INTEGRATED WATERSHED MANAGEMENT IN NAGALAND:

A KEY TO SUSTAINABLE DEVELOPMENT

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DECLARATION BY THE CANDIDATE

I, Ms. Nukshienla Imchen, hereby declare that the subject matter of this thesis is the research work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other university/institute.

This is being submitted to Nagaland University for the award of the degree of Doctor of Philosophy in Geography.

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This is to certify that the thesis entitled "INTEGRATED WATERSHED MANAGEMENT IN NAGALAND: A KEY TO SUSTAINABLE DEVELOPMENT" is submitted by Ms. Nukshienla Imchen for the Degree of Doctor of Philosophy in Geography of this University. The work presented embodies the original work of the candidate. According to the best of my knowledge, this thesis has not been submitted for the award of any other Degree of this University or any other University.

Ms. Nukshienla Imchen has put in more than two hundred days of research work in the Department of Geography under my supervision.

(M. S. Rawat)
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Contents

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Nukshienla Imchen

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List of Abbreviations

%	Percentage
A	Area
AP	Andhra Pradesh
ASTER GDEM	Global Digital Elevation Model
Au	Gold
BOD	Biological Oxygen Demand
Ca	Calcium
CaO	Calcium oxide
Cn	Cyanide
CRIDA	Central Research Institute for dryland Agriculture
CSWCRTI	Central Soil & Water Conservation Research Institute
Cu	Copper
DANIDA	Danish International Development Agency
DDP	Desert Development Programme
DPAP	Drought Prone Area Programme
EEC	European Economic Community
et al.	And Others
FAO	Food and Agriculture Organization
FeO	Ferrous Oxide
Fig.	Figure
FSI	Forest Survey of India
GB	Gaon Bora
GDP	Gross Domestic Product
GIS	Geographic Information System
GLASOD	Global Land Assessment
GON	Government of Nagaland
Govt.	Government
ha	Hectare
i.e.	That is
ICAR	Indian Council of Agricultural Research
IHD	International Hydrological Decades
IIRR	International Institute of Rural Re-construction
Inc.	In charge
IWDP	Integrated Watershed Development Programme
IWMP	Integrated Watershed Management Programme
K	Kilo
Km	Kilometer
Kms	Kilometers
L_b	Basin Length
Ltd	Limited
m	Meter
	Magnesium
Mg	
MgO	Magnesium Oxide

mm	Millmeter
MRAE	Ministry of Rural Affair & the Environment
msl	Mean Sea Level
MW	Mega Watt
Na	Sodium
NASTEC	Nagaland Science and Technology Council
NBSS	National Board of Soil Series
NBSSLUP	National Bureau of Soil Survey & Land-use Planning
NEPED	Nagaland Environmental Protection and Economic Development
NGO	Non-Governmental Organization
Ni	Nickel
no.	Number
NPCB	Nagaland Pollution Control Board
NSDP	Nagaland State Domestic Project
NWDP	National Watershed Development Project
NWDPRA	National Watershed Development Project in rainfed Areas
°	Degree
OECD	Organization for Economic Co-operation & Development
OECF	Oversees Economic Co-operation Fund
P	Perimeter
pH	Potential of Hydrogen
pp	Pages
ppb	Parts per Billion
ppm	Parts per Million
PRA	Participatory Rural Apraisal
Pt	Point/ Part
RF	Relative Factor
RVP	River Valley Project
SARS	State Agricultural Research Station
Sq	Square
TGA	Thermogravimetic Analysis
UNCCD	United Nation Conventio to Compact Desertification
UNDP	United Nation Development Program
UNESCO	United Nation Educational
VDB	Village Developmental Block
Viz.	As follows
Vol.	Volume
W	Watt
WCED	World Commission on Environment & Development
Wd	Mass Movement
WDPSCA	Watershed Development Project of Shifting Cultivation Area
Wt	Loss of top soil

Chapter 1

INTRODUCTION

INTRODUCTION

The study of interaction between humans and their environment is gaining wide recognition today and therefore, geographers study the impact of developmental activities on the environment generally under integrated watershed management. Integrated watershed management can be simply described as an integration of technology within the natural boundaries of a drainage area for optimum development of land, water and plant resources to meet the basic needs of the people in a sustained manner (Jayakumar, 2000). Integrated environmental management with development activities at the watershed level is known as integrated watershed management. In recent years, integrated watershed management has been identified as a tool for planning and management of watershed resources in mountain ecosystem which provides an ecologically sound economic base for the watershed and its people.

Firstly, a very brief discussion of the branches of Geography that are related to this research: The discipline geography has widened in its scope. Early geographers like Eratosthenes considered geography as the study of earth as inhabited by humans. Since then, geography has evolved to become a very complex discipline. Unlike other systematic sciences, geography is multidisciplinary because it integrates the items that other sciences study separately. As for example, geography studies the heterogeneous phenomena that occur in different parts of the world (Hartshrone, 1939). In another sense, geography deals with the human-environment relationship in spatial context for example, the surface of the earth, its natural environment and the human intervention affects the physical and cultural landscape in course of time (Saxena, 1999).

There are numerous sub-disciplines of geography. One of which is generally known as environmental geography concentrates on the application of geographical information (both physical and human) to offer solutions to environmental and developmental problems. Environmental geography, therefore, scrutinizes the various facets of the environment and its degradation, especially, the effects of economic development on the environment (Singh, 1989). Another one is called physical geography. Physical geography evaluates the impact of humans on the natural environment. Physical geography proposes that the quality of the lands (or the earth surface) is established by numerous factors, forces namely, human activities and

inputs from both the atmosphere above and the solid earth below (Strahler & Strahler, 1978).

After the 1950's the discipline has undergone major changes in its methodology and approaches. For example, the origin and development of Geomorphology which is an important branch of physical geography concerns itself with the scientific study of landforms and the processes that shape land. A sub-division of this branch of geography, geomorphology is Applied Geomorphology. It has come about as a result of the application of geomorphological principles to the study of human environment and activities.

Many scholars are interested in diverse themes and issues which belong to environmental geomorphology. Here are three out of many, such as, (1) geomorphological processes and terrain that affect human, including hazard phenomena such as floods and landslides (2) problems caused by humans in terms of disturbances like degradation of the land-water ecosystem (3) how the science of applied geomorphology can be used in environmental planning and management for sustainable development (Coates, 1973). This research explores these themes and issues from a different contextual reality.

Secondly, a brief discussion on "watersheds" which are the focus of this research: Watersheds are topographical units defined by the flow of water which is not defined by the political boundaries. The hydrologic cycle is a key factor in any watershed. The land use pattern and the changes taking place in a watershed greatly affect the movement of water and soil-erosion. It should be noted that human actions greatly affect them all and vice versa.

Researchers who have studied watersheds have had an area of interest which is socio-economic. One researcher studied how inhabitants have used land, water and forest resources to produce income; another has about the capital investments. Such researchers exemplify the modern concept of watershed management which consists of two approaches: 1) managing natural resources, and 2) managing socio-economic systems. The application of both approaches makes this concept truly an integrated one which is generally known by the term, "watershed approach". It can be applied in planning and allocation of resources especially in the rural development projects. As for example, watershed approach can be applied during the process of planning for specific resource sectors such as agriculture, forestry, or mining. Thus it is safe to

state that integrated watershed management is a holistic approach which is a process of formulating and implementation of a course of action involving natural and human resources in a watershed (Easter & Hufschmidt, 1985 and Brooks, *et. al*, 1991).

Integrated watershed management is a key to sustainable development. As stated before, watershed is a topographically delineated geo-hydrological unit draining at a common point by a system of streams. From the management perspective, a watershed is not just an area, but a land mass; it is a point of reference along the main flow channel, with its own particular drainage area (Rajora, 2002). Watershed management aims at the development of the environment for human benefit by balancing the socio-economic, technological and ecological forces and allocation of resources. This system of management is anticipated to fulfill the needs and the aspirations of the people but such management demands a geomorphic understanding so as to scientific management of natural resources, land and water which would guarantee sustainable development of watersheds.

STATEMENT OF THE PROBLEM

The depletion of the fertile top soil and other natural resources degradation in most of the hills in Northeast of India due to excessive shifting cultivation is a recurring phenomenon. This adversely affects the livelihood of the tribal people in these areas thus threatening even their survival. Therefore policies and strategies must urgently be developed to reverse the present trends of watershed degradation which is negatively affecting the total ecosystem. This would require scientific planning and implementation of those plans effecting sustainability of the resources (Rawat, 2002). This process would include making projects for soil conservation, afforestation, water resources development and management, minor irrigation, animal husbandry and other rural development activities. The researcher endeavors to explore relevant ways to effective watershed management in a selected area in Nagaland.

THE STUDY AREA

Nagaland is one of the eight Northeastern States of India. It is hilly and rugged in topography. The location of Nagaland spatially is within the coordinates of 25º 20' N to 27º 04' N latitudes and 93º 20' E to 95º 15' E longitudes. Politically it is bordered by States of Arunachal Pradesh in the north, Assam in the north and west, Manipur in

the south and it is has an international border with Myanmar in the east (Fig 1.1). Physiographically, it lies south of the Patkai Bum of Arunachal Pradesh. Naga Hills is an extension of the Patkai Bum. At its east lies the Plains of Brahmaputra of Assam and in the west the valley of Irrawady of Myanmar and towards the south is the hills of Manipur. The altitude varies between 195 m to 3048 m above msl. Physiographically, Nagaland can be divided into three NE-SW trending segments i.e., (1) High Hill ranges in the East (2) Medium High Hill ranges in Intermediate zone and (3) Western Low ranges. The hilly natures of rugged terrain and lofty ranges have a great bearing on the environment and development including the human landscape of Nagaland.

Hydrologically, Nagaland is situated at the tri-junction of the three major river basins of the region namely, the Brahmaputra, the Chindwin and the Meghna. The state of Nagaland is divided into eleven districts and major part of the land lies in the Brahmaputra River basin. The districts are Kohima, Dimapur, Peren, Phek, Mokokchung, Zunheboto, Wokha, Mon, Longleng, Tuensang and Kiphire (Fig. 1.3).

Human occupy the core of cultural or socio-economic environment of the State. Being producers they influence the environment and at times alter the physical environment. The human population is growing at an exponential rate and yet to be tapped and used fully. The State enjoys diverse climate ranging from sub-tropical to sub-Montane temperate and even micro climatic conditions within a short distance.

The forest cover occupies about 52% of total land area. About 80% of the rural population is directly dependent on forest resources for their survival. In order to do detail study of watersheds of Nagaland, ten sample watersheds have been identified. These are Chija Ho, Deodubi, Menung, Upper Kiliki, Kukhipani, Tsuhaoru Tao, Inkoron, Shen Ru, Lower Tizu and Liyung watershed (Fig. 1.2).

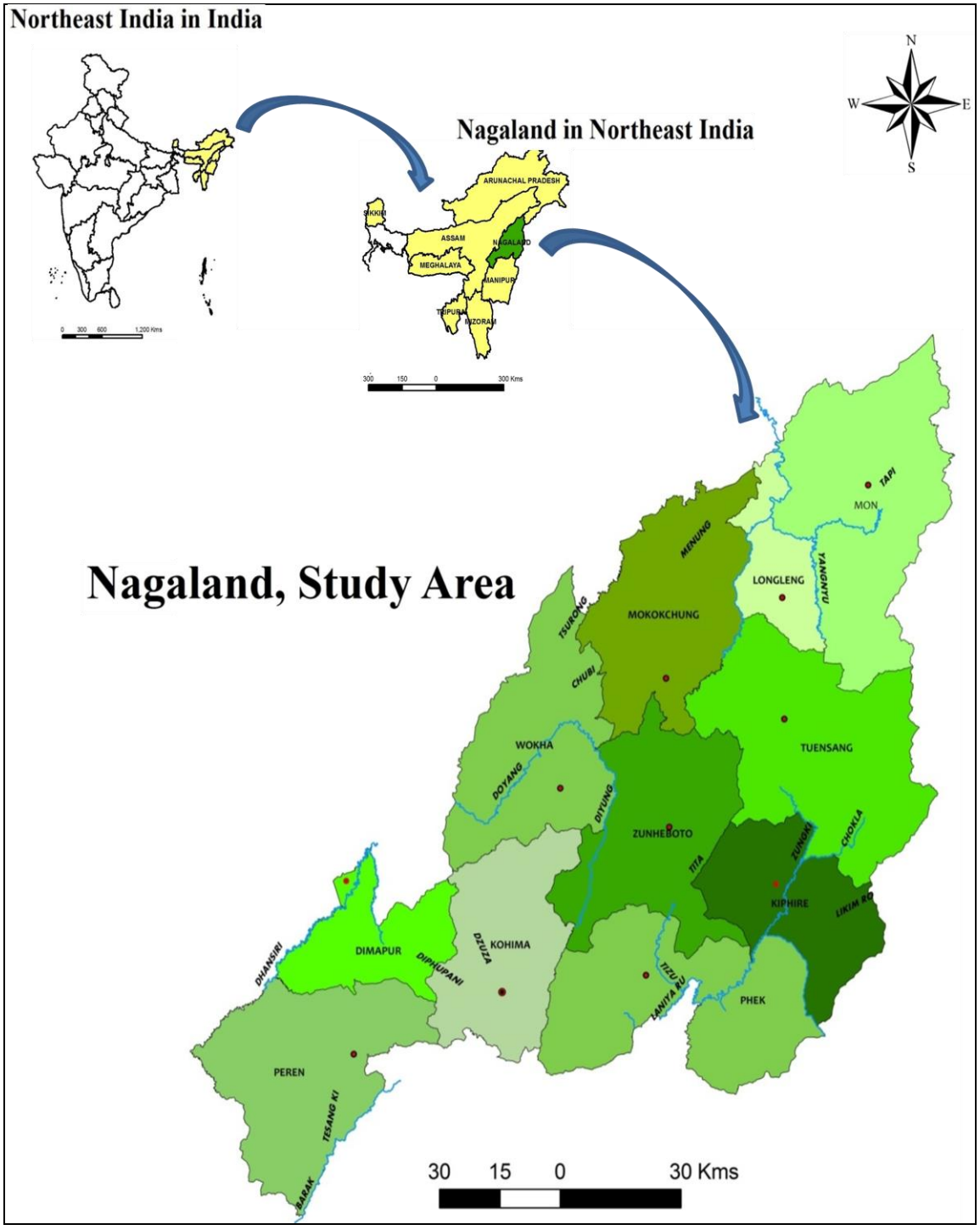

Fig. 1.1 Location Map of the Study Area viz., Nagaland, Northeast, India

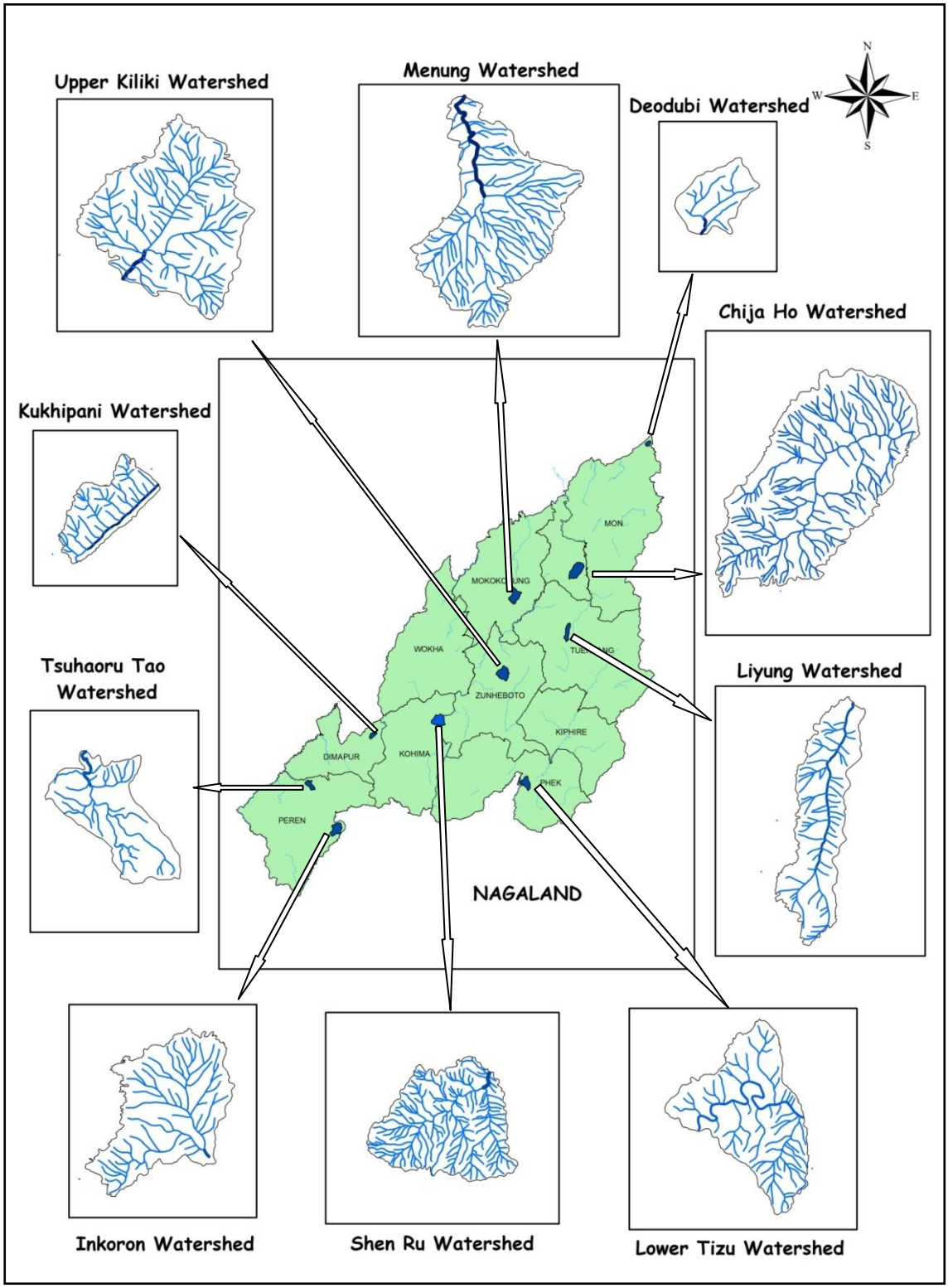

Fig. 1.2 Location of selected Sample watersheds in the Study Area viz., Nagaland, Northeast India

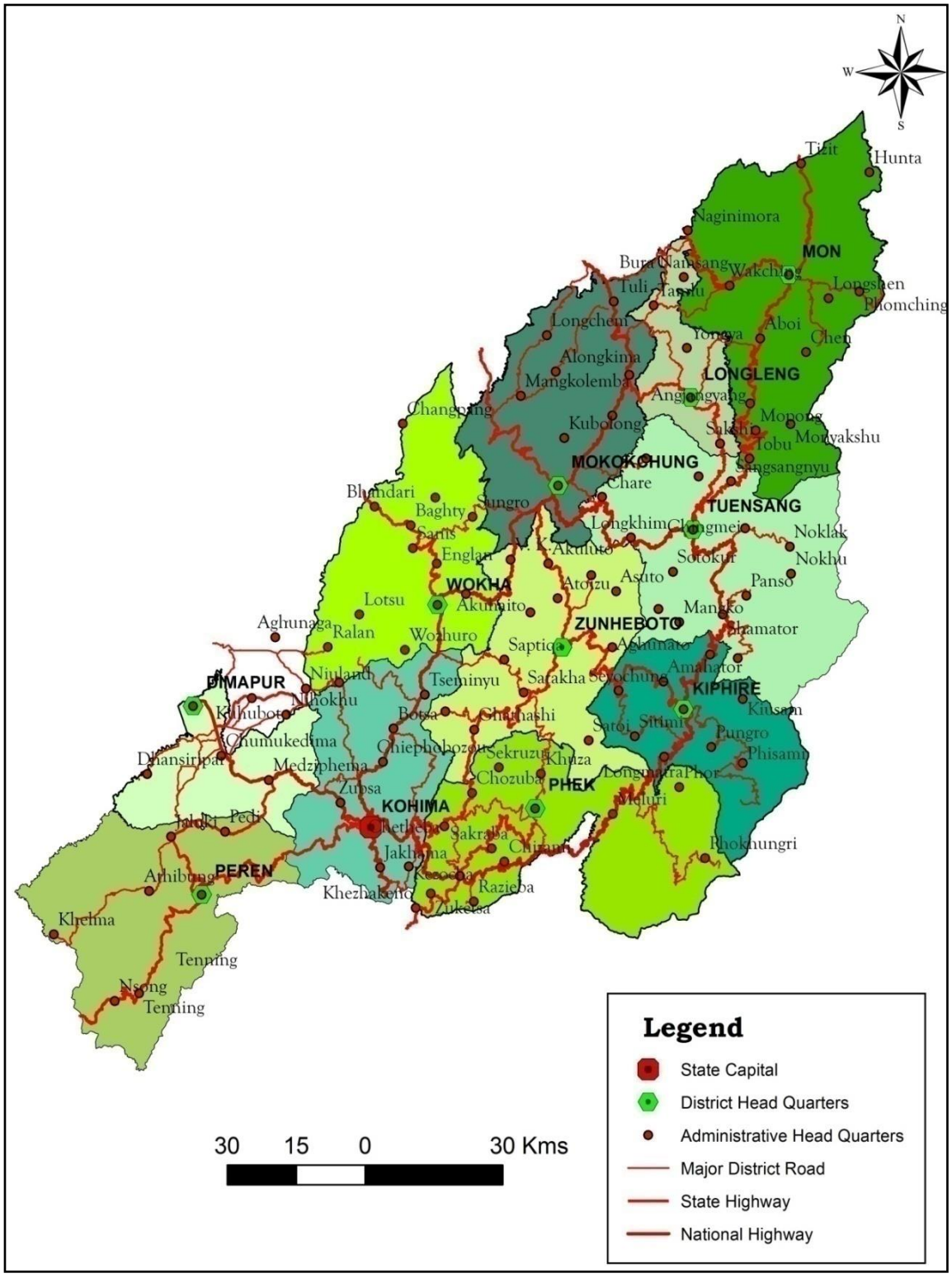

Fig.1.3 Index Map of the Study Area viz., Nagaland, Northeast India

THE OBJECTIVES

(1) To examine various ongoing watershed management projects in Nagaland.

(2) To develop spatial database for appropriate planning for integrated watershed management.

(3) To encourage people's participation in different levels for successful planning and implementation of massive watershed management programmes in Nagaland.

(4) To propose plans for integrated watershed management in the selected watersheds.

(5) To explore ways and means to promote sustainable development through integrated watershed management in Nagaland.

HYPOTHESIS

The pace of development and environmental conservation would have been accelerated much earlier if watershed management was introduced and promoted earlier.

Are actions urgently needed to be taken by policy and decision makers to implement the alternative approach of Integrated Watershed Management for sustainable development?

METHODOLOGY

This research has employed the watershed approach because in any development and environmental management activities in a mountain or hill ecosystem, this approach has scientifically proven that the inherent potential of all the resources is controlled by various factors such as physiography, geological base, soil, water and vegetation characteristics, climate, land use and socio-economic status. Watersheds have been widely recognized as a natural unit for environmental, socio-economic, natural resources use and management planning and sustainable development studies (Curry, 1997; Gregory & Walling, 1979). Watershed constitutes a technical and geohydrological unit which is self contained physically composite, functionally coherent for land, water and forest resources use and management planning. Therefore, watershed approach provides the best way of managing the resources so as to meet the present and future needs of the concerned community

without jeopardizing or destroying the environment and ecology. For sustainable development the holistic approach i.e., "Integrated Watershed Management" has been proved to be most effective in mountain ecosystem (Rawat, 2011). The present work has been done systematically as per the following methods.

a) Laboratory Work:

(1) Delineation of ten sample watersheds using Arc GIS 9.3 software and Satellite Imagery LISS IV. Google Earth and Toposheets have also been used to refer and confirm the boundary of the watersheds. The ten watersheds have been randomly chosen and delineated on the basis of different drainage network patterns. The work was done at the Nagaland GIS and Remote Sensing Centre, Kohima, Govt. of Nagaland.

(2) Base Maps of selected watersheds were prepared using ASTER GDEM.

(3) Detailed study and analysis of Topographical Maps and Satellite Imagery were conducted in the Cartographic laboratory of the Department.

(4) Detailed spatial database was created for micro level planning.

b) Field work:

(1) During field visits detailed data has been collected on meteorology, geomorphology, geology and general hydrology from different sites and departments of offices like Soil and Water Conservation, Geology and Mining, Geological Survey of India, Forest, Land Resources and Nagaland GIS and Remote Sensing.

(2) Data on environmental aspects and resources in the selected watersheds have been collected during the field work.

(3) Collection of detailed socio-economic information/data through secondary sources / Census etc. Questionnaires have been prepared and issued for feedback and gathered from various departments of offices in Nagaland to study for the ongoing watershed projects of the State.

c) Use of Research materials and instruments:

(1) Survey of India: Topographical Maps of Nagaland.

(2) Arc- GIS 9.3.

(3) Satellite Data: LISS IV Imagery, ASTER DEM, Google Earth.

(4) Field instrument – Altimeter, GPS handset, Brunton compass, measuring tape etc.

REVIEW OF LITERATURE

According to Coates, who introduces geomorphology in 1971 has defined this field as follows, "Environmental geomorphology is the practical use of geomorphology for the solution of problems where man wishes to transform or to use and change surficial processes". Many scholars have dealt with environmental geomorphology in the discussion of both specific topics and the various applications of geomorphology in terms of applied geomorphology which involved the issues and themes such as (1) the study of geomorphological processes and terrain that affect man including hazard phenomena such as floods and landslides (2) the analysis of problems where man plans to disturb or has already degraded the land-water ecosystem and (3) how the science of geomorphology can be used in environmental planning and management (Rawat, 2011). During the 1960s and 1970s geomorphology played a leading role in the resource surveys and mapping in several developing countries. The UNESCO has acknowledged the importance of applied geomorphology in its publication "Nature and Resources" being published since 1965 as well as in the programmes and publications of International Hydrological Decades (IHD). At the same time, geomorphological mapping was started in Poland, Russia and other countries with the main purpose of assessing their natural resources for economic development. Gautam (2011) has reviewed the role of applied geomorphological research carried out by different workers.

Integrated watershed management as a key to sustainable development in mountain ecosystem has increasingly become the focus of scientific interest in recent years. Rawat (2011) brings together geomorphological materials that have value in environmental and watershed management for sustainable development of the Himalayan watersheds. Babu and Dhyani (1998) has highlighted the socio-economic aspects of watershed management in India. Srivastava and Sinha, (1999) advocated that watershed management is a unique approach for the development of rain-fed areas on sustainable basis. It has a multi-pronged approach keeping the beneficiaries in the main focus. A wide spectrum ranging from soil conservation to overall development of the targeted rural areas are under watershed development activities. Watershed development activities aims at achieving a complex development objective, combining poverty alleviation and sustainable use of land, water and

vegetation resources based on a participatory watershed or catchment approach, recognizing community participation and integrated land and water management for optimal moisture retention and bio-mass production within the watershed. Watershed management is the process of guiding and organizing resources used on a watershed to provide desired goods and services without adversely affecting land, water and forest resources. To solve the problems of watershed areas and to achieve sustainable development, human social systems must merge in a compatible way with the natural ecosystems (Das, 1999).

Effective management of natural resources such as land and water is of paramount importance for a successful and sustainable watershed management. Watershed management projects need to be enlarged into a more participatory approach to achieve sustainable use of land and water resources. With the watershed as the unit of development, it is possible to work out a comprehensive approach for an efficient natural resource use plan. It has been observed that once productive resource like rain water has been made available to the people, they will indeed conserve the hilly watersheds as well as the natural resources to the best of their ability (Mittal, 1999). Sinha, (1999) describes watershed management is the rational utilization of land and water resources for optimum production with minimum hazards to natural resources. It essentially relates to soil and water conservation in the watershed which means proper land use, protection against all forms of deterioration, building and maintaining soil fertility, conserving water for farm use, proper management of local water for drainage, food production, sediment reduction and increasing productivity and uses.

Watershed development programmes are implemented by different departments at the centre and the states. Watershed approach is an accepted means to increase agricultural production while arresting ecological degradation in rainfed and resource poor areas. It also improves the level of living of the poor by providing more sustainable employment (Sharma & Kumar, 2010). Sheng (1990) presented a practical approach for planning watershed management projects or programmes. He emphasized the need for establishing sound data base and evaluation system. Sheng suggested that at the national or state level, quick reconnaissance surveys are useful to pinpoint major problem areas. More detailed surveys at the local or watershed level should concentrate on the critical watersheds that need more immediate attention by

planners and managers. Joshi (1986) discusses the causes and consequences of watershed degradation in the Himalaya. He indicated that poor land use practices are causing serious problems in downstream countries. Watershed management programmes are needed in all the countries and states of the Himalayan region. Tejwani (1986) stressed that training, research, demonstration and technology packages are essential to the development of successful watershed management programmes, yet they are grossly inadequate in most developing countries. Tejwani stressed that basic and applied research are needed to develop appropriate technological packages to solve the urgent problems of today and problems of a long-term nature. In country capabilities to plan and conduct research must be developed. This requires institutional strengthening as well as individual training and education.

Many prominent scholars like Bartarya, 1991, Bhardwaj & Dhayani, 1994 and Babu & Dhayani, 1998 and the tenth Five Year Plan, covering the period 2002-03 to 2006-07, which represents another step in the evolution of development planning in India, the concept of watershed development in the majority of the hill states of India has been visualized for sustainable and efficient utilization of the resources like land, water, vegetation, human and livestock for the benefit of the communities. Moreover, Furkumzuk (2011), in his Ph. D thesis has in particularly remarks that the effective integrated watershed management is rarely found in Nagaland, consequently requiring an effective approach to management of its natural resources in Nagaland.

SCOPE OF THE STUDY

The present study will add knowledge to the realm of integrated watershed management in different aspects of geography and resource management. A watershed level research can generate the information needed in terms of evaluation of biophysical and socio-economic parameters to formulate effective strategies for the scientific management of natural resources. Watershed management as a technology is not widely taught in the Indian Universities. However the planning and implementation process of watershed management requires well trained, well-oriented and committed man power for the successful results.

The present work will encourage for the introduction of courses on watershed management in the colleges and universities. The present study will also play an increasing role in strengthening applied research using latest techniques, and this will

highlight the need of such studies for sustainable development of Nagaland. This work will provide benchmark geospatial data base to ensure accurate and reliable decisions in planning. The outcome of the study will be useful for various researchers for further research of physical geographers, human geographers, environmental geographers, geomorphologists, hydrologists, ecologist, botanists, watershed managers and environmental scientists particularly engaged in mountain environment and sustainable development. The study adds the knowledge on the subject matter of different aspects of mountain environment, mountain geomorphology, watershed management and sustainable development. The outcome of this study will be useful for various research communities for further research.

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Chapter 2

GEOGRAPHICAL BACKGROUND

INTRODUCTION

Nagaland is the 16th State of the Union of India and one of the extreme northeastern States which lies between latitudes 25° 20' N to 27° 41' N and longitudes 93° 20' E to 95° 15' E with Myanmar in the east, Manipur in the south, Assam in the north and west and Arunachal Pradesh in the north (Fig. 1.1). Nagaland has a total geographical area of 16,579 km^2 divided into 11 districts namely, Kohima, Mokokchung, Zunheboto, Tuensang, Phek, Mon, Wokha, Dimapur, Longleng, Kiphire and Peren (Fig. 1.3). These districts are further divided into developmental blocks and circles for administrative conveniences. Nagaland is a hill state and hill/ mountain environment is fragile, highly susceptible to disturbance, with a low ability to rebound and to heal themselves after damage. The man-mountain relationship has never been more important than today. As government societies and individuals gradually exhaust the limited resources, and as population continue to expand, the prospects for man survival become increasingly dubious. This chapter describes about the environmental and geographical background of the study area as well as the human aspect of Geography. Geography is broadly divided in to two main branches as Physical geography and Human geography. Physical and human geography though, cannot be studied separately as various physical phenomena occurring spatially on the surface of the earth have human elements in them (Adhikari, 1999). Therefore, to understand the geographical background of a place or an area it is important to study both the branches and to do so we need to go deeper into each branch. Geographical studies include all types of studies from sciences to arts and commerce but it is marked by the difference where geographical studies of any matter or phenomenon include the spatial analysis (National Research Council, US, 1965).

PHYSICAL GEOGRAPHY OF NAGALAND

The physical geography deals with the study of the description of nature or physical phenomena like the size of the study area, physiography, topography, climate, geology, soil, drainage and vegetation. The sub-branches of physical geography thus deal with different kinds of physical phenomena (Adhikari, 1999). The physical geography of Nagaland is an interesting subject to deal with as we come across the diverse phenomena that are at play in nature. Nagaland is a small part of the Indian Himalayas. It lies bounded by other hill states and valleys. The

mountainous state of Arunachal Pradesh is in the north of the state; The Brahmaputra plains of Assam state lies in the north and west, at the south of the state is the valley of Barak River that is the Manipur state and finally it is internationally bordered by Myanmar/ Burma in the east which is also a catchment of Chindwin. Politically, Nagaland is one of the important states that hold a strategically important place in the country. Physiographically its place is in a significant location as the state though very small in size is with various topography and relief where high mountains upto the height of 3000 m above msl are found and as low as 150 m above msl in some places. Also, hydrologically, it is situated at the tri-junction of three major river systems giving rise to different geomorphological features. The topographical and relief differences also give rise to different climatic condition and thus we find variation in vegetation cover as well. Physiography and geology of the state also is a reason we find different types of soil in the state. Nagaland has a geographical area of 16,579 Km^2. with total forest cover of 13,044 Km^2, (FSI, 2013), and there are about 17 watersheds in Nagaland with area within 543 to 1731 Km^2.

PHYSIOGRAPHY AND TOPOGRAPHY

The most general and the broadest unit of geographic realm is the physiographic realm that incorporates a variety of ranges of environmental conditions. The term physiography involves more than the physical landscape and its constituent forms as it includes the climate, soil, hydrography, and other factors that relate to spatial changes in the overall natural landscape (Blij, *et. al*., 2004). The Indian physiographic divisions based on stratographic and tectonic history and relief along with erosional processes are the Northern Mountains, The Great Plains, The Peninsular Uplands and The Indian Coasts and Islands. The Himalayan Mountains are further subdivided into Western Himalaya, Central Himalaya and Eastern Himalaya. Nagaland falls under Eastern Himalaya which is further divided as Darjeeling-Bhutan-Assam Himalaya and Purvanchal. The Purvanchal covers an area of 94,800 Km^2. And it consist of Nagaland, Manipur, Tripura, Mizo Hills and Cachar districts along with a fifth of Halflong tashil of Assam State and a part of the district Tirap and Lohit (Singh, 2004). Further Nagaland can be divided into three distinct physiographic regions as Western low /Western low ranges, Middle hilly/Medium high hill ranges and Eastern mountainous / High hill ranges (Census, 1971).

