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भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

CHURACHANDPUR DISTRICT, MANIPUR

उत्तर पूर्वी क्षेत्र, गुवाहाटी

North Eastern Region, Guwahati

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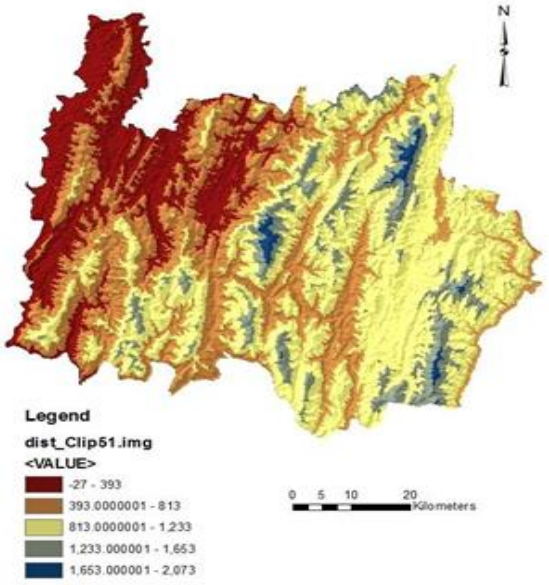
Govt. of India

AQUIFER MAPPING IN CHURACHANDPUR DISTRICT, MANIPUR

ANNUAL ACTION PLAN 2017-18

DIGITAL ELEVATION MODEL



Ministry of Jal Shakti
Department of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board
North Eastern Region
Guwahati
March- 2018

AQUIFER MAPPING IN CHURACHANDPUR DISTRICT, MANIPUR

CONTENTS

CHAPTER 1.0

INTRODUCTION

1. INTRODUCTION

Central Ground Water Board, North Eastern Region has carried out Aquifer mapping and management plan in Churachandpur District, Manipur during AAP 2017-18 covering an area of 322 sq.km. Under National Aquifer Mapping and Management (NAQUIM) program, combination of geologic, geophysical, hydrologic and hydro chemical information is applied to characterize the quantity, quality and sustainability of ground water aquifers. Systematic aquifer mapping will improve our understanding of the geologic framework of aquifers, their hydrogeological characteristics, quality and also quantifying the available ground water resources potential and proposing plans appropriate to the scale of demand and the institutional arrangements for management. Aquifer mapping at the appropriate scale can help to prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of our precious ground water resources, which, in turn, will help achieve drinking water security, improved irrigation facilities and sustainability in water resources development.

1.1Objectives: The objective of the study can be defined as follows:

a) to define the aquifer geometry, type of aquifers, ground water regime behaviours, hydraulic characteristics and geochemistry of aquifer systems on 1:50,000 scale and

b) to understand existing scenario of groundwater regime in shallow/deep aquifer

c) To work out a management plan for sustainable development of ground water.

1.2 Scope of the Study

The activities of this Aquifer Mapping and management plan can be envisaged as follows:

1.2.1 Data Compilation & Data Gap Analysis: One of the important aspects of aquifer mapping program 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, analyzed, 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 a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This was achieved by multiple activities such as hydro-geochemical analysis, remote sensing, besides detailed hydrogeological surveys to delineate multi aquifer system; to bring out the efficacy of various geophysical techniques and a protocol for use of geophysical techniques for aquifer mapping in different hydrogeological environs.

1.2.3. Aquifer Map Preparation: On the basis of integration of data generated from various studies of hydrogeology, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out characterization of Aquifers, which can be termed as Aquifer maps providing spatial variation (lateral & vertical) in reference to aquifer extremities, quality, water level, potential and vulnerability (quality & quantity).

1.3 Approach and Methodology

Aquifer mapping has been carried out by adopting a multi-disciplinary approach:

(i) Exploratory drilling and construction wells tapping various aquifers.

(ii) Ground Water Regime monitoring by establishing monitoring wells tapping different aquifers at different depths for long term monitoring of water level and quality.

(iii) Collection of various relevant technical data from the field in aquifer mapping area and also from the concerned State Govt. Agencies and other Institutes dealing with ground water and incorporating these data along with CGWB data for final output.

(iv) Preparations of a micro level mapping of existing aquifers, their potentials depth wise and sideways in 2D and 3D forms viewed from different angles by various GIS Layers.

(v) Formulating a complete sustainable aquifer management plan for ground water development.

1.4 Area Details:

Churachandpur district occupies the south-western part of Manipur state. It is bounded by North latitudes 24.25º and 24.44º and East longitudes 92·633º & 92·784º. The district covers 4570 sq. km geographical area constituting 20.47% of the total geographical area of the State and it is the largest district of Manipur in terms of area. It is bounded by Jiribam Sub-Division of Imphal East, Tamenglong District on the North, Bishnupur and

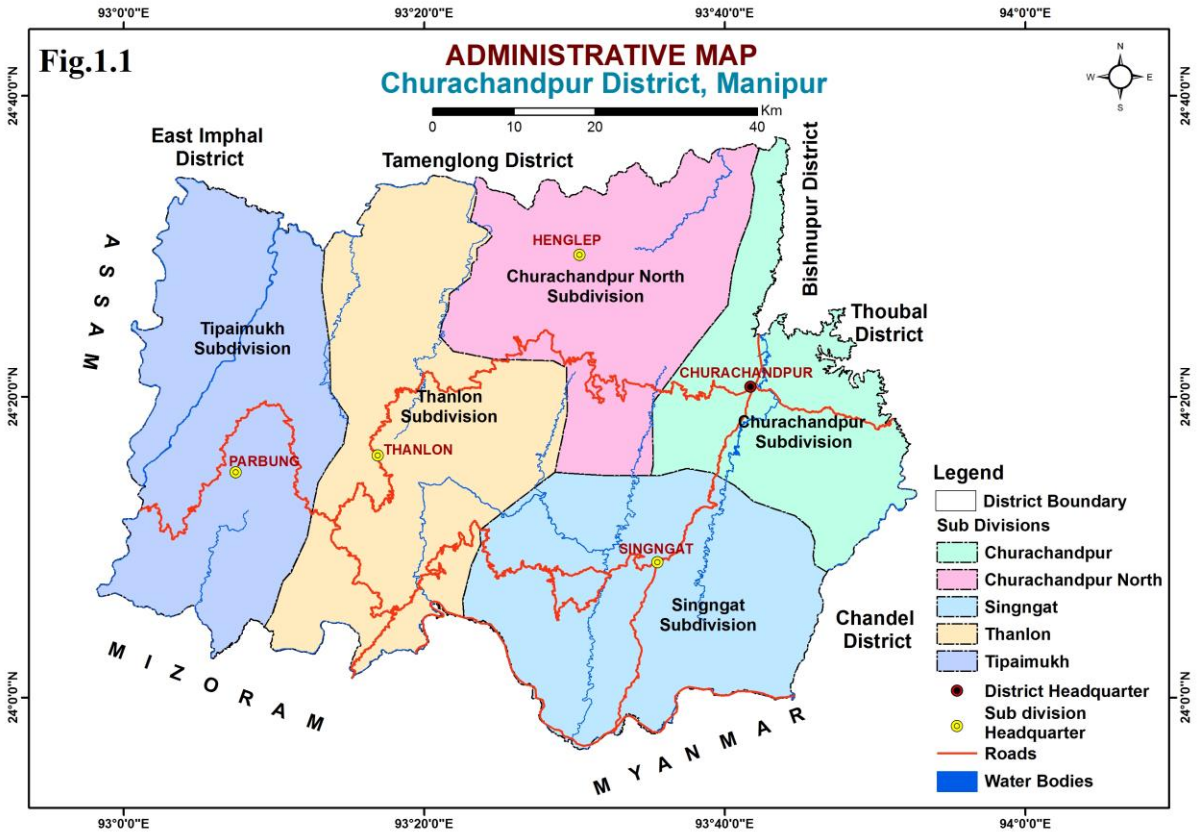
Chandel District on the East, Myanmar (Burma) and Mizoram state on the South and Cachar District of Assam on the West. This district with its headquarters at Churachandpur has been divided into 5 Sub-Divisions. Administrative map of the district is shown in **Fig.1**.

Total population of the district as per 2011 census is 2, 74,143. Sub-division wise population distribution in the district is given in **Table 1.1**.

