



From Prehistory to Present: Analyzing Dzuleke Village's Settlement Landscape and Ecosystem Practices through systematic survey and direct observation

Shreya Basak¹ and Arindam Sarkar²

¹PG Student (Semester: IV), Department of Geography, University of Calcutta

²Faculty, Department of Geography, Purash Kanpur Haridas Nandi College, University of Calcutta

Abstract: Dzuleke, a hill town situated in Nagaland, India, is a natural wonder endowed with extensive biodiversity, including bison and a distinctive array of flora and fauna. The village is located approximately 40 kilometers from the state capital, underscoring principles of communal living and clan affiliations. Its historical heritage is intricately connected with the rich cultural and traditions of the Zeliangrong Naga tribes, particularly the Zeme tribe. The origins of the village can be traced to the migration patterns of the Zeme tribe, a significant subgroup within the broader Naga ethnic community. The initial inhabitants of Dzuleke engaged in shifting cultivation, as well as hunting and gathering activities. The village was established to promote practical communal living, with a strong emphasis on clan and kinship ties. Historically, this was a hunting village renowned for captivating stories of head-hunters. The village's unique customs and traditions, rooted in its agricultural land, water resources, and resilient security measures against conflict, render it an invaluable resource for researchers and organizations dedicated to preserving cultural heritage.

The forest's remarkable biodiversity, both within and around the village, continues to attract botanists, environmentalists, and wildlife enthusiasts. The town, inhabited mainly by the Angami tribe, has fewer than 32 households and is nestled in a scenic valley surrounded by hills. Traditional Naga houses are constructed using locally available materials, and villagers engage in small-scale handicrafts and weaving to generate income while preserving their traditional skills. Most food is grown or reared organically, and the shift to organic farming and hunting bans drew the attention of the Tata Trust. In 2014, the Northeast Initiative Development Agency stepped in to promote organic farming and pig fodder. Dzuleke, a village in Nagaland, has undergone a significant transformation thanks to improved road infrastructure, which enhances tourism and showcases its natural beauty and cultural heritage. The community actively promotes eco-tourism to conserve its resources and traditional way of life. A study on Dzuleke examines its biodiversity, cultural heritage, and socio-economic dynamics through a structured approach. Qualitative methods include field surveys, ethnographic research, and interviews with village elders, local authorities, and artisans. GIS maps visualize infrastructure and resource management. The study offers valuable insights into the Dzuleke landscape, ecosystem, and sustainable development, along with recommendations for stakeholders to effectively support community-based initiatives.

Keywords: Prehistoric, ecosystem, organic, tribe, lifestyle

1. Introduction

1.1 Background of Dzuleke Village

Dzuleke village is nestled in the breathtaking landscape of Kohima District in Nagaland (Fig. 1, 2). The hidden beauty of this village captivates visitors with its stunning natural surroundings. The *Barail* mountain range surrounds this village, and rich, lush forests and vibrant ecology envelop it. Historically, the development of this village has been shaped by its strategic land use and natural resources, as well as its communal system, shifting cultivation, hunting, and gathering practices. Every corner of this village offers a unique view of nature, transforming the village's beauty into a true paradise due to its tranquillity. Dzuleke is a small village with only 32 households and 156 resilient residents. They celebrated their sustainable framing practices and the exceptional community of economic diversity. The villagers lead a harmonious life in harmony with nature, employing traditional techniques such as terraced farming and elder cultivation. These practices not only increase agricultural productivity but also strengthen essential ecosystem services, nurturing a deep bond between the local community and its environment. Nowadays, Dzuleke promotes its eco-tourism and attracts visitors with its stunning landscape and vibrant cultural heritage. Some organizational committees, such as the Northeast Initiative Development Agency (NEIDA) and the Tata Trust, have supported local communities' efforts to enhance their livelihoods through initiatives like organic farming and pig fodder production (Poyyamoli, 2018; Borah et al., 2018). Dzuleke village is preserving the natural resources to enhance the quality of life of the local community. This harmonious balance practice creates a unique experience for visitors and travelers.

1.2 Significance of the study

This study emphasises the substantial significance of understanding the relationship between traditional settlement, ecological conservation, and rural development. Dzuleke village exemplifies an indigenous resilience model, characterized by its land use patterns, environmental balance, biodiversity, and the livelihoods of the local community. The study of this village is very significant from various perspectives. Firstly, this study contributes to the documentation of indigenous knowledge practices, such as terraced farming, shifting cultivation, and communal land management, which help sustain the cultural identity of the Angami and Zeme tribes. Secondly, this study presents a unique opportunity for external intervention organisations, such as NEIDA and TATA Trust, to enhance the livelihoods of the local community without compromising ecological integrity. This study not only emphasised the land use pattern and infrastructural development but also visualizes ecosystem services, which are essential for conservation and tourism planning. Ultimately, this study is crucial for policymakers and planners interested in this area, as it promotes a culture based on ecology and rural development. It also provides a blend of traditional wisdom concepts to ensure a resilient future scenario for the local tribe community and landscape.

1.3 Literature survey

Khare, N, & Jamir, S (2018), studied about Food, 'Feeding Habits of Mithun (*Bos frontalis*) in Protected Area of Nagaland', the study was based on the food and feeding habits of *Bos frontalis*, the Mithun, aimed to gather insights for its conservation amid declining populations, despite being the state animal of Nagaland. It was found that Mithun predominantly prefers the leaf parts of plants, consuming approximately 80 percent of the 39 plant species identified, with whole plants being the second most favoured option. The research highlighted a strong preference for plant families such as *Moraceae*, *Poaceae*, and *Fabaceae*, particularly *Moraceae*, which was the most consumed. In total, 60 plant species from 15 different families were recorded, and *Mithun* was observed to spend over 50% of its time feeding, indicating a significant reliance on vegetation for sustenance. Das, A., et al. (2013) conducted a qualitative study on a new species of *Duttaphrynus* (*Anura: Bufonidae*) from Northeast India. As a result of research, a new species of montane toad, *Duttaphrynus*, has been identified in Nagaland, Northeast India. It is characterized by the absence of preorbital, postorbital, and *orbitotympanic* ridges, an elongated and broad parotid gland, a longer first finger than the second, and a mid-dorsal line. The tympanum is either hidden under a skin fold in males or absent in females. The species is compared to its relatives in India and Indo-China, and it is proposed that *Duttaphrynus wokhaensis* be considered a junior synonym of *Duttaphrynus melanostictus* (*Zootaxa*). Borah, J., et al. (2018) studied Quantifying carbon stocks in shifting cultivation landscapes under divergent management scenarios relevant to REDD+.

Shifting cultivation in tropical forests, particularly in northeast India, is expanding into old-growth areas and reducing fallow periods, which limits secondary forest recovery and contributes to carbon emissions and biodiversity loss. This study quantifies above-ground carbon stocks and models scenarios for carbon loss under continued shifting cultivation versus interventions like REDD+. Results show that a 30-year fallow can store about half the carbon of old-growth forests, while business-as-usual practices could lead to significant carbon loss. Protecting old-growth forests and allowing fallows to regenerate are the most effective strategies for carbon storage, with REDD+ offering potential benefits for both climate and biodiversity. Poyyamoli, G. (2018). Studied Ecotourism Policy in India: Rhetoric and Reality. This article critically reviews India's National Ecotourism Policy, highlighting significant flaws that enable greenwashing and contribute to the degradation of nature and culture in sensitive ecotourism areas. It identifies gaps between the policy's rhetoric and its actual impact. To promote authentic ecotourism in India, the article suggests remedial policy interventions informed by best practice case studies from Asia, emphasizing the importance of sustainable management of natural and cultural resources through community cooperation and collective action at local and regional levels. Baruah (2018) has studied the Scope of Recreational Fisheries in Northeast India, advocating for strategic investment and community-led management practices, which have substantial untapped potential for recreational fisheries.

1.4 Gap from Previous Research and Existing Publication

Although existing research on human-environment interactions in Northeast India is available, scholarly attention to the micro-level analysis of settlement landscapes, such as Dzuleke Village in Nagaland, spanning from prehistory to the present, remains limited. Current studies predominantly concentrate on ethnography and broad ecological assessments, often neglecting the temporal dynamics of landscapes and indigenous ecosystem management practices. Furthermore, remote sensing and geospatial techniques, including Geospatial Temporal Visualization (GTV), are underutilized in reconstructing the historical evolution of settlements and ecosystem adaptations within this region. There exists a significant gap in the integration of remote sensing data, satellite imagery, and ground-based validation techniques to analyse land use changes, biodiversity conservation efforts, and cultural landscapes over time. Addressing this gap will yield valuable insights into sustainable indigenous practices, historical land transformations, and resilience strategies, thereby enhancing the broader understanding of human-environment sustainability in sensitive mountainous ecosystems such as Dzuleke.

