केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

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

Simdega District
Jharkhand State

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

भारत सरकार

Government of India

जल शक्ति मंत्रालय

Ministry of Jal Shakti

जल संसाधन, नदी विकास और गंगा संरक्षण विभाग

Department of Water Resources, River Development & Ganga Rejuvenation

केन्द्रीय भूमि जल बोर्ड

Central Ground Water Board

Aquifer Maps and Ground Water Management Plan of Simdega district, Jharkhand

जलभृत नक्शे तथा भूजल प्रबंधन योजना

सिमडेगा जिला, झारखण्ड

Principal Authors

Sunil Toppo, Scientist-B
Dr. Sudhanshu Shekhar, Scientist-D
Dr Anukaran Kujur, Scientist-B

State Unit Office, Ranchi
Mid – Eastern Region, Patna

August 2022

राज्य एकक कार्यालय, रांची

मध्य- पूर्वी क्षेत्र, पटना

अगस्त, 2022

REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF SIMDEGA DISTRICT, JHARKHAND, 2021-22

CONTRIBUTORS'

Principal Authors

Sunil Toppo, Scientist-B
Dr Sudhanshu Shekhar, Scientist-D
Dr Anukaran Kujur, Scientist-B

Supervision & Guidance

T.B.N. Singh, Regional Director
B. K. Oraon, Scientist-E & OIC
Rajiv Ranjan Shukla, Scientist-E & OIC

Hydrogeology, Groundwater Exploration GIS maps and Management Plan

Sunil Toppo, Scientist-B
Dr Anukaran Kujur Scientist-B
Atul Beck, Assistant Hydrogeologist

Geophysics

B. K. Oraon, Scientist-E

Chemical Analysis

Dr Suresh Kumar, Assistant Chemist

REPORT ON NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN OF SIMDEGA DISTRICT, JHARKHAND, 2021-22

List of tables

List of figures

List of Annexure

REPORT ON AQUIFER MAPS AND MANAGEMENT PLAN OF SIMDEGA DISTRICT, JHARKHAND STATE (2021 – 22)

1.0 INTRODUCTION

The vagaries of rainfall, inherent heterogeneity & unsustainable nature of hard rock aquifers, over exploitation of once copious aquifers, lack of regulation mechanism etc has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from "**Traditional Groundwater Development concept**" to "**Modern Groundwater Management concept**". Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. This leads to concept of Aquifer Mapping and Ground Water Management Plan. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. The proposed management plans will provide the **"Road Map"** for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus the crux of NAQUIM is not merely mapping, but reaching the goal-that of ground water management through community participation.

During XII five year plan (2012-17) National Aquifer Mapping (NAQUIM) study was initiated by CGWB to carry out detailed hydrogeological investigation. The Aquifer Mapping programme has been continued till 2023 to cover whole country. The present study of Simdega district has been taken up in AAP 2021-22 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Simdega district and other user agencies for its effective implementation.

1.1 Objective and Scope of the study:

The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization
- Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

The groundwater management plan includes Ground Water recharge, conservation, harvesting, development options and other protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan.

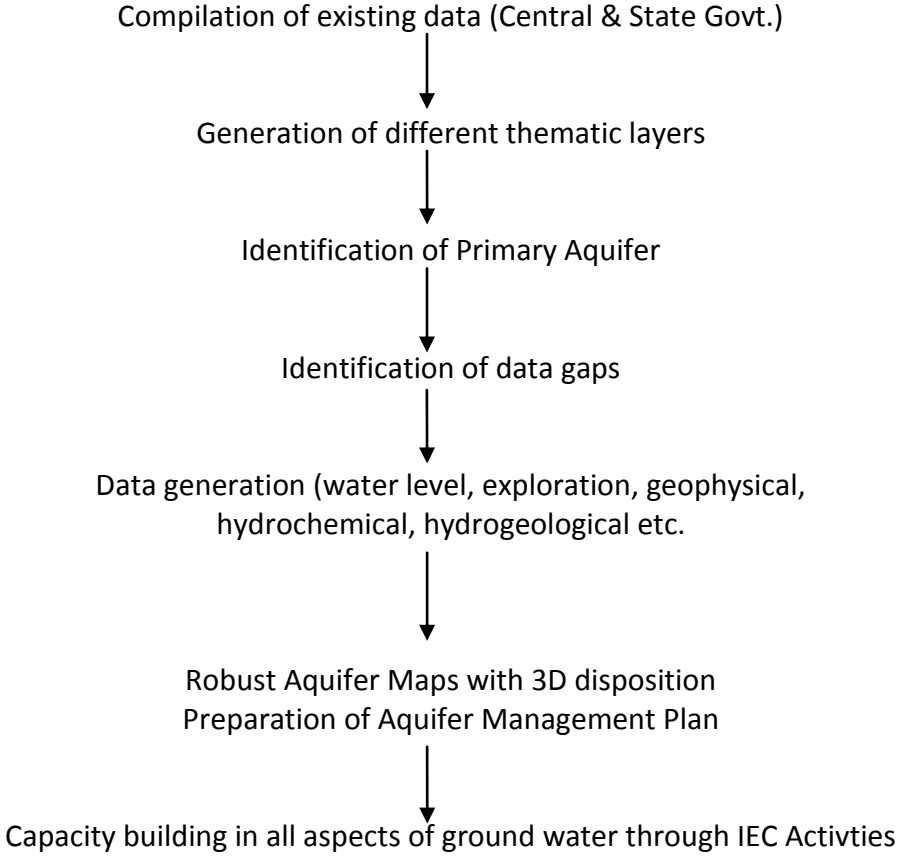
The main activities under NAQUIM are as follows:
a). Identifying the aquifer geometry
b). Aquifer characteristics and their yield potential
c). Quality of water occurring at various depths
d). Aquifer wise assessment of ground water resources
e). Preparation of aquifer maps and
f). Formulate ground water management plan.

The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a **"Road Map"** to systematically manage the ground water resources for equitable distribution across the spectrum.

1.2. Approach and methodology:

The ongoing activities of NAQUIM include hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:



1.3 Area details: Simdega district of Jharkhand state is located in the southern part of the state. It covers an area of about 3752.29 Sq. Km. The Simdega town is located about 170 km from Ranchi on Rourkela (Orisaa) road. The district is bounded in the north by the Gumla district, in the east by Ranchi district, in the south by Orissa state and in the west by the Chhatisgarh state. The district is situated between 22^0 20' 30" and 23^0 50' 15" N latitude and 84^0 01' 00" and 85^0 04' 30" E longitude. The district is covering Survey of India toposheet nos. 73 A/ 03, 04, 06, 07, 08, 11, 12, 15, 16, 73 B/ 01, 05, 09, 10, 13 and 14. The Simdega district comes under the south Chhotanagpur division. It has one sub – division i.e. Simdega Sadar sub – division. Further, the sub – division is divided into ten blocks namely – Simdega, Bano, Jaldega, Kolebira, Kurdeg, Thetaitanger, Pakartanr, Kersai and Bansjor (Fig. 1).

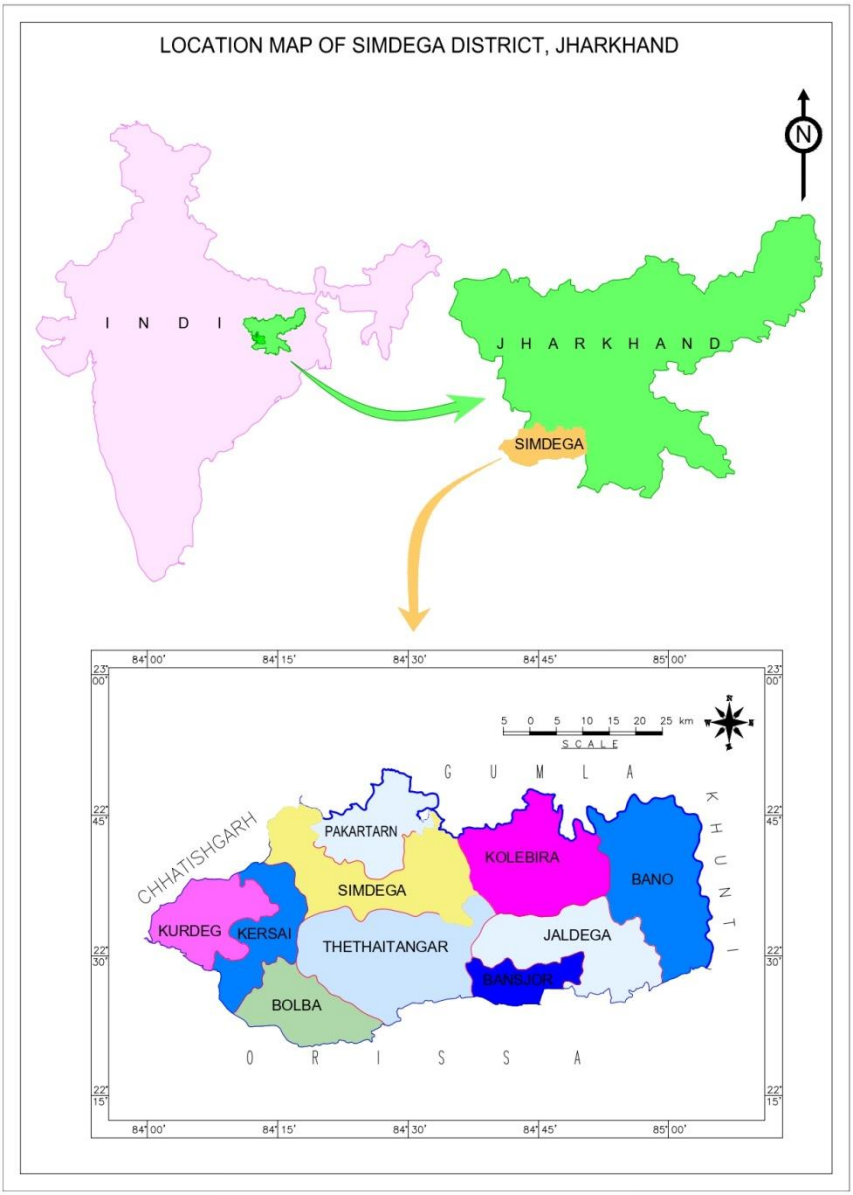


Figure -1: Location map of Simdega district

1.4 Data Availability, Data Adequacy and Data Gap Analysis

1.4.1. Data availability: Central Ground Water Board has carried out exploratory drilling in the district and drilled 10 exploratory and 07 observation wells by departmental rig during the year 2008-2009. In addition, 15 exploratory wells and 03 observation wells were drilled through outsourcing drilling during the year 2020 -21 in the district. At least three exploratory and one observation wells are to be drilled in each block to know the sub – surface geology, depth and thickness of water bearing formation with their yield and determine the different aquifer parameters.

In addition, 14 numbers of permanent observation well (HNS) of Central Ground Water Board located in the district for monitoring of ground water regime and to assess the chemical quality of ground water.

1.4.2 Data Adequacy and Data Gap Analysis: The available data of the Exploratory wells drilled by Central Ground Water Board, State Unit Office, Ranchi, Geophysical Survey carried out in the area, ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analyzed for adequacy of the same for the aquifer mapping studies.

After taking into consideration, the available data of ground water exploration, geophysical survey, ground Water monitoring and ground water quality, the data adequacy is compiled and the summarised details of required, existing and data gap of exploratory wells, ground water monitoring and ground water quality stations is given below in Table-1.

Table – 1: **Data adequacy and data gap analysis**

Exploration data			**Geophysical data**			**GW monitoring data (HNS)**			**GW quality data**		
Req.	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap
36	25	11	50	127	0	20	14	06	20	14	6

The data adequacy as discussed above indicates that the existing data is not sufficient for preparation of aquifer maps; hence data gap has been identified for Exploratory Wells, Geophysical Survey (VES), Ground Water Monitoring Wells and Ground Water Quality. Each three numbers of exploratory wells are required in Kurdeg and Kersai blocks, two numbers of exploratory wells are required in each block of Bolba and Bansjor of the district. Similarly, at least one exploratory well is required in Pakartarn block.

1.5 Climate and Rainfall: The Simdega district enjoys a healthy climate through out the year. Normal atmospheric temperature in the area often goes up to 42^0 c in summer and it goes down to about 4^0 c during winter.

The climate of the area could be divided in to three district season. The winter commences from November and extends of to middle of March, December being the coldest month. The winter season is characterized by heavy dew thick fog and cold wave. The rainy season last up to middle of October. The area is free from hot winds and dust storm. The

monsoon sets in by the middle of June and continues till the middle of October. The area receives rain fall mainly by North-west monsoon during rainy season and from retreating monsoon during inter-monsoon period, which originates in the Bay of Bengal. The average annual rainfall of the district is 1487 mm. Rainfall is the only sources of replenishment of ground water in the district.

The district belongs to the higher rainfall class with large annual variation. The average rainfall last ten years (2012 – 2021) of the distinct is 1230.56 mm. The maximum rainfall occurs during the first half of July to first half of August and contributes about 50 % of the total rainfall. The monsoon season contributes about 85 % of the total annual rainfall. However dry spell of 4-8 days have been very common in the month of July and /or August. The maximum humidity is observed during the monsoon season with mean value of 85%, where as the minimum humidity is observed during April-May which is 27 %. Generally the weather during the other seasons is more or less dry and in the comfortable zone.

The Decadal average annual rainfall (2012 to 2021) varies from 1058.31 to 1515.49 mm. The rainfall data for the period of 2012–21 has been worked out and analyzed Decadal average annual rainfall, standard deviation and coefficient of variation which are given table – 2. Block wise annual rainfall (2012 – 2021) is presented in Annexure - I.

Table – 2: Analytical data of monsoon rainfall (2012 – 2021) of Simdega district

Sr. No.	Block	Decadal average annual rainfall (mm)	Standard deviation	Coefficient of variation (%)
1	Simdega	1492.18	318.27	21.33
2	Kurdeg	1295.83	299.93	23.15
3	Bolba	1085.81	219.98	20.26
4	Thethaitangar	1515.49	271.36	17.91
5	Bano	1080.02	287.90	26.66
6	Jaldega	1058.31	278.01	26.27
7	Kersai	1229.03	379.56	30.88
8	Pakartarn	1285.86	227.58	17.70
9	Kolebira	1072.65	320.39	29.87
10	Bansjor	1190.45	255.32	21.45

1.6 Geomorhpology: The region in Chotanagpur plateau is having large physical inequalities presents a rich panorama of topographical features. The general configuration of region varies from valley fills, pedeplains, to structural ridges.

The large difference relief brings about strong, contrast climate, natural vegetation, surface drainage, ground water and soil profile. In the pat region the rivers are long deep and with terrace but in pedeplain area they are wide with gentle slopes. The general slope of the district is towards south direction. The general elevation of the district is 300 to 700 m above MSL. The major geomorphic units of the district are as follows –

1. Burried pediments: the pediments are gently sloping flat platform extending from foot of the hills and ridges. Basically it is a rock out surface but in the tropics and subtropics it is generally burried under the cover of transported material coming from the hills. Thickness of over burden is considerably high. Ground water potential of this geomorphic unit is moderate.

2. Dissected pediment: This is also a pediment but is heavily dissected. It is dissected by numerous streams flowing across it. Thickness of weathered material is also more and topography is much more rugged. Ground water potential of this geomorphic unit is poor to moderate.

3. Denudational hills/ inselbergs: There are numerous large and small isolated hills scattered throughout the district. Runoff is very high and regolith is absent thus the hills look like a dome. Since they are highly jointed and foliated, boulder, cobbles and pebbles are also present within the foot hills. Ground water potential of this geomorphic unit is very poor.

4. Valley fill: These are relatively low lying area between uplands. These valley fills constitute boulders, cobbles, pebbles, gravels, sand, silt and clay. These sediments are poorly sorted. Ground water potential of this geomorphic unit is moderate.

5. Dissected pediplain: the soil cover in this area is of considerable thickness as compared to other geomorphic unit of the area. These are undulating erosional surface with high intensity of pegmatitic veins in the granites and granite gneiss which is the underlying lithology of the unit. Ground water potential of this geomorphic unit is poor to moderate.

6. Denudational hills: There are numerous large and small isolated hills scattered throughout the district. Majority of the hills are devoid of vegetation cover except the highest ones. Ground water potential of this geomorphic unit is poor.

7. Structural ridge: Structural ridges are that hills area which shows a preferred orientation, in conformity to prevailing geological structure. Moderate reliefs, presence of forest are characteristic features. Runoff is very high. Ground water potential of this geomorphic unit is poor.

1.7 Land use:

The district is predominantly agrarian and majority of population in rural areas depend on agriculture and other allied activities, which do not give steady and sufficient income. Therefore, poverty and illiteracy dominate the rural scenario. Our land mass is fixed, but the competition among different kinds of uses for this land is increasing because of rapidly rising global population. Therefore, integrated land resource planning and management are required to resolve these conflicts.

Out of total geographical area of the district i.e. 3752.29 Sq. km, about 20 % area comes under net sown area, 27% under forests and the rest area falls under barren, cultivable waste, pasture

and other agricultural use. Block wise land utilization data of the Simdega district for the year 2019 - 20 is given in table – 3.

Table: 3: Land use pattern of Simdega district (2019 – 2020)

(Figures in Hectare)

Block	Area of the block (Sq. km.)	Forest land	Barren & non cultiva-ble land	Culti-vable waste land	Perm-anent past-ures & other grazing land	Land under miscell-aneous trees	Current fallow	Fallow land other than current fallow	Net area sown	Area sown more than once
Simdega	446.67	8763.83	2868.84	1235.63	266.02	1066.53	9209.18	10684.32	9822.74	409.44
Pakartarn	301.31	7982.68	3683.86	1668.14	0.00	1083.23	3624.54	3134.95	7007.29	246.23
Kurdeg	262.30	8162.81	2578.30	1936.00	508.81	1065.24	2674.85	2648.92	6503.09	425.60
Kersai	249.40	5324.06	1629.45	1579.08	270.58	307.35	3245.74	3711.03	6083.95	614.72
Bolba	288.63	12285.89	1744.11	1025.15	0.00	0.00	3912.08	3531.90	5221.45	240.72
Thethaitangar	624.15	18380.55	1874.08	2001.83	0.00	980.60	13931.88	11518.67	11034.40	132.85
Bansjor	164.50	5311.16	480.51	258.82	340.74	499.85	2436.86	2615.07	2321.64	87.48
Jaldega	428.20	14417.59	2385.99	255.94	1292.20	2187.66	8379.85	6241.62	5103.81	171.71
Bano	549.77	11124.27	2426.83	2441.34	67.78	3049.93	8248.58	11995.18	12666.00	334.18
Kolebira	437.36	10118.95	2072.62	2780.32	4.05	1817.41	4536.10	7242.18	13478.05	314.11
Total	**3752.29**	**101871.79**	**21744.55**	**15182.26**	**2750.18**	**12057.81**	**60199.66**	**63323.85**	**79242.43**	**2977.04**

Source: - District Statistics office, Simdega, GOJ

1.8 Soil: Soils in Simdega district have formed as a result of insitu weathering of crystalline rock (granite & gneisses), climate, topography and vegetation have contributed in the formation of soils in the area. The following types of soils are found in the entire district –

(i). Alluvial soil: All the river channels in the area are covered with alluvial soil recent of origin deposited over consolidated rocks. Alluvial fills are also found in patches away from the river channels. Thickness of these fills depends upon the topographical control. The alluvial sediments are comprised of coarse sand and gravel mixed with silt and clay, silt materials predominates over clayey materials.

(ii). **Grey eroded scarp soil:** This covers almost the entire are as a thin capping over granitic rocks.

(iii). **Red calcareous soil:** The red calcareous soils are found in some parts mainly in the intermontance valley. They are mostly sandy loam mixed with kankar.

(iv). **Forest soil:** Forest soil is confined to the reserve forest area and have surface layer of organic matter.

1.9 Hydrology and Drainage: The district is forming Sankh sub basin of the Brahmni basin. The river Sankh is the main river of the district, which flows north to south direction in the western part of the district. The tributaries of the river Sankh are the Palamara, Girma, Chhinda, Lurgi

and Dev rivers. The other important river of the district is the river South Koel which form the eastern boundary of the district. The river South Koel flows north to south direction and finally joint with the river Sankh in Oriissa state. All these drainage is characterized by rapid surface run – off. All these rivers are seasonal in nature. The drainage pattern of the district is dendritic.

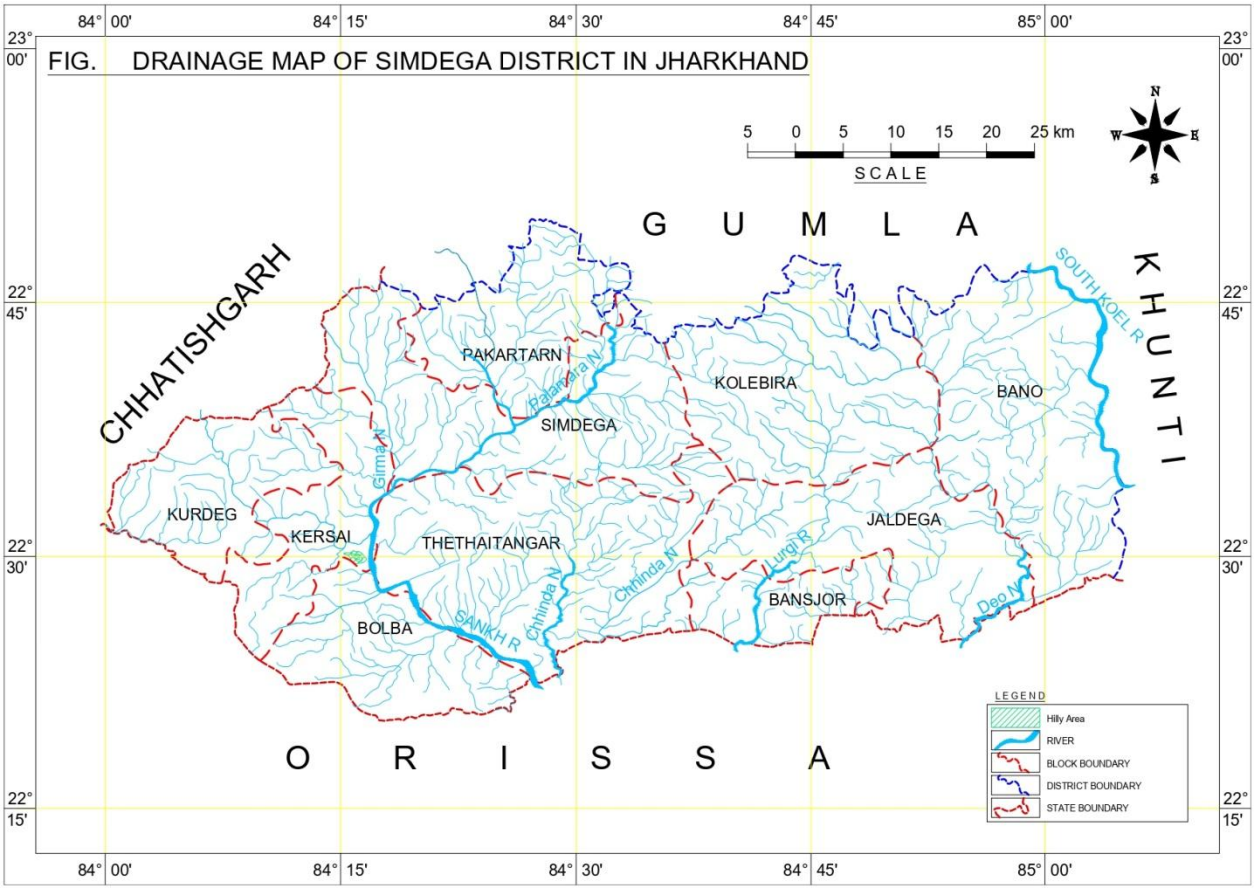


Figure – 2: Drainage map of Simdega district.

1.10 Agriculture and Irrigation practice: Agriculture and forestry are the two main occupations of the local population in the district. But the land available for the cultivation is limited because of the hilly and rigged topography. The absence of proper and the assured source of the irrigation have impeded the growth of agriculture.

Undulating topographic features characterize the district. The agricultural activity of the district is solely dependent upon the monsoon rainfall and the kharif crops mainly paddy is grown extensively. Irrigational facilities are not adequate in the district. Well is the most common source of irrigation, but this is not very dependable source. The major part of the district being rocky, it is difficult to dig deep dug wells. Where there exists facility for irrigation during Rabi season from the ponds and store water in small nalas, vegetable is the major crop grown in that area. The summer paddy is grown in low lying areas in few places. Irrigation data from state Govt. could not collected due the 6th Minor Irrigation censes under process. 5th Irrigation census data of Simdega district is unsatisfactory.

1.11 Cropping pattern:

The main economic activity in the district is agriculture. Paddy and Maize are the two main crops in the district. The agro climatic condition of the district is suitable for cultivation of a variety of fruits like mango, guava, jack fruit and vegetables like cauliflower, tomato, brinjal etc. There are some good clusters of vegetable cultivation in Kurdeg, Simdega and Kersai blocks in the district. However, in the absence of assured irrigation facility, agriculture in the district is primarily rain fed and as a result, mainly mono-cropping and subsistence farming is practiced in the district.

As per the agro-climatic zones delineated by Planning Commission, Simdega district falls under Zone (VI) i.e., Ranchi plateau and Netarhat hill region. It requires strategic planning so as to maximize the use of rainwater, increased ground water utilization level to achieve balanced crop production. Water resources also need to be developed through dug wells and lift irrigation. Watershed development also holds promise in the district.

The cropping pattern followed in the region is by and large under rain fed conditions. 85% of kharif is under paddy. The other main kharif crops are madua, maize, arhar and urad. Rabi crops are grown only in areas where there is irrigation facility. Main rabi crop of the district is vegetables like potato, tomato, cauliflower, brinjal etc. Productivity of agriculture is poor in the district. The erratic nature of the rainfall and its long inter spell gaps lead to frequent crop failure over a large part of the district. Area under crop for the year 2019 – 20 of the district is presented in table - 4.

Table – 4: Cropping pattern of Simdega district (2019 - 20)

(Area in hectare)

Sr. No.	Block	Major Crops					
		Paddy	Pulses	Maize	Oil seeds	Vegetable	Wheat
1.	Bagodar	2760.20	681.22	990.69	234.28	300.09	348.94
2.	Sariya	2932.39	792.44	1048.82	243.89	209.54	352.59
3.	Dumri	4939.41	855.74	1648.11	139.76	536.53	391.74
4.	Pirtarn	3943.02	698.01	964.88	258.91	379.89	410.06
5.	Giridih	6575.82	870.11	1309.82	390.89	330.80	584.04
6.	Gandey	6481.23	1136.87	1399.52	717.43	502.42	514.47
7.	Bengabad	6555.79	1503.71	1316.32	515.16	468.93	489.82
8.	Jamua	7476.96	1058.59	1448.21	581.30	1326.30	509.37
9.	Dhanwar	7214.26	1297.93	1493.58	701.01	578.07	688.85
10.	Birni	5903.46	967.53	1268.36	366.11	543.85	605.68
11.	Devri	7913.73	1018.38	1347.01	522.52	1171.74	516.07
12.	Tisri	4808.18	1016.11	1832.75	524.96	596.90	521.93
13.	Gawan	5014.30	1388.15	1936.64	514.01	400.41	696.62
Total		**72518.75**	**13284.79**	**18004.71**	**5710.23**	**7345.47**	**6630.18**

Source: - District Statistic office, Simdega, GOJ

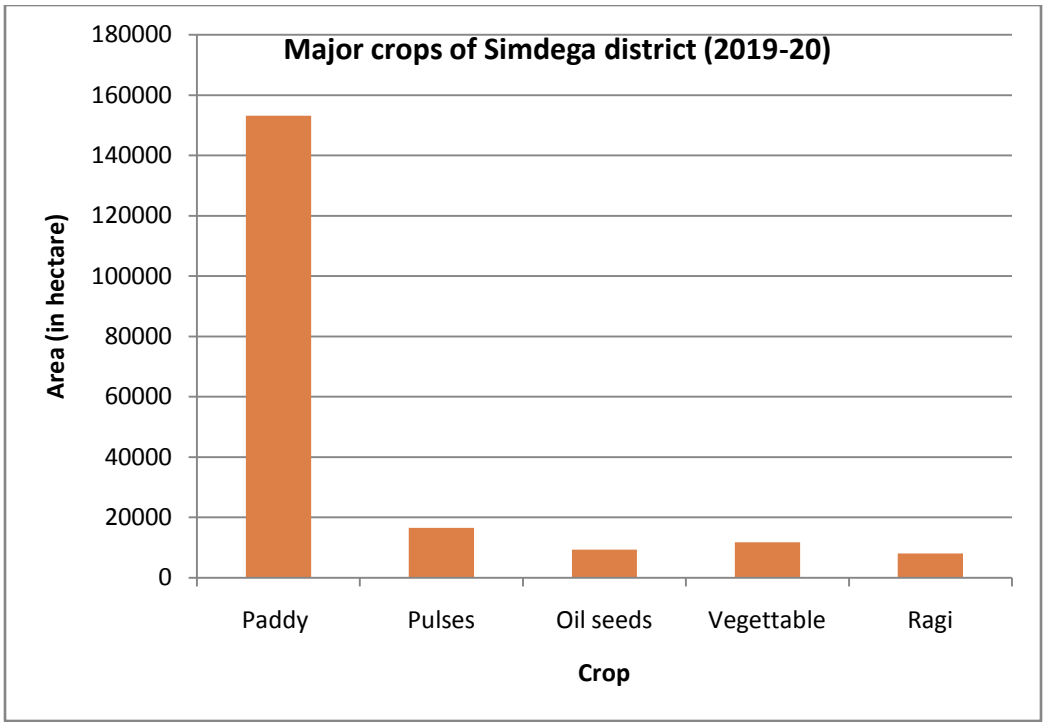


Figure – 3: Major crops of Simdega district (2019-20)

1.12 Geology of the area: In general the Simdega district forming South-Western part of the Chotanagpur plateau is predominated by Chotanagpur granite gneiss of Archean age, which forms the basement in the area. It occurs as large batholithic mass. The granite gneiss is foliated where as granites are massive, but foliation is sometimes seen in granitic rocks also. Both the rock units have same mineral composition. The minerals are quartz, feldspar and biotite. Pegmatite veins are seen intruded all along the granitic terrain.

The general geological succession of the district may be given as under –

Age	Formation
Recent to sub - recent	Alluvium
……Unconformity	……
	Dalma lava
Archean	Schist & phyllites
	Chotanagpur Granites & granite gneiss

In order to understand the sub-surface hydrogeology of the Simdega district, central Ground Water Board has constructed 25 exploratory and 10 observation wells. The drilling results have indicated that the granite gneiss of different shades varying from whitish grey to dark, grey to pink, having coarse grained texture are the most prevalent rock types encountered over the district. The lithologs of the 10 exploratory wells is given in Annexure – V. Geology of Simdega has been depicted in Fig-

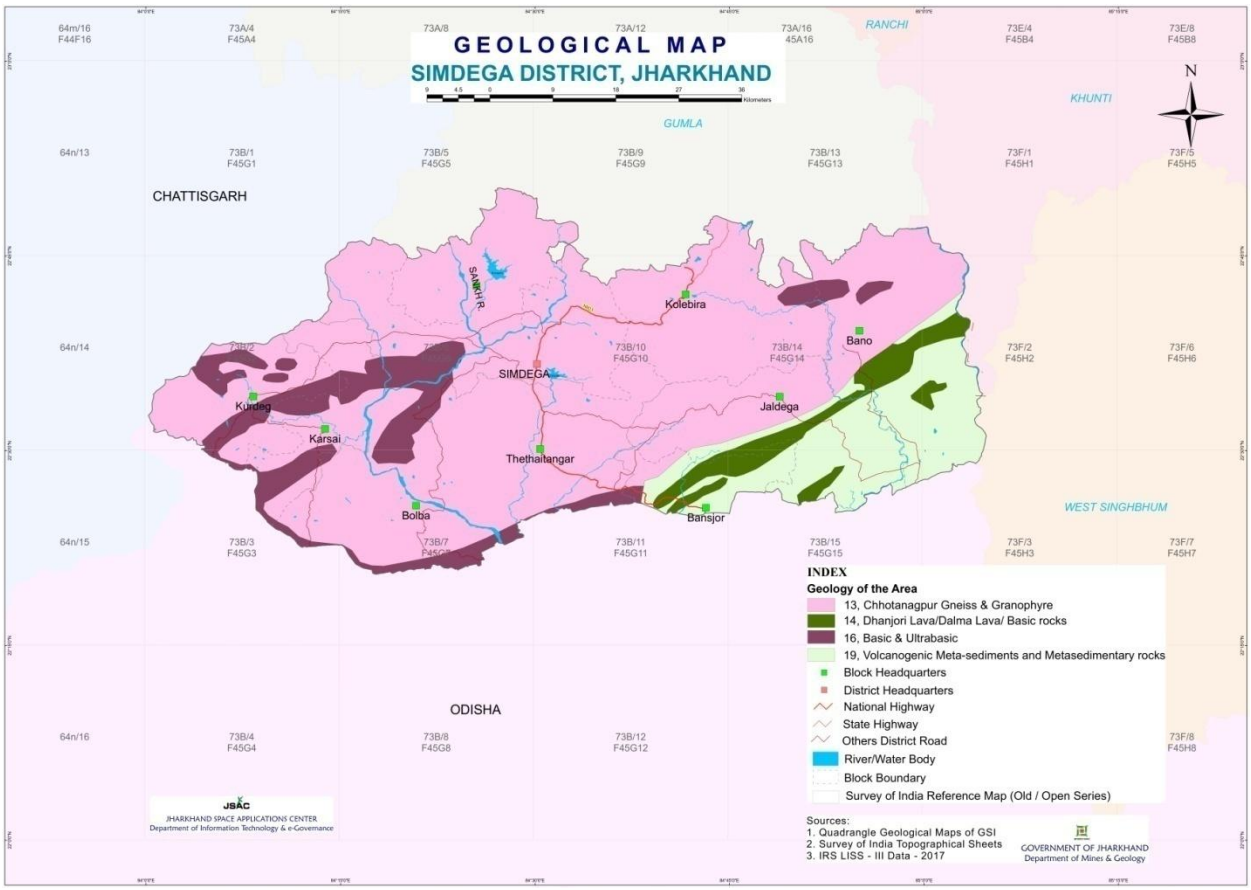


Fig-4. Geology of Simdega district, Jharkhand
Source: DMG, Jharkhand

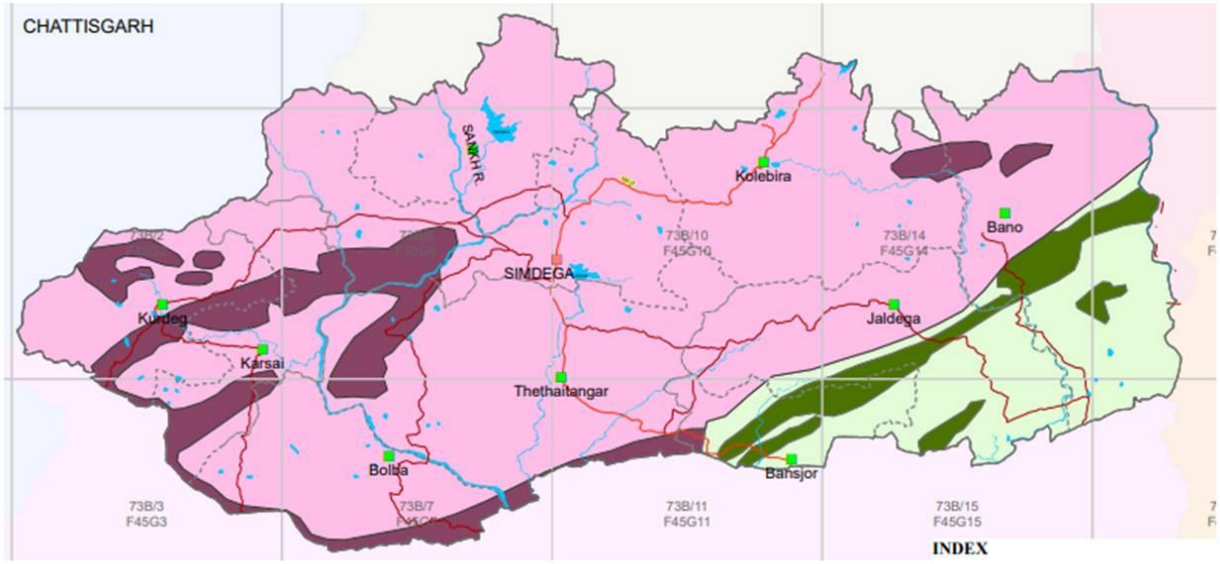
2. DATA COLLECTION AND GENERATION

Central Ground Water Board has established a network of observation wells under National Hydrograph Network programme to study the behaviour of ground water level and quality of ground water in the district. To understand the sub–surface geology, identify the various water bearing horizons including their depth, thickness and compute the hydraulic characteristics such as transmissivity and storativity of the aquifers, exploratory drilling programme was carried out by Central Ground Water Board has carried out exploratory drilling in the district and drilled 10 exploratory and 07 observation wells by departmental rig during the year 2008-2009. Similarly, 15 exploratory wells and 03 observation wells were drilled through outsourcing drilling during the year 2020-21.