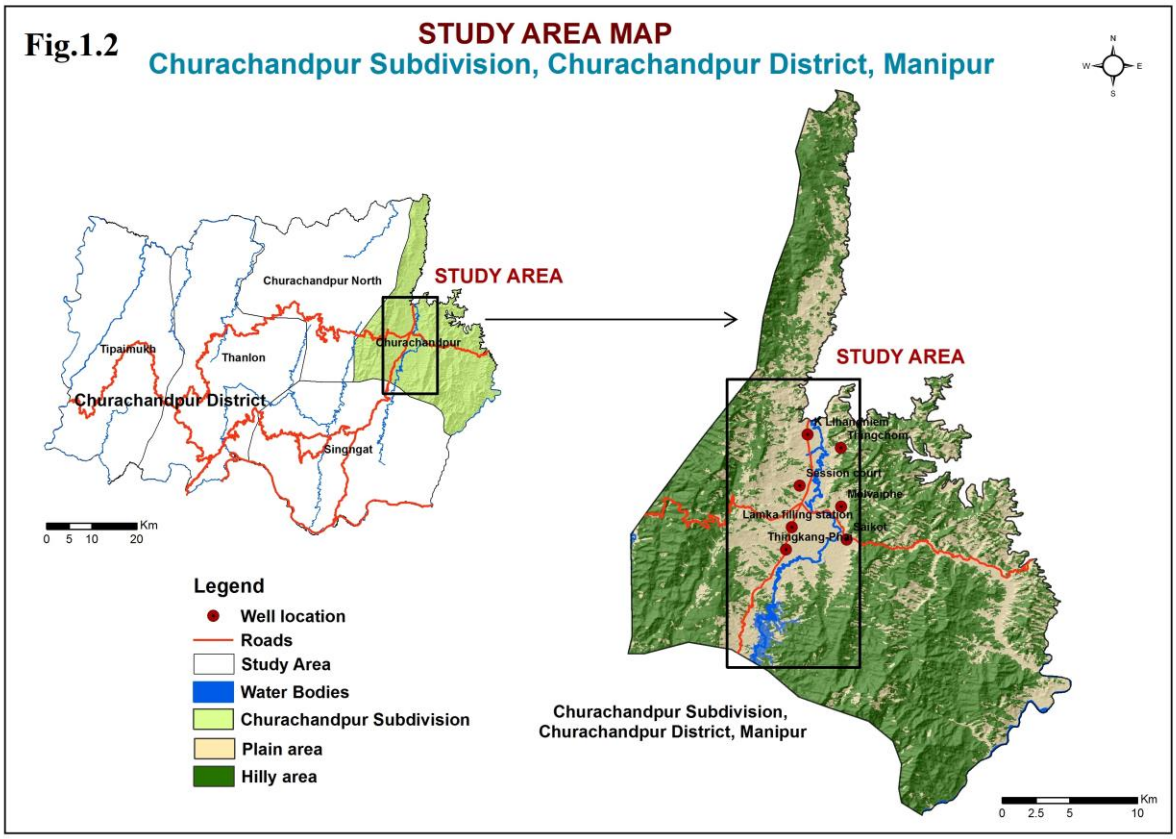
Table 1.1: Sub-division wise population distribution (2011 Census)

Sub-Division	Population
Churachandpur	28795
Churachandpur North	18464
Singngat	30616
Thanlon	22130
Tipaimukh	174138

Source: Statistical Handbook of Manipur, 2017



Study area: Of the total geographical area of 4,570 sq. km. of the district, **322 sq. km**. is the valley portion chosen for aquifer mapping.



1.5 Physiography

Churachandpur is gently hilly topography ranging from 110 m to 1915m above mean sea level. There are small valleys along the rivers Tuitha, Barak and others. The general appearance of the hill ranges is that of irregular ridges, occasional rising into conical peaks and flattens ridges of bare rocks. Only a small area of the district has elevation above 1500 m to 2000 m. Of the total geographical area of 4,570 sq. km. of the district, about 322 sq. km. is the valley through which the Khuga River, a tributary of Manipur River is flowing from south towards northern direction. This valley actually forms the southern extension of Manipur valley and is locally known as **Khuga valley**. In addition, there are other small valleys in the district namely Beheng, Leizangphei and Tuilaphai.

1.6 Drainage:

The drainage system of Churachandpur has been broadly divided into three system, viz., Tuitha drainage system, Barak drainage system and Tuivai drainage system. The study area covers Tuitha drainage system. The Tuitha (Khuga) river originates from Mualmet Tang in Singngat Sub-division. This is the only river running from south to north. It flows parallel to Imphal Tiddim Road. Important western tributaries are Nah Lui, Paldaai Lui, Zezaw Lui, Tuithuul Lui, Tuikhaam Lui and Waikhu Lok. Of all the above tributaries Tuithuul is the longest, draining the hill in the south-east section of the basin. The river finally drains into Manipur river in the east at Ithai to the south of the Loktak Lake. The Manipur river forms the inter-district boundary between Churachandpur and Chandel. Khuga dam is constructed across the Tuitha Lui for power generation, water supply and irrigation facilities around Lamka town.

1.7 Rainfall:

The climate of the district is generally cool and pleasant. Maximum temperature is 37^0 C while the minimum is 1^0 C. The average annual rainfall is 1638.83 mm. Average monsoon rainfall (June-October) is 1166.23 mm while average non-monsoon rainfall (November to May) is 594.13 mm.

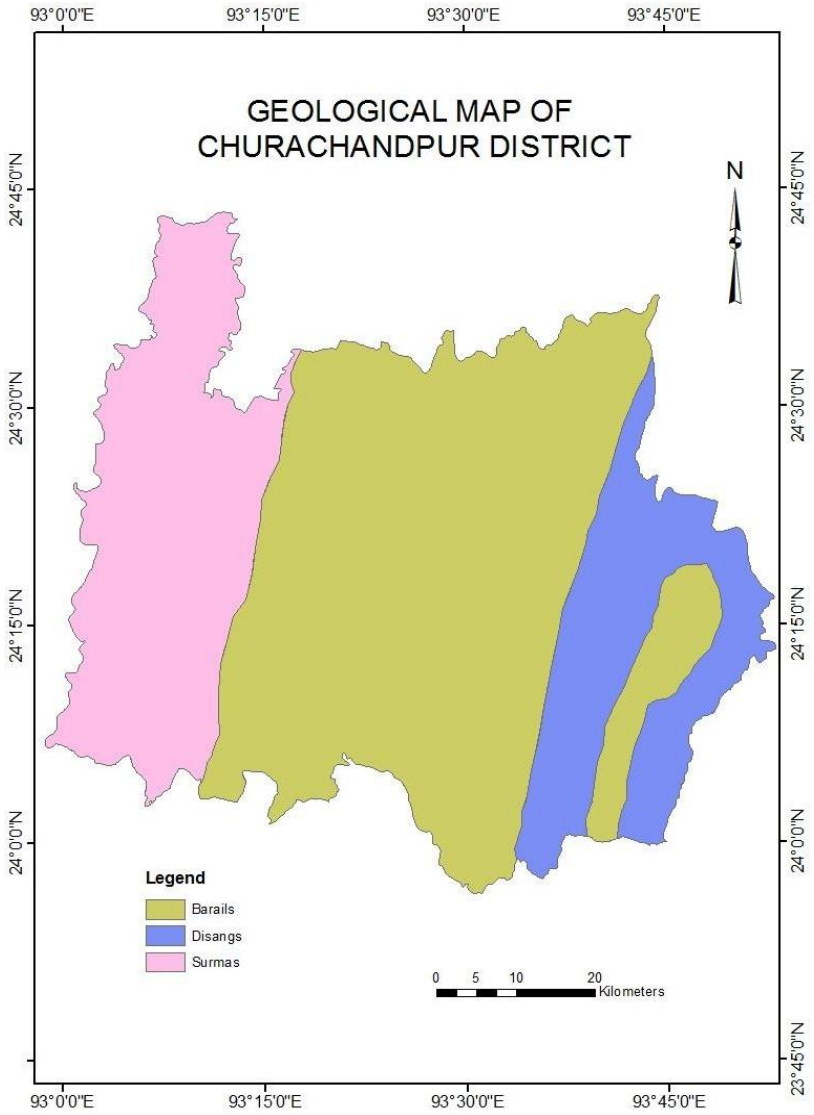
Table 1.2: Rainfall data

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Monsoon	Non monsoon
2014	0	18.46	39.61	54.71	259.36	268.33	140.57	250.33	205.56	37.44	0.01	0	1274.38	902.23	429.99
2015	30.7	5.93	16.92	285.37	91.06	241.62	355.91	276.51	169.54	101.19	8.31	2.28	1585.34	1144.77	779.73
2016	5.43	36.23	63.63	299.58	364.27	254.97	339.16	163.98	291.02	146.6	59.65	3.21	2027.73	1195.73	742.99
2017	5.17	21.26	217.12	265.58	171	333.54	391.55	278.09	312.97	281.28	4.18	101.54	2383.28	1597.43	552.79
2018	0.82	7.77	57.68	141.44	239.36	365.35	241.93	244.71	78.9	60.09	1.82	16.24	1456.11	990.98	465.13
Average	**8.424**	**17.93**	**78.99**	**209.34**	**5360.338**	**292.76**	**293.82**	**242.72**	**211.59**	**125.32**	**14.79**	**24.65**	**1638.83**	**1166.23**	**594.13**

1.8 Geology:

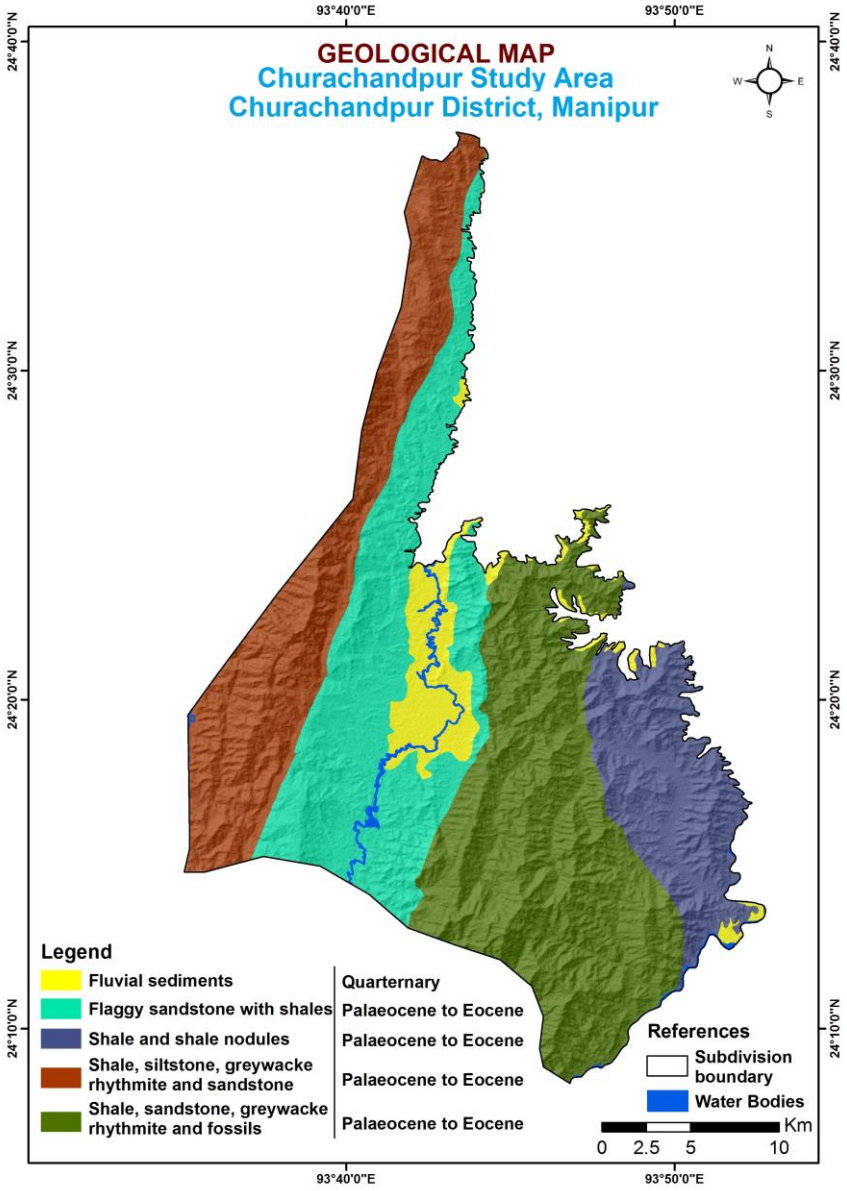
The rock of Churachandpur district is predominantly consists of the sediments of Tertiary and Quaternary age ranging from Eocene to Recent times. The Tertiary rocks of the area are divided into Disang, Barail and Surma units.