1.5 Objectives and Background of the Study

The primary objective of this study is to investigate the historical significance and contemporary settlement patterns in Dzuleke Village, Nagaland. It seeks to assess ecosystem practices by evaluating the sustainable methods employed by the residents of Dzuleke Village over time, identifying critical practices that have either persisted or changed in response to environmental and social factors. The research will help to assess the landscape changes of Dzuleke and its relevance through remote sensing and Geographical Information Technology Visualization (GITV). Another essential aim is to analyse the qualitative assessment of the local community by collecting feedback from them about their experience regarding settlement patterns, sustainability, landscape, etc. These objectives aim to provide a comprehensive understanding of the interplay between settlement dynamics, ecosystem practices, and technological interventions in Dzuleke Village. To understand the historical background and present settlement pattern, infrastructural development in Dzuleke village uses detailed historical maps and documents. Relevant land use and land cover data for Dzuleke Village have been generated and evaluated using geospatial technology, which was subsequently verified through ground surveys.

2. The Study Area

2.1 Location

Dzuleke village is primarily located in Nagaland, India (Figs. 01 and 02). It is encircled by the Barail mountain range, characterized by rich biodiversity, including diverse flora and fauna, dense forests, streams, and the cultural heritage of the *Angam Nagas*, who were the original inhabitants of the village. The area presents a scenic landscape with lush forests and undulating hills. Geographically, it extends approximately from 25.621° N to 93.956° E, within the Sechu–Zubza area of Kohima District, Nagaland. The Census Division of Dzuleke falls under the jurisdiction of Kohima. The village is located 51 km from Zubza, the sub-district headquarters, and 40 km from Kohima, the district headquarters and state capital. The nearest statutory town is Kohima. Additionally, Dzuleke is located approximately 18 km away from Khonoma village.

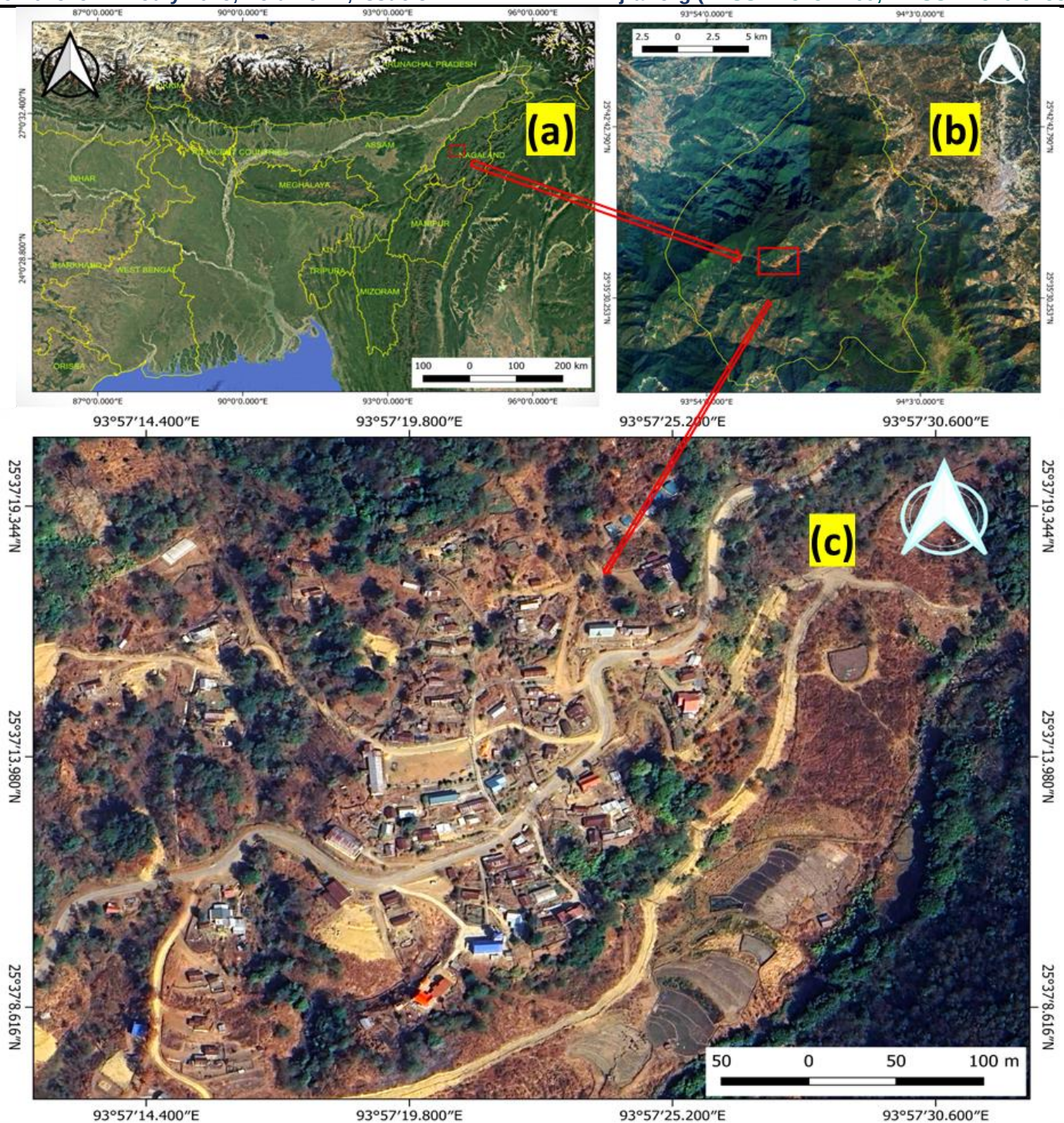


Figure 01. The image constitutes a multi-scale location map of Dzuleke Village, situated in Nagaland, Northeastern India. It is organized into three principal panels labelled (a), (b), and (c), each representing a distinct spatial scale. (a) Regional Map in the Context of Northeastern India. This panel illustrates the geographical position of Dzuleke within Nagaland, emphasized within the broader framework of Northeast India. The state boundaries of Nagaland, Assam, Manipur, Meghalaya, Mizoram, Arunachal Pradesh, Sikkim, Tripura, West Bengal, and Bihar are delineated in yellow. The red box and arrow designate the specific zone within Nagaland where Dzuleke is located. (b) District-Level Map displaying Local Terrain and Administrative Boundaries. This intermediate scale map enlarges the surrounding region of Dzuleke village. The village is highlighted within a red rectangle, indicating its location amidst a densely forested and hilly landscape. This map provides a topographic and administrative overview, illustrating the transition from a broader spatial context to the village scale. (c) Village-Level Map illustrating Micro-Level Settlement Patterns. This high-resolution satellite image of Dzuleke village is sourced from Google Earth. The map delineates roads, residential structures, agricultural lands (notably terrace fields), and patches of vegetation. It also illustrates the winding road system characteristic of hilly terrain. This panel offers valuable data for land-use analysis, planning, and the examination of ecosystem and settlement configurations



Figure 02. The photograph depicts the entrance sign to Dzuleke village, situated within the forested hills of Nagaland. This village is encompassed by verdant greenery and indigenous flora. The wooden signboard inscribed with "Welcome to Dzuleke" is positioned amidst dense vegetation. Dzuleke village is renowned for its community-driven biodiversity conservation and sustainable agricultural practices, contributing to its tranquil atmosphere. This welcome board signifies that the village is open to tourists (Fig.05).

