Peer Reviewed ISSN 0975 - 4121

GEOGRAPHIC

A Journal of
Geography Association of Mizoram

Volume No. 18, July 2023

GEOGRAPHIC

Editorial Board

Editor-in-Chief (Joint)	: Prof. Benjamin L. Saitluanga, Mizoram University
Associate Editors	: Prof. Rintluanga Pachuau, Mizoram University Prof. VP Sati, Mizoram University Prof. Anup Saikia, Guwahati University Dr. Dean Current, University of Minnesota
Managing Editors	: Dr. R. Zonunsanga, Mizoram University Dr. Udai B. Singh, Mississippi Watershed Management Organization
Section Editors	: Prof. Ch. Udaya Bhaskara Rao, Mizoram University Dr. Brototi Biswas, Mizoram University Dr. N. Bobby Singh, Mizoram University
Patron	: Hon'ble Vice Chancellor, Mizoram University
Cir. Manager	: Mrs. Lalliankimi, Mizoram University

Geographic is the official journal of the Geography Association of Mizoram (GAM). It is published annually in July. Authors, Editorial Board and Regular subscribers will receive the *Geographic* free of cost.

Subscription Rate

Inland	*Other Countries*	
Rs. 2650.00	$140	Single Copy

The requisite Draft/Bankers Cheque/Online payment should be made in favour of the Geography Association of Mizoram payable at Aizawl or directly at Geography Association Mizoram, PNB Account No. 1548050000727, IFSC Code - PUNB0154820.

Correspondence for publication in *Geographic* should be mailed to the Editor, *Geographic*, Department of Geography & Resource Manangement, Mizoram University - 796004 or Email -geographic.gam@gmail.com

Correspondence regarding subscription of *Geographic* should be reported to Mrs. Lalliankimi, Circulation Manager, Contact No. 9436199929, Department of Geography and Resource Management, Mizoram University.

The views contained in the papers of the journal are of the contributors and not necessarily of the Editors.

The *Geographic* journal is published by the Department of Geography & RM, Mizoram University.

G E O G R A P H I C

ISSN 0975-4121

Peer Reviewed

Vol.18. JULY, 2023

PUBLISHED BY THE DEPARTMENT OF GEOGRAPHY AND RESOURCE MANAGEMENT, MIZORAM UNIVERSITY

GEOGRAPHIC

Volume 18 **July 2023**

CONTENTS

Articles

NODE CENTRALITY AND ROAD ACCESSIBILITY IN MOUNTAINOUS AREA: A STUDY OF AIZAWL DISTRICT, MIZORAM

- Zoramkhuma
Benjamin L. Saitluanga

Abstract : *This study explores diverse methods to quantify node centrality in networks. The approach focuses on direct and indirect node interactions, investigating their influence on centrality and road network accessibility in hilly areas. Such an approach allows us to elucidate how a node is structurally connected to other nodes in the network and its components. The research establishes metrics for assessing node centrality in hilly road networks using specific measures. It highlights critical nodes, linking spatial interactions, centrality, and accessibility. By utilizing geospatial technology, the study maps node centrality in the Aizawl district, potentially guiding road network design to effectively address transportation and resource allocation issues.*

Keywords : *Centrality measure, Node Centrality, Accessibility, Spatial network*

1. Introduction

In road network analysis, networks (agents of flow) and nodes (origins and destinations) play fundamental roles as they facilitate movement between locations. However, a node on its own lacks significance and only gains value within connections (transport network). Nodes are important when well-connected by a transport network, making centrality and accessibility crucial in completing a transport network (Raut, 2015). Centrality, a fundamental concept in network analysis, aims to measure a node's relative 'importance' within a network. The road network system represents the communication mode, serving as a means of centrality, while the node is recognized as the center of diffusion within a complex network system in the area (Garrison and Marble, 1965).Transport networks enhance the efficiency of people and goods moving in various directions, improving accessibility for each node within the network. The study of road networks involves analyzing the distribution of centrality and its attributes across space in different dimensions, asserting that some places are more crucial due to their central nature. The study of transport networks primarily focuses on centrality measures for node analysis, their spatial distribution, and arrangement, which significantly contribute to local and global attraction (Wilson, 2000).

The intensity of interaction through vertices determines the degree of relationship between geographical spaces. Ullman's (1957 and 1980) three basic spatial interactions - complementary, transferability, and intervening opportunity - define different systems of linkages and connectivity at various scales,

***Zoramkhuma** is a Research Scholar, Department of Geography & Resource Management, MZU*
***Benjamin L. Saitluanga** is a Professor, Department of Geography & Resource Management, MZU*

generating spatial relationships. Transportation nodes and vertices are essential elements and links for interactions in geographical space, creating definitive relationships between spaces. The degree of interconnections may vary across perspectives and time periods, considering geographic, economic, social, and technical disparities. Geography consistently aims to analyze and interpret the relationships between spatial features and their patterns of interaction within specific geographical space. The diverse modes of interaction evolve over time and space, leading to significant modifications in interaction systems and patterns due to shifts in geographical, technological, and socio-economic elements. As time and space change, the varying interaction modes undergo changes, resulting in substantial alterations in interaction systems and patterns. Likewise, in recent decades, transport geographers have endeavored to successfully outline spatial interaction patterns through network analysis. Notably, geographical constraints in specific regions might lead to limited connectivity between spaces, presenting significant spatial interaction challenges. Conversely, geographical advantages can confer centralization and enhanced accessibility on certain areas. Consequently, road transportation has become the primary mode for the masses in the Aizawl district. Evaluating the effectiveness of the road transport network is essential to comprehend its role in spatial interaction regarding centrality and accessibility. This inquiry forms a foundation for policy-makers, planners, stakeholders, and further research in both Mizoram and particularly Aizawl district.

Centrality measures are crucial for defining node identities, attributes, network structural attributes, and network topological attributes. Central places or nodes seem to possess spatial advantages, benefiting local communities with improved transportation and socio-economic facilities. Recently, the focus has shifted towards distributing centrality values across all nodes (Crucitti et al., 2006; Chen et al., 2014; Ford et al., 2015). Centrality is a key property in complex network systems, transforming surrounding geographic space into point, linear, and spatial centrality forms. Similarly, node, linear, and spatial centrality are dynamic concepts that are not mutually exclusive, varying from one perspective to another and at different stages (Devkota, 2015). Centrality potentially determines node attributes, with some being relatively stronger than those of other spatial units in the region. Strong centrality can be attributed to the scale of attributes (Mavoa et al., 2012; Li et al., 2017). The centrality of a node is greatly influenced by its attributes and the distance from other nodes, taking into account geographical proximity and spatial distance.

The study employed centrality measurements to evaluate the accessibility of nodes or regions, drawing from Freeman's concept of social network analysis. Node accessibility, in this context, pertains to assessing the extent

of openness that generates interaction or potential interaction between a specific vertex and other vertices in the network through the shortest path (Porta, 2006; Belén et al., 2021). Additionally, a node is considered central and accessible when situated between other nodes. This position influences shortest paths by enabling, obstructing, or otherwise impacting the flow of communication within the network (Bonacich, 1987; Holme, 2003). The efficiency of node accessibility inherently relies on network structure and topology, influenced by movement patterns, directions, and flow (Kansky, 1963; Xie, 2007; Demsar et al., 2008). Simply put, the network's topology and structure shape the attributes of node and edge centrality. In a broader perspective, centrality's concept reveals the roles and identities of nodes and edges within the network system, considering nodes as common resources accessible from any point through edges (Garrison and Marble, 1965; Kilicman and Abdu, 2018).

Theoretically, in a transport network, access is available to anyone located in the network when entry and exit is possible. The level of accessibility varies according to one's locations within the transport system (Rodrigue, 2006). Hansen (1959) defines, "accessibility is defined as the potential of opportunities for interaction". So, "an examination of the accessibility of vertices in a transportation network (a graph) is an important element in any geographical analysis of transportation systems. It is therefore becomes obvious that the network vertices of high transportation accessibility may be considered privileged locations or places in the broader meaning of the term" (Mackiewicz and Ratajczak, 1996). The concept of accessibility connotes importance of a place and more particularly the ease with which one can commute from one place to another (Panday, 1986). But, the problem lies in the measurement of accessibility because accessibility alone is abstract in nature unless the assessment or measurement of the intensity of interactions is done by considering two subsidiary concepts – relative accessibility and integral accessibility (Ingram, 1971). Relative accessibility considered the degree of relationship between two points (or locations) on the same surface. Integral accessibility, on the other hand measures degree of interconnection of particular point with every other point on the same surface.

Geographical centrality is a dynamic concept that varies across different perspectives and stages. A spatial unit exhibits strong centrality when its average distance to other spatial units in the region is closer, often based on geographical proximity. Additionally, network characteristics may determine geographical centrality. A spatial unit possessing one or more attributes relatively stronger than other units in the region could also be considered to have strong centrality, often based on attribute scaling (Li et al., 2017). The study primarily focuses on centrality measures for analyzing spatial interaction, spatial distributions of centrality and

accessibility, and the arrangement of nodes, all of which significantly contribute to geographical centrality.

2. The Study Area

Aizawl district covers an area of 3,577 square kilometers. The district is geographically situated between 23o 18' N - 24o 25' N latitudes and 92o 37' E - 93o 11' E longitudes. Predominantly mountainous and is characterized by mountain ranges and deep river valleys with an average elevation of 1,000–1,300 meters above sea level. The mountain ranges are aligned from north to south and run parallel to one another. The ranges are separated by narrow and deep river valleys, which contribute to the rugged terrain of the area. The overall relief is higher, and the slopes are much steeper in the eastern half of the study area. The drainage systems are originated from the central parts of the state and flow either towards the north or south direction along north-south trending ridges. Aizawl district has a humid tropical climate with a short winter and a long summer season characterized by heavy monsoon rainfall. The study area has a significantly high population density of 113 persons per square kilometer, which is significantly higher than the state average density of 52 persons per square kilometer in the 2011 census. High population concentration was seen in the middle part of the district, especially along National Highway number 54, as well as along the main arterial roads. The socio-cultural characteristics are essentially uniform throughout the area which is dominated by tribal traditions, customs and organisation systems. Aizawl is the largest and capital city of Mizoram with a population of more than 228,442 peoples. Settlements are normally built on hilltops, rural settlement patterns depend on topographical factors and urban settlement patterns are characterized by the arrangement of the transport network and the location of administrative centers, educational institutes. Recently, the spatial organization of settlements and the establishment of new settlements were closely related to transport facilities.

3. Materials and Methods

The study addressed three methodological problems, data extraction namely, data modelling, network centrality measures.

3.1 Database Design

The spatial features including point and line features are the basis of road network database design. Line features symbolize the road network, while points denote settlements or nodes. Google Earth and Open Street Map (OSM) played a significant role in obtaining these features. The extracted data were utilized to create nodes and edges in data modeling. Afterward, the extracted data underwent transformation and conversion into readable, manageable formats for further manipulation and analysis. Geometric correction was employed to mitigate topological errors. To enable in-depth analysis, the extracted

data was initially stored in the ArcGIS and QGIS database. Point features were generated based on two fundamental principles: road intersections representing nodes or villages, and line edges representing 'dead-end connectivity' as well as 'dead-end nodes'. The entire network comprises 83 junctions (nodes/vertices) and 179 road segments (edges).

3.2 Data Modelling

A network model is to transformed spatial world into digital or computer based transformation. The fundamental of the network analysis is based on simple undirected graph techniques. A graph is a simple interactions and relational combination of one point to another; it can be used to represent topological space (Kilicman & Abdu, 2018). A Graph based representation of a network measures the topological possibilities or capacity of interaction of each node on the graph. Graph theory offers an opportunity to transform real world network structure in to computable platform. The study employs computation environment 'R' programming and Gephi statistical software and for spatial analysis and further mathematical calculations. Accordingly, topological or structural properties of network were measured with the help of centrality measures.

3.3 Centrality Measures

Watts and Strogatz (1998), Barabási and Albert (1999), Porta and Latora (2006), Rubulotta et al. (2013), Hellervik et al. (2019), and Sahitya and Prasad (2020) discussed centrality measures as the key variables that are considered for the measurement of node accessibility. Centrality measures were utilized for simplification of the complex network system that is influenced by the topological structure of the network. The study employed network centrality measures to scrutinize each network point, directly or indirectly linked to road network topology and arrangement. Centrality measures such as Degree of centrality, closeness centrality, betweenness centrality, eigenvector centrality, and eccentricity centrality are basis of node centrality measures. The centrality values (structural attributes) of nodes were used to measure degree of accessibility of nodes of the network. Later, the study used synthesis method to simplify node accessibility and centrality analysis. For overall accessibility and centrality levels, simple statistical techniques like Mean Accessibility Index (AI) were employed.

4. Result and Analysis

In network science, every connected node or village and town has some degree of centrality. A particular node may be more important than others if it is linked with other important nodes. Node distribution facilitates the understanding and identification of critical node and vertices in the network, which is important for the characterisation and visualisation of critical nodes and vertices inside the network (Kisgyorgy and Vasvari , 2014). It also measures and

examined the magnitude of importance of a road or intersection (node) and at what level a network is centralised on certain roads (Zhang, 2011).

4.1 Degree of Centrality (C_D)

The degree of centrality is a simple mathematical representation of the degree of point that is based on the concept of adjacency matrix (Niemiens, 1974; Freeman, 1979). The C_D of a vertex *v* in an undirected network is the number of links connecting to a node. Degree of Centrality (C_D) represents adjacent link of vertex v in network, which is simply defined as the degree of $C_D(v)$ of a vertex *v* in an undirected graph (Bolland, 1988; Porta, 2015; Zhang, 2017). The degree of centrality (C_D) is expressed as;

$$C_D = \frac{1}{|V| - 1} \cdot \sum_{j=1}^{|V|} a_{ij} = \frac{deg(i)}{N - 1} \dots\dots\dots (i)$$

where, $|V| = N$ represents the number of vertices, i the reference node, a_{ij} the number of the adjacent edges that originate from a node and deg (i) the degree of a node. Settlements showing Very high degree of centrality like Aizawl, Sialuk, Seling and Keifang/Saitual have significant potential to control the stability, flow of information and infrastructure which in turn has critical implications on the socio-economic development of the proximity nodes. Thus it can be argued that the Very High C_D and High C_D are more attractive and are significant for controlling the flow of commodities than those in the low scoring categories (Figure 1a). The study identified that about 86.75 per cent of villages which fell under Very Low C_D and Low C_D classes are insignificant in this network. It is important to note that settlements are aligned linearly along the direction of network which is influenced by geographical factors like the direction of mountain ranges and topographic structure which inadvertently affects the orientation of the network. Similarly, the CD values which are measured in this study clearly indicate the nature of the terrain of the district.

4.2 Eccentricity (CE)

Eccentricity centrality index is used to determine the shortest distance of a particular node from the furthest node in the network. Mathematically, the eccentricity *e(v)* of a vertex v in a connected graph G which is the distance between v and a vertex that are farthest from v in G, while he radius *rad (G)* is the smallest eccentricity among the vertices of G (Soliman, 2018). Settlements with less eccentricity values are more accessible than those nodes showing high values (Takes and Kosters, 2013). It is applicable for detecting the strategic locations or spatial location of facilities that provide required facilities within a short period of time in the context of a road transportation network. According to Iwabuchi et al, Degree of Eccentricity *(CE)* of *e(v)* of a vertex $v \in V$ can be denoted by the following equation;

$$e(v) = \max_{w \in V} \{d(v, w)\} \dots\dots\dots (ii)$$

where, distance *d(v,w)* between two vertices v, $w \in V$ is defined as the length

of the shortest path between v and w. The nodes with low scoring C_E values are centrally located and easily accessible from any point. On the other hand, the spatial distribution of eccentricity values highlights that node values progressively increase away from the center in all directions. The study shows that almost 45 per cent of the nodes are critical nodes because the diameter of the node is minimum from the isolated node. The highest accessible settlements (least degree of eccentricity) mainly found in and around western part of the study area. On the other hand, the least accessible nodes showing the highest degree of eccentricity are found in eastern portion of the study area. This means that the nodes in the central and middle parts of the network are more critical and that the farthest nodes are less influential and less significant (Figure 1b). These are significant for strategic planning to monitor the entire networking system.

4.3 Closeness Centrality (C_C)

Closeness centrality measures the shortest path of a particular node to other nodes in the network. It shows how fast a particular node can be reached from all other nodes in the network. "Closeness is a rough measure of the overall position of an actor in the network, giving an idea about how long it will take to reach other nodes from a given starting node" (Oliveira and Gama, 2012). Again, closeness centrality is applicable for strategic planning for locating emergency services, public distribution systems and public services infrastructure etc. This analysis also emphasises the distance of a prominent node (actor) to all others in the network by considering the space from each actor to the others. Then, the Closeness Centrality (C_C) is expressed as;

$$C_C(i) = \frac{N-1}{\sum_{j=i}^{N} d_{ij}} \dots\dots\dots (iii)$$

where, N is the total number of nodes in the network, d_{ij} is the shortest path length between node i and j. Simply, C_C measures the mean distance of vertex with other vertices through geodesic path. The calculated values are between 0 to1; with the higher value indicating that the node is more central. As shown by the relatively higher closeness centrality value Seling is the most centrally located node in the study area. Geographically, settlements with very high and high degree of closeness centrality are generally located within the central regions of the network. Location in the central position results in the overall road network topology having better accessibility and higher degree of control compared to other settlements in the network. The settlements located in the isolated areas have poor accessibility and are difficult to reach from any other point, which means that the settlements have limited resources compared to the higher value settlements. The Figure 1 (c) illustrated that geographic centrality in the centre/middle region of the area is influenced by the network proximity. Interestingly, the high scoring nodes are surrounded by the succeeding values. It shows that the low scoring nodes are diverge in the north-south direction from the highest centrality values in this

network. The spatial arrangement that emerges also reveals that nodes are arranged in varied patterns ranging from the compact to the dispersed type of distribution.

4.4 Betweenness Centrality (C_B)

In the network system, some of the nodes are more central rather than spatial distance, subject to their positions. Betweenness centrality also attempts to evaluate the criticality of a node in the network, with reference to the number of times a node is needed to be crossed through the shortest path in the network (Farhad and Ulfat 2019). Consequently the critical node therefore plays a mediating role between other nodes of the network. It also explains the role of third-party nodes for controlling the flow of information in the network. But in a network, the number of intermediary values may range from 0 to ∞. The same principle is also applied by scholars, Wasserman and Faust (1994) and Oluwajana et al. (2012).

$$C_B = \sum_{s \neq v \neq t \epsilon V} \frac{d(s,t|v)}{d(s,t)} \ldots\ldots\ldots (iv)$$

where, $d(s,t|v)$ is the number of shortest paths that are available between s and t passing through the node v and, $d(s,t)$ is the total number of shortest paths that exist between s and t. The above analysis shows that betweenness centrality measure is a straightforward method to investigate the structure of network topology. The study identified that almost 64 per cent of the total settlements that belongs to low and very low C_B classes. These settlements are therefore, considered insignificant (being between) for the flow of information. The distribution of low and very low C_B results called non-tree-edges (constant movement for crossing the nodes to and fro and cross edges) structure that yields minimum betweenness value. Thus, road segment between Seling and Aizawl (via Tuiral) is one of the important road segments in the whole network. Similarly, most of the highest betweenness values are observed along important road segments and ultimately these settlements are represented as major collection centres, dissemination centres, halting points and junctions, namely Seling, Tuirial, Aizawl, Keifang/Saitual and Darlawn. This measure determined the critical road segment/major roads, such as arterial roads, sub-arterial roads, and secondary roads (Figure 1d).

4.5 Eigenvector Centrality (C_E)

Eigenvector centrality measures the centrality of a node in a network based on the weighted sum of centralities of its neighbors (Jayaweera et al., 2017) or it measures the importance of a node based on its links with other central nodes (Wen et al., 2019). It defines the importance of a settlement through its connectivity to important settlements. Thus, the measure of eigenvector centrality in the network considers two important determinants such as firstly, the number of links or number of adjacency nodes and, secondly, the centrality values of adjacent nodes. This study applies the eigenvector centrality measure to evaluate

the degree of diffusion or dissemination of information, which then influences surrounding nodes. The following equation describes Eigenvector Centrality (C_E);

$$\lambda x = \sum_{j=1}^{N} a_{ij} x_j \ \ldots\ldots\ldots\ (v)$$

where, A is the adjacency matrix for this graph; $a_{ij}=1$ if vertices i and j are connected by an edge and 0 if not, $Ax = \lambda x$, $i = 1,\ldots,n$. then, λ denotes the largest eigenvalue of A and n is the number of vertices (Bonacich, 2007). Figure 2 (a) shows that there is a sharp declining trend of eigenvector centrality values between eigencentre and the next successive values indicate that the network is a centralised type of a network. The settlements with very high and high C_V are mainly confined in the middle part of the region, these towns and villages are strategically significant for the movement of information and the foundation of sustainable development in Aizawl district. The analysis also provides us to recognized which towns and villages serve as the hubs of networks that support the district long-term socio-economic sustainability.

4.6 Correlation of Centrality Measures

The correlation coefficient of centrality measures specified in the study has positive correlation in case of urban network in Aizawl district. In The strongest overall correlation among the centrality is experienced between C_C and C_E at $r=0.95$ followed by C_D and C_V correlation with $r=0.77$. On the other hand, the weakest positive correlation between centrality measures exists between C_D and C_E, and the correlation is also considered weak even though the correlation is positive ($r=0.25$). Degree of Centrality (C_D) and Eigenvector Centrality (C_V) are measures for neighborhood-based centrality, while Closeness Centrality (C_C), Betweenness centrality (D_B), and Eccentricity (C_E) are known as measures for shortest global/ path-based centrality. Thus, the study also examines the degree of associations between these two categories. The lowest correlation was found between C_D (i.e. neighborhood-base/local centrality measure) and C_E (shortest path-base/ global centrality measure). As for the correlation index, when the calculated value of global centrality measure increases the local centrality measures may increase with a limited value.

Table 1. Correlation Coefficient of Centrality Measures Index

Degree of Measures	Degree (C_D)	Eccentricity (C_E)	Closeness (C_C)	Betweeness (C_B)	Eigenvector (C_V)
Degree (C_D)	1.00				
Eccentricity (C_E)	0.25	1.00			
Closeness (C_C)	0.36	0.95	1.00		
Betweeness (C_B)	0.56	0.53	0.59	1.00	
Eigenvector (C_V)	0.77	0.37	0.56	0.48	1.00

4.7 Spatial Variations of Node Centrality within Centrality Classes

In the network centrality analysis, each of the centrality measures has a variety of topological structures and centrality patterns. Addressing the issue of the 'sensitivity of the nodes' the coefficient of variations of the centrality class reveals different characteristics. The level of dispersion around the mean of betweenness centrality measure is r=115.83 per cent, eigenvector is ranks second with a score of r=78.87 per cent, the degree of centrality third (r=46.49 per cent), closeness comes in the fourth position (r=24.37 per cent) and the least degree of variation is experienced in eccentricity (r=17.82 per cent). In the case of betweenness and eigenvector centrality measures the centrality between the settlements show a discrepancy in both the highest values and the minimum centrality values, which means that the distribution of centrality values are more inconsistent in these measurements. Comparing neighborhood-base and shortest path approaches (excluding betweenness), global-based centrality measures have a least degree of variation because all the nodes exist in the network are considered for the centrality of a particular node (Table 2).

Table 2 shows that a very high degree of centrality class is associated with diversity within the class. For high and moderate classes in the network the centrality values are more compact and uniform, meaning that the coefficient of variation have declined in these two classes. On the other hand, the low centrality class has a higher degree of spatial variations of node centrality while some nodes falling under this category were very low due to the location and positional problems in the network. Normally very high degree of centrality class experience greater coefficient of variations than those high and moderate classes. For instance, in the betwenness centrality measure the spatial variation of centrality in the moderate class is r=15.78 per cent and increases to r=34.27 per cent. Again, in the very low degree class the increase is more than four times with r=156.81 per cent of spatial variation within the class. On the other hand, in the eccentricity measure, the

Table 2. Coefficient of Variation on Centrality Classes Index

Class	Centrality Measures (Coefficient of Variations in Per cent)				
	Degree	Closeness	Betweeness	Eigenvector	Eccentricity
Very High	0	6.10	23.71	38.76	6.11
High	0	3.80	10.41	13.91	3.36
Moderate	0	4.77	15.78	12.66	4.07
Low	0	5.61	34.27	12.87	4.04
Very Low	0	7.43	156.81	25.00	3.22
All	46.49	24.37	115.83	78.87	17.82

diversity of centrality is more in the higher degree classes than in the lower centrality classes. This means that high degree of centrality is confined to a few segments of the network and a larger portion of the nodes are least central in the network. On the whole, it can be said that an increasing trend of node centrality within the network leads to a diversified centrality pattern in general and a decline in node centrality leads to a diversified centrality pattern in particular. It can be said that the least degree of centrality results in an increase of spatial variability. In the hilly areas, the diversity pattern increases rapidly with an increase in the network connectivity pattern because of the nature of the hill topography which does not allow a uniform increase in the centrality levels.

4.8 Level of Nodes Centrality and Accessibility

Centrality measures as the key variables that are considered for the measurement of node accessibility (Hansen, 1959; Watts & Strogatz 1998; Barabási & Albert 1999; Hellervik et al. 2019; Sahitya & Prasad 2020). The study adopted the idea of synthesisation method to simplify the overall picture of node accessibility by simple statistical techniques called Mean Accessibility Index (A_I), which can be expressed by the following formula:

$$A_I = \sum_{i \geq 1}^{n} \left(\frac{C_{Di} + C_{Ci} + C_{Bi} + C_{Ei} + C_{Vi}}{\bar{X}Deg} \right) \text{x} 100$$

where, A_I is mean accessibility index of *i* node, C_{Di} the weighted rank of i node in Degree of centrality measure, C_{Ci} is the weighted rank of *i* node in Closeness centrality measure, C_{Bi} weighted rank of i node in Betweeness centrality measure, C_{Ei} weighted rank of *i* node in Eccentricity centrality measure, C_{Vi} weighted rank of *i* node in Eigenvector centrality measure and $\bar{X}Deg$ is the mean of Accessibility Index.

The analysis highlights the fact that nodes lying in the middle parts of the network are more accessible and has greater influence than those nodes lying in the north, south and north-eastern clusters of the network. The settlements of nodes in the low category are found in the north, south and north-eastern tips of the network. The least accessible nodes are also embodied in the dead-end-nodes. Structurally, the levels of accessibility of the nodes deviate/decline from the central part of the network towards the extreme north and southern parts of the network. The highest accessible node in the network is Seling with 218.20 A_I values, followed by Aizawl and Saitual. They are the most important transport junctions in the entire network system. It also revealed that the level of accessibility as denoted by A_I is determined by the amount of clusters controlled by the nodes or complexity of network. For, instance, Seling node has the highest degree of accessibility due to the fact that there is a direct link with clusters from the north and indirect connection with the southern and north eastern clusters. Aizawl city is a major administrative and commercial hub in the district. Other smaller settlements like Dilkhan, Tuirial, Khanpui and Sesawng are found in this

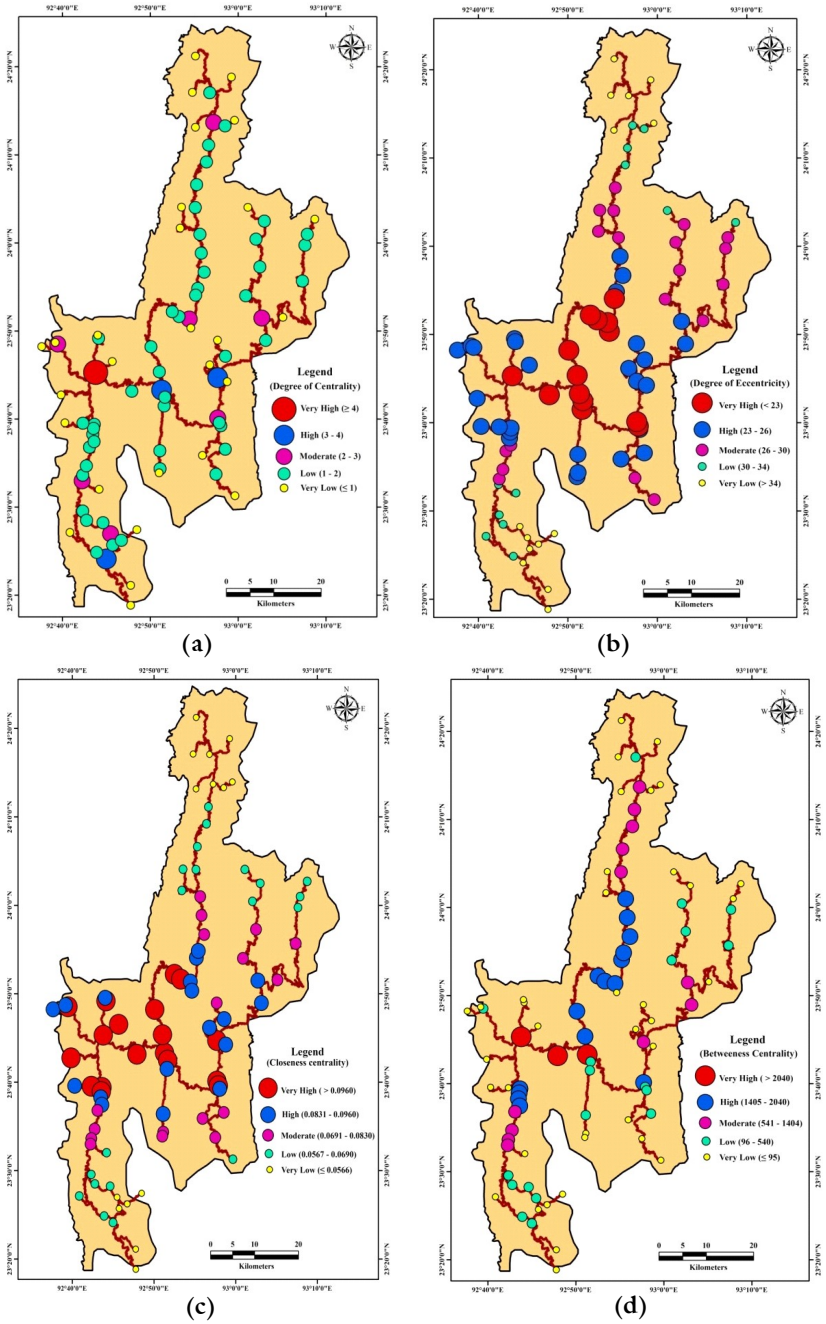
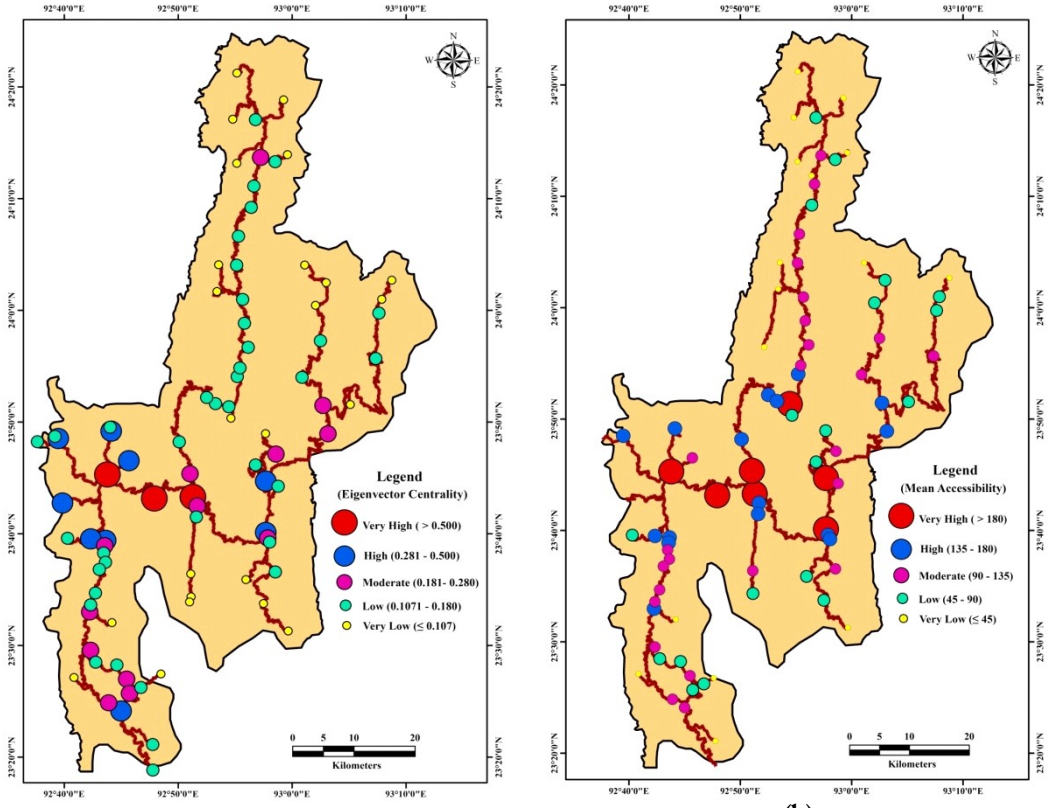


Figure 1. Spatial Distribution of (a) Degree of Centrality & (b) Degree of Eccentricity (d) Closeness Centrality and (d) Betweenness Centrality



(a) (b)

Figure 2. Spatial Distribution of (a) Eigenvector Centrality and (b) Mean Acessibility (A_I)

category due to their influences on their peripheral areas and their adjacency to high A_I nodes (Figure 2b). It indicates that accessibility level of a particular settlement is highly determined by the location and position of the settlements or nodes in the network.

5. Conclusion

The study identified that the combination of geographical, historical, economic and social factors are important factors for the existence of road networks which in turn is very crucial for the location of node centrality. It is found that the topologicl structure of road network in the study area is centralised network type as indicated by the hub and spoke organization model which is a part of centralized network. Seling and Aizawl are the central hubs of the network in the study area and offers a full array of services for the whole network. On the other hand, Sialsuk, and Keifang/Saitual vertices are acting as secondary establishments or hubs, offering a limited range of services for the low scoring nodes. In terms of interaction, the hubs

and spokes network system is a more efficient and facilitates optimum use of transport resources in the network. The study revealed that spatial distribution of nodes centrality is significantly determined by geographic centrality. Node centrality explains the nature of geographical centrality namely, global, local, isolated unit of centrality. All the very high and high centrality value nodes are confined to the central and middle parts of the network. These centrally located settlements are more influential in the flow of information through the network system. The results demonstrate the significance of centrality measures for critical probability of nodes with respect to the location and position of the node in the network. The models also demonstrate the efficiency and velocity of nodes for information dissemination on the basis of Euclidian distance (not dependent on geographic distance). On the other hand, both the location and position of node centrality determine heterogeneity and diversity of spatial/ geographical centrality. But, the problem of the study lies in the fact that the study only adopted matrix distance to obtain relatively general results and facilitate its application. At some point geographical constraints and its attributes form complex geographical factors to control the network system e.g., topography, population and economy etc.

The nature of the topological structure is varied amongst the global and local centrality measures. Especially for global centrality measures like Closeness centrality, Betweeness centrality and Ecentricity (i.e. very high and high class) are distributed in a longitudinal fashion which is primarily influenced by the arrangement of the road segments. Thus, geographical factors play a critical role in the segmentation of the road network and are associated with the spatial distribution of nodes or their alignment. In the context of local centrality measures like C_D and C_V, the critical nodes are distributed in compact forms and confined to a limited segment of the network. They are quantified as hubs or distribution center of the networks. The analysis found out that the low and very low degree classes are distributed in an irregular fashion, which points to the fact that the low scoring nodes are diverse in nature due to the influence of local and global factors. The correlation coefficient of centrality measures specifies the quality and quantity of relationship between the centrality measures. Table 1 show that all centrality measures have positive relationship. Between the centrality measures, local centrality measures are more associated than global centrality measures. On the other hand the lowest degree of correlation was observed between degree of centrality (local) and degree of eccentricity (global). Analysis of Coefficient of variation (C_V) shows that those nodes falling under low centrality categories experience greater diversity than those nodes under high centrality classes. This means that higher inequality exists within the lower classes, which is a consequence of the structural topology of the network. The study identified that important nodes and spatial distribution

of nodes in a systematic way. The study showed that the different concepts and measures of centrality are appropriate for identification and analysis of network centrality.

References

Barabási, A.L., and Albert, R. (1999): Emergence of Scaling in Random Networks. *Science,* 286 (5439), pp. 509–512.

Bel´en M., E. Ortega, R. Cuevas-Wizner, Antonio Ledda, Andrea De Montis (2021): Assessing road network resilience: An accessibility comparative analysis, *Transportation Research Part D*, 95.

Bolland J.M. (1998) : Sorting Out Centrality: An Analysis of the Performance of Four Centrality Models in Real and Simulated Networks, *Social Networks*. pp. 233-253.

Bonacich P (1987): Power and centrality: a family of measures. *American Journals of Sociology.* 92(5), pp. 1170–1182.

Bonacich P. (2007): Some unique properties of eigenvector centrality. *Social Networks,* 29, pp. 555–564.

Chen S., C. Claramunt and C. Ray (2014) : A spatio-temporal modeling approach for the study of the connectivity and accessibility of the Guangzhou metropolitan network, *Journal of Transport Geography,* 2014, Vol. 36, pp. 12–25.

Crucitti P, V. Latora, and S. Porta (2006): Centrality in Networks of Urban Streets. Chaos, American Institute of Physics, Salt Lake City, Utah, USA, 16, pp.1–9.

Crucitti P., V.Latora, and S. Porta (2006): Centrality in Networks of Urban Streets, *Chaos,* American Institute of Physics, Salt Lake City, Utah, USA, Vol. 16, pp.1–9.

Demsar U., O. Spatenkova and K. Virrantaus (2008): Identifying critical locations in a spatial network with graph theory in GIS. *Transactions in GIS*, 12(1):pp. 61–82.

Devkota B.P (2015): Network Structure and Economy: Modelling the Effects of Road Network Connectivity on GDP. *Proceedings of IOE Conference*, pp. 94-104.

Farhad A., L. Rao, S. Ulfat (2019): Assessment and modeling of urban road networks using Integrated Graph of Natural Road Network (a GIS-based approach)., *Journal of Urban Management,* 8, pp.109–125.

Ford A.C., Stuart L. Barr, R.J. Dawson and P.James (2015): Transport Accessibility Analysis Using GIS: Assessing Sustainable Transport in London. *International Journal of Geo-Information*. 34, pp. 46-53.

Freeman L.C. (1979): Centrality in Social Networks Conceptual Clarification. *Social Networks,* 1, pp. 215-239.