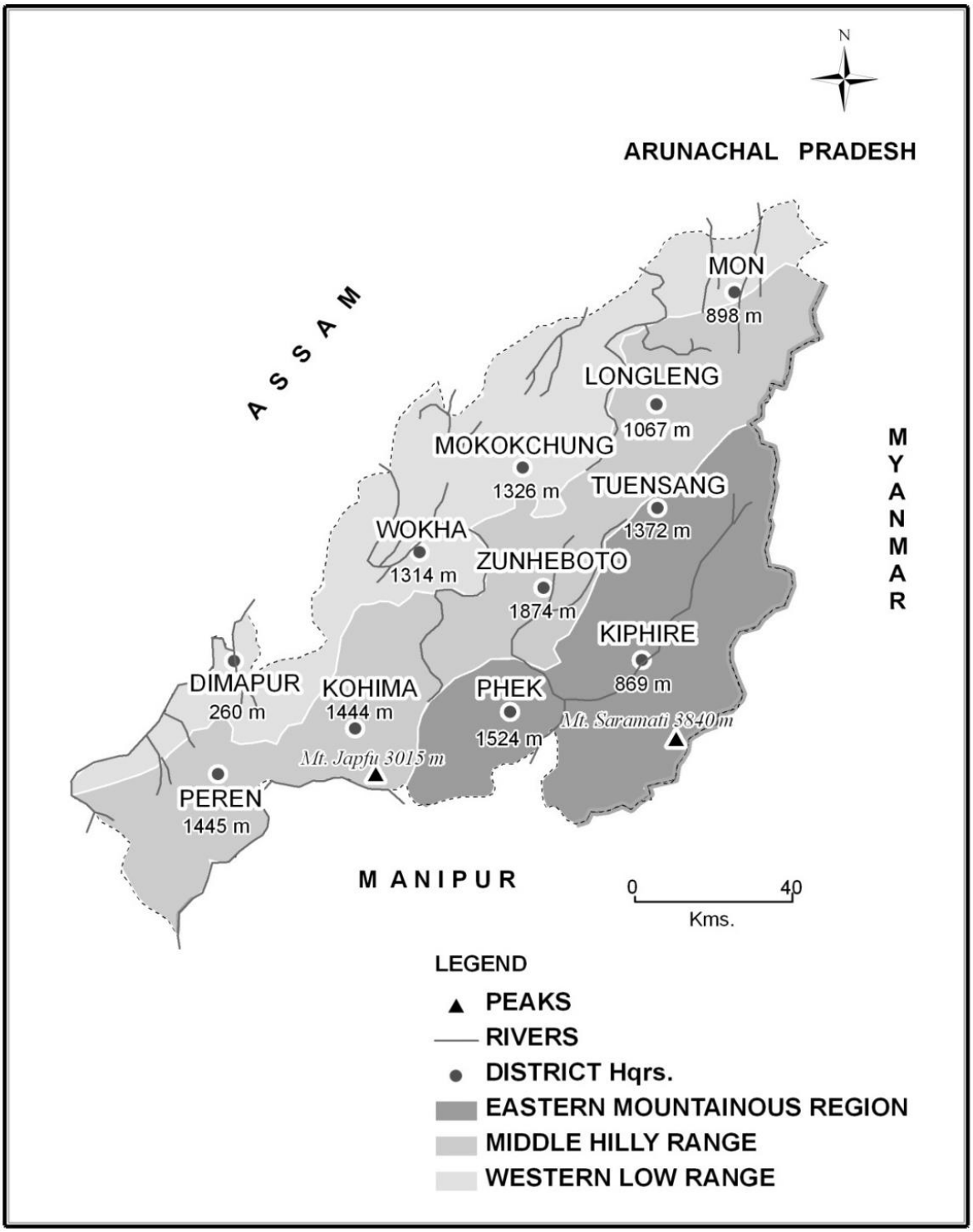


Fig. 2.1 Physiography Map of Nagaland (Source: Furkumzuk, 2011)

These ranges are aligned in northeast to southwest direction as it is with the geological structure of the state. The districts that come under the western low ranges are 10 percent of Peren, Dimapur, Wokha, Mokokchung and 30 percent of Mon. The Medium Hilly consists of 90 percent of Peren, Kohima, Zunheboto, 40 percent of Tuensang, Longleng and 70 percent of Mon districts. The eastern mountainous ranges consist of Phek, Kiphire and 60 percent of Tuensang districts. The rivers and streams that drain the land along with its geological history and structures give rise to the various topographical landforms of Nagaland. The most common feature we find in the state is the highly dissected hills with rivers and streams running along giving rise to its own sets of valleys. GSI (2011) divides Nagaland geomorphologically into four topographic units as

1. Alluvial plains: 150 to 200 meters above msl,
2. Low to moderate linear hills: 200 to 500 meters above msl,
3. Moderate hills: 500 to 800 meters above msl and
4. High hills: 800 meters and above

GEOLOGY

The geology of Nagaland forms a fairly young and mobile belt of the earth and it is a part of the northern extension of the Indo- Myanmar Range. This range has the Arunachal Himalaya on the north and stretches along Andaman and Nicobar Islands in the south. The Naga Hills represents the northernmost segment of Indo- Myanmar Range which terminates against the continental mass of the Mishmi Hills (Soibam, 1998). Tectonically and structurally Nagaland geology is very complicated. It is divided into three major structural units based on morphotectonic elements (Table 2.1 and Fig. 2.2). It is divided longitudinally from west to east as The Belt of Schuppen, The Inner Fold Belt and The Ophiolite Complex (Goswami, 1960; Mathur and Evans, 1964; Directorate of Geology & Mining, 1978).

Major Structural Units of Nagaland

Belt of Schuppen*:* The Schuppen Belt is characterized by the presence of sediments ranging in age from Eocene to Oligocene and Plio- Pleistocene along with the total absence of the Disang Group. This belt lies between the boundary of Assam valley alluvium along the flanks of Naga Hills at the west and the halflong-Disang thrust at

Table 2.1 Cenozoic Succession in Nagaland (modified after Agarwal & Ghoshe, 1986; Mathur & Evans, 1964; and International Chronographic chart, 2015)

<table>
<tr><th>ERA</th><th>PERIOD</th><th>EPOCH</th><th>GROUPS</th><th>BELT OF SCHUPPEN</th><th>INNER FOLD BELT</th><th colspan="3">OPHIOLITE BELT</th></tr>
<tr><td rowspan="16">Cenozoic</td><td rowspan="4">Quaternary</td><td>Holocene</td><td>Alluvium</td><td>Newer Alluvium
Older Alluvium</td><td>Newer Alluvium
Older Alluvium (High Level Terraces)</td><td colspan="3">Newer Alluvium
Older Alluvium (High Level Terraces)</td></tr>
<tr><td>Pleistocene</td><td>Dihing</td><td>Dihing Formation</td><td></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="6">-------Unconformity-------</td></tr>
<tr><td>Pleistocene</td><td rowspan="2">Dupitila</td><td rowspan="2">Namsang Formation</td><td></td><td colspan="3"></td></tr>
<tr><td rowspan="3">Neogene</td><td>Pliocene</td><td></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="6">-------Unconformity-------</td></tr>
<tr><td>Pliocene</td><td rowspan="2">Tipam
Surma</td><td>Girujan Clay
Tipam Sandstone Formation</td><td></td><td colspan="3"></td></tr>
<tr><td>Miocene</td><td>Bokabil Formation
Bhuban Formation (Upper Bhuban Middle Bhuban)</td><td>Middle Bhuban
Lower Bhuban</td><td colspan="3"></td></tr>
<tr><td></td><td colspan="6">-------Unconformity-------</td></tr>
<tr><td rowspan="5">Paleogene</td><td rowspan="3">Oligocene</td><td rowspan="4">Barial</td><td>Tikak Parbat Formation(Renji)</td><td rowspan="3">Barail group undifferentiated</td><td colspan="3">Jopi Formation (conglomerate sequence)</td></tr>
<tr><td>Baragolai Formation(Jenam)</td><td colspan="3"></td></tr>
<tr><td>Naogaon Formation(Laisong)</td><td colspan="3">Phokpur formation (Agglomerate sequence)</td></tr>
<tr><td colspan="4">-------Unconformity-------</td></tr>
<tr><td>Upper Eocene
Paleocene</td><td rowspan="3"></td><td rowspan="2"></td><td rowspan="3">Disang</td><td>Upper Disang Formation</td><td colspan="2" rowspan="3">Ophiolite Complex (Zhipu Formation)</td></tr>
<tr><td rowspan="2">Cretaceous</td><td>Upper</td><td></td><td>Lower Disang Formation</td></tr>
<tr><td></td><td colspan="6">-------Unconformity-------</td></tr>
<tr><td>Mesozoic</td><td>Pre Cretaceous (?)</td><td></td><td></td><td colspan="2"></td><td>Naga Metamorphic</td><td>Thongshunyu Formation
----Unconformity---
Nimi Formation</td></tr>
</table>

the east. There are six groups found within this belt, namely Barail, Surma, Tipam, Moran, Dihing and Alluvium.

***Inner Fold Belt*:** This belt is characterized by the wide spread of Disang rocks with isolated outliers of Barail as well as by two major synclinoria, the Kohima Synclinorium in the south and Patkai Synclinorium in the north. This belt lies at the central part of the state and beyond the state it extends upto the Pngsu Pass in Arunachal Pradesh. Three groups are present in the Inner Fold Belt, namely, Disang, Barail and Surma.

Ophiolite Belt: Ophiolite Belt is characterized by structurally controlled drainage and it is comprised of basic and ultra basic intrusive as well as extrusive rocks. The associated sedimentary rocks include limestone, chert, shale, sandstone and conglomerate. It lies between younger Disang sediments on the west and Saramati formation on the east. There are three groups present here namely, Naga Metamorphic, Disang and Barail.

Stratigraphy of Nagaland

Naga Metamorphic Complex: It comprises of mica schist, granitoid gneiss, and feldspathic meta grey wacke with tectonic slices of ophiolite of variable dimensions. This formation is overlain by the Nimi formation that consists of interbands of phyllite, quartzite, limestone, and quartzsericite schist.

***Zepuhu Formation*:** This formation lies between the Nimi Formation in the east and Disang group on the west. It is characterized by serpentinite, cumulates, and volcanic rocks where associated pelagic sediments including chert and limestone are interbedded.

Jopi/Phokphur Formation: This formation is considered equivalent to the Barail, comprises of tuffaceous shale, sandstone, greywacke, grit, and conglomerate. Minor limestone and carbonaceous matter are also noted in the rocks.

Disang Group: The major rock types that cover the most of the area in Nagaland is this group. It comprises of flysch sediments, splintery shale and sandstones.

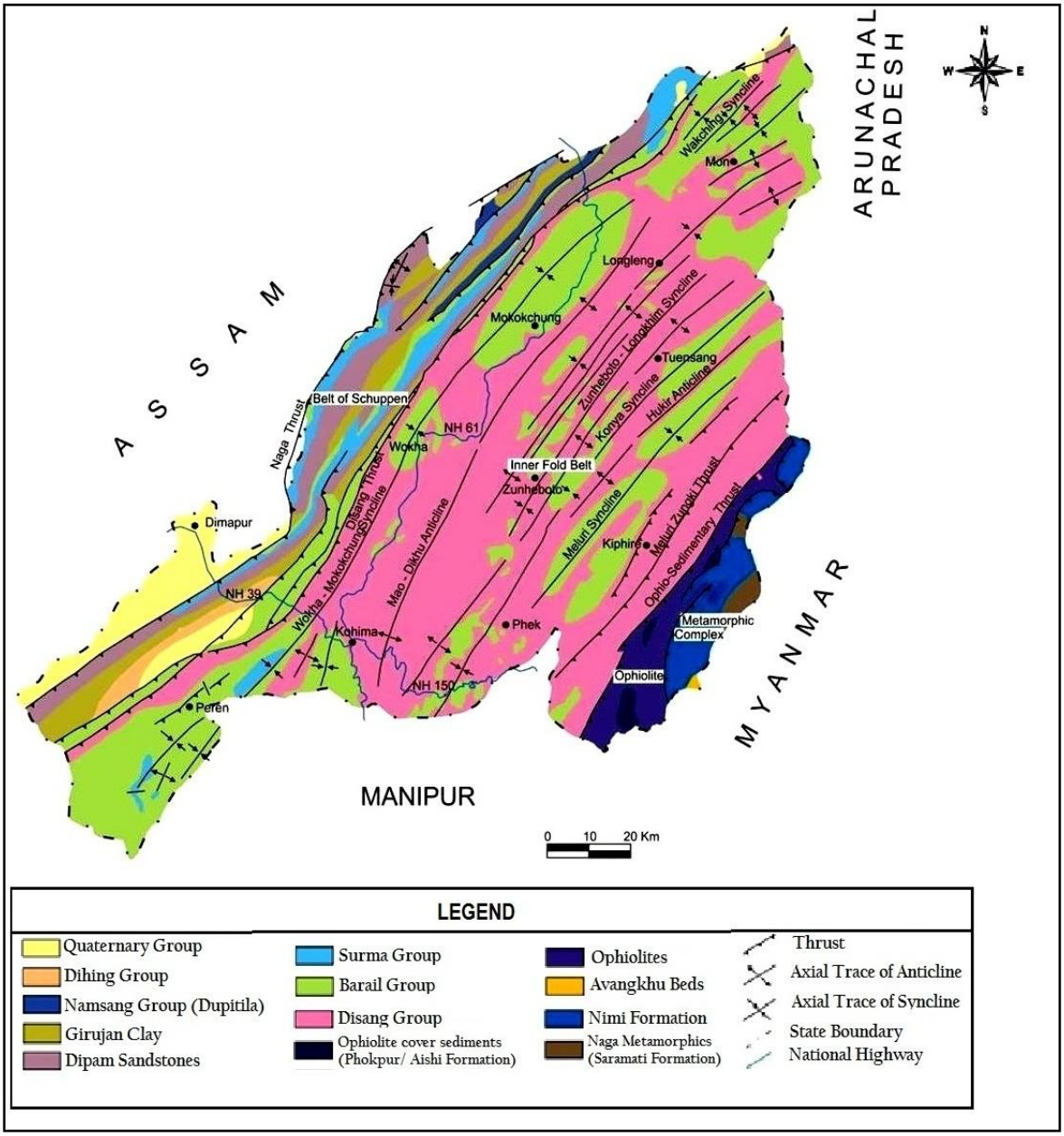


Fig. 2.2 Geological map of Nagaland (Source: Geological Survey of India, Shillong)

Barail Group*:* The rock of this group is found scattered all over the state. It also comprises of thick sequences of sandstones intercalated with thin papery shale. Barail may be divided into three formations that include Laisong, Jenam and Renji in the south and southwest and in the northern intermediate hills of Nagaland have Tikak Parbat, Baragolai and Naogaon formations. The Liasong Formation comprises of very hard, grey, thin bedded sandstones alternating with hard sandy shale. The Jenam Formation is made up of predominantly of massive sandstones with intercalations of shale, sandy shale and calcareous and iron stained shale. The Renji sandstones are

massive, hard, ferruginous, and very thick bedded and intercalated with minor shale. The Naogaon sandstones are hard, grey, thin bedded and fine to medium grained and intercalated with some shale and carbonaceous shale. The Tikak Parbat and Baraglai formations are made up of sandstone, shale, carbonaceous shale, and coal.

Surma Group: the rocks of this group are found exposed on the western margin of Nagaland. They comprise alternations of well-bedded sandstones, shaly sandstone, mudstone, sandy shale, and thin beds of conglomerate. It is subdivided into the Bhuban and Bokabil formations.

Tipam Group: The formations of this group are found exposed along the western fringe of Nagaland. The Tipam comprises of massive sandstones that are highly friable and contain subordinate clay and shale. The Girujan Clay Formation is essentially argillaceous, consisting of bluish-gray mottled clay, sandy clay and subordinate sandstone.

Dupitila Group: The Namsang beds belonging to this group lie unconformably over the Girujan Clay. They consist of sandstone, pebbles of lignite, conglomerate, grit, mottled clay, and lenticular seams of lignite. They are also confined to the Schuppen belt.

***Dihing Group*:** This group lies unconformably over Namsang beds and consists of an unconsolidated mass of Barail boulders and pebbles interspersed with clay and soft sand.

Alluvium and High Terraces: Alluvium and high-level terraces are found in many parts of Nagaland. The high-level terraces are dominantly boulder beds with coarse sand, gravel, and clay at various levels above the present rivers. The older alluvium occupies the northeastern tract of the Naga-Patkai ranges while the newer alluvium covers the western border of Nagaland. The older alluvium is composed mainly of cobbles and boulders with considerable amount of clay, silt, and sand. The younger alluvium occurs as recent alluvial deposits of rivers and streams. They are principally composed of dark gray to black clay, silt, and sand deposits.

SOILS

A land which is about 80 percent rural and one of the main activities being agriculture, study of soil in Nagaland is fundamental. Land is said to be the basic resource on which virtually every economic activity is performed by man. For all

practical purpose land is indispensable for the very existence and survival of man. Soils are directly derived from the parent formations such as siltstones, shales, sandstones, mudstones etc. In Nagaland the parent formations are of Tertiary rocks belonging to Barail and Disang group (GSI, Govt. of India, 2011). The foothills and the hills usually comprise of Alluvial and co-alluvium soil. The ecosystems significantly influence the process of soil formation. The soils of Nagaland are generally acidic, very rich in organic carbon but poor in phosphate and potash content. Soil is divided into 12 orders which is the broadest classification of soil. That is each of the soil of the world falls under these 12 orders (Schoonover & Crim, 2015). The 12 orders of soil found world over are Alfisols, Andisols, Aridisols, Entisols, Gelisols, Histosols, Inceptisols, Mollisols, Oxisols, Spodosols, Ultisols, and Vertisols. The soil of Nagaland falls under the four of them which are Entisol, Alfisol, Utisol and Inceptisol (Humtsoe, 2015).

Soil Order

Entisol: These soils are defined by the absence or near absence of horizon (layers) that clearly reflect soil-forming processes. They are formed on surface features of recent geologic origin, on underlying material that is highly resistant to weathering, or under conditions of extreme wetness or dryness. Entisols are found in the westernmost and the south-eastern part of Nagaland. It covers an area of 1213 Km^2 which is 7.32 percent of the total geographical area of the state. It is also known as the alluvial soil and is one of the most fertile soils mainly found at the low-lying area and the banks of rivers.

Alfisol: They are formed mostly under forest vegetation. In Nagaland it is found on the western low lying areas. They are generally fertile and productive having high concentration of nutrient cations (Ca, Mg, K, and Na) and form in regions with sufficient moisture for plants for at least part of the year. Alfisols cover an area of 478 Km^2. which is 2.88 percent of the total area and is the least common soil found in the state.

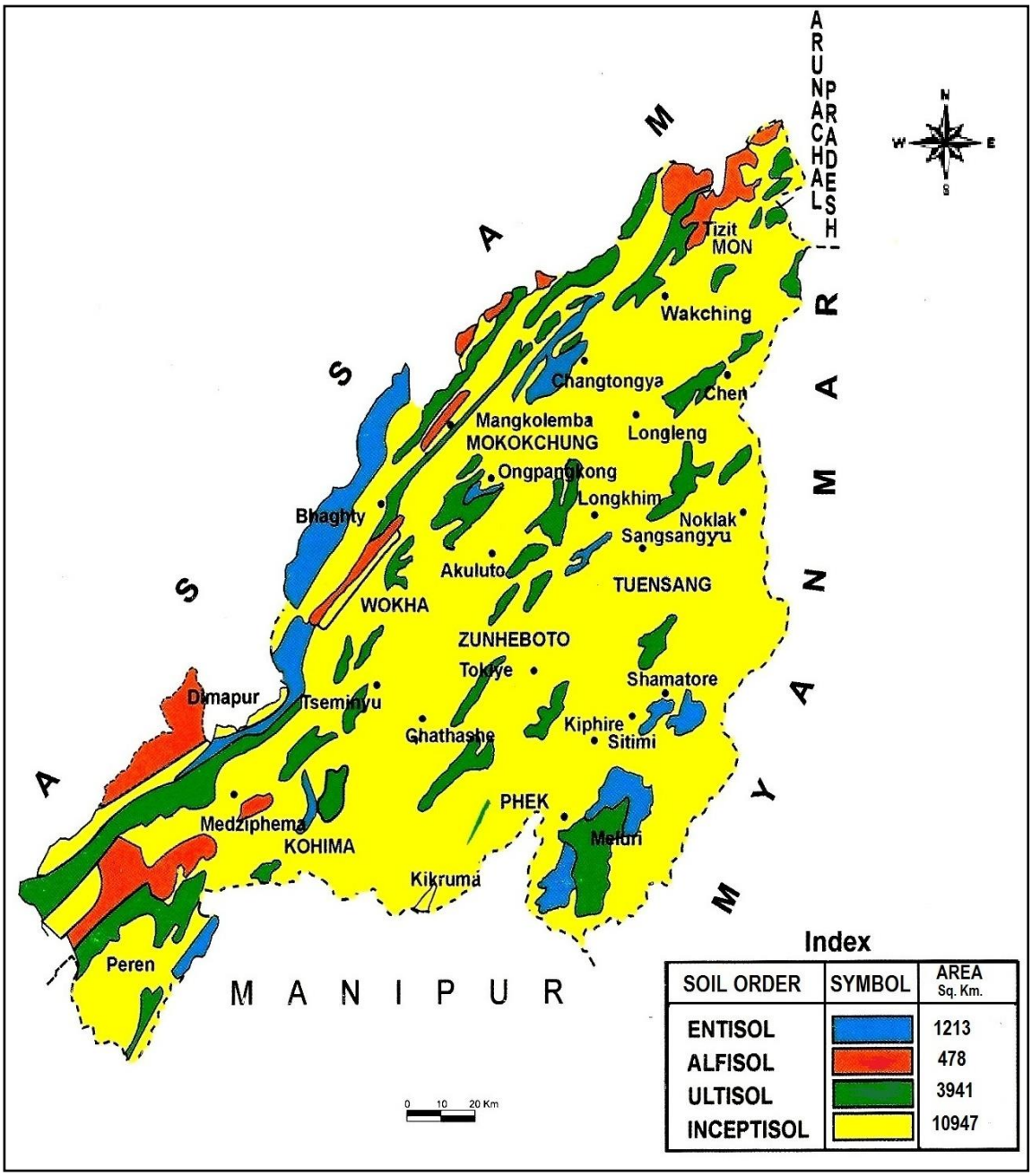


Fig. 2.3 Soil Map of Nagaland (Source: Department of Soil and Water Conservation, Govt. of Nagaland)

Ultisol: They are typically formed on older geologic locations in parent material that is already extensively weathered. They are found in Nagaland, mostly in the middle hilly ranges of the state. 23.52 percent of the state is covered by this soil order with an area of 3941 Km^2.

Inceptisol: The most widely spread soil found in Nagaland is the Inceptisol. These soils are in the beginning stages of soil profile development. The differences between horizons are just beginning to appear. Prominent in mountainous areas, but occur almost everywhere. They have widely variable productivity potential. With area coverage of 10,947 Km^2 that is 66.03 percent of the total is the most common soil order of the State.

DRAINAGE

Drainage system of an area refers to the system of flow of surface water through rivers and its tributaries within a basin. The study of drainage system is to study the streams, its direction of flow in which the surface water is carried into its mouth. Many factors or phenomena are related to the surface flow, for example, the slope of land, geological structure, amount of volume of water and the velocity of water. A number of perennial and seasonal rivers and streams are found dissecting the land of Nagaland. Barail and Japfu ranges and their extensions in Mokokchung and Tuensang mark a prominent water divide separating Brahmaputra and the Chindwin River systems. The southern part of the state towards the west is touched by another drainage system, Meghna drainage system. The drainage pattern is mainly dentritic and controlled by trend lines and lineament at laces. In plain country meandering pattern is observed. The drainage is structurally controlled and locally trellis in nature in the eastern mountain belt (GSI, Govt. of India, 2011).

Major Rivers of Nagaland

The major rivers of Nagaland flowing through the three drainage systems are Doyang, Dikhu, Dhansiri, Tisu, Tsurong, Nanung, Tsurang, Menung, Dzu, Langlong, Zunki, Likimro, Lanye, Dzuza and Manglu. These rivers have dentritic pattern and are of the order seven to nine. The westward flowing rivers that flow into Brahmaputra are Dhansiri, Doyang and Dikhu. The Tizu River is the only river in Nagaland that flows eastward and joins the Chindwin River in Burma.

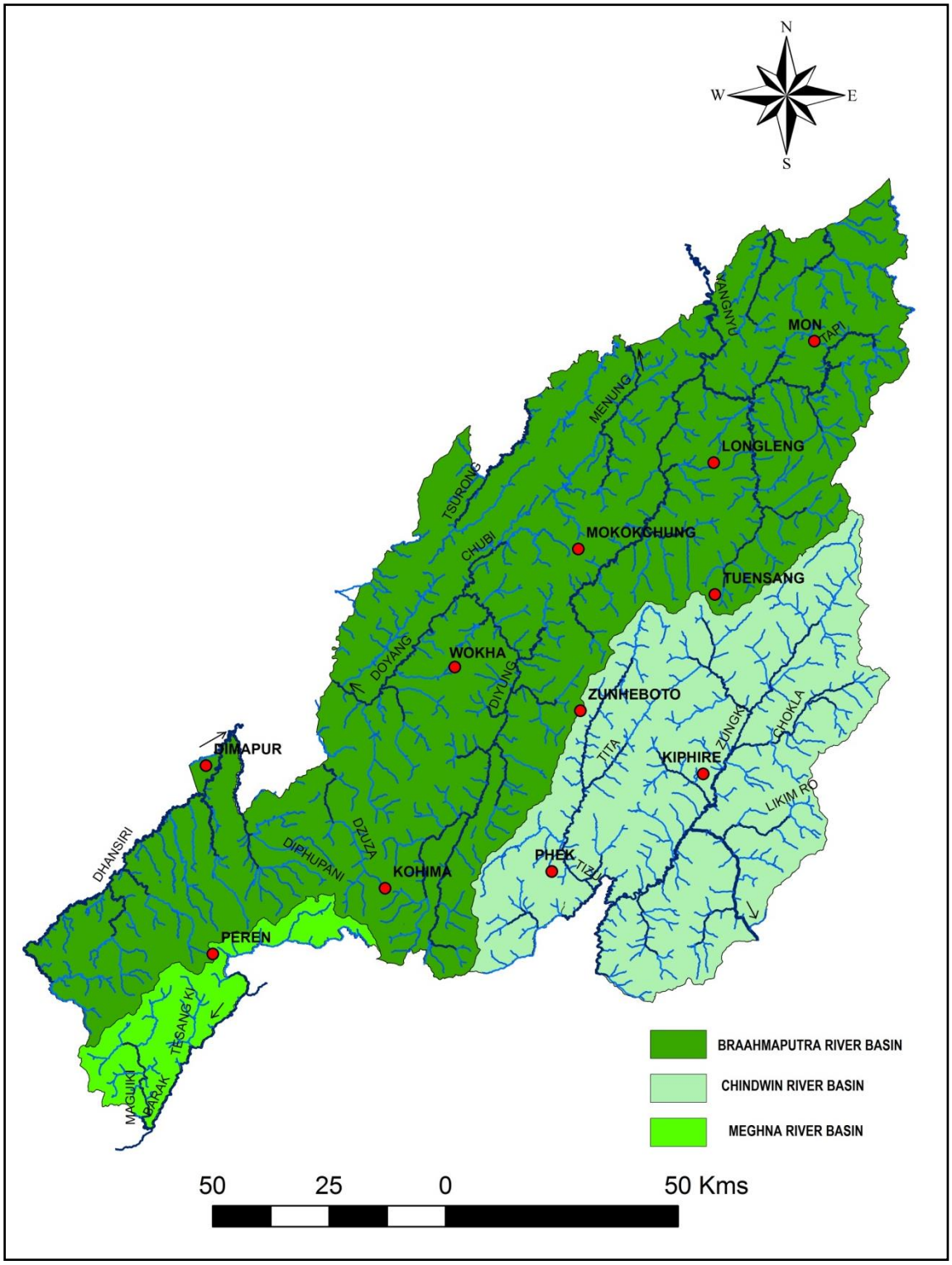


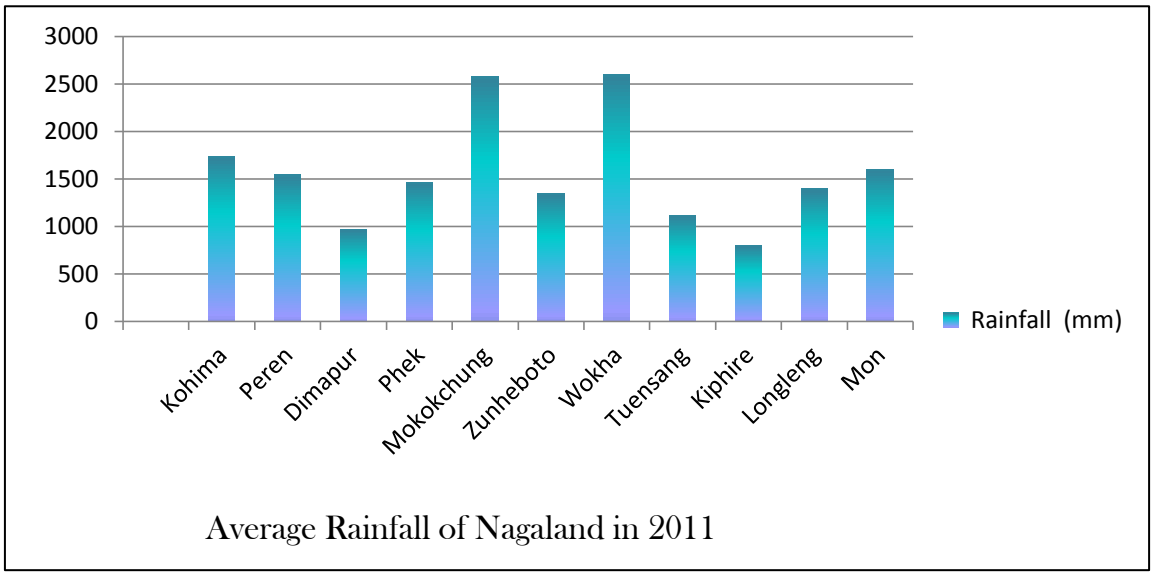
Fig. 2.4 Drainage System of Nagaland

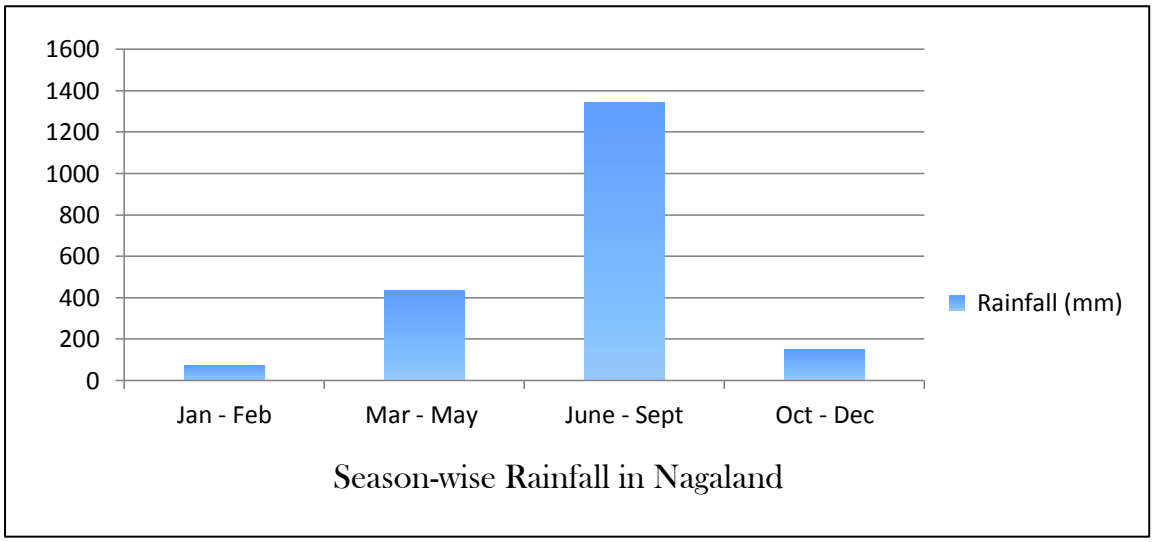
CLIMATE

The climate of Nagaland is humid tropical or typical monsoon with variations ranging from tropical to temperate conditions. Variations are caused by change in physiography such as: plain area experience warm and subtropical climate. The foothill areas with rolling to undulatory topography experience subtropical climate. Low to moderate ranges with varying degree of slopes have sub-montane climate (GSI, 2011). Monsoon starts from the month of May extending up to the month of September where May to June is considered as the wettest months. The moisture index ranges from 40 percent to 60 percent and annual average rainfall is in between 1500 mm to 1800 mm over the months of May to October and the potential evapo-transpiration is 1219 mm. The state however undergoes a shortage of water for a considerable period from November to April (State Level Nodal Agency for IWMP, 2011). The Table 2.2 shows the average rainfall data of the year recorded at the District headquarters (Fig. 2.5).

Table 2.2 Meteorological data of the year 2011 at the District Headquarters with the highest altitude (source: Dept. of Soil and Water Conservation)

Sl. No	Name of the District	Average rainfall in mm	Temperature			Average Relative Humidity %	Altitude in meters, msl
			Ave. Max. Temp. °C	Ave. Min. Temp. °C	Ave. Mean. Temp. °C		
1	Kohima	1735.8	22.28	11.77	17.0	65.4	1444.12
2	Peren	1542.4	30.05	19.81	24.93	85.79	1445.36
3	Dimapur	973.1	30.5	20.6	25.5	90.5	260.00
4	Phek	1465.6	25.7	17.5	21.6	79.3	1524.00
5	Mokokchung	2575.7	25.73	18.32	22.03	76.36	1325.08
6	Zunheboto	1351.4	21.26	11.68	16.47	79.8	1874.22
7	Wokha	2600.2	23.9	16.4	20.1	78.3	1313.69
8	Tuensang	1120.5	23.3	16.0	19.6	83.0	1371.60
9	Kiphire	801.2	27.17	15.17	21.17	77.9	896.42
10	Longleng	1395.1	28.39	20.32	24.36	81.5	1066.30
11	Mon	1601.0	26.0	15.7	20.8	84.7	897.64
Nagaland		**1560.182**	**25.88**	**16.71**	**20.98**	**80.23**	





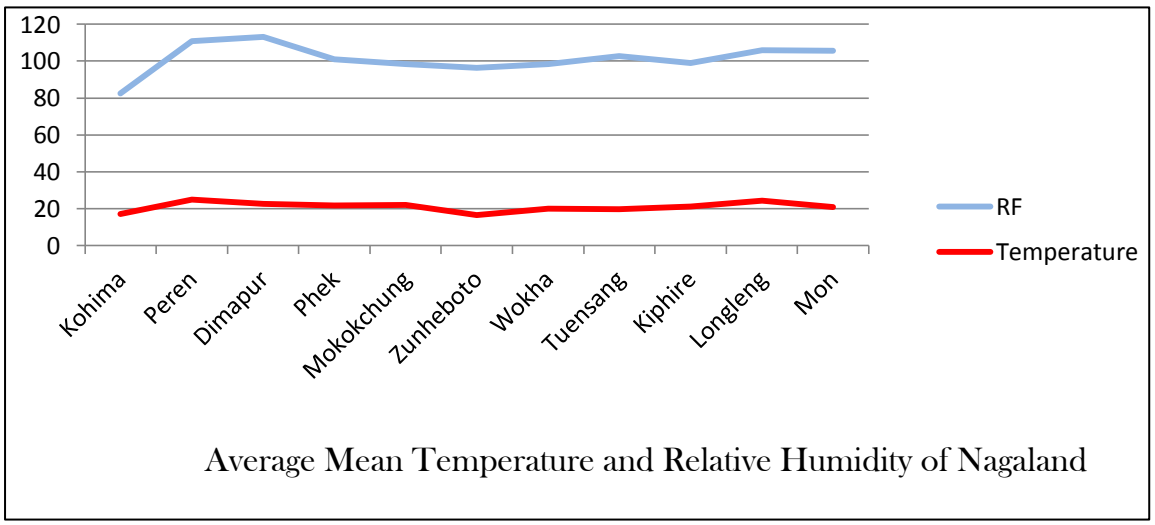


Fig. 2.5 Graphical representation of meteorological data recorded in different district Headquarters of Nagaland

Table 2.3 Season -wise Average Rainfall (mm) in Nagaland (modified after Ministry of Agriculture and Farmers Welfare, Agriculture Contingency Plan 2012-13)

Sl. No.	Season/ Months	Normal RF (mm)	Normal Days (number)
1	Pre-monsoon/ Summer (March - May)	436.76	34.21
2	SW Monsoon (June - September)	1342.98	86.07
3	Post- monsoon/ Autumn (October - December)	151.40	16.33
4	Winter (January - February)	74.9	5.18

Owing to different topography and relief features in the State annual rainfall or temperature of the state is not the same everywhere. Even within a few kilometers difference in the districts there are found to be vast difference in climate. For example the district of Kohima and Dimapur, they are just 74 Kms away from each other but Kohima is a cold place with heavy rainfall whereas Dimapur is a hot place with lesser amount of rain comparatively. We find similar cases for the rest of the state too where nearby places with altitudinal difference and topographical differences giving rise to difference in climate. Even within a particular area the relief features plays an important role in the weather conditions, low temperature and high rainfall is on windward slopes where as the leeward side experience dry weather. Heavy precipitation in the form of snow is also found at the top of the mountains of Japfu and Saramati during the chilly months of December to February.

VEGETATION

The location of Nagaland and its physiographic terrain favors a wide variety of forest types and other vegetation. As per classification by Champion and Seth (1965), the forest department has categorized the following forest types of Nagaland as follows

a. Northern Tropical Wet Evergreen Forest

Found in Mon district with dominant species hollong, makai, nahor etc.., here evergreen species dominate the deciduous species. It once filled the whole area of Namsa-Tizit area but now only a small portion in Zankam area in Mon district is found.

b. Northern Tropical Semi Evergreen Forest

These are found in the foothills of Assam-Nagaland border in Mokokchung, Wokha and Kohima districts. Here evergreen species are lesser in number while deciduous species are more in number.

c. Northern Sub-Tropical Broad Leaved Wet Hill Forest

The hills with elevation between 500 m and 1800 m in all the districts of Nagaland are covered with this type of forest. The dominant species found are mostly semi-deciduous. Important timber like koroi, pomas, sopas, gamai, gogra, hollok, sam, am, badam, betulaetc are found.

d. Northern Sub-Tropical Pine Forest

High hills with elevation between 1000 m to 1500 m in parts of Phek and Tuensang districts of Nagaland find this type of forest. Pine is the dominant species and others like quercus, schima, prunus, betula and rhododendron are also found along with it.

e. Northern Montane Wet-Temperate Forest

Higher reaches where the tallest mountains like Mt. Saramati stands, find this type of forest. Rhododendron, oaks, birch and juniperussp dominates the area.

f. Alpine Forest

Alpine vegetation is found at high altitudes in ridges of Saramati range, which is covered with snow for major part of the year from the month of October to April. After the snow melts during the brief summer a few annuals, herbs and shrubs along with mosses can be seen growing there. Species like rhododendron, abies and juniperus are found in semi-alpine area. Sub-alpine vegetation gradually merges into alpine vegetation which comprises of high altitude grasses and dwarf rhododendrons. Many members of primulaceace, saxifragacae and polygonaceace are also found.

In Nagaland, 83.3 percent of forests are owned by villagers and the Government has no control over the felling of trees in these areas. 78.68 percent of the total geographical area is cover with forest. Out of which 7.83 percent is very dense forest, 28.57 percent of moderate dense forest and 42.28 percent is the open forest. Over the years the forest cover of the state has been decreasing due to various factors, mostly due to human interference. A loss of 274 Km^2. is noted during the

2013 assessment which would mean loss of habitat for animals and birds, trees and biodiversity as a whole.

