationships between landforms and drainage characteristics, the physical and chemical characteristics of the soils and that between relief and the dominant species highlights a close relationship of geomorphology-plant-soil attributes.

Referring back to the micro areal units a detailed study particularly of soil and dominant tree species has been made. The whole study area has been categorised into 4 zones i.e. the low uplands - Barapani Lake Area where a primary indegeneous forest is found, the lower mid-uplands - Umbir Village where a secondary primary forest is studied, the mid-central uplands- Riat

Khwan Area (near Mawlai Gate) where a primary indegeneous forest is present along with a small pocket of secondary forest and the high uplands - Upper Shillong Area where a primary indigenous forest is being studied.

The analysis of geomorphic characteristics of landforms indicate that there is close relationships among these three i.e. geomorphology, the dominant tree species and soil characteristics.

5.1 Barapani-Lake Area

In the Barapani Lake area where the general relief is below 1000 metres, the average slope is mostly below 7^{o} though in certain pockets it ranges between 7^{o} -14^{o} with a drainage density mostly below 1 Km/Km^2 though at certain places it ranges between 1-2.5 kms/km^2 and the drainage frequency also mostly below 4 $streams/km^2$ and also ranging between 4-7 $streams/Km^2$.

In this area we find that the average leaf size is approximately around (18x14)cms, stem girth around 106 cms and the stem height being 15 metres with the thickness of the bark ranging between .7-1.1 cms.

In addition the physical characteristics of the soils show that it has a fine structure, sub-angular, crumb form with a size between 1-2 mm. The texture of the soils is loamy in nature. However the chemical characteristics indicates that the soil is acidic having high percentage of organic carbon, low

phosphate content and a moderate amount of potash content.To conclude we find that this area is dominated by five main tree species that is, **Schima khasyana, Clerodendron fistulacum, Docinia, Shorea robusta and Betula alriodis.**

5.2 Umbir Village

In Umbir village the general relief lies between 1000-1400 metres above sea level, the average slope is mostly between 14^{o} -21^{o} though in some pockets the slope exceeds 21^{o} and having a drainage density mostly between 2.5 - 4 kms/km^2 though in certain spots drainage density vary from 1-2.5km/km^2 and also above 4 km/km^2 with a drainage frequency mostly ranging between 7-10 streams/km^2 and in certain spots ranging between 4-7 streams/km^2 and also above 10 streams/km^2.

The village is dominated by a secondary pine forest where the pine needle size is (16x.3) cms, the stem girth is about 125 cms and the stem height being around 23 metres with a bark of thickness 3-5cms.

Soils of Umbir Village are fine, sub-angular and of granular form with a size between 1 - 2 mm. The textural classification of the soil is also loamy in nature thus highlighting the physical properties of the soil of the village. On the other hand the chemical characteristics of the soil are very acidic in nature where the pH value is only 3.93 resulting due to the presence of the pine forest. The soils also have a

high percentage of organic carbon, low phosphate and potash content.The only dominating tree species is the **Pinus insularis**.

5.3 Riat Khwan Area (Near Mawlai Gate)

In the Riat Khwan area the general relief is between 1400-1800 metres above sea level, the average slope is mostly between 7^{o}-14^{o} though in some pockets it lies below 7^{o} and having a drainage density mostly between 2.5-4 kms/km^2 while in some pockets it is between 1-2.5 Km/km^2 and also above 4 km/km^2 with a drainage frequency mostly between 7-10 streams/km^2 in some areas 4-7 streams/km^2 and also above 10 streams/km^2.

This area is dominated by the indigenous primary forest though in some patches there are secondary forest trees grown like the eucalyptus and pine trees. Here the average leaf size is (14x7) cms, a stem girth of 171 cms and a stem height of 19 metres with the thickness of the bark being between .6-.9 cms.

Soils of Riat Khwan area show two major structural types in the patches where there are secondary forest trees the soils are medium and of granular form with a size between 2-5 mm whereas on the other hand the major portion which is under primary forests, the soils are fine and of crumb form with a size between 1-2mm. The textural class highlights that the area has sandy clay loamy soils. The chemical properties of the soils indicate that the eucalyptus and pine trees have a very low pH value and very low phosphate content and a moderate potash content.

