DISTRIBUTION AND USES OF MEDICINAL PLANTS IN MAWTNENG VILLAGE

RI-BHOI DISTRICT, MEGHALAYA

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CHAPTER 1

INTRODUCTION

MEANING OF MEDICINAL PLANTS

Medicinal plants have been the basis of treatment of various diseases in traditional medicine as well as other forms of treatment from diverse cultures o the world. About 80% of the world's population still depends solely on traditional or herbal medicine for treatment of diseases, mostly in the developing nations. Most of the potent medicinal plants have relatively no toxic or adverse effects when used by humans, while some are very toxic to both humans and animals with the potential of damaging certain organs in the body. This calls for caution in the used of medicinal plants of which the use is presently on the increase due to easy availability, affordability, accessibility, and promoting efficacy comparable to the often high cost and adverse effects of standard synthetic drugs agents. This study highlights some safe medicinal plants with good toxicological profile which can be use and treat for humans. Several medicinal plants were evaluated for their good toxicological profile using online research. After much screening, only those medicinal plants without serious toxic effects in human were chosen and precisely discussed.

Medicinal plants are used worldwide as an alternative and/or a complementary medicine. Studies on these medicinal plants including pharmacological and toxicological evaluations are essential for drug research and development. Medicinal plants also can be poisonous, affecting the entire spectrum of organs systems, with some plants containing several toxic principles that effect different systems. Toxic principles can be found in different parts of medicinal plants: leaves, fruits, flowers, roots, stem bark. In evaluating the acute toxicity or subacute toxicity or medicinal plants, any animal species can be used, through rodents are used most often.

Medicinal plants are an essential natural resource for the treatment of more persistent diseases. Various medicinal plants can be used to treat similar diseases, depending on the country in which the diseases occur. In some localities, medicinal plants are perceived according to their traditional uses and represent a low-cost alternative to treat various diseases. However, more ethnobotanical studies are still needed to quantitatively document the use of medicinal plants and their beneficial effects when they are used as the only option to treat a disease, as well as their toxicological effects.

History of Use of Traditional Herbal Medicines

By definition, 'traditional' use of herbal medicines implies substantial historical use, and this is certain true for many products that are available as 'traditional herbal medicines'. In many developing countries, a large proportion of the population relies on traditional practitioners and their armamentarium of medicinal plants in other to meet health care needs. Although modern medicine may exist side-by-side with such traditional practice, herbal medicines have

often maintained their popularity for historical and cultural reasons. Such products have become more widely available commercially, especially in developed countries. In this modern setting, ingredients are sometimes marketed for uses that were never contemplated in the traditional healing systems from which they emerged. While in some countries, herbal medicines are subjected to rigorous manufacturing standards, this is not so everywhere. In Germany, for examples, where herbal products are sold as 'phytomedicines', they are subject to the same criteria for efficacy, safety and quality as are other drug products. In the USA, by contrast, most herbal products in the marketplace are marketed and regulated as dietary supplements, a product category that does not required preapproval of products on the basic of any of these criteria.

TRADITIONAL HERBAL MEDICINES OF MEGHALAYA.

Meghalaya is very rich in floral diversity, a significant part of which comprises medicinal and aromatic plants and there is a long- standing tradition of use of medicinal plants in the state. The development of medicinal plants sector in Meghalaya has a great scope or providing employment to the people as there is a huge and ever increasing market for medicinal and aromatic plants and their preparations in the country and abroad.

The Government o Meghalaya constituted the Meghalaya State Medicinal plants Board to handle all matters related to policy formulation, co-ordination of various agencies dealing with medicinal plants, local health traditions, sustained availability of medicinal plants, validation and certification issues and conservation and presentation of medicinal plants in the state.

Diversity of Medicinal and aromatic plants in Meghalaya:

Meghalaya with its wide ranging altitudes, forest types and resultant agro climatic conditions offers habitats for a very large number of medicinal plants. The richness is also the result of the people's traditional knowledge on them. Though the flora is well known and many ethno botanical publications have been brought out, a consolidated account of the medicinal plant diversity is still lacking. This is all the more essential when we consider different tribes inhabiting different districts with their diverse traditional practices. Altogether 834 medicinal plant species have so far been reported by various plant collectors.

Plants provide the predominant ingredients of medicines in most medical tradition especially among the tribal and the aboriginal people. This is also true among the tribal population of Meghalaya who possesses a rich traditional knowledge of medicinal uses of plants.

Mawtneng of Ri Bhoi district the study area has a wide variety of herbal medicinal plants ranging from trees, leaves, roots, fruits like banana, guava, pineapple, celery garlic ginger which are cultivated by the people while some are grown naturally in numerous areas. The plants grown in the areas have a great impact on the people and due to lack of modern medical centers in the past periods many traditional herbal practitioners have been treating certain illness and injuries using their own traditional knowledge about medicinal properties of the various plants found in the study area.

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DEPARTMENT OF GEOGRAPHY

CERTIFICATE

This is to certify that Ms/Mr Fenella A Syiem__ is a VI Semester Geography Honours student; St. Edmunds College Shillong. He/She has undergone a project title Distribution and Uses of Medicinal Plants in Mawtneng Village, Ri Bhoi District, Meghalaya , under the supervision of Sir Osmond. M. Kharmawphlang . This Project is a bonafied work of the student and has not been published in any form whatsoever. Hence, this report maybe placed for evaluation and consideration.

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Dated the ____ of May, 2024

ACKNOWLEDGEMENT

First and foremost, I would like to express my heartfelt gratitude to the Almighty, whose unwavering guidance has continually opened doors and paved the way for me to progress.

I am deeply grateful to my esteemed teacher, Sir Osmond M. Kharmawphlang, Head of the Department and our topic's supervisor, whose mentorship and support were instrumental in shaping this project. His invaluable advice and generosity will always be remembered with the utmost respect and appreciation.

I would also like to extend my thanks to Sir G. Kharkongor, Sir M. J. Ford, Miss W. Diengdoh, H. Kharbithai, and Sir Orlando (Lab Assistant) of the Geography Department. Their lectures and unwavering support, especially during our field study, provided me with essential insights and information that enriched this project significantly.

A special acknowledgment goes to the local guide of Mawtneng Village, whose extensive knowledge and guidance were invaluable. His insights into the medicinal uses of various plants greatly contributed to our research.

I must also express my deepest gratitude to my parents and friends, whose unwavering support and encouragement were a constant source of strength throughout this journey.

To everyone who has contributed to the completion of this research paper, I extend my heartfelt thanks. Your assistance and guidance have been invaluable, and I am truly grateful for your support. It brings me great joy to reflect on the fact that so many individuals lent a helping hand when I needed it most, ensuring the successful completion of this project.

STATEMENT OF THE PROBLEM.

The study of the plants of plants distribution and their remedies in traditional medicines help in developing and knowing the types of plants found in the area and how they are useful for medicinal purposes. The plants found in the village/study area had a great impact on local people in recent periods. However, this impact has been on a decline due hospitals, health care centers etc. in the neighboring areas in which modern medicines plays a major role.

The various medicinal plants found distributed in the village are almost everywhere from forested areas to agricultural fields and even settlement areas, which are of different types like roots, leaves, fruits, stems, barks, of trees etc which have different medicinal properties and uses for different purposes by consuming or by applying externally. The traditional knowledge associated with the conservation and presentation and use of medicinal plants is disappearing at an alarming rate. But however different measures can be taken to preserve the medicinal plants found in the village and through this study/ project we can in a small way identify the uses of the different medicinal plants found in Mawtneng Village and help them to conserve the different medicinal plants for future use.

OBJECTIVES

The main objectives of the study are:

1. To understand the types and distribution of medicinal plants found in Mawtneng village.

2. To understand the impact of medicinal plants of the area.

3. To understand the importance of biodiversity in the distribution of medicinal plants.

4. Measures to preserve the medicinal plants.

1.To understand the types and distribution of medicinal plants found in Mawtneng Village.

Understanding the types and distribution of medicinal plants in Mawtneng village would require conducting a botanical survey and engaging with local indigenous knowledge holders. However, we can provide a general overview of the types of medicinal plants commonly found in similar regions and factors that may influence their distribution :

i. Forest and vegetation Types: The vegetation in and around Mawtneng village likely consists of various habitats, including forests, grasslands, and wetlands. Different types of medicinal plants thrive in specific ecological niches, such as shade-loving plants in the forest understory or moisture-loving species near streams and niches.
ii. **Indigenous Knowledge:** Local communities, including indigenous tribes, often possess extensive knowledge about the medicinal plants found in their surroundings. Traditional healers and elders may be able to identify and provide information about the types, uses and distribution of medicinal plants in the area.
iii. **Habitat Disturbance:** Human activities such as deforestation, agriculture and urbanization can significantly impact the distribution of medicinal plants. Habitat disturbance may lead to the loss of certain plant species or changes in their abundance and distribution. Conversely, some medicinal plants may thrive in disturbed or secondary habitats.
iv. **Altitude and Climate:** The altitude and climatic conditions of Mawtneng Village influence the types of vegetation and plant species present. Medicinal plants adapted to specific temperature ranges, precipitation levels and soil types will be disturbed accordingly across different elevations and microhabitats.
v. **Endemism and Rarity:** Some medicinal plants may be endemic to the region, meaning they are found nowhere else in the world. Endemic species are often of particular interest for conservation due to their restricted distribution and potential medicinal value. Additionally, rarer endangered medicinal plants may require special conservation efforts to ensure their survival.
vi. **Cultural Practices:** Cultural practices and traditional medicine systems play a significant role in shaping the use and conservation of medicinal plants in the area. Certain plants may hold cultural significance or be included in traditional healing rituals, influencing their conservation status and management.

To gain a comprehensive understanding of the types and distribution of medicinal plants in Mawtneng village, a multidisciplinary approach that integrates botanical surveys, ecological studies, ethno-botanical research, and engagement with local communities would be necessary. This approach would help identify key species, assess their conservation status, and develop strategies for sustainable management and utilization.

2. The impact of medicinal plants in Mawtneng village can be multifaceted and significant, affecting various aspects of the community's health, culture, economy and environment. Here are some key areas where medicinal plants may have an impact:

i. **Healthcare:** Medicinal plants are likely a primary source of healthcare for the residents of Mawtneng village, especially in areas where access to modern medical facilities is limited. Traditional healers and community members may rely on locally available plants to treat a wide range of ailments, including common illnesses, chronic conditions, and injuries. The accessibility of medicinal plants can contribute to the health and well-being of community members, particularly in remote or underserved areas.

ii. **Cultural Practices:** Medicinal plants often hold cultural significance in indigenous communities, including Mawtneng village. Traditional healing practices, rituals and ceremonies may revolve around the use of specific plants, reflecting the community's cultural heritage and spiritual beliefs. The preservation and continued use of medicinal plants are essential for maintaining cultural identity and traditional knowledge systems within the community.

iii. **Economic Opportunities:** The cultivation, harvesting and sale of medicinal plants can provide economic opportunities for community members, contributing to livelihoods and local economies. In Mawtneng village, individuals may engage in small-scale farming or gathering of medicinal plants for personal use or for sale in local markets. Additionally, the growing global demand for herbal remedies and natural healthcare products presents potential avenues for income generation through the sustainable harvesting and commercialization of medicinal plants.

iv. **Conservation and Environmental Management:** The sustainable management of medicinal plants is closely linked to conservation efforts and environmental stewardship. Mawtneng village may implement measures to protect important medicinal plant habitats, prevent overharvesting and promote sustainable harvesting practices. Conservation initiatives aimed at preserving biodiversity and ecosystem health benefit not only medicinal plants but also the overall ecological integrity of the region, including soil health, water quality and wildlife habitat.

v. **Research and Development:** The rich diversity of medicinal plants in Mawtneng village presents opportunities for scientific research and development. Studies on the pharmacological properties, bioactive compounds and therapeutic uses of local plant species can contribute to the advancement of modern medicine and the discovery of new drugs. Collaborations between researchers, local healers and community members may facilitate the documentation of traditional knowledge,

the validation of medicinal plant efficacy and the development of evidence-based healthcare practices.

Overall, the impact of medicinal plants in Mawtneng village extends beyond healthcare to encompass cultural, economic, environmental and scientific dimensions. Recognizing the importance of medicinal plants and integrating their sustainable use into community development efforts can contribute to the health, well-being, and resilience of the village and its residents.

Importance of Biodiversity

3. Biodiversity plays a crucial role in the distribution of medicinal plants due to several interconnected factors:

i. **Ecosystem Health:** Medicinal plants are often part of complex ecosystems. Biodiversity ensures the health and resilience of these ecosystems, providing the necessary conditions for the growth and survival of medicinal plants. Healthy ecosystems are more likely to support a diverse range of species, including those with medicinal properties.

ii. **Genetic Diversity:** Biodiversity ensures genetic diversity within plant populations. This genetic variation can lead to differences in medicinal properties among individual plants of the same species. For example, certain genetic variants may produce higher concentrations of active compounds or exhibit unique therapeutic effects.

iii. **Ecological Interactions:** Biodiversity fosters intricate ecological interactions among species, such as pollination, seed dispersal and symbiotic relationships. Many medicinal plants rely on scientific interactions with other organisms for reproduction, dispersal or nutrient uptake. Changes in biodiversity can disrupt these interactions, impacting the availability and distribution of medicinal plants.

iv. **Climate Resilience:** Biodiverse ecosystems tend to be more resilient to environmental changes, including climate change. As climate patterns shift, certain habitats may become more or less suitable for medicinal plant growth. Biodiversity enhances the ability of ecosystems to adapt to these changes, potentially facilitating the migration or adaptation of medicinal plant species to new environmental conditions.

v. **Cultural and Traditional Knowledge:** Indigenous and local communities often have rich knowledge about the medicinal properties of plants in their surroundings. Biodiversity conservation is essential for preserving this traditional knowledge and ensuring continued access to medicinal resources. Loss of biodiversity can lead to the erosion of traditional healing practices and the loss of valuable medicinal knowledge.

vi. **Drug Discovery and Development:** Biodiversity serves as a valuable source of natural compounds with pharmaceutical potential. Many modern medicines are derived from plant-based compounds originally discovered in diverse ecosystems. By conserving biodiversity, we maintain a vast reservoir of potential drug candidates for future medical research and drug development.

Overall, biodiversity conservation is essential for maintaining the availability, efficacy and sustainability of medicinal plants. Protecting natural habitats and promoting sustainable harvesting practices are crucial strategies for ensuring the continued availability of these valuable resources.

4. Preserving medicinal plants at Mawtneng village requires a combination of conservation strategies, community involvement and sustainable management practices. Here are some measures that can be implemented:

i. **Community Education and Awareness:** Raise awareness among community members about the importance of medicinal plants, their ecological significance and the need for conservation. Engage with local schools, community organizations and traditional healers to educate residents about sustainable harvesting practices, the value of biodiversity and the cultural heritage associated with medicinal plants.

ii. **Documentation of Traditional Knowledge:** Work closely with traditional healers, elders and knowledgeable community members to document traditional medicinal practices and indigenous knowledge about medicinal plants. Record information about plant species, their uses, preparation methods and ecological significance. This documentation can serve as a valuable resource for future generations and contribute to the preservation of traditional healing practices.

iii. **Identification and Mapping:** Conduct botanical surveys and ecological assessments to identify key medicinal plant species in the area and map their distribution across different habitats. Identify priority species for conservation based on their medicinal value, rarity, or ecological importance. Develop a comprehensive inventory of medicinal plants to guide conservation efforts and management decisions.

iv. **Habitat Protection and Restoration:** Identify and protect important habitats for medicinal plants, including forests, grasslands, wetlands and riparian zones. Establish community-managed conservation areas, nature reserves or sacred groves to safeguard critical plant habitats from deforestation habitat degradation and land conversion. Implement habitat restoration projects to enhance the quality and resilience of degraded ecosystems.

v. **Sustainable Harvesting Practices:** Promote sustainable harvesting practices for medicinal plants to ensure their long-term viability and prevent overexploitation. Establish guidelines for responsible harvesting, including selective harvesting, seasonal restrictions and quotas for certain

species. Encourage rotation of harvesting areas to allow for natural regeneration and recovery of plant populations.

vi. **Cultivation and Agro-forestry:** Support community-based cultivation of medicinal plants through agroforestry, home gardens or community nurseries. Identify suitable species for cultivation based on their medicinal value, market demand and ecological requirements. Provide training, technical assistance and access to resources for community members interested in cultivating medicinal plants as a sustainable livelihood option.

vii. **Regulatory Measures:** Advocate for the enforcement of existing laws and regulations related to the protection of medicinal plants, biodiversity conservation and sustainable natural resource management. Collaborate with local authorities, government agencies and conservation organizations to strengthen legal frameworks, establish protected areas and implement monitoring and enforcement mechanisms.

viii. **Community Participation and Empowerment:** Involve community members in decision-making processes related to the conservation and management of medicinal plants. Foster partnerships between local communities, government agencies, NGOs and research institutions to co-design and implement conservation initiatives that align with community needs, priorities and cultural values. Empower local stakeholders to take ownership of conservation efforts and participate in monitoring, research and advocacy activities.

By implementing these measures in collaboration with local communities, policymakers and other stakeholders, it is possible to preserve the rich biodiversity of medicinal plants at Mawtneng village while promoting sustainable development and improving the well-being of residents.

LITERATURE REVIEW

- ***Dr. J.C.Kurian :-*** **Plants that heal** *: published by the Oriental Watchman Publishing House Pune, India.*

  The author of the book through this publication, has made an effort to identify useful plant species that has medicinal benefits supported by photographs of the same. The author further provides a brief description of each plant species with an addition of a written guide note on how the plants could be put to use to extract the medical benefits.

  The Research work has profited to a great extent from this particular book on description and medicinal use of plant species of : *Aloe vera, Hibiscus rosa sinensis, Luffa cylindrical, Mimosa pudica, Musa paradisiaca, Pistia stratiotes, Sansevieria zeylancia, Artocarpus heterophyllus* and *Centella asiatica* which are some of the plants found in the study area of Mawtneng.

- ***Mao. A. A, Sinha B. K, Verma D and Nandita Sarma :-*** **Checklist of Flora of Meghalaya :** *published by Meghalaya Biodiversity Board, Shillong, India.*

  The publication has enumerated various flora of Meghalaya. The authors have extensively examined and analyzed innumerable flora species of Meghalaya providing the readers or even field workers a detailed description on the distribution of such plants in Meghalaya affixed with photographs of only some of the same. The publication presented the plants under a plant family accompanied by the name in local language.

  The book has served as a great help in the research work as it thoroughly provided the distribution of plants under study like : *Oxalis corniculata, Begonia roxburghii* and *Clerodendrum glandulosum.*

- ***Dr. M. P. Singh :-*** **Wild Medicinal Plants** : *published by Daya Publishing House, New Delhi, India.*

  From providing the plant's family, genus, species and scientific name to giving a detailed description of the plant combined with an instruction on how to use the plant to giving a comprehensive account on the medicinal properties of the plants, the author has made the book a great source of information for forest officials and field staffs apart from coming to use in research for different scientists and students.

  Many information has been derived from this book on the research plants of Mawtneng village, in particular : *Oxalis corniculata.*

- ***Alok Senapati, Nihal Gurjee, Sudip Mitra and Latha Rangan :-*** **Flora of IIT Guwahati :** *published by Bhabani offset and Imaging Systems Pvt Ltd, Guwahati, Assam.*

  The authors in this publication, has tried to capture and analyze the flora of Assam providing the readers with photographs adjoined with the family, vernacular and scientific names of the different plant species. An adequate description of the plant has also been attached along with its distribution.

Although based in Assam, the book also serves as great source for the plants under research as some mentioned in the book are also found in Mawtneng village (study area) and other parts of Meghalaya as well. The book served great information on : *Clerodandrum glandulosum* in particular.

- **Handbook of Medicinal and Aromatic Plants of North-East India** *: published by Spectrum Publications, Assam, India.*
  The publication has attempted a herculean task in gathering and compiling a complete handbook on Medicinal and Aromatic Plants found in the North-Eastern Region of India with a purpose to arouse curiosity among the readers of the bioidiversity around them. The book has intended to give the first hand basic knowledge of the many species mentioned through an extensive description of the same accompanied with their botanical name, family, medicinal use, distribution in North East India and an attached photograph for each.
  Through this book, information has been drawn for the species of : *Begonia roxburghii, Indigofera tinctoria, Oxalis corniculata* and *Tagetes erecta.*

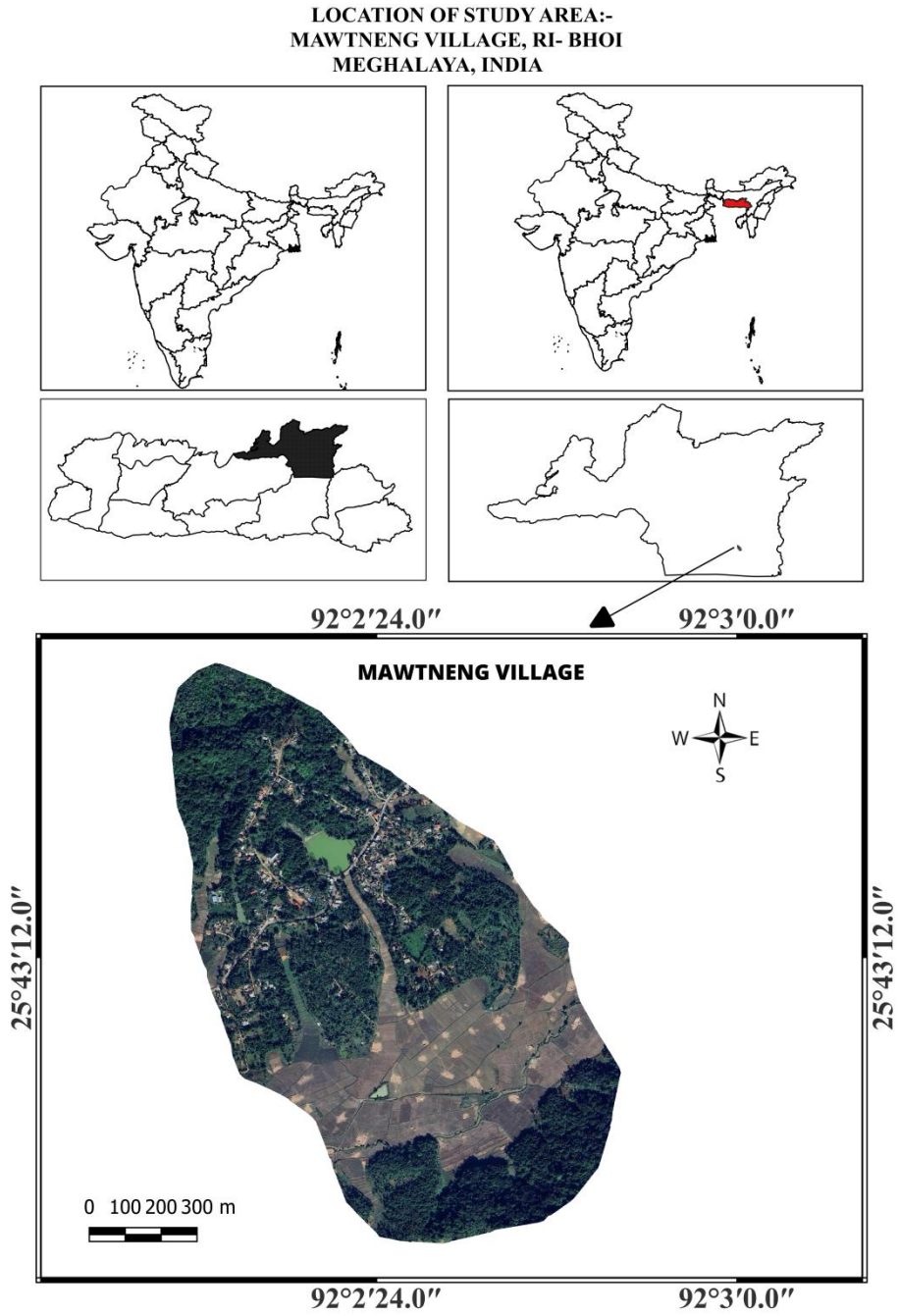
- ***S. K. Tripathi, Kalidas Upadhyaya and Nagaraj Hegde :-*** **Medicinal Plants of India : Conservation and Sustainable Use :** *published by Today and Tomorrow's Printers and Publishers.*
  The authors through this publication has given an extensive examination on the various medicinal plants that India possess through brief description of the plants, their botanical names, distribution in India and a direction on how to use the plants to extract its medicinal benefits. Besides all this, they have also made an effort to throw light on the conservation and sustainable use of the plants.
  The content of the book has especially benefitted the plant species of *Centella asiatica* which is the plant under study.

- ***Narayan Das Prajapati, S. S. Purohit, Arun. K. Sharma and Tarun Kumar*** :- **A Handbook of Medicinal Plants – A Complete Source Book :** *published by Agrobios, India.*
  The authors in this publication has done an extensive task of providing the readers with important information on the various plant species by offering knowledge on the plant's vernacular name, a brief description on the plant, its origin and distribution, propagation, chemical constituents and uses.
  The research work has acquired ample information from this handbook in the plant species of : *Rhaphidophora Pertusa.*

- ***T. Pullaiah :-*** **Biodiversity in India** : *published by Regency Publications, Delhi.*
  The author through this publication has supplied a great source of information for field staffs, forest officials and even students on the meaning of biodiversity, its impacts, biodiversity of the entire Indian sub-continent and an added information on the medicinal properties of the plants under study as well as uncovering the plants' name in their local language according to its area of origin.

  A great deal of information has been drawn especially for the plants under study, that of : *Oxalis corniculata* and *Aloe vera*

LOCATION OF STUDY AREA MAP

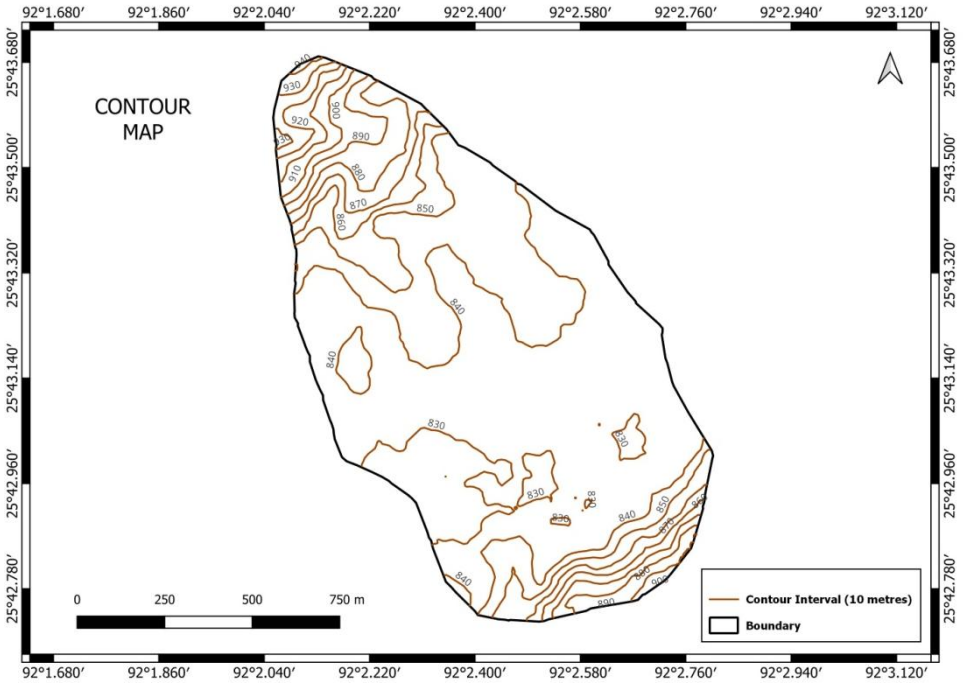


(Fig 1)

(Fig 1) Mawtneng is a medium size village located in Umsning block of Ribhoi district in the state of Meghalaya in India which is one of the eight states of North-Eastern Region of India. It is located between 92°3° N 92°6'36" N Longitudinal extent and 25°43'48" E to 25°45'36" E Latitudinal extent. Pin code of Mawtreng village is 793103. Umsning is the sub district head quarter and the distance from the village is 40 km. District head quarter of the village is Nongpoh which is 60 km away. It is located in the Universal Time Co-ordinates (UTC)/Greenwich Mean Time (GMT)+5:30 hoursand it follows the Indian Standard Time (IST)

CHAPTER-2

PHYSIOGRAPHY OF MAWTNENG VILLAGE



(Fig 2)

Contour line is a line on a map representing an imaginary line on the land surface, all points which are at the same elevation above a datum plane, usually mean sea level.

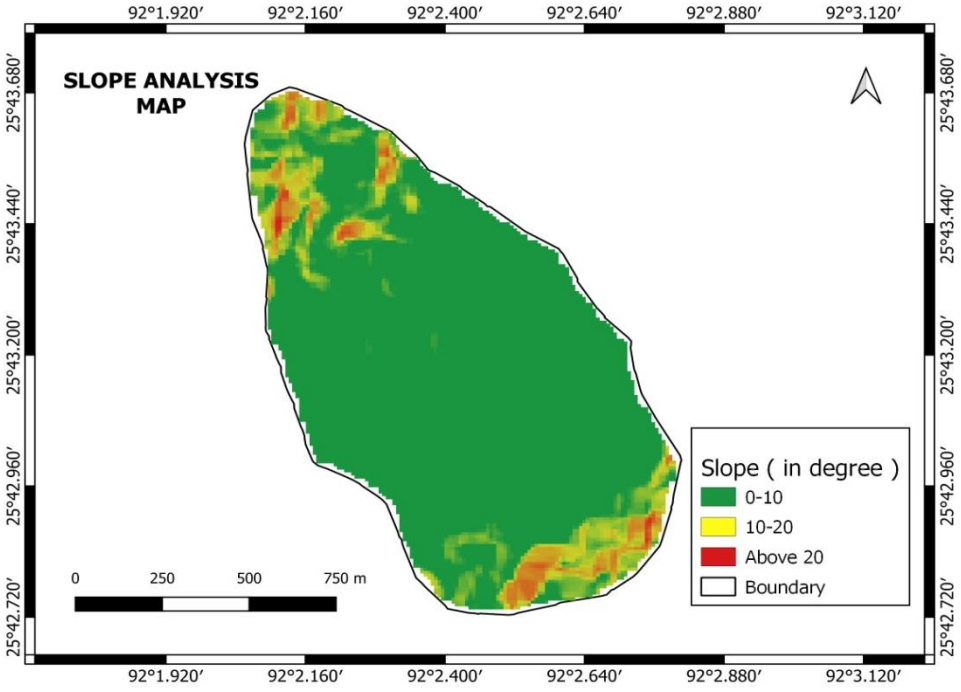
From the map given above (Fig 2), the contours show that the physiography in the Northern part of the village is a hilly area, where the highest elevation is at 940. The South-Eastern part also shows a hilly terrain, there is a deviation at the Central part of the region as it is characterized by having a flat topography declining elevation of 840. The South Western Part also shows undulating terrain.

Mawtneng Village is the 93rd most populous village, which is located in Umsning sub district's which is a sub district of Ribhoi district in the state Meghalaya in India.

The village is home to 551 people (According to the 2011 census), among them 267 (48%) are male and 284 (52%) are female. 1% of the whole population are from general caste, 0% are from schedule caste and 99% are schedule tribes. Child (aged under 6 years) population of Mawtneng village is 23%, among them 53% are boys and 47% are girls. There are 98 households in the village and an average 6 persons live in every family

Mawtneng has 39% (214) population engaged in either main or marginal works. 40% male and 37% female population are working population. 40% of total male populations are main (full time) workers. For women 37% of total female populations are main workers and agriculture is the main dominant economic activity of the people in Mawtneng Village.

A total of 341 people in the village are literate, among them 160 are male and 181 are female. Literacy rate (children under 6 are excluded) of Mawtneng is 80%, 80% of male and 80% of female population are literate here.



(Fig.3) **SLOPE ANALYSIS MAP**

Slope is a slanting line on the earth surface or any other flat surface which helps us to find out the position and direction of dip. The slope Analysis on contour is taken from the map of Assam Meghalaya from the toposheet no 83 C/1 and no 83 C/2.From the above map of Mawtneng Village, the slope analysis on contours is taken from the physiographic map of Mawtneng village where the contours are divided into 20 meter intervals and the lowest contour line is 880 located in the western part of the map where as the highest contour line is 1160 located in the north eastern part of the area.

From the above choropleth map Slope Analysis the study area has been divided into three categories and they are

1. Steep Slope Region: In the map it is shown that the area having high elevation i.e more than 37° are mainly found in the central part, north eastern part and western part of the region. This is mainly due to the geographical condition around the area which shows that the region is hilly and mountainous mainly in the north eastern part and it is scattered in the western part. It is represented by compact square lines.

2. Medium Slope Region: From the map it is shown that the medium slope region ranging between 25°-37" is mainly found in the central, north eastern, south eastern and scattered in the south western part of the area The slope found in this region is medium slope because it slowly dips from the steep slopes and emerges to the gentle slopes. It is represented by scattered square lines.

3. Gentle Slope Region: From the map it can be seen that the gentle slope region which is less than 25° is mainly found in the central part, the western part, certain parts of the south eastern part and it is scattered in the north eastern part of the region. This region has low elevation making it a plain area and these areas are mainly used for agricultural activity. It is represented by highly scattered square lines.

CLIMATE OF MAWTNENG VILLAGE

Distribution of Temperature

During the months of March and April, the atmosphere gradually warms up the advent of spring season. In the later part of April and early May, the temperature reaches the highest point. The maximum recorded at Tura and Shillong are 34 and 26 degree Celsius respectively.

The summer season (of the rainy season) starts as soon as south-west monsoon begin to blow over the region this is caused by local winds. It is termed “Pre-monsoon showers”. The rainy season begins at the last part of May and it last till the end of September or early October.

The autumn season begins in the early October and cool temperature atmosphere prevails up to the end of November.

The winter season or the cold season last from the month of December till the month of February, January, is the coldest month when the temperature in Shillong comes down to 1 or 2 degree Celsius.

The climate of the region differs from that of the Brahmaputra Valley Mainly due to its high relief, which in general makes the climate very salubrious. Brahmaputra plain is comparatively warmer in summer and cool in winter. However , the climate of the central part of the central and eastern Meghalaya (Khasi and Jaintia hills) is conductive, whereas western part of Meghalaya (Garo Hills) except for the winter (November and February) becomes oppressive as a result of high temperature and heavy rainfall, rendering the atmosphere exceedingly steamy although the temperature is slightly moderated by copious rainfall.

CLIMATE GRAPH OF MAWTNENG VILLAGE

TEMPERATURE, RAINFALL AND HUMIDITY TABLE 2018

Months	Rainfall (in cm)	Temperature (in °C)		Relative Humidity (in %)
		Maximum	Minimum	
January	34.3	19.7	7.3	68.70
February	4.7	20.3	6.8	67.55
March	69.7	26.1	11.8	53.90
April	58.4	29.7	15.7	56.75
May	296.2	28.5	17.2	75.10
June	345.3	27.9	19.6	81.70
July	285.8	28.0	20.4	81.80
August	426.1	27.8	20.2	81.90
September	401.5	28.1	18.9	80.10
October	228.5	26.5	15.9	77.90
November	36.2	24.2	10.1	67.00
December	19.3	22.1	9.1	71.4

Source : Metrological Department , ICAR, Barapani

Mawtneng village of Ri-Bhoi district enjoys a tropical and sub tropical climate. Summer is hot and humid whereas winters are very cool and dry. The altitude of the area plays a very important role in influencing and controlling the distribution of temperature throughput the year. The climate of the area is controlled by the Physiography, the alternating pressure of North West India , the Bay of Bengal as well as the maritime air masses coming from the south and south west.

In summer from March to June, the maximum temperature ranged from 26° to 29°C and the minimum temperature from 11° to 20°C .April is the hottest month in this area with a temperature of 29.7°C and it may drop down to 15.7°C in winter from November to February

,the maximum temperature ranges from 19 °C to 24°C and the minimum temperature ranges from 6°C to 10°C. February is the coldest moth in this area with a temperature of about 6.8°C and it may also rise to 20.3°C. Average annual rainfall is about 220cm. June, July and August are the wettest months of the year as it rains heavily in these months. Occasionally rainfall occurs during winter which is negligible and lasted for a short period.

In this area the relative humidity also varies from place to place and from months to months. The highest relative humidity was recorded from the month of June to August with 81.70% - 81.90% and was recorded in the month of March with only 53.90% respectively.

Based on the climatic conditions, Mawtneng village can be best described in terms of annual cycle of seasons. These seasons are:

Winter season:the winter season last from the month of December till the end of February. December is the coldest month of the year with the minimum temperature of 13°C. The northeast trade winds also bring down the temperature of the area drastically during the month of December and January.

Summer: Begins with the month of March where the temperature begins to rise and extends till the month of April. April is the hottest month where the temperature is highest and sometimes reaches 34°C.

Monsoon season: The season starts in the month of June and lasts till September .The temperature of this season reaches a maximum of 30°C. This season is also characterized by heavy rainfall in the region.

Autumn season: begins in early October and cool temperature atmosphere prevails the end of November. The temperature gradually comes down to 20°C to 25°C with little rainfall.

TEMPERATURE

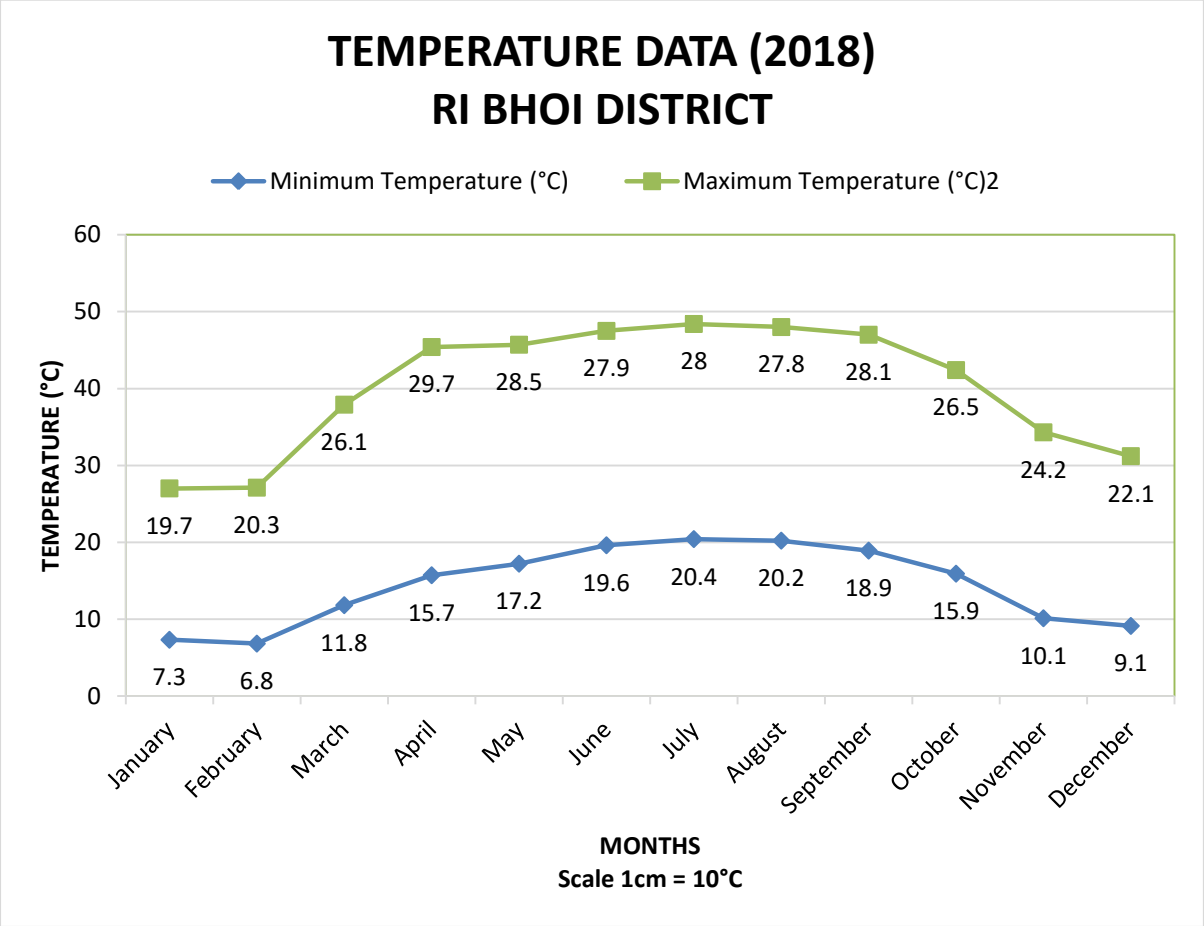
According to the Dictionary of Geography by Praveen Bhatia "Temperature refers to the degree of the heat of the body, mostly expressed in degrees on the centigrade (°C) scale or the Fahrenheit scale, and measured by the thermometer". On the earth, temperature decreases in general from the equator towards the poles, through the temperature of any place depends also upon other factors besides latitude on altitude, proximity to the sea, prevailing winds etc. Temperature also decreases with altitude

TEMPERATURE TABLE

Months	**Temperature (in °C)**	
	Maximum	**Minimum**
January	19.7	7.3
February	20.3	6.8
March	26.1	11.8
April	29.7	15.7
May	28.5	17.2
June	27.9	19.6
July	28.0	20.4
August	27.8	20.2
September	28.1	18.9
October	26.5	15.9
November	24.2	10.1
December	22.1	9.1

Source: Meteorological Department, ICAR, Barapani

TEMPERATURE DATA IN RI BHOI DISTRICT (2018)



INTERPRETATION: From the above temperature data graph taken in the year 2018 at Ri Bhoi District of Meghalaya, the vertical scale shows the temperature in centimeters and the horizontal scale shows the months in which the temperatures are recorded in °C. Both maximum temperatures as well as minimum temperatures are shown in the same graph.