Disang (Eocene to Upper Cretaceous) covers the eastern part of the district mainly concentrated in Churachandpur and Singngat sub-division consist of dark grey to black, splintery shale and intercalation of shales, siltstones and sandstone.



The Surma (Miocene to upper Oligocene) rock unit lies uncomfortably over the Barails in the western part of the district concentrating in Tipaimukh sub-division. The Surmas are arenaceous with alternation of sandstone and shale bands and having grey to brownish colour. Conglogomerate horizons also occur. The Surmas are argillaceous at the lower part and arenaceous in the upper part (Kumar, 1993).

Barails (Oligocene) are distributed at the central part of the district i.e., Thanlon, Henglep, western and central part in elongation from north to south in Churachandpur and Singngat sub-division.

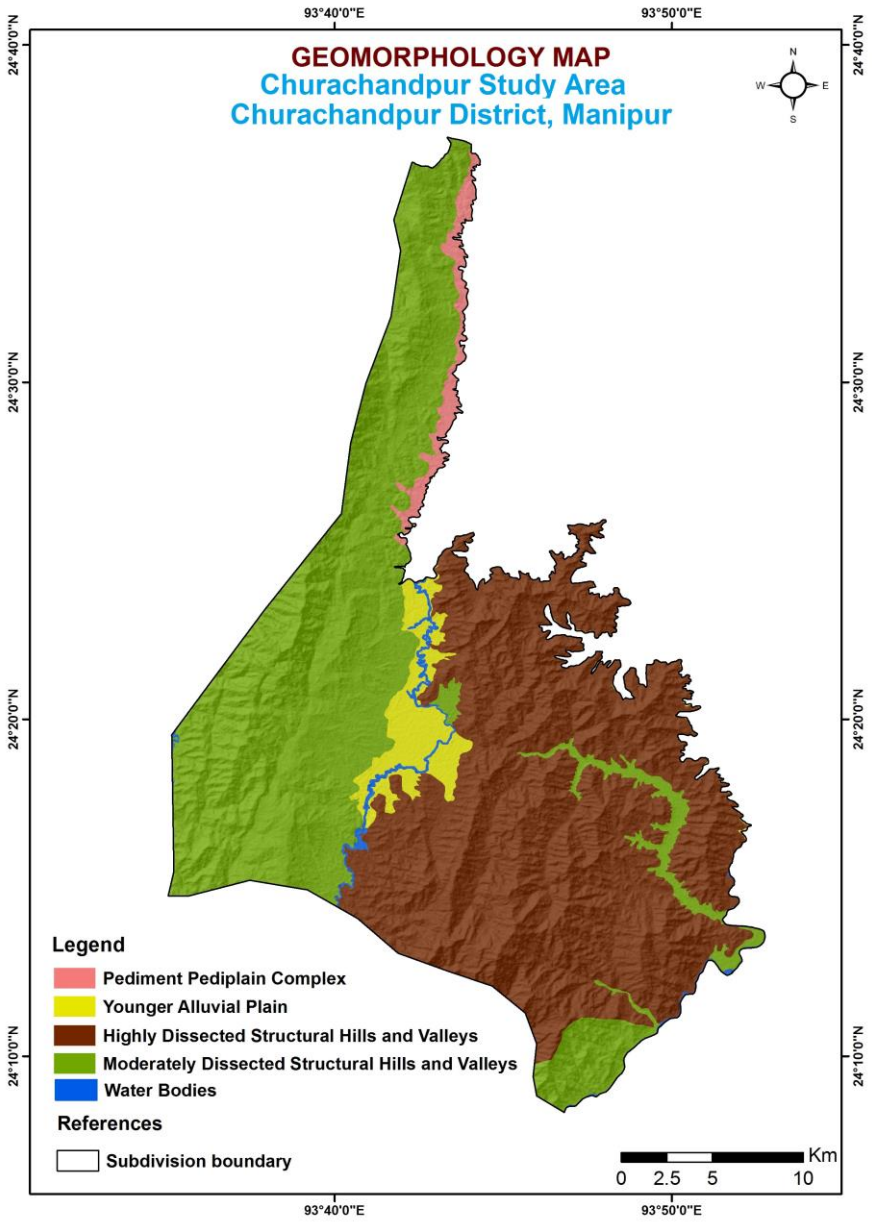


The Barails are characterized by a great thick column of arenaceous beds of flaggy sandstones interbedded with shales overlying the Disang (Carbonaceous matter is abundant in the form of coal streaks in the central part). This rock unit is found in the central part of the study area, running N-S to NE-SW direction, which has been dissected by Tuivai river and Tuitha (Khuga) river. The same rock unit is also occurred in the south-eastern part of Churachandpur district which is enclosed by Disang group.

Newer alluvium consisting of clay, silt and loam deposit over a small area in the Tuitha valley. The thickness of alluvium deposit in this area is about 10 meters. It is mainly composed of alluvial fans consisting of coarse pebbles and cobbles with some sand, silt and clay.

1.9 Geomorphology:

Information on landforms is an important input for land management and identification of potential zones of groundwater. The central part of the district is a valley of fluvio-lacustrine origin surrounded in all sides by hill ranges of denudo-structural hills trending NNE-SSW direction. A number of isolated hillocks of denudational remnants are found within the valley. Imphal River and its major tributaries are main drainage of the valley. These rivers are nearly NNE-SSW trend concurring with the regional structural trend.



The Tertiary rocks are overlain by alluvium thin veneer of alluvial formation of about 10 m thick in the Central valley part of the study area and formation is silty and clayey in nature.

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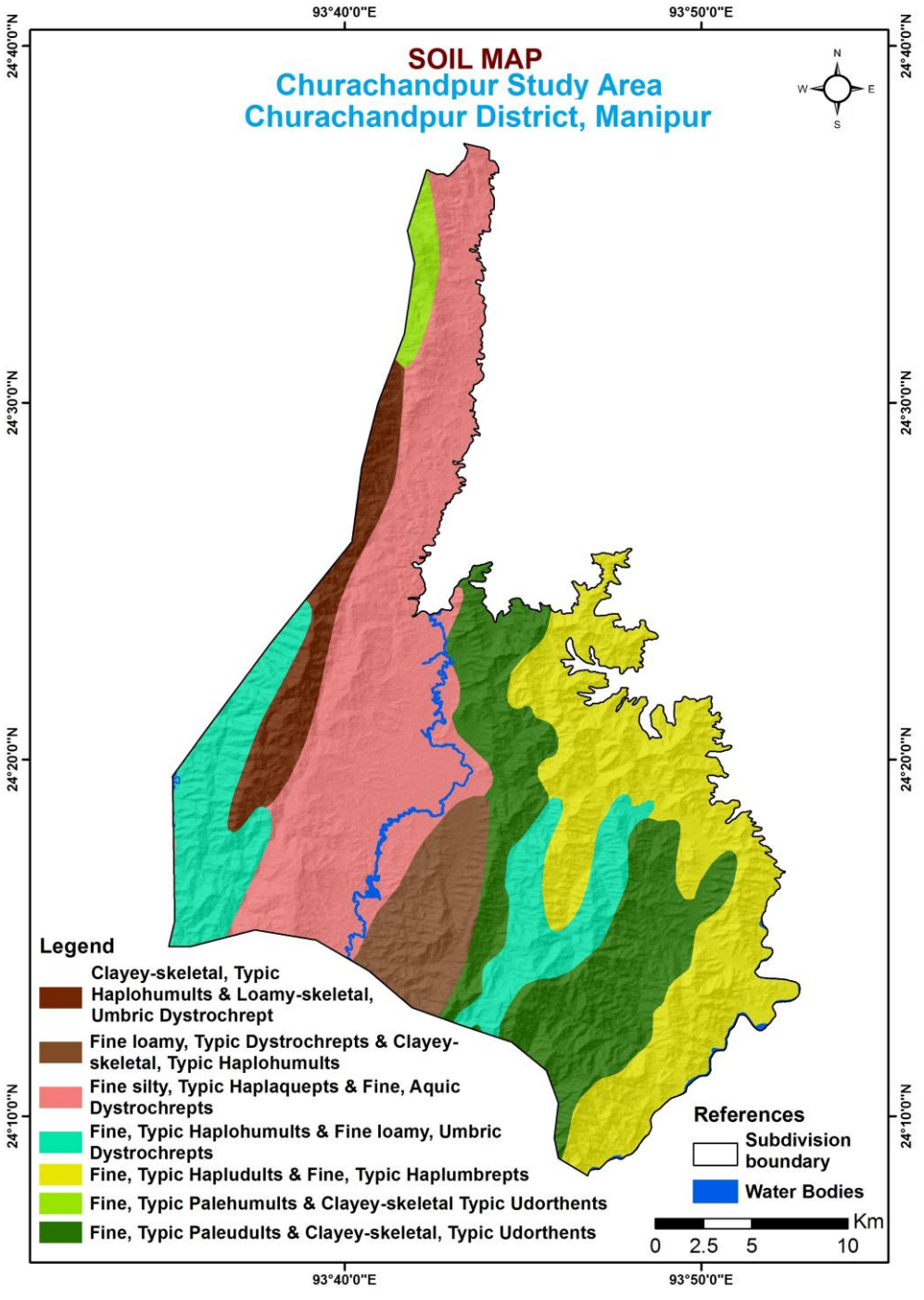
1.10 Soil

