HAZARD RISK
&
VULNERABILITY ANALYSIS
OF
AIZAWL DISTRICT

Prepared by
MIZORAM REMOTE SENSING APPLICATION CENTRE
AIZAWL, MIZORAM

Sponsored by
DISASTER MANAGEMENT & REHABILITATION DEPARTMENT
GOVERNMENT OF MIZORAM

FOREWORD

Disaster strikes unexpectedly and changes the lives of all that it touches. The effects of these disasters are also felt long after the event. The traditional approach adopted in managing disasters have been reactive with activities mainly focused on disaster relief. However, recently there is paradigm shift in this approach from relief centric to proactive prevention and mitigation centric approach. Hazards are a part of the natural and man-made environment. Hence, exposure to hazards and risks of disastrous consequences must be considered in all development planning. This has necessitated the study of hazard risk and vulnerability analysis for the plausible impending disaster within Aizawl district. It is essential that government bodies responsible for undertaking developmental activities and planning be fully aware of the impact of natural and man-made hazards on societies and economies. This itself may require certain institution-building initiatives during both the preparation and the implementation of the state and district level programmes and initiatives.

The advent of Space Technology has enabled us to generate detail maps in various fields using Satellite Remote Sensing Technology and Geographic Information System (GIS), which can be quantified and brought to the administrative mode to facilitate its effective use in planning and execution. In this regard, the Mizoram Remote Sensing Application Centre (MIRSAC), Science & Technology has taken up this project on Hazard Risk and Vulnerability Analysis of Aizawl District, Mizoram. The data collected and its analysis gives a perspective of the potential hazards and its possible spatial effects within the district. It also incorporates a database of available critical facilities in the district which can be linked with disaster management processes for effective planning of mitigation and rehabilitation activities.

I hope the report prepared by the Centre will be very useful to the DM & R Department and those involved in disaster management and I appreciate the hard work and efforts given by the Scientists of MIRSAC, Science & Technology for successfully completing the project. I hope this project report will provide valuable support to planners and decision makers engaged in formulating Disaster Management Plans especially for identification of seismically weaker areas, land slide prone areas, cyclone and flood prone areas and adopting appropriate preventive measures.

(PC. LALLAWMSANGA)
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Dated Aizawl
22nd March, 2013

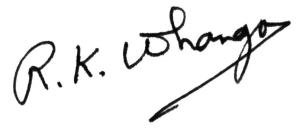
PREFACE

A hazard is a rare or extreme event in the natural or man-made environment that adversely affects life, property or activity to the extent of causing a disaster. It is an ever-present, inescapable part of life. Risk is sometimes taken as synonymous with hazard but risk has the additional implication of the chance of a particular hazard actually occurring. Thus, we may define hazard as a potential threat to humans and their welfare and risk as the probability of hazard occurrence.

Mizoram is vulnerable to natural calamities like landslides, earthquake, cyclone and flash floods. As such, it can be said that the State is a multi-hazard prone area owing to its natural physiographic form which has an inclination towards being more vulnerable to natural calamities. This necessitates a thorough understanding and study of such impending disasters so that proper mitigation measures and certain level of preparedness can be adopted before a disaster strikes. Mapping of vulnerable areas and disaster prone sites are thus pre-requisites for achieving a concise database required for studying hazards that can cause serious disruption to the functioning of a society, loss of human life, public and private property.

In this context, the preparation of Hazard, Risk and Vulnerability Analysis has been taken up for Aizawl District. The analysis has been done using Remote Sensing and GIS technology which is proven to be a dynamic and reliable technology-platform for producing accurate information required for disaster management. This study incorporates the analysis of different aspects of natural disasters that are prevalent and forecasted in the district. The data generated from these analysis will be a valuable source of information during the pre and post disaster management processes. The inclusion of critical facilities mapping in this analysis will be an added advantage for planning of rehabilitation procedures during and after disaster incidences.

I am very grateful and place on record my gratitude to the Department of Disaster Management & Rehabilitation, Govt. of Mizoram for giving this opportunity to work on Hazard, Risk & Vulnerability analysis of Aizawl District. I am sure that the data generated from this project will be helpful for further disaster management planning, rehabilitation and other decision-making processes for Aizawl District.