In the first graph, we can see that the temperature has started to increase from 19.7°C in January to 26.1°C in March and reaching its maximum in the month of April i.e. 29.7°C. The temperature sees a decline from the month of September at 28.1°C and then declines again till the month of December with January having the lowest temperature at 19.7°C.

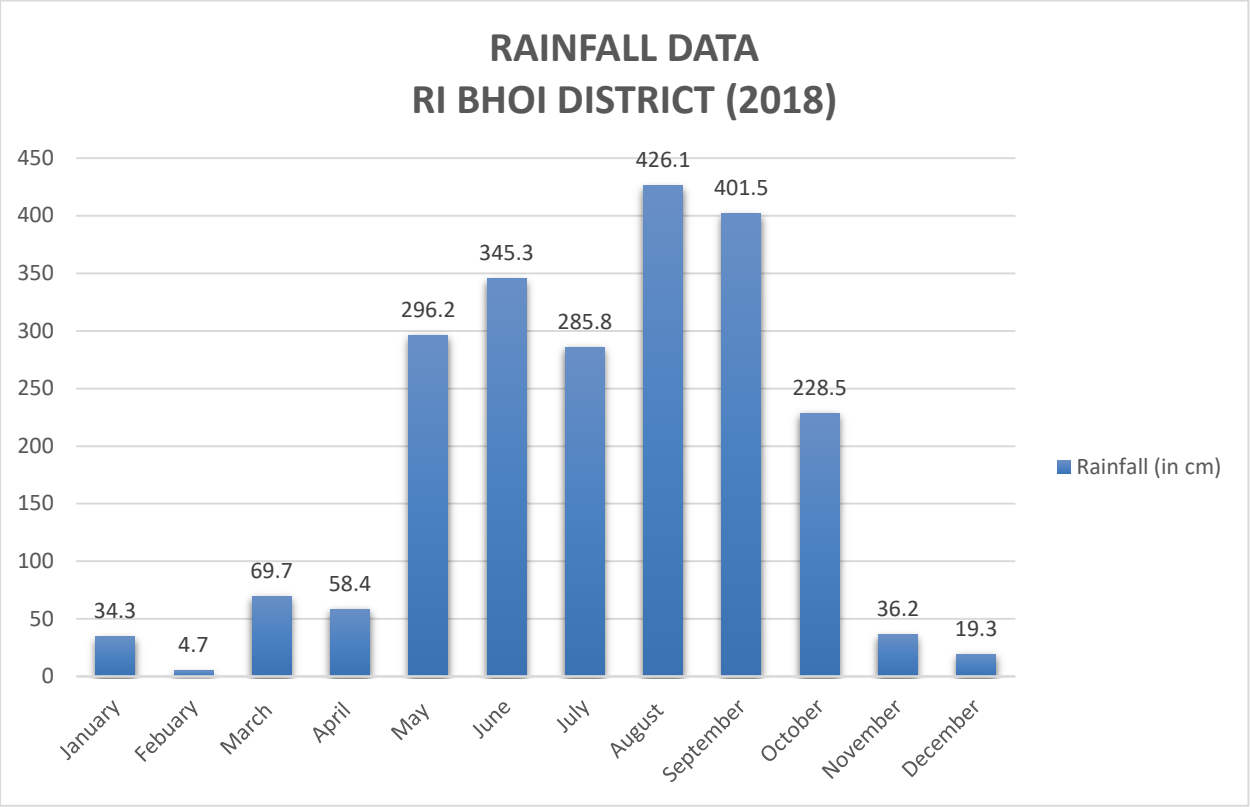
The lowest minimum recorded temperature was recorded in February at 6.8°C, after which saw a spike in the temperatures for the subsequent months. The peak minimum temperature was recorded in July at 20.4°C. The higher the altitude, the more reduction in the temperature as well.

RAINFALL: According to the dictionary of geography by Praveen Bhatia, "Rainfall means the total quantity of rain deposited on a given area during the given time, as measured by the rain gauges. Three types of rainfall are recognized, depending on the process by which the clouds were formed. They include orographic rainfall, cyclonic and conventional.

RAINFALL TABLE

Months	Rainfall (in cm)
January	34. 3
February	4.7
March	69. 7
April	58.4
May	296.2
June	345.3
July	285.8
August	426.1
September	401.5
October	228.5
November	36.2
December	19.3

Source: Meteorological Department, ICAR, Barapani



INTERPRETATION: Lying on the northern slope of Meghalaya plateau and on the rain shadow area , the study area also thus receives rainfall from the monsoon season. From the table received from ICAR Barapani, a graph has been plotted and it has been showed in (Fig. 4) the amount has been showed in the vertical scale in centimetres; where as in the horizontal scale is the month of the year. We clearly see that the rainfall is Mawtneng village is quite high despite it being located in the rain- shadow area where the highest rainfall is recorded in the month of August with 426.1 cm, where as the lowest rainfall is recorded is in February which is 4.1 cm only. Rainfall starts to pour down from the month of May which is around 296.2 cm, and it continues till the month of september and October where the rainfall is more than 200 cm. From the month of October, monsoon starts to change, where rainfall starts to decrease.

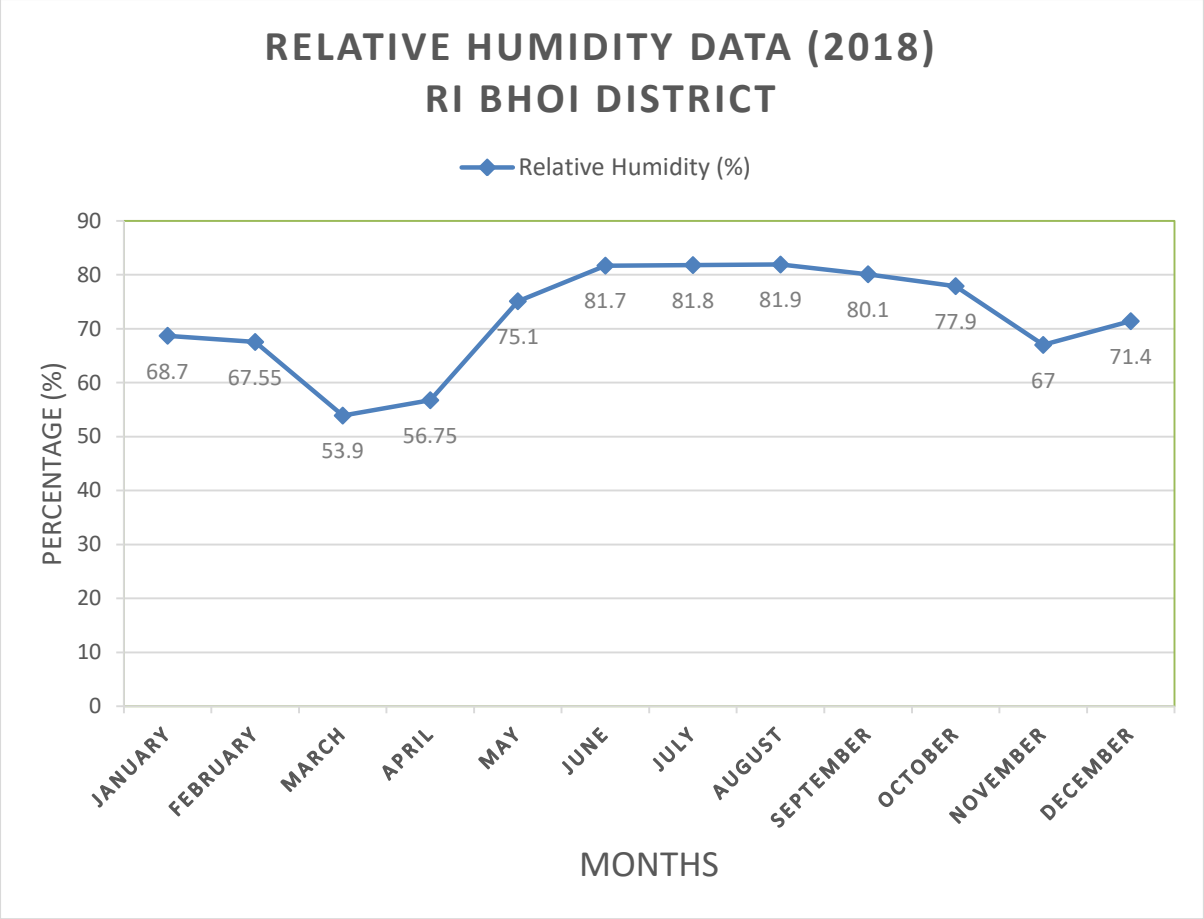
RELATIVE HUMIDITY IN RI BHOI DISTRICT (2018)

RELATIVE HUMIDITY: According to the Dictionary of Geography by Praveen Bhatia, "Relative Humidity is the ratio between the actual amount of water vapours in a given volume of the air and the amount that would be present if the air would be saturated at the same temperature generally expressed as percentage. It therefore affords a measure of the relative dampness of the atmosphere, and it is determined by means of a Hygrometer".

RELATIVE HUMIDITY DATA IN RI BHOI DISTRICT (2018)

MONTHS	RELATIVE HUMIDITY (In %)
January	68.70
February	67.55
March	53.90
April	56.75
May	75.10
June	81.70
July	81.80
August	81.90
September	80.10
October	77.90
November	67.00
December	71.40

Source: Meteorological Department; ICAR, Barapani.



INTERPRETATION: The relative humidity graph shown above shows the different percentages of relative humidity in Mawtneng village in Ri Bhoi district, Meghalaya.

The vertical scale shows the relative humidity in percentage and the horizontal scale shows the different months as recorded by the Indian Council of Agricultural Research (ICAR) in Barapani.

Here, the highest relative humidity was recorded in the month of August at 81.90%, mainly due to high precipitation whereas the lowest relative humidity was recorded in the month of March that is 53.90% mainly due to less precipitation. The relative humidity reaches almost 70% in January and February but takes a steep dive in the month of March at 53.9%. April saw a slight increase at 56.75% and shoots up in the month of May where the relative humidity hit 75.1% and continues to gradually rise. September saw the highest relative humidity where it reached 81.9% and gradually decreases again from October to December due to less precipitation/rainfall in these months.

SOIL OF MAWTNENG VILLAGE

The physiochemical characteristics of soil vary in space and time which is greatly affected by different factors such as topography, climate and physical weathering process, vegetation cover and several other factors. The plant species are also affected by the soil properties as well as soil fertility.

Conversion of forest to other forms of land can provoke soil erosion and lead to a reduction in soil organic content, lost soil nutrients and modification of soil structure. Reduction of the soil humus content and agricultural productivity is the effect of conversion of forest. The litter are persisting on the plantation floor through the years and shows low rate of decomposition.

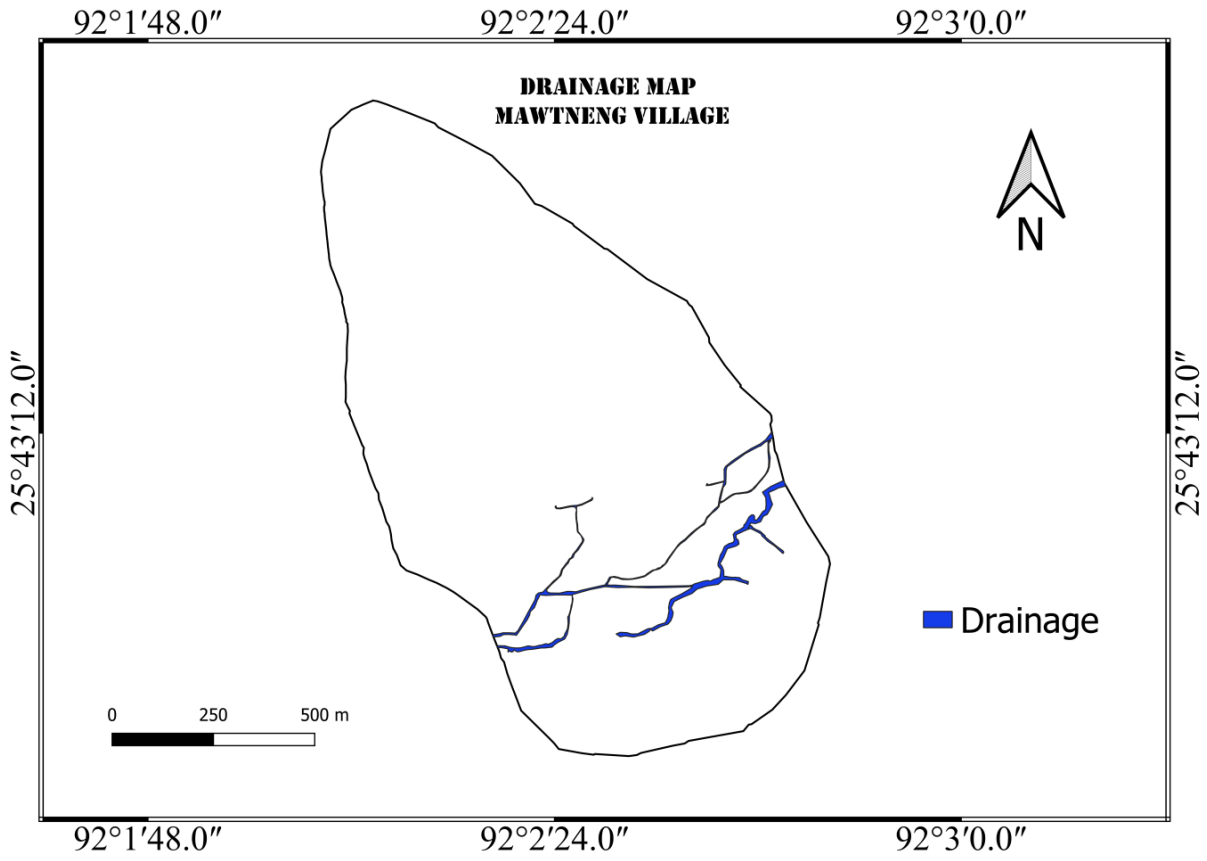
A number of physio-chemical occur on submergence of soil. Of these the more important are the increase in p.H. Value (indication of the acidity or alkalinity of soil and unit) is pH increase in specific conductance and decrease in oxidization reduction potential.

Therefore keeping in view the above consideration the present study was undertaken to understand the physical properties of soil under different land use pattern.

The present study area conducted in Mawtneng village which is in Ri Bhoi District of Meghalaya has mainly laterite soil which is found distributed throughout the Ri Bhoi area. The soil in this study area is formed mainly by leaching process. Much of the land in the study area is used mainly for agriculture purpose. They are mainly use for paddy cultivation which are mainly located along the streams. While the uplands are either forest land or put to some agricultural use such as broom cultivation or ginger cultivation . But much of the land is either fallow or built up areas.

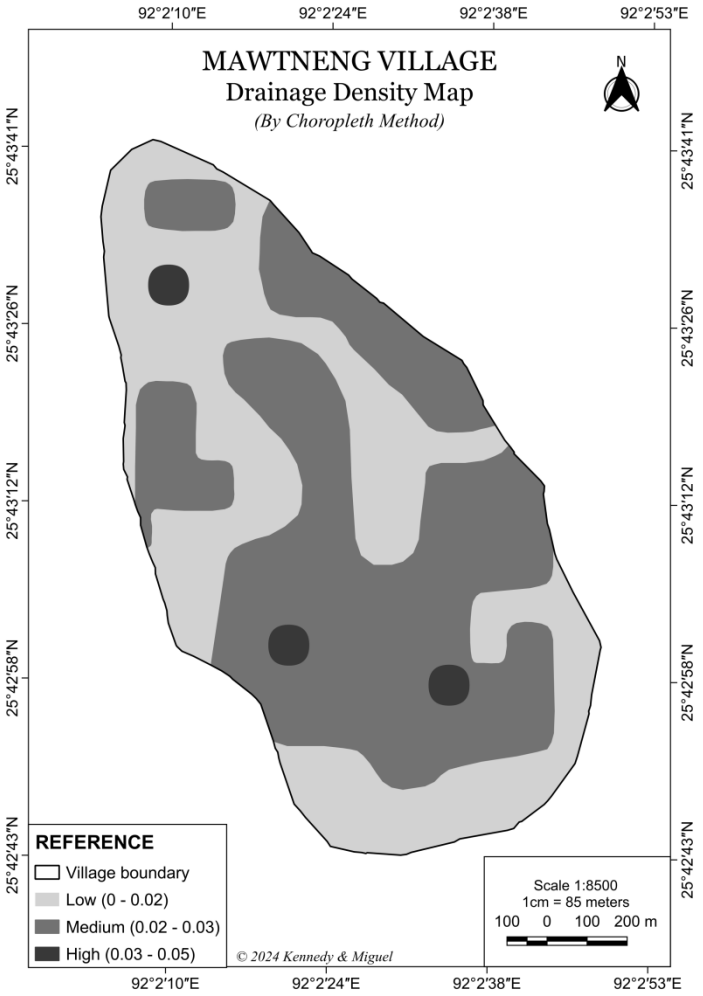
Thus this study area has a good potential for the cultivation of a variety of crops as the soil is fertile.

DRAINAGE OF MAWTNENG VILLAGE



(Fig.4)

Mawtneng has one main river to the South, Umtung River which is perennial in nature. It flows in East to West direction and joined by different tributaries from the North and North Western part of the area. Several ponds are found scattered in the Central and Eastern part of the area. The river has been the source of many agricultural activities that has been taking place in the region



(Fig.5)

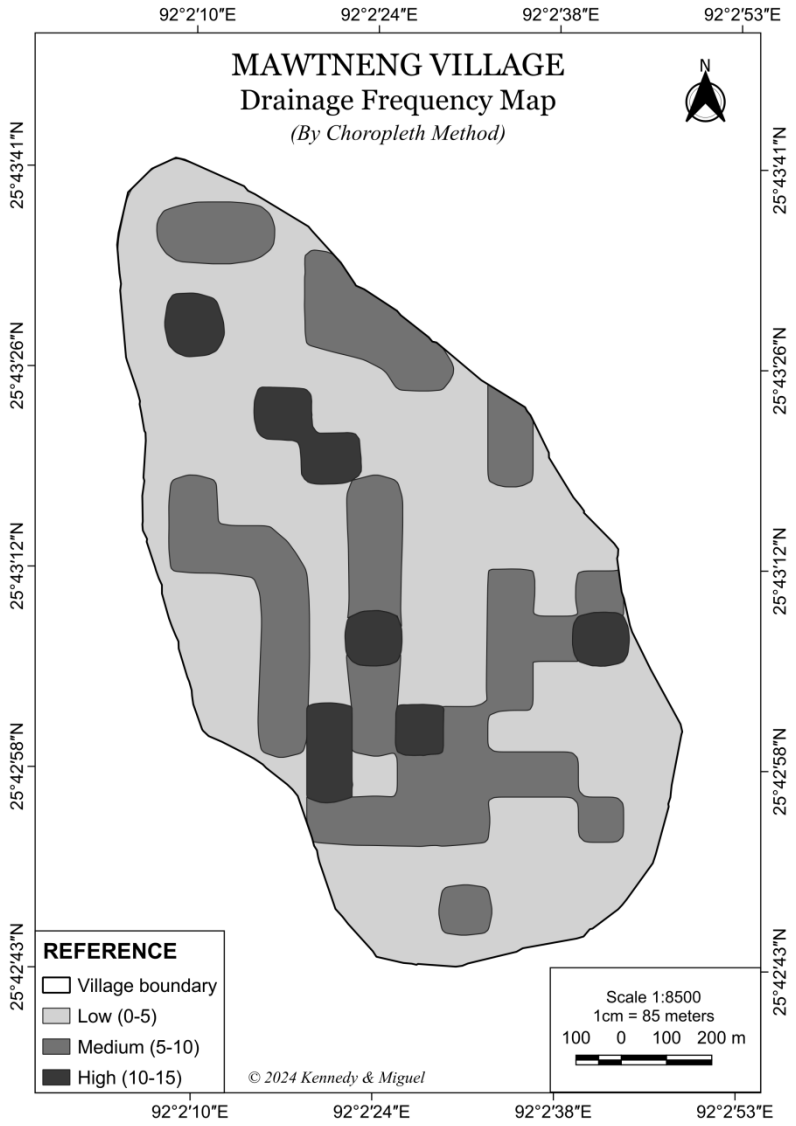
Drainage Density is the total number of rivers , streams and tributaries including a main stream divided by the total area. Drainage Density is calculated by dividing the total length of the rivers/streams in each grid divided by the total area of each grid. The total area is 72,80,159 sqm and the total length of the streams/rivers is 299.544 m and 1 grid is equal to 177740 sqm. The Total Drainage Density of the area is equal to 4.114m/sq m.

From the above choropleth map on drainage density the study area has been divided into three categories and they are represented by cartographic symbols namely compact,scattered and highly scattered square lines.

The areas having more than 0.006 m/sq m are considered as high density, areas ranging from 0.002-0.006 are considered as medium density and areas having less than 0.002 density are regarded as low.

The drainage density as observed from the choropleth map having high density is in the eastern and southwestern parts, scattered density is found in almost all parts of the study area which include the north, east, south and western parts of the area and the areas having highly scattered density include the north, the north eastern, south eastern, the south western and the north western part of the area.

The pattern of the rivers shows that it is an east to west flowing river which is perennial in nature and Um Tung being the main river/stream of the study area.



(Fig.6)

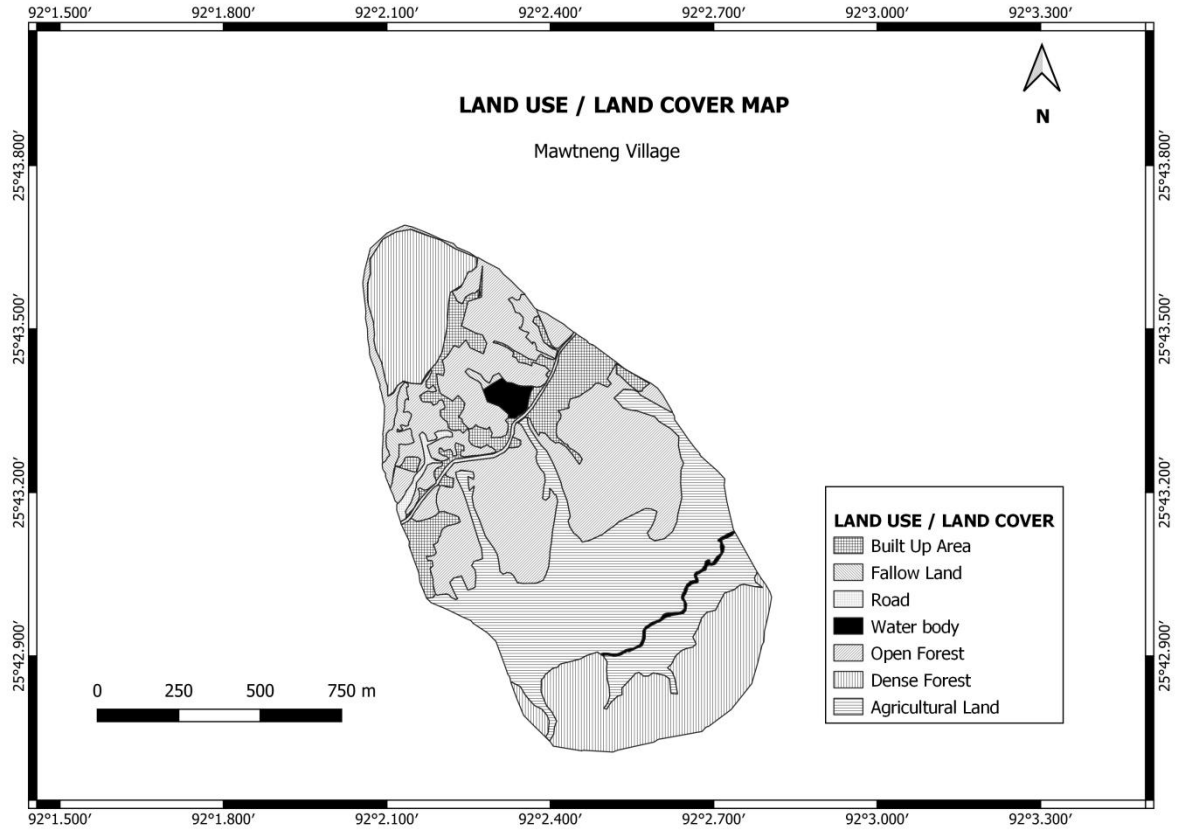
The Drainage Frequency is the total number of all rivers, streams and tributaries in each grid of a selected area or it is express as the ratio of the number of rivers/streams in a drainage basin to the area of the basin. The total area is 72,80,159 sq m and the total length of the streams/rivers is 299.544 m and 1 grid is equal to 177740 sq m.

From the above choropleth map on the drainage frequency of Mawtneng village, the area has been divided into three classes and has been represented by different cartographic symbols.

The areas having above 3frequencies are considered as high, areas ranging from 2-3 frequency are regarded as medium and areas having less than 2 are considered as low.

From the choropleth map we can interpret that the areas lying in the north eastern, central and south western parts have a high drainage frequency, areas having a medium frequency lie in the central part, east, south eastern and the western part of the area and the areas having low density are mainly found in the north, east, south and north western part of the study area. The pattern of the rivers shows that it is an east-to-west flowing river which is perennial in nature and Um Tung being the main river/stream of the study area. The grid having the highest number of frequency is 6 and the lowest is 0.

LAND USE/ LAND COVER



(Fig.)

FEATURES	AREA (in %)	AREA(in sq km)	LOCATION AND LAND USE
Dense Forest	9.62	0.122	South, South east and Western Part
Open Forest	44.30	0.563	North, West and North Eastern Part
Agricultural Land	32.85	0.417	Central, Western and Eastern Part
Fallow Land	1.98	0.025	Eastern and North Western Part
Water Bodies	1.43	0.018	Central, Western and Eastern Part
Built Up Area	9.18	0.117	North, West and Eastern part
Roads	0.64	0.008	Western, Central, Eastern
Total	**100**	**1.27**	

INTERPRETATION:

Land use or Land Cover is the physical material at the surface of the earth which includes grass, asphalt, trees, bare grounds, water, etc. from the above map based on the Land Use/ Land Cover of Mawtneng Village the study area has a total area of 1.27 sq km and the Land Use/ Land Cover and be classified into seven categories, these are: Dense Forest, Open Forest, Agricultural Area, Fallow Land, Built – Up Area, Water Body and Roads which can be further classified into two types Metalled and Un-Metalled Roads.

From the map it is found out that the major part of the Dense Forest is found in the North, South, South East and Western Part this is mainly due to the lack of settlements since Mawtneng village is less in population and majority of the villagers practices agricultural related activities and covers a total area of 0.122 sq.km which is 9.62 % of the total study area. Open Forest on the other hand is mainly located in the North, West and North Eastern Part which is found close to the Built-Up areas and covers a total area of 0.563 sq km which is 44.30 % of the total area. Agriculture area covers the highest area in the map about 32.85 % of the total area which is about 0.417 sq.km and is mainly located in the Central, Western and Eastern Part this is mainly because agriculture is the main economic activity of the people in the area.

Fallow Land constitute the smallest area of the region which is only about 0.025 sq.km which is only 1.98% of the total area and it is found scattered in the East and North Western Part of the region. Built-Up area is mainly found in the North, West and Eastern Part of the region which covers a total area of 0.117 sq km which is about 9.18% of the total area. The main Water Body flows through the central part of the map flowing from east to west which is then join by different tributaries from the north and north western part of the area. Several ponds are found scattered in the central and eastern part of the area. Roads are concentrated mainly on the Built-Up area starting from the western part, passing through the central part and goes off to the eastern part of the area which is then scattered into the different Built-Up area and agricultural area.

Thus, it can be seen that agriculture is the main domain of the Land Use / Land Cover of Mawtneng Village this is mainly due to the presence of the water body which includes rivers / streams and tributaries which is the main source of water in the region. The presence of the agricultural area may also be because of the fertility of the soil in the area and the physiography of the area shows that is mainly a plain area which is very suitable for agricultural activity. The presence of agricultural area has also led to the development of Built-Up or settlement areas which are located close to the agricultural areas. The Built-Up area consists of the settlements of the different people in the area and it can also be a market area of the region.

CHAPTER 3

MEANING OF THE TERM MEDICINAL PLANTS

A medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs. This description makes it possible to distinguish between medicinal plants whose therapeutic properties and constituents have been established scientifically, and plants that are regarded as medicinal but which have not yet been subjected to a thorough scientific study.

Meaning of Plants Diversity

Plants are a highly significant kingdom of organisms. Plants are invaluable because of its dominant role in ecosystem. Plant Biodiversity refers to the variety and variability of numerous plant species in their natural habitat. The diversity of plant exists for many reasons, a key factor being adaptive changes which allow different species to thrive in varied environment. Greater species diversity ensures natural sustainability for all life forms.

Medicinal plants are an important source of raw material for traditional medicine and other plant based medicines. At present, 80% of the population in the developing countries rely largely on plant-based drugs for their health care needs and World Health Organization (WHO) has estimated that in coming decades a similar percentage of world population may rely on plant-based medicines.

The formulation of these medicinal plants is used for primary health care like cuts, wounds, cough, pain, stomach probems or are used as raw material for manufacturing of medicines.

Mawtneng village is very rich in flora diversity, a significant part of which comprises of the medicinal plants. The great diversity and richness of flora is mainly due to the physical factors coupled with the nature of rainfall, temperature, altitude, and other geographical factors.

A few types of medicinal plants were found from the study area as per the survey conducted. These plants belong to numerous families. Majority of them were collected from the wild which is usually an unorganized manner of study.

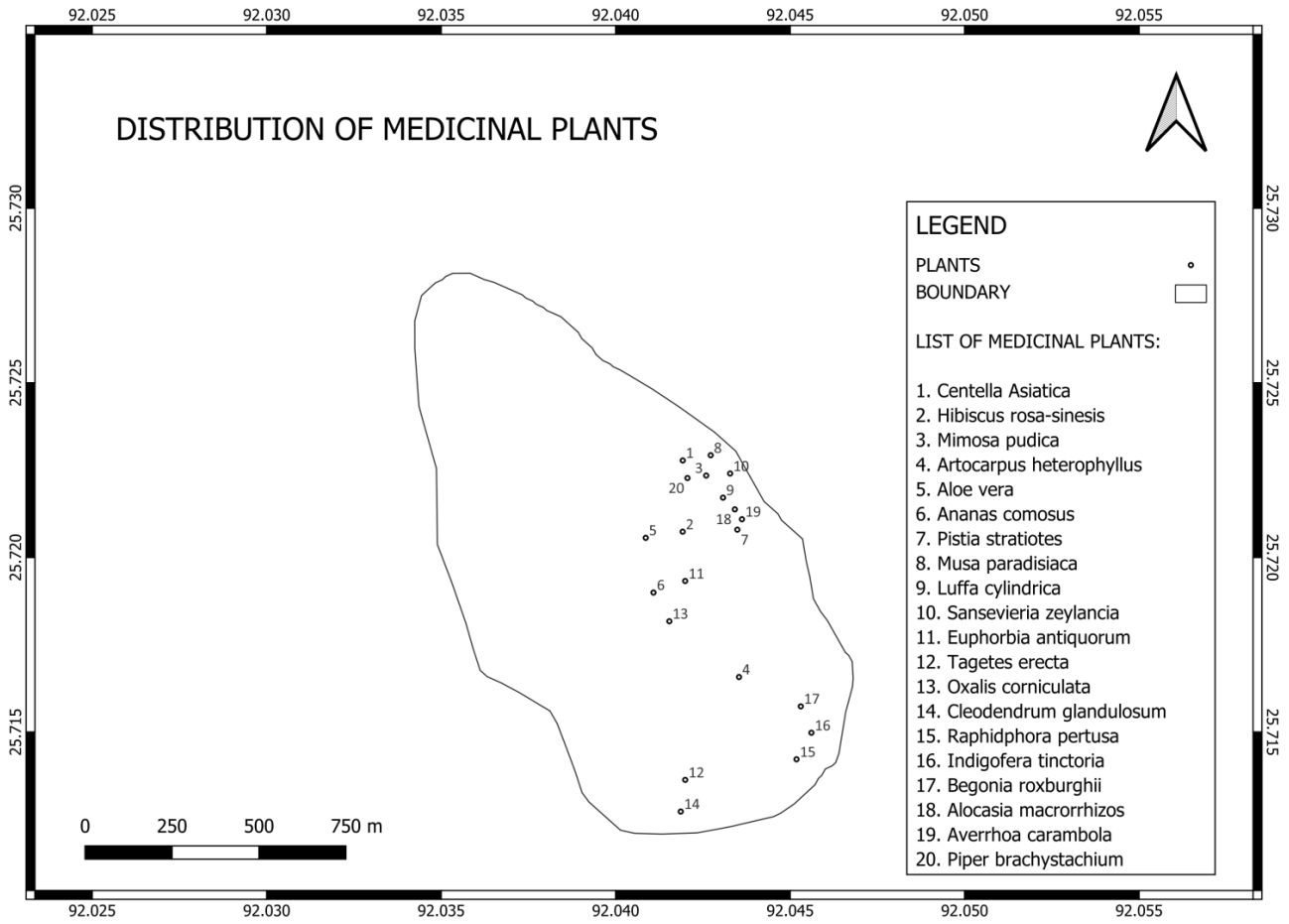
TYPES OF MEDICINAL PLANTS FOUND IN MAWTNENG VILLAGE

Mawtneng village, situated in Ri-Bhoi District of Meghalaya has an extensive biodiversity of the flora species. Many of such species possess medicinal properties. They are widely used in the village by the local people of the region or even in other areas as well. Their medicinal benefits have been extracted to treat patients since many years ago.

The following are some of the medicinal plants found in Mawtneng village. Each of which has their own medicinal benefits and uses :

1. ***Centella asiatica***
2. ***Hibiscus rosa-sinensis***
3. ***Mimosa pudica***
4. ***Artocarpus heterophyllus***
5. ***Aloe vera***
6. ***Ananas comosus***
7. ***Pistia stratiotes***
8. ***Musa paradisiaca***
9. ***Luffa cylindrica***
10. ***Sansevieria zeylancia***
11. ***Euphorbia Antiquorum***
12. ***Tagetes erecta***
13. ***Oxalis corniculata***
14. ***Clerodendrum glandulosum***
15. ***Raphidophora pertusa***
16. ***Indigofera tinctoria***
17. ***Begonia roxburghii***
18. ***Alocasia indica***
19. ***Averrhoa carambola***
20. ***Piper brachystachium***

DISTRIBUTION OF MEDICINAL PLANTS IN MAWTNENG VILLAGE



(Fig)

The above map shows distribution of the various medicinal plants that were found in Mawtneng village. Mawtneng village, situated in Ri-Bhoi District of Meghalaya has an extensive biodiversity of the flora species that possess medicinal properties. They are widely used in the village by the local people of the region or even in other areas as well. Their medicinal benefits have been extracted to treat patients since many years ago.

For Research purpose, 20 plants were taken for analysis, although there were a wide variety of such plants scattered in the region.

As observed from the map above, most of the plants that were analyzed and studied in this research paper was found along the Eastern part of the region, which were agricultural lands, open and dense forest areas, which had the maximum concentration of medicinal plants. Towards the South-Eastern and Southern part, few more medicinal plants were located and discovered, these were also agricultural lands and dense forested areas. The Central part of the village has its own concentration of some medicinal plants that are areas of dense forests.

1. *Centella asiatica*

- **Family:** Apiaceae
- **Common name:** Indian Pennywort
- **Local name:** Khling syiar
- **Description:** The Indian Pennywort is a common creeping herb, rooting at the nodes. It is an indigenous annual herb, belonging to the carrot family. The leaves are kidney-shaped, mildly toothed and palmately nerved arranged in opposite directions. The flowers are greenish to pinkish white found in clusters, each bearing three or four small flowers. Its seeds are pumpkin shaped. It is widely used and cultivated as a medicinal herb, eaten in many parts of North East India. It grows well in gardens and damp uncultivated areas.
- **Part used:** the whole plant
- **Medicinal use:**
  i. promotes urine flow
  ii. reduces inflammation
  iii. gentle laxative
  iv. blood purifier
  v. helps in nutrition process and excretion
  vi. soothes the nerves
  vii. used for relief from dysentery
  viii. used as a tonic improving memory
  ix. hairfall and growth
  x. cures abnormal swellings, fever.
- **Distribution:** Southeast Asia, China, North-East India. In Meghalaya, in Garo Hills: Balpakram, Jaintia: Ialong, Raliang, Jowai. Khasi Hills: Barapani, Nongpoh, Shillong.

2. *Hibiscus rosa-sinensis*

- **Family:** Malvaceae
- **Common name:** Hibiscus or China Rose
- **Local name:** Thadjain
- **Description:** Hibiscus is one of the most common garden shrubs used for hedges. It is very bushy, grows in any soil with little care. It has erect, green, cylindrical branched stems that grow upto 2.5-5m tall. Its leaves are simple, ovate, alternate, petiolate, reticulate venation with serated margins while its flowers are solitary, large, 'trumpet' shaped; five petals of colours varying from white, pink, red, peach or even purple; five green calyces, five locules, five sepals and varying number of stamens. They are half opened in the morning but as the weather warms up, it opens fully. The foliage of the shrub in deep green in colour or variegated.
- **Part used:** the whole plant
- **Medicinal use:**
    i. used for coughs and cold
    ii. gentle laxative and a softener of inflamed parts
    iii. soothes internal and external wounds
    iv. relieves inflammation
    v. lowers body heat

- **Distribution:** Tropical and sub tropical regions. In Meghalaya, in Khasi Hills: Nongpoh.

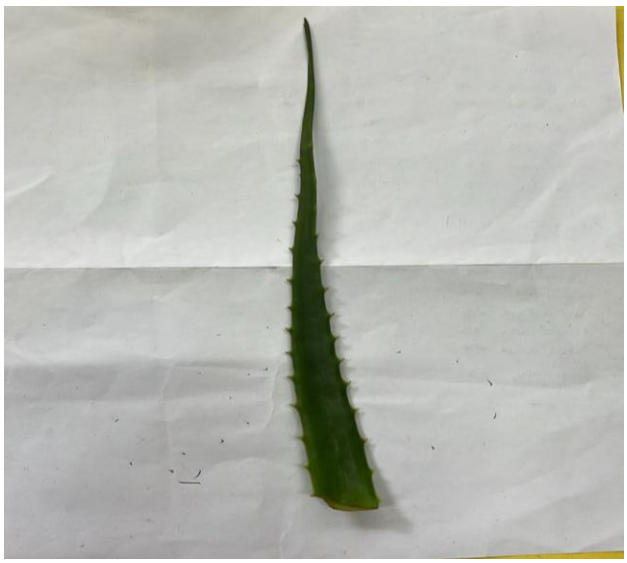
3. *Mimosa pudica*

- **Family:** Fabaceae
- **Common name:** Sensitive plant or touch me not
- **Local name:** Mynrain ka nia
- **Description:** This plant grows well in the low land tropics. It is a common diffused, spreading prickly creeping annual herb belonging to the Pea family. Leaves are bipinnate, small and pale green colour on a stalk, when touched; they fold together. They are sensitive to touch, hence its name. The leaflets also close when stimulated as warming, blowing and shaking. The stem is branched and slender with bristly hairs. The flowers are numerous, long-stalked, pink, solitary globose heads. Its seeds are pale brown in colour encapsulated in pod which are small and curved.
- **Part used:** the whole plant
- **Medicinal use:**
  - **i.** Used for liver disease
  - **ii.** Constipation relief
  - **iii.** Cures dysentery
  - **iv.** Cures kidney problem
  - **v.** Used for mouth and throat inflammation
  - vi. Used for cancerous ulcers, skin disease
  - **vii.** Aids scorpion stings
  - **viii.** Treatment of mumps
- **Distribution:** Native to tropical America and found in Asian countries. Grown all over South India. In Garo Hills: Balpakram, Khasi Hills: Nongpoh and throughout Meghalaya, Jaintia Hills: Syndai

4. *Artocarpus heterophyllus*

- **Family:** Moraceae
- **Common name:** Jackfruit
- **Local name:** Sohram
- **Description:** It is an evergreen tree around 30-70 feet tall bearing very large fruits sometimes weighing over 30 kilos. It grows well in the tropics. Short stout flowering twigs emerge from the trunk. Male flowers are tiny borne in oblong clusters of 2-4 inches in length; the female flower clusters are elliptic or rounded. Leaves are arranged in alternate manner and are glossy. Fruits are directly borne on the stems and trunks. The interior of the fruit consists of large 'bulbs' of yellow fleshy and a central pithy core. The unriped fruit is eaten as vegetable. The riped pulp covers the brown colour seeds.
- **Part used:** the whole plant
- **Medicinal use:**
  i. used for diarrhea
  ii. aids asthma
  iii. used for ulcers, wounds, insect bites, glandular swellings
  iv. used as laxative for toning the body
  v. used for acute abdominal pain
- **Distribution:** native to Bangladesh, India, Malaysia, distributed in Southeast Asian regions. In Meghalaya, in Garo Hills: Mahadeo, Khasi Hills: Nongpoh

5. *Aloe vera*



- **Family:** Liliaceae
- **Common name:** Aloe or Aloe Vera
- **Local name:** Aloe Vera
- **Description:** Aloe Vera, a perennial succulent belonging to the lily family, is a well known herbal medicine with multiple names, such as 'The First Aid Miracle Plant', 'The Burn Plant', etc. A succulent plant that grows in different sizes ranging from about 10 inches to 3 feet, cultivated for both ornamental and medicinal purposes. It is short stemmed and the leaves are in a rosette formation and have waxy coating, spiny-toothed on the edges and feel somewhat fleshy and juicy from the gel contained within. Colour ranges from light to dark green. Aloe Vera has healing properties, especially for burns and potted aloes are often kept in the house for use with minor household burns and scrapes. The drooping flowers are yellow in colour. When the plant is mature, from the middle, an erect stalk grows out which is a meter in height. The fruit is an oval capsule containing numerous seeds.
- **Part used:** The leaves and leaf pulp
- **Medicinal uses:**
  i. Burns, cures eczema, falling hair
  ii. Heals rashes wounds, fresh cuts
  iii. Used in Facial cosmetics
  iv. Psoriasis
  v. Blood purifier
  vi. Skin tonic
  vii. Promotes menstrual flow
  viii. Good laxative
  ix. Useful in eye diseases
  x. Checks tumour growth, enlargement of spleen, asthma, leprosy, jaundice
- **Distribution:** Assam, Meghalaya, Manipur

6. *Ananas cosmosus*

- **Family:** Bromeliaceae
- **Common name:** Pineapple
- **Local name:** Sohtrun
- **Description:** Pineapples have a distinctive appearance, characterized by their large, cylindrical shape with a crown of spiky green leaves at the top. The exterior skin of a pineapple is rough and covered in hexagonal-shaped patterns, resembling scales or eyes. The color of the skin can vary depending on the variety and ripeness, ranging from green to yellow or golden-orange. Pineapples come in various sizes, but they are generally large fruits, with most averaging between 5 to 10 inches. The outer skin of a pineapple is tough and fibrous, providing protection for the juicy flesh inside. Beneath the skin, the flesh is firm, succulent, and somewhat fibrous, with a texture similar to a blend of crispness and juiciness. Fruits, 10-30 cm long, pulp white to yellow, sweet, acidity variable. Seedless because of self-incompatibility. Fruit production in 12-36 months according to mean temperature. Propagated vegetatively by crowns, slips and suckers.
- **Part used:** Leaves, fruit
- **Medicinal uses:**
  i. Sinusitis
  ii. Antiamoebic
  iii. Vermifuge
  iv. Stomach disorders
  v. Ostcoarthritis
- **Distribution:** Meghalaya, Tripura, Assam, Arunachal Pradesh, Manipur. In Meghalaya, it is quite prevalent in Nongpoh and the whole of Khasi Hills.