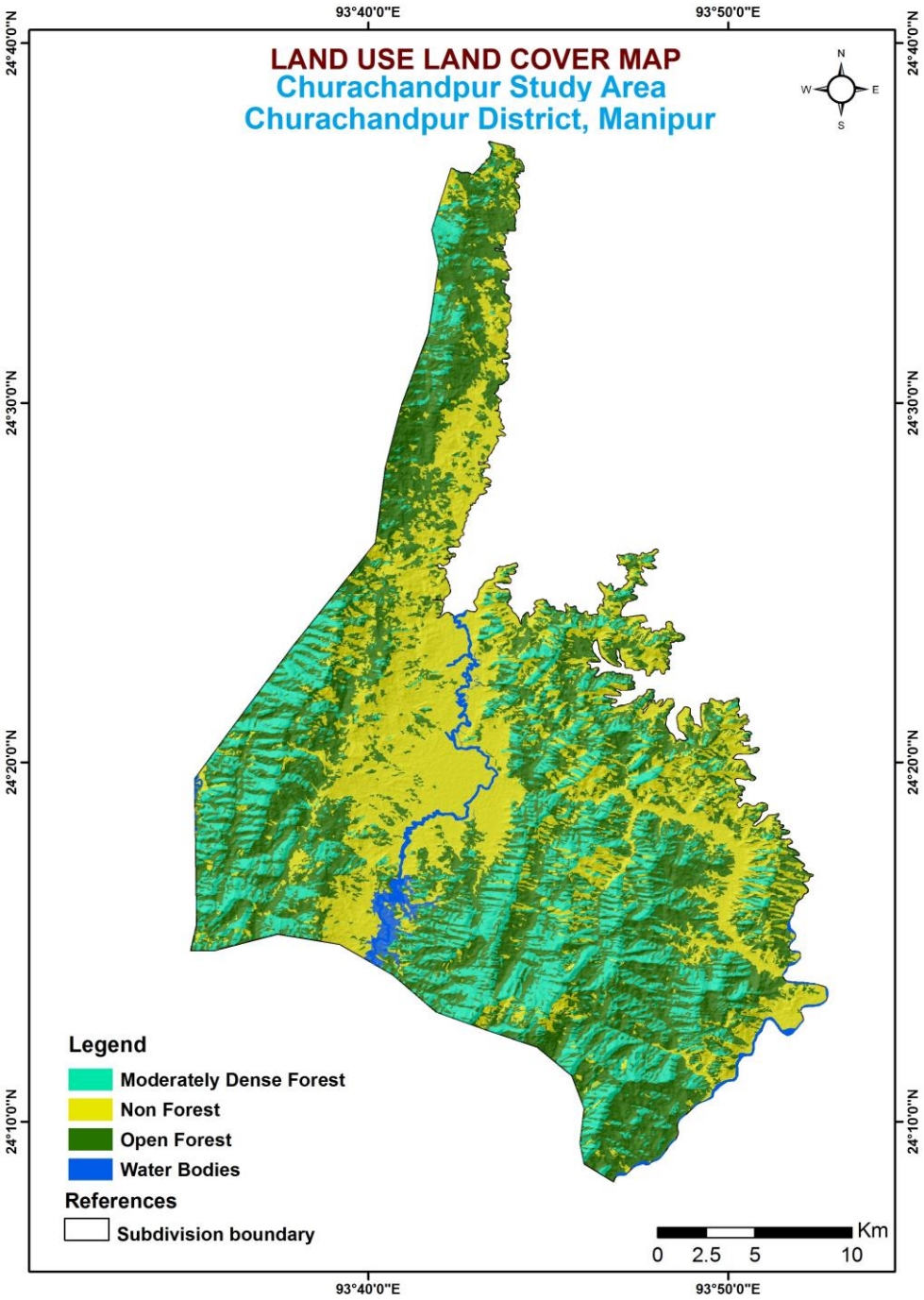
Soils of Churachandpur district is mainly derived from parent rock materials formed in the underlying geology such as Disangs, Barails and Surmas. Alluvial soils are generally deep in the flood plains. Soils in the upslope or hills are residual soils whereas soils in the valleys are transported soils from the hill slopes. Laterisation by oxidation is a common phenomenon in the study area. Hilly soils are moderately deep to shallow. Very steep slopes have very shallow soils and at places there are exposed parent rock materials. Soils are generally fertile in the valleys while moderately fertile in the upslope or hills.



1.11 Land use pattern:

The district is dotted by a few hillocks and hills of low heights. Of these, Punam hill has an elevation of 1009 m above the sea level. A large portion of the area is either under current 'jhum' or abandoned 'jhum'. Out of 4570 sq.km area, 4169 sq.km. area (91.23%) is covered by forest.

As per Department of Agriculture (2016-17), Manipur net sown area is 36.40 sq. km, area sown more than once is 7.57 sq.km with a total cropped area of 43.97 sq.km.



Agriculture:

Agricultural and related activities occupy the most important place in the economy of the district. Being the main source of livelihood of the people the entire economy of the district depends on the success or failure of food crops. Rice and maize are the two major crops of the district.

Churachandpur is a hilly terrain which has an excellent agro-climatic condition for sub-tropical fruits like orange, lemon, peach, etc. The valley area is suitable for tropical fruits like banana, pineapple, guava, papaya, etc. Pineapple thrives well on the hilly slopes as it can conserve moisture and resist soil wash from the slopes. The district is the largest producer of pineapple in the state. Orange grows abundantly on the hilly terrain in the past. Passion-fruit also favours the region and grown recently. It grows abundantly in the hills surrounding the Tuitha valley and has great scope for its development. Another plantation includes sugar-cane and tree-bean. Guava and tree-bean thrive well in Tipaimukh sub-division due to its tropical condition. Due to its favourable climatic condition, horticulture is the most promising crops thought to be the best substitution or option of the existing primitive shifting cultivation. This will prevent soil erosion and increase soil fertility as the soil will be covered throughout the year.

1.13 Irrigation:

As per Agricultural report (2017-18), Manipur two cereal crops i.e. Paddy and Maiza are cultivated in an area of 27780 ha and 2460 ha respectively. However, irrigated area is only 0.82 ha, that too for Paddy cultivation and from surface water source.

CHAPTER 2.0
Data Collection and Generation

2.1 Data Collection:

The preliminary works consist of collection, compilation and review of all existing hydrogeological and exploration data. Data were plotted in base map on GIS Platform (MapInfo Encom discover 11 using Projection category longitude/latitude (Indian for Pakistan, India, Bangladesh, Nepal projection).

2.1 Depth to Water Level:

To know ground water level and its behavior, 7 dug wells were established as key observations wells for periodical monitoring.

2.2 Ground Water Exploration:

Three nos. of ground water exploration have been carried out by the CGWB in this district. Existing exploratory well data are given in **Table.2.1**.

Table.2.1. Exploratory well

No. of wells drilled	3 wells
Depth range (in m)	76.20 – 113.40
Discharge (in m^3/hr)	45.82- 302.40
Drawdown	8.56-12.25 m
Transmissivity (m^2/day)	7.68- 71.70

2.2 Data Generation

2.2.1 Depth to Water Level:

Depth to water level data generated is given in T**able 2.2**.

Table 2.2 Depth to Water Level in Churachandpur district

Location	Longitude	Latitude	Water level Pre-monsoon (in m bgl)	Water level Post-monsoon (in m bgl)	Fluctuation (in m)
Lamka filling station	93.6936	24.3303	2.40	1.20	1.20
Tuaitengphai	93.6897	24.3153	3.40	1.89	1.51
Session court	93.6989	24.3578	1.40	0.78	0.62
Khuangnung	93.7042	24.3919	4.50	3.40	1.10
Mualvaphei	93.7265	24.3439	3.20	2.00	1.20
Thingchom	93.7263	24.3831	2.43	1.34	1.09
Saikot	93.7303	24.3221	5.20	3.34	1.86

2.2.2 Ground Water Exploration:

Three numbers of exploratory wells were constructed in the study. For understanding aquifer disposition, EW constructed at Kongwai village in Bishnupur district in the northern border of Churachandpur district, Manipur is also taken into consideration. A detail of exploration findings is given in **Table 2.3.**

Table 2.3 Details of Existing Exploratory wells

Aquifer	Location	Depth Drilled (in m)	Longitude	Latitude	Depth of construction (in m.)	Zones tapped (m. bgl)	Static Water level (m. bgl)	Discharge (m^3/hr)	Draw Down (m)	T (m^2/ day
Sandstone (Tertiary)	Saikot	79.9	93.73	24.34	78.00	16-21, 54-60, 63-74	0.42 (agl)	302.4	12.25	7.68
Alluvium	Konpui	76.20	93.69	24.32	65.00	48-63	25.20	47.23	10.00	
Alluvium	Kongwai	113.40	93.73	24.44	109.11	22-28,46-58,82-88,100-106	12.00	45.82	8.57	71.70

2.2.3 Ground water quality:

To know the water quality of the study area, water sampling done from shallow aquifers. Water samples were collected from dug wells that are established during aquifer mapping for finding the chemical quality in the study area. Ground water samples collected both during pre- monsoon and post- monsoon seasons and were analyzed in the Regional Laboratory of CGWB, NER.