(DR. R.K LALLIANTHANGA)
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22nd March, 2013

CONTENTS

CHAPTER I

INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Natural disasters like earthquake, landslides, cyclone, floods and volcanic eruption, etc. have always constituted a major problem in many developed and developing countries. The State of Mizoram with its relatively immature topography, fragile geologic base and active tectonics is vulnerable to various natural hazards like landslides, earthquake, flood, etc. The geographical location of Mizoram also subjects it to various climatic features that make it more susceptible to monsoon storms or cyclone. In recent years, the growth of population with unplanned development of settlements in steep slopes and other hazardous areas have increased their relative vulnerability towards natural hazards. However, most natural catastrophic events are basically complex phenomenon caused by a large set of factors; such as unstable slopes, tectonic movements, river dynamics, geological settings, climate change, etc, of which several are ill-known or un-mappable. Thus, prediction of hazards in space and time is, however, a very difficult task. It requires the acquisition of various resource maps in spatial domain, large number of historical records and sophisticated models for assessing nature of disasters and vulnerable areas. In spite of these constraints, several sound hazard investigations have been carried out and some of them constitute a reliable starting point for evaluating future hazards, social and physical vulnerability towards them and aimed to assess risk within an area.

The project on *Hazard Risk and Vulnerability Analysis of Aizawl District* is initiated following the request made to the Centre by Disaster Management & Rehabilitation Department, Govt. of Mizoram (Letter No. B.13012/72/2010-DMR. Dated 13th April 2010). The main concept of the project lies in the preparation and systematic analysis of data for hazard zonation of natural disasters occurring in the State. As highlighted in the project name, Aizawl district is studied for deriving the data mentioned in the objectives of the project and the project report is prepared not for Aizawl city only but for the whole district. These data were generated using Remote Sensing and GIS technique for its effective use in disaster management activities and allied planning purposes.

Aizawl district, like other districts of the State, is characterized by hilly terrain, steep slope and high relief with complex structural dispositions, and is geologically immature. It is, therefore, prone to all types of natural disasters such as landslides, earthquake, flood or cyclone. Being the State's district headquarter and owing to its economic importance, the study of natural disasters and its implication is necessary so that concerned departments and agencies can take mitigation measures when and where these disasters happen. As such, the natural disasters comprising of Landslide, Cyclone, Earthquake and Flood has been studied for Aizawl district. Hazard zone maps and statistics for each of these disasters are also prepared in Atlas form.

The project utilizes Remote sensing and GIS techniques for extracting data required during the process of risk and vulnerability analysis for the mentioned natural disasters. These data have been captured in a GIS environment which will facilitate further updation and analysis, if necessary. In this respect, the efficiency of a GIS environment in the updation process is well known and data that is updated will be reflected in the consequent maps prepared.

1.2. OBJECTIVES

The following are the main objectives of the project:

1) Hazard mapping for Landslide, Earthquake, Cyclone and Flood on 1:50,000 scale

2) Generation of Multi-hazard map.

3) Physical, Environmental and Socio-economic vulnerability mapping and analysis at block level.

4) Risk Assessment integrating hazard and vulnerability analysis.

5) Analysis on critical infrastructure and resources.

1.3 PHYSICAL SETTINGS

1.3.1 Location

Aizawl district is situated in the northern part of Mizoram, between 24ę 25' 16.04" and 23ę 18' 17.78" N latitudes and 92ę 37' 03.27" and 93ę 11' 45.69" E longitudes. It is bounded on the east by Champhai district and Manipur State, on the west by Mamit district and Kolasib district, on the north by Cachar district of Assam State and on the south by Serchhip district. The total geographical area of Aizawl district is 3576.00 Sq.km. and accounts for 16.96% of the total geographical area of the State. Aizawl district falls within the Survey of India topo sheet nos. 83D/15, 83D/16, 84A/9, 84A/10, 84A/11, 84A/13, 84A/14, 84A/15, 84E/1, 84E/2, 83H/3 and 83H/4. The location map of Aizawl district is shown in Figure No. 1.3.1.

1.3.2 Climate

The climate of Mizoram, as a whole, is controlled by its location, physiographic, pressure regime in the North West India and Bay of Bengal, warm and moist maritime tropical air masses from the Bay of Bengal, local mountain and valley winds. In addition, the Chin Hills, Arakan Yoma Hill tracts and Chittagong Hill tracts also play an important role in shaping the climatic condition of the State.