2.1 Hydrogeology:

Simdega district is mainly a dissected upland of ancient crystalline rocks which covers the major parts of the district. Ground water availability in crystalline rocks is considered to be poor because of the absence of primary porosity which is essential for the occurrence and movement of ground water. The secondary porosity in the form of fractures, fissures, joints etc. develop due to orogenic movements aided by weathering, making the crystalline rocks potential repository for the occurrence and movement of ground water. The ground water in the district is controlled primarily by the thickness of weathered zone, extent, size openness and interconnection of fractures, geological and topographical setting. In major part of the district fractured and weathered crystalline hard rock form the aquifer. Ground water in the district characterized by the hard rocks is located in the weathered residuum in the shallow depth under unconfined condition and circulates through the under lying fracture system extending to deeper horizon under semi – confined to confined conditions. Generally two types of aquifers are found in the district namely, the weathered aquifer and fractured aquifers. Hydrogeological map is shown in figure 5.

Hydrogeological Map of Simdega district Map



Colour	Formation	Lithology	Hydrogeological condition	Ground Water Potential
	Pre-cambrian	Dhanjouri Lava/Dalma Lava/Basic rocks	Ground Water Restricted to weathered zones/fractured zones having secondary porosity. Occur under unconfined to Semi-Confined and Confined condition	Limited Yield
	Pre- cambrian	Volcanogenic Metasediments and Metasedimentary Rocks		Moderate Yield upto 20 m3/hr
	Pre- cambrian	Basics/Utrabasics		Moderate Yield upto 20 m3/hr
	Pre -cambrian	Chotanagpur Granite-Gneiss		Moderately Good 10-30 m3/hr

Figure – 5: Hydrogeological map of Simdega district

2.1.1 Ground Water in Aquifer-I (Weathered):

Thickness of weathered aquifers varies from 2.50 – 45 m in granite terrain, based to CGWB exploratory wells. Within the depth zone of dug wells, the weathered zone influences to a greater in the hard rock formation constitute potential phreatic shallow aquifer. This zone of weathered and less fractured zone, should be developed either through large diameter open wells or shallow bore wells of 20 – 50 m depth which permits draft upto 10 m^3/hr for domestic as well as irrigating small holdings of land. Hand pumps constructed by State Government Department generally tap first fracture zones in 9 - 50 mbgl.

2.1.2 Ground Water in Aquifer-II (fractured): 35 numbers of boreholes have been constructed by CGWB in the district under ground water exploration programme upto maximum depth of 201.00 m. These borehole data reveals that, in general potential fractures are encountered between 9 - 193 m. The yield of exploratory wells found between 0.47 to 72.00 m^3/hr. Table-5 shows the Potential Fracture encountered during Ground Water Exploration in Simdega district.

Table – 5: Potential fractures encountered during ground water Exploration in Simdega district, Jharkhand

S. No.	Location	Block	Depth drilled (mbgl)	Depth of casing (mbgl)	Major lithology encountered	Potential fractured zone (mbgl)	Static water level (mbgl)	Yield (m3/hr)
1	Kolebira	Kolebira	83.62	3.00	Granite Gneiss	15.00 – 16.00 83.00 – 83.62	0.30 (magl)	72
2	Bano	Bano	199.20	8.20	Granite Gneiss	80.00 – 81.00 144.00 – 146.00	6.93	10.80
3	Lachragarh	Kolebira	199.92	11.50	Granite Gneiss	144.00 – 146.00	5.70	16.20
4	Pandripani	Thetaitangar	170.94	9.00	Granite Gneiss	18.00 – 19.00 109.00 – 111.50	4.40	28.08
5	Simdega	Simdega	199.92	12.00	Granite Gneiss	181.00 – 182.50	10.40	10.8
6	Joram	Thetaitangar	123.72	18.50	Granite Gneiss	9.00 – 15.50 75.00 – 77.00 130.00 – 131.00	2.15	44.28
7	Tutikel	Kolebira	135.00	17.79	Granite Gneiss	134.00 – 136.00	--	43.88
8	Bansjor	Bansjor	177.00	45.23	Phylite	54.00 – 55.00 175.00 – 176.00	--	35.5
9	Gangu Toli	Jaldega	201.00	14.74	Granite Gneiss	91.00 – 92.00 192.00 – 193.00	--	21.38

Source: CGWB

On the basis of field investigations and results of exploratory wells drilled in the district, salient findings are summarized as:-

- In general in fissured formations, discharge of well has been found in the range of 0.47 - 72.00 m^3/hr.
- Overall in the district the major potential fractures zones are found upto 150 m.
- First potential fracture zone encountered in the district widely varies from 9.00 - 181 m.
- Sometimes the potential fractures were encountered at very shallow level 15.00-16.00 m with very high yielding wells. These potential fractures may be tensile in nature occurring at shallow level, which is found to be potential repository of ground water. Some of the exploratory wells encountered upto the depth of 82.00 m which yielded high discharge e.g. Kolebira (72 m^3/hr) and Lachragarh (16.20 m^3/hr).
- Some of high yielding well where multiple fractures were encountered within 150 m depth are Kolebira (72.00 m^3/hr, Bano (10.80 m^3/hr), Pandripani (28.08 m^3/hr) , Joram (44.28 m^3/hr) and Tutikel (43.88 m^3/hr).

- In some occasion potential fractures were also encountered beyond 150 m depth. The well has yielded copious amount of discharge e.g. Simdega (10.80 m^3/hr), Bansjor (35.50 m^3/hr) and Gangu Toli (21.38 m^3/hr).
- At Kolebira well drilled at 83.62 m yielded discharge of 72 m^3/hr with peizometeric head 0.30 magl.

2.1.3 Ground Water Dynamics

2.1.3.1 Water Level Scenario – Aquifer – I (Shallow Aquifer): Water level scenario of shallow aquifer was generated by utilizing water level data of 42 monitoring wells representing shallow aquifer. The pre monsoon (May/June 2021) depth to water level monitored between 2.20 to 10.85 mbgl. The post monsoon depth to water level (Nov. 2021) in the dug wells ranges from 0.64 to 7.47 mbgl. Pre and post monsoon depth to water level maps were prepared for the year 2021 and presented in figure – 6& 7.

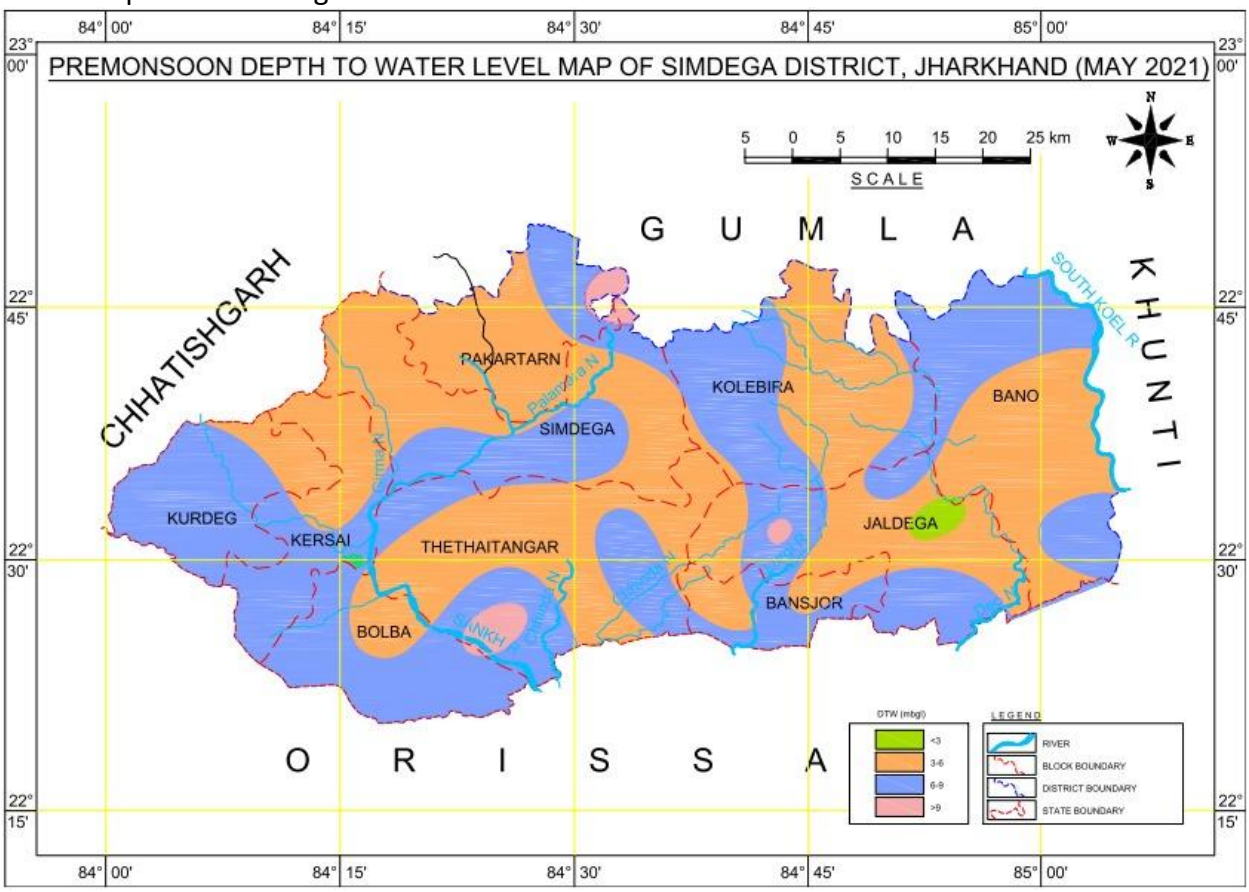


Figure – 6: Pre monsoon depth to water level map of Simdega district (May 2021)

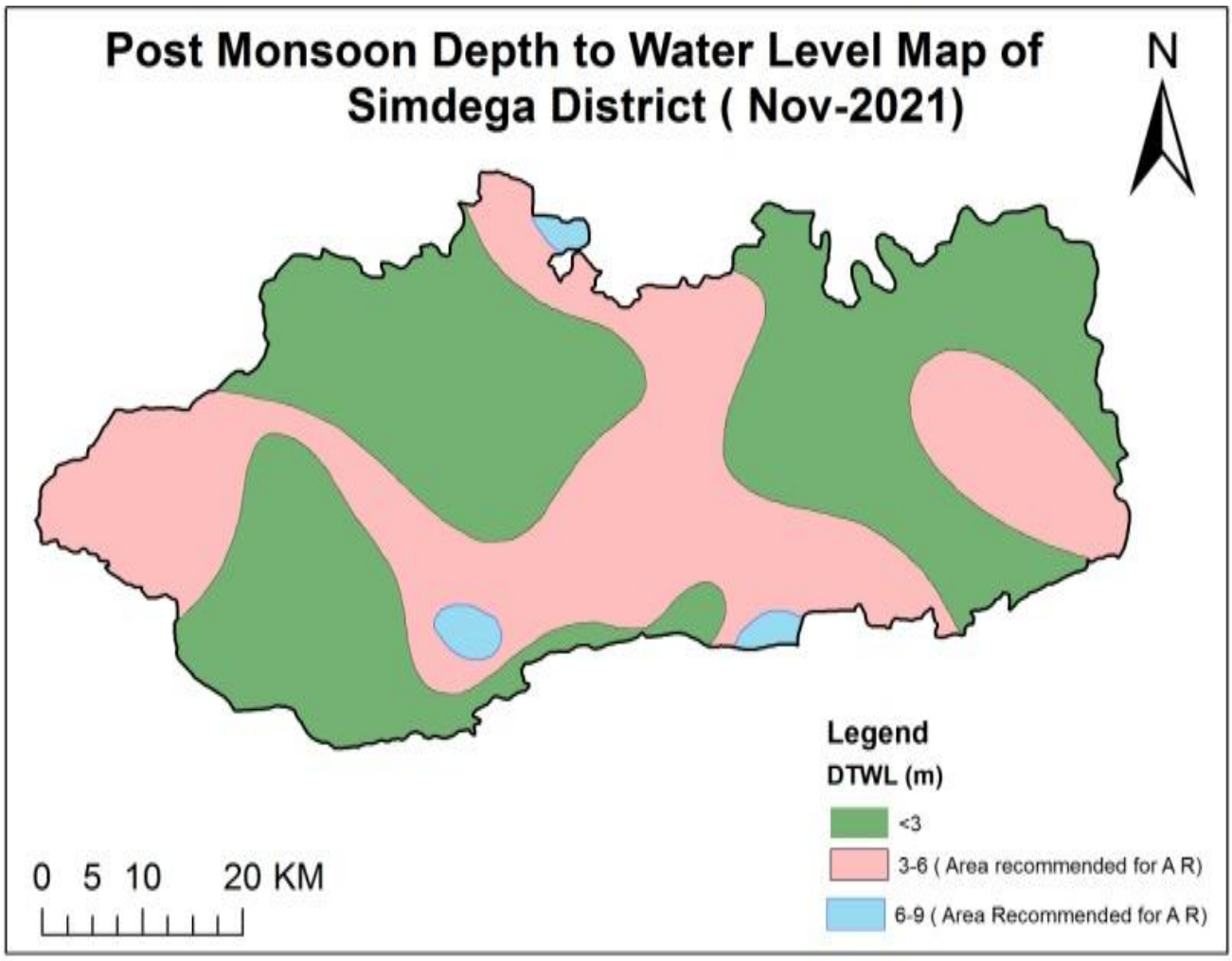


Figure – 7: Post monsoon depth to water level map of Simdega district (Nov. 2021)

2.1.3.2 Water level fluctuation: Seasonal ground water level fluctuation in shallow aquifer was studied with the help of 42 key wells which were monitored four times in different seasons during the year 2021. Any decline in water level in the dry and lean period is immediately restored with the onset of monsoon precipitation. Depletion of water in the ground water reservoir is replenished and thus the annual cycle of decline and rise of water level is maintained through time. The seasonal rise of water level varies from place to place. The seasonal water level fluctuation between pre and post monsoon period for the year 2021 observed between 0.85 to 6.15 m in the district. Seasonal water level fluctuation map between pre monsoon (May/June 2021) and post monsoon (November 2021) has been prepared and presented in figure – 8.

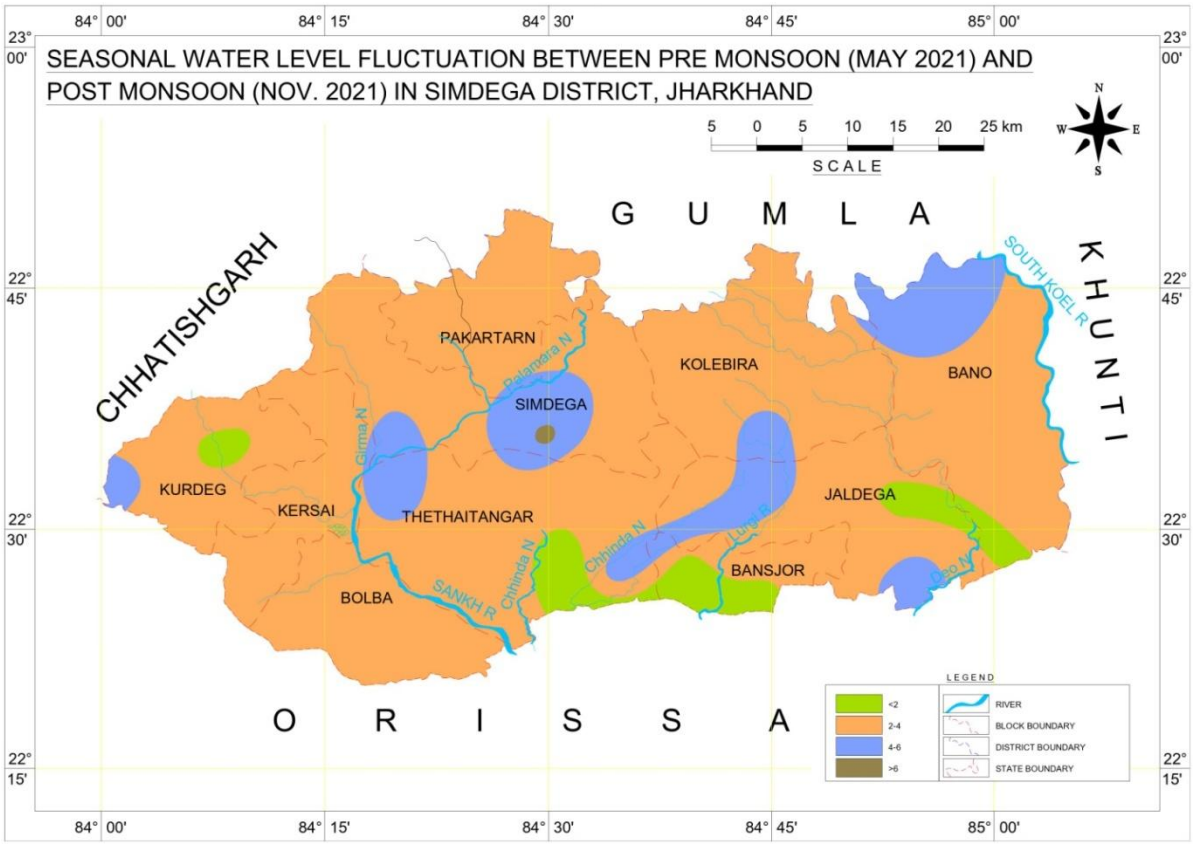


Figure – 8: Seasonal water level fluctuation map of Simdega district (2021)

2.1.3.3 Last ten years long term water level trend (2012 – 2021): In order to study long term behaviour of the water levels and also the effect of various developmental activities with time, the data for the period 2012 - 2021 have been computed ,analyzed and presented in table - 6. The post monsoon water level trend analysis showing rising trend in 90% wells. It may be due to extraction of ground water from dug well is very less because sufficient availability of hand pumps in recent years. The dug well was main source for ground water extraction 20 - 30 years back.

Table -6: Last ten years long term water level trend of Simdega district (2012 – 2021)

Sr. No.	Location	Water level trend (m/year)			
		Pre monsoon		Post monsoon	
		Rise	Fall	Rise	Fall
1	Bano	0.1798	--	0.1718	--
2	Biru	--	0.0230	0.0708	--
3	Bolba	--	--	0.1233	--
4	Jaldega	0.2622	--	0.0894	--
5	Kereya	--	--	0.1739	--
6	Kolebira	--	0.0462	--	0.0436
7	Lachragarh	--	0.1476	0.0473	--
8	Lomboi	--	--	0.0091	--
9	Tengratuku	--	--	0.0122	--
10	Thethaitangar	0.3983	--	0.0375	--

2.1.3.4 Hydrograph Analysis: Analysis of twelve (12) hydrograph network stations, were carried out using GEMS software (Figure - 9 a-l) and analysed for the period from 2012-2021. It is observed that the long-term water level trends during pre monsoon seasons are declining trend in 42% hydrographs of shallow aquifer-I represented by dug wells. Similarly, post monsoon long term water level trend is observed rising trend in the wells located at Bano, Bolba, Kurdeg, Kereya, Jaldega, Lachragar and Thethaitangar while declining trend observed in the wells located at Lomboi, Baribiringa, Tengratuku and Kolebira.