Freeman L.C., and White, D. R. (1991): Centrality in valued graphs: A Measure Of Betweenness Based on Network Flow. *Social Networks,* 13 (2), pp. 141–154.

Garrison L. and D. F. Marble (1965): *A Prolegomenon to the Forecasting of Transportation Development,* Evanston, North western University, Transportation Center.

Hansen G. (1959): How Accessibility Shapes Land Use. *Journal of the American Institute of Planners,* 25 (2), pp. 73 – 76.

Hellervik A., L. Nilsson and C. Andersson (2019): Preferential Centrality – A New Measure Unifying Urban Activity, Attraction and Accessibility. *Urban Analytics and City Science,* 46 (7), pp. 1331–1346.

Ingram D.R. (1971): The concept of accessibility: A Search for an Operational Form. *Regional Studies,* 5 (2), pp. 101 – 107.

Iwabuchi K., G. Sanders, K. Henderson, R. Pearce (2018): *Computing Exact Vertex Eccentricity on Massive-Scale Distributed Graphs*. Center for Applied Scientific Computing, Lawrence Livermore National Laboratory, Belfast, United Kingdom.

Jayaweera I.M.L.N., K.K.K.R. Perera and J. Munasinghe (2017): Centrality Measures to Identify Traffic Congestion on Road Networks: A Case Study of Sri Lanka. *IOSR Journal of Mathematics*, 13 (2), pp. 13-19.

Kansky K. J. (1963): *Structure of Transport Networks: Relation Between Networks Geometry and Regional Characteristics*. Research Paper No.84, Department of Geography, University of Chicago.

Kilicman A. and K. Abdu (2018): Topological Spaces Associated with Simple Graphs. *Journal of Mathematical Analysis,* 9 (4), pp. 44-52.

Kisgyorgy L. and G. Vasvari (2014): Analysis and Observation of Road Network Topology. *Conference Paper,* Budapest University of Technology and Economics, Source: https://www.researchgate.net/publication/281448739.

Li J., J. Qian and Y.Liu (2017): A Novel Analysis Method of Geographical Centrality Based on Space of Flows. *International Journal of Geo-info,* 6, pp. 153-167, Doi:10.3390/ijgi6050153.

Mackiewicz A.and W. Ratajczak (1996): Towards a New Definition of Topological Accessibility. *Transportation Research B: Methodological,* 30 (1), pp. 47-79.

Major T. H. (2006): *Analysis Of Layered Social Networks.* Ph.D Thesis, School of Engineering and Management, Air Force Institute Of Technology, Ohio.

Mavoa S., K.Witten, McCreanor and D. O'Sullivan (2012): GIS based destination accessibility via public transit and walking in Auckland, New Zealand. *Journal of Transport Geography,* 20, pp. 15–22.

Niemincn J. (1973): On the centrality in a directed graph. *Social Science Research,* 2, pp. 371-378.

Oliveira M and J. Gama (2012): An overview of social network analysis. *John Wiley & Son, International, Mining and Knowledge Discovery*, (2), pp.99–115.

Oluwajana1 S.D., Olufikayo O.A., Adebayo O.O., and S.V. Croope (2012): Assessment of Centrality

Properties of Akure Road network. *International Journal for Traffic and Transport Engineering,* 3(1): 82 – 94.

Pandy N.P. (1986): *Geography of Transportation: A Case Study of Western Madhya Pradesh,* Inter-India Publication. New Delhi-110015, pp. 18.

Porta S. and V. Latora (2006): Multiple Centrality Assessment: Centralità E Ordine Complesso Nell'analisi Spaziale E Nel Progetto Urbano. *Territorio,* 39, pp. 189–202.

Raut S.S. (2015): *Solapur District: A Study in Transportation Geography.* Ph.D Thesis, Unpublished, Dept. of Geography, Solapur University, Solapur.

Rodrigue J.P, C. Comtois and B. Slack, (2006): *The Geography of Transport Systems.* Routledge, Taylor & Francis Group, London & New York.

Rubulotta E., M. Ignaccolo, G. Inturriand, Y.Y Rofè (2013): Accessibility and Centrality for Sustainable Mobility: Regional Planning Case Study. *Journal of Urban Planning and Development*, 115, pp. 115 – 132, doi: 10.1061/(asce)up.1943-5444.0000140.

Sahitya K.S and C. S. R. K. Prasad (2020): Evaluation of Opportunity Based Urban Road Network Accessibility Using GIS. *Spatial Information Research,* DOI: doi.org/10.1007/s41324-019-00309-6.

Sergio Porta, Paolo Crucitti and Vito Latora (2005) : The Network Analysis of Urban Streets: A Primal Approach. *Chaos, American Institute of Physics,* Salt Lake City, Utah, USA, 13, pp. 12–21.

Soliman A. F. (2018): *Some Topological Applications on Graph Theory and Information Systems,* Thesis Submitted to Department of Mathematics, Faculty of Science, Menoufia University, Egypt.

Takes F.W. and W.A. Kosters (2013): Computing the Eccentricity Distribution of Large Graphs. *Algorithms,* (6), pp. 100-118.

Ullman E. (1957): *American Commodity Flow: A Geographical Interpretation of Rail and Water Traffic Based on Principles of Spatial Interchange,* Seattle, University of Washington Press.

Ullman E. (1980): *Geography as Spatial Interaction.* Seattle, University of Washington Press.

Wasserman S. and K. Faust (1994): *Social Network Analysis: Methods and Applications.* Cambridge University Press, United Kingdom.

Watts D. J. and S.H. Strogatz (1998): Collective Dynamics Of 'Smallworld' Networks. *Nature,* 393(6684), pp. 440–442.

Wen J.S, X. Zhao and G. Wu (2019): Sustainable development of urban rail transit networks: A vulnerability perspective. *Sustainability,* 11, pp. 1327-1335.

Wilson A.G. (2000): *Complex Spatial Systems: The Modeling Foundations of Urban and Regional Analysis,* Prentice Hall, Upper Saddle River, New Jersey.

Xie F. and D. Levinson (2007): Measuring the Structure of Road Networks. *Geographical Analysis,* 39, pp. 336–356.

Zhang J. and Yu Luo (2017): Degree Centrality, Betweenness Centrality, and Closeness Centrality in Social Network. *Advances in Intelligent Systems Research,* 132, pp. 300 – 309.

Zhang Y., X. Wang, P. Zeng and X. Chen (2011): Centrality Characteristics of Road Network Patterns of Traffic Analysis Zones. *Journal of the Transportation Research Board,* No. 2256, pp. 16–24.

ATTITUDE AND KNOWLEDGE TOWARD PLASTIC WASTE IN PUBLIC PLACES OF AIZAWL CITY

Malsawmtluanga
K.C. Lalmalsawmzauva

Abstract : *Improper disposal of plastic waste can be harmful to our environment. It has a hazardous effect on wildlife and the human food chain. Even though Aizawl City is a public place with few rules and regulations regarding plastic waste disposal, a huge amount of littering of plastic waste has been observed. Therefore, this research aims to study the attitude and knowledge toward plastic waste among the people who attend the study area. This study was a mixed approach where field observation and qualitative and quantitative data are derived. Three public places - Aizawl Zoological Park, Millennium Centre, and Lalsavunga Park were chosen for the study area. Primary data from 60 samples were collected through questionnaires and interviews. It is observed that a single-use plastic water bottle was the most common plastic waste which was disposed of improperly. From the data, most respondents have a great attitude towards Plastic waste and our environment. However, they score less than average on our environmental awareness scale. One interesting finding is that respondents tended to dispose of their plastic waste in an already polluted area. From the findings, regular cleaning of the area is suggested to significantly decrease the amount of littering. In addition, spreading awareness of plastic waste and how it impacts our lives through social media and education is highly suggested.*

Keywords : *Plastic waste, waste management, T-test, Factor analysis*

1. Introduction

The accumulation of synthetic plastic products in the environment has become a major concern for both the planet's health and the well-being of living organisms worldwide. Plastic wastes do not decompose easily and settle down in the earth, leading to an increase in the mass of waste in the Earth. Improper disposal is known to be toxic becoming carcinogenic to humans, birth defects, impaired immunity, endocrine disruption, and respiratory, nervous, and reproductive systems disorders (Aldag, 2023). Improper disposal of plastic waste has an effect on aquatic life where oceans, rivers, and streams are used as dumping grounds. Contamination of water, soil, and marine life leads to entanglement, death, or transformation of water bodies.

The pollution caused by plastics is harmful to human health and the environment, as plastic materials break down into microplastics that are less than 5 mm in size when exposed to environmental elements such as sunlight and wave action (Smith et al., 2018). This causes harmful chemical components to leak into food, beverages, and water (Alabi et al.,2019; Lusher et al,. 2017). The most common way that people consume plastic is through water, whether it's in bottles or straight from the tap (WWF, 2019).

Malsawmtluanga *is a Research Scholar, Department of Geography & Resource Management, MZU*
K.C. Lalmalsawmzauva *is an Assistant Professor, Department of Geography & Resource Management, MZU*

In recent years, there has been an increase in awareness of the pollution caused by single-use plastics worldwide (Nielsenet al., 2019; UNEP, 2018), and the manufacturing, distribution, and use of plastics have been banned or subject to economic controls in several nations (Adeyanju et al., 2021; Cristi et al., 2020). The problem of plastic pollution has also been addressed by volunteer activities (UNEP, 2018). Despite these initiatives, single-use plastic manufacturing and consumption have surged, outpacing current waste management and recycling capacities (Plastics Europe, 2020).

2. Literature review

Plastic is a material that both consumers and manufacturers strongly favour its use (Aday & Yener, 2014). It is generally accepted that plastic is more environmentally harmful than other materials or as being about the same (Lindh et al., 2016; Fernqvist et al., 2015).

There is a good attitude towards plastic waste around the world. According to a survey conducted by Ferdous (2013), understanding plastics has a good but insufficiently favourable impact on attitudes and behaviours among eighth graders in Lalitpur District, Nepal.

Hammami (2017) also surveyed secondary school students in Sharjah City, United Arab Emirates, discovering that most (37%) chose eco-friendly items and awareness efforts to lessen plastic pollution.

To explain the basic connection between human attitudes and their choice of waste management, various hypotheses have been put forth. Some theories concentrate on illuminating attitudes that motivate waste management and attitudes that alter in response to poor waste management practices (Essaw, et al, 2015). To explain people's attitudes toward waste management and their environmental behaviours the study draws on the tragedy of the commons (Hardin, 1959).

Environmental management is examined from two conceptual vantage points in "The Tragedy of the Commons" (Hardin, 1959). The first explains a situation in which members of society try to optimize their utility on property that is owned collectively, which results in the depletion of that resource. The second conceptual feature outlines a situation in which individuals of society pollute communally held resources as a result of disregarding their environmental responsibilities for public resources. Each person in a society is thus caught in a vicious loop of ignoring their duty to the common good (the environment). The commons consequently become the filth of society. Due to the sparse population in frontier areas, the theory contends that exploiting the commons is a cesspool benefit (Kreps, 1990).However, because of the significantly bigger cumulative impact of each member of the metropolis, the same behaviour there is intolerable. Thus, "The Tragedy of the Commons" is a problem of excessive population.

3. Significance of the study

Public places in Aizawl City are spaces that are open and accessible to the general public. They are also places where a large amount of public waste can be

found. Despite the rules and regulations regarding plastic waste, people still improperly dispose of their waste in large quantities. Therefore, the study aims to analyse the attitude and knowledge towards plastic waste and find out the factor affecting improper disposal of the same.

4. Aims and objectives

1. To assess the attitude towards plastic waste in public places of Aizawl City
2. To study the level of knowledge about plastic waste in public places of Aizawl City
3. To find out the factors affecting improper disposal of plastic waste in public places of Aizawl City

5. Null Hypothesis

1. There is no significant difference between younger (below 35 years) and older generations (35 years and above) in their attitude towards plastic waste in public places in Aizawl City.
2. There is no significant difference between the younger (below 35 years) and older generations (35 years and above) in their knowledge of plastic waste in public places in Aizawl City.

6. Methodology

Selection of Study Area : Three separate public locations in Aizawl City, the capital of Mizoram, India, were chosen for the study. The chosen sites were Aizawl Zoological Park, Lalsavunga Park, and Millennium Centre.

Sampling : stratified random sampling method was used to collect the samples. We interviewed 20 respondents from each of the three public areas, totaling 60 respondents. A structured questionnaire with a 5-point Likert scale was utilized to gather the data.

Technique of analysis : The quantitative data wereanalyzed using T-test and Factor Analysis. Principal analysis was used in the study to determine the most important factor impacting the incorrect disposal of plastic waste in public areas of Aizawl City. It is a dimensionality reduction technique used to transform high-dimensional data into a lower-dimensional space while retaining its most important patterns by finding orthogonal axes (principal components) along which the variance in the data is maximized, with the first principal component capturing the most significant variance and subsequent components following in decreasing order of importance (Jolliffe, 2002). Mean, median and mode statistics were also used to analyze the data.

7. Data Analysis

Data analysis has been carried out methodically according to the aforementioned objectives and hypotheses.

7.1 Assessment of attitude towards plastic waste

A variety of questions (variables) regarding attitude towards the environment were asked of the respondents to examine their attitude towards plastic waste. The answers ranged from 1 to 5 depending on the

respondents' attitudes, where 1 indicates "strongly disagree" and 5 indicates "strongly agree". The data obtained are then tabulated and analysed as follows (Table 1).

Table 1 illustrates that there is a generally positive attitude towards plastic garbage in the research area, which is evident from the fact that the mean response value is more than 4 points on the Likert scale. The attitude scale's total points accumulated are 88%, which likewise indicates a favourable attitude. According to the India State of Forest Report-2019 released by FSI (2019), the forest cover in Mizoram has declined from 86.2% in 2017 to 85.41% in 2019. According to the Indian Express article on 9th Feb 2021, there were over 1,300 wildfires reported in Mizoram in 2020. Among the variables, a highly positive attitude with a 4.8 Likert point and a total score of 96%, perception of forest fires has the greatest percentage of positive attitude points in the study region. This is a result of the regular forest fires that occur in the study area of Mizoram during the summer months. As a result, there is a lot of awareness about how to address the problem of forest fires, thereby

Table 1. Attitude towards Environment

S/No	Variables	Total score (out of 300)	Mean	Median	Mode	SD
1	Forest fires are detrimental to the nation.	288 (96%)	4.8	5	5	0.403
2	Polluting the environment is bad behavior	283 (94%)	4.7	5	5	0.454
3	Plastics thrown on the street look bad in terms of appearance	282 (94%)	4.7	5	5	0.462
4	it would be economically beneficial if plastics were collected and sold	282 (94%)	4.7	5	5	0.462
5	It would be nice to have a world where the environment is never polluted	276 (92%)	4.6	5	5	0.494
6	I would like to live in a clean environment	273 (91%)	4.5	5	5	0.501
7	I'm glad that plastic water bottles can be refilled.	270 (90%)	4.5	4.5	4	0.504
8	I want people to avoid harming the environment	249 (83%)	4.1	4	4	0.659
9	I get upset if I see plastic water bottles thrown by the roadside	233 (77%)	3.8	4	4	0.761
10	I'm glad to see plastic bags being reused	224 (74%)	3.7	4	4	0.516
	TOTAL	**2660 (88%)**	**4.41**	**5**	**5**	**0.514**

Source : Field Survey 2023

accounting for the optimistic outlook.

With an average 4-point Likert scale and 77% total points, the attitude towards recycling plastic is the least favourable of the attitude factors. This is because there are no recycling facilities in the study area. People's attitudes are therefore less positive in comparison to other factors.

7.2 Attitude among aged groups

Table 2. Age-group difference in attitude towards plastic waste in public places of Aizawl City by using t-Test

Age Group	N	Mean	Std. Deviation	t Value	Sig. (2-Tailed)
Below 35	10	127.41	14.92	0.561	0.582*
35 and above	10	137.75	23.23		

**Not significant at 0.05 level, df=18.*

As the calculated t-value (0.516), is less than the critical value (2.101), we accept our null hypothesis that there is no difference in attitude towards plastic waste in public places of Aizawl City. This demonstrates that the sentiments towards the environment are similar among younger (those under 35) and elder (those 35 and older) generations. Despite the rise of environmental awareness in social media and educational institutions, the younger generation in this study does not have better attitudes about the environment.

Table 3. Knowledge of Plastic Waste

Sl. No	Variables	Total Points received (out of 300)	Mean	Median	Mode	Sdt.
1	When plastics bum, they pollute the air	265 (88%)	4.41	4	4	0.497
2	plastics are insulators	252 (84%)	4.4	4	5	0.776
3	Storing food and drinks in plastic containers prevents deterioration	246 (82%)	4.1	4	4	0.065
4	Recycling helps protect the environment	236 (79%)	3.933	4	4	0.756
5	Plastics pollute the soil.	227 (76%)	3.783	4	4	0.783
6	Plastics negatively affect our health	222 (74%)	3.7	3	3	0.829
7	converting waste into valuable products is called Recycling	215 (72%)	3.58	4	4	0.530
8	Scattered plastics are an environmental problem	210 (70%)	3.5	3	3	0.567
9	Plastics are produced from petroleum	201 (67%)	3.5	3	3	0.798
10	Plastics can be recycled	137 (45%)	2.28	2	2	0.783
	TOTAL	**2211 (73%)**	**3.72**	**4**	**4**	**0.638**

Source: Field survey 2023

7.3 Knowledge on Plastic waste in public place

A variety of questions (variables) regarding knowledge about plastics were asked to the respondents with answers ranging from 1 to 5 depending on the respondents' attitudes, where 1 indicates a strong disagreement and 5 indicates an even stronger agreement. The data obtained are then tabulated and analysed as follows (Table3).

According to Table 2 above, knowledge about plastic garbage is rated at 3.7 Likert scale points, which is lower than attitude, which is rated at 4.41 Likert scale points. The median and mode of knowledge about plastic waste in the Likert scale are 4 points each. With 4.41 points on a Likert scale, most respondents have knowledge about the creation of air pollution through the burning of plastic garbage and knowledge of plastic as an insulator is relatively high.

The information that plastic can be recycled, on the other hand, received the lowest rating on the Likert scale, with only 2.28 points, which is on the disagreeing side of the scale. This lack of knowledge is not encouraging. It might be because the study location is in a state in north-eastern India, where there has been less development in many industries and, as was already mentioned, there is no recycling plant to be found. Therefore, people do not generally know how to recycle plastic, for this reason. It is also intriguing that most respondents were ignorant of the origin of plastic waste. Hence it scored only 3.5 points in the Likert scale.

7.4 Age-group difference in Knowledge of Plastic Waste

As the calculated t-value (2.29), is greater than the critical value (2.101), we reject our null hypothesis number 2.This indicates that there is a substantial gap in understanding of plastic trash between younger generations (those under 35) and older generations (those 35 and older). It implies that younger people are better informed than older people about plastic pollution. This could be attributed to public awareness campaigns and education.

7.5 Principal Component Analysis

The most significant factor influencing the improper disposal of plastic garbage in public locations in Aizawl City was identified by factor analysis in the study.

Principal Component Analysis (PCA) was used to analyse five (5) items related to the factors that influence inappropriate plastic waste disposal. A number of correlation coefficients of 0.3 and above were found when the

Table 4. Age-group difference in knowledge of plastic waste in public places of Aizawl City by using t-Test

Age Group	N	Mean	Std. Deviation	t Value	Sig. (2-Tailed)
Below 35	10	113	14.544	2.29	0.039*
35 and above	10	108	17.46		

**Significant at 0.05 level, df=18.*

correlation matrix was examined, showing that the data does not deviate from the correlation strength assumption. The Barlett's Test of Sphericity was significant (p-value =0.00û0.05), confirming the factorability of the correlation matrix, while the Kaiser-Meyer-Oklin value was 0.692, exceeding the suggested value of 0.6. Three components with Eigen values greater than one were found via PCA, accounting for 39.44 per cent, 26 percent, and 11 percent of the matrix, respectively.

The two elements account for about 65.45% of the matrix. The findings of the factor analysis for the variables influencing improper plastic trash disposal are shown in Table 5. The eigenvalues reflect the strength of each factor's impact on respondents' attitudes towards managing plastic garbage. The findings demonstrate that the notion that individuals frequently trash in already polluted areas (eigenvalue = 0.890) was the most significant factor. Lack of dustbins (eigenvalue = 0.792) was the next major issue impacting respondents' inappropriate trash disposal.

8. Findings

1. In Aizawl City's public spaces, it is found that there is a positive attitude towards the environment (scoring û4 on the Likert scale).
2. The respondents of the study area were least likely to recycle plastic but they have the best attitudes about forest fires.
3. The attitude of older and younger generations towards the environment was found to be more or less the same.
4. Respondent's level of knowledge on plastic waste (3.72) was lower than the level of attitude toward the environment (4.41) based on a Likert scale point.

Table 5. Principal Component Analysis of factors affecting disposal of waste

Factors	Components	
	1	2
Already Polluted	.890	-.249
No Dustbin	.792	.263
No Recycling Place	-.130	.737
No burning Place	.008	.778
Lawless	-.732	-.141
Eigenvalues	**1.972**	**1.300**
Total variance explained	**39.44%**	**26.00%**
Cumulative variance explained	**39.44%**	**65.45%**

Eigenvalues above 0.3 are highlighted
Source: Field survey, 2023

5. The respondents knew very little or nothing about plastic recycling and plastic source.
6. Younger generations have more knowledge than older generations about plastics.
7. People often disposed of trash where there were no dustbins.

9. Suggestion

1. Regular cleaning of an area is highly suggested to reduce the amount of improper plastic disposal.
2. Education towards plastic knowledge and awareness is also needed as the respondent's knowledge of plastic waste is low.
3. Social media should be utilized to create awareness towards plastic waste focusing more on older generations (above 35 years).

10. Conclusion

To conclude, plastic has many beneficial uses, we use it in our daily life yet it is hazardous to all living things when it becomes rubbish. Our understanding greatly influences how we feel about plastic garbage. Therefore, we must raise awareness of the issue and learn more about plastics. How it claims lives and how harmful it is to people. We acquire better attitudes the more knowledge we have. Therefore, in order to reduce plastic waste and save lives, it is everyone's job to educate the uninitiated, disseminate awareness among our friends and community, and advocate the use of disposable things.

References

Aday, M. S., & Yener, U. (2014): Understanding the buying behaviour of young consumers regarding packaging attributes and labels. *International Journal of Consumer Studies*. Vol. 38(4), pp. 385–393.

Aldag, R. J. (2023, June 8): Toxic waste. *Encyclopedia Britannica*.

Adeyanju, G. C., Nweke, A. O., Jegede, M. M., Afolabi, A. A., & Mbachu, C. O. (2021): Effectiveness of intervention on behaviour change against the use of non-biodegradable plastic bags: A systematic review. *Discover Sustainability*. Vol. 2, pp. 1–15.

Alabi, O., Ologbonjaye, K., Awosolu, O., & Alalade, O. (2019): Public and Environmental Health Effects of Plastic Wastes Disposal: A Review. *Journal of Toxicology and Risk Assessment*. Vol. 5, pp. 021.

Amenábar Cristi, M., Holzapfel, C., et al. (2020): The rise and demise of plastic shopping bags in Chile–Broad and informal coalition supporting ban as a first step to reduce single-use plastics. *Ocean and Coastal Management*. Vol. 187, pp. 105079.

Fernqvist, F., Olsson, A., & Spendrup, S. (2015): What's in it for me? Food packaging and consumer responses, a focus group study. *British Food Journal*. Vol. 117(3), pp. 1122–1135.

Ferdous, T., & Das, T. (2014): A Study about the Attitude of Grade Eight Students for the Use of Plastic in Gwarko, Balkumari, Lalitpur District. *Procedia-Social and Behavioral Sciences*. Vol. 116, pp. 3754–3759.

Hardin, G. (1959): Rational choice theory. *Science,* Vol. 137, pp. 18.

Hammami, M. B. A., Mohammed, E. Q., Hashem, A. M., Al-Khafaji, M. A., Alqahtani, F., Alzaabi, S., & Dash, N. (2017): Survey on awareness and attitudes of secondary school students regarding plastic pollution: Implications for environmental education and public health in Sharjah city, UAE. *Environmental Science and Pollution Research*. Vol. 24, pp. 20626–20633.

Jolliffe, I. T. (2002): Principal component analysis (2nd ed.). *Springer.*

Kreps, D. M. (1990): A course in microeconomic theory. *Princeton, NJ: Princeton University Press.* Vol 3, pp. 34

Lindh, H., Olsson, A., & Williams, H. (2016): Consumer Perceptions of Food Packaging: Contributing to or Counteracting Environmentally Sustainable Development? *Packaging Technology and Science*. Vol. 29(1), pp. 3–23.

Lusher, A., Hollman, P., & Mendoza-Hill, J. (2017): Microplastics in Fisheries and Aquaculture: Status of Knowledge on Their Occurrence and Implications for Aquatic Organisms and Food Safety. *FAO Fisheries and Aquaculture Technical Paper* 2017 (615).

Nielsen, T. D., Holmberg, K., & Stripple, J. (2019): Need a bag? A review of public policies on plastic carrier bags–Where, how and to what effect? *Waste Management*. Vol. 87, pp. 428–440.

Smith, M., Love, D., Rochman, C., & Neff, R. (2018): Microplastics in Seafood and the Implications for Human Health. *Current Environmental Health Reports*. Vol. 5, pp. 375–386.

UNEP. (2018) : Single-use Plastics : *A Roadmap for Sustainability.* Volume 6 revised edition.

A COMPARATIVE ANALYSIS OF SOIL PHYSICAL PROPERTIES UNDER DIFFERENT LAND USE SYSTEMS IN AIZAWL DISTRICT, MIZORAM

*P.C. Lalrindika**
R. Zonunsanga
P. Rinawma

Abstract : *Land use changes have resulted to a serious land degradation across the globe. This study aimed atinvestigating how various land use systems including jhum (J), jhum fallow (JF), teak plantation (TP), bamboo forest (BF), and dense forest (DF) affect distinct physical properties of soil like bulk density, soil texture, porosity, water holding capacity, and infiltration rate. The obtained Bulk Density of soil was found to be highest in TP, while it was lowest in DF. Textural class for all the soil is classified as sandy loam.DF shows the highest soil porosity and infiltration rate,whereas J accounts the lowest for both. Water holding capacity was found to be highest in J soils and it decreases in order for JF, TP, BF and DF soils. The results indicated that different land use systems have a considerable influence on soil physical propertieswhich may further enhance land degradation.*

Keywords : *Land use changes, land degradation, land use systems, soil physical properties*

1. Introduction

Soil, the essential component of our earth's natural resources, assumes a crucial functionwithin the Earth's ecosystem (Pathak, 2010; MoSPI, 2019). In response to the demands of a burgeoning population, anthropogenic activities like land use changes and theutilization of soil resources have substantially altered soil's physical, chemical, and biological properties, leading to severe land degradation worldwide (Singh et al., 2013; Hinge et al., 2019;Manpoong, 2019).These modifications in soil properties have significantly compromised its capacity to fulfill essential and wide-ranging ecosystem functions (NAAS, 2018).

Mizoram, characterized by its youthful and immature terrain, with 70% of slopes steeper than 33°, remains subject to active denudation caused by exogenetic processes (Anonymous, 2009; Pachuau, 2013). Consequently, the region faces continuous environmental degradation due to severe soil erosion, soil fertility loss, and deforestation (Sachchidananda, 1989). According to the report provided by the Indian Space Research Organization (ISRO, 2018; ISRO, 2020), approximately 7.3 lakh hectares (34.0%) of the state experienced land degradation, with Aizawl district accounting for more than 50% of this figure, encompassing 1,88,976 hectares.Shifting cultivation, the predominant agricultural practice in the State, has significantly contributed to land

P.C. Lalrindika *is a Research Scholar, Department of Geography & Resource Management, MZU*
R. Zonunsanga *is an Assistant Professor, Centre for Disaster Management, MZU*
P. Rinawma *is a Professor, Department of Geography & Resource Management, MZU*
* Corresponding Author e-mail: rinteapachuau21jan@gmail.com

use changes and environmental deterioration, resulting in hazards like soil erosion, moisture depletion, reduced fertility, and overall land degradation (Lallianthanga et al., 2014; Lallianthanga and Sailo, 2013; Lallianthanga and Hmingthanpuii, 2013; Jha, 1997). To ensure sustainable agricultural productivity, environmental preservation, and the well-being of plant and animal life, it becomes imperative to uphold soil health, encompassing the soil's physical, chemical, and biological processes (Ministry of Agriculture, 2012; NAAS, 2018).

To establish sustainable land use planning and land resource management policies, a comprehensive understanding about soil properties and their changes is of utmost importance across various land use and land cover types (Baruah et al., 2014; Shimrah et al., 2015). Evaluating soil characteristics or quality often involves categorizing soil indicators into physical, chemical, and biological aspects (USDA, 2008). Soil physical properties significantly influence soil productivity and, consequently, crop production by ensuring adequate availability of water content, nutrients, and oxygen for plants (Bhuyan, 2020). Additionally, soil physical properties is essential to determine the soil's suitability in the field of environmental and engineering applications, thereby influencing land use and management decisions (Phogat et al., 2015; Moorberg et al., 2017). Consequently, the primary aim of the current investigation is twofold: (i) to evaluate various soil physical properties, and (ii) to examine the influence of land use changes on soil quality.

2. Materials and Methods

2.1 Study Area

Aizawl District, situated in the northern parts of Mizoram, holds the distinction of being the second largest district in terms of area. The geographical location of the study are extends between 23°18'17.78"N - 24°25'16.04"N and 92°37'03.27"E - 93°11'45.69"E, encompassing an approximate area of 3576 sq. km (MIRSAC, 2007; Economics and Statistics Department, 2018). Due to its direct exposure to the southwest monsoon, the region experiences abundant rainfall, with an average annual record of about 2394.96 mm (Pachuau, 2013; MISTIC, 2018). Owing to its tropical location, moderate humid tropical climate is experienced with a temperature ranging between 23.83°C in the summer and 19.05°C during winter (MIRSAC, 2012). For this research, the study was conducted within Aizawl District, Mizoram (Figure 1) and five different land use land cover systems - Jhum (J), Jhum Fallow (JF), Teak Plantation (TP), Bamboo Forest (BF) and Dense Forest (DF) were selected for the study.

2.2. Sampling and methods of analysis

Three sites were selected to collect composite soil samples for every distinct land use land cover type, and the sample was obtained from a depth of 20 cm cut with soil auger. To ensure uniformity and minimize the possible influence of slope gradient on soil properties, an appropriate slope angle was chosen for each sampling

site. Subsequently, all samples were sieved using a 2 mm sieve which were then air-dried at room temperature for further analysis.

All the collected samples were analyzedusing standard analytical techniques. Soil bulk density was determined using the cylindrical core method, whilethe soil porosity was calculated based on soil bulk density using the formula: Soil Porosity (%) = 1 - (Bulk Density/2.65) (USDA, 2011). Soil particle size or textural class was estimated byBouyoucos Hydrometer method using the Soil Hydrometer ASTM 152 H. The water holding capacity was evaluated following the procedures outlined in the Ministry of Agriculture's Methods Manual (2011), and the infiltration rate was measured using the Single Ring Infiltrometer Method (USDA, 2011).

2.3 Statistical Analysis

The relationship between differentsoil properties were analyzed by using SPSS v. 21 (IBM Corp. 2012) in the present study.

3. Results and Discussion

The characteristics of the investigated soil physical properties concerning various land use systems are presented in Table 1, while Table 2 provides the calculated correlations between them. The findings revealed a substantial influence of different land use systems on soil properties, including bulk density, texture, porosity, water holding capacity, and

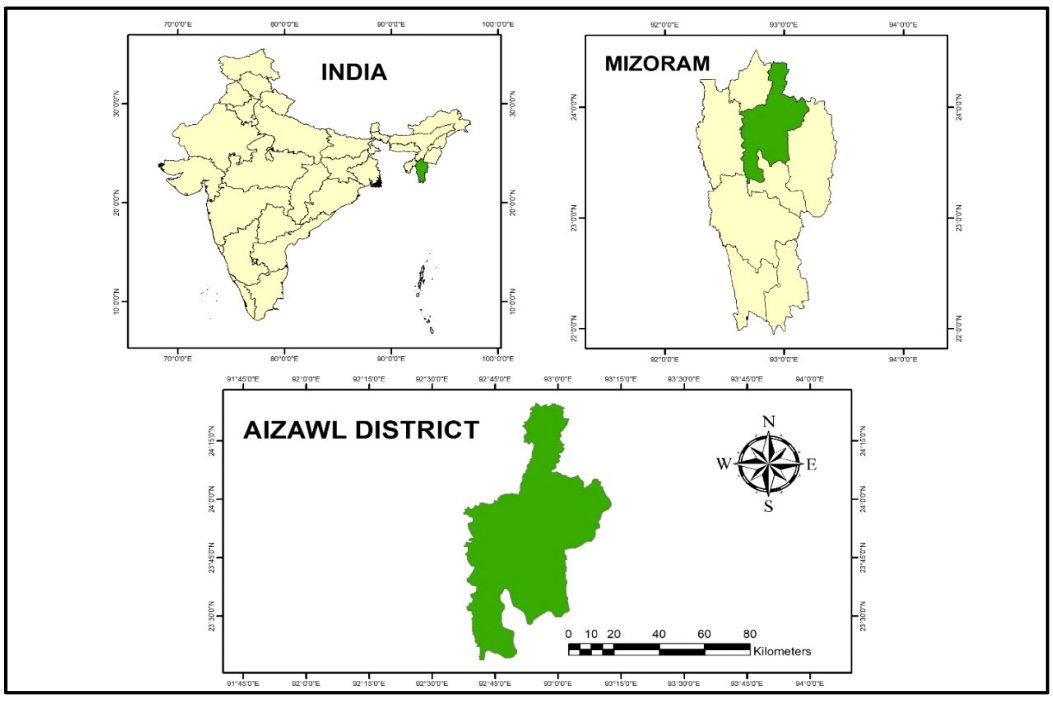


Figure 1. Study area location map

infiltration,which is an effective indicator of soil fertility status in a given area (Singh et al., 2009).

3.1 Bulk Density

Bulk density serves as an indicator of soil compaction within a particular area (USDA, 2014). The observed Bulk Density values fall within the range of 0.91 g/cm3 – 1.27 g/cm3, with teak plantation exhibiting the highest value, followed by areas under shifting cultivation and fallow land. The elevated bulk density in teak plantation, shifting cultivation, and fallow land may be attributed to the conversion of natural forests into plantation and agricultural areas (Manpoong and Tripathi, 2009).The lower Bulk Density observed in bamboo forest and dense forest areas can be attributed to the increased decomposition of organic plant litter that accumulates on the ground. This finding aligns with the report by Saplalrinliana et al. (2016), which indicated lower bulk density in forested regions with higher organic matter content. The results reveal a significant negative relationship between soil bulk density and both porosity (r = -.998) and infiltration rate (r = -.955). Conversely, a significant positive relationship is observed with clay content (r = .765) and water holding capacity (r = .858).

Higher bulk density indicates greater soil compaction and reduced soil porosity. The compaction of soil has detrimental effects on crop yields as it hinders root

Table 1. Characteristics of soil physical properties under different land use systems

	Shifting Cultivation	Fallow Land	Teak Plantation	Bamboo Forest	Dense Forest	Range	Mean
BD (g/cm^3)	1.21	1.12	1.27	1.02	0.91	0.91 – 1.27	1.11
Sand (%)	64.28	66.45	63.20	68.39	65.18	63.20 – 68.39	65.5
Silt (%)	22	20.40	18.66	17.89	22.64	17.89 – 22.64	20.32
Clay (%)	13.72	13.15	18.14	13.72	12.18	12.18 – 18.14	14.18
Textural Class	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam		
Porosity (%)	0.54	0.58	0.52	0.61	0.66	0.52 – 0.66	0.58
WHC (%)	43.08	42.08	40.58	37.67	31	31 – 43.08	38.88
Infiltration (in/hr)	0.42	0.51	0.37	0.76	1.22	0.37 – 1.22	0.66

Table 2. Correlation coefficient of different soil physical properties

	BD	Sand	Silt	Clay	Porosity	WHC	Infiltration
BD	1						
Sand	-.582	1					
Silt	-.288	-.359	1				
Clay	.765	-.553	-.580	1			
Porosity	-.998**	.552	.316	-.765	1		
WHC	.858	-.183	-.266	.397	-.863	1	
Infiltration	-.955*	.330	.391	-.638	.959**	-.960**	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

growth, restricts air and water movement, and lowers porosity, consequently leading to increased runoff and erosion (USDA, 2014). The practice of jhum cultivation, which involves clearing vegetation, exposes bare soil, leading to a decline in soil organic carbon and increased runoff rates, thereby intensifying soil loss (Chaudhary et al., 2016). Boley et al. (2009) also reported that even after 60 years, soil erosion and organic matter loss under teak plantations are not able to fully recover to their original properties.

3.2 Texture

Soil texture refers to the relative proportions of sand, silt, and clay present in a soil (Strahler, 2016). In the study area, the soil texture is dominated by the sand content, constituting more than 60% of the composition. The land use land cover analysis revealed that all areas were characterized by sandy loam, with an average particle size distribution consisting of 65.5% sand, 20.32% silt, and 14.18% clay. The highest sand content was observed in the Bamboo forest (68.39%), while the lowest was found in the teak plantation (63.20%).

The sand content exhibited a positive correlation with porosity (r=.552) and infiltration (r=.330), indicating that sandy soils have a higher capacity for water absorption and rapid drainage. However, the correlation with Water Holding Capacity was non-significant and negative (-.183). This suggests that sandy soils, being coarse-textured, have higher capacity of absorbing water and drains it rapidly, thus reflecting a lower water holding capacity (Phogat et al, 2016). On the other hand, Sandy loam are moderately coarse in texture, which can support a favorable condition for agriculture concern with respect to soil texture.

3.3 Porosity

The porosity of soil refers to the volume of pore space within the soil (Hess, 2011). In the present study, the calculated soil's porosity ranges from 0.52% to 0.66%.The study reveals that the dense forest exhibits the highest porosity, whereas porosity decreases in areas under shifting cultivation, fallow land, and teak plantation. The presence of pores in the soil allows easy movement of air and water, which indirectly influencesthe plant growth (Phogat, 2015).

It is also observed that soils in cultivated lands generally show a decrease in porosity, accompanied by an increase in bulk density (Masto et al., 2008). Notably, the current investigation also demonstrates a strong and significant negative correlation between porosity and bulk density (r=-.998). Additionally, clay (r=-.765) and water holding capacity (r=-.863) show significant and negative correlations with soil porosity as well.