The climate of Mizoram is of Tropical Monsoon type. Hence, Aizawl district in the north-central part of the State enjoys a moderate climate owing to its tropical location. It is neither very hot nor too cold throughout the year. Aizawl district falls under the direct influence of the south west monsoon. As such, the area receives an adequate amount of rainfall which is responsible for a humid tropical climate characterized by short winter and long summer with heavy rainfall.

1.3.3 Temperature

General information about the temperature of Aizawl district is generated through the analysis of the temperature data obtained from Directorate of Science and Technology, Government of Mizoram and Meteorological Centre at Pushpak, Zemabawk for a period of twenty six years i.e. 1986 ï 2011 and the temperature data is shown in Table No. 1.3.1. and in Figure No. 1.3.2.

The salient thermo-characteristics of Aizawl district is that, temperatures do not fluctuate much throughout the year. The highest temperature observed during the last twenty six years was recorded to be as high as 36.7 ^{o}C in the month of April, 1999. March, April and May are the warmest months for the whole year with average monthly maximum of 31.7°C, 32.8°C and 32.3°C respectively and the average monthly minimum temperatures for the same months are 22.3°C, 23.2°C and 23.9°C respectively. The temperature remains high till the month of September; however, the enduring monsoon brings down the temperature.

The temperature starts to fall down sharply from the month of November and reaches its minimum during December and January. January is the coldest month with an average mean temperature of 17.4°C and an average monthly minimum of 8.5°C, while the average monthly minimum in December is 10.2°C. However, the lowest minimum temperature recorded was 5.4°C on December, 1991.

1.3.4 Rainfall

The entire state of Mizoram is under the direct influence of south west monsoon. Hence, Aizawl district also receives an adequate amount of rainfall during the monsoon season. The study of the available rainfall data reveals that, generally, heavy rainfall starts from the second part of May and this heavy downpour usually ends in the first part of October. The average rainfall of Aizawl district is 3155.3 mm per annum and the highest rainfall received during a particular month was 2777.8 mm recorded in September, 2010. Precipitation is heavy during summer. The coincidence of the occurrence of south west monsoon and summer makes the climate favourable for inhabitants since the temperature is lowered to a considerable extent by the rains. In Aizawl district, July to September are the months receiving high rainfall while December, January and February are the driest months. The monthly rainfall data recorded for twenty years are shown in Table No. 1.3.2, the monthly average rainfall and maximum & minimum rainfall of the district is also shown in Figure No. 1.3.3.

1.3.5 Humidity

Humidity is a general term referring to the water vapour content of air at any one time and place. Of the various components of atmosphere, water vapour constitutes only a small fraction varying from nearly zero to about 4 per cent by volume. However, the meteorological significance of even a very small percentage of water in the air cannot be over-emphasized. In fact, in the heat budget as well as in day to day weather changes that we observe, atmospheric moisture plays a very important role. Relative humidity is the ratio of the airôs water vapour content to its water vapour capacity and being directly related to the rate of evaporation, it affects manôs comfort. From the Table No. 1.3.3 and Figure No. 1.3.4 we can see the average relative humidity for Aizawl district for a period of twenty one years is 78%. As seen from the table, this percentage is not varying much throughout the district since the weather condition of different parts of the district are more or less the same. The higher the humidity value, slower is the rate of evaporation. Hence, because of high relative humidity, the rate of evaporation from the soil is somewhat slow and vegetations get the benefits.

1.3.6 Soil

The soils are mostly red and yellow loamy. The soil is acidic in nature due to heavy rainfall. It contains high amount of organic carbon and is high in available nitrogen, low in phosphorus and potassium content. On the basis of rainfall and humidity, the soil moisture regime is classified as Udic. Classification of soils of the district have been done according to soil taxonomy (USDA 1994) on the basis of their physico-chemical and morphological properties. The soils found at order level are: - (1) Entisols (2) Inceptisols and (3) Ultisols. Base on the physical and chemical properties of the soil, 14 soil series were categorized for Aizawl district. These soils are formed under humid sub-tropical with mean annual rainfall of 3155.3 mm. The pedons comprises of mixed mineralogy and hyperthermic temperature class. The soils of Aizawl district are mainly deep to very deep, dark yellowish-brown to brown, sandy clay loam to clay in texture, weak to medium sub-angular blocky. The soils are acidic in nature and the pH ranges from 4.5 to 6.5. The soils found on steep slopes are well drained where as those found on valley plains are poorly drained.