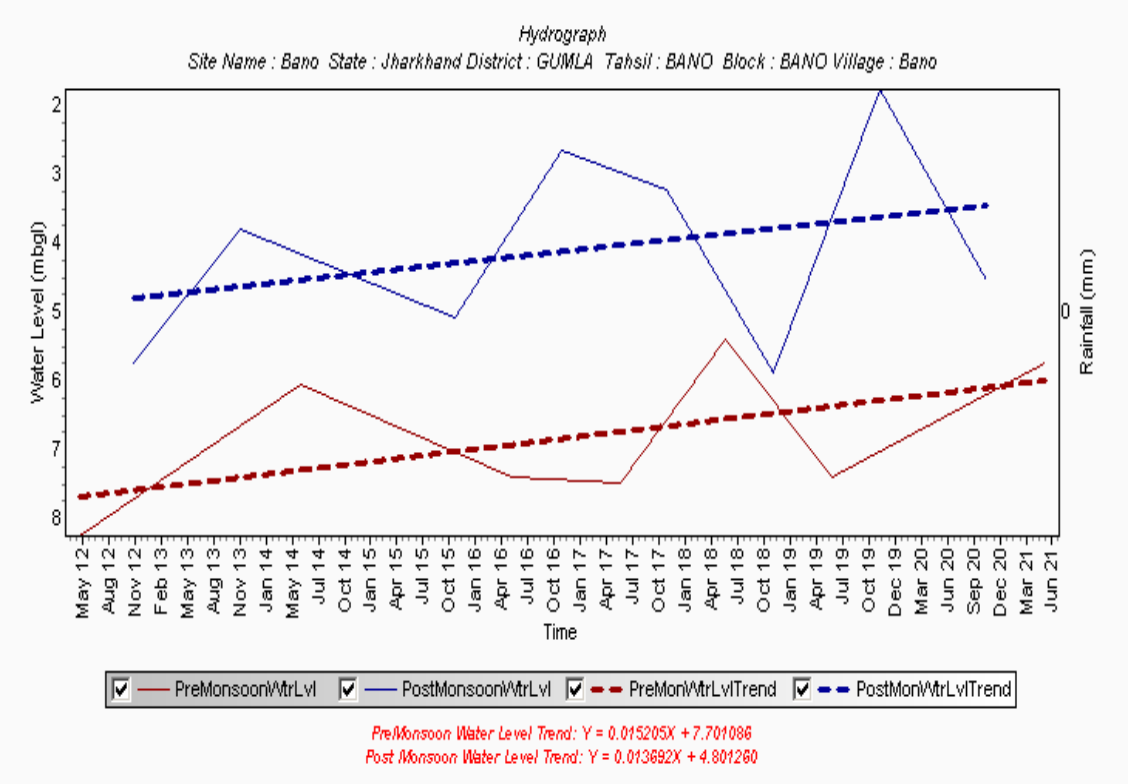


Figure – 9 (a): Hydrograph (2012-2021) of Bano network station

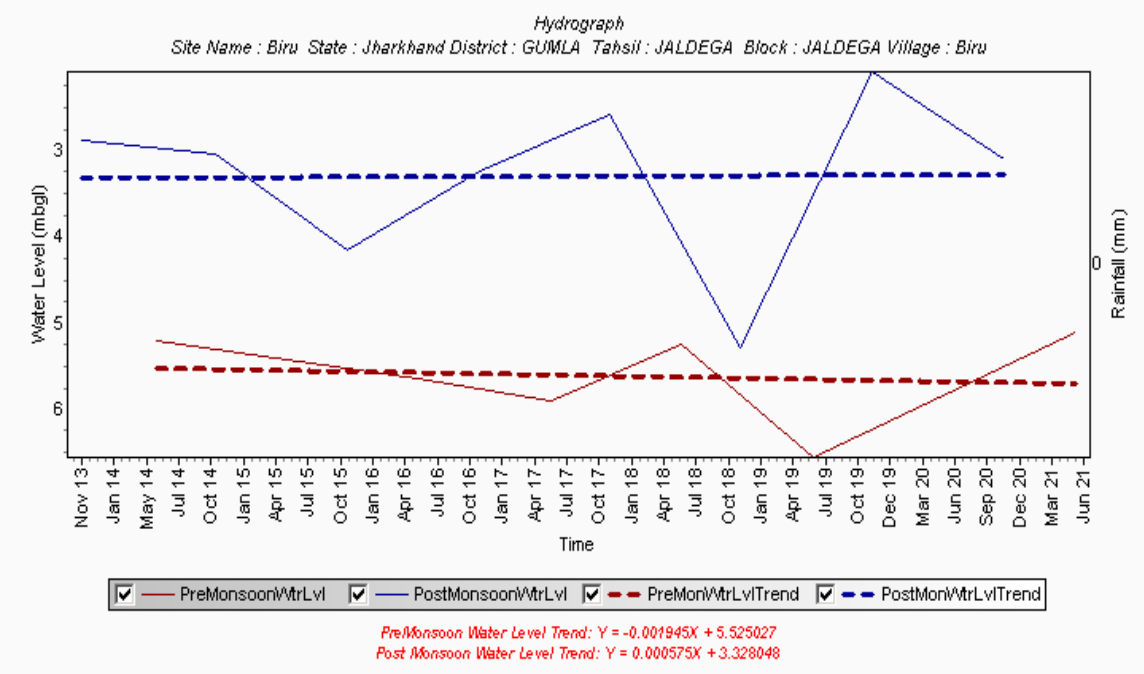


Figure – 9 (b): Hydrograph (2012-2021) of Biru network station

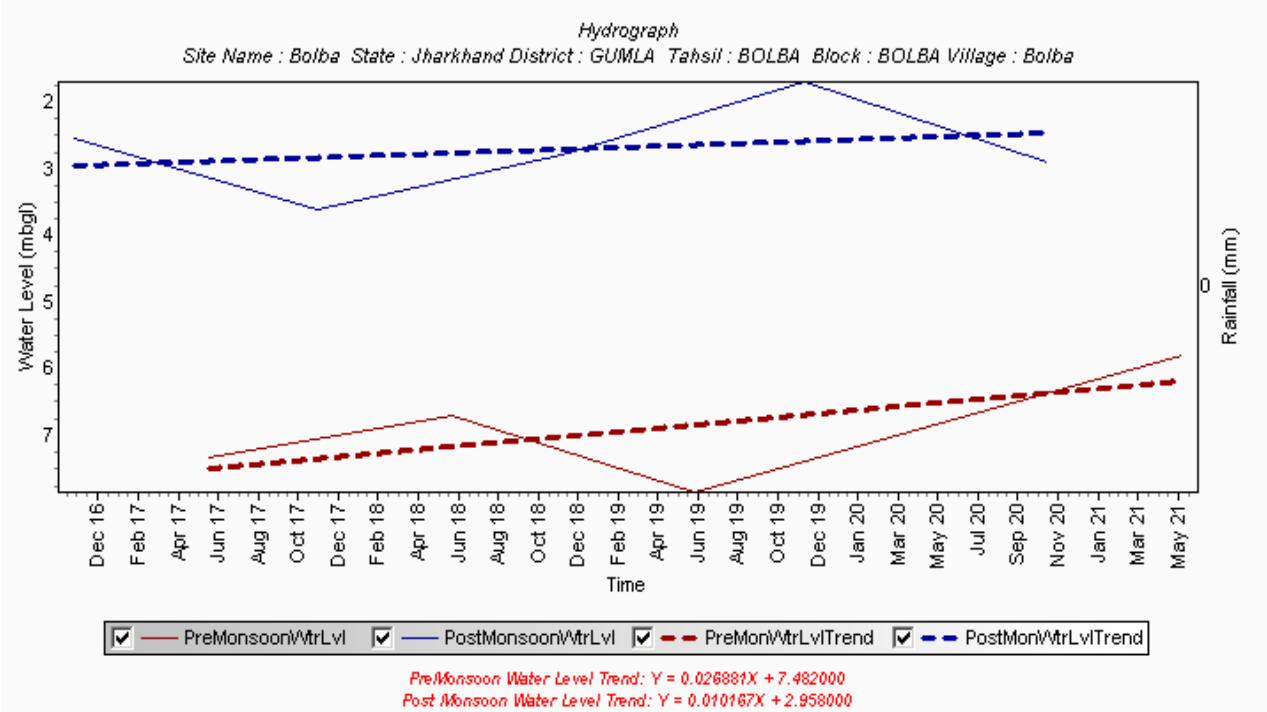


Figure – 9 (c): hydrograph (2012-2021) of Bolba network station

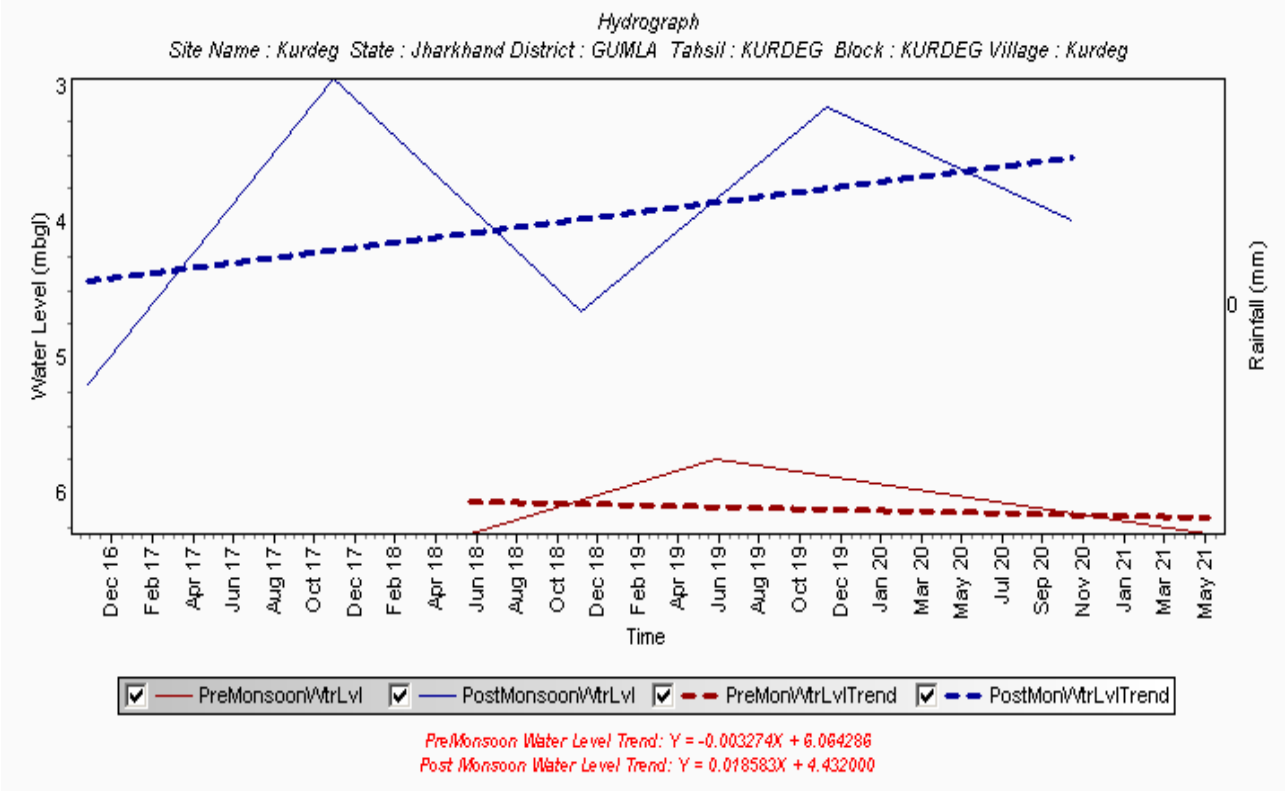


Figure – 9 (d): hydrograph (2012-2021) of Kurdeg hydrograph network station

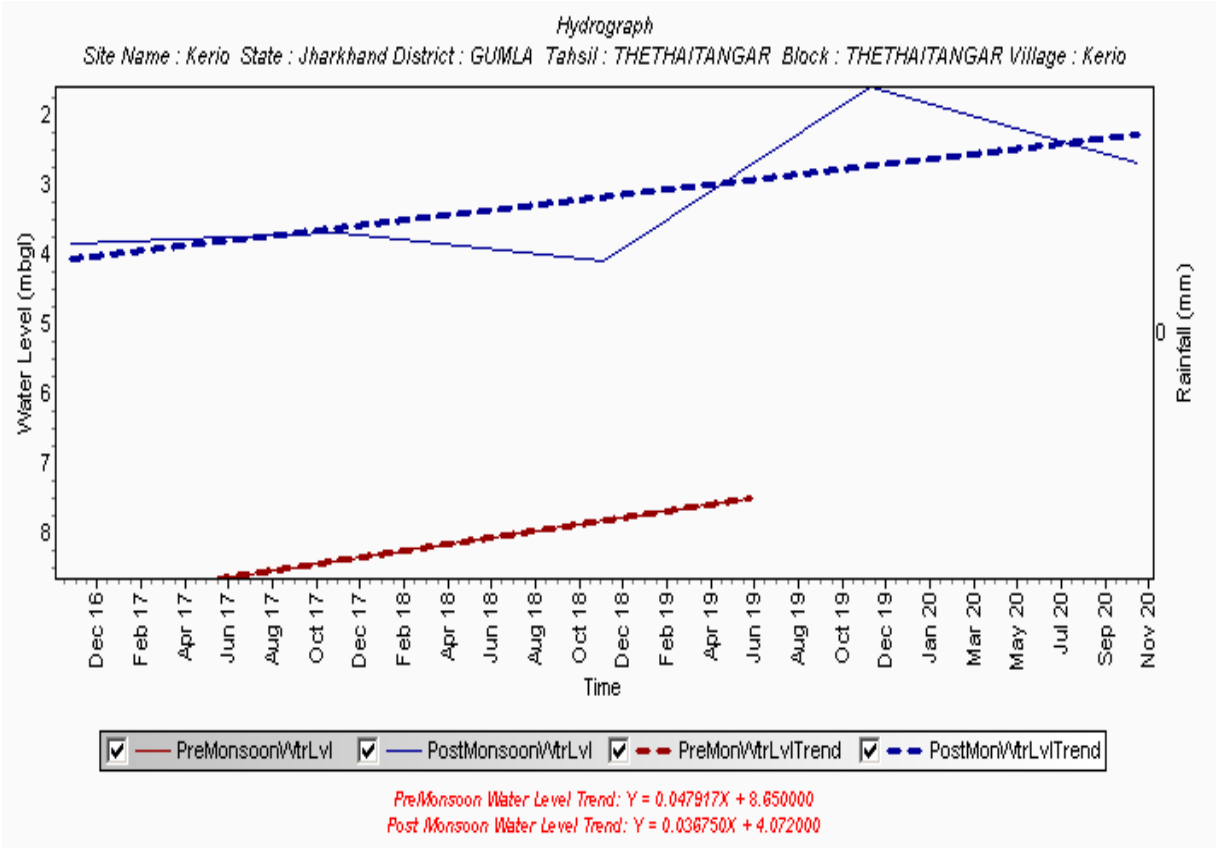


Figure – 9 (e): Hydrograph (2012-2021) of Kereya network station

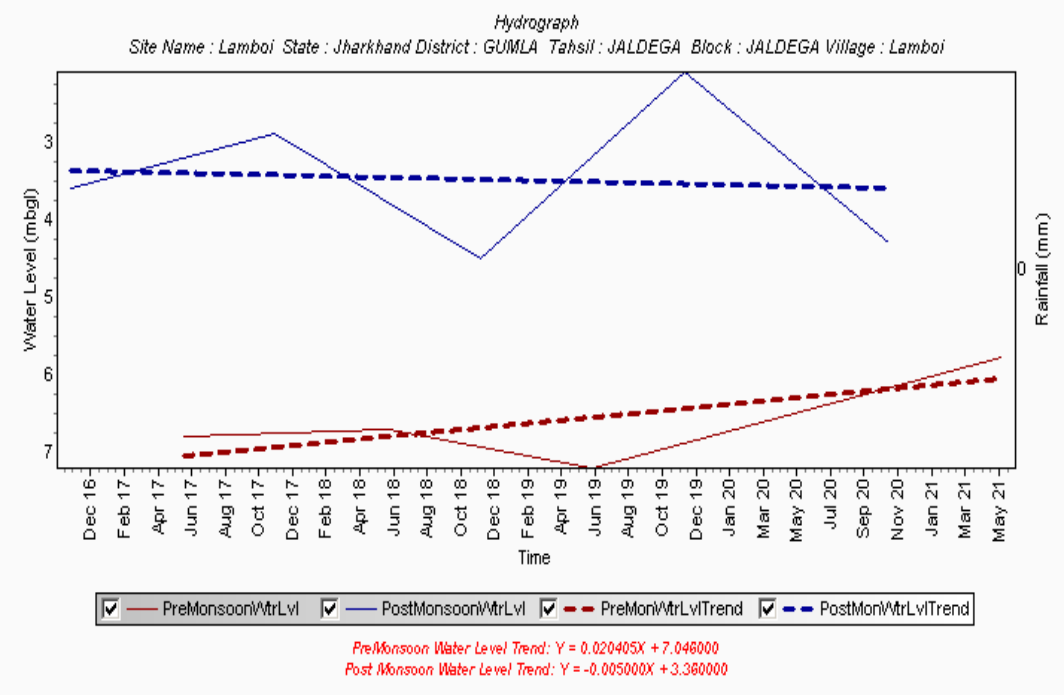


Figure – 9 (f): Hydrograph (2012-2021) of Lomboi network station

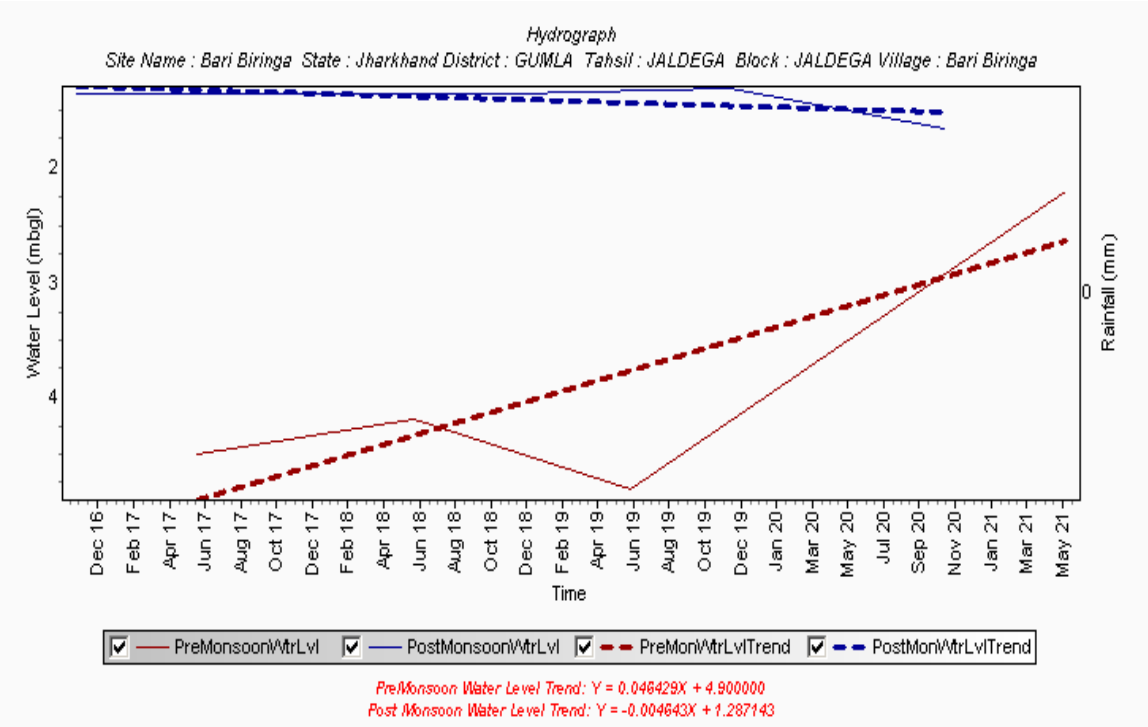


Figure –9 (g): Hydrograph (2012-2021) of Baribiringa network station

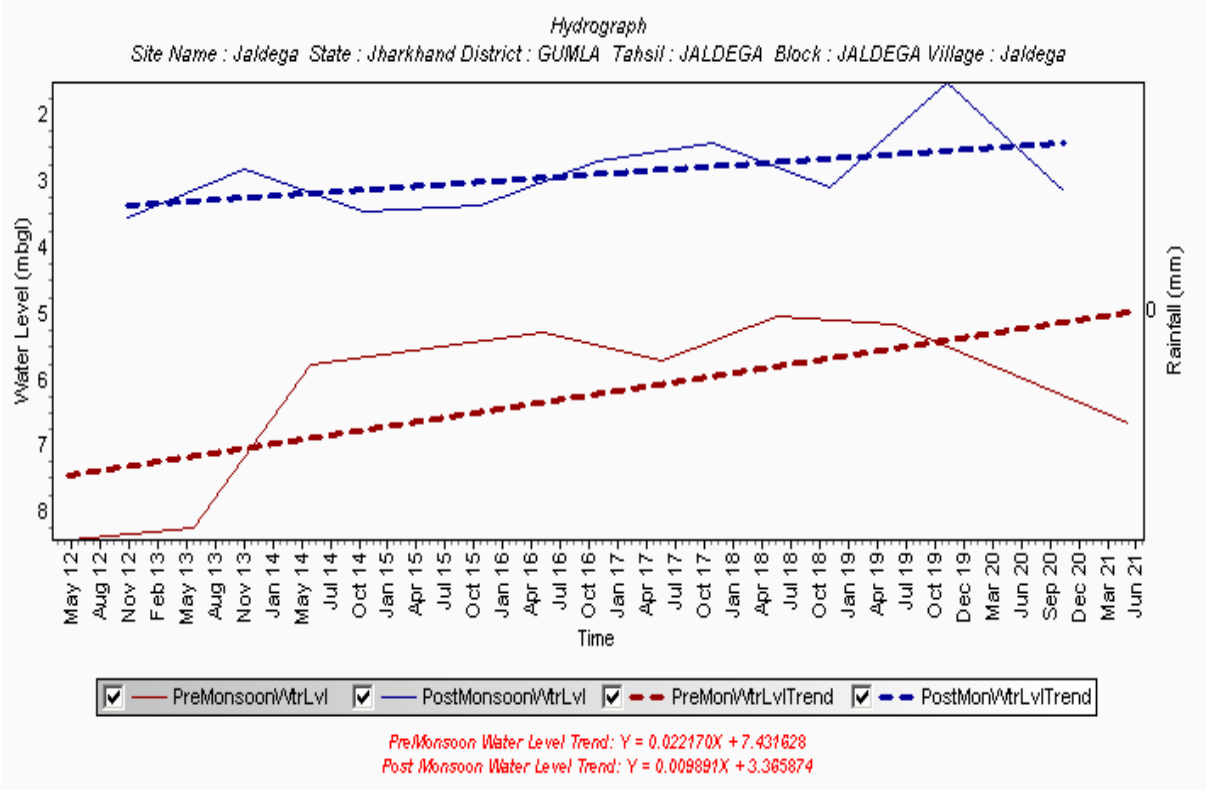


Figure – 9 (h): Hydrograph (2012-2021) of Jaldega network station

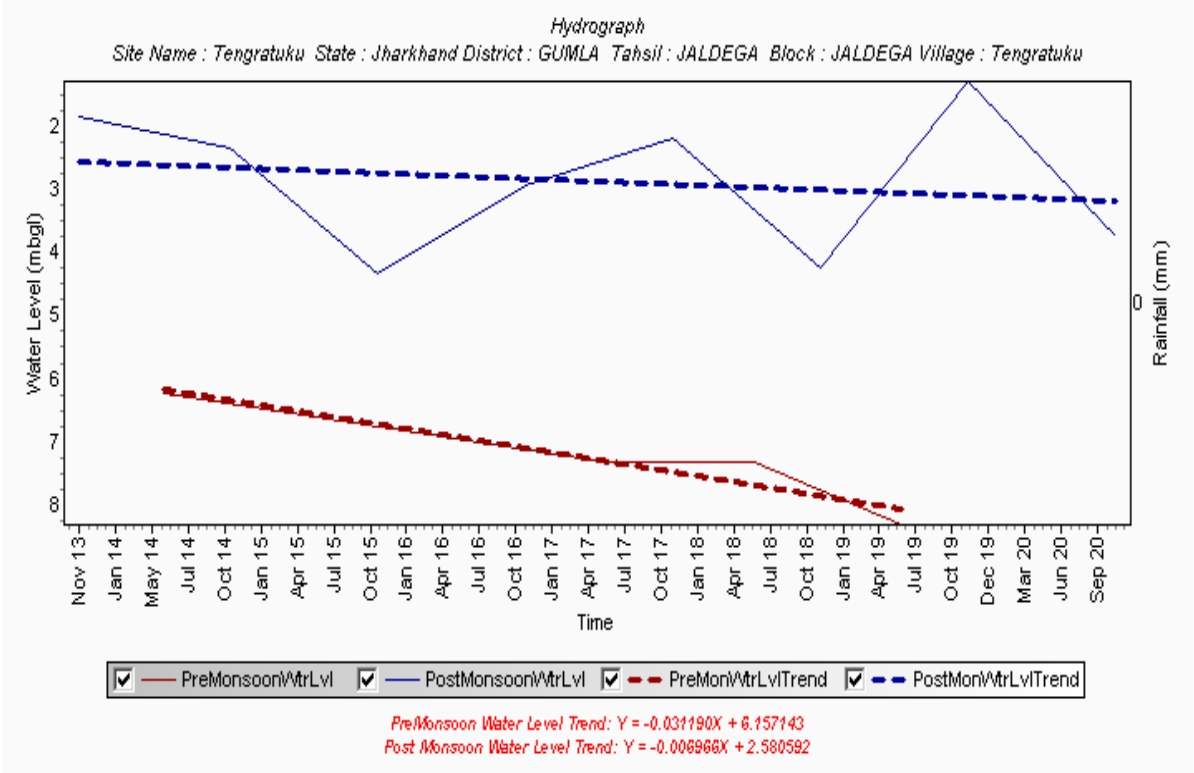


Figure – 9 (i): Hydrograph (2012-2021) of Tengratuku network station

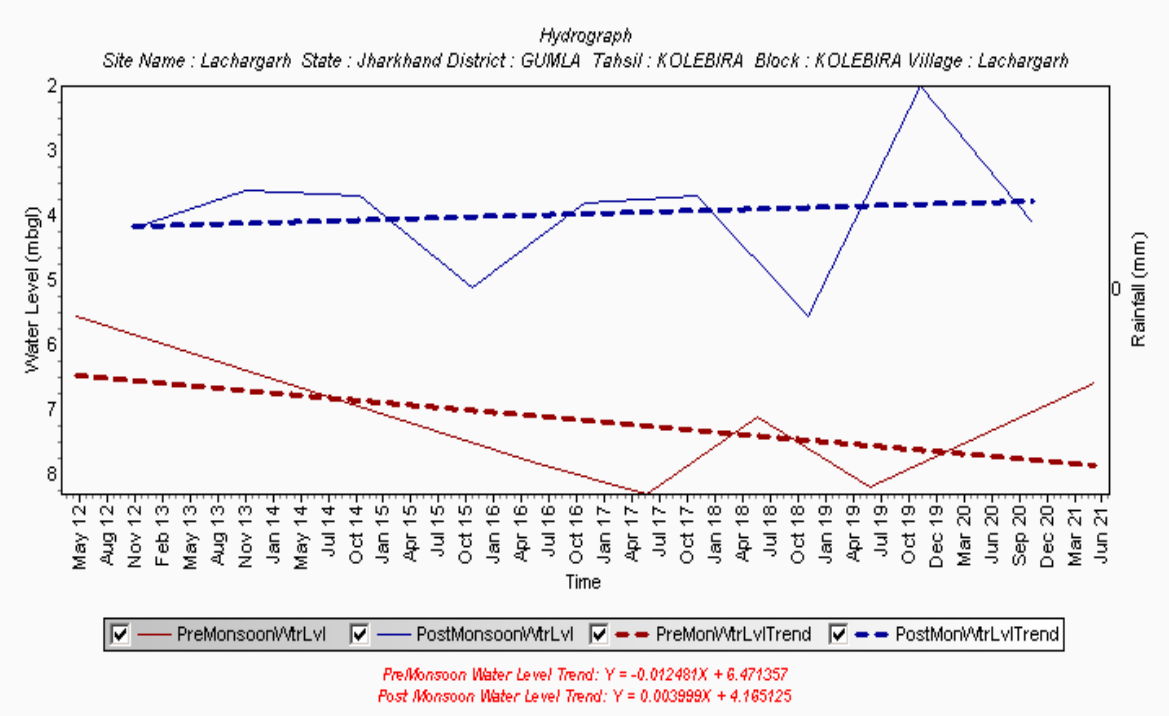


Figure – 9 (j): Hydrograph (2012-2021) of Lachragarh network station

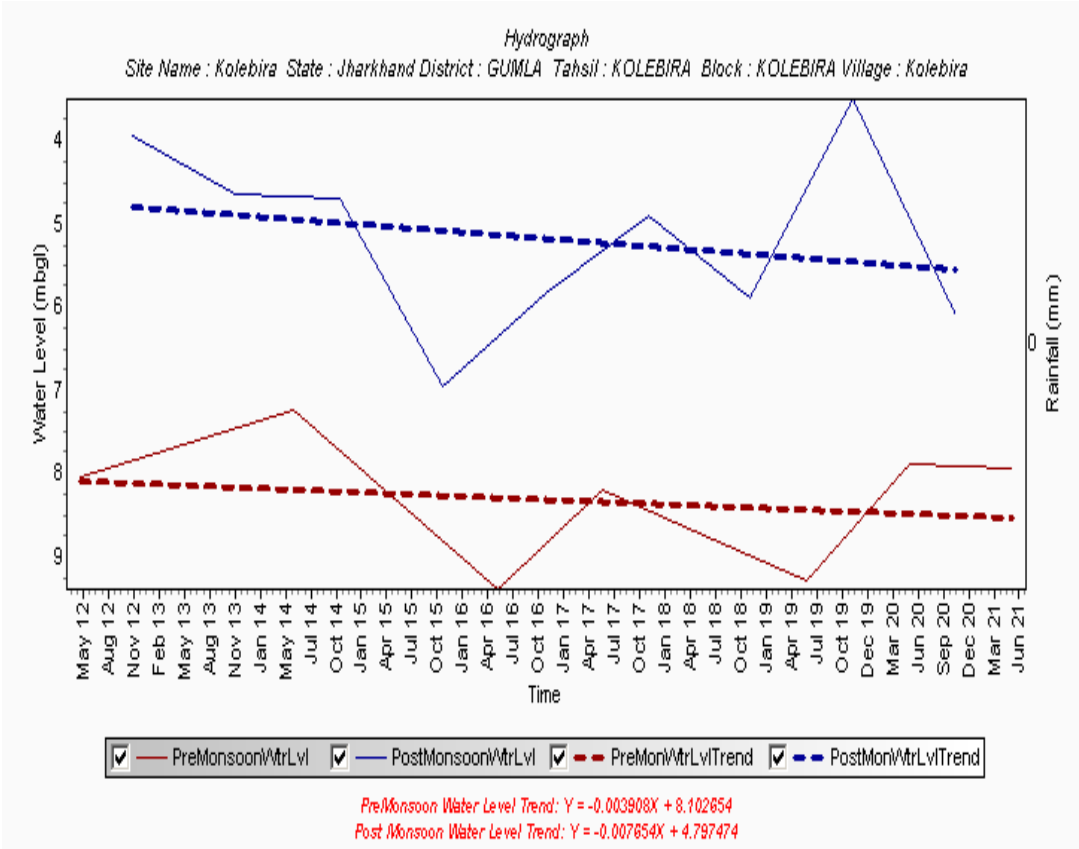


Figure – 9 (k): Hydrograph (2012-2021) of Kolebira network station

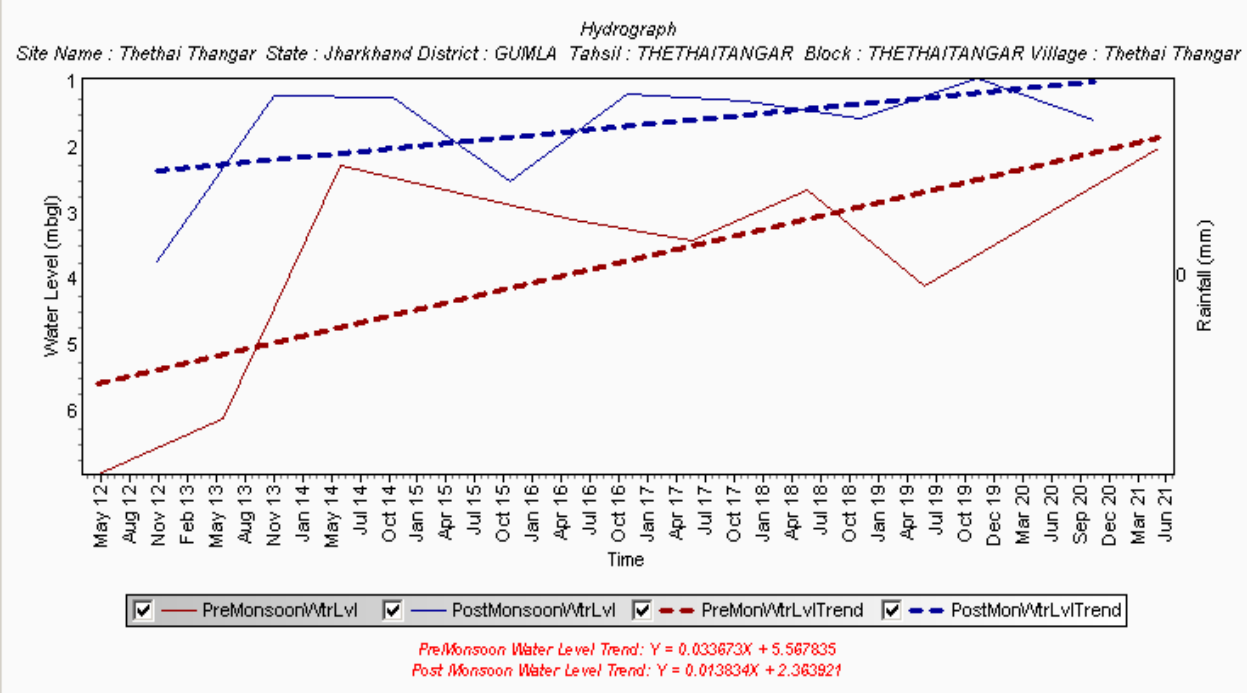


Figure – 9 (I): Hydrograph (2012-2021) of Thethaitangar network station

2.2 Geophysical survey: 24 VES were carried out under in-house activity during 2007-08 and 2008-09. Similarly, 103 VES were carried out through outsourcing activity during 2021-22 to identified the weather zone resistivity and its thickness as wells as find out deeper fracture zone in hard rock formations.

Outsourcing geophysical survey: 103 VES were carried out through outsourcing activity during 2021-22 to identified the weather zone resistivity and its thickness as wells as find out deeper fracture zone in hard rock formations. Based on the interpreted result of these 103 VES data, 80 VES sites the top weathered zone is very thin which is less than 9.00 m. However, some VES sites weathered zone extends more than 20 m depth.

The range of resistivity i.e. 50 – 150 ohm m at shallow depth (more than 9 m) are considered as semi weathered formation. On the basis of these considerations 26 sites are detected to be semi weathered zone. Based on the curve break techniques and current increase methods, the fractured zones have been delineated at so many sites. Sometimes the resistivity range is found less than 50 ohm m at deeper depth, it may be due to series of fractures. The fracture zones are generally available when the overall resistivity of the curve is little lesser than the very high resistivity. On the basis of these considerations in 45 numbers of VES the fracture zones are detected. Block wise VES carried out and recommendation for drilling is given below in table 7.

Table – 7: Block wise VES carried out and recommendation for drilling in Simdega district

Sr. No.	Name of the block	No. of VES carried out	No. of sites recommended for drilling	Name of recommended villages
1	Bano	14	08	Ganjhu Toli, Bano, Gerda, Jorponda, Jhariyadipa, Nimtur, Mahabuang and Hatinghorhe.
2	Bansjor	05	03	Lodhopara, Koydega and Bansjor.
3	Bolba	06	02	Kadopani and Belkuba.
4	Jaldega	08	02	Orga and Hutubda.
5	Kersai	06	05	Keundkasa, Saraitola, Sagjori, Lachragarh and Jatahdatoli.
6	Kolebira	14	04	Agharma, Salangapani, Barwadih and Bandarchua.
7	Kurdeg	06	04	Khulumunda, Ghagmundatoli, Sogsoga and Baha.
8	Pakartarn	10	03	Hardibera, Sogru and Kochedega.
9	Simdega	12	06	Katukona, Tamra, Biru, Gotra,Bangru and Samtoli.
10	Thethaitangar	22	08	Pandripani, Mundratoli, Bambkalbera, Meromdega, Demchutoli, Konmenjra, Thethaitangar and Marumora.
Total		103	45	

On the perusal of table – 25, it is observed that the about 44% of VES sites have been recommended for drilling. The secondary porosity fractured zone has developed moderately in the district. Water bearing deeper fracture zones are limited and their yield may varies from poor to moderate.

2.3 Ground Water Exploration: To assess the potentiality of the deep fractured rock 10 exploratory wells and 07 observation wells were drilled in Simdega district by Central Ground Water Board. In addition, 15 exploratory wells and 03 observation wells have been constructed by outsourcing drilling. The drilling results have indicated that granite gneiss of different shades varying from grey to dark grey to pink, having course grained texture sometime porphyritic, are the most dominant rock types met in the area. In the bore wells upper weathered zones are cased and only the fractured zones are tapped in the uncased well. The details of the exploratory and observation wells drilled in Simdega district are presented in annexure – IV and available lithologs of these wells are represented in Annexure – V. Summary of success bore wells drilled by Central Ground Water Board in the district is given in table – 9.

Based on the exploratory well data, it is observed that one to three sets of fractures have been encountered in the bore wells drilled in Simdega district. Based on morphotectonic analysis and exploratory drilling results, it confirms that the area has undergone several phases of tectonic deformations which lead to various sets of fractures, fissures, and faults etc which are ground water repositories. Various sets of fractures have been identified, on ground water point of

view. The shallow fractured aquifers upto the depth of 100 m and deep fractured aquifer exist upto 193.00 mbgl within the explored depth of 201.00 m. The following are the summarisaed results of Aquifer Test in exploratory wells in Simdega district

Table – 8: Summarized result of APT

Sr. No.	Location	Block	Discharge (m^3/day)	Drawdown (m)	T (m^2/day)	S
1	Kolebira	Kolebira	354.24	2.60	20.40	0.012
2	Lachragarh	Kolebira	324.00	30.88	3.66	--
3	Joram	Thethaitangar	872.64	24.12	46.91	--
4	Padripani	Thethaitangar	313.63	40.37	3.27	--
5	Tutikel	Kolebira	432.00	7.30	193.19	0.00094
6	Gangu Toli	Jaldega	432.00	38.58	51.77	0.0000052
7	Bansjor	Bansjor	606.53	13.32	154.46	0.000027

Based on Aquifer Parameters evaluation in the district, Transmissivity value of deep fractured aquifer is found to be between 3.27 to 193.19 m^2/day. High value of Transmissivity correlates to tensile fracture system. The Storage co-efficient value ranging from 1.20×10^{-2} to 5.20×10^{-6} which indicates semi-confined to confine aquifer system in the district.

2.4 Ground Water Quality:

The quality of water plays prominent role in promoting both the standards of agriculture production and human health. To evaluate the quality of ground water, samples have been collected from 42 dug wells and 42 representatives bore wells (hand pumps). The analytical results of water samples dug wells and hand pumps are given in Annexure- VI and VII respectively. The ground water samples were analyzed for major chemical constituents by using standard procedure at chemical laboratory in CGWB, MER, Patna. These samples have been considered to assess the chemical quality of ground water and its suitability for drinking and irrigational purposes. Since the samples are collected from the dug wells, they represent the quality of Aquifer I (phreatic/ shallow zone) and the bore well samples represent the Aquifer II (deeper zone) quality of ground water.

2.4.1 General range of chemical parameter of Aquifer-I in the area: - Evaluation of ground water suitability in relation to its different purposes has been classified for drinking / domestic and irrigation. Water is very essential for life. Many a times it has raw consumption or indirectly (in food). Hence, it should be free from turbidity, odor, bacterial and poisonous contents and also chemically soft, low T.D.S value and other chemical constituents should range within low to tolerable limits. Excessive and longer use of water beyond these limits may endanger too many health problems.

The distribution of different constituent in ground water can be described as follows:-

Hydrogen ions activity:

It is expressed in terms of pH and shows the acidity & basicity of the solution. Natural water reacts with H+ & H- ions and forms H_3O or ions. The recommended limit (6.5 to 8.5) by BIS, 2012 is base on taste, corrosion and scale formation criteria. The pH value in Aquifer-I ranges from 6.67 to 7.84.

Electrical Conductivity:

Generally, the water's electrical conductivity increases in the dry periods because of evaporation and decreases in the rainy days because of the precipitation and also to the surface runoff flow into reservoir. The EC value in Aquifer-I ranges from 71 to 1307.

Carbonate & bicarbonate:

Naturally occurring carbondioxide is the foremost source of carbonate and bicarbonate ions in ground water along with the carbon cycle and carbonaceous rocks. Leaching of calcite or dolomite bearing rocks (mainly carbonate) is also a principal source of these ions at places. Carbonate content of the area is not detectable. The bicarbonate concentration ranges between 24.60 295.20 mg/l.

Chloride:

The chloride anions in a certain water environment are characterized by a high stability. Thus, the concentration of chlorides shows little change after long flow distance because the dissolution of chloride is greater in water and the reaction between Cl^- and other ions in stratum is insignificant. The Chloride concentration ranges between 3.54 to 255.24 mg/l.

Fluoride:

Its low solubility in water makes it different form the rest of halogen family. Fluoride geochemistry is mainly governed by fluoride bearing minerals found in Chotanagpur Gneissic complex. The main sources are fluorite (CaF_2), fluorapatite & other minerals present in rocks contributing the ion in water. The Fluoride concentration ranges between 0 to 1.14 mg/l.

Sulphate:

Sources of sulphate are minerals pyrite (FeS_2), anhydrite ($CaSO_4$). Under some conditions considerable quantities of sulphate may be obtained from organic Sulphur compounds. The generalized formulae for sulphate reaction ius;

$$SO_4^{2-} + 2CH_2O \rightarrow 2HCO_3^- + H_2S$$

The Sulphate value ranges between 5.28 to 63.87 mg/l.

Sodium:

Sources of sodium are halite, sea spray, brines and some silicates. Common sodic silicates include plagioclase. The only common sink for sodium is reverse ion exchange that occurs when highly saline waters come in contact with calcium rich clays.

The Sodium concentration ranges between 1.00 to 133.20 mg/l.

Calcium: In mineral form, it is found as Calcite, aragonite, gypsum, anhydrite, anorthite, diopside etc. The Calcium concentration ranges between 8 to 120 mg/l.

Magnesium:
The most common source of large quantities of magnesium in natural waters is dolomite. Magnesium is also derived from the silicates olivine, pyroxene and amphibole. The main sink is montmomorillonite. The Magnesium concentration ranges between 2.43 to 29.20 mg/l.

Total Hardness:
It is expressed in terms $CaCO_3$ and it is equal to Calcium + Magnesium equivalent per liter. It can be classified as under:-

Hardness range (mg/l CaCO3)-	Class	
0- 60	-	Soft
61-120	-	Moderately hard
121-180	-	Hard
>180	-	Very Hard

In the study area, the total hardness value ranges from 35 to 345 mg/l.

The ground water of shallow aquifers in the area is alkaline in nature. The TDS value observed between 46.15 to 849.55 mg/l. Nitrate concentration found between 0.17 to 33.94 mg/l within the district.

2.4.1.1 Suitability of ground water of Aquifer – I (shallow aquifer) for drinking purposes: - The suitability of ground water for drinking purposes is determined on the basis of drinking water specification adopted by the Bureau of India Standards IS 10500 – 91 Revised 2012 and approved by World Health Organization (WHO). The number of water samples falling under various categories of permissible and desirable limits of various constituents and its percentage are given in table - 9.

Table - 9: Suitability of ground water of Aquifer- I for drinking purposes

Chemical constituents and quality parameters	**Ranges Desirable**		**No. of samples under desirable limits**	**No. of samples under permissible limit**	**No. of samples under excessive limits**
	Desirable limit	**Permissible limits in the absence of alternate source**			
pH	6.5 to 8.5	No relaxation	42 (100%)	Nil	Nil
TDS (ppm)	500	2000	38 (90.48%)	04 (9.52%)	Nil
TH as $Caco_3$ (ppm)	200	600	32 (76.19%)	10 (23.81)	Nil
Ca (ppm)	75	200	35 (83.33%)	07 (16.67)	Nil
Mg (ppm)	30	100	42 (100%)	Nil	Nil

Cl (ppm)	250	1000	41 (97.62%)	01 (2.38)	Nil
SO_4 (ppm)	200	400	42 (100%)	Nil	Nil
HCO_3 (ppm)	200	600	33 (78.57%)	09 (21.43)	Nil
NO_3 (ppm)	45	No relaxation	42 (100%)	Nil	Nil
F (ppm)	1.0	No relaxation	40 (95.24%)	02 (4.76)	Nil

On the perusal of table – 9, all the water samples are filling in desirable to permissible category. The ground water quality of Aquifer– I of the district is very good and suitable for drinking purposes.

2.4.1.2 Suitability of ground water of Aquifer – I for irrigation purposes: - Apart from domestic consumption, irrigation is consuming a major share of ground water for agricultural activities. The quality of water used for irrigation is an important factor in productivity and quality of irrigated crops. The suitability of water for irrigation purpose depends upon the Total Dissolved Solid in terms of EC value, concentration of Na, bicarbonate and its relative proportion to Mg and Ca. All these mentioned above either individual or with combination create concentration of Sodium (salinity) bicarbonate and alkalis type of hazard.
To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different classifications.

Sodium Percentage classification: -EC and sodium concentration are very important in classifying irrigation water. The salts, besides affecting the growth of the plants directly, also affect soil structure, permeability and aeration, which indirectly affect plant growth. Sodium is a major ion used for the classification of irrigation water due to its reaction with soil that reduces its permeability. Percentage of Na is generally used for assessing the suitability of water for irrigation purposes. Na is expressed as percent sodium or soluble-sodium percentage (Na %) using Eq.

$$Na\ \% = \left(\frac{Na^{+}+K^{+}}{Ca^{2+}+Mg^{2+}\ Na^{+}\ K^{+}}\right) * 100$$

Table- 10: Classification of ground water of Aquifer - I based on sodium percent.

Sl No.	Water class or category	Sodium percent	No. of samples falling	Percentage of samples
1	Excellent	< 20 %	10	23.81%
2	Good	20 – 40 %	24	57.14%
3	Permissible	40 – 60 %	8	19.05%
4	Doubtful	30 – 80 %	Nil	Nil
5	Unsuitable	> 80 %	Nil	Nil

(Where all ions are expressed in epm)

On the perusal of table 10, 100 % of water samples of aquifer – I (dug wells) falling under excellent to permissible category.

Sodium adsorption ratio (SAR): -In assessment of the quality of water used for irrigation, sodium adsorption ratio (SAR) is a vital parameter. Enhanced salinity decreases the osmotic activity of plants as well as stops water to reach to the branches and leaves of plants resulting in inferior production. Moreover, irrigation water with high sodium and low calcium favors ion exchange by saturation of Na and is detrimental to the soil structure due to scattering of clay particles resulting in minor production because of difficulty in cultivation. The sodium adsorption ration is calculated from the ionic concentration of Sodium, calcium and magnesium according the following relationship:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

SAR values can be used to predict the degree to which irrigation water tends to enter into cation exchange section in soil. The higher value of SAR indicates damage of soil. Based on the SAR value the groundwater suitability classification is shown in Table 11 which is showing that all the water samples (100%) of aquifer – I (dug wells) pertain to excellent class.

