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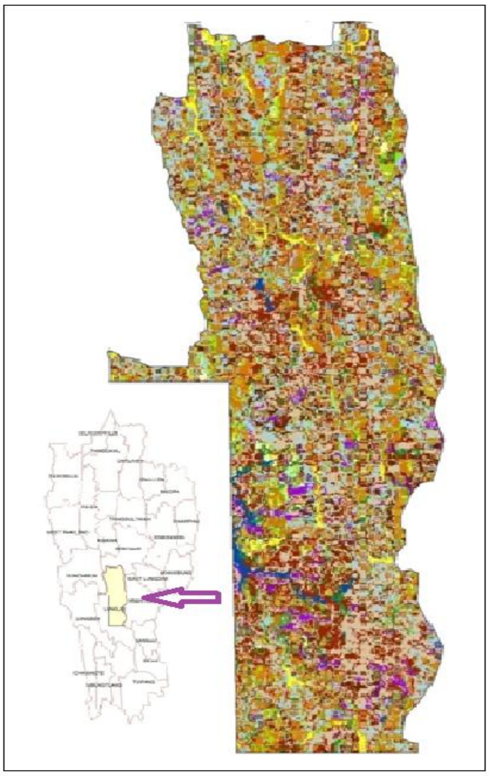
REPORT ON AQUIFER MAPPING IN PARTS OF LUNGLEI C & RD BLOCK, LUNGLEI DISTRICT, MIZORAM

ANNUAL ACTION PLAN, 2014-2015



Central Ground Water Board

केंद्रीय भूमिजल बोर्ड

Ministry Of Water Resources, River Development & Ganga Rejuvenation

जल संसाधन, नदीविकास और गंगा संरक्षण मंत्रालय

GOVERNMENT OF INDIA

भारत सरकार

NORTH EASTERN REGION

उत्तर पूर्वी क्षेत्र

GUWAHATI

गुवाहाटी

March 2019

REPORT ON AQUIFER MAPPING IN PARTS OF LUNGLEI C & RD BLOCK, LUNGLEI DISTRICT, MIZORAM

ANNUAL ACTION PLAN, 2014-2015

By

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Meghalaya

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DISTRICT AT A GLANCE

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	ii) Area (sq. km) under study	760
	ii) Population (as per 2011 census)	
	Lunglei block	7748
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	Station : Lunglei	2619
2.	**Geomorphology**	
	Major physiographic units	Denudational high hills and intermontane valley
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3.	**Land Use of district (in hectare)**	
	a) Forest area	354458
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5.	**Number of Ground Water Monitoring Wells of CGWB falls in the Study Area (As on 31-03-2015)**	
	a) No of Dug Wells	0
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6.	**Predominant Geological Formation**	Lower Tertiary Formations of Miocene Age. (Bhuban Formation)
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	Major Water Bearing Formations	formations of Tertiary Age. Ground water occurs in the form of spring which emanates through cracks/ fissures/ joints etc. available in the country rocks.
8.	**Ground Water Exploration by CGWB (As on 31-03-2015)**	
	No of wells drilled (EW, OW, PZ, SH)	NIL
9.	**Ground Water Quality**	
	Presence of chemical constituents more than permissible limit	Iron in deeper aquifer
	Type of water	Fresh

10.	**Ground Water Control and Regulation**	
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	No of Critical Blocks	Nil
	No of blocks notified	Nil
11.	**Major Ground Water Problems and Issues**	Concentration of Fe is beyond permissible limit in deeper aquifer

EXECUTIVE SUMMARY

The study area in Lunglei district, Mizoram falls under Survey of India Toposheet No. 84A/12, 84A/16 and 84B/13 and covers an area of 760 sq. km of Lunglei block. The area is bounded by North latitudes 22° 45' to 23° 15' and East longitudes 92° 40' to 92° 43'. Total population of the district is 161,428(2011 census), out o f which male and female were 82,891 and 78,537 respectively. The soils of the district, in general, have been derived from parent rock such as ferruginous sandstone, shale, alluvial and colluvial materials.

Forest area of the district occupies an area of 354458 hectares which is about 78% of the total district area. The fallow land account for 52716 hectares (1.16%), the total cropped area is 18380 ha (4%) and the net irrigated area is 760 ha (0.16%).

The major agricultural crops grown in Lunglei district include paddy, maize, pulses, oilseed, potato and tuber crops. The agricultural practices in the district are broadly of two distinct types, *viz*., (i) settled farming practised in the plains, valleys, foothills and terraced slopes and (ii) shifting cultivation practised on the hill slopes with slash and burn method. Lunglei district enjoys a moderate climate owing to its sub-tropical location and is neither very cold nor too hot throughout the year. In winter the temperature varies from 8^{0}C to 24^{0}C while in summer , it varies from 18^{0}C to 32^{0}C. The average humidity of Lunglei district ranges with a minimum of 60% to the maximum of 95 %.The study area has an average annual rainfall of 2619 mm. Bulk of the precipitation occurs from April to October, with July accounting for the maximum rainfall of the year.

Physiographically, the district is represented by parallel to sub parallel hill ranges trending North – South direction. The hills are steep and separated by rivers which flow either to north or to the south creating deep gorges. The drainage pattern generally observed are sub-dendritic, dendritic and trellis. The area is drained by one major perennial river namely the *Dhaleswari (Tlawng),* which flow through eastern part of the area. There are a number of perennial streams (Lui), which drain the area apart from the major river, viz. *DamteLui, MawngrawLui, VanvaLui, ArbawnLui, MengpuLui,*etc

There are no major or medium irrigation schemes in the study area. However, minor irrigation schemes involving surface flow irrigation are practised in the area. As per the data received from Irrigation department, Govt. of Mizoram, there are 16 nos. of minor irrigation projects in the district. The domestic water supply is provided mostly from springs or rivers and the distribution is mainly done by piped water supply.

Geologically, the area is underlain by Tertiary sedimentary rocks of Miocene age, belonging to Surma group. The rocks have been sub-divided into Lower Bhuban, Middle Bhuban and Upper Bhuban formations, on the basis of sum total characteristics presented by lithology, sedimentary structures and fossil studies.

Hydrogeologically, the entire area is occupied by semi-consolidated formations of denudation of structural hills belonging to Surma formations of Miocene age with limited areal extent of linear rolling valleys adjacent to Bangladesh border. The unit is characterized by low permeability and infiltration and acts as run-off zone. No dug well/ring well has been noticed in the study area. However, small ponds (spring tap chamber) like structures with very shallow depth i.e. within 2.0 m below ground level were noticed. Sixteen tubewells have been constructed in the study area by PHED, Govt. of Mizoram. The depth of the wells varies from 100 to 150 m. The depth to water level varies from 40mbgl at Thaizawl to 90 mbgl at Hauruang, Lunglei, Thualthu, Sekhum and Zobawk. Spring plays a major role in water requirement for the people especially in rural areas. The discharge of spring is within 30 lpm in the majority of cases throughout the season. On the other hand some ephemeral springs had been observed where the springs get dried up during the lean period. Yield of some perennial springs dwindles during the dry season (March – April). The springs are the lifeline of the habitation as people depend on them for their domestic water requirement. Jhum or shifting cultivation is one of the main reasons for depletion of yields of springs. To combat the harmful effects of jhumming, hill-slope terracing, contour bunding, stream bank erosion control, land reclamation, water harvesting, conservation & distribution, irrigation & check dams, gully plugging, afforestation etc., are to be implemented. Urban areas like Lunglei and other smaller towns should put into practice of Roof-top Rain Water Harvesting.

As per Ground Water Resource Estimation, adopting GEC-1997 methodology, the stage of ground water development of Lunglei block as on March 2013 is 11.17%. Based on the stages and development the district can be categorized under **safe** category.

The chemical constituents present in the ground water is within permissible limit and is good for drinking, irrigation and industrial purposes. However, higher concentration of iron is reported from hand pump/tube well in some localities of the district.

AQUIFER MAPPING IN PARTS OF LUNGLEI C&RD BLOCK, LUNGLEI DISTRICT, MIZORAM

1. INTRODUCTION

As per the Annual Action Plan of Central Ground Water Board, North Eastern Region, Guwahati for the year **2014-2015**, the author was assigned Aquifer mapping and Management studies under Survey of India Toposheet No. 84A/12, 84A/16 and 84B/13 for a geographical area of 760 sq. km covering parts of Lunglei Community and Rural Development Block under Lunglei District of Mizoram State.

Mizoram state is bestowed with abundant rainfall, however, it experiences scarcity of domestic water supply during summer. The reason is simple, over- dependence on surface water and springs and its steep topography resulting in run-off. Most of the rivers are rain-fed and hence, seasonal and majority of the springs also dry up during summer season. The Aquifer mapping and management program is designed to make a significant step forward in ground water resource management by identifying and mapping aquifers, quantifying the available ground water resources potential and proposing plans appropriate to the scale of demand, aquifer characteristics and the institutional arrangements for management. Aquifer mapping is a multidisciplinary study wherein a combination of geologic, geophysical, hydrologic and hydro chemical information is applied to characterize the quantity, quality and sustainability of aquifers.

1.1: Objectives

The objectives of the study are:

i. To define the aquifer geometry, type of aquifers, ground water regime behaviours, hydraulic characteristics and geochemistry of Multi- Layered alluvial aquifer systems on 1:50,000 scale

ii. Intervention of new geophysical techniques and establishing the utility, efficacy and suitability of these techniques in different hydrogeological set-up.

iii. Finalizing the approach and methodology on which National Aquifer mapping programme of the entire country can be implemented.

iv. The experiences gained can be utilized to upscale the activities to prepare micro level aquifer mapping.

1.2: Scope of the study

The activities of the Aquifer Mapping and Management Program can be envisaged as follows:

1.2.1: Data Compilation & Data Gap Analysis: One of the important aspect of the aquifer mapping programme was the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were assembled, analysed, examined, synthesized and interpreted from available sources. These sources were predominantly non computerized data, which was converted into computer based GIS data sets. On the basis of available data, Data Gaps were identified.

1.2.2: Data Generation: There was also an urgent need to generate data as it is a virgin area. This may be achieved through multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing alongwith detailed hydrogeological surveys to delineate multi aquifer system.

1.2.3: Aquifer Map Preparation: On the basis of integration of data generated from various studies of hydrogeology &drilling activities by PHED and DGM, Govt. of Mizoram, aquifers have been delineated and characterized in terms of quality and potential. Several maps have been prepared bringing out characterization of Aquifers, which can be termed as Aquifer maps providing spatial variation in reference to aquifer disposition, quality, water level, springs discharge, potential and vulnerability (quality & quantity).

1.2.4: Aquifer Management Plan Formulation: Aquifer Maps and ground water regime scenario will be utilized to identify a suitable strategy for sustainable development of the aquifer in the area.

1.3: Approach and Methodology

The Aquifer management involves:

- Identification of aquifer on the basis of geology;
- Identification of recharge and discharge areas;
- Assessment of aquifer capacity and yield through aquifer mapping;
- Protection of recharge area and built-up of groundwater level through artificial recharge.
- Treating groundwater as a common pool resource;

- Encouraging community use of groundwater and restricting individual use;
- Putting in place an institutional mechanism and legal back up for community groundwater management;
- Awareness generation regarding groundwater and science of hydrogeology

1.4: Location

The study area is spread over a geographical area of 760 sq. km under survey of India toposheet No. 84A/12, 84A/16 and 84B/13 covering parts of Lunglei Community and Rural Development block, Lunglei district, Mizoram. It lies between North latitudes 22° 45' to 23° 15' and East longitudes 92° 40' to 92° 43'.

Lunglei district is the biggest district in Mizoram and is bounded on the north by Mamit and Serchhip district, on the south by Lawngtlai and Saiha district, on the east by Myanmar and on the west by Bangladesh. It has an area of 4,538 Sq.km. There are three Civil Sub-Divisions, namely; Lunglei Sadar Sub-Division, Tlabung and Hnahthial Civil Sub-Divisions. The District is also divided into four Rural Development Blocks, viz; Lunglei, Hnahthial, Lungsen and Bunghmun. Lunglei town, situated in the south-central part of the state, is one of the most populous towns in the Mizo Hills. It is located 131 miles (235 km) south of Aizawl. The location map and base map of the study area is given in **Figure 1** and **Figure 2**.

1.5: Administrative Division

The study area covers parts of Lunglei Community and Rural Development Block of Lunglei District, Mizoram and covers 68% of the total geographical area of Lunglei Block. Details about the study area are presented in **Table –1.1**

Table-1:1 Administrative unit details of the study area

Sl. No.	Name of the CD Block	Total Geographical area of the Block (sq. km))	Block area falling under study area
			(sq. km)
1.	Lunglei block	1117	760

Source: Department of Economic and Statistics, Government of Mizoram

1.6: Demography

As per 2011 census, total population of the district is 161,428; out of which male and female were 82,891 and 78,537 respectively. Total population of Lunglei block is 77482 (2011 census). Number of households in the block is 15058.