3.4 Water Holding Capacity

The soil's water holding capacity serves as an important indicator of its ability to retain water and make it readily available for plant utilization (USDA, 2015). Across various land uses, the water holding capacity exhibited a range from 31% to 43.08%. Upon analyzing the data

collected from the study, it was observed that deforested areas, including shifting cultivation, fallow land, and teak plantation, possess a higher capacity to retain water for crop use. On the other hand, dense forests showed the lowest water holding capacity, followed by bamboo forests.

The research further revealed a significant positive correlation (r=.858) between water holding capacity and bulk density. Consequently, cultivated lands with higher bulk density, when compared to forested areas were found to have a higher water holding capacity, while the forested areas with lower bulk density allows free drainage of water through the pores due to lesser soil compaction. As soil porosity influenced the free movement of water, a high negative correlation (r=-.863) was also found between the water holding capacity and the soil porosity.

3.5 Infiltration

The downward entry of water into the soil is called infiltration and its velocity while entering the soil is the infiltration rate (USDA, 2015). In the study area, the average infiltration rate was determined to be 0.66 in/hr., ranging from 0.37 to 1.22 in/hr. As a result, all the soils in this region exhibit infiltration rates that fall within the range from moderately slow to moderate, based on the classification made by the U.S. Department of Agriculture (USDA, 1999).

Among various land use systems, forested areas demonstrated the highest infiltration rate. Notably, the infiltration rate exhibited a strong negative correlation with bulk density (r=-.955) and water holding capacity (r=-.960), while being significantly and positively correlated with porosity (r=.959). These findings suggest that higher porosity leads to increased infiltration, while dense soils with reduced pore space result in lower infiltration rates (USDA, 1999). Consequently, cultivated lands recorded comparatively lower infiltration rates, possibly due to soil compaction and diminished pore spaces, which, in turn, increase runoff and may contribute to soil nutrient loss through erosion.

4. Conclusion

The present study reveals diverse soil physical properties across various land use systems. It was observed that, anthropogenic factors, particularly the traditional practice of shifting cultivation with its associated deforestation, and plantation activities, emerged as the most influential drivers of changes in the soil's physical characteristics.These alterations in the soil structure could potentially impair its potential productivity and the overall soil ecosystem, leading to a decline in environmental quality. Consequently, it becomes imperative to prioritize the maintenance of optimal soil physical conditions to ensure sustainable agricultural production and effectively manage land degradation.

Given the interconnectedness of soil physical, chemical, and biological properties, it is highly recommended to conduct a more comprehensive study encompassing all three soil quality indicators. Such an in-depth analysis would furnish valuable insights into the overall health and status of the soil,

facilitating informed decision-making and resource management.

References

Anonymous (2009) : *New Land Use Policy : Executive Summary.* Government of Mizoram, Aizawl.

Baruah, U., Sahoo, A.K. and Sarkar, D. (2014):*Soil Resources of North Eastern States of India*. Today and Tommorow's Printers and Publishers, Ansari Road, New Delhi, pp. 1 – 21.

Bhuyan, S.I. and Laskar, I. (2020): Effects of Deforestation on Soil Physical Properties in Nongkhyllem Wildlife Sanctuary, Meghalaya, India. *Advance in Zoology and Botany,* 8(5): pp. 392 – 399.

Boley, J.D., Drew, A.P. and Andrus, R.E. (2009): Effects of active pasture, teak (Tectona grandis) and mixed native plantations on soil chemistry in Costa Rica. *Forest Ecology and Management*, 275: pp. 2254 – 2261.

Economics and Statistics Department (2018):*Statistical Handbook Aizawl District 2018*. Office of the District Research Officer, Economics & Statistics Department, Aizawl, p. 2.

Hinge, G., Surampalli, R.Y. and Goyal, M.K. (2019): Effects of Land Use and Soil Management on Soil Quality in India's North Eastern Himalayas. *J. Environ.* Eng., 145(4): pp. 04019007-1 – 04019007-9.

Hess, D. and Tasa, D.G. (2011) : *Mcknight's Physical Geography : A Landscape Appreciation*. Pearson India Education Services Pvt. Ltd, 10th Edition, Noida, India, pp. 332 – 333.

ISRO (2018):*Desertification/Land Degradation Atlas of Selected Districts of India.* ISRO Department of Space, Government of India, Ahmedabad.

ISRO (2020):*Status of Land Degradation of India*. NRSC, Hyderabad, retrieved from https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php,10th November, 2020.

Jha, L.K. (1997) : *Natural Resource Management Vol. I (Mizoram)*.A.P.H Publishing Corporation, Ansari Road, New Delhi.

Lallianthanga, R.K. and Hmingthanpuii (2013): Integrated Land Use Planning of Aizawl District, Mizoram, India using Geospatial Techniques. *International Journal of Advanced Remote Sensing and GIS,* 2(1): pp. 341 – 350.

Lallianthanga, R.K. and Sailo, R.L. (2013): Land use planning for sustained utilization of resources using Remote Sensing & GIS techniques: A case study in Mamit District, Mizoram, India. *American Journal of Engineering Research*, 2(11): pp. 216 – 222.

Lallianthanga, R.K., Sailo, R.L., Hmingthanpuii and Lalhmachhuana, H. (2014):Land Use Planning for Lawngtlai District, Mizoram, India: A Remote Sensing and GIS perspective. *International Journal of Current Research and Academic Review,* 2(3): pp. 42 – 53.

Manpoong, C and Tripathi, S.K. (2019): Soil properties under different land use systems of Mizoram, North-East India. *Journal of Applied and Natural Science,* 11(1): pp. 121 – 125.

Masto, R.E., Chhonkar, P.K.,

Purakayastha, T.J., Patra, A.K. and Singh, D. (2008): Soil Quality Indices for Evaluation of Long-Term land Use and Soil Management Practices in Semi-Arid Sub-Tropical India. *Land Degrad. Develop.,* 19: pp. 516 – 529.

Ministry of Agriculture (2011): *Methods manual-Soil Testing in India*. Department of Agriculture & Cooperation, Government of India, New Delhi.

Ministry of Agriculture (2012) : *Compendium on Soil Health*. Department of Agriculture & Cooperation (INM Division), Government of India, New Delhi.

MoSPI (2019) : *EnviStats India, 2019 :Volume II - Environment Accounts*. National Statistics Office, Ministry of Statistics and Programme Implementation, New Delhi, India, pp. 15 – 17.

MIRSAC (2007): *Natural Resources Mapping of Mizoram using Remote Sensing and GIS, Aizawl District (A Project Report)*. Mizoram Remote Sensing Application Centre, Science Technology & Environment, Aizawl, pp. 2 - 37.

MIRSAC (2012): *Meteorological Data of Mizoram*. Mizoram Remote Sensing Application Centre, Science & Technology, Aizawl, pp. 37 - 39.

MISTIC (2018): *Climate Profile of Mizoram*. Mizoram State Climate Change Cell (SCCC), Directorate of Science & Technology, Government of Mizoram, Aizawl, pp. 4 – 5.

Moorberg, C.J. and Crouse, D.A. (2017): *Soil Laboratory Manual. K-State Edition,* Kansas Agriculture Experiment Station, Kansas.

NAAS (2018) : *National Soil and Land Use Policy–for Serving Farmers and Safeguarding Agriculture*. Indian Council of Agricultural Research and National Academy of Agricultural Sciences, New Delhi, p-3.

Pachuau, R. (2013) : Mizoram *: A Study in Comprehensive Geography*. Northern Book Centre, New Delhi, p. 30.

Pathak, H. (2010): Trends of fertility status of Indian soils. *Current Advances in Agricultural Sciences,* 2(1): pp. 10 – 12.

Phogat, V.K., Tomar, V.S. and Dahiya, R. (2015) : *Soil Science : An Introduction, Chapter-6: Soil Physical Properties*. Indian Society of Soil Science, pp. 135 – 171.

Ranjan, G. and Rao, A.S.R. (2018) : *Basic and Applied Soil Mechanics – Third Edition*. New Age International Publishers, New Delhi, p. 19.

Sachchidananda (1989) : *Shifting cultivation in India*. Concept Publishing Company, New Delhi, p. 256.

Saplalrinliana, H., Thakuria, D., Changkija, S. and Hazarika, S. (2016): Impact of Shifting Cultivation on Litter Accumulation and Properties of Jhum Soils of North East India. *Journal of the Indian Society of Soil Science,* 64(4): pp. 402 – 413.

Shimrah, T., Rao, K.S. and Saxena, K.G. (2015): Soil Property Variations under different Land Use/Cover types in Traditional Agricultural Landscape in Northeast India. *Journal of Chemistry, Environmental Sciences and its Applications,* 2(1): pp. 73 – 97.

Singh, A.K., Bordoloi, L.J., Kumar, M., Hazarika, S. and Parmar, B. (2013): Land use impact on soil quality in Eastern Himalayan region of India. *Environmental Monitoring and Assessment,* DOI 10.1007/s10661-013-3514-7.

Singh, S., Mishra, R., Singh, A., Ghoshal, N. and Singh, K.P. (2009): Soil Physicochemical properties in a grassland and agro-ecosystem receiving varying organic inputs. *Soil Science Society of America Journal*, 73(5): pp. 1530 – 1538.

Strahler, A. (2013) : *Introducing Physical Geography.* 6th Edition, Wiley India Pvt. Ltd., Ansari Road, New Delhi, p. 345.

USDA (1999) : *Soil Quality Test Kit Guide*. Washington D.C., United States of America.

USDA (2008) : *Soil Quality Physical Indicators : Selecting Dynamic Soil Properties to Assess Soil Function*. USDA NRCS, Soil Quality National Technology Development Team.

USDA (2014) : Guides for Educators - *Soil Bulk Density/Moisture/Aeration*. USDA NRCS, p.1.

USDA (2015) : *Soil Quality Indicator Sheets : Physical Properties – Available Water Capacity.* USDA NRCS.

GROWTH OF RAPE CRIME IN RAJASTHAN: A SPATIAL ANALYSIS

Nimisha Dadhich
*Ramavtar Jat**

Abstract : *The accelerating incidents of rape crime in Rajasthan have become a serious social crisis of the present time. Using the National Crime Records Bureau (NCRB), this article explores the spatial growth of rape crime in Rajasthan. To analyse these spatial patterns, growth rate of rape crime from 2015 to 2021 was calculated and mapping was done with the help of ArcGIS software. The results for the study conclude that the spatial growth of rape crime in Rajasthan displays a picture of irregular distribution. Relatively less growth rate of rape crime was found in districts with high number of rape cases while relatively higher growth rate was found in districts with less number of rape cases.*

Keywords : *ArcGIS, Growth rate, NCRB, Rajasthan, Rape crime, Spatial analysis.*

1. Introduction

From the last three years Rajasthan is ranked first in the entire country in the number of rape cases. In the year 2021, out ofthe total 31,677 rape cases registered across the country, 6337 were in Rajasthan, while Uttar Pradesh has 2845 cases. In the year 2020, the registered cases of rape in Rajasthan were 5310 and in 2021 it increased by 19.34 percent (NCRB, 2021). While it ranks second after Uttar Pradesh in overall crime against women, it continues to be ahead in rape cases. The question is - is it fair to call the modern society more developed, civilized and educated than the ancient society, despite the ever-increasing incidents of crime against women? Under Indian Penal Code (IPC), crimes against women includes, Rape (Sec. 376 IPC), Kidnapping and abduction for various purposes (Sec. 363-373 IPC), Dowry deaths or their attempts (Sec. 302/304-B IPC), Torture, both mental and physical (Sec. 498-A IPC), Molestation (Sec. 354 IPC), Sexual harassment (Sec. 509 IPC), and Importation of girls (Sec. 366-B IPC). Rape is a violation of the fundamental rights of the victim under Article 21 of the Indian Constitution. Under section 375 of IPC rape is defined as sexual intercourse with a woman against her will and without her consent. Rape is not only a crime against women but against entire society (Khan, n.d.). Research on spatial distribution of crimes is developing rapidly, such as spatio-temporal analysis, hotspots analysis and crime mapping. Many studies have been done on these themes (Feng et. al, 2016; Kabiraj, 2022; Giedre et al., 2021;Khan &Azhar, 2019; Hart et al., 2020; Jha, 2015). This article focuses on spatial analysis of rape crime in Rajasthan.

2. Objective

The main objectives of this paper are follows.

***Nimisha Dadhich** is an Assistant Professor of Geography, Regional Institute of Education (RIE), Ajmer, Rajasthan*
***Ramavtar Jat** is a Research Scholar, Department of Geography, MLS University, Udaipur, Rajasthan*
* Corresponding Author

1. To study the trend of rape crime in Rajasthan during 2015-2021.
2. To analyse the spatial patterns of growth of rape crime in Rajasthan.
3. To map the spatial pattern of growth of rape crime in Rajasthan.

3. Data and Methodology

This article is based on secondary data which were collected from National Crime Records Bureau (NCRB). Growth rate was calculated to analyse the spatial patterns of rape crime. The applied formula for growth rate is as follows:

$$CGR = \frac{C1 - C0}{C0} x100$$

Where

CGR = Growth rate of rape crime

C1 = Rape crime in present year

C0 = Rape crime in starting year

Further, mean and standard deviation were calculated to classify districts in different categories on the basis of growth of rape crime (Table 3). Standard deviation method was employed to classify districts. Spatial mapping of rape crime was done with the help of Arc GIS (10.4) software.

4. Analysis and Discussion

Table 1. Year wise rape crime in Rajasthan (2015-2021)

S.No.	Year	No. of Cases	Rate
1	2015	3644	10.5
2	2016	3656	10.4
3	2017	3305	9.3
4	2018	4335	11.7
5	2019	5997	15.9
6	2020	5310	13.9
7	2021	6337	16.4

Source : NCRB, 2015-2021

Rajasthan being the largest state also records the highest number of rape cases for the last three years. The growth of rape cases is not only high but also increased tremendously from 10.5 to 16.4 during 2015 to 2021. The highest number of rape cases in the last seven years have been recorded in the year 2021

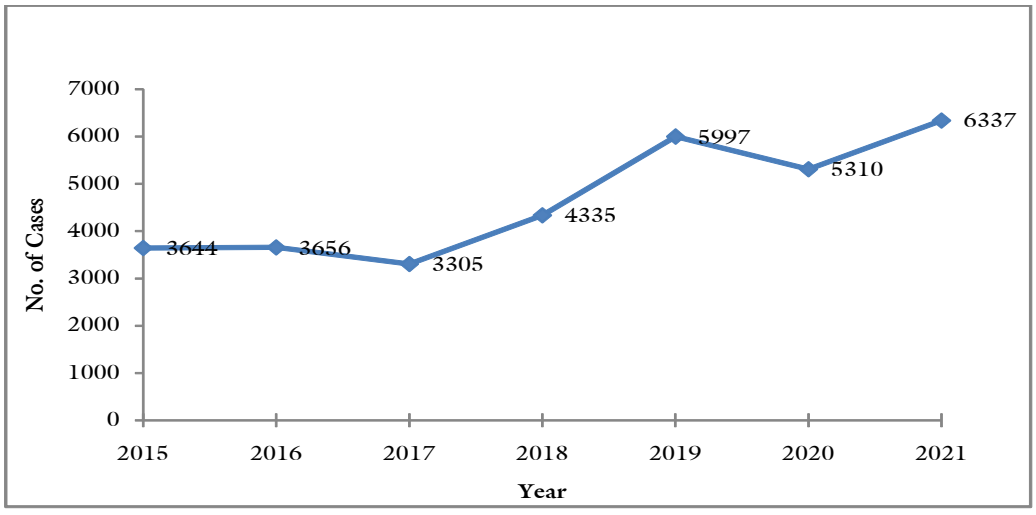


Figure 1. Rape crime in Rajasthan from 2015 to 2021

i.e. 6337 and the lowest have been recorded in the year 2017 i.e. 3305. There have been a fall from 2015 to 2017 and then a sharp increase from 9.3 in 2017 to 16.4 in 2021 (Table 1). Figure 1 shows the trend of rape crime in Rajasthan from 2015 to 2021.

Table 2 shows the number of cases in the different districts of Rajasthan in the year 2015 and 2021 respectively. The highest number of rape cases was recorded in the year 2021 in Jaipur that is 661. On the other hand, the lowest number of rape cases was recorded in the year 2015 in Jaisalmer.

Table 2. District wise growth rate of rape crime in Rajasthan (2015-2021)

S. No.	District	Total No. of Case		Growth Rate*
		2015	2021	
1.	Ajmer	125	231	84.80
2.	Bhilwara	90	230	155.56
3.	Nagaur	96	183	90.63
4.	Tonk	36	90	150.00
5.	Jaipur	362	661	82.60
6.	Jhunjhunu	88	135	53.41
7.	Sikar	92	197	114.13
8.	Dausa	53	141	166.04
9.	Alwar	254	497	95.67
10.	Bikaner	91	177	94.51
11.	Churu	81	163	101.23
12.	Sriganganagar	160	193	20.63
13.	Hanumangarh	122	198	62.30
14.	Bharathpur	244	303	24.18
15.	Swaimadhopur	58	117	101.72
16.	Dholpur	56	103	83.93
17.	Jodhpur	132	276	109.09
18.	Jalore	29	93	220.69
19.	Jaisalmer	9	20	122.22
20.	Barmer	120	236	96.67
21.	Pali	79	174	120.25
22.	Sirohi	60	113	88.33
23.	Kota	131	266	103.05
24.	Bundi	60	116	93.33
25.	Jhalawar	130	162	24.62
26.	Baran	86	130	51.16
27.	Udaipur	191	326	70.68
28.	Banswara	100	136	36.00
29.	Chittorgarh	106	115	8.49
30.	Dungarpur	117	101	-13.68
31.	Rajsamand	39	101	158.97
32.	Pratapgarh	191	215	12.57
33.	Karauli	56	138	146.43

Source : NCRB, 2015 & 2021
*Calculated by Authors

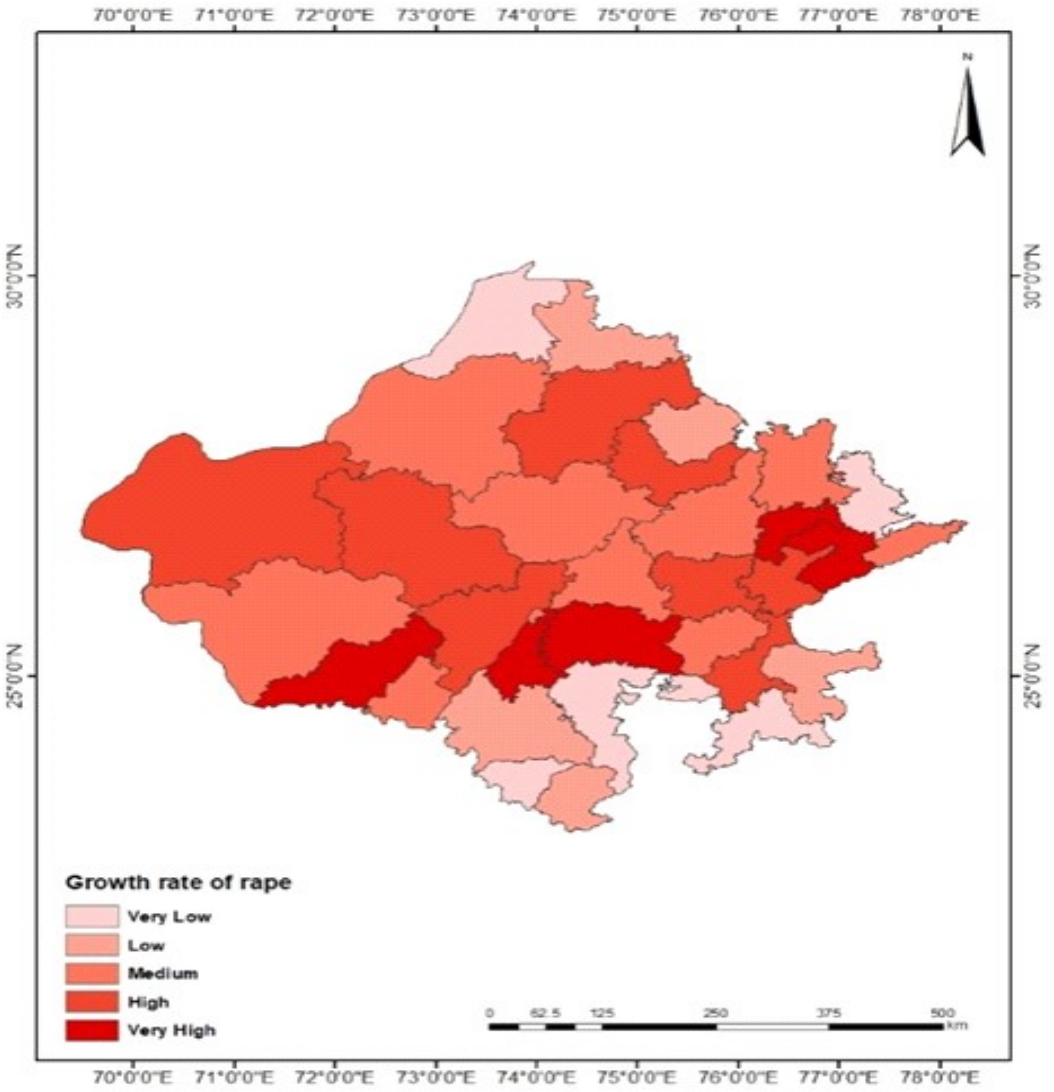


Figure 2. Growth rate of Rape Crime in Rajasthan (2015-2021)

With regards to the Figure 2, districts likeBhilwara, Jalore, Tonk, Rajsamand, Karauli and Dausa recorded very high growth rate of rape whereas low growth rate of rape were found in Chittorgarh, Durgapur, Bharatpur, Jhalawar and Sri Ganganagar. The medium range of growth rate of rape was found in the districts of Nagaur, Bundi, Kota, Alwar, Barmer, Jodhpur and Bikaner.

5. Conclusion and Suggestions

According to the results from the study, the spatial distribution of rape incidence and the unfortunate increase in rape cases in various districts of the state is found to be uneven. During the year 2015, minimum cases of rape were found in Jaisalmer, Jalore, Tonk and Rajsamand respectively. All these districts reported less than 50 cases.

However, during the year 2021, the above said districts except Jaisalmer have shown tremendous increase in the reported rape cases. It is pertinent to mention that the growth rate was the highest in Jalore (220.69) as it had less number of rape cases in 2015. Except Dungarpur (-13.68), all other districts of Rajasthan have shown an increase in the reported cases of rape. Relatively low rate of increase was witnessed in rape sensitive districts (Jaipur, Alwar, Udaipur, Bharatpur, Pratapgarh, Jodhpur) while relatively high rate of increase was observed in districts having low rape cases (Jalore, Tonk, Rajsamand, Dausa, Karauli) in 2015.

High occurrence of rape case represents an unsafe society. To make a safe and rape free society, government should take strict and effective measures. Some suggestions to curtail this problem

Table 3. Categories of districts on the basis of growth rate of rape crime.

Category	Statistical Value	Statistical Value (Growth Rate of Rape)	Name of Districts
Very High	Above than $\bar{x} + 2\sigma$	Above than 192.41	Jalore
High	$\bar{x}+\sigma$ to $\bar{x}+2\sigma$	140.6 to 192.41	Karauli, Tonk, Bhilwara, Rajsamand, Dausa
Medium	$\bar{x}$ to $\bar{x} + \sigma$	88.79 to 140.6	Nagaur, Bundi, Bikaner, Alwar, Barmer, Churu, Swaimadhopur, Kota, Jodhpur, Sikar, Pali, Jaisalmer
Low	$\bar{x}$ to $\bar{x} - \sigma$	36.98 to 88.79	Baran, Jhunjhunu, Hanumangarh, Udaipur, Jaipur, Dholpur, Ajmer, Sirohi
Very Low	Lower than $\bar{x} - \sigma$	Lower than 36.98	Dungarpur, Chittorgarh, Pratapgarh, Sriganganagar, Bharathpur, Jhalawar, Banswara

Note: Mean ($\bar{x}$) = 88.79, Standard Deviation (σ) = 51.81

of rape include

1. Just as cities are rewarded on the basis of cleanliness in the Swachh Bharat Mission, similarly the districts and cities with the lowest crime rates should also be rewarded.
2. Improvement of overall law and ordernot just in Rajasthan but also in the entire country.
3. Focus on empowerment of women on economic and social ground.
4. Censorship and control on social media and movies which promote improper sexualbehaviour.
5. Conduct of mass awareness campaignsespecially in the rural areas.
6. Provisionofspecial helpline numbers to girls which can come handy during needful situations.

Acknowledgements

The authors gratefully acknowledge National Crime Records Bureau (NCRB) for the free availability of crime related data. One of the authors, RamavtarJat, is thankful to the University Grants Commission, New Delhi, for awarding a Junior Research Fellowship.

References

Feng, J., Dong, Y., and Song, L. (2016): A spatio-temporal analysis of urban crime in Beijing: Based on data for property crime. *Urban Studies,* 53(15): pp. 3223–3245.

Giedre, B., Michael, G., Andrius, B. and Darius, V. (2021): Spatial distribution of criminal events in Lithuania in 2015–2019, *Journal of Maps*, 17(1): pp. 154-162.

Hart, T.C., Michelle, L.K. and Chataway, M. (2020): *Space, Time and Crime*. Schools of Information Faculty Publications. Retrieved March 25, 2023 from https://digitalcommons.usf.edu/si-facpub/556

Jha, D.K. (2015): Geography of Rape Crime in India: A Spatial Analysis of Official Data. *International Journal of Research in Social Sciences*, 5(5).

Kabiraj, P. (2022): Crime in India: a spatio-temporal analysis. *GeoJournal*. 1-22. DOI: 10.1007/s10708-022-10684-7.

Khan, M. and Azhar, R. (2019): Hotspot Analysis of Crimes Using GIS; A Case Study of District Abbottabad. *SSRN Electronic Journal*. Retrieved April 15, 2023 from 10.2139/ssrn.3312540.

Khan, T. (N.D.) : Section 375 of IPC: An Overview. *Legal Service India* (E - Journal), Retrieved April 16, 2023 from https://www.legalserviceindia.com/legal/article-5395-section-375-of-ipc-an-overview.html

NCRB (National Crime Records Bureau (2015): *Crime in India*. Ministry of Home Affairs, Govt. of India, New Delhi.

NCRB (National Crime Records Bureau) (2016): *Crime in India*. Ministry of Home Affairs, Govt. of India, New Delhi.

NCRB (National Crime Records Bureau) (2017): *Crime in India*. Ministry of Home Affairs, Govt. of India, New Delhi.

NCRB (National Crime Records Bureau) (2018): *Crime in India*. Ministry of Home Affairs, Govt. of India, New

Delhi.
NCRB (National Crime Records Bureau) (2019): *Crime in India*. Ministry of Home Affairs, Govt. of India, New Delhi.
NCRB (National Crime Records Bureau) (2020): *Crime in India*. Ministry of Home Affairs, Govt. of India, New Delhi.
NCRB (National Crime Records Bureau) (2021):*Crime in India*. Ministry of Home Affairs, Govt. of India, New Delhi.

A SPATIAL-TEMPORAL ANALYSIS ON POLITICAL DEVELOPMENT OF BRU ETHNICITY IN MIZORAM

Lalremruata Sailo
Lalherliana Sailo
Lalrinpuia Vangchhia

Abstract : *The present study examine spatial-temporal pattern of political development of Bru ethnic population in Mizoram. It focuses on the politics of origin of Bru settlement, patterns of population growth, and concentration of Bru electorates in the 2013 and 2018 general elections. The study is based on both primary andsecondary data whichwere collected between 2018 and 2019. A total of 24 Bru inhabited villages were surveyed accounting for 30 percent of the total Bru inhabited villages in Mizoram. Simple arithmetic and percentile methods have been used for data analysis. ArcGIS 10.5 software was employed to prepare maps. The study finds a highly increasing growth rate of Bru electoral voters after havingconcentrated settlements. On the other hand, electoral voter concentration decreased because Bru populations were migrated and distributed well to other villages from time to time. The study predicted that the homogeneity of Bru ethnicity will be declined in the future if the present pattern of change is followed.*

Keywords : *Political development, Bru ethnicity, growth, concentration, homogeneous settlement*

1. Introduction

The Brus are one of the distinct ethnic communities living in the State of Mizoram, North East India. Majority of the Brus are found in Tripura but are also found scattered in other neighboring states of Assam and others (Vanlaltlani, 2007). In Mizoram, Brus are minority tribesthat settled mostly in the western belt bordering Tripura State and Bangladesh. The term "Bru" means "Man" (TRI, 1986; Chawngkunga & Dothansanga, 2013). In earlier days, the whole Riang community was under the rule of a chief called 'Rai'. This system of administration has been existence during their earlier settlement in Tripura where from they migrated to a hill district the Hill District now called Mizoram (TRI, 1986). The present study spatial-temporal patterns of development among the Bru tribes in Mizoram. The study mainly focuses on the origin of Bru settlement in Mizoram and electoral politics of the Bru ethnic group in Mizoram.

2. Objectives

1. To trace the origin of Bru settlements in Mizoram
2. To find the political development of Bru ethnicity in Mizoram
3. To study the growth of eligiblevoters of Bru ethnicity in Mizoram
4. To study electoral voters' concentration of Bru ethnicity in Mizoram

***Lalremruata Sailo** is an Assistant Professor, Department of Geography, Govvernment Champhai College*
***Lalherliana Sailo** is a Research Scholar, Department of Geography & Resource Managment, MZU*
***Lalrinpuia Vangchhia** is an Assistant. Professor, Department of Geography, Govt. Hnahthial College*

3. Methodology

The present study relies uponboth primary and secondary data of Bru voters in the 2013 and 2018 MLA (Member of Legislative Assembly) elections of Mizoram. Primary data has been collected during 2018 – 2019. Secondary data has also been used such as the Electoral Roll of 2013 & 2018 (ECI), Census of India data, Population data from Mizoram Police, and Population data from the Tribal Research Institute. The collected data has been analyzed by simple arithmetic, percentile. Maps have been prepared by Arc GIS 10.4.1.

Probability Proportional to Size (PPS) sampling technique was used to select sample villages. Sample size (household) was determined with the formula given by Yamane (1976). The total sample size was 394. After selecting the villages, questionnaires were distributed proportionately among the selected villages with the help of the following formula

$$nh = \frac{Nh}{N} xn$$

Where nh= sample size for stratum h, Nh= population size for stratum h, N=total household size, and n=total sample size.

3.1 Study Area

In Mizoram, Brus are settled in the districts of Mamit, Kolasib, Lunglei, and Lawngtlai. They are mostly settled in the western flank of the state bordering their original homeland Bangladesh as well as Tripura and Assam. As per the final electoral roll of 2015, there are 43 villages in the Mamit district, 12 villages in Kolasib and Lunglei districts, and, 15 villages in the Lawngtlai districts. Generally, Bru settlements are situated beside the stream or river valleys due to the fondness for water where they can easily find fresh marine food items. In the study, 24 villages from the Bru inhabited districts that comprises 30 percent of the total Bru inhabited villages of the state were selected.

3.2 Limitations of the study

In writing and interpreting Bru's history, there is an insufficiency of literature that deals with the influx of Bru in Mizoram. Minority studies have failed to gain the attention of contemporary geographers, historians, sociologists, and anthropologists, which leaves the published work of colonial officers, missionaries, and politicians rather than academicians to be much sought after. The spatial-temporal pattern of growth and concentration among Bru voters is not able to be studied until the 2013 MLA election. Thus, the study compares only two consecutive years of election i.e., 2013 and 2018.

4. Results and Discussions

4.1 Origin of Bru Settlement in Mizoram

The Bru themselves admit that they are not original inhabitants of Mizoram (Vanlaltlani, 2007). Public opinion among the Mizos is that their geographical origin lies somewhere outside India. But this opinion never leads the Bru to feel that they are outsiders in India. According to Vanlaltlani (2007), the original homeland

of the Bru is the valley of Yangtse Kiang and Hwangho rivers in China. To avoid local war in their original abode, left their homeland and scattered in Vietnam, Thailand, Myanmar, Chittagong Hill Tracks of Bangladesh, and India.

Some believed from folklore that the Bru/Riangs formally settled in some parts of Chittagong Hill Tracts of Bangladesh under their King Kachhok/ Khachouh but were in course of time-driven out by the powerful Mogs or Mughals (Vanlaltlani, 2007) and as a result they moved to the north to take shelter in Amarpur and Belonia Sub-Division Tripura (TRI, 1986).Then they scattered to several places like Mizoram, Tripura, and Myanmar, even as some remain in the Chittagong Hill Tracks (Vanlaltlani, 2007).

There is a problem withthe timing of the entry of Brus into Mizoram. Some claimed that Bru temporary settlement existed in Mizoram even before the Mizo occupied Mizoram. But the Bru, instead of continually dwelling in Mizoram, or occupying the whole of Mizoram, moved to other places in the Chittagong Hill Tracks, Tripura, and other places doing jhum cultivation. Nevertheless, several places, villages, hills, lakes, etc. of Mizoram seem to be named after Bru's words,some proof of their previoussettlements. Time and circumstances might have pressed the Bru to come back to Mizoram today, instead, they are now scattered in several placesin the western belt around Mizoram.

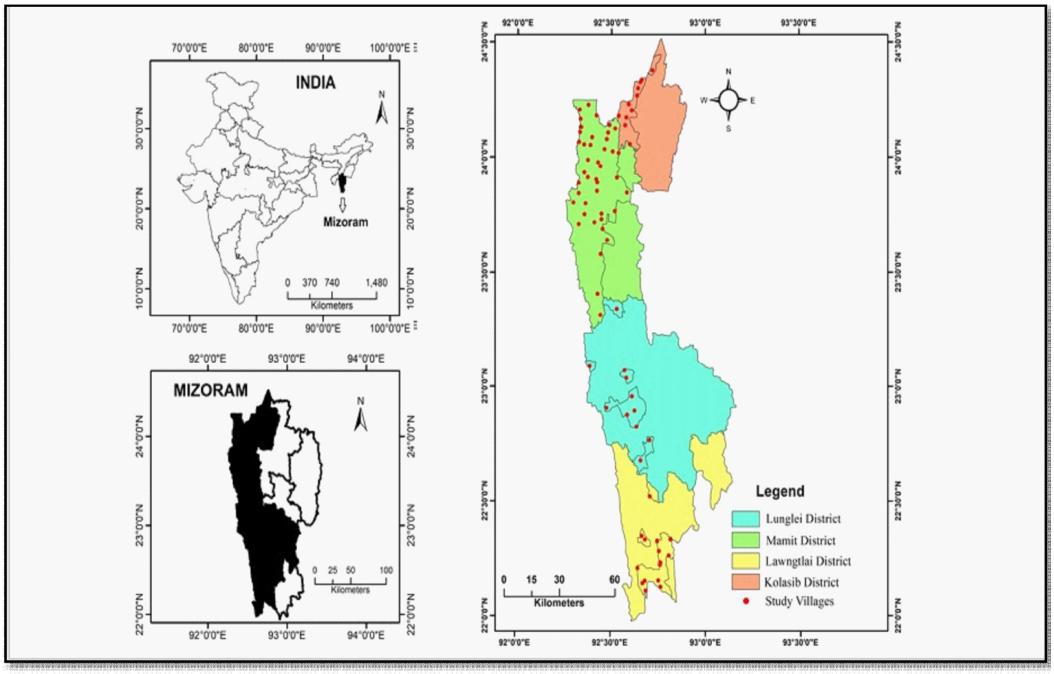


Figure 1. Study Area map showing Bru inhabited villages

(Vanlaltlani, 2007)

In the year 1926 June, two Bru warriors Dumbawma and Keikapa were asked to eliminate a wild rogue elephant in Darlak village, Mizoram, and they were permitted to settle in Kawrtethawveng village, Mizoram with their families. In 1931, Zamuang village has a wild rogue elephant, to tackle this problem the Lusei chief with the consultation of the government officials asked two Bru warriors Dumbawma and Keikapa to migrate to Zamuang with a family 15. They are the first who settled in Mizoram with the permission of the government of Mizoram (Chawngkunga & Dothansanga, 2014).

In 1946, A. Macdonald, the then superintendent of the Lushai Hills, through an official order (No 734-47G on 29 April) declared that the race Pawi, Paihte, Hmar, Lakher, Chakma, Reang (Tuikuk), Matu, Chawrai, Hrangkhawl, Langrawng be deemed "Lushais" for the tenacity of House tax assessment under notification No 4973 of 16th July 1946 (Patnaik & Lalthakima, 2008).

Bru, Mizo, and other hill tribes who had wandering experiences often had a ruler or chief in every village responsible for the administration of their villages. The Bru call the such ruler of the village Chaudhury or Chaudhri and the Mizo called him Lal. The Mizo started having a village chief, Lal, while they were settling in the Lentlang area, the western part of Chin Hills in western Myanmar. This area is near the boundary between Myanmar and Mizoram. The period is usually dated to 1500 A.D. before they arrived in Mizoram. This village chief of the Mizo was the guardian of his people, leader, and defender in times of attack by the enemy, and above all, giver of food through the same means in times of scarcity. The practice of a Chaudhury system in the Bru village is similar to that of the Lal system (Vanlaltlani, 2007).

4.2 Political Development of Bru Ethnicity in Mizoram

According to The Representation of People Act 1954, Mizoram elects their village council representatives. In this election the Mizo Union party got the majority and during their tenure (1953-1970) Bru villages were not considering to give village council. Also, during the Union Territory of Mizoram only Mizo village was given a village Council. But, in 1987 when Mizoram became a full-fledged State, for the idea of liberty, equality, and fraternity the state government created 26 Bru Village councils (Chawngkunga & Dothansanga, 2014).

Mizoram Government tookspecial considerationforthe Bru community asthey are the most vulnerable groups in the state. During the period of Union territory, Peoples' Conference party (1978-1984) granted a nominated Assembly member seat to V. Nunzira, while Mizoram Pradesh Congress Committee nominated Zoduha as the Legislative member.With the development from time to time, political thinking among the Brus is lifted to the ground (Chawngkunga & Dothansanga, 2014).

The movement towards mass consciousness of their ethnic identity came

early in the 1980s, being initiated by Bru students. The Bru consciousness started mainly in the Teirei and Dampa areas where the Presbyterian Church of Mizoram (PCM) runs educational schools for Bru children (Vanlaltlani, 2007). The Bru who tried to enter politics migrated to Mamit from different districts of Mizoram in the hope of support from their clan and trying to claim autonomous status in the western belt (Hrangchal, 2020; Sailo & Pachuau, 2022).It is to be noted that the growing tide of political and social unrest among the Bru started during the 1970s-80s.