2.2 Physiography

The village is named after the Dzuleke River (Fig.01). It is a small, remote, and verdant settlement situated amidst lush rainforests. Renowned for its spectacular landscapes, it is characterized by a bowl-shaped valley encircled by the Barail Mountains, including Mt. Kedieutsukeru, Mt. Pauna, and the Dzukou Valley. The pathway within the village is narrow, lined with native flora and fauna, and dotted with a few tin houses. The climate is monsoonal, with annual rainfall ranging from 1,800 mm to 2,500 mm and temperatures between 10 °C and 25 °C. The sky is predominantly overcast, with infrequent glimpses of sunshine. A gentle breeze often sweeps through, creating a soothing atmosphere. A significant portion of the village is comprised of paddy fields, with terrace farming observed on the hillside steps, where crops such as corn, cabbage, chili, bitter gourd, eggplant, carrot, radish, coriander, and garlic are cultivated. The hillside gradient, approximately 10° to 20°, is well-suited for terraced agriculture. The village comprises only 32 households, which primarily lack access to technological resources. Mobile network connectivity is limited, with inadequate cell tower coverage and internet facilities. During the rainy season, the river, lined with shallow shingles, gurgles loudly; it transforms into a stream of crystal-clear water in autumn. Dzuleke aspires to develop as an eco-tourism model but faces challenges due to resource constraints, insufficient funding, and limited technological expertise. The main livelihoods include timber collection, agriculture, and income from homestays. The village river also serves as a breeding ground for trout fish, representing a burgeoning initiative for livelihood diversification. At times, the paddy fields are temporarily converted into small fish breeding grounds.

2.3 Climate and soil

Its climate is monsoonal, with temperatures ranging from 10°C to 25°C and rainfall averaging between 1,800 and 2,500 mm. Most of the time, clouds cover the sky. The sun is visible on a couple of occasions. There is a light wind, which contributes to the calm weather. Most of the region is covered in ultisols, alfisols, entisols, and inceptisols. Inceptisols, which make up over 66 percent of Nagaland, are soils with fine clay, clay loamy, and fine loamy clay textures. Entisols, characterized by a fine loamy texture, cover 7.3 percent of the area. Alfisols are light-coloured, mineral-rich soils that make up 2.9 percent of the land area. Twenty-three percent of the land is made up of clayey Ultisols. In this area, clayey soil is ideal for terrace farming and paddy production. Paddy farming requires much water. Very little water percolates through clayey soil due to its

extremely low percolation rate. Thus, paddy cultivation is the optimum use for it. Clayey soil particles are less than 0.002 mm. Because there is little air or water flow, it can remain moist for extended periods. However, under dry and chilly conditions, it could bake hard. There are plenty of nutrients in the clayey soil.

2.4 Natural vegetation and agriculture

Dzuleke, a small verdant village, experiences substantial rainfall during the monsoon season. Such heavy precipitation is a crucial factor in the development of dense forests. Lush, green rainforests with tall canopy trees surround the majority of the village. This verdant village also serves as a biodiversity hotspot, boasting a diverse array of flora and fauna. Numerous species of herbal trees, medicinal plants, and both known and unknown plant species are present. Simultaneously, another section of the village is cultivated with paddy fields, and terraced farming is practiced on the hillside slopes. Alongside paddy cultivation, villagers also engage in vegetable gardening to enhance their income, cultivating crops such as garlic, maize, cabbage, chili, bitter melon, eggplant, carrots, radishes, beans, and coriander. Considering that carrots and beans are prone to late rotting, the community has devised several processing methods. In paddy cultivation, nurseries are established in April, followed by the planting of saplings in June, and the harvest occurs in October. Post-harvest, the land is left fallow until the next monsoon, during which the soil naturally replenishes its nutrients without the use of chemical fertilizers. During the monsoon, rainfall causes nutrients and minerals to flow down from the topsoil, thereby enhancing soil fertility. The gentle slope of 10° to 20° facilitates the development of soil health. Tobacco plants, containing a gum-like substance that traps insects, are also found in the area. Additionally, a portion of the land is utilized for jhum cultivation and elder cultivation, both of which are widely practiced and highly popular here.

3. Data and Methodology

This study employed a mixed-method approach, integrating both primary field-based observations and secondary spatial data analyses. The methodology was designed to trace the temporal evolution of Dzuleke village's settlement patterns and ecological knowledge systems. Primary data were collected through extensive field visits to Dzuleke village, situated in Nagaland. Structured and semi-structured questionnaires were administered to residents, including village elders and youth, to gather insights on traditional ecological practices, settlement histories, and resource management strategies. In-depth interviews provided a qualitative understanding of indigenous knowledge systems and cultural narratives related to the landscape.

Photographs were systematically captured and subsequently analyzed to document current land use patterns, architectural typologies, and ecological indicators. Ground sketches and field notes supported visual documentation. Secondary data sources included historical maps, satellite imagery, and official land records. These sources were interpreted to identify changes in settlement expansion, forest coverage, and land utilization over time. A comparative analysis was conducted between historical and contemporary spatial data to understand the extent of anthropogenic modifications and the continuity of ecological systems. Remote sensing techniques were employed utilizing high-resolution imagery from recent years, while GIS tools were used to map and analyse spatial trends. The integrated approach ensured a comprehensive understanding of the evolving landscape and the resilience of the ecosystem practices of Dzuleke village. Remote sensing data have been obtained from sources such as Google Earth and USGS Earth Explorer. To identify the state of settlement and changes over time, utilize Spatial techniques, geospatial software, and Google Earth's historical imagery. Interactive interviews have been conducted with residents to collect data regarding traditional and contemporary ecosystem practices. To provide a brief overview of the community's practices, documentation has been done based on agricultural methods, resource management strategies, and conservation efforts. Secondary data was collected from various sources to compare current practices with their historical background, identifying trends in sustainability. Comprehensive feedback has been gathered from the local community during field surveys. Transcripts from interviews, as well as representative focus groups and discussions with community members, have been generated. Visual ethnographic data, including photos and videos, have been collected during field surveys to document community life and practices. Semi-structured interviews have been conducted with community representatives to gather insights into their perceptions of agriculture, settlement patterns, climate change, and sustainability. Group discussions have been facilitated to explore community knowledge, attitudes, and experiences related to ecosystem practices and technology use.

4. Results and Discussion

4.1 Geology and geomorphology

Numerous geological features are present in this region. It is classified under the Barail group of rock units. Situated between the Brahmaputra and Barak basins, an area of approximately 80,000 square kilometers is covered by the Barail Range, which constitutes the tertiary range of Northeastern India (GSI, 2011). This range extends from Nagaland to Manipur in the east and from Assam to Meghalaya in the west. In Nagaland, the Barail group comprises coal seams, shales, siltstones, and interbedded thin layers, alongside thick sandstone beds. These are divided into three subdivisions: Renji, Laisong, and Jenam. The Renji Formation, characterized by the hardest, ferruginous, heavily bedded, and multi-storey massive sandstones, is the youngest and highest segment of the Barail, with thicknesses ranging from 700 to 1000 meters. Palynofloral evidence suggests a depositional environment similar to a river-to-deltaic setting, indicating a late Oligocene age (Singh et al., 2014). The Laisong Formation features alternating strata of sandstone, siltstone, and shale. Weathered rocks exhibit pink and reddish-brown hues, while the sandstones are firm, compact, well-bedded, and vary in colour from white to grey, including white kaolinitic bands. The Laisong Formation, situated above the Disang, has a thickness of approximately 900 to 2000 meters and indicates an age corresponding to the middle to late Eocene (approximately 36.6 to 53 million years ago), as evidenced by fossil occurrences (GSI, 2011; Singh et al., 2014). The Jenam Formation is distinguished by coal seams, thin sandstone bands, carbonaceous layers, shale, and dark grey siltstone. Its basal portion contains abundant carbonaceous shale. The Jenam rocks, located above the Laisong Formation, have a thickness ranging from 900 to 1200 meters. Fossil data indicate an Oligocene age (23 to 36.6 million years ago) and suggest a brackish depositional environment. The Green Village area boasts a rich biodiversity, abundant flora and fauna, extensive canopy forests, and a nearby stream. Fauna such as bears, wild boars, squirrels, and bison inhabit this region. Although these animals often damage crops, hunting and poaching are prohibited (Tata Trust, 2019). Additionally, numerous boreal animals, colourful insects, birds, and butterflies can be observed.