Table 2.4 District-wise Forest Cover of Nagaland (Area in Km^2) (Source: Forest Survey of India, 2013)

District	Geographical Area	2013 Assessment				Percentage of GA	Change	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Kohima	3,283	289	1,136	1,472	2,897	88.24	- 26	0
Peren								
Dimapur	758	0	75	352	427	56.33	35	0
Phek	2,026	276	652	764	1,692	83.51	- 75	0
Mokokchung	1,615	6	519	835	1,360	84.21	11	0
Zunheboto	1,255	85	385	515	985	78.49	- 53	0
Wokha	1,628	1	491	862	1,354	83.17	- 24	0
Tuensang	4,228	609	1,027	1,490	3,126	73.94	- 106	1
Kiphire								
Longleng								
Mon	1,786	32	451	720	1203	67.36	- 36	1
Nagaland	16,579	1,298	4,736	7,010	13,044	78.68	-274	2

HUMAN GEOGRAPHY OF NAGALAND

Human geography studies the location and distributional aspect of cultural phenomena, resulting from ever changing man-nature interaction. Human geography is defined as the synthetic study of the relationship between human societies or activities and the earth's surface (Adhikari, 1999). Human geography tends to explore the social, economic, culture, political and population dimensions of human existence, and situate analysis in geo-graphical space (Gibson, 2009). Human geographers therefore study the patterns of interaction between human cultures and environments. They focus mainly on the causes and consequences of human settlement and distribution over the landscape. The economic and cultural aspect of human geography is better understood when the landscape of economic and cultural activities taking place is described and likewise human activities alters and create the landforms of the earth's surface.

The human geography of Nagaland is an interesting topic as we find in this small geographical area a number of variation, culturally and socio-economically. This is no doubt due to the presence of topographical and relief difference, but it is also because of the history behind the origin of the Nagas. The land is divided into eleven districts and when we look at it closely each district is for a different tribe, with some exceptions like Kohima where Angami and Rengma tribes live within the same district. The north and south of the state also differ in physical stature of the people. Different languages not intelligible with each other are also observed. We find two systems of cultivation practiced in Nagaland which is also a north south difference. It is interesting to note that the inhabitants of the state, for centuries stayed in a closed community. There were raids and disputes over land as the ancestors of the land were establishing their territories. For better defense position and attack as well, villages were built at the most commanding area on the hill tops. Hence most of the villages in Nagaland are usually situated at the top of the hills. With a self sufficient economy there was very little interaction with other tribes and villages because of which Nagas got itself isolated from one another and lived their lives entirely woven around their own land, their families, their clans, the area or blocks and hence their own village (Directorate of Census Operations, Nagaland, 2011).. The headhunting practice popular with the ancient Nagas, isolation from outside their land, and other cultural practices came to a drastic change with the coming of Christianity from the Americans and education from the Britishers as well as the missionaries. Cultural landscape and the socio economic disperse of the land can be thus studied in human geography.

POPULATION

Human occupy the core of cultural environment of many region. The growth of population has great bearing on man-land ratio, value of land, quality of life and socio-economic dimension of a region. The State has 1,978,502 people living in the various towns, districts and villages Department of Economics and Statistics, Government of Nagaland, (2014).The population density is 119 persons per Km^2 against the country's population density which is 382 persons per Km^2 and the northeastern population density of 148 persons per Km^2.

Table 2.5 District-wise Area, Population and Density, Sex Ratio, (Source: Statistical Handbook, 2014)

Sl. No.	District	Area in Km^2	2011		
			Population	Density per Km^2	Sex Ratio
1	Kohima	1463	267,988	183	928
2	Peren	1651	95219	58	915
3	Dimapur	927	378,811	409	919
4	Phek	2,026	163,418	81	951
5	Mokokchung	1,615	194,622	121	925
6	Zunheboto	1,255	140,757	112	976
7	Wokha	1628	166,343	102	968
8	Tuensang	2536	196,596	79	929
9	Kiphire	1130	74,004	65	956
10	Longleng	562	50,484	90	905
11	Mon	1,786	250,260	140	899
Nagaland		**16,579**	**1,978,502**	**119**	**931**

As shown in the map, (Fig. 2.6), population is mainly concentrated in the capital city and the business hub of the State. Kohima, the city is densely populated as the Directorates of all the Offices and the Nagaland Civil Secretariat as well as Accountant General (A & E) are here and the central government servants from main land as well as from all the other districts of the State stay permanently and temporarily. Dimapur is the commercial hub of Nagaland as it acts as the gateway to the State. Bordered with Assam and the only railway passing through Nagaland is Dimapur and so the influx of people in the area is high for commercial purpose. The moderately dense populated districts are Zunheboto, Wokha, Mokokchung and Mon. Among these group Mon is the most populated and highest in density too and Wokha is the least density. Below 100 persons per Km^2 are the districts of Longleng, Tuensang, Kiphire, Phek and Peren. Tuensang and Phek are the two largest districts and have low population densities where as Longleng with the smallest area also has low population density (Fig. 2.6). The large area of Tuensang and Phek controls the density while the low population is a factor for low density of Longleng.

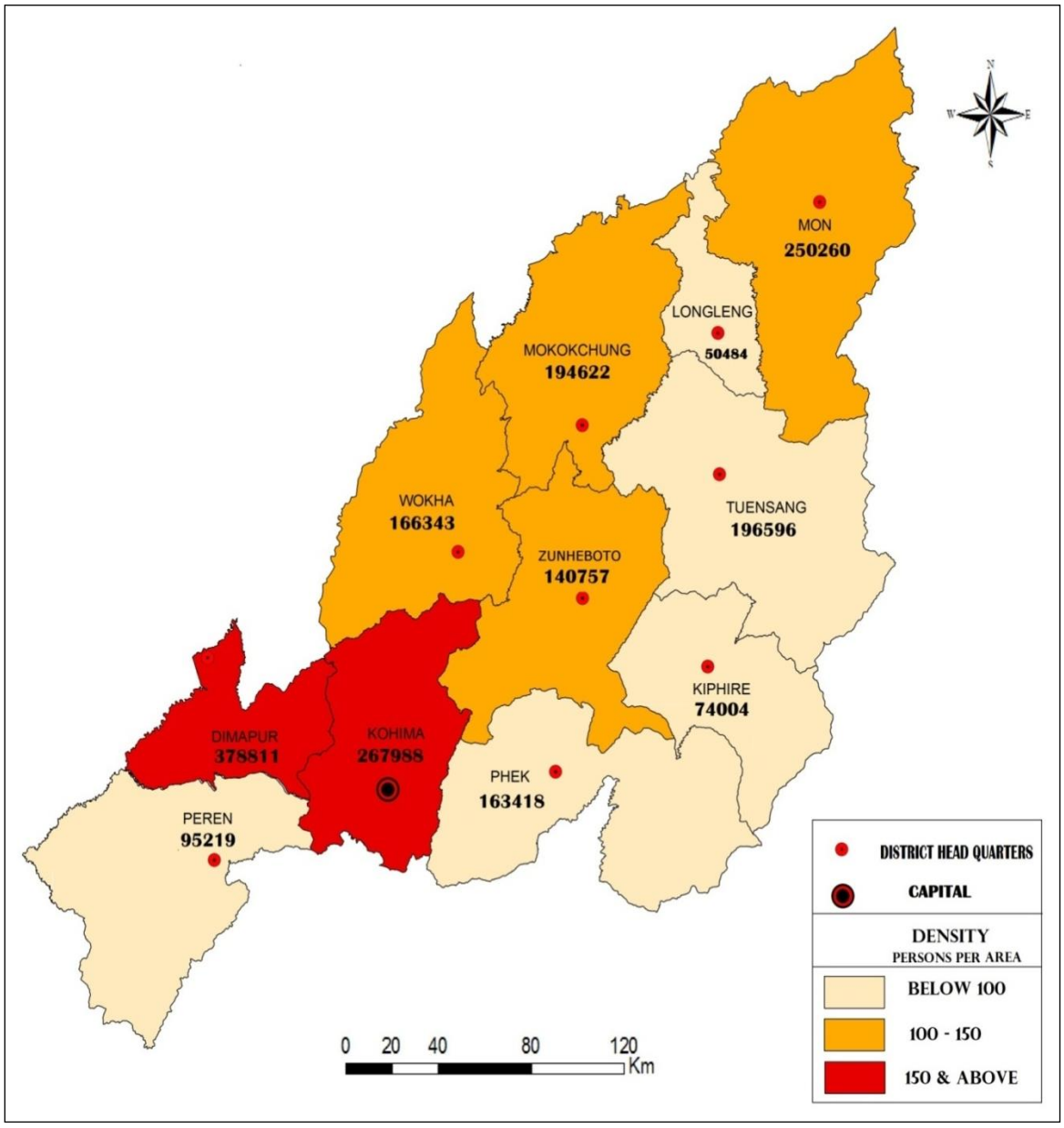


Fig. 2.6 Map showing distribution of population and density in Nagaland

Literacy

As per the census 2011, literacy rate of Nagaland is 79.5 percent where male literacy rate is higher than the female's by 6.64 percent. Mokokchung has the highest literacy rate that is 91.62 percent, followed by Wokha which has 87.69 percent and the third highest in Literacy rate is found to be in Zunheboto. The highest Literate population is in Dimapur (278,037) followed by Kohima (197,489). We also find the least literacy rate in Mon district which is as low as 56.99 percent and the second least literacy rate of the state is Kiphire (69.54 percent) (Table 2.6 and Figure 2.7).

Table 2.6 District-wise Total Population in Nagaland (Source: Department of Economics and Statistics, Government of Nagaland, 2014).

Sl. No.	District	Total Population		
		Person	Male	Female
1	Kohima	267,988	138,966	129,022
2	Peren	95219	49,714	45,505
3	Dimapur	378,811	197,394	181,417
4	Phek	163,418	83,743	79,675
5	Mokokchung	194,622	101,092	93,530
6	Zunheboto	140,757	71,217	69,540
7	Wokha	166,343	84,505	81,838
8	Tuensang	196,596	101,933	94,663
9	Kiphire	74,004	37,830	36,174
10	Longleng	50,484	26,506	23,982
11	Mon	250,260	131,753	118,507
Nagaland		**1,978,502**	**1,024,649**	**953,853**

Table 2.7 District-wise Literate Population and Literacy Rate in Nagaland (Source: Department of Economics and Statistics, Government of Nagaland, 2014)

Sl. No.	District	Literate Population			Literacy Rate (%)		
		Person	Male	Female	Person	Male	Female
1	Kohima	197,489	107,038	90,451	85.23	88.69	81.48
2	Peren	62,204	34,584	27,620	77.95	82.84	72.58
3	Dimapur	278,037	150,142	127,895	84.79	87.54	81.77
4	Phek	105,893	57,926	47,967	78.05	83.66	72.21
5	Mokokchung	159,494	83,479	76,015	91.62	92.18	91.01
6	Zunheboto	102,881	53,504	49,377	85.26	87.85	82.62
7	Wokha	128,208	67,385	60,823	87.69	90.81	84.48
8	Tuensang	117,511	63,653	53,858	73.08	76.31	69.59
9	Kiphire	41,232	22,675	18,557	69.54	74.88	63.97
10	Longleng	29,859	16,139	13,720	72.17	74.48	69.63
11	Mon	119,626	67,432	52,194	56.99	60.94	52.58
	Nagaland	**1,342,434**	**723,957**	**618,477**	**79.55**	**82.75**	**76.11**

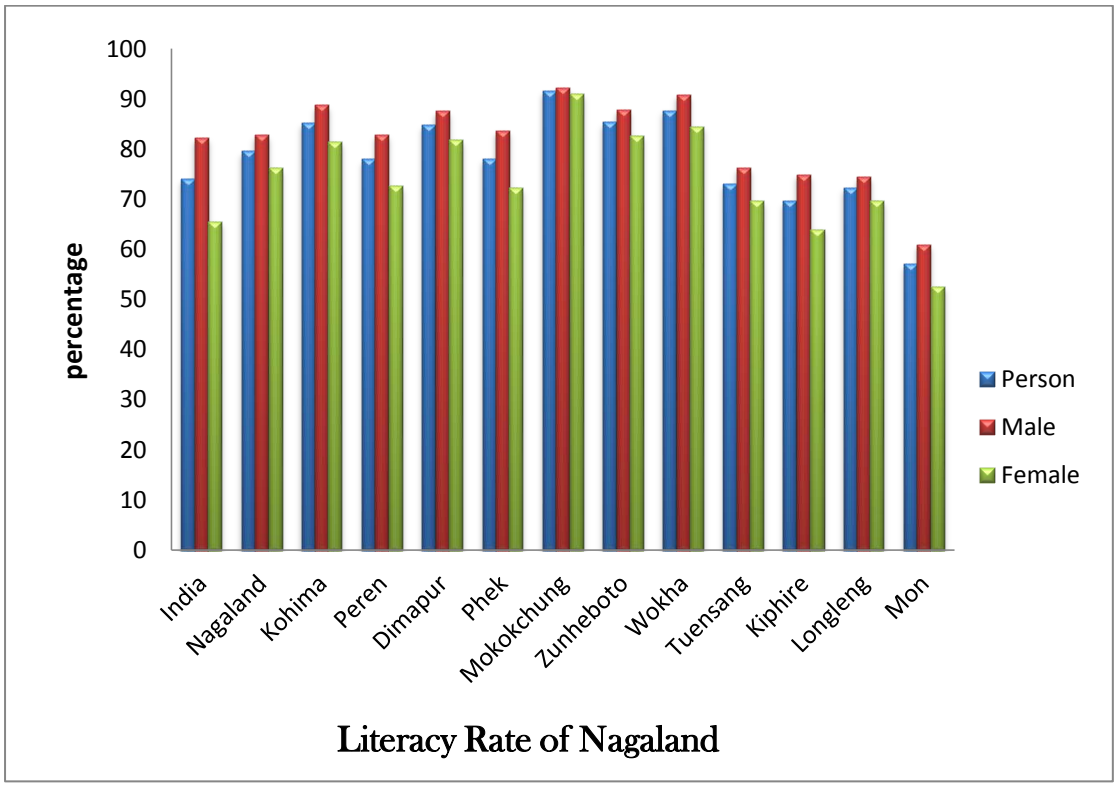


Fig. 2.7 The combined bar diagram showing Literacy Rate of Nagaland (Source: Census, 2011

Population in Towns and Villages

The state has a total of 1400 inhabited villages covering the eleven districts. The total rural population is 1,407,536 which consist of 71 percent of the total population of the State. There are 19 statutory towns and Kohima and Dimapur districts has the maximum urban population consisting of 55.86 percent of the total urban population and 16 percent of the total population of the State lives in these two urban areas, the district headquarters. The highest percentage of rural population is found to be in the district of Mon. Rural population other than the two districts Kohima and Dimapur tend to be almost the same in all the districts with slight variation and they are higher than the urban population of its district. The statistics clearly points that Nagaland is a rural state and that it can be managed well with proper management approach as the people are still in a setting close to the nature with practices of Agriculture based economy. Spatially the villages are built in the hill tops of almost all the districts and thus the villages are hills away from each other except for those low lying villages found in the valleys of Dimapur along the western border between Assam valley and Nagaland.

Table 2.8 Distribution of Villages and Towns in Nagaland (Census, 2011)

Sl. No	District	No. of Inhabited Villages	Rural population	% of Rural Population	No. of Statutory Towns	Urban Population
1	Kohima	105	146,900	54.82	02	121,088
2	Peren	102	81,429	85.52	02	13,790
3	Dimapur	219	180,942	47.77	03	197,869
4	Phek	117	138,843	84.96	02	24,575
5	Mokokchung	107	138,897	71.37	03	55,725
6	Zunheboto	191	113,160	80.39	01	27,597
7	Wokha	151	131,339	78.96	01	35,004
8	Tuensang	138	159,822	81.29	01	36,774
9	Kiphire	90	57,517	77.72	01	16,487
10	Longleng	49	42,871	84.92	01	7,613
11	Mon	131	215,816	86.24	02	34,444
Nagaland		**1400**	**1,407,536**		**19**	**570,966**

SOCIO-ECONOMY

Nagaland with its maximum rural population, agriculture is the most popular and common practice of the rural people. The total 1400 villages spread in all the districts, here people are directly or indirectly involved in primary and secondary sectors of economy. With its vast mountains and hills and valleys providing the natural land as their own, Nagas they farm and sustain their lives. In the past with lesser population each villages had their own economic system which could provide all their needs but with the population growth as well as migration of villagers to the towns and cities for search of other means of livelihood, and also introduction education and modernization in the State, Agriculture itself is not sustainable. The common practice of shifting cultivation with low productivity and high environmental degradation has become a questionable method. At the other hand Nagas heritage and past revolve around this practice which cannot be totally eliminated. The towns and cities are a different picture of the Naga society all together as its concentration is mainly towards the tertiary economic activity. The farmers here are of different scale as they do other form of farming other than rice cultivation and they consist of minimum population in the urban population.

Economy

The economy of Nagaland in the villages consists of cultivation which is 68.03 percent of the total work force (Rawat, 2014). The dependency of employment in agriculture was as high as 96.50 percent during the 1950's and 60's and has declined quite considerably to 68 percent in 2000 but still it is the main stay for these people (GON, 2011). The age old practice of jhum cultivation is prevalent in almost all the districts and comprises of 90 percent of the total land under agriculture. The villages in the districts of Kohima, Dimapur, Phek, Wokha, Tuensang and Peren practices terrace cultivation. There is a big gap between the rural poor and the urban rich. The productivity and the efficiency of people (workers) in Nagaland is not very encouraging compared to the rest of India, where as human resources of the state is not at all inferior to others as literacy and Human Development Index is much more compared to the National rate.

Languages

According to the Linguistic Survey of India 2013-14, the languages spoken by the Nagas are broadly grouped under the Tibeto-Burman family. Each of the tribes speaks a speech which is not intelligible to other tribes. The dialects are different from one tribe to another, which is different even range wise and in some cases village wise within the same tribe. Thus, there arose the need to adopt a lingua-franca known as Nagamese which is a form of Assamese with a vocabulary drawn from Naga and Assamese speeches. Nagamese is spoken and used for commercial purposes as a common language for all, while English which is the official language of the State is used in offices, schools and colleges and all other written form.

Nagaland represents an ideal model of synthesis of modernity and tradition. The Naga society is well known for its tribal cultural landholding system, land use pattern including jhum practice and its rich traditional knowledge base. It is the society and the community itself that can play the vital role in the participatory approach to biodiversity conservation and natural resources management. Food and environmental security have become a major issue of concern. Environmental management of degraded jhum-agro-ecosystems is the need of the hour. So far, environment has not been taken seriously as the Socio-economic and other components in development planning.

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Chapter 3

RIVER SYSTEMS AND WATERSHEDS IN NAGALAND

INTRODUCTION

River system is the network of streams and rivulets within the River basin which has its own mechanism bio-physical or geo-hydrological and even socio-economical. The earth as a whole acts like a huge basin with various drainage networks that ultimately flows into the ocean. In India the entire geographical area is divided into six water resources regions (1) Indus River Systems, (2) Ganga River Systems, (3) Brahmaputra River Systems, (4) All the other rivers flowing to Bay of Bengal, (5) All the rivers flowing to Arabian Sea and (6) Desert River system. These are further divided into 66 river basins of India (Palanisami, *et.al.* 2000). The Brahmaputra is one of the world's largest rivers with a drainage area of 580,000 Km^2. (50 percent in China, 33.6 percent in India, 8.1 percent in Bangaladesh and 7.8 percent in Bhutan). In India, its watershed is shared by Arunachal Pradesh (41.9%), Assam (36.3 %), Meghalaya (6.1 %), Nagaland (5.6 %), Sikkim (3.8 %) and West Bengal (6.3 %). An extremely dominant monsoon interacting with a unique physiographic setting, fragile geological base and active seismo-techtonic instability together with anthropogenic factors have moulded the Brahmaputra into one of the world most intriguing gigantic fluvial system (Ives & Messerli, 1989; Goswami, 1985). River basin is a part of the earth surface from which a river collects its water, drains through the channels and eventually releases through its mouth. It is the source area of the precipitation eventually provided to the stream channels by various paths (Leopold, 1964). River basin is a naturally defined spatial unit and can be considered as a natural unit wherein physical and human aspects can be studied from geographical or other angles. River basin is an open system as it is receiving energy or output through the water and sediment lost by the basin, largely through the basin mouth (Gregory & Walling, 1973).

The Brahmaputra River system is the only river system from India that covers a part of Nagaland. The Chindwin River system from Myanmar touches the eastern part of Nagaland and the third River System of Meghna mainly found in Bangladesh covers a small part in the southern part of the State (Fig. 3.1). The various rivers found in Nagaland flows into River Brahmaputra, Chindwin and Barak which ultimately flows into the Bay of Bengal. Nagaland is situated almost at tri-junction of these three major river systems of the region. The Brahmaputra river system on the

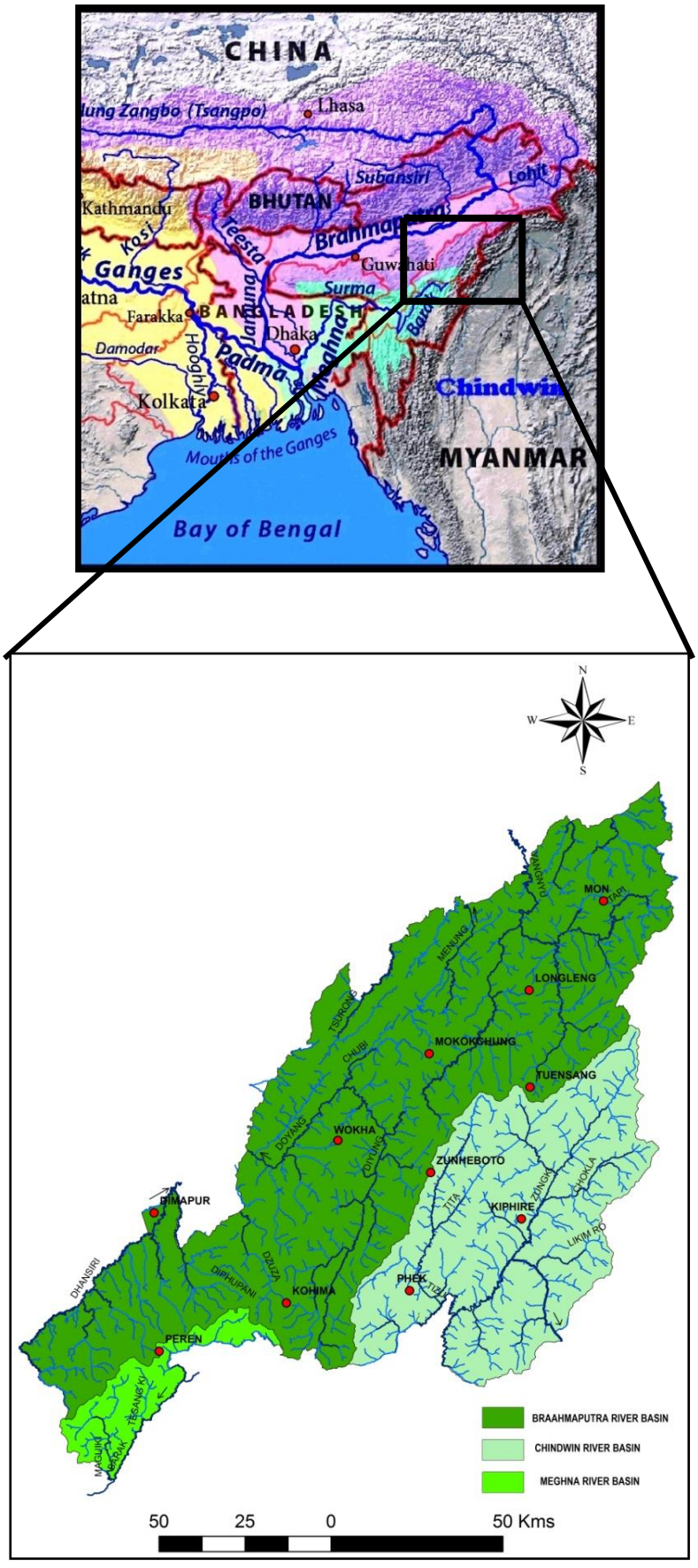

Fig. 3.1 The three River Systems and their drainage basins in Nagaland

west and north, the Meghna river system on the south west and the Chindwin river system on the east (Fig. 3.1). The watershed areas in Nagaland that drain into Brahmaputra and the watershed area of rivers that drains into Chindwin are roughly equal, but one of the interesting differences between the two watersheds is that in case of Brahmaputra watershed a couple of rivers drain the area and they join Brahmaputra River in Assam separately whereas in case of Chindwin watershed all tributaries join together and finally run into Chindwin. Detail description has been presented in the respective pages.

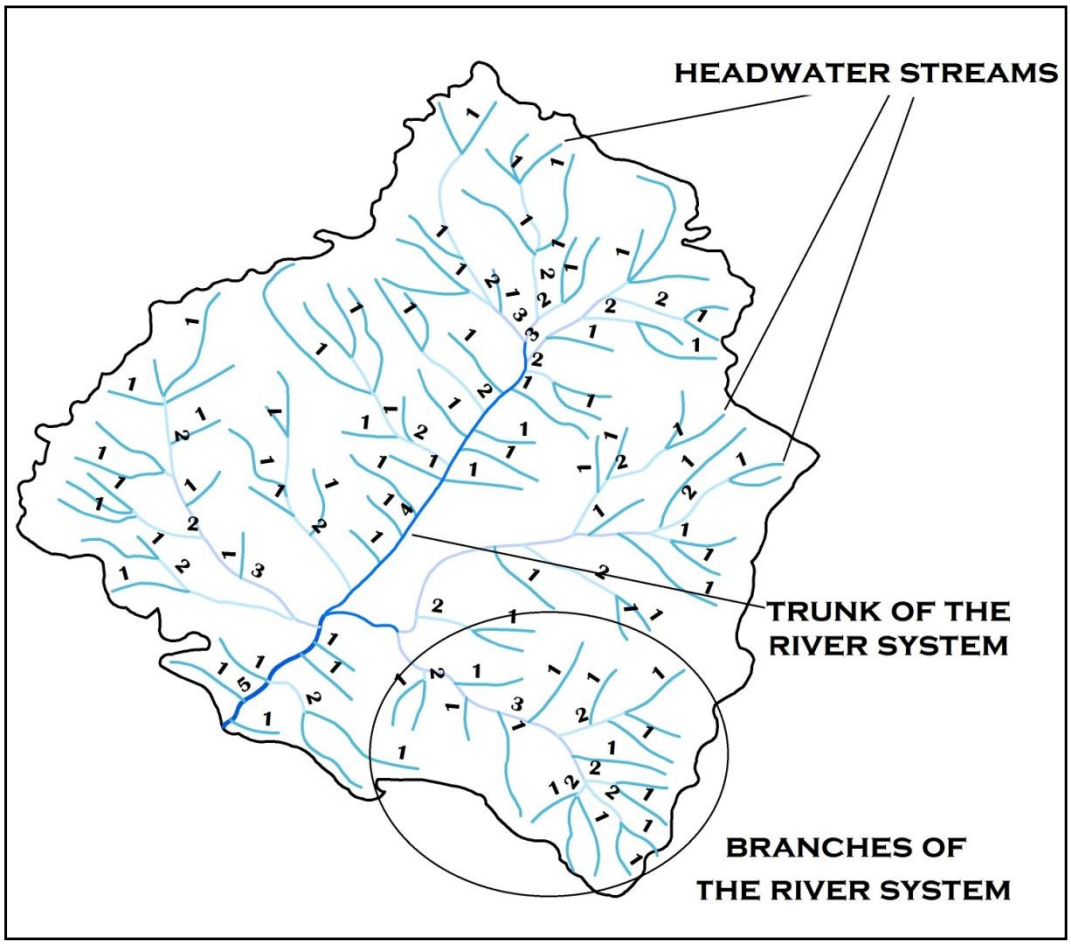

Fig. 3.2 Ordering of streams in the upper Kiliki watershed of Zunheboto hills, Nagaland

In a River System (Fig. 3.2), a network of streams consists of headwaters that flow from the tip without any other stream or tributary flowing into it. These headwaters are the first order streams and when two such streams meet and flow as one it is known as second order stream and when two second order streams meet they form third order streams and so on. All these streams flow into a bigger river which also

journey towards a pond or lake or an ocean. The combined over view of the river system looks like a tree and thus the main river is called the trunk and the tributaries which flows into it is its branches. Geomorphologists categorize streams based on the balance and timing of the storm water runoff and base flow components. There can be three categories, Ephermal streams that flow less than 30 days in a year as it flows only during or immediately after periods of precipitation, intermittent streams that flow only during certain times of the year lasting more than a month and perennial streams that flow continuously during both wet and dry period. Nagaland has all the three categories of streams cutting through its landforms. Nagaland has a rugged topography and unlike the plains it is more dissected into valleys and hills by a number of seasonal and perennial streams and rivers with U shaped tiny valleys in between. The networks of streams and rivers are numerous and bring out the unique characteristic profile of the land.

THE BRAHMAPUTRA RIVER SYSTEM IN NAGALAND

The Brahmaputra River has a total length of 2880 Km and is the 22nd longest river in the world (Sarma, 2005) and its total drainage area is around 573,394 Km^2 and shared by China (Tsangpo), India (Brahmaputra), Bhutan and Bangladesh. The river Brahmaputra enters India after passing 1700 Km in China across the Sadiya Frontiers in Arunachal Pradesh (Singh, *et. al*, 2005, Rao, 1979). In India Brahmaputra runs 760 Kms across Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim and West Bengal (Rahaman & Varis, 2009). The statistics of area coverage in India state-wise is shown in Table 3.1.

Tributaries of Brahmaputra River System flowing in Nagaland cover an area of 10942.36 Km^2. It is the largest basin in Nagaland with four major rivers and other streams and tributaries draining in it. They are Dikhu, Melak, Doyang, and Dhansiri rivers.

The Dikhu River has its source near Zunheboto from central Nagaland near the Nuhuto Hill and flows in a northerly direction. The river traverses towards the north along the border of Mokokchung, Longleng and Mon districts draining their territories. The Dikhu River has two main tributaries, one from Kuthur above Tuensang town and the other from the Konyak region. Towards north the Dikhu is joined by its main tributary. The Yangu which is an important river in the territories

of the Phoms and Konyaks flows below Longkhum, Ungma in Mokokchung. From Ungma, the Dikhu River forms the boundary between Mokokchung and Tuensang districts. The Dikhu flows further north through the hills of the Konyak area and finally takes leave of the Naga Hills at Naginimora. It flows into the Brahmaputra River in Sibsagar district of Assam (Fig. 3.3, 3.3a).

Table 3.1 River Brahmaputra System in India, State-wise (After Rahaman & Varis: Sharma 2005: Singh, et. al., 2005: CWC, 2008)

Brahmaputra draining Indian States	**Drainage Area ($Km^{2)}$**	**% of total area of the State**
Arunachal Pradesh	81,424	97.23
Assam	70,634	90
Meghalaya	11,667	50
Nagaland	10,942	66
Sikkim	7,300	100
West Bengal	12,585	15

The Melak River has its source at Mokokchung and flows in a northerly direction till it reaches Tuli range in the northern part of Mokokchung district. Before entering Assam it is joined by Tsurang River. The Tsurang River flows through the valley of Changki in a north to south direction near the boundary between Mokokchung and Wokha districts. It then flow west right through the Desoi valley in a northern direction till it enters Assam. The Tiru and Tizit rivers lie in the wettest parts of Nagaland which receives heavy rainfall, thereby producing two middle-sized rivers, the Tiru and the Safrai rivers. Both the rivers flow almost parallel east to west and join up as they enter Assam. The Tizit River has its source in the northern most point of Nagaland in Mon district and flows in a westerly direction at first and then turns west in the Tizit valley until it enters Assam at Namsa. The Tizit River is joined by the Tekang River at Namsa and their confluence area is covered by dense forest (Fig. 3.3, 3.3 a).

The Doyang River is the longest river in Nagaland. The Dzuu and the Sidzu rivers are two head streams running parallel to each other before reaching Doyang. The Dzuu River starts its journey from Japfu peak northward and is joined by other tributaries. The Sidzu River originates from Mao Gate and flows in a north-west

direction towards Chakhabama,. It then joins the Dzuu River below Kijumetouma which is then known as the Doyang River as it flows in a northerly direction and receives tributaries from Zunheboto and Mokokchung districts. The Doyang River makes a right angle turn to the west at Doyang Bridge along the Wokha-Mokokchung road. Two tributaries- the Chubi, draining from the southwest area of Mokokchung and Chudi, draining almost the whole of the Rengma area river meets the Doyang River just before it emerges out of Nagaland. The flow direction of Doyang is north easterly course for about 74 km from the south and thereafter takes sudden turn of right angle to the northwest and traverses in a southwest direction. After flowing towards the southwest for a few kilometers it finally drains into the Dhansiri in Golaghat district of Assam (Fig. 3.3, 3.3b).

The Dhansiri River is an important river draining the State. The river forms a part of the south-western boundary between Assam and Nagaland. This river rises in the southwest of Kohima district and flows towards the south-western part of the State. It then runs a westward course forming a natural boundary with North Cachhar Hills of Assam at the extreme south west of the State. The rivers Intangki, Monglumak and the Amaluma drain the greater part of the Zeliang area as they flow into the river Dhansiri at different points. The Diphu and Dzudza rivers have their source at the Japfu mountain range and separately flow into the Dhansiri. Having debauched from North Cachhar it takes an eastward direction and flows through the Rangapahar- Dimapur plains. It changes its course and runs northward until it drains into the Brahmaputra (Fig. 3.3, 3.3c).