1.3.7 Geology and Geomorphology

The district occupies the north-central part of the State and represents a monotonous sequence of argillaceous and arenaceous rocks, which are classified by Geological Survey of India into two formations viz., Middle Bhuban and Upper Bhuban Formations. The formations are folded into almost N ï S trending anticlines and synclines and affected by longitudinal, oblique and transverse faults of varying magnitudes. An attempt has been made to classify the rocks into various stratigraphic divisions, but lack of any characteristic rock type and index

fossils make it difficult to classify in detail. Therefore, the formations are classified into two, on the basis of lithological assemblage and sedimentary structures.

Structure: The structural elements noticed in the area are both primary and secondary in nature. The beds generally trend N-S to roughly NNW-SSE and dip on either side from 15° to 65° with local variations at the vicinity of faults.

Primary Structures: The rocks of the area exhibit various types of primary sedimentary structures which are useful in understanding the environment of deposition. The sediments show prominent primary bedding. Laminated bedding is common in some cases. Bedding is the most common sedimentary structure observed in the rocks of the study area. The thickness of bedding varies from few centimetres to more than a metre. Flaser and lenticular bedding are common structures observed in sandstone unit. Cross bedding is also observed in certain sandstone units. They are noticed in both middle and upper Bhuban Formations. Both planar and trough type cross bedding are noticed within the fine grained sandstone unit. Ripple marks are another important primary structures observed in the rocks. They are preserved at many places especially where the fine sediments dominate. The morphology of the ripples varies widely. Linguoid, rhomboidal and parallel crested ripples occur in close association at number of places. In thickly bedded sandstones, ripple drift lamination, both in-phase and out-phase is common. These structures indicate shallow marine to deltaic environment of deposition for the sediments.

Secondary Structures: The thick sedimentary sequences of the area have been folded into a number of anticlines and corresponding synclines. The general strike of bedding is N 30° E ï S 30°W which swerves to N 30° W to S 30° E in the north ï central part of the mapped area. The axial trace of the synclines follows the prominent river valleys and their corresponding axial traces of anticlines passes through the ridges (sometimes along the flanks of the ridges). Generally, the anticlines are having sharp crests while the corresponding synclines are relatively having broader troughs. At certain places, the strike of the beds is obliterated because of faulting. The joints are generally tight and widely spaced except in the shale bands where they are closely spaced.

The lineaments are mapped using the Digital Elevation Model, Satellite imagery and ground checks. Some lineaments which are confirmed by other reports and study are classed as Faults, while other lineaments which show lateral displacements are referred to as Inferred Faults and other major lineaments with no prominent displacements are classed as Lineaments. The area has been affected by a number of faults of varying magnitude. They are mostly transverse/oblique in disposition, except Uaithlâk lui ï Sêr lui Fault located between Sâmtlâng and Lunglêng villages, which is longitudinal in disposition. Major oblique faults are Châmgte Fault, which divides Sialsûk and Châmring villages; Chite Fault and Chakai lui Fault which are located within Aizawl city; Muthi lui ï Sabual lui Fault which cuts across the Tuirial river; Sihdarh lui ï Tuirini lui Fault which runs in between Tualbung and Hriangtlâng villages; Matai lui Fault in the northern part of the district, and Rawkawn lui Fault near Suangpuilawn village. The faults are delineated with the help of Satellite Imagery, SOI topographical maps, field criteria like shifting of axial plane, course of the rivers, etc and subsequent ground check. The general trend of the oblique faults is roughly NNW-SSE. In some cases, the throw of the fault could not be measured or estimated due to the absence of any marker horizon. Presence of other minor faults is indicated in the area by reversal of dips. As the area is a part of a linear belt of folds which comprises not only Mizoram but also its adjoining areas, the area bears tectonic marks of folding and faulting. The dislocation and the deformation of strata gave rise to linear structural features in the area. The prominent directions are NNW ï SSE and E-W, and the less prominent ones are in almost all direction e.g. NNE ï SSW. The lineaments are varying in lengths. The total length of lineaments (including faults and inferred faults) is 101.06 km.