7. *Pistia stratiotes*

- **Family:** Araceae
- **Common name:** Water lettuce
- **Local name:** Syntu um
- **Description:** Water lettuce, scientifically known as Pistia stratiotes, is a free-floating aquatic plant belonging to the Araceae family. It is native to tropical and subtropical regions around the world and is commonly found in freshwater habitats such as ponds, lakes, rivers, and marshes. It forms rosettes of light green leaves that are arranged in a circular fashion, giving the plant a compact and rounded look. The leaves are broad, oval-shaped, and have a slightly ruffled or crinkled texture along the edges. The upper surface of the leaves is often covered in fine hairs, while the underside is smooth.
- **Parts used:** Whole plant
- **Medicinal use:**
    i. Used to treat eczema
    ii. Treats swellings and urinary tract infections
    iii. Ulcers
    iv. Leaves treat stomach problems
    v. Also used to treat skin diseases, such as boils, piles and syphilitic sore
    vi. Leprosy
- **Distribution:** Meghalaya, Mizoram, Manipur, Assam, Tripura, Arunachal Pradesh

8. *Musa paradisciaca*

- **Family**: Musceae
- **Common name**: Banana
- **Local name**: Sohlyndung
- **Description**: A banana is a tropical fruit that belongs to the Musaceae family, and it's one of the most popular fruits worldwide. One of the most known and cultivated in Tropical and Semi Tropical countries. Typically, it has a curved cylindrical shape, though some varieties may be straighter. Its size can vary, but it's generally about 6 to 8 inches long. The banana's skin is thin and smooth, initially green, and as it ripens, it turns yellow. The skin is easily peeled, revealing the soft, creamy flesh inside.
- **Parts used:** Root, stem, leaves, flowers, fruit
- **Medicinal use:**
    i. Root used as tonic for congestion of liver and to prevent scurvy
    ii. Prescribed for veneral disease, blood disorder, diarrhoea
    iii. Stem is used to treat ulcer, cures asthma, nervous disorders, diarrhea, dysentery, jaundice, asthma, piles
    iv. Stops bleeding of wounds and cuts
    v. Leaves useful in remedy in severe inflammation of eye, used for headaches
    vi. Heals wounds, applied on blisters or inflamed surfaces
    vii. Flowers checks bleeding during menstruation, good for earaches
    viii. Used for diabetes
    ix. Fruit used in cure of diabetes, diarrhea, indigestion
    x. Acts as gentle laxative, used for anaemia, cures colon and rectum diseases
- **Distribution:** Mizoram, Manipur, Assam. In Meghalaya, in Garo Hills: Nokrek, Balpakram and the whole of Khasi Hills.

9. *Luffa cylindrica*

- **Family**: Cucurbitaceae
- **Common name**: Sponge gourd
- **Local name**: Sohparow
- **Description**: The *Luffa cylindrica*/sponge gourd is a tropical running herbaceous vine plant with rounded oval leaves and large yellow flowers. The fruits are smooth and elongated cylindrical that can grow up to 30cm in length. The young fruit is used as a cooked vegetable although some gardeners grow smooth luffa for the fibrous interior, young fruit is rich in phosphorous, iron and calcium. When mature the fruit's flesh dries out leaving behind fibrous network that resembles a sponge, hence its common name. The fibrous netting is an excellent sponge but there are also industrial applications as water filter.
- **Part used**: Seed, fruit, leaves.
- **Medicinal Use**:
    i. Used for its diuretic, laxative, and anti-inflammatory properties.
    ii. It is also believed to have antioxidant and anticancer potential.
    iii. It is used to treat various ailments such as constipation, skin disorders and arthritis.
    iv. Juice is used against internal hemorrhage
    v. Used to treat liver diseases, iron deficiency, anaemia
- **Distribution**: Sponge gourd is native to tropical Asia especially in North East India and South Asia and Africa but now it is cultivated in many warm regions worldwide, including parts of Asia, Africa, America and Australia.

10. *Sansevieria zeylancia*

- **Family**: Asparagaceae
- **Common name**: Bowstring hemp, snake plant, mother-inlaw's tongue.
- **Local Name**: Syntu wait
- **Description**: Bowstring hemp is a hardy perennial plant with stiff upright leaves that grow in rosettes pattern. The leaves are long, sword shape and typically with dark green and light green horizontal stripes. The plant is known for its air purification abilities and its ability to thrive in low light conditions.
- **Part used:** Roots of the plant
- **Medicinal Use**:
    i. The dried rhizomes and roots provide material for antiseptic ointments
    ii. The roots are used for purgative, tonic, expectorant and anti-fever remedies
    iii. Treatment of septic wounds
    iv. An aqueous extract of the plant possesses antifungal properties
    v. Leaves contain bioactive compounds believed to have anti-inflammatory, antimicrobial and analgesic properties.
    vi. Extracts from the plant are used to treat minor wounds, skin conditions and respiratory issues.
- **Distribution**: Bowstring hemp is native to West Africa but now is cultivated as an ornament plant in many parts of the world. It is commonly grown indoors as a houseplant due to its low-light tolerance and neglect.

11. *Euphorbia Antiquorum*

- **Family**: Euphorbiaceous
- **Common Name**: Triangular milkwort
- **Description**: Euphorbia antiquorum is a succulent plant with thick, fleshy stems and branches. It typically grows up to 2 meters tall and is characterized by its cylindrical stems, which have distinct rings or nodes along their length. The stems are usually green to graygreen in colour and may have small spines along the edges.
- **Part used**: Stems and leaves
- **Medicinal Use**:
    i. Traditionally have been used to treat ailments such as skin diseases, wounds, respiratory problems, and gastrointestinal disorders.
    ii. induce diuresis and relieve constipation,
    iii. disperse swelling and draw out toxin
    iv. kill parasites and relieve itching
    v. leaves purge heat and remove stagnation, activate blood and remove toxin.
- **Distribution**: Euphorbia antiquorum is native to India and other parts of South Asia. It is also cultivated as an ornamental plant in many other tropical and subtropical regions around the world. It is widely distributed in Khasi Hills in Meghalaya.

12. *Tagetes erecta*

- **Family:** Asteraceae.
- **Common Name**: Marigold.
- **Local name**: Tiew myngor
- **Description**: Marigolds are flowering plants with vibrant, daisy like slooms that come in shades of yellow, orange and red. They typically have a strong, distinctive scent. Marigolds can range in height from a few inches to several feet depending on the variety.
- **Part used**: Flowers
- **Medicinal Use**:
    i. Used in traditional medicine for their anti-inflammatory, anti-microbial, and wound healing properties.
    ii. Extracts from marigold flowers have been used to typically treat minor cuts, bruises and skin irritations.
    iii. It has also been traditionally formulated in tea for ages, as it has great digestive benefits.
    iv. It is also used for coughs, colds, mumps, fluid retention, and sore eyes
- **Distribution:** These plants are native to Central and South America but have been cultivated and naturalized in many ways around the world including the various states of India; Karnataka, West Bengal, Tamil Nadu, Andhra Pradesh and Maharashtra. Additionally, certain species of marigold are used in culinary applications, particularly in Mexican and South American cuisines.

13. *Oxalis corniculata*

- **Family:** Oxalidaceae
- **Common name:** Yellow wood sorrel
- **Local name:** Jajew Dkhiew
- **Description:** The Oxalis corniculata is a hairy, creeping perennial herb. Its stems are creeping and rooting at the base with ascending or suberect branches. The leaves of this plant are digitately 3 – folialate; leaflets subsessile, cuneate or acute at base, appressed hairy flower – yellow. Petals oblanceolate oblong, style hairy. Capsule oblong, narrowed to the apex, pubescent. The seeds are many, transversely ribbed. The fruits are oblong capsules, narrowed to the apex, 2.0 cm long and pubescent
- **Part used:** The Leaves
- **Medicinal use:**
  i. Anti-inflamatory
  ii. Anxiolytic
  iii. Anticonvulsant
  iv. Antifungal
  v. Antiulcer
  vi. Antinociceptive
  vii. Anticancer
  viii. Antidiabetic
  ix. Hapatoprotective
  x. Hypolipidemic
  xi. Abortidacient
  xii. Antimicrobial
  xiii. Wound healing properties
  xiv. Source of Vitamin C
  xv. It has eye diseases healing properties
- **Distribution:** Entire NEI upto an elevation of + 500m. In Meghalaya, in Garo Hills: Darugiri village. Jaintia Hills: Raliang, Jowai, Jarain, Khong Shnong and Jalong. In Khasi Hills: Nongpoh, Nongstoin, Mawlai, Shillong

14. *Clerodendrum glandulosum*

- **Family:** Verbenaceae
- **Common name:** East Indian glory bower
- **Local name:** Jaren
- **Description:** This is a perennial shrub or small tree of only 1.5-3m tall. Leaf stalks are 2-20cm long, carrying broadly ovate to elliptic-cordate leaves, which are 7-17 cm long, 6-21 cm wide. Leaf base is wedge shaped to heart shaped, margin entire to slightly wavy, tio long-pointed. Flowers are borne in 4-6 branched corymbose cymes, at the end of branches.
- **Part used:** The young and tender leaves
- **Medicinal use:**
  i. decoction of leaves is used for hypertension.
  ii. leaves and roots are used for skin diseases, cough and dysentery
  iii. used for rheumatic pains
  iv. used for abdominal pain, heart disease
  v. anti-inflammatory
- **Distribution**: Indo-Malaya confined to North-East India : Garo hills : Balpakram; Jaintia Hills : Garampani, Raliang, Jarain, Shangpung;
  Khasi Hills : Nongpoh. Also common in China and SE Asia at altitudes of 500-2000m.

15. *Rhaphidophora pertusa*

- **Family:** Araceae
- **Common name:** Mini monstera
- **Local name:** Tymphiahkhiew
- **Description:** A lofty semi epiphytic climbing shrub with stout clinging roots. Stems cylindrical, dark green, sub-fleshy, about 10 cm girth, shiny, smooth, hairless, rooting at nodal regions. Leaves alternate, arranged in two rows, broadly elliptic to oblong 18-45 X 12-26 cm base rounded and unequal, apex shortly cuspidate, unlobed or perforate or pinnately lobed with many parallel nerves; leaf stalks 15-40 cm long, swollen and with a sheath at base, deeply grooved on the upper surface. Flowers bisexual, minute, greenish-yellowish, numerous, compact in a special structure called 'spadix', which is cylindrical and about 8X2 cm. Spadix is partially covered by a hood like structure known as 'spathe'.Berries numerous, small, many seeded, red when riped.
- **Part used:** Juice
- **Medicinal use:**
  i. treatment of snake bites and scorpion stings
  ii. stems used for treating ulcers, colon pain
  iii. used in bronchiopathy and abdominal tumours
  iv. stem juice used to cure ascites, inflammation of spleen and liver
  v. heals fractures, swellings
  vi. aids cold, coughs, bronchitis
- **Distribution:** Arunachal Pradesh, Peninsula Thailand, Melanesia and West Pacific

16. *Indigofera tinctoria*

- **Family:** Fabaceae
- **Common name:** True Indigo
- **Local name:** Rymbai ksaw
- **Description:** Ancient dyeplant known for the clarity and fastness of the blue produced. Leaves contain indicant, which must be oxidized by fermentation to produce the dye. Fresh herbage (strongest when in flower) is steeped in water for 12-48 hours with frequent stirring. A blue sediment will form which is the dye. Needs long growing season
- **Part used:** Leaves
- **Medicinal use**
    i. Epilepsy
    ii. Nervous disorder
    iii. Asthma
    iv. Bronchitis
    v. Fever
    vi. Stomach pain
    vii. Liver diseases
    viii. Skin conditions
    ix. Wounds sores
    x. Hemorrhoids
    xi. Gonorrhea
- **Distribution:** Arunachal Pradesh, Nagaland

17. *Begonia roxburghii*

- **Family:** Bignoniaceae
- **Common name:** East Himalayan Begonia
- **Local name:** Jajew slawang
- **Description:** It is a small or average size herbaceous plant. Leaves 6-12nby 4-8 inches, ovate, acuminate, irregularly toothed, glabrous or minutely pubescent on the nerves, very obliquely cordate at base and unequal, strongly nerved; petiole 3-9 inches long. Flowers fragrant. Flowers are unisexuees, colour yellow, pink or red, the male and female flowers are on different plants. The male flowers have from 2 to 4 tepals, seldom upto 8, and a great number of cheesecloths. Cheesecloths form a globulous mass or a yellow coloumn in the center of the flower. The female flowers have 2 to 5 tepals, seldom upto 10 different plants.
- **Part used:** Leaves
- **Medicinal use:**
  i. to cure cough
  ii. aids dysentery
  iii. used to treat jaundice
  iv. used for digestive disorders
  v. used to treat skin infection
  vi. aids bee sting
- **Distribution:** Himalayas, Indo-china and North-East India. In Meghalaya, prominent in Garo Hills : Baghmara-Balpakram, Jaintia Hills : Garampani, Jarain, Rytiang, Sonapur, Sutnga, Syndai, Dawki , Khasi Hills : Nongpoh, Umsaw, , Mawshun, Pongtung.

18. *Alocasia indica*

- **Family:** Araceae
- **Common name:** Giant Taro
- **Local name:** Wang
- **Description:** This is a large, evergreen, mainly rhizomous, sometimes tuberous rooted perennial plant. The leaves are usually peltate, oblong, to ovate and arrow-shaped, and have cylindrical leaf stalks.
- **Part used:** Rhizome
- **Medicinal use:**
    i. used against herpes
    ii. cures scabies
    iii. treats piles
- **Distribution:** Prevalent in Assam and Nagaland

19. *Averhoa carambola*

- **Family:** Averhoaceae
- **Common name:** Starfruit
- **Local name:** Soh pyrchong
- **Description:** A slow growing beautiful evergreen tree with delicate small pinnate foliage, small tropical tree, no more than 25 feet tall, originally from Southeast Asia. The green leaflets are sensitive to light and fold inward at night. It has small, pink coloured flowers with a dark red heart. The carambola plant will flower and fruit four times yearly. This tropical fruit, fleshy five lobbed, ovate to elliptoid, is attractive yellow-orange and pleasantly aromatic. Carambola is eaten fresh or in fruit salads.
- **Part used:** Fruit
- **Medicinal use:**
  i. treats jaundice
  ii. astringent
  iii. cures cough, fever, diarrhea
  iv. used to treat inflammatory skin disorders and fungal slin infections
- **Distribution:** Assam, Meghalaya, Manipur, Tripura. In Garo Hills: Balpakram, Mahadeo and also prevalent in Khasi Hills

20. *Piper brachystachium*

- **Family:** Piperaceae
- **Common name:** Hill pepper
- **Local name:** La-tyrpad
- **Description:** A much branched climber, woody branches thickened at the node and rooting. Leaves elliptic-ovate or elliptic lanceolate, bluntly caudate-acuminate, glabrescent, 5 nerve at the base; the pair of supra nerves often much higher up, base rounded or acute. Fruiting small, about 0.1 inches in diameter.
- **Part used:** leaves, spikes
- **Medicinal use:**
  i. used to treat cough, bronchitis, asthma
  ii. aids digestion
  iii. Anti-inflammatory, antioxidant and anti-microbial
  iv. Menstrual support
- **Distribution:** Arunachal Pradesh, Nagaland.

SUGGESTIVE MEASURES

Medicinal plants have been used in healthcare since time immemorial, they play vital roles in disease prevention. Medicinal plants are globally valuable sources are disappearing at a high speed.The medicinal plants biodiversity is being depleted due to man-made and natural calamities. Moreover, the indigenous knowledge associated with the conservation and use of medicinal plants is also disappearing at alarming rate.

Threats to medicinal plants

Earth is losing one potential medicinal plants every two years at an extinction rate. The threats are degradation of habitat due to expanding human activity, overexploitation, the drug industry's, high dependence on wildlife population, habitat destruction, urbanization, forest decline, industrialization, changes in agricultural practices, excessive use of agrochemicals, natural and man-made calamities, genetic erosion etc. Unplanned development and overexploitation of medicinal plants from non- managed, natural resources has not only resulted in shortage of various herbs, but extinction of several species in nature. The ultimate goal of conservation biology is to maintain the evolutionary potential of species by maintaining the natural levels of diversity which is essential for species and population to respond to long and short term environmental changes in order to overcome stochastic factors failing which would result in extinction.

Need for conservation of medicinal plants

More than 95% of the medicinal plants are collected from the wild; a number of them have become endangered in their natural habitats. In India large number of medicinal plants are extracted from the wild to meet the increasing demand for raw material needed for domestic consumption and for export. The two main strategies are ex situ (protection of species outside their natural habitats) and in situ (in their natural surroundings) conservation. There is a need for coordinated conservation efforts based on these strategies.

1. In situ conservation means the conservation of a species in its natural habitat and the maintenance and recovery of viable population of species in their original place. Its retains the material in its original location, where it was found, and it conserves the natural process of evolution, which is not possible in case of ex-situ conservation. In situ conservation entails protecting endangered plants in their natural habitat; it provides for the rehabilitation and enhancement of number ecosystems which host the above mentioned species, in contexts where they interact with other organisms. Threat assessment, establishment of a network of medicinal plants forest reserves, involving local stakeholders, botanical, ecological, trade and ethno- medical surveys, assessment, intraspecific variability of prioritized species, designing species recovery programmes, establishment of a medicinal plants seed centre etc. Conclusively, no in situ conservation project can succeed without the complete cooperation and involvement of local people.

2. Ex situ conservation

Ex situ conservation is the technique of conservation of all levels of biological diversity outside their natural habitats through different technique like zoo, captive breeding, aquarium, botanical garden, and gene bank. It plays key role in communicating the issues, raising awareness, and gaining widespread public and political support for conservation actions and for breeding endangered species in captivity for re-introduction. Conservation of medicinal plants include a combination of methods, depending on facto such as geographic sites, biological characteristics of plants, available infrastructure, and network having an access to different geographical areas, human resources and number of accessions in a given collection.

Preserving medicinal plants at Mawtneng village requires a combination of conservation strategies, community involvement and sustainable management practices. Here are some measures that can also be implemented:

i. **Community Education and Awareness:** Raise awareness among community members about the importance of medicinal plants, their ecological significance and the need for conservation. Engage with local schools, community organizations and traditional healers to educate residents about sustainable harvesting practices, the value of biodiversity and the cultural heritage associated with medicinal plants.

ii. **Documentation of Traditional Knowledge:** Work closely with traditional healers, elders and knowledgeable community members to document traditional medicinal practices and indigenous knowledge about medicinal plants. Record information about plant species, their uses, preparation methods and ecological significance. This documentation can serve as a valuable resource for future generations and contribute to the preservation of traditional healing practices.

iii. **Identification and Mapping:** Conduct botanical surveys and ecological assessments to identify key medicinal plant species in the area and map their distribution across different habitats. Identify priority species for conservation based on their medicinal value, rarity, or ecological importance. Develop a comprehensive inventory of medicinal plants to guide conservation efforts and management decisions.

iv. **Habitat Protection and Restoration:** Identify and protect important habitats for medicinal plants, including forests, grasslands, wetlands and riparian zones. Establish community-managed conservation areas, nature reserves or sacred groves to safeguard critical plant habitats from deforestation habitat degradation and land conversion. Implement habitat restoration projects to enhance the quality and resilience of degraded ecosystems.

v. **Sustainable Harvesting Practices:** Promote sustainable harvesting practices for medicinal plants to ensure their long-term viability and prevent overexploitation. Establish guidelines for responsible harvesting,

including selective harvesting, seasonal restrictions and quotas for certain species. Encourage rotation of harvesting areas to allow for natural regeneration and recovery of plant populations.

vi. **Cultivation and Agro-forestry:** Support community-based cultivation of medicinal plants through agroforestry, home gardens or community nurseries. Identify suitable species for cultivation based on their medicinal value, market demand and ecological requirements. Provide training, technical assistance and access to resources for community members interested in cultivating medicinal plants as a sustainable livelihood option.

vii. **Regulatory Measures:** Advocate for the enforcement of existing laws and regulations related to the protection of medicinal plants, biodiversity conservation and sustainable natural resource management. Collaborate with local authorities, government agencies and conservation organizations to strengthen legal frameworks, establish protected areas and implement monitoring and enforcement mechanisms.

viii. **Community Participation and Empowerment:** Involve community members in decision-making processes related to the conservation and management of medicinal plants. Foster partnerships between local communities, government agencies, NGOs and research institutions to co-design and implement conservation initiatives that align with community needs, priorities and cultural values. Empower local stakeholders to take ownership of conservation efforts and participate in monitoring, research and advocacy activities.

By implementing these measures in collaboration with local communities, policymakers and other stakeholders, it is possible to preserve the rich biodiversity of medicinal plants at Mawtneng village while promoting sustainable development and improving the well-being of residents.

CONCLUSION

The project on the study of medicinal plants in Mawtneng village has revealed the rich knowledge of the local people regarding the use of these plants for treating various ailments. Their profound understanding of each plant demonstrates a deep-rooted tradition of herbal medicine.

However, deforestation, environmental degradation, and habitat loss are threatening the medicinal plants in the area, leading to a gradual loss of traditional knowledge. Besides the suggestive measures that has been listed previously, it is crucial to motivate the younger generation to learn about the medicinal uses of plants to prevent this knowledge from disappearing. Introducing simple, low-cost technologies can facilitate the sustainable utilization of medicinal plant biodiversity and preserve traditional knowledge. Local production centers could be established for this purpose.

The state government should consider listing important medicinal plant species and developing guidelines for their collection and use. Establishing more botanical and medicinal plants gardens could help protect endangered species and promote conservation efforts. Research is particularly needed to support rural communities, especially those reliant on medicinal plants for healthcare and those living in forest areas, by diversifying their livelihood opportunities through sustainable production and trade of medicinal plants

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"Diversity of Flora and Macroinvertebrates, its role in the terrestrial ecosystem: A case study of Mawtneng Village, Ri Bhoi District, Meghalaya"

A Project

submitted to the Department of Geography

for the award of the Degree of

Bachelor of Arts in Geography

By

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CERTIFICATE

This is to certify that **Mr L.Kennedy Vaiphei** is a VI Semester Geography Honours student; St. Edmunds College Shillong. She has undergone a project title **"Diversity of flora and macro invertebrates, its role in the terrestrial ecosystem: A case study of Mawtneng Village, Ri-Bhoi, Meghalaya"**, under the supervision of **Miss Wanrihun Diengdoh**. This Project is a bonafide work of the student and has not been published in any form whatsoever. Hence, this report may be placed for evaluation and consideration.

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Dated: The 11th May 2024

L. Kennedy Vaiphei
6th Semester Geography (H)

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1.1. INTRODUCTION

In the intricate tapestry of terrestrial ecosystems, the diversity of flora and macroinvertebrates from the vibrant threads that weave together the intricate fabric of life. From towering trees to tiny beetles, each organism plays a vital role in shaping and sustaining the delicate balance of nature.

Flora, encompassing a handful of plant species, forms the foundation of the terrestrial ecosystems. From the lush canopies of tropical rainforests to the sparse landscapes of deserts, plants not only provide habitats for countless organisms but also serve as the primary producers, harnessing energy from the sun through photosynthesis and converting it into organic matter. This process not only sustains their own growth but also provides essential nourishment for a multitude of herbivores and omnivores, thereby initiating the flow of energy through the ecosystem.

Complementing the verdant tapestry of plants are the often-overlooked macroinvertebrates, a diverse array of small organisms that inhabit terrestrial environments. From beetles and spiders to millipedes and earthworms, these invertebrates play indispensable roles in nutrient cycling, soil aeration, and decomposition. Through their voracious appetites and efficient recycling of organic matter, macroinvertebrates break down dead plant material and animal remains, returning essential nutrients to the soil and facilitating the growth of new vegetation. Furthermore, they serve as vital links in the food web, serving as prey for a variety of predators and contributing to the complex dynamics of terrestrial ecosystems.

Together, the intricate interplay between flora and macroinvertebrates shapes the structure and function of terrestrial ecosystems, and we will be looking at the statements and objectives of this case study on this subject-matter, the area where the study was conducted in, the physical characteristics of the area, the classifications of the species of the flora and macroinvertebrates found and furthermore.

Meghalaya's diversity in flora is abundant because the natural forests spread out across its geographical area. Forests of the State shelters more than 3500 flowering plants, 352 orchids, 40 bamboo species and about 800 medicinal plants resources. The state is part of the Indo Burma Biodiversity Hotspot of the world. There are about 40 endemic plant species and 75 threatened plant species found in Meghalaya *(Meghalaya Forest Department).* The purpose of this research is to address the biodiversity change in the area and along the way identify and document the species of flora and macroinvertebrates in the surrounding environment.

1.2. LITERATURE SURVEY

Parkash (2021) in his paper "*Floristic and ethnic perspective on wild forest plant species of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India*" elucidates the indigenous traditional knowledge of wild plants usage by *Khasi* people (ethnic group) of Nongkhyllem Reserve Forest, Nongpoh, Meghalaya, India. About 117 different wild forest plant species belonging to 63 families were collected and enumerated for their traditional usage. Most of the plant parts utilized were of herbs (44) followed by trees (32) and shrubs (28). The climbers (7) and scrubs (6) have been utilized least in traditional usage by *Khasi* people in Nongkhyllem Reserve Forest. It is interesting to mention that due to overexploitation, some plant species, i.e., *Abroma augusta* L., *Phlogacanthus thyrsiflorus* (Roxb.), *Puereria tuberosa* L., *Eryngium foetidum* L., Nees, *Smilax aspera* L. and *Houttuynia cordata* Thunb. were utilized in colossal quantity, and these plant species are nearing their threshold and hence, are under threat. Only two plants of *A. augusta* L. were found around forest edge areas of reserve forest, so there is a need of the hour to conserve this plant species in situ and ex-situ conditions. This study emphasizes research potentials and the need to document traditional knowledge about wild forest plant species utilization to benefit society and humankind through scientific intervention.

Mazebedi & Hesselberg (2020) carried out a research on the abundance, diversity and distribution of terrestrial macroinvertebrates of Gcwihaba cave, northwest Botswana. Inventories of cave species and in-depth understanding of cave ecosystems are essential for informing conservation approaches for the unique and vulnerable cave fauna. Gcwihaba cave is the largest cave in Botswana but its ecology is poorly understood. This study set out to provide the first quantitative survey of the cave's terrestrial macroinvertebrates. Macroinvertebrates were collected from sample sites at 10 m intervals into the cave from the cave entrance. At each site, macroinvertebrates on the cave floor were collected by quadrat sampling while macroinvertebrate from cave walls were collected by visual opportunistic searches. Moisture content, pH and electrical conductivity of the cave floor substrate were measured at each site to examine the influence of the floor properties on the distribution of macroinvertebrates on the cave floor. Twelve species in 10 families and 8 orders of terrestrial macroinvertebrates were collected. The occurrence of taxa varied across the sites, with most taxa occurring in the light and twilight sectors of the cave (within 30 m), whereas the dark sector (beyond 30 m) was dominated by cave cockroaches (Gyna sp.). The abundance of the cave cockroaches, darkling beetles (Tenebrionidae, Tenebrio sp.) and cave wasps (Sphecidae)

positively correlated with floor substrate of high moisture content and high electrical conductivity, which became increasingly common with distance into the cave. The abundance of other taxa from the cave floor positively correlated with a floor substrate of high pH and low moisture, which was common near the cave entrance.

Prasad (1963) in his book "*A Text Book of Invertebrate Zoology"* discuss the vast diversity of animal species, noting that there are over one million known species. Among these, approximately 5% are classified as vertebrates, possessing a backbone or vertebral column. The remaining 95% of animals lack a backbone and are known as invertebrates. Currently, there are about 30 invertebrate phyla, each characterized by a fundamental structural pattern that is shared among its members. This implies that while there are variations in external features, the basic anatomical blueprint within each phylum remains consistent. Invertebrate phyla are often categorized as lower and higher, based on their size and complexity of body organization. Lower invertebrates tend to be smaller and simpler in body structure, whereas higher invertebrates are typically larger and more complex.

Cai, Dong, Kattel, Zhang, Peng & Gong (2023) in their article "*Macroinvertebrate diversity and ecosystem functioning across the eutrophication gradients of the middle and lower reaches of Yangtze River lakes (China)*" underscores the pivotal roles played by invertebrates in ecosystems, such as soil aeration, pollination, organic matter processing, and serving as prey. Moreover, it highlights the role of macroinvertebrates in maintaining ecosystem functioning, such as nutrient cycling, biomass production, and leaf decomposition. Studies have shown that indices like species richness, Shannon diversity, and Simpson diversity of macroinvertebrates are positive indicators of organic matter breakdown and nutrient cycling in lakes and rivers. Additionally, functional diversity and phylogenetic diversity of macroinvertebrates play crucial roles in explaining ecosystem functioning variations, reflecting enhanced functional specialization in freshwater systems. However, despite extensive research on macroinvertebrate diversity, some aspects, like litter decomposition and nutrient cycling, remain limited in lakes and rivers. Furthermore, while biodiversity strongly influences ecosystem functioning in floodplain lake ecosystems, environmental factors can also directly and indirectly affect macroinvertebrate diversity.

Bokolial & Syiemlieh (2014) in their book "*Vernacular names of plants of Meghalaya*" gives a detailed record of the multifarious vernacular names of plants found in the state in Khasis, Pnars, and Achiks. The authors, by recognizing the danger of the loss of precious indigenous knowledge, are actively trying to salvage, for the benefit of humanity, as much of it as possible before it is forever entombed with the cultures that gave it birth. The authors also

emphasises the importance of vernacular names, especially helpful for conservation biologists to communicate and deliver the conservation message to the local people. The book contains some 1455 plant species comprising of around 3500 vernacular names.

Joseph (1981) wrote a detailed book on the flora of Nongpoh and its vicinity. He says that the knowledge of the flora of the northern slope of Khasi and Jaintia Hills facing the valley of Brahmaputra is nil or very meagre as compared to the southern, facing the Bay of Bengal. So, he felt the need to explore and study the floral diversity of the northern slopes which he says is almost terra incognita botanically. About 1036 taxa belonging to 639 genera of 159 families had been gathered from an area of only about 200 sq. km. which indicate the richness of the species in the study area. This book is a great achievement in the field of floral study and identification, encompassing a huge number of floral species found in Nongpoh.

1.3. STATEMENT TO THE PROBLEM

The limitations and problems on this study is that no previous literature on the documentation of plants and macroinvertebrates of Mawtneng village is available making it very limited in terms of reference and research according to the available knowledge. Since there are no documentations on this topic, this paper aims to address this issue by sampling and documenting the plants and macroinvertebrates species of the area, classify them into their subordinate kinds. With the purpose of collecting samples, we can study the biodiversity of the area on a micro level and then later on connect and compare to the regional distribution of the diversity of flora and macroinvertebrates, therefore contributing information to the distribution of flora and fauna. This study can be important for current academics as it can be used for biodiversity studies, ecosystem functioning, ecosystem services, climate change research and conservation biology.

1.4. STUDY AREA

Mawtneng Village is located in Bhoirymbong Community & Rural Development Block of Ri-Bhoi District, Meghalaya, north of the city of Shillong and 56km away from district headquarters, Nongpoh *(Fig.1)* It lies between 92°3’ N to 92°6’36” N longitude and 25°43’48” E to 25°45’36” E latitude. The village has an average height of 879 m (AMSL). Mawtneng is the selected area for this case study and particularly the research was carried out in the village of Mawtneng along the agricultural and forested areas of the village. It is bounded by a thick forest in the north-northwest, agriculture fields in the south-southeast-east, and a neighbouring village in the west. According to our social survey, the village has 210 households with a population of 1300. A total of three schools supports the education of the village. According to

the 2011 census, the literacy rate of the village was 76.91%. Public facilities are also available, and the village mainly runs on an agricultural economy, which is mainly farming of rice and ginger. The total area of the study area is 1.36km². The village pin code is 793103.

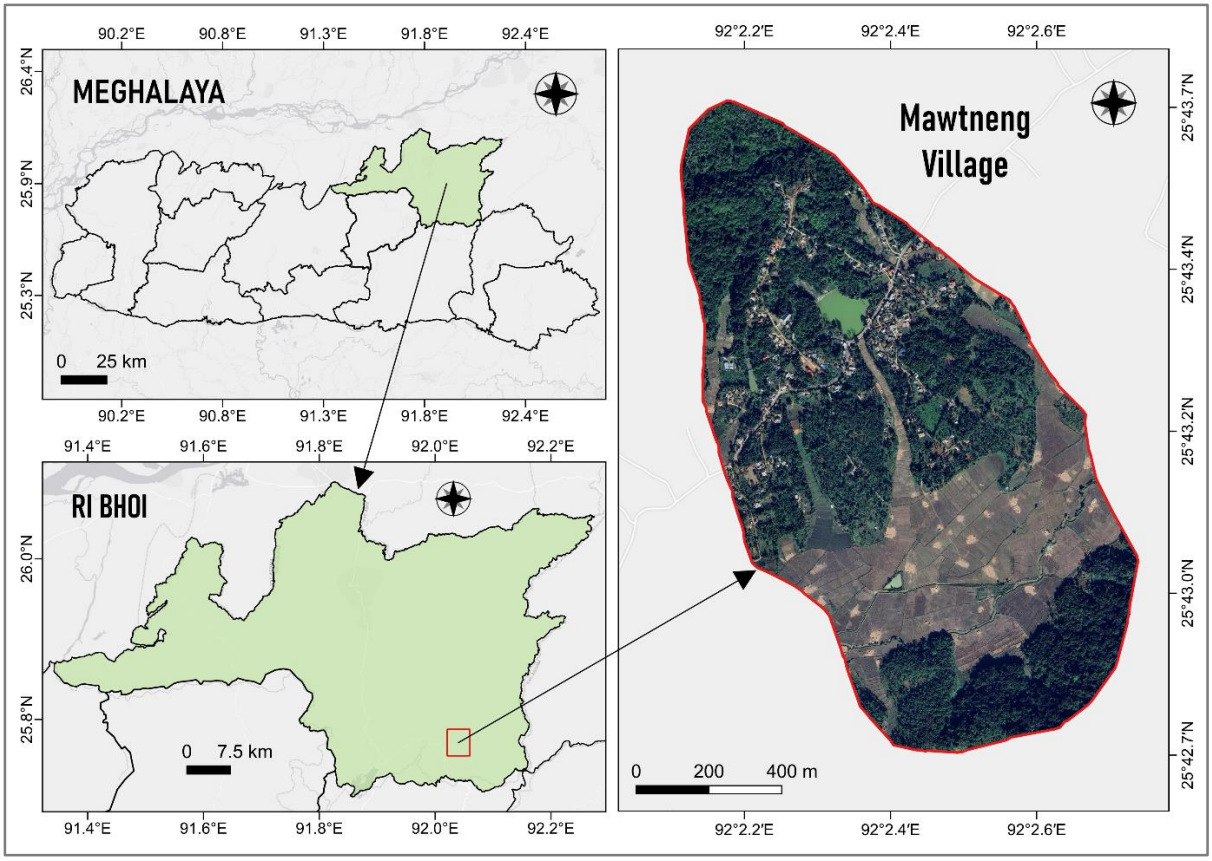


Fig.1. Location Map of Mawtneng Village

1.5. MATERIALS AND METHODS

On February 17 2024, a one-day field study was carried out to identify the local macroinvertebrates and terrestrial plant species at Mawtneng Village, Ri Bhoi District, Meghalaya. The field research was performed in favourable weather without rain or wind. To give rich context and detail as well as to enlarge patterns and trends, a combination of quantitative and qualitative data was gathered during this fieldwork. In this field study, primary data was prioritized more than secondary data since it guarantees that the material is relevant to the study goals and offers new insights that secondary data cannot. We were assisted by the village guide, who showed us where to look for the species. Garmin etrex 30 handheld GPS was used to mark the location of the sampling sites, and the elevation (*Table 1*). Mobile cameras were also used to photograph the species observed. The iNaturalist and PlantNet Apps were used to help document and identify the species, and fresh specimens were carefully collected.

Apart from these two applications, the common names, scientific names, habitat, habit, description, distribution, and conservation status of the identified species were verified and proofread using the resources from Global Biodiversity Information Facility (GBIF), the Royal Botanical Gardens (Kew Gardens), International Union for Conservation of Nature (IUCN), etc.

The primary data documented includes 21 macroinvertebrates and 29 floral species. The team concentrated on the forest regions where the majority of the species were found, covering a significant portion of the terrain. Following the species' documentation, secondary data were gathered from the college library, the Botanical Survey of India, the NEC Library's collection of books and other web sources. It is evident from the work that a mixed method is used to obtain robust data from the research, mixed methods are less common than standalone analyses, largely because they require a great deal of effort to pull off successfully, mixed method of collected data encompasses careful consideration and integration of both types of data into robust and strong conclusions.

1.6. AIMS AND OBJECTIVES

- To understand the biodiversity of the terrestrial ecosystem in the study area.
- To identify and understand the distribution of the flora and macroinvertebrates in the study area.
- To understand the role played by the flora and macro invertebrates in the area.
- To monitor the health of ecosystem of the study area.
- To identify the various factors that can affect the terrestrial ecosystem.

1.7. RESEARCH QUESTIONS

- What are the different types of flora and macro invertebrates found in the study area?
- What is the level of distribution of both flora and macro invertebrate in the study area?
- What is the role of flora and macro-invertebrates on the terrestrial ecosystem in the study area?
- What are the various bio-indicators to monitor the health of the ecosystem of the study area?
- What are the threats to the terrestrial ecosystem of the study area and the measures on how to protect and preserve it?