The samples were tested for different physico-chemical parameters like pH, total disolved solids (TDS), Electrical condctivity (EC), sodium, potassium, chloride, fluoride, total hardnes and iron. pH was measured by 1, 10 Phenantroline method using a visible spectrometer (DR-2700, Hach, USA) at 510 nm. Fluoride in water was determined by SPADNS method (colorimetric) by using a visible spectrometer (DR-2700, Hach, USA) at 570 nm. Chemical analysis result is given in **Table 2.4**.

Table 2.4 Results of chemical analysis

Location	Longitude	Latitude	Type of well	pH	EC (µs/cm) 25^{0}C	TDS	Cl-	F-	Na	K	Fe
BIS Standards				**6.5-8.5**		**500-2000**	**250-1000**	**1-1.5**			**0.3**
Lamka filling station	93.694	24.330	Dug well	8.04	680.5	449.13	56.72	0.74	42.77	4.00	0.229
Thingkang-Phai	93.689	24.315	Dug well	8.05	199.1	131.41	10.64	0.26	7.10	1.15	0.121
Session court	93.699	24.358	Dug well	8.22	407.8	269.15	17.73	0.45	29.24	1.63	0.092
K Llhangniem	93.704	24.392	Dug well	8.09	258.7	170.74	24.82	0.43	17.71	2.81	0.376
Molvaiphe	93.726	24.344	Dug well	8.10	243.0	230.00	23.00	0.43	18.78	3.20	0.230
Thingchom	93.726	24.383	Dug well	7.90	345.0	265.00	32.00	0.44	34.54	2.31	0.320
Saikot	93.730	24.322	Dug well	8.10	354.0	345.00	24.00	0.54	54.89	4.65	0.120

CHAPTER 3.0

Data Interpretation, Integration and Aquifer Mapping

3.1 Data Interpretation

Based on lithological log two principal aquifers are delineated in the district, i.e., Alluvium & Sandstone. Alluvial aquifer composed of sand, silt and gravel and clay. Sandstone aquifer of Tertiary age is composed of sandstones interbedded with shales.

Aquifer Disposition: The thickness of alluvial aquifer ranges from 15 to 113 m. To know the aquifer disposition two sections have been constructed.

i) NNE- SSW Section: Section constructed along the valley reveals presence of four granular zones separated by thick clay beds. Granular zones are dominantly composed of sand with gravels.

ii) NW- SE Section: Section constructed across the valley reveals that alluvial aquifer abruptly terminates against sandstone aquifer near foothill probably due to presence of a fault. In the central part of the valley alluvial thickness recorded upto 105 m while in the foothill are the thickness reduces to nearly 15 m. The sandstone aquifer is missing in the Konpui EW constructed in the valley area upto an explored depth of 76.20 m while it encounters at 105 m depth at Kongwai EW. At Saikot EW, near foothill, sandstone aquifer encountered from 15 m depth and continued upto an explored depth of 82.87 m. Presence of three granular zones are identified in the Saikot EW separated by thick shale layers.

Aquifer characteristics:

Three exploratory wells have been constructed to decipher aquifer characteristics of the area and are presented in **Table.3.1**

Table 3.1 Aquifer characteristics

Aquifer	Location	Depth Drilled (in m)	Longitude	Latitude	Depth of construction (in m.)	Zones tapped (m. bgl)	Static Water level (m. bgl)	Discharge (m^3/hr)	Draw Down (m)	T (m^2/ day
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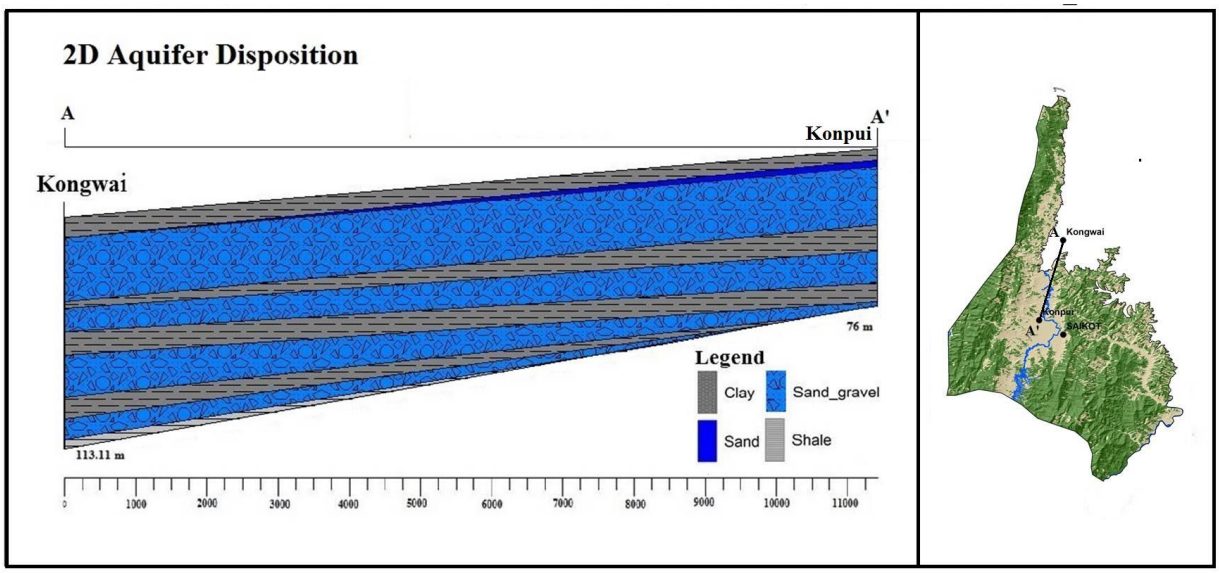


Fig. Aquifer disposition along NNE-SSW

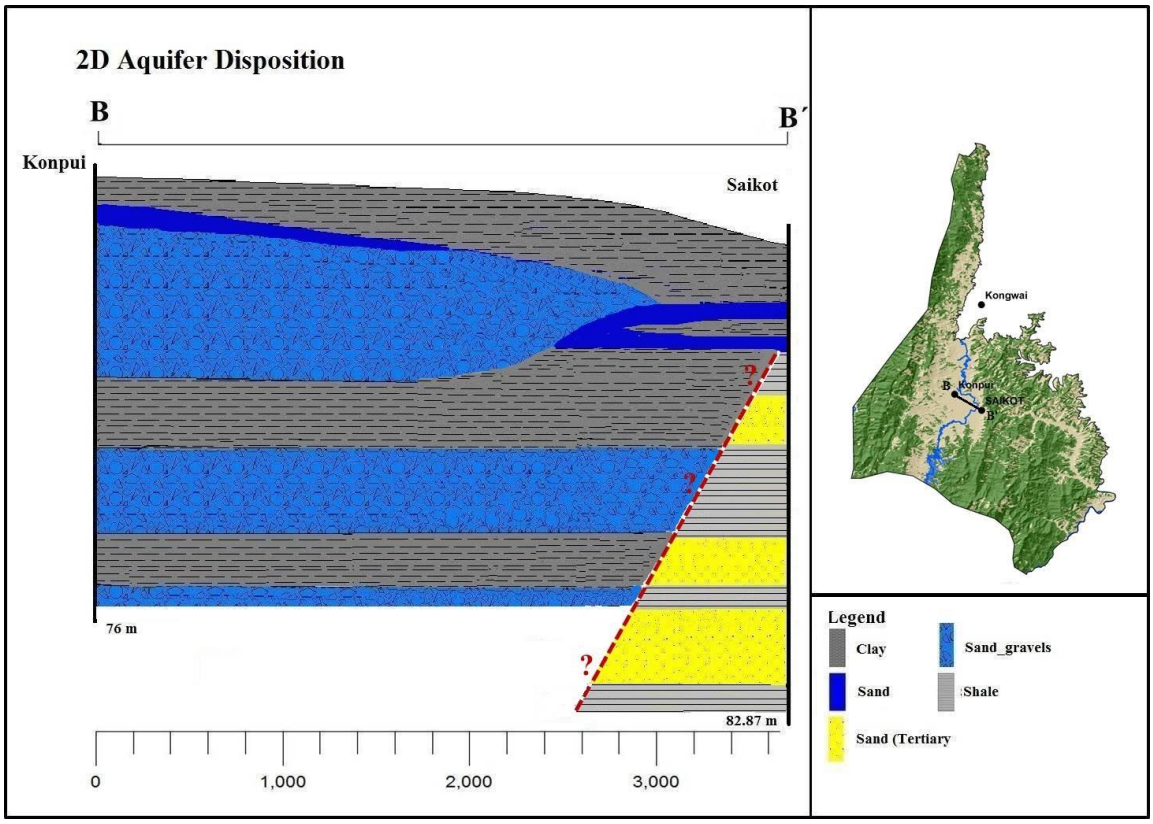
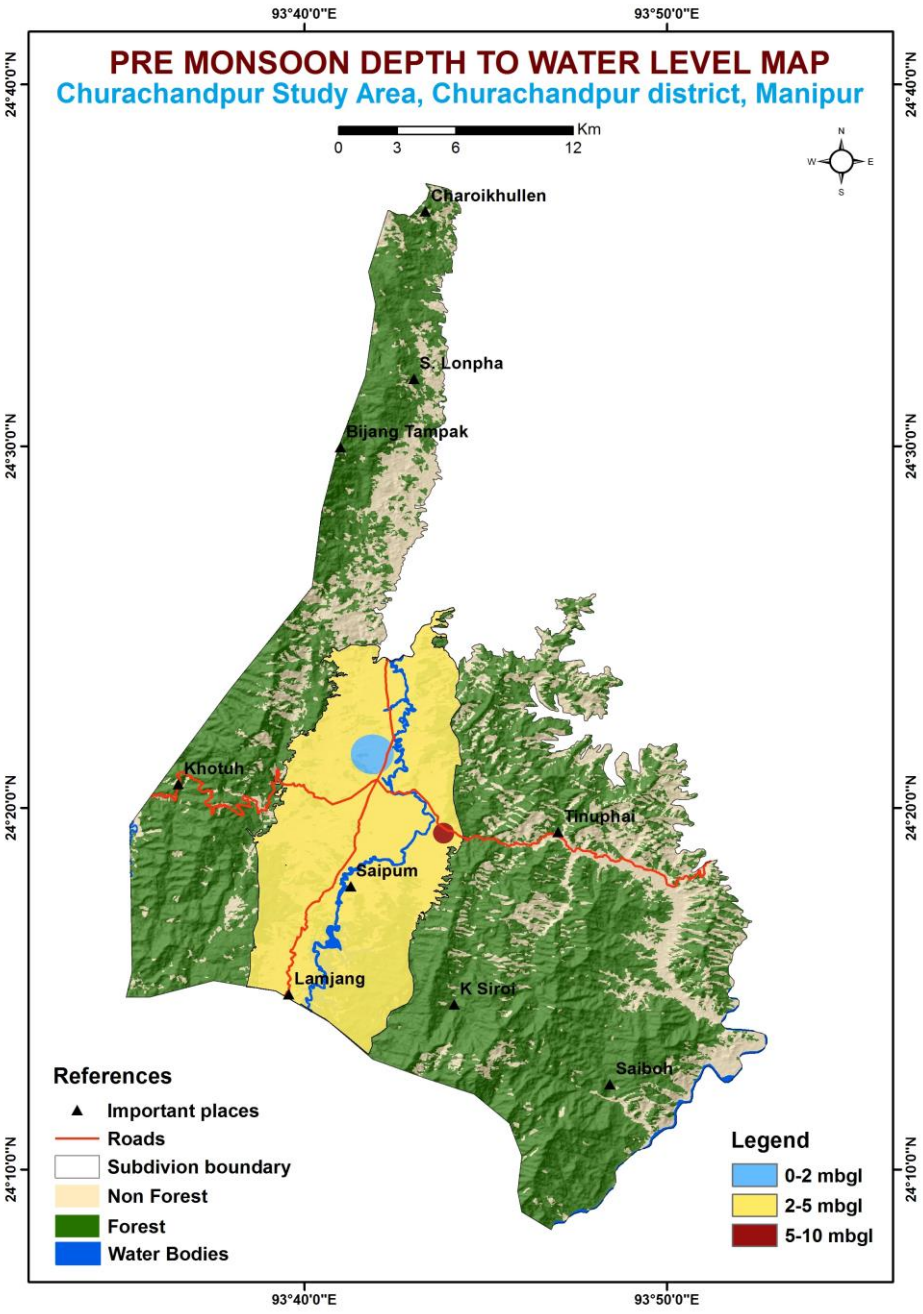