1.7: Communication

Lunglei is the second largest city of Mizoram after Aizawl and is also the headquarter of Lunglei district. It is located at a distance of 175 km via Saisuk from Aizawl and perched at an altitude of 1222 metres. It is not connected by Air and Train. The nearest airport is Lengpui Airport and the nearest Rail head is Silchar. It is connected with National Highway 54 only Via Serchhip and Thenzawl. Maxi Cab and Bus Service are available in day and night to the state capital, Aizawl.

1.8: Data availability & data gap analysis

The data on various attributes of the study were collected from the available literatures of Central Ground Water Board, State Government Department of Mizoram and various Central and State Government agencies. The summarized table presenting the Data Requirement, Data Availability and Data Gap Analysis is presented in Table 1.2.

Table1.2 Data Availability and Data Gap Analysis in study area

Sl. No.	Items	Data Requirement	Data Availability	Data Gap
1	Climate	Season-wise Rainfall pattern	Annual Rainfall of one Meteorological Station	Time-series data on Rainfall
2	Land use	Latest Land Use pattern	No Data	Latest data required
3	Geomorphology	Detailed Information on Geomorphology of the area	District level information	Block level information
4	Geophysics	Geophysical data of the Study area	No Data of the study area	Entire area unexplored
5	Exploration Data	As per requirement of Advanced Geophysical Studies for Integration of data and Validation of Techniques	No Data of the study area	Entire area unexplored
6	Monitoring Regime	Representative Monitoring Wells distributed over the Study Area	No Monitoring Well	Entire area unexplored
7	Recharge Parameters	Recharge parameters for different soil and aquifer types based on field studies	Recharge parameter norms given in Ground Water Resources Estimation	Field study for parameters

1.9: Soil

Broadly, the soil of the district has been derived from parent rock such as ferruginous sandstone, shale, alluvial and colluvial materials. In general, the soil formations have been categorized into the following groups.

i) Hill Soil: It includes colluvial soil, formed along the steep side slopes because of accumulation of material on slope surface.

ii) Valley Soil: Occurs as a mixture of colluvial and alluvial materials. It is restricted to the rolling valleys along the river courses.

iii) Terrace Soil: These are the remnants of deposits of cobbles and pebbles which make it excessively drained.

1.10: Industries

There is no major industry in the study area.

1.11: Mining Activities

There is no mining activity in the study area. However, stone quarry is located in place such as Zobawk in the study area.

1.12: Urban Area

Lunglei town is the only urban area in the entire study area, which is also the district headquarter of Lunglei district. It is located in the southern part of the study area. As per Census 2011, it has a total population of 57011.

1.13: Previous Work

No Ground Water Studies/Aquifer Mapping and Management studies have been carried out in the study area earlier.

Acknowledgement:

The study was carried out under the overall supervision of Dr. U.Gogoi, Regional Director, Central Ground Water Board, North Eastern Region, Guwahati and Shri. T. Chakraborty, Officer in- Charge, CGWB, SUO, Shillong. Guidance rendered from time to time by Shri B. Ray, Senior Hydrogeologist was very useful and thankfully acknowledged. Colleagues at State Unit Office, Shillong and North Eastern Region, Guwahati have given valuable technical input from time to time during the course of study and it is thankfully acknowledged. Sincere thanks are offered to the Public Health Engineering Department, Government of Mizoram for assisting the author in field studies and for providing all necessary logistics and valuable data used during the course of study. Efforts by the Department of Irrigation, Govt. of Mizoram, District Administration of Lunglei district and District Statistical Office in providing valuable information about the study area are thankfully acknowledged.

2. DATA COLLECTION AND GENERATION

One of the main objectives of the study was to generate strong data base. Based on the data gap availability and data gap analysis, the sub-surface data, groundwater level data and groundwater quality data were generated. Data collected/generated in the study area is presented in **Table 2.1.**

Table 2.1: Data collected/generated in the study area

Sl. No.	Items	Data Generated/collected
1	Climate	Time series data on rainfall from 1986 to 2013
2	Land use	Latest Land use pattern/agriculture data
3	Geomorphology	Detailed Information on Geomorphology of the area
4	Irrigation	Latest irrigation data
5	Spring Studies	Data of 16 Springs ,monitored
6	Water Quality	Samples collected for quality analysis

2.1: Climate

Lunglei district enjoys a moderate climate owing to its sub-tropical location and is neither very cold nor too hot throughout the whole year. In winter the temperature varies from 8^0C to 24^0C while in summer it is between 18^0C to 32^0C. Snowfall does not occur in the district, though frost is often experienced in the eastern part. The western part of the district is lower in elevation compared to the eastern part and hence, it experiences a little warmer climate than the eastern part. The district receives adequate rainfall under the influence of South-west Monsoon. Generally, winter starts in the month of November and the cold spell persists till the end of February. The average humidity of Lunglei district ranges with a minimum of 60% to the maximum of 95 %.

2.1.1: Rainfall

Rainfall occurs mainly under the influence of south-west monsoon, which starts between April – May and lasts till September – October. It rains heavily from the month of May to September and maximum rainfall is received during the month of July. In fact 80% of the total rainfall occurs in the period from May to September. The monthly rainfall data from 1986–2013 have been presented in **Table 2.2**.

The study area has an average annual rainfall of 2619 mm. Bulk of the precipitation occurs between April and October, with July accounting for the maximum rainfall of the year. Between January and March, non-monsoon precipitation contributes about 20- 22% of the total annual rainfall.

Table2.2: Monthly Rainfall Data, Lunglei Town (in mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1986	0	0	7.5	182.5	106.5	461.5	330	478	438.5	249.5	0	0	2254
1987	0	0	54.7	145.3	182	421	441	467	472	237	55	0	2475
1988	0	21.3	59	117.3	363.3	446.3	467	381.6	336	464.3	35.7	0	2691.8
1989	0	14	20	63	267	287	478	440.7	430.7	431	0	0	2431.4
1990	0	20.9	195	256.4	286.8	354.5	448.9	406.8	409.6	102.4	35.4	61.4	2578.1
1991	32.1	4.6	44.4	207.3	391.1	491.1	415.5	290	327.6	275.8	25	22.4	2526.9
1992	1.6	41.8	21	35.6	130.2	432.1	489.4	415	327.4	250.3	30.3	2.4	2177.1
1993	10	146.9	81.8	119.7	438.8	451	507.5	385.9	315.9	229.5	14.7	0	2701.7
1994	0	0	194	131.7	121.7	1103	269	330.3	143.3	97.3	13.7	0	2404
1995	0.7	3.3	11.3	19	245.7	178.3	319	587.3	295	167.7	242.7	0	2070
1996	0	25.3	155.3	156	349.7	407.7	455.7	483.3	296.1	294.3	12	0	2635.4
1997	6.7	9.3	199	106.7	309	589.7	1088.3	402.7	451	65.7	17.3	39.3	3284.7
1998	16	43	130	166.3	652.3	382.6	636.3	510.3	393	178.7	6.3	0	3114.8
1999	0	0	27.6	13.6	321	623	552.2	335.2	386.2	214.2	6.6	27.2	2506.8
2000	6.8	3	109.6	207	660	509.4	360.8	793.8	349.2	184.6	71.2	0	3255.4
2001	0	5.4	7.6	51.4	428.8	517.6	379	344.4	261.8	245.8	101.6	0	2343.4
2002	15	0	77.2	66	447	341	695.4	352.4	286	69.8	86.8	0	2436.6
2003	0	0.3	46	68.8	195.8	878.5	334.3	330.3	306.3	155.5	0	15.5	2331.3
2004	0	0	11.8	230	194	884.5	641.3	367.8	377.5	130.8	12.5	0	2850.2
2005	0.5	0	62.3	67	167.7	147.2	311.1	447.6	372.6	264.5	10.3	13	1863.8
2006	0	0	0.7	27.9	432.6	582.9	512.8	360.4	301.5	146.3	0	0	2365.1
2007	0	53.9	7.2	189.6	344.1	359.2	559	579.8	766.9	182.4	92	0	3134.1
2008	73.3	14.6	17.1	13.0	193.0	209.4	399.5	445.0	253.3	86.7	0.0	0.0	1704.9
2009	0.0	0.0	18.0	0.5	99.3	143.1	577.5	1086.0	1248.0	325.0	348.1	0.0	3845.5
2010	0	0.3	81.93	80.5	272	509.7	438.5	563.25	972.3	676	24	160	3778.48
2011	10.9	0	56.3	73.9	396.8	405.3	331.4	511.4	376.2	159.9	0	0	2322.1
2012	0	16.8	25.3	274	245	618	276	520.1	403	270	65.8	0	2685
2013	0	1.6	0.4	88.3	482.5	405.6	377.4	484.8	533.1	209.9	0	0	2584.1
Average	**6.2**	**15.2**	**61.5**	**112.8**	**311.6**	**469.3**	**467.6**	**467.9**	**422.5**	**227.3**	**46.7**	**12.2**	**2619.7**
Max.	**73.3**	**146.9**	**199**	**274**	**660**	**1103**	**1088.3**	**1086**	**1248**	**676**	**348.1**	**160**	**3845.5**
Min.	**0**	**0**	**0.4**	**0.5**	**99.3**	**143.1**	**269**	**290**	**143.3**	**65.7**	**0**	**0**	**1704.87**

Source: Department of Economic and Statistics, Government of Mizoram

2.2: Land Use/Land Cover

Land utilisation statistics provide detailed information of the land use pattern in the area. The socio-cultural factor plays a dominant role in land use both in rural and urban areas. Landforms, slope, soil, natural calamities and natural resources are the important factors which control the land use pattern of the area. Based on the land utilization, the total area is divided into various types of landforms such as forest, cultivable land, fallow land, cropped area etc. which in turn reflects the degree of development of agricultural activities and cultivation potential.

Different categories of Forest occupy the largest area followed by Barren and Wastelands and Scrub lands. Agriculture, plantation crop land, is limited to small patches of the study area. Built up urban area is the district Headquarter, Lunglei. The land use pattern is presented in **Figure 3**. The land utilization statistics of Lunglei district during the year 2012-2013 is shown in **Table 2.3**.

Table 2.3: Land utilization pattern in Lunglei district (area in hectares)

Land Classification	**Area in hectares (2012-13)**
A. Geographical Area	453800
B. Reporting Area	453800
1. Forests	354458
<u>2. Area not available for cultivation</u> a.(i) Area under non-agricultural uses	0
b. Barren and uncultivalble lands	0
c. Water logged land	
d. Social Forestry	8247
e. Land under still water	3117
f. Other land	3300
TOTAL (Column a to f)	14664
(ii) Barren and unculturable lands	1050
TOTAL = Col. i& ii	15714
*3.*Other uncultivable Lands excluding fallow land	12982
a. Permanent pastures and other grazing lands	1530
b. Land under Misc. tree crops & grooves etc.	9800
c. Cultivable wastelands	1652
<u>*4. Fallow lands*</u> a. Fallow lands other than current fallows	46335
b. Current fallows	6381
TOTAL = (a+b)	52716

Land Classification	Area in hectares (2012-13)
5. Net area sown	17930
6. Area sown more than once	450
7. Total Crop area	18380
C. Net irrigated area	761
D. Gross irrigated area	642

Source: Department of Economic and Statistics, Government of Mizoram

The forest area covers about 78% of the total geographical area. Net sown area in the district is only about 4%.

2.2.1: Agriculture

Agriculture occupies a prominent place in the economy of Mizoram and is a major source of occupation for the people since time immemorial. The diverse topography and unique agro-climate condition of the region has made it very conclusive for growing varied type of Agricultural and Horticultural crops. The method of cultivation has remained primitive. For various reasons this method of cultivation has not undergone significant changes till today. The main reasons are lack of suitable land for wet rice cultivation (WRC) and lack of adequate resources. The mountainous state with its steep slopes and narrow valleys and a few wet areas led to the tradition of felling forests on the steep slopes, burning the remains of the forest and growing crops without terraces and terraces without contour cultivation.

The agricultural practice through traditional system is the most important means of sustaining livelihood of the tribal communities of the district. Shifting cultivation in hill slope, wet field cultivation in the foot hills are the major agricultural practices prevalent in the region.

2.2.2: Area and Production of Crops in the district

The major agricultural crops grown in Lunglei district include paddy, maize, pulses, oil seed, potato and tuber crops. Of these, paddy was cultivated in maximum areas (8611 Ha) in the district with production of 9464.90 MT during the year 2008. The maize follows the paddy production with an annual production of 1703.30 MT having area coverage of 1263.60 Ha.

The agricultural practices in the block are broadly of two distinct types, *viz*., (i) settled farming; practised in the plains, valleys, foothills and terraced slopes and (ii) shifting cultivation; practised on the hill slopes with slash and burn method.

2.2.3: Cropping Pattern

The cropping pattern in the region is characterised by predominance of rice. Food crops account for more than 80 per cent of the gross cropped area, which is suggestive of prevalence of subsistence agriculture and lack of crop diversification. About 70 per cent of the gross cropped area is accounted for cereals alone. A remarkable feature of shifting cultivation is that a wide variety of crops is grown in the *jhum* fields. *Jhum* paddy is the dominant crop and is mixed with maize, millets, beans, tapioca, sweet potato, ginger, cotton, tobacco, chillies, sesame and vegetables. The production units are more or less self-contained, each family growing crops according to its needs. Major food crops of the region are cereals and pulses which are cultivated in 78 per cent of the cropped area.