Sampling Site No.	Latitude (DMS)	Longitude (DMS)	Elevation (in meters)
L1	25°43’01.5”	92°02’29.2”	870
L2	25°43’01.4”	92°02’29.4”	870
L3	25°42’59.0”	92°02’33.8”	872
L4	25°42’58.2”	92°02’38.5”	873
L5	25°42’57.6”	92°02’38.3”	873
L6	25°42’57.5”	92°02’38.5”	873
L7	25°42’56.2”	92°02’39.5”	873
L8	25°42’55.4”	92°02’39.9”	876
L9	25°42’55.7”	92°02’39.5”	875
L10	25°42’55.6”	92°02’39.7”	876
L11	25°42’55.1”	92°02’40.3”	878
L12	25°42’54.6”	92°02’40.2”	878
L13	25°42’54.6”	92°02’40.2”	878
L14	25°42’54.4”	92°02’39.8”	879
L15	25°42’54.3”	92°02’39.8”	879
L16	25°42’53.0”	92°02’38.8”	879
L17	25°42’53.2”	92°02’37.8”	877
L18	25°42’52.8”	92°02’37.6”	878
L19	25°42’51.2”	92°02’37.3”	879
L20	25°42’51.2”	92°02’37.3”	879
L21	25°42’51.0”	92°02’35.0”	882
L22	25°42’51.5”	92°02’35.9”	880
L23	25°42’50.9”	92°02’35.7”	881
L24	25°42’51.0”	92°02’35.5”	882
L25	25°42’51.2”	92°02’33.0”	877
L26	25°42’51.0”	92°02’32.3”	876
L27	25°42’50.6”	92°02’32.2”	876
L28	25°42’50.7”	92°02’30.5”	877
L29	25°42’50.9”	92°02’30.7”	879
L30	25°42’58.3”	92°02’37.2”	875
L31	25°42’54.5”	92°02’37.5”	874
L32	25°42’58.6”	92°02’36.2	874
L33	25°43’09.2”	92°02’27.1”	880
L34	25°43’08.9”	92°02’27.3”	880
L35	25°43’09.4”	92°02’27.3”	879
L36	25°43’09.3”	92°02’27.3”	879
L37	25°43’10.5”	92°02’26.8”	881
L38	25°43’10.7”	92°02’26.7”	881
L39	25°43’11.1”	92°02’26.7”	881
L40	25°43’11.3”	92°02’26.6”	882
L41	25°43’16.3”	92°02’25.9”	885
L42	25°43’20.7”	92°02’22.1”	886
L43	25°43’21.2”	92°02’16.4”	889
L44	25°43’22.8”	92°02’16.1”	897
L45	25°43’21.5”	92°02’18.6”	890
L46	25°43’21.5”	92°02’18.8”	889
L47	25°43’20.7”	92°02’20.6”	888

L48	25°43’20.9”	92°02’21.0”	879
L49	25°43’20.5”	92°02’16.1”	891
L50	25°43’20.9”	92°02’15.8”	887

Table 1. Species sampling sites with coordinates and elevation

2.1. PHYSIOGRAPHY

Physiography of an area can be defined as the geological structures, processes and the different stages of its development.

Meghalaya is the result of upliftment of submerged sediment of marine transgression. Thus, the landforms of this plateau consist of several types of depositional, erosional, senile and juvenile features. Ri Bhoi being one of the components of the Meghalaya plateau has its physiographical features almost similar to that of the Khasi Hills and so does our study area, Mawtneng.

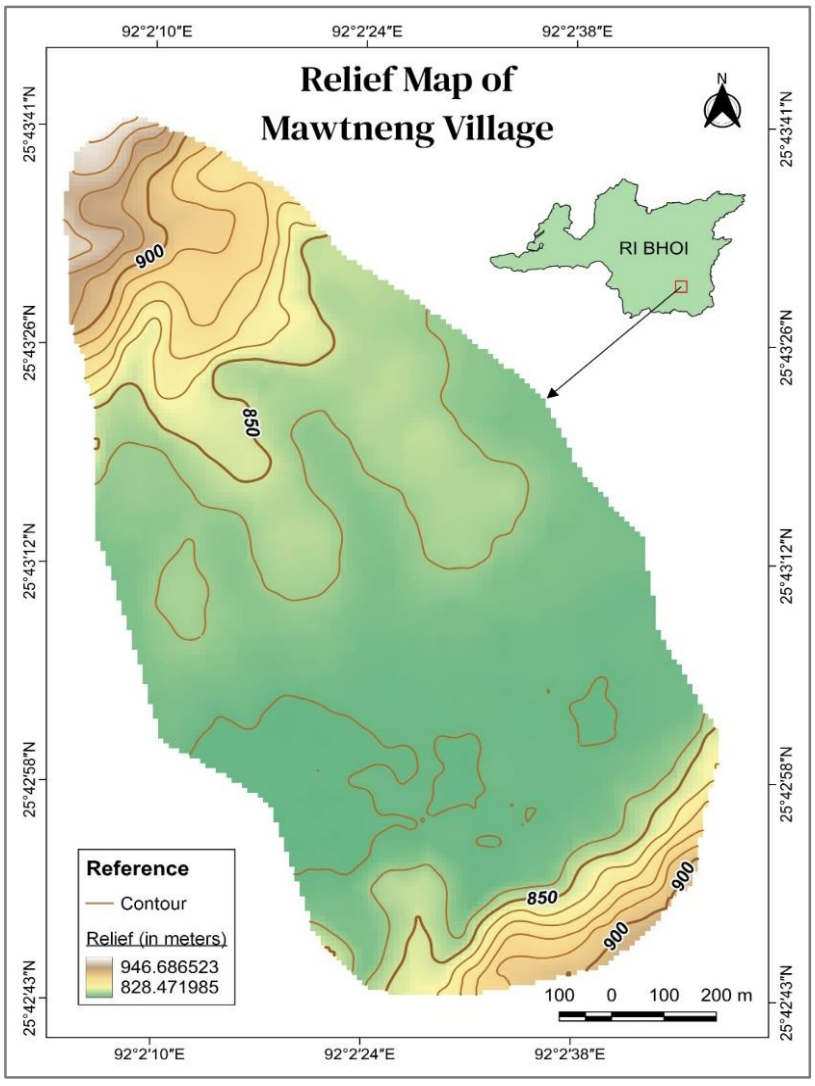


Fig.2. Relief Map of Mawtneng Village

The map *(Fig.2)* shows the relief features of the Mawtneng. We can see that the highest elevated area is in north and southeastern region as compared to the central region. The highest elevation is 946 m and lowest in 828 m. The low elevation is due to the fact that is it a plain area where agriculture is practiced while the areas in the higher elevated areas are built up areas and forested areas.

2.1.1. SLOPE ANALYSIS

The term 'slope' denotes some small portion of the land surface which is inclined from the horizontal one. It may be scientifically explained as the ratio between the vertical rise and the equivalent horizontal distance on the surface of the earth.

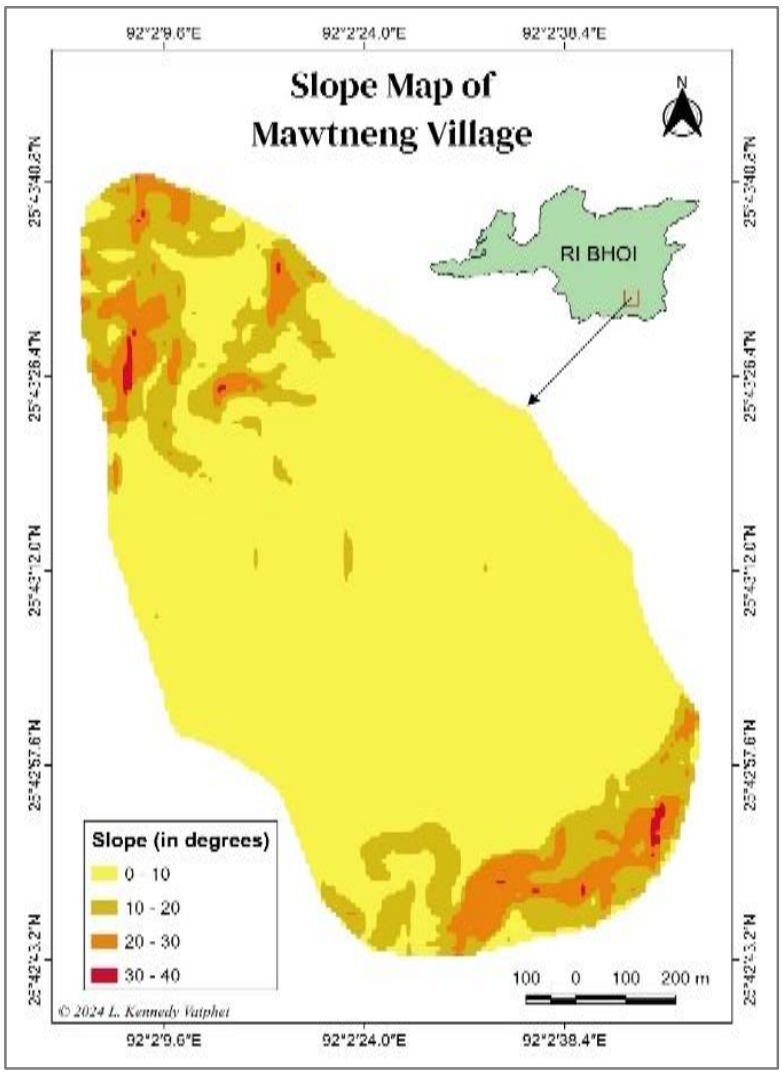


Fig.3. Slope Map of Mawtneng village

In our study area, we have classified the distribution of slope (in degrees) into 4 classifications, with a 10° interval. As we can see from the map (*Fig.3*), the area is largely

highlighted by the first category i.e. from 0°-10°. Because the area under the yellow shading is a plain and from the contours (*Fig.2*), the wide gap lines shows a gentle slope. The other types of slopes are prominent in the north, north-west and especially in the south-eastern area. The southern area has contour lines close to each other hence indicating a steep slope as well as in the north west. On the other hand, the northern area has a concave slope.

Hence, in general we can conclude that the area is dominated by low elevation ranging from 0° to 20°. The elevation mostly increases towards the northwestern and southeastern region and gradually decreases towards the central part.

2.1.2. SLOPE ASPECT

Aspect is the orientation of slope, measured clockwise in degrees from 0 to 360, where 0 is north-facing, 90 is east-facing, 180 is south-facing, and 270 is west-facing. Aspect values indicate the directions of the physical slopes**.**

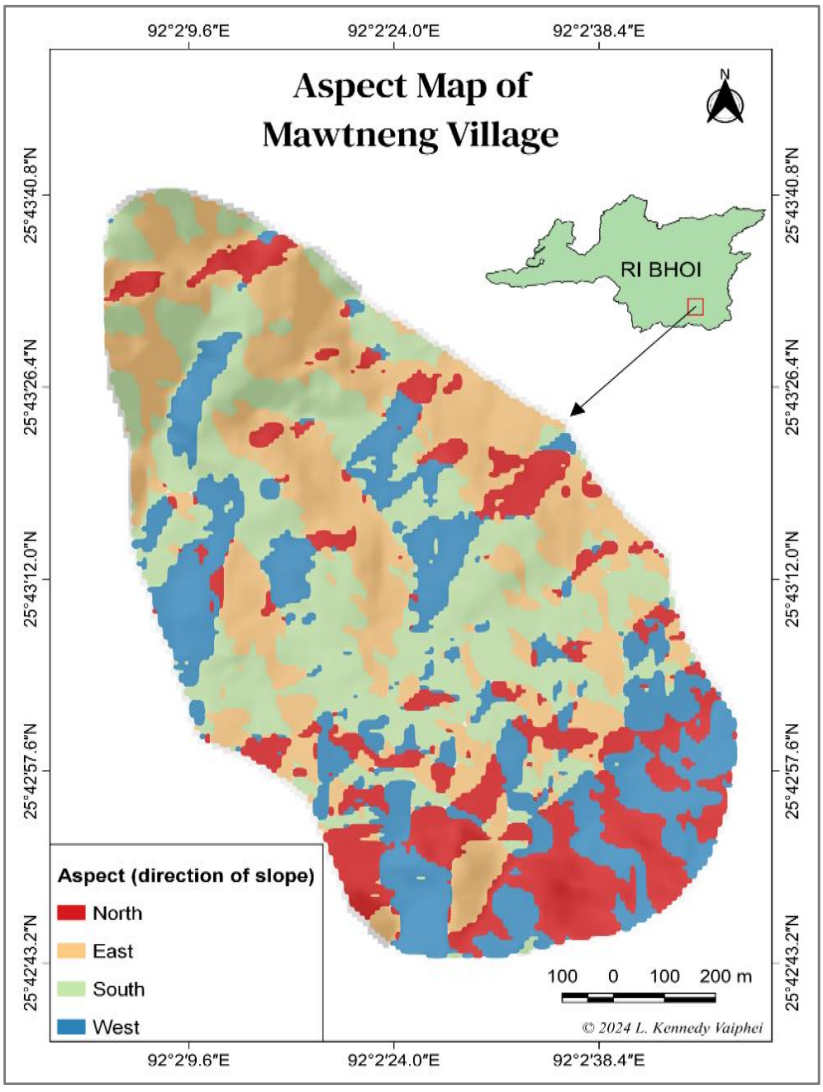


Fig.4. Aspect Map of Mawtneng Village

From the map (*Fig.4*), we can see that orientation of the gentle slopes lies majorly in the east direction with some patches lying towards the west. The slopes on the northern part of the map faces towards east as well with some patches towards the direction of the north and west. The steep slopes in the southern part faces towards the north and west directions. The least aspect degree is the south direction that can be seen on only some small patches in the map.

2.2. CLIMATE OF MAWTNENG VILLAGE

Mawtneng of Ri Bhoi district enjoys a tropical and sub-tropical climate. Summer is hot and humid whereas, winters are cool and dry. The altitude of the area plays a very important role in influencing and controlling the distribution of temperature throughout the year. The climate of the area is controlled by the physiography, the alternating pressure of Northwest India, the Bay of Bengal as well as the maritime air masses coming from the south or the southwest.

Table 2: Recorded weather data of Ri Bhoi, Meghalaya (2018)

Months	Rainfall (in cm)	Temperature (in °C)		Relative Humidity
		Maximum	Minimum	
January	34.3	19.7	7.3	68.70
February	4.7	20.3	6.8	67.55
March	69.7	26.1	11.8	53.90
April	58.4	29.7	15.7	56.75
May	296.2	28.5	17.2	75.10
June	345.3	27.9	19.6	81.70
July	285.8	28	20.4	81.80
August	426.1	27.8	20.2	81.90
September	401.5	28.1	18.9	80.10
October	228.5	26.5	15.9	77.90
November	36.2	24.2	10.1	67.00
December	19.3	22.1	9.1	71.4

Source: Meteorological Department, ICAR, Barapani

In summer from March to June, the maximum temperature ranges from 26°C to 29°C and the minimum temperature ranges from 11°C to 20°C. April is the hottest month in this area with a temperature of 29.7°C and it may drop down to 15.7°C. in winter from November to February, the maximum ranges from 19°C to 24°C and the minimum temperature of about

6.8°C and it may also rise to 20.3°C. Average annual rainfall is about 220 cm. June, July and August are the wettest months of the year as it rains heavily in these months. Occasionally rainfall occurs during winter which is negligible and lasted for a short period. In this area the relatively humidity also varies from place to place and from Months to Months. The highest relative humidity was recorded from the month of June to August with 81.70% - 81.90% and was recorded in the month of March with only 53.90% respectively.

Based on the climatic conditions, Mawtneng Village can be best described in terms of annual cycle of seasons. These seasons are:

Winter Season: The winter season last from the month of December till the end of the February. December is the coldest month of the year with the minimum temperature of 13°C. The northeast trade winds also bring down the temperature of the area drastically during the month of December and January.

Summer season: Begins with the month of March where the temperature begins to rise extends till the month of April. April is the hottest month where the temperature is highest and sometimes reaches 34°C.

Monsoon Season: The season starts in the month of June and last till September. The temperature of this season reaches a maximum of 30°C. This season is also characterized by heavy rainfall in the region.

Autumn Season: Begins in early October and cool temperature atmosphere prevails till the end of November. The temperature gradually comes down to 20°C to 25°C with little rainfall.

2.2.1. RAINFALL

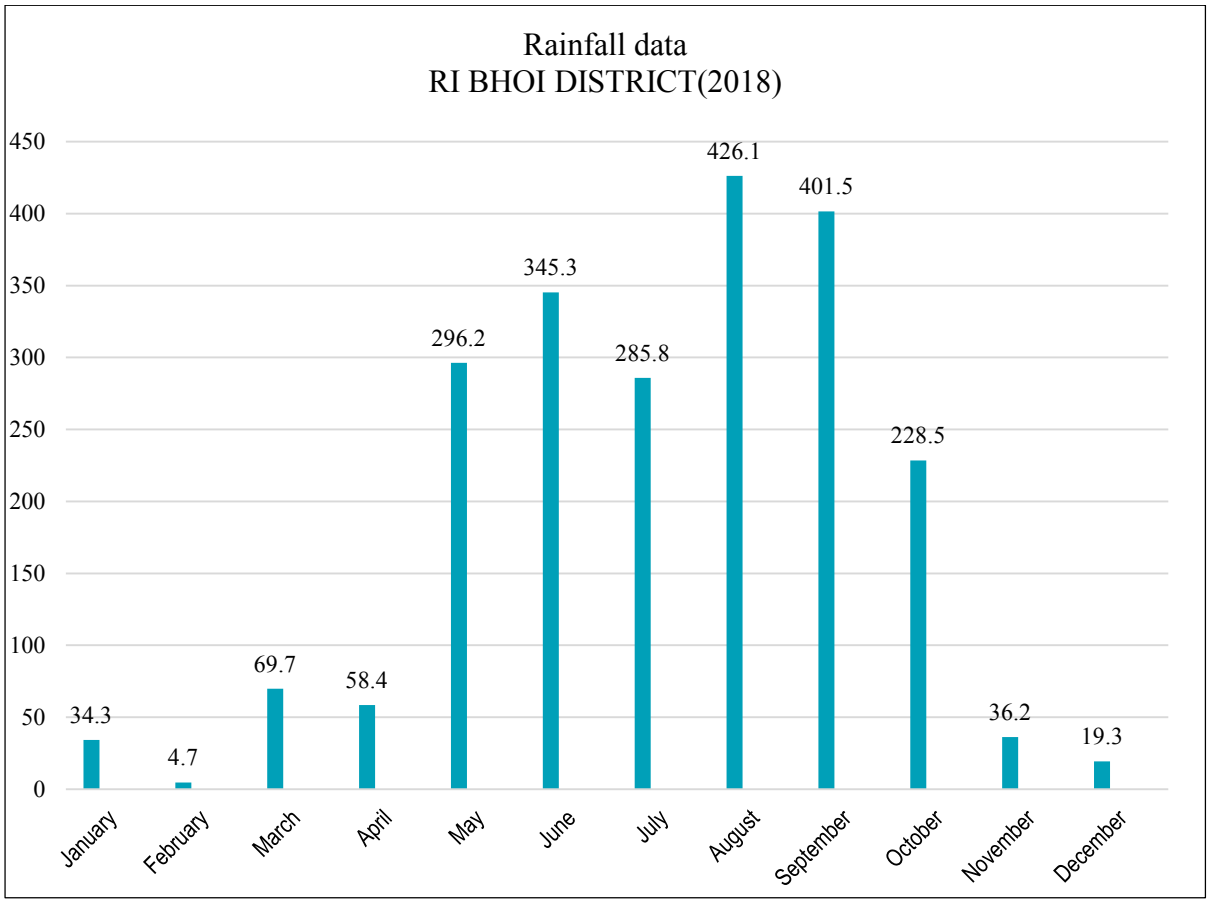
According to the dictionary of Geography by Praveen Bhatia, "Rainfall means the total of rain deposited on a given area during the given time; as measured by the rain gauges". Three types of rainfall are recognized, depending on the process by which the clouds were formed. They include orographic rainfall, cyclonic and conventional.

Table 3. Rainfall data of Ri Bhoi, Meghalaya

Months	Rainfall (in cm)
January	34.3
February	4.7
March	69.7
April	58.4
May	296.2
June	345.3
July	285.8
August	426.1

September	401.5
October	228.5
November	36.2
December	19.3

Source: Meteorological Department, ICAR, Barapani



Scale 1cm = 50mm of rainfall

Graph 1. Rainfall Data

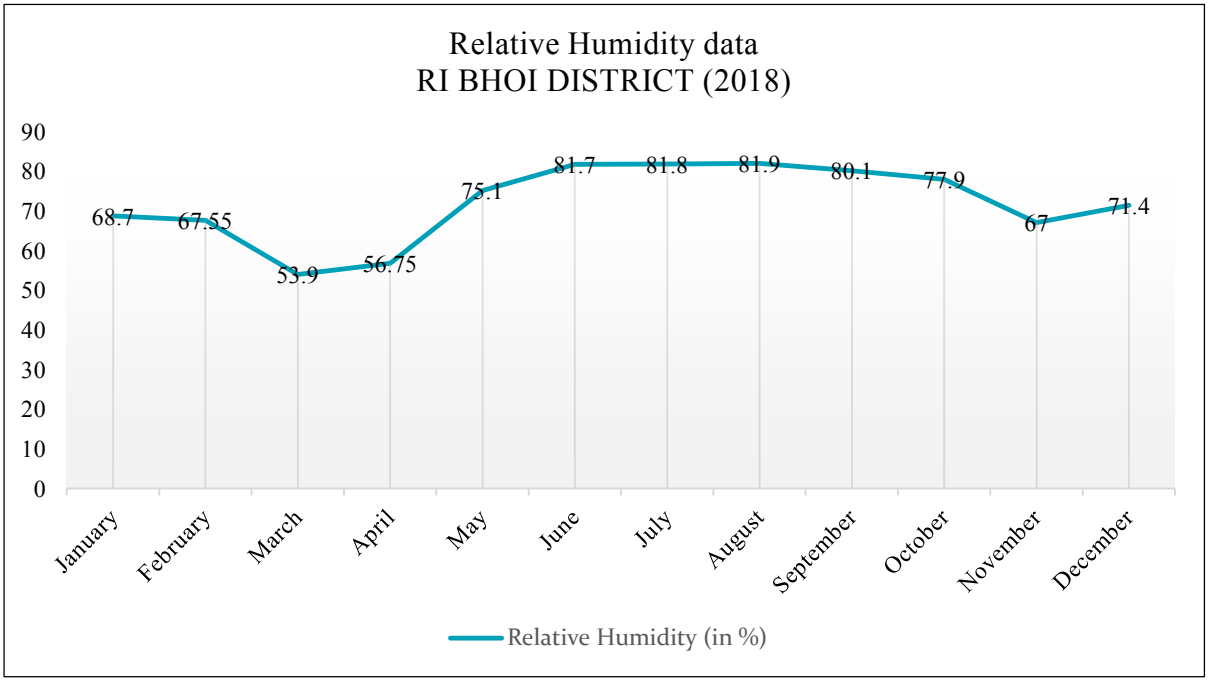
Interpretation: Lying on the northern slope of Meghalaya plateau and on the rain shadow area, the study area also thus receives rainfall from the monsoon season. From the table we can see that the amount has been shown in the vertical scale in centimeters, whereas in the horizontal scale is the month of the year. We can clearly that the rainfall in Mawtneng village is quite high despite it being located in the rain shadow area, where the highest rainfall is recorded in the month of August with 426.1cm, whereas the lowest rainfall recorded is in February which is 4.1cm only. Rain starts to pour down from the month of May which is around 296.2cm, and it continues till the month of September and October where the rainfall is more than 200cm. From the month of October, monsoon starts to retreat where rainfall starts decreasing.

2.2.2. RELATIVE HUMIDITY

According to the dictionary of Geography by Praveen Bhatia, "Relative Humidity is the ratio between the actual amount of water vapors in a given volume of the year and the amount that would be present if the air would be saturated at the same temperature generally expressed as percentage. It therefore affords a measure of the relative dampness of the atmosphere and it is determined by means of Hygrometer."

Table 4. Relative Humidity of Ri Bhoi, Meghalaya

Months	Relative Humidity (in %)
January	68.70
February	67.55
March	53.90
April	56.75
May	75.10
June	81.70
July	81.80
August	81.90
September	80.10
October	77.90
November	67.00
December	71.4



Scale 1cm = 10% Relative Humidity

Graph 2. Relative Humidity data

Interpretation: The Relative Humidity graph shows the different percentage of humidity in Mawtneng Village, Ri Bhoi District, Meghalaya. Where in the vertical scale it shows the Relative Humidity in percentage and in the horizontal scale it shows the different months. Here, the highest Relative Humidity was recorded in the month of August which is 81.90%, mainly due to high precipitation of monsoon season, whereas the lowest Relative Humidity was recorded in the month of March which is 53.90% mainly due to less rainfall. The Relative Humidity is almost at 70% in January and February but it suddenly decreases in the month March and then started rising again from the month of April till it reaches above 80% in the month of June to September and decreases again from the month of October to December, due to less rainfall, dry and cold weather months.

2.3. SOIL

The soil is the very heart of the biosphere. Meghalaya, 'the abode of cloud' is very biologically diverse and rich in its biotic components and geologically the Meghalaya plateau comprises of rocks from the oldest Precambrian gneissic complex to the Recent alluvium formations. Therefore, the soils of Meghalaya are very complex in their characteristics and properties.

On the basis of the local environmental conditions such as the geology, topography, climate, and natural vegetation, the soils are classified into four major soil groups and they are:

1) **Red Loamy Soils**: The Red Loamy Soils occupy the entire central part of Garo hills and central uplands of Khasi and Jaintia hills from west to east and are generally loamy and red colour. They are rich in organic matter and nitrogen and are usually acidic.
2) **Red and Yellow Soil**: They parallel from the west to east along with the southern slope of Red Loamy Soils. These vary in colour from reddish-yellow to yellowish-brown. The soils are generally found in the grade of fine textured, ranging from loam to silty-loam and are suitable for cultivation of rice, potatoes and horticulture. But they are low in humus content due to limestone being their parent material.
3) **Laterite Soils**: They are found extended from west to east in the northern part of the state. It is the result of the weathering of rocks like granites, quartzite, geneises etc. The soils are yellowish-red in colour. The places under its extend are under the rain shadow area and as a result dehydration takes places and constituents of the top soil are leached out.

4) **Alluvial Soils**: These soils evolved from recently deposited alluvium and are found all along the northern, western and southern parts of the state. The soil texture in this region varies from sandy to clayey-loam and are acidic in character.

Thus, the soil types of Meghalaya are acidic in nature and pH of the soil varies from acidic (pH 5.0 to 6.0) to strongly acidic (pH 4.5 to 5.0) due to intense leaching. The acidic soils are rated low in available Boron and Molybdenum just like all the acid soils of the North-Eastern region. Majority of the Meghalaya soils are rich in organic carbon with high nitrogen supplying potential of the soil, but deficient in phosphorus and medium to low in potassium according to the Department of Agriculture, Meghalaya.

2.3.1. Soil of Mawtneng Village

The district of Ri Bhoi, where Mawtneng Village is located, has soils that is derived from Gneissic complex parent material and may be broadly classified into hill and plain soils. They are dark reddish brown in colour varying in depth from 20-200 cm. Patches of black loamy soil and lime silt constitute the major portion. This soil is much suitable for growing both local and improved varieties of crops.

Thus, according to the information given, our area of study has the soil characteristics of the laterite soil group, and the red and yellow soil. According to the 17 samples collected by the soil group, it was found that the soil color varies from light yellowish grey, light yellowish brown and red to dark yellowish grey, red and brown. They are silty and sandy in texture and like all the soils in Meghalaya, they range from moderately acidic to strongly acidic. Like other types of soil, the soil found in Mawtneng lacks phosphorous and ranges from medium to low in potassium in the terms of soil composition but are they low in organic carbon and nitrate.

In our study area, the plain was use for cultivation purposes as majority of the population follows agriculture, in which they cultivate rice and potatoes, and also practiced broom cultivation. Thus, it is quite a self-sustaining village.

Soil samples: (*Fig.5)*

2.4. DRAINAGE DENSITY OF MAWTNENG VILLAGE

The geological formations, its resultant topography and tendency of head-ward erosion by rainwater have led to the creation of drainage network in Meghalaya. Subsequently, the Ri Bhoi district has a unique topographical condition and is blessed with vast and varied water resources in the forms of rivers, reservoirs, lakes, swamp, pond, mini barrages and low lying paddy. The present study area is also blessed with 3 ponds with the largest one being a community pond, and the area also has a river known as Umtung which serves as an important source of water for cultivation and other activities.

In our study area, the drainage system has been studied under drainage density and drainage frequency.

2.4.1. Drainage Density

Drainage density is the total length of stream channels per unit area. The value of drainage density reflects the climate over the basin and the influence of other basin characteristics including rock type, soil, vegetation, land use, and topographic characteristics. From the information collected through the Geographic Information System (GIS), the area has 8 drainage basins.

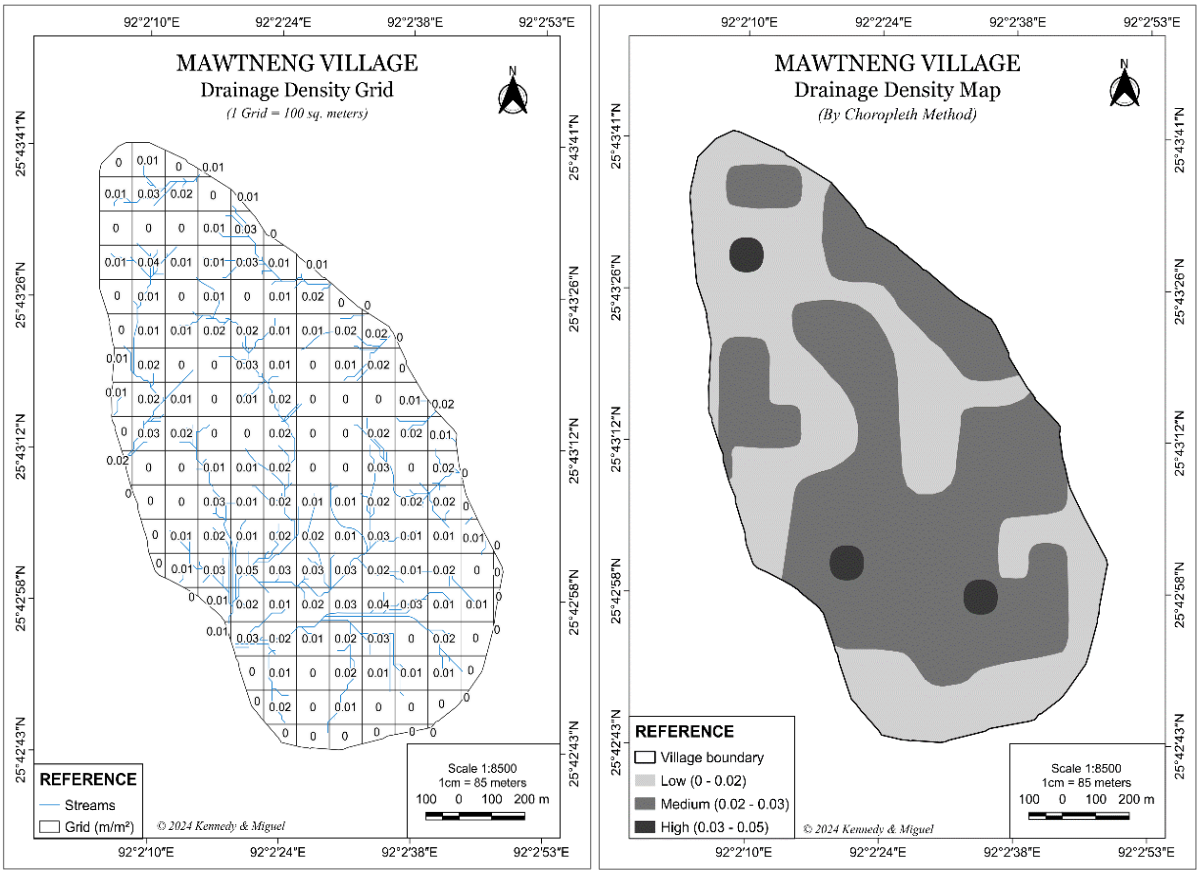


Fig.6. Drainage Density of Mawtneng Village

A total of 164 grids are placed on the map (*Fig.6*) with each grid being represented by the total length of the channels in their particular grids. After calculating the densities, we have classified the values into three categories i.e. low, medium and high. With low ranging from 0 to 0.02, medium from 0.02 to 0.03 and high from 0.03 to 0.05. From the choropleth map and the divisions, we can see that the area has a low drainage density, as the highest value is 0.05. The choropleth shading is mostly under the medium and low classes. Therefore, the study area falls under low drainage density.

Horton (1945) defined that basins of low drainage density are the product of runoff processes dominated by infiltration and subsurface flow.

2.4.2. Drainage Frequency

Drainage frequency is the number of streams per unit area. It is calculated by dividing the total number of streams by the total area of a basin or watershed. It is associated with lithology, degree of slope, stages of fluvial cycle and amount of surface run-off. With the help of QGIS, we calculated the drainage frequency of the study area as follows:

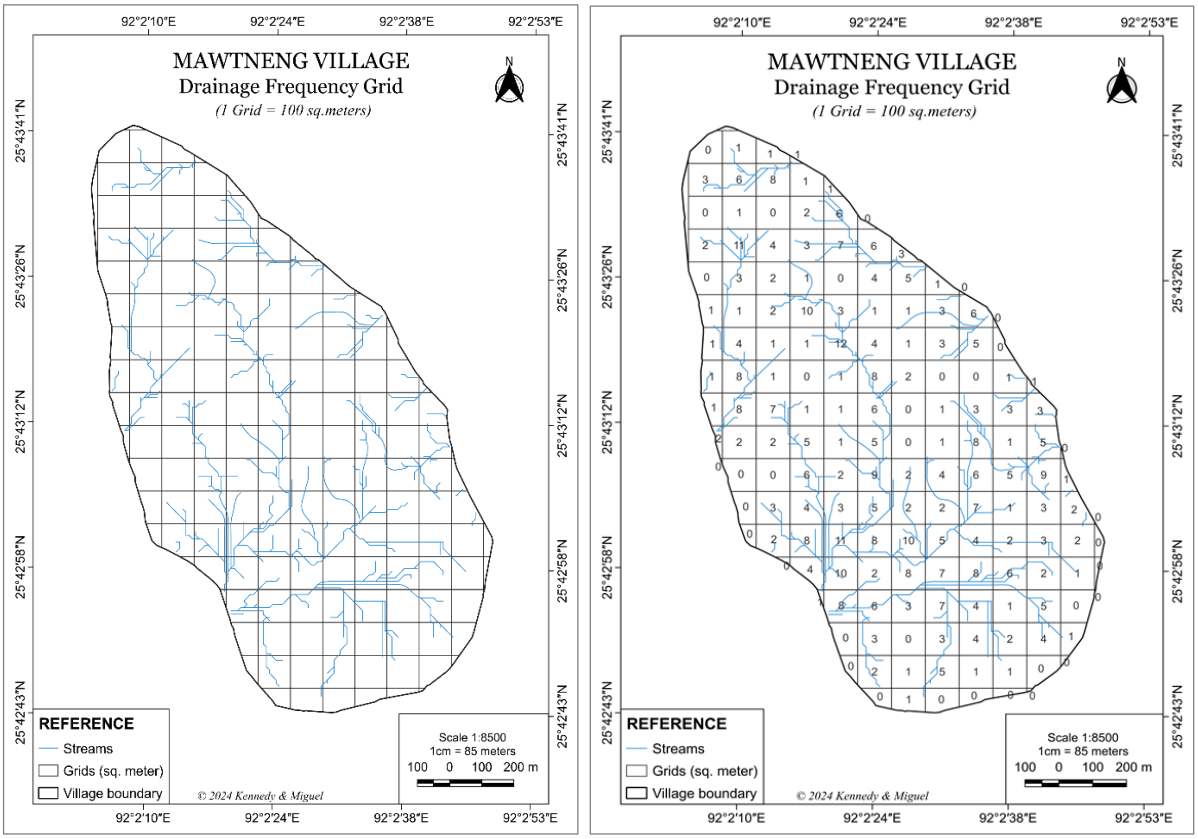


Fig.7. Drainage Frequency Grid

The drainage basin of the study area is divided into 164 small grid cells, where 1 grid is equal to 100 square meters (*Fig.7*). The streams are counted for each cell and then divided

with the area of the cell. The stream frequencies in the area ranges from 0 to 12 number of streams per unit area. The drainage frequency is divided into 3 groups viz. High, ranging from 10-15 number of streams per grid, followed by Medium, ranging from 5-10, and Low, from 0-5, and a choropleth map is developed out of it (*Fig.8*).

From the choropleth map, we can see that low and medium stream frequencies are dominant throughout the landscape. On the other hand, high frequency is found in few pockets, mainly in the areas of the confluence of streams.

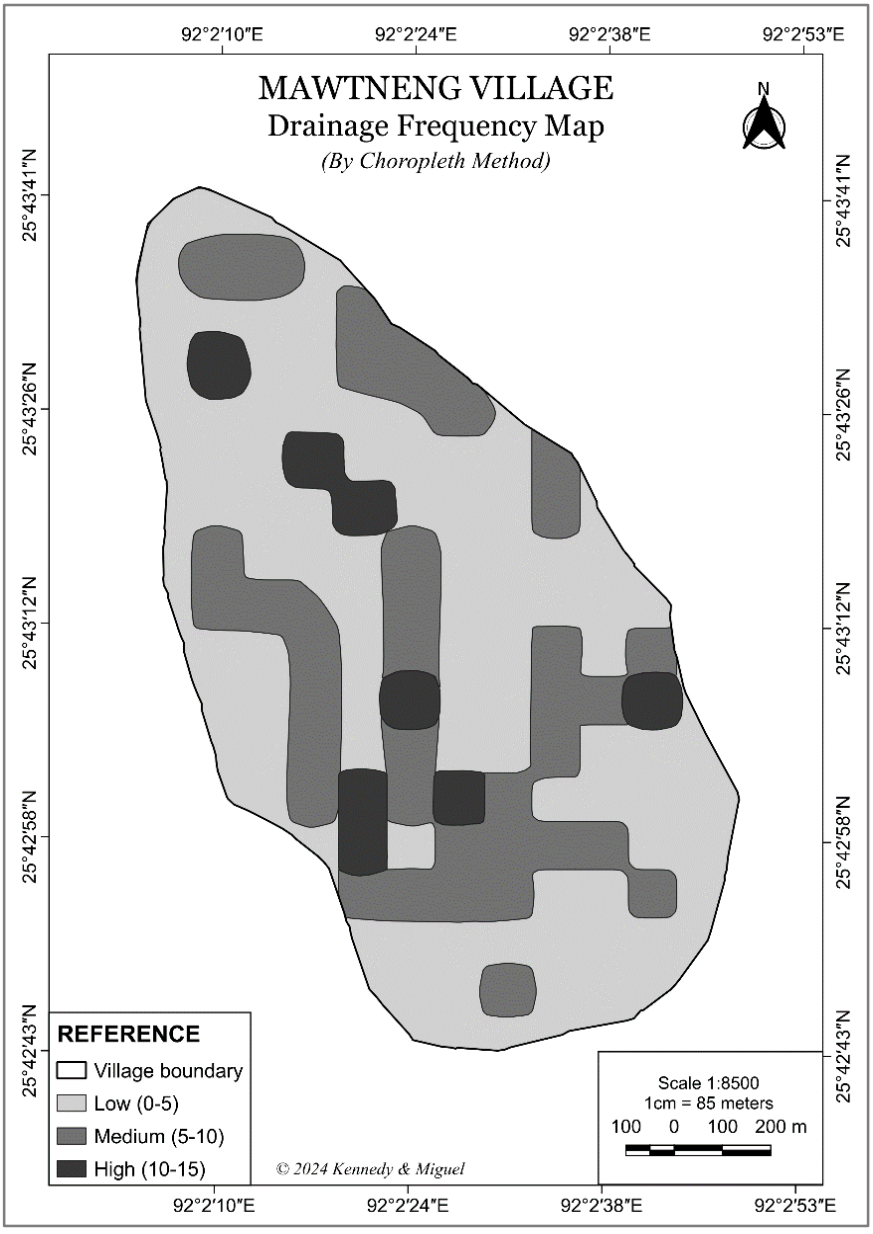


Fig.8. Drainage frequency map of Mawtneng Village

3. IDENTIFICATION, TYPES AND DISTRIBUTION OF FLORA AND MACROINVERTEBRATES IN THE STUDY AREA

3.1. Plant Diversity of Meghalaya

The floral diversity of Meghalaya is well reputed for its richness and has been a center of attraction for many botanists. Meghalaya harbors about 3,128 species of flowering plants and contributes about 18% of the total flora of the country including 1,237 endemic species. A wide variety of wild cultivable plants, edible fruits, leafy vegetables and orchids are found in the natural forests of Meghalaya. A total of 3,272 plant species could be listed from various literatures that has been reported from the state of Meghalaya. The compilation of threatened plants as per the IUCN Red List, RDB, and CAMP revealed the presence of 385 threatened species. This accounts for about 11.77% of the total plants in the state. These threatened species belonged to 274 genera and 108 families. Besides some rare orchids and other pitcher plants, there are hundreds of species of orchids, fern, mosses, fungi, lichens, grasses and palms. The most important forest product of this state is timber. There are rich varieties of flora in the Nongpoh region. Rare species of plants and seasonal flowers like Dahila, Canna, Gladiolus, Begonia, Tropaeolum, Aster, Polargonium, Antirrhinum, Crinum, Celosia, Pansy, Calenduala etc. Meghalaya has abundance of such plants also which were and heal. They have medical use. The medicinal plants, which are cultivated in Meghalaya include ipecac, sarpagandha, castor oil, chiretta, paederia Foetida Salix alba, cinnamon, etc. are also commonly planted. Meghalaya have various classes of plant life which grow naturally to make their state rich and varied in natural vegetation. The Khasi and Jaintia hills are considered to be the centre of diversity for several primitive families such as Elaeocarpaceae, Elaeagnaceae, Anonaceae, Ranunculaceae, Piperraceae, Menispermaceae, Caryophyllaceae, Lauraceae, Myricaceae, Lazarbiaceae and primitive genera like Sarcandra, Corylopis, Myrica, Magnolia and Michelia.