Fig. Aquifer disposition along NW-SE

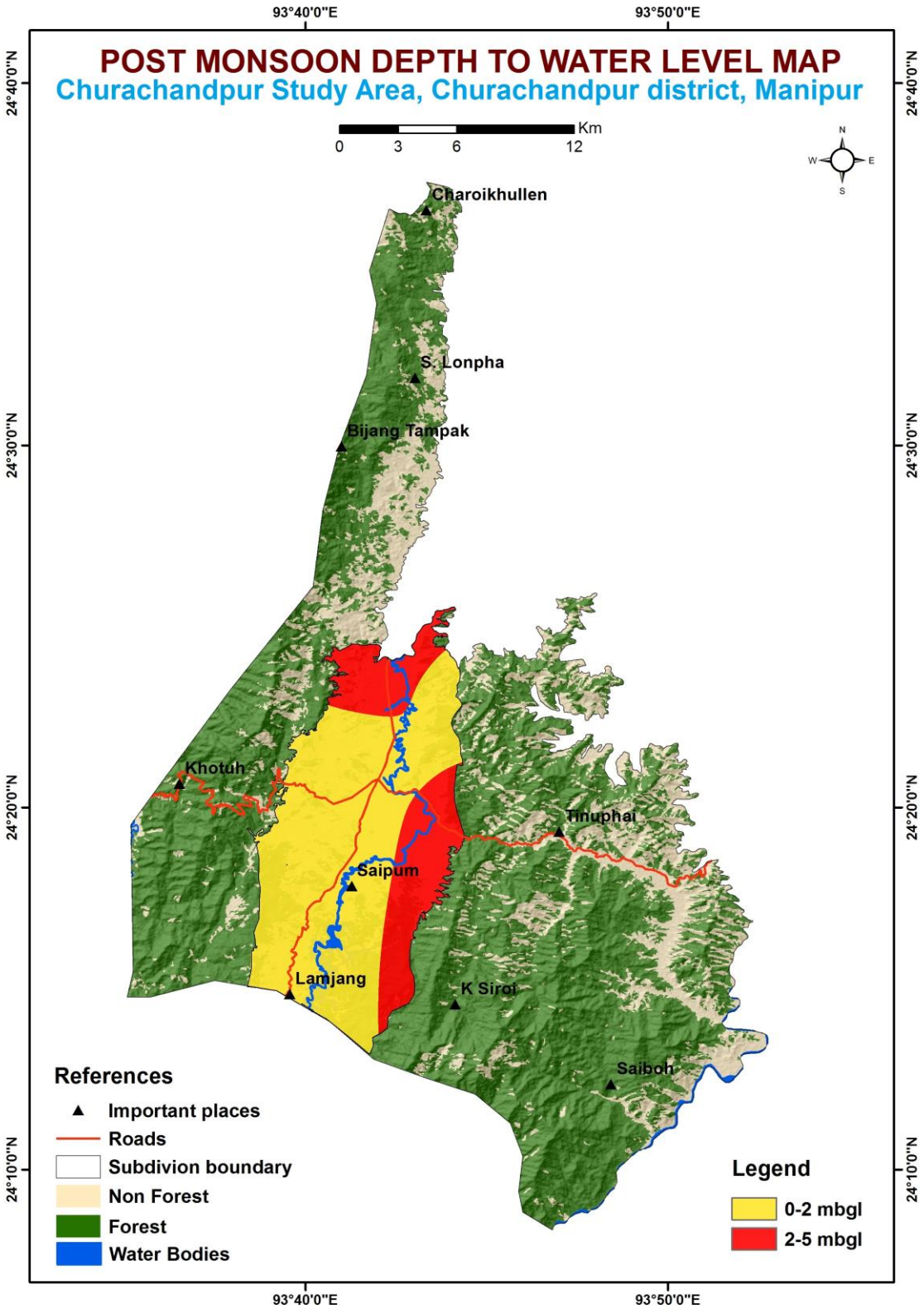
Depth to water level:

To study ground water regime, depth to water level from 8 monitoring stations are measured seasonally.

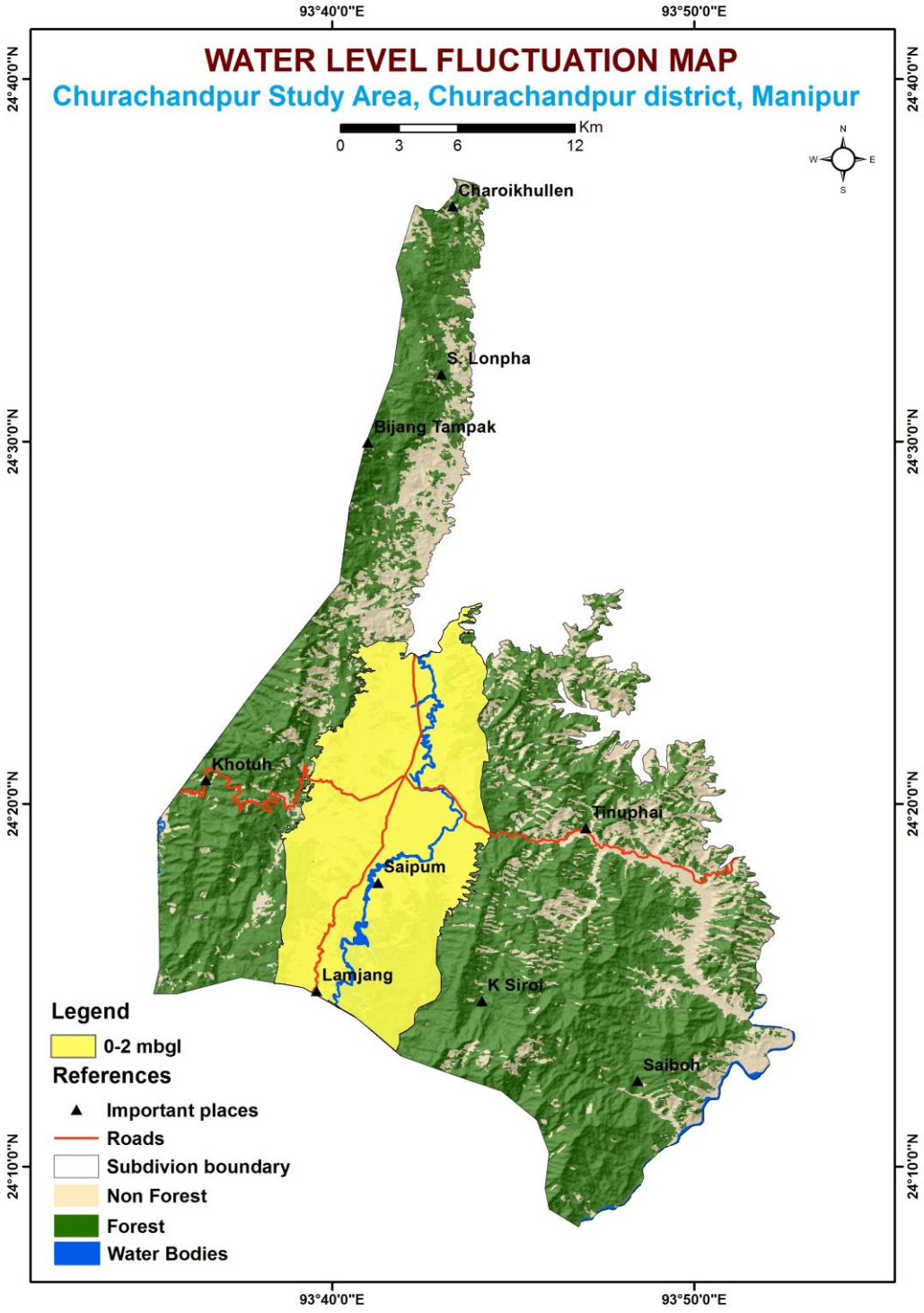
Pre-monsoon water level: Water level ranges from 1.4 to 5.2 m bgl during pre-monsoon. From depth to water level map, it is observed that almost total valley part under study is having a water level within 2-5 m bgl range. At Saikot village, near foothill of the eastern part of the valley, deepest water level of 5.2 m bgl has been recorded.