The political development of Brus in Mizoram could be traced back to June 15, 1990, when they formed a Riang Democratic Convention Party (RDCP). The policy of this party was to safeguard the Bru culture, language, and customs and to develop the welfare of the Bru people (Lalthakima, 2008). The Riang Democratic Party (RDP) was formed in 1990 at Lunglei and the R.D.P branch was also opened in the Chakma Autonomous District Council (CADC) area. In 1992, Chandro Mohan Riang was elected as a Member of the District Councill (MDC) from the Vathuampui constituency. However, Riang Democratic Party (RDP) became extinct with the defection of Chandho Mohan Riang to the Indian National Congress in 1993 (Doungel, 2015).

The Bru National Union (BNU) was formed in 1994 for the protection, development, and upliftment of the Bru (Reang) community (Hrangchal, 2002). The Bru (or Reang) represented by the Bru National Union (BNU) also demanded Autonomous District Council (ADC) but it was followed by a violent ethnic clash in 1997 which led to the displacement of around 35,000 Brus and their settlement at eight refugee camps in North Tripura. This led to the formation of an armed outfit called the Bru National Liberation Front (BNLF) (Hnamte, 2006).

On the 23rd and 24th of September, 1997 the Bru National Union (BNU) held its firstsignificant and crucial conference at Saipuilui village. The conference was attendedby some 400 delegates of the Bru community including delegates of the Brucommunity from Tripura. The Conference adopted a resolution demanding the creation ofa separate Autonomous District Council for the Bru community within Mizoram. This came as a big surprise to the Mizos in general. The Mizos in the WesternBelt of the then Aizawl District strongly reacted to the demand for an Autonomous District Council by the Brus. The Mizo Zirlai Pawl (MZP) with its Headquarters at Mamit was the first NGO to react officially. It held a meeting at Rengdil village on the 14thof October, 1997, and raised strong objections against the demand. In fact, even prior tothe objections raised by the MZP, a number of Bru families had already migrated afterdisposing of their properties, indicating that there had already existed a covert butunarmed movement much earlier (Chawngkunga & Dothansanga, 2014).

The BruNational Liberation Front (BNLF), a militant organization, or the armed Wing of theBNU, was also

formed. However, the formation and existence of this outfit (BNLF)were not known to Mizoram Police nor other intelligence agencies till the killing of Pu Lalzawmliana, a Wildlife Game Watcher of Mizoram Forest Department on 21st October 1997. The BNLF cold-bloodedly murdered Pu Lalzawmliana, Forest Game Watcher, at Persang (Damparengpui Reserved Forest). On 23rd October 1997 when the news about the murder of Pu Lalzawmliana was received, approximately 1,000 persons fromdifferent villages in the Western Belt went to the area to search and recover the deadbody. Due to the apprehension of a law-and-order problem, the State Police and BSF tried to stop them at Tuipuibari (Hrangchal, 2020).

Tension built up on the evening of 24th October 1997 when the crowd came to knowthat the brutal murder of Pu Lalzawmliana was committed by the Bru militants. Eventhough the Policecould persuade the crowd to go home, some miscreants burnt down afew houses vacated by Brus at Tuipuibari. Between 19th – 21st October 1997, members of BNLF visited Bru villages of Tuirum, Khamrang, Falkawn, Hnahthialzawl, andDamparengpui and threatened them to leaveMizoram immediately stating that theywere going to attack Mizoram Police force (Hrangchal, 2020).

On October 23rd and 24th, 1997 suspected BNLF militants coming from Tripura State visitedZawlpui village and threatened Bru families to leave Mizoram on the same nightitself. Accordingly, thirty (30) Bru families left for Tripura. On 23rd November 1997, BNLF verbally declared that all Brus from Mizoram should leave Mizoram before 26th November 1997. Consequently, on the night of 30th November 1997 three (3) unknown BNLF militants visited Khawhnai village and threatened the Bru families that they should leave Mizoram immediately; Accordingly, three (3) Bru families left on the same night (Hrangchal, 2020).

In the last week of November 1997, BNLF again issued an Order that Bru community members staying in the Western Belt should leave Mizoram before the 25th of December, 1997. Fearing reprisal from the Mizos who have started burning houses in some villages, and also because of the strong warning from their own Organization as mentioned earlier, a number of Bru families migrated to neighboring states, mostly to Tripura (Hrangchal, 2020).

Ethnic identity and ideology with regard to separate political administrations had always interfered with a physical disturbance that was seen as undesired by the dominant society. One could not justify the actions and reactions that happened in the continuous flow of history and its entailing interactions. Thus, the political tensions of the Bru could be labeled as full of intricate ideological conflicts.

4.3 Growth of Bru Ethnicity in Mizoram

The KhondolBruwere settlers of Belonia under the Amarpur Sub-Division,Tripura. Just before the British came to Mizoram, they settled west of Longtorai hillwhich is the third hill west

of Zampui hill, for fear of the constant threat of invasion by theMizos. Due to the terror of the Mizos, no other tribes ventured to settle near them. Till 1920 noTuikuk had ever set foot on the eastern part of Tripura and till 1939 there was only onevillage of Tuikuk at Kanchan plain which consisted of only 8 (eight) houses (Hrangchal, 2002). Among the Khondolbru, Raibangkha was given a chieftainship at Serlui, he is the first Bru Chief in Lushai Hills. His son Purberai succeeds to the throne till the chieftainships have been ceased in 1954 (Lalhluna, 2013).

After 1950, village-like Kolalian, Kananthar, Baraghone, Sihthiang, Bazarunga, Lungmawi, and Maubuang are Bru villages in the vicinity of Zawlnuam. In the Kawrthah area Thaidawr, Mualthuam, Dinthar, Tumpanglui, Sarali, Tuipuibari, and Zohmun are Bru occupant villages. In the vicinity of Mamit, Khanthuam, Saipuilui, Bawngva, Chilui, Tlangkhang, and Sertawkzawl. Phuldungsei has Tuirum, Khawhnai, Damparengpui, Hnah-thialzawl, Falkawn, Phulpui 'W' and Pukzing Vengthar are all Bru village in Mamit District (Chawngkunga & Dothansanga, 2014).

The history of the Bru population in Mizoram presents a somewhat confusing picture. The population of Bru in Mizoram is negligible till 1960. The number of Riang speakers was only 51 in the 1951 census, which increased to 9,815 within a decade (Saitluanga, 2022). However, the 1971 census report shows the population of Bru in Mizoram to be 9828 persons.By the year 1996, their population, according to the claim of the Bru Students' Association, had risen to a booming 70,000. The same year, the Mizoram unit of BharatiyaJanata Party (BJP) submitted a memorandum to their party president L. K. Advani claiming the Bru population as 74,000. The Bru Students' Association (BSA) yet again submitted another memorandum on 20th September 1997 to the Election Commission of India claiming their population in Mizoram as over 80,000 (TRI, 1986). However, the Censusof India, 2001 & 2011 denoted that there are 17,015 persons in 2001, and in 2011 only 32,149 persons who speak Kokborok/ Reang in Mizoram. It appears that there is a process other than biological.

According to the Mamit District Police report 2002, Brus who fled from Mizoram are 2940 families with a number of 14907 persons. However, in March 2005 the Government of Mizoram estimated that the Bru refugees, due to insurgency, were 16,000 persons. While the Bru Welfare Association of Mizoram (BWAM) claimed that it crossed 35,000. As per the Mamit District Police report in 2002, there are 895 families with 4834 persons in Mamit district, 306 families accompanied by 1371 persons in Kolasib district, Lunglei district has 642 families with 3151 persons, Lawngtlai district has 909 families with 5441 persons. This figure illustrates that the Bru population in Mizoram (2002) was 2752 families with 14,797 persons excluding the refugees.

4.4 Growth of Bru Voters in Mizoram 2013-2018

The total number of Bru voters increased from the 2013 to 2018 election by 2,537 (See Table 1). Based on the two elections s i.e., 2013 and 2018, the growth rate of Bru voters in Mizoram is 0.23 (22.83 %) which is more than 3 times higher than the average growth rate of voters in Mizoram (7.25%). The highest growth rate of Bru voters was found in the Kolasib district (29.57%) followed by Lawngtlai district (24.69%), Mamit district (20.39%), and Lunglei district (16.66%). Table 1 shows the numbers, changes, and growth of Bru voters in Mizoram during the last two MLA elections.

4.5 Growth of Bru Voters among the selected Villages 2013-2018

Among the selected villages the number of Bru voters in 2013 was 11,854 which increased to 14,386 where the average change was 10.40 percent. Similarly, the average growth rate during the period was 0.25 (25.01%) which is 4.56 percent lesser than the average growth rate of the whole of Mizoram. The highest growth rate is found in Buhchangphai, Kolasib district where the number of Bru voters increases by 118.82 percent whereas the lowest growth rate is found in Zamuang village of Mamit district.

4.6 Classification of villages based onthe growth rate of Bru voters

As shown in Table 3, all the villages were classified into 5 divisions based on the growth rate of Bru voters 2013 and 2018 elections such as very low growth rate (below 10), low growth rate (10-20%), moderate (20-30%), high growth rate (30-40%) and very high growth rate (above 50%). The average growth rate percentage of the villages (25.01) was selected as a base for the moderate class. The growth rate less than the average was classified as low or very low. Similarly, the villages having higher growth rates than the average of the study area were classified as having high and very high growth rates. Most of the villages are in low growth rates were 33.33 percent of the total village falling under the category. A very low growth rate was found in 4 villages (16.67%), a moderate growth rate found in 7 villages (29.17%), a high growth rate in found 2 villages (8.33%),

Table 1. Growth of Bru Voters in Mizoram 2013-2018

District	Year		Change in No.	Change in %	Growth rate	Growth Rate in %
	2013	2018				
Mamit	7878	9484	1606	9.12	0.20	20.39
Kolasib	1339	1735	396	17.25	0.30	29.57
Lunglei	1507	1758	251	10.64	0.17	16.66
Lawngtlai	1130	1409	279	10.05	0.25	24.69
Mizoram	**13867**	**16404**	**2537**	**11.77**	**0.23**	**22.83**

Source: Electoral Roll 2013 &2018

Table 2.Growth of Bru Voters among the selected Villages 2013-2018

Village	Districts	2013	2018	Change in No.	Change in %	Growth rate	Growth in %
Damparengpui	Mamit	1,327	1,691	364	12.06	0.27	27.43
Tuipuibari		1,645	1,932	287	8.02	0.17	17.45
Thaidawr		613	676	63	4.89	0.1	10.28
Vawngawnzo		205	282	77	15.81	0.38	37.56
Tlangkhang		158	180	22	6.51	0.14	13.92
Liandophai/Bawngva		506	647	141	12.23	0.28	27.87
Hmunpui		99	121	22	10	0.22	22.22
West Phulpui		318	485	167	20.8	0.53	52.52
Nalzawl		681	843	162	10.63	0.24	23.79
Zawlnuam (Vengthar)		244	261	17	3.37	0.07	6.97
Zamuang		394	406	12	1.5	0.03	3.05
K. Sarali		419	443	24	2.78	0.06	5.73
Sihthiang		824	954	130	7.31	0.16	15.78
Chuhvel		445	563	118	11.71	0.27	26.52
Buhchangphai	Kolasib	85	186	101	37.27	1.19	118.82
South Chhimluang		301	345	44	6.81	0.15	14.62
Bukvannei		367	517	150	16.97	0.41	40.87
Zodin		586	687	101	7.93	0.17	17.24
Tuisenchhuah/Bolia	Lunglei	409	432	23	2.73	0.06	5.62
Phairuangkai		425	506	81	8.7	0.19	19.06
Putlungasih		673	820	147	9.85	0.22	21.84
Zochachhuah	Lawngtlai	150	179	29	8.81	0.19	19.33
Saibawh		451	592	141	13.52	0.31	31.26
Nghalimlui		529	638	109	9.34	0.21	20.6
Overall		**11,854**	**14,386**	**2532**	**10.40**	**0.25**	**25.01**

Source : Electoral Roll 2013 &2018

Table 3. Classification of villages based on the growth rate of Bru voters

Growth rate in %	Class	No. of village	Villages
Above 40	Very high	3	West Phulpui & Buhchangphai, Bukvannei (12.5%)
30 - 40	High	2	Saibawh & Vawngawnzo (8.33%)
20-30	Moderate	7	Nghalimlui, Putlungasih, Hmunpui, Nalzawl, Chuhvel, Damparengpui & Liandophai/Bawngva (29.17%)
10-20	Low	8	Thaidawr, Tlangkhang, South Chhimluang, Sihthiang, Zodin, Tuipuibari, Phairuangkai & Zochachhuah (33.33%)
Below 10	Very low	4	Zamuang (Lungmawi), Tuisenchhuah/Bolia, K. Sarali & ZawlnuamVengthar (16.67%)

and a very high growth rate found in 3 villages (12.5%).

4.7 Spatial-Temporal Change of Bru Voters' Concentration

In the 2013 election, the total Bru voters in Mizoram were 11,854 accounting for 48.25 percent of the total voters of Mizoram (24,570). While in 2018, Bru voters comprise 28.03 percent of the total voters in the 4 districts. Bru voters' concentration by comparing the 2013 and 2018 elections was decreased by 20.21 percent. It indicates the increasing rate of Bru voters is lower than the state average. Table 4 explainsthe concentration of Bru voters in 2013 and 2018.

Among the selected villages, Bru voters comprise 77.23 percent of the total voters in 2013 and 78.26 in 2018 which was an increase of 1.03 percent. Bru voters concentration is highest in Zochachhuah village where all the voters belong to the Bru population. On the other hand,

4.8 Changing Patterns of Bru Voter's Concentration 2013-2018

The average change of Bru voter concentration among villages of the study area is 1.03 percent. The highest change has been found in South Chhimluang (79.81%) whereas it is lowest in ZawlnuamVengthar (-77.9%). All the villages were classified into 5 such as very low (below 10%), low (-1 to -10%), moderate (-1 to 1%), high (1 to 10), and very high (Above 10). As shown in Table 5, changesin Bru voters concentration from 2013 to 2018 are very low among 6 villages (25%), low among 2 villages (8.33%), moderate in 5 villages (20.83%), high among 6 villages (25%) and very high in 5 villages (20.83%).

5. Conclusion

From their origin, the ethnicities of Bru increased in their number especially after they have a large inhabitant settlement. The ethnic concentration is very high in many villages which makes their political development

Table 4. Bru Voters Concentration in Mizoram 2013-2018

District	Year						Change in %
	2013			2018			
	Total Voters	Bru Voters	Bru Voters in %	Total Voters	Bru Voters	Bru Voters in %	
Mamit	15,091	7,878	52.20	31,681	9,484	29.94	-22.27
Kolasib	3,047	1,339	43.94	7,906	1,735	21.95	-22.00
Lunglei	3,019	1,507	49.92	7,271	1,758	24.18	-25.74
Lawngtlai	3,413	1,130	33.11	4,463	1,409	31.57	-1.54
Mizoram	**24,570**	**11,854**	**48.25**	**51,321**	**14,386**	**28.03**	**-20.21**

Sourc e: Electoral roll 2013 and 2018

Table 5. Bru Voters Concentration in the Selected Villages 2013-2018

Village	Districts	2013			2018		
		Bru Voters	Total Voters	Bru Voters in %	Total Voters	Bru Voters	Bru Voter in %
Tuipuibari	Mamit	1,327	1,351	98.22	1,628	1,607	99.05
Damparengpui		1,645	1,648	99.82	1,687	1,671	98.71
Thaidawr		613	629	97.46	633	623	98.42
K. Sarali		205	214	95.79	221	208	95.28
Vawngawnzo		158	177	89.27	174	160	94.12
Sihthiang		506	557	90.84	567	513	93.52
Tlangkhang		99	701	14.12	714	101	91.95
Liandophai/Bawngva		318	376	84.57	379	323	90.48
Nalzawl		681	796	85.55	795	691	86.92
West Phulpui		244	1,271	19.2	1,316	248	85.22
Chuhvel		394	1,040	37.88	1,046	400	67.66
Zamuang (Lungmawi)		419	445	94.16	445	424	38.24
Zawlnuam (Vengthar)		824	859	95.93	895	837	18.84
Hmunpui		445	952	46.74	668	452	14.15
South Chhimluang	Kolasib	85	528	16.1	542	86	95.91
Bukvannei		301	313	96.17	318	305	74.95
Buhchangphai		367	489	75.05	499	374	15.87
Zodin		586	632	92.72	731	687	93.98
Tuisenchhuah/Bolia	Lunglei	409	477	85.74	481	415	86.28
Putlungasih		425	683	62.23	690	433	82.81
Phairuangkai		673	818	82.27	826	684	62.75
Zochachhuah	Lawngtlai	150	152	98.68	156	156	100
Saibawh		451	458	98.47	478	464	97.07
Nghalimlui		529	548	96.53	559	537	96.06
Overall		**11,854**	**16,114**	**77.23**	**16,448**	**12,399**	**78.26**

Source : Electoral Roll 2013 & 2018

Table 5. Classification of Villages in Change of Voters Concentration 2013-2018

Change in %	Class	No. of village	Villages
Above 10	Very high	5	South Chhimluang, Tlangkhang, West Phulpui, Chuhvel & Putlungasih (20.83%)
1 to 10	High	6	Liandophai/Bawngva, Vawngawnzo, Sihthiang, Nalzawl, Zochachhuah & Zodin (25%)
-1 to 1	Moderate	5	Thaidawr, Tuipuibari, Tuisenchhuah, Nghalimlui & K. Sarali (20.83%)
-1 to -10	Low	2	Damparengpui & Saibawh (8.33%)
Below -10	Very low	6	Phairuangkai, Bukvannei, Hmunpui, Zamuang, Buhchangphai & ZawlnuamVengthar (25%)

homogeneous. By comparing the last two consecutive MLA elections of Mizoram i.e., 2013 and 2018, the growth rate of Bru electoral voters increased by 22.83 percent which is 3.15 times higher than the growth rate of all electoral voters in Mizoram. Among the selected villages of the study area, the average growth rate of Bru electoral voters in the same period (25.01%) is 3.45 times higher than the growth rate of all electoral voters in Mizoram. During the period, Bru voters concentration i.e., the percentage of Bru electoral voters to the total eligible voters of the state declined by 20.21 percent. This indicates electoral voters of Bru ethnicity migrated to another district and more distributed very well in 2018 as compared to the 2013 MLA election. However, among the selected villages, low increasing patterns of change (1.03%) in electoral voter concentration have been found among the Bru ethnicity. If the same trend of changing patterns is continued in the next election, electoral voters' concentration of Bru ethnicity will be minimal which will make more heterogeneous electoral voters in the election.

References

Chawngkunga, C. and Dothansanga, C. (2014): *Mizoram Tuikuk (Reang/Bru) Chanchin*. Lengchhawn Press, Aizawl.

Hrangchal, L.T. (2002): *The Bru Crisis in a Nutshell,* Prepared & Edited Exclusively for Mizoram Police. (Unpublished).

Lalhluna, R.K. (2013): *Mizo History: Kamkeuna (An Introduction to Mizo History)*. Mizoram Publication Board, Aizawl.

Patnaik, K.J. and Lalthakima (2008): *Mizoram : Dimensions and Perspectives,* Concept Publication, New Delhi.

Sailo, L. and Pachuau, R. (2008): Livelihood and Economic Status of Bru Ethnic Population of Mizoram. *Geographic*, 16: pp. 25-39.

Saitluanga, B.L. (2022): Mizoram through the Ages. *In Northeast India through the Ages : A Transdisciplinary Perspective on Prehistory, History, and Oral History.* Bhattacharyya, R. (ed.), Routledge, New Delhi, pp 306-331.

Tribal Research Institute (TRI) (1986): *A Brief Account of Riangs in Mizoram.* Tribal Research Institute, Aizawl.

Vanlaltlani, T. (2007) : *A Study of Religious Identity Among the Bru of Mizoram,* ISPCK, Delhi.

UNRELIABLE PIPED WATER SUPPLY IN AIZAWL CITY

- C. Ramhnehzauva

Abstract : *This paper examines the piped water distribution system and the degree of water supply unreliability as well as the strategies employed by residents to cope with the unreliable piped water supply. Data was gathered via questionnaire administered to 750 respondents' mainly female household heads. Based on the Aizawl Municipal Corporation (AMC) 2020 report of population (3,59,829) and the Government of India 10th Plan recommendation of standard norms of the per capita water supply (135 lpcd) the water demand in the City worked out as around 48.57 million litres per day (MLD). However, in the present situation the PHED makes available only about 22.99 MLD of water to the City residents. Thus, it can be estimated that there is a large gap between the supply and the demand, which is as high as 25.58 MLD. This translates to about 47.33 per cent of water demand not satisfied by supply. Findings also show that the coping strategies employed by residents include: storage (100 per cent), collection (62.11 per cent), purchased (58.86 per cent) and pumping (3.63 per cent). A shortage of water supply in cities is often taken as a sign of failure of the government.*

Keywords : *Aizawl city, piped water supply, unreliable, coping strategy, storage strategy*

1. Introduction

In official statistics, the percentage of population with access to potable water is considered a relevant measure of water supply. But, reality is more complex. This research is designed to provide an understanding of the reality of piped water supply in Aizawl city. With the Government's water supply schemes through pipelines having its limitations, the residents of Aizawl are facing acute domestic water problem. Most families in Aizawl have been subjected to heavy rationing of water for domestic purposes. The scarcity of water has socio-economic impact on the people of Aizawl. People adjusted their water use pattern with the availability of small quantity of water, though a majority of households consume water below the specified norms, they, largely, show satisfaction with the available supply. Even people do not mind fetching water from unsafe sources during the lean period. It can be stated that the supply of water in Aizawl is going to be a big challenge in future. The rapid increase in population, depleting water resources and enhanced consumer needs are going to create a difficult situation.

2. Literature Review

Water is one of life's necessities that have no substitute. It is the life blood of the biosphere (Falkenmark & Rockstrom, 2004). Water is needed to support socio-economic activities such as agriculture, mining, food production and for maintaining healthy ecosystems. Water scarcity is an imbalance between demand and availability (FAO, 2010) and exists when the demand for water exceeds the supply (Molle & Molinga, 2003). Water

***Dr. C. Ramhnehzauva** is an Assistant Professor, Department of Geography, Goverment Lawngtlai College*

demand already exceeds supply in many parts of the world, and more areas are expected to experience this imbalance in the near future mostly due to population increase (Abaje et al., 2009). It is projected that by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two- thirds of the world's population could be living under water stressed conditions (UN-Water, 2007). Another report projects that by 2030, water demand will exceed supply by 50 per cent in most developing regions of the world (Negoianu & Goldfaid, 2008).

In many developing countries, unreliable or intermittent water supply, or water supplied on a sporadic basis, is a common occurrence. Water supply interruptions can last for hours or even days, with the amount of time water is unavailable outnumbering the amount of time it is available. According to the World Bank's online database of utility data (IBNET1), more than 10 per cent of the population in 28 countries has intermittent water supply. In India, for example, 83 per cent of the population have unreliable/intermittent water supply, with water available for just 10 hours a day on average. Water is available for one or two hours a few days a week in some cities. There are several drawbacks to having an unreliable/intermittent water source. It causes problems for users especially the poor who lack the means to store large quantities of water at home (Conradin et al., 2010; Christodoulou & Agathokleous, 2012).

Unreliable water supply causes capacity constraints (supply scarcity), private water infrastructure investment by households and businesses as a response to supply scarcity, and declining revenues as facilities deteriorate and consumers fail to pay or disengage from the public network. Users cope at the household level by collecting water from hazardous sources such as wells and surface water, buying water from tanker trucks or commercial bottled water, reducing their water intake, pumping to abstract the largest volume of piped water when it is available, and building water storage tanks (Majuru et al., 2016). These coping mechanisms have direct costs and time implications for collection, as well as rescheduling activities based on water availability. To cope, wealthier households spend money, while poorer households spend time or cut back on their consumption (Guragai et al., 2017). Some econometric studies have attempted to measure coping costs, showing that households spend two to five times their current energy bills to deal with intermittency, amounting to 1% to 12% of their monthly income (Cook et al., 2016; Pattanayak et al., 2005; Zerah, 1998). Contaminated water leaking through pipes, cracks and fittings during low-pressure conditions, microbial biofilms that develop under stagnant conditions in pipes and are released during re-pressurization, and contamination during household storage, all contribute to microbial contamination in intermittent supplies (Kumpel & Nelson, 2016).

3. Objectives of the Study

The objectives of the study are as follows:

1. to study the piped water supply distribution system,
2. to investigate the degree of unreliability of piped water supply, and
3. to probe the coping strategies for unreliable piped water supply.

4. Methodology

4.1 Study Area

Aizawl, the capital of Mizoram state, is situated in on the hillcrests, steep slopes and small valleys. It is located on a north-south elongated ridge, which acts as the main hill from which many small ridges and valleys are extending towards the east and west directions. The topography is highly undulating and rugged. The unique physical attributes of this rugged land are marked by extreme fragility and frequent landslides, limited land space, steep slopes and lack of accessibility. The city reveals a rapid and uncontrolled growth pattern with multi-storey settlements that has mushroomed unplanned on highly risk prone slopes. The altitude varies from 120 m to 1400 m above mean sea level. It falls between 23° 40' N to 23° 50' N latitudes and 92° 40' E to 92° 49' E longitudes. It covers an area of about 128.98 sq km, and as per Aizawl Municipal Corporation (AMC) Report 2020, the population is 3,59,829 persons. There are a number of streams in and around Aizawl City, but none of them is dependable for providing adequate water. The only dependable source is river Tlawng located more than 1,000 m below the city.

4.2 Data and Methods

The present study is based on the information obtained from primary and secondary sources.

1. Households' survey was carried out in 15 Local Councils out of 83 Local Councils existed in the study area during November – December 2018. This amounted to coverage of 18.07 per cent of the total Local Councils. The number of sample households selected from each of the sample Local Councils are 50 households, thus data was collected from 750 households. The sample households have a total population of 4,454 persons, and the mean value of households' size is 5.91, with a standard deviation of 0.90. About 69 per cent of the sample households own their homes and 31 per cent live in rented houses.
2. A stratified random sampling procedure was used to select Local Councils for the survey, i.e. number of population and geographical location were taken into considerations to give an overall view of each corner of the study area. Households to be surveyed were selected based on random sampling method and it is believed that they are reasonably representative households in the study area. Data were collected through a structured schedule and an effort was made to get the relevant information from the ones that were assumed responsible for the collection and use of water. Being responsible is here understood as the one administering the water

and not necessarily the ones fetching it. For this reason female household heads or other female family member and not children were preferred as respondent.

3. The quantity of water received through individual piped water connection is calculated from the size of the water tank, where they are directly connected to pipeline. Moreover, the information obtained is based not on actual observation but on recollection of the respondents. The household adopted coping strategies to unreliable water supplies were analyzed using descriptive statistic of percentages.
4. Relevant secondary data also collected from various sources. The PHED, Government of Mizoram, is approached for collection of data on the quantum of water distribution through public supply and other relevant information regarding the piped water supply distribution system. Population data is collected from Aizawl Municipal Corporation (AMC), Sanitation Report, 2020. Besides, the study also collected secondary data which entailed the collection and analysis of published materials and information.

5. Results and Discussion

5.1 Piped Water Supply Distribution System

As the study area is a hilly, the profile is very much undulating and the population is very much scattered, uniform supply of water to the consumers from one or two reservoirs is not possible. As such, service reservoirs are constructed at different places to maintain uniform distribution of water to the consumers. However, in some localities there is no suitable land to construct service reservoir. Service reservoirs are usually called Zonal Tanks. Water drawn through pumping main is discharge into an old storage reservoir of 12.00 lakhs gallons capacity at Tuikhuahtlang locality. It was constructed in 1900, with cement concrete underground reservoir but without outlet, partition wall and cover since it is for collection of rainwater only. Thence, this reservoir has been repaired to prevent leakages and has been provided outlet and scour pipes at the bottom for cleaning. A partition wall has also been made to facilitate cleaning of one compartment without emptying the whole tank. Even cover has been provided to prevent water from too much evaporation and pollution from impurities brought by wind. However, the capacity of the reservoir remains the same.

There are two other main reservoirs at Laipuitlang locality with capacities of 12.00 lakhs and 6.00 lakhs gallons side by side. They are of trapezoidal shape and constructed during 1953 to 1954 with cement concrete with nominal RCC beam at the bottom, for collection of rainwater. They are located at the crest of Laipuitlang. An independent line was drawn from the main reservoir at Tuikhuahtlang to the other reservoirs at Laipuitlang. Since the later is higher than the former by 23 m, therefore booster pumps were installed at Chanmari locality to pump water. This inter-connection line

is drawing water from the main reservoir at Tuikhuahtlang to distribute in the northern parts of the City and there is no branch line. Hence, separate feeding main lines were laid from the reservoirs at Laipuitlang to feed zonal tanks in the northern parts.

There are twenty-two zonal tanks distributed in eighteen different Local Councils area. Zonal tanks are pressed steel tanks of fourteen numbers and R.C.C tanks of eight numbers with a capacity varying from 225,000 litres to 900,000 litres and the total capacity is of 12,500,000 litres. Each zonal tank covers particular zone for uniform distribution of water. The area and number of population covered by each tank differs from place to place. From the two reservoirs at Tuikhuahtlang and Laipuitlang, each zonal tank is connected by feeding main line. From Laipuitlang reservoir, feeding main line branches out to seven zonal tanks in the northern part of the study area. The other fifteen zonal tanks have been directly connecting from the main reservoir at Tuikhuahtlang.

Therefore, from the two reservoirs located in the highest points water is made to flow by gravity to twenty-two zonal tanks, from zonal tanks water again flows to supply tanks located at different localities to supply water to the consumers. The elaborate process of distributing water has led to high frictional losses in the long service lines due to extreme low pressure prevailing in the system. The piped water supply is distributed to the residents through house connections. A house connection is allowed on payment of charges wherever any consumer desiring house connections they should have to bear the cost of materials and construction. The cost is the reason why poor families find it hard to afford house connection. House connection is allowed from supply tanks only which is nearest to the house. However, in some areas where supply tanks are not conveniently located, connections from sub-mains and branch lines have been provided depending on the merit of each case.

On the supply front, transmission and distribution networks are largely of very poor quality, in addition to being outdated and badly maintained resulting in higher operating costs. The present water supplies are unable to operate to the full capacity due to leakage/wastage of water. According to PHED, the present leakage/wastage of water is roughly about 25 per cent of production, which is a costly loss for all concerned. Leakages exist in many pipe joints, valves, etc. The elaborate process of distributing water has led to high frictional losses in the long service lines due to extreme low pressure prevailing in the system. Since water is distributed via gravity from overhead tanks of various heights, water pressure weakens at the end of the distribution lines and becomes uneven depending on the topography.

5.2 Unreliable Piped Water Supply

In respect of water supply, though a significant progress had been made in the post independence period, yet much more needs to be done. Until today, more than three lakh population shares Aizawl Greater Water Supply Scheme Phase I &

II which could only pump water 22.99 MLD. This signifies the magnitude of water scarcity in the City. Based on the Aizawl Municipal Corporation (AMC) 2020 report the population is 3,59,829 persons and the Government of India Tenth Plan recommendation of standard norms of the per capita water supply (135 litre per capita per day) the water demand in the City worked out as around 48.57 million litres per day (MLD). However, in the present situation the PHED makes available only about 22.99 MLD of water to the City residents. Thus, it can be estimated that there is a large gap between the supply and the demand, which is as high as 25.58 MLD. A shortage of water supply in cities is often taken as a sign of failure of the government.

Owing to shortage, water cannot be provided to all the consumers at the same time, so that, water is supplied on a rotational basis among the distribution zones. Highly intermittent supply is the rule in the study area and supply is available only once in a week. Within a day, service is available only for around 10000 households therefore to cover all the consumers for supplying water six days are required. However, in VIP lines supply is available more than once in a week.

The water supply timings in terms of duration of availability could be very instrumental within the domestic environment. In fact, it is the perception and experience of the fluctuations in water supply that fundamentally contribute to the existence of the water problem itself. A basic need and service like water on tap for 24 hours a day has been unheard of for decades in most Indian towns (McIntosh and Yñiguez, 1997). In the study area as well, piped water supply is available only for a few hours per week resulting to limited quantity of water supply to the people. As the supply is highly erratic, people store water in the tanks. The largest 43.95 per cent of the households do received piped water between 2 to 3 hours, about 32.37 per cent receive more than 3 hour, and 23.68 per cent get supply less than 2 hours per week (Table 1).

Table 1 : Duration of Water Supply (% of households)

Less than 2 hour	2 – 3 hrs	More than 3 hrs
23.68	**43.95**	**32.37**

Source : Sample Households Survey, 2018.

In general, the situation is poor for all the people; however, the situation is more dismal in the outer areas. In fact, more than 50 per cent of the residents each in the outer area received piped supply less than 2 hour per week. Despite supply is available once in a week, the duration of supply of water is extremely low. The duration of supply demonstrates that the area is the main explanatory factor of these variations. For example, areas situated closer to the two main reservoirs on an average benefit from a little longer water supply. Besides, households that are closer to the supply tanks get a little longer duration of supply. Simultaneously, the quantity of water supply from the main reservoirs to zonal tanks and from zonal tanks to supply tanks depends on the distance among them. In fact, supply tanks closer to zonal tanks are sometimes filled with water more than one time to their total capacity. This result confirms the importance of

geography in the water supply situation. It is also noticed that connections taken from the sub-mains or branch lines due to inconvenience of supply tank generally get longer duration of supply because sub-mains or branch lines are directly connected to the zonal tanks.

Variation in duration of water supply and differences in water pressure cause disparity in quantity of water supply to the consumers. It is difficult to estimates the overall present rate of water supply to the consumers due to wide range of variations in supply to the consumers. Undoubtedly, the present rate of piped water supply is generally poor for all families. Table 2 present the quantity of water supply to the households per week through house connections. Interestingly, there is a positive significant relationship between the duration of supply and the quantity of supply. About 38.9 per cent of the households get a supply of less than 4,000 litres, 41.84 per cent get between 4,000 litres to 6,000 litres, and a meagre 19.2 per cent get supply of more than 6,000 litres, per week. It can be seen that areas located closer to the two main reservoirs get more supply.

Table 2: Quantity of Water Supply per Week (in litres)
(% of households)

Less than 4000	4000 - 6000	More than 6000
38.95	**41.84**	**19.21**

Source : Sample Households Survey, 2018.

Depending on house location, numbers of connections on the distribution line and topography, residents receive various amount of water supply. Generally, inequality in water supply from the public network takes the typical geographic shape where peripheral areas get lower volumes per residents. Besides, distance and topography, households' economic status also plays an important role as far the amount of water received from piped supply is concerned. Therefore, there is not only a shortage of water but there is uneven distribution of supply also. Reliability of the service is known to vary not only from one part of the City to the other but also from one colony to the other.

5.3 Unreliable Water Supply Coping Strategies

Inadequate and unreliable supply includes a big variety of situations. It concerns poor families, without the financial capacity to get sufficient water in terms of quantity and quality in order to satisfy their needs. However, inadequate and unreliable water supply does not affect only poor families; it concerns also rich people with an insufficient supply from house connections or unsafe access to water in terms of quality and quantity. The survey indicates that all income groups are affected by insufficient water supply.

In order to cope with water shortage, people develop strategies to satisfy their needs. The survey indicates that the households proceed to the hierarchy of their needs according the necessary quantity and quality for each use. They identify the type of source, the quantity and quality necessarily for each consumptions: water for drinking and cooking, water for bathing, water for cleaning (utensils, laundry, cleaning the house), water for toilets and make a choice. A central question is, if these

strategies are a real choice for the households or if they are constraint to adopt them. Often, it is not a real choice, as alternative water supply solutions are very located and usually only one or two are available. The problem of alternative source is aggravated as the choice depends also from the financial capacity of the households. The survey showed that households might adopt more than one coping strategy. Given the relations between geographic location and availability of water, one can assume that people's behaviour varies according to the areas and inhabitants of some area rely on larger panoply of strategies.

Depending the level or type of water scarcity and income, households developed coping strategies, which are more or less expensive. Not all the households have the capacity to adopt the same strategies, as the cost of each strategy is not the same. The cost of compensatory strategies includes both monetary and time opportunity costs. The monetary cost comprises investments on water storage tank, and purchasing water from private tanker. The time opportunity cost is the monetary value of time by households in collecting water, queuing, pumping. Here, the focus is to list the strategies used in the study area, a very simple classification is proposed which categorises the strategies into different groups. By strategy, consideration is made on behavioural pattern where households develop coping strategy to anticipate inadequate and unreliable supply as well as behavioural patterns where household reacts to such problems. The following strategies have been observed :

5.3.1 Storage Strategy : Storage of water is a dominant strategy. It is adopted in order to remedy the intermittent supply and irregularity of piped water supply. As 24/7 water supply do not exist in the study area, storage may even not be considered as a coping behaviour for households. However, it is considered as a coping strategy, when the member of the households responsible for storing and has to remedy to another activity in order to do so.

5.3.2 Pumping Strategy : Pumping strategies concern households with accessed to ground water through hand pumps or wells. In wells, generally, an electric water pump is connected to the source.

5.3.3 Collection Strategy : It refers to water collected from rainwater, and tuikhurs (spring). It may be daily, frequently (many times per week or per month) or seasonally strategy of access to the source. This strategy takes up time and there is a physical limit to the water that can be carried to home.

5.3.4 Purchase Strategy : People buy water from private tankers during the dry winter season. The frequency may be several times per week or per month, or seasonally. Tankers supply mostly housing societies of middle and upper class.

At the onset, it clearly appears that, on the one hand, most of the households use more than one strategy to cope with shortage of supply. On the other, though the strategies are numerous, a larger number of households adopt some, while a marginal group chooses other. Table 3 shows number of coping strategies

adopted, of the total households only 15.26 per cent adopted one strategy, 48.42 per cent adopted two, and 36.32 per cent adopted three strategies. Four different types of coping strategies have been observed, i.e. storage strategy, collection strategy, purchase strategy, and pumping strategy. Among these strategies, households have adopted a mixture of strategies to cope with the insufficient water supply. Among four different strategies, storage strategy is the most widespread strategy and all the households practiced it. Collection strategy is the second most widespread (62.11 per cent) strategy, followed by purchased strategy (58.86), and only 3.63 per cent have adopted pumping strategy.