3.2. Macroinvertebrate Diversity of Meghalaya

Macroinvertebrates occupy different trophic levels in a food chain due to diverse feeding habits many feed on algae and bacteria, some eat leaves and other organic matter, some are filter-feeders and quite a few are predatory on other insect larvae, crustaceans and small fish. Because of their abundance and intermediate position in the aquatic food chain, benthic macroinvertebrates play a critical role in the natural flow of energy and nutrients including assisting in breakdown of leaf litter and organic matter decomposition. Aquatic macroinvertebrate assemblages comprise primarily of insect larvae that have terrestrial adult life forms, insects whose adult life-history stages such as beetles and true bugs are also aquatic,

and include arthropods such as crustaceans, and organisms from other phyla such as mollusks and annelids Benthic macroinvertebrates are an important part of the food chain, especially for fish and other predators. Faunal diversity is also well represented by the presence of a variety of vertebrates of about 958 species and sub species belonging to 451 genera and about 4580 species and sub species of invertebrates belonging to 2094 genera. The most successful of all land living animals are the insects. Of all the species on earth, 73.5% are invertebrates and most of these are insects and they are the most successful creatures adapting to the early environment on land. Meghalaya has a number of reptiles comprising snakes both poisonous and non-poisonous-king cobra, coral and viper among the poisonous snakes, and pythons, blind snakes and copper heads among the non-poisonous snakes and lizards. The lakes and rivers have variety of amphibians and fish species like frogs, toads (amphibians), rohu, mrigal (fish species) etc. Ants, flies, beer and beetles are common among the insect population. Meghalaya, along with the rest of the North Eastern region abounds in many exquisite varieties of butterflies.

3.3. Natural Vegetation of Meghalaya

Meghalaya is well reputed for its floristic richness. Its location, physiographical features and rich ethnic interactions have all contributed very favorably towards this richness and large scale endemism. Due to favorable environmental factors, physiographical features, geographical location, biotic influence, human interaction etc., the vegetation of the state is very rich and diverse.

Tropical Forest

These forests are met within areas up to an elevation of 900m and with an average rainfall of about 200cm. They are more important from an economic point of view and are the source of many of our useful plants yielding timber, fuel, fodder, medicine aromatics and other non-timber forest produce.

Tropical Evergreen Forest

These forests usually occur in more wet slopes and valleys. These seldom form continuous belts due to various exogenous factors. They are complex in structure and rich species diversity.

Tropical semi-Evergreen Forest

These type of forests occupy the North and North-Eastern slopes of the state. Like the former, the forests are much complex and stratified. However, there is a preponderance of deciduous tree species along with evergreen species compared to the former type.

Tropical Moist and Dry Deciduous Forest

This is a very prominent vegetation of Meghalaya covering larger areas in the East and West Garo hills, Ri Bhoi etc. The rainfall in this forest belt is slightly lower than the previous vegetation areas. Temperature too is higher. These forests are characterized by seasonal leaf shedding and profuse flowering.

Subtropical Pine Forest

The pine forests are seen above the tropical zone and are confined to the higher reaches of the Shillong Plateau in Khasi and Jaintia Hills. The altitudinal range is 900m-1500m. The pine forests unlike the tropical forests are less complex in structure and comparatively poorer in respect of species richness when seen with tropical types.

Forest cover of Ri Bhoi

The recorded forest area in the state is 0.85 million hectares, which is 42.34% of the geographical area. According to legal classification, Reserved forests, protected forests and unclassified forests constitute 11.71%, 0.13% and 88.16% of the total forests respectively. The control of unclassified forests mostly rests with the autonomous district councils of Khasi Hills, Jaintia Hills and Garo Hills.

3. 4. IDENTIFICATION OF FLORA & MACROINVERTERBRATES IN THE STUDY AREA

Table 5. Checklist of plant species documented in Mawtneng Village, Ri Bhoi, Meghalaya

SL. NO.	COMMON NAME	SCIENTIFIC NAME	FAMILY	KHASI NAME	GROWTH HABIT	USES	DISTRIBUTION *(within India)*	IUCN RED LIST
1	Indian-rhododendron	*Melastoma malabathricum* L.	Melastomataceae	Krah rngai, soh khing, syntiew-soh-pdang, ka-dieng-kum, soh klong.	Shrub or tree	Medical properties, prevention and treatment of heart diseases, dysentery diarrhea, etc.	Northwestern (Jammu & Kashmir, Himachal Pradesh and Uttarakhand) and the northeastern region (Sikkim, Arunachal Pradesh, Meghalaya, Mizoram, Manipur and Nagaland)	**CR**
2	Vegetable fern	*Diplazium esculentum* (Retz.) Sw.	Aspleniaceae	Jhur-tyrkhang	Herb	The young leaves are eaten as lalab with rice	Himalayan region, northeastern states, southern India and Andaman & Nicobar Islands	**LC**
3	Croften weed	*Ageratina adenophora* (Spreng.) King & H. Rob.	Asteraceae	Bat iong, Bat japan, Bat nongrim, Langtana Kynbat iwtung	Shrub	Treatment such as wounds, itching, measles, skin diseases, uterine bleeding, and also act as antibacterial and astringent activity.	Northeast India, Bihar, Maharashtra, Gujarat, Uttar Pradesh	*N/A*

4	Taro	*Colocasia esculenta* (L.) Schott	Araceae	Sla wang, Wang, Ka wang panai	Shrub	Medical purposes, food ingredient, etc.	Madhya Pradesh, Andhra Pradesh, Orrisa, northeastern states	**LC**
5	Tropical Soda Apple	*Solanum viarum* Dunal	Solanaceae	Dieng-soh-pdok-ba-kthang	Shrub	Medical purposes	From the Himalayan foothills in the north to the Nilgiris in the south	**LC**
6	Tropical white weed/ Billy goat-weed	*Ageratum conyzoides* L.	Asteraceae	Kynbat myngai, Bat Dkhar.	Subshrub	Traditional medicinal plants for dysentery, diarrhea, etc.	South India, Northeast India	**G5** *(NatureServe)*
7	Bananas (Genus *Musa*)	*Musa x paradisiaca* L. *Musa acuminata* Colla *Musa balbisiana* Colla	Musaceae	Pashor-kait, pashor, kait sying	Herbaceo-us tree	Nutritional snacks, Digestive health, invertebrate food, social uses, etc.	Andhra Pradesh, Tamil Nadu, Maharashtra, Kerala, Gujarat, Telangana and Uttar Pradesh	**LC**
8	Indian Strawberry/ False Strawberry	*Potentilla indica* (Andrews) Th. Wolf	Rosaceae	Soh berry khlaw, Soh pdah, Soh shah	Herb	Edible fruits, medicinal uses, etc.	Northeastern states of India	*N/A*

9	East Indian Glory Bower	*Clerodendrum colebrookianum* Walp.	Lamiaceae	Dieng-ja-kangum, Dieng-ja-rem-kynthei, Jhur-jarem	Subshrub or shrub	Medical purpose, ornamental plant, soil stabilization, etc.	Mostly found in parts of South India including Kerala, Karnataka, Tamil Nadu and parts of northeastern states	**NE**
10	Indian Spurge tree	*Euphorbia neriifolia* L.	Euphorbiacea	Sar-a	Succulent shrub or tree	Traditional Medicine, ornamental plant, Latex production, as a poison, etc.	Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, and parts of northeastern states	**LC**
11	Elephant Apple	*Dillenia indica* L.	Dilleniaceae	Soh-kyrbam	Shrub or tree	Culinary, medicinal and cultural uses, etc.	Assam, Manipur, Arunachal Pradesh, the eastern parts of India	**LC**
12	Wild hops	*Flemingia strobilifera* (L.) W.T.Aiton	Fabaceae	Ka-khong	Shrub	Culinary uses, natural dye, Herbal medicine, etc.	The Himalayas, South India and Northeast India	*N/A*
13	Ginger-lily/ Kahili ginger	*Hedychium gardnerianum* Sheppard ex Ker Gawl.	Zingiberaceae	Sying Khlaw	Shrub	Medical purposes, invasive species control, etc.	Meghalaya, Assam, and Arunachal Pradesh	*N/A*
14	Common lantana	*Lantana camara* L.	Verbenaceae	Soh-pang-khlieh	Subshrub or shrub	Act as a host plant, ornamental plant, medical purposes for wound healing, fever treatment, etc.	It is distributed throughout India, spanning from the Himalayan foothills to the southern regions.	**G5** *(NatureServe)*

15	Tiger grass/ Broom grass	*Thysanolaena latifolia* (Roxb. ex Hornem.) Honda	Poaceae	Synsar	Shrub	Broom making, rope making, ornamental purposes, etc.	Assam, Arunachal Pradesh, Meghalaya, and Nagaland, northern India.	**LC**
16	Thickhead/ Redflower ragleaf	*Crassocephalum crepidioides* (Benth.) S. Moore	Asteraceae	Jathymmai, ja-il, sla aeroplane-jableh	Herb	Medical practices for treating skin conditions, digestive issues and inflammation, etc.	Assam, Meghalaya, Odisha	**NE**
17	Palm grass	*Setaria palmifolia* (J. Koenig) Stapf	Poaceae	Phlang	Herb	Traditional medicine, used as fodder for livestock, etc.	The Himalayas, Kerala, Tamil Nadu	*N/A*
18	Water Pepper /Marsh-pepper smartweed	*Persicaria hydropiper* (L.) Delarbre	Polygonaceae	Kynbat sat	Herb	Medical purposes for diarrhea , to stop bleeding, for common cold, etc.	The Himalayas and other parts of India	**LC**
19	Climbing hempweed/ Mile-a-minute	*Mikania micrantha* Kunth	Asteraceae	Bat karo, Bat Refujee, Mei india	Subshrub	Medicinal purposes, treatment of skin, antiseptic, etc.	Common in Northeast India and the Himalayas	*N/A*
20	Pineapple	*Ananas comosus* (L.) Merr.	Bromeliaceae	Soh trun	Herbaceo-us herb	Culinary, beverages, canning, etc.	Assam, Meghalaya, Tripura, Nagaland, Kerala, Karnataka	*N/A*
21	Packing leaf	*Phrynium pubinerve* Blume	Marantaceae	Sla Met	Herb	Ornamental purposes, etc.	Northeast India, South India	*N/A*

22	Ovate spikerush	*Eleocharis ovata* (Roth) Roem. & Schult.	Cyperaceae	*N/A*	Herb	Wetland stabilization, water filtration, etc.	Tropical and subtropical regions of India, including East Himalaya	*N/A*
23	Angel's tears	*Brugmansia suaveolens* (Humb. & Bonpl. ex Wild.) Sweet	Solanaceae	*N/A*	Shrub	Traditional medicinal purposes	Kerala, Karnataka, Tamil and some parts of northeastern India	**EW**
24	Wild iris	*Dietes grandiflora* N.E.Br.	Iridaceae	*N/A*	Herb	Ornamental purposes	Kerala, Karnataka, Maharashtra	**LC**
25	Blue sage	*Eranthemum pulchellum* Andrews	Acanthaceae	*N/A*	Shrub	Ornamental plants, garden Borders, Hedging, Pollinator Attraction, etc.	Native to Himalaya, Indo-China, also found in Peninsular India	*N/A*
26	Golden dewdrops	*Duranta erecta* L.	Verbenaceae	*N/A*	Shrub	Ornamental plant, Topiary and pruning, etc.	Tamil Nadu, Kerala, Andhra Pradesh, West Bengal	**LC**
27	Needlewood tree	*Schima wallichii* (DC.) Korth.	Theaceae	Dieng nganbuit	Tree	The hard and durable timber of the tree is used for house construction, leaves are used as fodder, etc.	Native to the Himalayas, and is widely distributed in the southern and northeastern parts of India	**LC**

28	Oriental Trema	*Trema orientale* (L.) Blume	Cannabaceae	Dieng lata, Dieng langta	Shrub or tree	Ornamental planting, agroforestry, traditional medicine, etc.	Kerala, Tamil Nadu, Assam, West Bengal, Bihar, MP, Odisha, Maharashtra, Andaman & Nicobar Islands	**LC**
29	Swamp rice grass	*Leersia hexandra* Sw.	Poaceae	*N/A*	Herb	Forage for livestock, hyper accumulator of heavy metals, etc.	Kerala, Maharashtra, Odisha, Tamil Nadu, northeastern states	**G5** *(NatureServe)*

(Source: iNaturalist, PlantNet, Global Biodiversity Information Facility, Royal Botanic Gardens, International Union for Conservation of Nature & Wikipedia)

Fig. 9.1 Melastoma malabathricum L

Fig. 9.2 Diplazium esculentum (Retz.) Sw

Fig. 9.3 Ageratina adenophora (Spreng.) King & H. Rob

Fig. 9.4 Colocasia esculenta (L.) Schott

Fig. 9.5 Solanum viarum Dunal

Fig. 9.6 Ageratum conyzoides L.

Fig. 9.7 Genus Musa

Fig. 9.8 Potentilla indica (Andrews) Th. Wolf

Fig. 9.9 Clerodendrum colebrookianum Walp

Fig. 9.10 Euphorbia neriifolia L.

Fig. 9.11 Dillenia indica L.

Fig. 9.12 Flemingia strobilifera (L.) W.T.Aiton

Fig. 9.13 . Hedychium gardnerianum Sheppard ex Ker Gawl.

Fig. 9.14 . Lantana camara L.

Fig. 9.15 Thysanolaena latifolia (Roxb. ex Hornem.) Honda

Fig. 9.16 Crassocephalum crepidioides (Benth.) S. Moore

Fig 9.17 Setaria palmifolia (J. Koenig) Stapf

Fig 9.18 Persicaria hydropiper (L.) Delarbre

Fig. 9.19 Mikania micrantha Kunth.

Fig. 9.20 Ananas comosus (L.) Merr.

Fig. 9.21 Phrynium pubinerve Blume

Fig. 9.22 Eleocharis ovata (Roth) Roem. & Schult

Fig. 9.23 Brugmansia suaveolens (Humb. & Bonpl. ex Wild.) Sweet

Fig. 9.24 Dietes grandiflora N.E. Br

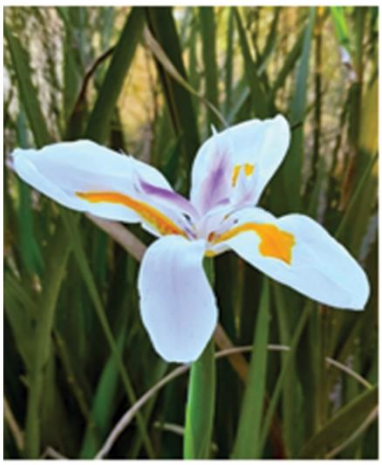


Fig 9.25 Eranthemum pulchellum Andrews

Fig. 9.26 Duranta erecta L

Fig. 9.27 Schima wallichii (DC.) Korth

Fig. 9.28 Trema orientale (L.) Blume

Fig. 9.29 Leersia hexandra Sw

Fig.9. Plant photos

SL. NO.	COMMON NAME	SCIENTIFIC NAME	GENUS	FAMILY	HABITAT	DESCRIPTION	DISTRIBUTION *(worldwide)*
1	Paddyfield Parasol	*Neurothemis intermedia*	*Neurothemis*	Libellulidae	Usually found in grasslands and other similar open habitats.	Yellowish red dragonfly with reddish brown eyes.	Widespread in many Asian countries.
2	Carinate Locust	*Trilophidia annulata*	*Trilophidia*	Acrididae	Found at the edges of a rice field on the ground amongst grasses, stones, branches, twigs, and other detritus.	Band-winged grasshopper, 1.3-1.9cm in size, has light and dark brown colors that act as good camouflage.	Found in Asia.
3	Chinese rice grasshopper	*Oxya chinensis*	*Oxya*	Acrididae	Common in moist and swampy areas, dominates the irrigated rice environment.	Medium-sized short-horned grasshopper with a green, brown, and yellow color, having a hairy and wrinkled surface.	Found in south and southeastern Asia, and Oceania.
4	Black-Striped Orchard Spider	*Leucauge celebesiana*	*Leucauge*	Tetragnathi-ae	Commonly found in orchards surrounded by secondary jungle.	Colorful and distinctive spider. It has a body length (excluding legs) of 13mm. The abdomen is white with yellow-green sides with black stripes separating the white from the colored flanks. Another black stripe runs right down the middle.	Found from India to China, Japan, Sulawesi, and New Guinea.

5	Asian Honey Bee	*Apis cerana*	*Apis*	Apidae	Encompass a wide range of climatic zones including moist tropical rainforests, wet-dry tropical savannas, mid-latitude steppes, and taigas.	Adults are black in color, with four yellow abdominal stripes. There are also distinctions between worker bees, queens, and drones.	Native to south, southeast, and east Asia.
6	Vivid Metallic Ground Beetles	N/A	*Chlaenius*	Carabidae	Usually found in moist and wet places, such as under leaf litter and by mud.	Some are mostly black, but many have an emerald green, copper, or bronze sheen on them. Legs and antennae are pale, almost orange.	Native to the Palearctic (including Europe), the Near East, North Africa, Afrotropical region, and the Nearctic.
7	Tiger moths	N/A	*Nyctemera*	Erebidae	Often can be seen feeding at flowers; it is common around its preferred food plants of the daisy family, for example groundsel, ragworts, and *Cineraria.*	A genus of tiger moths, which are medium in size, the adults having a wingspan of 35-45mm. The wings are usually dark with lighter patches, while the body is often aposematically colored.	Widespread in many Asian countries, especially in the south, southeast, east Asia, and Oceania.

8	Tiger moths	N/A	*Creatonotos*	Erebidae	Found in various secondary habitats.	Palpi short and porrect. Hind tibia with one pair of sours. Forewings rather narrow. Forewings in some species with vein 10 from cell and vein 5 in both wings.	The moths in this genus are found in the Afrotropics, South and East Asia, Sundaland, and Australia.
9	Sharptails	N/A	*Stenocatantops*	Acrididae	Most grasshoppers prefer dry, open habitats with lots of grass and other low plants, though some species live in forests or jungles.	Short-horned grasshoppers, brown with a yellowish antenna, and has a small head with prominent eyes. Its hind femur is yellowish with a dark line along the medial area, and its hind tibia and tarsus are red.	The recorded distribution of species includes: India, China, Indo-China, and Malesia through to Australia.
10	Orchard Spiders and Allies	N/A	*Leucauge*	Tetragnathi-ae	Shrubby meadows, woodland edges, orchards, etc.	Its cephalothorax is elongated with elevated cephalic region and covered with hairs. The abdomen is silver-white, long and narrow. The abdomen is marked with some colored spots and dark lines.	India to China, Laos, Taiwan, Moluccas

11	Acrobat Ants and Cocktail Ants	N/A	*Crematogaster*	Formicidae	They can be found either outdoors (trees, under rocks, etc.) or indoors (homes, electrical wires, etc.), most species are arboreal.	Characterized by a distinctive heart-shaped gaster (abdomen), yellowish-brown to dark brown color.	Ecologically diverse genus of ants found worldwide
12	Great Evening Brown	*Melanitis zitenius*	*Melanitis*	Nymphalidae	Found in variety of habitats, including dense forests, open grasslands, and urban forests. They are commonly seen flying at dusk.	Warm brown ground color and a broad patch of ochraceous yellow above the subapical black spots. The underside of the wings is sprinkled with dark brown lines.	Found in Asia
13	Red-spot Jezebel	*Delias descombesi*	*Delias*	Pieridae	They lived in a variety of habitats, including tropical dry evergreen forests, grasslands, scrubland, wetlands, and community parks.	Medium-sized butterfly having bright a yellow upper surface with a large red spot on the underside of its hindwing, with a black border.	India (Sikkim, Assam, etc.), Nepal, Bhutan, Myanmar, Thailand, Vietnam, and the Malay Peninsula
14	Dark-branded Bushbrown	*Mycalesis mineus*	*Mycalesis*	Nymphalidae	Found in lowlands, such as in open areas of primary and secondary forest, along river banks, roadsides and parks.	Medium-sized butterfly, has a dark grayish brown upper side and a paler underside with a white post-discal stripe on the fore and hindwings.	Widespread in India, Nepal, Sri Lanka, China, Southeast and East Asia

15	Grass Yellows	N/A	*Eurema*	Pieridae	They like to fly quickly, close to the ground, and are found in open grassy or bushy terrain.	Fairly small, very similar-looking butterflies, bright yellow with a black border around both wings on the upperside	Found throughout India, and the Oriental region, Australia and Oceania, to the New World.
16	Fungus-growing termites	N/A	N/A	Macrotermitin -ae *(subfamily)*	Most commonly found in savannas, but can also be found in rain forests, where they are less common	This subfamily consists of 12 genera and about 350 species and are distinguished by the fact that they cultivate fungi inside their nests to feed the members of the colony.	This subfamily has a widespread distribution through the tropics of Africa, the Middle East, and southern and southeastern Asia
17	Harvestmen	N/A	*Gagrella*	Sclerosomati -dae	Gardens, residential landscapes, under rocks, tree trunks, climbing garden vegetation, etc.	Harvestmen look like spiders because they have eight legs, but they are not real spiders. Instead of eight eyes, they have two eyes that look sideways. They lack silk glands and spinners.	Found worldwide
18	N/A	N/A	*Neriene*	Linyphiidae	Grasslands, marshes, scrub, woodland, gardens, etc.	N/A	Widespread in western and central Europe, eastern and western North America, and parts of Asia.

19	Black-and-white Spiny Spider	*Gasteracantha kuhli*	*Gasteracantha*	Araneidae	This species builds orb webs in open forests and shrubby areas and waits for prey in the center of the web.	Males are much smaller compare to females. They possess hard, shiny abdomens armed with six black conical spines. They are black and white in color.	Widespread from India to Japan, the Philippines, and Java in Indonesia.
20	Flower Crab Spiders	N/A	*Thomisus*	Thomisidae	Gardens, meadows, flowers, fences, plants, scrubs, under rocks, etc.	They are often white but can change color to match their surroundings. Their front legs are longer and stronger than their back legs, and their abdomen is globular, sometimes with spots or lines.	Worldwide distribution, with the notable exception of most of South America.
21	N/A	*Graptostethus incertus*	*Graptostethus*	Lygaeidae	N/A	N/A	Although originally restricted to the Old World (Palaearctic, Ethiopian, and Oriental Regions), some species like *G. servus* have spread to parts of the New World.

Table 6. Checklist of macroinvertebrate species found in Mawtneng Village, Ri Bhoi, Meghalaya

(Source: iNaturalist, Global Biodiversity Information Facility & Wikipedia)

Fig.10.1 Neurothermis intermedia

Fig. 10.2 Trilophidia annulata

Fig. 10.3 Oxya chinensis

Fig. 10.4 Leucauge celebesiana

Fig. 10.5 Apis cerana

Fig. 10.6 Genus Chlaenius

Fig. 10.7 Genus Nyctemera

Fig. 10.8 Genus Creatonotos

Fig. 10.9 Genus Stenocatantops

Fig. 10.10 Genus Leucauge

Fig. 10.11 Genus Crematogaster

Fig. 10.12 Melanitis zintenius

Fig. 10.13 Delias descombesi

Fig. 10.14 Mycalesis mineus

Fig. 10.15 Genus Eurema

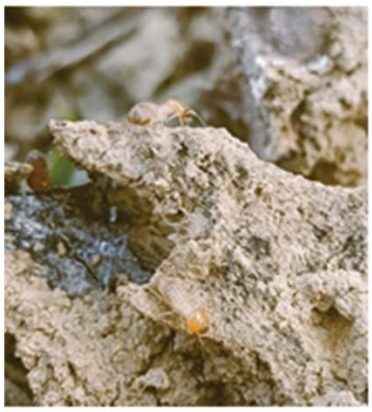


Fig. 10.16 Sub-family macrotermitinae

Fig. 10.17 Genus Gagrella

Fig. 10.18 Genus Neriene

Fig. 10.19 Gasteracantha kuhli

Fig. 10.20 Genus Thomisus

Fig. 10.21 Graptosthethus incertus

Fig.10. Macroinvertebrate photos

4.1. BIO-INDICATORS TO MONITOR THE HEALTH OF THE ECOSYSTEM.

Biological indicators are living organisms such as plants, planktons, animals, and micro-organisms, which are exploited to detect pollutants in a given ecosystem. They explore the life span or residence time of pollutants integrating past, current, and future ecosystem status. Naturally occurring biological indicators are regularly used to assess a given ecosystem detecting positive and negative changes therein.

How various bio-indicators talk about environmental health?

1. **Species Diversity**: High species diversity indicates a healthy ecosystem as it suggests a stable and balanced environment with robust ecological processes, such as nutrient cycling, pollination, and pest control. Conversely, a decline in species diversity can signal environment degradation, habitat loss, pollution and other stressors.
2. **Population Trends**: Monitoring the population sizes of key species can indicate the health of the ecosystem. If pollution causes the reduction of an important food source, the animals dependent in it for food may decrease. If toxins are present, certain plants may not be able to grow in the area affected.
3. **Water Quality Indicators**: Parameters like pH, dissolved oxygen, nutrients level, (nitrate, phosphate), and presence of pollutants (heavy metals, pesticides) can indicate water quality. Algae blooms are often used to indicate large increases of nitrates and phosphates in lakes and rivers. The levels of certain liver enzymes in fish increase if they are exposed to pollutants in the water.
4. **Air Quality Indicators**: Presence of certain lichen species, which are sensitive to air pollution, can indicate air quality. Additionally, monitoring levels of pollutants like ozone and particulate matter can provide insights into ecosystem health.
5**. Soil Health**: Indicators such ah soil pH, nutrient levels, organic matter content, and microbial activity can reflect the health of the soil and its ability to support plant and microbial communities. Changes in the functioning of the nervous systems of worms are also used to measure levels of soil pollution.
6. **Microorganisms** can also be used as indicators of toxins in an ecosystem. Some microorganisms will produce stress proteins if exposed to certain pollutants. By measuring the levels of stress proteins, we can get an idea of the level of pollution present in the environment.

Types of bio-indicators

Plant indicators

• The presence or absence of certain plant or other vegetative life in an ecosystem can provide important clues about the health of the environment: environmental preservation. There are several types of plant bio-monitors, including mosses, lichens, tree bark, bark pockets, tree rings, leaves, and fungi. Lichens are organisms comprising both fungi and algae. They are found on rocks and tree trunks, and they respond to environmental changes in forests, including changes in forest structure - conservation biology, air quality, and climate. The disappearance of lichens in a forest may indicate environmental stresses, such as high levels of sulfur dioxide, sulfur-based pollutants, and nitrogen oxides.

• The composition and total biomass of algal species in aquatic systems serves as an important metric for organic water pollution and nutrient loading such as nitrogen and phosphorus. There are genetically engineered organisms that that can respond to toxicity levels in the environment; e.g., a type of genetically engineered grass that grows a different color if there are toxins in the soil. Example, the most well-known bio-indicator, a lichen is a composite organism that arises from algae or cyanobacteria in a mutually beneficial relationship (symbiotic relationship). The hardy lichens are (or both) living among filaments of a fungus useful bio-indicators for air pollution, especially sulfur dioxide pollution.

How are lichens able to act as bio-indicators?

1. Lichens live on surfaces such as trees or rocks or soil and are very sensitive to toxins in the air.
2. They have no roots, no cuticle, and acquire all their nutrients from direct exposure to the atmosphere rather than from the soil.
3. Their high surface area to volume ratio further encourages the interception and accumulation of contaminants from the air.
4. They are able to react to air pollutants all year round.
5. Compared with most physical/chemical monitors, they are inexpensive to use in evaluating air pollution.

Animal indicators and toxins

An increase or decrease in an animal population may indicate damage to the ecosystem caused by pollution. For example, if pollution causes the depletion of important food sources, animal species dependent upon these food sources will also be reduced in number: population decline. Overpopulation can be the result of opportunistic species growth. In addition to monitoring the size and number of certain species, other mechanisms of animal indication include monitoring the concentration of toxins in animal tissues, or monitoring the rate at which deformities arise in animal populations, or their behavior either directly in the field or in a lab.

Frogs as bio-indicators

1. Most frogs require suitable habitat in both the terrestrial and aquatic environments, and have permeable skin that can easily absorb toxic chemicals.

2. These traits make frogs especially susceptible to environmental disturbances, and thus frogs are considered accurate indicators of environmental stress: the health of frogs is thought to be indicative of the health of the biosphere as a whole. Microbial indicators and chemical pollutants Microorganisms can be used as indicators of aquatic or terrestrial ecosystem health. Found in large quantities, microorganisms are easier to sample than other organisms. Some microorganisms will produce new proteins, called stress proteins, when exposed to contaminants such as cadmium and benzene. These stress proteins can be used as an early warning system to detect changes in levels of pollution.

Aquatic insects and other macroinvertebrates act as indicator of water quality. They are preferred bio-indicator for measuring water quality because -

1. Aquatic macro-invertebrates are found in nearly every body of inland (non-marine) water, so they are ubiquitous.

2. They are easy to collect compared to a lot of other things like fish.

3. They live in the water all the time and are reasonably long-lived. Pollution can and sometimes does occur steadily over time (imagine a wastewater treatment plant outfall or a paper mill dumping waste into a river). Sometimes, every trace of the pollutant has disappeared from the water by the time a researcher can collect water sample from the stream. However, many of the insects were in the stream during the pollution event. This means that, even if you can no longer find the pollutant in the water, or never even

knew a pollution event occurred, the organisms in the stream can show you that something is wrong.

Bio-indicators and bio-monitors

Bio-indicators qualitatively assesses biotic responses to environmental stress (e.g., presence of the lichen indicates poor air quality) while bio-monitors quantitatively determine a response (e.g., reductions in lichen chlorophyll content or diversity indicates the presence and severity of air pollution).

4.2. THREATS TO BIODIVERSITY

Extinction or elimination of a species is a natural process of evolution. Current trend in biodiversity loss is mainly attributed to anthropogenic pressure in the form of exploitation of bio-resources, degradation and loss of habitats, the rapid spread of invasive alien species (IAS) and climate change.

Loss of biodiversity has serious consequences for ecosystem functioning and flow of goods and services which would affect human wellbeing. The first noticeable effects of human activity on extinction rates can be seen in the elimination of large mammals from Australia, North and South America at the time humans first colonized these continents. For thousands of years, the total area of natural grassland and forest in North America, Central America, Europe and Asia has been steadily reduced to create pastures and farmlands to supply human needs.

Extinction rates are best known for birds and mammals. The highest species extinction rates during historic times have occurred on islands. The threat of extinction is greater for some groups of species than for others. The protection of rare species is an important focus of conversation efforts. Rare species are considered to be especially vulnerable to extinction. The term rare has a variety of meanings. A species may be considered rare if it occupies a narrow geographical range, like the Venus flytrap (*Dionaea muscipula*) occurring only in the savanna of the coastal plains of the Carolinas in the eastern USA. A species may also be considered rare if it occupies only one or a few specialized habitats. Salt marsh cord grass (*Spartina patens*) is found only in salt marshes and nowhere else. Finally, a species may be considered rare if it is found only in a small population. A species that is found in only a single geographical area is damaged by human activity, the population sizes of many species will be reduced, and

some species will go extinct. Ecologists have observed that not all species have an equal probability of going extinct, and particular categories of species are most vulnerable to extinction and such species need to be carefully monitored in efforts for conservation of biodiversity.

Causes of Species Extinction

1. **Habitat destruction**

The fragmentation of habitats of species of plants, animals, and microbes due to deforestation, construction of roads and railways tracks across natural ecosystems having rich biodiversity, mining activities, location of industries, construction of dams and reservoirs across major rivers passing through hilly and densely forested terrain etc. is the major cause of habitat destruction and loss which leads to large scale of loss of biodiversity.

Deforestation at ever increasing rate in many parts of the world has destroyed original places of endemic species. Large-scale deforestation in the Himalayan ecosystems, western and eastern Ghats of India has resulted in the widespread loss of habitats of several species. Large areas of forest covers, woodlands and grasslands have been converted into agricultural farms, commercial forests and grazing pastures throughout the world. Most of the temperature grasslands (e.g. steppes of Russia, prairies of USA and Canada, pampas of Argentina, veld of South Africa, downs of New Zealand) have been now converted into croplands. Tropical rainforests, having the richest biodiversity in the world, are being destroyed in many countries.

Wetlands have been reclaimed for various purposes such as for urban settlements, cropland etc. the mangroves provide suitable habitats for a number of species of land and marine organisms but now larger chunks of mangroves have been destroyed. Under coastal region development programs, shrimp farming and pisciculture. It may mention that fragmentation of habitats i.e. segmentation of habitats of large areal extent into smaller patches of habitats, reduces biodiversity as it separates populations of species into different isolated groups, reduces large habitats into small habitats etc. Such a situation impedes reproduction and speciation with the result isolated species become more vulnerable to diseases and extreme events such as volcanic eruption, prolonged, droughts, atmospheric storms, tsunamis etc., and are ultimately lost.

2. **Habitat Fragmentation**

Habitat that formerly occupied wide areas is now often divided up into pieces by roads, towns, canals, power lines etc. Habitat fragmentation is the process where a large, continuous area of habitat is both, reduced in area and divided into two or more fragmentations. The fragments are often a patchwork of habitat modified or degraded landscapes. Habitat fragments differ from the original habitat in two ways. One fragments have a greater amount of edge habitat fragmentation may limit the potential of species for dispersal and colonization. It also reduces the foraging ability of animals, habitat fragmentation causes such edge effects as microclimatic changes in light, temperature, wind etc.

3. **Overexploitation**

The harvesting of wild animals and plants beyond a critical sustainable limit may be termed as overexploitation. Here, the scope of overharvesting has been limited to the species of land and animal species. The overexploitation of species includes both legal and illegal actions. Illegal hunting by poachers for each item of animals which have a very high price in the world market has been responsible for the extinction or reduction in the number of species of animals in many parts of the world.

Overexploitation threatens about one-third of the endangered vertebrates in the world, as well as other species. Growing rural poverty, increasingly efficient methods of harvesting and the globalization of the economy combine to exploit species to the point of extinction even if a species is not completely eliminated by overexploitation the population size may become so low that the species is unable to recover.

4. **Shifting or Jhum Cultivation**

Some rural people destroy biological communities and hunt endangered species because they are poor and have no land of their own. In many countries, there is extreme inequality in the distribution of wealth, with the majority of wealth (money good farmland, timber resources etc.) owned by a small percentage of the population. the local poor people with a traditional way of life in rural areas have often established local systems of rights to natural resources. These local people are quite distinct from settlers who have arrived more recently and not close to the land. In fact, tropical areas of the world have had particularly a long association with human societies, species since the trophic have been free of glaciation and are particularly amenable to human settlement.

People have lived in every terrestrial ecosystem for thousands of years as hunters, gathers and farmers. A common pattern in many countries of the developing world is that local farmers are forced off their land by large landowners and business interests, often backed up by the government, the police and the army. The local farmers often have no choice except to move to remote underdeveloped areas and attempt to their livelihood through shifting cultivation.

This commonly practiced agricultural and jhum cultivation greatly affects forest structure and species composition by creating a mosaic of forest patches of different ages. In shifting cultivation, plots of natural free vegetation are burnt away and the cleared patches are formed for two or three seasons, after which after which their fertility goes down to a point where adequate crop production is no longer possible. The trees are cut down, the fallen material is burnt and crops are planted in nutrients-rich ash. After two or three harvests, the nutrients are washed out of soil by the rain. The farmers then abandon this patch and cuts down a new patch of forest trees elsewhere for crop production. This systems, jhum cultivation in northeast India is practised in these areas because the farmers are unwilling to spend the time and money required to developed more permanent forms of agriculture on land that they do not own and may not occupy for very long. This system works well and does not degrade environmental much as long as human population density is low and there is low and there is abundant forest land and move to remote, underdeveloped are species, as where they feel move safely. In such a situation rather than being called shifting cultivators in order to distinguish them from traditional farmers who have long inhabited rainforest areas.

5. **Invasive Alien Species**

Habitat has obvious distribution, biological harmful fragmentation, effects communities are intact, insignificant losses can be taking place due to changes caused by human activities. Three such changes caused changes are the introduction of exotic species, increased level of diseases and excessive exploitation of particular species are European colonization, horticulture and agriculture, and accidental transport.

The great majority of the exotic species may kill or eat native species at the point of extinction, or may so alter the habitat that many native species to the point of extinction, or may so alter the habitat that many natives are no longer able to persist the effect of erotic species is maximum on islands. Diseases causing microorganisms, if

introduced to new virgin areas may cause epidemics and are eliminated completely. Invasive alien species (IAS) and non-native or exotic organisms that occur outside their natural dispersal potential. They are known by several other names such as native introduced.

Some Local Threats in Meghalaya

- **Over-exploitation of Forest Products**: One of the direct and major threats to biodiversity and ecosystem services in Meghalaya is over-exploitation of forest leading to soil erosion and land degradation. As most of the people living in and around forests are primarily dependent on forest products, there is excessive extraction of Non-timber Forest Products (NTFP) from the protected areas, community forests and village forests.

  Some of the NTFP extracted from the forested areas include medicinal plants, fruits, vegetation, brooms, etc. The harvesting of Agar (*Aquilaria malaccensis*), many orchid species and medicinal plants from the forest is a regular practice in the southern parts of the Nokrek Biosphere Reserve. Many species of orchids are illegally smuggled out of the biosphere reserve and sold in nearly markets by the local villagers (Singh et al. 2011).
- **Shortening of Jhum Cultivation Cycles**: The increasing population, globalization and demand for cash income has pushed the traditional jhums to a form of distorted jhum practices. The original jhum cycle allowed maintenance of forest cover through a process of restoration for 10-15 years, which is now reduced to 3-5 years. The shortening jhum cycle has therefore depleted soil nutrients thereby reducing production and affecting recovery of forest. An increasing incidence of jhum and shortening of jhum cycle are the main factors responsible for the loss of forest cover and a significant reduction in agricultural outputs (Mishra & Ramakrishnan 1982, Ramakrishnan 1985, Kushwaha & Kuntz 1993). The study on forest management in Garo Hills Conservation area found highly fragmented patches of forests in south western portion of Garo Hills (Kumar et al. 2002). Task force on Shifting Cultivation (1983) estimated that nearly 3.81 million ha of forest areas in North Eastern India has been deforested for jhum.

- **Invasive Alien Species**: Invasive alien species (IAS) are considered among the major threats to global biodiversity. These species not only affect the life cycle of native species but also alter the habitat condition negatively affecting the regeneration of many species leading to loss of wildlife habitat and ecosystem services. Invasive species of flora and fauna can progress through the stages of introduction, establishment and dispersal to a full range through various pathways. In India, most of the invasive species are intentional or unintentional introductions.

  A detailed study on status and distribution of invasive plants in Meghalaya by Naithani (2014) reveals that the following species have led to drastic changes in the structure and composition of native vegetation in the state: *Lantana camara, Mikania micrantha, Eupatorium adenophorum, Bidens pilosa, Triumfetta rhomboidea, Ageratum conyzoides, Spilanthes clava, Hyptis suaveolens, Spermacoce hispida, Sida acuta* and *Solanum viarum*. This study has also given an exhaustive list of invasive plants in various districts.

- **Climate Change**: The Climate Change Research Institute (CCRI) and India Meteorological Department (IMD) indicate significant change in climatic pattern in the state. Overall, the temperature shows an increase though the state with localized variations. The western part of the state exhibits an increase in minimum temperature while the central part exhibits a high increase in maximum temperature. It is predicted that during 2021 to 2050, there would be an increase temperature, in different district by 1.6-1.9 °C. It is also seen that there has been an overall increase in rainfall during last 100 years. The district of West and East Garo hills, however, showed drastic decrease in rainfall (MSCCAP, 2011). There are, however still the preliminary results and more extensive data collection and analysis is required to project climate Change in temperature, rainfall and also increasing pest outbreaks. A growth simulation model based on INFOCROP (Aggarwal et al. 2006 ab) predicts high to moderate vulnerability of rice crop in terms of products in various districts (MSCCAP, 2011). Even though Meghalaya is the wettest place, the state still experiencing shortage of potable water during summer. Studies on climate change in eastern Himalaya indicate that the climate changes could lead to diminishing crop and livestock diversity which will have implications for

agrobiodiversity and food security. Climate change, especially warming is known to cause upward migration of both plants and animals. Climate change increase risk for species with narrow geographic range or climate range, particularly larger or more specialized species.

4.3. IMPACT OF FLORA AND MACROINVERTEBRATES ON THE STUDY AREA.

WWF has identified the Eastern Himalayas as a priority Global 200 Ecoregion while Conservation International has up-scaled the Eastern Himalaya Hotspot which initially covered the states of Arunachal Pradesh, Sikkim, Darjeeling Hills, Bhutan, and southern China to the Indo Burma (Hotspot) which now includes all the eight states of North East India, along with the neighboring countries of Bhutan, southern China and Myanmar. The population and diversity of the region's birds largely reflects the diversity of habitats associated with a wide altitudinal range. North East India supports some of the highest bird diversities in the orient with about 850 bird species. The Eastern Himalaya and the Assam plains have been identified as an Endemic Bird Area by the Royal Society for Protection of Birds, (ICBP 1992). The global distribution of 24 restricted-range species is limited to the region. The region's lowland and montane and moist-to-wet tropical evergreen forests are considered to be the most northernmost limit of true tropical rainforests in the world.