2.3 Physiography

Physiographically, the district is represented by parallel to sub parallel hill ranges trending North – South direction. The hills are steep and separated by rivers which flow either to north or to the south creating deep gorges. Puruntlang near S.Chawngtuiis the highest peak in Lunglei district and stands at a height of 1758 m while the lowest elevation found is Tlabung where the elevation is as low as 20 m.

2.4 Drainage

The drainage pattern generally observed are sub-dendritic, dendritic and trellis. Radial pattern is locally developed around some isolated mounds and hillocks. The area is drained by one major perennial river namely the Dhaleswari (Tlawng), which flow through eastern part of the area. It flows through N-S trending valleys and the flow is northerly. There are a number of perennial streams (Lui), which drain the area apart from the major river, they are namely DamteLui, MawngrawLui, VanvaLui, ArbawnLui, MengpuLui, etc.The drainage map is shown in **Figure 4**.

2.5 Geomorphology

The terrain exhibit a very immature topography. The topography and physiographic expression of the district is imparted by approximately N-S trending steep, mostly anticlinal, parallel to sub-parallel hill ranges and narrow adjoining synclinal valleys with series of parallel hummocks or topographic highs. The western limbs of the anticlines are steeper than the eastern limbs. Based on the remote sensing data, landform map has been prepared for the study area. The slope map is given in **Figure 5**.The geomorphological map is given in **Figure 6**. The study area can be divided into the following units as given below (**Table 2.4**):

Table 2.3: Geomorphological Unit of the Study Area

Sl. No.	Geomorphic Unit	Area (in Sq. Km.)	%
1.	High Structural Hill (height above 1200m)	95.63	2.11
2.	Medium Structural Hill (height from 800-1200 m)	592.82	13.06
3.	Low Structural Hill (height below 800 m)	3322.52	73.22
4.	Valley Fill	213.63	4.71
5.	Flood Plain	12.94	0.29
6.	Linear Ridge Area	300.45	6.62
	Total	**4538.00**	**100.00**

Source: PHED, Government of Mizoram

2.6: Hydrology and surface water utilisation

2.6.1: Surface water Resources

Rainfall is the only source of water in the area. The surface water is very important as it contribute to the ground water. However, despite receiving heavy rainfall most of it goes as surface runoff due to its topography.

2.6.2: Irrigation

There is no major or medium irrigation scheme in the study area. However, minor irrigation schemes like flow irrigation schemes are available. Flow irrigation involves diverting streams and rivulets and irrigating the fields by gravity. Irrigation through ground water is not yet practiced. As per the data received from Lunglei Irrigation Division, Govt. of Mizoram, there are 16 nos. of Minor irrigation project in Lunglei block.

2.6.3: Water Supply

The domestic piped water supply is mostly through springs or through river. The irrigation water supply is also through surface water source and in some parts it is through minor irrigation tanks.

2.7: Geology

Geologically, the area is occupied by shale, siltstone, and sandstone of Surma Group of Miocene age. The rocks have been sub-divided into Lower Bhuban, Middle Bhuban and Upper Bhuban formations, on the basis of sum total characteristics presented by lithology, sedimentary structures and fossil studies. The Geological map is given in **Figure 7**.The general geology of the area is presented in Table 2.5

Table 2.5: General Geology of Lunglei block

Group	Formation	Lithology
SURMA GROUP	Upper Bhuban Formation	Mainly arenaceous rocks which includes mainly thickly bedded, grey, khaki, buff coloured fine to medium grained, at places friable, kaolinised sandstone with very fine grained sandstone, siltstone, shale (grey, olive green) interbands, with shell limestone as lensoidal bodies, conglomeratic at places, grey, very fine grained to fine grained, hard compact, calcareous sandstones
	*****************Contact conformable to transitional***************	
	Middle Bhuban Formation	Mainly argillaceous rocks which include grey, khaki shale, silty shale and siltstone/ shale interlaminations with grey, buff coloured hard, compact, micaceous, fine to medium grained, thinly to moderately bedded sandstone with a few thick, grey, hard, very fine grained, micaceous sandstone bands
	*****************Contact conformable to transitional***************	
	Lower Bhuban Formation	Mainly arenaceous rocks which includes fine to very fine grained, compact, blue, ash, green coloured, massive to well bedded sandstone exhibiting turbidite features and well laminated siltstone, olive green silty shale/shale interlaminations

Source: Geological Survey of India

2.7.1: Structure

The major structural trends of the area coincide with regional tectonic trends of the State. The average strike of the bedding is NNE-SSW with dips varying from 40° to 50° towards both east and west. The sediments are folded into close to open asymmetrical anticlines and synclines along N-S axis. Locally the folds are doubly plunging and show shallow (15° to 20°) plunge towards north /south. Faults present in the area are longitudinal, transverse and oblique types affecting the folded sequence. The major faults are longitudinal strike faults along the crest of the folded beds. The bedding joints are most prominent. The palaeo current directions inferred from sedimentary features reveal a mean southerly transport direction which is indicative of a southerly slope of the basin floor.

2.7.2: Sub- surface Geology

No details about the sub-surface geology of the area are available. No ground water exploration activity was carried out by CGWB in the area. State Government departments have drilled a few tube wells but lithologs are not available.

2.8: Hydrogeology

Hydrogeologically, the entire Lunglei district is occupied by semi-consolidated Surma formations of Miocene age. The low linear ridges comprise mainly mixture of areno-argillaceous assemblages such as shale, siltstone, mudstone and hard, compact sandstones. The unit is characterized by low permeability and infiltration. It acts as run-off zone. The moderate linear ridges which occupy almost the entire block are comprised of hard and compact sandstone, shale, and siltstone. This unit is also characterized by very low permeability and infiltration and acts as run-off zone. Ground water potential is low, occurs mostly in secondary porosity like fractures, joints etc.. The linear rolling valleys with limited areal extent are underlain by shale, sandstone and siltstone alternations. The weak planes such as fractures and joints have served as conduits for movement and storage of ground water. These planes obtain their recharge from precipitation through the overlying weathered zone and ground water emerges in the form of springs.

2.8.1:Springs

Spring locally known as *tuikhurs* (artificially fabricated small pits to collect seepage water) plays a major role of water requirement for the people especially in rural areas. Considering that the number of hand pumps is negligible and not perennial and rain water is available only during rainy season, the other alternative sources are not accessible, heavy pressure shifts to the tuikhurs. It is found that the location of the spring is mainly restricted to foothills and intermontane valleys in the area. The hydrogeological studies reveal that joints, fractures and faults are the main controlling factors for the occurrence of springs in the study area. In the area 16 springs have been inventoried and monitored both during pre and post monsoon seasons (**Table 2.6)** to ascertain the characteristics and type of springs. These springs were monitored during September and December 2014 and February 2015 respectively. The pre-monsoon and post monsoon spring discharges are shown in **Figure 8 and 9**.

It is observed that the discharge is mostly within 30 lpm in majority of the springs throughout the season. The maximum spring discharge (45 lpm) was observed at Haulawng III. On the other hand some ephemeral spring is observed which dried up during the month of February 2015.

The springs are the lifeline of the habitation as people depend heavily for their domestic water supply needs on these springs. Jhum or shifting cultivation is one of the main reasons for depleting yields of Springs. For sustainable management and revival of this important source catchment area of the springs has to be maintained and jhum cultivation has to be stopped completely .

It was found that majority of the magnitude of spring discharge falls within the sixth order (*Meinzer,*1923; 0.1 to 1lps).

Table 2.6: Hydrogeological details of springs in the study area

Sl. No.	Village	Location	Geo Co-ordinates	Elevation (m amsl)	Geology	Discharge (lpm) Dec-14	Discharge (lpm) Feb 15
1.	Thaizawl	50m N of VEC residence	92°48'04" 22°48'49"	941	Bhuban Sandstone	15	5.5
2.	Haurang	50 m from community hall, along the road towards Lunglei	92°42'36" 22°52'59"	596	Do	6	dry
3.	Zobawk I	Opp. Indoor Stadium	92°49'16" 22°51'29"	1049	Do	9	0.5
4.	Zobawk II	20 m from Sl.3 towards Lunglei town	92°48'36" 22°50'38"	1048	Do	11	1.2
5.	Zobawk III	50 m from Sl.5 towards Lunglei town	92°47'37" 22°51'02"	1049	Do	12	0.4
6.	Pukpui I	10 m from KV gate along the highway	92°45'17" 22°55'54"	782	Do	17	1.8
7.	Pukpui II	100m from location 6 along the highway	92°47'55" 22°56'43"	741	Do	12	2
8.	Pukpui III	Near Twang bridge	92°43'25. 1" 23°00'15"	382	Do	30	3.6
9.	Mausem	Opp. road side Market	92°46'22" 23°00'31"	734	Do	15	1.3
10.	Haulawng I	Near the trijunction, 5m towards Sekhum	92°46'33" 23°02'38"	939	Do	8	dry
11.	Haulawng II	20 m from Sl.10 towards Sekhum	92°46'22" 23°03'21"	938	Do	9	0.5
12	Haulawng III	10 m from Sl.11 towards Sekhum	92°46'34" 23°03'51"	940	Do	45	6
13	Haulawng IV	Betw.Mausem and Haulawng Village. 2 km from Haulawng	92°46'39" 23°02'15"	923	Do	9.2	0.8
14	Sekhum	Along the highway. 50 m from sekhum dispensary towards Lungei	92°45'08" 23°07'55"	834	Do	13.5	1.5
15	Lunglei I	Along the road side, near main market	92°44'52" 22°52'54"	1079	Do	18	1
16	Lunglei II	10 m from abandoned petrol pump, towards Zobawk, along the road side	92°45'30" 22°52'10"	1082	Do	25	2

3.DATA INTERPRETATION, INTEGRETION AND AQUIFER MAPPING

3.1 Aquifer System

No dugwell/ring well has been noticed in the study area. However, it was observed that some small dug out pits (spring tap chamber) occur with very shallow water level i.e. within 2 m below ground level.

The public Health Engineering Department of Government of Mizoram have drilled a numbers of tube wells in Lunglei block. The details of tube well drilled in the study area are given in **Table 3.1**.

Table 3.1: Details of tube well drilled in the study area

Sl. no	Village	Lithology	Geomorphology	Depth of well (m)	Depth to water level (mbgl)	Utilisation
1	Hauruang	Shale & Siltstone	SHL	110	90	Domestic & Drinking
2	Hrangchalkawn	Shale & Sandstone	SHL	100	70	Domestic & Drinking
3	Lunglei	Sandstone	SHH	110	90	Domestic
4	Ramlaitui	Shale & Siltstone	SHL	150	70	Domestic & Drinking
5	Thualthu	Sandstone	Valley	100	90	Domestic & Drinking
6	Chhipphir	Shale & Siltstone	SHM	100	70	Irrigation
7	Kanghmun	Shale & Siltstone	SHH	100	80	Irrigation
8	Sekhum	Shale & Siltstone	SHL	120	90	Drinking & Domestic
9	Zotuitlang	Shale & Siltstone	SHL	110	85	Drinking & Domestic
10	Zotuitlang	Shale	SHL	110	78	Drinking & Domestic
11	Ramlaitui	Shale & Siltstone	SHH	150	70	Domestic
12	Thaizawl	Shale & Siltstone	SHM	100	40	Irrigation
13	Zobawk, Chalnghakainbul	Shale	SHM	100	90	Domestic
14	Zobawk, Hrangvunga Point	Shale & Sandstone	Valley/ Depression	110	70	Domestic by distillation
15	Zobawk, Venglai	Shale & Siltstone	Valley	120	80	Drinking & Domestic
16	Zobawk, Vengthar	Shale	SHM	130	70	Domestic

Source: PHED, Government of Mizoram

(Abrv. SHL/SHM/SHH : Structural Hill Low/ Structural Hill Moderate/ Structural Hill High)

As per the data from PHED, Government ff Mizoram, 16 wells have been constructed in the block. The depth of the well varies from 100 to 150 m. The depth to water level varies from 40m (Thaizawl) to 90 m (Hauruang, Lunglei and Thualthu, Sekhum and Zobawk). The depth to water levels in tubewells have been shown in **Figure 10.**

Attempts have been made to monitor the tubewells during field studies, however, it was found that most of the wells are not traceable while some of them are sealed and defunct**.**

It is inferred from the available data that an unconfined aquifer occurs within 10m from ground level. Similarly, a semi-confined fractured aquifer occurs within 50m from ground level mostly in splintery shale areas or hard compact Bhuban sandstone formation. The same is depicted in a schematic litho-section of the area in **Figure 11**.