The dominating tree species are **Schima wallichiana** which are of the same family of **Schima khasyana** found in the Barapani lake area, **Pinus insularis** the same species as that found in Umbir village, **Prunus podum, Etna and Eucalyptus globulosses**

5.4 Upper Shillong Area

The Upper Shillong Area which has a general relief above 1800 metres above sea level, the average slope is mostly below 7^{o} though in certain pockets it ranges between 7^{o} -14^{o} with a drainage density being mostly below 1 km/km^2, at certain places it ranges between 1-2km/km^2 and the drainage frequency also mostly below 4 streams/km^2.

This area is dominated by indigenous plant species having average leaf size approximately around (14x4)cms, stem girth around 162 cms and the tree height being 19 metres with thickness of the bark ranging between .7-1cm.

The physical characteristics of the soil show that they are medium sized (2-5 mm), sub-angular to angular and of crumb form. The texture of the soils is sandy clay loamy in nature. However, the chemical characteristics show that the soil is acidic in nature having a high percentage of organic carbon, low phosphate content and a moderate amount of potash content.

It may be concluded that this area is dominated by five main tree species i.e., **Querus montana, Myrica esculanta, Michelia champaca, Prunus podum** the same species are also found

in Riat Khwan area and **Pinus khasyana** the species which is from the same family like the one we get in from Umbir village secondary pine forest and the forest at Riat Khwan area.

It may be accounted that geomorphology provides the framework on which climate is acting through vegetation, forms the soil. All the sites studied are subject to pedogenesis - the complex of physical, chemical and biological processes that forms the soil profile where the depth of soils tends to increase downslope. However, differences in soil humus (organic carbon), structure and fertility results from the base status of the parent rock materials. In the study area the soils are derived from the acidic rocks, the colour ranges from brown to dark brown showing that the soils contain iron oxides.

On the other hand vegetation is often a good indicator of the soil and climatic conditions but there are instances where the reliability varies from place to place, depending on other local factors particularly the geomorphic attributes. In some cases the presence or absence of certain plant species indicates the texturity of the soil as for example a narrow seepage zone changes the vegetal density and height of the dominant tree species but it is important to note that vegetal cover in high rainfall areas may be dense and uniform and the type of vegetation may not have any importance to the nature of the soil or parent rock material.[1]

In general all soils are greatly influenced by

geomorpohology and climate which has a dominating influence too on the distribution of plant species. In general the finer the soil texture better is the inherent fertility but poor drainage leads to a longer time for the salts to be removed or be dissolved through leaching. Therefore because of the control of geomorphic boundaries on moisture conditions that coincide with soil boundaries, geomorphology determines the major plant communities.

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CHAPTER VI

CONCLUSION & SUGGESTIONS

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CONCLUSION AND SUGGESTIONS

The study area which is the Upper part of the Umiam Basin, though is very small for such a study occupying an area of only about 117 sq.kms occupies a very important position in understanding the interplay of geomorphic features, plant distribution and soil characteristics. With reference to the geological aspects and climate of the study area, it can be accounted that soils are the most important component on which man relies directly or indirectly other than water.It has been influenced by the parent rock material, landscape and vegetal cover in association with the climatic parameters which reign in a particular location.

However this study draws attention to the importance of three major environmental factors that is the geomorphic attributes, the dominant tree species and the soil characteristics. Also, as accounted earlier it can ascertain that each of these factors expresses identifiable characteristics of the environment where sometimes vegetal or landform or soil differences or their respective combinations have a great significance to the study of phytogeomorphology.

In the light of the above discussions it can be said that phytogeomorphology provides the base to solve the problems of land management and landuse planning through detailed surveys. Also, mismanagement of an area especially in the field of

land use results to the loss of soil fertility, soil erosion, crop failures and associated economic problems which can be avoided by accessing in advance the land potentiality basing on geomorphic characteristics, natural and induced vegetation and soil characteristics.

The following findings are mainly highlighted through the landform-plant-soil relationships:

(1) The general relief of the study area can be categorized into four upland zones, that is, the low uplands, the mid-lower uplands, the mid-central uplands and the high uplands.

(2) The average slope ranges from about 7^{o} to 21^{o}, the drainage density from about 1 km/km^2 to 4 kms/km^2 and the drainage frequency ranges from about 4 $streams/km^2$ to 10 $streams/km^2$.