Post-monsoon water level: Water level ranges from 0.78 to 3.4 m bgl. From depth to water level map, it is observed that almost total valley part under study is having a water level within 0-2 m range indicating water logging condition. In the eastern periphery of the study area along foot hill belt and in the northern belt, water level ranges from 2-5 m.



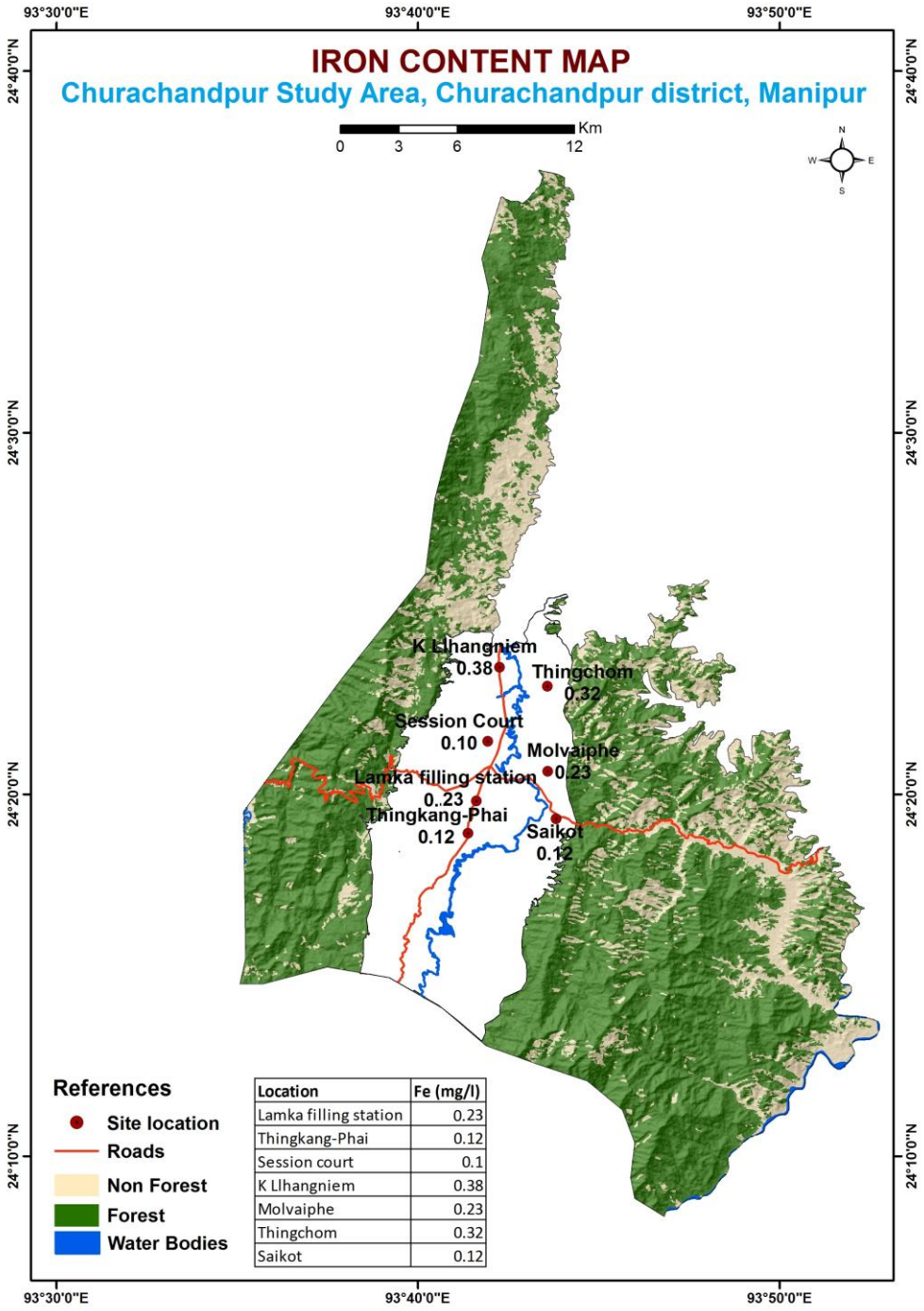
Water level fluctuation: Seasonal fluctuation ranges from 0.62 (Session court area) to 1.86 m (Saikot village) with an average fluctuation of 1.24 m.



Ground water quality: The results shows that pH of the Ground water varies from 7.9 to 8.22 indicating slightly basic character of the ground water. The value of EC during pre-

monsoon season varies from 199 to 656 µs/cm at 25^0C. The fluoride content varies from 0.26 to 0.74 mg/l.

Iron content in the ground water ranges from 0.092 to 0.376 mg/l except in one location (Naransiena village) concentration is 2.23 mg/l.



CHAPTER 4.0

Dynamic Groundwater Resources

The study area covers Churachandpur district where rechargeable area is 32100 ha. The computation of ground water resources carried out (as on March 2017) following GEC 2015 methodology.

Data and assumptions used in the assessment: Following data and assumptions are used in the assessment:

- Rainfall recharge has been computed by both RIF following the norms recommended by GEC'2015. The normal monsoon and non-monsoon rainfall in the district is the average of rainfall data for last 5 years is 1088.9 mm and 532.16 mm respectively.
- The population figures were collected from Census, 2011and projected to 2017. The per capita domestic requirement for the district is considered as 60 lpcd.
- Ground water extraction for irrigation and domestic use is 95.21 ham.

Recharge: The aquifers of the study area are recharged by rainfall. The area experiences south-east monsoon. Total ground water recharge is 8054.86 ham.

Extraction: The agriculture in the area generally rain fed and whatever irrigation potential created and utilized is by surface source only. For agricultural use annual ground water extraction is only 75.25 ham. Industrial activity in the district is almost nil and ground water extraction is for industry is thus considered as nil. Ground water extraction for domestic use is 19.96 ham. Dependency on ground water is calculated from village amenities part of census 2011. Gross ground water extraction is 95.21 ham.

Allocation of resources up to 2025: The net ground water resource is allocated for domestic use is 407.46 ham. Net available resource for future use is 4469.48 ham.

Stage of groundwater extraction: Groundwater is mainly utilized for domestic purposes. The stage of groundwater development in the district is mere 1.92%.

The net groundwater availability, existing ground water (G.W.) extraction and stage of development for 2017 is shown in Table 4.1.

Table 4.1: Net groundwater availability, existing extraction and stage of G.W. extraction as on March 2017.

Recharge worthy area (in Ha)	Total annual GW recharge (in Ham)	Environmental flow (in Ham)	Annual extractable GW resource (in Ham)	Existing gross GW extraction for all uses (in Ham)	Stage of GW extraction (in %)
32200	5502.4	550.24	4952.19	95.21	1.92