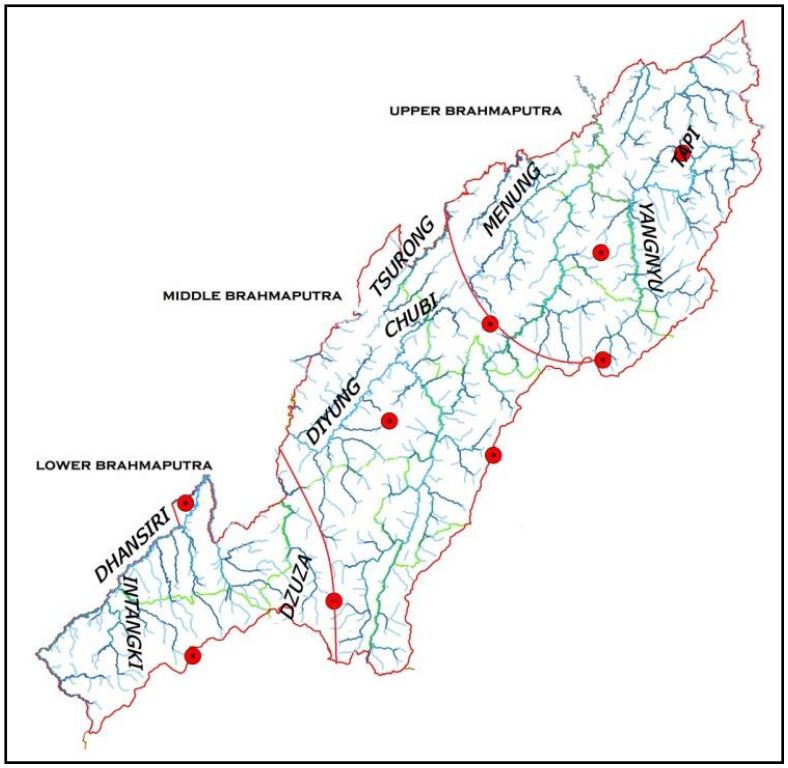

Fig. 3.3 Brahmaputra River Basin in Nagaland

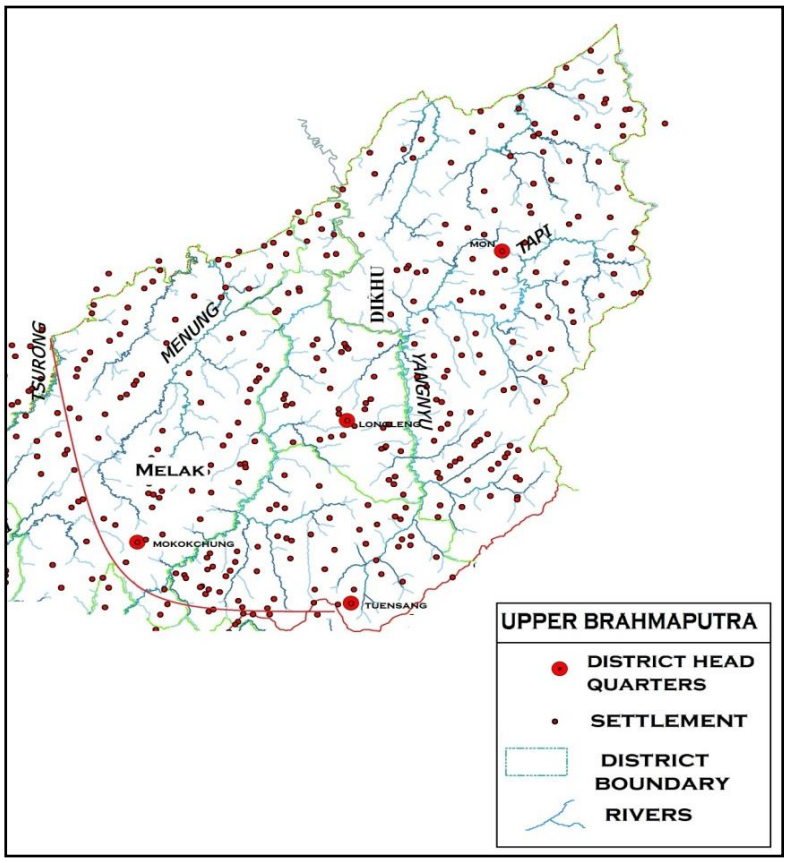

Fig. 3.3 (a) Upper Brahmaputra Basin

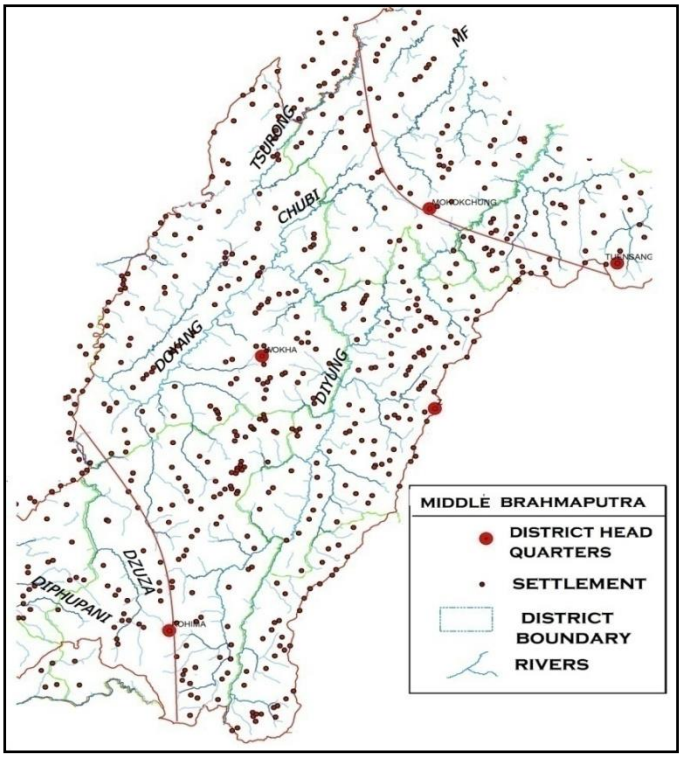

Fig. 3.3 (b) Middle Brahmaputra Basin

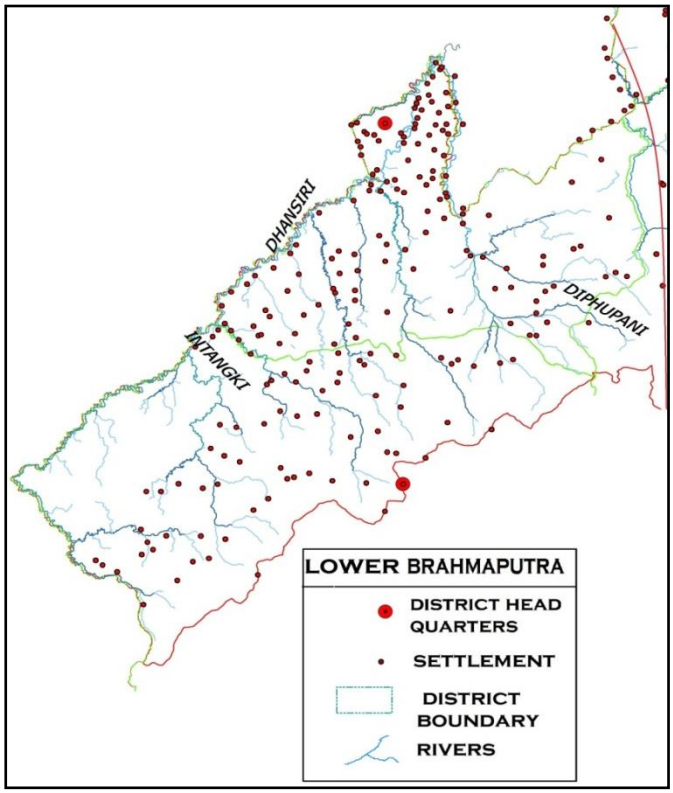

Fig. 3.3 (c) Lower Brahmaputra Basin

THE MEGHNA RIVER SYSTEM IN NAGALAND

Meghna River is one of the major rivers of Bangaladesh which joins with the two rivers coming from India i.e. The Brahmaputra River and the Ganges at a place called Chandpur, Bangaladesh. These three rivers finally flow as The Lower Meghna and empties into the Bay of Bengal. The Meghna in Bangaladesh covers about 15 percent of the total drainage in the country. The Meghna River System in Nagaland is only about 5 percent of the total land; nevertheless it is important as it drains most part of the Peren District and a small part of southern Kohima. The total area coverage of the system in Nagaland is 809.03 Km^2. The major river of the Meghna System in Nagaland is the Barak River. The boundary between Manipur and Nagaland runs along Barak River. The major tributaries flowing into the Barak are Magui Ki and Tesang Ki (Fig 3.4).

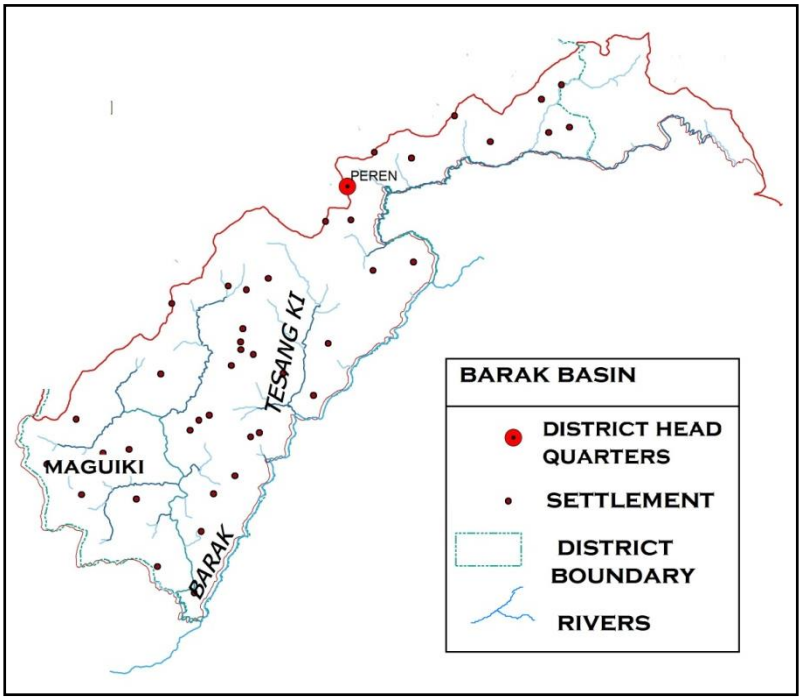

Fig.3.4 Barak River Basin

THE CHINDWIN RIVER SYSTEM IN NAGALAND

The Zungki River, the longest tributary of Tizu River has its source at the north- western part of Chendong forest in the south of Teku and flows in a southerly direction towards Noklak, Shamator and Kiphire till finally joins Tizu River below Kiphire. The Likimro is another tributary of the Tizu River and has its source at the Saramati Mountain. The Lanye River has its source in the north Henopong forest in Tuensang district and flows in a northerly direction towards Phek. Below the Satoi Mountain it turns in an easterly direction and joins the Tizu River and then it later joins the Likimro River some 25 Kms downstream. After the Lanye joins Tizu, the Zungki and the Likimro rivers join the Tizu River and pass the mountainous region into Myanmar where it flows into the Chindwin River. The Tizu River forms an important drainage system in the eastern part of Nagaland and runs in a northeast direction for about 20 Kms. It then takes a bend and assumes a south easterly course. The river finally leaves Nagaland and exhausts itself into the Chindwin River in Myanmar (Fig. 3.5).

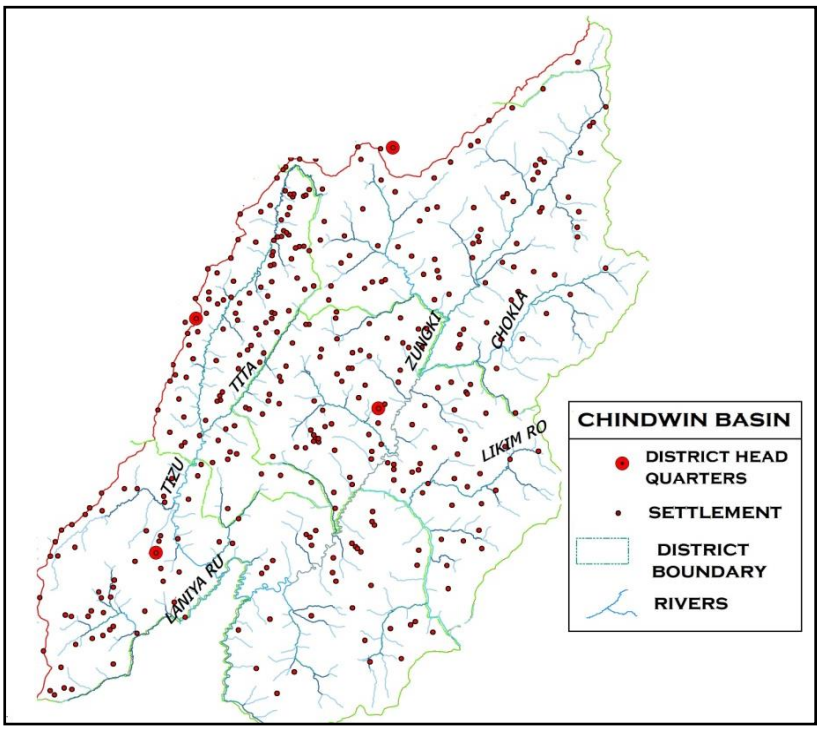

Fig. 3.5 Chindwin River Basin

WATERSHEDS IN NAGALAND

A watershed may be defined as an area which contribute rainwater falling on it and allows the water to flow in one or more water courses with a single outlet at the end. The watersheds in Nagaland are characterized by a great degree of inaccessibility, fragility, marginality, diversity, specific niche opportunities and a unique human ecology. Watersheds are a part of river system delineated along the ridges covering smaller rivers. The ideal area of the watershed is 500 to 5000 Km^2 (Table 3.2).

Table 3.2 Classification of Natural Environmental Units based on Mansinghsal Associates 1958 (source: Palanasami, *et.al*. 2000)

Natural Environmental Units	Area	Classification Based on
Water resources regions	500000 Sq. kms <	Large River Bodies flowing from the source to the Ocean
River Basins	50000- 500000	Large Prominent Rivers flowing into the water Resources Regions
River sub- basin	5000-50000	The division starts from down water right and left of the river course.
Watershed	500-5000	Based on the streams and areas of the catchment.
Sub-watershed	50-500	Early manageable hydro-geological unit.
Micro watershed	5 >	Planning unit

A watershed is delineated on the ridgeline or high reaches within which all the water falling on it flows into the same outlet. The outlet could be a pond, lake or a bigger river. In other words watershed is defined as the geographical area on the surface of the earth whose boundary is defined by the topography of the earth (Department of land Resources, Govt. of Nagaland & Northeastern Space Applications Centre, 2012).

The Department of Land Resources, Govt. of Nagaland with The National Bureau of Soil Sciences and Land Use Planning (NBSSLUP) has come up with a book on Watershed Atlas of Nagaland using GIS technique. According to the study

made and delineation of the area under rivers and streams, there are 3 river basins, 6 sub-catchments, 22 watersheds, 117 sub-watersheds, 626 mini-watersheds and 3324 micro-watersheds. However, based on the classification above in Table 3.2, the watersheds were redefined into seventeen watersheds in Nagaland with an area of 543 to 1731 Km^2 (Fig. 3.6). The largest river basin in Nagaland, Brahmaputra contains eleven watersheds. The largest watershed is the Yangnyu watershed which is found covering part of the districts of Mon, Longleng and Tuensang is 1731.36 Km^2 in area and the smallest watershed is Tisa watershed in Mon district with an area of 542.69 Km^2. The Chindwin River System consists of five watersheds. The largest watershed of Chindwin is Right Bank Tizu or RB Tizu with an area of 1290.61 km^2 and the smallest is RB Upper Zungki whose area is 572.77 Km^2. The watershed of Meghna River System is Barak and its area is 809.03 Km^2 (Table 3.4)**.** A watershed provides a natural environmental unit for planning a developmental initiative as it is a suitable unit for technical efforts to conserve soil and maximize the utilization of surface and subsurface water for crop production (Palanisami *et. al.,* 2000). Watershed is an ideal unit for conserving, regenerating and judicious use of all the resources like land, water, plants and animals.

Table 3.3 Basin wise details of Hydrological units of Nagaland (Modified after Watershed Atlas of Nagaland, Department of Land Resources, GOI 2012)

Basin	Basin Area (Km^2)	No of catchments	No of sub catchments	No of watersheds	No of sub watersheds	No of mini-watersheds	No of micro-watersheds
Brahmaputra	10.94	1	4	11	77	407	2200
Meghna	0.81	1	1	1	5	30	187
Chindwin	4.82	1	1	5	35	187	937
Total	16.57	3	6	17	117	624	3324

Table 3.4 River Basin of Nagaland (Modified After Watershed Atlas of Nagaland, Department of Land Resources, GOI)

Order	No. of division	Area of the division (in Km^2)
Basin 1. Brahmaputra(Left Bank of Brahmaputra) 2. Chindwin(Tributaries of the Chindwin in Nagaland) 3. Meghna (Tributaries of Brahmaputra that flows into Bangladesh)	3	800.00 to 10950.00 10942.36 4187.04 809.03
Sub- Catchment 1. Dhansiri 2. Tizu 3. Dikhu 4. Melak 5. Barak 6. Disang-Tisa	6	540 to 5760 5758.13 4817.04 3279.60 1362.50 809.03 542.12
Watersheds	17	543 to 1731
Sub watersheds	117	85 to 217
Mini-watersheds	626	5.60 to 73.00
Micro watersheds	3324	1.13 to 7.80

The seventeen watersheds delineated in the three river basins of the study area are given in Fig. 3.6. The Brahmaputra basin consists of larger watersheds comparatively. The various geo-hydrological units of the study area are represented in the Fig. 3.7. This map is a representation of the way the drainage units are divided into basins, which are further divided into watersheds, watersheds into sub watersheds and sub- watersheds into micro-watersheds. It shows that each unit is a part of the other units and that in some ways they are interdependent to each other, but also they exist independently from one another with its own geo-hydrological personality. For an integrated watershed management program, the proper delineation of area is a must. The study is an attempt to create spatial data base for planners and decision makers for easy access to watershed boundaries and for selection of watersheds in a prioritized manner. Every watershed like human beings differs from one another.

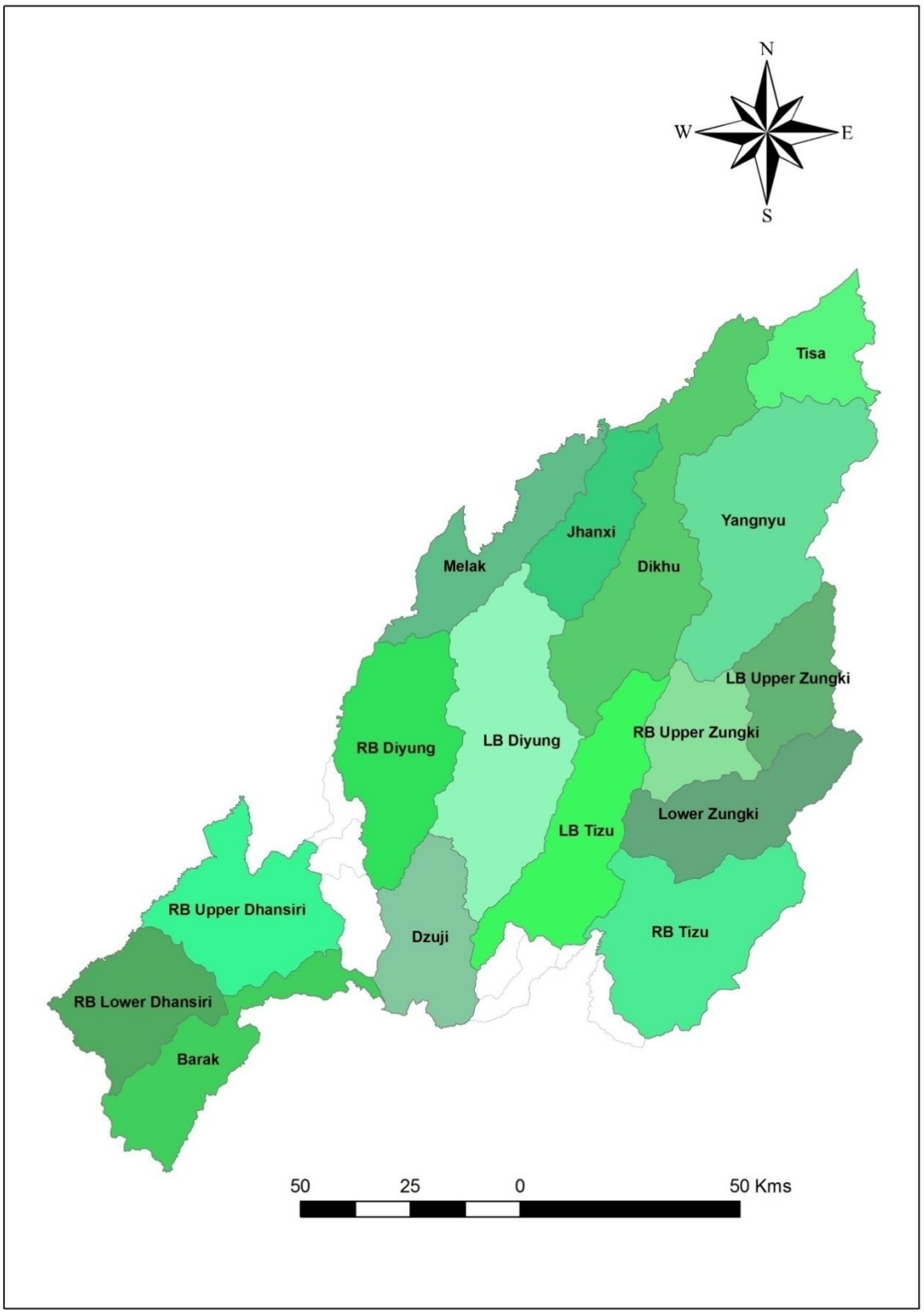

Fig.3. 6 The seventeen watersheds in Nagaland (Area 543 to 1731 Km^2)

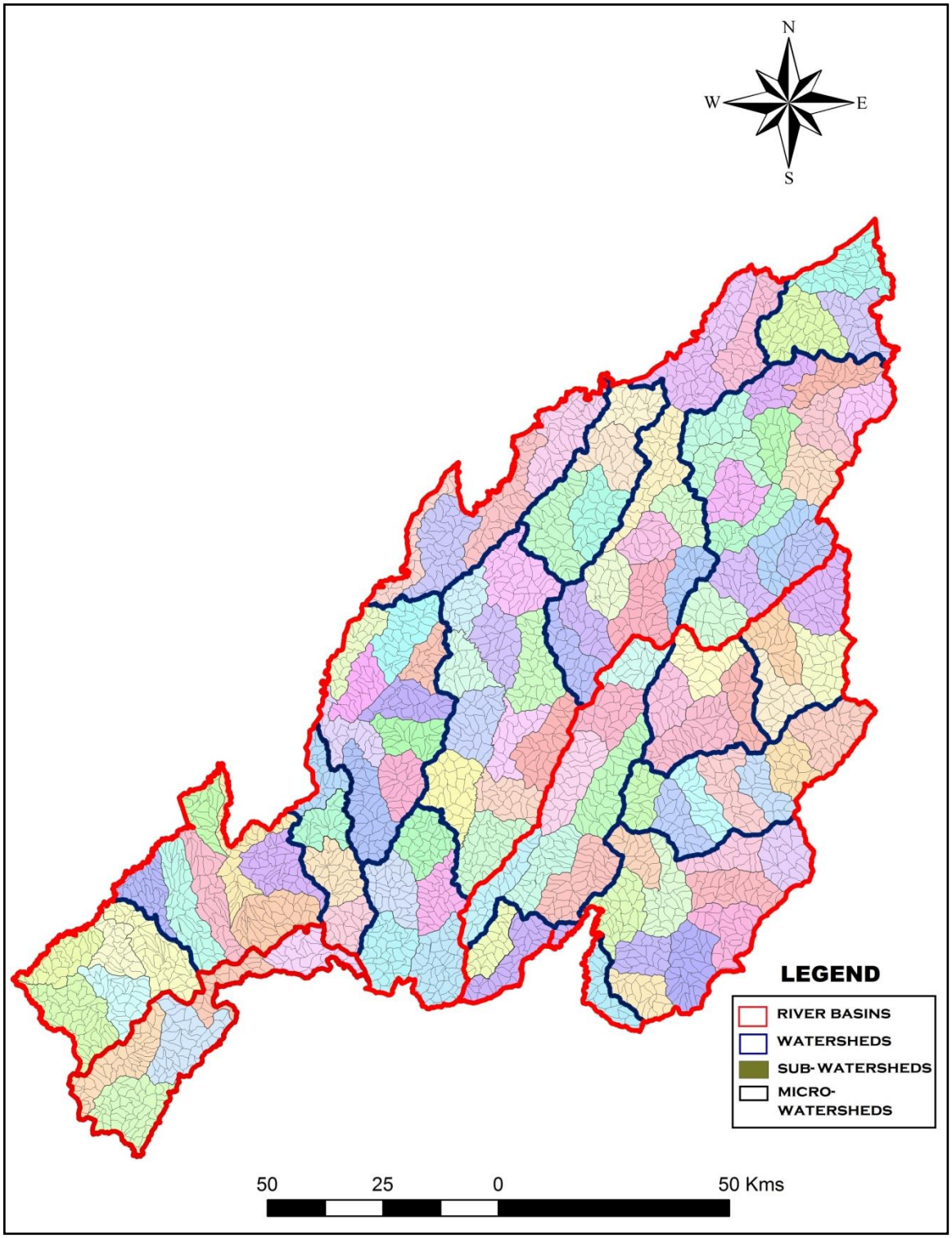

Fig. 3.7 Various geo-hydrological units (Catchment area) in Nagaland

INTRODUCTION OF SAMPLE WATERSHEDS IN THE STUDY AREA

The first and foremost step to develop an area is to identify and delineate the area upon which the developmental activities will be performed. Micro watersheds have proved to be ideal for area planning as it has geo-hydrological unity. Today the introduction of GIS and Remote Sensing technologies has created a vast opportunity for the development of database maps which are used for area planning. Using the same technology database maps of ten sample watersheds of the study area has been developed. The Brahmaputra river basin as explained in Fig 3.3 is divided into three as Upper, Middle and Lower Brahmaputra for better comprehension of the various rivers and streams flowing on it. From the Brahmaputra river basin there are eight watersheds selected. Chija Ho, Deodubi, Liyung and Menung watersheds are delineated from the Upper Brahmaputra basin. Chija ho is the largest area among the sample watersheds with 30 Km^2, Deodubi is the smallest watershed with an area of 4.23 Km^2, Menung watershed is 21.92 Km^2 and Liyung is 12.33 Km^2. In the middle Brahmaputra river basin, Upper Kiliki and Shen Ru watersheds are identified with an area of 23.23 Km^2 and 22.03 Km^2. The lower Brahmaputra river basin consist of Tsuhaoru Tao and Kukhipani watersheds with an area of 9.9 Km^2 and 5.5 Km^2.Lower Tizu watershed is delineated from Chindwin River basin with an area of 15.46 Km^2 and Inkoron watershed is delineated in the Barak river basin with an area of 15.63 Km^2 (Table 3.5).

Table 3.5 Basic Morphometrical Parameters of the sample watersheds

Watershed	**Area (A)**	**Perimeter (P)**	**Length of the basin (L_b)**
	In Km^2	(In Kms)	
Chija Ho	30	29.26	9.06
Deodubi	4.23	8.95	2.98
Inkoron	15.63	23.82	6.25
Upper Kiliki	23.23	24.13	7.83
Kukhipani	5.8	12.35	3.57
Liyung	12.33	23.1	5.47
Menung	21.92	26.97	7.58
Shen Ru	22.03	22.26	7.6
Lower Tizu	15.46	19.65	6.22
Tsuhauru Tao	9.9	16.32	4.82

The perimeter "P" of Chija Ho is the biggest (29.26 Km) followed by Menung watershed (26.97) and the smallest is the Deodubi watershed (8.95). The Basin Length was derived using the formula $L_b = 1.312*A^{0.568}$.

DRAINAGE PATTERNS

The drainage pattern that is commonly found in the study area as well as in many drainage basins of the world is the dentritic pattern. This pattern is recognized in Upper Kiliki (Fig.3.8.a), Shen Ru (Fig. 3.8.b) and Chija ho watersheds (Fig. 3.8.a). The dentritic pattern is characterized by tributaries of the watershed joining at acute angles (Zang and Guilbert, 2012). Dentritic streams have branching appearance as it flow downhill in the same general direction and they join to make larger streams. This pattern is common where the bedrock is uniform, without faults, folds, or other major structures or zones of weakness to capture the streams and also where the rock layers are horizontal. Lower Tizu (Fig. 3.8.b) watershed is characteristics by dentritic pattern on a meandering river which suggests that the river is at its least frictional work form (Twidale, 2005). Inkoron (Fig. 3.8.a) and Menung (Fig. 3.8.b) watersheds are of parallel pattern. The streams or tributaries run parallel to each other in long straight lines before they join at small acute angles. The parallel pattern is also a common pattern found especially in lower Brahmaputra of the study area. Deodubi, Kukhipani (Fig. 3.8.a) and Tsuhaoru Tao (Fig. 3.8.b) shows rectangular pattern, each watershed comprises of bending tributaries at almost right angle. Liyung (Fig. 3.8.b) watershed is an example of a trellis pattern where the tributaries are short and all of them join the main stream or river at almost right angle.

WATERSHED MORPHOMETRY

Morphometrical analysis can be used as a tool to study the watershed by using quantitative measures and this study will help the planners as well as the watershed community to understand the geo-hydrological personality of the watershed they live in. Morphometry can be defined as the precise measurement of landforms and the shape or geometry of any natural form, be it plant, animal, relief feature and its study enable an enhanced understanding of the geological and geomorphic history of a simple approach to describe basin processes and to compare basin characteristics (Mesa, 2006). The hydrological entity of the river system is interrelated with the

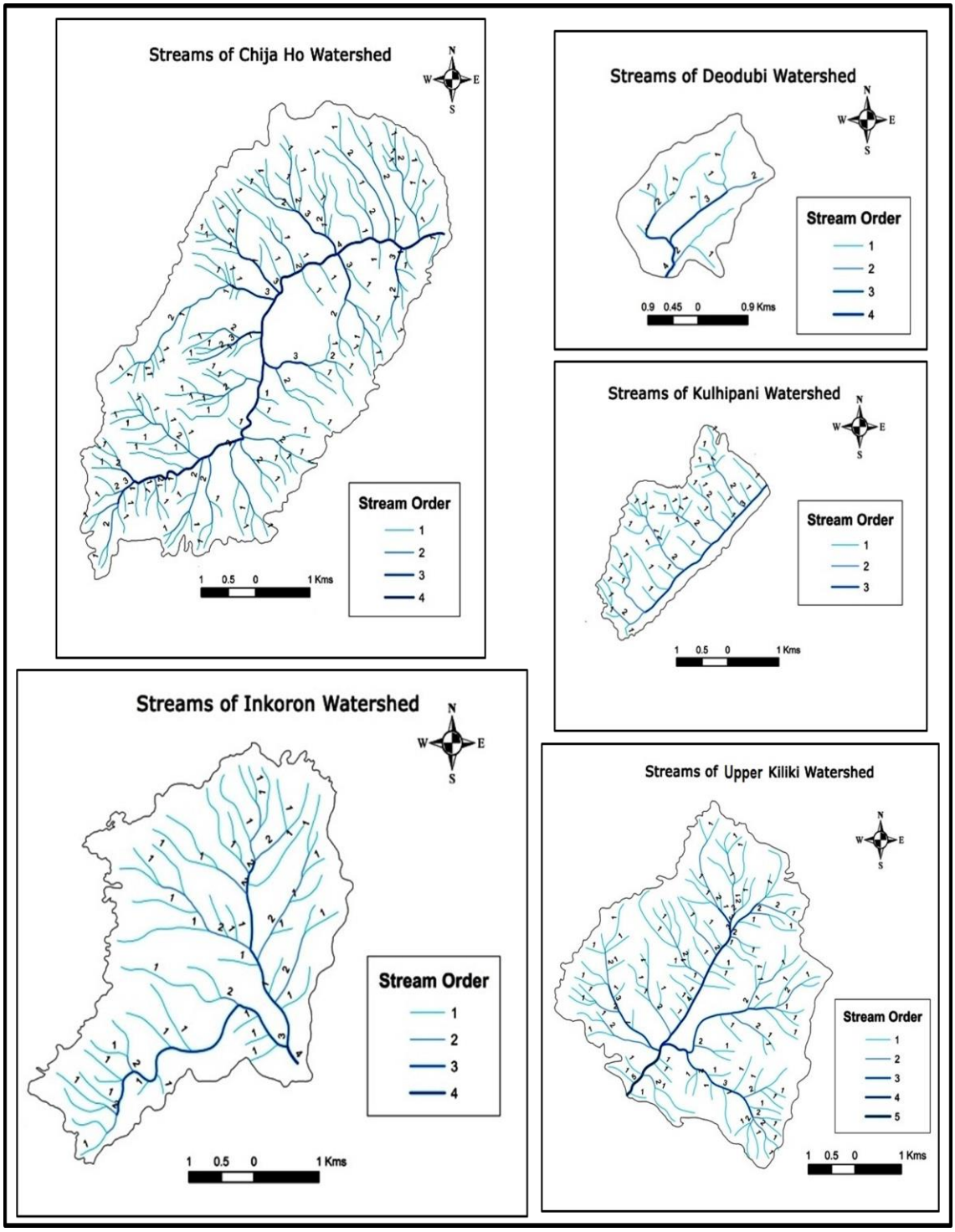

Fig. 3.8(a) Drainage pattern, order and network of the sample watersheds in Nagaland

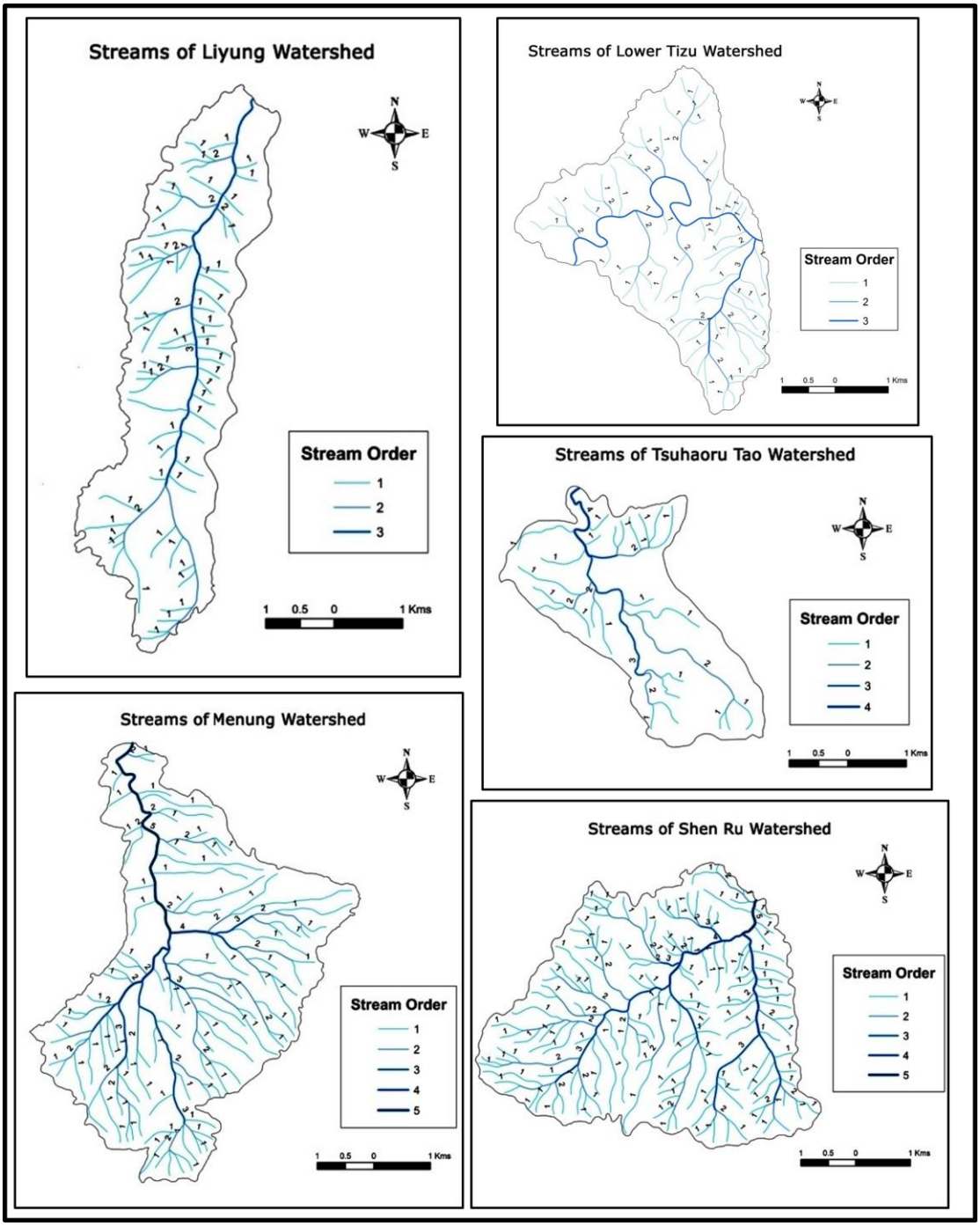

Fig. 3.8(b) Drainage pattern, order and network of the sample watersheds in Nagaland

physiographic characteristics of the drainage basin, such as shape, size, length of the streams and orders etc.., (Chorley 1969, Gregory & Walling, 1973). Watershed Morphometry consist of two branches viz. (1) drainage morphometry which includes the consideration of linear, areal, and relief aspects of fluvially originated drainage basin and (2) relief Morphometry includes which the analysis of terrain characteristics through various curves and profiles (Furkumzuk, 2011). Here is an attempt to describe the morphomertical features of the sample watersheds using different formulae.

Stream ordering

The use of stream ordering was widely used after the works of Horton (1932 & 1945). His methodology of ordering the stream was designating the streams or tributaries flowing from the headwaters without any other branches as the First Order, streams that received only first order were designated as Second Order, large branches receiving only the first and the second order as the Third Order and so on (Horton, 1932). This system of ordering was further studied and modified by Strahler (1952), where he assumed that when two stream segment of order "N" meet they form stream "N+1". Thus all headwater streams are designated as first order, the two first orders produces a second order, two second orders produces the third and so on. The stream ordering of the present study has followed Strahler's method of stream. The stream order map of the ten watershed (Fig 3.8.a. & Fig. 3.8. b) suggests that three watersheds Menung, Shen Ru and Upper Kiliki are of fifth order, Chija Ho, Deodubi, Inkoron, Tsuhaoru Tao are of fourth order and Lower Tizu, Liyung and Khukipani are of the third order watersheds. The number of streams in the first order is the highest number and it decreases as the order increases. The highest order or the order of the watershed is the least which is one in all the watersheds (Table 3.6).

Stream Length

The total stream length of the different order of each watersheds measured from the topographic sheet (1:50,000) is presented in Table 3.6. The total length (L_u) of the Chija Ho watershed is the highest with It shows that Chija Ho has the largest Total length of 118.94 Km, the second is the Upper Kiliki watershed with 110 Km Stream length and the third is 103.93 Km and the lowest total stream length is of Deodubi

Table 3.6 Order wise Stream Number and Stream Length (in Km)

Morphometeric parameters	Stream Order (u)	1st	2nd	3rd	4th	5th	Total Number/Length
Chija Ho	N_u	147	36	9	1		193
	L_u	75.69	27.06	6.69	9.5		118.94
	L_{sm}	0.51	0.75	0.74	9.5		
Deodubi	N_u	10	5	2	1		18
	L_u	5.9	1.73	2.24	5.57		15.44
	L_{sm}	0.59	0.35	1.12	5.57		
Inkoron	N_u	47	14	2	1		64
	L_u	34.22	7.75	6.68	0.73		49.38
	L_{sm}	0.73	0.55	3.34	0.73		
Upper Kiliki	N_u	103	26	6	2	1	138
	L_u	67.6	23.88	7.48	3.39	7.69	110
	L_{sm}	0.66	0.92	1.25	1.7	7.69	
Kukhipani	N_u	38	7	1			46
	L_u	13	5.95	5.94			24.89
	L_{sm}	0.34	0.85	5.94			
Liyung	N_u	64	8	1			73
	L_u	29.95	6.33	6.47			42.75
	L_{sm}	0.47	0.8	6.47			
Menung	N_u	99	24	6	2	1	132
	L_u	64.79	16.34	6.85	2.52	5.17	95.67
	L_{sm}	0.65	0.68	1.14	1.26	5.17	
Shen Ru	N_u	139	26	6	2	1	174
	L_u	73.56	16.94	8.25	3.82	1.38	103.95
	L_{sm}	0.53	0.65	1.38	1.91	1.38	
Lower Tizu	N_u	61	12	1			74
	L_u	34.28	9.33	2.42			46.03
	L_{sm}	0.56	0.78	2.42			
Tsuhauru Tao	N_u	25	7	2	1		35
	L_u	16.45	5.84	3.33	2.04		27.66
	L_{sm}	0.66	0.83	1.67	2.04		

watershed which is 15.44 Km, followed by Kukhipani (24.89 Km) and Tsuhaoru Tao (27.66 Km). It is noted that the different patterns of watersheds of similar sizes when compared shows difference in number of streams in the various orders as well as the length. Menung has parallel patterns of its stream network and has a watershed area of 21.92 Km^2 while Shen Ru shows dentritic pattern with an area of 22.03 Km^2. The table 3.6 clearly shows that the dentritic pattern of Shen Ru watershed has much higher number of streams which is 174 in total compared to 132 of Menung watershed. Also the length of the streams in Menung is 95.67 Km lower than Shen Ru which has 103.95 Km.