Table 3. Number of Strategy Adopted

Number of Strategy Adopted	Percentage of Household
One	15.26
Two	48.42
Three	36.32

Source : Sample Households Survey, 2018

Table 4. Unreliable Water Supply Coping Strategies

Strategy Adopted	Percentage of Household
Storage	100
Collection	62.11
Purchased	58.86
Pumping	3.63

Source : Sample Households Survey, 2018

All the households adopted storage strategy in order to remedy to highly intermittent supply. In other words, storage of supply is inevitably, since supply is available only once in a week, this is also merely a few hours. In fact, storage of supply water is a weekly strategy. There are significant differences in the types of storage tank and storage capacity of the households. Generally, households had more than one or two storage tank, one or two at the ground level, and one or two on the roof or any other place higher than their houses. The ground-level tanks store water directly from the piped distribution line and it is normally bigger than the one on the roof. If households have rooftop tanks, they used to pumped water from the ground level tanks to the rooftop tanks by electrical pump. On the other hand, if a households have no rooftop tanks usually they are directly connected the connection piped line to the water tanks located at the higher place. Thus, the family obtains sufficient water pressure by opening its taps (water flows down from the roof tanks or tank located at higher place) people spend significant amount of money in the form of capital expenditure as a coping cost to avert inadequate and unreliable water supply.

6. Conclusion

The piped water supply system in Aizawl City is ridden with a number of problem and shortcoming. It is unable to cater the need of the daily water requirements of all the residents, all the area of the City and throughout the year. It means that it failed to supply water at desired level to all the people, to all the areas and at all the time of the year. Highly intermittent supply is the rule in the study area, as water supply is available only once in a week for about an hour or so. In the event of inadequate piped water supply, the residents of Aizawl City face acute shortage of domestic water that compelled them to meet their domestic

water needs from either the traditional sources or water tankers, at the cost of time and money. Majority of the households' use more than one strategy to cope with unreliable water supplies and that there are some strategies which are adopted by large numbers of households whereas the others have only a few households using them. All the households' practiced water storage strategy followed by collection of water from rainwater and tuikhur. Again, a large number of percentages have adopted purchased strategy. Unreliability of water supplies has imposed significant coping burdens on the households. Some of the coping strategies adopted do not result into obtaining safe and sufficient quantities of water for the households. The poor households suffer most as they rely on labor intensive and time consuming strategies as opposed to wealthy households who engage in capital-intensive strategies. Therefore, the provision of adequate potable domestic water to residents of Aizawl obviously needs careful planning taking into account the City's peculiar environmental setting, the rapid rate of population growth and haphazard expansion of the built-up-area, as well as the need to install facilities that will not only meet the present needs but the future needs of the City dwellers as well.

References

Abaje, I.B., Ati, O.F. and Ishaya, S. (2009): Nature of Potable Water Supply and Demand in J e m a ' a LGA of Kaduna State, Nigeria. *Research Journal of Environmental and Earth Sciences,* 1(1): pp. 16-21.

Aizawl Municipal Corporation (AMC) (2020): *Sanitation Report*, 2020. (Unpublished)

Christodoulou, S. and Agathokleous, A. (2012): A study on the effects of intermittent watersupply on the vulnerability of urban water distribution networks. *Water Science & Technology: Water Supply,* 12: pp. 523–528.

Conradin, K., Kropac, M.A. and Spuhler, D. (Eds.) (2010) : *The Sustainable Sanitation and Water Management Toolbox*. SEECON International GMBH, Basel.

Cook, J., Kimuyu, P. and Whittington, D. (2016): The costs of coping with poor water supply in rural Kenya. *Water Resources Research*, 52: pp. 841-859.

Falkenmark, M. and Rockstrom, J. (2004): *Balancing Water for Human and Nature : The New Approach in Ecology*. Earthscan Publication, London.

FAO (2010): *Enduring Farms: Climate change, Small holders and Traditional FarmingCommunities*. FAO, Rome.

Guragai, B., Takizawa, S., Hashimoto, T. and Oguma, K. (2017): Effects of inequality of supply hours on consumers' coping strategies and perceptions of intermittent water supply in Kathmandu Valley, Nepal. *Science of the Total Environment,* 599-600: pp. 431 - 441.

Kumpel, E. and Nelson, K.L (2016): Intermittent Water Supply:

Prevalence, Practice, and Microbial Water Quality. *Environ. Sci. Technol,*. 50: pp. 542–553.

Majuru, B., Suhrcke, M. and Hunter, P. (2016) : How Do Households Respond to Unreliable Water Supplies? A Systematic Review. *International Journal of Environmental Research and Public Health,* 12: pp. 5954-5974.

Molle, F. and Mollinga, P. (2003) : Water poverty indicators : Conceptual problems and policyissues. *Water Policy,* 5: pp. 529- 532.

Negoianu, D. and Goldfaid, S. (2008): Just Add Water. *Journal of American Society of Nephrology,* 19(6) : pp. 1041-1043.

Pattanayak, S.K., Yang, J.C., Whittington, D. and Bal Kumar, K.C (2005) : Coping with unreliable public water supplies: Averting expenditures by households in Kathmandu, Nepal. *Water Resources Research,* 41: pp. 1–11.

UN-Water (2007): *Coping with water scarcity – challenge of the 21st century.* UN Water accessedhttps://www.un.org/waterforlifedecade/pdf/2006_unwater_coping_with_water_scarcity_eng.pdf

Zerah, M.-H (1998): How to assess the quality dimension of urban infrastructure: The case of water supply in Delhi. *Cities,* 15: pp. 285–290.

EVOLUTION OF RAILWAY TRANSPORT SYSTEM IN TRIPURA, INDIA: A CHRONOLOGICAL APPROACH

Stabak Roya
*Saptarshi Mitraa**

Abstract : *Indian Railways is the fourth largest railway network in the world. The journey of railway transportation in India was started in 1853 as an inalienable tool of imperialism. Later on, many Indian states, especially provincial states, were getting connected with the railway services.Pre-independence period, the railway becomes the prime mode of transportation, mainly for long-distance in India. Some states were connected with railways immediately after the Independence (1947), and few others struggled for railways connectivity. Tripura, a tiny state of Northeast India which merged with India during 1949, although southernmost part of the state connected at last through railways in the year 2019 due to central-state political relationship, domestic political instability, tribal movement and locational disadvantage. This study aims to find out the chronological evolution process of the railway transport system in Tripura. The study has been carried out mainly based on the archive data and secondary data analysis. The cartographic techniques also help to illustrate the sequential development of the railway transport system in the state. Developmental dynamics exteriorise that the growth pattern of railways in Tripura is socio-political by its idiosyncrasy, which continues as an imperative role in further developing the railway transport system of the state.*

Keywords : *Indian Railways, Railway Development, Railway Geography, Transport History*

1. Introduction

Railway transportation is the pillar of economic development, socio-cultural interaction, industrial growth and infrastructural development of any country, region, and state (Choudhary & Rao, 2018; Skorobogatova & Merlino, 2017; Wagner, 2012). Infrastructural development is the most crucial aspect of the railway transport system (Sharma & Kumar, 2014). In India,the first commercial passenger train was run between Bori Bunder, Bombay and Thane on April 16, 1853 (Roy & Mitra, 2016; Rao, 2012; Bhandari, 2005). Before 1853, few experimental railway routes had been developed by Britishers in India to carriage raw materials like cotton, stone and labours (Darvill, 2011). Sequentially railways spread in Eastern India (1854) and South India (1856). In 1864, Calcutta-Delhi and 1867, the Allahabad-Jabalpur railway line developed respectively (Wolmar, 2017). Under the guarantee system, many railway companies, including Eastern India Railway, Great India Peninsula Company, Madras Railway, Bombay Baroda and Central India Railway companies, were the primary investor in developed railways in India (Rao, 2012). The main goal of railway development in

Stabak Roya, *Department of Geography and Disaster Management, Tripura University*
Saptarshi Mitraa* *is an Assistant Professor, Department of Geography and Disaster Management, Tripura University*
**corresponding author*

British India was exporting raw materials like cotton, jute, and other agrarian products to support Britain's industrial development and rule India smoothly (Bogart & Chaudhary, 2012; Knight, 2012; Ramanathan, 2004; Banerjee, 1999). The beginning of the exploration of the resources from Assam Province was associated with the 'Treaty of Yandaboo', which was signed between the British and the king of Myanmar on February 24, 1826 (Saikia, 2010). The region was nature's storehouse containing mineral resources, forest resources, water resources, plant resources. As a result, the Britishers were captivated to explore the region (Dikshit & Dikshit, 2014; Pandey, 2008).

By following the fundamental principles of imperialism, the Assam-Bengal Railway was developed in 1892 to export tea, oil and other natural resources from Assam (Hilaly, 2016; Singh, Narain, & Kumar, 2011; Guha, 1968). During the initial phase (1890s), the Assam-Bengal railway route stretch was about 150 km long from Comilla to the Chittagong on the coast of the Bay of Bengal in undivided Bengal. Chittagong town to Chittagong port line was constructed in1895. In 1896, the Metre Gauge line from Comilla to Akhaura and Akhaura to Karimganj was constructed (Taher, 2020).

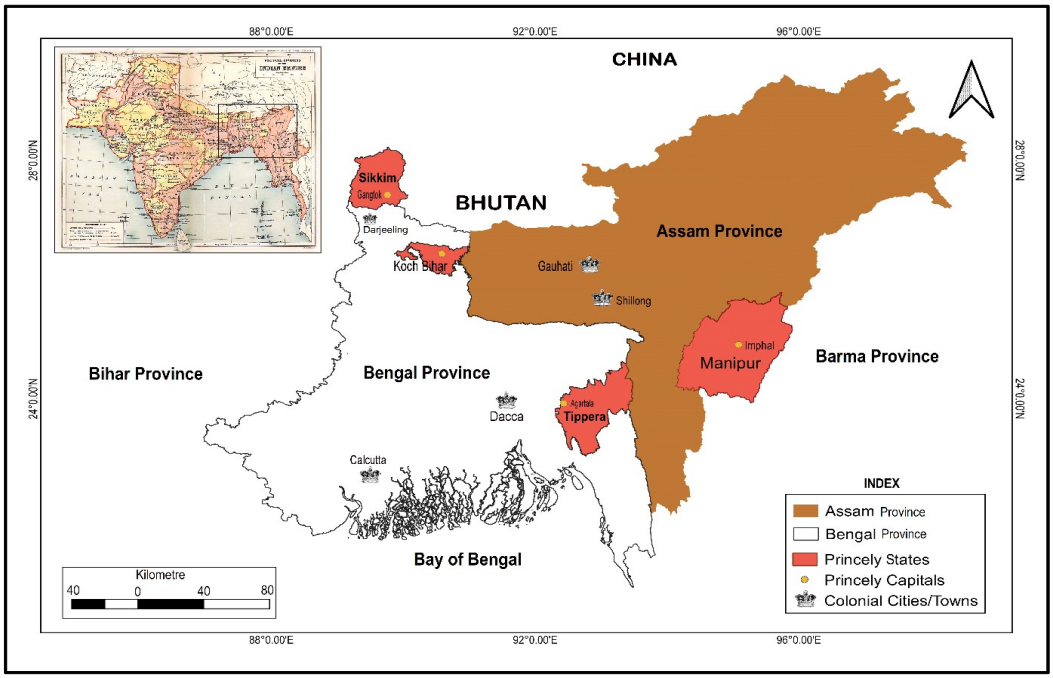


Figure 1. Location of the Northeast India under British Empire

(Source : Prepared by the authors, 2021 based on Historical Information and Map of the British Indian Empire from Imperial Gazetteer of India, 1909)

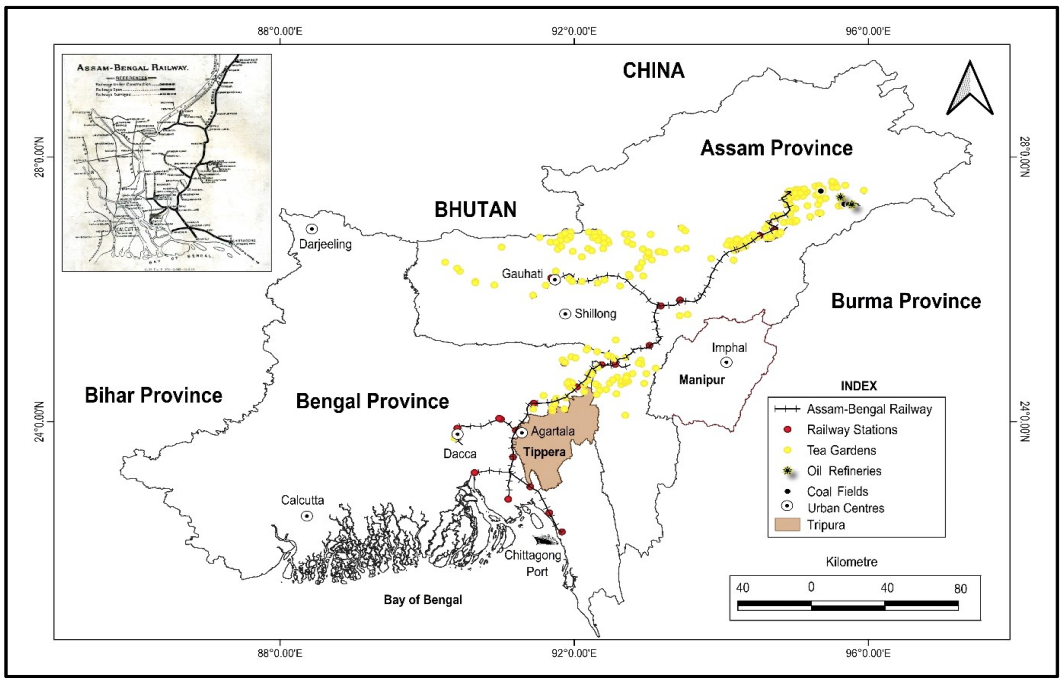


Figure 2. Assam-Bengal Railway and Location of Tripura

(Source : Prepared by the Authors based on Historical Information and Map of the Assam-Bengal Railway, 1929)

Many branch railway lines like Laksam-Noakhali section, Laksam-Chandpur and Akhaura-Ashuganj were developed during that period (Fig. 2). Later on, during 1912-1915,the railway line was extended from Comilla to Sylhet, located about 235 km north of Chittagong (Government of India, 2011; Daimari, 2008).The railway was constructed through the comparatively less rugged western part of Assam and the riverine eastern part of Bengal (Thacker & Company, 1861; Iqbal, 2007). At the same time, the British Government started exporting the region's natural resources because it is a major source of hydrocarbons, especially natural gas and oil, coal, limestone, tea, bamboo, and other resources (Rao, Indian Railways, 2012). In 1947, The Partition of Bengal divided Bengal into two parts called India and East Pakistan with 3,323 km long Radcliffe Line (Dutta, 2018; Mitra, 1990). After the partition of Bengal, the entire Northeast India was in a position of landlock situation with mainland India (Baruah, 2020). The Government of India developed the "Siliguri Corridor" immediately after the partition of Bengal to connect Northeast India with other parts of the country (Chakraborty, 2018; Ghosh, 2016; Barthakur, 2014). In the meantime (1949), princely state Tripura was merged with India (Haokip, 2012; Kirit Bikram Kishore Deb Barman vs State of

Tripura and Others, 2004). The inhabitants of Tripura previously contacted the outer world through Undivided Bengal,especially via Comilla and Dhaka (Bidyabhushan, 1929).But the partition of Bengal, made Tripura an extreme outpost from India's heartland and became landlocked. As a result, a well-connected native state became an isolated, landlocked region with its immense geostrategic importance (Ahmed, 2013; Chakraborty, 2006). During 1946-47, A huge number of political migrants came to Tripura from Noakhali, Chandpur, Raipur (Dhaka), Comilla, Sylhet and Chittagong and the nearby area of East Bengal (Ghoshal, 2012 (a); Ghoshal, 2017 (b), Shajymon, 2017). These political immigrants experienced railway transportation because they were witnessed railway development in the eastern part of undivided Bengal. Since 1951, the people of Tripura demanding railway services for connecting with other parts of India. In 2008, Capital city Agartala connected with meter gauge line subsequently meter gauge converted into broad gauge in 2016 (Roy & Mitra, 2020; Directorate of Economics & Statistics Planning (Statistics) Department, 2018; Ministry of Railways, 2018). In October 2019, Sabroom, the southern most point of Tripura, was connected through Indian Railways (Prasad, 2019; Patel, 2019). The state has about 264 km long railway track with 27 railway stations from Churaibari Railway Stations in North to Sabroom Railway Station in South (Roy, Bajpayee, & Mitra, 2019). About seven long decades, the people of Tripura are struggling for a full phased railway transport system that started in1952. The development process of railway transportation was slow for many reasons like physiographical factors like topography, relief, drainage system, central-state political relationship, socio-political movement of the state (Roy & Mitra, 2016). This study tries to understand the nature of the chronological evolution of the railway transport system in Tripura.

2. Methodology

The study is based on the secondary data and information collected from the Office of the General Manager, Northeast Frontier Railway, Guwahati, Office of the Area Manager, Lumding Division, Badarpur and Office of the Station Superintendent of each railway stations of Tripura. Archived materialshave been collected from the website of Northeast Frontier Railway (NFR) Archive of the leading newspapers published from Agartala, Tripura like The Tripura Times, The Tripura Observers, The Dainik Sambad (Bengali), The Daily Desher Katha (Bengali) have been analysed to understand the chronological development of the railway transport system in the state. The Proceedings of the State Legislative Assembly since 1971 has been analysed to recognise the demand of the state forthe railway transport system. Bir Chanda State Central Library has been accessed to find out historical data related to railway transportation development in Tripura. Information has been collected from Indian Railways, Bangladesh Railways,

Tea Board of India, Guwahati and Bangladesh Tea Research Institute (BTRI). Analysis of old maps has been made which were collected from Government Gazetteers. The growth rate has been calculated based on available data and explains accordingly. QGIS v. 3.10.0 software has been used for visual annotation of chronological growth of railway development in Tripura.

2.1 Study area

The study extendeds within the state of Tripura, which is located in the northeastern region of India. Geologically Tripura falls under 'Assam-Burma Province' (Brahma, Sircar, & Karmaka, 2013; Goldberg, 2013). The origin of the landscape is highly multifaceted which is cumulative product of rock structure, lithology, slope, drainage system, altitude, vegetation, physiography and geomorphic elements (Mazumder, 1984). The altitude of the region varies 15-780 m from Mean Sea Level (MSL) (Saha, 2014). Six major hill ranges namely Baramura, Deotamura Atharamura, Longtharai, Sakhan and Jampui located in the state with prevailing riverine valleys (Directorate of Economics & Statistics Planning (Statistics) Department, 2009). Due to valley and ridge topography and its regional setup, all railways route of Tripura is not smooth (Roy & Mitra, 2016). Some of the railway stations of Tripura are located about 110 m above MSL, and some are located at the lowest altitude (19-30 m) (Roy & Mitra, 2016). Presently, 264 km long operational railway track extends in Tripura between Churaibari Railway Station [CBZ] (24°26'N and 92°14'E) in the North to Sabroom [SBRM] (23°0'N and 91°42'E) in the South with twenty-five intermediate stations namely Nadiapur [NPU](24°23'N and 92°12'E), Dharmanagar [DMR](24°22'N and 92°10'E), Panisagar [PASG](24°16'N and 92°09'E), Pencharthal [PEC](24°11'N and 92°06'E), Kumarghat [KUGT] (24°09'N and 92°02'E), Nakata [NLKT] (24°03'N and 92°00'E), Manu [MANU] (23°59'N and 91°59'E), S.K. Para [SKAP] (23°58'N and 91°58'E), Jawaharnagar [JWNR] (23°55'N. and 91°54'E), Ambassa [ABSA] (23°55'N and 91°51'E), Mungiakami [MGKM] (23°53'N and 91°42'E), Teliamura [TLMR] (23°51'N and 91°37'E.), Jirania [JRNA] (23°49'N and 91°25'E), Jogendranagar [JGNR] (23°48'N and 91°18'E), Agartala [AGTL] (23°47'N and 91°16'E), Sekerkote [SKKE] (23°44'N and 91°16'E), Bishalgarh [BLGH] (23°40'N and 91°16'E), Bishramganj [BHRM] (23°35'N and 91°21'E), Udaipur [UDPU] (23°30'N and 91°28'E), Garjee [JRJE] (23°25'N and 91°29'E), Santirbazar. [STRB] (23°19'N and 91°31'E) Belonia Railway Station [BENA] (23°14'N and 91°29'E), Jolaibari [JLBRI] (23°11'N and 91°35'E), Thailik Twisa [THTW] (23°7'N and 91°36'E) and Manu Bazar [MUBR] (23°3'N and 91°38'E) Railway Station (Fig. 3).

3. Chronological growth process of railway transport system in Tripura

Tripura was a princely state which merged with the Union of India in 1949

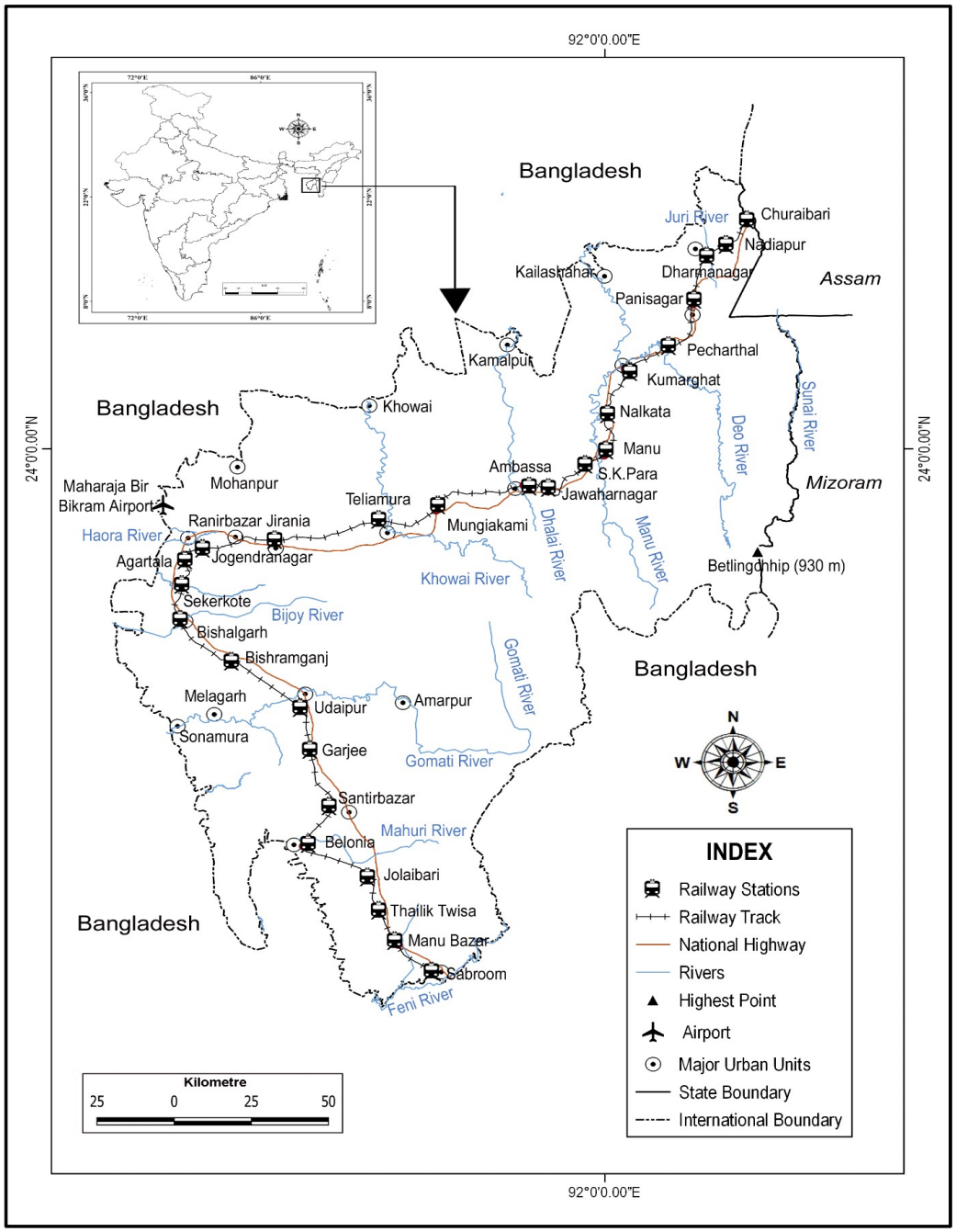


Figure 3. Location Map of the Study Area (*Source : Prepred by the authors, 2021)*

(Gan Chaudhuri, 1985). That time the total population of the state was about 6,39,029 and maximum concentration was found in Agartala City (Census of India, 1951). As per the Census of India 1951, about 6831 population was lived in Agartala City. The Agartala Municipality was established between 1862 to 1896 during Maharaja Bir Chandra Manikya (Bera, 2010). Physiographically, Agartala City has developed in the synclinal flood plain of the river Haora and Kata Khal (canal). Earlier the River Haora was flowing through the heart of Agartala City. (Santra et al., 2018). The western part of Agartala City is situated in the flood plain of River Haora and Titas of Bangladesh. The Eastern portion of the city are terraced, a greater part being made up deeply dissected uplands, forming the uppermost terraced, characterised by moderate to steep erosional scarps on the banks of rivers (Sen et al., 2015; Ramesh, 1981). At the same period, one more city was developed in the western portion of Tripura namely Brahmanbaria in Bangladesh, located about 25 km away from Agartala City. Brahmanbaria was developed during the period of Mughal due to its quality cloth called 'Muslin' (Lakshmanan et al., 2001). In 1868, Brahmanbaria Municipality was established. Due to cultural homogeneity with Brahmanbaria and adjoining areas, earlier people of Tripura use to travel from undivided Bengal because the eastern and northern part of Tripura was hilly and forested, and the western and southwestern part of Tripura was comparatively plain (Fig. 4). Two townships developed side by side due to geographical and cultural homogeneity and enjoyed the common transport link. Akhaura Railway station was the common transport node (Fig. 4). This transport node was connectingeastern and western part of undivided Bengal through metre gauge railway line. Transport connectivity was much higher in the western part of undivided Bengal. The people of Tripura used these transport route to connects undivided Bengal specially Dhaka and Kolkata.

But after the partition of Bengal (1947), an inevitable break down has been taken place for the people of Tripura because the entire railway transport system and another mode of communication fall under the land of then East Pakistan. As a result, one side land lockedness and another challenging physiography with flawed transportation system of the eastern part of Tripura cumulatively make people aggrieved to struggle for better transport communication. In these circumstances, the general people of Tripura demanded railway services for the state and started a new socio-political struggle era.

3.1 Period 1951-60

On December 2, 1951, a mass meeting was organised at Pratapgarh near Agartala City to place the demand of railway connectivity for Tripura (Debnath, 2016). The demand wasto extension railway upto Sabroom, the southernmost part of the state, located about 113 km away from Agartala City (Mitra & Roy, 2020). During 1951, Mr. Dasarath Deb and Mr.Biren Datta was selected as Member of Parliament (MP)

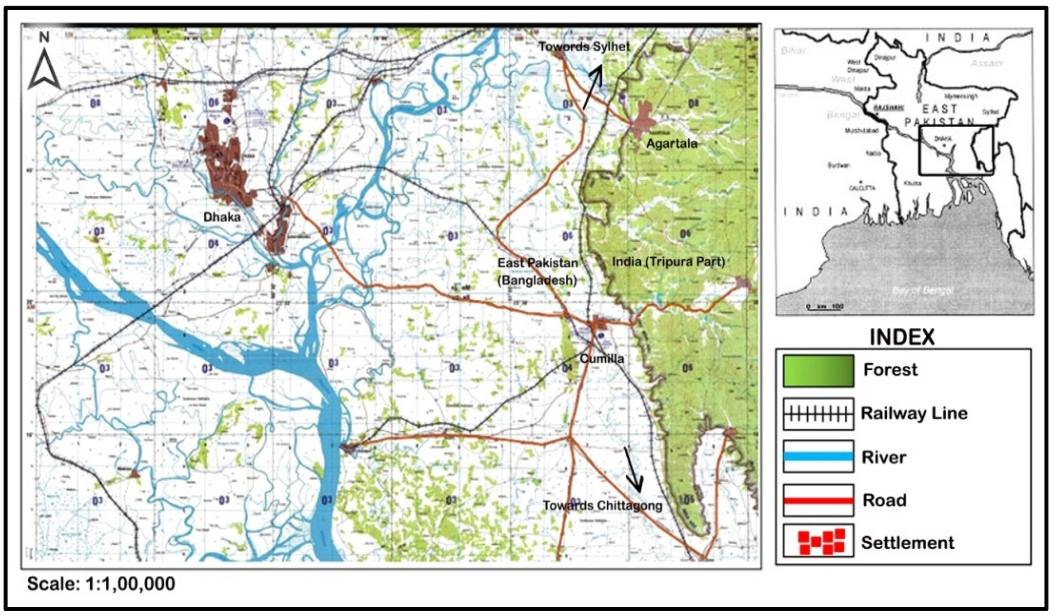


Figure 4. Travel Route of Tripura before 1947

(Toposheet Source: NF-46-1, U502, 1952)

from Tripura (Debnath, 2016). As per the demand of the people of the state, they participated in Railway Budgetary Discussion on the Indian Parliament and placed the demand for railways for the state of Tripura in the year 1953 and 1954 (Table 1). Later, in 1955, on February 23, Members of the Parliament demanded railways for Tripura and Manipur to the Union Planning Minister Mr. Gujrarilal Nanda. In 1955, during railway budget 'Cut Motion' proposal for railway extension in Tripura has been placed by the former Member of the Parliament Mr. Dasarath Deb and Mr. Biren Datta. Heretofore, Members of the Parliament put particular emphasis on the strategic location of Tripura for providing railways. But on August 7, 1956, the Ministry of Railway response in the question-answer session and discard the logic to the developed railway transport system in the state. In 1957, during the discussion on the rail budget, the Members of the Parliament from Tripura emphasised extending railway to Sabroom, the southernmost point of Tripura.

On 1959 February 15, members of the Rail Prabartan Committee meet with the then Union Railway Minister Jagjiban Ram and demand railways in Tripura. On March 2 1959, placed a proposal in the Parliament to extend railways to the Sabroom.

In the railway budget of 1959–60, the Ministry of Railways, Government of India sanctioned a project to the developed railway line tracing 30 km long from Kalkalighat (24°34'50"N. and 22°17'43"E.) Assam to Dharmanagar,

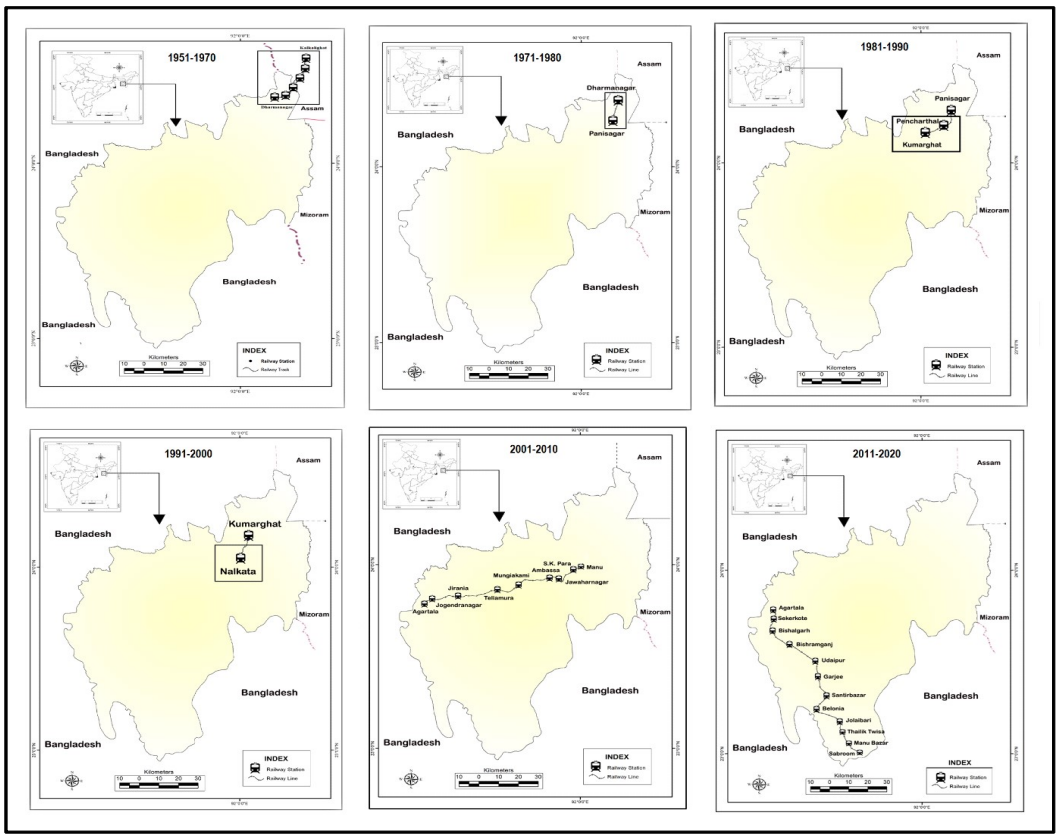


Figure 5. Decadal Development of Railways in Tripura
(Source: Prepared by the Authors, 2020; using QGIS)

Tripura (24°22'12"N and 92°10'11"E) (Fig. 2 and Roy & Mitra, 2016). There was a total of six stations, namely Dharmanagar (DMR), Nadiapur (NPU), Churaibari (CBZ) railway stations in the jurisdiction of the state of Tripura and Thilbhum (TBX), Chand KhiraBagan (CHBN) and Kalkalight (KKGT) railway stations in the state of Assam. The relief of this section varies between 30-50 m. Out of the total sanctioned railway track, only about 36.91 per cent track fallen Tripura including three railway stations.

3.2 Period 1961-1970

The railway line constructed from Kalkalighat (Assam) to Dharmanagar (North Tripura) started in1961. Constructional work of Churaibari, Nadiapur and Dharmanagar railway stations had been completed in this phase. But due to lack of operation and maintenance, the line was abundant for few years, and again, from 1964, the regular operation started on this route (Table. 1).

Further, due Indo-Pak and Indo-Sino war in 1965 and 1967, respectively

Table 1. Decadal Growth of Railway Transport system of the State

Period	*Track Distance*			*No. of Stations*			*Name of the Stations*
	Actual (km)	Cumulative Growth	Growth Rate	Actual	Cumulative Growth	Growth Rate	
1951-1960	0	0	0	0	0	0	
1961-1970	10	0	0	3	0	0	Churaibari, Nadiapur and Dharmanagar
1971-1980	11	10	10%	1	3	-67%	Panisagar
1981-1990	22	21	100%	2	4	100%	Pecharthal and Kumarghat
1991-2001	21	43	-5%	1	6	-50%	Nalkata
2001-2010	87	64	314%	8	7	700%	Manu, S.K. Para, Jawaharnagar, Ambassa, Mungiakami, Teliamura, Jirania, Jogendranagar and Agartala
2011-2020	113	151	30%	12	15	50%	Sekerkote, Bishalgarh, Bishramganj, Udaipur, Garjee, Santirbazar, Belonia, Sanirbazar, Jolaibari, ThailikTwisa, Manu Bazar and Sabroom
Total	264	264		27	27		

Source : Northeast Frontier Railway, 2019 & Computed by the Authors, 2020

the national financial recession had been taken place and thus, the project was terminated midway. During this decade, no progress has been recorded.

3.3 Period 1971-1980

In 1972, Tripura got the statehood (Raatan, 2008). Earlier, Tripura was granted autonomy within India as a Union Territory (Saigal, 1978). After statehood effect, the state administrative mechanism creates a new propulsion to develop railway transport system in the state (Government of Tripura, 1972). On 1977 April 12 and May 26, former Finance Minister Mr. Nripen Chakraborty of the Coalition Government of Tripura wrote a letter to the former Union Railway Minister Mr. Madhu Dandavate for Railway development in Tripura (Lok Sabha Secretariet, 1977). In the meantime, the political scenario of the state was changed. Mr. Nripen Chakraborty becomes the Chief Minister of the state (Rattan, 1988). He met and raised the railway demand to rail minister Madhu Dandavate on January 12, 1978 and Chairman of Planning Commission on February 6, 1978. No initiative had been taken by the Ministry of Railways, Government of India. People Tripura formed Rail Industry Movement Committee on February 15, 1978, and observed demand week between 19-24 February 1978.

Figure 6. Decadal Growth Rate of Railway Transport System (Source: Prepared by the authors, 2021)

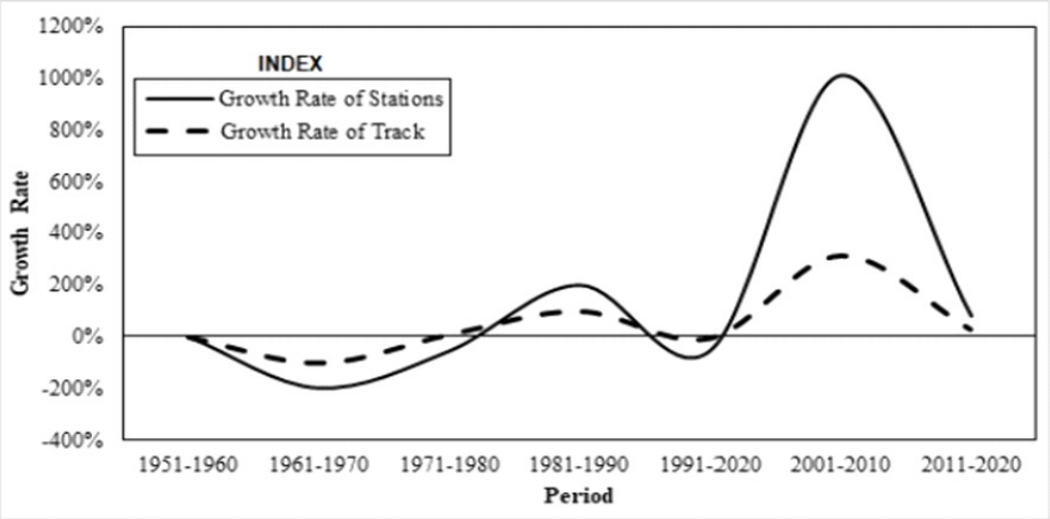


Figure 6. Decadal Growth Rate of Railway Transport System
(Source: Prepared by the authors, 2021)

During the period of former Prime Minister Mr. Morarji Desai (March 24 1977 to July 28 1979), Ministry of Railways sanctioned some fund for re-extension of railway lines from Dharmanagar to Kumarghat (Government of India, 1978). The project commenced but in 1980 again the project ran out of steam due to state domestic politics and tribal movement in hills. After the tribal movements of 1980, Dinesh Singh committee recommended railway extension in Tripura which was opposed by the Upajati Juba Samiti because they think the railway will destroy their unique identity. Physiography between Dharmanagar and Panisagar nearly plain (Fig. 5). The average elevation is about 28 m. The railway track from Dharmanagar to Panisagar (11 km) was developed between two anticlinal valleys of Machhlithum anticline and Khubai anticline (Murphy, 1988). The slope of a track on the northern side due to Juri river basin. After long socio-political movement, during 1971-1980 about 4.17 per cent (11 km) new track was established.

