

**GEOMORPHOLOGY AND LAND USE PLANNING  
OF UMRAN BASIN MEGHALAYA  
A CASE STUDY OF SAIDEN & DULONGNAR VILLAGES**

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NORTH-EASTERN HILL UNIVERSITY  
SHILLONG : MEGHALAYA**

**OCTOBER, 1989**



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This is to certify that the dissertation submitted by Mr Hiambok Jones Syiemlieh for the Degree of Master of Philosophy (M. Phil.) at the Department of Geography, NEHU, Shillong, Meghalaya, entitled **Geomorphology and Land Use Planning of Umran Basin: A Case Study of Saiden & Dulongnar Villages, East Khasi Hills District, Meghalaya** is a bonafide study of the author to the best of my knowledge and belief.

This study may now be placed before the examiners for due evaluation.

SHILLONG

THE 31<sup>st</sup> OCTOBER 1989.

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As time passes on, the inquisitive human mind in striving for more knowledge. A lot is to be explored and so man strives for more, for, from every higher platform more hidden faces are seen. Thus with a humble effort this dissertation has taken its shape.

In the course of establishing the few facts presented here, I feel heavily indebted to all those who contributed and helped for the success of this work.

I express my sincere thanks to my Supervisor and Guide Professor R.K. Rai who had always helped me till the final stages of my work.

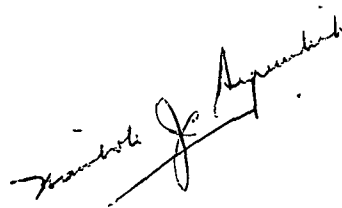
I express my gratitude to all my teachers in the Department who were ready to help me at any time. I would also thank my friends who encouraged and helped me to complete this dissertation.

My thanks also goes to the Librarian and Staff of the Geological Survey of India for rendering all necessary help. At this point I cannot forget Mr. Joseph F. Khongbuh for his generous help and in making the whole work beautiful.

I would also thank my encouraging mother who was eager to see the work complete. And also my wife, Aretha and little Amanda who morally supported me.

(ii)

Lastly, I take the responsibility of all mistakes committed in this dissertation.

A handwritten signature in black ink, written in a cursive style. The signature appears to read "Hiambok Jones Syiemlieh".

SHILLONG

(HIAMBOK JONES SYIEMLIEH)

THE 20 OCTOBER 1989.

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**CHAPTER - I**

**INTRODUCTION**

## INTRODUCTION

The study of landforms, their evolution and developments have attracted the natural historians right from the 17th Century. The quest of the human mind to know what was near and around him brought people from different disciplines, and together they worked at their own quarters to unravel the mystery of the earth, its evolution, configuration and present developments. In the 1870's the foundation of geomorphology was firmly laid and in 1877 a new era in the field began. James Hutton brought out a new face in geomorphology by waiving the constraints of catastrophism thus bringing uniformitarianism as a new and relevant geomorphic thought.<sup>1</sup>

Geomorphology, often described as the "science of landforms",<sup>2</sup> studies the landforms as presented by nature at present and tries to understand their origin. A historic element is therefore inevitable for the interpretation of the earth's surface.<sup>3</sup>

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1. Higgins, C.G. 1975. "Theories of Landscape Development: A Perspective", Theories of Landform Development, George Allen & Unwin, London, 1981, p. 5.
  2. Thornbury, W.D. 1954. Principles of Geomorphology, Wiley Eastern, New Delhi, Second Ed. 1985, p.1.
  3. Syiemlieh, H.J. 1986. "Geomorphology of Smit and Its Environs", M.A. Dissertation, Dept. of Geography, NEHU, Shillong, Unpublished.

Man, on the other hand, has to adapt to the different situations and conditions which nature gives him. Thus, man has to interact and negotiate with the landforms. Man encounters landscape in his daily life and for his own convenience he opposes it to a large extent. In this encounter man has little realised that geomorphic elements have a great role in deciding the potentialities of an area. The modern man in fact tries to update the methods and techniques for his own survival and benefit. In order to achieve this, land which is the base of human survival must be studied. This kind of study can never isolate itself from landscape configuration. To plan for the best use of land, it is essential to understand the characteristics of the area. Thus, there exists a close relationship between geomorphology and land use planning.

In the light of the above relationship the present study - "Geomorphology and Land Use Planning of Umran Basin: A Case Study of Saiden and Dulongnar Villages, East Khasi Hills District, Meghalaya", has been undertaken.

### **The Study Area**

Taking into consideration the aerial aspect, it is thought that the drainage basin will be most appropriate unit of study. Its boundaries are well demarcated by the divides and covers an area of 298.1 km<sup>2</sup> approximately. It lies approximately in between 91°45' E to 92° E longitudes and 25°45' N

# LOCATION OF THE STUDY AREA

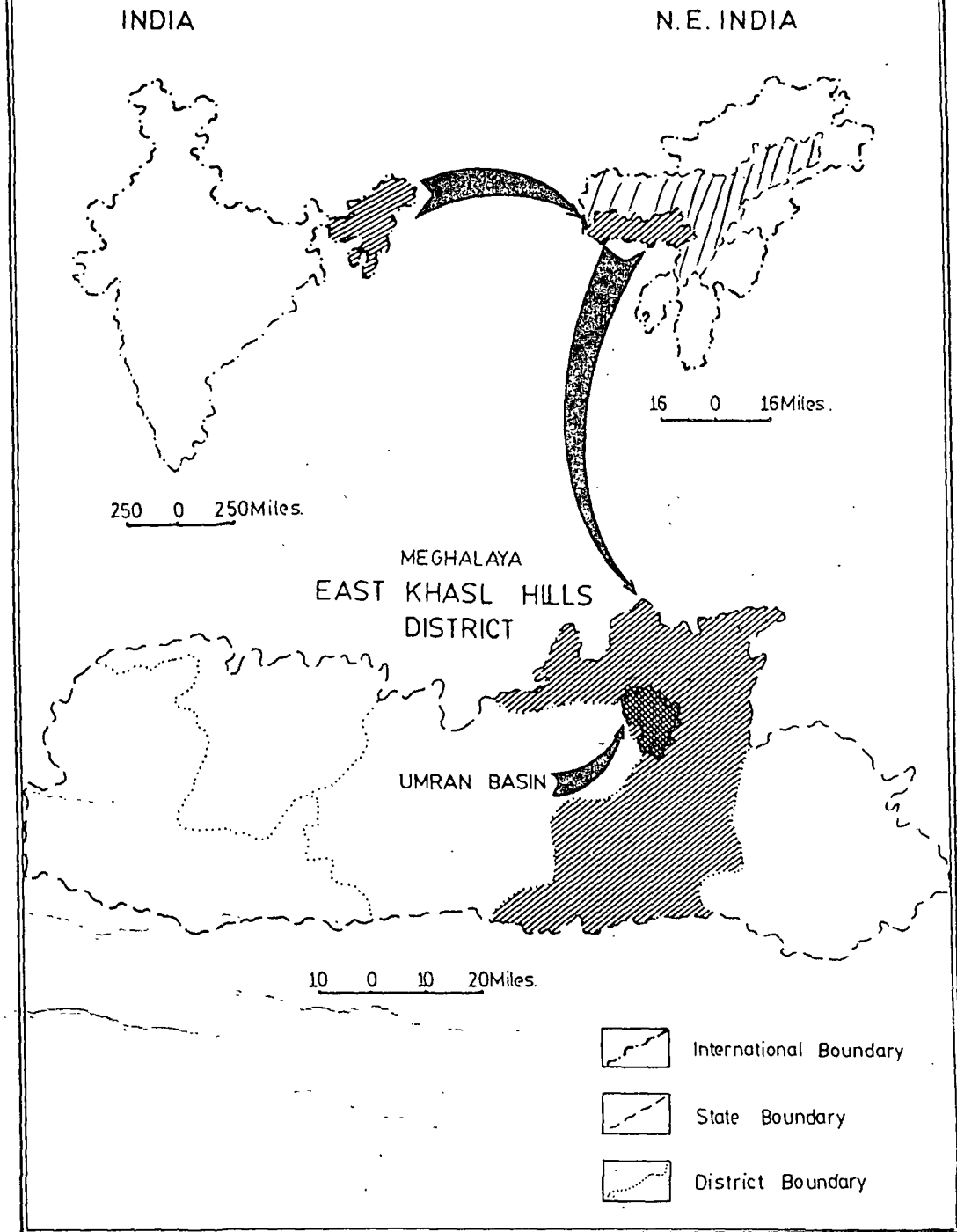


Fig. 1

to 25°55' N latitudes. About 65 per cent of the population of the basin depends on agriculture.

The basin is bounded in the north and south by two growing urban areas - Nongpoh and Umsning respectively. Umtasor village limits its western boundary while its eastern borders extend a little beyond Mawrong village.

The Umran river basin is characterised by diverse geologic and geomorphic characteristics. Structural control over the basin is well defined, coupled with at least one stage of rejuvenation. Thus it is evident that there exists planation surfaces in the basin which is conducive for geomorphological studies.

Climatic conditions in the basin varies from subtropical to almost temperate type. Rainfall ranges from 700 to 800 ml annually and temperature as low as 15°C in winter and a maximum of 29°C in summer. The basin area is therefore warmer and receives less rainfall than Shillong. It is to be noted that the basin area lies in a rain shadow region.

Several categories of landuses could be identified at different levels depending on the landform units. However, due to lack of data pertaining to this subject, a sample survey of two variant villages has been taken. As stated before a large section of the population in the basin depends on agri-

culture. It is important to mention here that there is a difference between the locals and the migrants. Migrants here refer to Khasi migrant population who have migrated from the southern parts of Meghalaya, specially after the partition of India and Pakistan, when the border trade with the plains had been restricted in this matter of dependence. The locals are more interested in food crops while the migrants are not. The latter have migrated from the southern parts of Meghalaya where the topography is rugged. This section of the population is therefore less experienced in lowland cultivation. They are therefore more interested in perennial cash crops which are suitable for cultivation over the slopes. As a result, they prefer to occupy the slopes as they have done in their original villages.

### **Objectives**

A set of objectives have been laid and attempts have been made to fulfil these targets keeping in mind the above facts. These are:

- (a) to understand the geomorphic characteristics of the Umran basin arising out of lithology and structural characteristics of rocks;
- (b) to identify and examine the various geomorphic factors operating in the basin and the processes thereby involved in relation to the various rock types, topography, climate, soil and vegetation;

- (c) to understand the implications arising out of the drainage system and its analysis;
- (d) categorisation of slope and its significance;
- (e) assessment of land use in the basin and to understand the cropping pattern; and
- (f) to bring out the relationship between geomorphology and land use and to plan for better use of land.

### **Methodology and Data Base**

The work has been done in three stages viz., (a) Pre-field stage, (b) Field-work stage, and (c) Post-field stage.

#### **(a) Pre-field Stage**

In this stage the relevant literature as regards the area and the field of study have been collected and studied. These materials include meteorological data, geological information and topographical maps. The areal, linear and relief data of the basin have been extracted from 1:63360 Survey of India topographic sheets (1911) Nos.  $78\frac{0}{13}$  &  $78\frac{0}{14}$ . Taking the help of these, plotting of the long profile of the rivers, area height curves and other related diagrams have been possible. Superimposition of maps has also been tried in order to obtain a clearer picture of landforms in the basin. Stream adaptation to the lineaments was also seen after superimposition of the drainage network on the geological map. In fact, such superimposition was possible only after the reduction of the geological map to a suitable and compatible scale.

**(b) Field Work Stage**

At this stage, site visitation and investigation commences. Identification of the different landform units and confirmation of such information at site takes place. Information on different aspects like weathering soils and their characteristics, slope characteristics, climate, fluvial features, landuse and vegetation are obtained, estimated or measured. Photographs have also been taken to help the explanation of different aspects including geology, landforms, landuse and vegetation cover. In addition to these, some secondary data have been obtained from the Community Development Block Office at Umling.

**(c) Post Field Work Stage**

This is the last stage of work where final preparation of maps and diagrams, physical and chemical analysis of soil samples, interpretation and presentation of the results takes place. All information available from the toposheets have been extracted and possible statistical analysis such as correlation analysis have been tried in order to obtain reasonably accurate results.

The morphometric and basic data so collected as well as those from other sources are used for the construction of a major part of this dissertation.

## Plan of Work

The entire work is divided into six chapters.

In Chapter I, a general introduction of the basin and plan of work has been outlined.

Chapter II is devoted to the geological history of the Meghalaya plateau and that of the basin in particular. The tectonic and structural characteristics of rocks is discussed here. The area being guided by its geology has, therefore, a long history of events which are responsible for the evolution of the interesting landscape.

Chapter III is engaged in describing the numerous physical processes involved in the evolution of the present landscape. The processes of weathering, mass wasting and soil formation, climatic conditions and the vegetation cover of the basin are the important aspects covered in this chapter. In addition to this, the role of geomorphic factors in changing landscape, analysis of slope and its implications have also been highlighted here. A geomorphic classification of landforms in the basin have also been attempted.

In Chapter IV, the drainage system is taken into consideration and evolution, pattern and morphology of the system is covered. Analysis of the different variables have been attempted in order to understand the nature of the network

and also estimate the effects of lithology on the system.

The existing land use finds its place in the fifth chapter. A categorisation of land use, existing land use pattern and cropping pattern in the basin have been discussed. This chapter, in fact, deals more specifically with the two sample villages which represents most villages in the basin.

Chapter VI discusses the impact of geomorphology on land use. The relationship between geomorphic landforms and land use is highlighted here. The last part of this chapter considers in a nutshell the correlation of geomorphology with land use planning. This may be taken as an initial step towards a more detailed work yet to be done.

Finally, the last part of the work concludes by giving the summary of the findings. Suggestions on the basis of the findings is incorporated here.



CHAPTER - II

GEOLOGY AND STRUCTURE

## GEOLOGY AND STRUCTURE

### 2.0. Geology

It is well known that the whole of Meghalaya plateau has been subjected to a lot of diastrophic disturbances in its geological past. The different forces acting on this part of the land mass have separated it from its larger counterpart - the Peninsular India, throughout the millions of years that have passed. The fact that this area or region as a whole falls around the intersection of the two seismo-tectono-magnetic (STM) belts,<sup>1</sup> is an answer given by the theory of Plate tectonics to the seismicity of this area. Count De Ballore's proposal of a 'polygon of instability' formed by Shillong, Guwahati, Goalpara, Bogribari, Dhubri, Tura and Cherrapunjee reflects the degree of the unstable nature of this region.<sup>2</sup> It has also been asserted that the compressional forces acting along the north-south axis play a great role in tectonism of this area.<sup>3</sup>

From the above, it could be drawn that there is an accumulated energy stored over this area due to the strain caused by the active north-south forces. The plate margin

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1. Rao, R.V.R. Some Major Geotectonical Aspects of Environmental Development of N.E. Himalayas of Arunachal Pradesh, G.S.I. Misc. Publ. No. 43.
  2. Count F. M. de Ballore. G.S.I. Memoirs, Vol. XXXV, Part 3.
  3. Ibid.

convergence over this part of the region indicates a weak crust mantle structure. This is expressed physically in the form of low lying areas, scarps, faults etc., which are in fact very much related to the geology of the area. The existence of sedimentary basins with accumulation of sedimentary deposits coupled with organic remains and resulting to low density continental crust cannot be denied. These basins may be local but due to extensive normal faulting they are formed parallel to the margins of the pre-existing lines of weakness thus influencing the structure and nature of the lower strata. The forces that are acting continuously over this area subject these basins to subsidence and uplift. However, the thinner crust cannot withstand these forces so that they start collapsing and fracturing. This is evident over the Surma and Assam valleys which were 22 km and 27 km respectively which fractured and collapsed. On the other hand, the thicker Shillong plateau estimated to be 40 km in thickness did not collapse but was uplifted.<sup>4</sup> The movements in this area could be well correlated to the plate movements as there occurs a transgression into the continents at such instances. On the stoppage of these movements a regression takes place resulting to tremendous shocks that occur from time to time.

The result of the different movements in this plateau were the uplifts that led to the erosion of the area, subsidence

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4. Dutta, T.K. and Saikia, M.M. - Plate Tectonics Model in the Programme of Mineral Exploration - A Proposition With Reference to N.E. India, G.S.I. Misc. Publ. No. 43.

that led to deposition and intrusions of land and sea emissions.<sup>5</sup> Thus, the sequence of the rock strata is of a very wide range from the oldest to the recent. The geological sequence have been traced out to be mostly of Pre-Cambrian rocks which are acutely folded and overlying these are the Mesozoic and Tertiary deposits.<sup>6</sup> The geological succession is as follows.<sup>7</sup>

**Table - 1: General Stratigraphic Sequence of Geological Formation in United Khasi & Jaintia Hills**

Geological age	Group name	Formation name	Rock types
Recent	Newer Alluvium (thickness not known)	Unclassified	Sand, silt & clay
----- Unconformity -----			
Pleistocene	Older Alluvium (thickness not known)	Unclassified	Sand, clay, pebbles, granite and boulder deposit
----- Unconformity -----			
		Simsang Formation 1150 m.	Silt, stone, sandstone alternation

5. Singh, R.P. "Geomorphology of the Shillong Plateau of Assam", Proc. of the Pre-Cong Symp. IGU, Gauhati, 1968, p.1.

6. Bhattacharjee, C.C. "Structure and Petrology of the Shillong Plateau", Proc. of Pre-Cong Symp. IGU, Gauhati, 1968, p.18.

7. Panda, G.C. "Geomorphology: Rural Settlements in Khasi & Jaintia Hills, Meghalaya", Ph.D. Thesis, Department of Geography, NEHU, Shillong, (Unpublished), 1987, pp. 18-19.

Table - 1 (Contd.)

Geological age	Group name	Formation name	Rock types
Eocene	Jaintia Group	Shella formation 600 m.	Alternation of sandstone, limestone
		Langpar formation 100 m.	Calcareous shale, sandstone, limestone
		Mahadek formation 100 m.	Arkose, glauconite
Upper Cretaceous	Khasi Group	Bottom Conglomerate formation 25 m.	Conglomerate, arkose
		Jadukata formation 140 m.	Sandstone, conglomerate, alternations
-----Unconformity-----			
Jurassic	Sylhet Trap 600 m.	-	Basalt, alkali-basalt, rhyolite, acid-tuff
Pre-Cambrian		Intrusive (acid & basic)	Perphyrite, coarse granite, apatite, quartzveins, epidorite, dolorite, basalt
		Shillong Group	Quartzite, phyllite & conglomerate
-----Unconformity-----			

Table - 1 (Contd.)

Geological age	Group name	Formation name	Rock types
Archaean		Gneissic complex	Biotite gneiss, biotite horn-blends, gneiss, magmatite, mica schist, sillimanite, quartz-schist, biotite-granulite, pyroxene granulite, etc.

Source: Geological Survey of India, 1974, Geology and Mineral Resources of the States of India, Part IV, Misc. Publ. No. 30, pp. 69-78.

### 2.1. Structure

It is of general understanding that the Meghalaya plateau is "an autochthon of crystalline rocks that constitute the Foreland Spur of the Indian Shield".<sup>8</sup> It is blocked by the Himalayas from the north-west and the Naga Hills oppose it from the south-east. The rocks in the region are folded with lineaments and are isoclinal. It has been noted that the folds in the Shillong Series are not frequent. The folds that occur in this formation are "in general open, asymmetrical folds with steep axial planes and gently plunging axes".<sup>9</sup> These folds surround the granitic pluton and are generally known as Myllem granite. The rocks in these areas differ

8. Ibid.

9. Ibid.

from those of the main mass in two important aspects. They differ in structure by being sub-parallel or almost parallel to the margins of the pluton and secondly, they are more metamorphosed than the main pluton mass.<sup>10</sup>

South of the granites and gneisses are the pre-Tertiary and Tertiary rocks which lie almost horizontally except for the southern portion beyond Mahadek. In these areas the beds are inclined, varying from moderate to steep and at the same time concealing beneath the Bengal alluvium. The southern portions ends abruptly and the line of contact is a tear fault generally known as the Dawki fault. The fault line is a long one measuring about 250 km and running from Haflong to Dawki and ending around Dalu (Garo Hills).

## 2.2. Stratigraphy

### Archaean Gneissic Complex

The oldest rocks in the plateau are the Archaean metamorphic gneisses consisting of pink and grey mica-gneiss which are at places traversed by quartzite veins. The lithological contact of this formation with that of the Shillong group is generally in the N.E.-S.W. direction. These rocks are believed to be the north eastern extension of the Indian Peninsula, separated from the main land by the Garo-Rajmahal Gap.<sup>11</sup> The rock types in this classification are listed in the table I.

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10. Ibid., p. 19.

11. Panda, P.C. "Geomorphology & Rural Settlements in Khasi & Jaintia Hills, Meghalaya", Ph.D. Thesis, Dept. of Geography, NEHU, Shillong, (Unpublished), 1983, p. 31.

### Pre-Cambrian Rocks

The major rock types that dominate the plateau are of Pre-Cambrian origin. There are two types of rocks in this category. The Shillong Group of rocks comprises of quartzite, phyllite and conglomerate while the Intrusives are of acidic and basic types. In these, quartzites, high grade schists, calc-silicate rocks, granulites and granites are more common. On the other hand, the younger basic intrusives of the Khasi Greenstone overlay the two older strata of gneisses and Shillong series.

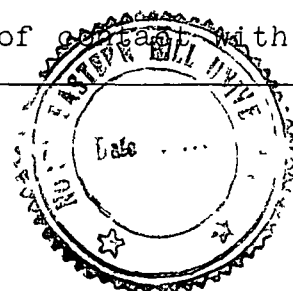
The acidic gneisses are usually banded and associated with schists. They are often sillimanite bearing. In such cases, there might be a combination with some other rocks like cordierite, rutile, garnet, corundum and spinel. In alternating bands of magnetite and quartzite there occurs banded iron ore at Hahim and nearby places and also at Chandralinga in the Goalpara district. These are estimated at about 50 million tonnes. Another multi-metallic mineralized zone has also been reported at Umpyrtha. Pegmatites that occur in the gneissic structure do not produce minerals of economic importance.<sup>12</sup>

--Metamorphism in the Shillong series of rocks vary widely. The quartzites interbedded with bands of argillites are less metamorphosed except along the point of contact with

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12. Bhattacharjee, C.C. Op.cit., p. 20.

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to overlies the eroded pre-cambrian basement. The trap rocks from a monocline culminating in a flexure along the southern fringes. This has been subsequently eroded at places exposing the traps as inliers.<sup>15</sup> This is thought to be of the same age as that of the Rajmahal trap that lies buried under the Bengal alluvium. It is therefore thought to be of the Jurassic age.<sup>16</sup> These are classed under the Pre-Tertiary formations.

### **Cretaceous Tertiary Sediments**

These sediments occupy the southern parts of Meghalaya plateau. They are found to be extensive and also thought to be a continuation of the cretaceous-tertiary sediments of the Bengal Basin.<sup>17</sup> These are comprised mainly of sandstones and shales except for three well defined fossiliferous limestones. These sediments are divided into two major groups as follows:

- a) Khasi Group, and
- b) Jaintia Group.