4.2 Landscape, People, Society, and Culture

The bowl-shaped village of Dzuleke is surrounded by a beautiful stream hidden in a lush green canopy forest of the Barail Mountain, akin to *Mount Kedieutsukeru*, Mount Pauna, and the Dzukou Valley, which hosts a diverse array of flowers and wild animals. Dzuleke, a small village with only 32 households and approximately 156 inhabitants, is situated in the secluded hills of Nagaland, with a focus on ecotourism. The town features two churches: one Catholic and one Baptist. Paddy fields surround the village, and terrace farming is practiced at the base of the hill. The residents cultivate crops such as beans, coriander, bitter eggplant, carrots, radishes, corn, cabbage, garlic, and chili (Fig. 03). The terrain slopes vary between 10° and 20°, facilitating step cultivation. The local fauna includes species such as bears, wild boars, squirrels, bison, and monkeys. Twenty years ago, the village council made a bold decision to prohibit hunting and trapping of wild animals in the surrounding forests, which has contributed to the region's ecological wealth. Consequently, Dzuleke has become a habitat supporting a broader diversity of flora and fauna. The small village population and its firm adherence to ethnic traditions offer an insightful glimpse into rural life. It is an Angami and Zemi tribal village located in the Kohima district, comprising only 200 Angami Naga households, and has developed into a notable ecotourism destination. The community is predominantly Christian and speaks the Tenyidie language. Originating from the historically warrior-oriented head-hunting communities of ancient Nagaland, the Angami Nagas have transitioned from a martial past to a more contemporary lifestyle with government integration. They celebrate the Sekrenyi festival at the beginning of the lunar year, which involves various rituals, singing, and dancing. Agriculture remains their primary occupation.

4.3 Ecosystem Services

Ecosystem services are the direct and indirect benefits that ecosystems, also referred to as natural capital, offer to people's well-being and standard of living. It is four types:

4.3.1 Provisioning Services

It is mainly the services provided by nature, such as water, food, and vegetables, that have direct access to the ecosystem. The Dzuleke village is full of provisional services because it is surrounded by a rich biodiversity.



Figure 03. Behind the scenes, this road plays a multifaceted role in the village, linking homes, farms, and cultural sites. The rural pathway winds its way through the lush, leafy landscape of Dzuleke, framed by the soft blue sky and shrouded in mist-covered hills that add to the village's scenic charm. The open spaces also support the local economy and help preserve environmental values.

4.3.1.1 Fresh water

The name Dzuleke originates from the Dzuleke River, a magnificent watercourse concealed within the rainforest. The river's flow is notably vigorous during the rainy season, whereas in autumn, it diminishes to a modest stream of clear water, accompanied by shallow shingles along the agricultural areas. The local inhabitants predominantly rely on a limited number of natural resources, including mountain streams and rivers situated within the jungle. These water sources play a crucial role in enhancing both the ecosystem and the villagers' livelihoods. The water is primarily utilized for daily activities such as drinking, agriculture, and fishing. Additionally, nine deep wells serve the community effectively. Currently, the government has undertaken numerous initiatives aimed at improving the quality of life. Among these, the JAL JEEVAN MISSION is particularly noteworthy; it provides safe and adequate drinking water to individual households via piped connections in rural areas. These efforts serve to bridge the gap between isolated villages and modern society. Access to fresh water contributes to the improvement of soil quality, supports paddy cultivation, terrace farming, and fishing, and enhances food production, thereby fostering food security and promoting overall health. Such foundational utilities generate a higher level of economic utility. The cultivation of high-quality vegetables, such as carrots, cabbage, garlic, corn, chili, and bitter gourd, has expanded to local markets for sale. This not only fulfils domestic needs but also supports commercial activities, generating substantial revenue for the village. This income facilitates the enhancement of village infrastructure, cultivation practices, and the overall standard of living for the local population.

4.3.1.2 Food Production

The predominant method of cultivation practiced in this region is terrace farming, which supports food production and ecosystem services. Harvesting occurs once annually, and cultivation relies heavily on the monsoon season. The primary crop cultivated is paddy, which is sown in nursery beds in April, transplanted by June, and harvested within the first week of October. Some farmers opt for vegetable gardening, which yields higher revenue. Historically, cultivation was limited to domestic needs; however, it has now expanded to commercial purposes. The local variety of garlic is cultivated, with harvest time in January. The most extensively cultivated crops include maize, cabbage, chili, bitter gourd, and eggplant, which are sold commercially immediately after harvest. Crops such as carrots, radishes, and beans have a longer shelf life and are processed to maintain a sustainable supply. Although coriander and mustard are also cultivated, their shorter shelf life often results in spoilage if not sold promptly. Post-harvest, fields are left fallow, allowing

natural nutrient replenishment without the use of chemical fertilizers. During the monsoon season, nutrients are naturally replenished through the downward flow of water and minerals from the topsoil, illustrating the benefits of terraced cultivation. The slope of the land ranges from 10° to 20°, making it highly suitable for agricultural practices. A portion of the land is utilized for jhum cultivation, which remains a widespread and sustainable practice in the area. In Dzuleke and the eastern regions of Nagaland, traditional elder cultivation is a prevalent practice. Wild animals, such as bears, wild boars, squirrels, and bison, pose a threat to crops, although government regulations strictly prohibit hunting these animals. Specific rules and regulations are in place for crop protection. In cases of farming within forested areas and crop destruction by wild animals, individuals may seek permission to protect their crops until harvest. However, any activity beyond designated farm boundaries, particularly if it involves killing animals outside their property, is subject to legal penalties. The penalty fee for first offenses is Rs. 20,000; subsequent offenses carry higher fines, namely Rs. 40,000 and Rs. 80,000.

4.3.1.3 Timber for fuel

Dzuleke, a village of Kohima district, lacks modern energy availability. Timber has traditionally been the only energy source used for cooking rice, curry, and other household needs as fuel. Other than Jhum cultivation, another special type of farming is practised in the village, which is locally termed as the “Elder cultivation” where trees are cut from below and cleared up. Firstly, the land or area is cleared. Then, some of the trees of the elder develop into some size of sprouts. The sprout trees grow enough to provide firewood for one year. After the availability of firewood and material for construction, furniture, and handicraft creation, the tree is cut down, and the land is burned. The exact process is followed again for two consecutive years, starting with the selection of the healthiest and straightest variety of sprouts, trimming the unwanted parts, and so on. Finally, the cultivators leave the piece of land and return to it after about 7-8 years. The selling of timber thereby allows additional income for local families. However, cutting trees and using them as fuel is now banned because such activities destroy a significant amount of flora and fauna, including species such as reptiles and bats. Excessive logging and over-exploitation have already led to deforestation and soil degradation. For that reason, the government discouraged Jhum cultivation and deforestation in many parts of the village. Therefore, sustainable management of timber is necessary. However, many people no longer use much firewood; instead, they rely on LPG, rice cookers, electric kettles, and other alternatives, as LPG is widely available everywhere and considered an essential fuel. Two agencies are refilling the cylinders in the village.

4.3.1.4 Traditional medicine

The biodiversity hotspot of Dzuleke has several types of traditional medicine that are crucial for ecosystem services. It is surrounded by dense vegetation, so various kinds of plants help to cure. No medicinal plant should be cultivated. However, they use leaves, roots, and different parts of local plants to cure their illnesses. They boil the leaves of the plant and drink the water to alleviate gastric problems. They use several types of leaves for curing bleeding and wound care. Moreover, a kind of leaf is used for recovering piles. Additionally, they employ various recovery techniques.

4.3.2 Supporting Services

Nature provides many services that are crucial for the ecosystem. Those include photosynthesis, soil formation, the nutrient cycle, and the hydrological cycle, among others. They are sustaining and improving the ecosystem.

4.3.2.1 Soil characterization

Most of the area is covered with Inceptisols, Entisols, Alfisols, and Ultisols. The fine clay, clay loam, and fine loamy clay-textured soils are Inceptisols, which cover nearly 66 percent of Nagaland's area. 7.3 percent is covered by Entisols, characterized by a fine loamy texture. Alfisols are coloured soils that are full of minerals and cover 2.9 percent of the land area. The clayey Ultisols cover 23.8 percent of the area. Clayey soil is conducive for paddy cultivation as well as terrace farming in this region. A significant amount of water is required for paddy cultivation. Clayey soil has an extremely low percolation rate, i.e., very little water percolates through it. It is therefore best suited for paddy farming. The particle of clayey soil is less than 0.002 mm. Air and water movement are limited, allowing the area to remain wet for extended periods of time. However, it may bake hard in frosty and dry conditions. The clayey soil is full of nutrients.

4.3.2.2 Primary production

The village engages in various forms of primary production. These are agroforestry, sustainable agriculture, and forest preservation. Through agroforestry, they cultivate crops such as paddy and multiple types of vegetables, including carrots, cabbage, garlic, corn, chili, coriander, and bitter guard. It also helps to generate revenue through the sale of products to both the external and local markets. Shifting cultivation, known as ‘Jhum’ in regional terms, terrace farming, and elder cultivation are very popular here. They maintain their livelihood through the collection of wood, honey, and other resources, which is a prominent example of elder

cultivation. After their cultivation, they are left in the field to absorb the nutrients naturally. These processes collectively improve the quality of the soil and increase production. Also, they use land for grazing. They obtain a milky product and meat from domestic animals.