3.4 Period 1981-1990

In the railway budget of 1985, there was no monetary allocation for the railway in Tripura. The state broke in anger. Former Chief Minister Mr. Nripen Chakraborty raised his voice against the deprivation of Central Government. The agitation took place for the entire month of May in the state. On May 17 1985, five student-youth organisations showed mass Satyagraha and civil disobedience in New Delhi (Debnath, 2016). Mr. Taranimohan Sinha placed a bill regarding railway development in the State Legislative Assembly on May 24, 1985. Congress opposed that bill because of the viability of the proposal. Railway Mans Employees Association submitted

Table 2. Chronological Events of Growth Process of Railway Transport in Tripura

Time Frame	Events
October 15, 1949	Tripura Marge with India
December 2, 1951	Mass Meeting at Patapgarh near Agartala City for place the demand of Railway connectivity for Tripura
1953 & 1954	First selected Member of Parliament, Mr.Dasarath Deb and Mr.BirenDutta participate in Railway Budget Discussion
February 15, 1959	Mr.Dasarath Deb (Former Member of Parliament from Tripura East Constituency & Former Chief Minister of Tripura) and Mr.NripenChakraborty (Former Chief Minister of Tripura) met Former Railway Minister, Mr.Jogjeevan Ram with Demand of Railway
1959-1960	A sanctioned railway route from Kalkalighat, Assam to Dharmanagar, Tripura
April 22, 1964	First passenger train reached Dharmanagar
March 26, 1986	First passenger train reached Pecharthal
January 4, 1990	First passenger train reached Kumarghat
December 27, 2002	First passenger train reached Manu
October 5, 2008	First passenger train reached Agartala
January 20, 2017	First passenger train reached Udaipur
May 7, 2018	First passenger train reached Garjee
February 9, 2019	First passenger train reached Belonia
October 4, 2019	First passenger train reached Sabroom

Source : Computed by the Authors from News Paper Archives, 2019

a memorandum to the Union Ministry of Railways on July 10, 1985, to extend the railway in Tripura. With a slow process on March 26, 1986. Railway reached from Dharmanagar to Pencharthal about a 22 km stretch (Fig. 5). State leadership met former Prime Minister Mr. Rajiv Gandhi and submitted a memorandum for railways on March 9, 1987 (Debnath, 2016). After mid of April few socio-political activities like agitation, gate meeting, cycle rally, mass sitting demonstration, Long March, Jatha (Jathas is the rally of mass to stand on various significant issues affecting the people and the alternative policies of the Left) and strike had been taken place for railway extension in Tripura. In 1989, New Government form in New Delhi under the leadership of former Prime Minister Mr. V.P. Singh (December 2, 1989, to November 10, 1990) and took the initiative to Dharmanagar-Kumarghat railway extension project. Finally, on January 4, 1990. The railway line came to Kumarghat (Fig. 5).

3.5 Period 1991-2000

Former Member of the Legislative Assembly Mr. Pabitra Kar placed a proposal in the year of 1995. On the legislative budget in demand of railway but the proposal was opposed because railway is the subject of the Central Government (Debnath, 2016). On July 16 1996, Kumarghat to Agartala railway line was announced by the Ministry of Railway Government of India. On October 23 1996, Prime Minister H.D. Devgowda unfurled the foundation stone of Kumarghat-Agartala railway line project. Many organisations satirised this railway project as 'Imaginary Rail'. Through the Ministry of Railway

sanctioned extension of the railway up to Agartala in 1996 but due to shortage of adequate funds, the project got delayed (Ministry of Railways, 2014). In 1999, people of Tripura met with former Railway Minister Mr. Rambilash Paswan and put the demand to keep the matter of extension of rail to Agartala in the railway budget. At the same period, some stations like Jawaharnagar (23°55'N and 91°54'E), S.K. Para (23°58'N and 91°58'E) and Nalkata (24°03'N and 92°00'E) Stations and railway tracks destroyed as a part of political activities. Jawaharnagar and S.K. Para stations are located in the Atharomura hilly range, where the tribal political movement was most active during 2001-'02 (Table 2).

On September 5 1998, a high-level meeting was held in New Delhi regarding the commencement of railway work with former Member of the Parliament Mr. Samar Chowdhury's initiative. At that time, train service commenced from Kumarghat to Manu as daily service between Silchar, Headquarters of Cachar District in Assam and Manu in Dhalai District of Tripura (Saha, 2009).

3.6 Period 2001-2010

The Peace building, social transformation and rehabilitation of extremist open a new horizon for railway expansion. During this period government took many initiatives in peace building like rubber cultivation for economic development, border management and offer government service to the ex-extremist. But processes werealso not smooth for speedy construction of railway upto Agartala. The people of Tripura handed over a memorandum to former Prime Minister Atal Bihari Vajpayee July 30, 2002.

On April 7, 2005, former Chief Minister Manik Sarkar met with former Prime Minister Mr. Manmohan Singh having the demands of railway line extension to Sabroom, broad gauge to Agartala and proclamation National project (Debnath, 2016). The trial run of rail took place to Ambassa from Manu on January 26, 2008. On February 27, 2008 Ministry of Railway sanctioned the Agartala-Sabroom railway extension project (National Project vide RB L/No 98/W-1/NL/NF/6 Dated 24.10.2008). The trial run at Agartala had been taken place in June 29 2008. On October 5, 2008 capital city Agartala was connected with mainland India through a meter gauge line (Table 2).

It is observed that the growth rate, about 314 per cent for rail route and 700 per cent for railway stations, respectively during 2001-2010. Maximum developmental works for railway transportation has been taking place during the 2001-2010.

3.7 Period 2011-2020

On August 5, 2013, the people of Tripura demanded broad-gauge line and handed over a Memorandum to the railway minister and the chairman of railway board at Delhi (Debnath, 2016). Ministry of Railways, Government took the initiative to convert meter gauge line into broad gauge under unigauge project (The Press Trust of India, 2017). In the year 2015, Badarpur-Kumarghat-Agartala section (excluding Badarpur

railway station) was taken over by "Mega Block" project for gauge conversion. After the Mega Block Project, Agartala, was connected by broad gauge track to the rest of the country without any 'Break-of-bulk' point (Northeast Frontier Railway, 2015) Work of Agartala-Sabroom Section has been started in 2008. About 42.96 km long Agartala-Udaipur railway track has been operated for passenger traffic from August 28 2016. About 23.325 km long Garjee-Belonia railway route has been constructed during the last quarter of 2018 (Sinha, 2019). The Prime Minister, Mr. Narendra Modi flag off the Gargi-Belonia railway line (ANI, 2019). The project's total cost is about Rs. 3407 crores as sanctioned by Ministry of Railways, Government of India. This project's primary objective is to connect the southernmost part of Tripura with its border town, Sabroom. The strategic location of Sabroom and its distance from Chittagong port only about 72 km, which can open a new window to access the market of South and Southeast Asia. According to Hon'ble Prime Minister of India, this line will promote Tripura as a gateway to South and Southeast Asia (Tripura Observer, 2019).The first passenger train reached at border town Belonia on February 9, 2019 (Fig. 2). The first passenger train reached at Sabroom on October 8, 2019 (Prasad, 2019). According to the Northeast Frontier Railway officials, this railway service will be benefited for the local passengers of Tripura and help in the economic development of the state (Patel, 2019). After seven decades, the state received a full phased railway transport system.

3.9 Future scope

Many new infrastructural interventions have been made for the development of railway transport system in Tripura. About 15.054 km long unreconstructed Agartala-Akhaura Railway Project also will feed tremendous development activities of Tripura. There will be two stations between Agartala and Akhaura, namely Nischitapur (India) and Gangasagar (Bangladesh). Only about 5.46 km long line falls under the Indian side which IRCON International Company constructs. According to the director IRCON, the International project will complete tentatively in September 2021 (Press Trust of India, 2019). Due to unfavourable soil conditions, the project is delayed. The Ministry of Development of North Eastern Region (DoNER) funding for the development of railway track in Indian side (5.46 km) and Ministry of External Affair, Government of India bearing the cost of lying the track in Bangladesh side (10.6 km). An approximate estimate of the project is Rs. 972.52 crores.

This rail link will connect Agartala with Kolkata via Dhaka (Bangladesh), which will hugely diminish travel time between Agartala to Kolkata. The distance between the Agartala and Kolkata will be reduced from 1650 km to 530 km (Fig. 7). Due to cultural homogeneity, education, health, trade and commerce etc. Kolkata is the major destination for the people of Tripura. Presently, almost 40 hours needed to reach Kolkata by train via Lumding, Guwahati, Siliguri and Malda. Due to the establishment of a new international

railway route through Bangladesh via Dhaka, it will reduce travel time 40 hours to 10 hours only (Press Trust of India, 2019). This route will help in freight mobility and goods transportation from the northeastern state and vice-a-versa. India can access Chittagong port faster from Agartala, and Agartala will become the next growth centre of North-east India.

The railway transport of Tripura has strengthen for future development like it connect Tripura with rest of India. Tripura is a 'land-locked state, does not have sea-port in this circumstance's railway become the most cost-efficient mode of transport. Due to rugged topography, road transportation is not a comfortable mode for passenger transport (Mitra & Roy, 2020). But Railway transport of Tripura is suffering inadequate infrastructural facility. Singletrack is another issue for less traffic volume.

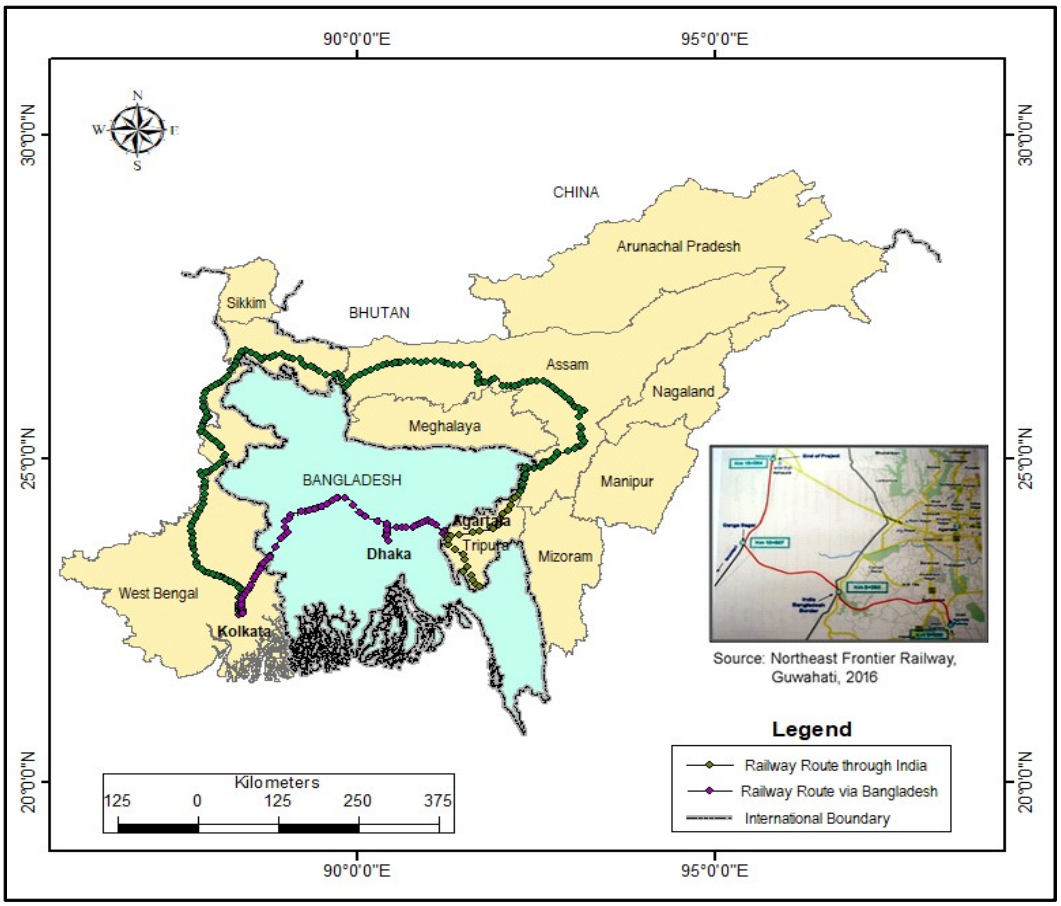


Figure 7. Agartala-Akhaura Rail Link (Prepared by Authors, 2019)

4. Conclusion

After seven decades-long socio-political movements, Tripura got the minimum railway services. Chronological development indicates the trends of railway development in the State of Tripura. The development pattern of Railways in Tripura influenced by socio-political and economic factors. Governmental approach and initiative plays a crucial role in the development process in Tripura. Before 1991, the Government of India focuses on the domestic market, due to which fewer initiatives had been made to the developed railway transport system in Tripura. But after 1991, due to the effect of Liberation, Privatisation and Globalisation (LPG) policy, the Look East and Act East Policy of the Government of India silently play a significant role inthe development ofthe railway transport system in Tripura. Due toits strategic location and its trade opportunities with the South East Asian markets. Ministry of Railway, Government of India, made a continuous effort to transform this railway route into atrans-Asian trade corridor. But the state has ample opportunities to be a new gateway of south-east Asia. Many new projects are under construction or proposed level like Trans-Asian Railway Link and Agartala-Akhaura Rail Link, which will support the entire railway transport system of Tripura. Evidence from seven decades-long historical patterns of railway development in Tripura suggested that both socio-political movement and Government initiatives played a crucial in every decade, and some patterns will be followed to maintain the momentum of development. Due to India's different policy initiatives like Act East Policy, Tripura is projected as a future gateway to Southeast Asia. To support the future demand of the regional railway development in the state became the prime emphasis of both the State and Central Government.

Acknowledgement

The authors would like to thank Mr. S. Umesh, Area Manager, Badarpur; Tapas Debnath, Senior Journalist at 'Daily Desher Katha'; Mr. PrabitaKar, Former Member of Legislative Assembly, Government of Tripura and Mr. Jitendra Choudhury, Former Member of the Parliament, Government of India for their kind help and valuable suggestions.

References

Ahmed, S. (2013) : *Foreign Direct Investment, Trade and Economic Growth : Challenges and Opportunities.* Routledge, New Delhi.

ANI. (2019, February 9) : PM inaugurates Garjee-Belonia railway line in Agartala. Agartala, Tripura, India : Asian News International (ANI). Retrieved March 27, 2020, from https://www.youtube.com/watch?time_continue=67&v=X9av1U2Udts&feature=emb_logo

Banerjee, D. (1999) : *Colonialism in Action : Trade, Development, and Dependence in Late Colonial India.* New Delhi : Orient Longman.

Barthakur, R. (2014) : *Gateway to the ASEAN.* Guwahati : Federation of Indian Chambers of Commerce & Industry.

Baruah, S. (2020, March 27) : *Assam, Northeast India and the "unfinished business" of partition*. Guwahati : Frontline.

Bera, G. K. (2010) : *The Land of Fourteen Gods: Ethno-cultural Profile of Tripura*. New Delhi: Mittal Publication.

Bhandari, R. R. (2005) : *Indian railways: glorious 150 years*. New Delhi: Ministry of Information & Broadcasting, Govt. of India.

Bidyabhushan, K. S. (1929) : *Sri Rajmala*. Kolkata: Bengal Printers Ltd.

Bogart, D., & Chaudhary, L. (2012) : Regulation, Ownership, and Costs : A Historical Perspective from Indian Railways. *American Economic Journal : Economic Policy,* 4(1), 28-58.

Brahma, J., Sircar, A., & Karmaka, G. P. (2013) : Hydrocarbon Prospectivity in Central Part of Tripura, India, Using an Integrated Approach. *Journal of Geography and Geology,* 5(3), 116-134. doi:10.5539/jgg.v5n3p116

Census of India. (1951) : *Primary Abstract of Census*. New Delhi : Office of the Registrar General & Census Commissioner, India.

Chakraborty, K. S. (2006) : *Entrepreneurship and Small Business Development : With Special Reference to Tripura*. New Delhi: Mittal Publication.

Chakraborty, G. (2018) : Look East Policy and Northeast India: Is It a Conjectured Vision. In A. Sarma, & S. Choudhury, *Mainstreaming the Northeast in India's Look and Act East Policy* (pp. 63-95). Singapore: Springer Nature.

Choudhary, A. K., & Rao, S. (2018) : History of Rail Transportation and Importance of Indian Railways (IR) Transportation. *International Journal of Engineering Development and Research,* 73-77. Retrieved March 17, 2020, from https://www.ijedr.org/papers/IJEDR1803014.pdf

Daimari, P. (2008) : *Five Year Plan and Industrial Development in Assam*. Guwahati: Eastern Book House Publication.

Darvill, S. (2011, December 15) : *India's First Railways*. Retrieved from IRFCA: https://www.irfca.org/docs/history/india-first-railways.html#roorkee

Debnath, T. (2016): *Amar Shahar Agartala*. Agartala : Book World.

Dikshit, K. R., & Dikshit, J. K. (2014) : *North-East India : Land, People and Economy*. New York: Springer. doi: 10.1007/978-94-007-7055-3

Directorate of Economics & Statistics Planning (Statistics) Department. (2009) : *Economic Review of Tripura 2008-09*. Agartala: Government of Tripura.

Directorate of Economics & Statistics Planning (Statistics) Department. (2018) : *Economic Review of Tripura 2017-18*. Agartala: Government Tripura.

Dutta, A. (2018) : Barbed Wire Border Fencing : Exclusion and Displacement at the Indo-Bangladesh Borderland. *Indian Council of World Affairs,* 74(1), 42-60. Retrieved from http://journals.sagepub.com/home/iqq

Gan Chaudhuri, J. (1985) : *A Political History of Tripura*. New Delhi: Inter-India Publication.

General Manager (Construction) (2018) : *Brief of All Projects*. Maligaon : Northeast Frontier Railway.

Ghosh, A. (2016) : *The Importance of Being Siliguri, or the Lack Thereof Border-Effect and the "Untimely" City in North Bengal*. Kolkata: Mahanirban Calcutta Research Group.

Ghoshal, A. (2012) : Changing Mentality of the Bengalee Refugees: The Story of Tripura (1946-1971). *Refugee Watch, 39 & 40,* 17-24. Retrieved from http://www.mcrg.ac.in/rw%20files/rw39_40/2.pdf

Ghoshal, A. (2017, July) : Tripura: A Chronicle of Politicisation of the Refugees and Ethnic Tribals. *Social Change and Development,* 14, 27-41. Retrieved from https://www.okd.in/downloads/jr_17_july/article-3.pdf

Goldberg, M. (2013) : *Tripura Hills*. Chicago: Encyclopaedia Britannica, Inc. Retrieved May 3, 2020, from https://www.britannica.com/place/Tripura-Hills

Government of India (1978) : *Lok Sabha Debate*. New Delhi : Lok Sabha Secretariat.

Government of India (2011) : *Report on the Administration of North East India (1921-22)*. New Delhi: Mittal Publishers Distributors.

Government of Tripura (1972) : *Assembly Proceedings*. Agartala: Tripura Legislative Assembly Secretariat.

Guha, A. (1968) : A Big Push Without a Take-off : A Case-Study of Assam, 1871-1901. *The Indian Economic and Social History Review,* 199-221. doi:https://doi.org/10.1177/001946466800500301

Haokip, T. (2012) : Political Integration of Northeast India : A Historical Analysis. *Strategic Analysis*, 36(2), 304-314. doi:https://doi.org/10.1080/09700161.2012.646508

Hilaly, S. (2016) : Railways and Colonialism : The Kachugaon Forest Tramway in Assam. *Global Journal of Indian History and Culture*, 1(1), 45-57.

Iqbal, I. (2007) : The Railways and the Water Regime of the Eastern Bengal Delta, c1845–1943. *Internationales Asienforum,* 38(3-4), 329-352.

Kirit Bikram Kishore Deb Barman vs State of Tripura and Others, GLR 258 (Gauhati High Court April 30, 2004).

Knight, L. (2012) : *Britain in India,* 1858–1947. New Delhi : Anthem Press.

Lakshmanan, T. R., Subramanian, U., Anderson, W. P., & Leautier, F. A. (2001) : *Integration of Transport and Trade Facilitation : Selected Regional Case Studies*. Washington, D.C.: World Bank.

Lok Sabha Secretariet (1977) : Tripura. *The Journal Parliamentary Information,* 23(2). Retrieved from https://eparlib.nic.in/bitstream/123456789/762866/1/jpi_June_1977.pdf

Mazumder, S. C. (1984) : *Geomorphology of Tripura*. Shillong: North Eastern Hill University.

Ministry of Railways (2014) : *Report of the Standing Committee on Railways (Fifteenth Lok Sabha) on Ongoing and Pending Railway Projects, with special emphasis on Projects in North Eastern Region*. New Delhi: Lok Sabha Secretariat.

Ministry of Railways (2018) : *Indian Railways Year Book 2017-18*. New Delhi: Railway Board, Government of India.

Mitra, A. (1990, November 3) : Parting of Ways: Partition and after in Bengal. *Economic and Political Weekly,* 25(44), 2441-2444.

Modi, N. (2019, February 9) : PM Modi lays foundation stone and inaugurates development projects at Agartala, Tripura. Agartala, Tripura. Retrieved March 27, 2020, from https://www.narendramodi.in/pm-modi-lays-foundation-stone-and-inaugurates-development-projects-at-agartala-tripura-543443

Murphy, R. W. (1988) : Bangladesh enters the oil era. *Oil and Gas Journal,* 29(2), 76-82.

Northeast Frontier Railway (2015, August 3) : Mega Block in Badarpur-Kumarghat-Agartala Section. Guwahati, Assam, India.

Pandey, N. N. (2008) : *India's North East Region : Insurgency, Economic Development and Linkages with South-East Asia*. New Delhi and Institute of South Asian Studies, Singapore: Manohar Publishers.

Patel, A. (2019) : *Indian Railways Starts first DEMU train services in Tripura-Dharmanagar-Sabroom*. New Delhi: Metro Railway News.

Prasad, N. (2019) : *Indian Railways flags off first DEMU train services in Tripura between Dharmanagar to Sabroom.* Financial Express. Retrieved October 9, 2019, from https://www.financialexpress.com/infrastructure/railways/indian-railways-flags-off-first-demu-train-services-in-tripura-between-dharmanagar-to-sabroom-details-here/1730430/

Prasad, N. (2019, October 9) : Indian Railways flags off first DEMU train services in Tripura between Dharmanagar to Sabroom; details here. Agartala, Tripura, India.

Press Trust of India. (2019, September 7) : Agartala-Akhaura railway project likely to be delayed. p. 4. Retrieved November 13, 2019, from https://timesofindia.indiatimes.com/city/agartala/agartala-akhaura-railway-project-likely-to-be-delayed/articleshow/71022964.cms

Press Trust of India (2019, February 19) : EA delegation visit Agartala-Akhaura railway site. Retrieved from https://www.business-standard.com/article/pti-stories/mea-delegation-visit-agartala-akhaura-railway-site-119021900562_1.html

Raatan, T. (2008) : *Encyclopaedia of North-East India*. Delhi : Kalpaz Publication.

Ramanathan, R. (2004) : *Indian Transport Towards the New Millennium : Performance, Analysis and Policy.* New Delhi : Concept Publishing Company.

Ramesh, N. R. (1981) : Evidence of stone age culture in Pleistocene sediments of Tripura. *Indian Journal of Earth Science*, 14(1), 321-328.

Rao, M. A. (2012) : *Indian Railway.* New Delhi: National Book Trust.

Rattan, K. (1988) : *Former Tripura CM Nripen Chakraborty faces Criticism.* New Delhi: India Today. Retrieved from https://www.indiatoday.in/magazine/indiascope/story/

19880531-former-tripura-cm-nripen-chakraborty-faces-criticism-797291-1988-05-31

Roy, S., & Mitra, S. (2016) : Railway Transport System in Tripura, India : An Geographical Analysis. *Geographical Review of India,* 78(1), 40-57.

Roy, S., & Mitra, S. (2020) : Railway Stations of Tripura, India : An Assessment of Infrastructural Conditions. In S. Bandyopadhyay, C. R. Pathak, & T. P. Dentinho, *Urbanization and Regional Sustainability in South Asia* (pp. 177-200). Belgium: Springer.

Roy, S., Bajpayee, S., & Mitra, S. (2019) : Infrastructural Intervention and Development of Railway Transport System : An Evidence from Agartala-Sabroom Section, Tripura, India. *Indian Journal of Regional Science.*

Saha, S. (2014) : *A Study of the Geohydrological Problems of the Khowai and Haora River Basins, West Tripura.* Tripura Univeristy, Geography and Disaster Management. Agartala : Shodhganga. Retrieved March 29, 2020, from https://shodhganga.inflibnet.ac.in/bitstream/10603/180835/7/07_chapter%202.pdf

Saigal, O. (1978) : *Tripura : Its History and Culture.* Delhi : Concept Publishing Company.

Saikia, J. (2010) : *Documents on North East India.* New Delhi : Shipra Publications.

Santra, A., Mitra, S., & Debbarma, D. (2018) : Impact of Urbanisation on Land Use Changes in Agartala City, India. *Research Journal of Humanities and Social Sciences,* 9(2), 1-8. Retrieved from https://www.researchgate.net/publication/327144012_Impact_of_urbanization_on_land_use_changes_in_Agartala_City_India

Sen, S., Santra, A., Debbarma, D., Mitra, S., & De, S. K. (2015) : Morphology of Tilla-Lunga Topography in West Tripura District, Tripura, India. *ANNALs NAGI*, 35(2), 77-93. Retrieved from https://www.researchgate.net/publication316668526_Morphology_of TillaLunga_Topography_in_West_Tripura_ District_Tripura_India

Shajymon, M. L. (2017) : *Socio cultural impact of immigration in twentieth century Tripura.* Guwahati : Assam Don Bosco University. Retrieved April 23, 2020, from http://hdl.handle.net/10603/176491

Sharma, S. K., & Kumar, A. (2014) : A comparative study on Indian and World wide Railways. *International Journal of Mechanical Engineering and Robotics Research,* 1(1), 114-120. Retrieved February 14, 2020, from https://www.researchgate.net/publication/262672727_A_comparative_study_of_Indian_and_worldwide_railways?enrichId=rgreq-79ff6d791e1e7f8a7475bdef18a4d9cdXXX&enrichSource=Y292ZXJQYWdlOzI2MjY3MjcyNztBUzoxMDE3NzU4MjY3NTE0OTFAMTQwMTI3NjY1Nzc4MA%3D%3D&el=1_x_2&

Singh, S. N., Narain, A., & Kumar, P. (2011) : *Socio Economic and Political Problems of Tea Garden Workers: A Study of Assam.* New Delhi: Mittal Publications.

Sinha, D. (2019, February 10) : Indian Railways connects remote parts of

North-East with inauguration of GarjeeBelonia line in Tripura. New Delhi : Financial Express.

Skorobogatova, O., & Merlino, I. K. (2017) : Transport Infrastructure Development Performance. *Procedia Engineering 178,* 319-329.

Taher, A. (2020) : *Brief History of Bangladesh Railway*. Dhaka : Government of Bangladesh. Retrieved April 22, 2020, from https://web.archive.org/web/20111220203245/http://www.railway.gov.bd/brief_history.asp

Thacker & Company (1861) : *A Sketch of Eastern Bengal with reference to its railways, and Government*. Calcutta : Thacker, Spink and Co.

The New Indian Express (2019, October 10) : Diesel Electric Multiple Unit train chugs off between Dharamnagar-Agartala-Sabroom section. New Delhi.

The Press Trust of India (2017, April 18) : *All Metre Gauge tracks to be converted into Broad Gauge: Government*. Retrieved November 2018, 08, from https://m.economictimes.com/industry/transportation/railways/all-metre-gauge-tracks-to-be-converted-into-broad-gauge-government/articleshow/58144283.cms

The Press Trust of India (2019, July 2) : *India TV.* Retrieved from https://www.indiatvnews.com/news/india-indian-railways-begin-service-in-tripura-agartala-sabroom-line-bangladesh-border-531966

Tripura Observer (2019, February 9) : In Tripura, Modi dedicates new train line to nation. Agartala, Tripura. Retrieved from https://www.tripura india.in/update/index/in-tripura-modi-dedicates-new-train-line-to-nation

Wagner, L. (2012) : Infrastructure Lessons for Economic Growth and Business Success. *Area Development*.

Wolmar, C. (2017) : *Railways and The Raj: How the Age of Steam Transformed India.* London: Atlantic Books. doi:10.14296/RiH/2014/2249

IMPLICATION OF OIL PALM PRODUCTION ON FARMERS ECONOMY IN MIZORAM

Lalherliana Sailo
P. Rinawma
Lalrinpuia Vangchhia
Lalremruata Sailo

Abstract : *Oil Palm is one of the most profitable vegetable oilsgrown in humid tropical regions. Presently, Oil palm plantation has triggered a heated debate over opportunities and threat for national economy and rural livelihoods in tropical countries. The present study analyses impact of Oil Palm production on farmer's economy and livelihood in Mizoram. It is observed that Oil palm plantation is not profitable for small farmers. Many farmers want to stop Oil palm plantations due to expensive maintenance and low-income return.*

Keyword : *Oil palm, rural livelihood, income return, farmer's economy, Mizoram*

1. Introduction

Oil palm is a key ingredient in a profitable global value chains as compared to any other vegetable oil. Oil palm grows best in humid tropical regions where low-income population lives in biodiversity-rich forests (Sunderlin et al., 2005).

In the present world, expansion of oil palm plantation has triggered heated debates over opportunities and threats for the national economy, rural livelihoods, and tropical forest landscapes (Meijaard & Sheil, 2019; Qaim et al., 2020). A good number of studies have found Palm oil provides higher income streams for smallholders and, creates jobs for landless rural families while making them more competitive in global agricultural supply chains (Dib et al., 2018; Feintrenie et al., 2010; Gatto et al., 2017), but with different results across rural populations (Cahyadi & Waibel, 2016; Jelsma et al., 2017). Past studies also suggest that sustainable production of palm oil is likely to contribute for reduction of rural poverty without adding further pressure on forests to achieve higher economic returns and recent market demands for environmental certification (Purnomo et al., 2020; Sayer et al., 2012; Wilcove & Koh, 2010).

In Mizoram, oil palm plantations started in 2004 in 7 districts of the state such as Aizawl, Kolasib, Mamit, Serchhip, Lunglei, Lawngtlai and Saiha. Area and production of Oil palm have increased substantially during the initial period but it declinessignificantly in the recent years. Vangchhia and Sati (2017) observed that oil palm is beneficial for only big and settled farmers but not fruitfully beneficial for small/marginal farmers. Many farmers want an abandoned

***Lalherliana Sailo** is a Research Scholar, Department of Geography & RM, MZU*
***P. Rinawma** is a Professor, Department of Geography & RM, MZU*
***Lalrinpuia Vangchhia** is an Assistant Professor, Department of Geography, Government Hnahthial College*
***Lalremruata Sailo** is an Assistant Professor, Department of Geography, Government Champhai College*

plantation of oil palm due to many factors. Currently, the study of livelihood development from oil palm production is highly important. The present study attempts to analyse the implications of oil palm production (OPP) on the livelihoods of oil palm farmers in Mizoram.

2. Objectives

The objectives of the study are

1. To examine the benefits of oil palm economy
2. To study the implication of oil palm production on farmers' household assets
3. To suggest measures to achieve sustainable oil palm plantation in Mizoram

3. Methodology

The study is based on a primary survey conducted during 2018-2019. Required information like income and various household assets obtained by oil palm cultivators before and after oil palm production were collected. Farmers' perceptions on the economic implication of oil palm production for their livelihood were also obtained. Secondary data collected from the government of Mizoram were used to get an overview of oil palm plantations and production in Mizoram. Primary data werecollected from seven districts of Mizoram where oil palm plantation is practiced such as Aizawl, Lawngtlai, Mamit, Saiha, Serchhip, Kolasib and Lunglei. Applying the sampling method given by Yamane (1967), 2693 oil palm farmers were selected from 184 villages covering 28.4 percent of the total oil palm farmers of Mizoram by purposive random sampling techniques. The collected data have been analysed with Principal Component Analysis, Z scores standardized techniques, Pearson's coefficient of correlation, and other simple arithmetic methods. Maps have been prepared by using Arc GIS 10.1.

3.1 Study Area

The study covers seven districts of Mizoram such as Aizawl, Lawngtlai, Mamit, Saiha, Serchhip, Lunglei and Kolasib districts. Champhai District is not included due to absence of oil palm plantation. During the study period i.e., 2018-2019, a total of 10843 farmers have practicedoil palm plantation. Mamit district got the highest number of oil palm farmer i.e. 3042 followed by Kolasib (2155), Lawngtlai (2007), Lunglei (1803), Serchhip (1390), Aizawl (403) and Saiha (43). The study covers 184 villages from seven districts comprising 2693 oil palm farmers. The total oil palm plantation area is 2261.52 Hectares.

4. Result and Discussion

4.1 Overview of Oil Pam Plantation in Mizoram 2018-2019

During 2018-2019, oil palm was plantedby 10843 farmers in 197 villages of Mizoram. Lunglei district has the highest number ofvillages actively practicing oil palm plantation followed by Lawngtlai district (46) Mamit district (42), Kolasib district (29), Serchhip district (15), Saiha district (10) and Aizawl district (6). On the other hand, Mamit district has the highest number of farmers who involved in oil palm

plantation. With 3042 farmers, the share of Mamit district is 28.05 per cent of the total oil palm farmers of the state. Mamit district is followed by Kolasib district (2,155), Lawngtlai district (2007), Lunglei district (1,803), Serchhip district (1,390), Aizawl district (403) and Saiha district (43).

During the study period, the whole state of Mizoram produced 21367.57 Metric ton of Fresh Fruits Bunches (FFB) of oil palm from 25,923 hectare of land. Mamit district produced 49.96 per cent of the total state production while 42.7 per cent was produced from Kolasib district. The two districts produced almost all of the total oil palm production in the state accounting for 92.66 per cent of the state total FFB production. There was no FFB production in Saiha district during this period.

The average monthly income of farmers in Mizoram from their oil palm products is Rs. 10,838.48. Farmers in Kolasib district earns the highest income where the average monthly income of oil palm farmers was Rs. 23,283.83 which is followed by Mamit district. Farmers in Aizawl district have the lowest income. No farmer has any income from Oil palms in the Saiha district since there is no production till the study period. Table 1 shows an overview of oil palm plantations in Mizoram during 2018-2019.

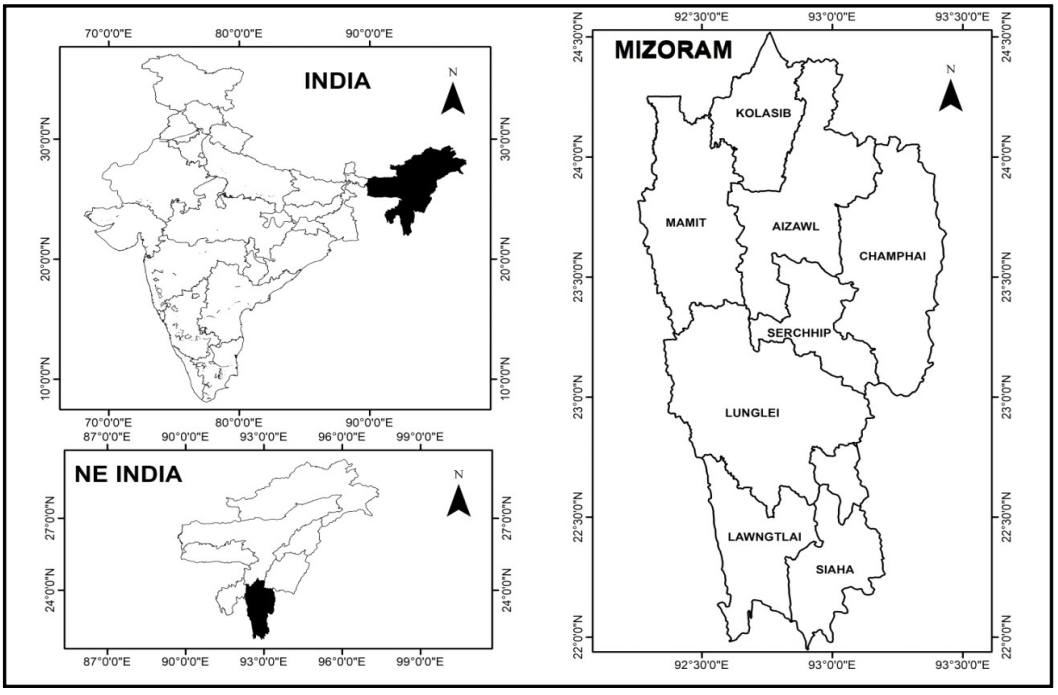


Figure 1. Location Map of the Study Area

4.2 Farmers Family Income and Oil Palm Plantation

Farmers practicing Oil palm in the study area are classified into three income groups. Most of the families (50.13%) have an income of Rs. 5000 to 10000. More than 30 percent of the total surveyed family earned Rs. 10000 per month whereas 19.36 percent have income less than Rs. 5000. The percentage composition of families having monthly income below Rs. 5000 is the highest in the Lunglei district whereas it is the lowest in Aizawl district. Aizawl district has the highest number of family in the highest income group.

4.3 Annual Income change before and after Oil Palm Production 2018-2019

The average annual income of oil palm farmers in the study area before Oil Palm production was Rs. 28,485.71 which increased to Rs. 30,234.14 after oil palm production. Thus, the annual income of the farmers is increased by rupees 1748.43 (5.66%). The highest change in income was found in Mamit district where the annual income of oil palm farmers increased by 13.79 percent. Mamit district is followed by Kolasib district (11.50%), Aizawl district (6.52%), Lunglei district (2.91%), Lawngtlai district (2.91%), and Serchhip district (1.96%).