~~(a) The Khasi Group~~ - This formation is distinct from its arenaceous nature comprising of the Jadukata and Mahadek formations. The former consists of alternations of conglomerate

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15. Panda, P.C. Op.cit., p. 37.

16. Ibid., p. 35.

17. Ibid., p. 37.

the granitic mass. Those around Jowai present a highly metamorphosed structure than those nearby Shillong, though the latter type is present in large areas.<sup>13</sup>

The basic rocks that intrude into the Shillong Series are metamorphosed into epidiorite. These are generally known as Khasi Greenstone. Both discordant and concordant types occur in certain places nearby Shillong.

The Shillong Series and Khasi Greenstone have been thought to be older than the Myllem Granite. This is because of the fact that the intrusion of the granitic mass occurred at some definite time period after which there was no sedimentation or igneous activity in the plateau. This was probably upto the Upper Jurassic times. These granites are coarse grained and generally coloured pink.<sup>14</sup>

Excepting for the eastern part of Garo Hills, the Paleozoic and Lower Mesozoic rocks are largely absent. In the southern margins of the plateau, there occurs a trap rock at Sohbar, generally known as the Sylhet Trap. The Sylhet Trap is exposed in a narrow east-west strip, 80 km long and 4 km wide with a maximum thickness of 550-600 mts. They seem

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13. Ibid., 21.

14. Ibid.

and sandstone. This formation lies unconformably over the Sylhet trap. Their extension is limited to the north of the Raibah fault which happened to be the shore line at the time of their deposition.

With the progressive migration of the shoreline towards the north, more and more deposition took place resulting to the 'bottom conglomerate formation'. The Mahadek formation also is another later formation overlying unconformably over the Pre-Cambrians and Sylhet Trap volcanics. The basal conglomerates are the first while feldspars and sandstones follow the sequence, interbedded with clays. The sandstones that occur on the top are coarse and massive.<sup>18</sup>

**(b) The Jaintia Group** - There are two sub-divisions in this group, namely, the Langpar Formations and the Shella Formations. The former overlies the Mahadek formation of the Khasi group. The main components of this formation are calcareous rocks and sandy limestone. The deposition of these sediments is the beginning of the corresponding conditions for the later deposits generally known as the Shella formation. A successive deposition of the three members of this category has been established. They are the Therria-Lakadong limestones which forms the lower stratum, Lakadong-Umlatdeh limestones of the middle stratum and Narpuh-Prang-Siju forming the upper layers.

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18. Bhattacharjee, C.C. Op.cit., p. 22.

### Area of Quarternary and Recent Deposit

The rocks of the tertiary group occurring in the plateau are extensions of the Indian Shield. The Jaintia Series, which is the lowest component of the shelf facies crop out in the southern slope of the plateau. The series have been sub-divided into three stages viz., Kopili, Sylhet limestone and Therria. The latter lies without any visible unconformity on the Cretaceous on the western part. On the eastern part it overlaps on the Cretaceous and lies conformably on the older base rocks. Most of the rocks of this series are limestones, shales and sandstones of the Eocene times. The limestones are all fossiliferous.<sup>19</sup>

Thus, the whole of Meghalaya Plateau has got a long history of diastrophic disturbances. Throughout its geological history such disturbances have led to irregularities in the underlying strata. Apart from the remnant of the oldest landmass, its subjection to the different forces of earth movements have resulted to an admixture of different geological formations, ranging from the oldest to the newest. The whole plateau is mainly composed of Pre-Cambrian rocks having 'acute folds and steep dips'.<sup>20</sup>

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19. Ibid., p. 23.

20. Panda, P.C., Op.cit., p. 25.



Plate 1(b): Exposed rocks in road cutting.

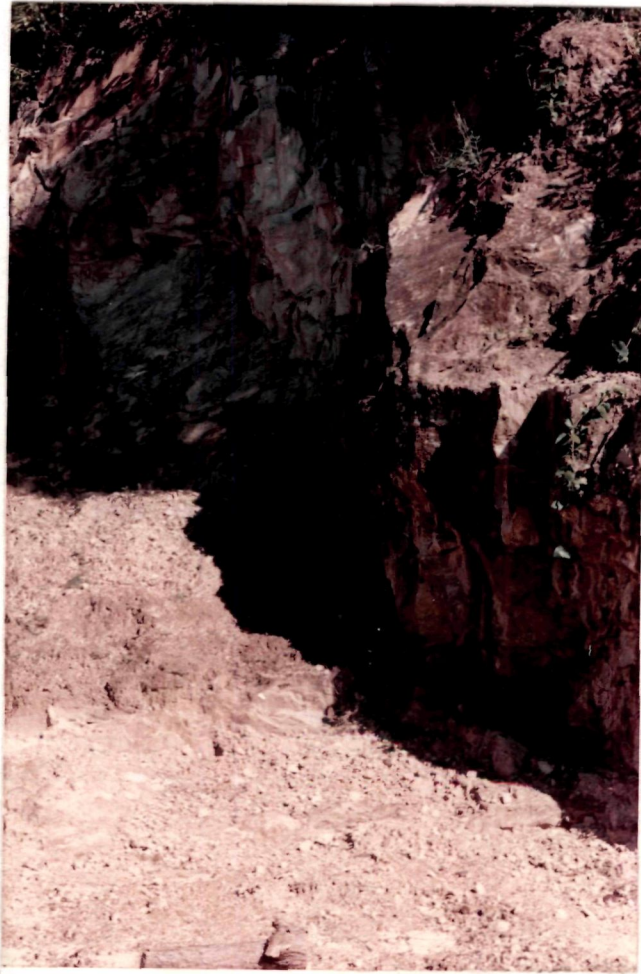


Plate 1(a): Exposed rocks in road cutting.

### 2.3. Geology & Structure of Rocks in the Study Area

Considering the area covered by the basin, the underlying rocks are mostly Archaean metamorphics. Near Umsning, the southern point of access of the basin, muscovite have been located. Moving further towards the north, the gneissic character becomes more predominant.<sup>21</sup> Major part of the basin is underlain by gneiss and granite accompanied by bands of schistose rocks and amphibolite which are also of the Archaean age<sup>22</sup> dominating the southern part of the basin. The southern position is mostly gneissic in character while the northern parts are dominated by non-porphyritic granites. Porphyritic granites occur in patches within the non-porphyritic mass.

The general stratigraphy in the basin is as follows (after Verma & Rajendran).<sup>23</sup>

**Table - 2: General Stratigraphy of Umran Basin**

Age	Group Name	Rock Types
Pre-Cambrian	Intrusive	Very coarse grained porphyritic granite, Khasi greenstone and granophyre dykes
		----- Intrusive contact -----
	Shillong Series	Conglomerate, sandstone, shale, slate/phyllites.
----- Unconformity -----		

21. Mazumdar, S.K. (1965-66). "Systematic Geological Mapping Around Nayabungalow, UK & J Hills District, Assam", GSI Unpublished Reports.

22. Verma, P.P. & Rajendran, N. (1985). "A Report on the Photo-geological Mapping in the Area Around Nongkhlaw and South of Nongpoh, East and West Khasi Khasi Hills Districts, Meghalaya", GSI Unpublished Reports, Shillong, p.4.

23. Ibid.

UMRAN BASIN  
GEOLOGY

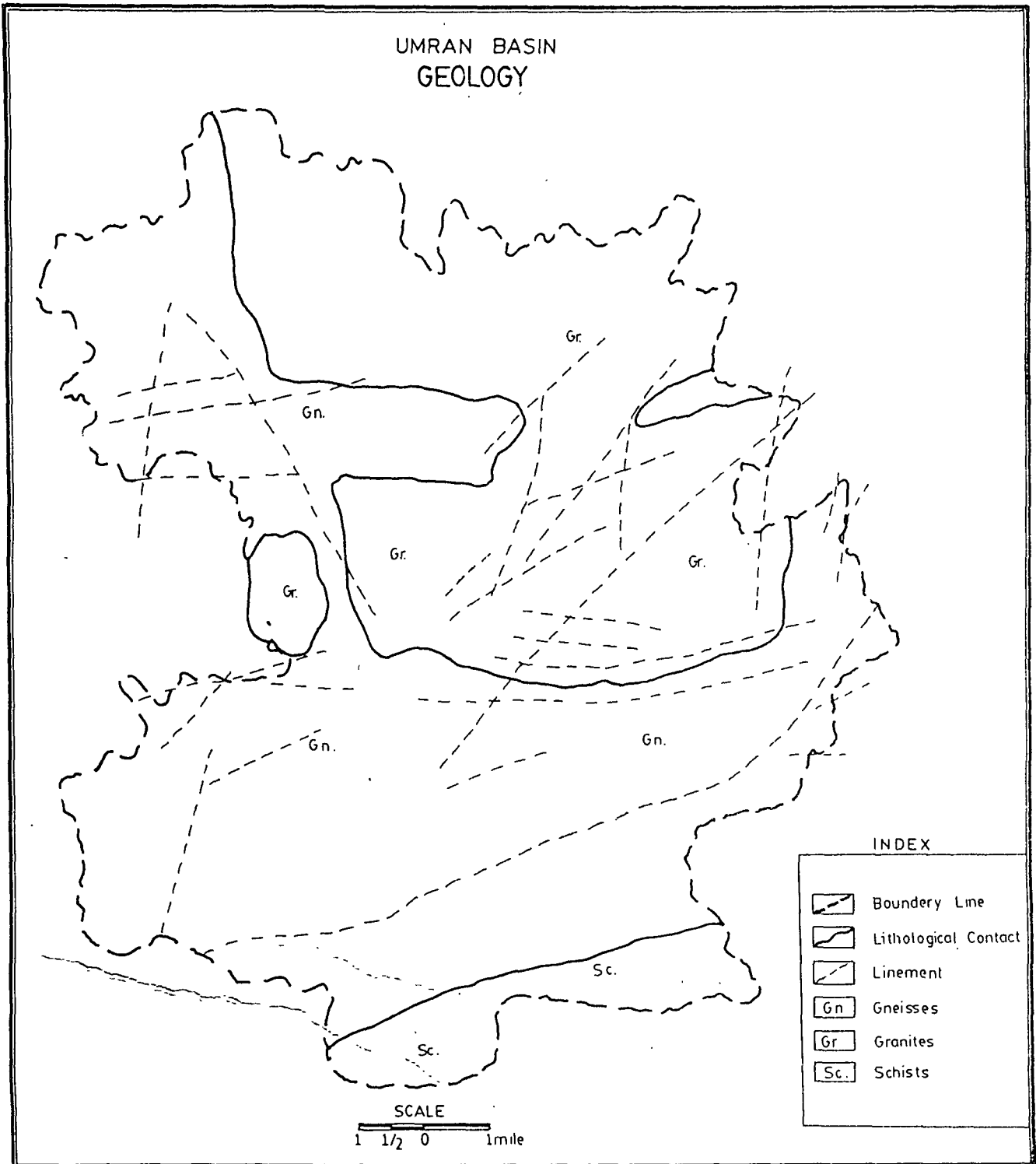


Fig. 2

Table - 2 (Contd.)

Age	Group Name	Rock types
Archaean	Intrusive	Non-porphyrific granite Gneiss and Schists with meta- quartzites, amphibolite, etc.

The above table shows the different rock strata in the basin. The domination of the rocks of the Archaean age is well described by the occurrence of gneisses, schists and granites. Gneisses of the area have medium to fine grains. The major rock types are quartz-biotite-gneiss with or without sillimanite granite gneiss and homophenous granites.<sup>24</sup> North of Myrdon, quartz-feldspar-biotite gneiss, quartz-biotite gneiss are observed with bands of schists continuing till the contact with porphyritic granites. Exposure of migmatic rocks associated with phases of pegmatites and granites have been observed at a quarry located north of Umrans village.

Schists occurring in this area are marked with thick argilite in sequence with bands of granite which forms a prominent ridge. East of Umsning market, these argilites have been metamorphosed to phyllitic grade. In the south-eastern direction not far from the basin's boundary lies a contact zone of the schistose rocks and those of the Shillong

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24. Ibid., p. 5.

series. It is however difficult to demarcate the zone of contact of the schistose rocks and that of the gneissic structure because of gradual increase in the degree of metamorphism.<sup>25</sup> Quartz veins characterise the schistose rocks, which is absent in the gneisses. On the other hand, the nearing of the zone of contact of schist and gneiss is marked by the presence of pegmatite veins.<sup>26</sup> The studies around Nongpoh to ascertain the occurrence of iron ore reveal that there are no major pegmatite veins. However, thin quartz veins intruding the gneiss have been confirmed.<sup>27</sup>

The granitic mass is largely of a non-porphyrific variety though there are patches of porphyritic type too. The non-porphyrific variety occurs with or without foliation or incipient foliation as observed along the National Highway 40, in between Umrān village and Umsamlem village. Its colour is generally grey though it may be occasionally pink due to the presence of pink feldspar.<sup>28</sup> These granites are coarse grained with phenocrysts.<sup>29</sup>

The porphyritic granites occurring in patches have a number of enclaves of gneiss and schists. Foliation occurring

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25. Ibid., p. 7.

26. Ibid., p. 8.

27. Goswami, A.C. (1960). "Report on Investigation of Alleged Occurrences of Iron Ore in Nongpoh, U.K. & J. Hills, Assam", GSI Unpublished Reports, Shillong, p.3.

28. Verma, P.P. & Rajendran, N., Op.cit., p.5.

29. Ibid., p. 9.

in the non-porphyrific variety has also been observed in the porphyritic variety has also been observed in the porphyritic variety. This porphyritic mass have been considered to be 'emplaced'<sup>30</sup> during the post Shillong period even though the two have never been in contact. Porphyritic granites are intrusive into the gneissic mass.<sup>31</sup>

The gneisses and schists are a product of sedimentary rocks. There is an alternate occurrence of resistant gneiss and a comparatively soft and weathering prone schist leading to a ridge and valley topography.<sup>32</sup> The presence of gneissic bands in granites suggest that granite is not an intrusive pluton.<sup>33</sup> The gneissic mass is highly deformed and its subjection to the forces of earth movements have resulted to a highly metamorphosed mass. In the process the primary characteristics of the mass cannot be traced.<sup>34</sup>

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30. Ibid., p. 10.

31. Lasker, B. (1949). "Preliminary Report on the Dam Site on the Umtru River in Khasi Hills", GSI, Unpublished Reports, Shillong, p. 2.

32. Verma, P.P. & Rajendran, N. Op.cit., p. 12.

33. Ibid., p. 13. Here it seems that there is a controversy because in the earlier work, the study was carried on a small scale only. The latter work done in 1985 seems to be more comprehensive and is taken as a base of the present study.

34. Bandopadhyay, D.N. "Report on Systematic Geological Mapping and Preliminary Mineral Investigation in Parts of Khasi Hills District, Meghalaya, Nowgong & Kamrup Districts, Assam", GSI Unpublished Reports, Shillong, pp. 6-7.

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CHAPTER - III

PHYSICAL PROCESSES

## PHYSICAL PROCESSES

### 3.0. Climate

The most important of all physical influences to which man is subjected to is climate. It is this factor that governs man's action and determines the economic potential of an area. It is this factor that controls human habitation, human occupation and society. In North East India climate is very much controlled by its location and diversity of relief which abound this region.<sup>1</sup>

The whole of North East India is very much influenced by the topographical features present in the region. The northern parts are bounded by the Himalayas rising upto 7000 m, forming a bend at the north eastern end at Sadiya. It then aligns south easterly to form the Patkais, the Chin Hills and the Yomas which have average elevations of 1800 m.<sup>2</sup> In these areas of uneven topography, there is a large variation in the climatic conditions due to uneven distribution of rain and sunshine.

In spite of all differences the south-west monsoon has a great influence over this area due to its proximity

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1. Nandi, K. (ed.) 1982. Resource Potentials of N.E. India, Climate of N.E. India, Meghalaya Science Society, Shillong, p. D-15.
  2. Ibid.

to the Bay of Bengal. The western disturbances occurring in winter do exert their influence during their period of operation. Thus, the region as a whole receives rainfall both in summer and winter, though the winter rains are not very significant. (Fig. 4).

This region has four seasons in a year, with a comparatively short winter and a long summer. Briefly the main features could be discussed.

**(i) Winter**

This is a short season beginning with January and lasts till February. It may however be anticipated one month earlier in case of higher altitudes. Rain and thunder showers are always associated with the spells of the western disturbances passing over this area at this time of the year.

**(ii) Pre-Monsoon (Hot Weather Season)**

When the cold weather starts disappearing, the hot conditions gradually increase by the month of March. In fact, the temperature during this season is not very high but is uncomfortable due to humid conditions. These conditions last till the end of May. Weather conditions could never be satisfactorily predicted as the changes are sudden. Thunder storms are frequently accompanied by squalls.

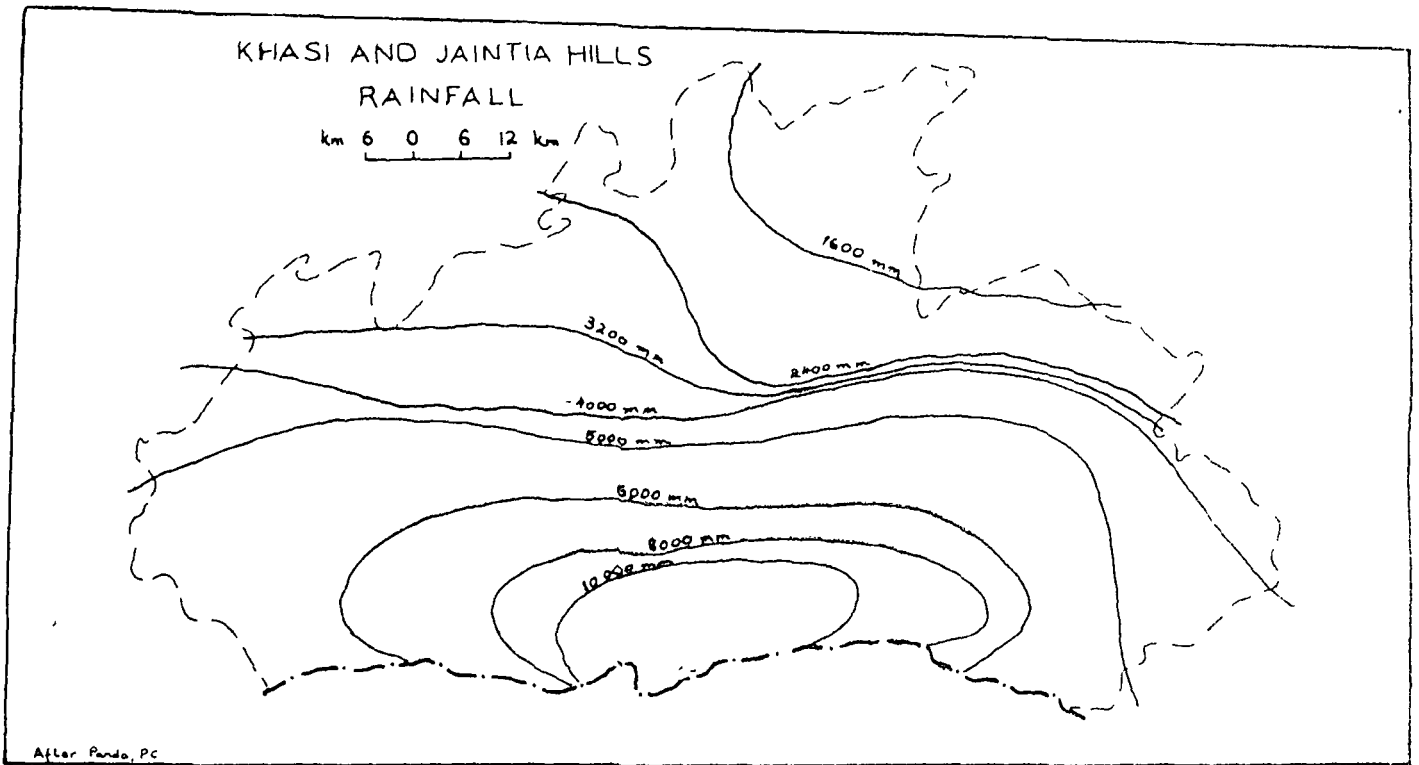


Fig. 3

**(iii) Monsoon Season**

This season continues from May onwards till about September. The rain bearing winds from the Bay of Bengal move in at this time to deposit the much needed rains. A large part of the annual rains are received during this period and the resultant feature - floods. Temperature is fairly high at this period.

**(iv) Post Monsoon Season**

The aftermath of the main monsoon season is mostly dry though just after the rains there is a gradual change and not a sudden one. Temperature too is reducing at a slow pace.

In the basin area the winters are pleasant with temperatures dipping to only 15°C (Fig. 4). It is mostly dry but as pointed above the western disturbances do bring some moisture to this area too. When the hot season starts, the temperatures gradually increase and during summer it may soar as high as 29°C. Rains received during this period touch the 700 mm mark over a span of about 60 rainy days, in the 5 months period (Data incorporated in Table 3).

Humidity coefficient is very high throughout the year. It is highest around September when it is about 95%. The lowest value is around 70%.