Table -11: - Classification of ground water of Aquifer – I based on SAR value

Sl No.	Water class	Type of Water	SAR Value	No. of samples falling	Percentage of samples
1	Excellent	Low sodium water	< 10	42	100%
2	Good	Medium sodium water	10 – 18	Nil	Nil
3	Fair	High sodium water	18 – 26	Nil	Nil
4	Poor	Very high sodium water	> 26	Nil	Nil

Residual sodium carbonate content (RSC): -Water containing Co_2 on way gets saturated with Co_2 and forms bicarbonates. The excess bicarbonate of Mg and Ca are precipitated out as carbonates. This produces impermeability to the top soil. Bicarbonate concentration of water has been suggested as additional criteria of suitability for irrigation water. Groundwater samples that had RSC indices of positive value imply that the cumulative concentration of CO_3^{2-} and HCO_3^{2-} is higher than the combined Ca^{2+} and Mg^{2+} concentrations. This would indicate that there is a residual carbonate to react with sodium, presenting sodium hazard to the soil when irrigated with such water. A negative value indicates no residual carbonate. Residual sodium carbonate is determined by using the formula –

$$RSC = (CO_3^{2-} + HCO_3^{2-}) + (Ca^{2+}) + (Mg^{2+}) \quad \ldots\ldots$$

(Where concentration is expressed in epm)

Table- 12: - Classification of ground water of Aquifer – I based on RSC value

Sl No.	RSC (mg/l)	Irrigational suitability	No. of samples falling	Percentage of samples
1	< 1.25	Safe for all type of crops	41	97.62 %
2	1.25 – 2.50	Safe for semi-tolerant to tolerant crops	01	2.38%
3	> 2.50	Safe with application of gypsum of the rate of 8.5g/ham of irrigation water applied for 1.0 ml/liter RSC	Nil	Nil

(All the values are expressed in epm.)

On the perusal of table 12, about 97.62 % of water samples of aquifer - I falling under safe for all type of crops category and rest 2.38% of water samples falling under safe for semi-tolerant to tolerant crops. Classification of irrigation water Piper's diagram is shown below

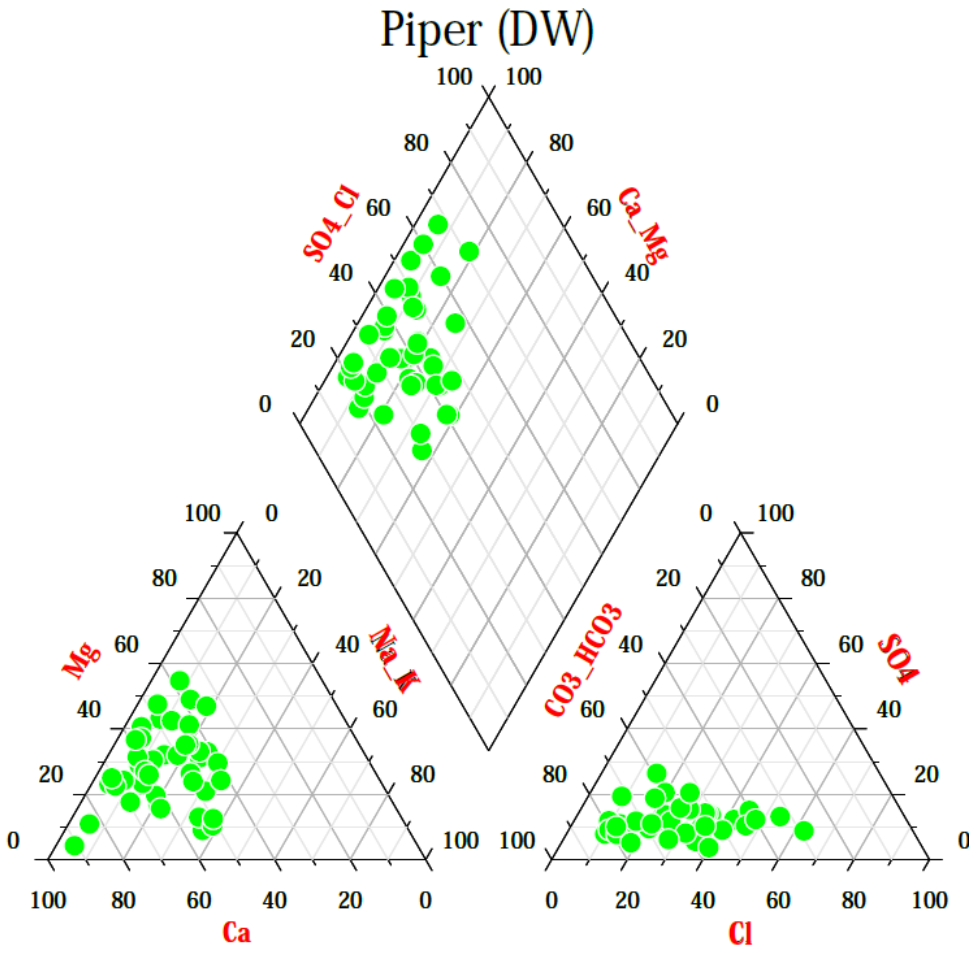


Figure – 10: Piper' diagram for shallow water samples of Simdega district

Classification of Ground water

The Piper diagram is used to categorize the type of water. It comprises of three parts: one diamond shaped diagram in the middle and two trilinear diagrams sideways in the bottom. The comparative concentrations of cations (left diagram) and anions (right diagram) in each sample is depicted in the trilinear diagram. For presenting ions in a piper diagram, the cations are clustered into three major divisions: sodium (Na) plus potassium (K), calcium (Ca), and magnesium (Mg). The anions are likewise grouped into three main categories: bicarbonate (HCO_3^{2-}) plus carbonate (CO_3^{2-})), chloride (Cl^-), and sulfate (SO_4^{2-}). Each sample is denoted by a point in each trilinear diagram; the type of water samples will make the grade according to the symbolic area in piper diagram. Most of the samples from shallow aquifer fall in the region where alkaline earth's ($Ca+HCO_3$) exceed alkali metals ($SO_4^2 + Cl$). This suggests that in the study area shallow aquifer is dominated by Ca-HCO3 type water.

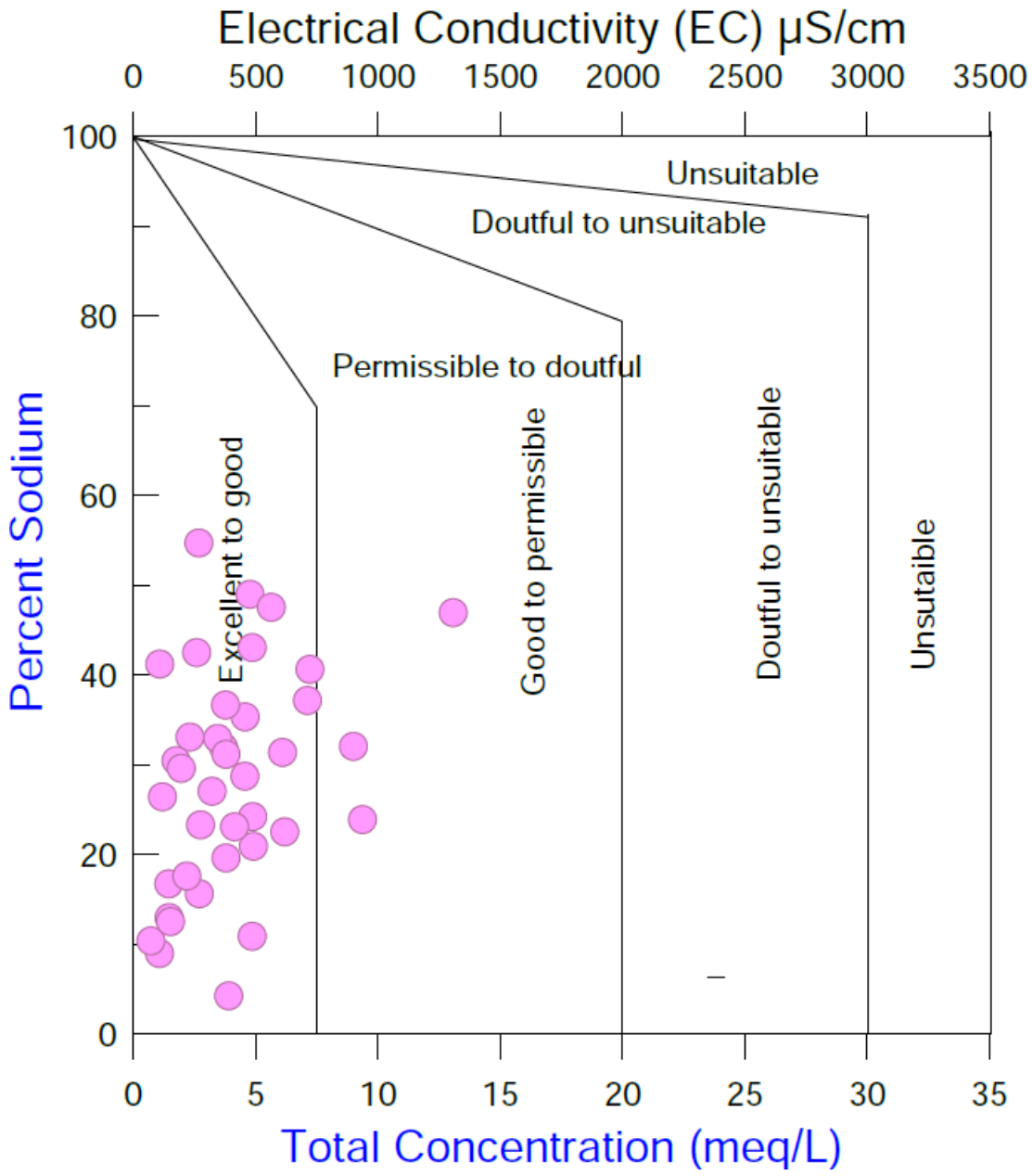
Suitability of ground water based on Electrical Conductivity (EC): - Wilcox 1948 suggested a water class classification for suitability of water for irrigation. The classification is given below as a table- 13.

Table - 13: - Classification of ground water of Aquifer - I based on electrical conductivity (EC)

Sr. No.	Water Class	Rages of EC	No. of samples falling	Percentage of samples
1	Excellent	< 250	12	28.57%
2	Good	250 – 750	26	61.90%
3	Permissible	750 – 2250	04	9.52%
4	Doubtful	2250 – 3000	Nil	Nil
5	Unsuitable	> 3000	Nil	Nil

On The perusal of table 13, about 28.57 % of samples falling under excellent water class and 61.90 % of water samples of Aquifer – I (dug wells) falling under good water class. Rest about 9.52 % of water samples falling under permissible water class.

EC maps of dug well samples i.e. Aquifer – I has been prepared and shown in figures- 10. The values for sodium percentage, SAR, RSC and EC of water samples Aquifer – I collected from dug wells are given in Table – 14.



Plot of sodium percent versus electrical conductivity (after Wilcox 1955)

Figure- 11: EC map of Aquifer – I of Simdega district

Table - 14: Values of Sodium percentage, SAR, RSC and EC of water samples collected from Aquifer – I (Dug wells) Simdega district.

Sr. No.	Village	Block	District	Na%	SAR	RSC	EC
1	Konsode	Bano	Simdega	16.75	0.28	0.01	144
2	Bano	Bano	Simdega	43.08	1.69	0.23	485
3	Lachragarh	Kolebira	Simdega	40.66	1.91	-1.07	721
4	Jaldega	Jaldega	Simdega	32.08	1.61	-2.76	899
5	Bansjor	Bansjor	Simdega	8.977	0.06	-0.19	106
6	Kulamara	Bansjor	Simdega	49.02	2.03	1.33	476
7	Gangu Toli	Jaldega	Simdega	31.94	1.01	-0.18	368
8	Hatinghode	Bano	Simdega	19.63	0.57	-0.97	378
9	Orga	Jaldega	Simdega	32.95	1.04	-1.19	344
10	Gerda	Bano	Simdega	28.75	0.75	-1.57	455
11	Kohipat	Bano	Simdega	37.19	1.50	-2.07	711
12	Nawamile Paro	Bano	Simdega	15.64	0.37	-0.49	269
13	Amba Toli	Kolebira	Simdega	31.19	1.03	-0.89	378
14	Kolomdega	Jaldega	Simdega	26.45	0.48	-0.19	118
15	Lomboi	Jaldega	Simdega	33.11	0.88	-0.19	231
16	Pandripani	Thetaitangar	Simdega	12.97	0.19	-0.49	145
17	Biru	Simdega	Simdega	17.61	0.18	-0.19	218
18	Kolebira	Kolebira	Simdega	47.58	2.09	-1.08	563
19	Putri Toli	Kolebira	Simdega	10.38	0.07	-0.30	71
20	Baribiringa	Jaldega	Simdega	10.9	0.35	-0.25	485
21	Mama Bhagina	Jaldega	Simdega	12.53	0.12	-0.49	151
22	Kereya	Thetaitangar	Simdega	54.74	1.81	0.51	267
23	Devbahar	Thetaitangar	Simdega	42.53	1.24	0.62	258
24	Thethaitangar	Thetaitangar	Simdega	30.48	0.61	0.21	174
25	Taraboga	Thetaitangar	Simdega	23.33	0.62	-1.09	274
26	Koronjo	Bolba	Simdega	24.24	0.81	0.34	487
27	Bolba	Bolba	Simdega	31.41	1.12	-1.57	609
28	Khanda Nishan	Bolba	Simdega	4.25	0.07	-0.66	389
29	Kersai	Kersai	Simdega	46.97	3.20	-3.26	1307
30	Paikpara	Thetaitangar	Simdega	20.93	0.75	-1.37	490
31	Lathakhamhan	Thetaitangar	Simdega	41.24	0.83	0.01	107
32	Simdega	Simdega	Simdega	35.36	1.30	-0.87	456
33	Belgarh	Simdega	Simdega	27.07	0.46	-0.69	321
34	Dumardih (Bhelwa Toli)	Kurdeg	Simdega	36.69	1.21	0.73	376
35	Kurdeg	Kurdeg	Simdega	23.11	0.75	-0.37	413
36	Gariyajor	Kurdeg	Simdega	23.91	1.12	-2.05	936
37	Kinkel	Kersai	Simdega	22.55	0.85	-1.16	618
38	Banabira	Simdega	Simdega	29.62	0.61	-0.29	195
39	Sewai	Simdega	Simdega	25.01	1.17	-1.62	860
40	Ludi Bahar	Simdega	Simdega	25.97	0.98	-0.26	563
41	Kobang	Pakartarn	Simdega	35.11	1.25	-0.67	468
42	Kurushkela	Simdega	Simdega	24.25	0.40	-0.30	118

2.4.2 General range of chemical parameter of Aquifer - II in the area: - The variation range of the concentration in ppm of different chemical constituents and quality parameters of Aquifer - II (hand pumps samples) represented in tables 15.

Table- 15: Ranges of chemical constituents of Aquifer - II in Simdega district (hand pump samples)

Chemical Constituents and quality parameters	**Ranges of the concentration(in ppm)**	
pH	6.77	7.70
EC (micro siemens/cm at 25^0c)	133	1127
TDS (ppm)	86.45	732.55
TH as $CaCo_3$ (ppm)	55	500
Ca (ppm)	12	160
Mg (ppm)	1.22	30.40
Na (ppm)	4.59	68.72
K (ppm)	0.21	19.13
HCO_3 (ppm)	61.50	393.60
Cl (ppm)	3.54	113.44
SO_4 (ppm)	6.33	63.9
NO_3 (ppm)	0	29.10
F (ppm)	BDL	3.87

The ground water of aquifer - II in the area is alkaline in nature. On the perusal of table - 19, the pH value ranges 6.77 to 7.70 mg/l. The EC value ranges between 133 to 1127 mg/l. Overall in the district, the TDS value varies from 86.45 to 732.55 mg/l. and the total hardness ranges between 55 to 500 mg/l. Calcium and Magnesium values varies from 12 to 160 mg/l and 1.22 to 30.40 mg/l respectively. Similarly, the Nitrate value ranges from 0 to 29.10 mg/l while Fluoride value found between 0 to 3.87 mg/l.

2.4.2.1 Suitability of ground water of Aquifer – II (deeper aquifers) for drinking purposes: - To know the ground water quality of Aquifer - II, water samples were collected from bore wells (Hand pump). The number of water samples falling under various categories of permissible and desirable limits of various constituents and its percentage are given in table - 16.

Table - 16: Suitability of ground water of Aquifer- II for drinking purposes

Chemical constituents and quality parameters	Ranges Desirable		No. of samples under desirable limits	No. of samples under permissible limit	No. of samples under excessive limits
	Desirable limit	Permissible limits in the absence of alternate source			
pH	6.5 to 8.5	No relaxation	42 (100%)	Nil	Nil
TDS (ppm)	500	2000	39 (92.86%)	03 (7.14%)	Nil
TH as $Caco_3$ (ppm)	200	600	35 (83.33%)	07 (16.67)	Nil
Ca (ppm)	75	200	36 (85.71%)	06 (14.29%)	
Mg (ppm)	30	100	40 (95.24%)	02 (4.76%)	
Cl (ppm)	250	1000	42 (100%)	Nil	Nil
SO_4 (ppm)	200	400	42 (100%)	Nil	Nil
HCO_3 (ppm)	200	600	35 (83.33%)	07 (16.67)	Nil
NO_3 (ppm)	45	No relaxation	42 (100%)	Nil	Nil
F (ppm)	1.0	No relaxation	30 (71.42%)	06 (14.29%)	06 (14.29%)

On the perusal of table – 16, it is observed that about 100% ground water samples of aquifer – II falling under desirable limits to permissible limits category except Fluoride. The Fluoride value is found beyond permissible limit in 06 samples (14.29%). Overall, the ground water quality of Aquifer – II of the district is good and suitable for drinking purposes.

2.4.2.2 Suitability of ground water of Aquifer – II for irrigation Purposes: To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different classifications.

Sodium Percentage classification: - Sodium content is usually expressed estimated using the formula –

Sodium percent $= \left(\frac{Na^{+}+K^{+}}{Ca^{2+}+Mg^{2+}\,Na^{+}\,K^{+}}\right) * 100$ …….

Table- 17: Classification of ground water of Aquifer - II based on Na%

Sl No.	Water class or category	Sodium percent	No. of samples falling	Percentage of samples
1	Excellent	< 20 %	09	21.43%
2	Good	20 – 40 %	30	71.43%
3	Permissible	40 – 60 %	03	7.14%
4	Doubtful	30 – 80 %	Nil	Nil
5	Unsuitable	> 80 %	Nil	Nil

(Where all ions are expressed in lpm or epm)

From Table 17, about 21.43 % of water samples of aquifer – II falling in excellent water class. About 71.43 % of water samples falling in good water class. Only 7.14 % of water sample (03 No.) falling under permissible category.

Sodium adsorption ratio (SAR): - The sodium adsorption ration is calculated from the ionic concentration of Sodium, calcium and magnesium according the following relationship:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$$

Ground water classification into four classes based on SAR value is given in table- 18 which is showing that all the water samples (100%) of aquifer - II falling under excellent water class.

Table - 18: - Classification of ground water of Aquifer – II based on SAR value

Sl No.	Water class	Type of Water	SAR Value	No. of samples falling	Percentage of samples
1	Excellent	Low sodium water	< 10	42	100%
2	Good	Medium sodium water	10 – 18	Nil	Nil
3	Fair	High sodium water	18 – 26	Nil	Nil
4	Poor	Very high sodium water	> 26	Nil	Nil

(Where all ions expressed in lpm)

Residual sodium carbonate content (RSC): Residual sodium carbonate is determined by using the formula

$$RSC = (CO_3^{2-} + HCO_3^{2-}) + (Ca^{2+}) + (Mg^{2+}) \quad \ldots\ldots$$

(Where concentration is expressed in epm)

Table - 19: - Classification of ground water of Aquifer – II based on RSC value

Sl No.	RSC (mg/l)	Irrigational suitability	No. of samples falling	Percentage of samples
1	< 1.25	Safe for all type of crops	42	100 %
2	1.25 – 2.50	Safe for semi-tolerant to tolerant crops	Nil	Nil
3	> 2.50	Safe with application of gypsum of the rate of 8.5g/ham of irrigation water applied for 1.0 ml/liter RSC	Nil	Nil

(All the values are expressed in lpm or epm)

On the perusal of table - 19, 100 % of water samples of aquifer - II falling under safe for all type of crops category. Classification of irrigation water modified Piper's diagram is shown below in figure – 11.

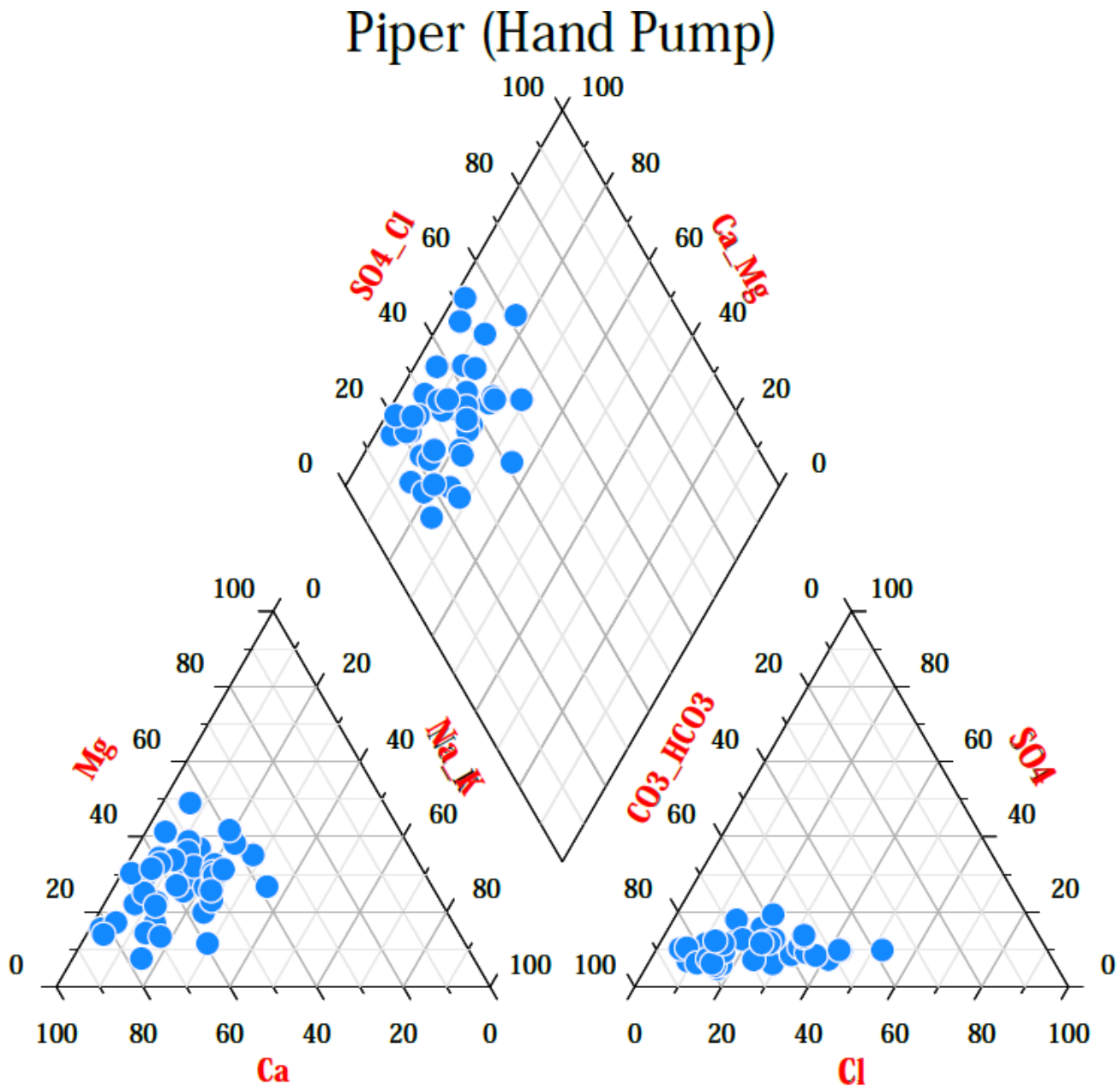


Figure – 12: Piper' diagram for deeper water samples of Simdega district

Piper diagram revealed that 64% belong to calcium-bicarbonate (Ca-HCO3) hydrochemical facies. This suggests that in the study area deeper aquifer is dominated by Ca-HCO3 type water.

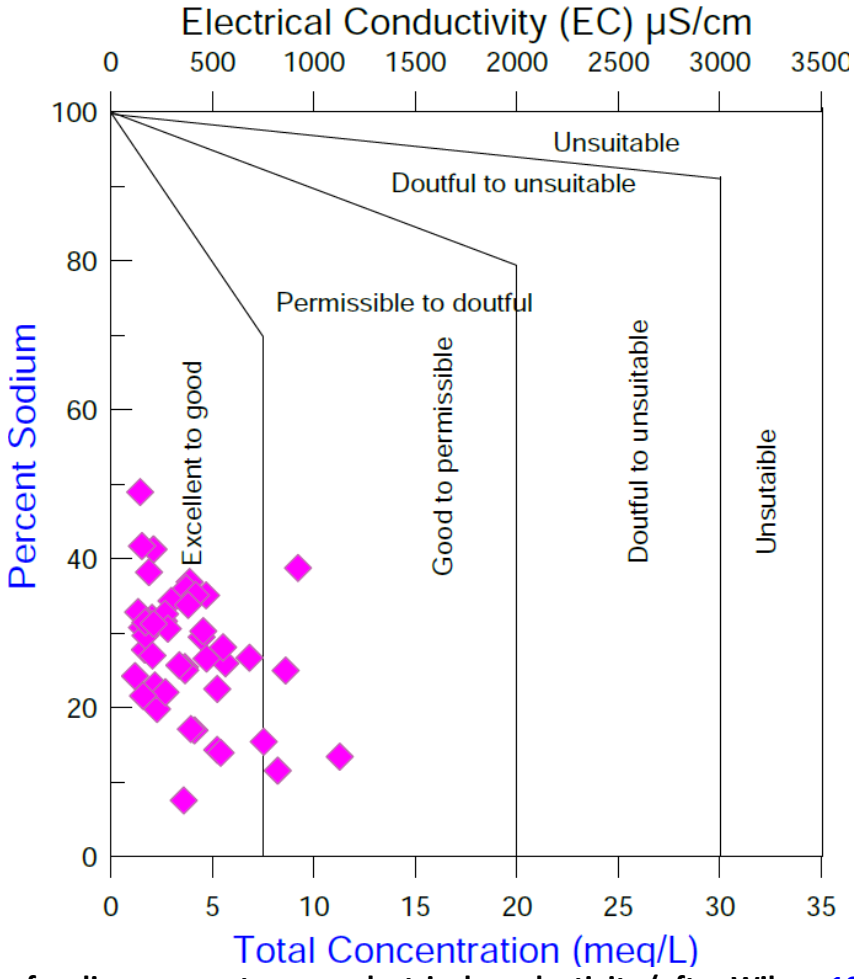
Suitability of ground water based on Electrical Conductivity (EC): - Wilcox 1948 suggested a water class classification for suitability of water for irrigation. The classification is given below as a table - 20.

Table - 20: - Classification of ground water of Aquifer - II based on (EC)

Sl No.	Water Class	Rages of EC	No. of samples falling	% of samples
1	Excellent	< 250	15	35.71%
2	Good	250 – 750	23	54.76%
3	Permissible	750 – 2250	04	9.52%
4	Doubtful	2250 – 3000	Nil	Nil
5	Unsuitable	> 3000	Nil	Nil

On The perusal of table 20, about 35.71 % of samples falling under excellent water class and 54.76 % of water samples of Aquifer – II (dug wells) falling under good water class. Rest about 9.52 % of water samples falling under permissible water class.

EC maps of dug well samples i.e. Aquifer – II has been prepared and shown in figures- 12. The values for sodium percentage, SAR, RSC and EC of water samples of Aquifer – II collected from hand pumps are given in table – 21.



Plot of sodium percent versus electrical conductivity (after Wilcox 1955)

Figure- 13: EC map of Aquifer – II of Simdega district

Table - 21: Values of Sodium Percentage, SAR, RSC AND EC of water samples collected from Aquifer – II (Hand pumps), Simdega district

Sr. No.	Village	Block	District	Na%	SAR	RSC	EC
1	Konsode	Bano	Simdega	19.82	0.48	-0.09	226
2	Bano	Bano	Simdega	23.01	0.56	0.01	216
3	Lachragarh	Kolebira	Simdega	15.44	0.64	-3.26	752
4	Jaldega	Jaldega	Simdega	34.37	0.96	0.42	297
5	Bansjor	Bansjor	Simdega	36.91	1.24	0.52	387
6	Kulamara	Bansjor	Simdega	22.52	0.77	-1.77	523
7	Gangu Toli	Jaldega	Simdega	16.96	0.50	-0.77	411
8	Hatinghode	Bano	Simdega	14.34	0.46	-0.86	523
9	Orga	Jaldega	Simdega	25.47	0.78	-1.39	364
10	Gerda	Bano	Simdega	7.549	0.15	-0.77	358
11	Kohipat	Bano	Simdega	17.15	0.45	-0.67	393
12	Nawamile Paro	Bano	Simdega	22.10	0.54	-0.08	268
13	Amba Toli	Kolebira	Simdega	48.98	1.17	0.41	143
14	Kolomdega	Jaldega	Simdega	27.82	0.55	0.01	166
15	Lomboi	Jaldega	Simdega	25.04	0.76	0.03	365
16	Pandripani	Thetaitangar	Simdega	29.49	1.02	-0.57	446
17	Biru	Simdega	Simdega	41.29	1.10	-0.29	209
18	Kolebira	Kolebira	Simdega	38.78	1.80	-0.45	921
19	Putri Toli	Kolebira	Simdega	30.78	0.55	0.11	152
20	Baribiringa	Jaldega	Simdega	13.95	0.45	0.04	540
21	Mama Bhagina	Jaldega	Simdega	36.06	1.16	-0.28	370
22	Kereya	Thethaitangar	Simdega	35.13	1.22	0.22	417
23	Devbahar	Thethaitangar	Simdega	31.64	0.90	0.02	260
24	Thethaitangar	Thethaitangar	Simdega	26.61	0.92	-0.57	470
25	Taraboga	Thethaitangar	Simdega	32.08	0.75	0.11	201
26	Koronjo	Bolba	Simdega	32.61	0.91	0.42	266
27	Bolba	Bolba	Simdega	28.11	1.05	-0.87	552
28	Khanda Nishan	Bolba	Simdega	30.62	0.79	-0.09	280
29	Kersai	Kersai	Simdega	38.21	1.01	-0.39	187
30	Paikpara	Thethaitangar	Simdega	33.81	1.11	-0.18	380
31	Lathakhamhan	Thethaitangar	Simdega	30.3	1.06	0.04	454
32	Simdega	Simdega	Simdega	29.70	0.65	-0.19	169
33	Belgarh	Simdega	Simdega	32.87	0.64	0.11	133
34	Dumardih (Bhelwa Toli)	Kurdeg	Simdega	31.51	0.64	0.11	169
35	Kurdeg	Kurdeg	Simdega	25.71	0.74	-0.28	336
36	Gariyajor	Kurdeg	Simdega	13.42	0.65	-3.53	1127
37	Kinkel	Kersai	Simdega	11.55	0.48	-3.96	821
38	Banabira	Simdega	Simdega	41.72	0.94	0.12	152
39	Sewai	Simdega	Simdega	26.71	1.15	-1.26	682
40	Ludi Bahar	Simdega	Simdega	27.03	0.64	-0.48	204
41	Kobang	Pakartarn	Simdega	31.28	0.76	-0.49	210
42	Kurushkela	Pakartarn	Simdega	21.62	0.41	-0.19	157

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various aquifer characteristic maps on hydrogeology, aquifer wise water level scenario both current and long term scenarios, aquifer wise ground water quality, 2-D and 3-D sub surface disposition of aquifers by drawing fence and lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated which has been discussed in details.

3.1 Aquifer Disposition

3.1.1 Hydrogeological Cross Section: To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' (south west – north east direction in middle part), B-B' (west – east direction in middle part) and C-C' (west - east direction middle to northern part).

3.1.1.1 Hydrogeological cross section A-A': Hydrogeological cross section A-A' represents the area in SW – NE direction in portion of the district. The data of 5 exploratory wells i.e. Auga, Taraboga, Pandripanii, Tutikel and Kuladurum have been utilised. The Aquifer- I ranges 9.00 – 23.89 m representing weathered Granite Gneiss, while Aquifer-II ranges from 18.00 – 136.00 m representing fractured Granite Gneiss. Generally 1- 2 fracture zones were encountered. Location map of cross section is shown in figure – 14. Hydrogeological cross section of A-A' is shown in figure- 15 .