Stream Length Ratio

The stream length ratio is obtained by dividing the mean stream length of the next higher order by the lower order, i.e., $L_{sm} = L_u + 1/ L_u$

Where,

"L_{sm}" is the stream length ratio, "$L_u + 1$" is the length of the higher order stream and "L_u" is the length of the lower order stream. Table 3.6 gives the various values of stream length ratio obtained in the ten sample watersheds.

Bifurcation Ratio

The ratio of the number of segments of a given order to the number of segments of the higher order is termed as bifurcation ratio (Horton, 1945)

i.e., $R_b = N_u/N_u+1$

Where,

"R_b" is the bifurcation ratio, "N_u" is the number of streams of the lower order and "N_u+1" is the number of streams of the higher order. Table 3.8 shows the bifurcation ratio of the ten sample watersheds of the study area.

Mean Bifurcation Ratio

The mean bifurcation "R_{bm}" ratio is the average of the bifurcation ratios of the different orders. Liyung watershed shows highest mean bifurcation ratio of 8, followed by Kukhipani and Lower Tizu, where as Deodubi has the lowest value of 2.08.

Drainage Density

Horton (1932) defined drainage density "D" as the length of streams per unit of the drainage area, i.e., $D = \Sigma L_u / A$

Where,

"D" is the drainage density, ΣL_u is the total stream length and "A" is the area of the same basin. The highest drainage density is found in Upper Kiliki watershed and the lowest is in Lower Tizu (Table 3.8).

Stream Frequency

The stream frequency is derived by dividing the total number of streams by the total watershed area (Horton, 1945). Stream frequency in other words is defined as the total number of streams per unit area, i.e., $F_s = \Sigma N_u = A$

Where,

"F_s" is the stream frequency, "ΣN_u" is the total number of streams of all orders and "A" is the area of the same basin. Table 3.8 shows the different stream frequencies of the sample watersheds. Highest stream frequency is maintained by Kukhipani watershed, 7.9 streams per unit area and the lowest of them is the Tsuahaoru Tao watershed which is 3.54.

Drainage Texture

Drainage texture gives us an idea of how close the streams or river channels are from one another. Drainage texture as explained by Thornbury(1967) defines the relative spacing of drainage lines. Horton (1945) says that both drainage density and frequency is included in the study of drainage texture.

Length of overland flow

According to Kanth and Hussan (2012) Length of overland flow L_g is the length of water over the ground before it gets concentrated into definite stream channels and higher value of L_g is indicative of low relief and where as low value of L_g is an indicative of high relief. The length of overland flow is derieved by using the formula

$L_g = 1/ D * 2$

Where,

"L_g" is the Length of Overland flow, and "D" = Drainage Density.

The highest value of L_g is found in Tsuhaoru Tao followed by Lower Tizu and Inkoron. The lowest value is found in Upper Kiliki watershed.

Table 3.7 A summary of Formulae used for the computation of Morphometric Parameters

Parameter	Symbol/ Formula	Description	Reference
Stream Order	Hierarchical Rank		Strahler (1964)
Mean Stream Length (L_{sm})	$L_{sm} = L_u/N_u$	L_u= Total Stream Length of order u; N_u = Total no of stream segment of order u.	
Drainage Texture (R_t)	$R_t = L_u/L_u$-1		Horton (1945)
Length of overland flow (L_g)	$L_g = 1/D*2$		
Mean Bifurcation Ratio (R_{bm})	R_{bm}= Average R_b of all orders		Schumm (1956)
Drainage Density (D)	$D = L_u/A$		Horton (1932)
Drainage Frequency (F_s)	$Fs = N_u/A$		
Form Factor (R_f)	$R_f = A/L_b^2$		
Circulatory Ratio (R_c)	$R_c = 4*\pi*A/P^2$		Miller (1953)
Basin Length (L_b)	$L_b = 1.312*A^{0.568}$		Nooka Ratnam et.al (2005)
Compactness Coefficient (C_o)	$Co = 0.2821*P/A^{0.5}$		
Shape Factor (B_s)	$Bs = L_b^2/A$		

Table 3.8 Bifurcation Ratio of the sample watersheds

Watersheds	Bifurcating Ratio R_b				Mean Bifurcating Ratio R_{bm}
	1st order/ 2nd order	2nd order/3rd order	3rd order/ 4th order	4th order/5th order	
Chija Ho	4.08	4	9		5.69
Deodubi	2	2.5	2		2.08
Inkoron	3.36	7	2		4.12
Kiliki	3.96	4.33	3	2	3.32
Khukipani	5.43	7			6.22
Liyung	8	8			8
Menung	4.13	4	3	2	3.28
Shen Ru	5.35	4.33	3	2	3.67
Lower Tizu	5.08	12			6.03
Tsuhau Ru	3.57	3.5	2		3.02

Table 3.9 Summary of Linear parameters of the sample watersheds

Watershed	Drainage density (D)	Stream frequency (F_s)	Drainage texture (R_t)	Length of overland flow (L_g)
Chija Ho	3.96	6.43	6.6	0.51
Deodubi	3.65	4.26	2.01	0.55
Inkoron	3.16	4.09	2.69	0.63
Kiliki	4.74	5.94	5.72	0.421
Khukipani	4.28	7.90	3.72	0.47
Liyung	3.47	5.93	3.16	0.58
Menung	4.36	6.02	4.89	0.46
Shen Ru	4.72	7.89	7.82	0.423
Lower Tizu	2.29	4.79	3.77	0.67
Tsuhau Ru Tao	2.8	3.54	2.14	0.71

Table 3.10 Summary of Shape Parameters for the sample watersheds

Watershed	Elongation Ratio (R_e)	Circulatory Ratio (R_c)	Compactness Coefficient (C_o)	Form Factor (R_f)	Shape Factor (B_s)
Chija Ho	0.68	0.44	1.21	0.365	2.74
Deodubi	0.78	0.66	1.23	0.476	2.1
Inkoron	0.7139	0.34	1.7	0.400	2.49
Kiliki	0.694	0.501	1.412	0.378	2.64
Khukipani	0.76	0.48	1.44	0.46	2.19
Liyung	0.72	0.29	1.86	0.41	2.43
Menung	0.6971	0.38	1.63	0.3815	2.6211
Shen Ru	0.6970	0.56	1.34	0.3814	2.6218
Lower Tizu	0.7134	0.502	1.409	0.399	2.502
Tsuhau Ru Tao	0.74	0.47	1.46	0.43	2.35

Elongation Ratio

Elongation ratio is the ratio between the diameter of the circle of the same area as the drainage basin and the maximum length of the basin (Nongkynrih and Hussain, 2011). It is derieved by using the formula,

$R_e = 2(A/\pi)\ 0.5/\ L_b$

Where,

"R_e" is the elongation ratio, "A" is the area of the watershed, $\pi = 3.14$ and "L_b" is the Basin length. It is observed that Deodubi watershed is the highest in

elongation ratio followed by Kukhipani watershed and the lowest is Chija Ho watershed.

Circulatory Ratio

The basin circulatory ratio was used to measure the shape or outline form of a drainage basin by Miller (1953). It s the ratio of basin area of a circle with the that of the basin perimeter (Furkumzuk, 2011). The following formula is used to calculate the basin circulatory ratio (R_c)

$R_c = 4 \pi A / P^2$

Where,

"R_c" is the basin circulatory ratio, $\pi = 3.14$, "A" is the area of the watershed and "P" is Perimeter of the watershed.

The highest ciculatory ratio is Deodubi and the lowest is the liyung watershed.

Compactness Coeffient

Pareta and Pareta (2011) elucidate compactness coefficient as Gravelius (1914) has defined that it is the ratio of perimeter of watershed to circumference of circular area, which equals the area of the watershed.

$Co = 0.2821 * P / A^{0.5}$

Where,

"Co" is the compactness coefficient, "P" is the perimeter of the watershed and "A" is the area of the watershed. The compactness coeffient is the highest in liyung watershed and thew lowest is Chija Ho watershed.

Form Factor

Form factor is the ratio of the basin area to the square of the basin length (Horton, 1932). Form factor would always be less than 0.7854 (for a perfectly circular basin) Smaller the value of form factor, more elongated will be the watershed. The watersheds with high form factors have high peak flows of shorter duration, whereas, elongated watershed with low form factors have lower peak flow of longer duration. The formula used in derivaton of the form factor is,

$R_f = A / L_b^2$

Where,

"R_f" is the form factor, "A" it the area of the waterhsahed and "L_b" is the Basin Length.The form factor is the highest in Deodubi watershed and the lowest in Chija Ho watershed.

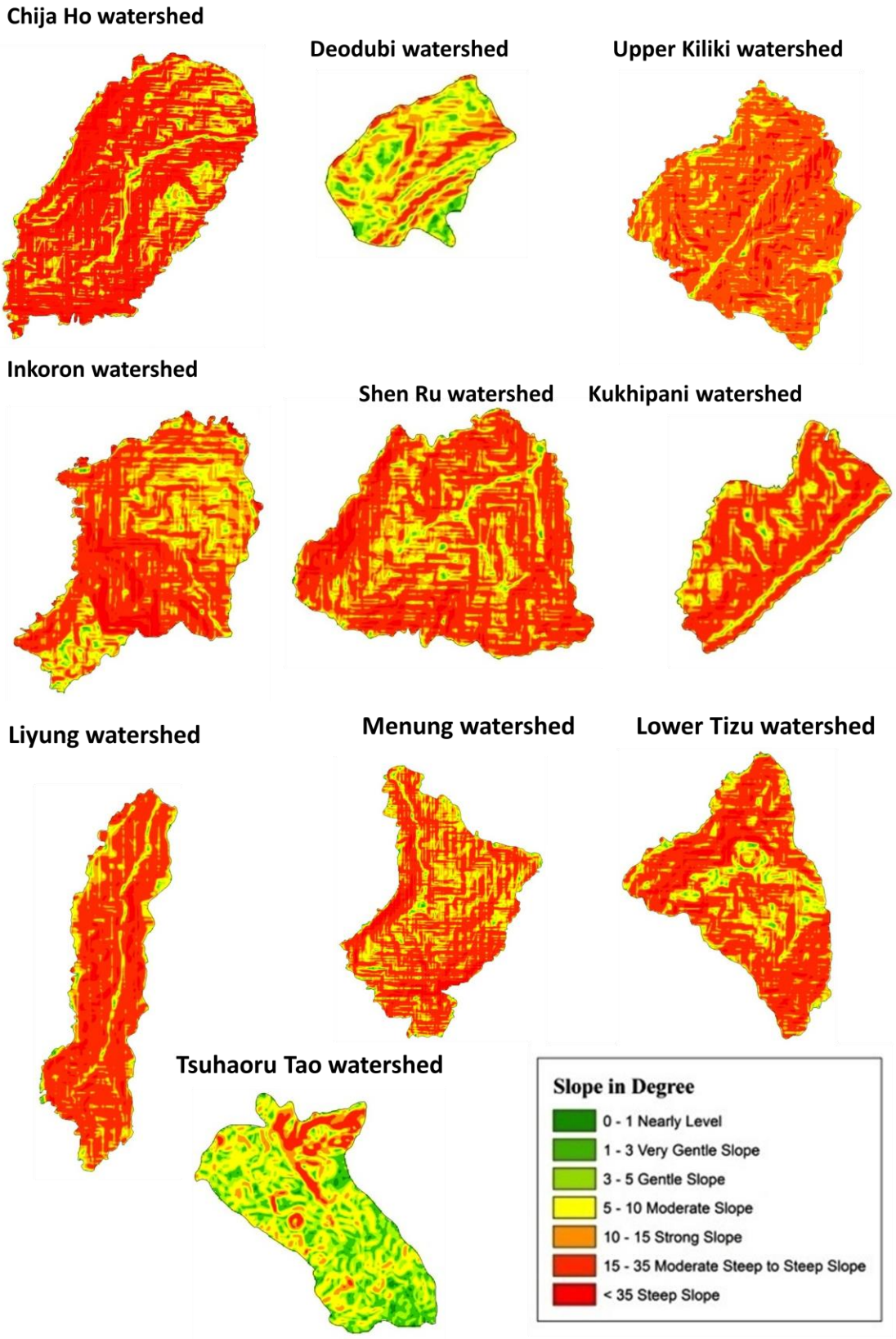

Fig. 3.9 Slope Maps of sample watersheds

Shape Factor

Basin Shape is the ratio of the square of basin length to the area of basin

$Bs=L_b^2/A$

Where,

"Bs" is the Basin shape, "L_b" is the Basin length and "A" is the Area of the basin.The shape factor is the highest in Chija Ho watershed and the lowest in Deodubi watershed.

Slope Analysis

According to Furkumzuk, (2011) slope is defined as the angular inclination of terrain between the crest and valley bottoms. The variation and complexity in the landscapes are brought out by anlysisng the slope of a watershed. Slope analysis helps in determining the speed of flow of water as steeper the slope faster will be the flow and gentler the slope water would flow at a slower rate. Maps of slope average has been generated for the sample watersheds using Arc GIS 9. The slopes are generated in degrees and are classified as Nearly level (0-1), Very Gentle Slope (1-3), Gentle Slope (3-5), Moderate Slope (5-10), Moderate to Steep Slope (15- 35) and Steep Slope (above 35). The Fig 3. 8 shows that the two watersheds, Deodubi and Tsuhaoru Tao are areas with very gentle slope to Moderate slope, and the rest of the sample watersheds have strong slope to moderate slope.

The morphometrical analysis can be used by watershed developers and planners to understand the physical elements that governs the shape and size of the watershed as well as the personality that the watershed exhibit. To prioritize watersheds of its degradation degree of soil, parameters of linear and shape morphometry can be used where there is lack of information about its soils. The slope can be determines by slope maps which helps in the study of the drainage flow and the degree of inclination of the landforms. Morphometrical analysis can be incorporated with the other aspects of a watershed for example, socio-economic factors like population, density of population, common activities of the people etc. and other physical factors like climate, vegetation etc. to give strategic plan for watershed development and management in a sustainable manner.

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Chapter 4

ENVIRONMENT, RESOURCES AND DEVELOPMENT

INTRODUCTION

Geography right from its beginning, deals with the man-environment relationship in the spatial context and today it has become an interdisciplinary science concerned with the face of the earth and its natural environment as well as the human intervention which has changed the physical and cultural landscape over the years. Geographical perspective tries to understand the interrelationship that exists between the human and the environment. Environment is a French word 'Environ' for 'surrounding' which include all forms of plants, animals, human beings, air, water, land, buildings, parks, vehicle etc which we are directly or indirectly dependent for our survival (Uberoi, 2010). Environmental Protection Act (1986) defined Environment as the sum total of water, air and land, their interrelationship among themselves and with the human beings. Another definition of environment suggests that it is the aggregate of all the external forces, influences and conditions, which affect the life, nature, behavior and the growth, development and maturity of living organisms (Douglas & Holland, 1947). Environment can be broadly divided into two, the natural environment and the cultural environment. The natural environment consist of four interlinking systems namely, the atmosphere, the hydrosphere, the lithosphere and the biosphere. These four systems are in constant change and such changes are affected by human activities and vice versa (Kumarasamy *et. al.*, 2004). The cultural environment consists of socio-economic-political arena where human plays the vital role in bringing various changes and development. Human beings are a part of both the environments. The physical components as well as the cultural components are inseparable whole systems which are interlinked individually and collectively myriad ways (Kalavathy, 2004).

Environment constitutes of three elements, physical, biological and cultural. The physical elements are landforms, water bodies, climate, soils, rocks and minerals which determine the variable character of the human habitat, its opportunities as well as limitations. All living organisms come under the biological elements and they constitute the biosphere while man-made features like economic, social and political are the cultural elements. Whether it is the physical or biological or cultural, all these elements act as a resource for human needs and development. In other words the

environment consists of resources for human progress and development. All the elements becomes a resource when it is scarce and economically useful (World Trade Organization, 2010). A natural substance is a resource when scarce, or else people could consume as much as they wanted at no cost to themselves or to others. Also, it has to be economically useful in the sense that a natural element can exist in the form where humans cannot access it for direct consumption or production. Environment provides us with a variety of goods and services necessary for our day to day lives. The deterioration of the environment and its resources is caused by several factors, the main factor being population explosion. The menacing demographic growth is leading to increasing incompatibility between resources and the number of human beings. Mankind has been overusing and depleting natural resources. Environment is the source of life on earth and it is not only directs but also determines the existence, growth and development of mankind and its activities (Saxena, 2006). Geography provides an approach towards understanding the environment and the impact of human life on that environment. It is also a search for solutions to the environmental problems that confront us. The hills and mountains have specific natural environment and ecological settings. In the present century, environmental degradation has emerged as a major global concern for human survival. In the opinion of the World Commission on Environment and Development (WCED), the future is to face an ever increasing environmental decay, poverty, hardship and ever more polluted world.

Resources can be defined in a broad sense as everything that is derivable for the use of man from any part of the universe (Worthington, 1964). Resources are often divided into renewable and non renewable. Renewable resources are all those that are of organic origin as well as some inorganic such as water and soil, whereas the non-renewable resources are all inorganic. Worthington has attempted an ecological relationship between human beings and every other elements of the environment and is being presented as in the Figure 4.1 below.

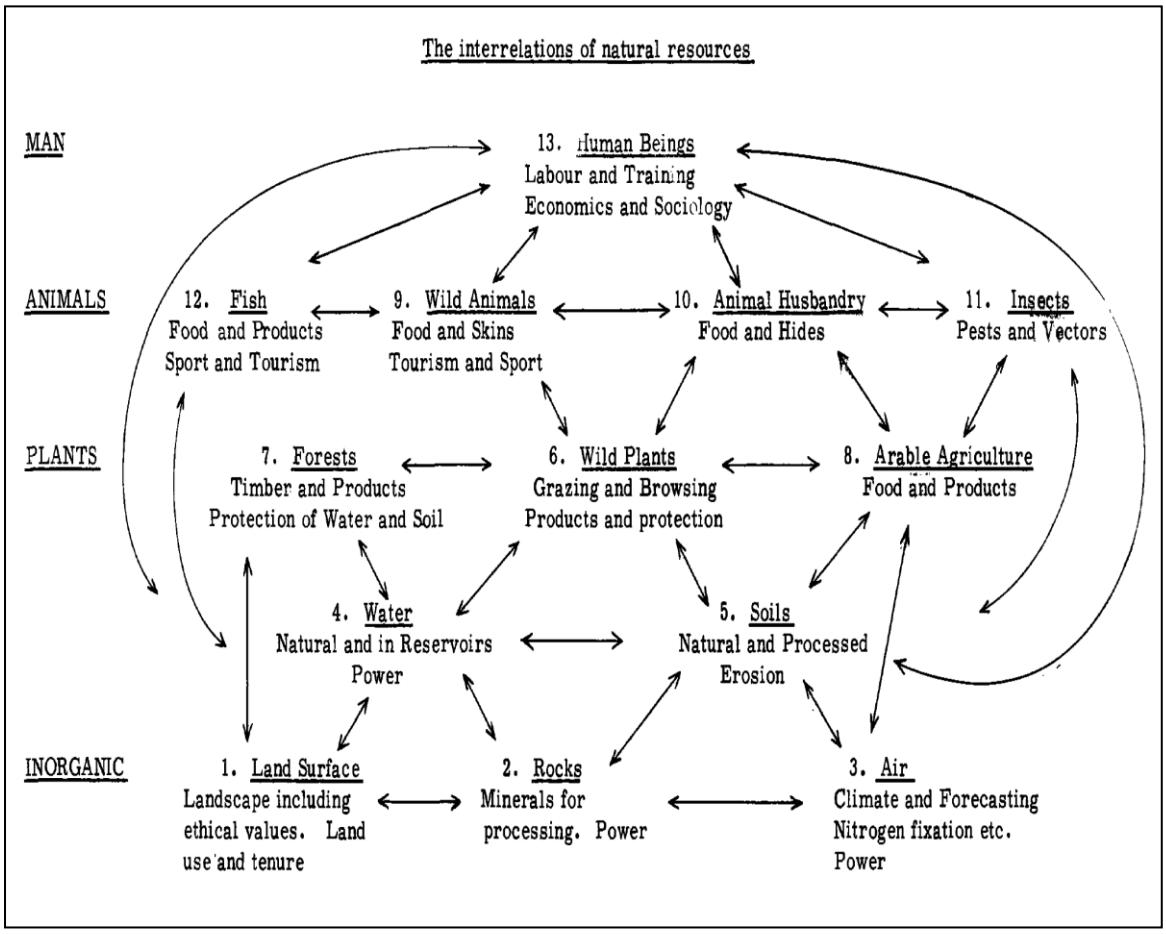

Fig. 4.1 Interrelations of Natural Resources (after Worthington, 1964)

By developing these ecological relationships we can arrange subjects within which the varied natural resources fall into an order or a pattern. It starts with the base with three main divisions on which the rest depends- land surface, the rocks underneath it and the air above it, each containing its own major natural resources. Next comes the water and soil which is an intermediate between organic and inorganic resources and these are the two most important natural resources for human kind. For without them any living organisms cannot survive. Thirdly are the plants and animals, the biotic components. Plants are further divided as wild plants resources on their own accord, forest when the plants are brought under some form of control and production as in forests and domesticated plants when their genetical capacity has been molded to produce domesticated plants which are used largely in arable agriculture. Animals are given four divisions as wild animals which are resources on their own accord, domesticated animals as in animal husbandry, insects which vary in number and variety and aquatic animals like fishes and others. Finally human beings which is at the top of the interrelation of natural resources which is directly or

indirectly dependent on the resources below and interact with everyone of them (Worthington, 1964).

Our environment provides us with a variety of goods and services necessary for our day to day lives. The natural resources in the form of matter and energy are of vital significance for the successful survival of all types of life in general and for human beings in particular. In fact, all aspects of human society (social, cultural, political and economic) depend on resources. The resources are fundamental base for the economic growth and development of human society. The modern economy is a resource-based economy and the development of a country or a region is based on its resources, especially natural resources. People have been using their biophysical environment to satisfy their needs. This process is called resource utilization. As cultural evolution proceeds, new resources are discovered and better methods of utilization are found. This is called resource development. The Himalayan ecosystem is one of the most important and most threatened of life support system on earth. In the shadow of the Himalaya live more than 175 million people, some of them the poorest in the world. The northeastern region of India is well known for its ethnic and cultural heterogeneity, floral and faunal diversity, land use pattern, agricultural practices and traditional knowledge base which are considered as "Mega-Hot Spot" of biodiversity (Fig. 4.2 & 4.3). Out of the total population about 90 percent of the people live in the villages and derive their livelihood directly from agriculture with the predominance of shifting cultivation in this entire region.

Development is a process of improving the quality of all human lives with three equally important objectives, which are (1) Raising people's living standard, i.e. incomes and consumption, level of food, medical services, education through relevant growth processes, (2) Creating conditions conducive to the growth of peoples' self-esteem through the establishment of social, political and economic systems and institutions which promote human dignity and respect and (3) Increasing peoples' freedom to choose by enlarging the range of their choice variables, e.g., varieties of goods and services. Development is not purely an economic phenomenon but rather a multi-dimensional process involving reorganization and reorientation of entire economic and social system. Improvement of complex systems (as earth is a complex one) can occur in different parts or ways, at different speeds and driven by different forces. Also the development of a part of the system may be detrimental to the

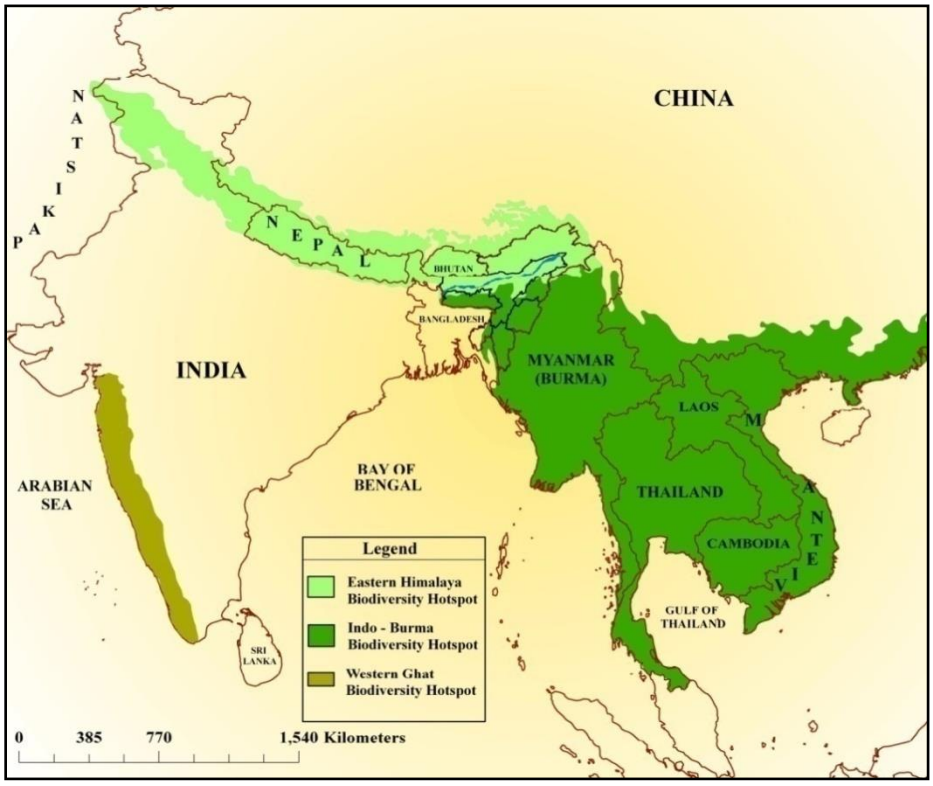

Fig. 4. 2 Himalayan and Indo-Burman Biodiversity Hotspot zones in Asia (Goswami et.al., 2012)

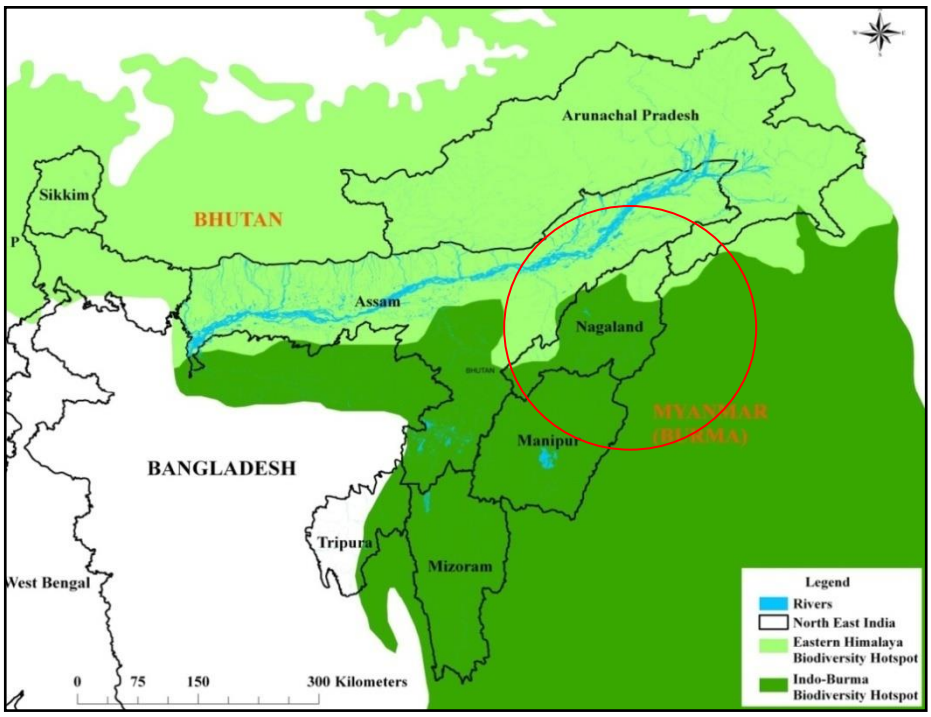

Fig. 4.3 The Study Area, Nagaland bearing both Eastern Himalaya and Indo-Burma Biodiversity Hot Spot (Goswami et.al., 2012).

development of other parts, giving rise to conflicting objectives and conflicts (FAO, 2011). Defining 'development' thus is not as easy as it looks. In its simplest form it is defined as 'good change' and is considered as the objective of moving to a state relatively better than what previously existed (Chambers, 1997). A process towards a desirable state in a society can explain what development means. In this process of change or say development it affects the lives of the people as well as the settings of the environment. There can be four dimensions of development as given by the (FAO, 2011), economic, human, sustainable and terrestrial development.

- The economic development emphasis on the improvement of the way endowments and goods and services are used within the system,
- The human development is a people centered development where the focus is put on the improvement of the various dimensions affecting the well-being of individuals and their relationships with the society,
- The sustainable development considers the long term perspectives of the socio-economic system, to ensure that improvements occurring in the short term will not be detrimental to the future status or developmental potential of the system.
- Territorial development is development of a specific region achievable by exploiting the specific socio-economic, environmental and institutional potential of the area, and its relationships with external subjects.

Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc. In the process development has had its constructive and destructive outcomes where when people have accomplished a luxurious lifestyle the environment had its share of destruction as well. Environment is a place where we live in and it is the responsibility of human beings to take care and preserve the nature for generations to follow. All the resources that human beings require for their sustenance of life or for other purposes should be conserved through wise use. It means that sensible and long-termed approach to development and utilization of any resources should be taken into consideration. To develop a resource or an environment as a whole scientific research as well as technological development generally takes a considerable time. Thus sustainable development which is development that meets the needs of the present without compromising the ability of the future generations to meet their needs is highly recommended for a better

tomorrow. Therefore, development is a process whereby the people come to utilize the resources available to bring about a sustained increase in per capita production of goods and services.

Environment, Resources and Development in Nagaland

Nagaland though not big in area comprises of various physiographic features, landforms, climate and culture. The diversified environment of Nagaland, physically and culturally, brings about a host of resources to be discussed for its development. The resources of the state can be divided as biotic resources and abiotic resources. From a geographical point of view, understanding of area differentiation in distribution of phenomena such as forest, soil, water etc and to examine the factors responsible for such differentials is first and foremost vital task.

Distribution of Biotic Resources in Nagaland

Human: Nagaland has a total population of 1,980,502 out of which 1,025,707 (52%) are male and 954,896 (48%) are female according to the *Census of India. 2011: District Census Handbook*. This population shares 0.16% of the total population of the country. The current Population of Nagaland is showing a decrease of 9,434 persons from the population in the year 2001. This indicates a negative growth rate of (-) 0.47 percent during the decade from 2001-2011. The decadal growth rate of population for the last three decades has been more than 50 percent in the State. Nagaland had also stood out for having the highest decadal growth rate of population during the decades 1981- 1991 and 1991-2001. The state is inhibited by 16 major tribes and many other smaller tribes having cultural similarities as well as differences.

Out of 11 districts 6 districts (Wokha, Dimapur, Phek, Tuensang, Kohima and Peren) have recorded positive growth while the remaining 5 districts have shown negative growth of population. According to the Provisional Census of India, 2011 the highest decadal growth among the districts is recorded in Dimapur at 23.13 percent closely followed by Kohima at 22.8 percent. Both the districts have shown a growth rate above the National growth rate of 17.76 percent. Phek district has recorded a growth of 10.19 percent followed by Tuensang at 5.81 percent, Peren at 4.61 percent and Wokha at 3.11 percent. The State has population density 119 persons per Km^2 which is way below the National figure of 382 persons per Km^2.

Table 4.1 District-Wise Population Characteristics in Nagaland (Source- Census, 2011: District Census Handbook)

Sl. No.	Districts	Male Population	Female Population	Total Population	% share in total Population
1	Dimapur	198163	181606	379796	19.17
2	Kiphire	37758	36275	74033	3.74
3	Kohima	140118	129945	270063	13.64
4	Longleng	26588	24005	50593	2.55
5	Mokokchung	100229	92942	193171	9.75
6	Mon	132062	118609	250671	12.66
7	Peren	49530	45424	94954	4.79
8	Phek	83684	79610	163294	8.24
9	Tuensang	101977	94824	198801	9.94
10	Wokha	84429	81810	166239	8.39
11	Zunheboto	71169	69845	141014	7.12
Nagaland		**1,025,707**	**954,895**	**1,980,502**	**100.00**

The sex ratio has gone up to 931 which are the highest in the last five decades but it is still below the National level of 940 females per 1000 males. Nagaland has shown a big improvement in literacy rates from earlier Census years. From 61.65 percent in 1991, it has gone up to 66.59 percent in 2001 and in 2011 it stands at 80.11 percent which is above the National level of 74.04 percent. Mokokchung district is on the top of the list with 92.68 percent literates. Mon district finds its place (56.6%) at the bottom of the list.

Livestock: In Nagaland along with agriculture, livestock are also commonly reared and is an integral part of the livelihood of the farmers. Pigs and poultry are the most reared animals for the Nagas, with cows reared in some pockets of the State. Pig rearing is simple and is fed with the by-products of paddy, maize, taro, vegetables and gathered forages. Poultry is also becoming common in the last decade as it has high market value and is easily reared. The livestock census of Nagaland in Table 4.2 shows that number of fowls in the state is the highest, followed by pig which accounts to 697,791 and the least of them is the horses accounting for 332. Though not in very large scale compared to other states and countries, the state is rich with domestic animals. The state is slowly increasing in the number and production of live stocks and if these resources are maintained, managed and developed for mass production there will an increase in the per capita income of the state dwellers and give opportunity for employment as well.

Table 4.2 Livestock Census of Nagaland as per 2007(Source: Directorate of Economics & Statistics, Nagaland 2013)

Sl No	Livestock	Number
1	Cattle	469,818
2	Buffalo	35,022
3	Mithun	33,345
4	Pig	697,791
5	Sheep	3649
6	Goat	178,072
7	Rabbit	41,922
8	Horse	332
9	Dogs	161,617
10	Fowl	2,746,576
11	Duck	119,730

Aquatic Animals: In Nagaland pond culture is commonly practiced in foot hills whereas in Kohima and Phek districts farmers practice paddy cum fish culture. There are total of 28.80 Km^2 Water Area of ponds and tanks in Nagaland. The year 2012 to 13 215 new ponds were built for the beneficiaries. The total production of aquatic animals is 7465 MT where capture production is 417. 40 MT and culture production is 7095.5 MT.

Table 4.3 Productions of Aquatic Animals in Metric Tonnes, 2012-13 (Source: Directorate of Economics & Statistics, Nagaland 2013)

Sl.No	Species	Capture	Culture	Total
1	Major Carps	190.30	3339	3529.30
2	Exotic Carps	77.40	3547	3624.40
3	Minor Carps	57.80	0	57.80
4	Murrels	10.75	6.70	17.45
5	Cat Fishes	20.95	62	82.95
6	Minnows, Trash Fishes	17.80	135	153.10
7	Fresh Water Prawn	4.75	5.50	10.25
8	Crab	6.80		6.80
9	Snail	13.25		13.25
10	Frogs	15		15
11	Turtle	.50		0.50
12	Aquatic insects & others	2.10		2.10
Total		**417.40**	**7095.5**	**7465**

Forests: In Nagaland the forest cover is 13, 044 Km^2 which is 78.68 percent of the total geographical area (FSI, 2013). From Table 4.4, the area covered by the various category of forest are, Very Dense Forest which is 1298 Km^2, Moderate dense Forest is 4736 Km^2 and open Forest is 7010 Km^2 .Forest cover in Nagaland varies altitudinal wise where very dense forest is highest at elevation 2000 m to 3000 m, moderate dense forest is maximum at elevation of 1000 m to 2000 m and open forest at 500 m to 2000 m. The dense forest is maximum at higher altitude as they are not easily accessible for human consumption and also the land is not preferable for agriculture. Open forest on the other hand are maximum at the intermediate elevation as there are heavy removal of forest trees for shifting cultivation and other primary activities.

Table 4.4 Altitude-wise Forest Cover of Nagaland (Source: India State of forest Report, 2013)

Altitude Zone (meters AMSL)	Very dense forest	Moderate dense forest	Open Forest	Total
0-500	0	1,089	1,984	**3,073**
500- 1000	16	1,352	2,462	**3,830**
1000-2000	587	2,047	2,462	**5,096**
2000-3000	682	240	100	**1,022**
Above 3000	13	8	2	**23**
Nagaland	**1,298**	**4,736**	**7,010**	**13,044**

Distribution of Abiotic Resources in Nagaland

Land: Nagaland covers an area of 16,579 Km^2, with 42.12 percent of dissected land. The highly dissected land of Nagaland is found to be with 95 percent of hard rock which covers an area of 15,722 Km^2 (Directorate of Geology & Mining, 2007). Ridges, plateaus, steeps and undulating lands covers an area of 48.57 percent and the rolling land and valleys covers 7.54 percent only (Table 4.5); thus the State is mostly hilly and mountainous. Because of its rugged topography and its dissected landforms we find various changes over a distance of the area in climate, vegetation and habits of the people. Land is an important resource because essentially every activity is land based. Agriculture is one of the most important land based activity in Nagaland as majority of the people are either farmers or involved in agricultural based activities.