NONGPOH

RAINFALL & TEMPERATURE

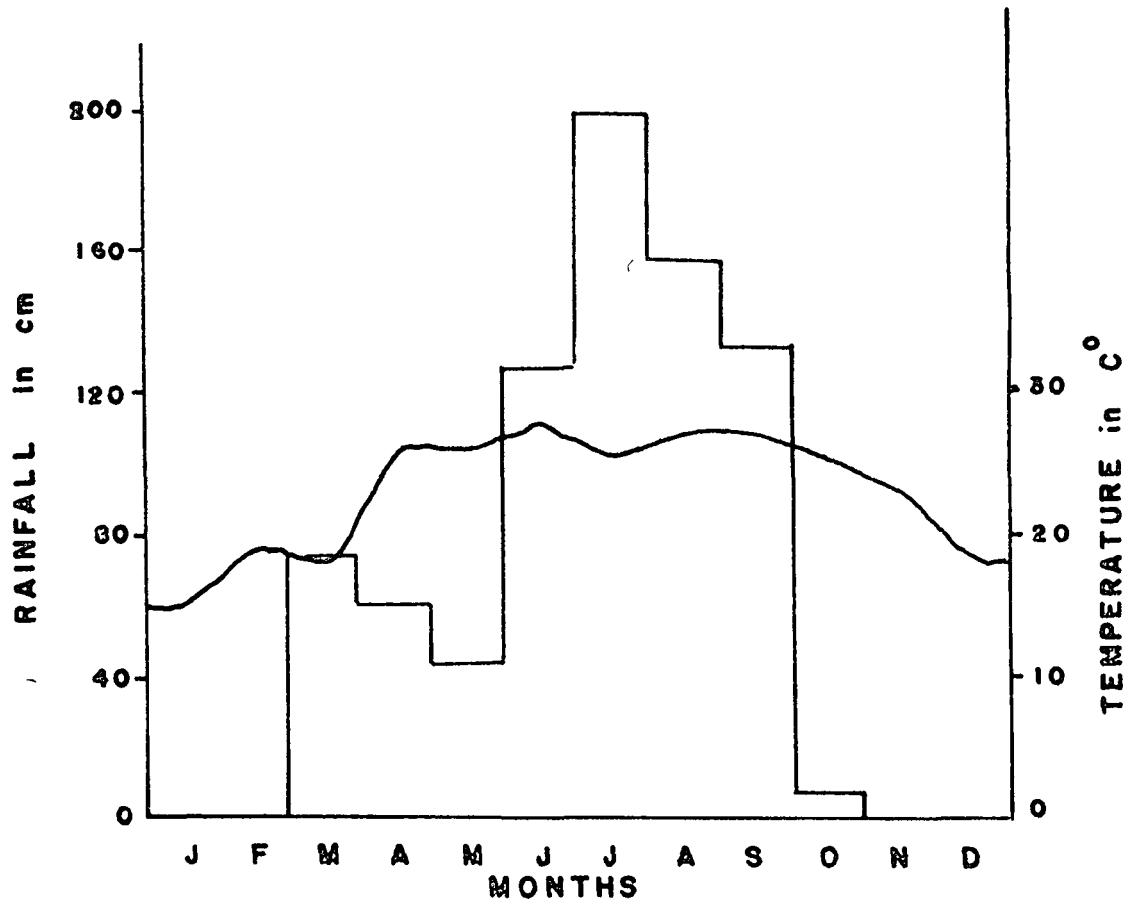


Fig. 4

Table - 3: Temperature/Humidity (°C/%)

Months	1984	1987
January	15/01.6	15.3/88.8
February	15.8/85	18.5/88.8
March	25.7/85.6	17.6/90.4
April	26.2/69.9	25.5/86.8
May	25.5/96.6	26.3/81.5
June	27.17/83.03	27.9/88.2
July	27.1/78.3	25.2/89.7
August	29.8/89.4	26.6/89.3
September	27.61/95.4	26.9/89.4
October	25.3/96.0	24.2/73.4
November	20.4/84.2	21.05/68.95
December	17.1/86.2	17.1/26.8

**Rainfall (cm/Rainy days)**

Months	1984	1987
January	-	-
February	-	-
March	30.2/2	74.1/8
April	11.0/10	59.5/9
May	91.7/19	42.2/10
June	166.6/18	125.7/18
July	216.27/25	199.8/24
August	114.5/15	157/20
September	158.8/15	132.3/22
October	12.83/8	4.8/5
November	4.1/1	-
December	7.7/1	-

Source: Eri Seed Farm, Sericulture Department, Government of Meghalaya, Nongpoh.

Much of the available sunshine is obstructed by clouds. Sunny weather prevails mostly over short periods of the year, that is, during the Pre-Monsoon and Post-Monsoon seasons. During winters there is sunshine in the morning but the afternoons are generally cloudy. In summer there are maximum clouds.<sup>3</sup>

### 3.1. Weathering and Mass Wasting

Weathering or the disintegration of rocks takes place over a period of time. Weathering is one of the major processes in the evolution of landforms. The degree of activity is generally higher in humid areas. While there are two subdivisions in the process namely, chemical and physical, the latter is of greater significance specially in humid areas. The nature of weathering depends on different factors like climate, soil, bed rock and so on.

Chemical weathering refers to the disintegration of rocks through a chemical process. This means that there is a change in the properties of a rock, both physically and chemically due to the process of change. The chances of deep weathering in humid areas like Meghalaya is high but the changes that take place have not been established to that extent.

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3. Ibid., p. D-16.

There are certain factors that govern chemical weathering in humid areas. These have been clearly dealt with by Faniran and Jeje in the following table.<sup>4</sup>

**Table - 4: Major factors affecting depths of weathering**

Climatic factors	Temperature: High temperature increase the rate of endothermic chemical reactions
	Precipitation: High precipitation increases the availability of the principal agent in weathering process: water.
Biotic factors	Vegetation cover: a dense forest canopy protects the surface from wash processes and provides organic acids which are capable of mobilizing certain rock minerals, especially iron by chelation. Conversely, open vegetation of the savanna type favours immobilization of iron and favours surface runoff.
Geomorphic factors	Landsurface stability: weather penetration is favoured by a low rate of surface denudation prevailing on gentle slopes.
	Age of landsurface: prolonged stability (persistence of ancient land surfaces) allows deep profiles to develop.
Site factors	Free drainage: elevated sites promote downward movement and frequent renewal of groundwater essential to rapid decomposition of rocks.
	Reception zone: sites experiencing convergent runoff may have increased water supply, but this may be combined with poor site drainage.

4. Faniran, A. & Jeje, L.K. Humid Tropical Geomorphology, Longmans Group Ltd., New York, pp. 53-54.

Table - 4 (Contd.)

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Geologic factors	<p>Rock type: presence of minerals particularly susceptible to alteration increases rate of weathering penetration and may promote early disaggregation of rock.</p> <p>Rock texture: rock texture affects behaviour under weathering attack. Crystalline rocks of coarse texture disaggregate more rapidly than fine-textured rocks, which may undergo more rapid alteration. Texture in sedimentary rocks affects permeability and rate of weathering penetration.</p> <p>Rock fissility: faults, joints and fractured grain boundaries promote weathering penetration, especially in crystalline rocks.</p> <p>Hydrothermal alteration: rocks previously subject to varying forms of hydrothermal activity may become additional susceptible to groundwater weathering on exposure.</p>
<hr/>	
Chronologic factors	<p>Climatic change: variations of climate and vegetation with time alter the balance of weathering and erosion. Fluvial conditions in the arid zone during the Tertiary and Pleistocene have led to the presence of relict deep weathering.</p> <p>Tectonic change: variations of crystal stability affect land surface stability and the period available for weathering penetration.</p>

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From the table it could be inferred how the chances of deep rock weathering are high in these areas. The high amount of rainfall reaching over 200 cm in a month with 25 rainy days is significant. This increases the work of the principal agent of erosion - water, in the process of weathering. The geomorphic factors are also responsible to a large

extent for the furtherance of deep weathering and the process of soil formation. The areas of lower relief in the study area are enhancing the processes.

Physical weathering usually affects the sub-surface and are mainly of two categories. Firstly, those that are subjected under the influence of gravity inducing a mass downslope movement and secondly, those that are carved by external agents like running water.

Mass movement plays an important part in the weathering of rocks in the humid areas. This process is mainly gravity induced movements of regolith. However, it excludes those which are carved or transported by external agents like running water. Mass movement is governed by different factors reflecting the diverse nature of their origin. Geology, slope gradient, climate, nature of waste that is being move, the type and density of ground cover, land use and the degree of human interference<sup>5</sup> are a collection of factors responsible for mass movement.

According to Sharpe (1938), the process of mass wasting depends on the nature of water (or ice) present in the moving mass, the nature of movement and the speed of the movement.<sup>6</sup> There are a collection of processes in mass movement which

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5. Ibid., p. 90.

6. Ibid., p. 83.



Plate 2(b): Mass Wasting

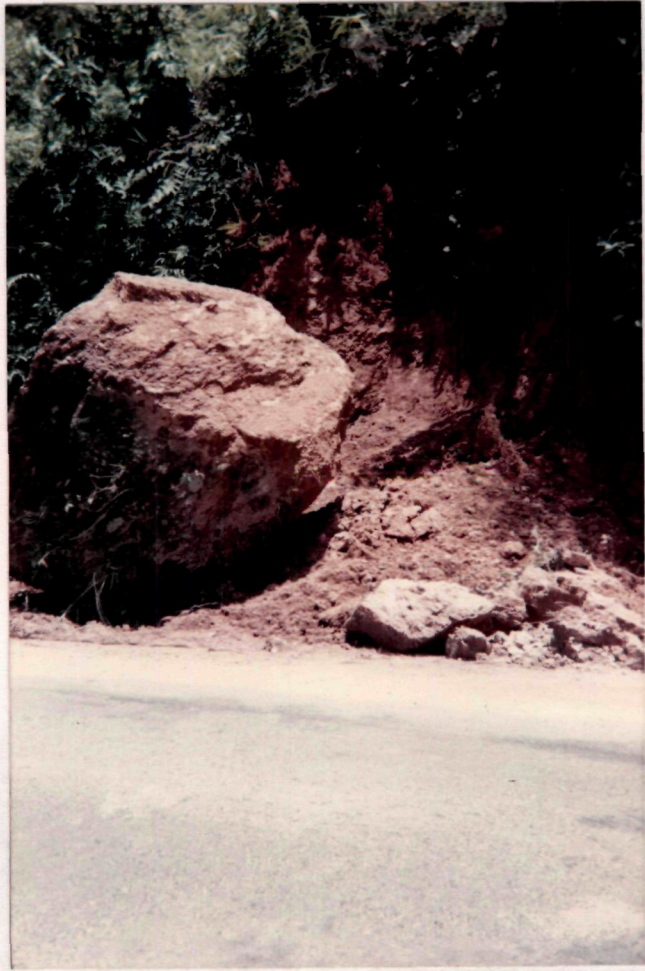


Plate 2(a): Minor Landslide

have been identified as creep, landslides and subsidence, of which landslides are more common in the area of study.

Soil creep refers to very slow imperceptible deformation or movement of slope material no matter what the causes of movement are. Landslides, which are more common in these areas, are phenomena occurring during the rainy season mostly. These are perceptible downslope movements which involves sliding of debris resulting from failure. These are observed by the road side and river banks.

In this connection, the effect of vegetation in restricting landslides is doubtful. The Tanzanian example confirms the role of vegetation in protecting landslides to a certain extent, while the Hongkong experience does not.<sup>7</sup> After observation of a number of areas that are prone to this problem, it has been found that the presence of larger trees or roots of bamboos on top of slide sites may trigger off landslides rather than protecting them. In fact, the presence of grasses is more congenial and more protective in this respect.

On the other hand, the intensity of rainfall and the largeness of drops could be considered as important factors in the event of soil erosion. The importance of soil conditions

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7. Ibid., p. 90.

should not be ignored at this juncture as they play a great role in the erosional and sliding processes. Depending much on the intensity of rainfall, the raindrops too act accordingly to produce a cumulative effect of erosion along the slopes.

In humid areas it is a known fact that the infiltration and through-flow would not be capable to cope with the inputs of precipitation. The result is that water starts accumulating in the surface depressions and later on flow as rills, sheet, or as channelised flow.<sup>8</sup>

### 3.2. Soil Composition and Classification

It is beyond doubt that soils of this area are mostly acidic. Perhaps the climatic factors are responsible to a large extent in this regard. The soil analysis of the different samples taken within the basin show that the pH range lies between 4.53 to 5.41. This is concerned with the samples collected from the two villages. However, as per data collected the upper limit of pH reaches 6.28<sup>9</sup> at Marngar.

As far as NPK ratio is concerned the soils are rated on a scale depending upon the presence of the three major elements.<sup>10</sup>

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8. Ibid., p. 97.

9. As per list available from Soil Testing Lab., Government of Meghalaya, Shillong (Table 5).

10. Soil Rating Chart - Table 6.

Table - 5: Soil Sample Analysis of Some Villages in Umran Basin

Name of Place	pH	Organic Carbon %	P <sub>2</sub> O <sub>5</sub> (Kg/Ha)	K <sub>2</sub> O (Kg/Ha)
Marngar	5.44	1.37	6.73	145.60
	5.61	0.57	3.14	44.80
	5.14	1.37	1.79	112.00
	5.43	0.63	3.14	145.60
	5.12	1.42	4.48	84.00
	5.19	1.27	4.48	67.20
	5.66	1.83	1.79	252.00
	5.43	1.33	3.14	364.00
	5.59	3.54	3.14	319.20
	6.28	0.06	4.48	593.60
	5.94	2.57	3.14	548.80
	5.45	1.66	3.14	330.40
Umsning	5.14	1.37	1.79	229.60
	5.10	2.17	4.48	268.80
	4.74	0.28	4.48	268.80
	5.41	0.68	21.07	212.80
	5.15	1.20	3.14	560.00
	4.58	1.14	15.25	414.40
	4.99	1.31	21.07	537.60
	5.06	1.83	8.07	537.60
	4.42	0.78	3.14	515.20
	4.44	1.20	1.79	100.80
	4.58	0.60	4.04	134.40
	4.42	2.40	3.14	123.20
	4.60	0.60	3.14	134.40
	5.04	0.28	Trace	319.20
	5.43	1.31	10.76	1064.00
5.40	2.97	5.83	2688.00	

Table - 5 (Contd.)

Name of Place	pH	Organic Carbon %	P <sub>2</sub> O <sub>5</sub> (Kg/Ha)	K <sub>2</sub> O (Kg/Ha)
Umran	5.35	0.69	4.04	403.20
	5.20	1.20	4.48	218.40
	5.25	0.57	4.48	392.00
	5.09	0.40	Trace	151.20
	5.50	0.28	4.04	537.60
	5.35	0.91	16.14	151.20
	5.58	2.50	8.97	268.80
	5.89	0.57	11.66	
	5.34	0.86	10.76	
	5.48	0.57	11.66	
	5.66	0.51	8.97	
	5.57	1.31	8.97	
	5.12	1.38	4.04	448.00
	5.30	1.14	4.04	100.80
	5.04	2.88	4.04	156.80
	4.92	1.74	6.73	173.60
	5.27	1.80	6.73	235.20
	5.13	1.38	8.07	190.40
	4.86	1.26	6.73	414.40
	5.13	0.96	3.14	358.40
4.93	2.40	5.83	403.20	
5.45	0.28	1.79	190.40	
5.35	0.68	1.79	268.80	
5.50	1.03	1.79	67.20	
4.93	1.20	9.86	268.80	

Table - 5 (Contd.)

Name of Place	pH	Organic Carbon %	P <sub>2</sub> O <sub>5</sub> Kg/Ha)	K <sub>2</sub> O (Kg/Ha)
Mawnong	4.75	1.62	4.04	89.60
	5.00	0.78	1.79	44.80
	4.80	1.80	1.79	224.00
	5.25	2.40	1.79	72.80
	5.30	1.20	3.14	117.60
	5.05	2.40	4.04	151.20
	5.15	2.82	0.90	95.20
	5.35	0.60	Trace	89.60
	5.15	2.10	0.90	100.80
	4.90	1.80	4.04	56.00
	4.95	1.20	4.04	44.80
	4.90	1.80	3.14	117.60
	Umtrew	4.69	1.88	5.83
6.20		0.74	Trace	
Umsaw Nongbri	5.28	0.48	14.35	448.00
	5.15	1.29	17.49	582.40
	5.00	2.40	4.48	526.60
	5.56	0.60	9.86	448.00
	5.58	0.57	4.04	286.00
	5.68	3.00	11.66	403.20
	5.90	1.20	4.48	436.80
	4.95	1.62	40.36	403.20
	5.05	0.03	8.07	436.80
	5.09	0.60	4.48	548.80
	5.77	0.90	11.35	520.80
	5.00	1.20	3.14	352.00
	5.60	1.20	3.14	112.00
	5.32	1.50	4.04	520.80
	5.32	1.20	0.90	117.60
4.70	0.30	0.90	548.80	
Saiden	5.25	1.26	3.14	100.80

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

Table - 6: Soil Rating Chart

	Low	Medium	High
Organic Carbon (Kg/Ha)	0.5	0.5 - 0.75%	0.75%
P <sub>2</sub> O <sub>5</sub> (Kg/Ha)	28.03	28.03 - 56.05	56.05
K <sub>2</sub> O (Kg/Ha)	134.5	134.5 - 336.3	336.3
T.S.S. (mmhos)	Critical	Non-critical	

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

Most of the soils have adequate nitrogen as per the soil rating chart. On the other hand, they are mostly deficient in potassium and phosphorus, some of them reaching critical levels.

Soils here are mostly hill soils with the exception of the deposited silt in the river valleys. The colour range varies from grey (lightest) to brown which is the darkest. The samples collected reveal colours Light Brownish Grey as the lightest and brown the darkest. The texture is sandy and the structure, very coarse with angular or sub-angular blocking.

The overall results of the samples taken from the two villages portrays a critical position of P<sub>2</sub>O<sub>5</sub> content in the soil with an average of 12.4 kg/ha. The forested and uncultivated hill slopes have less symptoms of this deficiency

than those which are cultivated or recently cultivated. The chemical analysis reveals that in the lowlying areas where cultivation is being carried on for a longer period the organic carbon content, that is the nitrogen equivalent has fallen down to critically low amounts.

The soils of the two villages could be classed under sandy soils with pale colours near to the river bed and higher up in the hill top the tinge is darker as shown by analysis reports in Table 7.

**Table - 7(a): Chemical Analysis of Soil Samples (Saiden and Dulongnar)**

Sample No.	pH	Organic Carbon (%)	P <sub>2</sub> O <sub>5</sub> (Kg/Ha)	K <sub>2</sub> O (Kg/Ha)	N <sub>2</sub> %
1.	5.06	0.17	4.04	128.80	0.015
2.	5.17	0.97	6.73	487.20	0.084
3.	5.20	Trace	42.15	50.40	Trace
4.	5.41	0.86	15.25	106.40	0.074

**Table - 7(b): Physical Analysis of Soil Samples (Saiden and Dulongnar)**

Sample No.	Colour	Texture	Structure
1.	10 YR 6/3 (Pale/Brown)	Sandy	Very coarse sub-angular blocks
2.	10 YR 6/2 (Light Brownish grey)	Sandy	Very coarse, granular blocking
3.	2.5 YR 3/2 (Very Dark Greyish Brown)	Sandy	Coarse, sub-angular blocking
4.	7.5 YR 5/4 (Brown)	Sandy	Very coarse, sub-angular blocking

NATURAL  
VEGETATION  
(KHASHI HILLS)

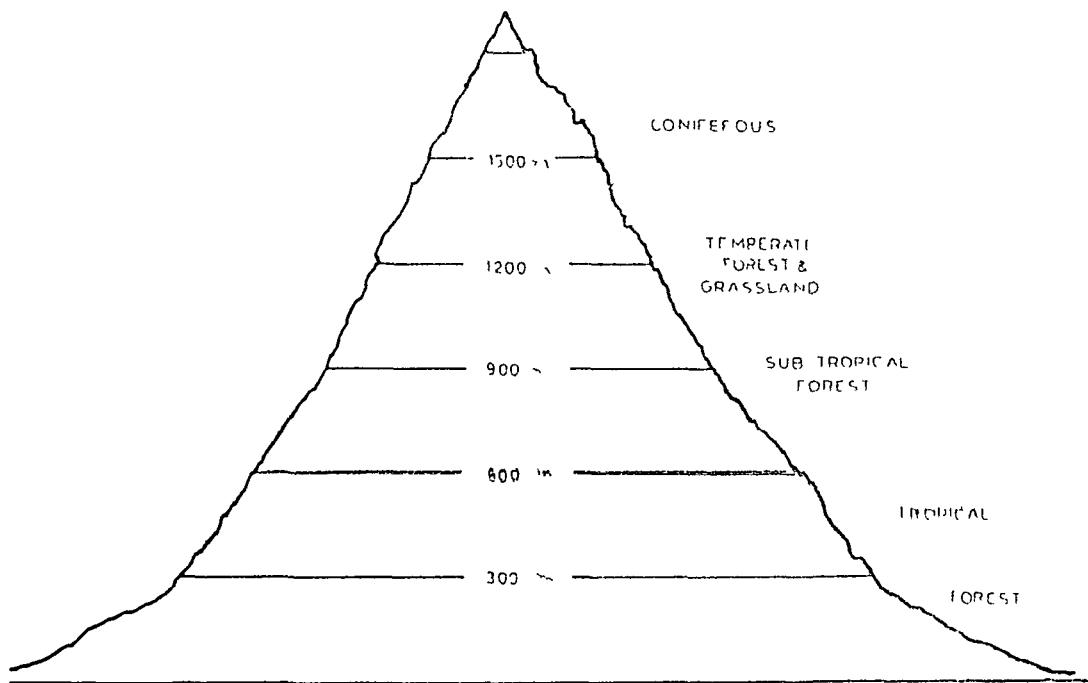


Fig. 5

### 3.3. Vegetation

The basin is very rich in its flora. The study that was conducted sometimes in the 60's have yielded a spectacular result. The flowering plants alone have been found to be of 1040 species belonging to 158 families.<sup>11</sup> Besides these, there are other plants that grow wild in the area. Trees of evergreen, semi-evergreen as well as coniferous are found in this basin. Evergreen and semi-evergreen are found mostly around the 900 ft (274.32 m) to 2900 ft (883.92 m) elevation. Above this, comes the transition zone of the mixed type with that of the conifers. It is at this level that *Pinus insularis* Eich., makes its first appearance. (Fig. 5).

There are a lot of tall tree species in the basin and these form the canopy. There are others which make a distinction from the rest of the taller trees by their stature and branching.

The forest does not display prominently the storeyed nature but it is evident that the tall trees form the canopy and so the highest layer. As there are no medium or short trees, the intermediate zone is absent. Rather the tall shrubs take the place of this layer. The trees are often entwined with lianas and a lot of undergrowths. Orchids, ferns and

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11. Rao, A.S. (1968). "The Vegetation of the Khasi & Jaintia Hills", Proc. of Pre-Cong. Symp. 21st IGU (India) - 1968, Department of Geography, Gauhati University, Gauhati.