4.3.2.4 Decomposition

Decomposition is the process of breaking down organic matter from complex to simple forms. The village is green, so the amount of decomposable material is quite normal. The complex organic matter is converted into simple nutrients, including carbon dioxide and oxygen. This process primarily occurs through the actions of bacteria, fungi, earthworms, and other organisms. Decomposition is part of the nutrient cycle. Here, people leave the land fallow for the next monsoon after harvesting. Weather conditions, including rain, wind, and temperature fluctuations, begin to break down agricultural residue or organic matter into smaller pieces once it is left in the field. Bacteria, fungi, and earthworms decompose leftover leaves, roots, branches, and other plant materials, turning the complex organic matter into simpler forms. After they die, their bodies decompose and mix with the soil, thereby increasing soil fertility. During the monsoon, rain helps carry simple organic matter from the topsoil downward, aiding in the step cultivation process.

4.3.2.5 Waste absorption

Soil and water absorb the waste products of the village. The soil and water easily absorb the perishable matter of the village. Wastage of vegetables by local people, perishable products, and waste from plants, among other sources, mixes with the soil and water. They are also improving the soil quality. Organisms, such as bacteria and fungi, decompose the perishable product. Although the water, monsoonal rain, and wind help break down the complexity of this product and mix it well with the soil, which makes the soil more fertile. Now the village is developing slowly under the authority. Tourism is becoming increasingly popular, which is improving both the economic condition and the livelihood of local people. Nevertheless, it has a significant disadvantage for the village. The tourist uses plastics and various non-perishable products, which are not absorbed into the soil or water. Instead, the non-perishable product decreases the quality of the soil. It takes the lives of many marine animals and plants, as well as those of terrestrial animals, such as birds and other animals. The non-perishable product also brought the beauty of the green village. The tourist discards plastic bottles and other waste here and there, thereby polluting the town and spoiling its beauty. Dzuleke has no waste collection or management as such in this village. However, the segregation of wet waste is practiced here. The wet waste is used as a source of food for the animals.

4.3.2.6 Biological diversity and maintenance

Dzuleke village, a designated biological hotspot, is abundant in diverse flora, fauna, and various other species. It hosts numerous known and unknown plant varieties. Additionally, wild animals such as bears, wild boars, squirrels, and bison inhabit the jungle. Many colourful birds also frequent the area. The government actively undertakes measures to preserve the biodiversity of the village. Often, wild animals destroy crops and vegetables, leading villagers to kill them. People also hunt animals and birds for personal purposes or monetary gain. Currently, the government has implemented measures to conserve wildlife, including a complete ban on hunting. Strict rules and regulations are in place to protect the animal kingdom. In cases where crops are threatened by wild animals in designated farming areas, villagers can seek consent and take proportionate actions to safeguard their crops until harvest. However, cultivating in forest areas is prohibited, particularly if it results in harming or killing animals.

First-time offenders face a fine of Rs. 20,000, second-time offenders face a fine of Rs. 40,000, and third-time offenders face a fine of Rs. 80,000. Presently, the Dzuleke Eco-tourism Board (DETB) promotes eco-tourism initiatives. The DETB aims to develop sustainable tourism despite limited resources and funding. Additionally, the DETB operates under the auspices of the Northeast Initiative Development Agency (NEIDA), an organization affiliated with the TATA Trust. Community-based eco-tourism was initiated in 2014 by the TATA Trust. NEIDA, which was registered under the Society Registration Act of 1860 in 2012 in Kohima, Nagaland, seeks sustainable solutions for rural areas in Northeast India. Through ecotourism, the government has generated revenue to support the village's development.

4.3.2.7 Habitat provision

There are only 32 homes with 156 people. Everybody treats each other like family. They have worked on eco-tourism. They have several types of vegetable and flower gardens surrounding their house. There is a "Self-Payment counter" for vegetables on the way to Dzuleke (Fig. 08), which is surprising. Honesty and trust are abundant everywhere. Dzuleke is a tiny green village that focuses on ecotourism. The Dzuleke Eco-Tourism Board (DETB) is most popular for promoting eco-tourism in the area. Now, many homestays are built mainly for tourism. The local people maintain the hospitality of the homestay. It is also a source of earning money.

4.3.2.8 Regeneration and degeneration of the plan

Elder cultivation is one of the primary methods for regenerating and rejuvenating plants. In this cultivation, on the first day, the land or area is cleared. Some of the elder trees with spiky branches and sprouts of this size will emerge, and then they are cut for firewood or construction. Spread out, sort, and remove everything from the field, ensuring that the sap of the trees is not too close to the fire during the burning process. New sprouts will come from the stumps within one year. When the new sprouts start growing, the healthiest and straightest ones are selected, while the unwanted ones are trimmed out. Over the next two years, the sprouts are allowed to grow. After two years, the land is left abundant and is then moved to another site for cultivation. After 7-8 years, one can return to cultivate the land again.

4.3.3 Regulating services

Many of the essential functions that enable human life are provided by ecosystems through regulating services.

4.3.3.1 Climate Regulation

Forests are essential for climate regulation. The plants absorb the polluted air and clean the environment. The village is covered with dense rainforest. The village near the Dzukou is surrounded by a diverse array of flora and fauna, as well as a dense forest. The forest is also playing a crucial role in the carbon cycle. The forest is absorbing the strong carbon dioxide and mitigating its harmful effects, such as pollution. The forest maintains a balance in the environment. The village also promotes ecotourism (Fig. 04). It is primarily aimed at preserving the environment through tourism, which also helps generate income. Through cultivation, the environmental cycle continues. The forest plays a crucial role in fighting against global warming. However, many people are illegally cutting down trees. Jhum cultivation and slash-and-burn cultivation are the most prevalent methods here, where a vast portion of the land is burned initially, producing a significant amount of smoke and contributing to pollution. Because of deforestation, the absorption process is decreasing. Now, the government is implementing policies to protect the forest, which is a positive signal for regulating the climate for the future.

4.3.3.2 Flood Prevention

The small green village of Dzuleke receives heavy rainfall during the monsoon season. It receives an average of 1,800 mm to 2,500 mm of rainfall. This leads to a flood-like situation, destroying numerous crops and vegetables. It also affects the small village economy. However, on the other hand, floods enrich the soil with nutrients, which in turn helps produce high-quality fruits, vegetables, and crops. When it comes to flood prevention, dense vegetation is most effective in mitigating the impact of flooding. The root system of the forest canopy absorbs the excess water generated by the flood. Additionally, the root helps prevent soil erosion. It is a hilly region, so the excess water goes downward. It should not cause a significant problem in the village. Additionally, the government has undertaken several drainage system projects to prevent the region from experiencing flood situations. Flood is not a common phenomenon in this place.

4.3.3.3 Erosion Control

The area is hilly, so soil erosion is a common issue in the village. Additionally, due to terrace farming and monsoonal rains, erosion is common in these areas. The soil on the top of the hill flows downward through the hill slope, carrying water that causes soil erosion. Here, trees help to control soil erosion. The roots of the tree hold the soil particles firmly in place. That is why the soil cannot go away. The government is now developing a drainage system to help reduce soil erosion. Also, tree cutting is a standard issue here. That is why the number of trees is decreasing as the soil becomes loose, which is a significant cause of soil erosion. The government has banned deforestation now, through productive policies.

4.3.3.4 Pest control and control of pathogens

Cultivation is one of the primary sources of income in this village. Here, commonly cultivated paddy, corn, garlic, carrot, bitter gourds, radish, etc. The crops and vegetables are affected by several types of pests. Indigenous Technical Knowledge (ITK) is primarily utilized to address agricultural challenges. The local people mainly use it. It is a natural process based on experience, as well as a sustainable and eco-friendly process for controlling the effects of pests. Additionally, it has been scientifically proven to yield better results. ITK serves as the foundation for local decision-making in various fields, including natural resource management, agriculture, healthcare, and education. It fosters a sustainable agricultural process by minimizing resource exploitation. For the control of pathogens, they primarily use natural processes. They use several types of medicinal plants that protect them from pathogens. They boiled or mashed the leaf to treat various ailments. Also, there is a hospital where the doctor comes once a week. He also provides medicine to them.