Table 1. Overview of Oil Palm Plantation in Mizoram 2018-2019

District	No. of farmers	Area covered (Ha)	Village Covered	Production of FFBs (MT)	Monthly Income in Rupees
Aizawl	403	859	6	8.776	48268
Lawngtlai	2,007	4161	46	624.283	3433556.5
Mamit	3,042	5612	42	10675.53	58715393
Saiha	43	86	10	0	0
Serchhip	1,390	2130	15	248.26	1365430
Kolasib	2,155	6853	29	9123.028	50176654
Lunglei	1,803	6222	49	687.699	3782344.5
TOTAL	**10,843**	**25,923**	**197**	**21367.572**	**117521646**

Source : Agriculture Department, Mizoram, 2018-2019

Table 2. Monthly Income of Oil Palm Farmers

District	Monthly Income in Rs (No. of family in %)		
	1000 to 5000	5000 to 10000	10000 above
Aizawl	0.00	36.44	63.56
Lawngtlai	18.00	43.43	38.57
Mamit	11.42	53.36	35.21
Saiha	6.74	62.92	30.34
Serchhip	1.05	70.96	27.99
Kolasib	28.31	61.12	10.58
Lunglei	69.98	22.66	7.35
Average	**19.36**	**50.13**	**30.51**

Source: Field Survey, 2018-2019

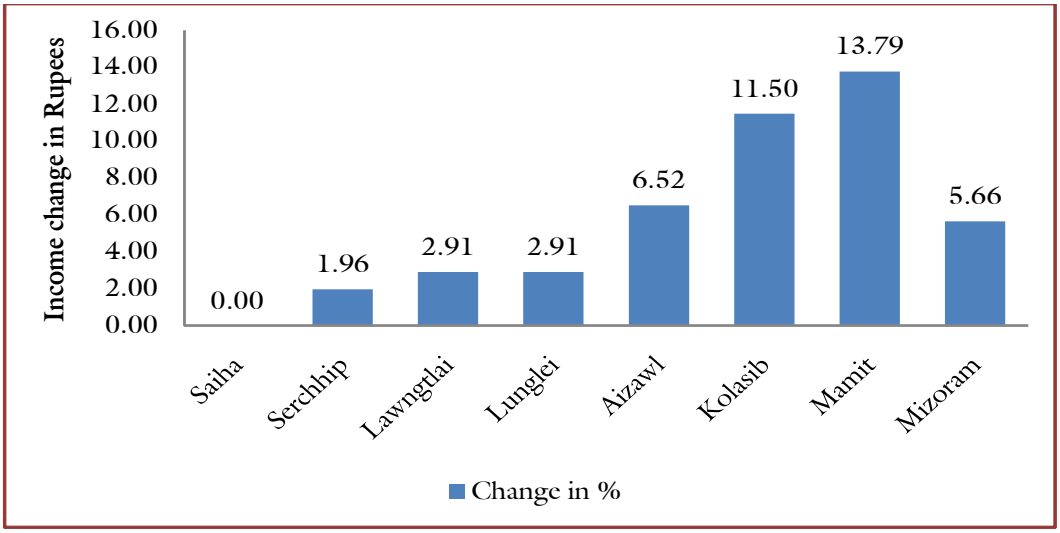


Figure 2. Annual Income change before and after Oil Palm Production 2018-2019

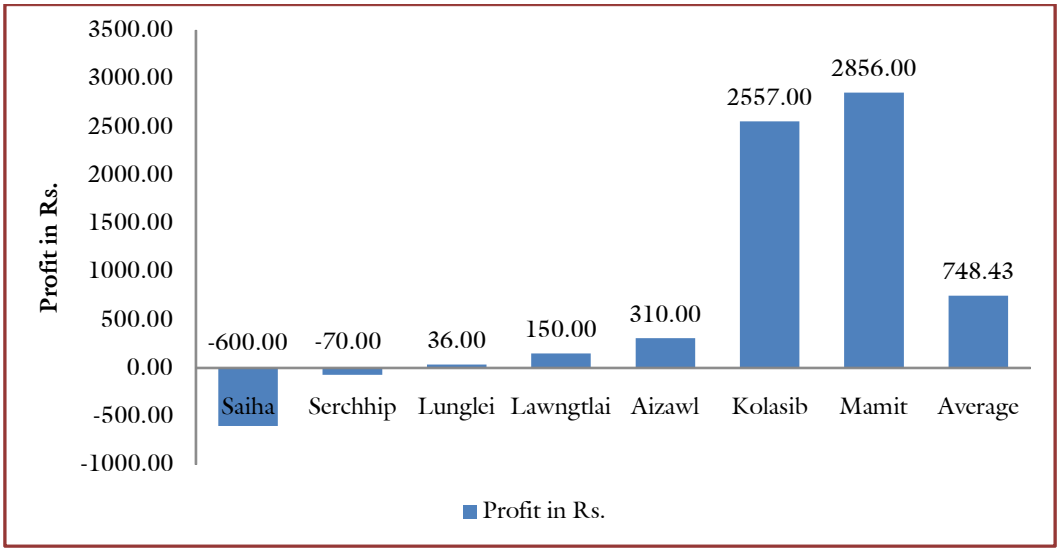


Figure 3. Monthly Profit earn by Oil Palm Farmer

4.4 Expenditure of Oil Palm Farmers on their Plantation

On an average, oil palm farmers spent Rs. 1000 monthly for the maintenance of their plantation. Highest expenditure found in Aizawl district where oil palm farmers spend rupees 2000 per month. Aizawl district is followed by Kolasib district (Rs. 1200), Mamit district (Rs. 1000), Lunglei district (Rs. 900), Serchhip district (Rs. 700), Lawngtlai district (Rs. 600) and Saiha district (Rs. 600).

4.5 Monthly Profit Earned by Oil Palm farmer

On an average, anoil palm farmer of the study area profited Rs. 748.43 per month. The monthly profit earnedwas the highest in Mamit district where every oil palm farmer profited Rs. 2,856 monthly. Mamit district is followed by Kolasib district (Rs. 2,557), Aizawl (Rs. 310), Lawngtlai district (Rs. 150) and Lunglei district (Rs. 36). The farmer from Serchhip and Saiha district did not earn any profit. In the two districts, the monthly expenditure was higher than the return income byRs. 70 andRs. 600 respectively. Figure 3 shows the monthly profit earned by oil palm farmer in the study area.

4.6 Oil Palm Production and Improvement of Household Assets

Improvement of household assets among oil palm farmers has been measured by comparing household assets after production and before production of FFB. 12 different household assets were selected as an indicators such as number of long chair per household in per cent (N_Longchair), number of household having water connection in per cent (Water_Conn), number of household having LPG connection in per cent (LPG_ Conn.), number of motor vehicle per household in per cent (N_Motor_Veh), number of two wheeler per household in per cent (N_Two wheeler), number of television per household in per cent (Television), number of refrigerator per householdin per cent (N_ Refrigerator), number of washing machine per householdin per cent (N_Washing M), number of household having computerin per cent (N_Computer), number of household having internet connection in per cent (N_Internet), number of mobile phone per householdin per cent (N_Phone) and number of household subscribing newspaperin per cent (N_Newspaper). Table 3 shows district wise household assets change before and after oil palm production.

After getting the value of household assets change before and after oil palm production of the farmers,the standardize score of each indicators have been calculated and find composite score of the district as shown in the Table 4.

4.7 Impact of Oil Palm Production on Farmers' Household Assets

According to the composite score, by comparing the pre- and post- Oil palm plantation period, the level of household assets improvement among oil palm farmer was the highest in Aizawl district. Kolasib and Mamit were highly improved among the district, Lawngtlai district is developing moderately whereas

Table 3. Household Assets change before and after oil Palm Production in %

Indicators	Aizawl	Lawngtlai	Mamit	Saiha	Serchhip	Kolasib	Lunglei
N_Longchair	7.56	5.38	0.31	9.3	3.44	5.77	4.00
Water_Conn.	6.72	25.5	41.19	0	4.58	10.61	0.00
LPG_ Conn.	4.2	0	0	0	4.87	6.71	3.36
N_Motor_Veh	6.72	30.31	42.9	0	1.15	4.52	15.96
N_Two wheeler	4.2	113.03	146.96	0	3.44	9.05	6.72
N_Television	16.81	6.8	7.02	4.65	5.73	7.96	4.20
N_ Refrigerator	11.76	7.08	4.99	4.65	6.3	12.79	3.36
N_Washing M	10.92	1.42	2.5	0	2.87	5.46	1.68
N_Computer	5.04	7.08	12.01	0	1.43	10.92	0.84
N_Internet	13.45	0	0	4.65	4.01	10.45	3.36
N_Phone	87.39	17	56.47	55.81	32.66	35.41	9.24
N_Newspaper	4.2	5.95	0	4.65	0	8.58	0.00

Source : Field survey, 2018-2019

Table 4. District wise value of Z-Score

Indicators	Aizawl	Lawngtlai	Mamit	Saiha	Serchhip	Kolasib	Lunglei
N_Longchair	0.84	0.09	-1.64	1.44	-0.57	0.23	-0.38
Water_Conn.	-0.39	0.84	1.87	-0.83	-0.53	-0.13	-0.83
LPG_ Conn.	0.53	-0.99	-0.99	-0.99	0.78	1.45	0.23
N_Motor_Veh	-0.48	0.97	1.73	-0.89	-0.82	-0.61	0.09
N_Two wheeler	-0.59	1.17	1.72	-0.65	-0.60	-0.51	-0.54
N_Television	2.16	-0.19	-0.13	-0.69	-0.44	0.09	-0.79
N_ Refrigerator	1.24	-0.05	-0.63	-0.72	-0.27	1.52	-1.08
N_Washing M	2.02	-0.58	-0.29	-0.97	-0.19	0.52	-0.51
N_Computer	-0.06	0.36	1.37	-1.09	-0.80	1.15	-0.92
N_Internet	1.64	-1.01	-1.01	-0.09	-0.22	1.05	-0.35
N_Phone	1.70	-0.93	0.54	0.52	-0.35	-0.25	-1.23
N_Newspaper	0.25	0.76	-0.98	0.38	-0.98	1.53	-0.98
Composite Score	**0.74**	**0.04**	**0.13**	**-0.38**	**-0.41**	**0.50**	**-0.61**

Table 5. Improvement of Household Assets, District Wise, Mizoram

Index	Levels of Improvement	District
Above 5	Very High	Aizawl
0.1 to 0.5	High	Kolasib & Mamit
0.1 to -0.1	Moderate	Lawngtlai
-0.1 to -0.5	Low	Saiha & Serchhip
Below -0.5	Very Low	Lunglei

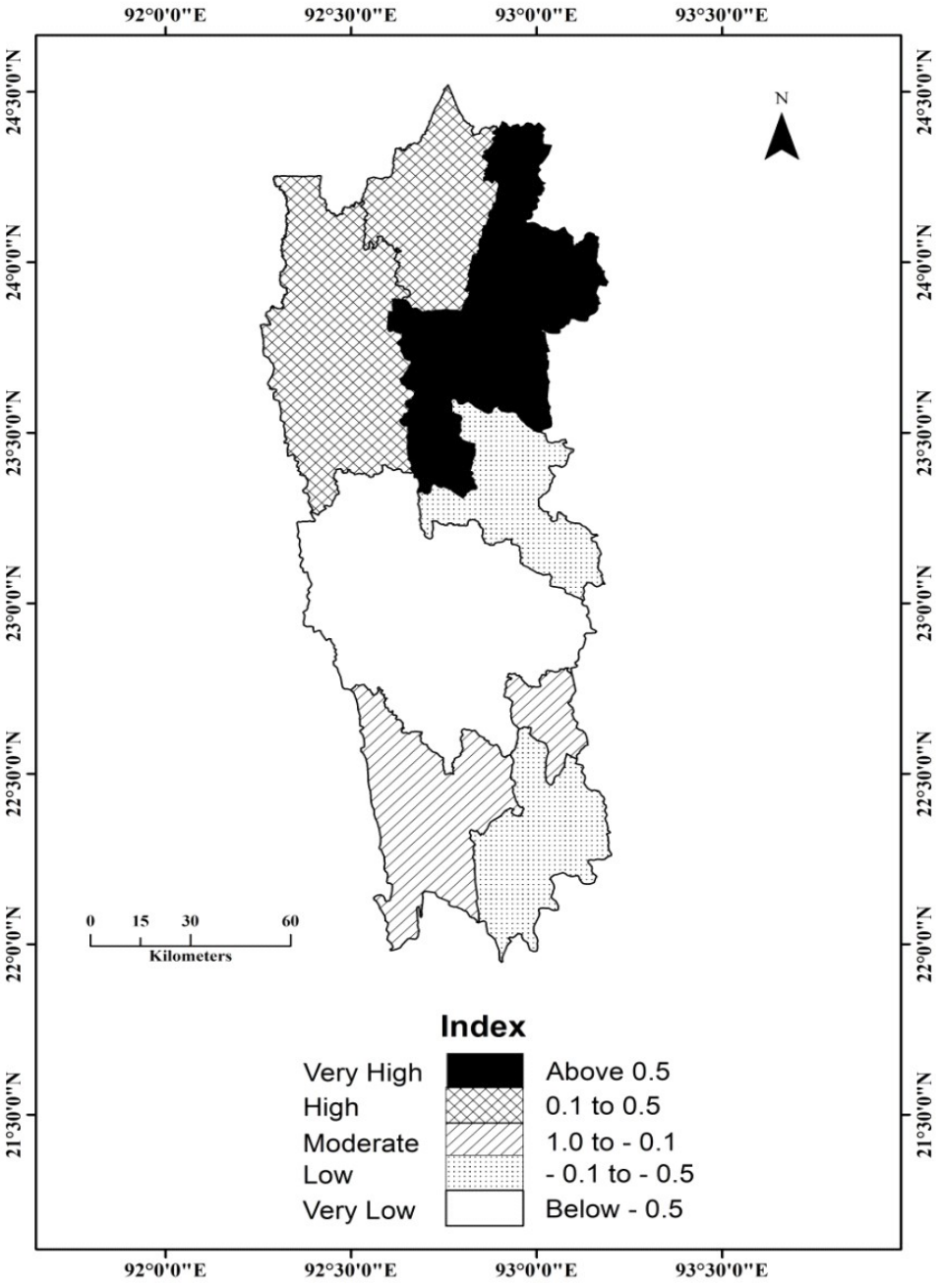


Figure 4. Levels of improvement in household assets

Saiha and Serchip were low and Lunglei was very low. Table 5 shows district wise level of improvement in household assets among oil palm farmers.

5. Factor Analysis:

Factor Analysis was applied to find out the factor which effects whether high or low in households assets development. PCA was run in the computer software Statistical Package for Social Sciences (SPSS) to extract communalities and components. Using Kaiser's criterion of taking eigenvalues more than 1, four components were extracted which altogether explain 59.4 per cent of total variation in the data set. The percentage of variation explained is considered good enough to carry forward the analysis.

After component loadings were estimated, the individual indicators with the highest component loadings are grouped into intermediate composite indicators. Since we extracted four components, there are also four intermediate composites as shown in the right-hand side of Table 2. The intermediate composites were normalized squared rotated component (factor) loadings. The squared factor loadings represented the proportion of the total unit variance of the indicator, which was explained by the component. The weights are normalized squared factor loadings and scaled to unity sum.

Once the intermediate composite indices have been constructed, they were aggregated by assigning a weight to each

Table 6. Factor Loading of the Component Indices

Indicators	Component				Squaring Factor Loading Scale to Unity Sum			
	1	2	3	4	1	2	3	4
Water_Conn.	0.96	-0.07	-0.22	-0.16	0.92	0.01	0.05	0.02
N_Motor_Veh	0.92	-0.05	-0.36	-0.13	0.85	0.00	0.13	0.02
N_Computer	0.90	0.06	0.30	0.19	0.81	0.00	0.09	0.04
N_Two wheeler	0.89	-0.17	-0.40	-0.12	0.79	0.03	0.16	0.01
N_Longchair	-0.73	0.22	-0.19	0.61	0.54	0.05	0.03	0.38
N_Television	0.04	0.93	0.24	0.14	0.00	0.86	0.06	0.02
N_Phone	-0.17	0.91	-0.14	-0.16	0.03	0.83	0.02	0.03
N-Washing M	0.00	0.84	0.51	0.10	0.00	0.71	0.26	0.01
N_Internet	-0.41	0.65	0.54	0.32	0.17	0.42	0.29	0.10
LPG_ Conn.	-0.26	0.14	0.95	0.05	0.07	0.02	0.91	0.00
N_ Refrigerator	0.01	0.45	0.72	0.52	0.00	0.21	0.52	0.27
N_Newspaper	-0.09	-0.04	0.21	0.97	0.01	0.00	0.04	0.94
Expl. Var.	5.94	3.06	1.65	1.08				
Expl./Total Var.	0.51	0.26	0.14	0.09				
Total Var.	**11.73**							

"Extraction Method: Principal Component Analysis.
Rotation Method : Varimax with Kaiser Normalization."
a. Rotation converged in 6 iterations.

of them equal to the proportion of variance explained by the respective component. Weight Score (Wi) is obtained by multiplying the variable weight and weight of respective component. Finally, the resulting weight or final weight is obtained which is rescaled again to sum up to one to preserve comparability.

The highest factor which effects improvement of household assets is number of household having water connection. It also indicates development in the household is concentrate most in water accessibility as well as oil palm production is helpful to increase water intake of the family. The other factors contributing household assets are as number of household having motor vehicles with the total weight score of 0.14 followed by No. of Household having computer, No. of Two wheeler per Household, No. of Long chair per Household, No. of TV per Household, No. of Mobile Phone per Household, No. of Washing Machine per Household, No. of Household having Internet Connection, No. of Household having LPG connection, No. of Refrigerator per Household and No. of Household subscribing newspaper.

6. Conclusion and suggestions

The study finds oil palm plantations have economically positive implications for livelihood development among oil palm farmers but are not high in terms of income, profit earns, and household assets. The monthly income earned by the farmers has not significantly increased after having OPP. Besides Mamit and Kolasib, increase in income is very minimal in the other districts. Expenditure for the maintenance of oil palm plantations is high and the farmers do not have much profit from oil palm production. Household assets were generally improved among the farmers who produced and sold the FFB but it is concentrated very limited to a few districts like Aizawl, Mamit, and Kolasib. Farmers beneficially used the profit from

Table 7. Weight of the Indicators

Indicators	Domain Weight	Weight for respective factor	Weight Score (Wi)	Resulting weight (Wi=1)
Water_Conn.	0.92	5.94	5.48	0.16
N_Motor_Veh	0.85	5.94	5.02	0.14
N_Computer	0.81	5.94	4.80	0.14
N_Two wheeler	0.79	5.94	4.72	0.13
N_Longchair	0.54	5.94	3.19	0.09
N_Television	0.86	3.06	2.64	0.08
N_Phone	0.83	3.06	2.55	0.07
N-Washing M	0.71	3.06	2.17	0.06
N_Internet	0.42	3.06	1.30	0.04
LPG_ Conn.	0.91	1.65	1.50	0.04
N_ Refrigerator	0.52	1.65	0.86	0.02
N_Newspaper	0.94	1.08	1.02	0.03

OPP to develop water connections, motor vehicles, and computers. The study suggests achieving sustainable plantation of oil palm plantations that accessibility to farms should be improved to reduce the expenditure of the farmers. Moreover, small farmers need to get assistance from the government to increase the profit earn from OPP. The government may give more assistance to the farmers in terms of cleaning of plantation area, wages for manpower during harvesting, the selling process of FFB, and protection from wild animals, especially for the new plantation.

References

Cahyadi, E.R. and Waibel, H. (2016) : Contract farming and vulnerability to poverty among Oil palm smallholders in Indonesia. *The Journal of Development Studies,* 52(5): pp. 681–695.

Dib, J.B., Krishna, V.V., Alamsyah, Z. and Qaim, M. (2018) : Land-use change andlivelihoods of non-farm households : The role of income from employmentin oil palm and rubber in rural Indonesia. *Land Use Policy,* 76: pp. 828–838.

Feintrenie, L., Chong, W.K. and Levang, P. (2010): Why do farmers prefer oil palm? Lessons learnt from Bungodistrict, Indonesia. *Small-scale Forestry,* 9(3): pp. 379–396.

Gatto, M., Wollni, M., Asnawi, R. and Qaim, M. (2017) : Oil palm boom, contractfarming, and rural economic development : Village-level evidence from Indonesia. *World Development*, 95: pp. 127–140.

Jelsma, I., Schoneveld, G.C.,Zoomers, A. and Van Westen, A.C.M. (2017) : Unpacking Indonesia's independent oil palm smallholders : An actor-disaggregatedapproach to identifying environmental and social performance challenges. *Land Use Policy*, 69: pp. 281–297.

Meijaard, E. andSheil, D.(2019) : The moral minefield of ethical oil palm and sustainabledevelopment. *Frontiers in Forests and Global Change*, 2, 22.

Purnomo, H., Okarda, B., Dermawan, A., Ilham, Q.P., Pacheco, P., Nurfatriani, F. and Suhendang, E. (2020) : Reconciling Oil palm economic development and environmental conservation in Indonesia : A value chain dynamic approach. *Forest Policy and Economics,* 111, 102089.

Qaim, M., Sibhatu, K.T.,Siregar, H., & Grass, I.,(2020) : Environmental, economic, andsocial consequences of the Oil palm boom. *Annual Review of Resource Economics,* 12: pp. 321-344.

Sayer, J., Ghazoul, J., Nelson, P. and Boedhihartono, A.K. (2012) : Oil palm expansiontransforms tropical landscapes and livelihoods *Global Food Security,* 1(2):pp. 114–119.

Sunderlin, W.D., Angelsen, A., Belcher, B., Burgess, P., Nasi, R., Santoso, L. and Wunder, S. (2005) : Livelihoods, forests, and conservation in developing countries : an overview. *World Development,* 33(9): pp. 1383–1402.

Vangchhia, L. and Sati, V.P. (2017) : Impact of Oil Palm on Rural Livelihood : A case study of

Mamitand Kolasib District, Mizoram, North East India, *Natural Resources Management for Sustainable Development and Rural Livelihood,* Todays & Tomorrow publisher, New Delhi, pp.413-423.

Wilcove, D.S. and Koh,L.P., (2010): Addressing the threats to biodiversity from oil-palm agriculture. Biodiversity Conservation, 19(4):pp. 999–1007.

Yengoh, G.T. and Armah, F.A.(2016): Land access constraints for communities affected by large-scaleland acquisition in Southern Sierra Leone. *Geojournal,* 81(1): pp. 103–122.

STATUS OF HIGHER EDUCATION IN MIZORAM: AN INTER-DISTRICT ANALYSIS OF GROSS ENROLMENT RATIO AND GENDER PARITY INDEX

David Rosangliana

Abstract : *Gross Enrolment Ratio (GER) is a key indicator for measuring the expansion of higher education. However, Mizoram currently faces a challenge as 75% of its youth aged 18 to 23 are not enrolled in higher education, indicating a poor GER. This study utilizes the All India Survey on Higher Education (AISHE), conducted annually by the Ministry of Education (MOE), Government of India (GOI) since 2010-2011, along with the 2011 Census data and the new district demarcation of Mizoram in 2019. The purpose is to calculate and analyze the GER and Gender Parity Index (GPI) of higher education in eleven districts of Mizoram, India.*

Keywords : *GER, GPI, Inter-district analysis, Mizoram*

1. Introduction

It is now essential to create a reliable database in India due to the expanding size and diversityof higher education market. Additionally, it is necessary for planning, developing policies, honouring international agreements, conducting research, etc. MOE, DHE, and other stakeholders decided to conduct AISHE starting in 2010–11 on an annual basis with the following goals: to identify and catalogue all institutions of higher learning across the nation; to gather information from all higher education institutions on various aspects of higher education. The study includes all of the national institutions that offer higher education. But regrettably, a few states/ UTs aren't responding to this survey very effectively. Out of all the Indian States and Union Territories, Mizoram is the most responsive in the interim. As a result, there is a considerable chance of receiving reliable data, a positive outcome, and an analysis that will reveal Mizoram's true picture.

GER is the number of pupils (or students) enrolled in a given level of education regardless of age by the population of the age group which officially corresponds to the given level of education, and multiplies the result by 100. In other words, GER is the total enrolment in higher education, regardless of age, expressed as a percentage to the eligible official population (18-23 years) in the given period.According to the definition of GER, whether or not the students fall under the designated age range, a high GER often denotes a high level of involvement. The total number of students enrolled in all sorts of educational institutions—public, private, and all other institutions that offer structured educational programs—should serve as the basis for GER at each level of education. It should be noted that GER can be higher than 100% due to inclusion

***David Rosangliana** is an Assistant Professor, Department of Mathematics, Govt. Zirtiri Residential Science College, Aizawl, Mizoram*

of underage and overage students due to early or late enrolment, as well as grade repetition.

Higher Educational Institutions have been classified in following 3 broad categories :

(a) University & University Level Institutions i.e. the Institutions which are empowered to award degree under some Act of Parliament or State Legislature.

(b) Colleges/Institutions which are not empowered to provide degree in its own name and therefore are affiliated/ recognized with Universities.

(c) Stand-alone institutions (not affiliated with Universities) which are not empowered to provide degree and therefore run Diploma Level Program

A number of literatures have been produced on GER and related aspects by a number of scholars (Rowan-Kenyon, 2007; Kumari, 2015; Ghara, 2016, 2017). They have studied gross enrolment ratio of higher education, rural-urban gender disparities of higher education and college enrolment. Adeyami and Akpotu (2004) had studied Gender Analysis of Student Enrolment in Nigerian Universities. Hussain and Rosangliana (2018) analyzed student's enrolment of higher education in Mizoramwhich at the time had eight districts. Data are usually obtained from government and independent publications. Because India's latest census was in 2011, and three new districts were created since then, estimating new population, age population, and calculating higher education GER and Gender Parity Index (GPI) of districts is a challenge, particularly for the three new districts and four affected districts.

2. Database and Methodology

The state's population statistics was gathered from the census database and the AISHE report. The total population and age group population of the districts were approximated and computed using the state's new district boundaries. The GER of all districts for male, female and total was then determined using AISHE data and the estimated age population. As a result, GPI was computed using the district GER. The following formula is used for calculation:

$GER_{th} = E_{th} * 100/P_{th},a,$

where GER_{th} = Gross Enrolment Ratio at level of education 'h' in the year 't',

E_{th} = the enrolment at the level of education 'h' in the year 't' and

P_{th},a = the population in age group (18-23 lbd) (last birth day) which officially corresponds to the level of education 'h' in the year 't'.

Here, we need to know the total enrolment for a given level of education, population of the age group (18-23 years) corresponding to the specified level (higher education). AISHE gives the enrolment data in higher education on yearly basis since 2010-2011. MOE published estimates of population yearly in the age group 18-23 years for all states and Union Territories. The populations of the districts of Mizoram in the age group 18-23 years are estimated based on the state's estimated total population in the age group 18-23 years and integrating the age-wise population from the 2011 census of India as well as three

new districts delineation of Mizoram in 2019.

3. Result and discussion

District-wise GER of Mizoram during 2020-2021 has been calculated by taking the percentage of student enrolment of higher educational institution in that particular district from 18-23 years population of the same district where Male and Female GER are also calculated separately which are shown in the following figures :

The data presented in Figure 1 shows that Aizawl has the highest male GER with a score of 57.8, followed by Lunglei with 15.4 and Lawngtlai with 14.4. The remaining eight districts have male GER scores below ten, with Mamit having the lowest score of 2.8. The pattern of female and total GER in the eleven districts of Mizoram, as shown in Figures 2 and 3, is similar. Aizawl has the highest GER in both categories, while Mamit has the lowest. Aizawl ranks first, followed by Lunglei in the male GER category, and the other nine districts have scores below ten, with Mamit being at the bottom in

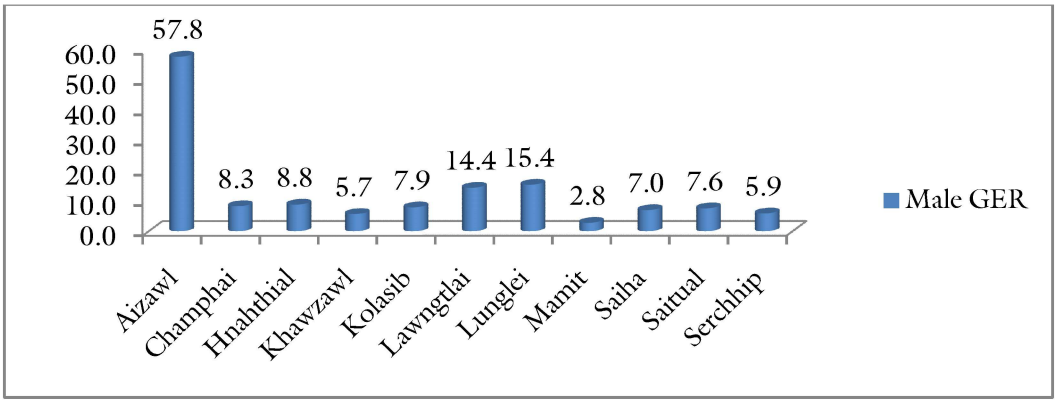


Figure 1. Male GER of higher education in Mizoram districts 2020-2021

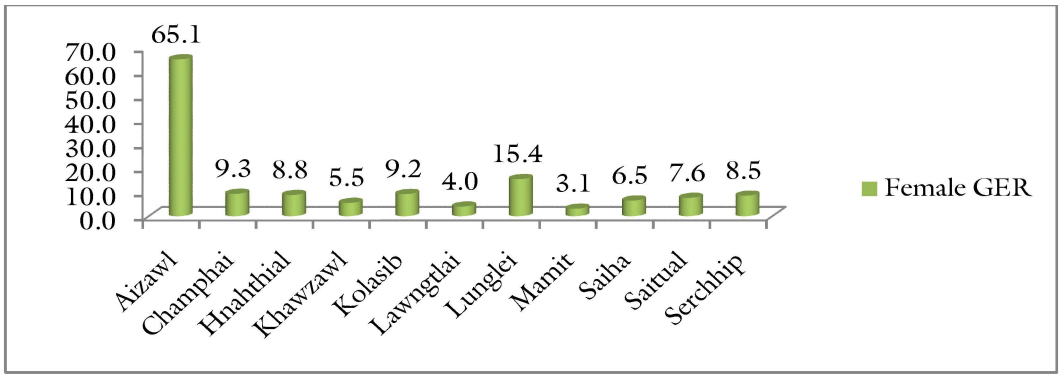


Figure 2. Female GER of higher education in Mizoram districts 2020-2021

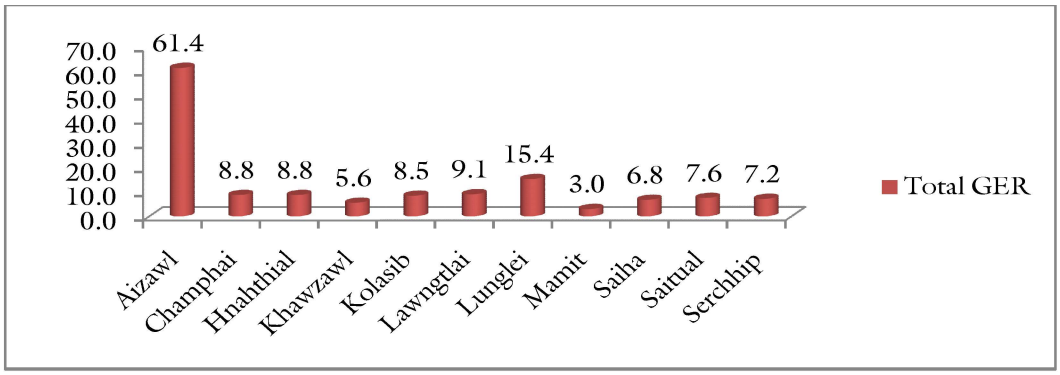


Figure 3. Total GER of higher education in Mizoram districts 2020-2021

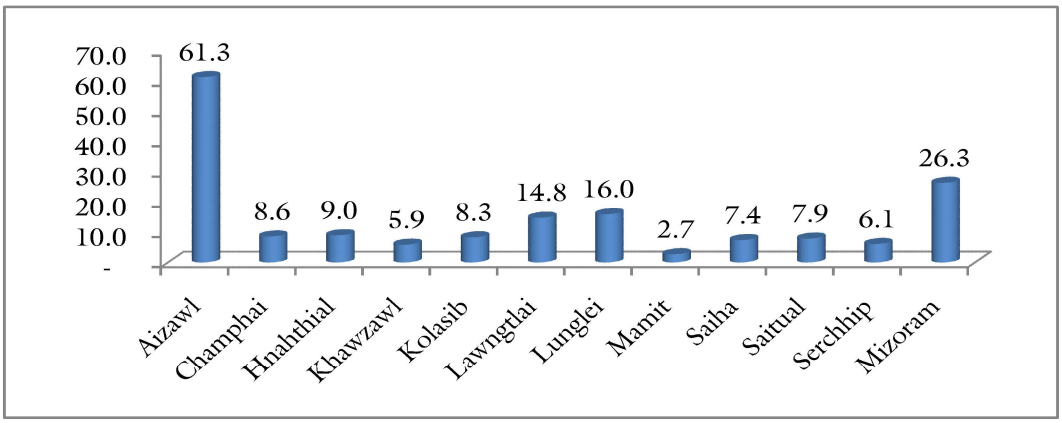


Figure 4. Male GER of higher education in Mizoram districts 2020-2021 (ST)

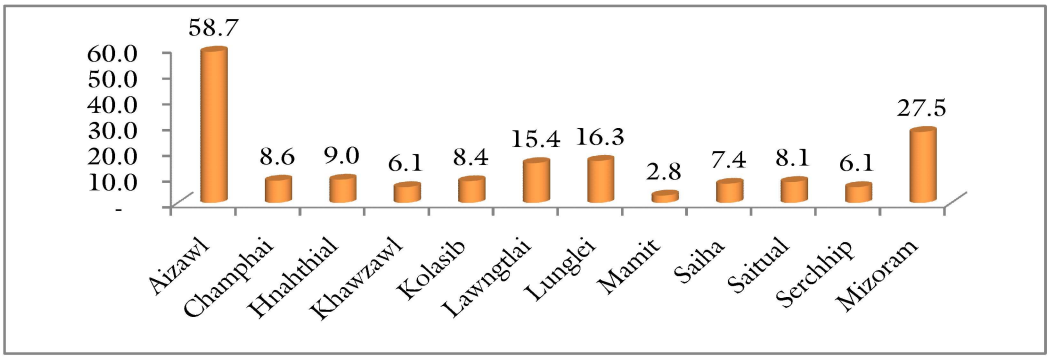


Figure 5. Female GER of higher education in Mizoram districts 2020-2021 (ST)

both cases. This indicates a significant disparity in male, female, and overall GER among the districts. However, at the state level, the male, female, and total GER are 26.2, 27.5, and 26.8 respectively. Figure 4, Figure 5, Figure 6, and Table 1 below indicate the District GER of Scheduled Tribe (ST) and Scheduled Caste (SC):

Since ST made up 94.43 percent of the population in Mizoram in 2011, the state's overall GER and the ST category are comparable for males, females, and the whole category. However, SC only

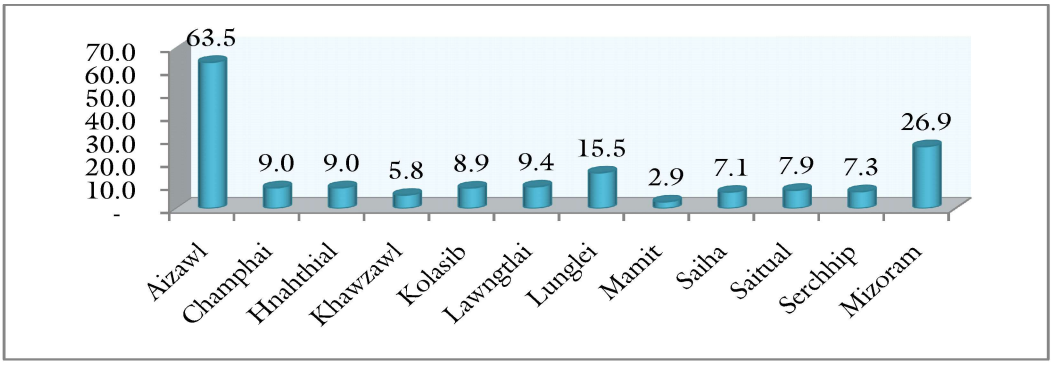


Figure 6. Total GER of higher education in Mizoram districts 2020-2021 (ST)

Table 1. GER of higher education in Mizoram districts 2020-2021 (SC)

Sl. No.	District	Male	Female	Total
1	Aizawl	333.9	247.4	300.0
2	Champhai	0.0	NA	0.0
3	Hnahthial	0.0	NA	0.0
4	Khawzawl	0.0	0.0	0.0
5	Kolasib	0.0	0.0	0.0
6	Lawngtlai	18.8	214.3	78.3
7	Lunglei	0.0	0.0	0.0
8	Mamit	0.0	0.0	0.0
9	Saiha	0.0	40.0	15.4
10	Saitual	NA	NA	NA
11	Serchhip	0.0	0.0	0.0
12	Mizoram	163.9	168.2	165.4

Note : NA means Not available (No male/female/total SC population in that district)

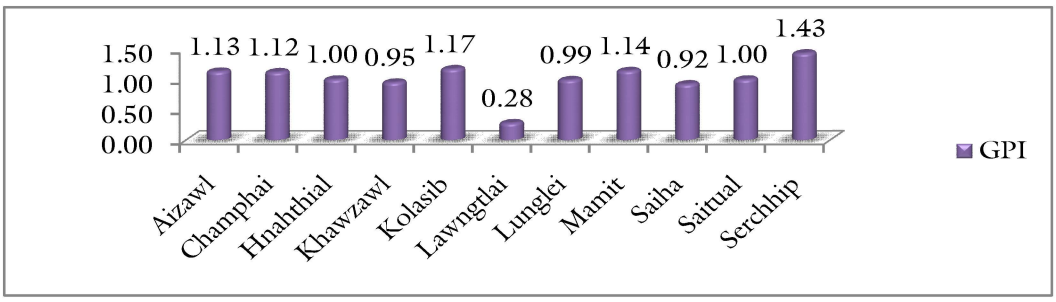


Figure 7 : GPI of higher education in Mizoram districts 2020-2021

makes up 0.11 percent of the population of Mizoram, which may be insignificant compared to the rest of the State. In fact, the GER of the SC category varies greatly between different districts, ranging from 0.0 in some to very high values in others. In other districts, it is even impossible to calculate the GER because there are no SC residents there.

United Nations Educational, Scientific and Cultural Organization (UNESCO) released GPI, which is a socioeconomic index usually designed to measure the relative access to education of males and females. In its simplest form, it is calculated as the ratio of female to male values of a given indicator in a given stage of education (primary, secondary, higher, etc.) GPI equal to 1 indicates parity between females and males. In general, a value less than 1 indicates a disparity in favour of boys and a value greater than 1 indicates a disparity in favour of girls.The following table highlights GPI of Mizoram higher education for the year 2020-2021:

Except for Lawngtlai, which had a GPI of 0.28, other districts in Mizoram had good GPIs, with the combined GPI of eleven districts being 1.05. There are five districts with GPIs greater than 1.00, indicating that female enrolment is higher than male enrolment in those districts, while four districts have GPIs less than 1.00, with parity noted in two.