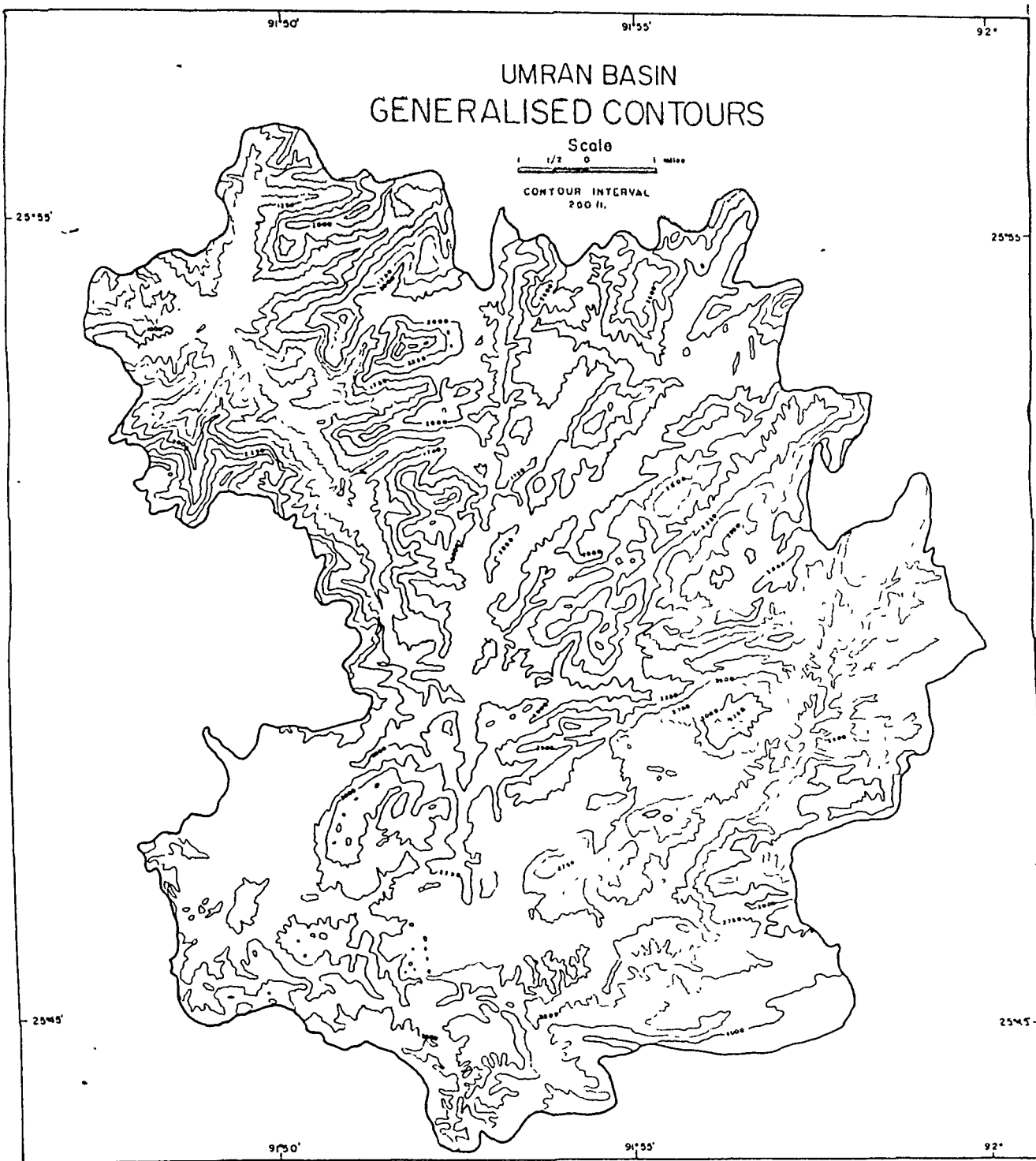


Fig. 6

other epiphytic plants are supported by the larger trees. The shrubs are dense and impenetrable, creating damp conditions beneath. This leads to the growth of different varieties of parasitic and saprophytic plants which includes a large varieties of mushrooms and wood fungi.<sup>12</sup>

The present situation is completely different. The description given by Rao has been a great help to the present research but the forest area has reduced considerably. The forest cover has been so much eroded that the hills are now almost barren and instead filled with bamboo grooves excepting for the areas reserved under the government forests. The large and tall trees that were so abundant then have been cut and instead there is a trend of afforestation by the people themselves. People have started planting trees and specially those which can be easily domesticated. There is also an increasing need to preserve the rest that is growing under nature's care as the system is dwindling fast.

#### **3.4. Geomorphology of the Basin and the Role of Geomorphic Factors in Changing the Landscape**

The basin as it is seen physically is almost flat except for certain areas at different points. Considering the bench marks along the main road, a drop of 805 ft (845 m)

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12. Ibid., pp. 98-99. There is a vivid account of the vegetational cover of Khasi & Jaintia Hills in this article, though very brief. However, this is an account of the conditions 21 years back and the situation has now changed.



Plate 3(c): Eroded gneissic bed just above the drop.



Plate 3(d): The falls - commonly known as Margaret falls.



Plate 3(a): One of the 1st order streams originating from Umsning.



Plate 3(b): Umrans river moving over an almost flat area before reaching the drop.

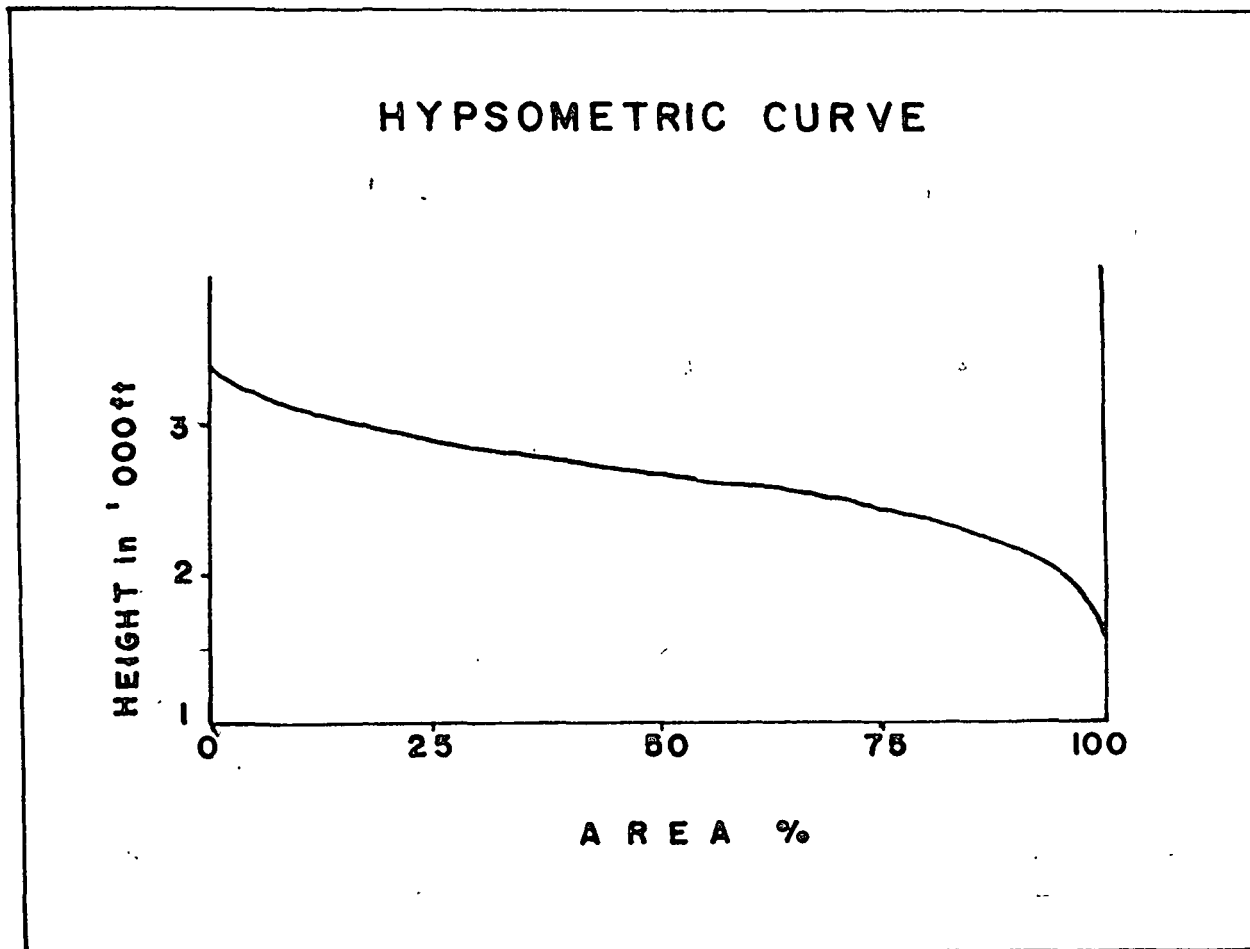


Fig. 7

7(c): Area-Height Relationship

<u>Height (in ft.)</u>	<u>Area (Sq. Miles)</u>
More than 3000	21
2500 - 3000	58
2000 - 2500	31
Less than 2000	5

is seen from the 45th mile (72.4 km) to the 29th mile (46.7 km). The drop is very prominent along the 10 miles (16.1 km) from Umsning to Umdihar 35th mile (56.3 km) where the difference of the bench marks is 681.81 ft (207.8 m). On the other hand, the drop from Umdihar to Nongpoh at the 29th mile (46.7 km) is just 123.84 ft (37.7 m).<sup>13</sup> Taking into account the drop from Umsning to Umran (42nd mile) it is seen that the slope gradient of the road is of the ratio of 99.22 ft/mile (18.79 m/km), that from Umran to Umdihar is 54.88 ft/mile (10.4 m/km) and from Umdihar to Nongpoh is 20.64 ft/mile (3.9 m/km). It is very interesting to note that the gradient of the road synchronises with the zones of contact of the different rock strata, one of which is at Nayabungalow in between the 44th (70.8 km) and 45th mile (72.4 km).<sup>14</sup> The road from here onwards runs on the gneissic structure till it reaches Umdihar where there is an exposition of gneissic enclave within porphyritic granites.

On the other hand, the river shows a slightly different picture. The gradient of the profile is steep at two points. The initial stages indicates a drop of 600 ft (182.9 m) in 1.5 miles (2.4 km) of its course. This would mean that

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13. These figures are according to the information available in toposheets 78-0/13 and 78 0/14. Distances are in miles and are later converted by the author. They are measured from Gauhati and are likely to be different in the latest maps.

14. As per verification from the toposheet No. 78 0/14.



Plate 4: River Umrn meandering over flood plains,  
attempting to changes its course.

there is a fall at the initial stages. The second drop is observed at around the 12th mile (19.3 km) of the course where there is a sudden break of the gentle slope of the profile. Here there is a sharp fall of 250 ft (76.2 m) in a mile distance. From here down the course the gradient remains steep with a drop of 125 ft per mile (23.7 m/km) till the 18th mile (29th km) distance from the origin. Then the gradient start reducing till it meets the Umtrew river.<sup>15</sup>

The drops occurring indicate that there are resistant rocks preventing rapid erosion. It was found that at the heads the gradients of most streams are steep.<sup>16</sup> This simply points out that the steep gradient at the head of the river is because of its origin from the higher elevation leading to a higher degree of erosion.<sup>17</sup> It is to be noted that the nature of the bedrock has a great role to play in this respect. This means that the gneissic and granitic masses have their own differences though their composition is similar. Granites and gneisses are believed to be eroded in the same manner because of their composition.<sup>18</sup> However, it has been noted that permeability is slightly different. The granitic mass seems to be more permeable than the gneissic complex.

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15. Ibid.

16. Morisawa, M. (1985). Rivers, Geomorphological Texts, Longman Group Limited, Hongkong, p. 87.

17. Sparks, B.W. (1960). Geomorphology, Longman Group Ltd., Hongkong, 2nd Ed., 1972, p. 47.

18. Morisawa, M. Op.cit., p. 138.

# UMRAN BASIN SETTLEMENT PATTERN

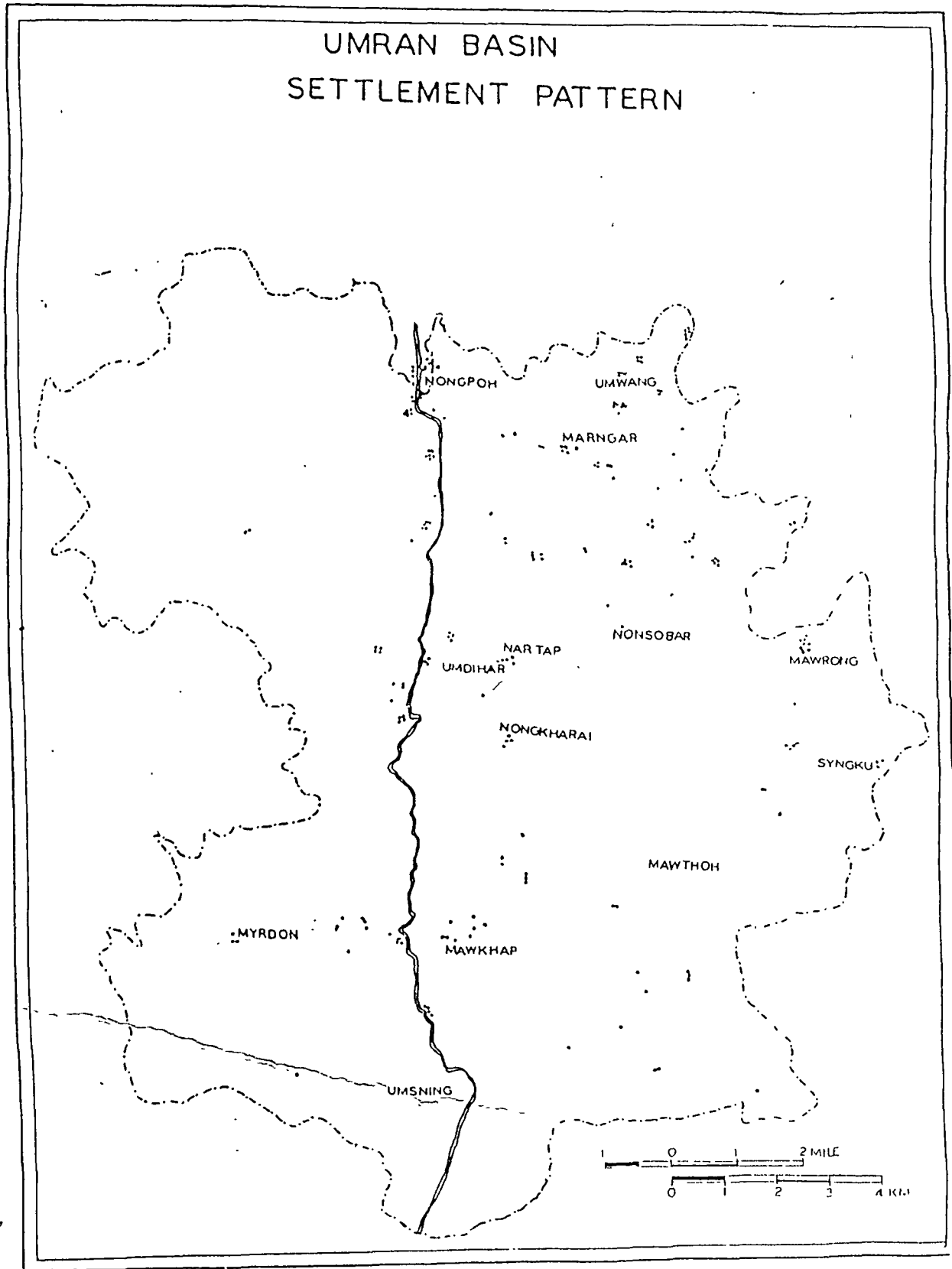


Fig. 8

This is reflected in the drainage density analysis, where the average density over the granitic surface is below 6 mile/sq.mile ( $3.72 \text{ km/km}^2$ ). On the other hand, the density over the gneissic structure ranges between 4 to 9 miles/sq. mile ( $2.5$  to  $5.6 \text{ km/km}^2$ ). In fact, the rocks in this area are of resistant type as such high surface permeability is likely to occur, hence a lower drainage density. The drops might also be due to the presence of the resistant rocks developing into knickpoints.<sup>19</sup>

It is evident from the hypsometric curve (Fig. 8) that the basin has the maximum area with altitude from 2500 - 3000 ft above sea level while the areas below 2000 ft are minimal. The basin has a general slope from the south to the north-west. The slope along the road is of a series of terraces as after each drop there is almost a plain condition. It is also interesting to be noted that in the course of downflow, pool and ripple sequence is maintained. The river flows over the exposed gneissic material for certain kilometres at different places, at such places large boulders are common on the river bed. The lower part of the basin after the falls could be indicative of the active stage of the river where it is still seeking for its stability. At such dynamic metastable equilibrium stage, it is expected

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19. Sparks, B.W. Op.cit., p. 180.

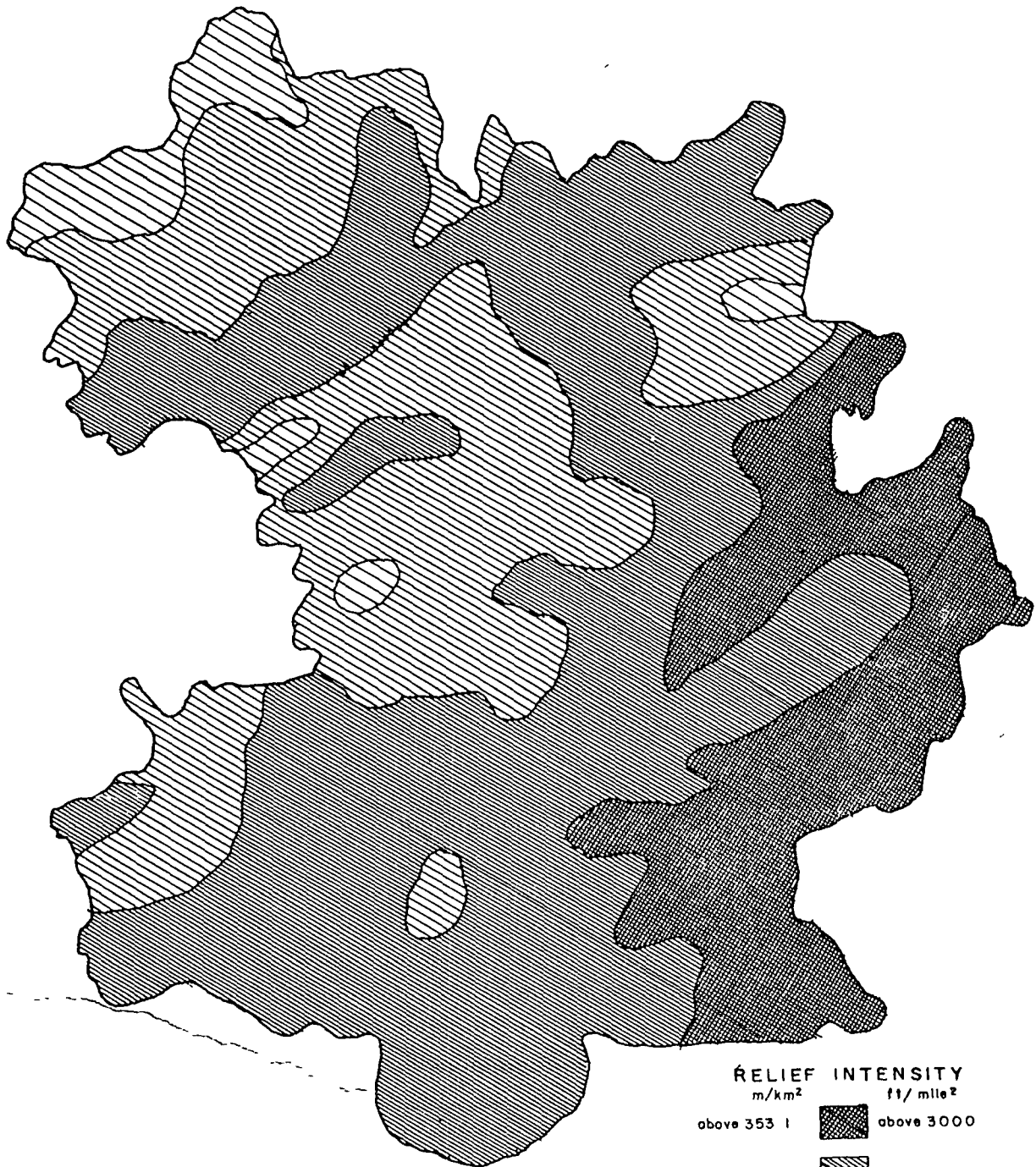


Plate 5(a): Settlements Over Areas of Moderate Slopes.



Plate 5(b): Settlements of Khasi Migrants.

UMRAN BASIN  
ABSOLUTE RELIEF



RELIEF INTENSITY	
m/km <sup>2</sup>	ft/mile <sup>2</sup>
above 353 1	above 3000
294 2 - 353 1	2500 - 3000
235 4 - 294 2	2000 - 2500
below 235 4	below 2000

SCALE  
1 1/2 0 1 mile

Fig. 9

that geomorphic thresholds and complex responses play significantly in the establishment of stream stability.<sup>20</sup>

### 3.5. Slope and Its Significance

Absolute relief map (Fig. 9) confirms the general slope of the basin from south-east to north-west. However, the average slope (Fig. 10) defines this differently. The areas of lower altitude which should generally be less steep, are steeper. This is due mainly to the break in the river profile indicating a possible rejuvenation of the upper part of the river's course. It is because of this reason that the river has an opening in the north-west. It is however very peculiar that the river courses are not moving in the shortest possible route to the outlet. The Umran river itself takes a semi-circular route to reach the outlet. The main factor behind this is lithology and this will be discussed later.

The areas of steeper slope angles (above 20°) cover an area of about 27 sq. miles (70 sq.km). These have very less settlements and are thus forested areas. The rest of the area with slope angles ranging from 10.8° to 19.9° is where the majority of the population resides. In fact, there is a large settlement that has been abandoned in the lower portions of the basin. (Fig. 8).

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20. Schumm, S.A. (1975). "Episodic Erosion: A Modification of the Geomorphic Cycle", Theories of Landform Development, George Allen & Unwin, London, 1981, p. 78.

UMRAN BASIN  
AVERAGE SLOPE

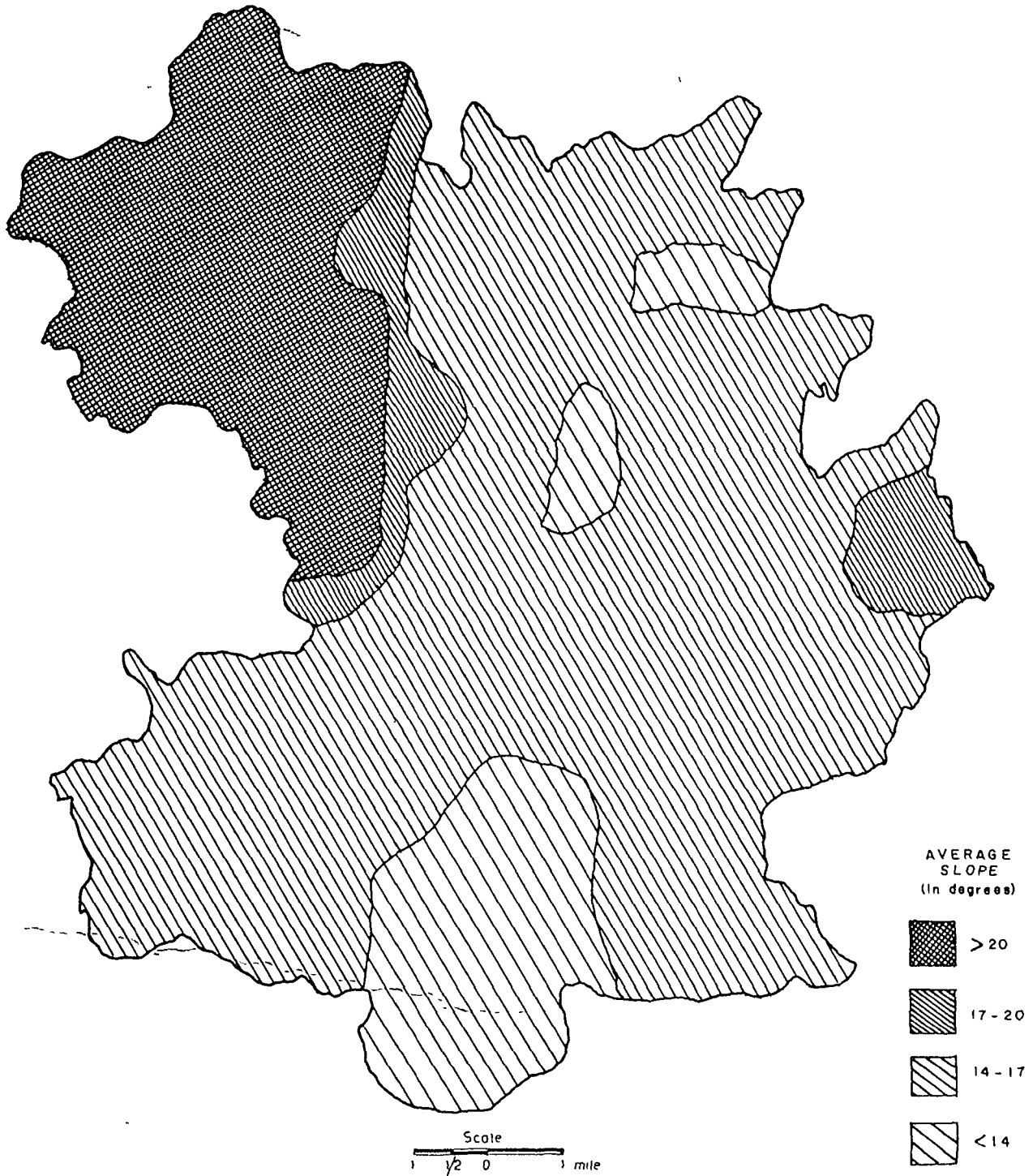


Fig. 10



Plate 6(b): Narrow winding roads  
are causing frequent  
mishaps.