Table 4.5 Landform and Area Coverage of Nagaland State, (Source: Soils of India Series, 2000)

Landform	Area (Km^2)	% Total Geographical Area
Dissected land	6694.7	42.12
Gently sloping land	293.6	1.77
Rolling land	1197.4	7.21
Plateau	144.8	0.87
Ridges	667.5	4.02
Steep lands	6584.2	39.05
Undulating lands	768.9	4.63
Valleys	55.5	.33

Water: Nagaland is endowed with many streams and rivers flowing through it from three river systems. Rivers and streams are a main source of drinking water and other domestic activities. Ponds, lakes and wells are also some of the sources of water for domestic purposes in Nagaland. Rain water harvesting is one of the most common practices during the rainy season though in dry season people depend on the perennial streams and ground water drawn from wells. River dam is also an important source of energy and Nagaland has seven mini hydro power projects (2008)

Table 4.6 The function hydro power projects in the different parts of Nagaland as in the year 2008 (Source: Department of Power, Government of Nagaland, 2008)

Sl.No	Hydro project	Capacity	District
1	Likimro Hydro Electric Project	24 MW	Kiphire
2	Duilumroi-l Mini Hydel Project	540 MW	Peren
3	Duilumroi-ll Mini Hydel Project	200 MW	Peren
4	Dzuza Hydro Electricity Project	1.5 MW	Kohima
5	Tsutha Mini Hydel Project	700MW	Zunheboto
6	Telangsao Mini Hydel Project	600 MW	Mon
7	Doyang	75 MW	Wokha

Mineral: Mineral resources which in order of economic importance comprises of Petroleum and natural gas; nickel- cobalt- chromium bearing magnetite; high grade limestone/ marble; coal and dimensional decorative stones. A reserve of approximately 26.77 million tones of petroleum and natural gas within the Schuppen belt has been proved at Changpang oil field and five million tonnes of nickel, cobalt and chromium bearing magnetite deposit within the Ophiolite complex has already been proved in Pokphur area of Nagaland by exploratory drilling with 0.13 to 1.63

percent of Nickel, 0.09 percent of Cobalt and 4 percent of Chromium (Table 4.5). The National Metallurgical Laboratory, Jamshedpur, has completed the first phase of Research and Development works and produced a ferro-nickel alloy (Ni- hard) having commercial use (Government of Nagaland, 2007).

Table 4.7 Mineral Resources of Nagaland in Order of Economic Importance (Source: Directorate of Geology and Mining, 1978)

Economic mineral deposit (and host formation)	Inferred reserves (million tonnes)	Proved reserved (million tonnes)	Grade
Petroleum and Natural Gas (within 'belt of Schuppen' and self facies) in foothill region.	600.00 prognosticated	26.77 in Changpang Oil field only(Natural Gas not estimated)	About one million tonnes produced used in refinery.
Magnetite with nickel cobalt and chromium (within Ophiolites) in Phek and Tuensang districts.	Not yet explored fully	5.00 (only at pokphur)	Ni-0.13 to 1.63% Co – 0.09% Cr_20_3-4% Fe_2-03-42% Fe0-24%
Limestone & Marble (within ophiolites and metasediments) in Phek and Tuensang districts.	More than 1000.00	More than 100.00	CaO – 50 to 56% R_2O_3·MgO, insoluble etc. very low.
Coal (within belt of Schuppen) in foothills of Wokha, Mokokchung and Tuensang districts	More than 50.00	10.00(in different areas)	Low ash, low moisture, high volatile, high calorific value and high Sulphur(4%)
Dimensional & Decorative stones (marble, Spilite, Basalt, Chert, Dunite, Gabbro, Serpentinite, Pyroxenite, Quartzite, Slate, Sandstone etc.) in Phek, Tuensang and other districts also.	Not yet explored fully	Substantial reserves	Take good polish, Serpentinite and Dunite could find use as refractory materials.
Other associated metals like zinc, molybdenum & other possible precious metals such as gold and platinum groups(within ophiolitesand metasediments) in Phek and Tuensang districts.			Cu -0.1 to 1.3 % Mo – 15 to 210ppm Au – 0.5 ppm Pt – 20 ppb

The Oil and Natural Gas Cooperation Ltd. has been carrying out exploration in the foothills and commercial production from Changpang Oilfield in Wokha district and had extracted approximately One million tonnes of Oil till April 1994, after which the operation has been suspended. There has been also small coal production under unorganized sector in unscientific way by the local populace in the foothills of the state.

Development in Nagaland

The Socio-economic development over the years has improved considerable in the land when we observe the table above. It is to be noted though that the development activities without proper planning strategies can be destructible to natural resources. With the growth of population the demand on land grows and its utilization increases. In order to bring about any development in the land some changes is required in the original settings of the landform. Construction of road, buildings, and shifting agriculture does require such changes. Landslides, soil erosion, sedimentation, degradation of forest are some of the developmental hazards faced in Nagaland. There is very little interface between the government and the academic community in Nagaland with regard to the economic planning and development. Nagaland State has a special status in the Indian union. Article 371 (A) of the Constitution of India provides that the custom and tradition of Naga people is protected and that the land ownership continue to remain in the hands of the individuals, clan, communities and villages.

The figures of development indicators presented in the Table 4.6 are impressive during the period between 1962-63 and 2001-02. After the year 2001-02 much more development has been achieved so far. According to the findings of a socio-economic study (Rawat, 2014), the GDP of the state as estimated during 2002-03 is ₹ 26, 4148 lakh with an average annual growth rate of 8.18 percent giving a per capita income of ₹ 12,292 with an average growth rate of 2.8 percent. The Net State Domestic Product (NSDP) of Nagaland during 2003 (at current prices) stood at ₹ 4458.29 crores. Of this, the contribution of the primary sector comprising of agriculture and allied departments accounted for 33.37 percent of NSDP of Nagaland.

Table 4.8 Indicators of Socio-economic Development in Nagaland (After Thakar (2002) & Directorate of Economics & Statistics, Nagaland 2013)

Sl. No.	Item	Unit	1962-63	2002-03	2012-13
1	Total length of road	Kms	873	9860	15,078
2	Villages connected with roads	Number	NA	1092 (79.4%)	1145
3	Water supply provided	No. of Villages/ Habitations	Nil	1304	1408
4	Generation of Electric power	MW	0.20	29	103
5	Villages electrified	Number	6	1216	1258
6	Life Expectancy	Years	NA	73.4	73.4
7	Literacy	Percent	17.91	67.11	79.55
8	Primary school	Number	592	1311	1662
9	Middle School/ High Schools	Number	22	121	802
10	Government Hospitals	Number	8	13	14
11	Dispensaries/ Sub-centres	Number	3	422	547
12	Hospital Beds	Number	613	2065	2798
13	Area under irrigation	000’ ha	1.51	65.63	92.45
14	Food grain products	000’ tonnes	61.82	386.30	431.95

It must be noted that the overall percentage contribution of agriculture to NSDP was 30.41 percent and within the primary sector it contributed an astonishing 91.33 percent. Food and environmental security have become a major issue of concern. Environmental management of degraded Jhum-agro-ecosystem is the need of the hour. So far, environment has not been taken seriously as the social, economic and other components in development planning. Biotic and abiotic natural resources are plenty in the state, wise use and proper planning for its development is necessary so that people can enjoy the use of its resources as well as conserve them for future generation.

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Chapter 5

WATERSHED DEGRADATION

INTRODUCTION

Watershed degradation threatens the livelihood of hill people and constrains the ability of the governments to develop a sustainable economic base. In the day-to-day struggle to subsist, the long term view of resource conservation and management has been lost by the most watershed inhabitants (Rawat, 2002). This distress migration from the hills of active population and leadership is affecting development potential in terms of resources and talents. The environmental economic and social costs will be severe if nothing is done to correct the existing situations. Young rock formations, friable surfaces, steep slopes, extreme seasonal and diurnal temperature changes and intense monsoon rains make the watershed prone to erosion. Widespread deforestation has aggravated erosion, led to increased downstream flooding and reduced base flows. This deterioration in the natural water resources has resulted in the loss of biodiversity and natural habitat. Agricultural activities on steep slopes and depleting vegetative cover with consequent erosion are also destroying the ecosystem and the productive potential of the watersheds (Rawat, 2006)

Watershed is home for man and all other living organisms. Degradation of watersheds means degradation of dwelling places of all living beings. It is important to understand the mechanism of how our watershed works and to study the cause and effect of degradation so that it may be well taken care of. Watershed degradation is a marked deterioration in the hydrological behavior of a river system which reduces the potential of land and water by causing a water flow of inferior quality, quantity and timing. Watershed is a unit defined by natural settings where flow of water determines the shape, size and nature of the watershed. Ridges are the boundaries of a watershed and nature does not recognize man-made political boundaries such that a watershed may belong to two or more different communities or states or countries. In a watershed the socio-economic-political activities of human beings plays an important role in determining the health of a watershed. Apart from naturally caused destruction of the environment, for example, by floods, earthquakes, tsunamis, volcanoes etc, which is not in our control, today more challenges are being faced as a result of our human efforts to change the physical landscape and the environment itself for our own gain. The extent of activities that brings natural resources to stop being productive and lose the capability to replenish itself for further use by human and other living organisms is becoming a serious threat for the existence of life itself. The effects of degradation may seem unimportant and insignificant when seen in the small

areas but when all the watersheds are put together it just cannot be ignored. The world-wide trend of land degradation is 70 percent of dry lands in agricultural use and desertification damages is 30 percent of the world's area (The Food and Agriculture Organization of the Nation and Earthscan, 2011). Water problem is similar to the land degradation as the population of the world tripled, use of water has increased six-fold and today 2.4 billion people lack access to basic sanitation and 1.1 billion people lack access to safe water source. Agriculture and deforestation of river basins continue to take toll on watersheds and their ecological and hydrologic functioning, increasing vulnerability to repeated droughts and floods in various part of the world (Duda, 2003). Watersheds are environmental and land management natural units which determine the health of a region.

Nagaland is a hill state where the occupants are mostly farmers. That would mean that Nagas are closely associated with their environment as they follow age old traditional farming of subsidence. With 1400 villages and a population of 1,407,536, Nagaland constitutes 71.14 percent of the total population living a rural life. There are 19 towns in the state which are occupied by only 28.85 percent of the total population who are mostly involved in tertiary activities. The watersheds in Nagaland are characterized by a great degree of inaccessibility, fragility, marginality, diversity, specific niche opportunities and a unique human ecology. These biophysical characteristics also give rise to inter-linkages that create objective circumstances influencing the use and patterns of natural resources and ultimately affecting the environment.

NATURAL RESOURCES AND LAND USE/ LAND COVER IN NAGALAND

Our environment provides us with a variety of goods and services necessary for our day-to-day lives. The natural resources in the form of matter and energy are of vital significance for the successful survival of all forms of life in general and for human being in particular. In fact, all aspects of human society (Social, cultural, political and economic) depend on resources. The resources are the fundamental base for the economic growth and development of human society but their withdrawals from nature, mode of their use by human being and their disposal have enormous adverse effect on the environment. The main natural resources of a watershed are the land, water and vegetation. Land is where all the human activities are performed and water and vegetation are the source of existence of life. These three resources are

interlinked with one another. The total land area of Nagaland is 16,579 Km^2 upon which the main human activities of the land like agriculture, quarry, construction of roads and buildings are performed. Water and vegetation found in land have their own entity as natural resources as well. Rivers, streams, lakes, ponds and natural springs are the sources of water for human consumption and other utility and rainfall is one of the most important phenomenons that helps maintain the availability of water in the sources. Rain fed streams and rivulets are commonly found in the settlement areas and most of them run dry during the winter season. Average rainfall of Nagaland is 1765.88 mm (Department Soil & Water Conservation, 2013).

LAND USE LAND COVER

Out of the total land area of Nagaland, 3.3 percent of land is used for non-agricultural purposes. Roads, buildings and other structures include this category. Forest covers an area of 7677.33 Km^2 which is 46.31 percent. Cultivated land is 22.85 percent and 26.97 percent of land is the fallow land which sums up to 49.83 percent of the land that is affected by agriculture. Current cultivated land is 10.67 percent of the total area and major portion of the land under cultivation is subjected to Jhumming. All the land of the State is rain fed except for some pockets of the agriculture land which is under irrigation.

Table 5.1 Land Use Status of Nagaland (source: State Level Nodal Agency for IWMP, Dept. of Land Resources)

Land Use	Area in Km^2	Percentage

Land under non Agriculture Use		560.21	3.38
Recorded Forests		7677.33	46.31
Rain fed area under	a. Cultivated	1769.49	10.67
	b. Cultivable waste	2018.73	12.18
Permanent pastures and other grazing lands		0	0
Land under misc. tree crops and groves		82.28	.49
Current fallow		1243.61	7.50
other fallow		3227.36	19.47
Total Geographical Area		**16,579**	**100**

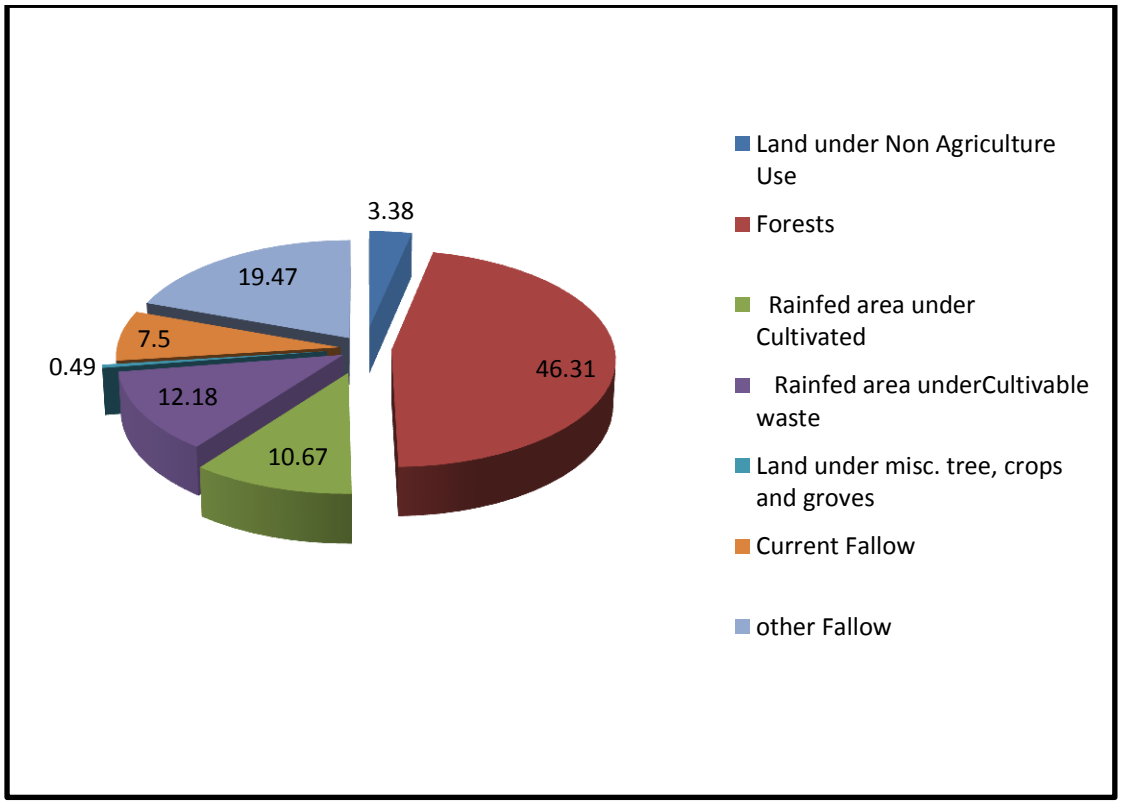


Fig. 5.1 Land Use (in % of the total area) in Nagaland

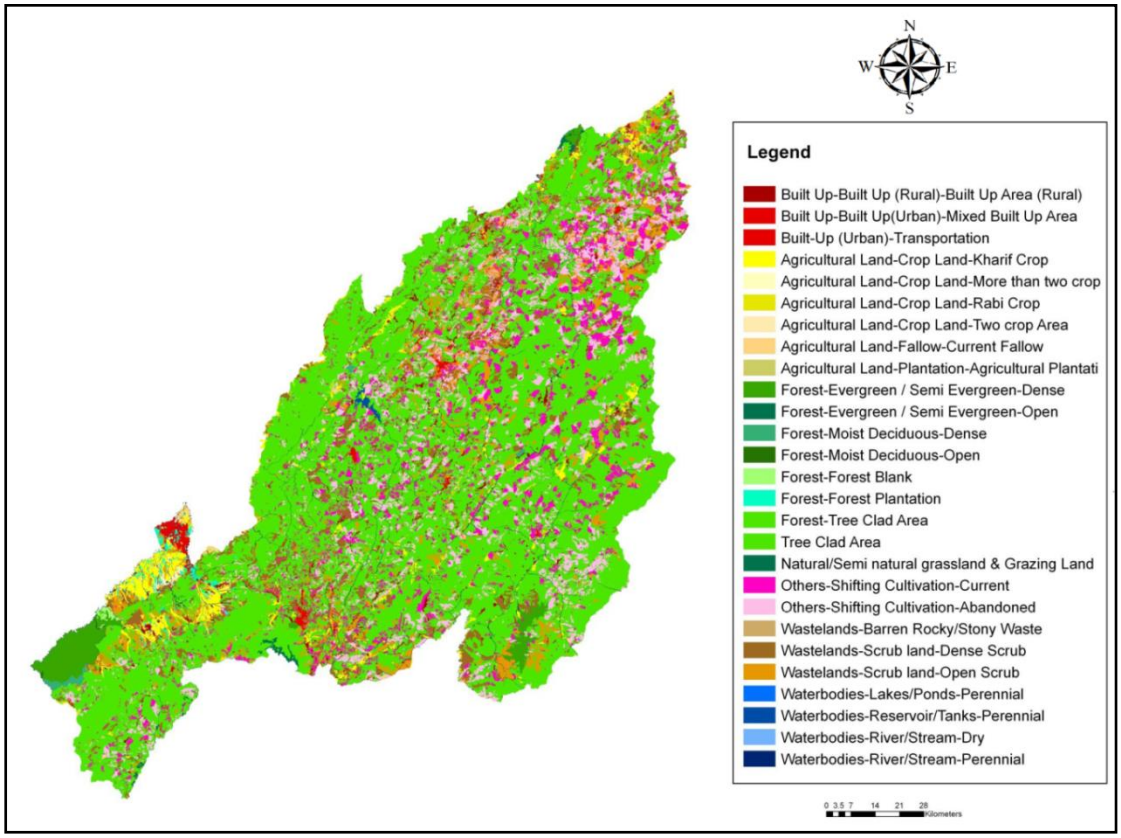


Fig. 5.2 Map showing detailed Land use in Nagaland (after NASTEC)

WATERSHED DEGRADATION IN NAGALAND

The deterioration of environment and ecological base in various watersheds in spatiotemporal terms due to mismanagement of the resources and environmental system having damaging repercussions are reflective of unsustainable policy frame and planning strategies followed so far. Their observable signs can be listed as

1. Extensive deforestation accounting for loss of flora, fauna and some rare species.
2. Drying up of springs which are main source of drinking water and fall in the underground water table.
3. Intensifying rate and frequency of floods and droughts.
4. Land degradation due to accelerated soil erosions, mass-wasting processes, mass movement, massive land sliding, desertification, wastelands, salinity and water logging.
5. Deterioration in quality of air and water.
6. Pressure of population resulting in unemployment and mass migration.
7. Unplanned urbanization and unprecedented growth of urban slums etc.

8. Shifting cultivation and intensive agriculture without taking adequate care of soil fertility.
9. Massive development of hydropower sector without proper water management, which leads to high rate of siltation and water logging.
10. Improper use of pesticides, fungicides, herbicides etc cause soil damage and biological imbalance
11. Excessive tapping of underground water accounts for steep fall in underground water table.
12. Excessive use of non-degradable material like plastic creates problems of waste management.

The different forms of watershed degradation and its causes are presented in the following pages.

Deforestation

Deforestation is a known process taking place everywhere in the world. Nagaland is also not safe from it. Nagas usually clear the forest for shifting cultivation, for collecting fire wood and for making furniture. Natural causes for deforestation may be due to wild fire. As population rise, the extraction of firewood increases, thus the bias between firewood production and usage increases, therefore reinforcing deforestation and destruction of natural vegetation. Forest degradation may have severe effects on the people's sustainable use. Forests often found in headwater regions, do not only improve the annual retention capacity of the soil and thus help to provide a stable discharge rate, which is crucial for the sustainable use of the people, but they also help to decrease the risk of flash floods and thus prevent severe soil erosion during heavy rain. The department of Forest, Ecology and Environment of Nagaland has made an assessment of the changes that has occurred in the forest coverage of the state from 2005 to 2007. The forest has been categorized into four, namely very dense forest, moderately dense forest, open forest and scrub. There is marked land cover changes of Forest from 2005 to 2013. A loss of 637 Km^2 of moderately dense forest and open forest is seen which account to 5.14 percent of decrease while very dense forest is increased by 1.41 percent. Scrub land is reduced to 2 Km^2 from 9 Km^2 which is 77.78 percent of decrease and non forest land is increased by 21.62 percent (Table 5.2 and Figure 5.3). Change in forest cover in Nagaland is mainly due to the biotic pressure, particularly shortening of shifting cultivation cycle (FSI, 2013).

Table 5.2 Change in Forest Cover (2005 through 2013), Source: Forest Survey of India, 2013

Category of Forest	2005 (Km^2)	2013 (Km^2)	Change (Km^2)	% of change
Very dense forest	1280	1298	18	(+)1.41
Moderately dense forest	5072	4736	-334	(-)6.59
Open forest	7313	7010	-303	(-)4.14
Scrub	9	2	-7	(-)77.78
Non-forest	2905	3533	628	(+)21.62
Total Forest Area	**13665**	**13044**	**-621**	**(-) 4.54**

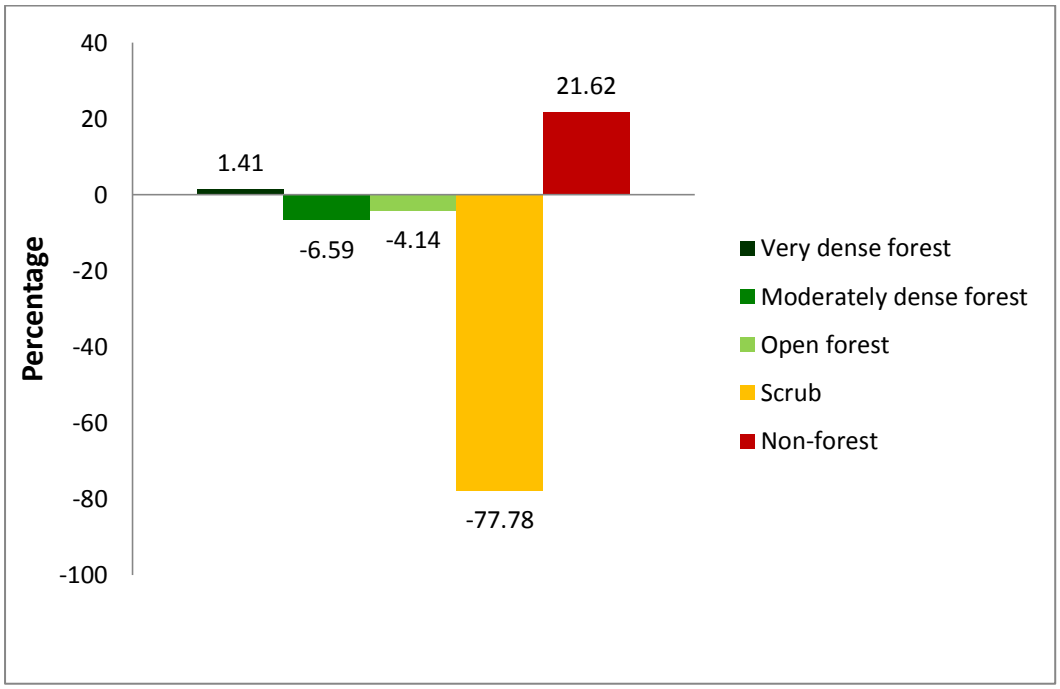


Fig. 5. 3 Changes in Forest Cover though 2005-2013

Land/ Soil Degradation in Nagaland

Nagaland is a hilly state except for a narrow belt of foot hills bordering Assam and the small valleys in between the lower range of the western and north eastern flank. The peculiar terrain condition and high rainfall in the state give an interesting scope for land degradation studies. Land degradation as defined by the Global Assessment of Human Induced Soil Degradation (GLASOD) is the temporary or permanent reduction in the productive capacity of land as a result of human action. Mapping has been done by NBSS & LUP in 1994 and revised in 2004 based upon GLASOD guidelines. Loss of top soil (Wt) is in general, encountered in all the units.

Degree of Soil degradation is of two types namely, water erosion and chemical deterioration. Loss of topsoil through water erosion is the most common type of soil degradation. It is generally known as surface wash or sheet erosion. The most common phenomena of the terrain definition or mass movement (Wd) is rill and gully formation. According to GLASOD, water erosion is classified as loss of top soil and terrain deformation which are further classified as slight, moderate, strong and extreme degree of degradations.

- Light: somewhat reduced agricultural suitability.
- Moderate: greatly reduced agricultural productivity.
- Strong: biotic functions largely destroyed; non-reclaimable at farm level.
- Extreme: biotic functions fully destroyed, non-reclaimable.

Slight degree of degradation of top soil is found to cover an area of 490 Km^2 which is about 2.9 percent of the total area of Nagaland. Moderate soil loss covers an area of 1790 Km^2 which is 10.8 percent and strong top soil loss is 7670 Km^2 which is a great amount of top soil being washed away by the running water either in streams or overland flow. So far extreme degree of degradation is not found in Nagaland. The terrain of any given place is dynamic and undergoing various changes noticeable or unnoticeable. The Terrain deformation by water erosion in Nagaland is Moderate to Strong and 44 percent of the total area is under terrain deformation covering a total area of 7330 Km^2. Extreme terrain deformation is absent in the State. Thus water is a strong agent that leads to land degradation as 60 percent of the State is losing its top soil which is the most important part of the land economically and terrain deformation is about 40 percent of the total area of the State. Chemical deterioration (Cn) is where the soil losses its organic matter and nutrients in areas where agriculture is practiced on poor or moderately fertile soils without sufficient application of manure or fertilizer. As the soil loses its chemical composition such as organic matter and nutrients it leads to decreased production. The rapid loss of organic matter after clearing the natural vegetation is also included in this type of soil degradation. Thus a total area of 9950 Km^2 or 60 percent of the land is deprived of important chemical compositions necessary for the healthy growth of vegetation (Table 5.3). It appears the chemical degradation and the removal of the natural vegetation is the main causative factors of soil degradation (Chamua, *et. al*., 2000) as shown in Table 5.3.

The Table 5.4 presents the severity of land degradation in Nagaland. It is studied under two types of land degradation, by water erosion and chemical deterioration as we check the severity classes. Both the water erosion and chemical deterioration in Nagaland is under Moderate, strong and extreme severity class. The moderate severity covers an area of 480 Km^2, 3 percent of the total area, strong severity class is 3270 Km^2 which is 20 percent of the total area and extreme severity class covers an area of 6200 Km^2 which is 37 percent. Thus we find that 60 percent of the soil in Nagaland is under severe land degradation.

Table 5.3 Status of Soil Degradation in Nagaland, Source: Soils of India Series (Chamua, *et. al*., 2000)

Soil Degradation type	Degree of Degradation (Area in Km^2)				Total area
	Slight	Moderate	Strong	Extreme	
Water Erosion					
Wt loss of top soil	490 (2.9)	1790 (10.8)	7670 (46.3)	-	9950 (60.0)
Wd Terrain deformation	-	660	6670 (40.2)	-	7330 (40.2)
Chemical Deterioration					
Cn Loss Organic matter, loss of nutrients, acidification	490 (2.9)	1790 (10.8)	7670 (46.3)	-	9950 (60.0)
Total Area*	490 (2.9)	1790 (10.8)	7670 (46.3)	-	9950 (60.0)

- *Since the degradation is a complex type in all the cases, the maximum area covered under a particular degree of degradation indicates the total area.
- Figures in parenthesis indicate per cent coverage of total geographical area.

Table 5.4 Type of Soil Degradation, Source: Soils of India Series (Chamua, *et. al*., 2000)

Soil degradation type	Severity class (Area in Km^2)				Total Area	% of TGA
	Slight	Moderate	Strong	Extreme		
Water erosion	-	480	3270	6200	9950	60
Chemical Deterioration	-	480	3270	6200	9950	60
Total Area*	-	480 (3)	3270 (20)	620 (37)	9950 (60)	60

- *Since the degradation is a complex type in all the cases, the maximum area covered under a particular degree of degradation indicates the total area
- Figures in parenthesis indicate per cent coverage of total geographical area.

Table 5.5 Categories of wastelands in Nagaland Source: Department of Land Resources, 2000

Category of wastelands		Area in Km^2	% of total geographical area
Shifting Cultivation	Current Jhum	1,014	6.12
	Jhum re-growth (fallow)	5,316	32.06
Degraded Forest		2,842.80	17.15
Cultivable Wastelands (gullied and/ ravenous land, land with or without scrub, marshy/swamp/ waterlogged, degraded pasture/ grazing land, etc.)		960.92	5.80
Uncultivable wastelands		Yet to be estimated	-
Total		10, 133.72	61.13

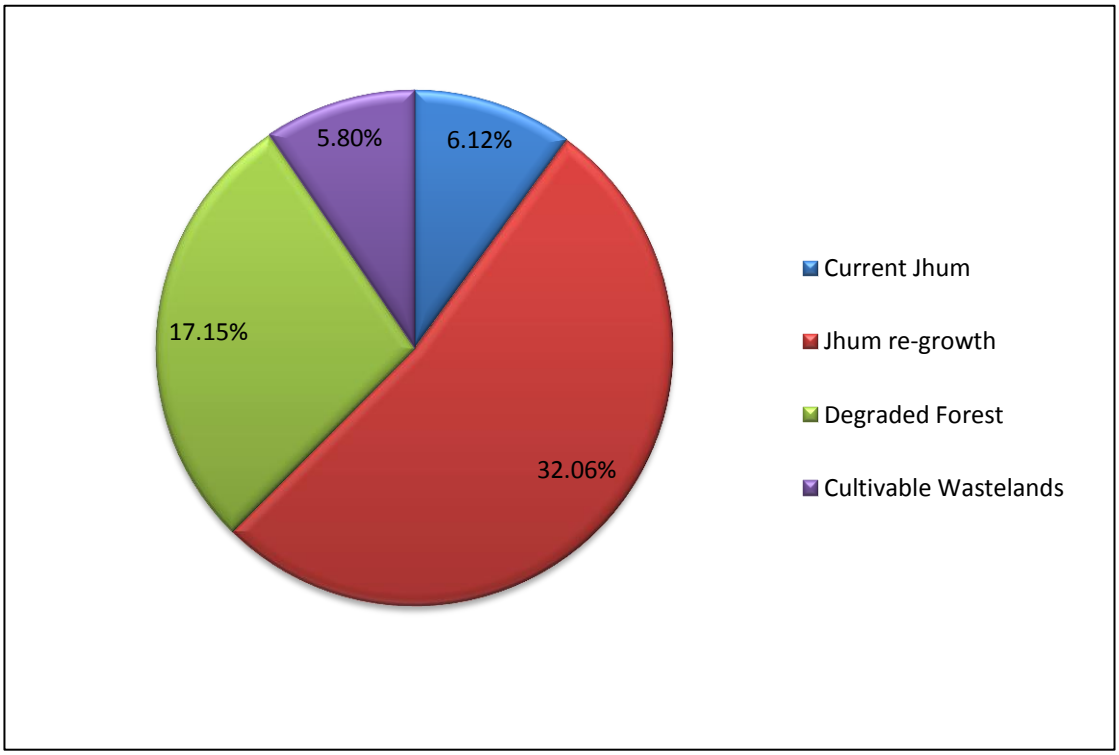


Fig. 5.4 Waste Lands in Nagaland

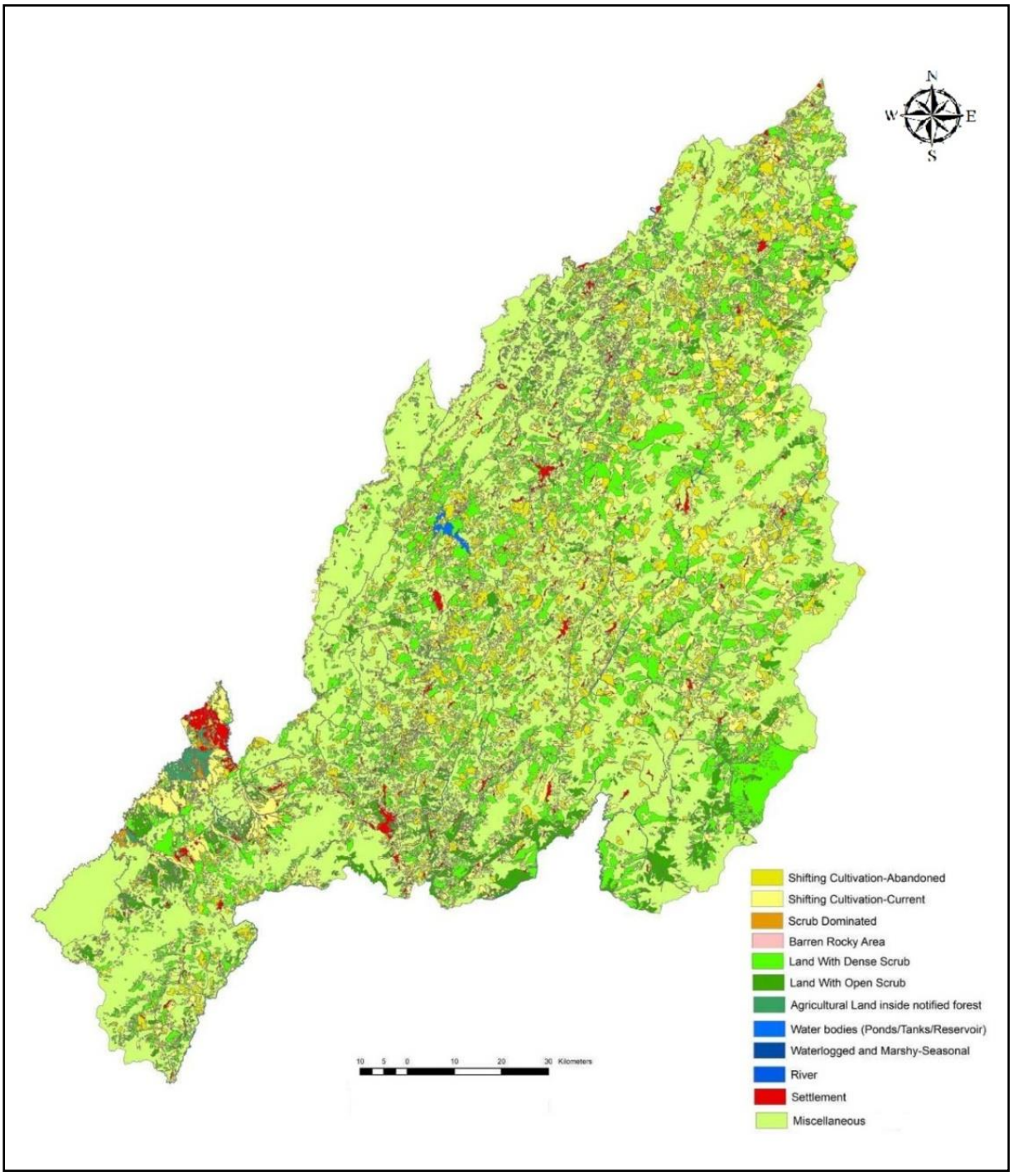


Fig 5.5 Waste Land Map of Nagaland (Source: State Level Nodal Agency for IWMP)

Water Degradation

Water is one of the most important resources of mankind. There are many rivers and streams flowing through the state but there is little documentation as monitoring water is a recent phenomenon and taken up on a limited basis. The surface water of the State is unprotected from untreated industrial effluents and waste water, runoff pollution from chemical fertilizers and pesticides. There are no sewage treatment facilities and the streams existing near the settlements are used for washing clothes and some are used as waste dump because of which the quality of the water is compromised. Only one river, Dhansiri, out of the many is monitored along five stations in and around Dimapur on a quarterly basis. The recorded assessment of the river shows that the different parameters, pH, conductivity, dissolved oxygen, BOD, total dissolved solids, total hardness, calcium, magnesium, alkalinity and chlorides etc. to be all within the permissible limit (NPCB).

CAUSES OF WATERSHED DEGRADATION

Natural Causes

Degradation is caused by natural causes such as the amount of rainfall, its intensity, variability and distribution, soil texture, structure, depth, moisture, infiltration rate and topography. Under such natural condition watershed is degraded in a natural process. However when human intervene, the natural causes and its effects are usually amplified causing more damage than it has to be for the watershed. It is important to note that most causes of degradation are closely interdependent and more than one cause lead to the prevailing degraded features. For example the gully erosion or landslides and alteration of discharge are caused both by natural as well as human intervention. In Nagaland most of the landslides are susceptible to areas near roads and building structures.