3.2: Changes in Ground Water Scenario over the Years

No ground water monitoring well is available in the study area. Hence, ground water scenario over the years could not be established. Moreover, Groundwater development in the study area is almost negligible. However, average ground water level data of the state have been provided by PHED, Mizoram and is given in **Table 3.2.**

Table 3.2: Average Depth to Water Level of Mizoram from 2000-2012

Year	Average DTWL (mbgl)
2000-2001	12.36
2001-2002	8.50
2002-2003	15.40
2003-2004	12.40
2004-2005	12.70
2005-2006	13.71
2006-2007	12.70
2010-2011	10.58
2011-2012	10.15

Source: PHED, Government of Mizoram

The above data indicates that there is no depletion of water level from 2000-2012.

3.3: Hydrochemistry

The quality of ground water is as important as that of the quantity. Eleven numbers of water samples had been collected from springs both in pre and post monsoon period and analyzed. The parameters analyzed were pH, EC, TDS, CO_3, Cl, SO_4, F, Ca, Mg and are shown in **annexure I**. It is found that spring water is potable. All the chemical constituents' analyses are within the permissible limit set by BIS.

As per the studies carried out by PHED, Govt. of Mizoram, sporadic occurrence of higher concentration of iron has been reported from deeper aquifer (tube well) in some localities of the block. Results of chemical analysis carried out by PHED, Govt. of Mizoram is shown in **Table 3.3**.

The most common form of iron in solution in ground water is ferrous ion (Fe^{+2}). Major sources of iron are ferromagnesian minerals like Pyroxenes, Amphiboles, Biotite, Magnetite, Olivine etc. Availability of iron for aqueous solutions is strikingly affected by environment condition, especially changes in degree of oxidation or reduction. This type of water is clear when first drawn from the well and soon becomes turbid and then brown due to the precipitation of ferric hydroxide. This is a common behavior of ground water high in iron in several areas (Hem, 1985). The red coloration is due to the presence of hydroxides of iron. However, there is no direct correlation between iron concentration and intensity of colour. The permissible limit of iron in drinking water is 1 mg/l. In the study area, higher concentration of iron is reported in the deeper aquifer. The concentration of Iron in the wells ranges from BDL to 10 mg/l. The range of concentrations of Iron present in the study area is given in **Figure 12 and 13** respectively.

Removal of the Iron is best effected by aeration process followed by sedimentation and filtration. Potassium permanganate or chlorine/chloride may be employed to oxidize the iron, which is then filtered from the waters. The process is applicable very much when bacteria is present in the water. Iron can also be removed by the addition of a mixture of sodium carbonate and sodium phosphate to precipitate iron as insoluble, followed by settling and filtration.

Table 3.3: Water quality data collected from tube wells

S.N.	Village	pH	Alkalinity (mg//l)	Hardness (mg//l)	Chloride (mg//l)	Fluoride (mg//l)	Iron (mg//l)	Ammonia (mg//l)	Nitrate (mg//l)	TDS (mg//l)
1	Hauruang	7	196	200	0	0	0.48	0	0	475
2	Hrangchalkawn	6.8	780	80	10	0.1	1.2	0.5	0	1044
3	Lunglei	7.8	76	60	11	0	0	0.5	0	176
4	Ramlaitui	7.8	234	210	10	0	0.1	0	0	545
5	Thualthu	6.8	136	122	0	0.5	1	0.5	0	310
6	Chhipphir	6.9	130	200	18	0.1	0.1	1	0	418
7	Kanghmun	6.7	180	140	0	0.4	0	0.5	0	384
8	Sekhum	6.8	120	120	2	0.2	0	0	0	290
9	Zotuitlang	6.8	120	168	7	0.5	0.8	0.5	0	354
10	Zotuitlang	6.8	150	110	0	0.2	0.3	0.5	0	312
11	Ramlaitui	8	300	100	50	0.5	3	NA	0	540
12	Thaizawl	6.5	70	140	80	0	10	NA	0	348
13	Zobawk, Chalnghakainbul	6.5	120	200	50	0	10	NA	0	444
14	Zobawk, Hrangvunga Point	6.5	100	100	50	0.5	5	NA	0	300
15	Zobawk, Venglai	7.5	220	300	60	1	0	NA	0	696
16	Zobawk, Vengthar	7.5	150	300	40	0.5	10	NA	0	588

Source: PHED, Government of Mizoram

4. GROUND WATER RESOURCE ESTIMATION

The dynamic ground water resource has been assessed based on Ground Water Resources Estimation methodology of 1997. In this methodology two approaches are recommended – water level fluctuation method and rainfall infiltration method. However as the data on ground water level is insufficient, rainfall infiltration method was used. Moreover, hilly area having slope of more than 20% are not taken into consideration as they are not worthy of recharge. Hence, the remaining area is delineated into command and non-command area and assessment is done for both monsoon and non-monsoon seasons. The main source of ground water recharge is precipitation. Recharge from sources such as ground water irrigation, recharge from ponds and tanks, check dams, nala bunds is nil and only surface water irrigation is taken into account. The total annual recharge is obtained as the arithmetic sum of recharge from rainfall and the recharge from sources other than rainfall. Thus ground water resource potential for the block as on March 2013 is as follows.

Table 11: Net ground water availability (ham)

Annual Replenishable GW resources				Total annual ground water recharge	Natural discharge during non-monsoon season	Net ground water availability
Monsoon season		Non-monsoon season				
Rainfall recharge	Recharge from other source	Recharge from rainfall	Recharge from other source			
46.62	Negligible	14.11	Negligible	60.73	6.07	54.66

Table 12: Categorization of ground water resources (ham)

Net Ground water availability	Annual GW draft			Domestic and industrial uses upto 2025	Ground water availability for future irrigation	Stage of ground water development (%)	Categorization
	Irrigation	Domestic and industrial uses	Total				
54.66	0	6.11	6.11	22.23	10.21	11.17	**Safe**

The stage of ground water development for Lunglei block as on March 2013 is 11.17%. Based on the stages and development and long-term water level trend analysis the district can be categorized under **safe** category.

5.GROUND WATER RELATED ISSUES

Approach to most parts of the area was main constraint due to prevailing atmosphere and heavy rains during June to September. Major part of the area identified for aquifer mapping is occupied by forest cover. The area is virgin and therefore the basic ground water data is not available. It is sparsely populated and has no irrigation facility. Majority of people are totally dependent on agriculture and are poor and having marginal land holding.

Low stage of ground water development and higher concentration of Iron in hand pump/tube well has been reported from some localities of the block.

6.GROUND WATER MANAGEMENT PLAN

The groundwater management involves the optimum utilization of sub-surface water based on geological, hydrological, economic, ecological and legal consideration for the welfare and benefit of the society. The management of the ground water resources has to be taken up after understanding the varied hydrogeological characteristics. There is a need for scientific approach for proper management of the ground water resource for the sustainability of the resource for the present and future generation.

Ground Water

As the area is characterized by hilly terrain, the scope for development of ground water lies only in low lying depression and valley fills which hold good prospects for ground water development. Structures like ring wells, shallow tube wells are the feasible ground water structures. The fractured, fissured rocks and the intersection of faults /lineaments hold good prospects for ground water. **Dugwells/Ring wells with 2-3 m diameter & 15-20 m depth below the ground level may be constructed in the valley areas of Zobawk, Thaizawl, Haurang etc.**Tube well can be drilled in such formation down to a depth of about 100m tapping about 2 to 4 fractured zones with a diameter of 152.4 mm. As ground water is poorly developed/ exploited, dugwells are the preferred structures as of now in low-lying areas and valleys. The normal way of irrigation in the hills is by diverting small streams. In other areas, the irrigation is provided from natural sources only during rainy months. The hydro-geomorphology of the hilly region is such that groundwater resource cannot be easily utilised for irrigation purpose. In such areas techniques for harvesting rainwater appears to be essential.

Spring

Spring water is of good quality and is suitable for drinking purposes as per BIS standard. As the people in rural areas are totally dependent on spring, there is a need for scientific approach for proper development and management of this precious resource. **Development of springs having high discharge in places such as Haulawng, Pukpui, Zobawk, Lunglei will help in mitigating the water requirement especially in rural area during lean periods.** It may be recommended that the development of springs having high discharge will help in mitigating the water requirement of the people to a great extent.

Rain water harvesting

Rainwater harvesting is not a new concept, it was practiced by the people of Mizoram since ages. However, it is gaining popularity in a new way with more scientific approach due to the ever-increasing demand of water. In the study area too, traditional roof top rainwater water harvesting techniques are in use by the people in almost all the house hold. In rural areas where the pipe water supply is not available, roof top rainwater harvesting has been implemented. In this technique rainwater is harvested from the roof and transported by using bamboo pipes. This water is collected in a sump and is used in time of requirement. **R**ain water harvesting can take up in a big way by involving the community and other non-Governmental Organization.

The district being hilly, most of the rainfall goes as run-off. Structures like **check dams, Nala bunds, Contour bunding** can be constructed in rural areas to check surface run off which will also help in restoring spring yield.

Groundwater in the area is infested with iron, therefore before consumption aeration/ filtering/ installation of Iron Removal Plant is necessary.

Creating public awareness for effective use of water resources is essential for proper management of ground water resources. Hence, the co-operation of public is as important as the technical or administrative considerations. It is essential to create awareness of water resources through village welfare association. Imparting training programme to the beneficiary is essential to involve the stakeholders in water management process.

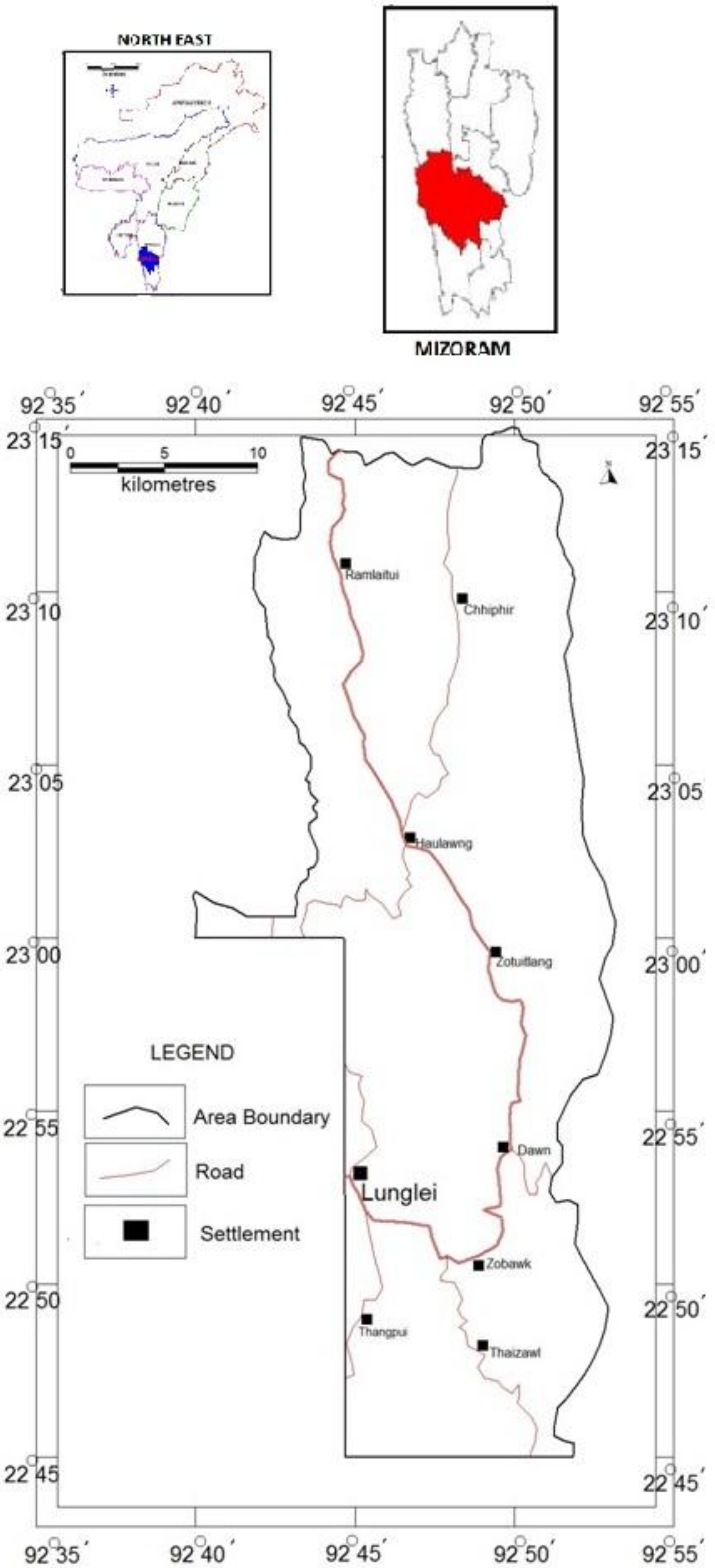
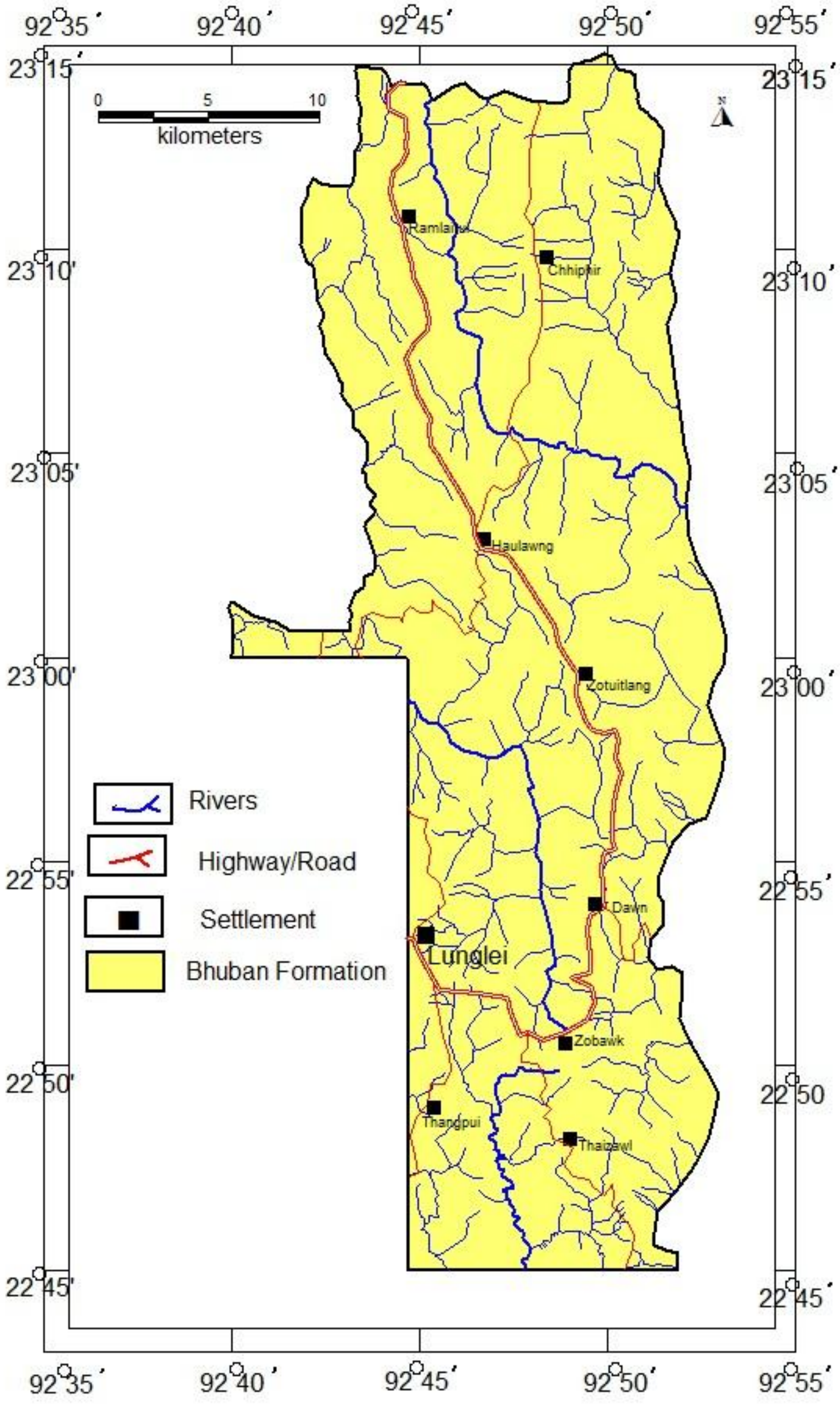