Plate 6(a): Roadside settlements cause a lot of disturbance to traffic movement and these are mostly food stalls, which attract a lot of customers, specially truck drivers. This results to parking on the roadside causing great inconvenience to movement of traffic.

It is also very interesting to note that the roads have been built mostly in areas where the slope angles are less. The Shillong-Gauhati Road has in a way been constructed over areas with slope angles lesser than  $18^{\circ}$  in the basin.

Land use is also greatly affected by the slope angles. In areas of steeper slope angles people usually cultivate the slopes either shifting or in cases where the migrated population settles, there is a permanent plantation. In areas with slope angles of  $17^{\circ}$  and less there is more of settled agriculture as more lowlying lands are available. Thus, from Umsning downwards till the 43rd mile (70th km) the area is almost plain. It is here that a lot of agricultural lands are found. Again such areas are found at an elevation of about 2100 ft (640 m) and 1750 ft (533 m) above sea level. Besides these that could be noticed by the road side, a lot of other areas too have been used for lowland cultivation wherever possible.

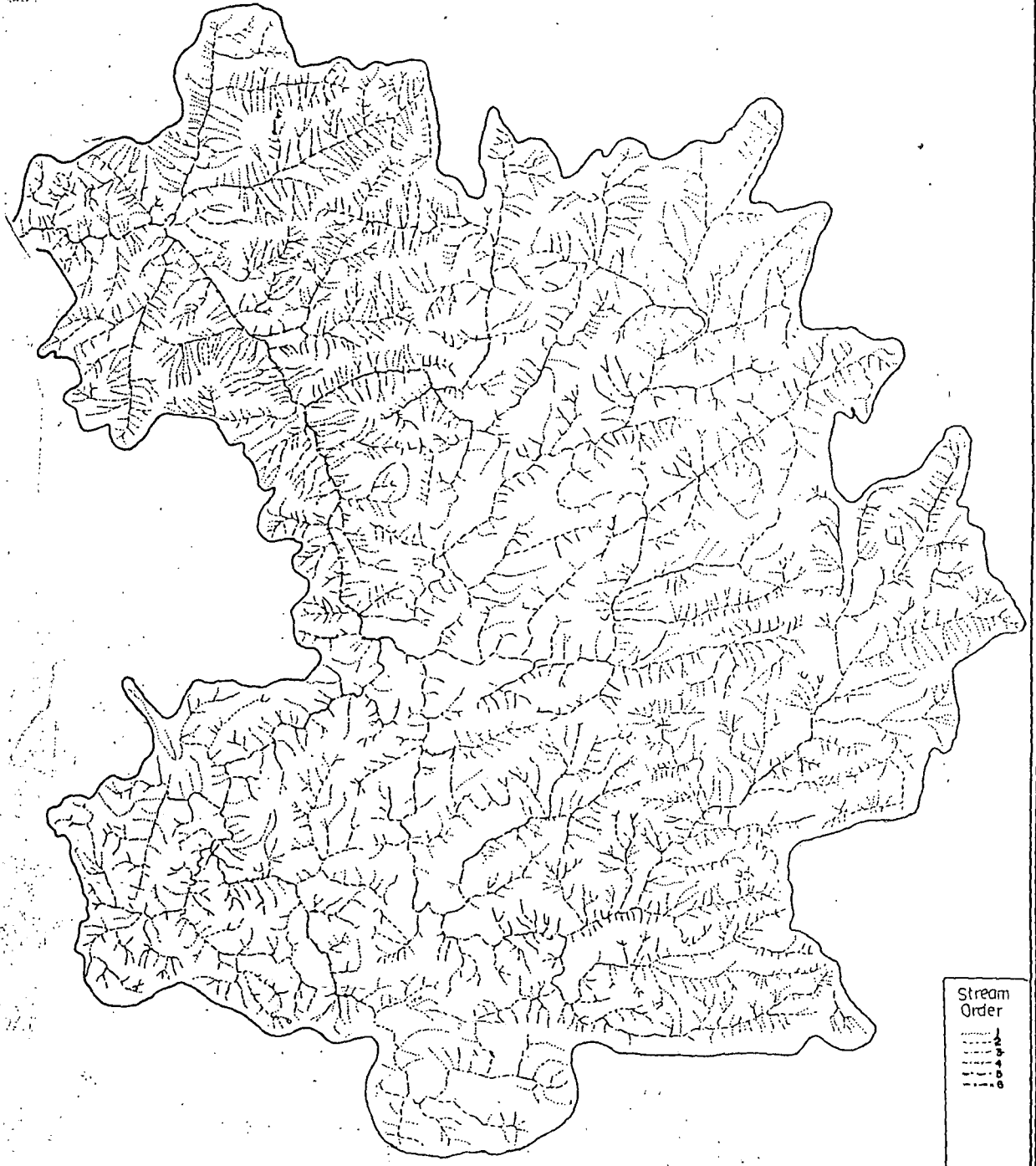
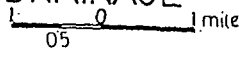
It is therefore evident that there is a significant role played by slope on the different aspects specially the land use.

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**CHAPTER - IV**

**FLUVIAL MORPHOLOGY AND GEOMORPHIC  
CLASSIFICATION OF LANDFORMS**

UMRAN BASIN  
DRAINAGE



Stream  
Order

- 1
- 2
- 3
- 4
- 5
- 6

Fig. 11

## FLUVIAL MORPHOLOGY AND GEOMORPHIC CLASSIFICATION OF LANDFORMS

### 4.0. Drainage System

The characteristics of the river system are moulded and controlled by the different factors which are either independent or dependent. Of the independent factors, the climatic and geologic variables are important. On the other hand, the dependent variables interact with each other at their own capacities coupled with the major independent variables to produce the net effect - the drainage system.

River systems are very much influenced by relief, structure, soil, climate and vegetation. The basin's underlying structure is composed of hard gneissic material and the granitic mass. In such cases, the river system as a whole would also be following the easier paths to move along. In the basin area it would be expected that the streams will take the most favourable course not of its own choice but guided by the winding valleys. The river has narrow channels along its course except while it moves over the flood plains where it meanders and have comparatively wider channels.

The system is not a large one. The total area of the basin is just 115 sq. miles (298.1 sq. km) approximately. The area is in fact a dissected one, with streams running in different directions adapting to the topographic conditions and lineaments to a large extent. The river originates 22.5

UMRAN BASIN  
SUPER-IMPOSITION OF DRAINAGE ON GEOLOGY

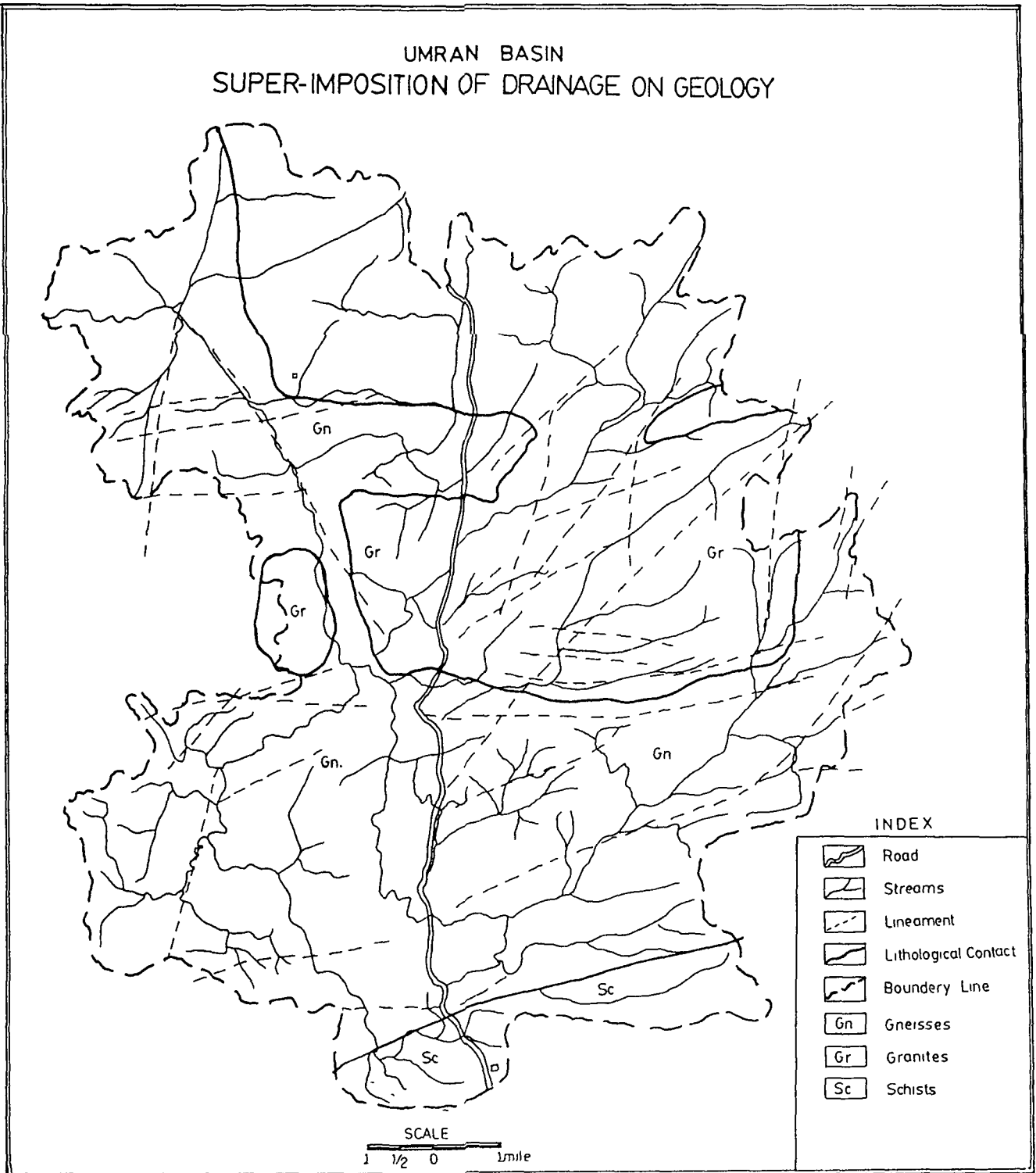


Fig. 12

(36.2 km) away from the point where it meets the Umtrew river. From the place of its origin the river flows south-east wards and near Umran village it swings north-west and continues along this direction till it meets the Umtrew river. At this point it takes a sharp turn to the west where it travels for 2 miles (3.2 km) to merge with the Umtrew river.

In the basin there are a large number of lineaments. The major drainage lines follow these lineaments which run for long distances in different directions.<sup>1</sup> Comparing with the geological map (Fig. 12 ), the major drainage lines are controlled by the lineaments. It has been specially pointed out that the lineaments in the gneissic terrain probably represent the master joints.<sup>2</sup>

The system is very much controlled by the climatic conditions occurring in this area. Throughout the winters and Pre-Monsoon periods there is very less rain amounting to about 14 cm and less. During this period the soil becomes drier than in other parts of the year. Thus when the first rains come the soil absorbs a large amount of rain water resulting to a lesser surface runoff (Kirkby 1969). It is to be noted that rainfall does not come in heavy downpours

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1. Verma, P.P. & Rajendran, N. (1985). "A Report on the Photo-geological Mapping in the area around Nongkhlaw and South of Nongpoh, East & West Khasi Hills District, Meghalaya", GSI Unpublished Reports, Shillong, p. 4.
  2. Ibid.



Plate 7(a): Third order stream in spate after a heavy shower.



Plate 7(b): Excessive silting and sand deposits over flood plains.



Plate 7(c): Excessive silting and sand deposits over flood plains.

at the beginning. There are light showers with an average precipitation of about 1-2 cm a day. In the later months when the Monsoon operates fully there are heavy downpours lasting for 6-7 days at a stretch, with a daily average of 7-8 cm (Table 3). Thus, when there are such heavy downpours the runoff is too large for the channel to contain it. This results into floods along certain parts of the course and all tributaries of the Umrans river as well as the Umrans itself. The Umrans river in its upper courses usually floods even before being joined by its tributaries. On the other hand, the tributaries also face the same problem before they meet with the main river. It has been observed that the different tributaries with catchments varying in size from 6 sq. miles (15.5 km<sup>2</sup>) to 15 sq. miles (38.8 km<sup>2</sup>) are flooded during summer or rather have a very high water mark during the rainy season. The main reason for this is because of the narrow channels that have a lesser volume of intake than what is discharged.

#### **4.1. Evolution of Drainage**

The very nature of the rock structure on which the river system flows directly gives the idea that the area have had a lot of disturbances in the geological past. In spite of such occurrences the rivers have been doing their own work.



Plate 8(a): Water level in the dry months.



Plate 8(b): Pool riffle sequences displayed.

The gneissic structure which is an earlier formation would also have rivers of an older age. On the other hand, the granitic mass which is intrusive into the gneiss<sup>3</sup> must have been eroded to a very large extent, by comparatively new rivers.

In the case of the northern parts of the Meghalaya plateau there is no doubt that the general slope is towards the north. Evolution of drainage is not a question of where it flows but the starting of the initial drainage. From the drainage map it is seen that the catchment area of the Umrang river is not very large. Therefore, the general tendency of the streams to flow is along the slope which always tends to the point of exit.

It is always thought that the evolution of drainage depends much on the bedrock and climate. Permeability of the bedrock is important in determining the frequency of streams in an area. The angle of dip of the bedrocks and their formation plays an important role in the preservation of water in them. The presence of impermeable rocks at certain levels and not necessarily just below the surface would account for the development of springs. These act as aquifers and the ground water potential thus created serve as sources of the streams that occur here.

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3. Bhattacharjee, C.C. (1968). "Structure & Petrology of the Shillong Plateau", Proc. of Pre-Cong. Symp., IGU, Gauhati, p. 18.

UMRAN BASIN  
DRAINAGE PATTERNS

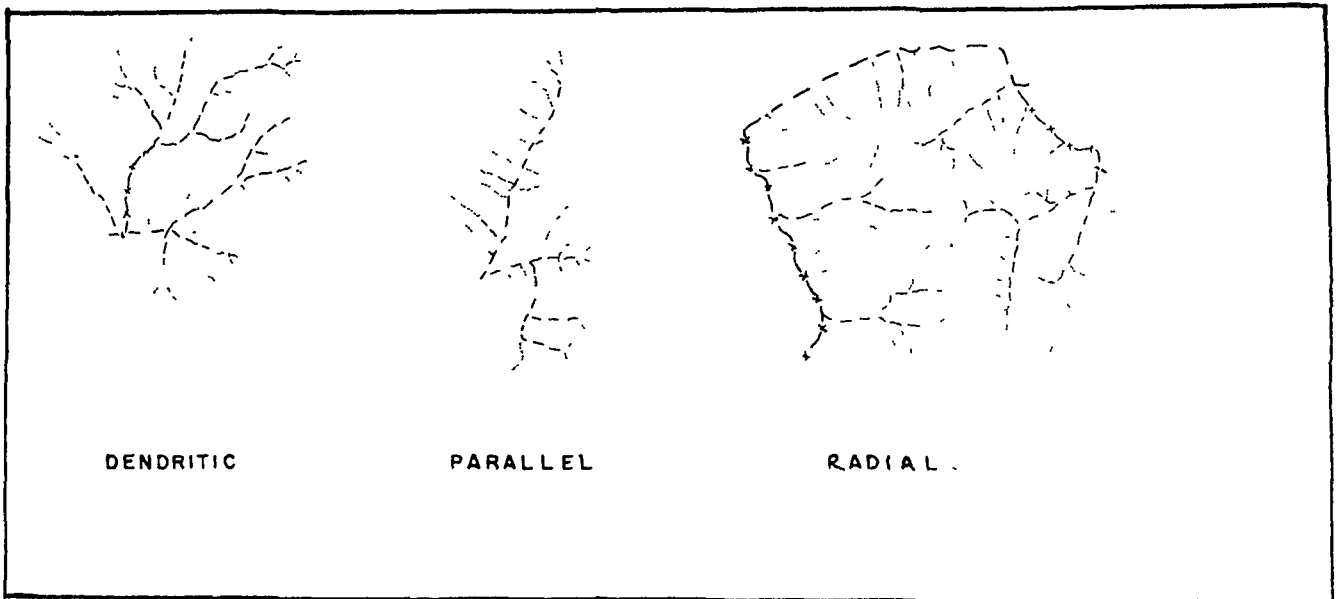


Fig. 13

#### 4.2. Drainage Pattern

The overall pattern of drainage in the basin is dendritic, parallel and radial. However, it should be noted that the rivers are following the lineaments to a large extent. At the headwaters, a parallel type is commonly observed, while dendritic, pinnate and radial are less observed (Fig.12). It is a result of the conformation of the rivers to the structure of rocks as they carve their way through the dissected topography.

As far as the dendritic pattern is concerned, the main factor leading to its development is the nature of slope as well as the existing landscape. Structural controls are less evident and the streams follow a random orientation. This pattern is observed where the lineaments are minimum, that is in the northern portions of the basin.

The almost parallel pattern formed at the headwaters may be explained by the initial stream development conforming to the lineaments. This indicates the structural dependence of a greater degree. This more prevalent in the basin area as the rock formation is complex.

Radial pattern is observed to the north-west of Umdihar. This reflects the dome-like formation of rocks. It is likely because of the intruding granites that underlie in this area. With the passage of time the rocks over this area

UMRAN BASIN  
DRAINAGE DENSITY

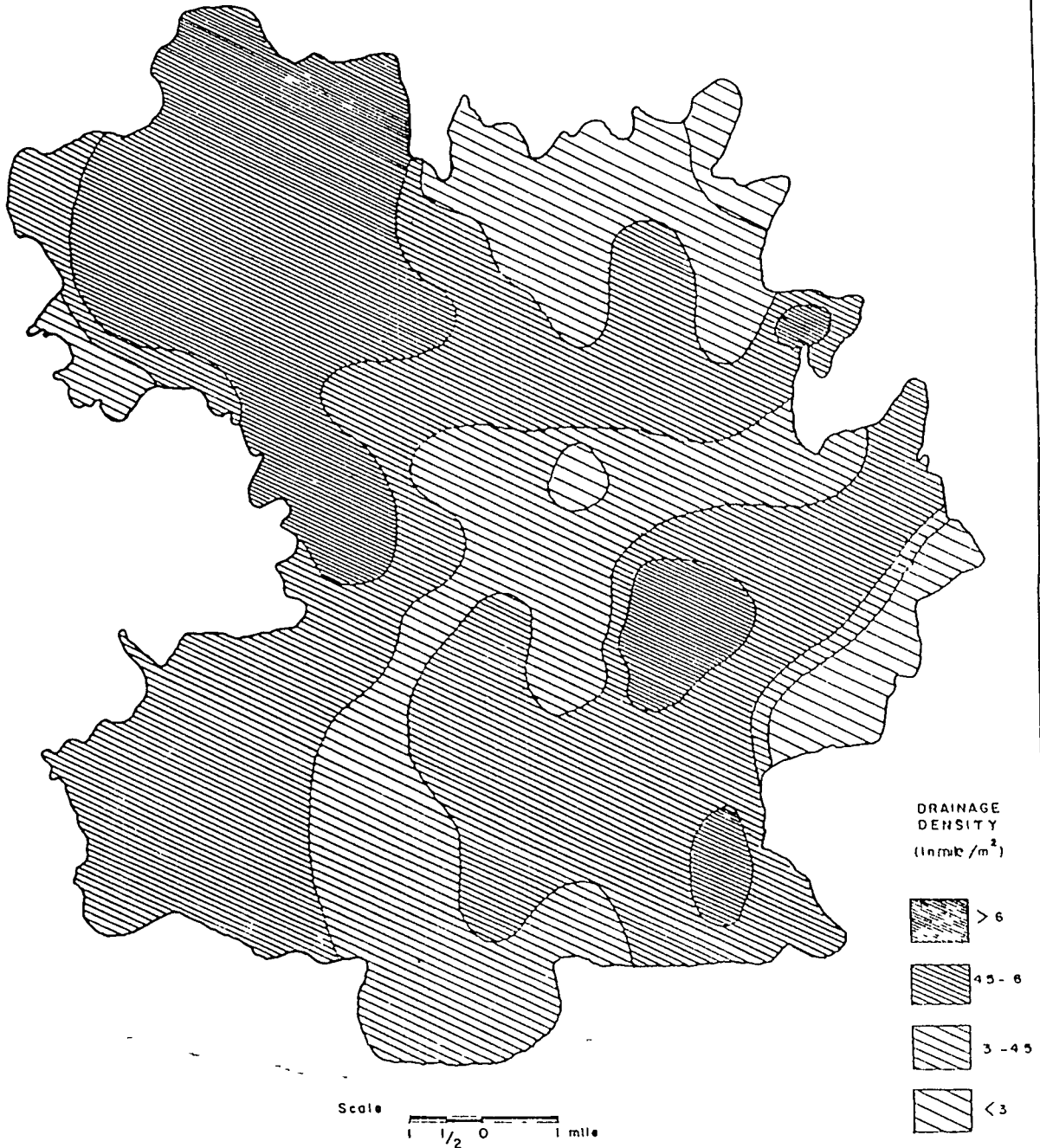


Fig. 14

have been eroded and the streams are in the process of adjusting with the underlying strata.<sup>4</sup>

#### 4.3. Drainage Analysis

The overall picture of drainage network in the basin is coarse with only some portions near the mouth where it is medium.<sup>5</sup> The drainage density analysis is on the average ranging from 3 to 6 m/m<sup>2</sup> (1.87-3.74 km/km<sup>2</sup>). The peripheral areas having very coarse drainage is because of the locational factor. This is in fact relative to the slope of the area, as with steeper slopes, there is an increase in the drainage net.<sup>6</sup> (Fig. 14).