The region has been identified by the Indian Council of Agricultural Research as a center of rice germplasm while the National Bureau of Plant Genetic Resources (NBPGR), India, has highlighted the region as being rich in wild relatives of crop plants. It is the center of origin of citrus fruits. Two primitive variety of maize, Sikkim Primitive 1 and 2 have been reported from Sikkim (Dhawan,1964). Although jhum cultivation, a traditional system of agriculture, is often cited as a reason for the loss of forest cover of the region, this primary agricultural economic activity practiced by local tribes reflects the usage of 35 varieties of crops. The region is rich in medicinal plants and many other rare and endangered taxa. Its high endemism in both higher plants, vertebrates and avian diversity has qualified it to be a biodiversity 'hotspot' and this aspect has been elaborated in details in the subsequent sections. In 1995, International Union for Conservation of Nature identified Namdapha in Arunachal Pradesh as a center of plant diversity.

The following figures highlight the biodiversity significance of the region:

- 51 forests types are found in the region broadly classified into six major types- tropical moist deciduous forests, tropical semi evergreen forests, tropical wet evergreen forests, subtropical forests, temperate forests and alpine forests.
- Out of nine important vegetation types of India, six are found in the North Eastern region.
- These forests harbor 8,000 out of 15,000 species of flowering plants. In floral species richness, the highest diversity is reported from the states of Arunachal Pradesh (5000 species) and Sikkim (4500 species) amongst the North Eastern States.
- According to the Indian Red data book published by the Botanical Survey of India, 10 percent of the flowering plants in the country are endangered. Of the 1500 endangered floral species, 800 are reported from North East India.
- Most of the North Eastern states have more than 60% of their area under forest cover, a minimum suggested coverage for the hill states in the country.
- North East India is a part of the Indo Burma 'hotspot'. The hotspot is the world's second largest, next only to the Mediterranean basin with an area 2,206,000 square kilometers (825,000 sq. mi.) among the identified.

Insects are important because of their biodiversity, ecological role, and influence on agriculture and natural resources. This chapter documents the dominance of insects in the study area and shows how they have been central to many ecological lives. Insects create the biological foundation for all terrestrial ecosystems. They cycle nutrients, pollinate plants, disperse seeds, maintain soil structure and fertility, control populations of other organisms, and provide major food resources for other taxa. Most major insect's pests in agriculture are non-native species that have been introduced into a new ecosystem, usually without their natural biological control agents.

Positive impacts of macroinvertebrates

i. **Pollination**: Pollination is a process by which plants propagate their species. Small animals and insects play an important role in pollination. Insect pollination results in a uniform crop and, in some cases, an improvement of quality of fruit. A very good example of an insect which is a good pollinator is a honey bee.

ii. **Predators and Parasites**: Some insects are very valuable to man because they kill the insect pests feeding the crops. Examples: mud wasps feed on caterpillars, ants feed on various types of insects, birds feed on insects, thus protecting the crop. It is always necessary therefore to grow trees in fields along the bunds, to enable birds to nest in them and feed on the insects in the field.

iii. **Insects as weed killers**: Some of the insects feed on menacing weeds and destroy them and so they are considered helpful to man. In many cases the presence of these insects has led to the complete eradication of the weed of the weed or at least in keeping it under check.

iv. **Insects as soil builders**: Some insects like ants, bees, larvae, flies, crickets and earthworms are found in the soil. Ants, termites, bees and wasps build terrestrial nests and during the process of making tunnels and burrowing into the soil, the soil particles gets disintegrated. Soil aeration is facilitated. Sub-soil is brought to the surface resulting in the turning of the soil and the soil is enriched by addition of insect of saliva. The excreta and the bodies of dead insects also enrich the soil. The earthworm also plays a very important role in soil building, in fact the earthworm is known as the "*friend of the farmer*".

v. **Insects as scavengers**: These are insects which feed upon the dead and decaying plant and animals matter. Since insects help to remove from the Earth's surface the dead and decomposing bodies, which could otherwise be a health hazard, they are referred to as scavengers. In addition to cleaning the filth from human habitations, these insects help to convert dead bodies into simpler organic substances, before returning them to the soil where they become easily available as food for growing plants. Examples: termites, maggot of flies, larvae and adults of beetles, etc.

A few common insects whose existence is taken for granted and their ecological relevance are:

* **Butterflies**: they are important pollinators like bees. This lime butterfly is mostly dependent on citrus plant species and other nectar plants throughout its life cycle and is a good indicator of environmental health.

* **Dragonflies**: One of the most widely recognized insects, need clean aquatic systems and are a good indicator of health of local aquatic systems. These, along with damselflies, are well known biological predators with both larvae and adults acting as natural biocontrol agents. They are highly sensitive to changes in their habitats and are declining due to increasing habitat loss, anthropogenic activities, pollutants, climate change and rapid urbanization.
* **Grasshoppers**: Feed on different plants and can cause serious damage to economic crops. However, in a biodiversity-rich region, they are an important component of the food chain, being an important food source for many birds.
* **Paper wasps**: They are important for the environment. They act as predators and devour pests including greenflies and caterpillars. Wasps are good pollinators as well. Many flies act as pollinators too. Their larval stages are parasitoids of eggs and larvae of other insects helping to keep the host species under control.
* **Rainbow leaf beetles**: They are found in forests, woodlands and mountain grasslands. They mostly depend on leaves and flowers of some specific plant family like Apocyanaceae. The species are also known to be poisonous to its predators for they feed on dogbane that contains poisonous cardenolides.
* **Fireflies**: They are a good indicator of a healthy environment, especially a good aquatic system. They avoid regions with chemical toxicity. They are good pollinators and natural pest control agents in several ecosystems.

5.1 FINDINGS

One field survey tour was carried out for the sampling and documentation of the floral and macroinvertebrate species of the study site (*see Fig. 1*). Different variety of plants and macroinvertebrates, belonging to different genera and families were found during the study. These diverse lifeforms are due to many interdependent geographical and anthropogenic factors such as climate, soil, relief, water, land use patterns, etc. The diverse flora of the region includes elements from tropical Indo-China, Indo-Malayan or temperate East Asia and the Gondwana heritage of Deccan Plateau. The high altitudinal range, topography, varied rainfall and edaphic conditions accord a unique array of vegetation to the state, which ranges from tropical to sub-tropical types (Gatphoh 1937, Kanjilal et al. 1982, Raychaudhuri 1992, Hussain 1992 & 1994, Elias 1994, Kharbuli et al. 1999). Biogeographically, the region is divided into Eastern Himalayas and Northeast India (Rodgers & Panwar 1988).

5.1.1. Floristic diversity

A total of 28 plant species, belonging to 28 genera and 21 families were documented; one sample was identified up to the genus level. The list of plant species identified in Mawtneng Village are shown in *Table 4*. Enormous floral diversity exists in the study site, but due to limited time and resources, only the above numbers of species were documented, which were relevant to the research topic only. The studied plant families are clustered into four groups based on their occurrence. The Asteraceae is in Group I, represented by 4 genera and 4 species each. Poaceae in Group II, represented by 3 genera and 3 species each. In Group III, Verbenaceae and Solanaceae are represented by 2 genera and 2 species each respectively. The remaining 18 families are represented by 1 genus and 1 species each (*see Table 7*). The top 4 dominant plant families of the study area are shown in *Fig.11*.

The plants are also classified according to their growth habit into 6 groups viz. herb, shrub, subshrub, subshrub or shrub, shrub or tree and tree (*see Fig.12*). According to growth habit analysis, Herb possessed the highest number of species i.e. 10 species, followed by Shrub (9 species), Subshrub (2 species), Subshrub or shrub (2 species), Shrub or tree (4 species), and Tree (2 species). The important herbs include *Diplazium esculentum* (Retz.) Sw., *Potentilla indica* (Andrews) Th. Wolf, *Setaria palmifolia* (J. Koenig) Stapf, *Persicaria hydropiper* (L.) Delarbre, *Crassocephalum crepidioides*

(Benth.) S. Moore, *Phrynium pubinerve* Blume, *Leersia hexandra* Sw., *Dietes grandiflora* N.E.Br., and *Eleocharis ovata* (Roth) Roem. & Schult.

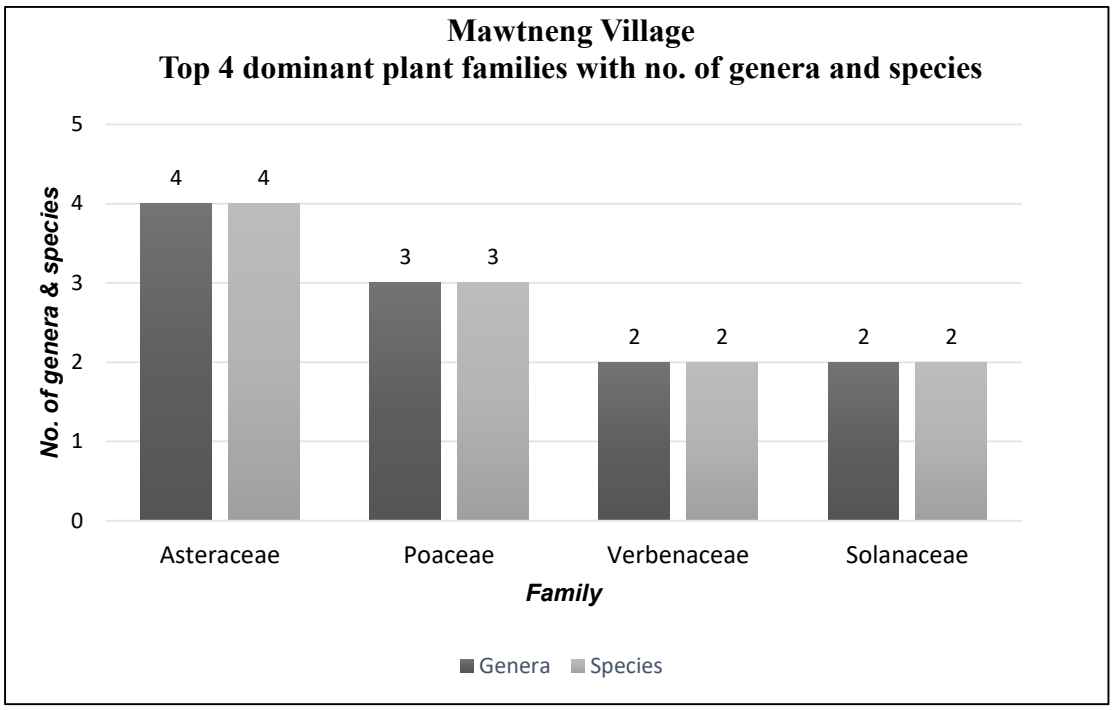


Fig.11. Top 4 dominant plant families in Mawtneng Village, Ri Bhoi, Meghalaya

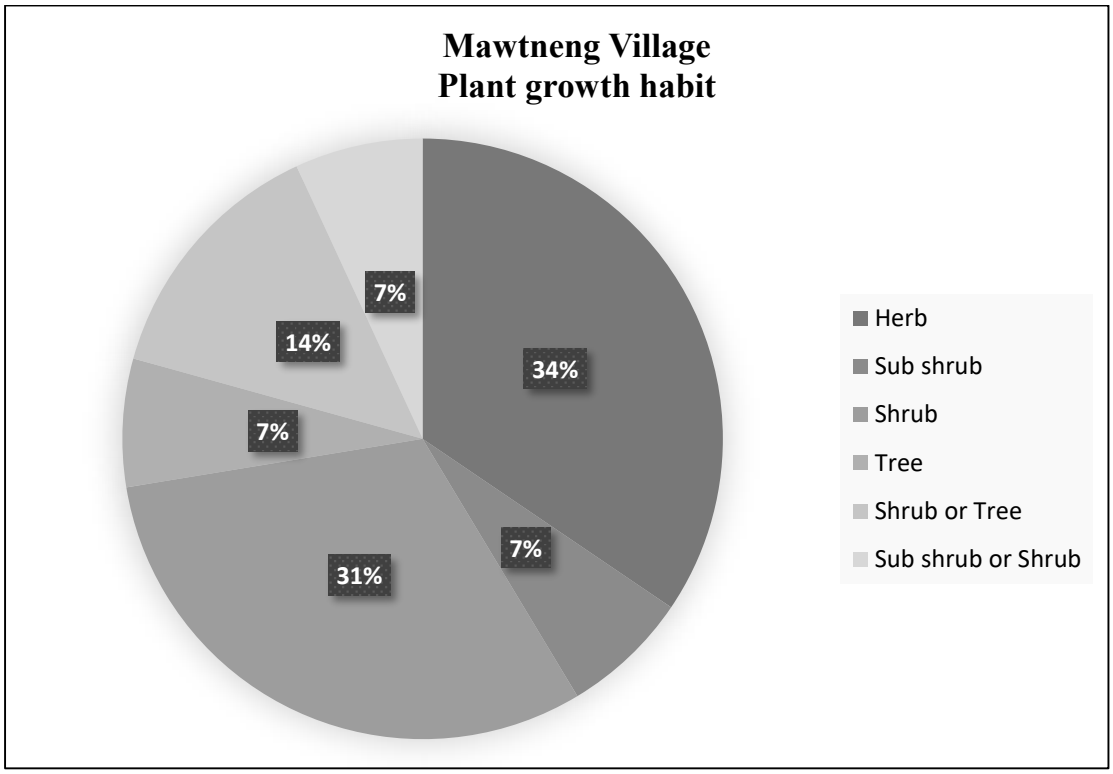


Fig.12. Growth habit wise distribution of plant species in Mawtneng Village, Ri Bhoi, Meghalaya

Table 7: List of plant families, genera and species at Mawtneng Village, Ri Bhoi

Family	Genera	Species	Group
Asteraceae	4	4	I
Poaceae	3	3	II
Verbenaceae	2	2	III
Solanaceae	2	2	
Cannabaceae	1	1	IV
Lamiaceae	1	1	
Marantaceae	1	1	
Theaceae	1	1	
Bromediaceae	1	1	
Musaceae	1	1	
Euphorbiaceae	1	1	
Iridaceae	1	1	
Fabaceae	1	1	
Araceae	1	1	
Acanthaceae	1	1	
Polygonaceae	1	1	
Cyperaceae	1	1	
Rosaceae	1	1	
Aspleniaceae	1	1	
Melastomataceae	1	1	
Dilleniaceae	1	1	
Zingiberaceae	1	1	
Total	29	29	4

Similarly, the common shrubs are *Colocasia esculenta* (L.) Schott, *Solanum viarum* Dunal, *Flemingia strobilifera* (L.) W.T.Aiton, *Hedychium gardnerianum* Sheppard ex Ker Gawl., *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda, *Brugmansia suaveolens* (Humb. & Bonpl. ex Wild.) Sweet, *Eranthemum pulchellum* Andrews, and *Duranta erecta* L. Only one important timber yielding tree species was observed i.e. *Schima wallichii* (DC.) Korth. The flora of Meghalaya comprises about

4,243 species of flowering plants belonging to 1449 genera and 216 families (Mao et al. 2016), of which a large number of species are endemic (Khan et al. 1997). The flora of the Khasi and Jaintia hills is most richly saturated by eastern Asiatic elements, and the area is one of the most important centres of survival of the tertiary flora of eastern Asia (Takhtajan 1988). Some of the flowering plants documented in the study sites are *Melastoma malabathricum* L., *Brugmansia suaveolens* (Humb. & Bonpl. ex Wild.) Sweet, *Dietes grandiflora* N.E.Br., *Duranta erecta* L., *Flemingia strobilifera* (L.) W.T.Aiton, etc. Besides the tall trees, herbs and shrubs species, the upper storey of the vegetation was covered by epiphytes like lichens, ferns, orchids, and bryophytes. The paddy fields, open grounds, and the river plains are also covered with other herbaceous species, which are distributed all over the study area.

After analyzing and studying each of the plant species, it is found that all of them exhibits some form of value or uses. *Phrynium pubinerve* Blume (locally known in Khasi as Sla Met), is found widely distributed in the study area and elsewhere in Meghalaya and Northeast; the leaves of which are being used by the locals as wrapping and packing material as alternative of plastic. The State of Meghalaya harbours about 850 species of medicinal plants, of which 377 species are used by 70-80% population. A good number of medicinally important herbs, shrubs, and climbers were also encountered in the study area. Almost all the observed plants species have medicinal properties used for treatments of wounds and other diseases. *Mikania micrantha* Kunth (known locally as Bat karo/Bat refujee/Mei India) is used by the people of the village and elsewhere in the Sate as a traditional medicine to stop bleeding and as antiseptic. Other medicinal plants documented in the study area includes *Ageratum conyzoides* L., *Ageratina adenophora* (Spreng.) King & H. Rob., *Euphorbia neriifolia* L., *Setaria palmifolia* (J. Koenig) Stapf, etc. Ornamental plant species such as *Trema orientale* (L.) Blume, *Duranta erecta* L., *Dietes grandiflora* N.E.Br., *Dietes grandiflora* N.E.Br., etc. are distributed widely in the area.

Some invasive alien species are also observed frequently such as *Lantana camara* L., *Mikania micrantha* Kunth and *Ageratina adenophora* (Spreng.) King & H. Rob., which are great nuisance to the area, negatively affecting the native flora of the hills. There are 249 wild species of edible plants belonging to 153 genera which are still consumed by people in Meghalaya (Sawian et al. 2007). The people of the village also used many cultivated and wild plants as food such as *Colocasia esculenta* (L.) Schott,

Clerodendrum colebrookianum Walp., *Ananas comosus* (L.) Merr., *Diplazium esculentum* (Retz.) Sw., and *Potentilla indica* (Andrews) Th. Wolf. Further, the plant species were classified according to their IUCN Red List status. Many of the observed species were evaluated by IUCN, only a few were not evaluated. Among the evaluated plant species, all of them, except *Melastoma malabathricum* L., *Clerodendrum colebrookianum* Walp., *Crassocephalum crepidioides* (Benth.) S. Moore, and *Brugmansia suaveolens* (Humb. & Bonpl. ex Wild.) Sweet falls under the Least Concern (LC) category of the IUCN Red List. *Brugmansia suaveolens* (Humb. & Bonpl. ex Wild.) Sweet, which the IUCN has classed as Extinct in the Wild (EW) was also observed in the study area, as a cultivated plant.

Since Mawtneng Village provides necessary habitats such as water bodies, good soil, favorable climate, swamps, paddy fields, forests, open grounds, etc., the plant diversity is rich in the area, with many plants growing without much disturbances. However, some human and domesticated animal activities could be seen which may pose a threat to the local plants such as over grazing and uncontrolled grazing, improper agriculture practices, cutting of tress for firewood, expansion of settlement, roads and infrastructure, and other unsustainable practices.

5.1.2. Macroinvertebrate diversity

Similar to the plant diversity, rich faunal diversity has also been observed at Mawtneng Village. Habitat heterogeneity (variations in soil types, vegetation, and microclimates), environmental conditions (temperature, pH, and dissolved oxygen), vegetation cover, dispersal ability, land use, etc. greatly affects the richness of terrestrial macroinvertebrates of the area. The faunal diversity of Meghalaya constitutes a total of 5538 species recorded so far, of a total 89,451 species known from India. Nearly 35% of Indian Mammals and 50% of Vertebrates including birds are represented in the state (ZSI,1995). Invertebrates are represented by 2114 genera and 4580 species, of which 3624 species are insects. Among invertebrates, the porifera is the smallest group represented by only one genus and one species (Pattanayak 1999).

During the course of the study, a total of 21 macroinvertebrate taxa belonging to 14 families and 1 subfamily were collected, amongst which 11 taxa were identified to genus level (*see Table 5*). The common macroinvertebrate taxa identified to species level includes Paddyfield Parasol, Carinate Locust, Chinese rice grasshopper, Black-

Striped Orchard Spider, Asian Honey Bee, Great Evening Brown, Red-spot Jezebel, Dark-branded Bushbrown, Black-and-white Spiny Spider, and *Graptostethus incertus.* The studied families are clustered into three groups based on their dominance. The family Acrididae is placed in Group I represented by 3 genera and 3 species. Tetragnathidae, Erebidae, Nymphalidae and Pieridae are placed in Group II, which are represented by 2 genera and 2 species each respectively. The remaining 9 families and 1 subfamily are in Group III, represented by 1 genus and 1 species each respectively (*see Table 8*). Of the 14 families, 5 families are dominant in the landscape (*see Fig.13*).

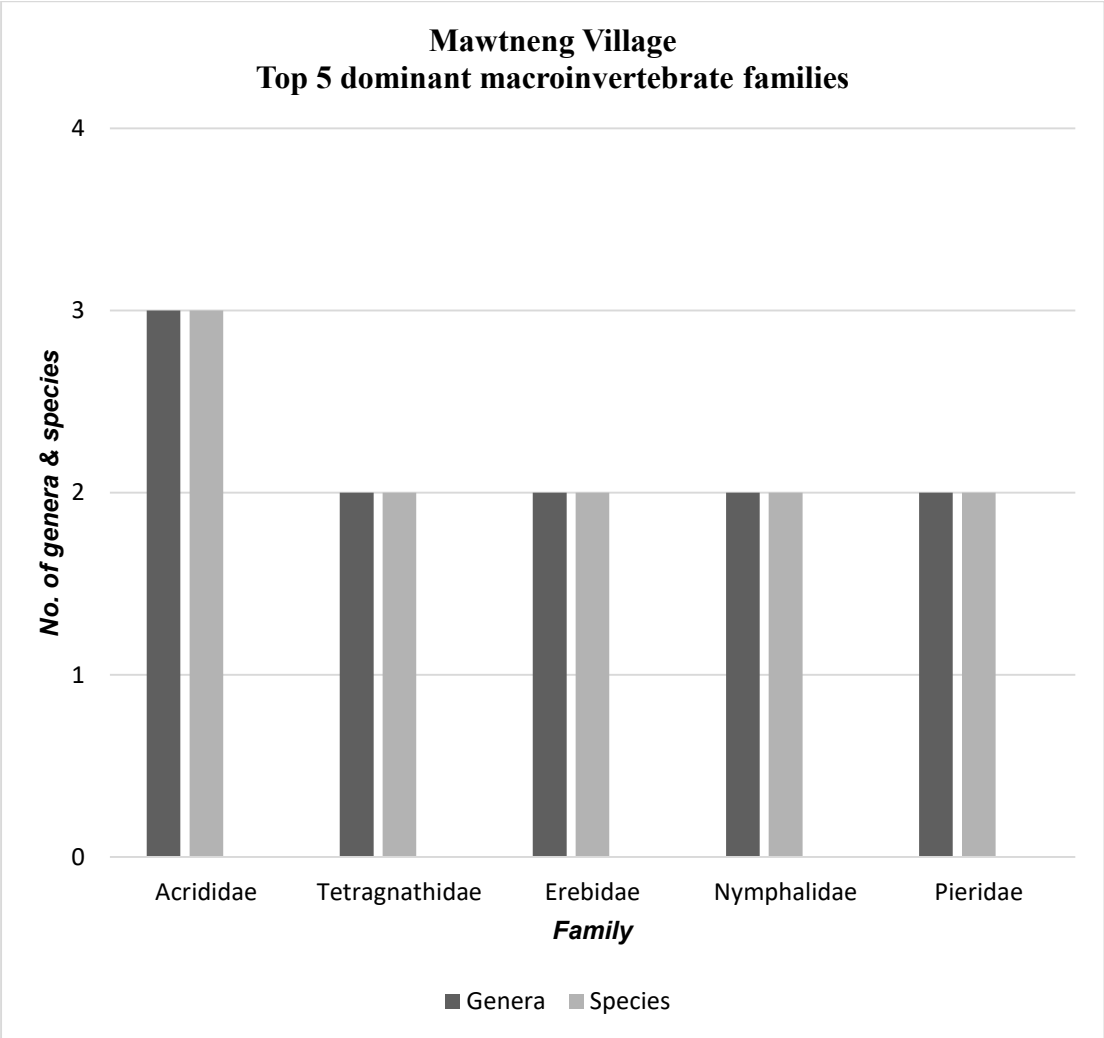


Fig.13. Top 5 dominant macroinvertebrate families in Mawtneng Village, Ri Bhoi, Meghalaya

Table 8: List of macroinvertebrate families, genera & species in Mawtneng Village, Ri Bhoi

Family	Genera	Species	Group
Acrididae	3	3	I
Tetragnathidae	2	2	II
Erebidae	2	2	
Nymphalidae	2	2	
Pieridae	2	2	
Apidae	1	1	III
Carabidae	1	1	
Formicidae	1	1	
Libellulidae	1	1	
Sclerosomatidae	1	1	
Linyphiidae	1	1	
Araneidae	1	1	
Thomisidae	1	1	
Lygaeidae	1	1	
Macrotermitinae *(sub family)*	*	1	
Total	20	21	3

The invertebrate diversity of Meghalaya is represented by 4,580 species belonging to 2094 genera. The Fauna of Meghalaya series by ZSI (1995-2000) gives an exhaustive list of invertebrates including 223 species of mollusks belonging to 67 genera and 28 families. Every year, new species of insects are discovered from Meghalaya. For example, in 2014 alone, five species of insects viz. *Micraspis pusillus, Alaptus jowainus, Paraleptomenes darugiriensis, Gonatocerus jaintiacus, Berta apopemta* were recorded (ZSI, 2014). In this study, the species belonging to the order Araneae i.e. Spiders, which constitutes the largest order of Arachnids are distributed widely throughout Mawtneng Village. They are found to inhabit the gardens, fences, flowers, shrubby areas, bamboo grove, forest, river, ponds and other water bodies, and the open paddy fields surrounding the village. Six species of spiders of the families Tetragnathidae, Thomisidae, Sclerosomatidae and Araneidae were documented. These identified spider species include *Black-and-white Spiny Spider (Gasteracantha kuhli), and Black-Striped Orchard Spider (Leucauge celebesiana).* Similarly, the species belonging to the family Acrididae (Short-horned Grasshoppers) which includes *Trilophidia annulata, Oxya chinensis,* and the genus *Stenocatantops* were found inhabiting the landscape, mostly found in the paddy fields, open land, and forest

surrounding the village. Butterflies are also common. According to an estimate, the state of Meghalaya is likely to have over 500 species of butterflies. A total of 298 species of butterflies have been reported from Garo Hills, eight of which are listed under Schedule I and 33 under Schedule II of Wildlife (Protection) Act, 1972 (Kunte et al. 2012, Sondhi et al. 2013). In our study, 3 species of butterflies were documented and identified. These includes Great Evening Brown (*Melanitis zitenius),* Dark-branded Bushbrown (*Mycalesis mineus),* and Red-spot Jezebel (*Delias descombesi).* The butterfly species are widespread in the Indian subcontinent and Southeast Asia. Other macroinvertebrates observed during the study includes Asian Honey Bee, Vivid Metallic Ground Beetles, Tiger moths, Acrobat Ants and Cocktail Ants, Fungus-growing termites, Paddyfield Parasol, and *Graptostethus incertus.*

SUGGESTION AND CONCLUSION

In total, 29 plant species and 21 macroinvertebrate species were identified during our one-day fieldwork to Mawtneng Village, Ri Bhoi, Meghalaya. Based on our study and analysis of the different species and the natural environment of the study area, here are some of the suggestive measures that can be adopted:

i. Providing awareness and educating the people on the importance of macro invertebrates as they serve several functions within the terrestrial and aquatic ecosystem. They provide a valuable "cleaning service" by scavenging dead and decaying bacteria, plants and animals, which helps recycle nutrients back into the system. They are important food for fish, birds, amphibians and reptiles.
ii. To conserve the diversity of flora in the study area, the clearing of forest areas for firewood or agriculture should be monitored and controlled.
iii. Promote sustainable agriculture practices that minimize habitat destruction, such as agroforestry, organic farming and integrated pest management.
iv. Conduct regular community-based monitoring and research to assess the health of ecosystems, identify threats, and develop effective conservation strategies.
v. Implementing land use plans that protect diverse habitats, such as protected area, buffer zone, etc.
vi. Engaging the villagers in conservation efforts through education, awareness campaigns, and involvement in habitat restoration projects.

vii. Proper utilization and efficient use of Government schemes and programs for overall development of the village and its surrounding.

There are many limitations which can be found in this research work, which, indeed occur in every research. Some of the drawbacks of our study are time constraint, small area coverage, limited resources and expertise, limitation in the methods and materials, small sample size, and availability of limited scientific literature of the study area. These limitations greatly influenced the quality of our research findings. Also, due to limited equipment and pre-field work briefing, the collection and identification of species samples were not satisfactory. However, the present inventorisation and documentation of plant and macroinvertebrate diversity of Mawtneng Village will immensely help in enriching the current academic research on the topic. It will also provide the necessary information and details about plant and macroinvertebrates of Mawtneng Village, thereby, acting as a valuable resource to create awareness and educate the local people as well as the academic community. Flora and fauna play a fundamental role in the ecosystem. Flora serves as the primary producers, capturing energy from the sun through photosynthesis and formed the foundation of energy flow in the ecosystem. Macroinvertebrates, from insects to spiders, to worm, plays a critical role in nutrient cycling, decomposition, soil aeration, and pollination.

Preserving the biodiversity in Mawtneng Village is not only crucial for the environment, but also for the cultural, economic well-being of the community, and for the future generations. It could call for integrated approaches that include community engagement, scientific research, and policy making to ensure sustainable development while maintaining the rich biodiversity of the region. Last but not the least, this research is just the tip of an iceberg, which provides the foundation of future researches. Future studies could build on our research by using larger and more diverse samples to validate and expand on our findings.

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Application (App) used for Species Identification

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LAND USE / LAND COVER AND LAND CAPABILITY ”

A CASE STUDY OF MAWTNENG VILLAGE,

BHOIRYMBONG, RI-BHOI DISTRICT, MEGHALAYA.

Submitted by : Wandaphira Kharsyiemiong
Exam Roll No : A2107192
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Submitted in partial fulfilments of the requirements for the Degree of the Bachelor of Arts in Geography

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CERTIFICATE

This is to certify that Ms/Mr WANDAPHIRA KHARSYIEMIONG is a VI Semester Geography Honours student; St. Edmunds College Shillong. He/She has undergone a project title LAND USE LAND COVER AND LAND CLASSIFICATION under the supervision of Sir/Madam. MARK J.FORD. This Project is a bonafide work of the student and has not been published in any form whatsoever. Hence, this report maybe placed for evaluation and consideration.

M.J Ford
Associate Professor
(Supervisor)

O.M.Kharmawphlang
Head of Department

Shillong
Dated the 10th of May, 2024

CONTENTS

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I would like to express my gratitude to he Principal Br. Simon Coelho for granting us the permission to go for the field trip at Mawtneng village in Ri-Bhoi District , Meghalaya.

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Shillong

Dated 10th of May 2024

Wandaphira Kharsyiemiong

6th Semester

IMPORTANCE OF FIELD STUDY

The project report on **"LAND USE LAND COVER AND LAND CAPABILITY"** is a case study of **MAWTNENG VILLAGE**. Before discussing about this particular study it is necessary to understand the meaning and importance of field study .

As the term suggest, field studies are learning experience outside of the classroom. Field studies allow students to gather their own primary data, provide oppportunities to extend classroom learning through direct observation and experience and allow for scientific research through field study

In geography the word field study is used as a generic term to cover the methods by which primary data is obtained. It is an empirical study undertaken on the subject. Field study in geography is very important as it involved the minute observation of landscape both natural and cultural in the field.

Field study constitutes important aspects of geographical studies. It helps in understanding the realities of man and the environment in his immediate surroundings and their connection to one another. The importance of field study is as follows:-

1. It is of great pedagogical importance as it lets students experience the geography of a particular region which theoretical context cannot do.
2. Field study enhances our understanding about patterns and spatial distributions, their associations and relationships at the local level.
3. Field study facilitates the collection of local level information that is not available through secondary sources.
4. It is very important as it helps to gather required information so as the problems under investigation is studied in depth as per the predefined objectives.
5. Field studies enable the investigator to comprehend the situation and processes in totality and at the of their occurrence.
6. All the geographical skills are used in practical during field work. We get to learn and apply the skills of sampling, data collection, data processing, making questionnaires, map making, statistical techniques to derive results, observational skills and skills of interviewing, etc.
7. It helps us understand theoretical concepts better.
8. In a field study, working with a partner or in a group gives us opportunities for interactive learning.
9. It gives us a chance to experience a wide variety of environments and landscapes.
10. Develops an understanding and sensitivity about the culture of environments and landscapes.

CHAPTER 1

INTRODUCTION

Land use is the term used to describe the human use of land. It represents the economic and cultural activities like agricultural, residential, industrial , mining and recreational uses that are practiced at a given place. According to Food and Agricultural Organisation (1999), "land use is defined as the total arrangement activities and inputs that people undertake in certain land cover type." The utilisation of land depends upon physical factors like topography, soil, climate as well as upon human factors such as the density of population duration of occupation of the area.

Land cover is the physical material at the surface of the earth. It includes grass, asphalt, trees, bareground, water, etc. Land use is the observed (bio) physical cover on the earth's surface. According to Food and Agricultural Organisation (1999), "land cover is defined as the observed physical cover on the earth's surface including vegetation and human constructions."

Land capability may be defined as the ability of the land to support natural plant growth / wildlife habitats or human habitats Land capability is based on the understanding that every component of land has its own particular capacity to provide ecosystem services. According to Food and Agricultural Organisation (1983), land capability is the "quality of land to produce common cultivated crops and pastures plants without deterioration over a long period of time. Land sustainability is the fitness of a given type of lands for a specified kind of land use."

Land use classification

Land is used for various purposes to grow plants and livestock for food and fibre. Depending on the soil type and the terrain, they may be many potential uses a specific parcel of land. According to the Indian general land use are as follow:

1. Total geographical area
2. Total reporting area
3. Forests
4. Area not available for cultivation
    a. Non-agricultural areas
    b. Barren and uncultivable land
5. Other uncultivated land excluding fallow
    a. Permanent pastures and grazing land
    b. Land under tree crops and groves
    c. Culturable waste
6. Fallow land
    a. Current fallow
    b. Other fallow

7. Net sown area
8. Area sown more than once
9. Total cropped area
10. Area under irrigation

Land capability classification

Land capability classification is a scientific appraisal of the physical characteristics of the land, its inherent soil qualities and the management practices. It is based on the regional units thus surveyed delineate problematic and potential arable lands responsive to the use of bio chemical techniques and to varying degrees of farm management practices. In simple words, it is the arrangement of land units into a variety of categories based on the properties of the land or its suitability for a particular purpose.

The first Land Capability Classification was first developed in USA by the Soil Conservation Service (now called the Natural Resources Conservation Service) in the late 1930s and early 1940s. In India the primary aim of soil survey has to achieve land capability classification. The All India Soil and Land Use Survey organisation has identified eight different land use capability classes. These are as follows:

Land suitable for cultivation

Class I: Very good cultivable land with no special difficulty in farming.

Class II: Good cultivable land which needs protection from erosion or floods, drainage improvement and conservation of irrigation water.

Class II: Moderately good cultivable good cultivable land where special attention has to be paid to erosion control, conservation of irrigation water, intensive drainage and protection from floods.

Class IV: Fairly good land suited for occasional or limited cultivation needs intensive erosion control intensive drainage and very intensive treatment to overcome soil limitation.

Land not suitable for cultivation

Class V: Very well suited for grazing but not for arable farming, needs protection from gullying.

Class VI: Well suited for grazing or forestry but not for arable farming.

Class VII: Fairly well suited for grazing or forestry but not for arable farming.

Class VIII: Suited only for wildlife, recreational facilities and protection of water supplies.

STATEMENT TO THE PROBLEM

The forces of nature often destroy the soil cover of an area. The process of soil destruction is the result of natural forces as well as human activities like deforestation, unscientific use of agricultural land etc. Such damage and destruction causes the following problems on the land and soil:

1. Soil degradation : Soil degradation is one of the most serious problems associated with high input farming. Degradation of the soil usually stems from the hallmark of conventional intensive farming , erosion , soil compaction, loss of nutrients and biotic activity and poisioning by , chemicals , salt acid or bases
2. Soil erosion : Soil erosion refers to the removal of top soil . Soil erosion is a growing menace in many parts of the world. Soil erosion is a very slow process involving thousands of years. Although soil erosion is a natural process, faulty and careless cultural practices, especially in areas of steep slopes, thin or loose layer of soil hastens the process of soil erosion.
3. Use of synthetic agricultural chemicals: the intensive use of agro chemical fertilisers and pesticides causes serious environmental problems. With the constant use of pesticides, organisms begin to show resistance to the chemicals. Pesticides can kill off beneficial organisms that prey on pests.
4. Over irrigation: Excess water due to over irrigation leaches away nutrients needed by crops, prevents roots from getting oxygen , kills soil organism and promotes mold growth. Prolonged irrigation may result in salination decreasing, soil fertility and eventually leading to impoverished farmlands.
5. Loss of genetic diversity: Farmers reliance on hybrids varieties of seeds enhance the risk of crops being damaged by pests or diseases. In natural ecosystem, a wide variety of strains helps ensure that some will be restraint to specific pests or diseases, disruption of natural habitats causes elimination of wild relatives of food crops, thus depleting the genetic diversity which could be used to strengthen agricultural strains.
6. Saline and alkaline soil: Soil salinity and alkalinity are found in the relatively less rainfall recording areas where the rate of evaporation is generally higher than the rate of precipitation. Under such conditions, the ground water level rises and saline and alkaline efflorescence consisting of sodium salt, calcium and manganese appear on the surface as a layer of white salt through capillary action.
7. Overgrazing
8. Cultivable wasteland

OBJECTIVES

i. To understand the different land use/ land cover of Mawtneng village.
ii. To understand the land capability of Mawtneng village.
iii. To understand the physical parameters of the soil of Mawtneng village.
iv. To understand the chemical parameters of the soil of Mawtneng village.

v. To suggest measures on land use in Mawtneng village.

RESEARCH QUESTION:

i. What are the different types of land use of Mawtneng village?
ii. What are the different land capabilities of Mawtneng village?
iii. What are the different physical parameters of soil of Mawtneng village?
iv. What are the different chemical parameters of soil of Mawtneng village?
v. What suggestive measures can be suggested to improve the land use of Mawtneng village?

METHODOLOGY:

i. Field observation on the study area on the different land use and land cover of the study area.
ii. Interview with the people on the different land use of the study area.
iii. Identification and surveying of the different land use/land cover.
iv. The area under study is sketched.
v. Detailed area mapping is done with the help of Topographic map and satellite imagery.
vi. GPS coordinates of sample sites were taken.
vii. Soil samples were collected from different areas.
viii. Soil samples were tested and analysed in the department.

LITERATURE REVIEW

1. Hussain, M.(2012): Geography of India, Mcgraw hill Education (India) Private Limited pp:6.9-6.14, 9.1-9.3
   The book discuss the vital role that the soil and the importance of soil in the environment. It also describes the force of nature that destroys the soil cover of the soil and the process of soil destruction. It also highlights the land utilisation on which how various land are put to be in different activities.
2. Hussain, M. Systematic Agricultural Geography, Rawat Publications, Jaipur pp: 258-259
   This book Systematic agricultural geography explain about the various land capability of soil and their classification into different classes according to their ability on the basis of various factors.
3. Gautam, A., geography of resources: exploitation, conservation and management, Sharda Pustak Bhawan, Allahabad-211002 pp: 110-112.

This book presents the current problems of how soil are being degraded and how the soil loses its fertility due to uses of chemical fertilisers.

4. Singh, J., Dhillon, S.S., Agricultural Geography, Tata McGraw-Hill Publishing Company Limited, New Delhi pp:332-333
   This book provides a classification of land based on the its capability, potentiality and suitability for agriculture land capability classification gives us an overview of an easy comparison among the different soil that occur in a particular area.
5. Gautam, A., Advanced Economic Geography, Sharda Pustak Bhawan, Allahabad-211002 pp: 126-127
   This book explains about the problem of soil degradation that is taking place worldwide. It explains about the accelerated soil erosion that has plagued the earth since the dawn of conventional agriculture.
6. Tiwari, R.C.,Geography Of India, Prayag Pustak Bhawan, Allahabad-211002 pp: 215-219
   This book describes about the land use classification and optimum utilisation of land resources. It explains about how different land is being used into different undertakings by human being in order to meet their means of support.
7. Khullar, D.R., India A Comprehensive Geography, Kalyani Publishers, Ludhiana pp: 644-650.
   This book explains about the land in India being put to various uses. It gives us an overview on how the spatial and temporal differences in land utilisation is caused due to physical factors as well as human factors
   .
8. Duthraj, S.V, Soil and Soil Fertility , Axis Publications, New Delhi-11002, 2012
   This book provides an excellent overview of soils in agriculture and environmental science. The book retains essential information on topics relating to soil such as soil formation, organic matter, mineralogy and soil water movement and storage.