Socio-Economic and Political Causes

Various socio-economic as well as political causes can lead to land degradation. Over exploitation of resources without proper planning is one of the main causes of degradation of watersheds. Agriculture which is the most practiced activity and the rapid population growth causing higher demand for agricultural goods and others are important matters to look into. Underdevelopment as well as rural-urban migration often enhances degradation processes. Rural-urban migration

contributes to the occurrence of degradation, since urban populations need more firewood than rural population. Hence growth of urban populations in general goes hand in hand with an increase in deforestation and thus degradation.

Degradation Due To Shifting Cultivation

Shifting cultivation which is being commonly practiced in hilly places all over the northeast hill region is also very popular in Nagaland. Generally the cultivation practice leads to the cutting of woods and clearing of jungles which decreases the forest cover of that area. The land can be used for cultivation for some years only till the soil is fertile enough to give good crops and is left as fallow land for the soil to regenerate its fertility while the farmers clear another forest area to do the same. This system therefore encourages clearing of massive areas of the forests which bring about degradation of land.

Table 5.6 State Jhum Land Survey Epilogue (Source: State Jhum Land Survey Report 2005-2006, Department of Soil & Water Conservation, Nagaland Kohima. September 2007)

Sl. No	Districts	Geographical area in Km^2	No. of villages surveyed	No. of House hold	No. of jhumia families	Per cent jhumia families	Area under jhum annually Km^2	Jhum cycle (Years)	
								Max.	Min.
1	Kohima	3114	78	24922	7563	29.95	38.17	16	6
2	Peren		69	12632	10431	82.56	47.89	15	6
3	Mokokchung	1615	72	21609	12094	55.97	75.12	15	7
4	Tuensang	4228	79	18631	16941	90.93	145.31	14	5
5	Kiphire		63	12035	9302	77.29	78.31	18	6
6	Longleng		26	13139	11086	84	66.01	12	7
7	Wokha	1628	105	14796	12668	85.62	94.94	10	4
8	Mon	1786	92	27070	24270	89.66	192.2	12	5
9	Zunheboto	1255	165	20361	14925	73.30	116.58	16	4
10	Phek	2026	91	22303	15194	68.13	74.63	10	5
11	Dimapur	727	183	37699	1740	4.62	7.72	15	3
	Total	16,579	1023	225251	136114	61	936.88		

The Table 5.6 is clear to see that annually an area of 936.77 Km^2 is used for jhumming which is 5.65 percent of the total geographical area of the State and on an average area of fresh jungle cut for jhumia is 0.67 Ha or about 1 Km^2 annually. The cultivable land loses its fertility after 2 to 3 years which lead to clearing of fresh lands for cultivation as a necessity. Jhumias leave their jhum lands as fallow lands for replenishment, the period is the jhum cycle and normally the cycle has to be 12-14 years to get back the nutrients and maintain its fertility but it has cut down to 6 to 3 years even (NPCB) thus degrading the soil even more. The degradation of forest area

and the soil cannot be therefore taken lightly in Nagaland as clearing of jungle is in an alarming rate.

Today, agriculture occupies 40 percent of the land surface and consumes 70 percent of global water resources and helps manage biodiversity at the genetic, species and ecosystem levels (Ahamad, 2010). Traditional agriculture, an indigenous form of farming is the result of the co-evolution of local, social and environmental systems. It exhibits a high level of ecological rationale expressed through the intensive use of local knowledge and natural resources including the management of agro-biodiversity in the form of diversified agricultural systems (Information resources Associations, 2013). There are four diversified forms of traditional agriculture practiced by the villagers of Nagaland - the Jhum system (shifting cultivation), terrace rice cultivation, firewood reserve forests and home gardens. The practice of slash and burn agriculture is known locally as 'Jhum' as the word derived from Assamese language meaning 'collective work'. The Naga way of life revolves around this system of cultivation which governs most of their life, culture and tradition. In Nagaland, over 40 percent of the area is subject to Jhum cultivation (NEPED & IIRR, 1999). The extended area under Jhum is also the maximum in the State compared to other states of North east India. According to the village profile of the Department of Agriculture (2001), there are 184,127 farming households consisting of 1,360,925 persons comprising 68.44 percent of the total population. Of the total Naga farmers, 70 percent have been practicing jhum cultivation on the steep slopes. Terrace cultivation is practiced in the southern part of the state as well as some districts in the northern part. Mostly women are engaged in agriculture leading to feminization of agriculture in the State, a trend that is happening globally among the developing countries. For rural people to have sustainable livelihoods, the key is having access to secured land, water, forests and other means of production. Food security should be assured with an increasing access to water for domestic and irrigation purposes, land and markets as well as other economic opportunities. Rural women and nature work in partnership with each other with a special relationship (Mies & Shiva, 1993). The area under production per hectare under terrace rice cultivation is increasing across the State. Perhaps because of the increase in TRC with proper water management, the shortfall of rice from Jhum is somewhat mitigated. The main source of energy for both lighting and cooking in the households of rural areas is

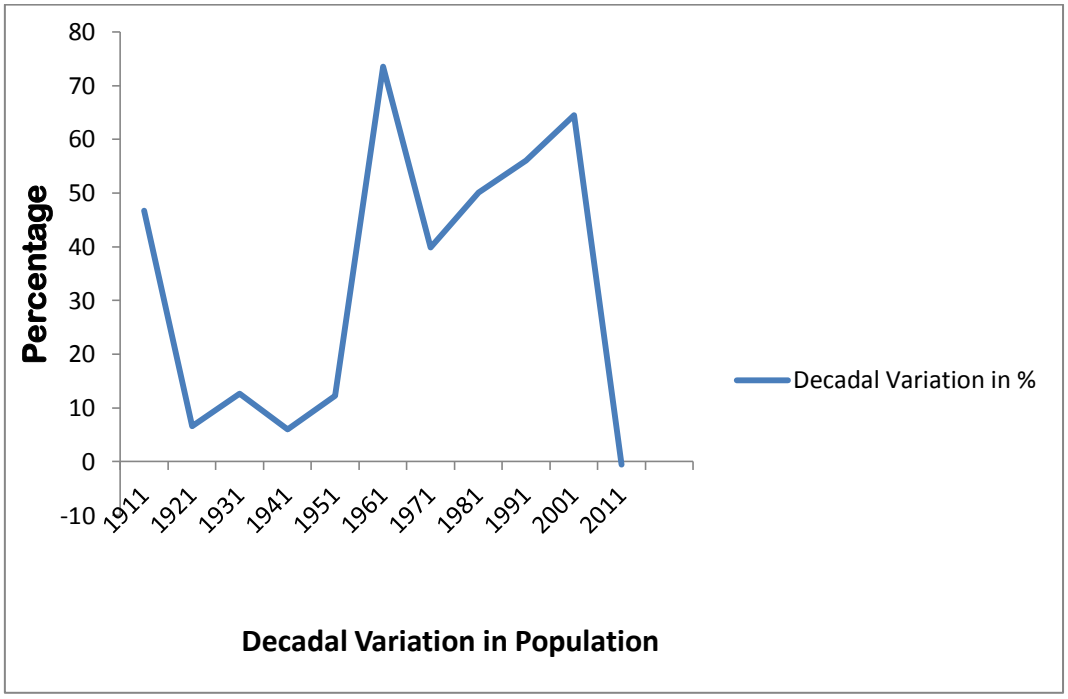
firewood. Zabu is also a farming system practiced mostly by the Chakesang tribe where combination of forest, water and agriculture incorporating livestock and fishery, which is well founded soil and water conservation base. The limit to terrace construction is not the slope but availability of irrigation water.

RAPID GROWTH OF HUMAN POPULATION IN NAGALAND

The State is among one of the country's highest population growth rate. The watershed community as it increases rapidly leads to increase usage of natural resources in terms of fire wood, drinking water, and land for constructions of various purposes and especially cultivation. A decadal population trend given in the Table 5.7 explains how population growth has taken place. The 20th century has experienced a rapid growth of population. The earliest decadal population growth was 46.76 percent and there is a constant population increase in the next four decades with 6 to 12 percent growth rate after which an exponential growth of population is experienced in the 1950s to 60's with 73 percent of growth rate. After which it declined to 39.88 percent and the state has seen gradual increase during the last four decades. The latest population census however shows a slight decline from the previous decade which is 0.58 percent but the fact remains the population has definitely grown at an exponential rate since the beginning of the twentieth century. From the Figure 5.6 it is clearly seen how population has increased in this century. It is normal for a society that is growing and developing grows in population too but the effects of its activity which is usually harmful for the natural environment should be taken into consideration and sustainability of the resources of any developmental activities is required and should be in mind.

Land resource degradation or watershed degradation has been a matter of considerable concern in recent years. Degradation of watersheds in Nagaland is often associated with shifting cultivation too. These watersheds are under constant threat of mass wasting and erosion caused by depletion of forest cover, unscientific agronomic practices and hydrological imbalance. The ever increasing population and urban growth has forced the increasing use of marginal farm land, which was considered to be steep, sterile and degraded. The study area is subjected to ecological stress and rapid deterioration of natural environment and socio-economic conditions. The degradation of highland watershed has created an overall adverse impact, disturbance

and imbalance in the ecosystem. The hill slopes are under tremendous pressure. As a consequence of degradation, the study area is facing acute shortage of drinking water, depletion of groundwater resource, increased soil erosion, lower productivity of land and loss of biodiversity. The need of the hour is to reverse this trend. The proper



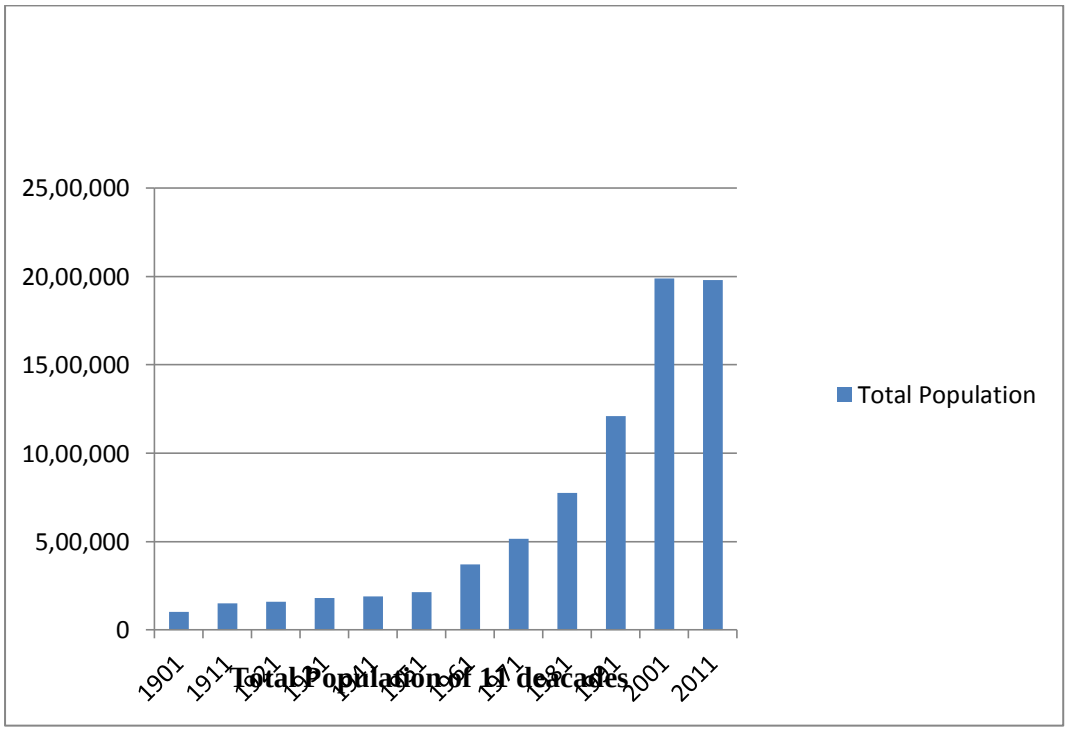


Fig 5.6 Diagram representation of Decadal Variation in percentage and Total Population

Table 5.7 Population trend in Nagaland (Source: Statistical handbook of Nagaland, 2013)

Year	Person	Decadal Variation	Decadal Variation in %
1901	101,550	-	-
1911	149,038	(+) 47488	(+) 46.76
1921	158,801	(+) 9763	(+) 6.55
1931	178,844	(+) 20043	(+)12.62
1941	189,641	(+) 10797	(+) 6.04
1951	212,975	(+) 23334	(+) 12.30
1961	369,641	(+) 156225	(+) 73.55
1971	516,449	(+) 147249	(+) 39.88
1981	774,930	(+) 258481	(+) 50.05
1991	1209,546	(+) 434616	(+)56.08
2001	1,990,036	(+) 780490	(+) 64.53
2011	1,978,502	(-) 11534	(-) 0.58

conservation and development is possible only through integrated watershed management in Nagaland and sustainable development strategy can be evolved ensuring people's participation and equitable share of benefits. Efforts should be directed to share benefits. Efforts should be directed towards enhancing productivity, augment production of usufructs, better returns from existing resources, achieve social and gender equity, capacity building of watershed inhabitants, equitable distribution of the benefits of the ecological, land and water resources. This can be achieved only through integrated watershed multidisciplinary watershed programmes with optimum land use and involvement of the villagers at all stages of planning, execution and maintenance. The success of any sustainable development can be realized by strengthening village level institution.

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Chapter 6

INTEGRATED WATERSHED MANAGEMENT IN NAGALAND

INTRODUCTION

Integrated watershed management may be defined as the development and management of the watershed resources in such a manner as to achieve optimum production which can be sustained without causing deterioration in the resources base or disturbing the ecological balance (Das, 1998). The ever increasing population and the need to provide a better quality of life to people, the pressure on land, water and forest resources is tremendous especially in the Himalayan region. The Himalayan watersheds are under constant threat of mass wasting and erosion caused by depletion of forest cover unscientific agronomic practices and hydrological imbalance. The environment in the study area has been greatly affected by changes in land use mainly due to shifting cultivation, deforestation, slash and burn on steep hill slopes accelerated soil erosion and landslides. There has been a phenomenal increase in the pressure on both the land and water resources of the area and this has had a serious impact on environment, ecology, development and the hydrological regimes. The hydrological responses of watershed manifested in changes in valleys, erosion, sediment transport and water quality are affected by geological conditions, the land use pattern and disturbances from deforestation and other human activities. Watershed is an area draining the rain water into a stream. It is a converging mechanism which increases minor streamlets and rivulets into progressively major, deeper, or wider, and lower level streams, tributaries and rivers. Each watershed shows distinct characteristics, which are so much variable that no two watersheds are identical (Sen, 1984). All the characteristics affect the disposal of water. The characteristics of a watershed are the combination of size, shape, physiography, climate, drainage, land use, vegetation, geology, soil, hydrology and socioeconomics of the environment of the watershed. Watershed management arrests soil erosion, reclaims vast tracts of eroded lands, improves soil moisture, harvests rainwater, reduces floods, recharges ground water and revives greenery (Murthy, 1994). In Nagaland the soil and water conservation department manages the watersheds particularly taking care of soil and water, the Forest department looks after the vegetation cover of the land and the Agriculture department after the cultivation sector in a watershed. It is therefore necessary for the state to formulate an integrated

approach of management so that the state can be benefitted at its maximum through integrated watershed management.

The balance between economy and ecology depends on the working out of a healthy partnership between human and nature. Environmental conservation and management in the shifting cultivation areas is of utmost priority for environmental management and economic development in the area because the existing agricultural and development activities have aggravated the problems of environmental degradation. Therefore, in recent years integrated watershed management has been identified as the main strategy for sustainable development. There has been a growth in our awareness of the need to manage our natural and cultural resources on a national basis. Simultaneously, understanding of related issues like equity, sustainability and people's initiatives in resource management has also grown. Integrated watershed management in Nagaland attempts to assess the environment problems which have emerged as a result of jhum cultivation, other development activities and the natural processes in the state and formulate a strategy for environmental conservation and economic development to achieve sustainable development.

IMPORTANCE OF INTEGRATED WATERSHED MANAGEMENT FOR NAGALAND

Man's fate is bound up with his environment. He derives not only his physical sustenance- air, water, fuel, fibre, shelter from the environment but also the means of social intellectual, moral and spiritual growth. It is now dawning upon man that the process of development that he has pursued in meeting his basic and other demands by the exploitation of minerals, plant and animal kingdoms of the earth has led to the deterioration and destruction of the environment at local, national, regional and global levels. There is a global concern for the increasing incompatibility between the depleting environmental resources and exploding population growth. To face this challenge there is no other alternative than sustainable development. The World Commission on Environment and Development (WCED, 1987) pinpoints in its report "Our Common Future", it is impossible to separate economic development issues from environmental issues; many forms of development erode the environmental resources upon which they must be based, and environmental degradation can

undermine economic development. Many present economic trends leave an increasing number of people poor and vulnerable, which at the same time degrade the environment. A development crisis and ecology are not separate. They are one, interwoven locally, regionally, nationally and globally, into a net of cause and effect. Therefore, it is a desperate need to integrate the environment and economics in decision making and planning (Rawat, 2002).

The declining per capita land and fresh water availability coupled with soil erosion and depleting/degrading land and water resources are posing serious threat to food, environmental, social and economic security in the state. Watershed approach is a holistic approach and gives room for sustainable development in the hill areas. Integrated watershed management is a single window for integrated, participatory and sustainable area development programme where watershed as geo-hydrological unit is important to harmonize the use of natural resources like land, water, vegetation, livestock, fisheries and human resources. Watershed has been used extensively because of importance of water balances in the study of ecosystems. Watershed also allows accurate measurements and monitoring of components of water balance on hydrologic cycle, sediment, energy, heat, carbon and nutrients balances in a watershed ecosystem. This can provide a network of monitoring stations on sites within a basin in a nested form or otherwise to track down the status of pollutants at different points. The monitoring at the level of watersheds or sub-watersheds in a basin will help in analyzing impacts of current and future activities and accordingly plan area specific management options or alternatives based on the priorities as per the intended project objectives. Integrated watershed management covering the area from the highest point (ridge line) to the outlet is, therefore, the process of formulating, implementing and managing a course of actions involving natural and human resources in a watershed, taking account of all the factors operating within the watershed.

The deterioration of natural resources in the study area can be contained and the total resources properly developed by adopting the watershed approach. The basic unit of development is a watershed, which is a manageable hydrological unit. In this approach, development is not confined to agricultural lands alone, but covers the area, starting from the highest point of the area (ridge line) to the outlet of the nalah or the natural stream or a river. This will involve implementation of ameliorative measures on barren hill slopes, marginal lands, privately owned agricultural lands and badly cut

nalahs and river courses. In terms of resources development, it starts from the most important one that is water and extends to the resources of fuel, fodder, livestock and all associated components. By adopting watershed, as a unit, different measures are adopted and executed carefully in each of the topo-sequences according to its capacity. This approach is thus a vastly improved strategy over the existing broad and basically un-integrated programmes (ICAR, 1987). Watershed management programs are being implemented increasingly in Asian countries by non-governmental organizations other than the conventional departments of soil conservation and forestry (Lal, 2000). The protection, improvement and rehabilitation of mountain and / or upland watersheds are of critical importance in the achievement of overall development goals. Recognizing this, many developing countries are turning increasing attention and resources to the field of watershed management. Natural resources in the present context refer to land, water, and forests including grasslands , humans and livestock, further, the integrated use of these natural resources is now termed as 'watershed management' (Yadav, *et.al.* 2010). There is a need for technology development projects, designed carefully for the viability of small-scale ecosystem management on a watershed basis in Nagaland. Integrated watershed management has been adopted by the Department of Soil and Water Conservation and some other Departments of Government of Nagaland as a tool for planning and management of watershed resources in watershed ecosystems of the state. Of course, this tool is providing an ecologically sound economic base for watersheds and its people. At present, many watershed management projects are under implementation in Nagaland by different departments of Government of Nagaland in different places with different aims and objectives and approaches but effective watershed management is rarely found in the study area due to lack of research and demonstration. Scientific strategy needs to be formulated avoiding conflicting sets of objectives and administrative format. There is a desperate need to establish this type of very carefully conceived pioneer efforts in Nagaland where there is no awareness of the benefits of the watershed management and integration of technologies within the material boundaries of drainage area for optimum use and development of land, water and forest resources to meet the basic minimum needs of the people in sustained manner. Projectization of the scattered programmes of soil conservation, afforestation, water resources development and management, minor irrigation, animal husbandry

and other rural development activities into well prepared micro watershed projects based on a study of climate, land, water and forest resources on the one hand and man and animal resources on the other offers hope for bringing about sustained natural resources development based on principles of ecology, environment, economics, employment generation and energy conservation. Therefore, integrated watershed management may be considered as an alternative for planning and development of natural resources especially land, water and forest to sub-serve the socio-economic needs of the people of Nagaland.

REVIEW OF INTEGRATED WATERSHED MANAGEMENT PROGRAMMES IN INDIA

Watershed development based activities in India were initiated in the year 1956 at the Central Soil and Water Conservation Research and Training Institute, Dehradun. The main focus of all the watershed based programmes was at integrated development of land and water resources for sustained livelihood (Ramana, 2000). Some of the names of the projects under watershed development in India are the Drought Prone Area Programme (DPAP), Desert Development Programme (DDP), Integrated Watershed Development Programme (IWDP), Watershed Development Project in Shifting Cultivation Area (WDPSCA), Integrated Watershed Management Programme (IWMP), National Watershed Development Project for Rainfed Areas (NWDPRA) and National Watershed Development Programme (NWDP). Throughout the years of implementing the watershed projects in various watersheds of the country, there are important issues that need to be addressed. The Study of watershed programmes in India by Palanisami *et.al*. (2000) has aroused some issues relating to it. They are: -

1. Rainfed agriculture and watershed development research.
2. Decision support system for watershed development,
3. Socio-economic and institutional issues.
4. Participatory watershed development.
5. Sustainability and replicability.
6. Equity issues.
7. Supply driven to demand driven models.
8. Capacity building, administrative issues.
9. Cost sharing.
10. Conflict resolution and
11. Monitoring and evaluation.

Addressing the issues for maximum development bringing out sustainability whether to the resources usage or the continuation of the projects independently by the watershed community has become very important.

Table 6.1 Growth of nationally and internationally funded watershed management programmes in India (After Sikka & Samra 2000)

Schemes/Projects	Year of launch	Watershed Nos./Area	Sponsoring Agencies
Research watersheds	1956	42 Nos	Ministry of Agri., GOI/CSWCRTI, ICAR
Soil Conservation in RVP catchments	1961-62	29 catchments in 9 states	Ministry of Agri., GOI
Operational Research Watersheds	1974	4 Nos	CSWCRTI, ICAR
Watershed Management in Catchments of Flood Prone Rivers	1980-81	10 catchments in 8 states	Ministry of Agri., GOI
Model Watersheds	1983	47 Nos	CSWCRTI & CRIDA, ICAR
Watershed Development in Rainfed Areas	1984	28 Nos (3.47 lakh ha)	World Bank (A.P., Karnataka, M.P. & M.S)
Watershed Development in Ravines Area	1987	0.62 lakh ha	EEC
Drought Prone Area Programme (DPAP)	1987	91 districts, 615 blocks	MRAE, GOI
Desert Development Programme (DDP)	1987	21 districts, 131 blocks	MRAE, GOI
Western Ghats Development Programme (WGDP)	1987	158 blocks	Union Planning Commission
Indo-German Watershed Project	1990-91	5 states	Germany
Indo-German Bilateral Project	1990-91	5 states	Germany
NWDPRA	1991	2497 Nos	Ministry of Agri., GOI
IWDP(Hills & plains)	1991	1.12 lakh ha	World Bank
Comprehensive Watershed Development Project	1991	1.13 lakh ha	DANIDA(Karnataka, Tamil Nadu & Orissa)
Rel Majra Watershed Project	1991	1 No	CSWCRTI, ICAR/ Ministry of Agri., GOI
Doon Valley Project	1993	1.72 lakh ha	EEC
Integrated watershed Development Project(IWDP)	1994	25 states	MRAE,GOI
Indo-Swiss Participatory Watershed Development	1995	0.35 lakh ha	Swiss Government
Attapadi Wasteland Comprehensive Environment conservation Project	1996	507 km^2	OECF, Japan

WATERSHED MANAGEMENT PROJECTS IN NAGALAND: A REVIEW

There have been attempts to manage our natural resources and to conserve it through implementation of various projects under the state government, central government and internationally sponsored schemes. Out of 60 different government offices there are only four offices under which watershed projects are being carried out. The different schemes implemented in the state are -

1. Integrated Watershed Management Programme (IWMP)
2. Watershed Development Project of Shifting Cultivation Areas (WDPSCA)
3. River Valley Project (RVP)
4. United Nation Development Program (UNDP)
5. National Watershed Development Program for Rain-fed Areas (NWDPRA)

The different watershed projects have been carried out in Nagaland since 1987 when the first project started through Soil and Water Conservation department, Nagaland. The first to be implemented was the WDPSCA, a centrally sponsored scheme. A total of 45 projects were carried out between 1987 and 2011. The driving institution of the project was water, forest, agriculture, environment, land and rural development. The selection of the watershed was done village-wise. The total area covered by the project was 135 Km^2 to 180 Km^2. The Soil and Water Conservation Department carried out through the RVP from the year 2004 to 2012; it is also a completed project under Central sponsored scheme. Under this scheme five projects were completed covering an area of more than 40 Km^2 for each project. The area was delineated according to Basin or catchment or watershed basis which fell under very high priority. The main driving institutions for RVP in Nagaland were water, land, forest, agriculture and rural development. The third watershed project taken up by the department is the IWMP which is a state sponsored program. The project started in the year 2007 and is continuing till date. A 2 Km^2 area is selected village-wise for each project. 15 projects each for five year is taken up by the scheme which saturates after the five years. The fourth project which is an international scheme is the UNDP implemented by the department. It got started in the year 2009 and is still undergoing (Table 6.2 & 6.3).

Table 6.2 Watershed Projects of different departments in Nagaland (Questionnaire)

Department	Scheme	No of projects	Year of implementation	Projects completed	Projects still undergoing	Driving institutions for the project
Soil & Water Conservation	IWMP	75	2007-08	60	15	Water, forest, agriculture, land & rural development
	WDPSCA	45	1987-88	45	none	Water, forest, agriculture, land, environment & rural development
	River Valley Project	5	2004-05	3	2	Water, forest, agriculture, land & rural development
	UNDP		2009-10	70	none	Agriculture land, forest and rural development,
NEPED	WDPSCA	63	2006-07	63	None	Forest, agriculture, land, environment & rural development
Agriculture	NWDPRA	120	2007-08	None	120	Water
Land Resources	IWMP	8	2009-10	None	8	Water, forest, agriculture, environment & land
	IWDP	42	1994-95	42	None	Water, forest, agriculture, land, environment & rural development
Total		358		283	145	

Table 6.3 Methods of selection of the watersheds for the projects and schemes in Nagaland (Questionnaire)

Department	Scheme	Selection of watersheds	Watersheds under two or more political n boundaries	Consideration of upstream and downstream community	Total Area coverage of the project for one term (ha)	Total Area coverage of the project for whole term (ha)
Soil & Water Conservation	IWMP	Village wise	Yes	No	200	
	WDPSCA	Village wise	Yes	Yes	300 to 400	
	River Valley Project	Basin/watershed basis (falling under very high priority)	Yes	Yes	4000	
	UNDP	Village wise				
NEPED	WDPSCA	Village wise and district wise	No	Yes	500	
Agriculture	NWDPRA	Village wise	Yes	Yes	500	
Land Resources	IWMP	Village wise and district wise	No	Yes	500 to 1000	343000
	IWDP	Village wise and district wise	No	Yes	500	304430
Total			50%	75%		

NEPED (Nagaland Environmental Protection and Economic Development) is a semi-governmental organization dealing with watershed programme. The scheme they are working under is WDPSCA which started from the year 2006 and completed in 2011. The department has completed 63 projects which covered a total area of 315 km^2. Their main driving institutions were agriculture and environment .

Agriculture department of Nagaland implemented the NWDPRA scheme in the year 2007 and is still continuing with the project covering various parts of the state. There are 120 projects implemented by the department and is still under the process of development. The area taken for one watershed is 5 Km^2. A total of 600 km^2 is being covered by the same.

The Land Resource department of Nagaland has one completed project and one that is still undergoing. IWDP which is already completed had 42 projects, it was started in the year 1994 and its main driving institutions included water, forest, agriculture, environment, land and rural development. The total area covered by the project was 3044.30 Km^2. The second project, IWMP started in the year 2009 and is an ongoing project of eight. All the eight projects are yet to be completed. So far 3430 Km^2 of area is covered by the project (Table 6.2 & 6.3).

Out of the total 368 projects implemented by the four departments, 213 are completed and 145 are undergoing. The selections of watersheds for the projects were done either village wise or district wise. 50 percent of the project officers said watersheds fall under two or more political boundaries, thus the watersheds are delineated according to its definition. But the other 50 percent has mainly based more on the political divisions for the delineation. 75 percent of the project considered upstream and downstream community which is a very important consideration for the development of any watershed. The watershed area taken up for the projects were between 200 Ha to 500 Ha or 2 to 5 Km^2.Generally all the departments used topographical sheets (1:50,000) as base maps for delineation of the watersheds. Except for NEPED, who used Resource map and land Resources through physical or field survey. Cartographic methods and GIS were used for map making. The watersheds are either near human settlement or with human settlement which falls under the land owned by communal village or individual. 57 percent of the decision

making for the watershed management system was done by the committees and for environmental legalization they were done at administrative level.

OBSERVATIONS OF WATERSHED MANAGEMENT PROJECTS IN NAGALAND FROM THE QUESTIONNAIRE

The watershed projects by the governmental agencies are mainly focused on the rural development. The villagers are the main beneficiaries. The use of different methods to identify and delineate the watershed is old and needs to be improved with new technologies that are available today. Except for Land Resource and NEPED who uses GIS and Remote Sensing techniques, the rest are still using cartographical techniques. Watershed boundary should not be based on political boundaries but naturally bounded so that the geo-hydrological unity of a watershed is not lost. It is observed that most of the watersheds are delineated or chosen based on villages and districts. It is also observed that the watersheds are near human settlement or with human settlement which helps in the development and management of the watershed area. The land ownership of the villages in which watersheds are chosen to be developed is usually owned by the village as a common property or by individual. This indicates that the villagers play a very vital role in the programmes as their understanding to the management and development of their own land stay at stake. Continual implementation of the project in a sustained manner even after the five term project is over depends upon the will and participation of the villagers whose land is being under the management program.

The projects of the governmental schemes have been of great help for most of the villages. It has been a common ground where the socio-economic level of the villages has been uplifted. Employment has been created for the village people as they are usually unemployed during the non-agricultural seasons. The physical elements of the watersheds have been kept in mind during the watershed developmental and management projects. Soil erosion is checked, soil moisture is enhanced and ground water is recharged. At large socio-economically people have been given awareness about livelihood and micro enterprises and ecological balance is also maintained.

Recently, the Department of Land and Resources, Government of Nagaland has released the GIS maps consisting of various micro watershed map layers for the implementation of the Integrated Watershed Management Projects in Kohima District

where all together, 14 micro watersheds are selected in the initial phase of the watershed conservation and development plans of the state government. Seven different layers of GIS based maps viz., aspect map, contour map, relief map, drainage map, slope map, land use map and soil map have been generated for every single watershed and in addition consisted of an action plan map as a target for the different activities to be taken up with a focus, fully aimed at the development and uplift of rural people. The GIS based watershed conservation and development projects implementation help to select the right crop for a particular area with the exact treatment required by that particular type of land and thus generating higher yield and also helps in application of the proper soil management practices. The GIS based development planning system also helps in creating an environment friendly system of development by integrating all the components of watershed in the development process.

PRIORITIZATION OF TEN SAMPLE WATERSHEDS OF THE STUDY AREA USING MORPHOMETRIC ANALYSIS THROUGH GIS SOFTWARE (AFTER KANTH AND HASSAN, 2012)

The quantitative analysis of morphometric parameters is of great utility in river basin evaluation, watershed prioritization for soil and water conservation, and natural resource management at micro level (Kanth, & Hussan 2012). Watershed prioritization is the ranking of different sub-watersheds of a watershed so that there can be orders in which the process of treatment and soil conservation measures can be taken. By analyzing the Morphometry of a watershed the technique can be used for prioritization of micro-watersheds even without the availability of soil maps (Biswas et al., 1999). Morphometry can be defined as the precise measurement of landforms and the shape or geometry of relief feature and its study enable an enhanced understanding of the geological and geomorphic history of a drainage basin (Strahler, 1969). Morphometric descriptors represent relatively a simple approach to describe basin processes and to compare basin characteristics (Mesa, 2006).

The sample watersheds have been analyed morphometrically using different formulae. Five parameters each in linear and shape parameter has been considered and calculated. The river basin or a watershed is a dynamic unit with streams and rivers flowing over the land cutting and changing the landscape in the process. The

study of morphometry helps correlate with the land use landcover too. The Linear parameter like drainage density (D_d), stream frequency (F_s), bifurcation ratio (R_b), drainage texture (R_t), length of overland flow (L_g) has a direct relationship with erodibility, the higher the value, more is the erodibility (Kanth and Hussan, 2012). Thus in order to prioritise the watersheds for planning the linear parameter with the highest value is numbered as 1 then the second highest as 2 and so on. Where as the shape parameters include form factor (R_f), shape factor **(**$B_{s)}$, circulatory ratio **(**R_c), elongation ratio **(**R_e) and compactness coefficient (C_o) which have an inverse relationship with erodibility which means lower the value, more the erodibility (Nooka Ratnam, 2005), therefore lowest value is given 1 and the next higher value 2 and so on. Then all values of each watersheds are added and an average value is calculated which is the compound value (Cp). The watersheds have been broadly classified into three priority zones according to their compound value (Cp) as High (<4.6), Medium (4.6-5.8) and Low (> 5.8) as shown in the Table 6.5 below.

Table 6.4 Morphometric parameters of the sample watersheds

Watershed	Linear parameters					Shape parameters				
	Drainage density (D)	**Stream frequency (F_s)**	**Mean Bifurcating Ratio R_{bm}**	**Drainage texture (R_t)**	**Length of overland flow (L_g)**	**Form Factor (R_f)**	**Shape Factor (B_s)**	**Circulatory Ratio (R_c)**	**Compactness Coefficient (C_o)**	**Elongation Ratio (Re)**
Chija Ho	3.96	6.43	5.69	6.6	0.51	0.365	2.74	0.44	1.21	0.68
Deodubi	3.65	4.26	2.08	2.01	0.55	0.476	2.1	0.66	1.23	0.78
Inkoron	3.16	4.09	4.12	2.69	0.63	0.400	2.49	0.34	1.7	0.7139
Kiliki	4.74	5.94	3.32	5.72	0.421	0.378	2.64	0.501	1.412	0.694
Khukipani	4.28	7.90	6.22	3.72	0.47	0.46	2.19	0.48	1.44	0.76
Liyung	3.47	5.93	8	3.16	0.58	0.41	2.43	0.29	1.86	0.72
Menung	4.36	6.02	3.28	4.89	0.46	0.3815	2.6211	0.38	1.63	0.6971
Shen Ru	4.72	7.89	3.67	7.82	0.423	0.3814	2.6218	0.56	1.34	0.6970
Lower Tizu	2.29	4.79	6.03	3.77	0.67	0.399	2.502	0.502	1.409	0.7134
Tsuhauru Tao	2.8	3.54	3.02	2.14	0.71	0.43	2.35	0.47	1.46	0.74

Table 6.5 Prioritization of sample watersheds of the study area on the basis of morphometric parameters

Watershed	Linear parameters					Shape parameters					Compound Value (Cp)	Final Priority
	Drainage density (D)	Stream frequency (F_s)	Mean Bifurcating Ratio R_{bm}	Drainage texture (R_t)	Length of overland flow (L_g)	Form Factor (R_f)	Shape Factor (B_s)	Circulatory Ratio (R_c)	Compactness Coefficient (C_o)	Elongation Ratio (Re)		
Chija Ho	2	3	4	2	6	1	10	4	1	1	3.4	High
Deodubi	10	8	10	10	5	10	1	10	2	10	6.8	Low
Inkoron	8	9	5	8	3	6	5	2	9	6	6.1	Low
Upper Kiliki	3	5	7	3	10	2	9	7	5	2	5.3	Medium
Khukipani	6	1	2	6	7	9	2	6	6	9	5.4	Medium
Liyung	7	6	1	7	4	7	4	1	10	7	5.4	Medium
Menung	4	4	8	4	8	4	7	3	8	4	5.4	Medium
Shen Ru	1	2	6	1	9	3	8	9	3	3	4.5	High
Lower Tizu	5	7	3	5	2	5	6	8	4	5	5.0	Medium
Tsuhauru Tao	9	10	9	9	1	8	3	5	7	8	6.9	Low

The sample watersheds under high priority to be treated are Chija Ho and Shen Ru, those under medium priority are Upper Kiliki, Kukhipani, Liyung, Menung and Lower Tizu and the low priority watersheds are Deodubi, Inkoron and Tsuhaoru Tao. Watershed prioritization has become one of the most challenging and important task for planning and implementing of its development and management programs. Each watershed is unique and possess its unique morphometric characteristics and these characteristics shows the relativity of hydrologic response of the watershed to the morphometric parameters. The high priority watersheds consist of high value of drainage density and frequency with low elongation ratio and form factor. High priority indicates the greater degree of erosion in the particular watersheds and it becomes potential candidate for applying soil conservation measures. Therefore, immediate attention towards soil conservation measures is required in these watersheds to preserve the land from further erosion and to alleviate natural hazards.