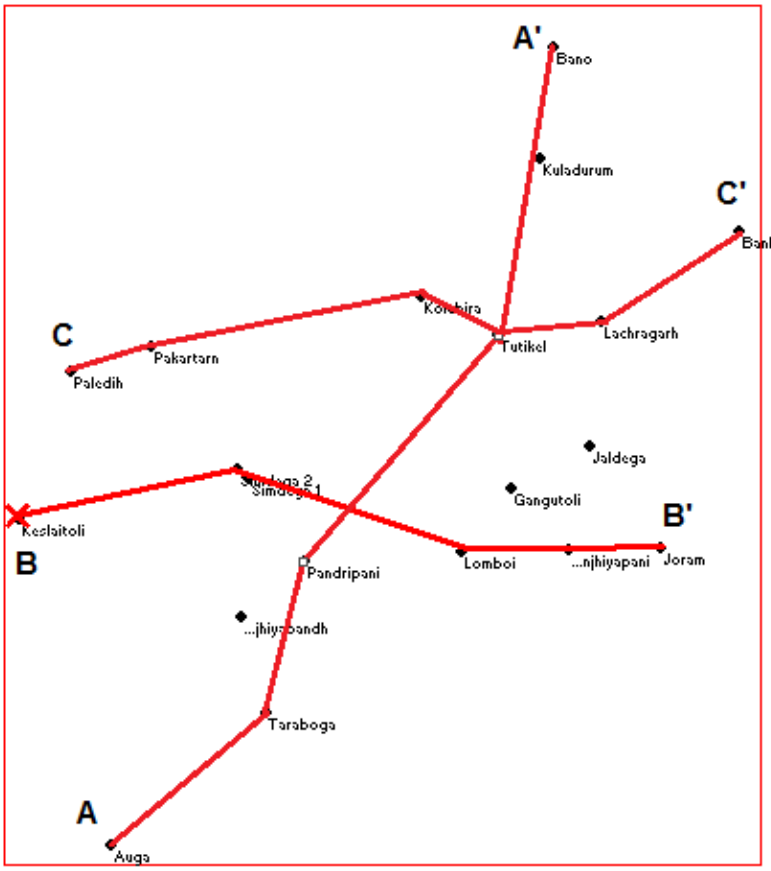


Figure – 14 : Location map of cross section

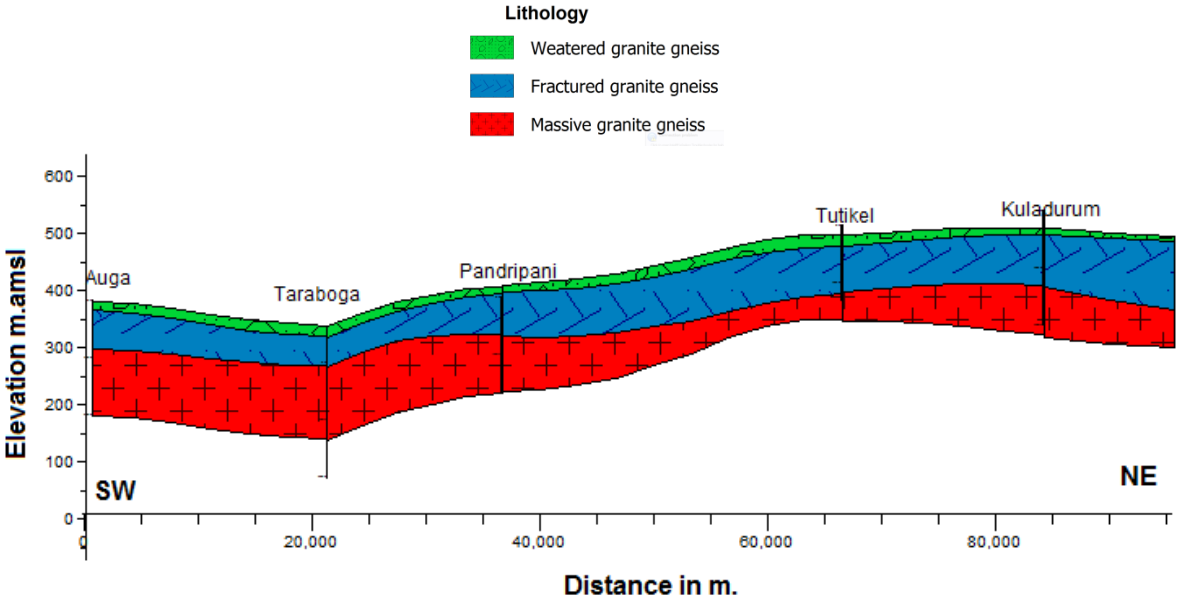


Figure – 15 : Hydrogeological cross section along A – A'

3.1.1.2 Hydrogeological cross section B – B': Hydrogeological cross section B-B' represents the area in central part of Simdega district. The data of 4 exploratory wells i.e. Keslaitoli, Pakartarn, Simdega2, Lomboi and Binjhiyapani have been utilised. The Aquifer- I ranges 5.50 – 18.31 m representing weathered Granite Gneiss, while Aquifer-II ranges from 11.50 – 182.50 m representing fractured Granite Gneiss. Generally 1 - 2 fracture zones were encountered. However, this section well yield varies from 0.13 – 3.00 lps. Hydrogeological cross section of B-B' is shown in figure - 16.

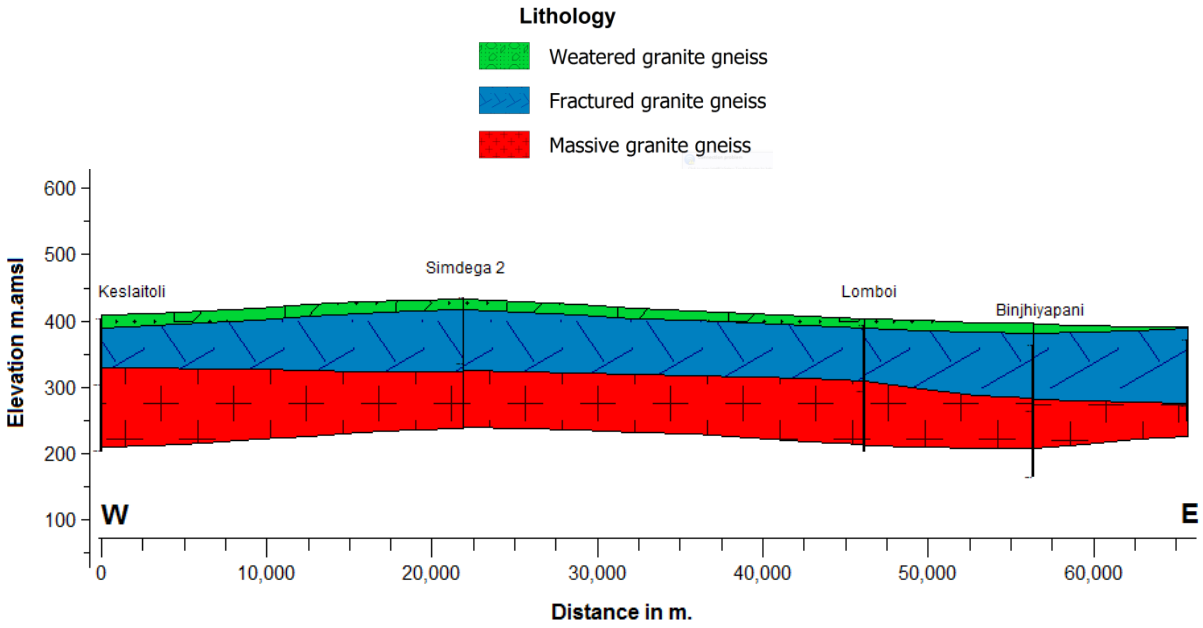


Figure – 16: Hydrogeological cross section along B – B'

3.1.1.3 Hydrogeological cross section C – C': Hydrogeological cross section C-C' represents the area in central part of Simdega district. The data of 6 exploratory wells i.e. Paledih, Pakartarn, Kolebira, Tutike, Lachragarh and Banki have been utilised. The Aquifer- I ranges 5.50 – 18.31 m representing weathered Granite Gneiss, while Aquifer-II ranges from 15.00 – 131.50 m representing fractured Granite Gneiss. Generally 1 - 2 fracture zones were encountered. However, this section well yield varies from 0.13 – 25.00 lps. Hydrogeological cross section of B-B' is shown in figure - 17

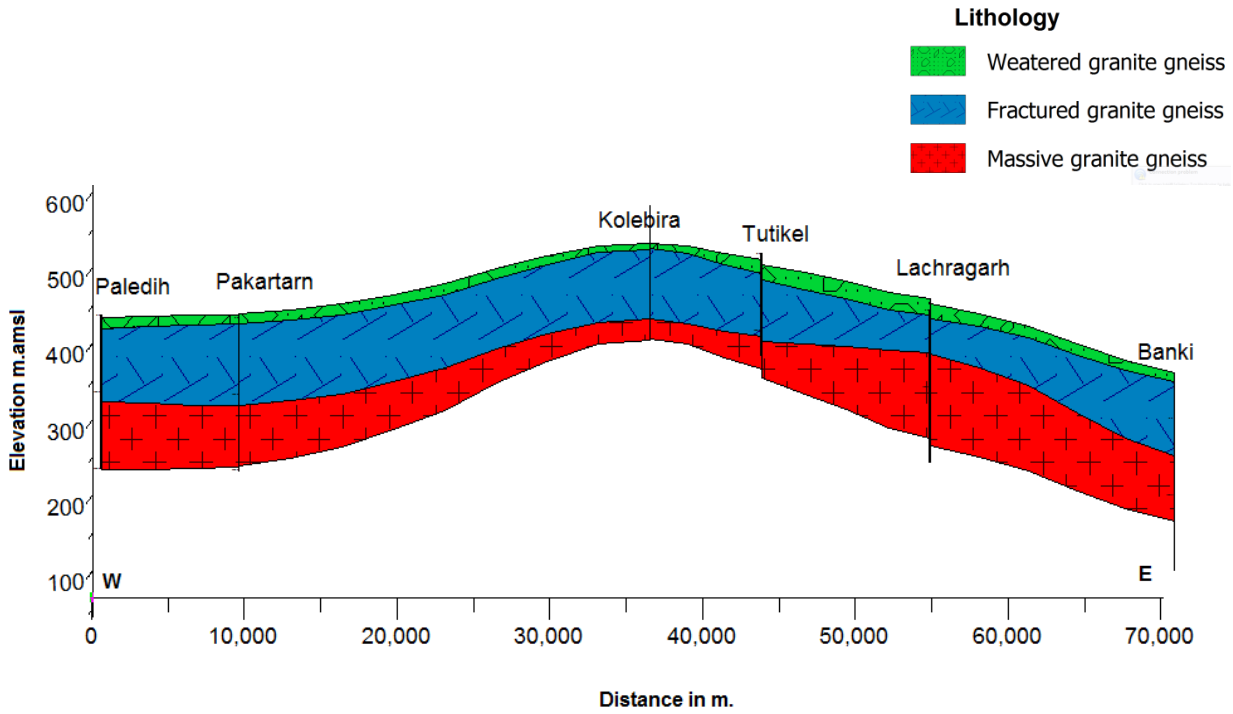


Figure – 17: Hydrogeological cross section along C – C'

3.1.2 2-D & 3-D and Aquifer Disposition: The 3-D map in hard rock area of the district showing spatial disposition and vertical extent of Aquifer-I indicating its depth of weathering while the Aquifer – II showing occurrence of fractured rock thickness is presented in **figures – 13**. Based on the drilling data of exploratory wells maximum thickness of Aquifer - I (weathered zone) in **hard rock area** is 25.0 m. The depth of Aquifer – II (fracture zone) ranges from 11.00 to 182.50 mbgl.

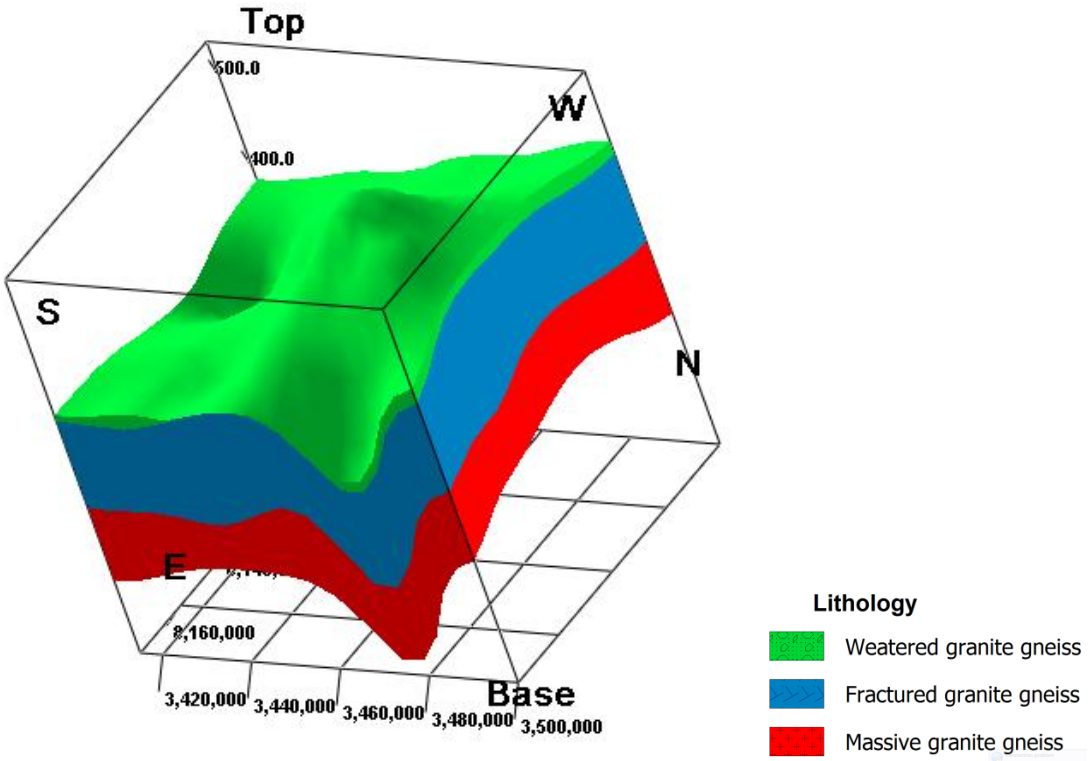


Figure – 18: 3D subsurface lithological models with Aquifer Disposition in hard rock areas of Simdega district

3.2 Aquifer Characteristics: - The sustainability of ground water Resources is better understood by the aquifer properties. The Table - 22 depicts the aquifer parameters details in Simdega district. The aquifer performance tests conducted at various exploratory wells reveal that aquifers can sustain to sufficient pumping hours and can give sustained yield with normal draw down.

Table 22: Aquifer characteristics of Simdega district

Type of aquifer	**Formation**	**Depth range of the aquifer (mbgl)**	**SWL (mbgl)**		**Thickness (m)**	**Yield (m^3/hr)**	**Aquifer parameter**	
			Pre Monsoon (2021)	**Post Monsoon (2021)**			**T (m^2/day)**	Sy/**S**
Aquifer - I	Weathered Granite gneiss	5.00 – 30.00	2.20 – 10.85	0.64 – 7.47	1- 10	Upto 10	--	--
Aquifer - II	Fractured Granite gneiss	9.00 – 182.50	--	--	0.50 – 6.50	0.47 – 72.00	3.27 – 193.19	0.0000052 – 0.012

3.3 Aquifer Map: Based on Aquifer Disposition, Aquifer Geometry, Aquifer Characteristics, Aquifer Maps in Simdega district have been prepared as under

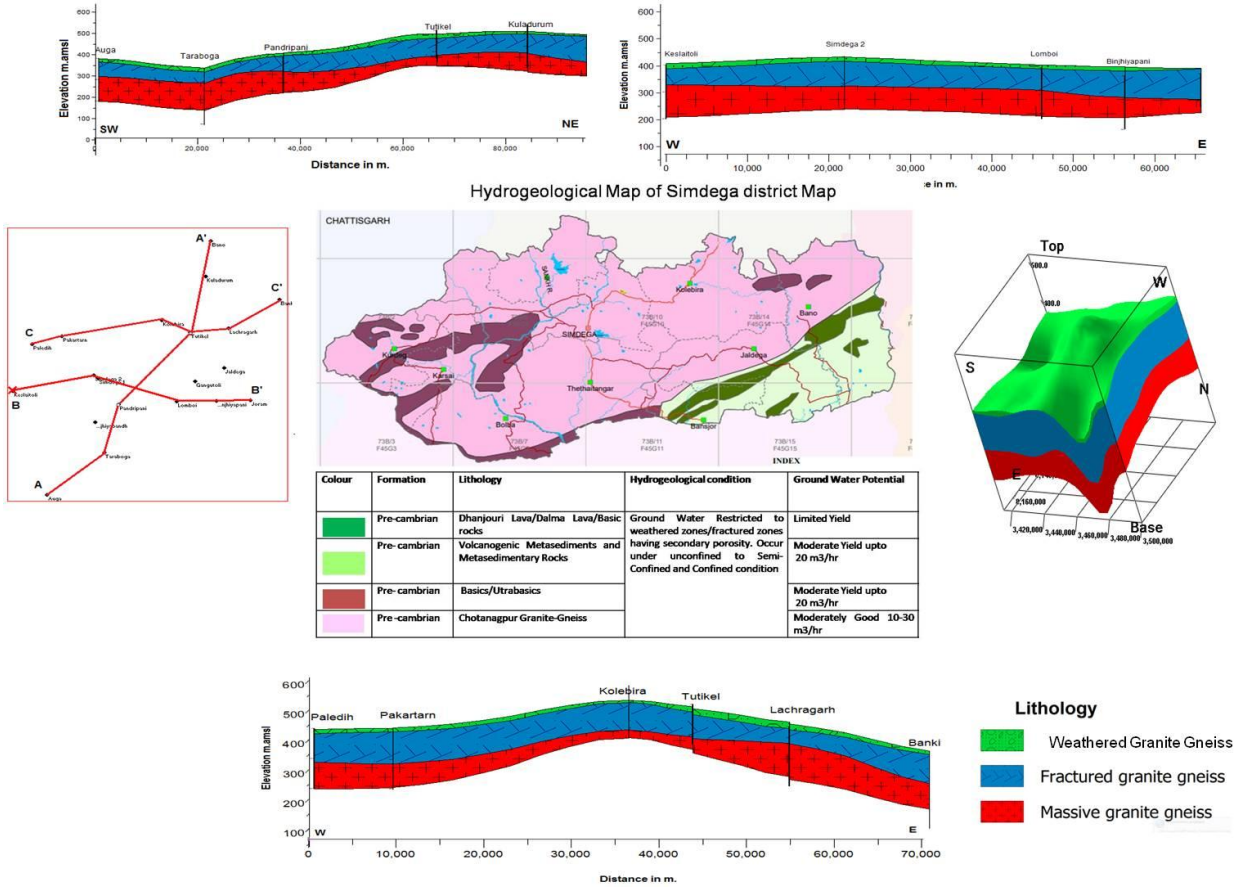


Fig:19 Aquifer Maps, Simdega district, Jharkhand

4. GROUND WATER RESOURCE

Ground Water Resource of the area has been estimated block wise based on for base year as on 31st March-2020. In the present report GEC 2015 methodology has been used and based on the assessment has been made using appropriate assumptions. This methodology recommends aquifer wise ground water resource assessment of both the Ground water resources components, i.e., Replenishable ground water resources or Dynamic Ground Water Resources and In-storage Resources or Static Resources. The assessment of ground water includes assessment of dynamic and in-storage ground water resources, but the development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

4.1 Assessment of Annually Replenishable or Dynamic Ground Water Resources (Unconfined Aquifer i. e Aquifer-I)

The methodology for ground water resources estimation is based on the principle of water balance as given below –

Inflow – Outflow = Change in Storage (of an aquifer)

The equation can be further elaborated as

ΔS= RRF+RSTR+RC+RSWI+RGWI+RTP+RWCS±VF ± LF -GE-T-E-B

Where,

ΔS – Change is storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels

RC – Recharge from canals, RSWI – Recharge from surface water irrigation

RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks& Ponds

RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow), GE-Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

The dynamic Ground Water Resources has been assessed by CGWB, SUO, Ranchi in association with State Ground Water Directorate, Jharkhand based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of Simdega district is in Table-23.

Table-23: Dynamic Ground Water Resources of Simdega district (As on 31st March -2020)

S. No.	Items	
1	Area in ha	375229
2	Annual Extractable Ground Water Recharge in ham	21416.22
3	Current Annual Ground Water Extraction for irrigation in ham	1807
4	Current Annual Ground Water Extraction for domestic in ham	840.77
5	Current Annual Ground Water Extraction for industrial in ham	0
6	Current Annual Ground Water Extraction for All uses in ham	2647.78
7	Annual GW Allocation for Domestic Use as on 2025 in ham	846.62
8	Net Ground Water Availability for future use in ham	18762.58
9	Stage of Ground Water Development (%)	12.08

4.1.1 Recharge Component: During the monsoon season, the rainfall recharge is the main recharge parameter, which is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying groundwater level fluctuation between pre and post monsoon periods with the area of assessment and specific yield. Monsoon recharge can be expressed as:-

$R = h \times Sy \times A + DG$

Where,

h = rise in water level in the monsoon season, Sy = specific yield

A = area for computation of recharge, DG = gross ground water draft

The monsoon ground water recharge has two components- rainfall recharge and recharge from other sources. The other sources of groundwater recharge during monsoon season include seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, and water conservation structures. During the non-monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-monsoon recharge.

The season wise assessment of recharge from various components such as rainfall and other sources was done and presented in table - 24 and figure - 20. The recharge from rainfall contributes maximum component 21266.69 ham during monsoon season and recharge from other sources is 548.75 ham, whereas during non-monsoon season, recharge from rainfall is 837.59 and the recharge from other sources is 586.73 ham. The total annual ground water recharge is 23239.76 ham and total natural discharge is 1823.54 ham. Annual extractable ground water resource after natural discharge is estimated as 21416.22 ham.

Table – 24: Recharge Components evaluated for Resource Estimation: Simdega district

Block	Recharge from rainfall during monsoon season (ham)	Recharge from other sources during monsoon season (ham)	Recharge from rainfall during non monsoon season (ham)	Recharge from other sources during non monsoon season (ham)	Total annual ground water recharge (ham)	Total Natural Discharges (ham)	Annual Extractable Ground Water Resource (ham)
Bano	3116.4	55.46	128.3	54.13	3354.29	167.71	3186.58
Bansjor	880.45	16.31	36.88	10.18	943.6	94.36	849.24
Bolba	1126.63	41.42	46.91	55.58	1270.54	127.06	1143.48
Jaldega	2291.86	50.87	95.42	39.48	2477.63	247.76	2229.87
Kersai	1046.49	23.30	43.57	25.63	1138.99	113.9	1025.09
Kolebira	2714.48	53.24	103.36	78.33	2949.41	147.47	2801.94
Kurdeg	1100.57	53.87	45.82	39.82	1240.08	124	1116.08
Pakartarn	1728.77	28.01	71.98	31.19	1859.95	186	1673.95
Simdega	3445.63	67.25	106.71	85.26	3704.85	185.24	3519.61
Thethaitangar	3815.41	159.02	158.86	167.13	4300.42	430.04	3870.38
Total	**21266.69**	**548.75**	**837.59**	**586.73**	**23239.76**	**1823.54**	**21416.22**

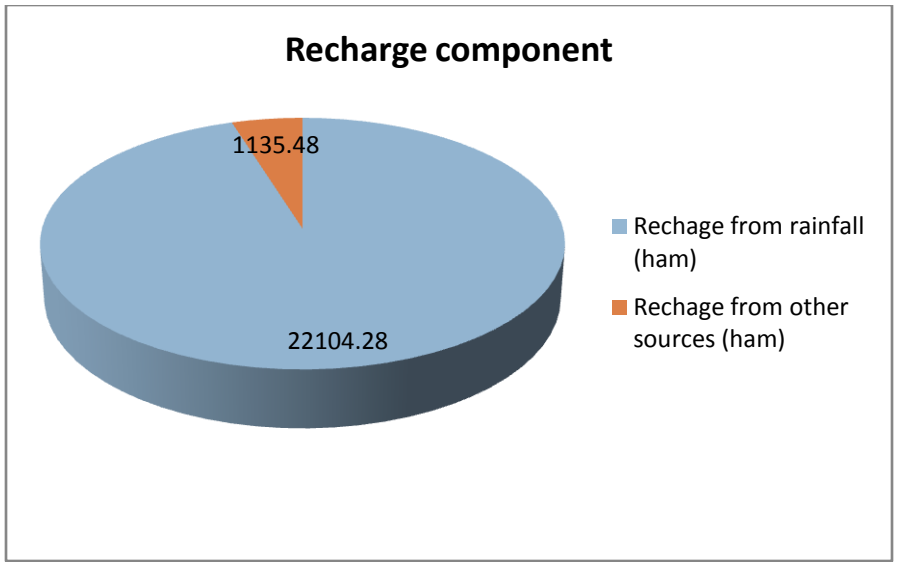


Figure – 20: Recharge from various sources

4.1.2 Ground Water Availability, Draft and Stage of GW development

The utilization of available ground water resources for various purposes is provided in table – 25 (As on 31st March 2020). The annual gross draft for all uses is estimated at 2647.78 ham with domestic sector being the major consumer having a draft of 840.75 ham. The annual draft for irrigation use was estimated 1807 ham. The allocation of net ground water available for future use is 18762.58 ham. The stage of ground water development is very low i.e., 12.08%.

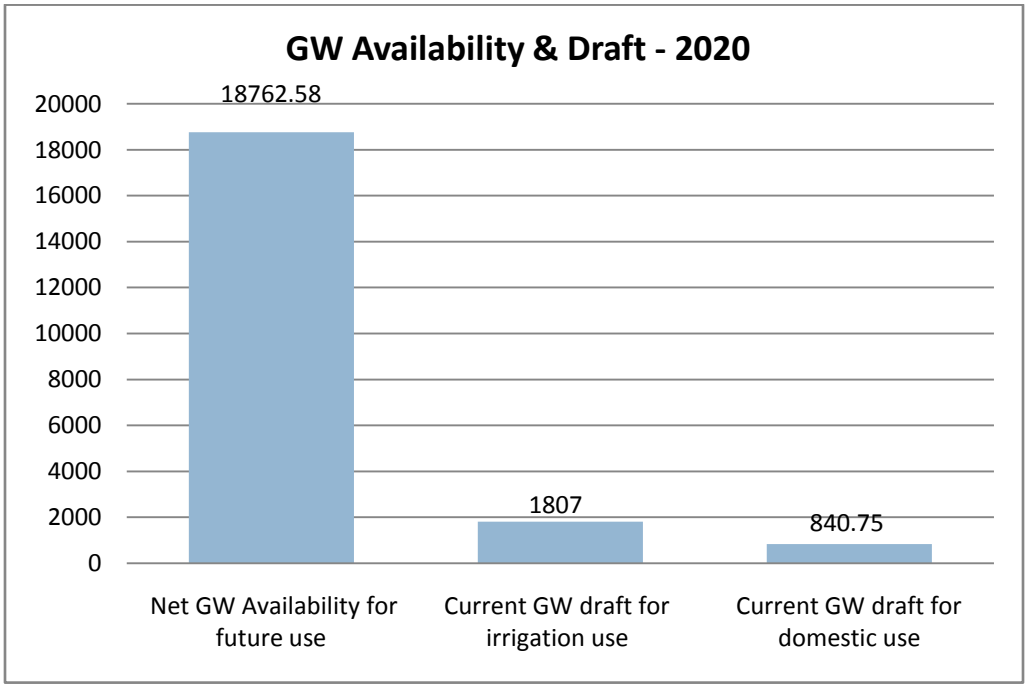


Figure – 21: Net GW Availability & Draft of Simdega district (2020)

Table – 25: Block wise dynamic ground water resource of Simdega district (As on 31st March 2020)

Assessment Units (block)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use	Ground Water Extraction for Domestic Use	Ground Water Extraction for Industrial Use	Total Extraction for all uses	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)
	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
Bano	3186.58	113	106.17	0	219.17	2966.68	6.88
Bansjor	849.24	4.5	33.67	0	38.18	810.82	4.50
Bolba	1143.48	176	40.62	0	216.63	926.56	18.94
Jaldega	2229.87	242.5	84.83	0	327.33	1901.95	14.68
Kersai	1025.09	51.5	51.75	0	103.25	921.48	10.07
Kolebira	2801.94	274.5	94.06	0	368.57	2432.71	13.15
Kurdeg	1116.08	125.5	63.32	0	188.82	926.82	16.92
Pakartarn	1673.95	64	49.49	0	113.49	1560.11	6.78
Simdega	3519.61	250	201.43	0	451.43	3066.78	12.83
Thethaitangar	3870.38	505.5	115.41	0	620.91	3248.67	16.04
Total	**21416.22**	**1807**	**840.75**	0	**2647.78**	**18762.58**	**Avg. 12.08**

4.2 Assessment of In-Storage Ground Water Resources or Static Ground Water Resources (Unconfined Aquifer i.e Aquifer-I)

The computation of the static or in-storage ground water resources is done after delineating the aquifer thickness and specific yield of the aquifer material.
The computations can be done as follows:-

SGWR = A *(Z2 - Z1) * SY
Where, SGWR = Static or in-storage Ground Water Resources
A = Area of the Assessment Unit, Z2 = Bottom of Unconfined Aquifer, Z1 = Pre-monsoon water level, SY = Specific Yield in the In storage Zone

For Aquifer I in hard rock area of Simdega district

AQUIFER I	
Area (A) (sq. km)	3090.60
Pre-monsoon (average) depth to water level (mbgl) (Z1)	6.01
Bottom of Unconfined Aquifer (mbgl) (Z2)	14.36
Specific yield (Sy)	3%
Saturated zone thickness (Z2-Z1) of aquifer (ST)	8.35
SGWR = A *(Z2 - Z1) * SY	774.20 mcm

4.3 Assessment of Total Ground Water Availability in Unconfined Aquifer (Aquifer-I)

The sum of Annual Extractable Ground Water Recharge and the in - storage ground water Resources of an unconfined aquifer are the Total Ground Water Availability of that aquifer.
Total Availability (unconfined Aquifer. i.e Aquifer-I) = Annual Extractable Ground Water Recharge + In-Storage Ground Water Resource
Total Availability (mcm) = 214.16 mcm +774.20 mcm = 988.36 mcm.

5. GROUND WATER RELATED ISSUES

Agriculture is the major occupation of the rural population of the Simdega district. About 95% population of the district is living in rural areas and depends on agriculture. Since the density of population is high there is acute pressure on land for agriculture use. But the land available for cultivation is limited because of rugged and hilly geomorphological set-up. The district of Simdega is mainly a dissected upland of ancient crystalline rocks which covers the major parts of this district.

Ground water conditions in crystalline rocks are generally considering to be poor because of the absence of two basic parameters i.e. porosity and permeability which are essential for the occurrence and movement of ground water in any rock type. Weathering aided by joints and fractures breaks down the original composition and texture of rocks producing pore spaces, hence imparting the secondary porosity and permeability. So due to the development of these properties even crystalline rocks have become good conduit for the occurrence and movement of ground water. Simdega is one of the most underdeveloped district of Jharkhand especially in the field of irrigation infrastructure (major and medium projects). Ground water resources of this district have to be developed on priority basis for giving a thrust to the agriculture production of this tribal dominated district.

5.1 Low Ground Water Development: One major issue of the area that is low ground water development. At present the overall stage of ground water development is only around 12.08%, based on Ground water resource assessment as on 2020. The Block wise stage of ground water development (SOD) of the district varies from 4.50 to 18.94 percent. Block wise stage of development of the district is shown in figure – 20.

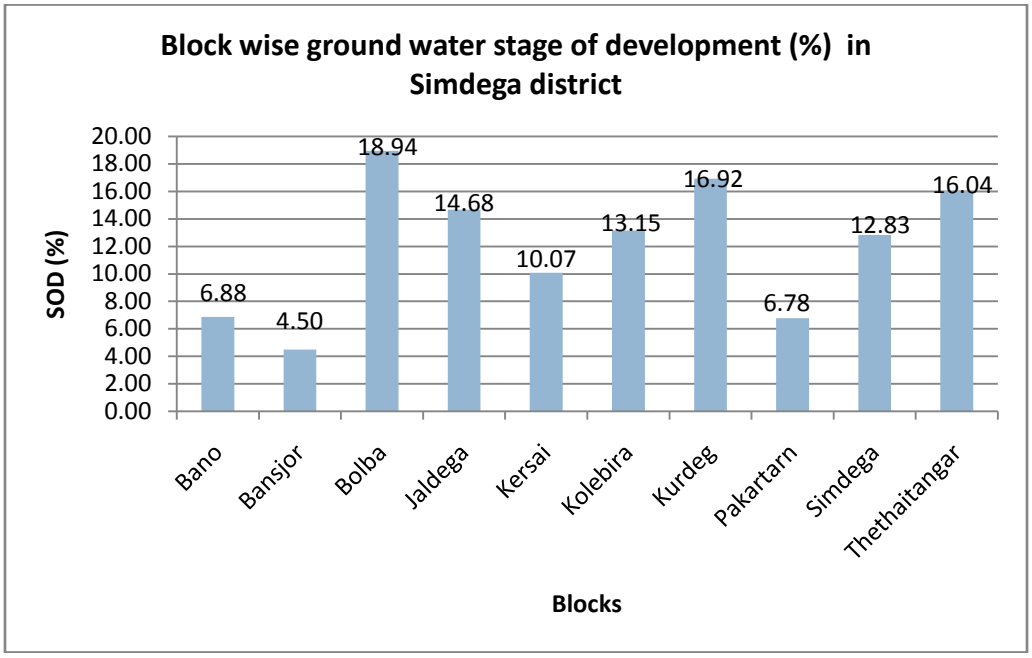


Figure – 22: GW Stage of development in Simdega district

5.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: Central Ground Water Board has constructed 25 exploratory wells in hard area of the district. The percentage of success bore wells (more than 3 lps discharge) is 36% with 24% of dry wells. Average thickness of weathering is 20 m and fracture zone is limited only. Low to medium Transmissivity value observed which varies from 3.27 to 193.19 m^2/day of fractured aquifer. The yield of bore wells drilled in the area is classified and presented below in figure – 23.

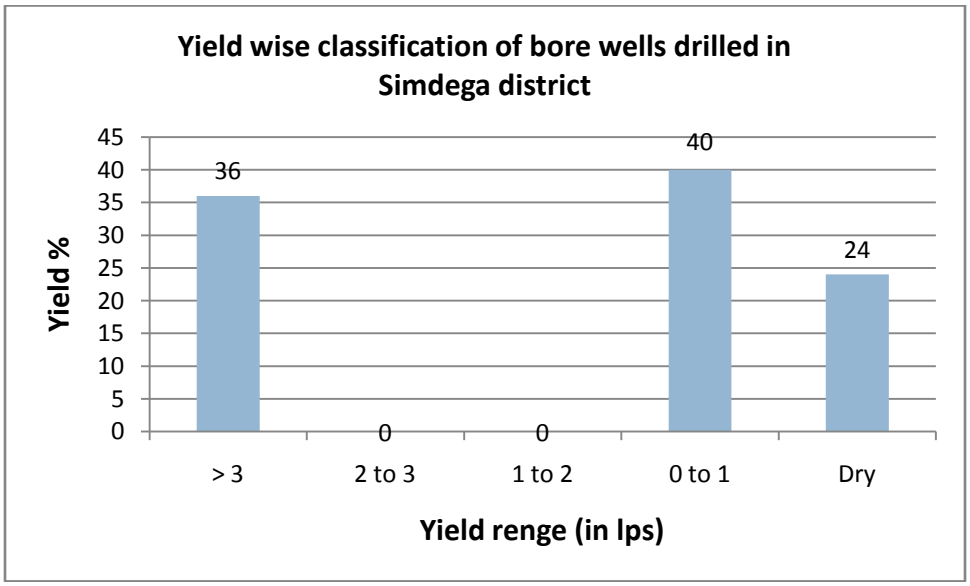


Figure – 23: Yield wise classification of bore wells drilled in Simdega district

5.3 Ground water contamination: Analytical result of water samples collected from the district, it is found the Fluoride concentration is beyond permissible limit in 06 samples of deeper aquifer (hand pump) and 02 samples of shallow aquifer (dug well). Rest all chemical parameter of shallow and deeper aquifer are found within desirable to permissible limit.