On the other hand, lithologic constraints do play a significant role in determining the drainage network in any area. It may be mentioned here that the gneissic structure occurring over this area offers resistance and as such results to low permeability. Owing to the lithologic factors, there is a variation in the drainage density of the areas flowing over the granitic mass and those flowing over the gneissic structure. The granites were later intrusions into the gneiss

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4. Morisawa, M. (1985). Rivers, Geomorphology Text Series - 7, Longmans Group, New York, p. 175.

5. Ibid., p. 140.

6. Dury, G.H. (1976). The Face of the Earth, Penguin Books, U.K., p. 84.

and as such they are younger than the base rocks. Even if the base rocks are seen to be less permeable the younger ones on top might never be so. This in fact is the situation here where the granites are more permeable than the gneisses, thus portrayed in the lower density of streams over former structures.

The long profile of the river (Fig.15) from the base clearly depicts the possibility of rejuvenation in the basin area. At an elevation of 2000 ft (609.6 m) above sea level a very clear drop is seen. In comparison with the upper portions of the course, the gradient of the river is more steep in the lower course.

The graph of stream numbers and stream order (Fig. 16) shows a gradual slope, almost  $45^\circ$  angle. This shows that there is some correlation between the two variables. On the other hand, there is an unsymmetrical arrangement of the stream segments in the basin. This is revealed in the bifurcation ratio where the 2nd order and 5th order streams outnumber their corresponding higher order streams. In the first case the main reason why this had happened, might be because of the short lengths of the 2nd order streams as they occur in the peripheral areas mostly. Due to this they soon meet other 2nd order streams after travelling short distances only. In the second case, the difference is not a large one.

LONG PROFILE OF UMRAN

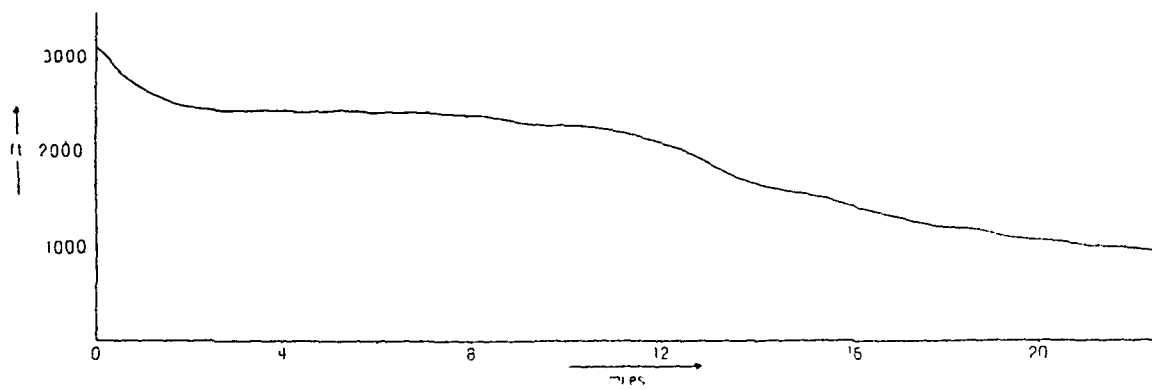


Fig. 15

Such instances might be possible when the channel has to manoeuvre through beds of different resistance. However, on the average the bifurcation ratio of the basin is well within the required norms<sup>7</sup> amounting to 4.89.

The streams have a large amount of suspended load and as a result the water is always turbid throughout the year. However, it should be mentioned that it is comparatively less during the winter season. The load which it transports is deposited at various places along the course. One such place is just before reaching Umran village at an elevation of about 2200 ft (670.6 m) above sea level. After this point the gradient starts dropping at a faster rate leading to the formation of pools and riffles. At about 2000 ft (609.6 m) above sea level, there is a sharp fall which forms a waterfall. Downwards from here the formation of pools and riffles is very common indicating the role of the two factors - Complex response and geomorphic thresholds, operating in the system. Thus after the point of possible rejuvenation the valley floor of a stepped nature is formed representing a 'dynamic metastable equilibrium' stage.<sup>8</sup>

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7. Clowes, A. & Comfort, P. (1982). Process and Landform - Conceptual Frameworks in Geography, Oliver Boyd, Edinburgh, UK, 1983, p. 85.
  8. Schumm, S.A. (1975). "Episodic Erosion: A Modification of the Geomorphic Cycle", Theories of Landform Development, George Allen & Unwin, U.K. pp. 75-76.

# GRAPHS

STREAM ORDER Vrs STREAM NUMBER  
& STREAM LENGTH

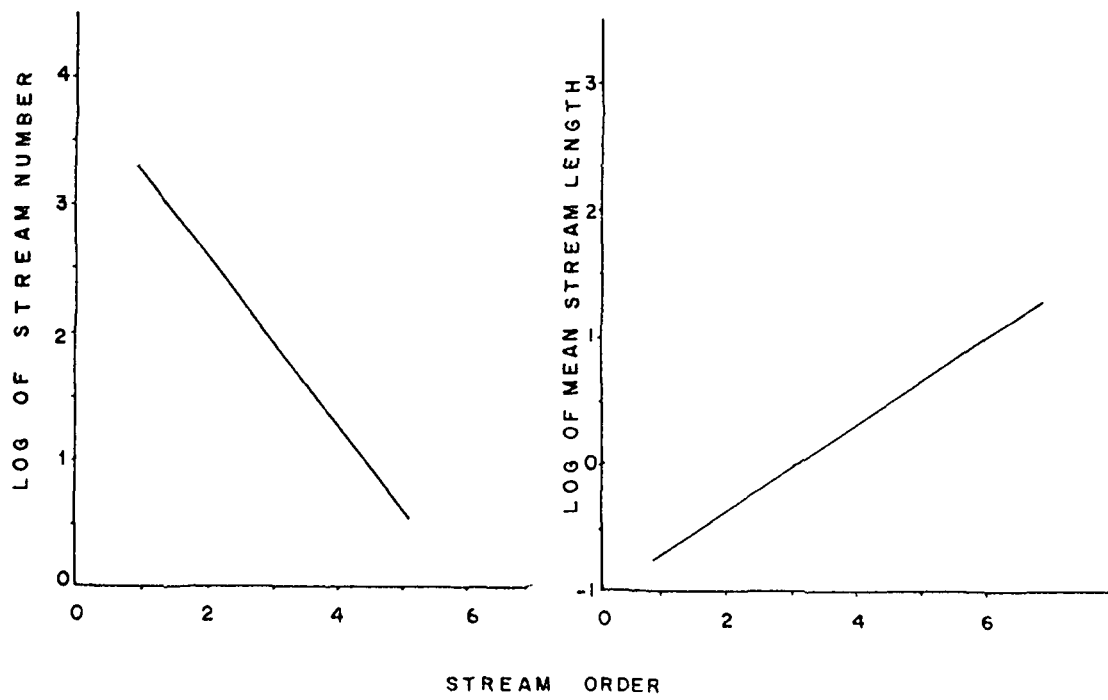


Fig. 16

Referring to the two villages - Saiden and Dulongnar, it is seen that they are drained by the tributaries to the river Umrans. From the toposheet the former village seems to be well drained than the latter. From spot surveys that have been conducted the latter had minimum problems as regards floods. On the other hand, the former village faces large problems due to floods. The cultivable flat lands near the streams normally get flooded after a consistent rain lasting about 6 hours and more. Erosion is always associated with floods and in the process, lateral erosion over flatter low-lands takes place as well as vertical erosion in areas of steeper gradients occur. In the south western boundary of Saiden village the Umrans had cut through the granitic bed and created two separate entities of granitic mass, as depicted in the geological map.

#### 4.4. Geomorphic Classification of Landforms

The classification of landforms is an important aspect of geomorphic study. Without the clear understanding of the landforms in the basin area it would be really difficult to evaluate the potentials of land in the basin. This classification is done purposely for the landuse potentials of the basin. Therefore, the best way towards the classification of a geomorphic unit is the identification of landscape into separate natural units based on origin, process and form.<sup>9</sup>

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9. Panda, P.C. (1983). "Geomorphology and Agricultural Land Use Capability Classification in Mawsynram Region, Meghalaya", Ph.D. Thesis, Unpublished, p. 163.

It is therefore essential that fundamental and permanent characters of landscape be taken as a criteria for the present classification. The criteria taken must be balanced and guided by the need for a simple model. Hence, a minimum number of classes should be created while maintaining their individual homogeneity. Each class shall therefore be completely distinct from another and must represent the existing systems.

The classification has two different approaches.<sup>10</sup> 'Physiographic' or 'Landscape' method considers the terrain and classifies it into natural units. The properties of these units are measured quantitatively and related to land uses. Secondly, the 'Parametric Method' tries to make precise measurements and is more applicable in areas with few land uses. This is in fact most suited for the analysis of small areas. These two methods have their own differences but they are not to be taken as conflicting each other in cases where there are limited materials available.

In land classification there are three main aspects. These are (a) Physical, (b) Economic, and (c) Social.<sup>11</sup> The most important of these factors is the physical which is most prominent in nature, for which this work relies on. Socio-economic considerations are however important in this

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10. Ibid., pp. 164-65.

11. De, N.K. (1985). "Landform Mapping in India", Facets of Geomorphology, Thinker's Library, Allahabad, p. 102.

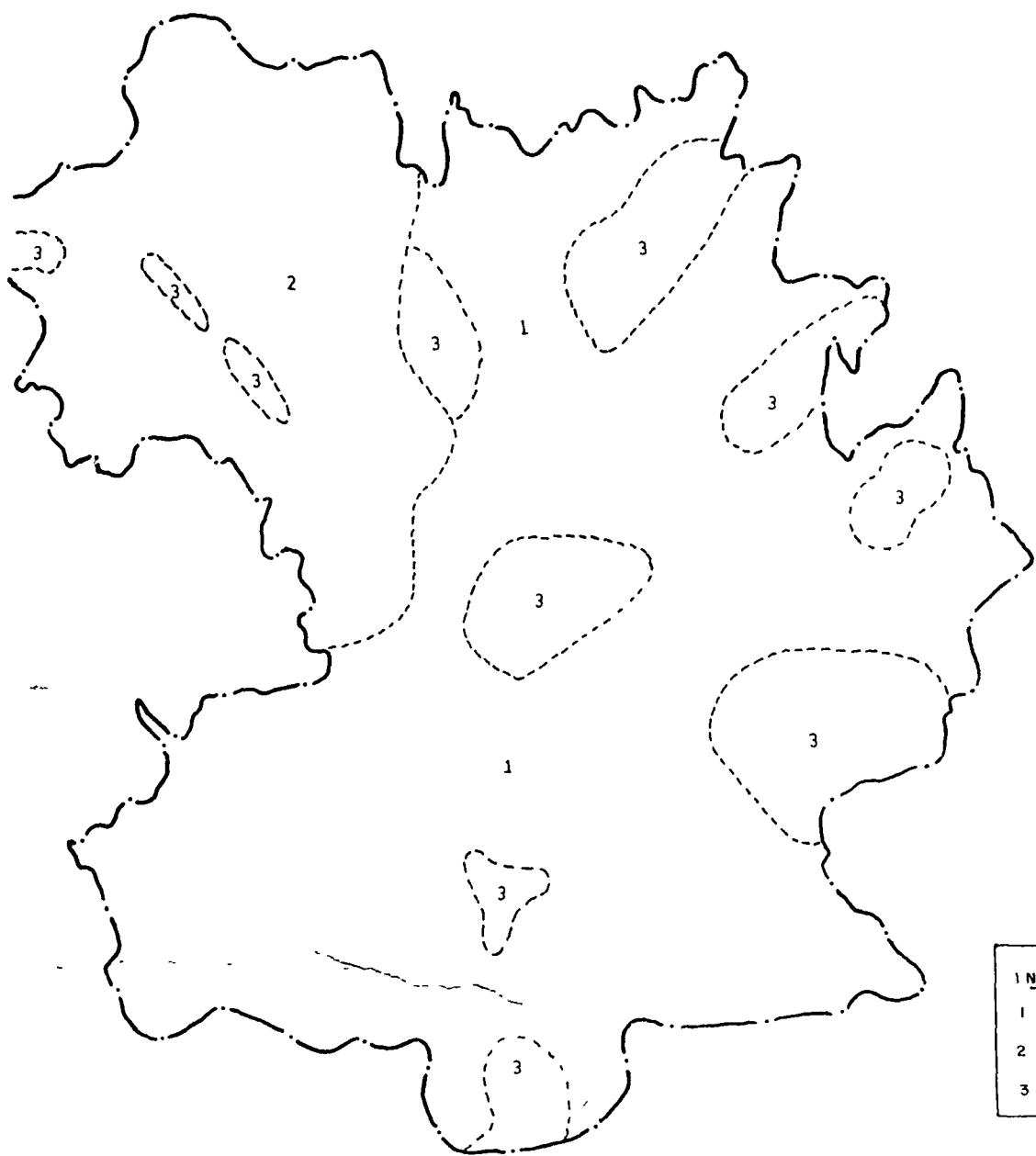


Plate 9(a): Landforms - Low Hills surrounding  
valleys and flood plains.



Plate 9(b): Landforms - beyond this flood plain lies the high hills with steep slopes.

UMRAN BASIN  
PRIMARY LANDFORM UNITS



INDEX	
1	Low Hills
2	High Hills
3	Flood Plains

SCALE 1 0 0 0 1 mile

Fig. 17

study for the evaluation of the different landuses. Thus utilising the available materials and information a landform classification has been attempted.

#### 4.5. Landform Units

Taking the above criteria the landform classification of the basin has been formulated. The existing landforms in the basin can be grouped into three primary units (Fig. 17), namely,

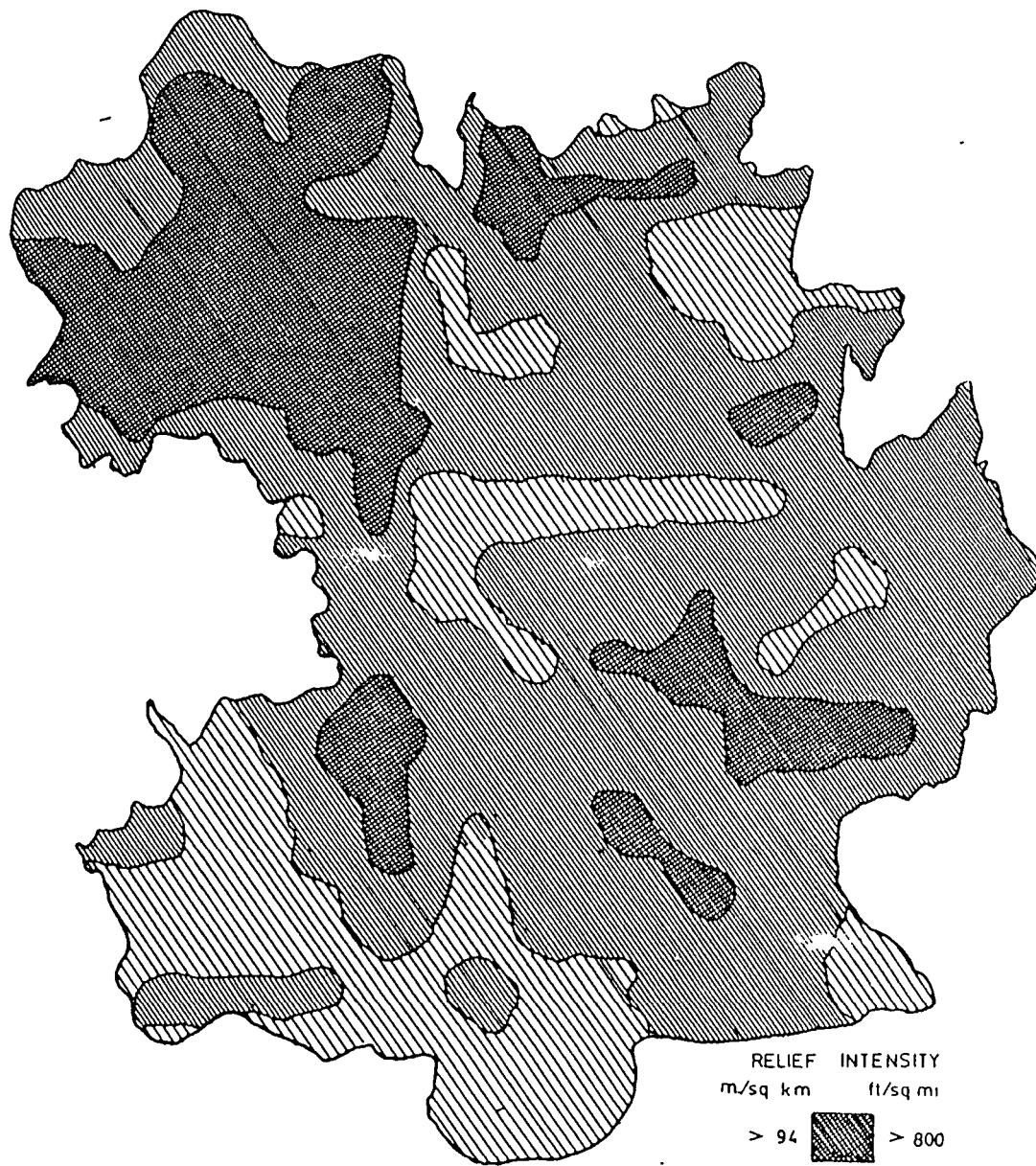
- i) Low Hills having Moderately Steep areas (with slope angles  $10^{\circ}$  to  $18^{\circ}$ ).
- ii) High Hills and Scarp Lands with Steep Slopes (with slope angles  $18^{\circ}$  and above).
- iii) Flood plains occurring in pockets in the basin.

Referring to the above, the first category is dominating the north-western portions of the basin. The rest of the basin falls in the second category. The third category of landforms in the basin occurs in different pockets. A clear understanding of the landform units is outlined in the following table:

**Table - 8: Landform Units Occurring in Umrans Basin**

Sl. No.	Primary Units	Area in sq.mile/ sq.km	Area in %
1.	Low Hills	72/186.5	62.6
2.	High Hills and Scarp	26/67.3	22.6
3.	Flood Plains	17/44.0	14.8

UMRAN BASIN  
RELATIVE RELIEF



RELIEF INTENSITY	
m/sq km	ft/sq mi
> 94	> 800
47-94	400-800
< 47	< 400

SCALE  
1 1/2 0 1 mile

Fig. 18

### 1. Low Hills

This unit have been underlain by the Pre-Cambrian granites in the northern parts of the basin. In the southern portions of the basin the underlying rocks are mostly the Archaean gneisses. A total area amounting to 72.6% of the basin area falls under this landform unit. This area has a moderately steep slope with slope angles ranging from  $10^{\circ}$  -  $17^{\circ}$ . The slopes are interrupted frequently by valleys, flood plains and the erosional surfaces. Drainage density displayed in this unit ranges from 3 - 6 mile/sq. mile (1.87 - 3.74 km/sq.km). The drainage lines follow the lineaments to a large extent, specially over the central part of the basin.

### 2. High Hills and Scarp Lands

These areas are concentrated in the north western parts of the basin. In these areas the slope angles tend to be higher ranging from  $17^{\circ}$  -  $30^{\circ}$ . This landform unit covers a total area of 26 sq. miles (67.5 sq.km) amounting to 22.6% of the basin area. These are areas of steep hills with relative relief higher than 800 ft (243.84 m). In this area the river Umran flows over an uneven bed with pool and riffle sequences. It is underlain mostly by the gneisses though some portions are covered by the intrusive granite.

Drainage density over this landform unit is relatively high and in most areas more than 6 miles/sq.mile (3.74 km/sq.km).

Streams that join the main river has to negotiate through the steep slopes causing the formation of an uneven bed.

### 3. Flood Plains and Wide Valleys

The flood plains are the valley areas which occur at different points in the basin. These occupy the least area of all the units and amount of 14.8% of the basin area. This unit is located in pockets. These are wide valleys providing large open spaces for settled cultivation. These areas have slope angles less than  $10^\circ$  but in the analysis of slope they do not figure. Thus, for these areas only spot surveys prove beneficial. On the other hand, it has not been possible to measure the drainage density of these areas in particular. In general these areas have drainage density between 3 - 6 miles/sq. mile (1.87 - 3.74 km/sq.km). Landforms of this unit represents relative relief of less than 600 ft (182.8 m). These areas are usually places of fluvial deposition and are therefore sandy in nature.

In addition to these there are flat lands on the hill tops too but these are yet to be estimated. Mention is also needed for the small valleys which have not been covered in this category.

This is in fact a preliminary survey. It needs further extension and modification pertaining to the variables taken in the classification. This is proposed to be undertaken in further studies.

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CHAPTER - V

EXISTING LANDUSE

## EXISTING LANDUSE

### 5.0. Categorisation of Land-Use

Land use classification in India had been taken since the last quarter of the 19th century. This was an outcome of the prevalent famines and food shortage occurring in the country. Such a classification was made under the guidance of revenue officials who operated in different areas of the country. The format of the broad classification had five classes, as follows.<sup>1</sup>

1. Area under forest,
2. Area not available for cultivation,
3. Uncultivated lands excluding current fallows,
4. Area under current fallows, and
5. Net sown area.

This classification gives a very broad picture of the land-use situation in the whole country. As such the net result was that nothing in particular was available in this scheme and the categories of land-use were not clearly depicted. Thus there was a need to change the scheme and in March 1950, the Government of India decided to adopt a new classification. This new classification had been suggested

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1. Das, M.M. (ed.) (1976). "Land use pattern and present method of land use data collection," Workable Methodology of Land Use Survey, NEIGS, Gauhati, p. 48.

by the FAO. This classification classifies land-use into nine types. These are:<sup>2</sup>

- I. Forest: Areas which are not cultivated and their ecology not disturbed.
- II. Barren and uncultivable land: Mountains and deserts which cannot be brought under cultivation without very high cost.
- III. Land put to non-agricultural uses: This includes land occupied by buildings, roads and railways or water canals and other lands put to uses other than agriculture.
- IV. Culturable wastes: These include lands available for cultivation, whether taken up for cultivation or abandoned. Such lands may be either fallow or covered with shrubs and jungles not put to any use. They may be assessed or unassessed and may lie in isolated blocks or within cultivated holdings. Land once cultivated, but not cultivated for five years in succession are also included under this class.
- V. Permanent pastures and other grazing land: These cover all grazing lands, whether they are permanent pastures and meadows or not. Grazing lands within forest areas are also included.
- VI. Miscellaneous ~~tree~~ crops and grooves not included in the net sown area: This includes all cultivable lands

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2. Ibid., pp. 49-51.

which are not included under net area sown. Lands under casuarine trees, thatching grass, bamboo bushes and other grooves for fuel wood etc., which are not included under orchards are grouped here.

- VII. Current fallows: This comprises of cropped areas which are kept fallow during the current year. For instance, if any seedling area is not cropped again in the same year, it is treated as current fallow.
- VIII. Other fallow land: This includes all lands which were taken up for cultivation but are temporarily out of cultivation for a period of not less than one year and not more than five years, due to unavoidable reasons.
- IX. Net area sown: This consists of net area sown with crops and orchards.