CHAPTER 2

PHYSICAL SETTING: LOCATION, PHYSIOGRAPHY, SOIL, CLIMATE, DRAINAGE OF MAWTNENG VILLAGE

LOCATION

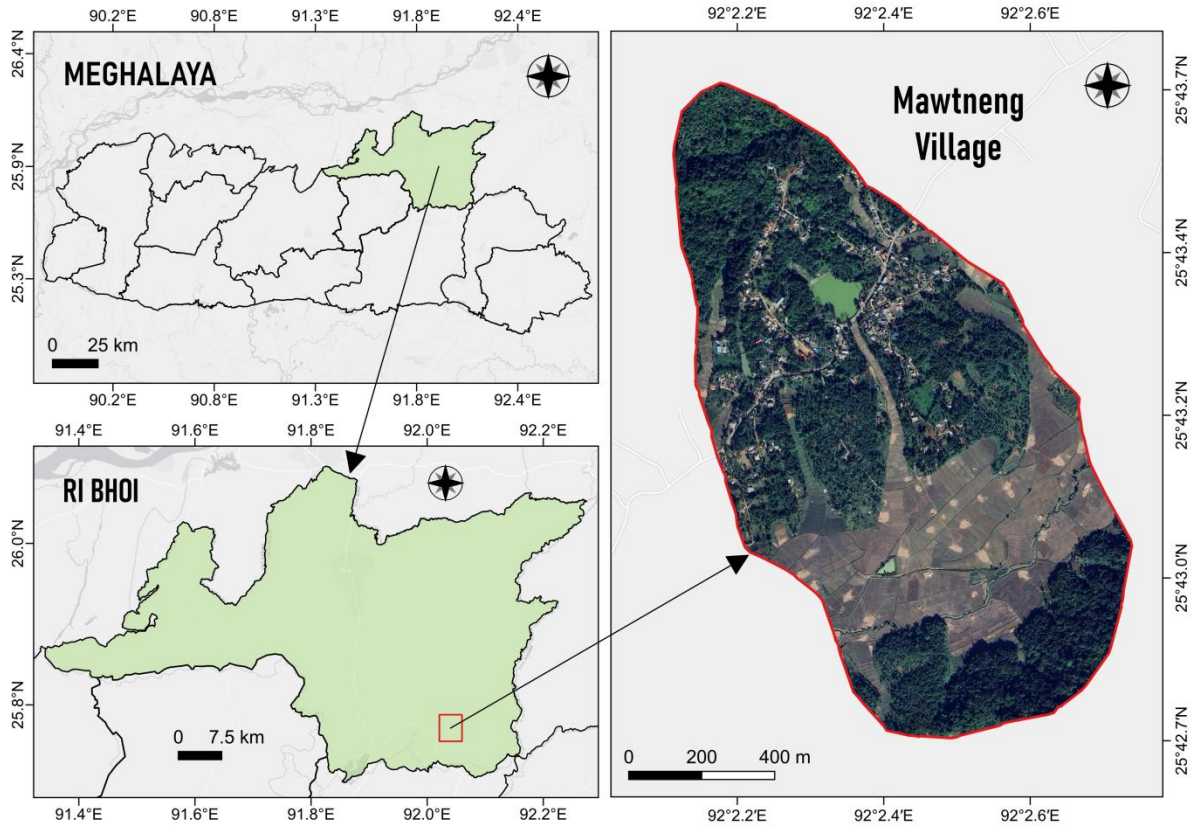


Fig 1: Location Map of Mawtneng Village

Mawtneng is a medium size village located in Umsning block of Ri-Bhoi district in the state of Meghalaya in India which is one of the eight states of North-Eastern Region of India. It is located between 92°3’N to 92°6’36’’NLongitudinal extent and 25°43’48’’E to 25°45’36’’E Latitudinal extent. Pin code of Mawtneng village is 793103

PHYSIOGRAPHY

Interpretation of physiography refers to the process analysing the physical features and characteristics of a particular area in order to understand its landscape and landform patterns, as well as the processes that have shaped them over time.

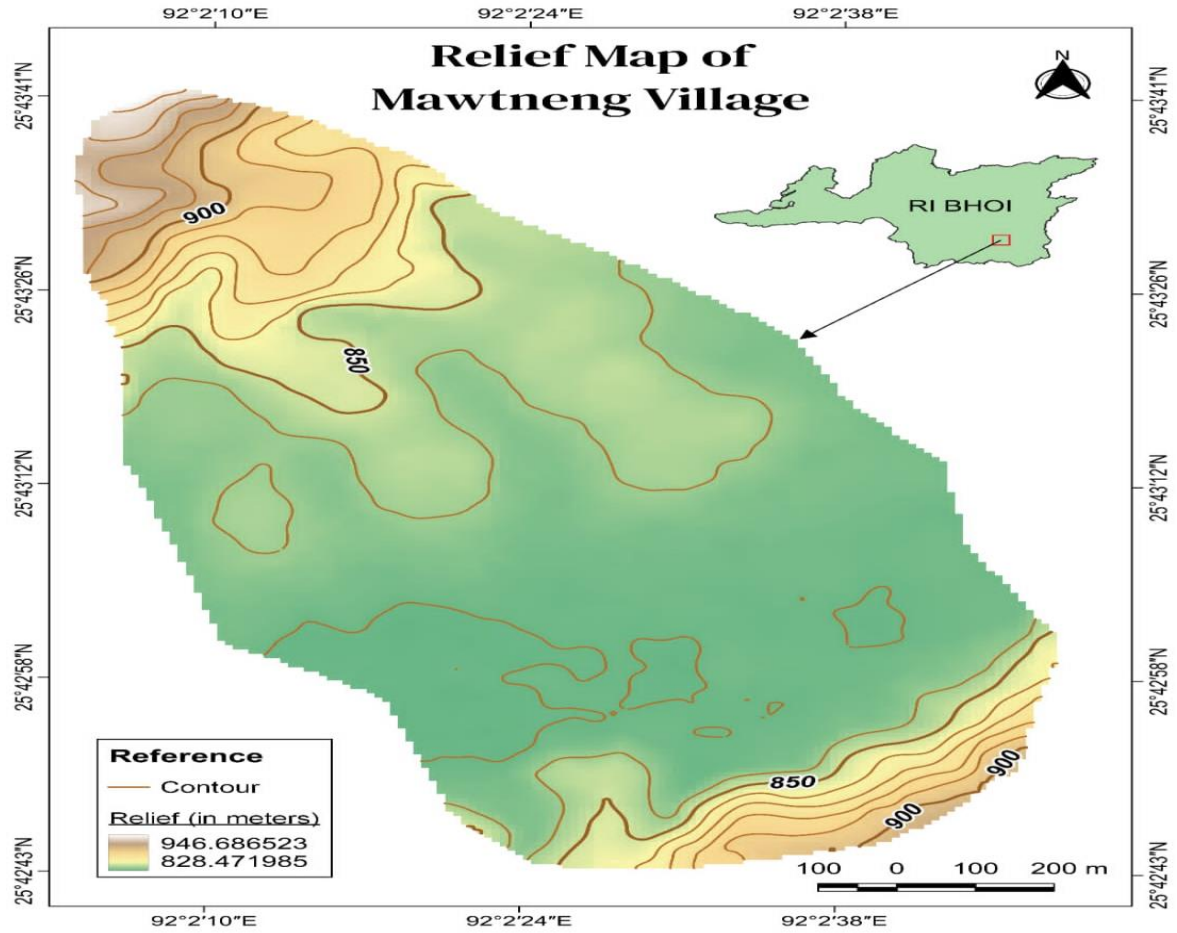


Fig 2: Contour Map of Mawtneng Village

The physiography of this area is covered mainly with hill slopes on the north western and the south eastern part of the area. Apart from the hill slopes on the central part it is mostly a flat area which is a continuation from the hill slopes formed due to its slope. From the map above with a 10 metres contour interval, we can see that the contour on the hill slopes is high which is about 900 metres compared to the contour on the central part of the study area which is mostly a flat surface is low which is only about 830.

From the map given below, slope analysis of the study area has been divided into three categories and they are:

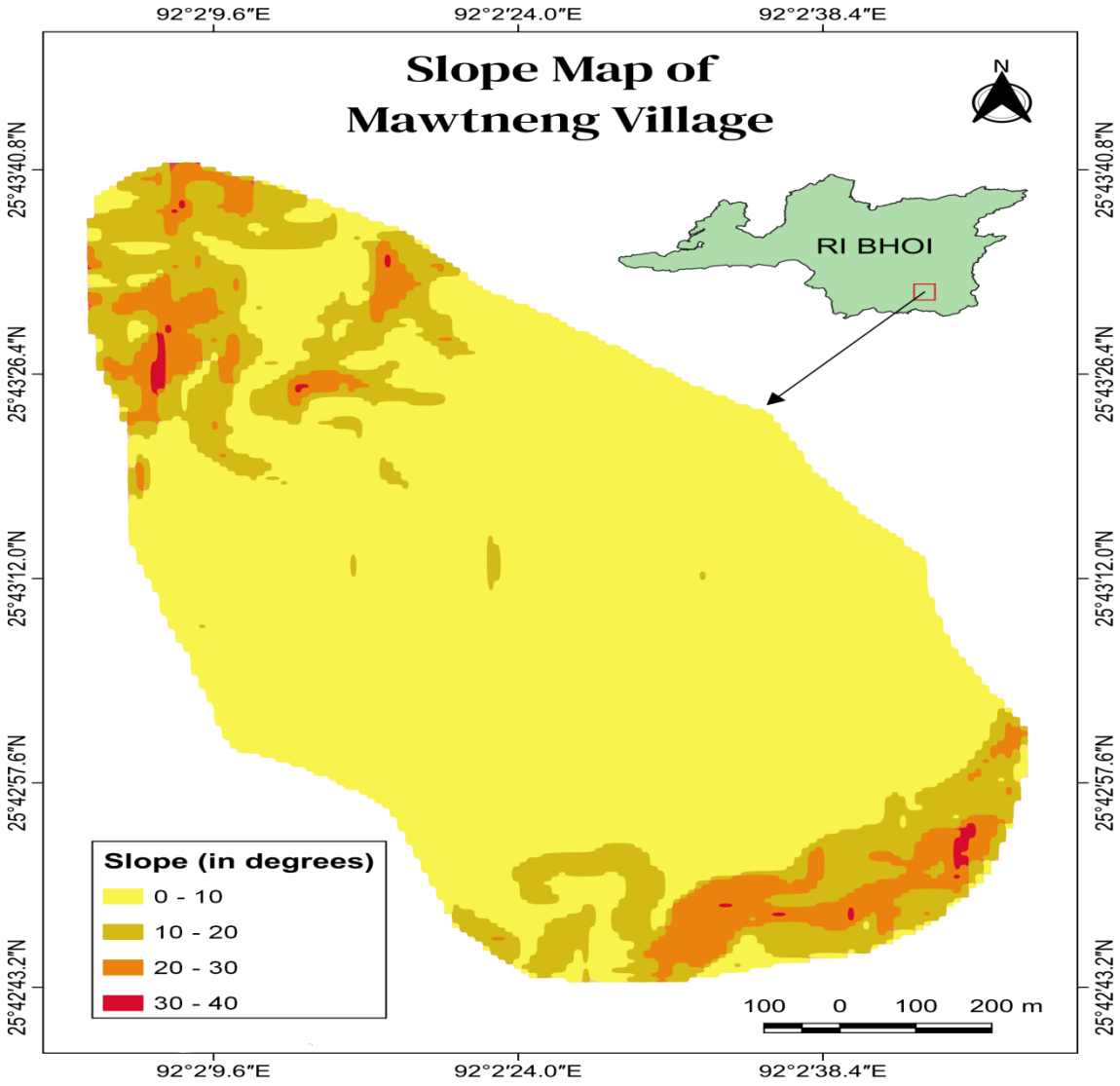


Fig 3: Slope Map of Mawtneng Village

1. Steep Slope Region: In the map it is shown that the area having high elevation i.e. more than 376 are mainly found in the central part, north eastern part and western part of the region. This is mainly due to the geographical condition around the area which shows that the region is hilly and mountainous mainly in the north eastern part and it is scattered in the western part of the area.
2. Medium Slope Region: From the map it is shown that the medium slope region ranging between 25-37 is mainly found in the central, north eastern, south eastern and

scattered in the south western part of the area. The slope found in this region is medium slope because it slowly dips from the steep slopes and emerges to the gentle slopes.

3. Gentle Slope Region: From the map it can be seen that the gentle slope which is less than 25 is mainly found in the central part, the western part, certain parts of the south eastern part and it is scattered in the north eastern part of the region. This region has low elevation making it a plain area and these areas are mainly used for agricultural activity.

SOIL

The physiochemical characteristics of soil vary in space and time which is greatly affected by different factors such as topography, climate, vegetative cover, microbial activities and several other biotic variables.

Present study which was conducted in Mawtneng village which is in Ri-Bhoi district of Meghalaya found that the entire study area consisted of laterite soil. Laterite soil is formed due to runoff and leaching process. Apart from having a laterite composition, the soil of Mawtneng is also loamy in nature which is composed mostly of sand, silt and clay. It has a pH value ranging from 4 to 6 which is highly acidic in nature. The texture of soil in the study area ranges from brown to red and it has a low chemical composition of due to its laterite composition .

CLIMATE

Months	Rainfall (in cm)	Temperature (in °C)	Relative Humidity (in %)
January	3.3	21	60.7
February	4.7	27.2	67.55
March	69.7	37.9	53.9
April	58.4	45.4	56.75
May	296.2	45.7	75.1
June	345	47.5	81.7
July	285	48.4	81.8
August	426.1	48	81.9
September	401.5	47	80.1
October	228.5	42.4	77.9
November	36.2	34.3	67
December	19.3	28.4	71.4

Source: Meteorological Department, ICAR, Barapani

Table-1

Mawtneng village of Ri-Bhoi district experience a climate conditions like the entire North Eastern region. That is, it has a wet and humid condition in summer and a cold and dry condition in winter. The climatic conditions of the study area range between tropical to subtropical climate. The altitude of the area plays a very important role in influencing and controlling the distribution of temperature throughout the year. The climate of the area is controlled by the physiography, the Bay of Bengal as well as the marine air masses coming from the south or southwest .Table 1 shows the range of temperature, rainfall and humidity.

RAINFALL: Lying on the Northern slope of Meghalaya plateau and on the rain shadow area, the study area also thus receives rainfall from the monsoon season. From the received from the ICAR Barapani a graph has been plotted. We can clearly see that the rainfall in Mawtneng in quite high despite it being located in the rain shadow area, where the highest rainfall is recorded in the month of august with 426.1 cm, whereas the lowest rainfall recorded is in February which is 4.1 cm only. Rainfall starts tom pour down from the month of May which is around 296.2 cm, and it continues till the month of September and October where the rainfall is more than 200 cm. From the month of October monsoon starts to change where the rainfall starts to decrease.

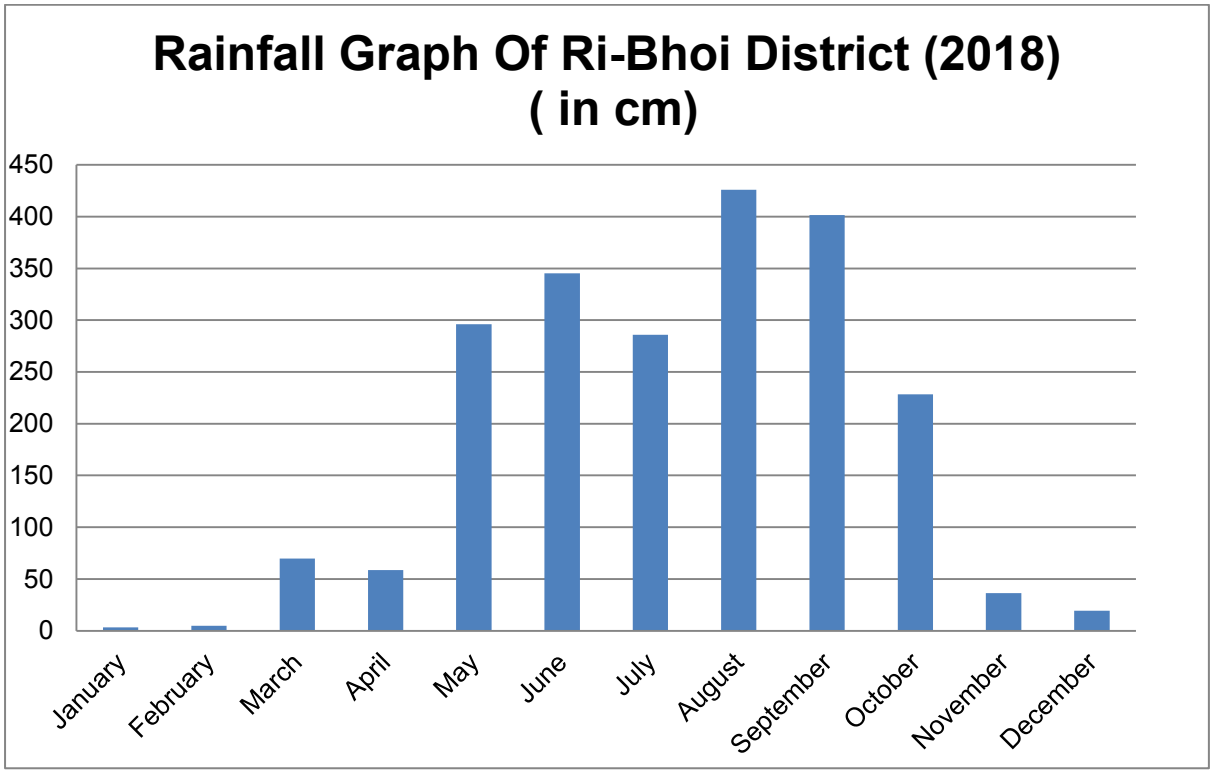


Fig 4 : Rainfall Graph of Mawtneng Village

TEMPERATURE: As we can see from the given table, they temperature in the Mawtneng starts to increase in the month of March with temperature of 26.1°C and reaching its highest temperature in the month of April 29.7°C the temperature started to declining in the month of September with 28.1°C till the month of January and February with 19.7°C – 6.8°C.

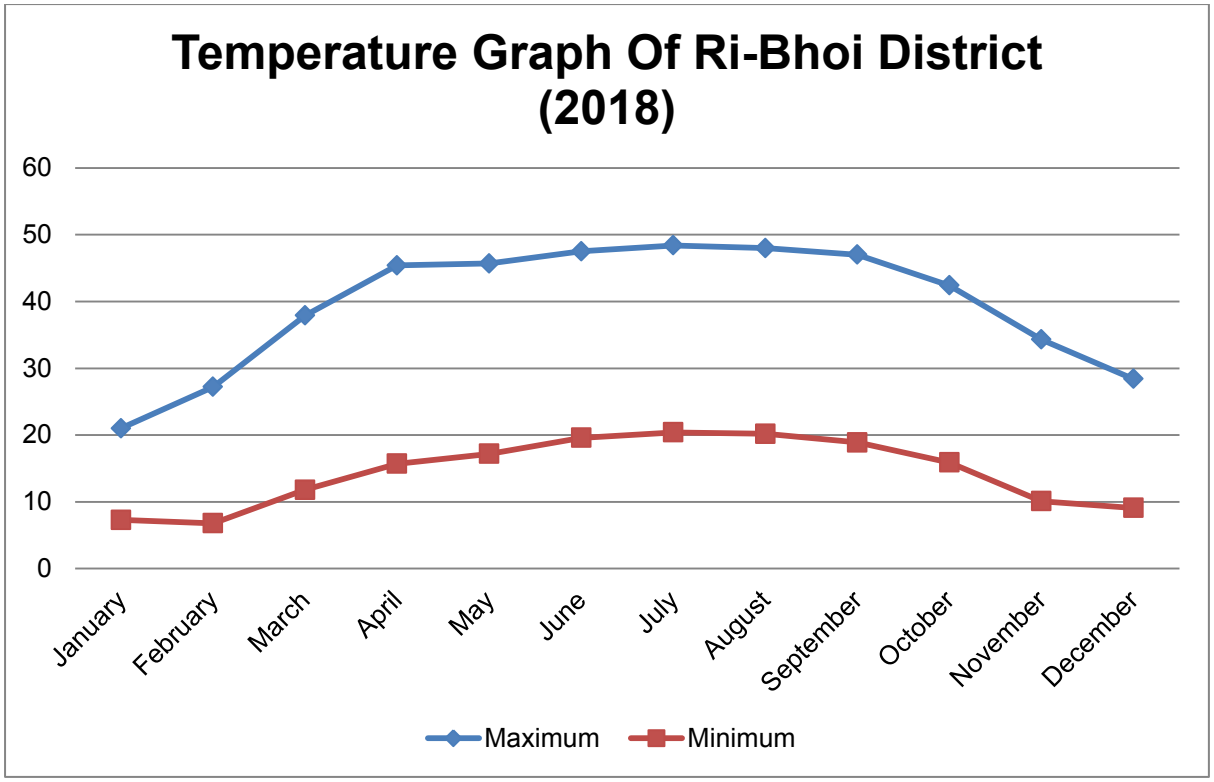


Fig 5 : Temperature Graph of Mawtneng Village

RELATIVE HUMIDITY: here the highest relative humidity is recorded in the month of August which is 81.90 %, mainly due to high precipitation whereas the lowest humidity was recorded in the month of March with 53.90 % mainly due to less precipitation. The relative humidity is almost at 70 % in the month of January and February but suddenly started decreasing in the month of March and then increases in the month of September and decreases again the month of October and December due to less rainfall in these months.

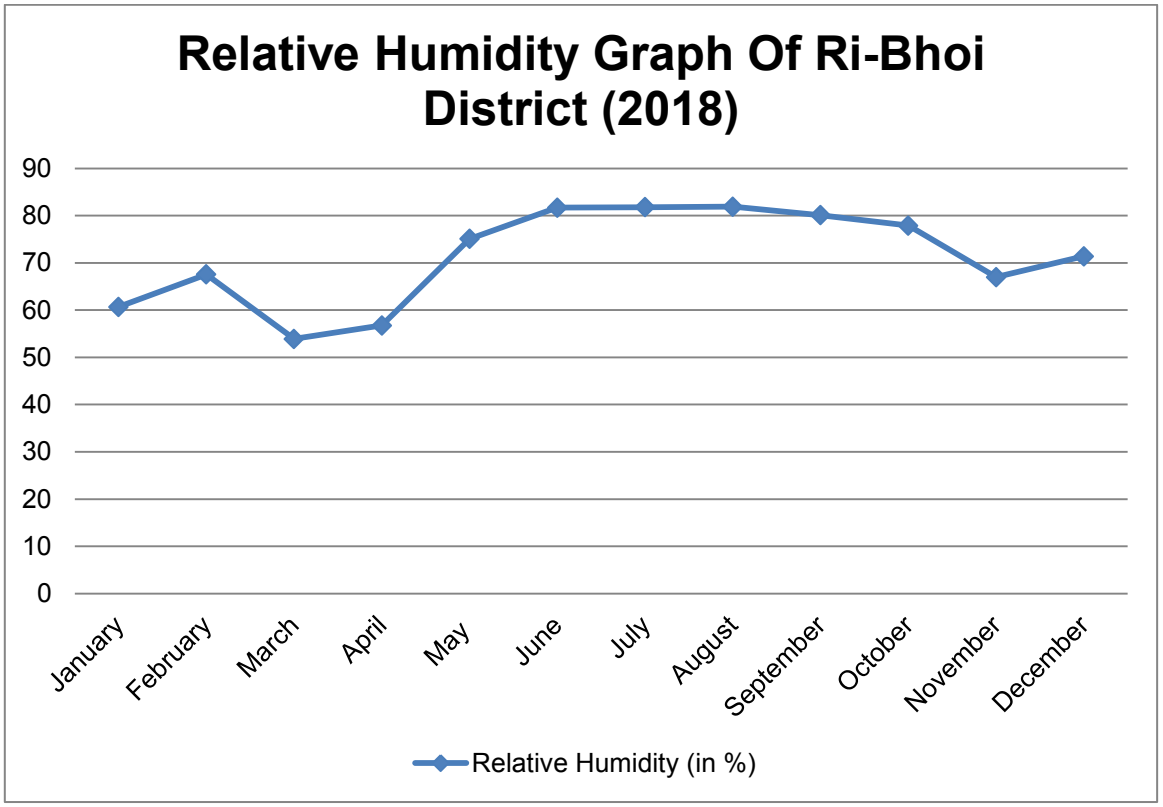


Fig 6 : Relative Humidity Graph of Mawtneng Village

DRAINAGE

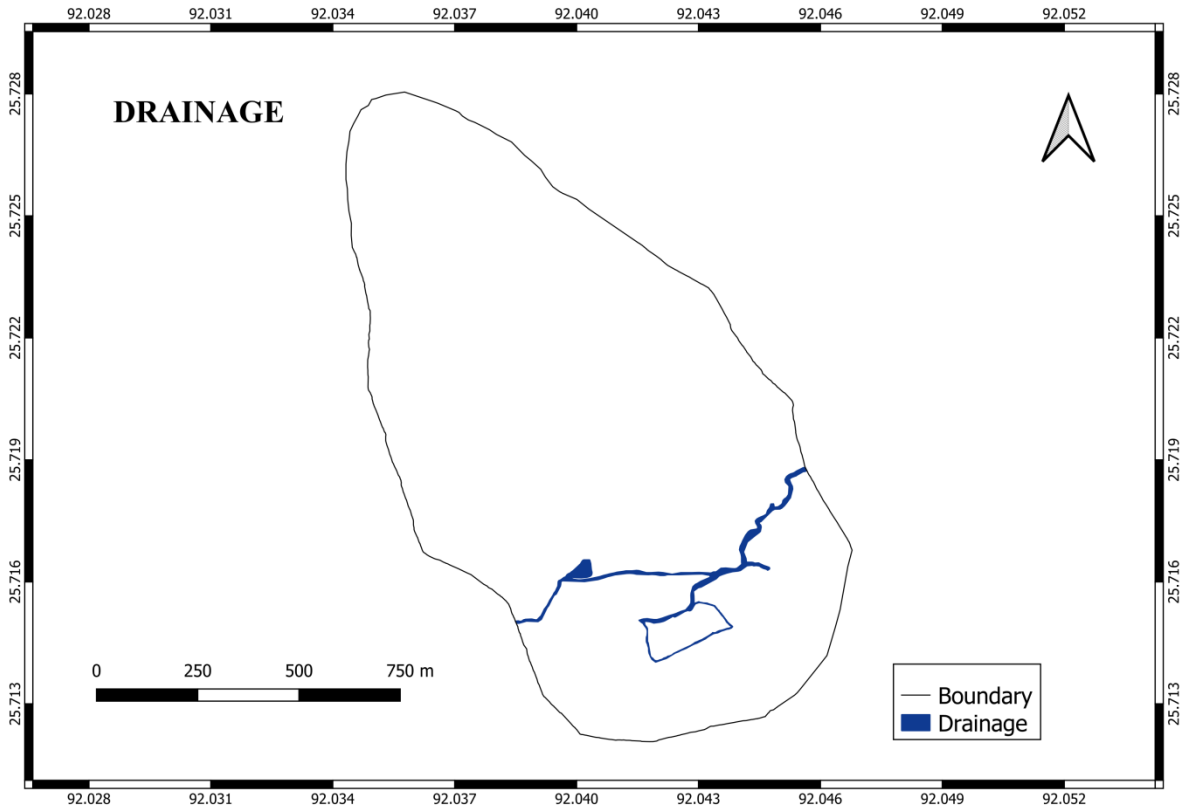


Fig 7 : Drainage map of Mawtneng village

Drainage is the natural; or artificial removal of the surface's water and sub-surface water from an area with an excess of water.in other words the flow of water through well-defined channels is known as drainage and the network of such channels is called a drainage system. The main drainage system in Mawtneng Village is the Um Tung river which is a perennial stream and its tributaries which are seasonal streams. The water from this river is being used for various domestic and agricultural activities. Various aquatic species have made this stream their home with majority being exotic and introduced species.

DRAINAGE FREQUENCY: The Drainage Frequency is the total number of all rivers, streams and tributaries in each grid of a selected area or it is express as the ratio of the numbers of rivers/streams in a drainage basin to the area of the basin. The total area is 72, 80, 15 9sq. m and the total length of the streams/rivers is 299,544 m and 1 grid is equal to 177740 sq. m

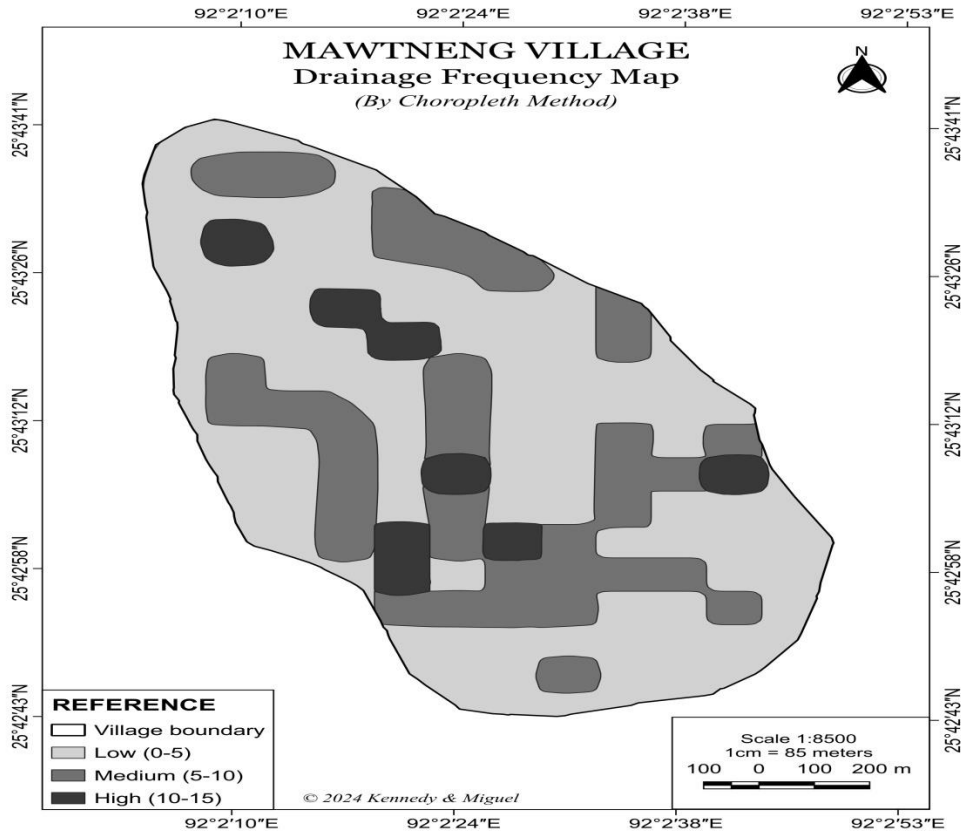


Fig 8 : Drainage Frequency Map of Mawtneng Village

From the above map on drainage frequency of Mawtneng village, the area has been divided into three classes and has been represented by the different colours.

The areas having above 3 frequencies are considered as high, areas ranging from 2-3 frequency are regarded as medium and areas having less than 2 are considered as low.

From the map we can interpret that the areas lying in the north eastern, central and south western part have a high drainage frequency. An area having a medium frequency lies in the central part, east, south eastern and the western part of the area and the areas having low density are mainly found in the north, east, south and north western part of the study area.

The pattern of the rivers shows that it is an east to west flowing river which is perennial in nature and Um Tung bring the main river/stream of the study area. The grid having the highest number of frequency is 12 and the lowest is 0.

DRAINAGE DENSITY: Drainage Density is the total number of rivers, streams and tributaries including a mainstream divided by the total area. Drainage Density is calculated by dividing the total length of the rivers/streams in each grid divided by the total area of each grid. The total area is 72,80,159 sqm and the total length of the streams/rivers is 299.544 m and 1 grid is equal to 177740 sqm. The Total Drainage Density of the area is equal to 4.114m/sq m.

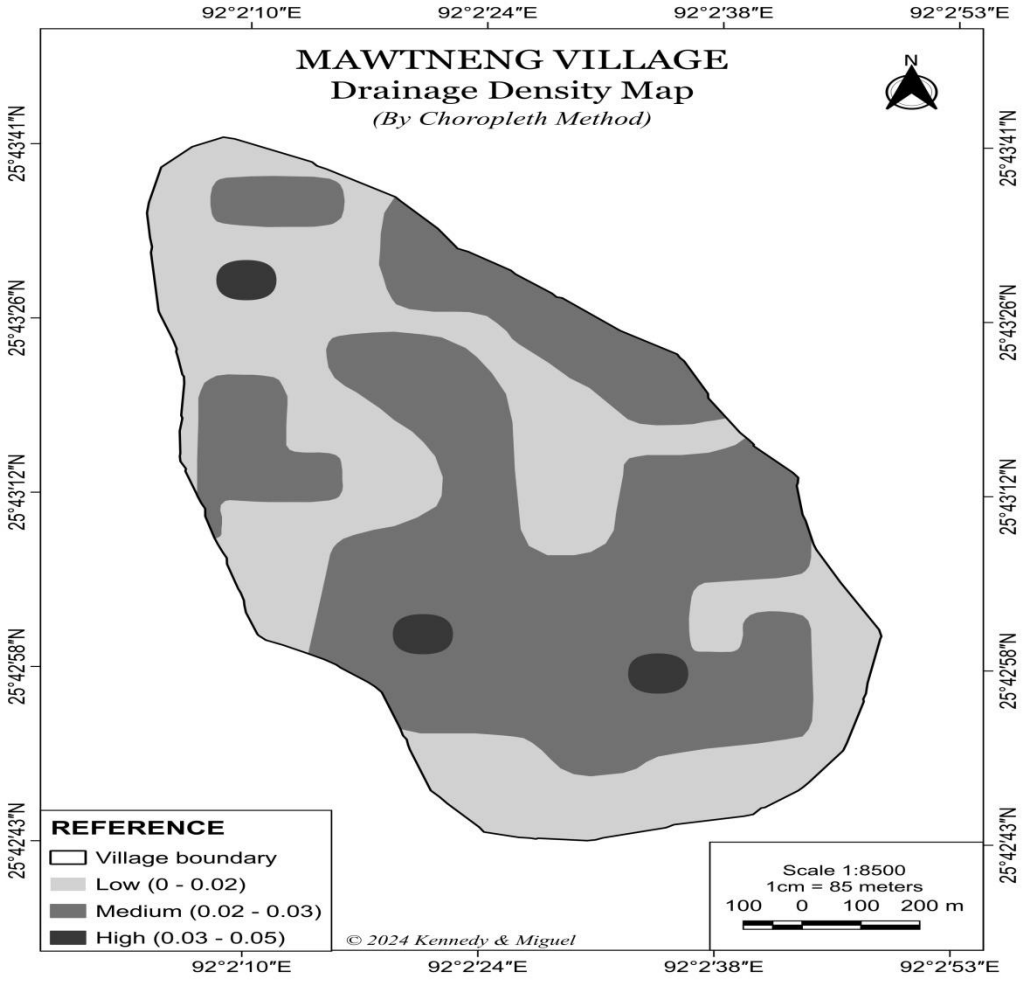


Fig 9: Drainage Density Map of Mawtneng Village

From the above choropleth map on drainage density the study area has been divided into three categories and they are represented by cartographic symbols namely compact, scattered and highly scattered square lines.

The areas having more than 0.006 m/sq m are considered as high density, areas ranging from 0.002-0.006 are considered as medium density and areas having less than 0.002 density are regarded as low.

The drainage density as observed from the choropleth map having high density is in the eastern and south western parts, scattered density is found in almost all parts of the study area which include the north, east, south and western parts of the area and the areas having highly scattered density includes the north, the north eastern, south eastern, the south western and the north western part of the area.

The pattern of the rivers shows that it is an east to west flowing river which is perennial in nature and Um Tung being the main river/stream of the study area.

CHAPTER 3

LAND USE LAND COVER OF MAWTNENG VILLAGE

On the earth surface certain land use land cover could be detected, land use is the process by which land is being used by various activities while land cover refers to the surface cover on the ground which includes forest, water, etc. Mawtneng is mostly an agrarian village where mostly people depend on agriculture for their livelihood. Since it is also located in the rural area there is still plentiful forest cover in the village where it serves as a source of various resources like firewood for the local villagers.

An attempt has been made to classify the land in the study area on the basis of Land Use Land Cover Classification adopted by the Government Of India Publication (2015-2016).The following table shows the different land use land cover that has been classified:

TABLE SHOWING THE DIFFERENT LAND USE LAND COVER OF MAWTNENG VILLAGE

FEATURES	AREA (in %)	AREA(in m)	AREA (in sq.km)
Dense Forest	9.62	122,477.921	0.122
Open Forest	44.30	563,587.375	0.563
Agricultural Land	32.85	417,901.356	0.417
Fallow Land	1.98	25,182.344	0.025
Water Bodies	1.43	18,152.124	0.018
Built Up Area	9.18	116,800.507	0.117
Roads	0.64	8,141.662	0.008
Total	100	1,272,243.07	1.27

Table - 2

INTERPRETATION:

From the map based on the Land Use/Land Cover of Mawtneng Village the study area has a total area of 1.27 sq.km and the Land Use / Land Cover can be classified into nine categories. These are Dense Forest, Open Forest, Open Scrubs, Agricultural Area, Fallow Land, Built-Up Area, Recreational Area, Water Body and Roads.

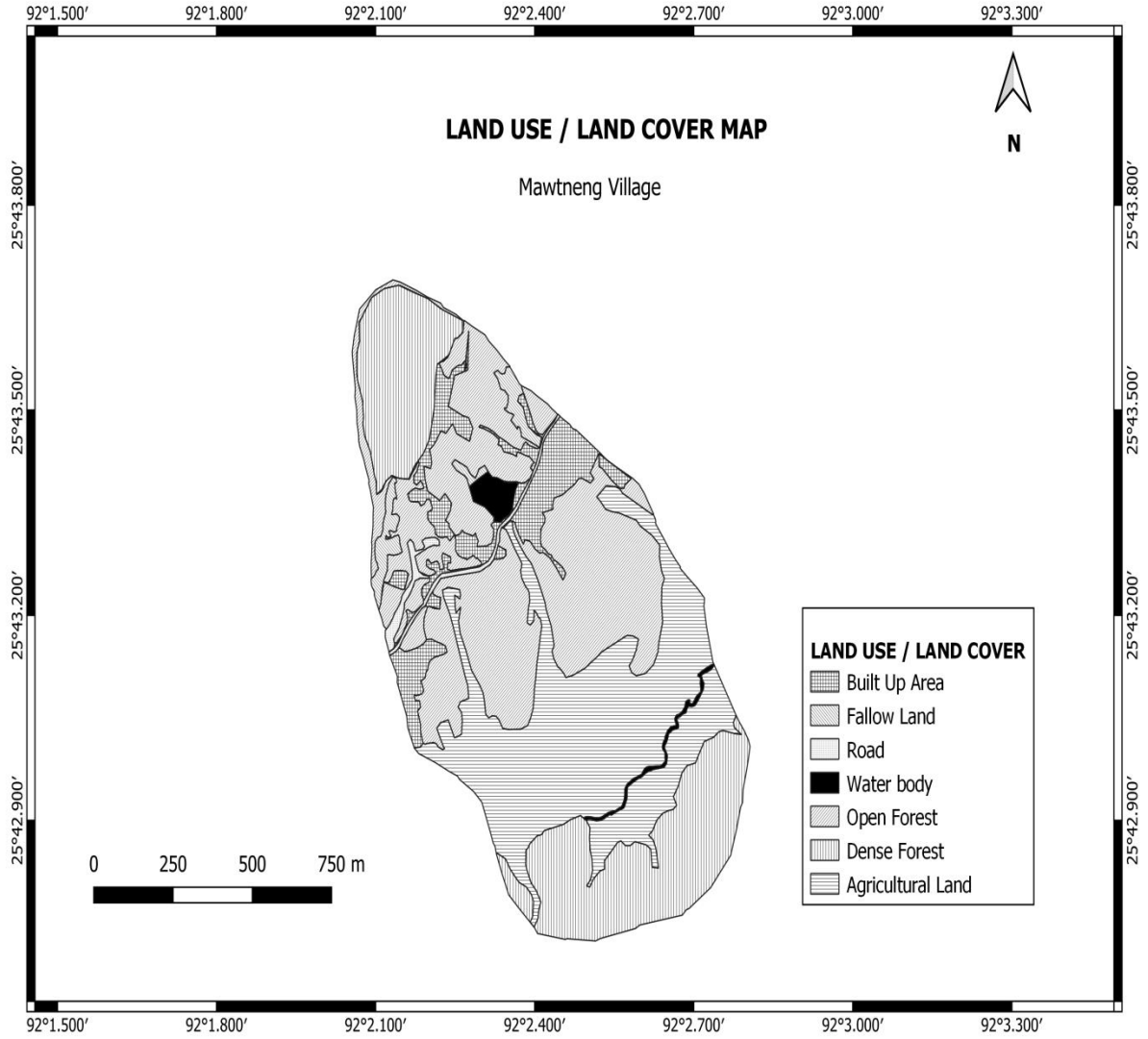


Fig 10 : Map showing the Land Use / Land Cover of Mawtneng Village

From the map it is found out that the major part of the Dense Forest is found in the North, South, South East and Western Part this is mainly due to the lack of settlements since Mawtneng village is less in population and majority of the villagers practices agricultural related activities and covers a total area of 0.122 sq.km which is 9.62 % of the total study area. Open Forest on the other hand is mainly located in the North, West and North Eastern Part which is found close to the Built-Up areas and covers a total area of 0.563 sq.km which is 44.30 % of the total area. Agriculture area covers the highest area in the map about 32.85 % of the total area which is about 0.417 sq.km and is mainly located in the Central, Western and Eastern Part this is mainly because agriculture is the main economic activity of the people in the area.

Fallow Land constitute the smallest area of the region which is only about 0.025 sq.km which is only 1.98% of the total area and it is found scattered in the East and North Western

Part of the region. Built-Up area is mainly found in the North, West and Eastern Part of the region which covers a total area of 0.117 sq.km which is about 9.18% of the total area. The main Water Body flows through the central part of the map flowing from east to west which is then join by different tributaries from the north and north western part of the area. Several ponds are found scattered in the central and eastern part of the area. Roads are concentrated mainly on the Built-Up area starting from the western part, passing through the central part and goes off to the eastern part of the area which is then scattered into the different Built-Up area and agricultural area.