Lithology: The Surma Group of rocks is represented in the area by Middle and Upper Bhuban Formations. The Middle Bhuban Formation is mainly a thinly bedded sequence with sandstoneï shale/siltstone ratio of about 50:50, with mudstone. Sandstone are fine to very fine grained, ash to bluish grey in colour, compact and hard, thinly bedded; rarely yellowish brown medium grained and friable. Few thick beds of sandstones are found in some areas. Shale and Siltstone are dark grey and grey in colour and usually splintery. This group of rocks occupies the core of anticlines, flanked on either side by the rocks of Upper Bhuban Formation. A few thickly bedded sandstone bands are noticed at certain places. These beds are important source of building and road construction materials in the area, and they form the main ridges of the area. The contact between Middle and Upper Bhuban Formations is gradational and transitional. The Upper Bhuban Formation occupies the core of Tlawng, Tuirial, Tuivawl and Tuirini synclines, and the lithology in these areas is mainly represented by shale ï siltstone and little mudstone. The arenaceous ï argillaceous ratio is about 50:50 in the lower part and 80:20 in the upper part of the formation. Geomorphically, this unit occurs as subdued hills giving rise to hummocky topography.

The lithological mapping was done with the help of topography and field checks, and is divided into five litho classes, viz., Sandstone, Siltstone and Shale, Limestone. In addition to these, recent alluvium deposits are observed and mapped, and have been classified into two classes, viz., Gravel, Sand & Silt, and Clayey Sand. Sandstone, the harder rock formation is found mainly along the ridgeline owing to its resistance to erosion, and it covers an area of 1279.50 sq.km., which is 35.78 % of the total area. Siltstone and Shale, are put together as they are almost inseparable, and this unit cover majority of the district with a total area of 2264.08 sq. km., which is 63.31%. Gravel, Sand and Silt are found along the major rivers i.e, Tlawng, Tuirial, Tuivawl and Tuirini rivers and covers an area of 5.42 sq. km which is 0.15 % of the total area. Clayey Sand deposits are found scattered all over the area along small streams and covers an area of 25.52 sq. km., which is 0.71 % of the district area. Limestone is found in small outcrops near Muthi village and along the banks of Tuirial river which covers about 1.47 sq. km i.e, only 0.05 % of the district area. The statistics of Lithology is given in Table No. 1.3.4 and the Geological Map is shown in Figure No. 1.3.5.

Sl No.	Rock Types	Area (Sq. Km.)	%
1	Sandstone	1279.50	35.78
2	Siltstone & Shale	2264.08	63.31
3	Limestone	1.47	0.05
4	Clayey Sand	25.52	0.71
5	Gravel, Sand & Silt	5.42	0.15
	Grand Total	**3576.00**	**100.00**

Table 1.3.4. Lithological statistics of Aizawl district

Geomorphology is essentially the study of relief features of the earthôs surface and factors that produced them. The main features of the district area are briefly summarized below:

Topography: The area is characterised mainly by six main ridgelines and intervening valleys and less prominent ridges. On the western flank of the district runs Tlawng river flowing for a total distance of about 87.45 km. It flows along a relatively small valley and dissected terrain which has practically no large flood plain. On the eastern side of Tlawng river runs a highly dissected ridge line, which starts from Tahreuh tlang near Chamring village towards northwest till Maubuang village and continues in northerly direction and extends upto Aizawl city whose total length is about 45.3 Kms. This ridge line varies in height. It attains a height of 1619 metres near Chamring, 980 metres near Aibawk, and 1156 metres at Tlangnuam and 1188 metres at Laipuitlang. This ridge line terminates at Bawngkawn saddle. Another ridge line continues in the northern side from Durtlang (1383 metres) and continues

towards Sihphir and Neihbawih tlang (1441 metres) and extends all the way to Kolasib district. The total length of this ridge within the district is about 10.12 km.