On the other hand, the villages present another picture. Their land-use patterns could be classed by identifying different bases. This has been done after separating the built up area from the hinterland of the village.<sup>3</sup> The built up area comprises of the principal area of the village which has the dwelling houses, places of religious worship, educational institutions, centres of cultural activities, public amenities, burial or cremation grounds, roads, markets (if any), kitchen gardens and shades for animals and birds. The

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3. Mohapatra, A.C. & K. Haloi (1984). "Landuse Classification in Tribal and Hill Areas of the North East: Case Study of the Khasi Hills", Seminar Papers on Applied Geography in the Perspective of Planning the Environment, the Urban Landscape and the Regional Population, North Bengal University.

hinterland comprises of the areas on which the village depends for its subsistence. These are the areas of cultivation, jhum fields, grazing grounds and forests.

Taking into consideration the above two different sets of classification it is clear that the basin area would be needing a different classification from that of the sample villages. However, in this context, it is to be noted that data available for the basin area is not adequate. The data is available only for community development blocks. Therefore, the data for Nongpoh C.C. Block has been taken as the base. The data available for the villages is approximate as the village boundaries are not well defined. At this point, it is important to mention that the reserved forest area occupies about 6 sq. miles (15.5 sq.km). Therefore, in order to get a generalised picture of the basin, the forest area will be excluded.

### **5.1. Present Land-Use Pattern**

It is very important to understand the system of land-holding in the area of study before discussing the land-use. The whole of the Bhoi area has no private lands as such. Raid lands or lands owned by the community are more prevalent. Raid lands are of four major types, and these are all meant for the use of the general public on being recommended by the concerned authority. The persons working in these plots

have the right of occupancy only and not to sell that plot to another person. If the person leaves the plot and is not interested to work, he is forfeited from occupying and working in that land allotted to him. The occupant may leave the plot fallow for a period not more than three years and then recultivate it or use it in some other way thereafter. Whatever may be the cause, if the person leaves the plot unused for a period of three years consecutively he has no right to claim that plot. In such a case, anyone who is interested may occupy that plot for himself<sup>4</sup> after paying a certain amount of money to the previous occupant of the plot.

The land-use pattern of the basin is difficult to be assessed as secondary data for the particular basin is not available. Taking the help of the secondary data available for the Nongpoh C.D. Block as well as that which is available for the two variant villages it is expected that the general landuse in the basin would be reflected. Analysing the available data it is seen that the forests are dominating the area. The estimates available till the year 1982-83 have shown the forests amounting to 22% of the total area in Nongpoh C.D. Block. In the villages the amount increases to 24%. However, this is not an indicator of the existence of large areas under forests. An average decline rate of about 6 ha/year

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4. Cantlie, K. (1937). Ka Ain U Khasi (Translated from Notes on Khasi Law by Cajee, T.), St. Anthony's College, Shillong, 1969, pp. 32-33.

Table - 9: Landuse in Nongpoh C.D. Block (Ha) - Saiden and Dulongnar

Category of Landuse	1981-82	82-83	83-84	84-85	85-86	86-87	87-88	Increase	% of total	Saiden	% Area	Dulongnar	% Area
1. Forest	25861	25866	25862	25866	25849	25843	25842	- 19	22.41	222	27	139	21
2. Barren Land	14453	14451	14449	15374	15376	15376	15375	+922	13.33	25	3	54	8
3. Land put to non-agricultural use	8540	1841	8543	8628	8635	8646	8651	+111	7.50	67	8	14	2
4. Cultivable waste	8628	8628	8630	8606	8610	8621	8619	- 9	7.5	7	1	44	7
5. Land Under Tree Crops & Grooves	15441	15441	15439	15417	15418	15412	15413	- 28	13.37	28	3	40	6
6. Permanent Pastures & Grazing land	24308	24307	24302	22243	22240	22238	22236	-2072	19.29	65	8	33	5
7. Current Fallows	3464	3464	3466	4364	4396	4401	4002	+538	3.47	19	2	24	3
8. Old Fallows	5698	5699	5701	5698	5662	5652	5649	- 49	4.90	9	1	3	5
9. Net Sown Area	8900	8903	8903	9108	9114	9110	9113	+213	-	105	-	5	-
10. Area sown more than once	235	300	300	311	235	311	270	+ 35	-	-	-	-	-
11. Total cropped Area	9135	9203	9208	9419	9349	9421	9383	+248	8.14	386	47	310	47
12. Total Geographical Area	115300	115300	115300	115300	115300	115300	115300	-	-	-	-	-	-
13. Net irrigated Area	2232	2241	2245	2245	2247	2247	2248	+ 16	1.95	-	-	-	-
14. Gross irrigated Area	2235	2244	2247	2248	2250	2251	2254	+ 19	-	-	-	-	-

Source: Nongpoh C.D. Block, 1988.

has been calculated as far as forests are concerned. This indicates a heavy loss of the meagre resources that this area possess. The increase of barren lands with an estimated rate of 130 ha/year account for 13 per cent of the total area in the C.D. Block. Land used for other purposes are increasing at about 16 ha/year which means that steadily a large part of the land shall be utilised for purposes other than agriculture. This refers to the built up areas as far as the basin is concerned. The declining land with tree crops and pastures reflect the major problems of depleting resources. On the other hand, the increasing trend of the current fallows and decreasing old fallows indicate the increasing pressure on land resources. People are keeping pace with the demands of the present day and as such there is a great need to increase grain production too. Thus, total cropped area increased from 9135 ha to 9383 ha in 1981-82 and 1987-88 respectively.

The ultimate analysis shows that land have been used for a variety of purposes. The forests and pastures are on the decline while areas under agriculture and non-agricultural purposes are rising.- The increasing reclamation of waste land needs attention. The overall situation is grave where the natural resources are depleting and man made barrenness is created.



Plate 10(a): Land Use - patches of jhum lands visible at the upper portion of the hill centre.

- Forests in most parts of the slopes.
- New road construction negotiating the slopes.
- Rice cultivation over low lands.



Plate 10(b): Jhuming - After clearing the undergrowths and shrubs, they are left to dry out and then burnt.

# NOTIONAL MAP OF SAIDEN AND DULONGNAR VILLAGES

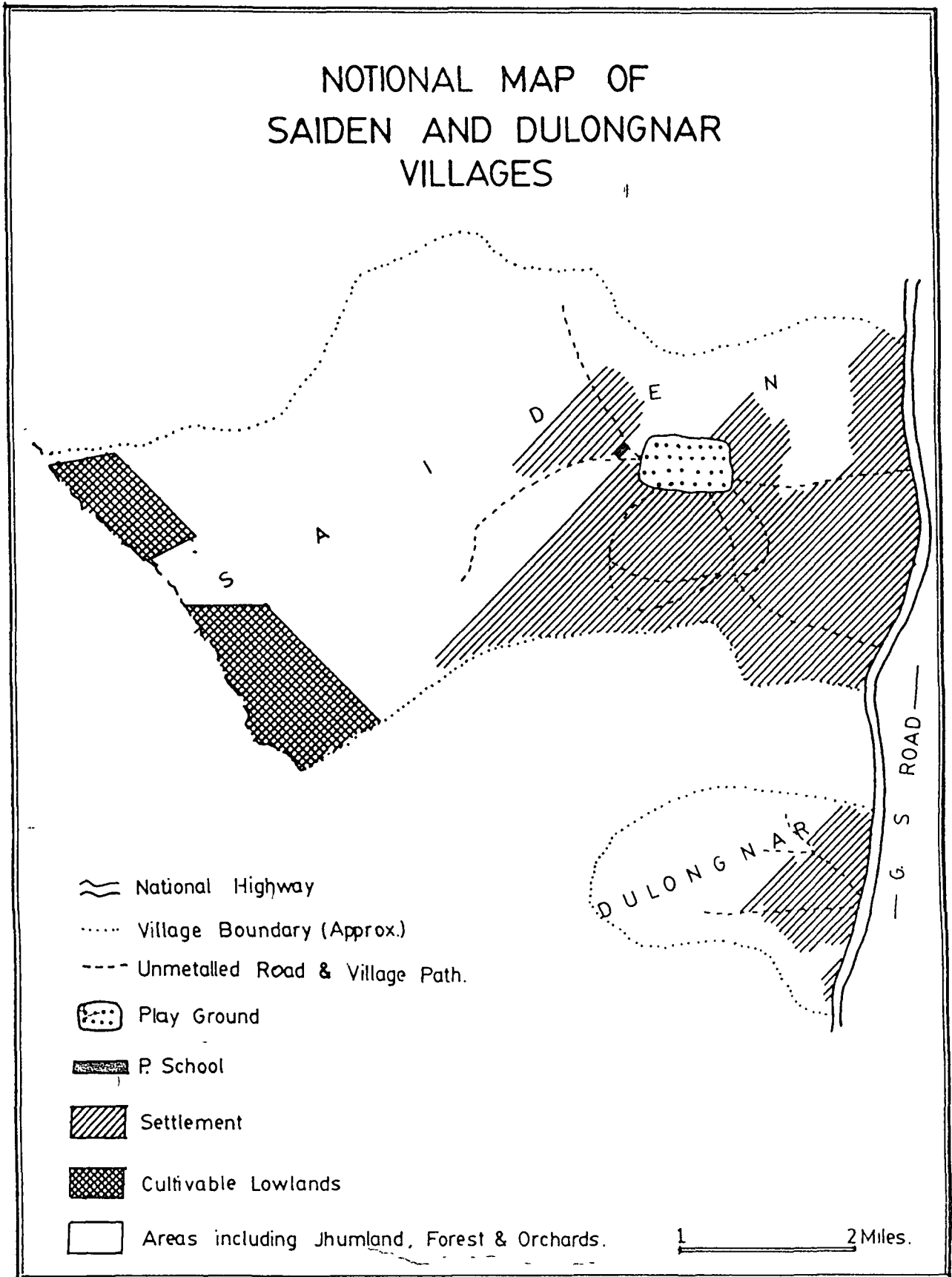


Fig. 19

Taking a closer look into the villages it has been found that there is more agricultural lands than forests. While forests account for 24% total cropped area amounts to 47%. In addition to these tree crops are significant, occupying 6% in Dulongnar and 3% in Saiden. This reflects the rapid depletion of the forest cover in the near vicinity of the village. The jhum lands where the people carry their 'rep shyrti',<sup>5</sup> is another factor that generates barren areas. The people are so much attached to this way of cultivation that it is really difficult to stop them from doing so. Recently, another problem that has come is the manufacture of wood charcoal by a crude destructive distillation method. A large number of trees have been cut for this purpose and as a result the forest cover is depleting.

A comparison of the two villages show that Saiden is larger than Dulongnar in size. It is quite interesting that in the different topographical conditions, the two villages have a sizeable area under crops. However, the forest cover in Dulongnar village is lesser than the C.D. Block figure as well as that of Saiden village. This indicates a more rapid depletion of the forest in the former village

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5. Khongsit, S. (1987). Hangne Tang Ia U Siej, Shillong, p. 55. The term 'rep shyrti' means in the local language synonymous with jhum; where the forests are cleared from November to January and burn in February-March.

than in the latter. This is relative to the emergence of the former just after the partition of India, as compared to the older and larger village of Saiden. Taking into consideration the topographical features of the area it is obvious that Dulongnar will have more barren lands than Saiden. Dulongnar is a village on a hill slope and the area surrounding it are used for cultivation. The generation of barren land is in fact, comparatively less as mostly tree crops grown, unlike jhuming which is practised elsewhere in the local villages. Even though the people are more interested in horticulture, they also cultivate paddy. Low lands nearby the village are used for the purpose. On the other hand, people of Saiden village utilise both the lowlying areas and hills for the different crops that they grow, as the slope gradient is not steep.

## 5.2. Present Cropping Pattern

The basin as it is, houses the poor and though they are attached to the soil for these long years their mode of living have never been changed. New inventions have never reached them, in the real terms, as they still use the old and age long methods of subsistence agriculture. It is really a pitiable site that the rest of the world have gone in for more and more mechanisation in agriculture while in the study area that age is yet to come. Thus, in that situation the production of the whole year of hard work never bears any fruit of sweetness. it is all consumed or at times less than the requirements.

CROPPING PATTERN OF  
NONGPOH BLOCK

1987 - 88

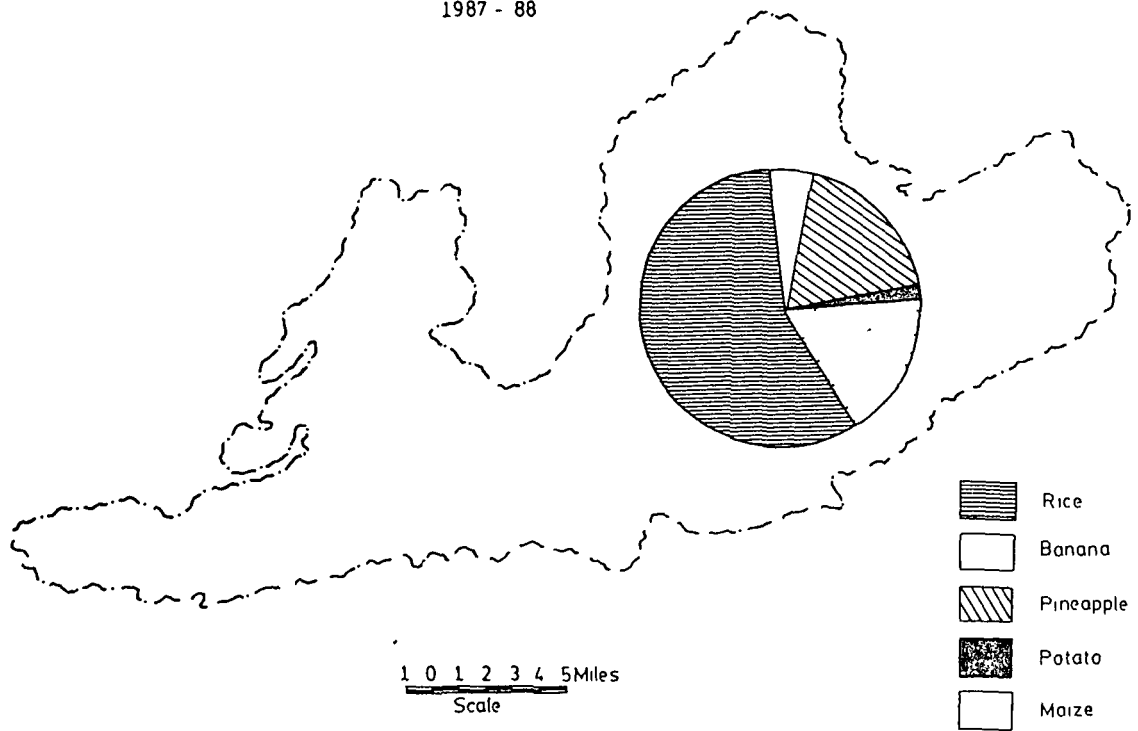


Fig. 20

A large percentage of area is under jhum but the particular details were not available. It is this type of system that is giving a lot of problems and it needs change. It seems easy and cheap to the local farmer but he does not know that he is not producing it economically. Besides jhum or shifting cultivation, there are areas that have been converted into permanent cultivable lands. These are usually found in the valleys where there is comparatively flat surface and terraces could be made. In the basin area there are two main crop seasons, that is, kharif and rabi.

Kharif crops in the basin are sown by mid-June while the rabi crops are sown in the winter months, beginning by November. Kharif crops that are grown include rice, maize, millets etc. which require a warm climate and more moisture. It is a speciality of rice to be grown on well watered areas. On the other hand, the rabi crops include potato, tobacco, ginger, bananas etc.

It is seen that there are certain major crops in the basin which are leading in production. These crops include rice, maize, pineapples, bananas, potatoes, arecanut, bay leaf, broomstick, betel leaf, ginger and millets. This indicates a wide variety of crops that are grown in the basin but it is to be kept in mind that some of these only come into trade and commerce. Of these the most important are



Plate 11(a): Land ready for paddy cultivation.



Plate 11(b): Paddy (rice) almost ready for harvest.

rice, maize, pineapples, bananas and potatoes. More recently, broomstick has become quite an important produce. Betel leaf and bay leaf has become items of demand in both local markets and outside.

In the basin, rice is the most common crop grown. It is usually grown once a year as a kharif crop. It is grown in the lowlying areas in the terraces (wet) as well as over the slopes (dry). Wet cultivation needs standing water while dry cultivation depends for its water supply on rainfall. Dry cultivation is usually carried out in the jhum lands while wet cultivation is in the permanent terraces. This crop is generally sown from June to August depending on the area where it is grown and on the seed used. The areas of higher relief complete sowing earlier while those at a lower elevation could take it over till early August. The crop is then harvested in November-December.

Pineapples are also grown in large areas in the basin. The plantations sometimes cover one hillock and are harvested every year in the summer months. The production of this area is sizeable. They go to the processing industry located at Byrnihat and also to the preservation centre of the Government of Meghalaya located at Shillong. Some of the produce also goes outside the state to be sold raw and also to the local markets including Shillong.

# CROPPING PATTERN OF SAIDEN AND DULONGNAR

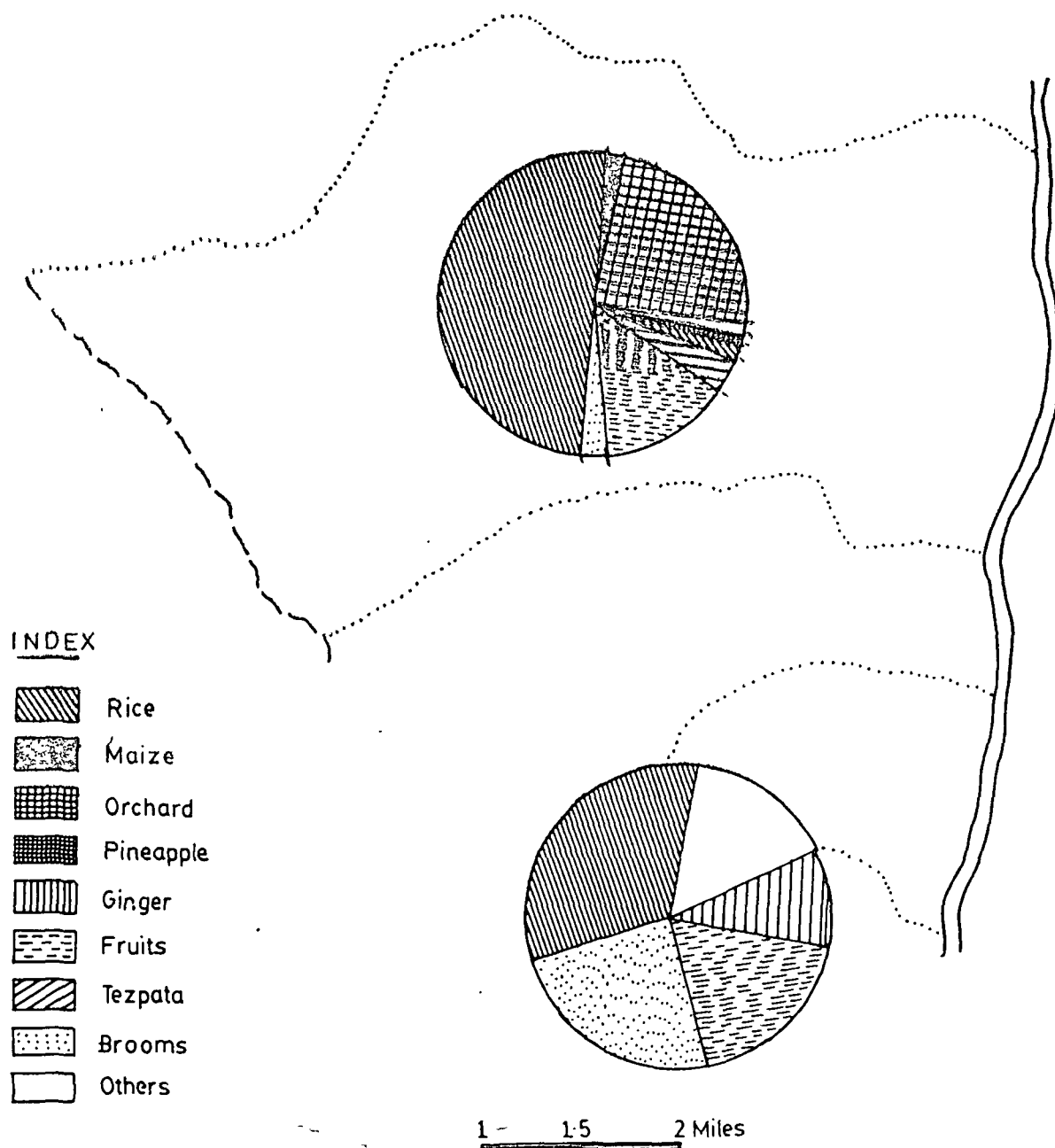


Fig. 21

Of late the demand for broomstick has been such that people are forced to domesticate it. It was otherwise wild but recently its use had spread all over the country and brought about a change in the picture. It was erstwhile demanded locally but now it is demanded from outside the state. It is therefore became an economic commodity. It is harvested just after the summer rains are over, that is around September.

On the other hand, it is interesting to note that betel-leaf is of importance. This is a creeper plant whose leaves are used for eating with arecanut. This item is at present of large demand not only in the local markets but it also goes to Guwahati. Owing to the large profits that the people get from this cash crop, the villages where the community growing it have developed greatly. This is very significant as such phenomenon is not observed elsewhere.

In the villages of Saiden and Dulongnar, it is very clear that the people are attached to the land. They are depending much on agriculture for their survival but not only survival but subsistence. This is the reason why the villages in the basin do not develop. The two villages are having adequate supply of the resources. Land, the major resource is not a problem for the two villages. It is the technology that demands more in this particular case. In the first place, there is a great need for the introduction

of machinery in agricultural field for at present there is a great demand for food. However, in this terrain modern large and bulky machines cannot be applied. Therefore there is a need for modification. It is also sad to observe that the modern techniques of farming like the use of fertilizers, improved seeds, plant protection and so on have not been able to appeal the people of this area resulting to poor yields and stagnated economy.

Technology apart, the basin's major crop is rice which is the staple food of the region. People try to work as much as they can for fulfilling their needs but have not opened their eyes towards more better ways of doing it. It is in fact high time for the people to think to improve their methods for their own betterment.

Besides rice, other crops grown in these villages are maize and ginger. Maize is grown as a rabi crop after rice. It however is not an important crop and the average yield is also low. Ginger is another important cash crop which is grown here. It is usually sown in March and harvested in winter depending on the demand of the commodity in the market.

As mentioned above, brooms have occupied an important position in the crop list of this area. This is a cash crop which is used by a large section of the people for clearing

in the houses. This commodity is now in great demand all over the country and as a result there are many broom plantations coming up.

Fruits occupy another major importance in the crops of this area. Important ones are pineapple, oranges, bananas, guava, jack fruits, lichis and plums. Pineapple plantations are widespread and the people are benefitted out of this crop. The oranges which are surviving now are just remnants of the poorest ones. After the migrants have shifted here, a large section of them brought up orange groves. These were very productive but subsequently a disease attacked most of the plants that the fruits are no more of food quality. As a result, these plantations declined. Other fruits mentioned in the list above are grown to some extent in the villages. Of these only bananas seem to have a good market value.