Figure 1: Location map of the Study Area



Figure

Figure2: Base map of the Study Area

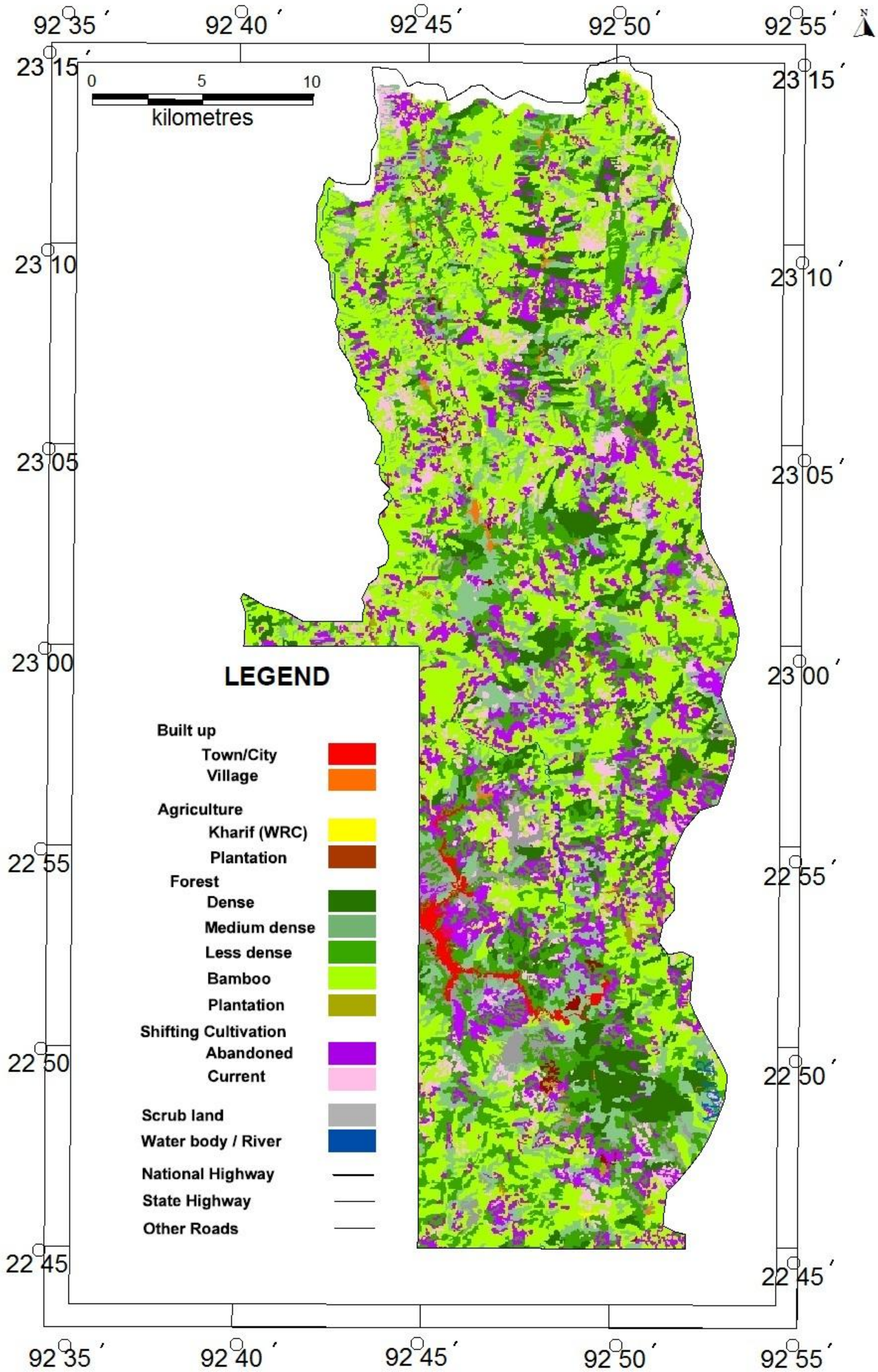


Figure 3: Land use map of the Study Area

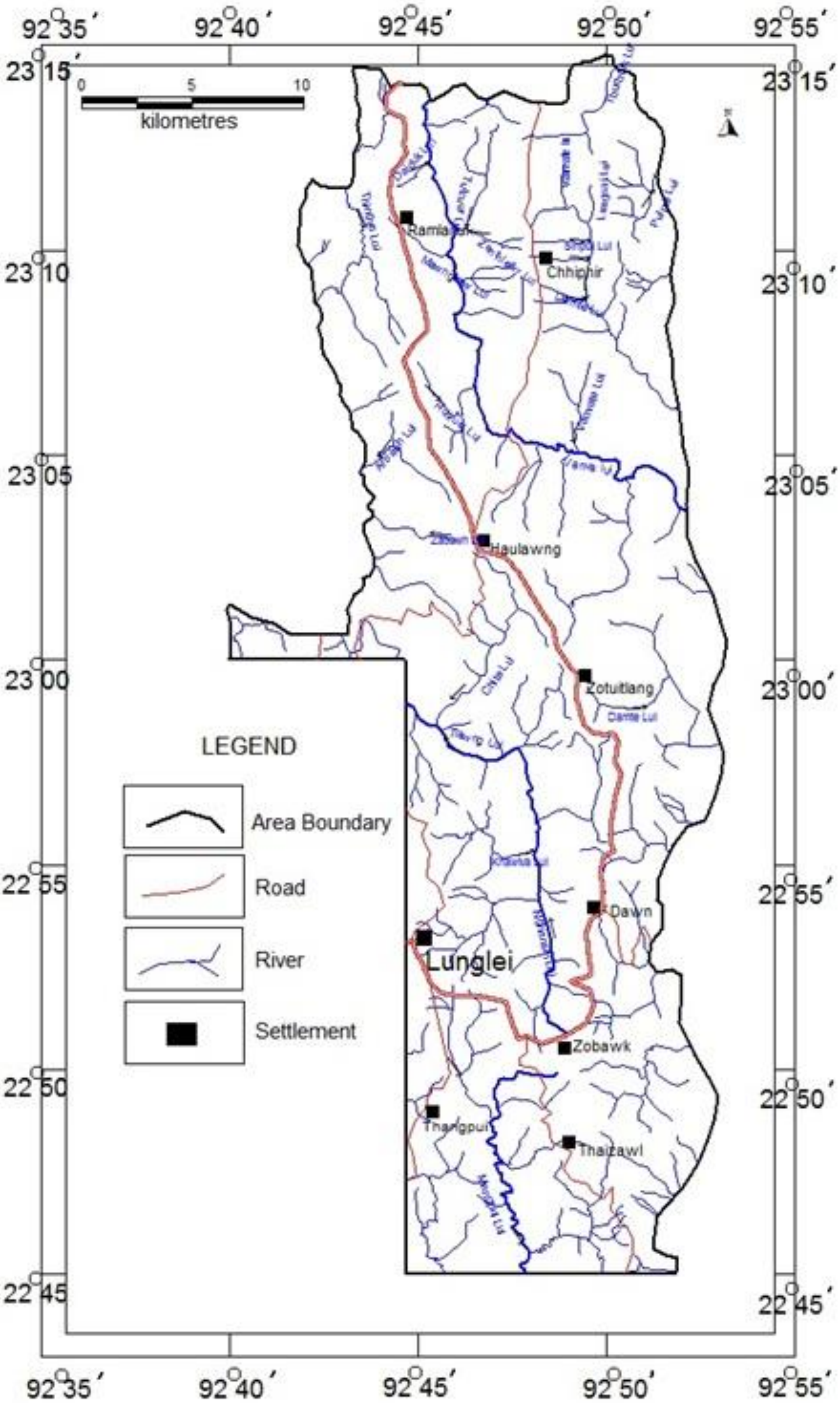


Figure 4: Drainage map of the Study Area

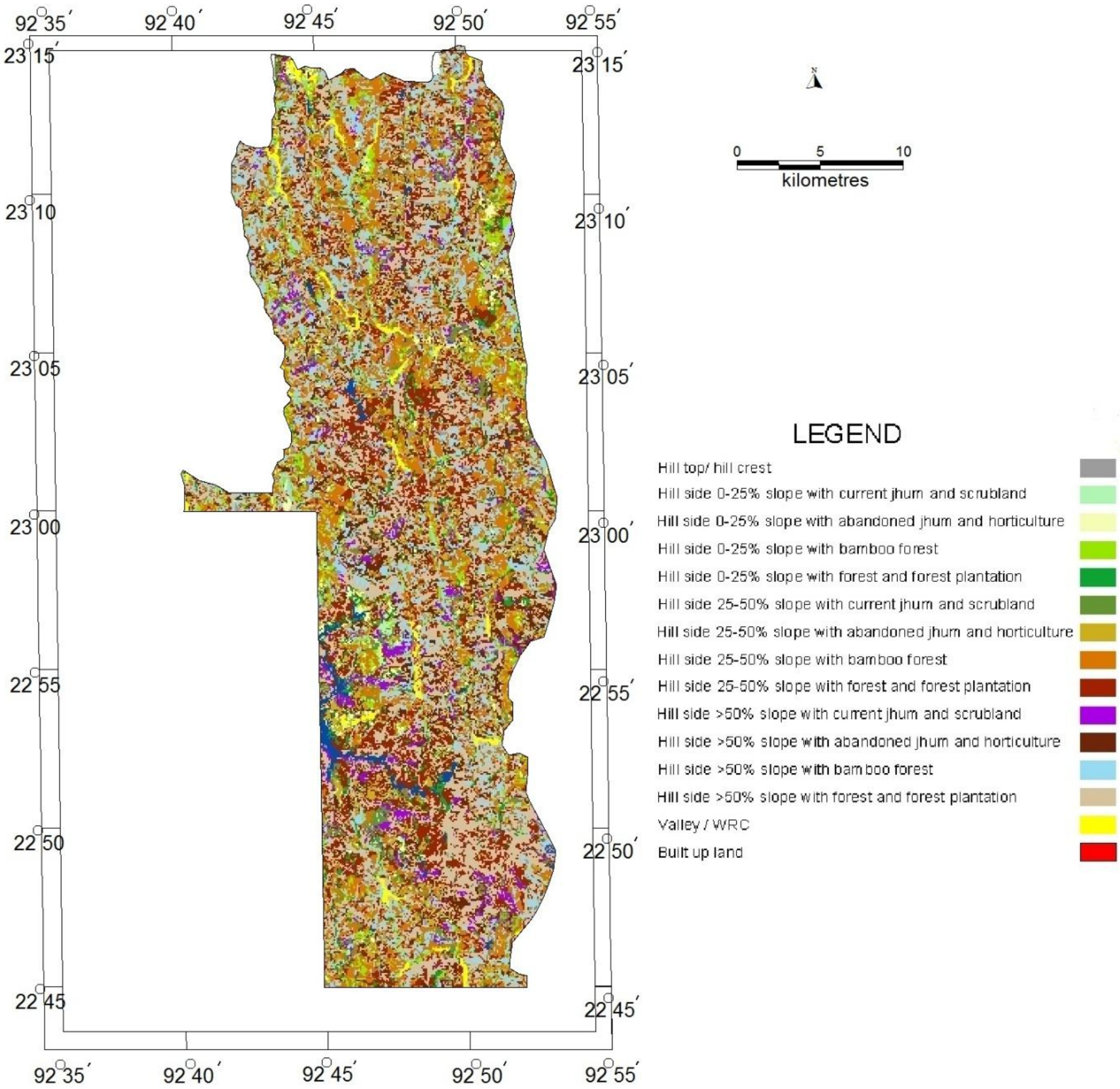