4.3.3.5 Pollination

Pollination is the transfer of pollen from one part of a plant to another. It facilitates fertilization and seed production. Wind, water, birds, and animals all play a role in the pollination process. As it is a forested area, it hosts a diverse array of flora and fauna, making pollination a common phenomenon for plant propagation. The village, situated in the Dzukou Valley, is densely populated with a diverse array of plant species.

Pollination occurs through wind flow, with pollen adhering to the feet and wings of birds and also to the legs of animals, thus aiding in the transfer of pollen from the male reproductive part of a plant to the female part of the same or different plants. During the rainy season, water helps in the transfer of pollen. Overall, pollination is a crucial factor in the growth and sustainability of the forest.

4.3.3.6 Water purification

They employ a natural purification method, which involves boiling water to purify it. Boiling water is considered the most effective option for purification, as the high temperature kills most bacteria, which cannot survive in extreme heat. This method is widely regarded as both popular and effective. Additionally, materials such as sand, gravel, and cloth are utilized in filtration techniques. This process involves creating layers of sand and gravel through which water is passed, resulting in automatic purification. The purified water is then used for drinking, cooking, and various other purposes.

4.3.3.7 Disease regulation

Regarding the treatment of various diseases, several types of medicinal plants are employed. For example, Nut Grass is used to cure fever, Solar Dermatitis, Diabetes, and to promote kidney health. Punarnava, also known as Spreading Hogweed, is used to treat anemia, wounds, and liver diseases. Tulsi, or Holy Basil, is applied for indigestion, heart health, and respiratory diseases. Additionally, garlic, ginger, Ginkgo leaf, Ginseng root, and Milk Thistle fruit are also used as medicinal remedies. Furthermore, there exists a hospital where a doctor visits once per week to provide medication to the local population.

4.3.3.8 Protection against pollution (plastic management)

The dense rainforest of Dzuleke village in Nagaland provides maximum protection from pollution. It is rich in flora and fauna. The trees absorb polluted air, such as excessive carbon dioxide. Additionally, perishable waste is absorbed by the soil, which helps prevent pollution. Now, ecotourism has started here. That is why many tourists visit, which has a positive impact on local revenue. However, there are negatives too, such as when visitors use plastic and litter, which does not get absorbed by the soil or water, leading to pollution. The government has implemented policies to clean up plastic and non-perishable waste. They place buckets on the roadside as a remedy.



Figure 04. The photograph depicts the stunning landscape of Dzuleke. The mist enveloping the hill creates a transcendent ambiance characteristic of a cold climate, which underpins the region's rich biodiversity. It presents a mist-covered mountain beneath a blue sky, accompanied by a small section of cultivated land, reflecting the community's commitment to sustainable small-scale agriculture. The forested hills exemplify harmonious interaction with natural and traditional ecological knowledge. The road adjacent to this agricultural land indicates limited infrastructural development. It demonstrates the indigenous community's efforts in landscape management and the preservation of environmental balance.

4.3.3.9 Species Regulation

This approach aims to conserve biological and ecological resources. To regulate species, various government policies are implemented. For instance, the government may impose a complete ban on hunting wild animals. Wild animals such as bison, bears, boars, and squirrels often destroy crops. Hunting in such contexts is prohibited. There are established rules and regulations to safeguard crops. For example, suppose a wild animal damages crops while farmers are farming in jungle-adjacent areas. In that case, they should seek permission from local authorities, such as community elders, to protect their crops until harvest. Conversely, killing a wild animal outside designated farming regions and reporting instances of damage caused by animals, such as bears or wild boars, may result in penalties. The penalties are set at 20,000 units for the first offense, 40,000 for the second, and 80,000 for the third. Additionally, the concept of eco-tourism has been promoted. This involves residents providing hospitality and services to tourists without harming the forest, thereby contributing to the protection of wild species and increasing village revenue. Such initiatives support rural development and promote environmental sustainability.

4.3.3.10 Domestication of plant and animal

The small village of Dzuleke features nearly every house with its garden and domesticated animals. The residents cultivate various vegetables around their homes, including beans, pumpkins, devil fig, cabbage, coriander, and mint leaves. These products are primarily consumed locally and also sold commercially. The villagers keep domesticated animals such as chickens, cows, cattle, and pigs, which serve as significant sources of milk and meat. Meat is a common and popular dietary choice within the community. Each household among the Nagas typically maintains at least one domesticated animal from this livestock, which provides both nutritional and economic benefits. Additionally, there exists a self-payment counter where they sell the vegetables.

4.3.3.11 Biodiversity monitoring

The village is a significant biodiversity hotspot, exhibiting a diverse range of flora and fauna. Numerous medicinal plants are commonly found in the area. A variety of vibrant flowers, both known and unknown, bloom abundantly. The region is home to a diverse array of animal species, including bears, wild boars, squirrels, and bison. Additionally, numerous colourful birds can be observed. Fishing is a popular activity and serves as an essential economic resource.

4.3.4 Cultural Services

When we desire to engage with the natural world, it also influences us. Nature governs their society and culture. The interaction between nature and humanity has been ongoing since ancient times. There is substantial evidence to support this, including images of plants, animals, and other natural elements.

4.3.4.1 Cultural Heritage

The village of Dzuleke embodies the hospitality and heritage of the Naga people, shaped by its natural environment, rich culture, and growing eco-tourism industry. Regarding the natural environment, it is recognized as a biodiversity hotspot home to diverse flora and fauna, including the distinctive state bird, Blyth's tragopan. The village is primarily inhabited by the Angami tribes, an indigenous ethnic group of Nagaland that was among the first to come under British colonial rule. Each group maintains a unique identity. The villagers celebrate the 'Sekrenyi' festival annually in February, which is the most prominent event for them. Their language is Angami, and their spiritual beliefs include a deity or spirit called 'Terhuomia.' Typical local cuisine consists of fried bamboo shoots, fish, and smoked meat, among other dishes. The *Melo Phita* dance is notably popular among the Angami community. Approximately 98% of the population identifies as Christian, while the remaining adheres to Animism. NEIDA, the Northeast Initiative Development Agency, was registered under the Societies Registration Act of 1860 in 2012. NEIDA aims to develop rural areas by providing amenities such as drinking water, shelter, and sanitation. The village promotes eco-tourism through DETB, which is supported by NEIDA and the TATA Trust. The eco-project was initiated in 2014. Eco-tourism has increased tourism in Dzuleke, becoming a source of revenue for the village. Residents open their homes to tourists. NEIDA also provides training for proper hospitality and management.

4.3.4.2 Archaeological Significance

Their houses are constructed with stone and tin; they engage in terraced farming. These are indicative of how people have adapted to the hilly region for their sustenance and have utilized slopes for agricultural purposes. They practice jhum farming and elder cultivation, which are also influenced by the regional landscape. The village is predominantly inhabited by the Angami tribes, an ethnic group from Nagaland that has preserved its culture since ancient times. The Angami tribes have persisted through the British colonial period.

4.3.4.3 Historical Landscape

The historical landscape of Dzuleke comprises dense forests, hills, and streams. The village is situated amid vibrant wildflowers and diverse wildlife. The Barail Mountain range borders the surrounding hilly region. The name "Dzuleke" is derived from the Dzuleke River. The inhabitants engage in various forms of cultivation,

including paddy cultivation, terrace farming, jhum cultivation, and elder cultivation. The slope angle ranges from 10° to 20°, which is highly suitable and advantageous for step farming. The village council has implemented numerous policies to enhance the population of local flora and fauna. Deforestation and hunting are strictly prohibited. Additionally, they have established the Dzuleke Eco-Tourism Board to promote tourism in the area.

4.3.4.4 Religious Heritage

The Angami tribe governs the village and represents the largest religious ethnic group in Nagaland. Historically, they fell under British colonial rule and are considered the first inhabitants of the region. Each individual possesses a distinctive identity. In February, they celebrate the "Sekrenyi" festival, the most significant among them. The language spoken by the Angami people is called Angami. Their deity or spirit is known as "Terhuomia." Their cuisine includes popular dishes such as fish, smoked pork, and fried bamboo shoots. The renowned Angami dance is called Melo Phita. Approximately 98% of the population practices Christianity, while the remaining individuals adhere to various forms of animism.

4.3.4.5 Science, Research, and Development

The local government has implemented several development policies. They have enacted bans on hunting and deforestation, which help conserve the unique biodiversity of this village. The Department of Environment, Tourism, and Biodiversity (DETB) promotes eco-tourism with the support of NEIDA and TATA Trusts. They prioritize the provision of drinking water, shelter, and other necessities. Additionally, the Nagaland government has launched various developmental projects and skill development initiatives aimed at rural advancement. Programs such as 'Awas Yojana' contribute to rural development by providing affordable housing to villagers. The 'Jal Jeevan Mission' facilitates water supply through taps and pipelines, while the 'Ujjwala Yojana' supplies LPG, thereby reducing reliance on fossil fuels.