Efforts also should be made to develop wastelands. This has been a barrier for developing our watersheds in the watershed management activities. Some villages have a lot of natural resources, forest products, stones etc. while some do not have any of these except land for cultivation. It will not be out of context to mention here that the state falls under the highly seismic prone zone. Thus, there is strong need for proper planning to ensure sustainable development and this necessitates scientific inputs from universities and government departments. Nagaland is recognised to be economically backward as compared to other states in the country. The rural economy of the study area solely depends on agricultural production. The traditional farmers have adopted and adapted looking at what nature gives them and devising ingenious systems that follow ecological principles while meeting basic needs for food, fuel and housing materials. Inspite of slash and burn agriculture in the watersheds, some areas with land suitable for terraces, irrigated rice production system have evolved, some hillslide terrace systems have been sustainably managed for hundreds of years. Using alder tree to fix nitrogen and contour bunding with stones to conserve soil, an extremely productive and intensive indigenous jhum practices are the existing watershed conservation and utilization activities for the sustainable development of the primary sector of local economy.

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Chapter 7

STRATEGY FOR SUSTAINABLE DEVELOPMENT

INTRODUCTION

Watershed management is a unique approach for the development of mountainous areas on sustainable basis (Srivastava, *et. al.,* 1999). Combe and Najjar (2009) recommend that sustainable watershed management seeks to protect the existing high quality resources before they become impaired or degraded. Many watershed management approaches are narrowly focused to respond to the short-term needs of decision makers or particularly interest groups and this maximizes the resource obtained, with little or no concern of the effect on the other watershed components or to overall environment. The result being unsustainable overexploitation of some resources, decrease in productivity of watershed resources, and environmental degradation. Although many of our watershed resources are over exploited and tremendous environmental damage exists, we can still develop a sustainable land stewardship through sustainable and holistic watershed management. This watershed management is dynamic, watershed–based, socially inclusive, and it can be designed to empower and meet the needs and aspiration of all interested parties (Tecle, 2003). A long-term vision with broad goals and objectives is central to a strategy (OECD, 2001). It is necessary to consider the essential components that have to be sustained within a watershed. Water, land, air, energy, space, and genetic materials are those components that cannot be substituted and are essential requisites. The supply of water or air or land or even minerals is practically fixed in terms of total quantity (Victor *et.al.,* 1998). There are three broad dimensions of environmental damage identified, (1) the threat posed to human life, health and continuing economic activity impairments to the functional, productive and assimilative capacities of ecological systems, (2) the threat to the natural world- the loss of biodiversity, the disappearance of particular habitats and the extinction, local and global, of particular species of flora and fauna and (3) the threat to socially, aesthetically and culturally significant environments, both rural and urban (Faucheux *et.al.,* 1998). There were many factors that made the government agencies, politicians, donors and the NGOs realize that unless there is a systematic development of hill areas through sustainable management of natural resources, no further development is possible. To achieve this

sustainable development watershed management approach has been widely accepted and highly appreciated.

Key challenges to Sustainable Development in Nagaland

- The foremost challenges faced by any watershed community is the diversity of watershed components, and their competitive sharing of limited needs such as water, land, food, air, and light. With the rapid growth rate of population in Nagaland the resources that were easily available before comes with a price today. It was never heard of buying water in the state some decades back but today a thousand litres of water costs more than a thousand rupees in urban area, like wise a quintal of wood is ₹ 3000 or more. The cost for agricultural products are the same too, costly. As the population grows more needs are to be satisfied with the limited growth or development of resources.
- Secondly the watersheds of Nagaland are highly susceptible to soil erosion, mud slides, landslides, subduction of land and it lies in a high risk zone of earthquakes. Any developmental activity needs to be done in a stable landform for it to be sustainable.
- Thirdly people still need to be educated with the current rate of natural resource degradation that will affect the future generation. It is undermining that the society at large is unaware of the actual status of environment in which they live.
- Fourthly there is a major shift of population from rural to urban. It brings imbalance to the settlement area as towns are crowded and villages are thinning out. With the disparity of population distribution in the state it becomes difficult for planners to plan on proper resource allocation.
- Fifthly, the economic production that is found maximum in the state is brought about by the agrarian community. The problem is the traditional practice of jhum cultivation which is an important part of the Nagas brings about the major degradation of natural forest and land. It is also found that along with jhumming, stone quarrying is a common practice in the land that bring about major changes in the landscape as mass area is exploited for stones.
- The developmental projects like road constructions, buildings, and other infrastructure are done without proper scientific knowledge which leads to mass destruction. We find landslides occurring more frequently on or near a

road. Buildings constructed in loose soils often are destroyed by landslides and mudslides.

- Unwise waste management is also another challenge causing unnecessary flooding and degradation of natural resources like drinking water.
- One of the most intractable problems of watershed development has been the lack of project sustainability when it comes to the various watershed management project initiated by various governmental and non-governmental agencies.

Concept of Integrated Watershed Management for Sustainable Development in Nagaland

Watersheds comprises of a common and central characteristic that they hold multiple, interconnected natural resources which are soil, water and vegetation and impact on one resource invariably affect the status of the others (White, 1992). The watershed context is a unifying framework as water which is the integrated element of a watershed that flow downhill, irrespective of social and political boundaries, resource use practices in upstream incites a chain of impacts to which downstream are naturally laid open. Watershed can be used as an effective and integrated investigation and understanding into the complex and reciprocal linkage between watershed resources- soil, water and vegetation and the interaction between the upstream and downstream communities (Brooks *et. al.*, 1996; Sheng, 1998). Watersheds, because of its 'unifying' significance are therefore presently widely acknowledged to be the logical natural units for integrated and sustainable management of natural resources; and the practice is popularly known as Integrated Watershed Management (Bewket, 2003). Communities and local institutions have yet to come to terms with the philosophy of watershed development. The technological approach has not realized the expected benefits and the need to integrate local wisdom and traditional systems (Sharma, 2005). The problem of environmental degradation of the state and their management is complex and multi-dimensional which needs involvement of scientific and systematic approach with socio-economic and socio-political considerations.

Principles of Integrated Watershed Management

1. Watersheds are natural units
    i) Delineation of watersheds.

ii) Natural processes like climate, geology, hydrology, soils and vegetation shape the landscape.
iii) Each watershed has unique living and non-living components that interact with one another.
iv) Human factors at work within a watershed.

2. Watershed Management is continuous and also a multi disciplinary approach
   i) Effective resource management is never ending.
   ii) Components of watershed whether natural or human induced are interdependent and one approach alone is not enough for its management.
3. A watershed management framework supports partnering, using sound science, taking well-planned actions, and achieving results
   i) People's Participatory is a must.
   ii) Relevant strategy for specific watersheds and people.
4. Flexible approach
   i) One size does not fit all.
   ii) Different watersheds have major differences in geology, land use, or vegetation.
   iii) Different communities vary in the benefits they want from their watersheds.
   iv) Watersheds change through time.
   v) Watershed management is a dynamic and continually re-adjusting process that is build to accommodate the various kinds of changes.

Key steps in starting or improving strategies for sustainable development

- Efficient application of known watershed-management technologies and effective technology transfer mechanisms should be developed.
- Increased public awareness of the need to balance the economic and environmental values of available watershed resources is necessary to promote watershed resource stewardship.
- Use of multi-objective decision analysis which permits tradeoffs among multiple objectives to arrive at efficient management of scarce water and other watershed resources.
- Efficient uses of limited watershed resources.

Approaches for Holistic and Sustainable Integrated Watershed Management

Watershed degradation in Nagaland is a simultaneous process as the practice of extensive jhum cultivation, deforestation and land exploitation continues. Integrated watershed management provides a holistic approach that integrates the physical elements of the watershed and the socio-economic and socio-political fabrics. With the emphasis of active share holder's participation working along with the planners and agencies, right from decision making and formulation of the work processes and plans to the execution of the plans and technologies will help the watershed approach bring success in a holistic development of the natural resources. In order for the approach to be sustainable and relevant to the watershed communities it should consider the present ongoing practices of agriculture, forestry and other activities of the watershed settlers. Without proper understanding of the present situation of a region or a place, no plan and strategy will be sustainable as well as successful. During literature review and the field visits, the present researcher and her team visited two watersheds where detailed work of management have been done and some management activities are still going on. Research work on the first (No. 1 below) was completed in the year 2011, by a senior Research Scholar of the Department of Nagaland University. The research results have been published in various national and international journals. The second (No. 2 below) watershed management project is being conducted by the Department of Agriculture, Govt. of Nagaland. Brief information has been presented below -

1. ***The Kiliki Watershed Management Project*: -**

The Kiliki watershed from Zunheboto district of Nagaland has been employed as an experimental laboratory. The Kiliki river basin is a representative watershed of Nagaland located almost at the centre of the state covering the urban and rural landscapes with different land uses encompassing a total area of 80 km². Watershed degradation in and around the study area threatens the livelihood of the people and constraints the ability of the government to develop a healthy agricultural and natural resource base. The conservation and management of natural resources like land, water and forests in the study area is an issue of concern for sustainable development and improving the livelihood of watershed inhabitants. The planning for environmental management and sustainable development for the study area revolves around its watershed and micro-watersheds.

2. *Yisemyong Watershed Management Project*: -

The Department of Agriculture has a State Agriculture Research Station (SARS) in Yisemyong, Mokokchung where various experimental activities are going on for the improvement of agriculture and other allied fields in agriculture. A model watershed, Yisemyong watershed has been managed by the department with the view to encourage farmers to plant trees which are of economic value, construct ponds and other reservoirs where fishery and water for irrigation purpose has been done. It is an important example for people to utilize and manage the land and water during the dry season. This watershed has developed the area which was barren some years back, but now it is one of the most agriculturally developed areas in the district. The watershed is planned in such a way that there are forest canopy at the top of the hill. This watershed has developed the area where the people practice horticulture, agriculture and floriculture at the slope of the hill and the water reservoir at the valley which is used for fishery. The above watershed models are ideal area planning for integrated watershed management and for sustainability of the environment in Nagaland.

STRATEGY FOR SUSTAINABLE DEVELOPMENT

Of late, there is an increasing realization that north-east region should qualify as a world treasure because of its natural wealth and phenomenal diversity of habitat and species. The region is comparatively less developed; therefore the region enjoys special status in the Indian constitution. World over, the region is recognized as one of the Hot –spots of mega biodiversity. However, during the recent years the area has received growing attention due to environmental degradation caused in the process of short term developmental motives and basic life survival activities. Nonetheless the wealth in the region in terms of natural resources and environment is immense and offer vast scope to develop the region. The immediate priority therefore is to arrest degradation using the scientific knowledge generated over the years in the region. The long term strategies are needed to address the development by fulfilling the aspirations of the populace as well as ensure the conservation in the area. The region is self sufficient in terms of scientific knowledge base to analyze the causes of degradation of resources and environment. Future strategies can be formulated by utilizing this scientific and developmental information for integrated and sustainable development of the region.

ECO-RESTORATION AND DEVELOPMENT OF NAGALAND THROUGH INTEGRATED WATERSHED MANAGEMENT

BRIEF ENVIRONMENTAL OVERVIEW OF NAGALAND

Nagaland is one of the extreme North-Eastern Hill States of India having eastern mountain ranges or high ranges in the east, middle hilly range or medium high hill ranges in the intermediate zone and western low ranges. The most important plain area about 2 percent of the total geographical area of the state is Dimapur. The hilly nature rugged terrain and lofty ranges have a great bearing on the population distribution and the cultural landscape of Nagaland. The study area harbours number of catchments which feeds all the rivers of Nagaland. The altitude ranging from 100 m to 3840 m above msl and climatic conditions that varies from sub-temperate to sub-tropical. The geographical location and varied climatic conditions have contributed to the state's unique environment and ecosystems that are home to numerous endemic and endangered species of flora and fauna. The agro-biodiversity consisting of both wild and domesticated varieties of plants and fruits is amongst one of the most diverse in the region. The state has an interesting land use as 20.4 percent Primary forest, 55.3 percent Jhum, 8.2 percent current Jhum, 4.6 percent terraced rice cultivation and wet rice cultivation, 0.9 percent horticulture and cash crop and about 10.6 percent area is under other land uses (Keitzar, 2009).

Nagaland has a total population of 1,980,602 out of which 1,025,707 (52 percent) are male and 954,895 (48 percent) are female according to the census of 2011. Due to the unique land ownership and management system of the Nagas there is little or no alienation of the people from their land and resources and therefore even farmers despite their poor economic condition can consider resource rich. A comparatively low population pressure, high regeneration rate of plant resources, community-based natural resource management initiative and most importantly shifting cultivation activities are the major controlling factors of ecological and environmental health of Nagaland. Nagaland represents an ideal model of synthesis of modernity and tradition. The Naga Society is well known for its tribal culture of land holding system, land use pattern including Jhum practice and its rich traditional knowledge base. It is the society and the community itself that can play the vital role in the participatory approach to natural resources management. Altogether there are 1428 villages (Census 2011) headed by Gaon Buras (GB's) or the traditional

headmen/ Village Head who look after the administrative functioning of the village. Each village has a Village Development Board (VDB) headed by a VDB Secretary and this Board serves as a decision making as well as implementing agency for all developmental work at the village level. All these villages have strong setup of independent democratic governance in the form of Village Councils. A Naga village government is more democratic in nature and practice than any other communities in the world. These Naga villages are the most permanent social and political units for all practical purposes. Presently there are 11 (eleven) districts in Nagaland headed by Deputy Commissioners.

ECO- RESTORATION AND DEVELOPMENT IN NAGALAND

Naga Hills are in urgent need of environmental conservation to check the eco-degradation and to remove poverty from the state. It will reduce migration of people in search for livelihood and develop a sustainable economy. Human beings have been interested in environment and ecology since the beginning of civilization. Even our ancient scriptures have included practices and values related to environmental conservation. Describing environment as a resource system, Singh (1998) advocated that environment as a generic concept for whatever is external and potentially influential upon a unit under study. In simple terms, the environment of a location comprises such things as air, water, soil, plants, animals etc. Each component constitutes a major resource, e.g., land, water and forest resources. All the components (resources) are inter-related for example one cannot visualize the existence of plant without soil, water and air. Thus environment not only comprises the life support system for the biological organism, it can be defined as a system of integrating resource subsystem. The UNEP noted that the environment includes a complex of natural, built and social components in the life of humanity. The science which elicits the functional inter-relationships among the different components of the environment on one hand and between the organism and environment on the other is called ecology. The ecological principles are directly applicable to environment and its management. It is advisable that the management of environmental resources upon which local communities depend should be decentralized and these communities should be given an effective share over the use of these resources (WCED 1987). Sustainable development implies the use of ecological system in a manner that satisfies current needs without compromising the needs of option of future

generations' strategies for sustainable development are same as the activities involved in integrated watershed management. In mountain ecosystem like Nagaland integrated watershed management is the ultimate key to sustainable development. The existing development practices and activities are not fit for sustainable development in Nagaland. Actions are urgently needed to be taken by the local political leaders, policy makers and decision makers at the highest level of government to implement the integrated watershed management as an alternative planning and development strategy in Nagaland.

Some of the strategic plans are suggested as below: -

1. The only solution lies in integrated multidiscipline watershed management which should involve local people specially the women at all stages of planning, execution and maintenance. Participatory Rural Appraisal (PRA) approach has been suggested. Optimum land use based in land capability for sustainable development has been recommended.
2. The primary objective of all the watershed management projects should be environmental conservation. Raising the living standard of local people specially the women and developing a sustainable model aiming at higher yield from land and water with rural involvement.
3. The pressure on forest is increasing with the expanding population. The efficient wood burning stoves, smokeless chullas, biogas and liquefied natural gas with stove etc.., may be developed and introduced in rural areas for efficient heating and cooking purposes as part of watershed management plans. This would ease the demand for fuel wood and would directly help to reduce the pressure on forest and promote ecological stability.
4. The social forestry programme of the watershed management plan should aim at creating awareness among rural households on the need for scientific forest management and also to increase the supply of firewood, fodder and timber for domestic use. Each household should be encouraged to plant 10 (ten) trees per year on their own land with planting material supplied free of cost by the Government. Massive planting must undertake in denuded forest areas with the objective to rehabilitation and upgrade such denuded areas of the watershed.

5. For planning, management, implementing and evolution of watershed management programmes, human resource is needed. Therefore, well-trained, well-oriented and committed personnel at field, middle management and supervisory level will be easily available if the Government creates training and educational opportunities for the successful watershed management.
6. Methods of Spring Sanctuary should be worked out. The development of Spring Sanctuaries inorder to augment the spring discharge by protecting recharge area from degradation by people and cattle should be based on favourable geological structure, setup of rock succession and geomorphological conditions.
7. Involvement of watershed area population in programmes, planning, execution and maintenance of the assets created by forming appropriate village level organizations and institutions within the watersheds.
8. Enhancement of local self-reliance by the formation of watershed Conservation Fund.
9. Promotion of sustainable use of natural resources.
10. Empowerment of beneficiaries particularly the disadvantaged section of the population.
11. Promotion of sustainable economic development by the community which directly or indirectly depend on the watershed natural resources like land, water and forest etc., that will mitigate the adverse effects of drought and prevent further ecological degradation.
12. Soil conservation plans may be formulated as follows
    a) Agronomic practices or biological measures.
    b) Mechanical or engineering measures.
    c) Check dams.
13. Plans to be formulated for the storage and recycling of runoff.
14. Introduction of water harvesting practices in the water scarcity areas of the watersheds.
15. Ground water recharge and development activities should be given priority.
16. Drainage management within the watershed.
17. Identification of alternate use of land through demonstration and action programmes.

18. Zoning of landslide hazard areas and suggesting measures for stabilization of slopes, prevention of landslides and evolving early warning systems.
19. Survey and analysis of socio-economic problems and suggesting measures for optimal utilization of local resources.
20. Creation of environmental awareness.
21. Selection and development of the best way of managing the renewable and non-renewable resources in the watersheds, to meet the present and future needs of the community.

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Chapter 8

SUMMARY AND CONCLUSIONS

SUMMARY

Nagaland the study area is one of the extreme north-eastern hill states of India. It has a total geographical area of 16,579 Km^2, and lies between latitudes 25º 20' N to 27º 04' N latitudes and 93º 20' E to 95º 15' E longitudes. The ranges of Nagaland are aligned in northeast to southwest direction as it is with the geological structure of the state. Nagaland is fairly young and mobile belt of the earth surface and is situated in a high risk zone of earthquake. The soils are generally acidic, very rich in organic carbon but poor in phosphate and potash content. There are plenty of rivers and streams flowing and cutting the landforms of the hill state. Variations of climate in Nagaland are caused by change in physiography such as: plain area experience warm and subtropical climate, the foothill areas with rolling to undulatory topography experience subtropical climate and the Low to moderate ranges with varying degree of slopes have sub-montane climate. The location of Nagaland and its physiographic terrain favors a wide variety of forest types and other vegetation as well. Because of its rugged topography and its dissected landforms we find various changes over a distance of the area in climate, vegetation and habits of the people. The present study on integrated watershed management in Nagaland: A key to sustainable development has been conducted during the year 2009-2014.

Land is an important resource because essentially every activity is land based. Agriculture is one of the most important land based activity in Nagaland as majority of the people are either farmers or involved in agricultural based activities. The economy of Nagaland in the villages consists of cultivation which is 68.03 percent of the total work force. The dependency of employment in agriculture was as high as 96.50 percent during the 1950's and 60's and has declined quite considerably to 68 percent in 2000 but still it is the mainstay for Naga people. With a rural population of 1,407,536 which consist of 71 percent of the total population of the State, agriculture is a major activity of the Nagas. In Nagaland 83.3 percent of forests are owned by villagers and the Government has no control over the felling of trees in these areas. This shows that the villagers are at large in position to develop or destroy the vegetation cover. The slash and burn activity of shifting cultivation which is commonly practiced in the study area is found to be the major reason for the soil erosion and land and forest degradation. A loss of 621 Km^2 of forest cover through 2005 to 2013 assessment which would mean loss of habitat for animals and birds,

trees and biodiversity as a whole. Shifting cultivation at the same time is an important activity for the Nagas as it is an age old traditional practice and cannot be totally stopped. The people are intrinsically involved with nature and their surroundings through this cultivation. Nagaland is endowed with many streams and rivers flowing through it from three river systems. Rivers and streams are a main source of drinking water and other domestic activities. Ponds, lakes and wells are also some of the sources of water for domestic purposes in Nagaland. Rain water harvesting is one of the most common practices during the rainy season though in dry season people depend on the perennial streams and ground water drawn from wells. River dam is also an important source of energy and Nagaland has seven mini hydro power projects. It is noted that the state enjoys monsoonal rain during the monsoon season, however undergoes a shortage of water for a considerable period from November to April. In Nagaland, 9950 Km^2 of area is under water erosion and chemical deterioration. Also most of the landslides are susceptible to areas where developmental activities like road construction, buildings etc are held.

Nagaland had also stood out for having the highest decadal growth rate of population during the decades 1981- 91 and 1991-2001. The 20^{th} century has experienced a rapid growth of population. An exponential growth of population is experienced in the 1950's to 60's with 73 percent of growth rate. This has also aggravated the agricultural activity as well as other developmental activity which leads to mismanagement of natural resources.

Most of the settlements of the state especially the villages are located on the hill tops, a factor to be considered while planning for the community development. It is the society and the community itself that can play the vital role in the participatory approach to biodiversity conservation and natural resources management. Food and environmental security have become a major issue of concern. There is a big gap between the rural poor and the urban rich. The productivity and the efficiency of people (workers) in Nagaland is not encouraging compared to the rest of India, whereas human resources of the state is not at all inferior to others as literacy and Human Development Index is much more compared to the National rate. Environmental management of degraded Jhum-agro-ecosystem is the need of the hour. So far, environment has not been taken seriously as the social, economic and other components in development planning. Thus the study area, which is under the

pressure of population growth and severe environmental degradation, needs a holistic planning and strategy in order to conserve and manage the natural resources under integrated watershed management for sustainable development.

A watershed is an area which contributes rainwater falling on it and allows the water to flow in one or more water courses with a single outlet at the end. The watersheds in Nagaland are characterized by a great degree of inaccessibility, fragility, marginality, diversity, specific niche opportunities and a unique human ecology. These biophysical characteristics also give rise to inter-linkages that create objective circumstances influencing the use and patterns of natural resources and ultimately affecting the environment. All the land of the State is rain fed except for some pockets of the agricultural land which is under irrigation. The environment in the study area has been greatly affected by changes in land- use mainly due to shifting cultivation, deforestation, slash and burn of forest on steep hill slopes which has accelerated soil erosion and landslides.

Watersheds comprises of a common and central characteristic that they hold multiple, interconnected natural resources which are soil, water and vegetation and impact on one resource invariably affect the status of the other. The watershed context is a unifying framework as water which is the integrated element of a watershed that flow downhill, irrespective of social and political boundaries, resource use practices in upstream incites a chain of impacts to which downstream are naturally laid open. Watershed can be used as an effective and integrated investigation and understanding into the complex and reciprocal linkage between watershed resources- soil, water and vegetation and the interaction between the upstream and downstream communities. Communities and local institutions have yet to come to terms with the philosophy of watershed development. The technological approach has not realized the expected benefits and the need to integrate local wisdom and traditional systems. The problem of environmental degradation of the state and their management is complex and multi-dimensional which needs involvement of scientific and systematic approach with socio-economic and socio-political considerations.

The watershed in Nagaland are under constant threat of mass wasting, accelerated soil erosion, drying up of springs, decline in river's water discharge and rainfall amount caused by depletion of forest cover, unscientific Jhum cultivation practices and geo-hydrological hazards. In view of the inadequate knowledge base,

lack of scientific and systematic data over an adequate time span and across diverse terrains and considering the intense dynamism and immense scale of the geo-hydro-meteorological processes in Nagaland, the wisdom behind the present developmental activities and planning strategy for sustainable development is not appropriate. Proper awareness at various levels, low-range data base and a holistic approach like integrated watershed management would bring us nearer to sustainable development involving better quality of life, improved economic status and adverse effect on life-support environment in Nagaland.

CONCLUSIONS

- The present study on integrated watershed management in Nagaland: a key to sustainable development was conducted in Nagaland and studied environment and development problems for the promotion of sustainable development.
- The environment of the study area has been greatly affected by the land use change mainly due to shifting cultivation, deforestation, slash and burn on steep hill slopes, accelerated soil erosion and land sliding.
- Efficient environmental management and eco restoration in the degraded watersheds are perquisite for sustainable economy of the state. Critical gaps exist in planning for economic development with environmental conservation to achieve sustainable development.
- The implementation of watershed management program has so far in Nagaland revealed that it should be a programme of the beneficiaries, of the people for the people and by the people.
- Population growth has given rise to the utilization of natural resources in an improper way.
- Population growth has aggravated the land use systems viz., cultivation, urbanization, deforestation etc.
- The need of the hour is to reverse trend of natural resources or environmental degradation.
- The proper conservation and development is possible only through integrated watershed management in Nagaland.
- Sustainable development strategy can be evolved ensuring people's participation and equitable share of benefits.
- Efforts should be directed towards enhancing productivity, augment production of usufructs, better returns from existing resources achieve social and gender equity, capacity building of watershed inhabitants, equitable distribution of the benefits of land and water resources, the ecological and water resources.
- This can be achieved only through integrated watershed multidisciplinary watershed programmes with optimum land use and involvement of the villagers at all stages of planning, execution and maintenance.

- The success of any sustainable development can be realized by strengthening village level institution.
- The statistics clearly points that Nagaland is a rural state and that it can be managed well with proper management approach as the people are still in a setting close to the nature with practices of Agriculture based economy.
- Nagaland represents an ideal model of synthesis of modernity and tradition.
- Understanding of related issues like equity, sustainability and people's initiatives in resource management has to be done in Nagaland.
- It is a desperate need to integrate the environment and economics in decision making and planning.
- Integrated watershed management should be considered as an alternative for planning and development of natural resources especially land, water and forest to sub-serve the socio-economic needs of the people of Nagaland.
- Formation of grass root level active groups which would be assisted to formulate their stakes and select activities towards preparation and implementation of a watershed management plan.
- Assessments of problems should be more relevant to physical, social, and economic needs and bear direct relevance to sustainability from ecology as well as socio-economics.
- It is therefore necessary for the state to formulate an integrated approach of management so that the state can be benefitted at its maximum through integrated watershed management.
- Effective integrated watershed management is rarely found in Nagaland. The development of appropriate practices is hampered by a lack of relevant training, insufficient applied research and no demonstration projects. Research that focuses on solving practical problems in the field needs greater financial and technical support.

SUGGESTIONS / RECOMMENDATIONS

- Formation of grass-root level active group which would be assisted to formulate their stakes and select activities towards preparation and implementation of a watershed management plans in the study area. These would also undertake subsequent action to share and services along with those for care of watershed.
- Assessments of problems should be more relevant to physical, social and economic needs and bear direct relevance to sustainability from ecology as well as socio-economics.
- It is recommended that watershed-wise planning and management of resources should integrated participatory watershed management programmes for sustainable development and micro watershed management systems made integral part of the watershed management planning, development and management at all level.
- There is an urgent need in the study area for establishment of a good network of hydrological and meteorological stations for the purpose of observing and measuring sufficient number of geo-hydro-meteorological parameters consecutively over a long period of time for the assessment of the physical environment of the watersheds and more importantly for the prediction of geo-hydrological hazards.
- Ensuring the sustainable development of Nagaland is a challenging endeavor and there are no easy straitjacket solutions. We have to innovate and ensure that good practices are adopted after suitable adaptation to local conditions.
- It is suggested that public awareness and the involvement of local communities are crucial for the successful and sustained management of watershed in the study area.
- Actions urgently need to be taken by policy makers and decision maker at the highest levels of government to halt and reverse watershed degradation.
- A balance between population and the environmental carrying capacity of watersheds must be achieved. In steep, mountainous watersheds undergoing severe degradation, significant policy and programme responses are needed in near future.

- Special institutional and organizational arrangements are needed in Nagaland to coordinate and effectively carryout the planning, funding, implementation and monitoring of watershed programmes.
- Effective implementation and monitoring of watershed practices is essential and requires technical personnel who are adequately trained and willing to work in remote areas under difficult conditions. Government and agencies should seek out reward and promote watershed specialists for the critically important jobs.

PLATES

Plate 1 A watershed in Tuensang District

Plate 2 Forest in Dzukuo Valley

Plate 3 Jhum Cultivation at Longsa Village, Mokochung

Plate 4 After Jhum Harvesting, Tuensang Village

Plate 5 Terrace cultivation at Hakchang Village, Tuensang

Plate 6 Terrace Cultivation at Phek Village, Phek

Plate 7 Massive Stone Quarrying in Wokha

Plate 8 Land Degradation due to Quarrying at Khonoma Village, Kohima

Plate 9 Firewood stocked up for winter at Jotsoma Village, Kohima

Plate 10 Firewood for commercial purpose at Longkhum Village, Mokokchung

Plate 11 Degradation of streams due to mismanagement of waste, Mohonkola, Kohima

Plate 12 Degradation of streams due to mismanagement of waste, Mohonkola, Kohima

Plate 13 Landslide in Urban area, Kohima

Plate 14 Landslide in National Highway 61

Plate 15 Massive natural vegetation desttroyed for jhumming

Plate 16 Wood collected for firewood during preparation of Jhum fields

Plate 17 Burning of forest for jhuming (Longsa, Mokokchung)

Plate 18 Jhum field after the burning (Longsa, Mokochung)

Plate 19 Dikhu River flowing through Tuensang District

Plate 20 An over view of Dikhu River in Nagaland

Plate 21 Longsa Village in Mokokchung

Plate 22 Pangsha Village in Tuensang

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ANNEXURE

Annexure I
Questionnaire

A QUESTIONNAIRE FOR PHD RESEARCH

TOPIC: INTEGRATED WATERSHED MANAGEMENT IN NAGALAND: A KEY TO SUSTAINABLE DEVELOPMENT

Name of the Researcher: Miss K. Nukshienla Imchen
Institution : Nagaland University

Dated:

Dear Respondents,

I am a research scholar, pursuing Ph.D. Degree from Nagaland University, Lumami. I am researching on the topic, "Integrated Watershed Management in Nagaland: A Key to Sustainable Development", under the supervision of Associate Professor, Dr. M. S. Rawat, Department of Geography.

To aid in my research I have designed a questionnaire which aims particularly to study the ongoing Watershed Projects and Schemes in Nagaland that are taken up by various Departments belonging to the Government of Nagaland, Other Semi-Governmental Agencies and Non-Governmental Organizations.

This research can be of benefit for many because it can provide insights and steps for bringing about transformation and development in the State of Nagaland by effecting change in both urban and rural settings. I am certain that this research can be an eye opener for those who want to make a difference but lacks direction.

May I therefore request you to kindly take some time out of your busy schedule and fill up this questionnaire for me and also for a noble cause! I am certain that your knowledge in this area can be useful to propel this research towards a genuine conclusion.

If you are concerned for your identity let me assure you that your individual answers will be anonymous and held in the strictest confidence.

Thanking you!

Yours sincerely,

Miss K. Nukshienla Imchen
Nagaland University

E-mail: kn_imchen@rediffmail.com Mobile Phone: 9612498724

SOME GENERAL INFORMATION OF THE RESPONDENT

1. Name of the respondent: ……..
2. Department/organization: …….
3. Government □ Non-government □ Semi-government □
4. Designation: …….
5. Place: ……
6. Date: ……....

INSTRUCTIONS: (Please note the following instructions before proceeding)
1. Please follow the serial number while answering.
2. Please answer all the questions.
3. Unless there is a hint to tick, please write a relevant answer.
4. For some questions you may have to estimate or guess. That is ok.

1. Is the department involved in any natural resources conservation, management and development?

   Yes□ No□

   If yes,

   a. Is the department involved in (*Multiple answers possible*)
      i. Conservation of natural resources □
      ii. Management of natural resources □
      iii. Development of natural resources □
      iv. All the above □
   b. What are the specific resources dealt with? (*Multiple answers possible*)
      v. Forest □
      vi. Water □
      vii. Soil □
      viii. Biodiversity □
      ix. Mineral □
      x. Others □ please specify……
2. Is the department working under any state/ national / international sponsored schemes or projects for resources management, conservation and development?

   Yes□ No□
3. Is the department working under any state/ national / international sponsored schemes or projects for watershed management? Yes□ No□

   If yes, please list out the schemes/ projects with the details as given below

Sl. No	Name of the Scheme/ project	State/ National/ International	Year of implementation	Completed/ yet to be completed

The following are specific questions to be answered only by departments that are initiating watershed management projects.

1. Is the department under any projects of watershed development? Yes☐ No☐

   If yes, is it State ☐/ National ☐ / International☐ sponsored scheme/ project?
2. How many such projects are being implemented in the department? _____
3. What was the year it started to implement in your office? _____
4. Is it still continuing? Yes☐ No☐
5. How many projects have been completed so far? _____
6. How many projects are still in the process of completion? _____
7. How many projects have been stopped before completion? _____
8. Which are the driving institutions for the project? (several answers possible)
   i. Water ☐
   ii. forest ☐
   iii. agriculture ☐
   iv. environment ☐
   v. Land ☐
   vi. rural development ☐

Defining a watershed area

1. Are the selected watersheds
   i. Village wise ☐
   ii. District wise ☐

iii. Others □ please specify _____

_____

2. Among the selected watersheds, are there any watersheds coming under two or more political boundaries?
   Yes□ No□
3. While delineating the watersheds, is the element of upstream and downstream watershed community considered? Yes□
   No□
4. What is the area commonly taken for each watershed in your project? _____
   If precise area is not known, indicate in approximation as follows
   i. 1 -10 km^2 □
   ii. 10-100 km^2 □
   iii. 100-1,000 km^2 □
   iv. 1,000-10,000 km^2 □
   v. >10,000 km^2 □
5. The total area coverage for one term of the project _____
6. The total area coverage by the project so far _____

Methods of watershed delineation

1. What was the base map used for delineating the watersheds in your projects?
   i. Topographical Sheets□
   ii. Aerial photographs□
   iii. Imageries□
   iv. None □
   v. Others □ please specify _____

   _____

2. What are the methods of map making used in the watershed delineation?
   i. Remote Sensing and GIS technique is used□
   ii. Cartography is used□
   iii. Others □ please specify _____

   _____

3. Whether coordinates in latitudes and longitudes of the selected watershed areas have been derived/ recorded?
   Yes☐ No☐

Components of watershed considered

1. Is the soil slope map prepared?
   Yes☐ No☐

If yes, it is prepared for

   i. One model watershed ☐
   ii. Few watersheds ☐
   iii. All the selected watersheds ☐

2. Which component/s of the watersheds is/are measured/ quantified in the watersheds of the project?
   i. Soil depth ☐
   ii. Soil texture ☐
   iii. Soil stoniness ☐
   iv. Availability of water ☐
   v. Quality of water ☐
   vi. Ecological diversity ☐
   vii. Average population density ☐
   viii. Migration pattern ☐
   ix. Others ☐ please specify _____
   _____

3. The selected watersheds are usually
   i. Without human settlements ☐
   ii. With human settlements ☐
   iii. Near human settlements ☐
   iv. Far from human settlements ☐

Watershed people and the environment

1. Under whose land ownership does the watersheds generally fall
   i. State ☐
   ii. Company ☐
   iii. Communal/ village ☐

iv. Group □
v. Individual, not titled □
vi. Individual, titled □
vii. Other □ (please specify) _____

2. Are there major constraints related to land tenure and rights to use natural resources (water, soil, vegetation) in the project areas?

Yes□ No□

3. Do human-environmental interactions influence watershed management aspects? *(e.g. conflicts between upstream and downstream farmers could lead to degradation of natural resources, demand for bio-fuels, population pressure on land, market forces leading to specialization***)**

Yes□

No□

4. At what level does the decision making process take place for the management system?
   i. Committees / community □
   ii. administrative level (district, province) □
   iii. river basin □
5. At what level does the decision making process take place for the environmental legislation?
   i. Committees / community □
   ii. administrative level (district, province) □
   iii. river basin □

Some general information about the project

1. objectives of the watershed management project or the scheme
   ……
   ……
   ……
   ……
   ……
2. Targeted group or beneficiaries
   ……
   ……
3. Implementing partners and their roles
   ……
   ……
   ……
   ……
4. Environmental, social, cultural and economic impacts of watershed management
   ……
   ……
   ……
   ……
5. In what ways the watershed management projects have been helpful to the watershed people?
   ……
   ……
   ……
   ……
6. Is the department/organization satisfied with the results of the watershed management projects or schemes?
   Yes,……
   ……
   ……
   ……
   No,……
   ……
   ……
   ……
7. What more can be done to help the watershed people with the watershed management project?
   ……
   ……
   ……

Annexure II

List of maps prepared by the author using GIS technique. The shape files and necessary base maps were obtained at the Nagaland GIS and Remote Sensing Centre, Kohima

1. Location Map of the Study Area viz., Nagaland, Northeast, India
2. Location of selected sample Watersheds in the Study Area viz., Nagaland, Northeast India
3. Index Map of the Study Area viz., Nagaland, Northeast India
4. Drainage System of Nagaland
5. Ordering of streams in the upper Kiliki watershed of Zunheboto hills, Nagaland
6. Brahmaputra River Basin in Nagaland
7. Upper Brahmaputra Basin
8. Middle Brahmaputra Basin
9. Lower Brahmaputra Basin
10. Barak River Basin
11. Chindwin River Basin
12. The seventeen watersheds in Nagaland (Area 543 to 1731 Km^2)
13. Various geo-hydrological units (Catchment area) in Nagaland
14. Drainage pattern, order and network of the sample watersheds in Nagaland
15. Map showing distribution of population and density in Nagaland
16. Drainage pattern, order and network of the sample watersheds in Nagaland
17. Slope Maps of sample watersheds