Figure 5: Slope map of the Study Area

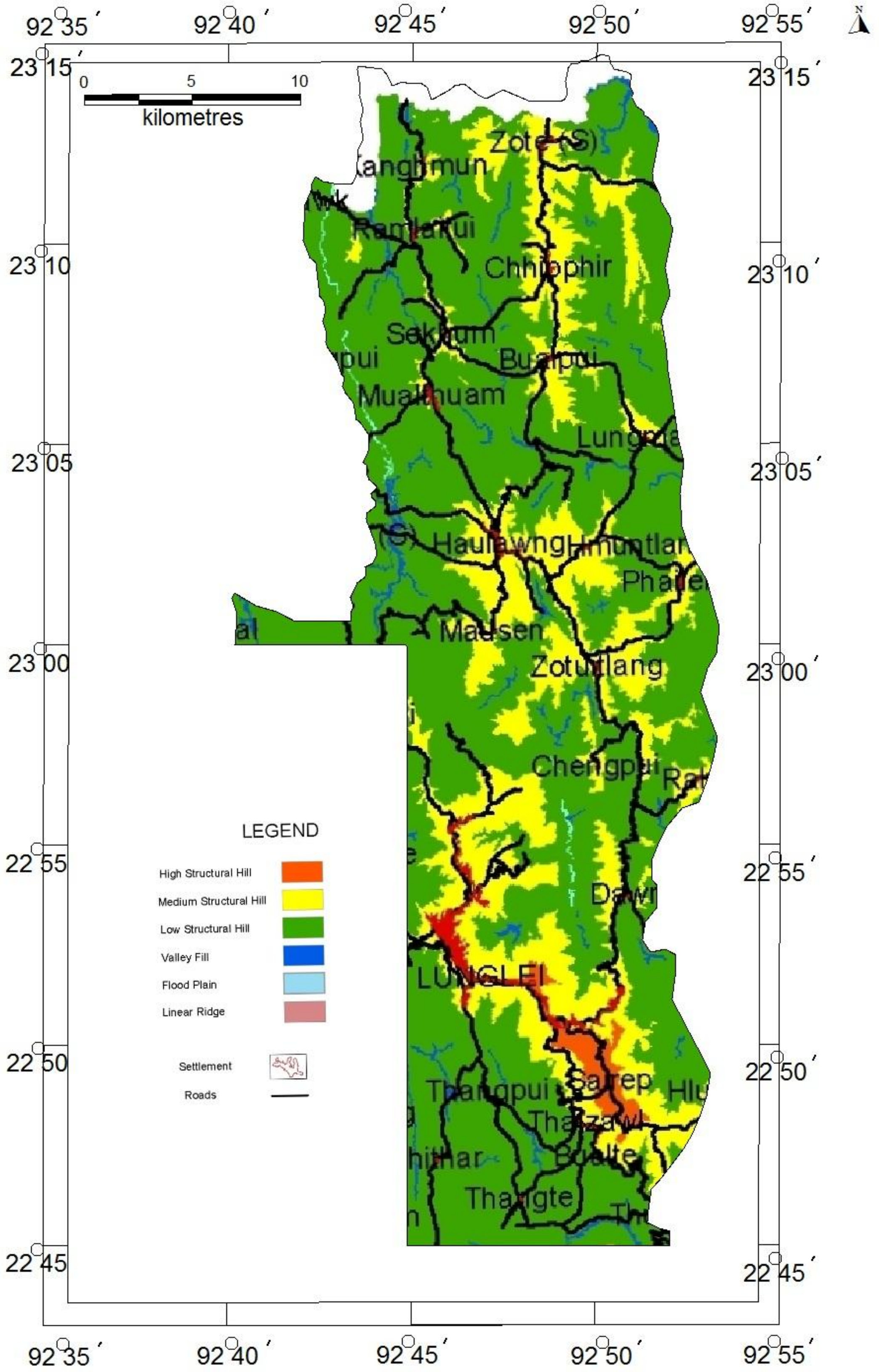


Figure 6: Geomorphological map of the Study Area

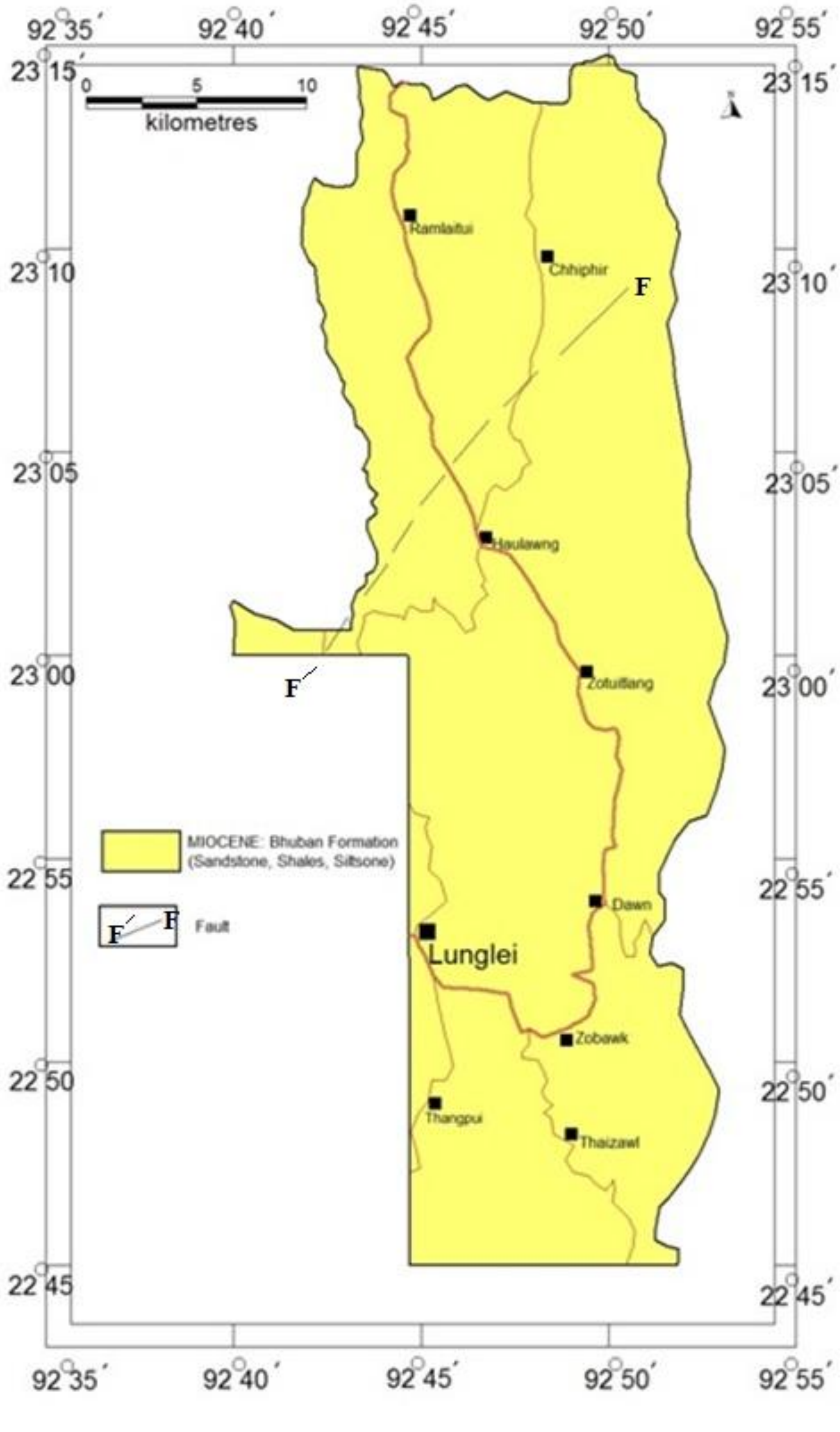


Figure 7: Geological map of the Study Area

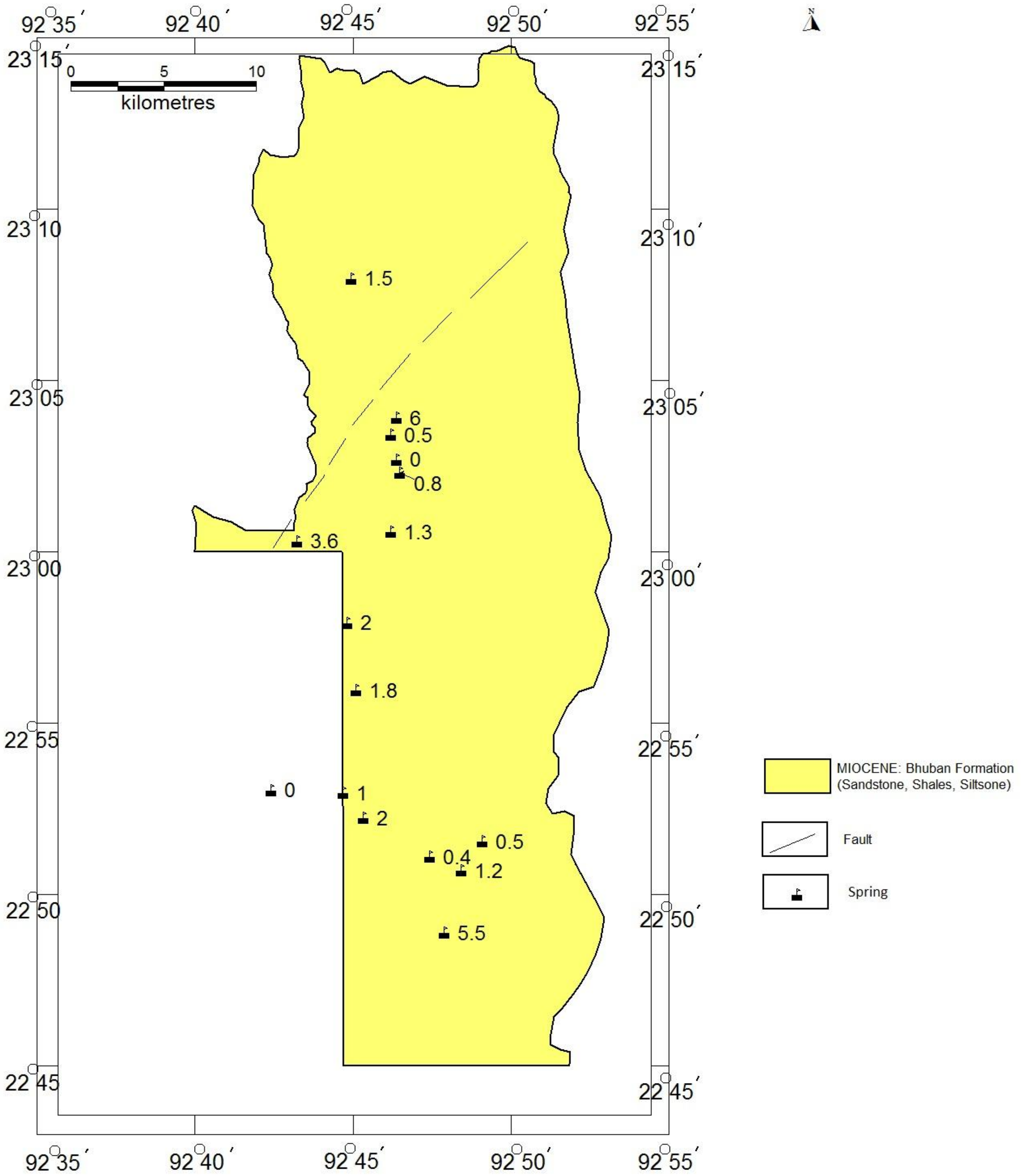


Figure 8: Pre- monsoon spring discharge(in Litre Per Minute)