Figure 05. This panoramic photograph captures the entrance area for tourists. The scene features a Tourist Information Centre where visitors can register their names for entry into the village. The gently curved road, tin roof, and bamboo-mud wall provide detailed insights into the traditional architecture of the area. The signboard indicates the importance of maintaining tourists' safety and discipline. On the right side, a temporary wooden structure hints at a local check post. This photograph provides a glimpse into the region's integration of ecological conservation, sustainable eco-tourism practices, and government-supported rural development initiatives.

4.3.4.6 Education information

The villagers of Dzuleke village are less educated. They are mainly busy with cultivation. However, eco-tourism has now begun, with NEIDA providing training in hospitality and management, which can serve as a source of income.

4.3.4.7 Recreation and tourism

They proposed eco-tourism as a means to attract tourists. It has become a popular spot for picnics among locals. The stunning natural environment and the stream provide considerable enjoyment for visitors. The region's rich biodiversity is highly captivating. Opportunities for trekking are available; the facility and the hills appeal to adventurers and nature enthusiasts alike. Additionally, there are options for natural walks, strolls through rice paddy fields, and more. NEIDA offers training to residents in hospitality and management. Many locals utilize their houses as homestays for tourists. Tourism also serves as a significant source of income.

4.3.4.8 Building architecture and climate resilience

Architectural design in mountainous regions such as Dzuleke encompasses various approaches to enhancing climate resilience. These hilly areas encounter distinct challenges, including heavy rainfall, erosion, landslides, and limited accessibility. Consequently, climate-resilient architecture has been developed (Fig.06). Thoughtful site selection is conducted to mitigate the risk of landslides. Additionally, local materials such as bamboo and stone are utilized, as they are well-suited for sustainability in this environment and help reduce transportation costs.



Figure 06. Traditional wooden structures and the undulating landscape showcase the deep connection between the local community and nature. The architecture features their time-honoured building methods, passed down through generations. The water puddles create a mystical atmosphere under the dramatic blue sky, illustrating a living example of sustainable rural living in harmony with nature's rhythms. This highlights how Traditional Knowledge Systems (TKS) can help preserve ecological resilience, especially in mountainous regions rich in biodiversity.

4.3.4.9 Layout Morphology of settlement

The houses are constructed using stone and tin, with walls made of stone and roofs of tin. There are approximately 32 houses inhabited by 156 individuals. The residents cultivate gardens around their homes. The community functions in a spirit of familial respect and unity. It is a Christian community. A primary school is also present. The primary occupation of the local inhabitants is agriculture. For eco-tourism purposes, they also utilize their residences as homestays. There are about five homestays available for tourists, which are relatively modest.

4.3.4.10 Living conditions

Stone and tin are used in the construction of the houses, with the stone used for the walls and the tin for the roof. Approximately 156 people reside in around 32 dwellings. Around their home, they cultivate beans, pumpkins, devil's fig, cabbage, coriander, and mint, among other plants, in a garden that serves both economic and dietary needs. Everyone treats one another as if they were family. The community is Christian. Rice, bamboo shoots, anishi, pork, and meat are among their popular foods. They have a traditional dress, *Mechala* in local name, which is a shawl.

4.3.4.11 Quality of life

Their livelihood primarily depends on agriculture. Only a few individuals engage in vegetable cultivation to generate income and improve their standard of living. Currently, the government has implemented projects and policies aimed at increasing benefits for the people. Eco-tourism is considered a promising avenue for improved livelihoods, with residents receiving training from NGOs. This initiative generates revenue for the state government, which, in turn, helps enhance the quality of life (Fig.07).

4.3.4.12 Habitat Services

For tourism, they prepare a variety of dishes for tourists and serve them. They rent out the house to tourists for a time and let them live there as a homestay. They serve as a guide for both sightseeing and trekking. They offered many speeches to the tourists. There are only five guides.

4.3.4.13 Spatial signification

The Dzuleke village is significant for its unique flora, fauna, and natural beauty. It is home to many wild animals, including bears, wild boars, squirrels, and bison. The Blyth's tragopan, which is the state bird of Nagaland, is also found here. Colourful flowers, birds, butterflies, lush green forests, hills, and streams have all contributed to the village's beauty. Many plants in the area are medicinal and help in healing. The land slope ranges from 10° to 20°, making it highly suitable and valuable for agriculture. Eco-tourism also plays a vital role in preserving the village's beauty. Additionally, it is a popular picnic spot, offering visitors fresh air that serves as a natural remedy for their health.



Figure 07 depicts their fieldwork conducted under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) during the years 2017 and 2018. This workboard provides detailed data regarding their public works projects, such as the construction of retaining walls. Specifically, it mentions the work ID (10/07/2017), project start date (01/11/2016), the number of person-days generated (124), their daily wages (172 Rs), and the executing agency (VDB Dzuleke) in Dzuleke, under the Sechu Zube block of Kohima district. These types of workboards reflect the employment guarantee scheme within tribal community areas, fostering development. Furthermore, such workboards enhance transparency and accountability in the work patterns of local governance.

4.3.4.14 Community development

The local government develops several policies. Hunting and deforestation are prohibited. It contributes to the preservation of wildlife, which sets this community apart from others. DETB works with NEIDA and TATA Trust to promote ecotourism. They prioritise the provision of shelter, drinking water, and other necessities. Additionally, under the Nagaland administration, various developmental projects and skills development initiatives have been initiated for rural areas. JAL JEEVAN MISSION supplies water by pipeline or tap, UJJWALA YOJANA provides LPG, which reduces the use of fossil fuels, and AWAS YOJANA aids in rural development and provides the people with inexpensive housing.



Figure 08. This photograph showcases a significant cultural feature of Dzuleke village, a self-payment shop constructed using local materials. This practice exemplifies the community's trust, values, and self-regulation. From this self-service store, visitors and residents can purchase products without supervision, trusting that all customers will leave proper payments, reflecting their communal beliefs, ethics, and moral principles. In the background of this shop, visitors can gain rare insights into the local lifestyle, mutual respect, and integrity. This self-operated shop exemplifies how rural development and eco-tourism can be achieved while upholding traditional values, without compromising environmental stewardship or community identity.

4.4 Rural household and livelihood

Dzuleke, stone, and tin are used for the construction of the houses, with the stone used for the walls and the tin for the roof. Approximately 156 people reside in around 32 dwellings. They cultivate a garden surrounding their home. Everyone treats one another as if they were family. The community is Christian. There is also a primary school within the village. Cultivation is the primary occupation of the local population. They also host homestays in their residence for ecotourism. There are perhaps five reasonably priced homestays for travellers. Few people cultivate vegetables to improve their lifestyle and generate income. The government is now implementing policies and projects to help promote and popularize the region. Ecotourism is a means of improving one's standard of living, where NGOs provide training to locals. It provides funding to the state government, which enhances living standards. They prepare and offer a wide variety of foods for tourists. They allow the visitor to stay in the residence for a period called a homestay. They serve as guides for both trekking and sightseeing. They give the visitor several speeches. Only five guides are available. Dzuleke Village in Nagaland is renowned for its innovative "**Self-Payment Shop**," which exemplifies trust and integrity within the community (Fig.08). This unattended establishment operates without a shopkeeper; patrons select items and deposit the exact payment into a designated receptacle. It is particularly popular among tourists, offering a diverse range of locally handcrafted goods, organic produce, snacks, and souvenirs. The shop embodies the strong moral values and traditional principles of the Angami tribe, fostering self-

regulation and mutual respect. The Self Payment Shop exemplifies community integrity, sustainable tourism, and the preservation of indigenous culture amid a rapidly modernizing world.

4.5 Sustainable Ecotourism in Dzuleke Village

The Northeast Initiative Development Agency (NEIDA) was established in 2012 and registered under the Societies Registration Act 1860. By providing essentials such as drinking water, shelter, and sanitary facilities, NEIDA aims to promote rural development. With assistance from NEIDA and TATA TRUST, the village supports ecotourism through DETB. In 2014, the eco-project got underway. Ecotourism has boosted the Dzuleke tourism industry, which in turn supports the village's finances (Fig. 8, 9). Local villagers welcome tourists into their homes. In this way, they can meet the demand of the hotel by using their home as a homestay. Homestays can significantly congest an area, leading to trespassing and threatening biodiversity. Additionally, NEIDA offers management and hospitality training to the local people, which makes Sustainable Ecotourism in Dzuleke Village.