On the eastern side of these two main ridges runs Tuirial river which originates near Chawilung village in the south and flows through the central part of the district until Kawrbel lui joins it. It then flows along the northwest boundary of the district in the northward direction. The total length of the river within the district is about 153 kms. On the eastern side of Tuirial river, which is the central part of the district, another major ridge line starts from Phulmawi village (1149 metres) in the south and continues towards Tlungvel (1288 metres, Thangnang tlang) and Thingsulthliah (1052 metres) villages. It continues in the northward direction through Sesawng and ends near Mualmam village. The total length of this ridge is about 30 km. Another ridge runs in the northern side near Hmunzawl village (880 metres) and ends near Sunhluchhip village (1040 metres). The total length of this ridge is about 18 kms. This ridge is terminated by a small stream (Tuitla lui) and the ridge line continues towards the northern side from Dil tlang (704 metres) and passes through Buallawn village (880 metres) and terminates at Tuisual stream, below Thingsat village. The total length of this ridge line is about 12 kms. Another ridge line starts near Zohmun village (Darlak tlang, 672 metres) and continues towards Suanglawn tlang (872 metres) and ends at Hmunte tlang (695 metres). The total length of this ridge line is about 18 kms.

In the middle portion of the district, runs Tuirini river near Phulmawi village in the south and flows in the northward direction and joins Tuirial river in the west of Hmunnghak village. The total length of Tuirini river within the district is about 40 kms. On the eastern side, flows two major rivers, namely Tuivawl and Tuivai rivers, both of which flows in the northward direction. The Tuivawl river forms the south-eastern boundary of the district. It flows through the district near Saisih tlang (802 metres) until it drains itself into Tuivai river near Ratu village in the north. The total length of Tuivawl river is about 80 kms. Tuivai river, on the other hand, forms the north-eastern boundary of the district. It enters the district near Daido village and flows towards south and forms the eastern boundary of the district until Tuiphal river joins it. It then flows in the northward direction and ultimately drains itself into Tuiruang river (Barak) in the north. The total length of this river within the district is 98 kms.

In between Tuivawl and Tuirial rivers, runs another major ridge line which starts from Tualbung village (1309 metres) and continues through Chalfilh tlang (1866 metres) and passes through Pehlawn, Kepran (1525 metres), Darlawn (1258 metres) and Ratu (902 metres) villages. It ends around 7.5 kms. north of Ratu village. The total length of this ridge line is about 52 kms. On the south eastern side of this ridge, another ridge line originates from Tawi tlang (1837 metres) and continues toward north through Ruallung (1350 metres) and Saitual (1202 metres) villages and ends near Sihfa village (1278 metres). The ridge line extends upto a length of about 23 kms. In between Tuivai and Tuivawl rivers in the northeastern part of the district, extends another major ridge line originating from Zawngin village (1220 metres) and continues northwards through Suangpuilawn village (1125 metres, Mauhak tlang), Vanbawng village (1393 metres) and Khawlek village (1273 metres). It terminates near Tuivai river in the north. On the north-eastern side of the district, runs another ridge line which is flanked on both sides by Tuvai river. The ridge starts from Lenhlingzo tlang (1717 metres) near Phuaibuang village, and it continues northwards through Khawlian and Daido (1074 metres) villages and ends at the northern boundary near Vangvu stream. The length of this ridge line is about 18 kms. Apart from the aforesaid ridges, several small ridges runs north-south direction within the district. Some areas like Tawi tlang and its surrounding and the foothills of Mawmrang tlang are characterised by many spectacular scarps. These scarps are generally very steep, and made up of hard rock units. The spurs are mainly running in east ï west directions. The spurs on the eastern side of the main ridge are relatively long and gentler than the spurs on the western side.

Geomorphic classes: Structural Hill constitutes the main geomorphic class and dominates the area. Structural Hills as the name implies, is of structural origin, associated with folding, faulting and other tectonic