5.3.1 Fluoride contamination: Consumption of water with fluoride concentration above 1.50 mg/l is harmful which results in acute to chronic dental fluorosis where the tooth become coloured from yellow to brown. Skeletal fluorosis which causes weakness and bending of the bones also results due to long term consumption of water containing high fluoride. Presence of low or high concentration of fluoride in groundwater is because of geogenic or anthropogenic causes or a combination of both. Natural sources are associated to the geological conditions of an area. Several rocks have fluoride bearing minerals like apatite, fluorite, biotite and hornblende. The weathering of these rocks and infiltration of rainfall through it increases fluoride concentration in groundwater. Anthropogenic sources of fluoride include agricultural fertilisers and combustion of coal. Phosphate fertilisers contribute to fluoride in irrigation lands. There are several methods available for the removal of fluoride from groundwater which is insitu or exsitu. To dilute the groundwater contaminated with fluoride, artificial recharge structures can be built in suitable places which will decrease its concentration. Rainwater harvesting through existing wells also will prove effective to reduce the groundwater fluoride

concentration. Exsitu methods which are conventional treatment methods like adsorption, ion exchange, reverse osmosis etc can be practiced at community level or at households to reduce fluoride concentration before ingestion.

Table – 26: Location details of Fluoride concentration found beyond permissible limit in ground water Simdega district

Sr. No.	Village	Block	Fluoride value (mg/l)
Dug well samples = Nil			
Hand pump samples = 06 Nos.			
1	Banabira	Simdega	1.69
2	Simdega	Simdega	1.86
3	Sewai	Simdega	2.18
4	Nawamile Paro	Bano	2.30
5	Paikpara	Thethaitangar	2.59
6	Lathakhamhan	Thethaitangar	3.87

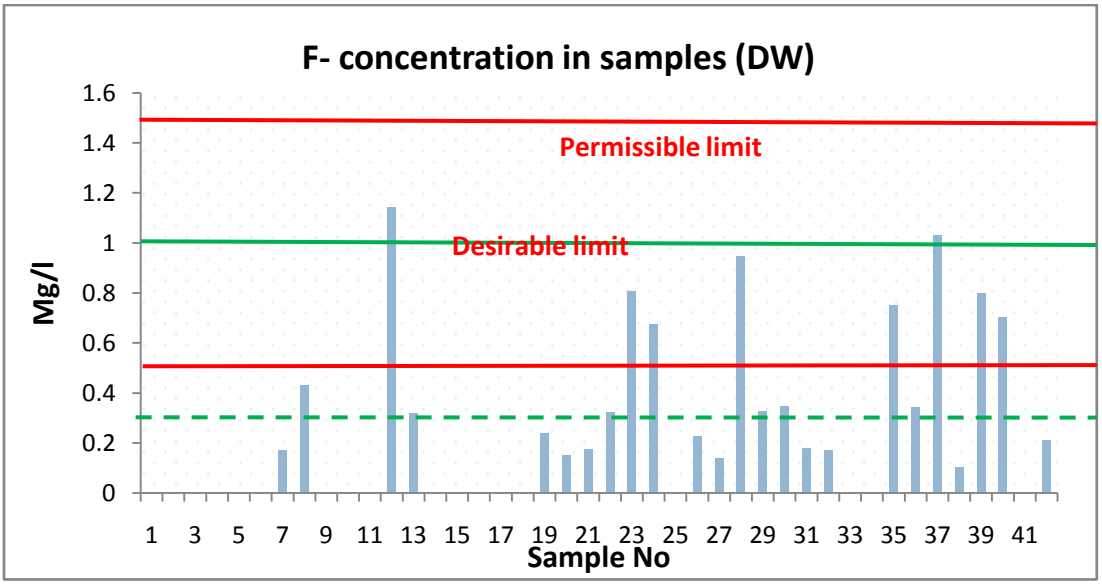


Figure – 22: Sample wise Fluoride concentration of shallow aquifer in Simdega district.

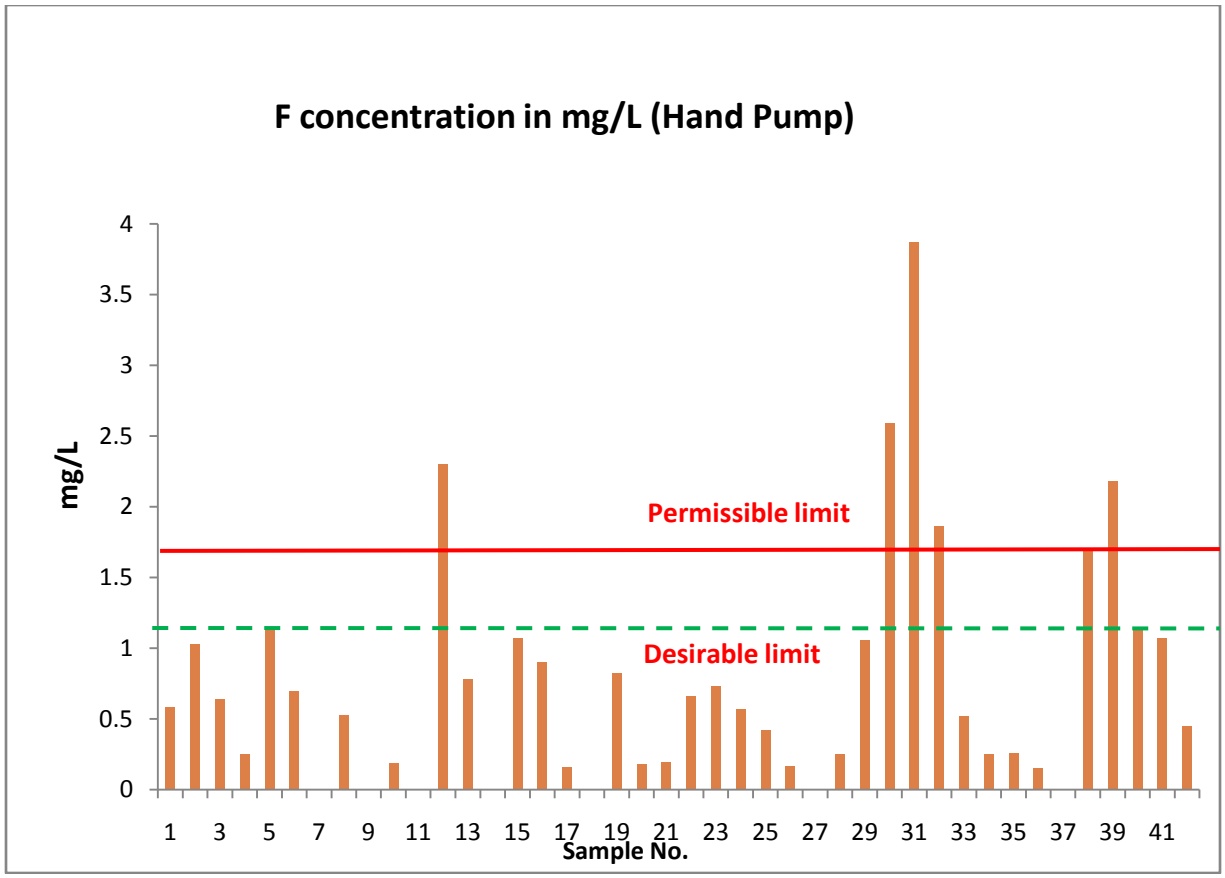


Figure – 25: Sample wise Fluoride concentration deeper aquifer in Simdega district

6. MANAGEMENT STRATEGIES

As discussed in previous chapter, the major ground water related issue in the Simdega is low ground water development owing to many socio-economic and hydrogeological reasons. To overcome these, it is imperative to have a robust ground water resource development plan for the district.

6.1 Supply Side Management : At present as per Ground Water Resource Estimation 2020, the stage of ground water development is very low i.e., 12.08 % and all the block of the district comes under safe category. However in some parts of the district long term declining trend has been noticed. Therefore, the ground water development should also be coupled with ground water augmentation, so that there is no stress on ground water regime of the area. The supply side Management can be done in following ways:

6.1.1 Ground Water Resource Development Strategy: In view of above, the focus of proposed management plan was to enhance the overall ground water development from the present 12.08% to 50%. Total 25016 dug wells (15-20 m depth; 2 to 4 m diameter @ Rs. 3.50 lakh/dug well) are recommended to be constructed in feasible areas. Similarly, 6080 shallow depth bore wells (70 - 100 m depth; 100-150 mm dia @ Rs.1.00 lakh/ bore well) are also recommended to be drilled in feasible areas. Proposed number of abstraction structure based on SOD 50% with future irrigation potential is given below in tables – 27 & 28.

Table – 27: Future Irrigation Potential & Proposed number of Abstraction Structures based on SOD 50%

District	Net GW Availability for Future Development (Ham)	future irrigation potential available (ha) considering (Δ) 0.45m	50% of future irrigation potential created (ha)	Proposed number of ground water structure (Dug wells)	Proposed number of ground water structure (Bore wells)
Bano	2966.68	6592.62	3296	3955	961
Bansjor	810.82	1801.82	900	1080	263
Bolba	926.56	2059.02	1030	1236	300
Jaldega	1901.95	4226.56	2113	2536	616
Kersai	921.48	2047.73	1024	1229	299
Kolebira	2432.71	5406.02	2703	3244	788
Kurdeg	926.82	2059.6	1030	1236	300
Pakartarn	1560.11	3466.91	1733	2080	505
Simdega	3066.78	6815.07	3408	4090	994
Thethaitangar	3248.67	7219.27	3610	4332	1053
Total	**18762.58**	**41694.6**	**20847**	**25016**	**6080**

It is necessary that proposed Additional ground water abstraction structure may be constructed in three phases with proper site selection. The results of the first phase of ground water development together with studies of the behavior of ground water regime will guide further ground water development to achieve 100% utilization.

Table – 28: Irrigation Potential Created & No. of structure for assured irrigation

Block	Type of abstraction structures to be constructed	Unit draft / command area (ham)	Proposed number of ground water abstraction structures	GW balance irrigation potential created for irrigation (ham)
Bano	DW	0.5	3955	1977.5
	BW	1.2	961	1153.2
Bansjor	DW	0.5	1080	540
	BW	1.2	263	315.6
Bolba	DW	0.5	1236	618
	BW	1.2	300	360
Jaldega	DW	0.5	2536	1268
	BW	1.2	616	739.2
Kersai	DW	0.5	1229	614.5
	BW	1.2	299	358.8
Kolebira	DW	0.5	3244	1622
	BW	1.2	788	945.6
Kurdeg	DW	0.5	1236	618
	BW	1.2	300	360
Pakartarn	DW	0.5	2080	1040
	BW	1.2	505	606
Simdega	DW	0.5	4090	2045
	BW	1.2	994	1192.8
Thethaitangar	DW	0.5	4332	2166
	BW	1.2	1053	1263.6
Total	**DW**	**0.5**	**25016**	**12509**
	BW	**1.2**	**6080**	**7294.8**

6.1.2 Rainwater Harvesting and Artificial Recharge structures

The supply side interventions also envisages construction of Rainwater Harvesting and Artificial Recharge structures in the areas feasible for construction of recharge structures based on the long term water level scenario and recharge potential of the aquifer as well as dilution of ground water contamination such as Fluoride observed in the district. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking

water sources of the area. It will ensure that the wells don't go dry during summer/lean/stress period in the areas of implementation and sufficient ground water availability is there in the wells even during the summer season. Thus not only the drinking and domestic water sources will be strengthened but additional irrigation potential can be created through artificial recharge structures.

Artificial recharge to Ground Water Master plan 2020

Recently in 2020, artificial recharge to Ground Water master plan 2020 of Jharkhand state has been prepared. The area identified for artificial recharge has been made based on post monsoon depth to water level (Nov. 2018) more than 3 m bgl with declining trend of more than 0.1 m/yr (2009 – 2018). In addition, area with water level more than 9 m bgl in the district has been considered for identifying the area. The volume of unsaturated zone available for recharge in identified areas is determined by computation of average depth of the unsaturated zone below 3 m bgl and then multiplied by area considered for recharge. Based on this master plan, feasible artificial recharge structures including roof rainwater harvesting structures are in Table- 29.

Table - 29: Artificial recharge structures feasible in Simdega district.

Area identified for artificial recharge (Sq. Km.)	Volume of unsaturated zone available for recharge (MCM	Total volume of Available Water for Recharge (MCM)	Proposed numbers of recharge structures (No's)	
			Percolation Tank	NalaBund/ Check dam / Gully Plug
65	3.20	3.72	10	62

6.2 Demand side Management:-The demand side intervention envisages the real water savings. The main demand side interventions may be-i) Promote improved irrigation technologies (drip or sprinkler irrigation, etc.), ii) Crop choice management and diversification (promote less intensive crops like pulses and horticulture), iii) Promoting treated municipal waste water for irrigation and construction use, and iv) Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.) The government should encourage and provide incentive the use of drip irrigation and sprinkler system.

6.3 Ground water Management Strategy for Fluoride affected areas: Fluoride contamination occurring in granite gneiss of Bano, Simdega and Thethaitangar blocks. Remedial measures recommended for Fluoride affected areas are as follows-

1. Purification/Filtration: Purification/ filtration of Fluoride contaminated ground water by distillation, reverse osmosis or ion exchange etc.

2. Awareness raising Program /Participatory approach: Peoples should aware about the ground water pollution of Fluoride. Management of schemes or project related Fluoride removal should be in hand of local peoples, so that peoples will keep the proper maintenance of machines and equipments.

6.4 Urban water supply: There is one urban area existing in the district namely Simdega. Average 75000 litres water supplies per day for Simdega urban area from Kelaghagh dam which is located about 4 km east - south of Simdega by Drinking Water & Sanitation Department.

6.5 Rural water supply: Drinking Water & Sanitation Department (DWSD), Simdega has constructed large numbers of bore wells to solve the water scarcity problem of the rural area of the district. In addition, numbers of small rural water supply schemes have been implemented by the Drinking Water & Sanitation Department, Simdega in rural area. Block wise number of Rural Water Supply Schemes of Simdega district is given below in table 29.

Table – 30: Block wise number of Rural Water Supply Schemes of Simdega district

Block	Water supply schemes							
	RWSS	MRWSS/ MRPWSS	SVS	PWSS	Solar based MRPWSS	Solar with HYDT	Other scheme	Remarks
Bano	1	--	--	--	237	--	--	--
Bansjor	0	--	--	--	42	--	--	--
Bolba	1	--	--	--	70	--	--	--
Jaldega	1	--	--	--	182	--	--	--
Kersai	2	--	--	--	15	--	--	--
Kolebira	3	--	--	--	196	--	--	--
Kurdeg	--	--	--	--	151	--	--	02 nos. WRSS under construction
Pakartanr	1	--	--	--	36	--	--	01 no. WRSS under construction
Simdega	1	--	--	--	161	--	--	01 no. WRSS under construction
Thethaitangar	--	--	--	--	*215*	--	--	01 no. WRSS under construction
Total	10	--	--	--	1305	--	--	05 nos. WRSS under construction

RWSS = Rural Water Supply Schemes
MWSS = Mini Water Supply Schemes
MRPWSS = Mini Rural Pipe Water Supply Schemes
PWSS = Pipe Water Supply Schemes
HYDT = High Yielding Tube well
SVS = Single Village Schemes

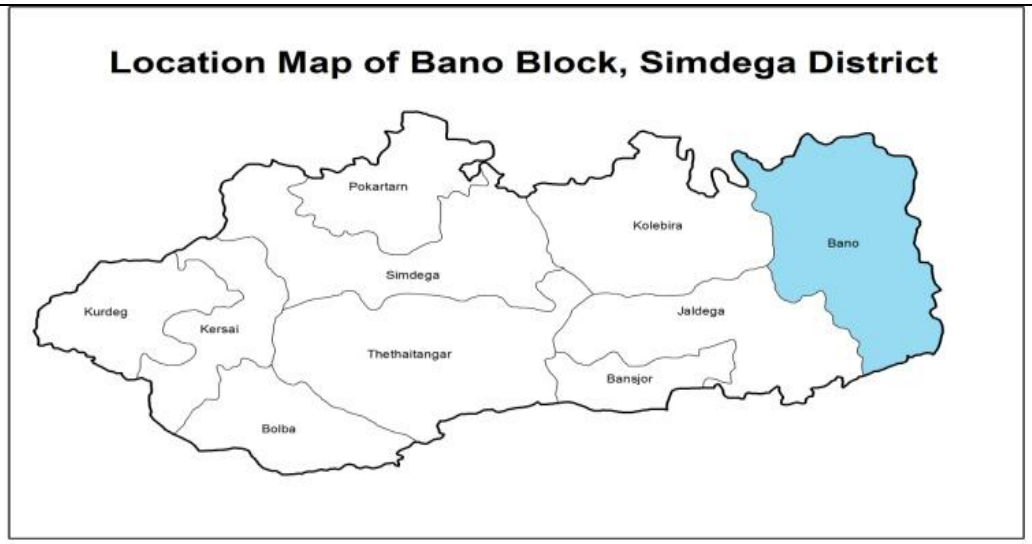
7.0 Sum-up

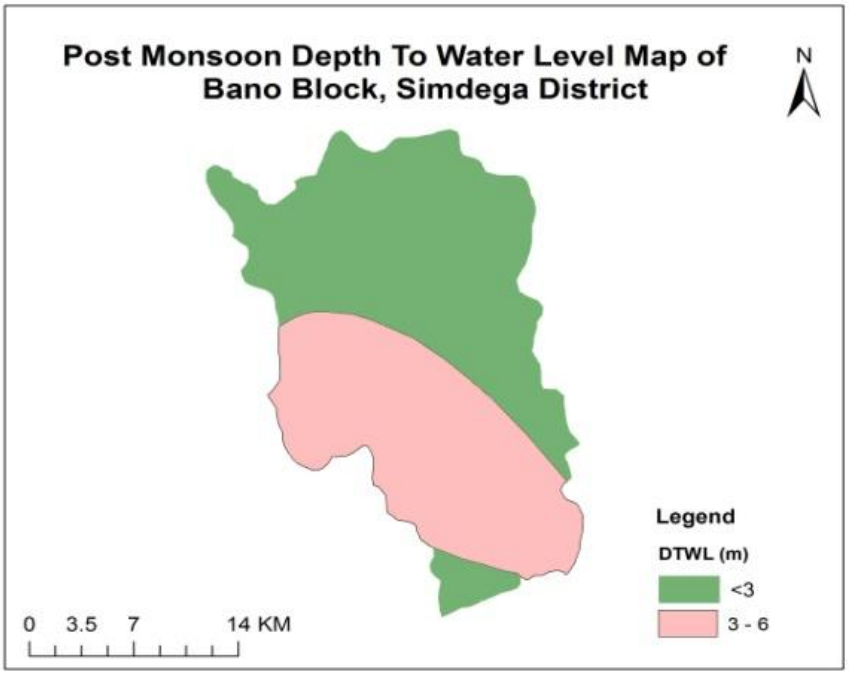
- The district of Simdega located almost the southern parts of Jharkhand state, covering an area of about 3752.29 Sq. Km. The district which acquired the status of an independent district on 30th April, 2001, has a close linkage with the parent district Gumla.
- The district is bounded in the north by the Gumla district, in the east by Ranchi district, in the south by Orissa state and in the west by the Chhatisgarh state. The district is situated between 22^0 20' 30" and 23^0 50' 15" N latitude and 84^0 01' 00" and 85^0 04' 30" E longitude. It has one sub – division i.e. Simdega Sadar sub – division. Further, the sub – division is divided into ten blocks namely – Simdega, Bano, Jaldega, Kolebira, Kurdeg, Thetaitanger, Pakartanr, Kersai and Bansjor
- The region in Chotanagpur plateau is having large physical inequalities presenting a rich panorama of topographical features. The general configuration of region varies from valley fills, pedeplains, to structural ridges. In the district three well marked erosion surfaces are clearly discernible.
- The district falls in the Agro climatic sub-zone-VI with average annual rainfall 1230.56 mm. The mean monthly temperature range from 4^{0}C in winter to 42^{0}C in summer.
- The major part of the district is having dendritic drainage pattern. The district is forming Sankh sub basin of the Brahmni basin. The river Sankh is the main river of the district, which flows north to south direction in the western part of the district. The tributaries of the river Sankh are the Palamara, Girma, Chhinda, Lurgi and Dev rivers. The other important river of the district is the river South Koel which form the eastern boundary of the district.
- Geologically the district of Simdega is mainly underlain by Archaean crystalline rocks which are highly deformed and metamorphosed. Major part of the district is occupied by granite gneiss. Eastern part of the district underlain by phylites and schist.
- In general in fissured formations, discharge of well has been found in the range of 0.50-72.00 m^3/hr. Overall in the district the major potential fractures zones are found upto 100 m. First potential fracture zone encountered in the district widely varies from 9 -182 m.
- Ground water occurs in unconfined to semi-confined state in Aquifer-I (upto the depth of 20 m). Yield of the open wells in Aquifer-I is restricted upto 2.5 m^3/day in weathered Granite-Gneiss.
- The Chotanagpur granite-gneiss, belonging to Precabmrian age constitutes the group of fissured formation hydrogeological units and to some extent phylites and schists as an Aquifer-II i.e deeper Aquifer in the area. The Potential fractured deeper aquifers (Aquifer-II) in the district have been observed upto 182 mbgl with the yield potential upto 72.00 m^3/hr.
- The analysis of aquifer parameters in the district shows that the transmissivity value ranges from 3.27 – 193.19 m^2/day. The storativity value also varies from 1.20 x 10^{-2} to 5.20 x 10^{-6}, which shows that aquifers are under semi-confined to confined condition.

- Ground Water quality is generally potable, except few patches Fluoride value found beyond permissible limit in 6 samples of hand pump.
- Based on Ground water Resources estimation 2020, the stage of ground water development in Simdega district is 12.08% and the entire block comes under safe category. Therefore there is sufficient scope for further ground water development.
- Three major ground water related issues in Simdega district are low ground water development, low ground water potential and fluoride contamination in the area.
- To suggest a sustainable ground water management plan there are two options-Supply Side Management Options & Demand Side Management Options
- The supply side interventions-I envisages Ground Water Management strategy through construction of 25016 dug wells and 6080 shallow bore wells in the feasible areas in the district to enhance the overall ground water development to 50%. Rain water harvesting and artificial recharge to be encouraged in feasible areas for ground water augmentation. In additional purification/filtration of Fluoride may also be adopted.
- The supply side interventions-II also envisages construction of feasible artificial recharge structures - 10 percolation tank, 62 Nala Bund/Check Dam/Gully Plug in 65 sq. km. identified area in Simdega district, which is Based on Artificial recharge to Ground Water master plan 2020 of Jharkhand state
- The demand side intervention envisages the real water savings. The main demand side interventions may be-i) Promote improved irrigation technologies (drip or sprinkler irrigation, etc.), ii) Crop choice management and diversification (promote less intensive crops like pulses and horticulture), iii) Promoting treated municipal waste water for irrigation and construction use, and iv) Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.) The government should encourage and provide incentive the use of drip irrigation and sprinkler system.

8.0 BLOCK WISE AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN

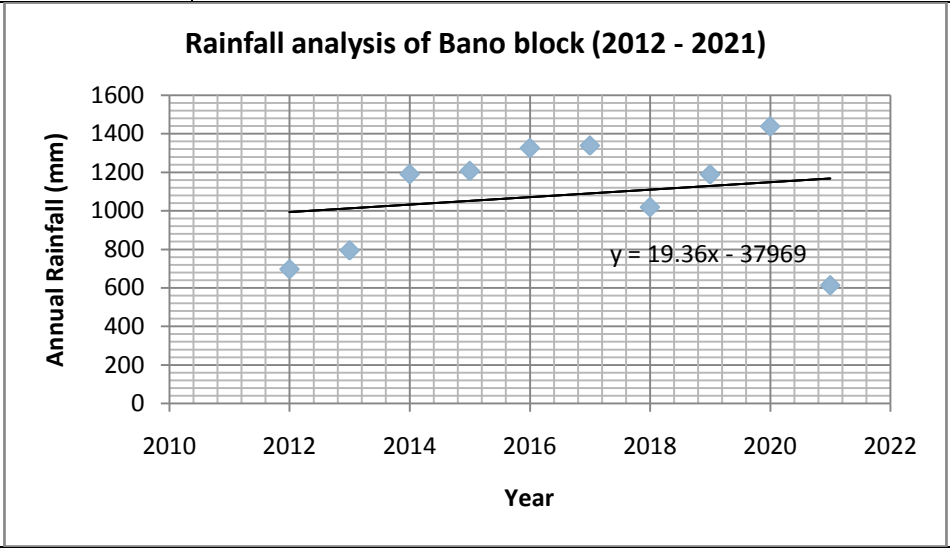
8.1 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, BANO BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES	
Block Name	Bano
Geographical Area (Sq. km.)	549.77
Hilly Area (Sq. km.)	78.00
Population (2011)	80462
1.1 Rainfall Analysis	
Decadal average annual rainfall (2012 – 2021)	1080.02 mm

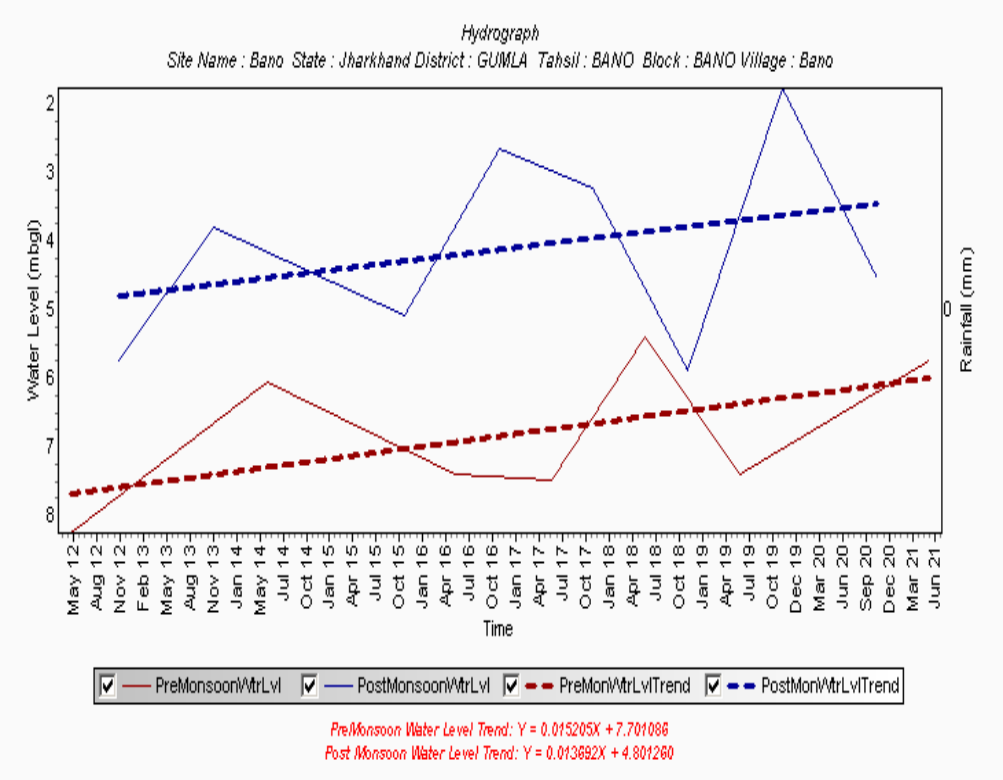
Standard deviation	287.90
Coefficient of variation (in %)	26.66
Long term rainfall analysis (2012 – 2021)	Normal = 60%, Excess = 10%, Moderate drought = 30%, Rising trend of 19.36 mm/year



1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	82.49 Sq. km.	
Net area shown	126.66 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	1.13 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	123.35
	Ragi	7.93
	Oil seeds	5.65
	Maize	0.41
	Pulses	11.46
	Vegetable	4.32

1.3 Ground water availability & extraction (2020)	
Net ground water availability for future use (MCM)	29.67
Current annual ground water extraction for all uses (MCM)	2.19
Annual extractable ground water for recharge (MCM)	31.86
Stage of ground water extraction (%)	6.88
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	3.90 – 7.25 mbgl.	1.93 – 3.13 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (22021)	1.55 – 4.79 m.	
1.5 Hydrograph & water level trend analysis		

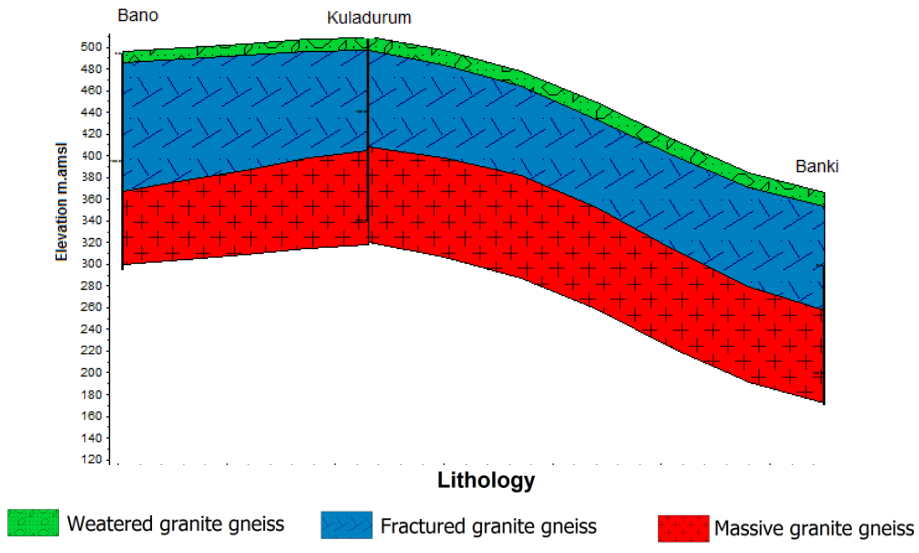


Hydrographs located at Bano showing Pre-monsoon rising water level trend @ 0.17.98 m/year.	Hydrographs located at Bano showing post-monsoon rising water level trend @ 0.1718 m/year.

2.0 AQUIFER DISPOSITION

2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II

2.2 Cross section: Four exploratory and one observation wells have been constructed in Bano block. The yield of these wells varies from 0 to 3.00 lps. The depth of occurrence of fractures zones ranging from 54.00 to 146.00 mbgl. The lithological cross section of selected three wells is shown in below

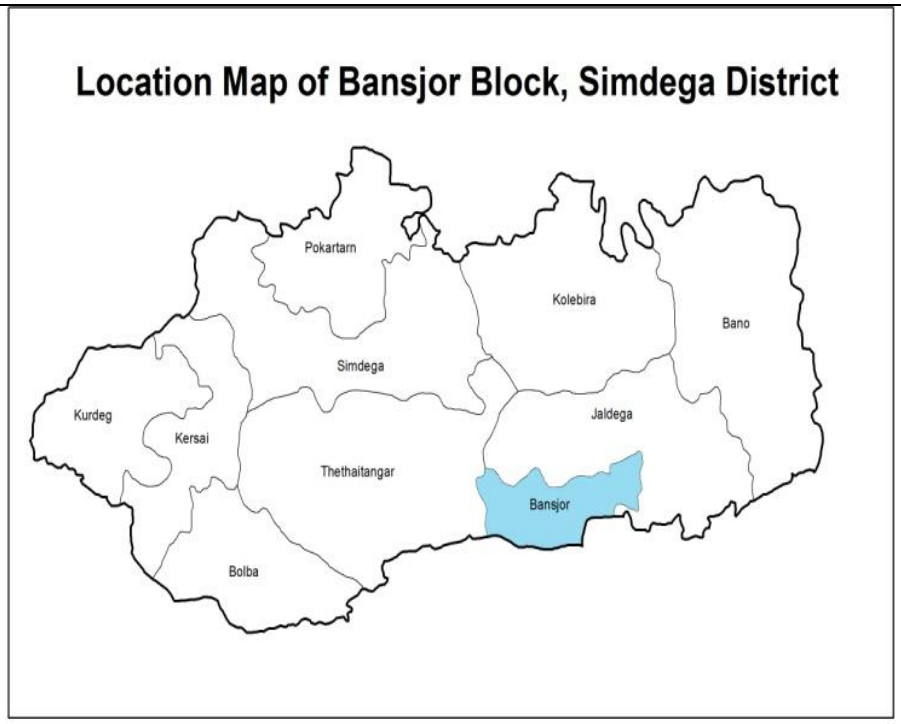


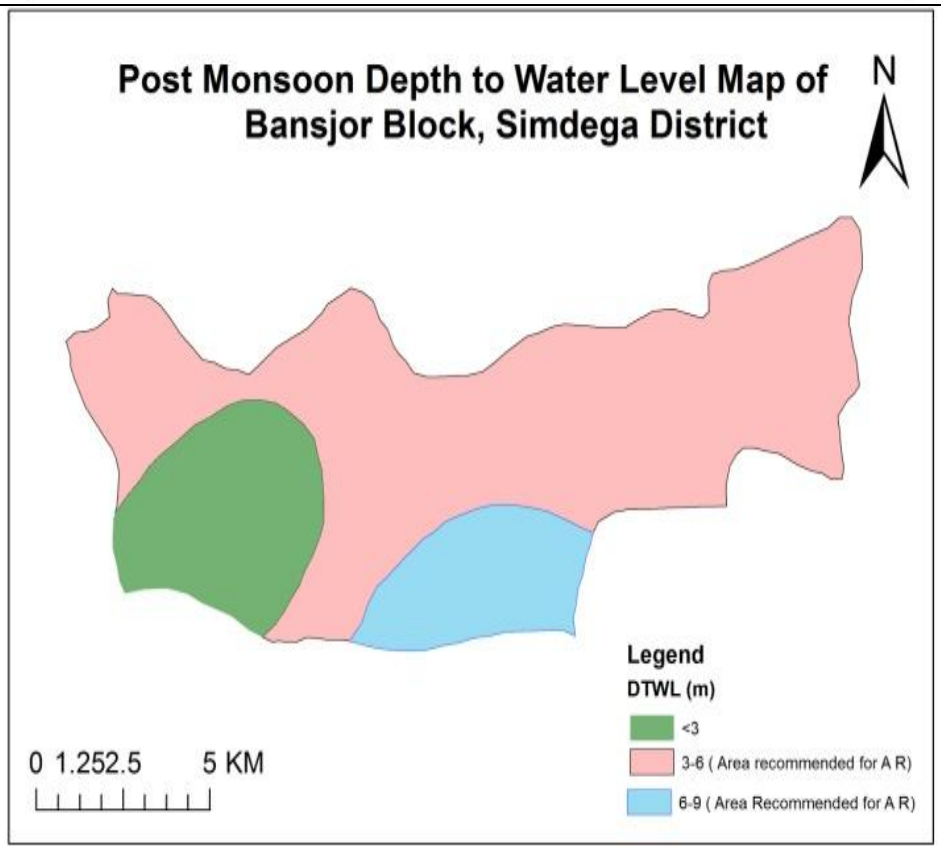
Lithological cross section of Bano block

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	31.87
Current annual ground water extraction for irrigation (MCM)	1.13
Current annual ground water extraction for domestic (MCM)	1.06
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	2.19
Net ground water availability for future use (MCM)	29.67
Stage of ground water extraction (%)	6.88
Category	Safe
3.2 Chemical Quality of ground water & contamination	
3.2.1 Variation in Major and Minor elements	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer varies from 144 to 711 µS/cm. TDS has been observed between 93.6 to 462.15 mg/l. Total hardness value ranges from 60 to 205 mg/l. Similarly, the Chloride value observed between 7.09 to 116.99 mg/l while the Sulphate value varies from 8.29 to 38.68 mg/l. Nitrate value ranges from 0.17 to 27.42 mg/l. Fluoride value found between 0 to 1.14 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.	
Semi – confined/ confined Aquifer (Aquifer – II)	
The EC value of the deeper aquifer varies from 216 to 523 µS/cm. TDS has been observed between 140.40 to 339.50 mg/l. Total hardness value ranges from 95 to 255 mg/l. Similarly, the Chloride value observed between 7.09 to 31.91 mg/l while the Sulphate value varies from 7.47 to 27.55 mg/l. Nitrate values observed between 0 to 13.56 mg/l. Fluoride value varies from 0 to 2.30 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose except Fluoride.	
3.2.2 Suitability for irrigation	
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 8.98 to 49.02 while RSC value observed between -0.19 to 1.33. SAR value ranges from 0.06 to 2.03 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 7.55 to 23.01 while RSC value observed between -0.08 to 0.01. SAR value ranges from 0.15 to 0.56 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation
3.3 Other issues	
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 6.88%.	
3.3.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: Central Ground Water Board has constructed 4 exploratory and one observation wells. Yield of these wells varies from 0 to 3.00 lps. One to two sets of water bearing fracture zones have been encountered within 200 m drilling. Thickness of the fracture zones found between 1 to 2 m only.	
3.3.3 Fluoride contamination: Fluoride value found beyond permissible limit (2.14 mg/l) at village Nawamile Paro.	