The people of these villages are to be made aware of certain developments in the processing of agro-products. Some of their produces could be processed at their homes and sold at higher rates.

The overall picture shows that rice is the most dominant crop in the two villages. Cash crops occupy a major share in the cropping pattern of Dulongnar while a variety of other crops appear in Saiden village.

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**CHAPTER - VI**

**IMPACT OF GEOMORPHOLOGY ON LANDUSE**

## IMPACT OF GEOMORPHOLOGY ON LANDUSE

### 6.0. Relationship of slopes, drainage and erosional factors with the availability of usable land surface in the basin

It has been highlighted in the previous chapters how geomorphology exerts its influence on the vegetation in the basin. It is to be remembered that even though elevation affects the cropping pattern, land use is almost the same. However, this largely depends on the population residing in the area. It is therefore important to understand how geomorphology affects landuse to a large extent.

As far as the slopes are concerned, a great deal has been discussed in the third chapter. The slopes in the basin range from  $10.8^\circ$  to more than  $30^\circ$ . Young, in his categorisation of slope has given the following classes.<sup>1</sup>

Table - 10: Categories of Slope

Slope Angle (gradient)	Description	Nature
Greater than $45^\circ$	Cliffs	Usually free faces common only in mountain area
$30^\circ - 45^\circ$	Very steep	The steepest slope on which debris lies. Usually scree and other slopes showing signs of rapid movement.

1. Clowes, A. and Comfort, P. (1982). Process and Landform: Conceptual Framework in Geography, Oliver Boyd, Edinburgh, p.38.

Table - 10 (Contd.)

Slope Angle (gradient)	Description	Nature
18° - 30°	Steep	Generally too steep for agriculture terracing in the tropics.
10° - 18°	Moderately steep	The upper limit of mechanised cultivation.
5° - 10°	Moderate	Soil erosion in dry areas
2° - 5°	Gentle	Often depositional areas, flood plains.
Less than 2°	Level	Often depositional areas, flood plains.

From the above table, it could be well seen that the slopes in the basin could be well utilised for many purposes. The category in between 10° to 18° refers to moderately sloping lands implying usable potential. Thus, as this occupies almost 3/4ths of the basin, it could be well assumed that usable land is in plenty. Barring all scarp areas and steep hills occurring in about less than 1/4th of the basin, spot visits have indicated that there are many pockets of wide valleys which may also be called as flood plains. These areas provide a sufficient amount of space for cultivation. Surveys of these areas and their estimation has not been possible at this stage.

As far as drainage is concerned, due to obvious reasons, these <sup>river</sup> flow over low lying areas. These rivers flow over such



Plate 12(a): High water level - a summer condition of river Umran.



Plate 12(b): Fluvial erosion - a serious problem.



Plate 12(c): Fluvial erosion - a serious problem.



Plate 12(d): Temporary embankments - a traditional way of combating fluvial erosion.

areas that are mostly cultivable and thus can provide irrigation facilities for areas under the crops. It is to be remembered that as one moves away from the river the amount of usable land is gradually reduced. In certain cases when the river cuts the granites or at the lower courses over the gneisses, there are deep gorges on both sides of the banks that they cannot be used for any purpose. The pool and riffle sequences occurring specially in the lower parts of the basin offer very little or even no space for cultivation near the banks of the rivers. It is also seen that the larger channels starting from the third order and above are frequently flooded. The main reason for this is the combination of too many streams of the lesser order to form one stream of the higher order. This is in fact the main hindrance of the valley locations in the basin.

In the recent past, it has been observed that erosional processes in the basin have increased due to human interference, specially of the forest cover. So long as the interference had not the critical limit, it was not defined. Recently, instances have been noticed of erosion effects that might produce serious results.

It is a known fact that runoff yields increases if and when vegetational cover is reduced. This is an induced phenomenon where reduced infiltration (due to lack of retainers)

results to higher rates of runoff. In such circumstances runoff from the smaller basins join the main stream at very short periods resulting to erosion at the confluence point. Here an instance of the above phenomena is cited. This is noticed at the confluence of the Umpylli and Umrans river where the sub-basin (Umpylli) reaches the confluence point at an earlier period causing loss of cultivable lands on the opposite side of the point. The net result of this phenomenon is an increased erosion from year to year.

#### **6.1. Role of Geomorphological Factors in the Evolution of the Existing Landuse Pattern**

It has been realised that geomorphological factors have a great role in the evolution of the existing landuse pattern. As mentioned earlier the two major communities of people living in the basin belong to two different economic as well as physical environments. The locals who have settled here for a longer period of time have selected better lands for their occupation and economic activities. On the other hand, the migrated people being used to the rough topography in their own areas try to use the hilly areas. It is therefore seen that the hills and lowlying areas are used differently. The former are usually converted into areas of settled cultivation by the migrated population while the locals continue their jhumming or 'shyrti' on these. The lowlands on the other hand, are mostly used by the locals for permanent cultivation.

There is a corresponding relationship between the existing landuse pattern and geomorphology to a large extent.

To mention the relationship clearly, a little more explanation is required. The use of slopes is limited due to obvious reasons. Jhumming, which is practiced on the slopes have been proved to be ineconomical.<sup>2</sup> The ICAR research team have found that the returns per man-day is Rs.5.42 while the rate of agricultural wages is Rs. 7.00 a day.<sup>3</sup> The second year's production would be poorer than the first which obviously would induce the jhumia to shift to another area. Therefore from year to year there are more and more barren lands. On the other hand, the people who have migrated from the south of Meghalaya specially seem to have earned an experienced hand in the use of the hilly tracts. They do not practice jhum but try to cultivate the slopes with permanent crops without much disturbance of the forest cover except for horticultural uses, where it is inevitable not to cut the vegetational cover. This system is economical and it also pays, even though the work is tough. The system practised by the Khasi migrants is therefore not jhum.

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2. Borthakur, D.N. (1983). Shifting Cultivation in N.E. India, ICAR Complex for NEH Region, Shillong, p. 26.

3. This rate is prevailing in the year 1983, but it varies from place to place.

The low lying areas are used for settled food crop cultivation mostly. These have been converted into terraces which are relatively small in narrow valleys while large in the wider valleys. At present tractors and power tillers are sometimes used for the preparation of the fields besides the bullocks that have been used for a long time. Human occupation of land is very much guided by the physical and economic reasons. At certain times, the natural environment is more powerful than human efficiency is reduced. On the other hand, economy largely depends on the favourable natural environments that the human hand cannot just guide itself to reach the projected destination.

Considering the three different geomorphic divisions in the basin, there are certain things that need to be discussed. Referring to the areas of the 1st category where moderate slopes occur, the settlements are more prevalent. On the other hand, this is not the case with the second category. This is a clear demonstration of preference of humans to negotiate with the slopes. However, human preference does not end here. The valley settlements as such are never prevalent, for by experience, people have found that they are frequently flooded resulting to loss of both life and property. They, therefore prefer to stay away from the flash floods that occur in the valleys by settling at a level which the floods cannot cause any damage to their houses at least. Thus the major portion of the population inhabits the moderate slopes.

## 6.2. Future Planning for the Proper Utilization of Land in the Basin Area

In the overall survey it has been found that this area needs a better planning of its landuse for the maximum benefit of the entire population residing there. From time to time the growth of population is tremendous. Thus with the passage of time, more and more people are occupying the unexpandable land surface. It is therefore thought that there should be ways and means for the proper utilisation as the people are more dependent on agriculture for their survival. The basin area has been divided into three main geomorphic regions representing the three landform units. On the other hand, these areas are hilly and as such there should be a practicable solution for the uplift of the rural population residing in this area.

In fact, the ICAR has already given a general three tier system of landuse for these areas specifically meant to combat shifting cultivation. This model gives the following idea.<sup>4</sup>

This has been evolved by a team of ICAR scientists who, after studying the whole situation had suggested this model. This model is appreciable to a large extent but it is a

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4. Borthakur, D.N. Op.cit., p. 75.

# MODEL LAND USE CONCEPT

(ICAR)

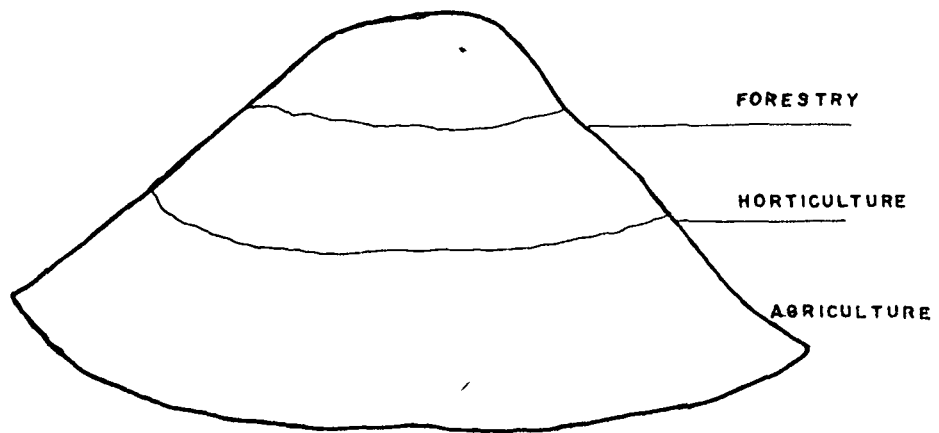


Fig. 22

**Table - 11: Land Use Pattern for Hill Slopes as an Alternative to Shifting Cultivation**

Slope	Portion of total area (approx.)	Land Use	Conservation measures
Lower portion	1/3 rd	Agriculture	Bench terracing
Mid portion	1/3 rd	Horti-pastoral	Half-moon terracing for horticultural plants and contour bunds
Top portion	1/3 rd	Agro-Forestry	Contour bunds.

big problem for the people to utilise this. As far as grants and loans are concerned, the government offers a lot of such incentives. However, this cannot carry on for long. To state some instances, it has been found that some villages have not been able to repay the loans resulting to forfeiture of such incentives. In view of this it is therefore advisable to minimise the inputs and look for methods that people can eventually operate by themselves. This will induce the people to work hard for the benefit that awaits. As such the financial implications involved will not be so large as to hinder the financing agencies from extending their services. In such schemes, there should be a wide variety of choices that would not only suit the place but also for the people to choose.

Here, it is important to bear in mind that the schemes are to be prepared in such a way that not only economy of the people is expected to be raised but also to protect the environment which is declining at a fast rate. Thus, taking the geomorphic classification as a base the plans could be suggested. In the first category where the slopes are moderate, a set of plans could be offered. In the second category where the slopes are higher, the plans will dwell mostly on agro-forestry and allied economic activities. In the almost plain areas of the third category, there will be a concentration of agriculture mainly for food production. This is however a preliminary exercise and would be subjected to more work in a higher stage, after confirming some of the results and also seeking the views of others. This however, conforms to the three landform units and within each unit there are hills and valleys that vary in their shape and extent. For these, accommodations have been made.

The model of land use planning that is thought to be the best, have been included in the following table:

**Table - 12: Land Use Model for Better Use of Land in Umran Basin**

Geomorphic Unit	Types of Areas	Existing Land Use	Proposed Land Use
I. Low Hills	(a) Valleys & Lower Slopes	Forests or Cultivated or abandoned	Permanent terraces for agriculture

## PROPOSED LAND USE

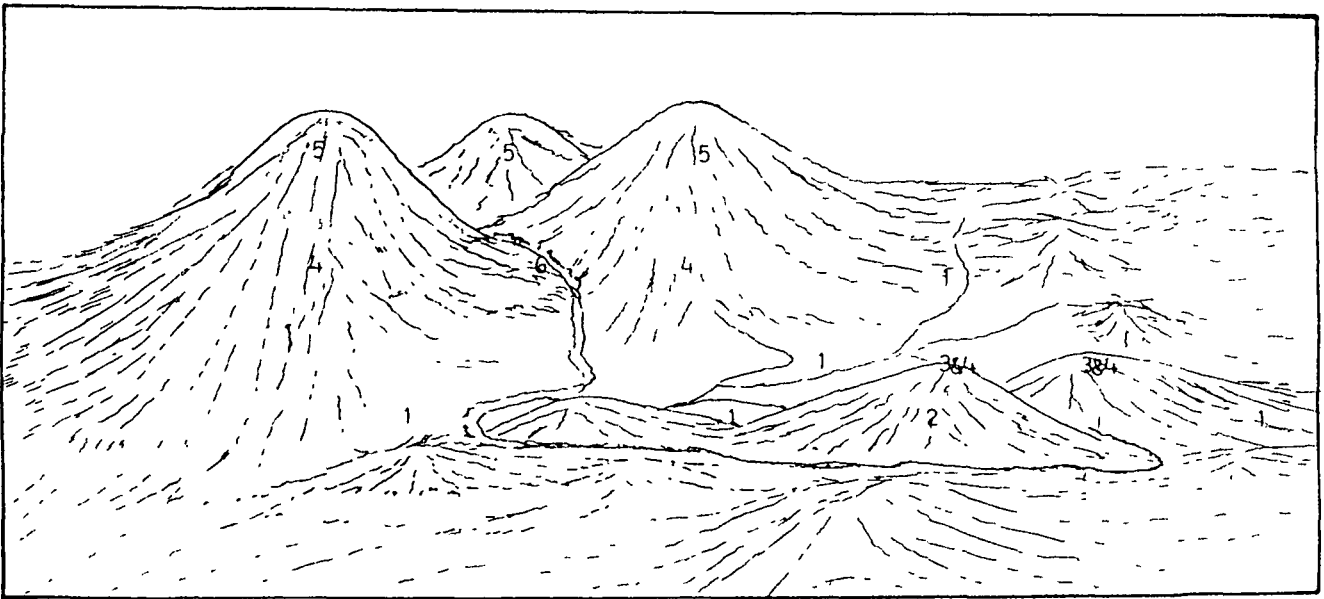


Fig. 23

### INDEX

- 1-Agriculture
- 2-Horticulture
- 3-Pastures
- 4-Agro-forestry
- 5-Forestry
- 6-Pisci-culture

Table - 12 (Contd.)

Geomorphic Unit	Types of Areas	Existing Land Use	Proposed Land Use
	(b) Medium	i) Forest	To be left undisturbed.
		ii) Barren (due to jhum)	For Agro-Forestry and allied economic activities.
	(c) Higher slopes & hill tops	i) Forest	To be left undisturbed.
		ii) Barren	To be reafforested with other tree species that could be marketed in a shorter time span.
		iii) Semi-Barren with grasslands	Trees to be left undisturbed; cash crops where applicable; better grasses for animal grazing.
II. High Hills and scarp lands	(a) Valleys	i) Forest, Semi-forest	Series of dams could be constructed for pisciculture; forest to be left undisturbed.
		ii) Barren	Dams to be constructed as above and to be reafforested.
	(b) Slopes	i) Forest	To be left undisturbed.
		ii) Semi-Forest	To be reafforested with suitable trees and other tree crops.
		iii) Barren	Same as above.
		iv) Grasslands	These should be improved in quality and shrubs raised so that shades will be available for animals.
III. Flood plains	All categories to be used for agriculture with improvement in irrigation facilities.		

In the above model it is expected that the moderate slopes will be used for a variety of purposes depending on the degree of slope. The valleys with the least degree of slope shall have permanent cultivation plots and these should preferably be terraced. Medium slopes in this category (i.e. from  $12^{\circ}$  to  $18^{\circ}$  approx.) can always be used for agro-forestry, whether in the natural forest or artificial one. Besides agro-forestry other allied economic activities could always be carried out like raising rabbits and other domesticated animals for the sake of their meat. All other areas with steeper slopes occurring in this unit shall have forests. If the forest cover is in its natural form it should be left undisturbed while in other areas where the forest cover have been eroded either partially or fully, reforestation is required. The species that are needed for the above purpose are those that grow fast so that the timber could be marketed in a short time span (i.e. within 20-25 years). In case the areas are suitable for grasslands, better species of grasses will have to be broadcasted over the area. However, if converted to grasslands these areas must also have shrubs that can provide shade for the animals. In such cases, a water canal or stream diversion will have to be more meaningful for the purpose assigned for.

For the second landform unit, where the slopes are steeper, a different kind of use is being proposed. In the

valley areas where there is a large scope for pisci-culture, a series of dams could always be thought of. The modern method of having some nursery ponds and some rearing ponds would in fact be more profitable even though this is quite expensive. It is therefore proposed that a series of dams specially along the first order and second order streams would be very convenient. Near the valleys, the slopes should not be disturbed much as this will induce silting. Instead, climber crops like betel-leaf could always be planted and made to climb the trees in order that the forest will not be altogether useless. Forest cover must be protected so that there is enough infiltration of rain water and that the source of water will not die out. The same applies to the higher slopes of this area. Forests are not to be disturbed as that will give the dams down below a longer life. Forests that are destroyed can always be raised with care such that they are beneficial to the investor while the natural forests are to be protected. In these forests, whether near the valleys or high up other allied economic activities can always be practised. These allied economic activities are however limited to certain numbers only as other methods are yet to be tried. These will be specified at a higher stage.

Referring to the third unit, (it is very clear that with the subtraction of jhum lands for agricultural purposes, there is a dire need for more land for food production. Therefore, an increase

of land for production over the valleys and flood plains would only be minimal. Here, it is suggested that the farmers should concentrate in these areas and try for better and new methods of farming. So far the people are just sticking to their old culture of sowing the traditional rice species. It is now time that they look for more production from the hybrids which produce twice more than the local varieties. In order to feed more number of mouths with the same traditional way it would be impossible. There is only one way out and that is by using more productive species which are nothing more than hybrids. These areas are very suitable for the growth of the hybrid varieties. In addition to the terraces that could be easily made here, irrigation facilities are not difficult at all. Water for irrigation could be brought through channels and using the gravitational pull. Such instances have been observed in some parts of the basin.

Taking into consideration the whole model it is thought that a general understanding of the area is necessary before really going into it. Secondly, the model concentrates on the agricultural land-use in particular, as the people are depending on this base. As far as new constructions are concerned it is hereby suggested that the third category be left for food production while the other two could be used for any purpose other than what has been specified. However, these should also be thought of as to how they would ultimately

develop. Inconvenience caused at a later stage by such development might be disastrous.

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CHAPTER - VII

SUMMARY AND CONCLUSION

## SUMMARY AND CONCLUSION

The Umran basin, though small, occupies an important position in Meghalaya. The National Highway No. 40 passes from middle of the basin. There are two emerging urban agglomerations of Nongpoh in the north and Umsning in the south. The basin has quite interesting characteristics which are summed up in the following paragraphs.

As far as geology is concerned very complex formations are portrayed. Geological facts present the following:

1. that there is a complex formation of rocks in the basin and indicated by the criss cross lineaments running in different directions - E-W, ENE-WSW, NW-SE and NE-SW;
2. that there was an intrusion of granites over gneiss; and
3. that the whole area has been subjected to diastrophic disturbances in the geological past.

Climate, soil and vegetation are other factors which have been considered. Climate is humid tropical and is therefore suitable for a variety of crops. The soil is fertile and crops that are grown in this area are of good quality. However being hill soils there are deficiencies in certain elements. Vegetation cover in the basin is dense. The undergrowths specially grow very fast.

Topographically, the area is dissected with good evidences of erosion surfaces at particular altitude. Slope analysis indicates that slope angles are higher at lower altitudes while the higher altitudes display less steep slopes. About 77% of the total basin area is under the latter category while the rest has steeper slopes. The drainage density analysis show denser drainage network in areas of higher slope angles and the divides. Geomorphic analysis suggests a possible rejuvenation not only of the basin but of the region as a whole.

The Umran basin may be divided into three main geomorphic units. These are, (1) Low Hills, (2) High Hills & Scarp Lands; and (3) Flood Plain.

The Low Hills refers to those areas of slope angles ranging from  $10^{\circ}$  to  $18^{\circ}$ . The High Hills and Scarp Lands comprise of those areas having slope angles above  $18^{\circ}$ . Lastly, the flood plains are those areas with slope angles less than  $10^{\circ}$ . This classification is mainly based on slopes and is a preliminary attempt to classify landforms in the basin.

Land use pattern in the basin conform to the prevailing geomorphological conditions to a large extent. It has been observed that the local people usually use the flat lands for settled cultivation while the slopes are left for jhum or shifting cultivation. However, the Khasi migrants from the southern parts of Meghalaya have brought something new

when they came to settle in this area. These people, as they were used with the harsh conditions at their home villages found the northern region of Meghalaya very comfortable. As such they used the slopes instead of the lowlying areas. They usually specialize in cash crops like oranges, pineapples and other fruits as well as bay-leaf, broomsticks, ginger and betel leaf.

The role of geomorphic characteristics in moulding the existing land use have been discussed to a certain extent in Chapter - VI. Apart from agriculture the impact of geomorphic characteristics has also been observed on some other important aspects like settlement and transport. The settlements are concentrated more in areas of moderate slopes. The transport lines, due to obvious reasons are less developed in areas of higher slopes.

Although the land use pattern in the basin, is to a large extent, been governed by the geomorphic characteristics of the region, the land resources are not utilized properly. As a result the possible income generation is correspondingly low. Thus with earnest efforts a land use model has been formulated with the object of better land utilization, saving natural environment and also for income generation. For this purpose, the geomorphic units form the base of the model.

To save environment and generate income, it is suggested that all lands with steep slopes are to be forested. In areas

of moderate slopes agro-forestry and allied economic activities are suggested. On the other hand, the gently sloping lands would be used for agricultural purposes to the maximum extent. Keeping in mind hill slope erosion in the area, it has been suggested that the slopes should not be disturbed unduly. Certain cash crops (and also plantations) could be raised on the slopes without much disturbing them.

Basing on the findings, a few suggestions have been given below:

1. The basin area has a lot of potentials for income generation, as these may be tapped;
2. There is an urgent need to save environment which is deteriorating at a fast rate. Earnest efforts should be made both by the government agencies and the people to save the forests and forest valuables including orchids, herbs and wild life.
3. This area can produce a huge quantity of foodgrains if proper planning is done and accepted. Rice in some of these areas may reach to a maximum yield of 6000 Kg/ha using the modern methods of cultivation. If all lowlands are utilized properly there is no doubt that this basin will be a major grain producing area in Meghalaya.

4. Besides rice, a host of other crops could be grown in this area. Some other crops like wheat can be grown as a winter crop in the lowlands.
5. Some varieties of tropical pines grow well in these areas. As such for reafforestation some of these varieties could be well used. In addition to this, they could be sold as timber. Private parties who are interested may be encouraged in taking up these schemes independently at appropriate areas.
6. Development in the basin is restricted only to a few focal points. Of these, Nongpoh and Umsning are the most important ones, both located along the National Highway No. 40. A careful planning is needed for them to develop as these would serve as models for the development and growth of other such areas.
7. The said National Highway connects Guwahati with different important places like Shillong, Agartala, Aizawl and Silchar. The traffic is therefore very high. In view of this, the highway requires widening for at least three lanes so that there will be less congestion.

Umran basin as a whole needs a lot of improvement. A lot more is to be done for the betterment of the people

in the basin. Further researches are to be conducted to explore the resources of the basin and to tap them. Whatever has been done here is just the starting and much is lying ahead.

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