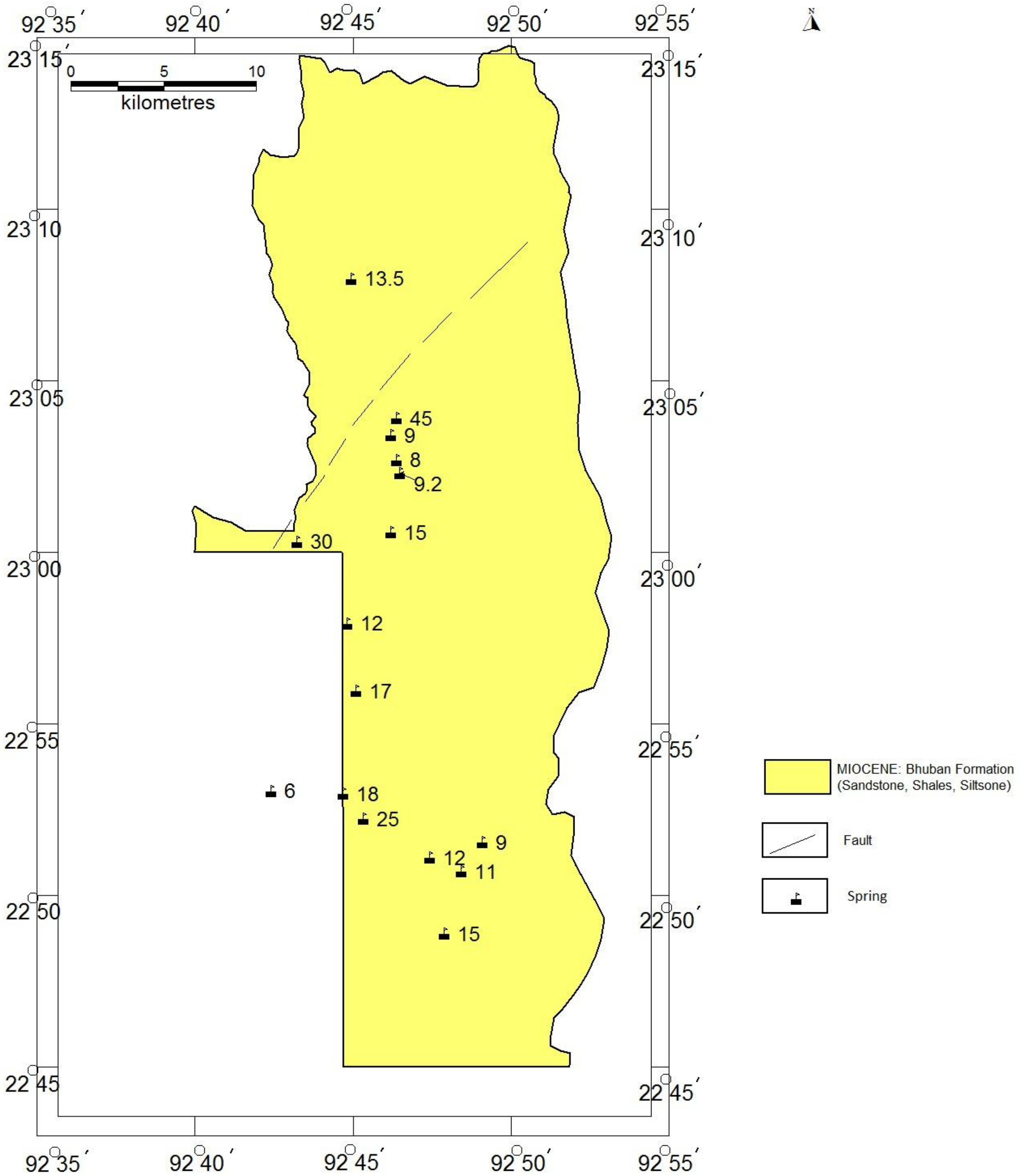


Figure 9: Post- monsoon spring discharge (in Litre Per Minute)

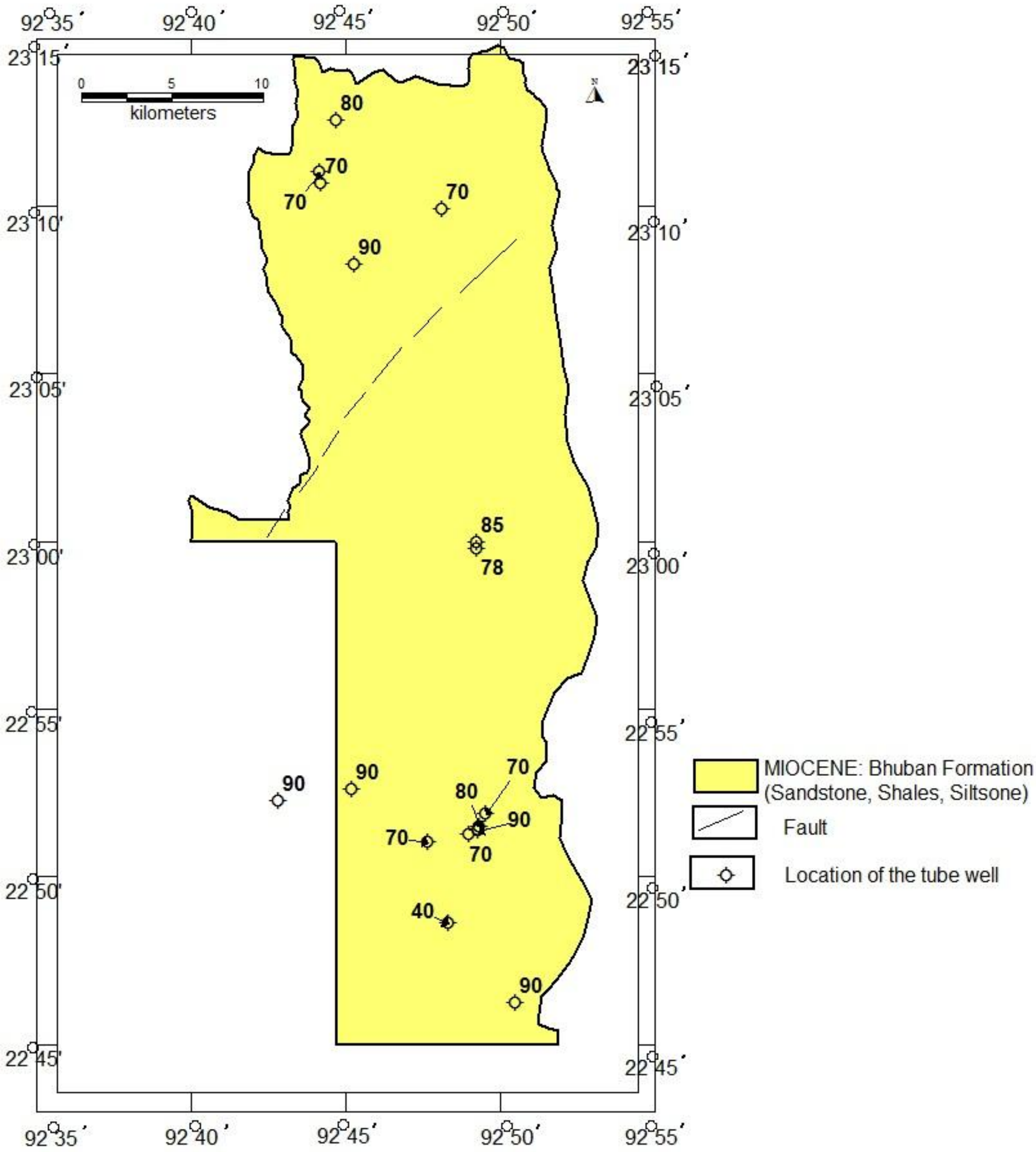


Figure 10: Depth to Water Level Map in Tube Well (in metres)

Source: PHED, Government of Mizoram

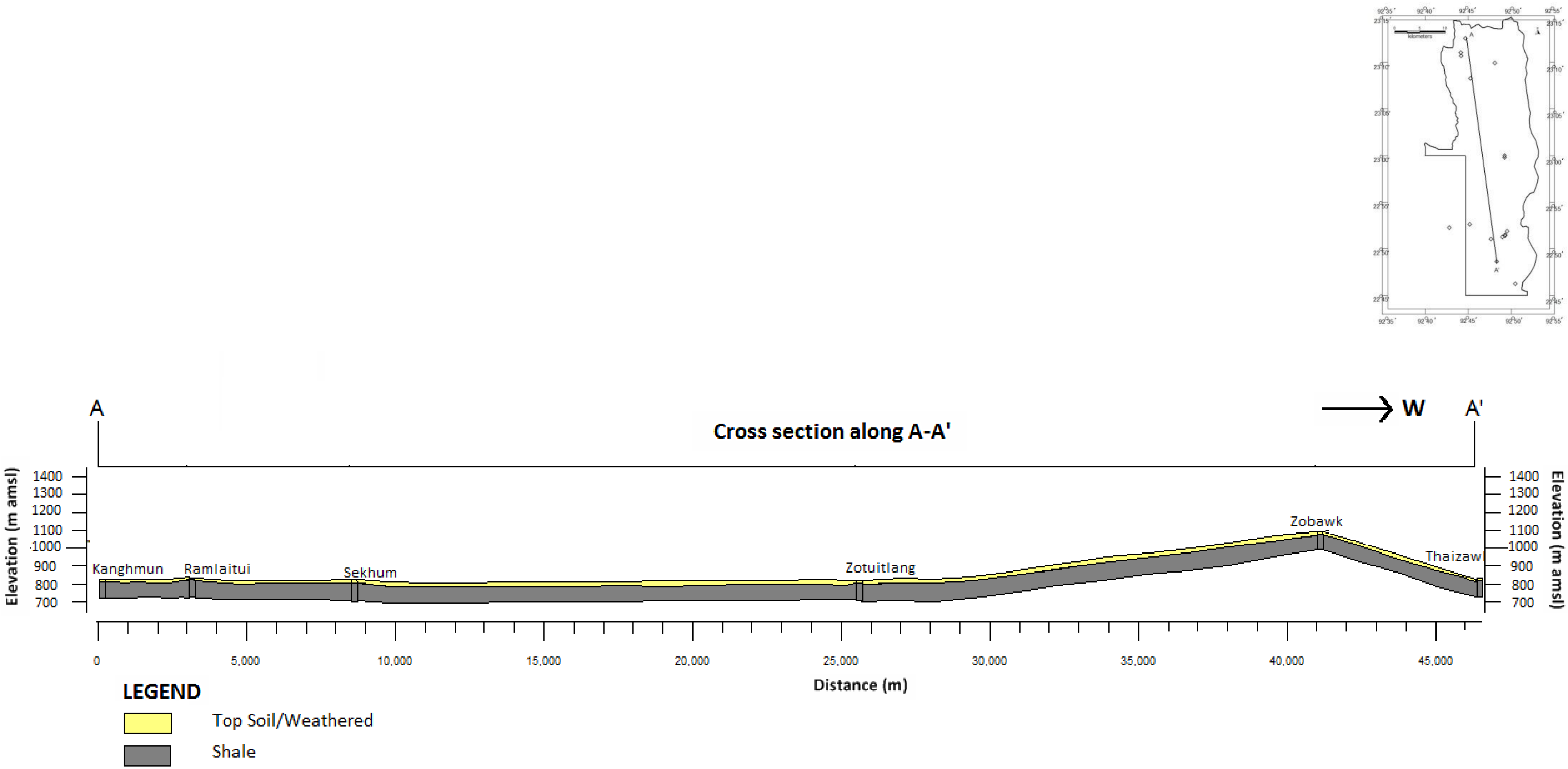


Figure 11: Schematic litho-section along Kanghmun – Zobawk, Lunglei Block, Mizoram