4. Conclusion

Based on population projections made public by the MOE, the GER for Mizoram districts was calculated using the AISHE database and by incorporating demarcation of new districts. The accessibility score for Aizawl, the state capital of Mizoram, is 61.4. There could be a number of reasons for this, but one of the most significant ones is migration to Aizawl from other districts. The least accessible district, however, is Mamit, and it has a GER of 3.0, which is incredibly low when compared to the state average. The findings imply that male and female GER are comparable throughout districts, with the exception of Lawngtlai. The GPI for the Lawngtlai district was 0.28, indicating that more girls need to enroll in this district's higher educational institutions. It is hoped that knowing the GER and GPI of Mizoram's eleven districts will help policymakers create future plans.

References

Adeyami, K. and Akpotu, N. (2004) : Gender Analysis of Student Enrolment in Nigerian Universities. *Higher Education,* 48:pp. 361-378.

Ghara, T.K. (2016) : Analysis of Higher Education GER – A Study for West Bengal. *IOSR Journal of Humanities and Social Science,* 21(2): pp.13-19.

Ghara, T.K. (2017) : Analysis of Higher Education GER – A Study for West Bengal and Orissa. *IOSR Journal of Humanities and Social Science,* 22(7): pp. 32-35.

Government of India (2023) : *All India survey on higher education 2020-2021.* Department of Higher Education, MOE, New Delhi.

Hussain, J. and Rosangliana, D. (): Analysis of Higher Education Enrolment in Mizoram. *Mizoram Educational Journal,* IV(1):13-24.

https://censusindia.gov.in/nada/index.php/catalog/1436/download/4513/DDW-0000C-13.xls Accessed on 29 May, 2023.

https://censusindia.gov.in/nada/index.php/catalog/43014/download/46682/ST-15-PCA-A11-APPENDIX.xlsx. Accessed on 29 May, 2023.

https://censusindia.gov.in/nada/index.php/catalog/42894/download/46562/SC-15-PCA-A10-APPENDIX.xlsx. Accessed on 29 May, 2023.

Kumari, R. (2015). Rural-Urban Gender Disparities in Access to Higher Education in Haryana (India). *International Journal of Science and Research (IJSR),* 6(5): pp. 1814-1823.

Rowan-Kenyon, H.T. (2007) : Predictors of Delayed College Enrolment and the Impact of Socioeconomic Status. *The Journal of Higher Education,* 78(2) : pp. 188-214.

UNESCO Institute for Statistics (2014) : *Higher Education in Asia : Expanding out, expanding up (The rise of graduate education and university research.)*

RISK PERCEPTION AND SATISFACTION TOWARDS RESIDENTIAL ENVIRONMENT OF TENANTS: A STUDY OF AIZAWL CITY

Lal Hmangaihzela
Benjamin L. Saitluanga
David Rosangliana

Abstract : *Because of its topography and geographical location, Aizawl, the capital city of Mizoram, is vulnerable to significant natural hazards like earthquakes, landslides and cyclones. Even though the occurrence and the severity of natural hazards cannot be stopped, the vulnerability can be reduced through awareness, education, preparedness, and prediction and warning systems. A study on Risk Perception emphasised the role of making prudent disaster reduction decisions. The main purpose of this study is to measure the level of risk perception and the factors which influence the risk perception of natural hazards like earthquakes and landslides in their residential environment among private renters in Aizawl City. The analysis reveals that the tenants' risk perception of natural hazards is relatively low compared to the natural conditions of their residential environment. Age, income, age and type of building, and slope degree influence the disaster risk perception in Aizawl.*

Keywords : *Risk perception, Satisfaction, Pearson's Correlation, Slope degree, Landslide Susceptibility Zone.*

1. Introduction

Risk perception is a multi-dimensional concept influenced by different factors, including an individual's personality, the type and the context of risk, culture, and the social context (Rahman et al., 2022). It refers to people's beliefs, attitudes, assessments, and feelings about thelikelihood and consequences of events (Miceli et al., 2008). Risk is perceived differently by individuals, and that perception influences decision-making at the individual, organisational andmunicipal levels (Cvetkovic, 2017).

At individual level, disaster management and preparedness might differ depending on the level of perceived risk. Bubeck et al. (2012) argued that risk perception largely influences risk management, determining the success of risk management in reducing vulnerability. Different studies show that disaster preparedness is positively related to the risk perception of the individual or the community (Miceli et al., 2008; Akbar et al., 2020; Nurjanah & Rezza, 2021), which means that people who have a high level of risk perception are more likely to have enhanced disaster preparedness. Perception of risk has been claimed as the most important factor that drives disaster preparedness (Slovic, 1987). Understanding people's risk perception

***Lal Hmangaihzela** is a Research Scholar, Department of Geography & RM, Mizoram University*
***Benjamin L. Saitluanga** is a Professor, Department of Geography & RM, Mizoram University*
***David Rosangliana** is an Assistant Professor, Department of Mathematics, Govt. Zirtiri Residential Science College, Aizawl*

and the determining factors is essential for improving riskcommunications, management decisions and designing effective mitigation policies (Rahman et al., 2022). Therefore, study on risk perception plays a vital role in Disaster Risk Management (DRM), providing valuable insights to authorities for planning and policies, especially pertinent forvulnerable communities.

Residential satisfaction may be defined as an individual's perception of the gap between the actual conditions and their expectation of residential environments (Ibem & Aduwo, 2013). Satisfaction, as a cognitive construct, is based on personal perception, which depends on knowledge, experiences, values, culture, and specific needs (Galster, 1985). Risk perception towards natural disasters is often studied through measurement of satisfaction. Perceived risk of individuals towards disasters is measured on the basis of their knowledge and experience. The present study focuses on measurement of satisfaction level of tenants in Aizawl City.

In hilly regions, sometimes, a great loss of lives and properties caused by earthquake-induced landslides even exceeds the losses caused by the earthquake itself (Chen et al., 2011). The occurrence or intensity of earthquakes cannot be controlled, but the risk can be reduced through disaster preparedness and management.

2. Objectives of the study

The main objectives of the study are

1. to measure the level of satisfaction of renters on their residential environment
2. to examine the relationship between tenants' satisfaction and their residential environment
3. to examine the relationship between Tenants' Satisfaction Index and selected socio-economic, housing and residential environment variables.

3. Literature Review

Recent years have witnessed researchers and policy makers paying more attention to the study of risk perceptionin disaster management. The majority of the research concentrated onthe study of the relationship between risk perception and experience of disaster or disaster preparedness (Nurjanah & Rezza, 2021; Çingi & Yazgan, 2022). Others examined factors that influence risk perception (Shaw et al., 2004; Sund et al., 2017) while some others concentrated on the level of risk perception of an individual or a particular community (Cvetkovic & Planic, 2022; Yildiz et al., 2023).

Risk perception allowsinsight into the concerned people's knowledge and coping capacity for potential hazards (Paek & Hove, 2017), helping policy design and disaster management plans. Moreover, accurate risk perceptions can help individualsmake the right decisions and approach appropriate preparedness, reducing the vulnerability of the risk (Andersson, 2011); and affectingthe disaster response and recovery (Cvetkovic & Planic, 2022).

Numerous studieshave been conducted to examinethe factors which

influence the perception of disaster risk. Socioeconomic factors like age, gender, education, employment, and income significantly impact disaster risk perception (Ho et al.,2008; Fernandez et al., 2018; Rahman, 2019). Some studies found that the disaster experience (Shapira et al., 2018), type of house (Qureshi et al., 2021), distance from the risk source (He & Zhai, 2015), and awareness of disaster (Shaw et al., 2004) influenced the risk perception. However, the level of risk perceptions across the countries is not even.

4. Methodology

4.1 Study Area

Aizawl, the capital of Mizoram, is situated in the Patkai hills of the eastern Himalayas. Owing to its geography, Mizoram is vulnerable to almost all natural hazards (Mizoram State Disaster Management Plan, 2020). The entire state is classified under Very High Damage Risk Zone (Zone V) of the seismic zones of India. The state experiences landslide frequently. As per Disaster Management and Rehabilitation Report 2013 – 2020, Mizoram loses 1572 houses with 68 lives because of landslides. In 2011, the total household inAizawl was 58,541 out of which 51.58 per cent lived in rented houses (SECC, 2011). Before the formation of the Aizawl Municipal Council (AMC) in 2008, no proper rules and regulations for the construction of buildings were implemented in Aizawl. Numerous buildings were constructed in hazard vulnerable zone. The congested unplanned city of Aizawl is thus vulnerable to different types of disasters like earthquakes, cyclones, hailstorms, cloudbursts, and landslides. More than half of the total geographical area (51.34%) of the city lies above 21° slope, and again, more than half of the total area (53.93%) lies in the category of high landslide susceptibility zone (see Figure 1 and Figure 2, respectively).

4.2 Sampling Design

For sampling, the study areawas divided into three zones based on the locational distribution - core, semi-periphery and periphery. Four municipal wards were selected to represent the entire city - one for core and peripheral zones and two for semi-periphery. Two municipal wards were selected in semi-periphery because some localities within this zone can also be considered to be the peripheral zone. Each municipal ward comprises 3–5 local councils with seventeen localities. Cluster sampling was employed to collect the data with the total sample size of 556 housing units covering 10 per cent of the entire household of the selected area.

4.3 Data and Methods

A structured questionnaire consisting of three sections was employed to collect household data, including tenants' satisfaction towards disaster, the socio-economic conditions of the households, and housing characteristics. A five-point Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied) was used to collect the tenants' satisfaction data. The five choices provided the neutral option if the renters

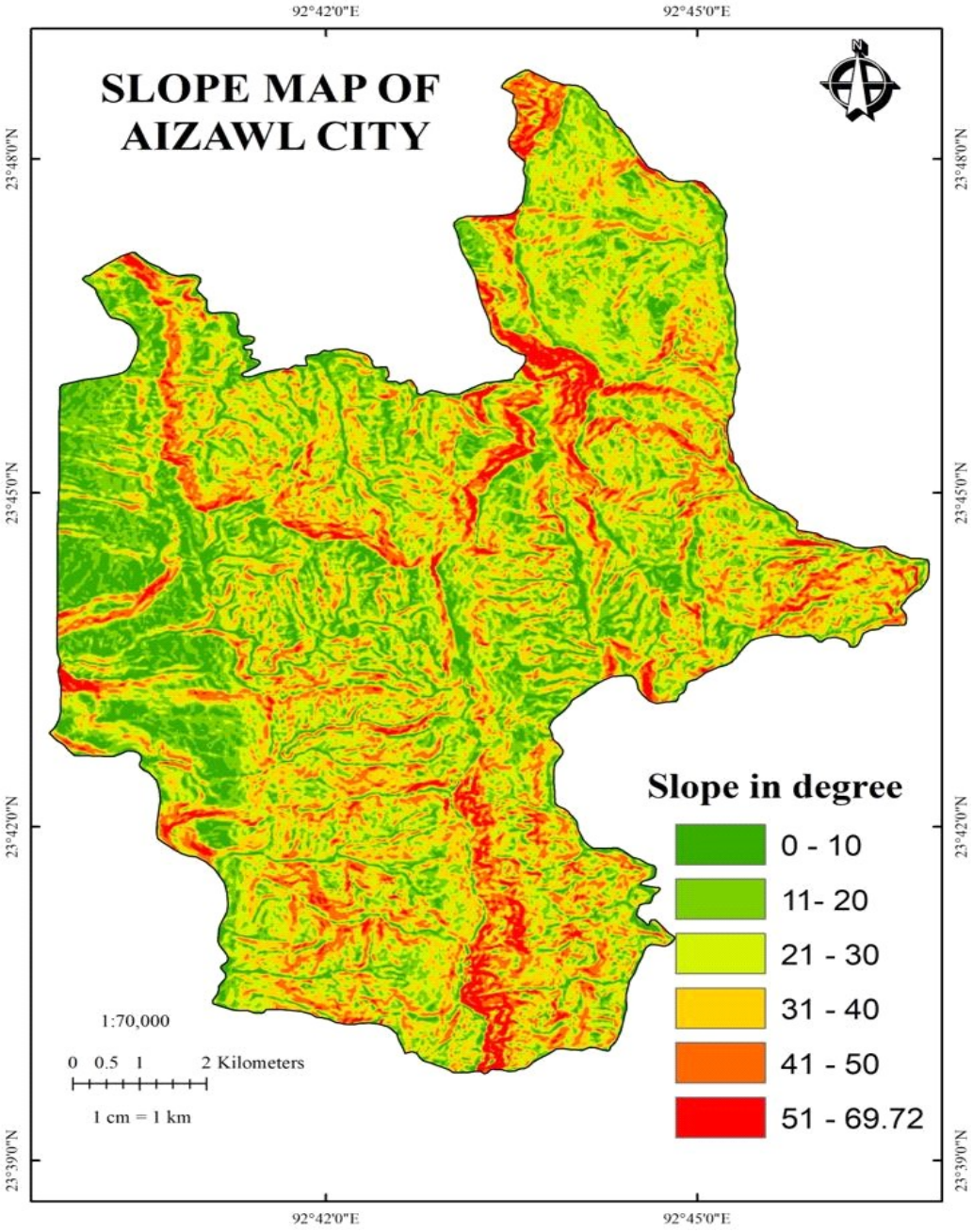


Figure 1. Slope Map of Aizawl City

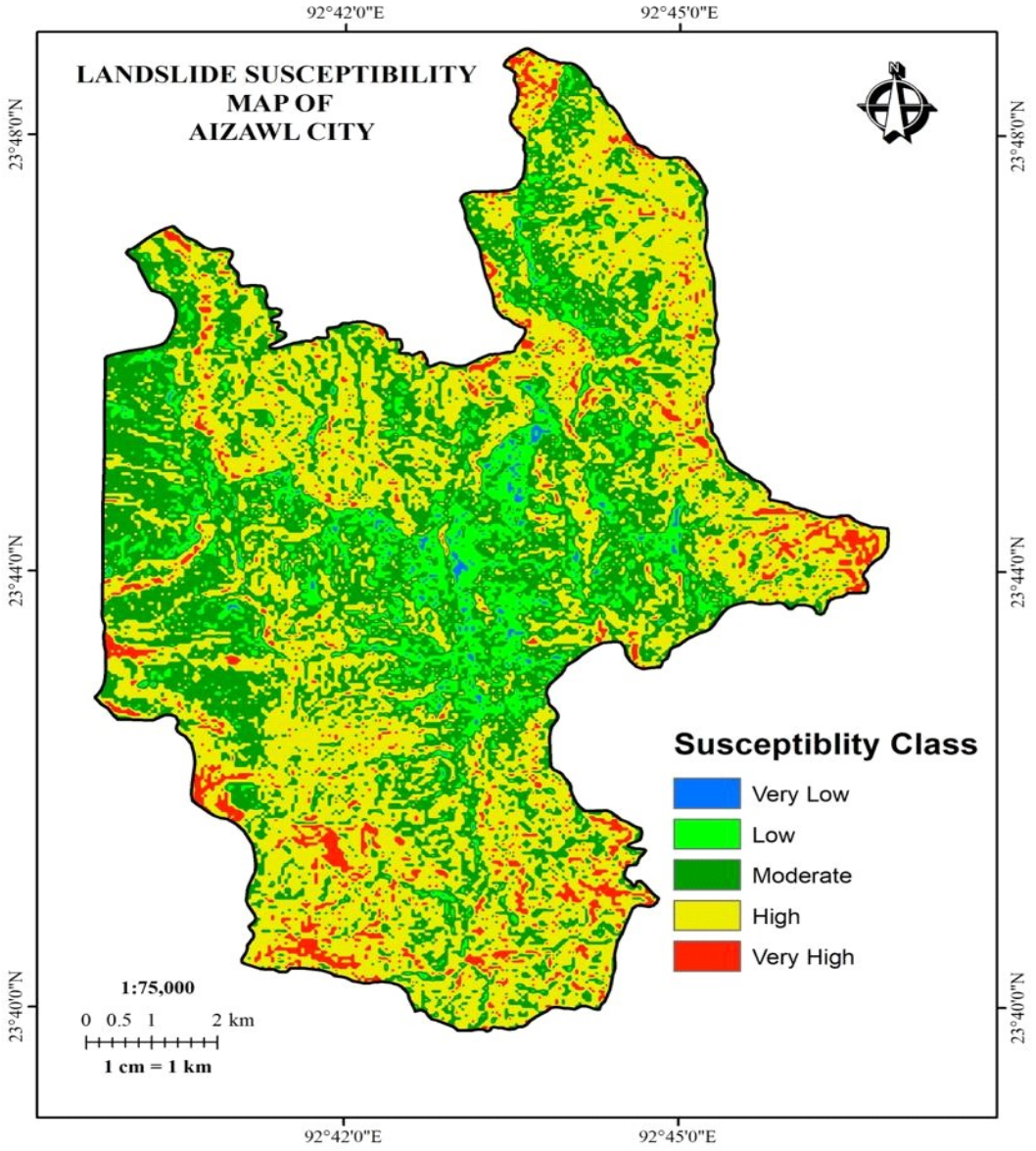


Figure 2. Landslide Susceptibility Map of Aizawl City

were neither satisfied nor dissatisfied. For measuring the residential areas' nature conditionsin disaster, two maps of Aizawl– Slope Map (Figure 1) and Landslide Susceptibility Zone Map (Figure 2) are generated from Alospulsar DEM and Weighted Overlay Methods, respectively, by using ArcGIS. The selected variables and their nature are mentioned in Table 1. Descriptive statistics like Mean and Standard Deviation Methods; and Pearson's Correlation Methods are used to analyse the data. Following Mohit et al. (2012), a Tenants' Satisfaction Index (TSI) is developed to integrate the satisfaction variables into one index. The formula is:

$$TSI = \frac{\sum_{i=1}^{N1} eq(s)_i + \sum_{i=1}^{N1} eq(b)_i + \sum_{i=1}^{N1} l(s)_i + \sum_{i=1}^{N1} l(b)_i + \sum_{i=1}^{N1} s_i}{\sum_{i=1}^{N1} EQ(s)_i + \sum_{i=1}^{N1} EQ(b)_i + \sum_{i=1}^{N1} L(s)_i + \sum_{i=1}^{N1} L(b)_i + \sum_{i=1}^{N1} S_i} \text{ X } 100$$

Where :
TSI is the Tenant' Satisfaction Index
N1, N2, N3, N4 and N5 are the number of variables selected for scaling under each component of residential environment
eq(s)i, eq(b)i, l(s)i, l(b)i, and si represent the actual score of the individual household on the ith variable in the earthquake (site), earthquake (building), landslide (site), landslide (building) and slope degree.
EQ(s)i, EQ(b)i, L(s)i, L(b)i, and Si are the maximum possible scores for the ith variable in the earthquake (site), earthquake (building), landslide (site), landslide (building) and slope degree.

5. Results

Descriptive analysis (Table 2) shows that the overall average satisfaction level of tenants regarding disaster is 3.98 out of 5 point scales. Among the five variables, tenants have the highest satisfaction with risk of occurrence of landslide (building) followed closely by occurrence of landslide on their house site. On the other hand, tenants have the least

Table 1. Selected variables and their nature

Section	Indicator	Data Type
Socio-economic Conditions	Age	Scale
	Sex	Dummy (If 1=Male. 0= Otherwise)
	Education Qualification	Categorical
	Family Size	Scale
	Income	Scale
Housing characteristics	Type of house	Dummy (If 1=fully concrete, 0=otherwise
	Age of Building	Categorical
	Duration of Staying	Scale
	Rental Value	Scale
Nature condition	Slope degree (Household)	Categorical
	Landslide Susceptibility Zone (Household)	Categorical

satisfaction with risk of occurrence of earthquake (building) and earthquake (site). The standard deviation (SD) shows that the perception of tenants shows greater variation on earthquake than landslide and slope degree.

Table 2. Average Satisfaction Score

Hazard/Disaster	Mean	SD
Earthquake (Site)	3.74	1.03
Earthquake (Building)	3.73	1.05
Landslide (Site)	4.15	0.85
Landslide (Building)	4.16	0.83
Slope Gradient	4.11	0.90
Overall	**3.98**	**0.93**

Table 3 shows the relationship between tenants' satisfaction on safety and the physical aspects of their residential environment. Expectedly, Pearson's Correlation showed negative relationships between satisfaction level and the two variables of physical environment viz. slope degree and landslide susceptibility. This means that tenants who lived in higher degree sloping zones and higher landslide susceptible zones have lower satisfaction levels. However, only the relationship between the slope degree and satisfaction levels is statistically significant at 99 per cent level of confidence.

Again, Pearson's Correlation is employed to determine the factors influencing the tenants' satisfaction regarding the disaster vulnerability of their residential environment (Table 4). To represent satisfaction level of tenants, an index called Tenants' Satisfaction Index (TSI) was derived by integrating the five indicators of satisfaction into one unit. Then, the TSI was correlated with eleven indicators which can be categorised into three groups like socio-economic conditions of the renter, the housing characteristics and the physical aspects of the location of the building. Among the socio-economic variables, the age of the respondents and household income show positive relationships with TSI and are statistically significant. The positive relationship indicates that older people were more likely to be satisfied than younger people, and households with higher incomes tend to be more satisfied than low-income households. Among the housing characteristics, housing type and building ageare significantly related to Tenants' Satisfaction Index (TSI). The positive relationship between satisfaction and type of housing stated that the renters

Table 3. Relationship between the tenants' satisfaction and nature conditions

Indicators	Earthquake (Site)	Earthquake (Building)	Landslide (Site)	Landslide (Building)	Slope Gradient
Slope Degree	-.177**	-.165**	-.131**	-.117**	-.116**
Landslide Susceptibility	-0.025	-0.066	-0.057	-0.055	-0.049

*** Correlation is significant at the 0.01 level (2-tailed)*

Table 4. Relationship between Tenants' Satisfaction Index and selected variables

Indicator	Pearson's r value
Age	.093**
Sex	0.053
Education Qualification	-0.041
Family Size	-0.036
Income	.087**
Type of house	0.074*
Age of Building	-0.08*
Duration of Staying	0.028
Rental Value	0.037
Slope degree (Household)	-.179***
Landslide Susceptibility Zone (Household)	-0.059

** Correlation is significant at the 0.10 level (2-tailed)*
*** Correlation is significant at the 0.05 level (2-tailed).*
**** Correlation is significant at the 0.01 level (2-tailed)*

who lived in a better quality building were more likely to be satisfied. On the other hand, the age of building showed a negative relationship, indicating that the renters who lived in the older building were less satisfied than the new building. Expectedly, slope degree and TSI have negative relationship which shows that respondents who lived in high degrees of slopes were less satisfied.

6. Conclusion

From our analysis, we observed that safety from natural disasters is not a priority for tenants as a few of them considered slope gradient and safety from disaster factors as the deciding factors of renting in Aizawl. Tenants' Satisfaction Index (TSI) is found to have positive relationship with age of respondents, household income, type of house, age of building and slope gradient. The younger, more educated generation has better awareness on disaster management sinceeducation plays a role in the perception of risk control regarding knowledge, understanding and preparedness as less educated are lessprepared than highly educated respondents (Ho et al., 2008; Rahman, 2019). It is also observed that tenants measured the safety of their residence mainly on the basis on the slope of the house site. If the slope is of the house site is gentle, their satisfaction on disaster is high. Moreover, household income and the nature of the building structure have significantly influenced the disaster risk perception. Higher-income renters have higher satisfaction with disaster safety. Moreover, the tenants who lived in better quality buildings and new buildings are more likely to be satisfied. Higher income has enabled them to choose their ideal

rental house, making them more satisfied than lower-income.

Disaster management and planning is an important issue in disaster-prone zones. Community participation is crucial in disaster management and plays an essential role in disaster response, mitigation, and management interventions. Disaster risk reduction measures are most successful when they directly involve the affected community. The present study found that the risk perception of natural disastersis low among older people. The behaviour of older people has a significant impact on the family and the community because they have higher authority in Mizo society. Creating awareness and training programmes on disaster management among older people is required and will significantly impact the disaster risk perception in Aizawl.

References

Akbar, Z., Suryaratri, R.D., Tri, Y.,Gumelar, G. andAriyani, M. (2020): Disaster Risk Perception and Household Disaster Preparedness : Lesson Learned from Tsunami in Banten. *Earth and Environmental Science,* 448, 012099, doi:10.1088/ 1755-1315/448/1/012099

Andersson, H. (2011): Perception of own death risk: An assessment ofroad-traffic mortality risk. *Risk Analysis: An International Journal,* 31(7): pp.1069–1082.

Bubeck, P., Botzen, W.J.W. and Aerts, J.C.J.H. (2012): A Review of Risk Perceptions and other Factorsthat influence Flood Mitigation Behavior. *Risk Analysis,* 32(9): pp. 1481 – 1495.

Chen, X.L., Zhou, Q., Ran, H. andDong, R. (2011): Earthquake-triggered landslides in Southwest China. *Natural Hazards and Earth System Sciences*. 12: pp. 351–363.

Çingi, T.G. and Yazgan, Ç.Ü. (2022):Examination of Risk Perception, Fear and Preparedness of Individuals Experiencing Earthquakes. *Journal of Disaster and Risk,* 5(2): pp. 656-668.

Cvetkovic, V. (2017): Disasterand risk research methodology: Theories, concepts and methods. *Belgrade: ZadužbinaAndrejevic.*

Cvetkovic, V. and Planic, J. (2022): Earthquake risk perception in Belgrade: implications for disaster risk management. *International Journal of Disaster Risk Management,* 4(1): pp. 69-88.

Fernandez, G., Tun, A.M., Okazaki, K., Zaw, S.H. and Kyaw, K. (2018): Factors influencing fire, earthquake, and cyclone risk perception in Yangon, Myanmar. *International Journal of Disaster Risk Reduction,* 28:pp. 140-149.

Galster, G.C. (1985): Evaluating Indicators for Housing Policy : Residential Satisfaction Vs MarginalImprovement Priorities. *Social Indicators Research,* 16: pp. 415-448.

Godovykh, M., Pizam, A. and Bahja, F. (2021): Antecedents and outcomes of health risk perceptions in tourism, following the COVID-19 pandemic. *Tourism Review,* 76(4): pp. 737-748.

Government of Mizoram (2020) : *Mizoram State Disaster Management Plan, 2020,* Disaster Management & Rehabilitation Department, Government of Mizoram, Chawnpui, Aizawl.

He, Z. and Zhai, G. (2015): Spatial Effect on Public Risk Perception of Natural Disaster : A Comparative Study in East Asia, *Journal of Risk Analysis and Crisis Response*, 5(3): pp. 161-168.

Ho, M.C., Shaw, D., Lin, S. and Chiu, Y.C. (2008): How Do Disaster Characteristics Influence Risk Perception? *Risk Analysis,* 28(3): pp. 635-643.

Ibem, E.O. and Aduwo, E.B. (2013): Assessment of Residential Satisfaction in Public Housing in Ogun State, Nigeria. *Habitat International,* 40: pp. 163-175.

Jones, E.C., Faas, A.J., Murphy, A.D., Tobin, G.A., Whiteford, L.M. and McCarty, C. (2013): Cross-cultural and site-based influences on demographic, well-being, and social network predictors of risk perception in hazard and disaster settings in Ecuador and Mexico. *Human Nature,* 24(1): pp. 5-32.

Miceli, R., Sotgiu, I. and Settanni, M. (2008):Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy. *Journal of Environmental Psychology,* 28(2): pp. 164–173.

Mohit, M.A., Ibrahim, M. and Rashid, Y.R. (2012) : Assessment of residential satisfaction in newly designed public low-cost housing in Kuala Lumpur, Malaysia. *Habitat International,* 34:pp. 18–27.

Nurjanah, N. and Rezza, A.M.(2021): Disaster Preparedness and Risk Perception : A Study in Bandung. *Tourism and Sustainable Development Review-Journal,* 2(1): pp. 32-38.

Paek, H.J. and Hove, T. (2017): Risk perceptions and risk characteristics, *In Oxford Research Encyclopedia of Communication,* Oxford University Press: New York, NY, USA. https://doi.org/10.1093/acrefore/9780190228613.013.283.

Qureshi, M.I., Khan, S.U., Rana, I.A., Ali, B. and Rahman, A. (2021): Determinants of people'sseismic risk perception: A case study of Malakand, Pakistan. *International Journal of Disaster Risk Reduction,* 55: pp. 102078.

Rahman, M.Z., Atun, F. and Martinez, J. (2022) : The Relationship Between DisasterRisk Perception and MultipleDeprivation : A Study on RangpurCity, Bangladesh, Using Geospatialand Statistical Approaches. *Environment and Urbanization,* 13(1): pp. 27–43.

Shapira, S., Aharonson-Daniel, L. and Bar-Dayan, Y. (2018) : Anticipated behavioral response patterns toan earthquake : The role of personal and household characteristics, risk perception, previous experience and preparedness. *International Journal of Disaster Risk Reduction,* 31: pp. 1-8.

Shaw, R., Kobayashi, K.S.H. and Kobayashi, M. (2004): Linking experience, education, perception and earthquake preparedness. *Disaster Prevention and Management,* 13(1): pp. 39-49..

Slovic, P.(1987):Perception of Risk. *Science,* 236: pp. 280-285.

Sund, B., Svensson, M. and Andersson, H. (2017) : Demographic determinants of incident experience andrisk perception : Do high-risk groups accurately perceive themselves as high-risk? *Journal of Risk Research,* 20(1): pp. 99-117.

Yildiz, A., Dickinson, J.,Priego-Hernández, J. and Teeuw, R. (2023): Children's disaster knowledge, risk perceptions, and preparedness: A cross-country comparison in Nepal and Turkey. *Risk Analysis,* 43: pp.747–761.

Prof. RINTLUANGA PACHUAU (1962 - 2022): An obituary

- Prof. Rualkhuma Colney
Founder President, GAM

A beloved son of Rev. Sapbawiha (L) and Mrs. Tlangsawikungi @Lapuii, Prof. Rintluanga Pachuau passed away at Aizawl, Mizoram on the 29th September, 2022, after suffering from cancer since 2018. The Professor was first referred to Tata Hospital, Kolkata and then to the Fortis Hospital, Gurgaon for operation. Thereafter, he again got operated at the BLK-MAX, Delhi on 30.10.2022. While he was continuing to take treatment at his residence, he happened to be hospitalised at P.C. Synod Hospital, Durtlang,Mizoram on 14.09.2022. He ultimately breathed his last on the 29th September, 2022 (4:15p.m).

Prof. Rintluanga Pachuau attended Primary and Middle Schools at Electric Veng, Aizawl and passed HSLC from KM High School, Dawrpui Vengthar, Aizawl. He graduated from St. Edmund's College, Shillong, Meghalaya in 1983. He obtained Master Degree (1985) First Class; M.Phil (1988) 'O' Grade and Ph.D (1992) from Department of Geography, NEHU, Shillong, Meghalaya without break in between. The Professor obtained his Doctorate Degree (Geography) at his young age of 30 and he was presumed to be one of the youngest scholars among his community, to obtain such a coveted degree.

Prof. Rintluanga Pachuau served as a Technical Assistant in the Department of Geography, NEHU, Shillong, during 1988-1992. Thereafter, he joined Pachhunga University College (PUC), Aizawl, Mizoram as a Visiting Fellow during 1992-2004. Ultimately, he joined the Department of Geography & Resource Management, Mizoram (Central) University as a Lecturer in 2004. Then he was promoted to Associate Professor in 2008 and become a Professor w.e.f. 09.11.2015.

Having obtained Ph.D at a young age, and he being the second Mizo scholar to obtain Ph.D. degree in Geography discipline, he had to take initiative and bear responsibility in pioneering and developing Geography discipline in the Mizo community, particularly as a subject at School and college levels. Apparently, he become the first person to write a book on the "Geography of Mizoram" (1992). His another book, 'Mizoram: A Study in Comprehensive Geography' is rightly included among the Text books for UG Course (Geography) under Mizoram University.

Prof. Pachuau had successfully guided out four (4) Ph.D Scholar and breathed his last leaving 4 Ph.D scholars working under his supervision, unfortunately. He has published three books and 30 research papers. He was one of the founding leaders of Geography Association of Mizoram (GAM), established in 2001 and was the first

Secretary of the Association. Under his able leadership as the Secretary of GAM in pressurising MZU authority, the Department of Geography and Resource Management, Mizoram University, was established in 2004. The he happened to hold almost all Office Bearer (OB) posts of GAM and held President's post during 2010-2016.

Mention cannot but be made of the Geographic, a journal published by the GAM as he pioneered and took initiative for its publication and become the first editor. His tenure as the editor lasted from 2008 to 2021. His untimely demise is a great lost to GAM and Geographic for he played such a huge and important role.

Prof. Pachuau proved himself to be a good Geographer and a researcher. He, as a geographer and a researcher was always interested to see the authenticity of the existing record as to the geographical or global location of Mizoram, including the exact point at which the Tropic of Cancer crosses Mizoram, i.e. the 23.30 degree North Latitude. As per the existing official record, the Tropic of Cancer (ToC) crosses Mizoram at the point near Thenzawl which is about 91 Km away from Aizawl. Prof. Pachuau, with his untiring efforts proved that the ToC cuts Mizoram, not at the point near Thenzawl but rather at Maubuang (Aizawl to Thenzawl road), about 33 Km away from Aizawl. Prof. Pachuau mentioned about the matters in his book, 'Geography of Mizoram' (1992, p. 23). Therefore, at the point identified by Prof. Pachuau, not being contested at any level, GAM, in collaboration with the Mizoram Remote Sensing Application Centre (MIRSAC) had erected the Landmark (Plaque and Signboard) on the 19th July, 2016, to exhibit that the Tropic of Cancer crosses Mizoram at the point.

Prof. Pachuau was a man of letters. He was also a proactive person in various walks of life. Beside his active involvements in his professional assignments and duties, he also endeared himself and participated in various Church and NGOs as well. He was good in sports too. He had been holding important Office Bearer posts both in the Mizoram Football Association and Mizoram Rifles Association for years together.

Prof. Pachuau married to S. Thangrimawii @Nutei, on the 15th December, 1995. They have three children, Rinthara Pachuau (L), RinfelaPachuau and Rinhlupuii Pachuau. His wife, Nutei is an Associate Professor, Department of Zoology, Govt. Zirtiri Residential Science College, Durtlang, Mizoram.

Prof. Rintluanga Pachuau was a builder and backbone, not only of GAM but the Department of Geography &Resource Management, MZU. The GAM pays homage to his departed soul and prays that God be with his bereaved family.

Return If Possible!

cut here

To

The Secretary
Geography Association of Mizoram
Department of Geography & RM
Mizoram University
Aizawl - 796004

Sub : Life Membership

Sir,

I am seeking a Life Membership to the Geography Association of Mizoram with immediately effect.

☐ I am sending Cash Amount/Demand Draft/Bank Cheque of Rs. 1000/- (Rupees One Thousand Only) in favour of Secretary, GAM, Aizawl.

OR

☐ I deposited Rs. 1000/- (Rupees ONe Thousand only) in favour of Geeography Association of Mizoram at Account No. 1548050000727 of Punjab National Bank, IFSC Code - PUNB0154820, Mizoram University Branch, Tanhril, Aizawl vide receipt/counterfoil No.....(enclosed herewith).

I promised to abide with the constitution of the Association.

Yours faithfully,

Place :
Date :

Signature :_____
Name :_____
Address :_____
Phone :_____
Email :_____

cut here

cut here

cut here

GUIDE TO THE CONTRIBUTORS

Geographic welcomes contributors from scholars of various branches of geography and allied disciplines, which have interface with geography.Papers sent for publication in the journal must have originality in one form or the other. If the paper sent for publication is recommended by the referee(s), the author(s) have to pay a publication charge an amount of Rs. 2,000/- for single author with which has to be increased by Rs. 500/- per additional author(s). The publication should be credited to Punjab National Bank, Mizoram University Branch, Aizawl in the name of the Secretary, Geography Association of Mizoram (PNB Account No. 1548050000727, IFSC Code - PUNB0154820). The payment receipt then be sent to the Editor.

Submission of Manuscript: Authors should submit a soft copy of the manuscript with original artwork and abstract to *geographic.gam@gmail.com.*

Title Page: The title page of the papers should contain the full title, name(s) of the author(s) and their full address.

Abstract: The paper should contain abstract of 50 - 150 words which should be kept in the opening of the paper.

Illustration: Illustration should be properly kept at appropriate places in the manuscript in their final forms. They should be numbered in order in which they are referred to in the text.

Tables: Tables should be numbered and headed with short titles. Consecutive numbers in brackets should indicate them in the text. They should also be properly kept at appropriate places in their final forms.

Reference: Details of references shouldbe listed at the end of the text in alphabetic order, using the following styles:

For books:

Peet, R. (1998) : *Modern Geographical Thought*. Wiley-Blackwell, New Jersey.

For articles:

Kumar, G. (2007) : Process of Urbanization in Developing Regions : A Case Study. *Geographic*, 2 (1):pp. 4-10.

The Editorial Board has right to accept or reject the papers for publication as per the recommendation of the referees.

GEOGRAPHY ASSOCIATION OF MIZORAM (GAM)

(Regn . No. SR/ MZ - 7 of 1983 – 84)

Office: Department of Geography, Mizoram University, Aizawl - 796004

EXECUTIVE COMMITTEE (2022-2025)

OFFICE BEARERS

President	:	Dr. K.C. Lalmalsawmzauva
Vice President	:	Dr. Lalrinmawia
General Secretary	:	Prof. Benjamin L. Saitluanga
Asst. Secretary	:	Dr. Vanlalṭanpuia
Treasurer	:	Dr. C. Nunsiamliani
Fin. Secretary	:	Mrs. F. Vanlalhmangaihsangi

EXECUTIVE MEMBERS

Dr. R. Ramthara	Prof. Rualkhuma Colney
Mr. C. Lalhumbika	Dr. C. Hmingsangzuala
Dr. Bobby Beingachhi	Dr. Lalrinpuia Vangchhia
Dr. PC Lalrohlua	Dr. David B. Lalhruaitluanga
Mr. R. Lalruatkima	Mr. K. Lalkroschhuanga
Mr. Gabriel Lalchhandama	Dr. C. Ramhnehzauva
Mr. Francis Zodinthara	Dr. Lalnghakmawia Thangluah
Ms. Janet Laltlansangi	Mr. KC Lalruatkima
Mr. Lalremruata Sailo	Mr. Lalhmangaihzela
Mr. Zoramkhuma	

The membership of GAM is open to geographers and all scholars from allied disciplines. The membership fee is as follows:

Membership Fee

Life Membership (Individual)	-	Rs. 1,000/-
Institutional (Life)	-	Rs. 2,000/-

Correspondence for membership of the Association should be directed to Secretary, GAM, email : geographic.gam@gmail.com or Phone : 9856537375