Thus, it can be seen that agriculture is the main domain of the Land Use / Land Cover of Mawtneng Village this is mainly due to the
presence of the water body which includes rivers / streams and tributaries which is the main source of water in the region. The presence of the agricultural area may also be because of the fertility of the soil in the area and the physiography of the area shows that is mainly a plain area which is very suitable for agricultural activity. The presence of agricultural area has also led to the development of Built-Up or settlement areas which are located close to the agricultural areas. The Built-Up area consists of the settlements of the different people in the area and it can also be a market area of the region.

CHAPTER 4

PHYSICAL AND CHEMICAL PARAMETERS OF SOIL

A. Physical Parameter: Physical parameters of soil refer to various physical characteristics or properties of soil that affect its behaviour and suitability for different purposes. Some common physical parameters of soil include:

1. Soil colour**:** Soil colour is one of the important characteristics of soil. Colour sometimes suggests the composition and chemical makeup of the soil. The red and yellow are high in iron oxides, the black soil are rich in organic matter and good for cultivation, the brown are rich in organic matter, making it ideal for plant growth, the grey can indicate poor drainage and might be waterlogged. White to pale soils have aluminium oxides and silicates. Colour can be deceptive too, for soil of high humus content are often dark, yet clay of warm temperate, tropical regions and regur of Deccan plateau (INDIA) with less than 3% organic content are some of the world's black soil.

2. Soil Texture: Soil texture refers to relative proportions of various particle size in a soil found in gravel, sand, silt and clay. A soil generally characterized by the size of its particles. A clayey soil may thus be described as fine, a sandy soil as coarse, while a silty soil is intermediate. A light soil consists mainly of sand, i.e., grains of quarts with considerable air space between them. Sand particles consist of small pieces of primary un-weathered rock fragments. The sand may either be 'coarse' where the particles are between 0.2 and 2 mm in diameter, or line where
the grains between 0.05 and 0.2mm are just visible to our naked eyes. They do not hold water well due to large poor space and do not stick together. Sand and gravel particles do not supply any nutrients for crop growth as they do not store nutrients. Silt particles are bigger then clay particles but smaller than sand particles. Its particles are assumed to have a diameter between 0.02 And 0.002 mm they can hardly be seen by our naked. They hold plants nutrients better than sand, but us well us clay. Silt particles allowed water and air to pass through readily yet retain moisture for crops growth. However, silty soil are low in organic matter and surface cross are easily formed after rains.
Clay particles are the smallest of all particles found in soil. This is an exceptionally fine grained soil. very retentive of moisture. The individual grains of clayey soil are 0.002 m in diameter. These particles consist mainly of hydrated aluminium silicates. A clay contains little air and can hold more water. so forming a sticky mass, but when it dries out completely, it formed a hard concrete like surface, seamed with numerous cracks. Clayey soil are often rich in plant food and give much better yield than the sandy soil.

B. Chemical Parameters**:** Chemical parameters of soil refer to various chemical characteristics or properties of soil that influence its fertility, nutrient content, and suitability for different uses. Some common chemical parameters of soil includes ;the pH value of the soil, its nitrogen content, phosphate, potassium, and its organic carbon.

1. Soil pH value: Soil pH is a measure of soil Acidity or Alkalinity in soil. The present of water in the soil is a significant determinant of soil aeration and its fertility. The various form of water are present in soil that exhibit a complex interrelationship. The proportion of exchangeable basis in a soil is obtain by the process of measuring concentration of hydrogen

ions. It is assumed that the proportion of other ions which can be held by the clay humus complex depends on the 'space' left by hydrogen ions. The proportions of free hydrogen ion in the soil solution is measured and stated as pH value.

Soil vary in pH form about 4, for strongly acid soil to about 10 overlaps between regimes, and a quite complicated classification scheme and taxonomy of soil has been devised to help soil scientist cope with the diversity.

2. Nitrogen**:** Nitrogen is found in all soils, and is required by all living creatures. In plants, nitrogen is the nutrient required in the largest amounts. It is a key constitution of critical organic molecules such as amino acid, nucleic acid and proteins. Deficiency in nitrogen can cause yellowish green colour of leaves and retarded or spindly growth of crops. Excess of nitrogen has got harmful effects. It causes delay in maturity or ripening of crops, it weakens the plants and consequently promotes 'lodging' or fall.

3. Phosphorus**:** Phosphorus is one of the major plant nutrients in the soil. It is a constituent of plant cell, essential for cell division and development of the growing tip of the plant. For this reason it is vital for seedling and young plants. Excess of phosphorus is not harmful like nitrogen. Excess help to counteract the bad effects of excessive nitrogen. Deficiency of phosphorus can lead to stunted growth of particularly in legumes and small grains.

4. Potassium**:** Potassium is a general tonic for all types of plants. It is particularly beneficial for root crops, different types of grass and for leguminous crops. It hardens the straw of cereal crops, as well as that of grass tribe and thereby reduce 'lodging'. Potassium gives stamina and sturdy growth and thereby helps to withstand adverse condition and plant diseases. Deficiency can lead to poor root
formation which may lead to easy lodging' or fall of the plant, borrowing on the outer edge of corn leaves, beginning first at the lower level of the plant. This is sometimes referred to as 'potassium firing'. It may occur in the early stages of growth. It is also caused dwarfed growth of the plants and sometimes deficiency may cause a series of yellow to white dots around the tip and sides of the leaves. After nitrogen, phosphorus and potassium come the group called the secondary elements viz. calcium, magnesium and Sulphur. These sediments, though required in comparatively small quantities, play quite an important role in plant life.

5. Organic Carbon**:** Organic carbon is a vital component of soil organic matter, which consists of decomposed plant and animal material. It is a fundamental element for soil health and fertility. Organic carbon helps to bind soil particles together, creating aggregates that improve soil structure and stability. Organic carbon serves as a source of nutrients for soil microorganisms. As these microorganisms break down organic matter, they release nutrients like nitrogen, phosphorus, and potassium that are essential for plant growth. Soils with higher organic carbon content have better water retention capacity. The organic matter acts like a sponge, holding onto moisture and making it available to plants during dry periods. Soils with high organic carbon content are generally more fertile and productive. They have better soil structure, nutrient availability, water retention, and contributing to overall soil health and sustainability. Maintaining or increasing organic carbon content in soil is essential for sustainable agriculture and environmental conservation. Practices such as minimizing soil disturbance and practicing crop rotation can help increase organic carbon levels in soil.

PHYSICAL AND CHEMICAL CAHARACTERISTICS OF SOIL OF MAWTNENG VILLAGE

SOIL SAMPLE	PHYSICAL CHARACTERISTICS		CHEMICAL CHARACTERISTICS						Vegetative Cover	Slope Angle
	Colour	Texture	pH	Nitrogen		Phosphate	Potassium	Organic Carbon		
				Ammonia Nitrate	Nitrate Nitrogen					
Sample 1	LYG	Silty clay	SA	Low	Low	Low	Low	Medium	Ginger	13°41’
Sample 2	YB	Silty clay	SA	Low	Low	Low	Very high	Medium	Bayleaves	14°32’
Sample 3	DYB	Silty clay	VSA	Low	Low	Low	Very high	Medium	Chestnut	19°12’
Sample 4	DYR	Sandy silt	VSA	Low	Low	Low	Low	Medium	Sweet potato	11°56’
Sample 5	DYG	Silty clay	SA	Low	Low	Low	Low	Medium	Ginger	11°56’
Sample 6	DYG	Silty sand	VSA	Low	Low	Low	Very high	Medium	Mustard	20°56’
Sample 7	LYB	Silty clay	VSA	Low	Low	Low	Low	Medium	Beans	9°20’
Sample 8	DYG	Sandy silt	SA	Low	Low	Low	Low	Medium	Chilli	18°77’
Sample 9	LYB	Sandy clay	SA	Low	Low	Low	Low	Medium	Barren land	0°
Sample 10	LYB	Silty clay	SA	Low	Low	Low	Low	Low	Cultivable wasteland	19°79’
Sample 11	LYB	Silty clay	VSA	Low	Low	Low	Low	Medium	Pineapple	18°17’
Sample 12	DYG	Sandy clay	VSA	Low	Low	Low	Medium	Medium	Bamboo	13°68’
Sample 13	DYB	Sandy silt	MA	Low	Low	Low	Low	Medium	Beans	22°40’
Sample 14	LYB	Sandy silt	SA	Low	Low	Low	Low	Low	Packing leaves	23°68’
Sample 15	DYB	Sandy clay	MA	Low	Low	Low	Low	Medium	Papaya	14°04’
Sample 16	LYR	Silty sand	SA	Low	Low	Low	Low	Low	Guava	28°50’
Sample 17	DYB	Silty clay	SA	Low	Low	Low	Low	Medium	Forested area	10°54’

LYG = Light Yellowish Grey LYB = Light Yellowish Brown LYR = Light Yellowish Red
DYG = Dark Yellowish Grey DYB = Dark Yellowish Brown DYR = Dark Yellowish Red
YB =Yellowish Brown

VSA = Very Strongly Acidic SA = Strongly Acidic MA = Moderately Acidic

Table-3

Soil Colour: A total number of 17 samples were collected form the study area and the soil colour of Mawtneng village vary form one area to another. From the map [fig.] the soil Mawtneng village can be divided into 7 colour i.e. Light yellowish grey , Light yellowish brown, Light yellowish red, Dark yellowish grey, Dark yellowish brown , Dark yellowish red , and Yellowish brown.

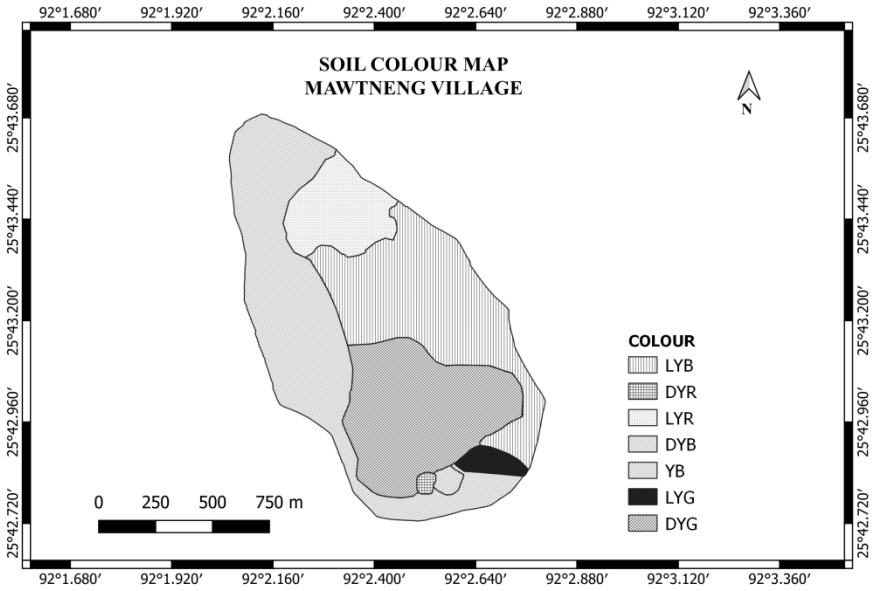


Fig 11: Soil Colour Map of Mawtneng Village

In the northern western and some of the southern part of the study area ,it is covered by Dark yellowish brown, which is suitable for the cultivation of soybean, corn, wheat, barley etc. In the eastern part of the study area ,it can be divided into two parts which is covered by the Light yellowish red and Light yellowish brown type of soil and these soil are typically well drained and moderately fertile and the crops suited for these type of soil are cotton, peanuts (ground nut), sorghum (Jowar), pulses(suchas, lentils, chick peas and mungbeans), sugarcanes and millets etc.

In the southern part it is mostly covered by Dark yellowish grey and some of Light yellowish grey, Yellowish brown, Dark yellowish red. Crops suitable for Dark yellowish grey soil are soybeans, peas etc. For Light yellowish grey, crops like potatoes, carrot, onions are suited for growing. For Yellowish brown crops like rice, corn, and tobacco are suitable. And for Dark yellowish red soil, cultivation of tomatoes, sugarcane, and chilli pepper etc are suitable.

TABLE SHOWING THE DIFFERENT SOIL COLOUR CONCENTRATION ACCORDING TO SLOPE ANGLE

SLOPE ANGLE CLASS (IN °)	SOIL COLOUR CONCENTRATION
0-10	LYB DYB
10-20	LYG YB DYB DYR DYG LYB
20-30	LYR LYB DYB DYG

Table-4

On the basis of slope angle, different soil colour concentration can also be identified based on the angle by which these soils occur on the study area. The first class that ranges between 0° to 10° the soil colour varies from light yellowish brown to dark yellowish brown. Hence we can say that between the slope angles of 0 to 10 its major soil colour is brown. The second ranging between 10° to 20° shows the different soil colours varies from across this slope angel. The soil colours varying in this class are light yellowish grey to yellowish brown to bark yellowish brown to dark yellowish red to dark yellowish grey to light yellowish brown. So this signifies that at this angle there is a variation in soil colour. Apart from the two class, the third class of slope angle has a soil colour variation from light yellowish red to light yellowish brown to dark yellowish brown to dark yellowish grey varying between an angle of 20° to 30°. Therefore at thus angle there is also a high variation of soil colour concentration.

THE LIST OF SOIL COLOURS ALONG WITH THEIR NAMES

DARK YELLOWISH GREY (Fig-12)

DARK YELLOWISH RED (Fig-13)

DARK YELLOWISH BROWN (Fig-14)

LIGHT YELLOWISH BROWN (Fig- 15)

LIGHT YELLOWISH GREY (Fig-16)

LIGHT YELLOWISH RED (Fig-17)

YELLOWISH BROWN (Fig-18)

Soil Texture : 17 sample were collected from the study area and the soil texture also varies from one area to another. From the samples collected, we found out that there are four types of soil texture that can be identified, they are Silty clay, Sandy slit, Silty sand, and Sandy clay.

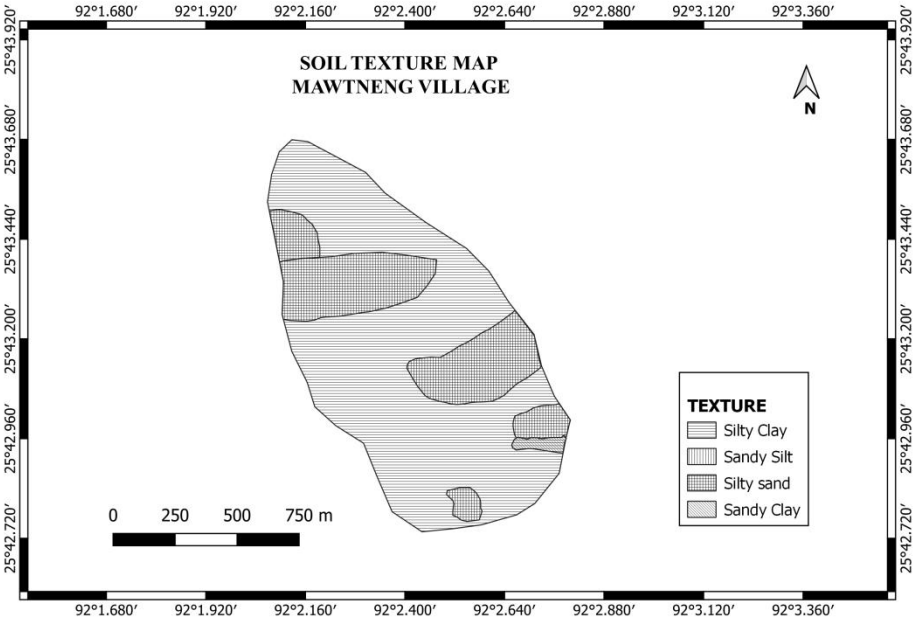


Fig 19: Soil Texture Map of Mawtneng Village

From among them, Silty clay is the most fertile soil, suitable for most crops. Silty clay is more prominent in the area, Sandy slit in the slopes, Sandy clay in the plain area and Silty sand in the slopes.

Soil pH: From the given map (Fig.) of Mawtneng village, the soil pH of entire area range from moderately acidic to very strongly acidic.

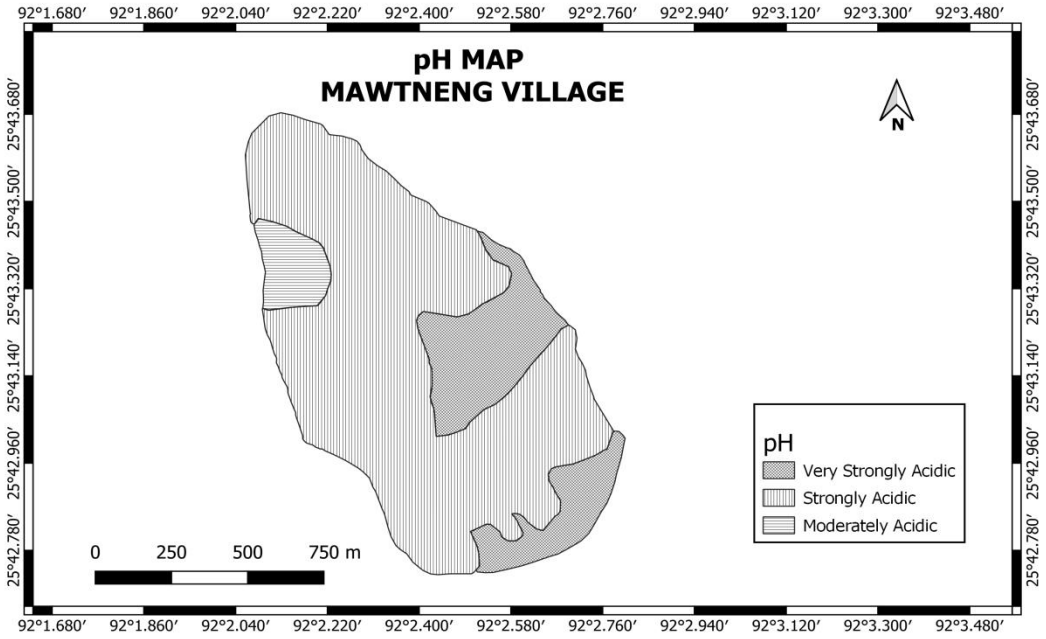


Fig 20: Soil pH of Mawtneng Village

In these study area the pH of strongly acidic type of soil is more prominent,followed by very strongly acidic type of soil and small portion of the area is moderately acidic type of soil.

Nitrogen: From all the 17 samples that were collected, nitrogen was tested in two categories i.e ammonia nitrate & nitrate nitrogen .

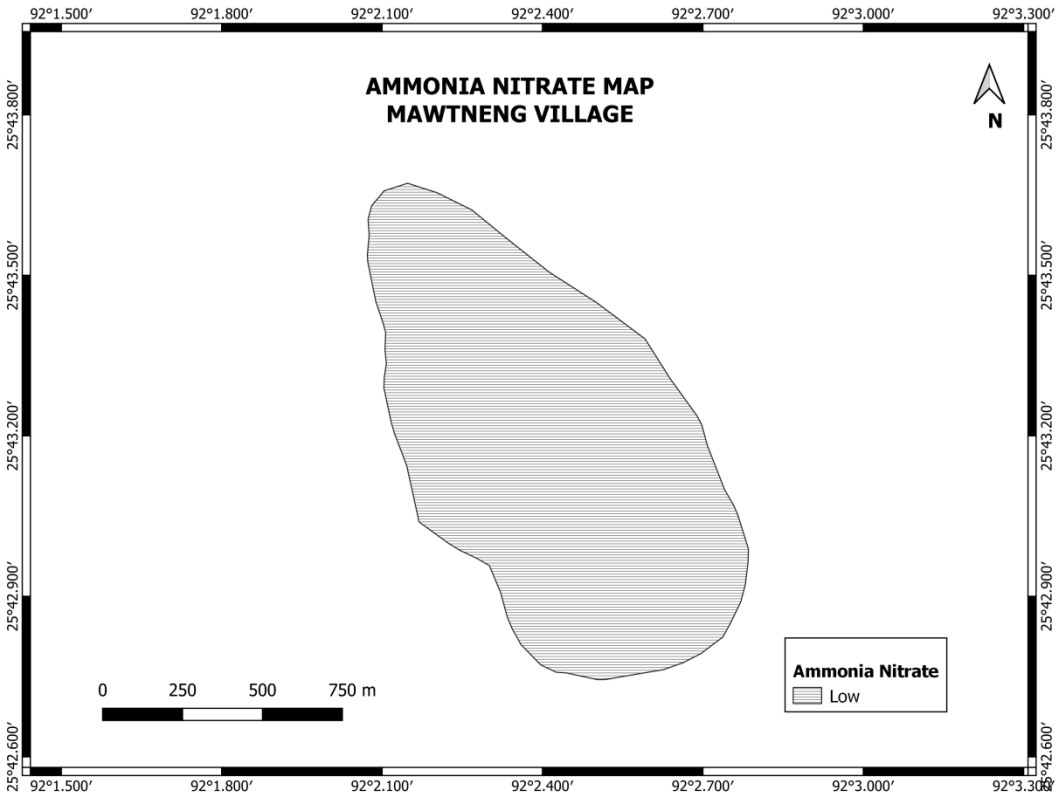


Fig 21: Ammonia Nitrate of Mawtneng Village

From the results, we found out that ammonia nitrogen content in this area is low .

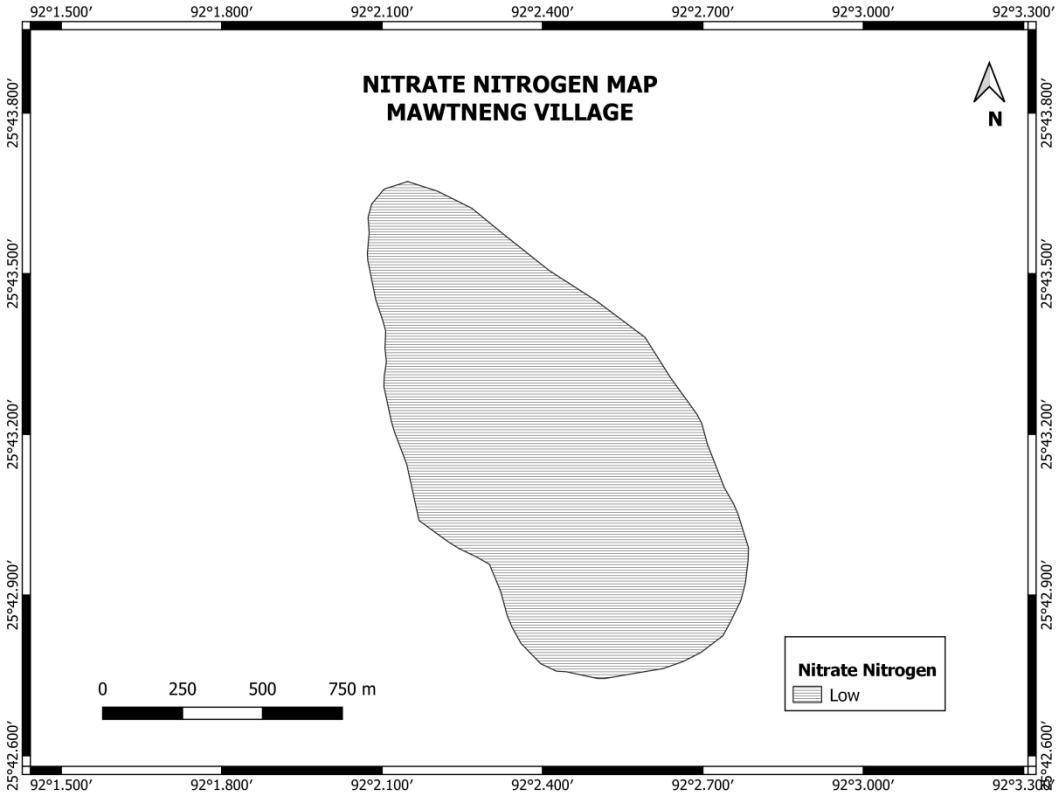
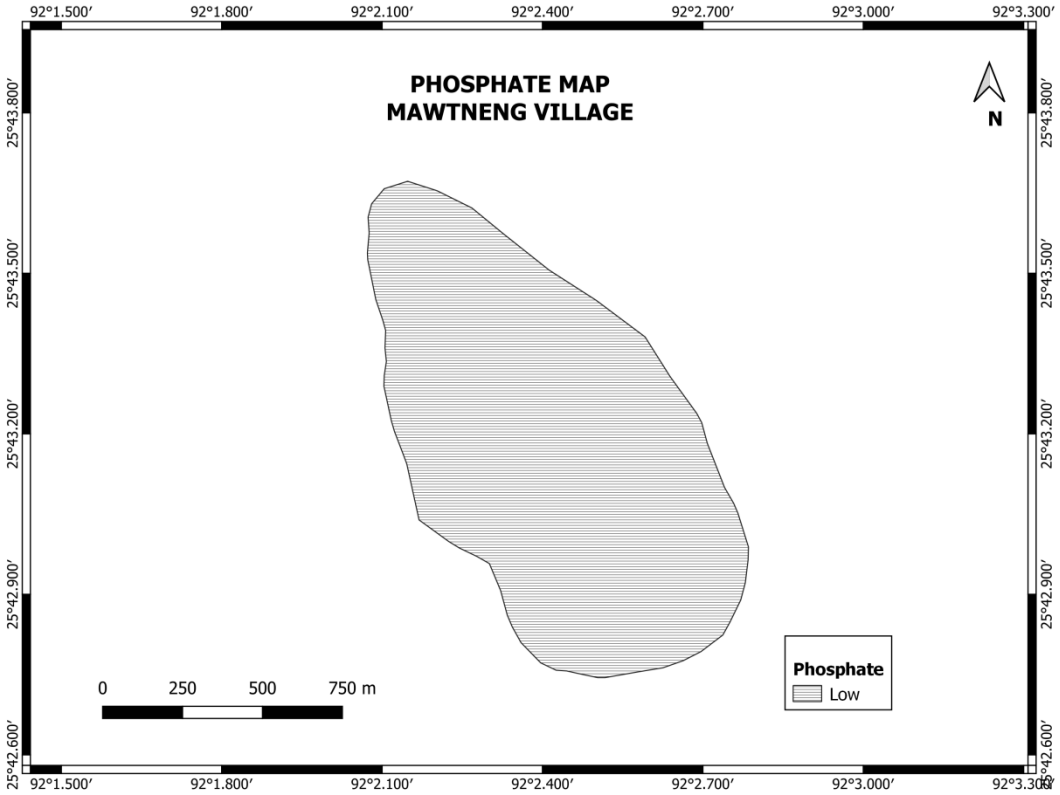


Fig 22: Nitrogen Nitrate of Mawtneng Village

From the map above, it shows out that nitrate nitrogen content in this area is low.

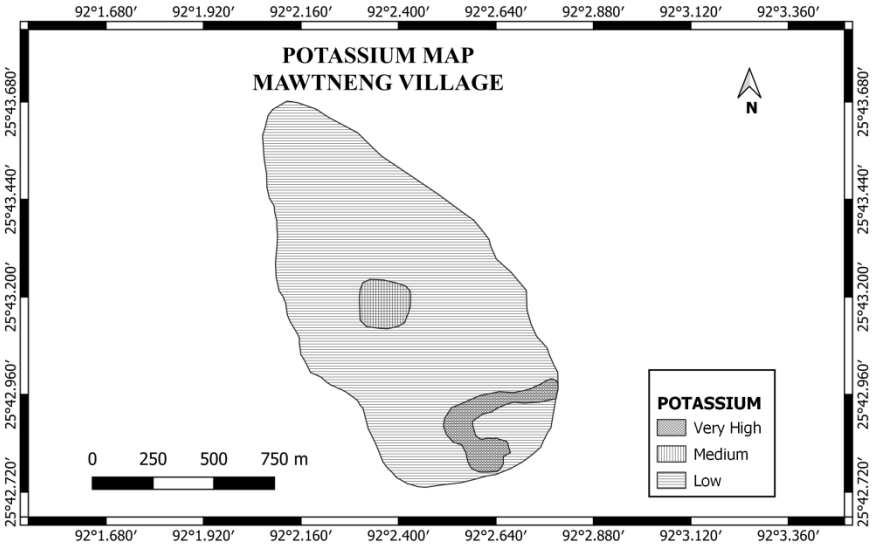
So in almost all parts of the Mawtneng village, the concentration of nitrogen is low (Both ammonia nitrate and nitrate nitrogen). And hence it takes longer for the germination of plants. This can occur when organic matter with high carbon content , such as sawdust is added to soil . Soil organism use any nitrogen available to break down carbon sources , making nitrogen unavailable to plants.

Phosphate: Map showing the distribution of Phosphate Fig 23



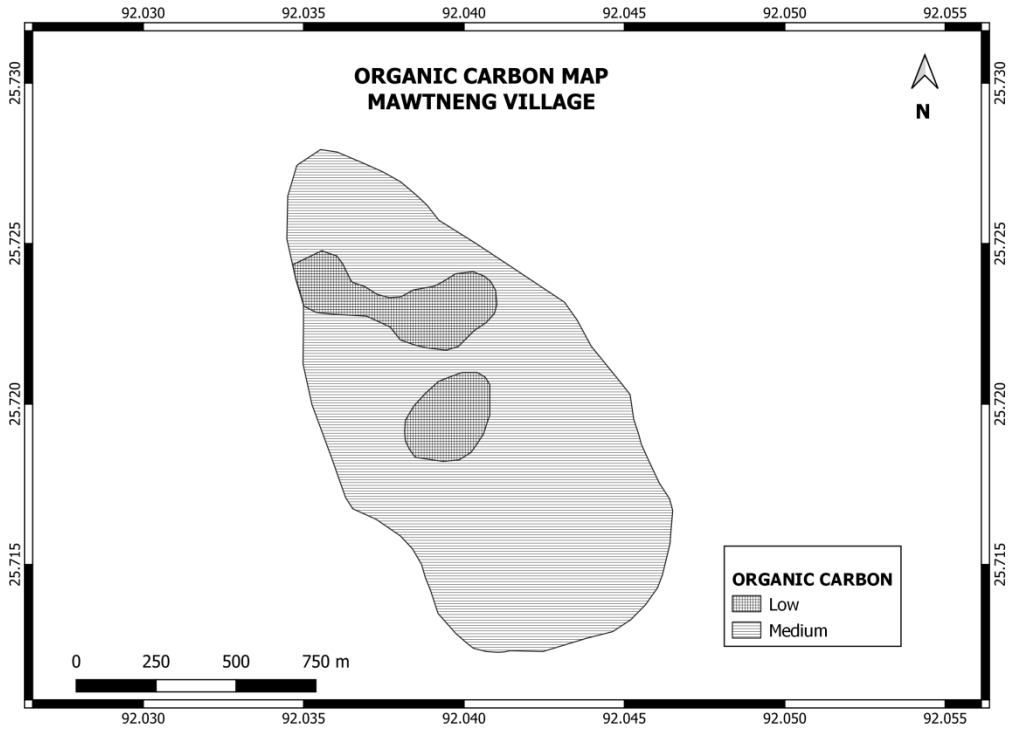
From the testing that have been conducted of the 17 samples that were collected from the study areas we found that phosphate is low in all the areas. There are several ways that phosphorus deficiency can occur in the soil. Natural sources of phosphorus such as animals manures , compost etc can be lost over time due to erosion or seepage . Plants may pull phosphate out of the soil if there is too much clay present in the soil.

Potassium: Map showing the distribution of Potassium Fig 24



As we can see from the map[Fig.24] Mostly all the areas are having low in Potassium, except a small portion in southern part are having very high in Potassium and a small portion in central part are having medium in Potassium.
Potassium deficiency can be caused by soil pH, extreme liming or calcium rich areas of fields or lack of soil oxygen.

Organic Carbon: Map showing the distribution of Organic Carbon Fig 25



Among the 17 sample that have been collected from the study area, the organic carbon in soil is mostly medium, except a small portion in North western and central part having low in Organic Carbon.

Soil Organic Carbon increased the Carbon exchange capacity (CEC), organic matter contribute to nutrients retention and turn over, soil structure, moisture retention and availability. Soil Organic Carbon is higher in Sandy soil with higher pH.

CHAPTER 5

LAND CAPABILITY OF MAWTNENG VILLAGE

17 samples were collected, the pH, NPK, OC were analysed. it is found that the area suffer from deficiency in many chemical criteria. In such a condition, this area is not well suited to cultivate without additional input of chemicals. Though much pressure has been applied to the area in paddy cultivation yet without proper utilisation the soil of the area will be redone.

An attempt has been made to classify the land in the study area on the basis of Land Capability Classification adopted by the All India Soil and Land Use Survey Organisation, it is found that the land classification falls under Class III - Class VI.

INTERPRETATION:

From the above map based on the Land Classification of Mawtneng Village the study area based on the Land Capability, can be classified into four categories. These are Class III, Class IV, Class V and Class VI only. These are further explained as follows:

TABLE SHOWING THE LAND CAPABILITY OF MAWTNENG VILLAGE

CLASS	AREA (in %)	AREA (in m)	AREA (in sq. km)
Class III	30.26	382830.509	0.383
Class IV	26.34	333,344.266	0.334
Class V	34.71	439,143.384	0.439
Class VI	8.69	109,989.21	0.11
Total	100	1,265,307.28	1.266

Table-5

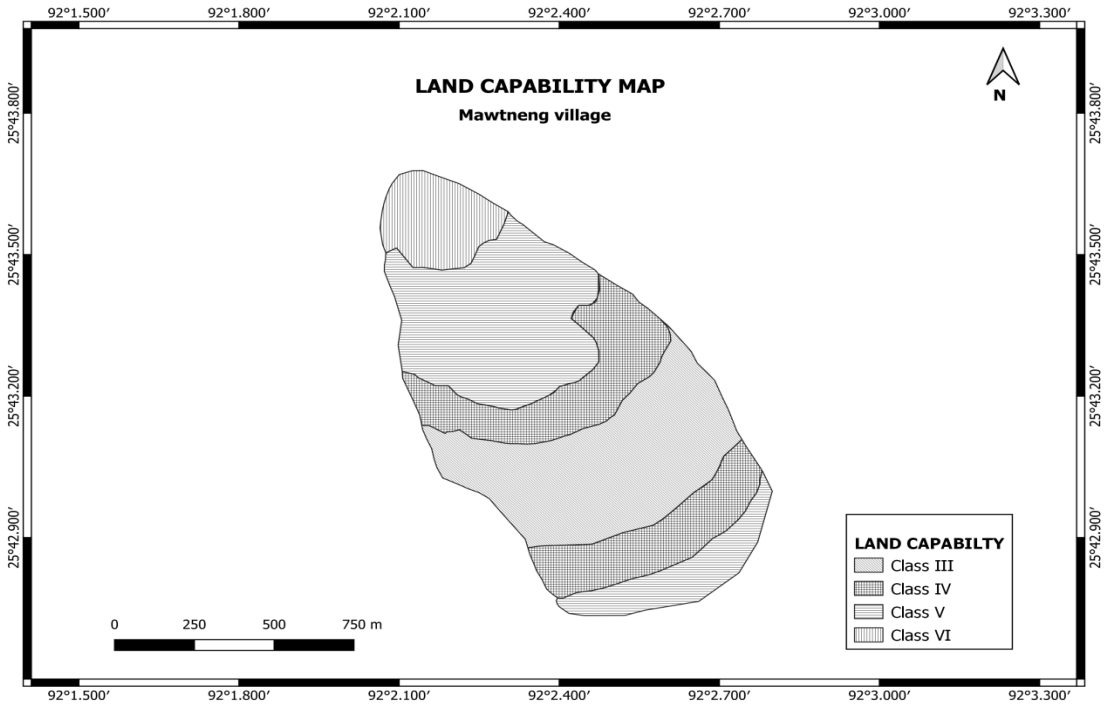


Fig 26: Map showing the Land Capability of Mawtneng Village

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1. Class III: From the map we can see that this type of class is dominant in the central part of the study area. It covers of an area of about 30% which is about 0.383 area sq.km. The main reason for this is due to the presence of Umtung river which flows from this part. The occurrence of this river makes this area a good cultivable land and proper irrigation from the river make it possible for a good yield.
2. Class IV: With respect to the map given above we can see that Class IV covers about 26% of the study area which covers about 0.334 sq.km. Since this area is located on the slanted area of the central part and in the Southern part there is a need for erosion control due its presence on the slanting area. Though this type of land is fairly good for cultivation yet some measures are needed to be taken in order to stop erosion or wearing off of top soil. Apart from all the class this is the least occurred class of land capability in the study area
3. Class V:From the map above this type of class covers the north eastern and the southern part of the study area it covers an area of about 0.439 sq.km which is about 34.71 % of the total land this type of class is not well suited for any cultivation but it best for grazing . due to its presence on the slating side of the hill slopes located in the study area this area suffers from extreme run off of soil from due to water or rainfall. This type of class is the dominant class of land classification of the study area
4. Class VI: Out of the total area of the study area this type of class covers 8.69% about which is 0.11 sq.km . It is mainly dominant it in the northern part of the study area where there is a massive amount of forest cover located in that area. Being located on

the rural area where the presence of forest is still abundant this class has high coverage on the study area.

Thus, it can be seen that physiography of the study area play a domain role of the Land Capability of Mawtneng Village. The presence of the water body which includes rivers / streams and tributaries which is the main source of water in the region, presence of the forest vegetation and its location play a substantial role on its land classification.

CHAPTER 6

FINDINGS

1. It is found that the study area (Mawtneng village) is located in the district of Ri-Bhoi in Meghalaya and the village has mostly a flat surface and has a slope slanting line on the earth surface or any other flat surface. The study area (Mawtneng village) has 3 major slope regions that being the steep slope region, medium slope region and gentle slope region.

2. It is found that the soil of the study area is laterite in nature which is formed mainly by runoff and leaching process.

3. The area of study is found to have a tropical and sub-tropical climate in nature, where the maximum temperature reaches 29°C and minimum temperature reaches 6°C at times. Rainfall ranges between 4.7cm during the driest months to 426cm during the wettest season. The relative humidity of the area depends on one place to another and in general the relative humidity is mainly between 81.70%-81.90%.

4. It is also found that the study area of Mawtneng village is drained by numerous streams. The drainage frequency of the study area has been divided into three classes i.e. 3 frequency which is the highest and 2-3 being regarded as medium and areas with less than 2 being considered as low. The river of Um Tung is the main river/stream of the study area.

5. On the aspects of physical and chemical parameters of soil, soil color ranges between light yellowish grey, light yellowish brown, light yellowish red, dark yellowish grey, dark yellowish brown, dark yellowish red and yellowish brown. The texture is a combination of silty clay, sandy silt, silty sand and sandy clay. The northwestern and some southern parts of the study area are more towards silty clay. The southern part is more towards silty sand and silty clay in some areas of the southern part. Silty clay is the most fertile soil type and is prominent in the study area. Sandy silt covers the slope area and sandy clay in the plains.

The chemical parameters are based on pH value. It has been found out that the entire study area ranges from moderately acidic to very strongly acidic. It is also found that the study area is low in ammonia and nitrogen. Nitrate content is very low in this area which makes the time for germination of plants longer. Phosphate is also low in all the study areas.

6. Potassium is also found out to be very low in this study area except for the southern part which has a very high concentration of potassium, and a small portion of the central part is medium in potassium.

7. The study area is medium in organic carbon except for a small portion in the northwestern and central part as they have low organic carbon content.

8. The area of study (Mawtneng village) has a total area of 1.27 sq.km.

9. It has been found out that in the study area (Mawtneng village) agriculture is dominant mainly due to the water bodies feeding the village and the fertility of soil in the area which makes it very suitable for agriculture.

CHAPTER 7

SUGGESTIVE MEASURES

- They should practice contour farming in the slopes of the village instead of shifting cultivation because shifting cultivation causes deforestation on a large scale.
- They should practice crop rotation, multi cropping and strip farming in order to prevent soil erosion.
- To prevent land degradation they should have proper management of wasteland and avoid over-using of fertilisers and pesticides.
- Another way to conserve soil is to encourage the cultivation of banana, papaya, mango and other types of fruit because these fruits have broad leaves and when it rains it prevent soil erosion as these broad leaf trees prevent direct contact of rainwater with the soil.
- Investing in infrastructures such as irrigation systems and storage facilities to improve access to markets and reduce post-harvest losses.
- Encouraging diversification of agricultural activities and promoting agro forestry practices to enhance resilience, improve soil health, and provide additional sources of income for the community.

CONCLUSION

The project work on the study of soil, land cover, land use and land capability of Mawtneng village has enhanced our knowledge and understanding of the topic, under this we study the problems, potential and real application of the soil, and 17 samples have been collected from the study area and from these samples that we have collected we had analyse the physical and chemical parameter of the soil, and we had also tested the chemical characteristics of the soil in the geography lab. Through this analysis we found out the soil in the study area is laterite which is rich in aluminium and iron, formed in wet and hot tropical area. This type of soil is good for growing crops like coffee, tea, coconut etc.

In conclusion, the people of Mawtneng village are heavily dependent on agriculture for their source of income. People of this village mostly practice traditional method of farming such as shifting cultivation. However, this farming method had lead to erosion and intense leaching which causes the soil of this area to be laterite. Thus the farmers are encouraged to practice contour bounding, crop rotation, and strip farming which will prevent soil erosion, and the government should also provide suitable scheme to promote and increase the crop yields of this area.

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