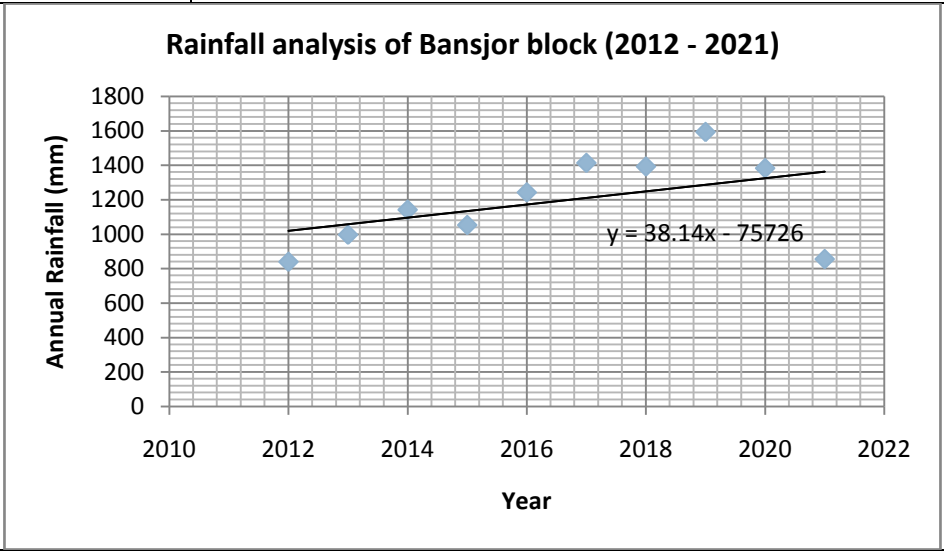
4. SUPPLY SIDE MANAGEMENT
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 6.88%. To enhance the ground water development from the present 6.88 % to 50% stage of development, recommended for construction of 3955 dug wells (10 -20 m depth; 2 to 4 m diameter) and 961 bore wells (up to 150 m depth) for creating additional irrigation potential 1977 ham through dug wells and 1153 ham through bore wells.
4.2 Proposed number of artificial recharge structures:-The average post monsoon depth to water level observed less than 3 m (2.65 mbgl). Hence, artificial recharge structures not proposed.
5. DEMAND SIDE MANAGEMENT
• Promoting Micro irrigation technique(drip or sprinkler irrigation, etc.), • Crop choice management and diversification

8.2 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, BANSJOR BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES		
Block Name		Bansjor
Geographical Area (Sq. km.)		164.50
Hilly Area (Sq. km.)		29.70
Population (2011)		25519
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1190.45 mm
Standard deviation		255.32
Coefficient of variation (in %)		21.45
Long term rainfall analysis (2012 – 2021)	Normal = 70%, Excess = 10%, Moderate drought = 20%, Rising trend of 38 mm/year	



1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	24.37 Sq. km.	
Net area shown	23.22 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	0.45 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 – 20
	Paddy	14.39
	Oil seeds	2.20
	Ragi	0.32
	Maize	0.44
	Pulses	2.05
	Vegetable	2.96

1.3 Ground water availability & extraction (2020)	
Net ground water availability for future use (MCM)	8.11
Current annual ground water extraction for all uses (MCM)	0.38
Annual extractable ground water for recharge (MCM)	8.49
Stage of ground water extraction (%)	4.50
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	3.30 – 7.50 mbgl.	2.20-6.24 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2018)	1.10 – 1.26 m.	
1.5 Hydrograph& water level trend analysis Hydrograph network not located in this block		
2.0 AQUIFER DISPOSITION		
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer – II	
2.2 Cross section: Only one exploratory well with one observation well located in the block.		
3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES		
3.1 Aquifer wise resource availability and extraction		
3.1.1 Phreatic Aquifer (Aquifer - I)		
Ground water resource estimation (As on 31st March 2020)		
Annual extractable ground water for recharge (MCM)	8.49	
Current annual ground water extraction for irrigation (MCM)	0.045	
Current annual ground water extraction for domestic (MCM)	0.34	
Current annual ground water extraction for industrial (MCM)	0	
Current annual ground water extraction for all uses (MCM)	0.38	
Net ground water availability for future use (MCM)	8.11	
Stage of ground water extraction (%)	4.50	
Category	Safe	
3.2 Chemical Quality of ground water & contamination		
3.2.1 Variation in Major and Minor elements		
Phreatic Aquifer (Aquifer - I)		
The EC value of the phreatic aquifer varies from 106 to 476 µS/cm. TDS has been observed between 68.9 to 309.4 mg/l. Total hardness value ranges from 50 to 135 mg/l. Similarly, the Chloride value observed between 3.54 to 17.73 mg/l while the Sulphate value varies from 10.44 to 18.00 mg/l. Nitrate value ranges from 0.67 to 4.42 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.		
Semi – confined/ confined Aquifer (Aquifer – II)		
The EC value of the deeper aquifer varies from 297 to 387 µS/cm. TDS has been observed between 193.05 to 251.55 mg/l. Total hardness value ranges from 100 to 130 mg/l. Similarly, the Chloride value observed between 7.09 to 14.18 mg/l while the Sulphate value varies from 11.73 to 18.02 mg/l. Nitrate values observed between 3.05to 3.18 mg/l. Fluoride value varies from 0.25 to 1.15 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.		
3.2.2 Suitability for irrigation		
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)	
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 16.75 to 43.08 while RSC value observed between -0.49 to 0.23. SAR value ranges from 0.28 to 1.69 and falling in excellent water class. The	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 22.52 to 36.91 while RSC value observed between -1.77 to 0.52. SAR value ranges from 0.77 to 1.24 and falling in excellent water class. The ground water of deeper	

ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	aquifer (Aquifer – II) is suitable for irrigation

3.3 Other issues

3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 4.50%.

4. SUPPLY SIDE MANAGEMENT PLAN

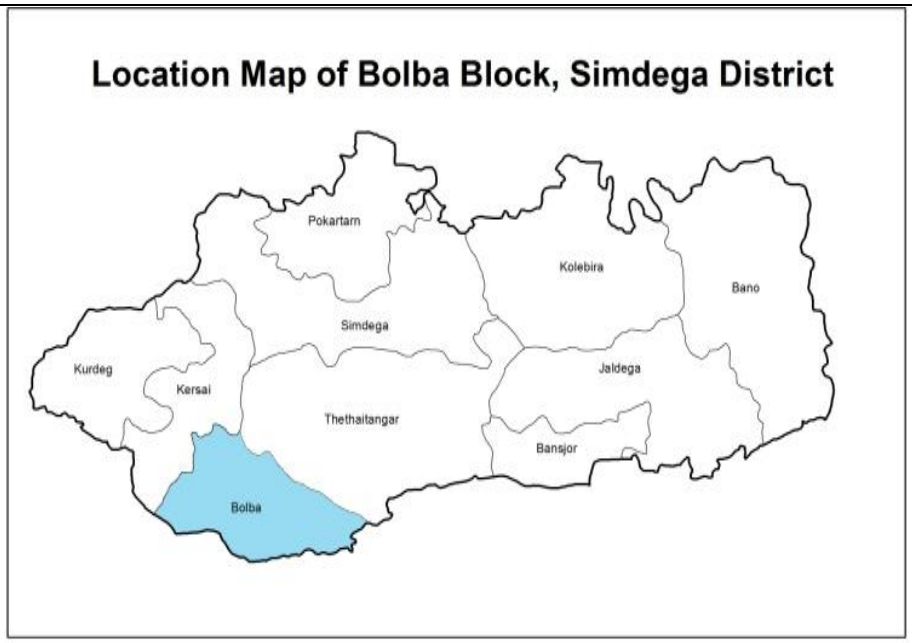
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 4.50 %. To enhance the ground water development from the present 4.50 % to 50% stage of development, recommended for construction of 1080 dug wells (10 -20 m depth; 2 to 4 m diameter) and 263 bore wells (up to 150 m depth) for creating additional irrigation potential 540 ham through dug wells and 316 ham through bore wells.

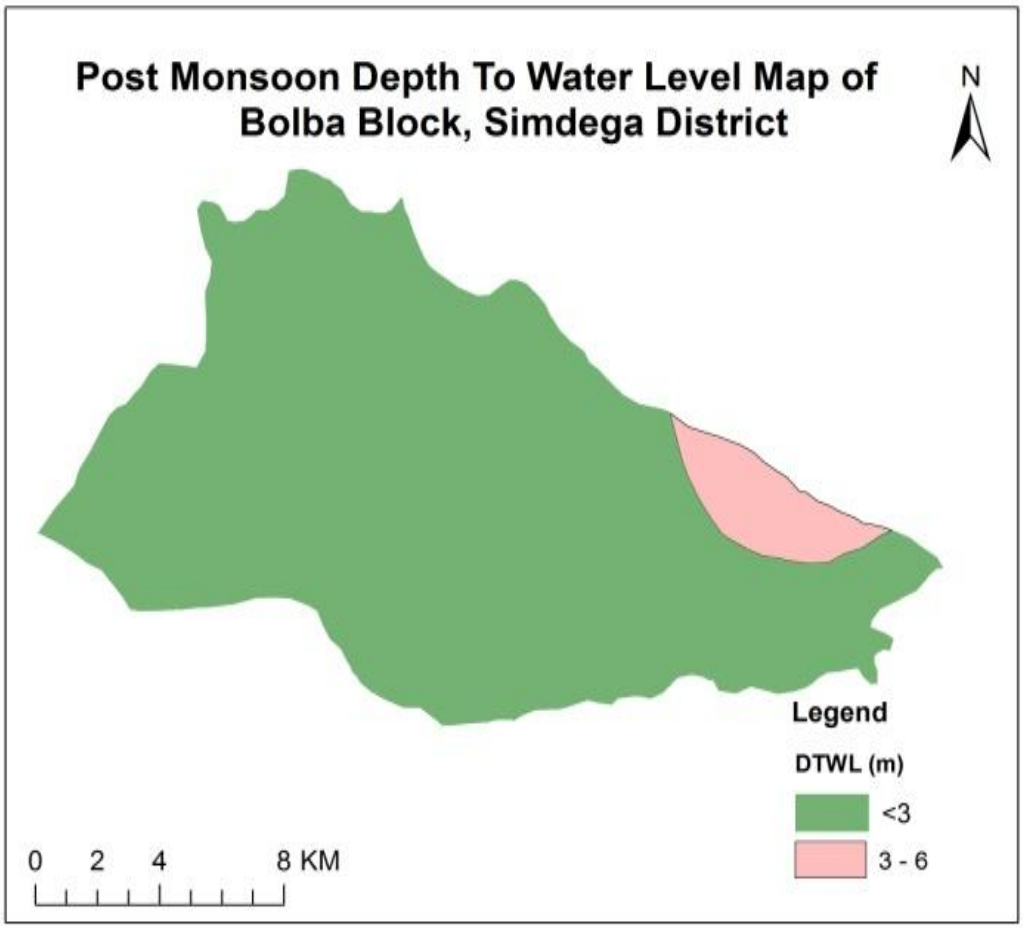
4.2. Ground Water Resource Enhancement/Artificial Recharge structures proposed

Annual extractable ground water for recharge (MCM)		8.49
Area of block (Sq. km.)		164.5
Area suitable for artificial recharge (Sq. km.)		131.01
Type of aquifer		Hard rock/Soft rock
Area feasible for artificial recharge in Sq. km.(Post monsoon water level> 3 mbgl)		131.01
Average annual monsoon rainfall		1190.45 mm
Average post monsoon water level		4.22 mbgl.
Thickness of unsaturated zone		1.22 m.
Sub-surface storage space		31.97 MCM
Surface water requirement @ 75% efficiency		42.52 MCM
Source water availability = 30% of Rain fall x area		46.79 MCM
Non-committed runoff = 50% of runoff		23.40 MCM
Surface water available for recharge = 60% of Non-committed water.		14.04 MCM
Surplus water available (MCM)		28.48
Proposed structures	Percolation tank (Average gross capacity – 0.188 MCM *2 filling = 0.38 MCM), 30% of water available for recharge	Nala Bund/Check dam / Gully Plug (Average gross capacity – 0.024 MCM* 3 filling = 0.072 MCM), 30% of water available for recharge
Proposed number of structures	19	98
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	7.22	7.06
5. DEMAND SIDE MANAGEMENT		

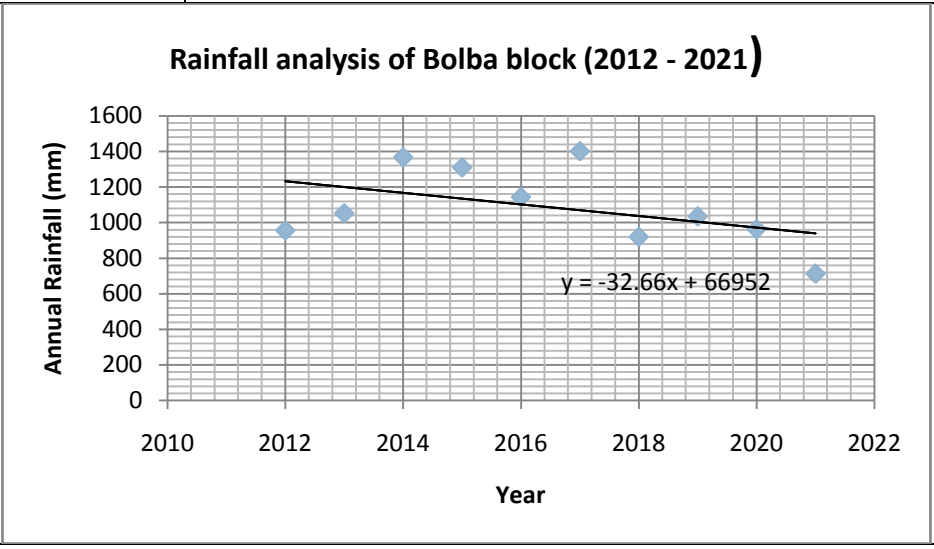
- Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.),
- Crop choice management and diversification(Promoting less intensive crops)

8.3 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, BOLBA BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES		
Block Name		Bolba
Geographical Area (Sq. km.)		288.63
Hilly Area (Sq. km.)		116.14
Population (2011)		30786
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1085.81 mm
Standard deviation		219.98
Coefficient of variation (in %)		20.26
Long term rainfall analysis (2012 – 2021)	Normal = 70%, Excess = 20%, Moderate drought = 10%, Declining trend of 33 mm/year	

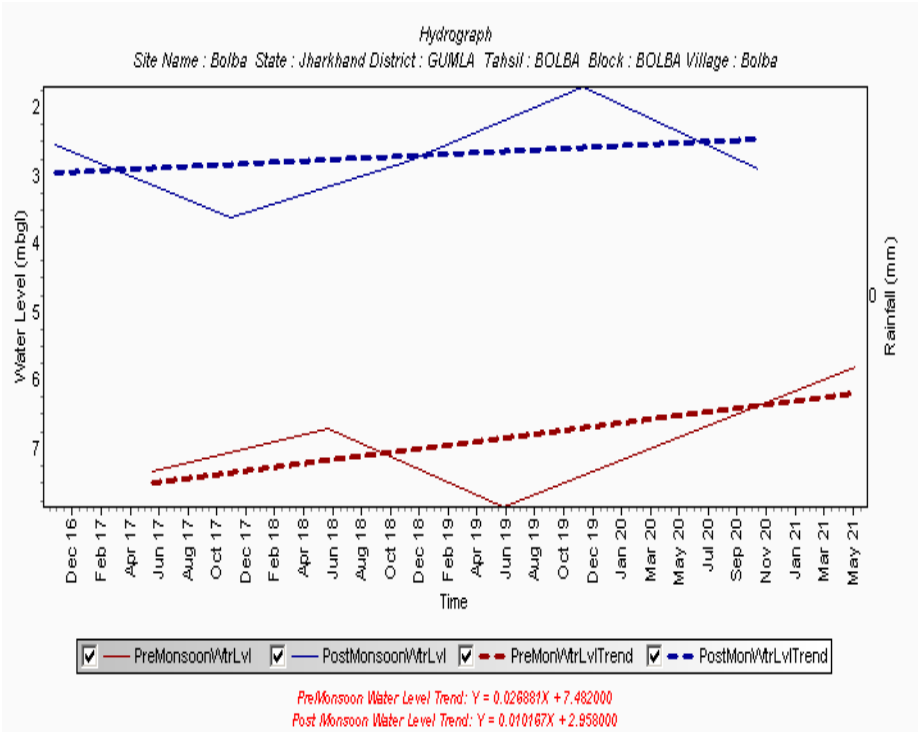


1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	39.12 Sq. km.	
Net area shown	52.21 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	1.76 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	44.26
	Ragi	0.71
	Oil seeds	2.47
	Maize	0.58
	Pulses	2.13
	Vegetable	1.94

1.3 Ground water availability (2020)	
Net ground water availability for future use (MCM)	9.27
Current annual ground water extraction for all uses (MCM)	2.17
Annual extractable ground water for recharge (MCM)	11.43
Stage of ground water extraction (%)	18.94
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	5.80 – 6.40 mbgl.	2.32 – 2.63 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2018)	3.48 – 3.77 m.	

1.5 Hydrograph& water level trend analysis

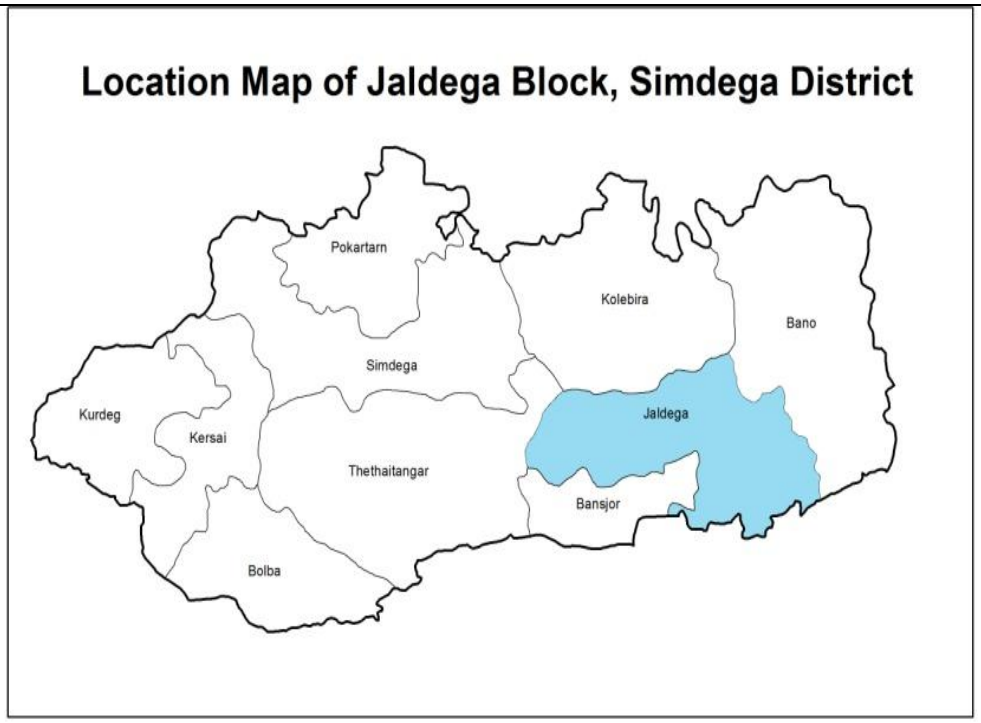


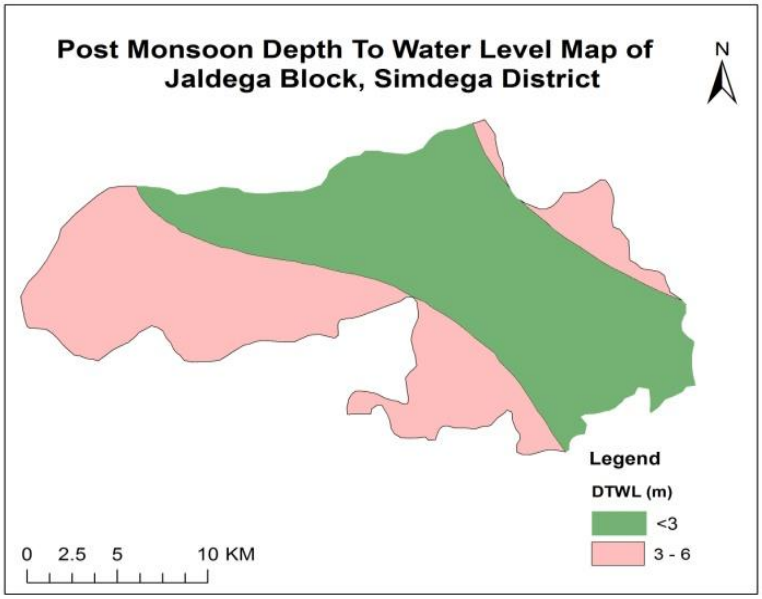
--	Hydrographs located at Bolba showing post-monsoon rising water level trend @ 0.1233 m/year.

2.0 AQUIFER DISPOSITION	
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II
2.2 Cross section: Only one exploratory well is located in the block.	
3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	11.43
Current annual ground water extraction for irrigation (MCM)	1.76
Current annual ground water extraction for domestic (MCM)	0.41
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	2.17
Net ground water availability for future use (MCM)	9.26
Stage of ground water extraction (%)	18.94

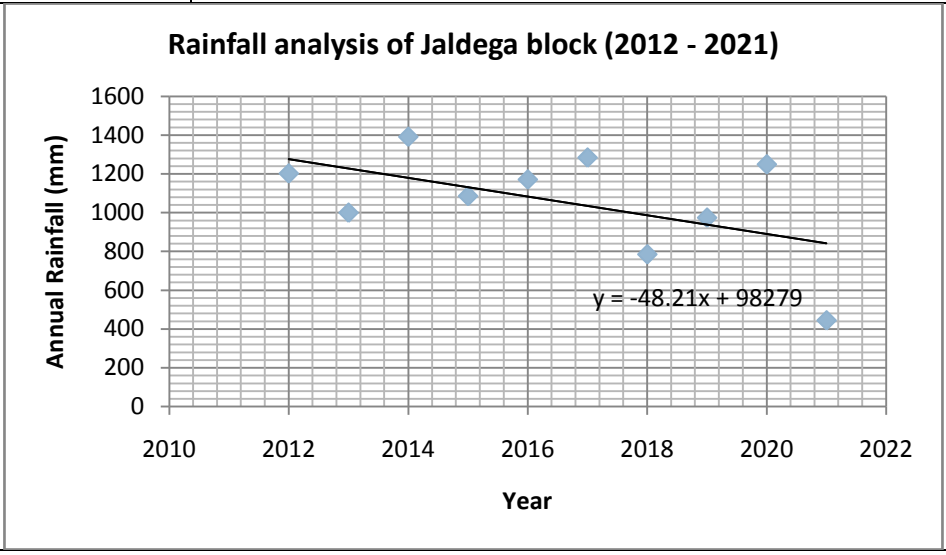
Category	Safe
3. Chemical Quality Of Ground Water & Contamination	
3.1 Variation in Major and Minor elements	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer varies from 389 to 609 µS/cm. TDS has been observed between 93.6 to 462.15 mg/l. Total hardness value ranges from 60 to 205 mg/l. Similarly, the Chloride value observed between 7.09 to 116.99 mg/l while the Sulphate value varies from 8.29 to 38.68 mg/l. Nitrate value ranges from 0.17 to 27.42 mg/l. Fluoride value found between 0 to 1.14 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.	
Semi – confined/ confined Aquifer (Aquifer – II)	
The EC value of the deeper aquifer varies from 216 to 523 µS/cm. TDS has been observed between 252.85 to 395.85 mg/l. Total hardness value ranges from 195 to 215 mg/l. Similarly, the Chloride value observed between 17.73 to 77.99 mg/l while the Sulphate value varies from 20.05 to 23.39 mg/l. Nitrate values observed between 5.72 to 28.69 mg/l. Fluoride value varies from 0.14 to 0.95 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.	
3.2.2 Suitability for irrigation	
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 4.25 to 31.41 while RSC value observed between -0.66 to -1.57. SAR value ranges from 0.07 to 1.12 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 28.11 to 30.62 while RSC value observed between -0.09 to -0.87. SAR value ranges from 0.79 to 1.05 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation
3.3 Other issues	
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 18.94%.	
4. SUPPLY SIDE MANAGEMENT PLAN	
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 18.94%. To enhance the ground water development from the present 18.94 % to 50% stage of development, recommended for construction of 1236 dug wells (10 -20 m depth; 2 to 4 m diameter) and 300 bore wells (up to 150 m depth) for creating additional irrigation potential 618 ham through dug wells and 360 ham through bore wells.	
4.2. Proposed number of artificial recharge structures	
Proposed number of artificial recharge structures	The average post monsoon depth to water level observed less than 3 m (2.48 mbgl). Hence, artificial recharge structures not proposed.
5. Demand side management	
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)	

8.4 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, JALDEGA BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES		
Block Name		Jaldega
Geographical Area (Sq. km.)		428.20
Hilly Area (Sq. km.)		77.31
Population (2011)		64286
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1058.31 mm
Standard deviation		278.01
Coefficient of variation (in %)		26.27
Long term rainfall analysis (2012 – 2021)	Normal = 70%, Excess = 10%, Moderate / Severe drought = 20%, Declining trend of 48 mm/year	

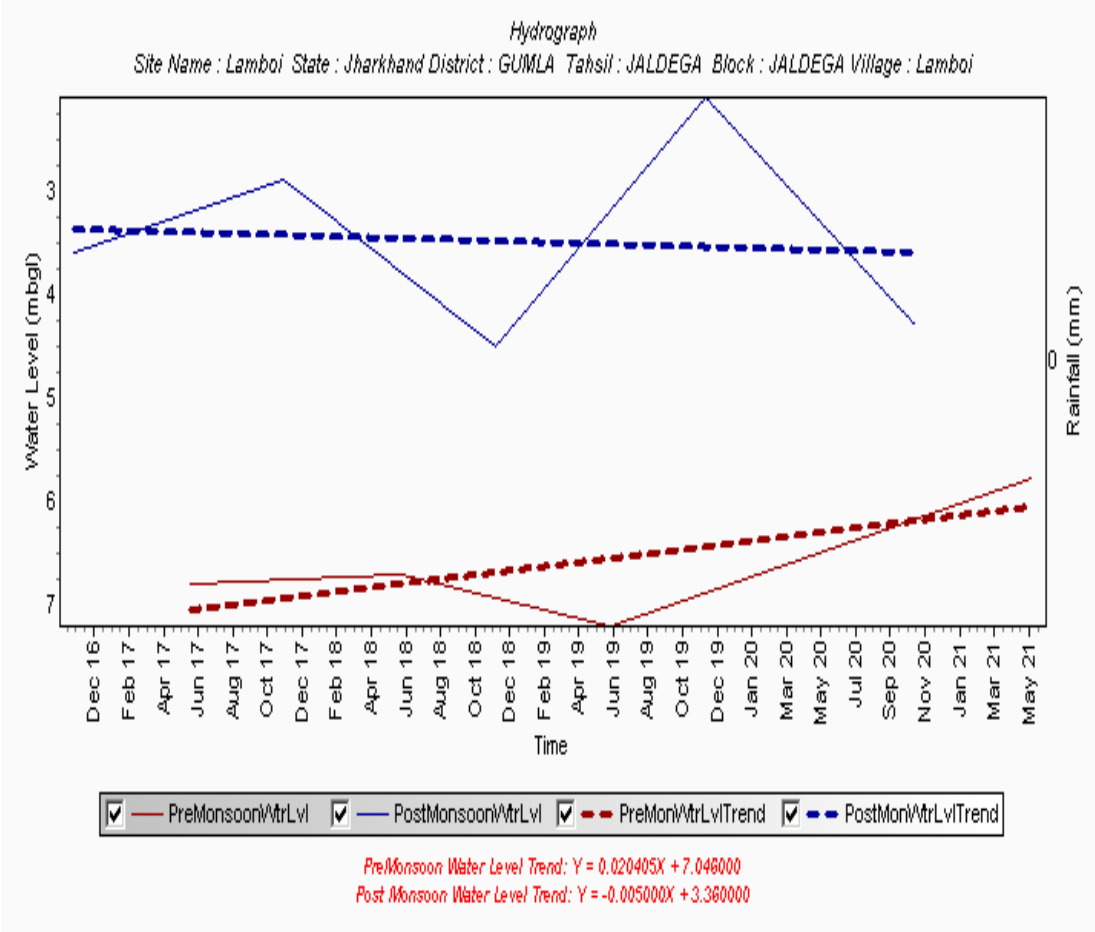


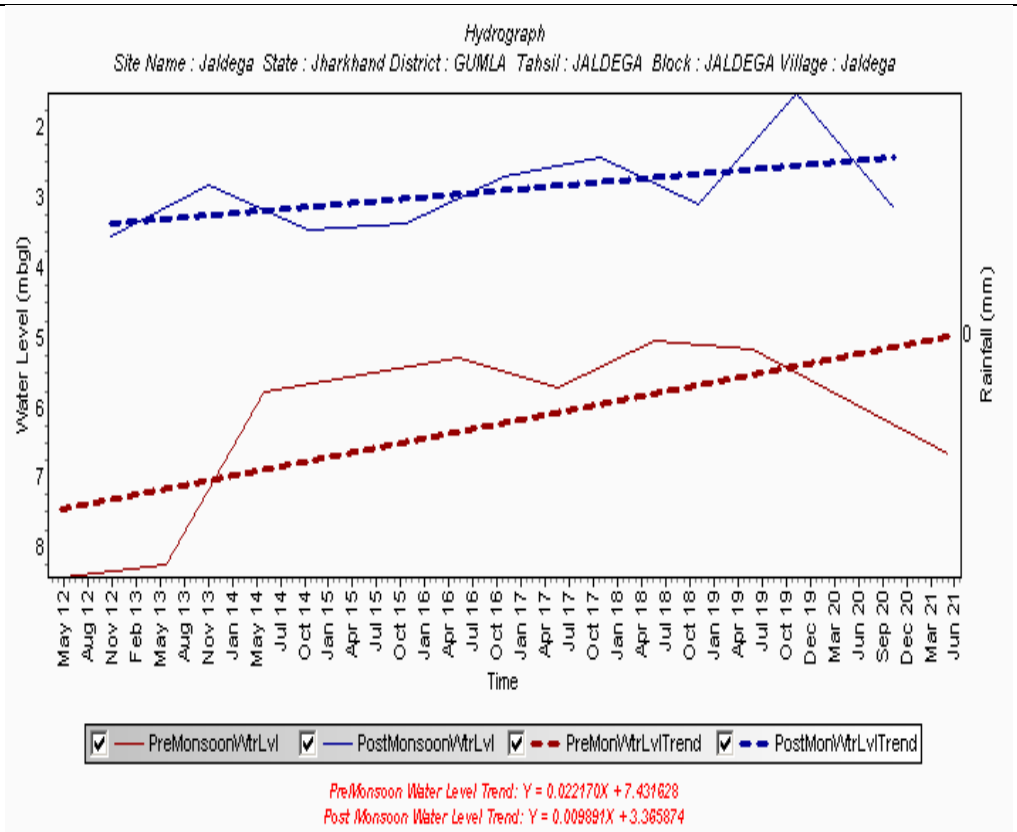
1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	83.80 Sq. km.	
Net area shown	51.04 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	2.43 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2016 - 17
	Paddy	32.68
	Ragi	1.66
	Oil seeds	3.74
	Maize	0.29
	Pulses	6.65
	Vegetable	3.34

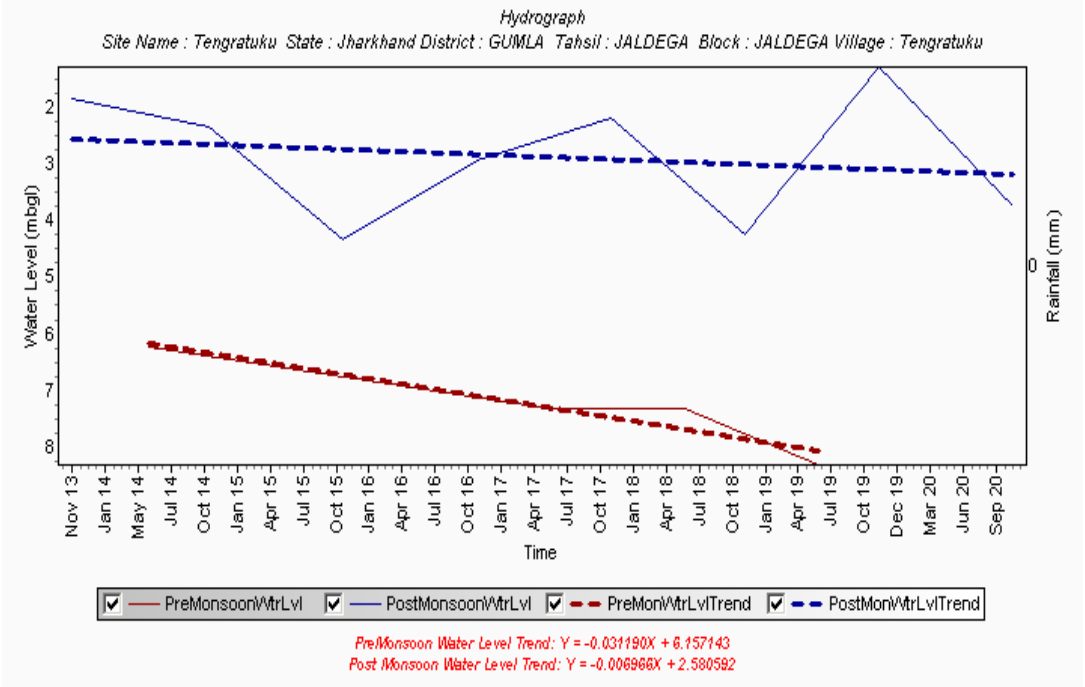
1.3 Ground water availability (2017)	
Net ground water availability for future use (MCM)	33.19
Current annual ground water extraction for all uses (MCM)	4.75
Annual extractable ground water for recharge (MCM)	37.93
Stage of ground water extraction (%)	14.68
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	2.20 – 7.65 mbgl.	1.35 – 3.18 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	0.85 – 5.83 m.	