processes. Structural Hill is further divided into three classes viz., High Structural Hills (above 1200m), which cover an area of 180.21 Sq. Km. or 5.04 % of the district, and are mainly found at the peaks of Hmuifang, Tawi, Chalfilh and Mawmrang tlang. Medium Structural Hills (500-1200m) which covers an area of 330.37 Sq.km. or 23.22% are found along the Aizawl, Neihbawih and along East Phaileng ridge. It is also found below the peaks of Hmuifang, Tawi, Chalfilh, Mawmrang tlang and Suangpuilawn ridge. Low Structural Hills (below 900m), which covers an area of 2530.93 Sq.km., or 70.77 % of the district and are found almost throughout the entire area. Valley Fill is of fluvial origin characterised by the unconsolidated sediments deposited by streams or rivers in a narrow fluvial valley. They are found mainly along Tuirial river, Tuirini river and their tributaries, and along the streams in the northern part of the district. It covers an area of 33.07 sq.km. which is 0.92 % of the total district area. Flood Plain, which constitute another geomorphic class, are found along the major rivers. They are formed by deposition of recent alluvium, such as gravel, sand and silt. This unit covers an area of 1.73 sq.km. i.e, 0.05 % of the district area. The Geomorphological map is shown in Figure No. 1.3.6.

1.3.8 Land Use / Land Cover

The major Land use/Land cover classes within the district can be broadly categorized into Built-up land, Agricultural land/Horticultural land, Forests, Bamboo forest, Forest plantations, Shifting cultivation, Scrubland and River/Water body. The Land use / Land cover map of Aizawl district is shown in Figure No. 1.3.7.

Built-up land: Built-up land includes settlement, recreational, commercial areas etc. These areas consist of Aizawl city, three notified towns namely Sairang, Darlawn and Saitual, and 98 villages. Aizawl city is the capital of Mizoram and also the headquarters for all government departments and educational institutions.

Agriculture land: Agriculture land comprises those areas, which are permanently used for crop cultivation including Agricultural/Horticultural Plantations.

Forest: The forest cover type of Aizawl district is mainly tropical wet evergreen forest mixed with semi evergreen and tropical moist deciduous forests comprising mainly of bamboo. There are also sub-tropical forests found at high altitude places like Chalfilh, Tawizo and Hmuifang villages. The vegetation consists of a mixture of several species. Depending on the density of the canopy cover, the forests are categorized into Dense/closed, Medium dense and Less dense forest.

Shifting cultivation: Shifting cultivation area commonly known as Jhum lands are classified into current shifting cultivation and abandoned shifting cultivation.

Scrub land: Scrub lands are those lands that are frequently disturbed by biotic factors and other human activities; as such the vegetation is sparse. These areas are mostly dominated by grass & shrub species. They are found along roadsides and on high altitude rugged/rocky terrains.

Water body: This class includes big rivers, lakes and ponds. Four important rivers namely River Tlawng, River Tuirial, River Tuivawl and River Tuivai drains Aizawl district. Two well known lakes are found within the district, namely, Tam Dil near Saitual town and Rung Dil near Suangpuilawn village.

1.3.9 Drainage

Aizawl district is drained by north flowing rivers like Tlawng, Tuirial, Tuirini, Tuivawl, and Tuivai. Only the southern tip of the district is drained by the south flowing River Mat. There are a number of streams and rivulets of various patterns and lengths that flow into these rivers. Most of these streams and rivulets are ephemeral in nature. Since the drainage system for a particular area is governed mainly by the natural drainage course and topography, the drainage patterns in the district are dendritic to sub-dendritic patterns.

1.3.10 Slope

Aizawl district is characterized by several prominent hill ridges running parallel to each other. Few plain areas of small dimensions in between the hills and along the river banks are noticed in certain parts of the district. They are more confined to the northernmost part of the district. The western part of the district along Tlawng river is characterized by narrow river valleys with ravines and gorges, except Sairang village, where small unmappable plain areas are observed. The river channel becomes wider as we go from south to north direction. The central part of the study area around Tuirial river and its confluence with Turini river, on the other hand, are characterized by gently sloping and low-lying hills. The rest of the district consist of a rather rugged hilly ridges consisting of many narrow valleys and small streams. Narrow valleys separate some of the hill ridges and few of them have gentle to steep slopes. Some of these steep slopes rise abruptly in few places and occupy spectacular places within the district. The hillside slopes range from mostly gentle to steep, and escarpments are also visible in several places of the study area. The south-eastern part and the easternmost part of the district, around Tawi tlang, Hriangmual tlang and Mawmrang tlang are respectively characterized by spectacular scarps. Besides, the hills of the eastern part of the district are larger in terms of areal extend than the western and central part. It may be roughly summarized that the eastern part of the district are more steeper as compared to the western parts.