(3) In the zones where the relief is below 1000 metres and above 1800 metres above sea level, the slope is mostly below 7^{o}. This is because of the presence of the Barapani Lake and the confirmation of a true plateau where it reaches its maximum height at the Upper Shillong Area, thus resulting to gentle slopes. Also, in these two zones the drainage density and frequency is low. It may be accounted that though the origin of streams occur in the Upper Shillong Area, there is low drainage density and frequency because the streams are too small to be depicted in the topographic sheet of R.F 1:50,000.

(4) There is a diversity of slopes, drainage

density and frequency in the middle uplands signify that geomorphic processes are active in these two zones.

(5) The physical characteristics of the soils vary from loamy to sandy clay loamy soils, angular to sub-angular, crumb to granular form and with a size of 1 - 2 mm to that of 2 - 5 mm.

(6) The chemical characteristics of the soils show that they are highly acidic (with pH ranging between 4 - 4.5) particularly in the area where pines and eucalyptus trees are found.

(7) The soils have high organic carbon content signify high accumulation of humus, low phosphate content reaching a critical stage where eucalyptus trees are found and a moderate to low potash content is noticed.

(8) The soils from the physical characteristics are fertile and can support a lot of vegetation but is critical from the chemical characteristics.

(9) The morphological characteristics of the dominant tree species show a tendency that the leaves are being more acute, the average height being more taller and the girth being more wider as we approach towards the high uplands.

(10) There is an overlapping of tree species as that of Schima and Prunus species in the uplands, may be because of similar conditions prevailing in this area. Perhaps

this may be also due to the ecotones for which comprehensive study is yet to be done.

Thus,it can be said that geomorphology provides the framework on which climate is acting through vegetation resulting in the formation of soils. All the sites studied are subject to pedogenesis - the complex of physical, chemical and biological processes that forms the soil profile where the depth of soils tends to increase downslope. However, differences in soil humus (organic carbon), structure and fertility results from the base status of the parent rock materials. In the study area the soils are derived from the acidic rocks and the colour ranges from brown to dark brown showing that the soils contain iron oxides.

On the other hand vegetation is often a good indicator of the soil and climatic conditions but there are instances where the reliability varies from place to place, depending on other local factors particularly the geomorphic attributes. In some cases the presence or absence of certain plant species indicates the texture of the soil as for example a narrow seepage zone changes the vegetal density and height of the dominant tree species but it is important to note that vegetal cover in high rainfall areas may be dense and uniform and the type of vegetation may not give any importance due to the nature of the soil or parent rock material.

Soil characteristics are greatly influenced by geomorpohology.has a dominating influence too on the distribution

of plant species. In general the finer the soil texture better is the inherent fertility but poor drainage leads to a longer time for the salts to be removed or be dissolved through leaching. Therefore the control of geomorphic boundaries on moisture conditions coincide with soil boundaries and determines the major plant communities.

Thus depending on the findings given in the above paragraphs a number of suggestions can be made for proper landuse planning with a view of maintaining the natural ecosystem of the area.

(1) Phytogeomorphic studies provide the base for geological exploration and survey not only for the normal mapping of stratigraphic units but also for that of mineral and water resources. It signifies that topography and vegetation can be used to indicate geological features such as dip, foliation, folds, faults and beds through the absence or presence and/or the changes in the type of vegetation.

(2) Mineral resources tend to be related to landscape through a number of predictions. They occasionally are visible on the surface but are more usually interpreted from the understanding of the location of plant groups under particular soil conditions reflecting geological formation.

(3) Geomorphic attributes can assist in landuse and land evaluation studies where the effects of geomorphology

through the parent rock material, the topography and drainage system with the interplay of climatic factors would reveal a lot of information on the potential landuse.

(4) Topography along with the influence of soils and the natural and induced vegetation becomes a prime determinant of landuse planning.

(5) Slope has a strong influence on the mechanization of activities. At the point where the slope is too steep land is devoted to forestry though the soil may be well suited for farming.

(6) Since the study area is a small catchment area it may be too hazardous for timber logging as this will affect the sediment load flowing to the lake. Preservation of the forests would greatly enhance the life of the lake as well as a part of wild life management.

(7) As natural vegetation is an excellent expression of the total effect of environmental factors, the population of the plant community, its species composition (including the dominant species) and vegetal succession contributes a lot to maintain the ecological balance and bio-diversity.

Thus Phytogeomorphology provides a sound base to an integrated approach of dividing landscapes into meaningful units, which have a uniformity of geology, geomorphology, vegetation, climate and soil.

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