Figure 09. The photograph showcases the Tourist Information Centre of Dzuleke Village. The traditional sloping roof of the tin house and bamboo, mud-plastered walls represent the indigenous household pattern of Dzuleke. The building serves as a guide house for visitors. The signboard in this photo describes that this region is affiliated with the Department of Tourism of the Nagaland Government. It is a knowledge hub about local traditions, culture, customs, biodiversity, livelihood, and more. This image depicts their efforts to promote eco-tourism activities without interfering with ecological balance

5. Outcomes

Dzuleke, a biodiversity-rich region of Nagaland, serves as a vibrant example of ecological sustainability, cultural preservation, and socio-economic identity. This village is renowned as the home of the Angami Naga community, where traditional practices are maintained in harmony with natural and environmental conservation. The landscape of this village is characterized by dense forests, wildflowers, and a diverse array of wildlife. Numerous medicinal plants embedded in their traditional practices underscore the ecological significance of this area. The livelihoods of the tribal community are intricately linked to the local ecosystem. Ecosystem services such as water purification, pollination, and nutrient cycling are integrated into their daily lives. Traditional agricultural practices, including terrace farming, shifting cultivation, and alder cultivation, are prevalent in this village. These methods not only support local food security but also sustain soil nutrients and biodiversity, reflecting Indigenous Technical Knowledge (ITK) and ecological importance. The natural resources of Dzuleke are vital for enhancing both the health and economic conditions of the residents. These resources are sustainably utilized to improve living standards and economic development through agriculture,

medicinal plants, and eco-tourism. The presence of homestays for tourists serves as an alternative tourism infrastructure that promotes engagement with the culture of the Angami tribe and the natural environment. According to residents, this land is not only perceived as a resource for management but also as an expression of the tribe's cultural pride. Establishing Dzuleke as an integrated developmental model requires education, infrastructural support, and policy guidance to more effectively balance the conservation of local nature and culture.

6. Conclusion and Recommendation

Dzuleke, located on the verdant hills of Nagaland, is a true treasure of cultural heritage. This village is surrounded by enriched biodiversity, including lush, dense forests, diverse flora, and fauna. The landscape's beauty creates a tapestry of vibrant natural colours that captivates the eye. The harmonious relationship between residents and nature reflects a profound connection, highlighting the beauty of living in harmony with the environment. Eco-tourism practices supported by some organizations play a crucial role in the development of this village. Visitors have the opportunity to experience authentic cultural traditions. These initiatives contribute to economic growth and promote environmental conservation. However, poor road conditions and limited communication infrastructure hinder mobility. Due to a lack of scientific interventions, the village suffers from limited agricultural productivity. Education levels remain a critical concern, as low literacy rates hinder the community's adoption of biodegradable alternatives, waste management improvements, plastic pollution reduction, and waste recycling efforts, all of which are vital for protecting the village and the environment. Furthermore, establishing partnerships with non-governmental organizations dedicated to sustainable development can bolster these efforts. Such collaborations can provide essential training and resources, empowering the community to take charge of its own development. Ultimately, these combined efforts will not only enhance the economic conditions of the village but also foster a hopeful and promising future for its residents.

Acknowledgments

We want to extend our heartfelt thanks to the tour guide in Khonoma, Nagaland, for his guidance during our field studies. We also appreciate the assistance of Mr. Heika, the tour operator in Kohima, Nagaland. A special thank you to Mr. Amirudiin, our driver in Kohima, for his support and help throughout the fieldwork. We would like to thank all the staff and stakeholders at Akim Homestay, Kohima, Nagaland, for the warm hospitality we received during our stay. We're grateful to MS. Megha Manna and MS. Debasmita Mondal, postgraduate students at the University of Calcutta, for their assistance during the field survey.

References

- Anonymous. (2020). Monitoring land use–land cover changes in the Eastern Himalayan landscape of Nagaland, Northeast India. *Journal of Himalayan Ecology*. <https://doi.org/10.1007/s10113-020-01620-9>
- Baruah, D. (2018). Scope of recreational fisheries in Northeast India. *Indian Journal of Fisheries*, Vol. 38(1 & 2). <https://doi.org/10.21077/ijf.2018.38.1and2.72961>
- Borah, J., Ghosh, S., Dasgupta, R., & Choudhury, D. (2018). Quantifying carbon stocks in shifting cultivation landscapes under divergent management scenarios relevant to REDD+. *Environmental Monitoring and Assessment*, 190(6), 1–13. <https://doi.org/10.1007/s10661-018-6704-z>
- Das, S., Longkumer, N., Ozukum, L., & Ngullie, T. (2022). Factors influencing the collection of non-timber forest products by forest dwellers in Nagaland, India. *Indian Journal of Agroforestry*, 24(1), 1–12. <https://doi.org/10.5418/IJA.2022.24.1.116573>
- Das, A., Chetia, P., & Sharma, S. (2013). A new species of *Duttaphrynus* (Anura: Bufonidae) from Northeast India. *Zootaxa*, 3646(4), 336–348. <https://doi.org/10.11646/zootaxa.3646.4.2>
- Geological Survey of India. (2011). *Geology and mineral resources of Nagaland*. Government of India, Ministry of Mines. <https://www.gsi.gov.in/>
- Jamir, S., Nongbri, B., & Kumari, R. (2023). Evaluation of spatio-temporal aspects of land use and land cover changes in Nagaland, North-East India. *Environmental Monitoring and Assessment*.

Liezietsu, M., Kumar, M., Jamir, S., Lal, D., et al. (2022). Quantifying land use/land cover change and landscape fragmentation over the Intanki National Park, Nagaland (India) using geo-informatics. In *Geo-*

Informatics for Sustainable Landscape Management (pp. 213–230). Springer. https://doi.org/10.1007/978-981-19-8169-5_19

Kath, S., & Mezhatu, R. (2023). Perception of farmers towards mobile-based extension agro advisory services in Nagaland, India. *Journal of Extension Education*, 34(2), 6831–6834. <https://doi.org/10.26725/JEE.2022.2.34.6831-6834>

Kechu, M., & Pankaj, P. P. (2023). Traditional fishing methods practiced by Ao and Sumi tribes in Dikhu River of Nagaland, India. *Journal of Fisheries*, 11(2), Article 112202. <https://doi.org/10.17017/j.fish.458>

Khare, N., & Jamir, S. (2018). Feeding habits of Mithun (*Bos frontalis*) in protected areas of Nagaland. *Excellent Publishers*, 7(10), 1416–1426. <https://doi.org/10.22271/animalsci.2018.v7.i10.2410>

Pamai, K., & Sharma, B. K. (2023). Faunal diversity of zooplankton in the selected wetlands of Nagaland, North-East India. *Records of the Zoological Survey of India*, 123(2S), 717–736. <https://doi.org/10.26515/rzsi/v123/i2S/2023/172600>

Pongen, L., Jamir, S., Rawat, M. S., & Yaden, S. (2024). Analyzing land use and land cover changes and its dynamics in Mokokchung District, Nagaland. *International Journal of Scientific Research in Science, Engineering and Technology*, 11(2), 45–60. <https://doi.org/10.32628/IJSRSET2512111>

Poyyamoli, G. (2018). Ecotourism policy in India: Rhetoric and reality. *International Journal of Tourism and Hospitality Research*, 1(1), 46–61. <https://doi.org/10.3126/ijthr.v1i1.21823>

Ronald, K., Singh, K. J., & Lodhi, M. S. (2023). Land use and land cover change study using RS-GIS and its impact on biodiversity: Itanagar Wildlife Sanctuary, Arunachal Pradesh. *Asian Journal of Environment & Ecology*, 22(4), 120–132. <https://doi.org/10.9734/AJEE/2023/v22i4514>

Singh, H. P., Nandy, D. R., & Singh, R. K. (2014). Stratigraphy and structure of the Tertiary sequences in parts of the Barail Range, Nagaland. *Journal of the Geological Society of India*, 84(2), 151–162. <https://doi.org/10.1007/s12594-014-0137-2>

Tata Trusts. (2019). The Dzuleke story: Sustainable tourism and conservation in Nagaland. *Horizons – Tata Trusts*. <https://horizons.tatatrusts.org/2019/march/nagaland-dzuleke-eco-tourism.html>