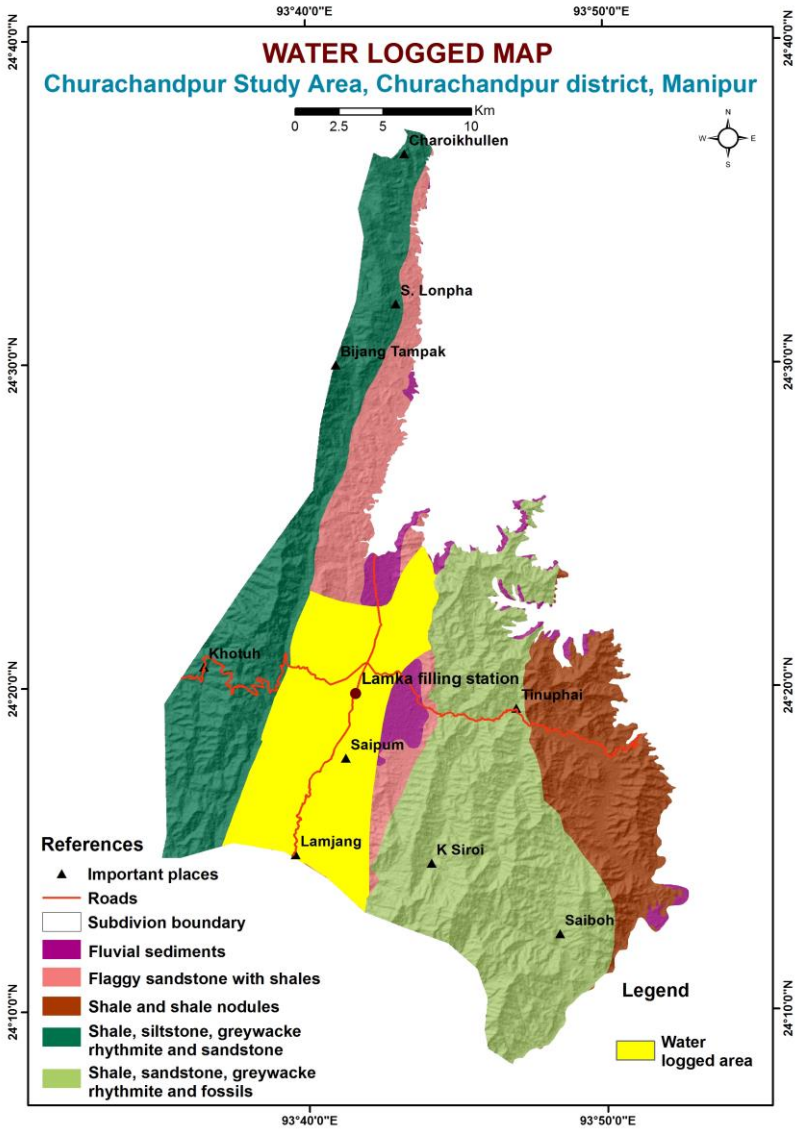
5.0 Groundwater Related Issues

5.1 Identification of issues: Two main groundwater issues can be pointed out in the area.

5.1.1. Low stage of ground water development & Water logging

Development of ground water is limited in this area. Most of the villagers depend on water from the rivers, streams and springs for their domestic requirements. A few wells of very shallow depth tapping the water table aquifer are present in the area.

Based on the pre- & post-monsoon depth to water level analysis it is observed that approx. 115.48 sq.km. area along the valley is under water logged condition.



CHAPTER 6.0
Management Strategies

The dynamic resource estimation presented here is taken from 2017 dynamic groundwater resources of Churachandpur district where resource was estimated district wise due to paucity of block-wise data.

Table No. 6.1 Salient features of GW resource of the district is given below-

Annual extractable GW resource (in Ham)	Annual allocation for domestic use upto 2025 (mcm)	Net GW availability for future irrigation use(mcm)	Stage of Ground Water Extraction (%)
4952.19	40.75	44.69	1.92

As per dynamic ground water resource estimation (2017) of the Churachandpur district, net groundwater availability is 44.69 mcm and stage of development is only 1.92 % (**Table No.6.1**). The area is having balance net ground water availability for future irrigation use in the tune of 44.69 mcm.

Agricultural data for Khuga valley is not available. It is assumed that about 40% of total valley area is under WRC during Kharif season, which is around 13,000 ha. Irrigation data show that about 820 ha land is having irrigation facilities. After Kharif season is over, the area which does not have irrigation facility (12,180 ha) remains fallow during the Rabi season. A management plan has been envisaged to use this vast fallow land for double cropping by utilizing the available groundwater as well as surface water resources. Basic aim is to increase the gross cropped area from 12,180 ha to 24,360 ha.

To use the groundwater for irrigation purpose a cropping plan has been designed for the district by using CROPWAT model developed by FAO. A suitable cropping plan for the district was prepared in consultation with scientists of Assam Agricultural University, Jorhat. Cropping pattern data for the district is presented in **Table 6.2**.Present cropping pattern, proposed cropping pattern and targeted increase in cropping intensity were shown in Table **6.3** and **6.4**.

Crop-wise and month-wise irrigation water requirement (Precipitation deficit) has been estimated from CROPWAT after giving necessary meteorological, soil, crop plan inputs and the same has been shown in Table 6.5. Crop-wise and month-wise Irrigation water requirement in ham has been further calculated in **Table 6.6**.

Table 6.2 Cropping pattern Churachandpur district, Manipur

CROPPING PATTERN DATA
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Cropping pattern name: Churachandpur

No.	Crop file	Crop name	Planting date	Harvest date	Area %
1	...Data\CROPWAT\data	Rice	01/06	28/09	15
2	...Data\CROPWAT\data	Rice	07/06	04/10	15
3	...Data\CROPWAT\data	Rice	14/06	11/10	10
4	...Data\CROPWAT\data	Rice	21/06	18/10	10
5	...ata\CROPWAT\data\	MAIZE (Grain)	25/10	26/02	10
6	...\CROPWAT\data\cro	Potato	25/11	03/04	10
7	...a\CROPWAT\data\cr	Pulses	07/11	24/02	10
8	...CROPWAT\data\crop	Small Vegetables	15/11	17/02	10
9	rape___mustard.CRO	Mustard	25/11	08/04	10

Source: CROPWAT

Table 6.3 Cropping pattern, proposed cropping pattern, intended cropping

Rice based cropping pattern				
1. Rice-Potato 2. Rice-Mustard 3. Rice-Vegetables	Present Cultivated area (**ha**)	Area to be cultivated (**%**)	Area to be cultivated (**ha**)	Irrigation requirement (**ha m**)
	1	2	3(= % of 1)	4
Rice	12180	12180	100	2349
MAIZE (Grain)		2436	20	425
Rape & mustard		2436	20	484
Pulses		2436	20	406
Potato		2436	20	583
Small Vegetables		**2436**	20	369
Gross cultivated area (1+potato/+mustard/+Veg+pulses)		**24360**	200	
Total irrigation requirement				4616

Table 6.4 Proposed cropping pattern with water deficit months and IWR

Rice based cropping pattern			
Crop	**Growing period (Months)**	**Periods/months of water deficit**	**Irrigation requirement (ha m)**
Rice	4	2	2349
Potato	5	3	583

Maize	6	5	425
Rape &Mustard	4	1	484
Vegetables	3	2-3	369
Pulses	4	2	406

The total area of rice cultivation is comprised of 12180 ha which is 50% of the targeted cultivated area of (24360 ha). During kharif season, rice is cultivated in June. Since this huge area cannot be cultivated in a single day (one planting date), so it is considered/ planned to cultivate rice in four stages during this period.

It is planned to utilize rice fallow of 12180 ha for the cultivation of potato, rape & mustard, pulses and vegetables. Net irrigation demand in the area is 4616 ham and gross irrigation demand considering 70% irrigation efficiency will be 6594 ham.

Table 6.5: Crop-wise monthly and annual precipitation deficit (mm) using CROPWAT 8

Crop Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Precipitation deficit (mm)											
1. Rice	0	0	0	0	223.7	0.2	0	0	0	0	0	0
2. Rice	0	0	0	0	72.6	98	0	0	0	0	0	0
3. Rice	0	0	0	0	60.8	160.8	0	0	0	3.3	0	0
4. Rice	0	0	0	0	0	147.5	0	0	0	0	0	0
5. MAIZE	77.4	46.2	0	0	0	0	0	0	0	0	34.4	50.9
6. Potato	69.7	83	67.2	0	0	0	0	0	0	0	7.8	19.6
7. Pulses	77.1	48.8	0	0	0	0	0	0	0	0	26.9	40.8
8. Small Vegetables	70.6	42.1	0	0	0	0	0	0	0	0	29.9	39
9. Mustard	62.3	67.8	45.6	0	0	0	0	0	0	0	6.2	22.8

Table 6.6 : Crop-wise monthly and annual Irrigation water requirement

	Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1. Rice	3654	0.00	0.00	0.00	0.00	817.40	0.73	0.00	0.00	0.00	0.00	0.00	0.00	818.13
2. Rice	3654	0.00	0.00	0.00	0.00	265.28	358.09	0.00	0.00	0.00	0.00	0.00	0.00	623.37
3. Rice	2436	0.00	0.00	0.00	0.00	148.11	391.71	0.00	0.00	0.00	8.04	0.00	0.00	547.86
4. Rice	2436	0.00	0.00	0.00	0.00	0.00	359.31	0.00	0.00	0.00	0.00	0.00	0.00	359.31
5. MAIZE (Grain)	2436	188.55	112.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	123.99	425.08
6. Potato	2436	169.79	202.19	163.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.75	583.42
7. Pulses	2436	187.82	118.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.39	406.08
8. Small Vegetables	2436	171.98	102.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	95.00	369.54
9. Mustard	2436	151.76	165.16	111.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.54	483.55
												Total	IWR	4616.34

As per Dynamic Ground Water Resource Estimation 2017, available groundwater resource for future irrigation is **4469 ham** and stage of ground water extraction is just **1.92 %.** The aquifer in the area is having good potential with an average discharge of about **45 m^3/hr.** This resource can be sustainably developed and used for irrigation purpose.

The gross irrigation requirement, calculated using 'CROPWAT' software, of the study area with the recommended cropping plan calculated as 6594 ham. As available groundwater resource is 4469 ham for future irrigation therefore, above-mentioned cropping plan can safely be implemented for the area.

CGWB's exploration has established that the aquifer of the district is medium to high yielding. A tube well of 100 m depth tapping 20 m saturated thickness of aquifer can yield 45 m^3/hr. If the well is allowed to run for 8 hrs for 100 days, it will create a draft of **3.6 ham**. Considering 200 m space between any two tube wells, in 12,180 ha about 3000 tube wells can be constructed. As per requirement, i.e., to meet the planned irrigation demand of 6594 ham, 1830 numbers of tube wells will be required to meet the demand.

Drilling should be carried out by deploying DTH Rig and rotary-cum-DTH combination rig. Extreme care may be taken due to presence of splintery shale, likely to be encountered at/after 25 m depth.