The slope of the area has been conveniently divided into nine (9) slope facets and slope map is shown in Figure 1.3.9.

1.3.11. Socio Economic condition

The area of Aizawl district is 3576.00 Sq km and is divided into three sub division viz : Aizawl, Sakawrdai and Saitual. According to 2011 census, the population of Aizawl district is 4,04,054, out of which 2,01,072 are male and 2,02,982 are female. The literacy percentage in the district is 98.50. The literacy percentage of male is 99.01 whereas the literacy percentage of female is 98. In Aizawl district, there are 545 Primary School, 517 Middle School, 64 High School, 80 Higher Secondary School, 17 Colleges, 1 University, 2 Theological Colleges, 1 College of Veterinary Science, 1 Women Polytechnic, 1 Industrial Training Institute, 1 Administrative Institute and 1 Forest Research and Training Institute.

As Aizawl is the headquarters of the district, the Secretariat and Directorate of various Departments are located in Aizawl city. Aizawl district has 8 Government Hospitals and 10 Private Hospitals, 1 TB Hospital, 1 Regional Institute of Paramedical And Nursing Sciences (RIPANS), 5 Community Health Centres, 7 Primary Health Centres, 113 Health Sub-Centres. It also has 1 Veterinary Hospital, 29 Veterinary Dispensaries. The district has 1 Telegraph Office, 1 Head Post office, 58 Branch Post Office, 7 Sub-Post Office and 11 Telephone Exchange. Regarding water supplies, there are 1250 nos. of Public Piped Water Points, 180 Drilled Water points and 791 Spring waters/Tuikhur(s). Aizawl city is being covered by the Aizawl Greater Water Supply Scheme which feeds a number of household with water connections. The district has various banking facilities like State Bank of India, Rural Bank, Apex Bank, United Commercial Bank, NABARD, IDBI, MUCO Bank, Vijaya Bank, SIDBI, United Indian Insurance Co. Ltd and Life Insurance Company, etc. There are as many as 78 number of banks in the district at various locations. In the district, there are 14922 families engaged in jhum cultivation and 585 families engaged in WRC agricultural practice. There are also 797 fish ponds within the district.

Aizawl district is well connected with road network spanning to other towns and villages. The whole length of the district is traversed by various road networks. The National Highway (NH-54) running from Kolasib district passes through Aizawl city, Seling, Thingsul-Tlangnuam, Thingsulthliah, Darlawng, Tlungvel, Phulmawi, etc. The National Highway 150 also runs along the northern ridges starting from Seling village to River Tuivai passing through villages like Sesawng, Khawruhlian, Hmunnghak, Khanpui, Pehlawn, E.Phaileng, Kepran, Sawleng,

Darlawn, Sailutar, Ratu, Lungsum, Vervek, Sakawrdai and Khawpuar. From E.Phaileng village, the district road runs towards north eastern part of the district passing through villages like Suangpuilawn, Lamherh, Vanbawng and Khawlek. Another district road starting from Keifang village joins this road at Suangpuilawn village. This district road passes through villages like Saitual, Dilkhan, Phullen, etc. The north eastern ridges of the district is traversed by village road from Phullen village upto Daido village and passes through Phuaibuang village, Khawlian village, N.E.Tlangnuam village, etc. The State Highway starting from Seling village run towards eastern part of the district upto River Tuivawl where it enters Champhai district. This road passes through Keifang village and serves inter-state road network with Manipur and Mizoram. From Keifang, a village road runs towards south and then passes through some villages like Rulchawm, Ruallung, Mualpheng, Tawizo, Maite, etc. Starting from Aizawl city there are two state highways, one of which runs north to south upto district boundary passing through Sihphir village and Neihboi village in the northern side. The other one passes through the villages of Melriat, Falkawn, Muallungthu, Aibawk, Sialsuk, etc. This road serves as an inter-district road network with neighboring districts like Serchhip and Lunglei. Besides this road network, a good number of Agricultural/Horticultural link roads have been constructed which serve for transportation of agricultural and horticultural produces from the interior parts of the district. The detailed socio-economic statistics of the district is given in Table No. 1.3.5, and the Transport network and Settlement map is shown in Figure No. 1.3.10.