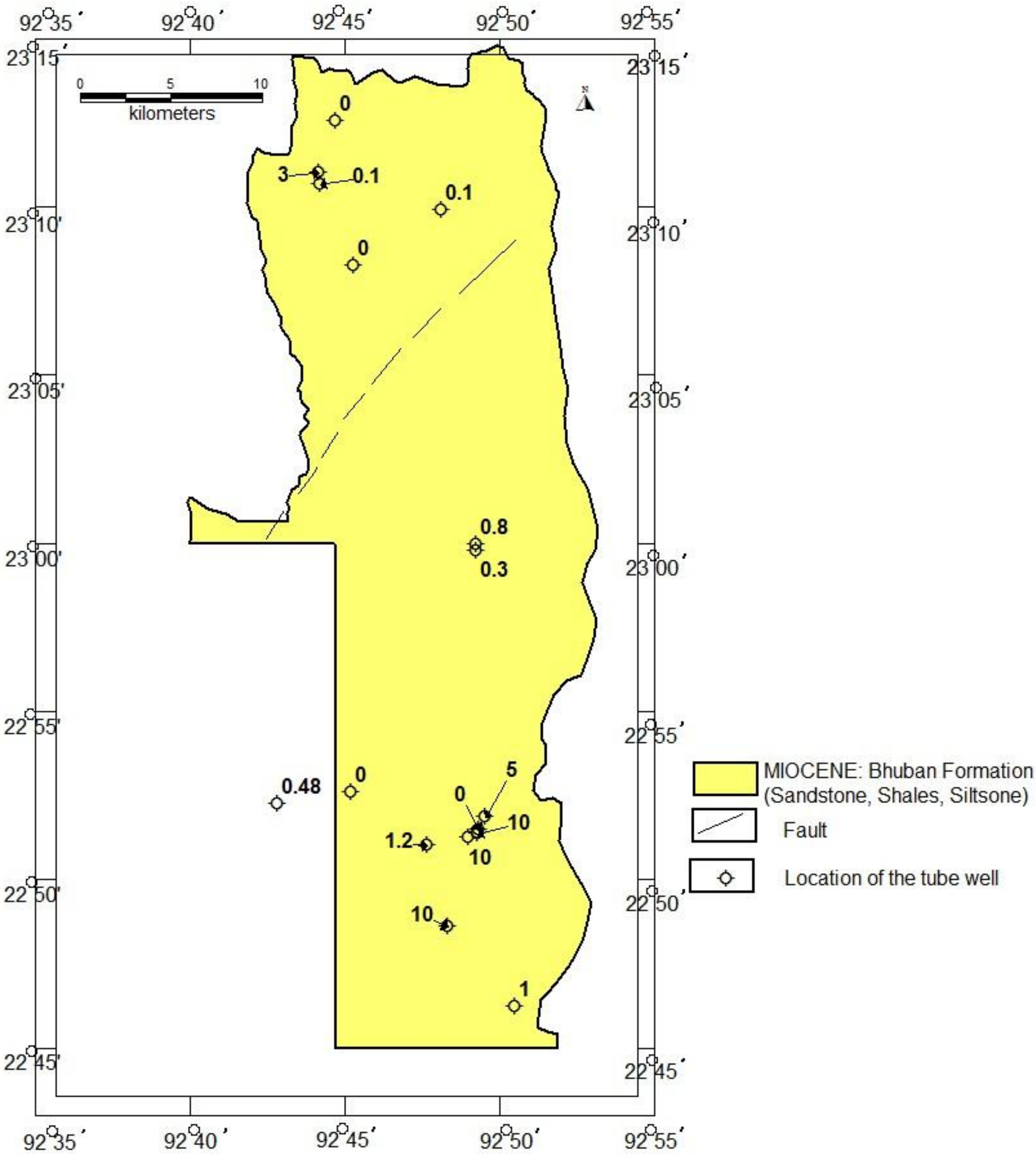


Figure 12: Concentration of Iron in Tube Wells (in mg/litre)

Source: PHED, Government of Mizoram

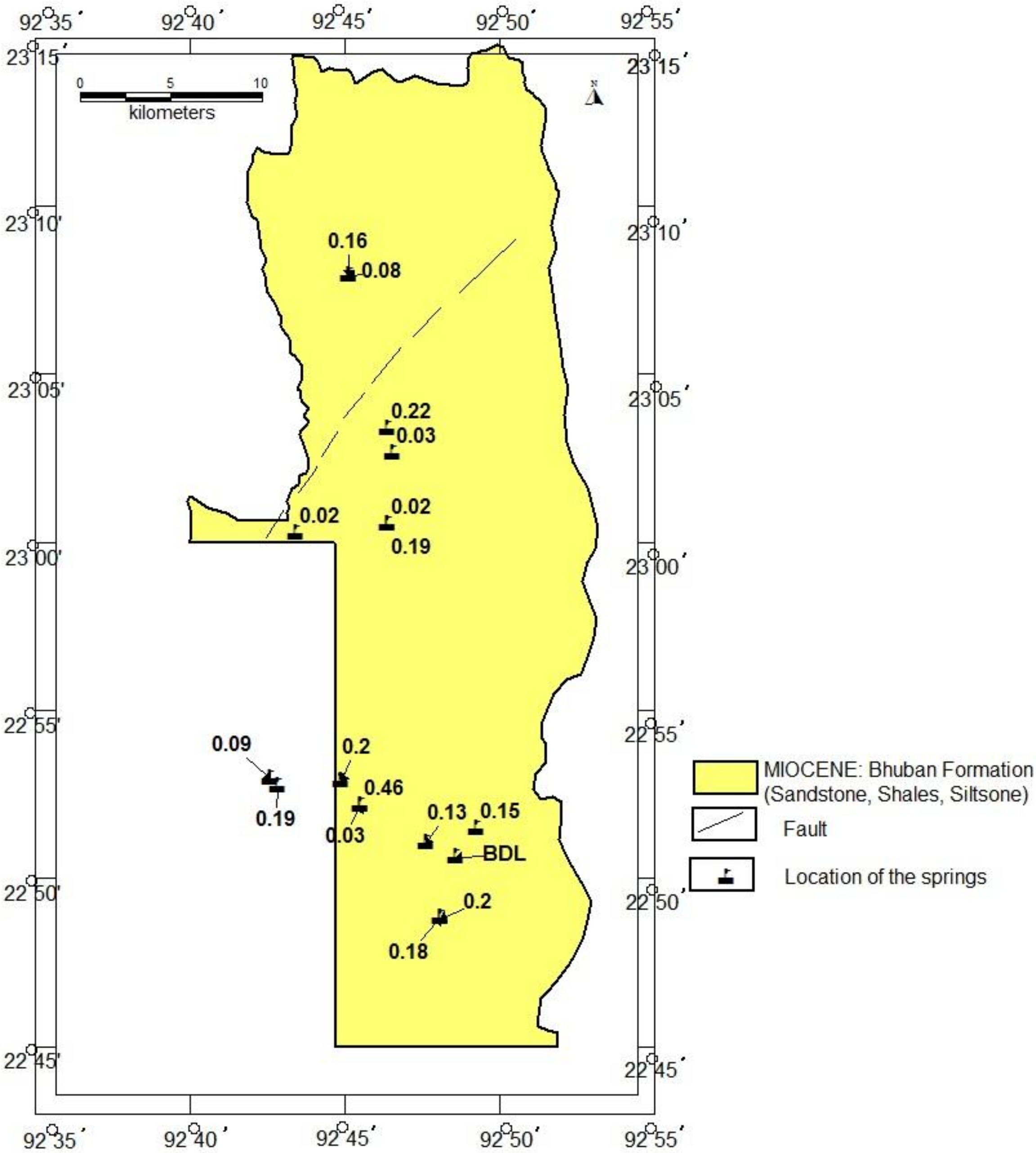


Figure 13: Concentration of Iron in Springs (in mg/litre)

11. PHOTOGRAPHS

View of Lunglei Town

Water Scarcity in pre-monsoon season
Location: Haulawng

Geology

Horizontal bedded sandstone
Location: between Ramlatui and Haulawng

Compact and massive sandstone
Location: Zobawk

Splintery Shale
Location: Mawsen

ROOP TOP RAIN WATER HARVESTING

Location: Zobawk

Location: Mausem

Location: Haulawng

Spring Tap Chamber

Location: Lunglei

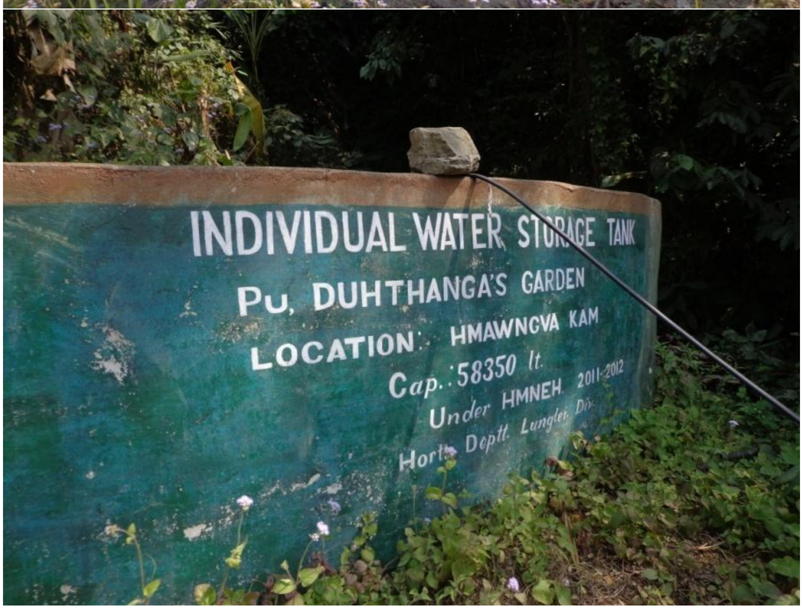
Location: Sekhum

Location: Zobawk

Rain Water Harvesting Structures

Location: Knaghmun

Location: Haulawng



Location: Hwawngva

Annexure I: Water Quality data of Springs, Lunglei Block, Mizoram

Location	Date of collection	pH	EC (micro mhos/l)	TDS (mg//l)	Turbidity (NTU)	TH (mg//l)	CO3 -2 (mg//l)	HCO 3 -1 (mg//l)	Cl- (mg//l)	SO4-2 (mg//l)	NO3 -1 (mg//l)	F- (mg//l)	Ca+ 2 (mg//l)	Mg+ 2 (mg//l)	Na (mg//l)	K (mg//l)	Fe (mg//l)
Haulawng	11.12.2014	8.32	359.3	190.8	0.2	116	32	72	7.99	5.75	BDL	0.05	19.2	9.6	16.16	1.06	0.03
Haulawng II	19.02.2015	8.3	414.7	221.4	0.3	128	32	84	11.99	14.43	BDL	0.5	20.8	24	3.11	1.05	0.22
Haurawng	24.09.2014	7.7	135.1	71.83	0.4	36	BDL	56	21.9	1.07	3.9	0.33	11.2	9.6	2.5	1.02	0.09
Lunglei-I	24.09.2014	7.8	136	72.6	0.3	44	BDL	64	7.99	4.81	8.8	0.54	8	14.4	1.16	1.1	0.2
Lunglei-II	24.09.2014	7.7	304.3	162.1	0.2	60	BDL	52	35.98	7.21	4.3	0.38	14.4	14.4	5.71	3.85	0.46
Lunglei-II	20.02.2015	8.3	255.1	137.3	BDL	68	16	72	7.99	2.57	18.8	0.27	14.4	16	10.5	1.06	0.03
Mausem	24.09.2014	8.36	203.1	108.7	0.1	48	16	36	15.99	1.26	0.1	0.23	9.6	14.4	1.81	1.2	0.19
Mausem	19.02.2015	8.32	469.6	250.6	BDL	136	24	128	5.99	7.13	15.5	0.55	12.8	19.2	22.75	1.12	0.02
Pukpui-II	11.12.2014	6.7	242.8	129	0.6	64	BDL	28	21.99	5.05	BDL	0.42	9.6	8	2.25	1.03	0.19
Pukpui-III	11.12.2014	8.31	372.1	198.7	0.2	112	44	84	25.9	8.05	2.6	0.33	19.2	25.6	10.8	1.14	0.02
Sekhum	23.09.2014	8.34	177.3	94.5	0.3	48	24	44	21.9	8.12	0.2	0.2	11.2	20.8	4.76	1.02	0.08
Sekhum	19.02.2015	8.39	431.4	230.1	BDL	128	24	60	17.9	12.21	BDL	0.52	17.6	20.8	1.07	1.02	0.16
Thaizawl	24.09.2014	8.37	148.3	79.2	0.1	40	16	48	25.99	3.10	4.4	0.35	6.4	16	14.93	1.2	0.18
Thaizawl	21.02.2015	8.1	126.9	71.7	BDL	48	BDL	40	7.99	4.81	18	0.24	8	9.6	2.53	1.81	0.2
Zobawk-I	11.12.2014	8.38	419.6	223.6	0.3	88	24	56	29.99	6.86	10.1	0.4	22.4	17.6	7.12	5.04	0.15
Zobawk-I	21.02.2015	8.3	343.6	183.7	0.2	108	32	88	13.99	1.302	17.9	0.26	22.4	12.8	19.83	1.13	BDL
Zobawk-I	21.02.2015	8.2	155.8	83.3	0.1	40	BDL	60	35.9	5.43	19.3	0.4	6.4	22.4	8.97	1.04	0.13