1.5 Hydrograph& water level trend analysis

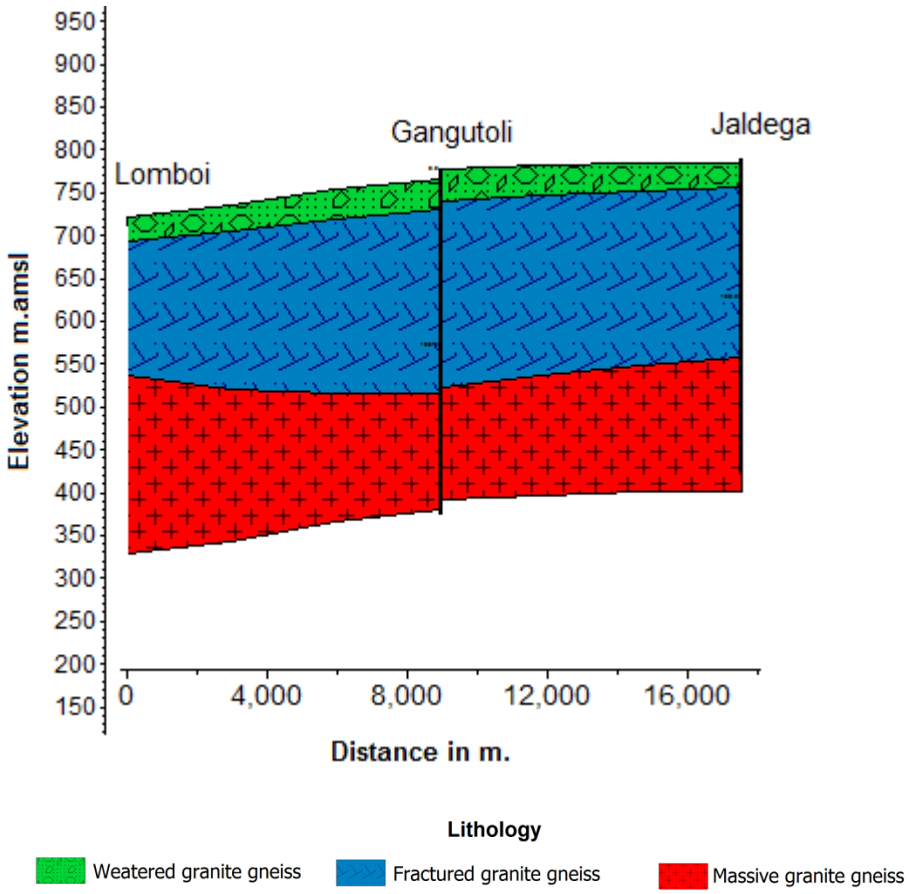






Hydrographs located at Jaldega showing Pre-monsoon rising water level trend @ 0.2622 m/year respectively.	Hydrographs located at Lomboi, Jaldega and Tengratuku showing Post monsoon rising water level trend @ 0.0091, 0.0894 and 0.0122 m/year respectively.

2.0 AQUIFER DISPOSITION	
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II
2.2 Cross section: Five exploratory and one observation wells have been constructed in Jaldega block. The yield of these wells varies from very low to 5.94 lps. The depth of occurrence of fractures zones ranging from 18.00 to 193.00 mbgl. The lithological cross section of selected three wells is shown in below	

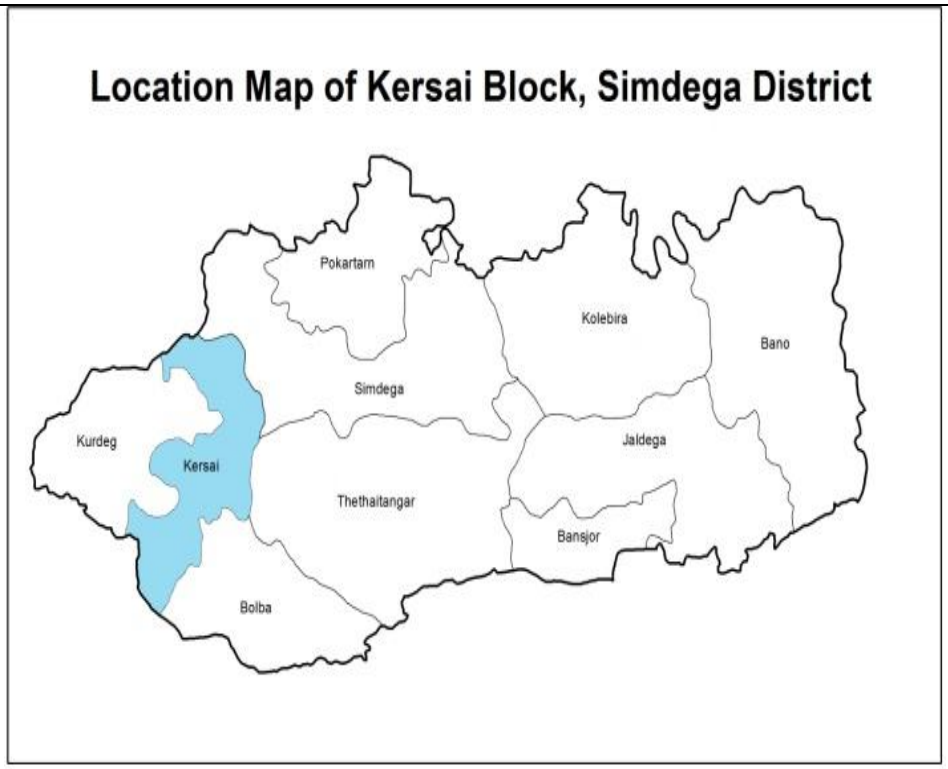


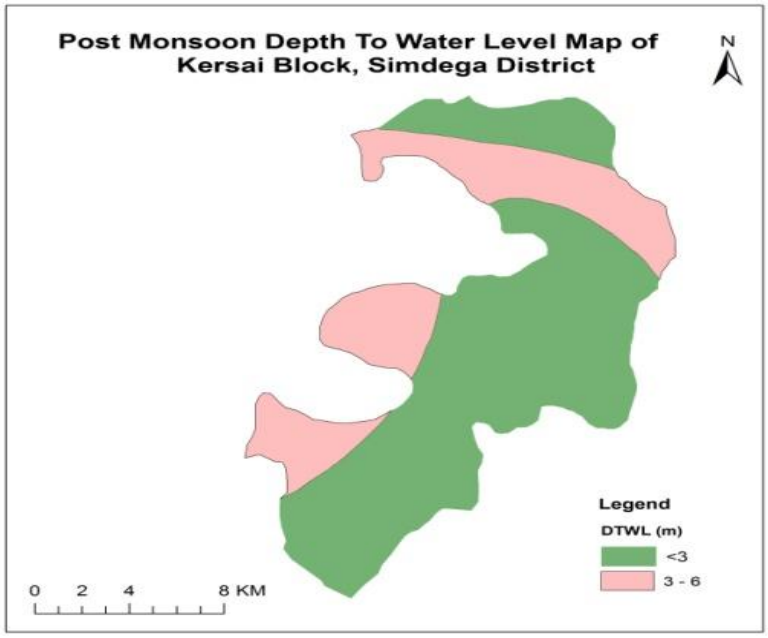
Lithological cross section of Jaldega block

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	22.30
Current annual ground water extraction for irrigation (MCM)	2.42
Current annual ground water extraction for domestic (MCM)	0.85
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	3.27
Net ground water availability for future use (MCM)	19.02
Stage of ground water extraction (%)	14.68
Category	Safe

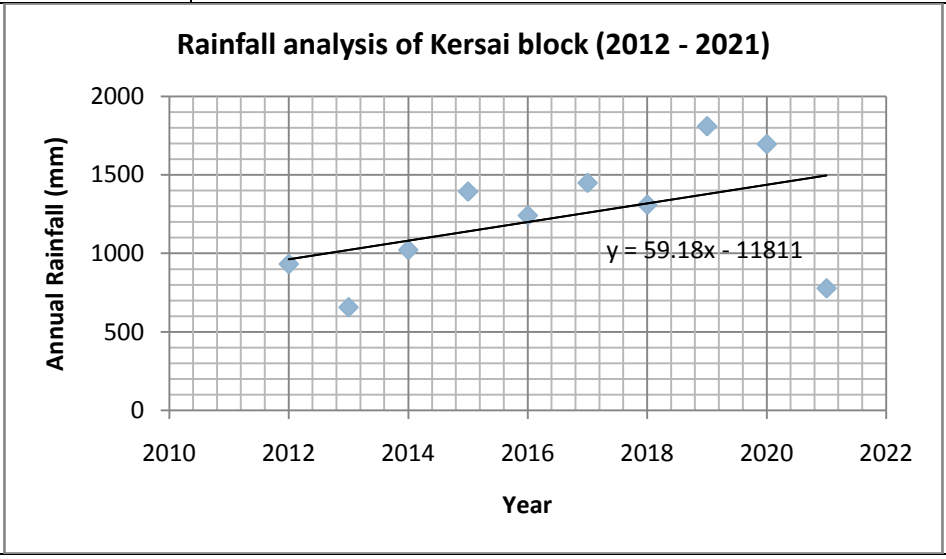
3.2 Chemical Quality of ground water & contamination	
3.1 Variation in Major and Minor elements	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer varies from 118 to 899 µS/cm. TDS has been observed between 76.7 to 584.35 mg/l. Total hardness value ranges from 45 to 300 mg/l. Similarly, the Chloride value observed between 9.27 to 127.62 mg/l while the Sulphate value varies from 7.36 to 57.97 mg/l. Nitrate value ranges from 3.06 to 28.72 mg/l. Fluoride value found between 0 to 0.17 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.	
Semi – confined/ confined Aquifer (Aquifer – II)	
The EC value of the deeper aquifer varies from 166 to 540 µS/cm. TDS has been observed between 107.9 to 339.95 mg/l. Total hardness value ranges from 60 to 220 mg/l. Similarly, the Chloride value observed between 10.64 to 67.36 mg/l while the Sulphate value varies from 11.04 to 29.38 mg/l. Nitrate values observed between 1.26 to 28.03 mg/l. Fluoride value varies from 0 to 1.07 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.	
3.2.2 Suitability for irrigation	
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 10.90 to 33.11 while RSC value observed between -0.18 to -2.76. SAR value ranges from 0.12 to 1.61 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 13.95 to 36.06 while RSC value observed between -0.28 to -0.42. SAR value ranges from 0.45 to 1.16 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation
3.3 Other issues	
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 14.68%.	
3.3.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: Central Ground Water Board has constructed 4 exploratory and one observation wells. Yield of these wells varies from 0 to 5.94 lps. One to two sets of water bearing fracture zones have been encountered within 200 m drilling. Thickness of the fracture zones found between 1 to 2 m only.	
4. SUPPLY SIDE MANAGEMENT PLAN	
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 14.68%. To enhance the ground water development from the present 14.68 % to 50% stage of development, recommended for construction of 2536 dug wells (10 -20 m depth; 2 to 4 m diameter) and 616 bore wells (up to 150 m depth) for creating additional irrigation potential 1268 ham through dug wells and 739 ham through bore wells.	
4.2 Proposed number of artificial recharge structures	
Proposed number of artificial recharge structures	The average post monsoon depth to water level observed less than 3 m (2.44 mbgl). Hence, artificial recharge structures not proposed.
5. DEMAND SIDE MANAGEMENT	
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)	

8.5 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, KERSAI BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES		
Block Name		Kersai
Geographical Area (Sq. km.)		249.40
Hilly Area (Sq. km.)		89.18
Population (2011)		39218
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1229.03 mm
Standard deviation		378.56
Coefficient of variation (in %)		30.88
Long term rainfall analysis (2012 – 2021)	Normal = 60%, Excess = 20%, Moderate drought = 20%, Rising trend of 59 mm/year	



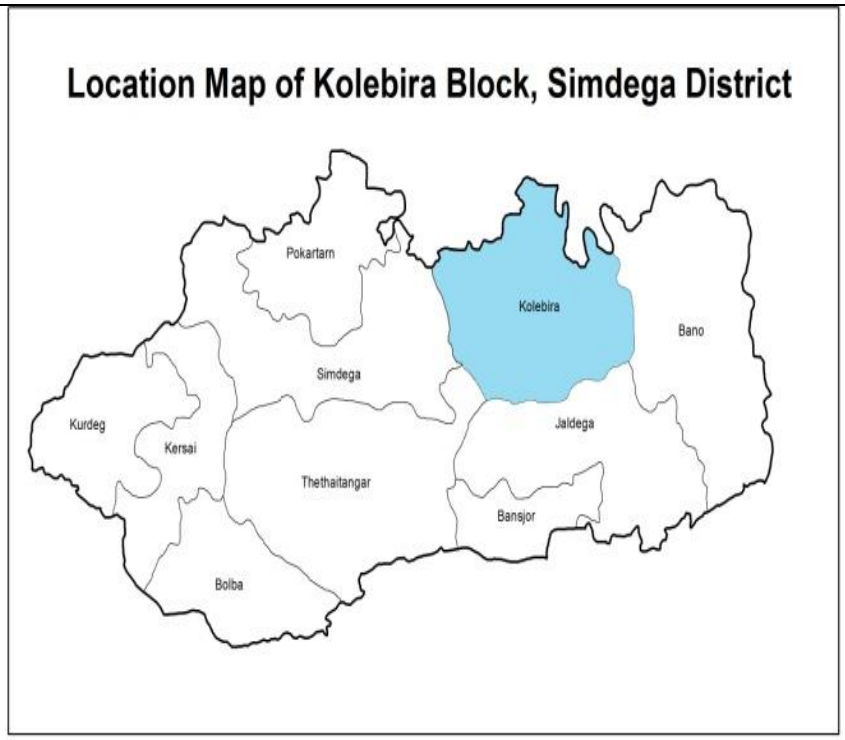
1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	32.46 Sq. km.	
Net area shown	60.84 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	0.52 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	44.01
	Ragi	0.41
	Oil seeds	4.50
	Maize	0.70
	Pulses	6.54
	Vegetable	9.21

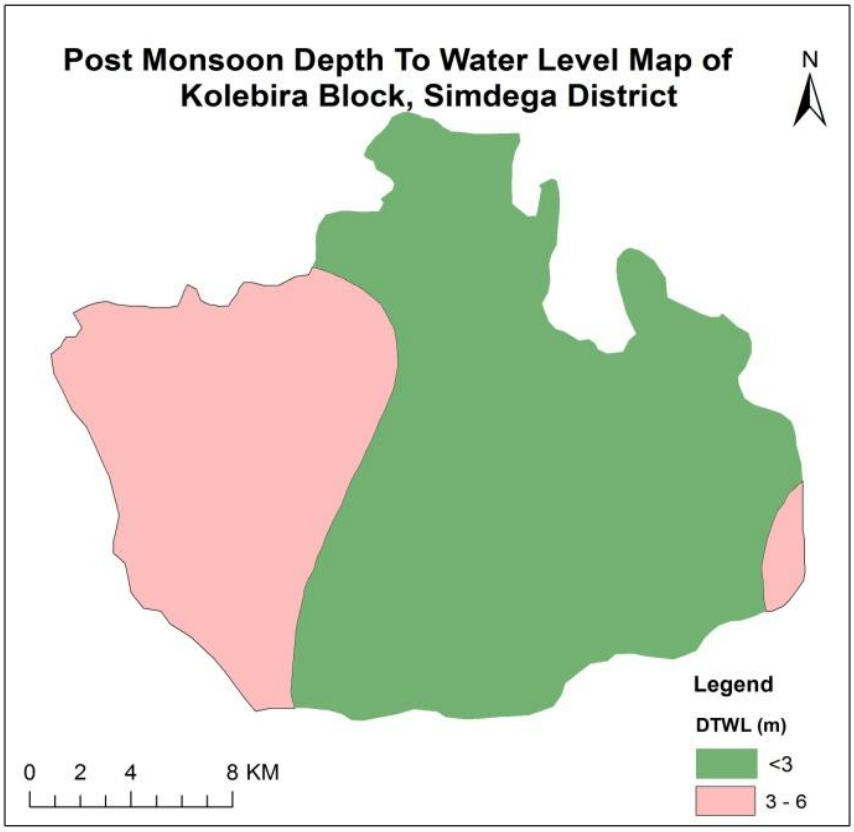
1.3 Ground water availability (2020)	
Net ground water availability for future use (MCM)	9.21
Current annual ground water extraction for all uses (MCM)	1.03
Annual extractable ground water for recharge (MCM)	*10.25*
Stage of ground water extraction (%)	10.07
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	5.90 – 5.92 mbgl.	2.58 – 3.25 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	2.65 – 3.34 m.	
1.5 Hydrograph& water level trend analysis: Hyrograph network station not located.		
2.0 AQUIFER DISPOSITION		
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II	
2.2 Cross section: Only one exploratory well located in the block.		
3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES		
3.1 Aquifer wise resource availability and extraction		
3.1.1 Phreatic Aquifer (Aquifer - I)		
Ground water resource estimation (As on 31st March 2020)		
Annual extractable ground water for recharge (MCM)		10.25
Current annual ground water extraction for irrigation (MCM)		0.51
Current annual ground water extraction for domestic (MCM)		0.52
Current annual ground water extraction for industrial (MCM)		0
Current annual ground water extraction for all uses (MCM)		1.03
Net ground water availability for future use (MCM)		9.21
Stage of ground water extraction (%)		10.07
Category		Safe
3.2 Chemical Quality of ground water & contamination		
3.2.1 Variation in Major and Minor elements		
Phreatic Aquifer (Aquifer - I)		
The EC value of the phreatic aquifer varies from 618 to 1307 µS/cm. TDS has been observed between 401.7 to 849.55 mg/l. Total hardness value ranges from 235 to 330 mg/l. Similarly, the Chloride value observed between 65.02 to 255.24 mg/l while the Sulphate value varies from 22.65 to 48.67 mg/l. Nitrate value ranges from 18.74 to 28.08 mg/l. Fluoride value found between 032 to 1.03 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.		
Semi – confined/ confined Aquifer (Aquifer – II)		
The EC value of the deeper aquifer varies from 187 to 821 µS/cm. TDS has been observed between 121.55 to 533.65 mg/l. Total hardness value ranges from 70 to 380 mg/l. Similarly, the Chloride value observed between 24.82 to 113.44 mg/l while the Sulphate value varies from 7.46 to 35.55 mg/l. Nitrate values observed between 4.14 to 27.8 mg/l. Fluoride value varies from 0 to 1.06 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.		
3.2.2 Suitability for irrigation		
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)	
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 22.55 to 46.97 while RSC value observed between -1.16 to -3.26. SAR value ranges from 0.85 to 3.20 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 11.55 to 38.21 while RSC value observed between - 0.39 to -3.96. SAR value ranges from 0.48 to 1.01 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation	
3.3 Other issues		

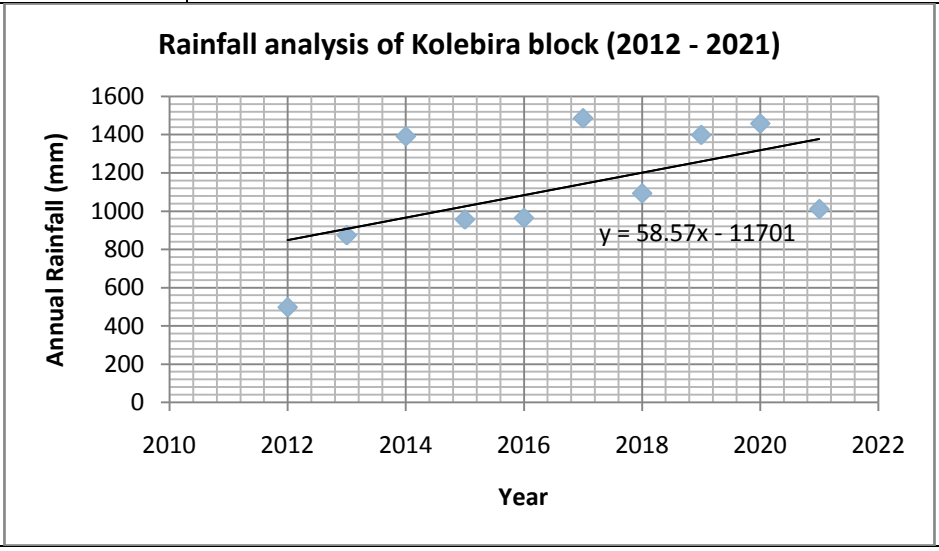
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 10.07%.	
4.SUPPLY SIDE MANAGEMENT PLAN	
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 10.07%. To enhance the ground water development from the present 10.07 % to 50% stage of development, recommended for construction of 1229 dug wells (10 -20 m depth; 2 to 4 m diameter) and 299 bore wells (up to 150 m depth) for creating additional irrigation potential 615 ham through dug wells and 359 ham through bore wells.	
4.2 Proposed number of artificial recharge structures	
Proposed number of artificial recharge structures	The average post monsoon depth to water level observed less than 3 m (2.92 mbgl). Hence, artificial recharge structures not proposed.
5. DEMAND SIDE MANAGEMENT	
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)	

8.6 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, KOLEBIRA BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES		
Block Name	Kolebira	
Geographical Area (Sq. km.)	437.36	
Hilly Area (Sq. km.)	54.00	
Population (2011)	71283	
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)	1072.65 mm	
Standard deviation	320.39	
Coefficient of variation (in %)	29.87	
Long term rainfall analysis (2012 – 2021)	Normal = 60%, Excess = 30%, Severe drought = 10%, Rising trend of 59 mm/year	



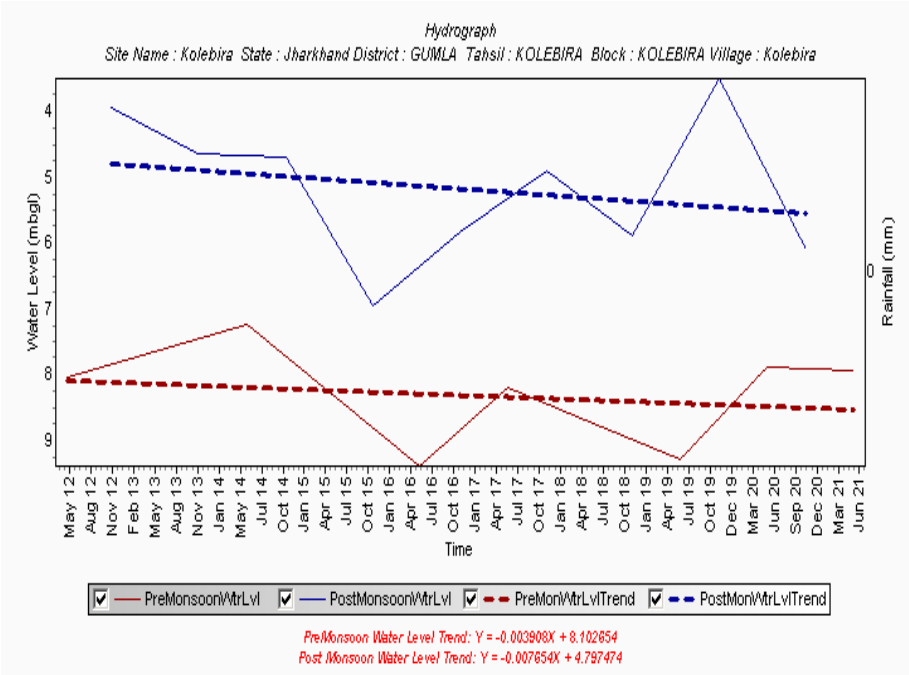
1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	45.36 Sq. km.	
Net area shown	134.78 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	2.75 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	99.63
	Ragi	8.52
	Oil seeds	1.56
	Maize	0.34
	Pulses	13.60
	Vegetable	3.44

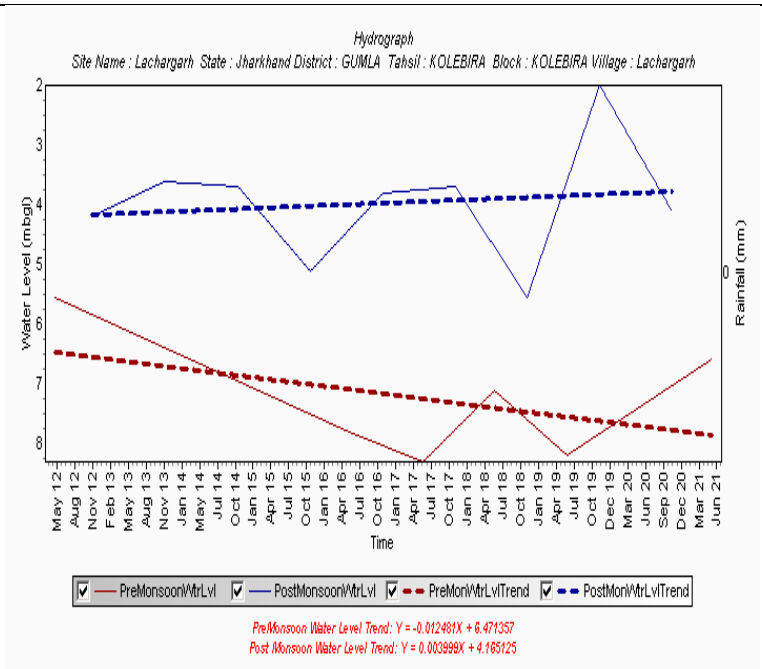
1.3 Ground water availability (2020)	
Net ground water availability for future use (MCM)	24.33
Current annual ground water extraction for all uses (MCM)	3.69
Annual extractable ground water for recharge (MCM)	28.02
Stage of ground water extraction (%)	13.15
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon	Post monsoon

	May 2021)	(November 2021)
	3.25 – 7.95 mbgl.	0.64 – 4.76 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	2.17 – 3.49 m.	

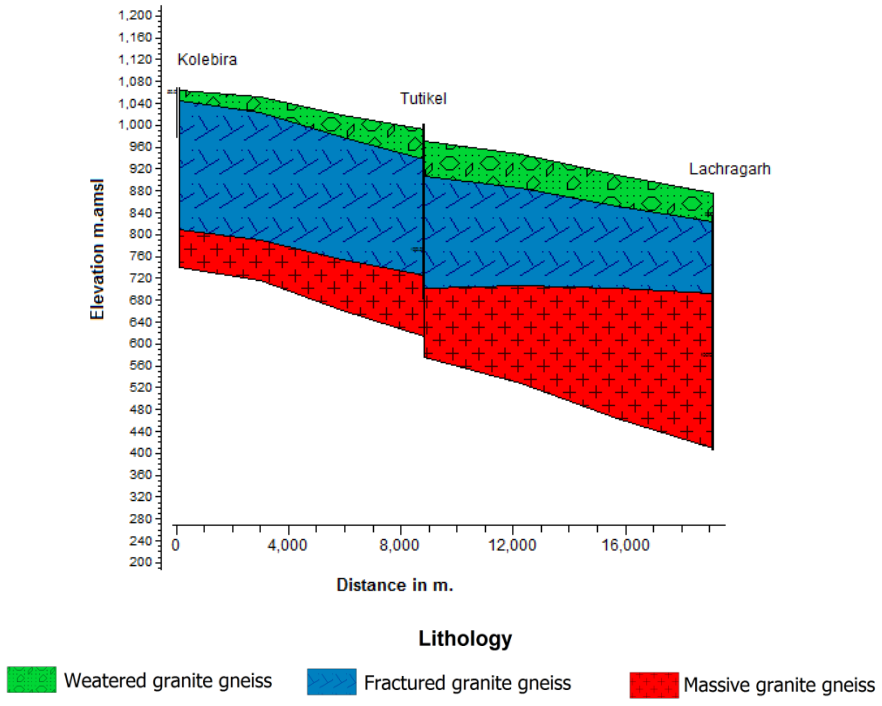
1.5 Hydrograph& water level trend analysis





Hydrographs located at Kolebira and Lacragarh showing Pre- monsoon declining water level trend @ 0.0462 and 0.1476 m/year respectively.	Hydrographs located at Kolebira showing post-monsoon declining water level trend @ 0.0436 while hydrograph located at Lachragarh showing

	rising water level trend 0.0473 m/year.
2.0 AQUIFER DISPOSITION	
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II
2.2 Cross section: Four exploratory and three observation wells have been constructed in Kolebira block. The yield of these wells varies from 0.45 to 20.00 lps. The depth of fractures zones ranging from 11.00 to 146.00 mbgl. The lithological cross section of selected three wells is shown in below	

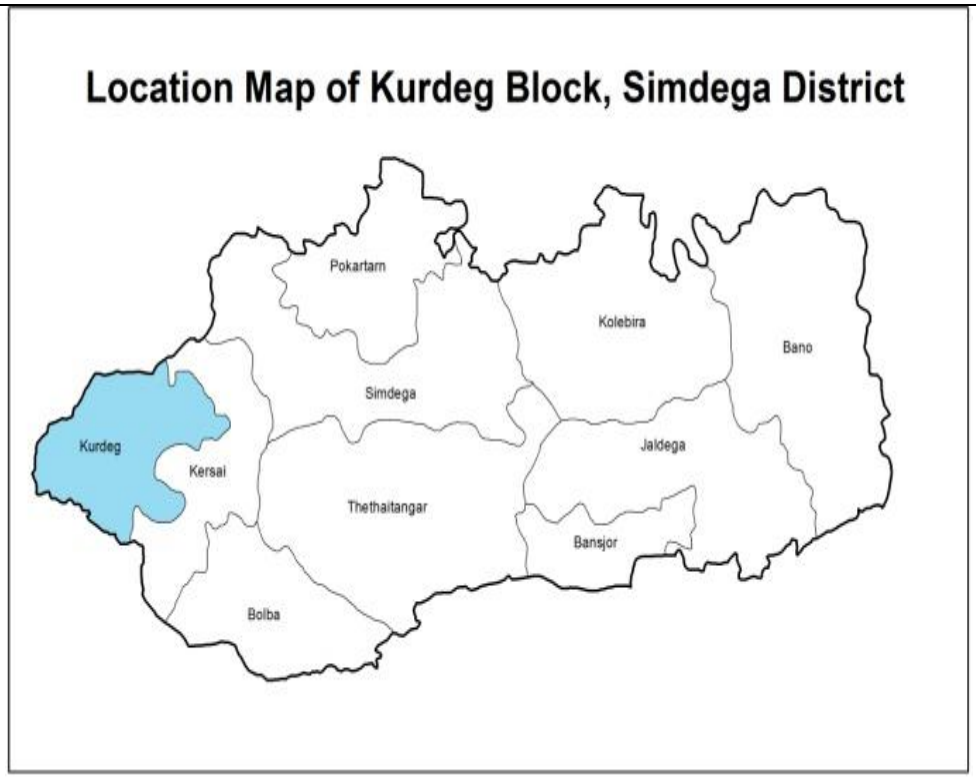


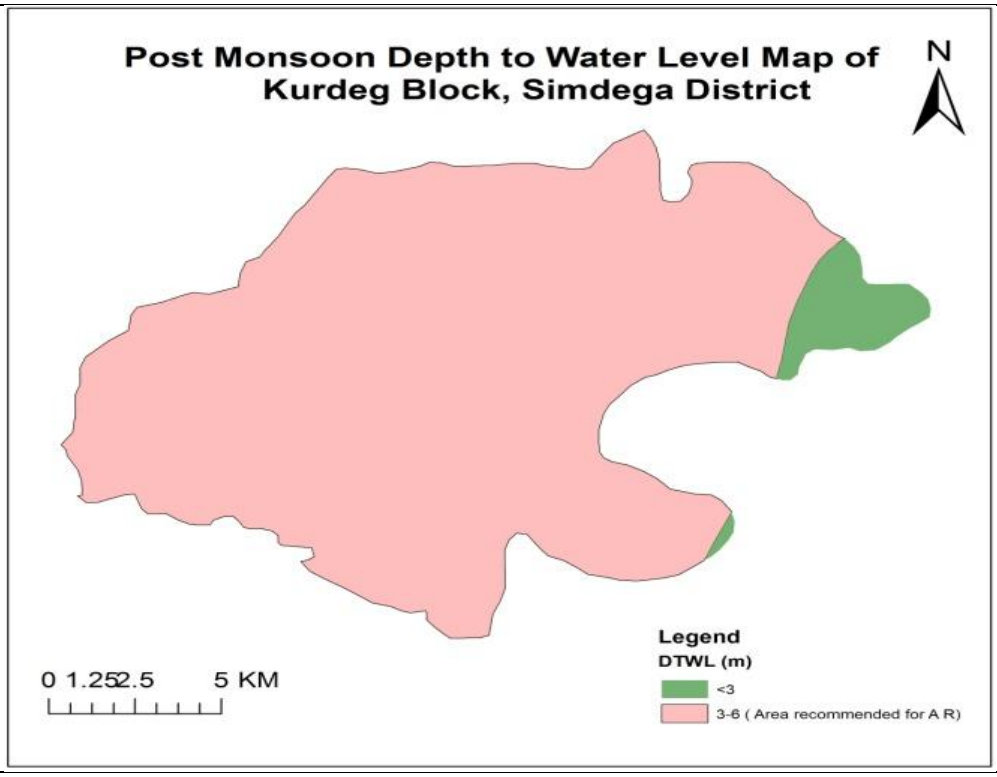
Lithological cross section of Kolebira block

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	28.01
Current annual ground water extraction for irrigation (MCM)	2.74
Current annual ground water extraction for domestic (MCM)	0.94
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	3.68
Net ground water availability for future use (MCM)	24.33
Stage of ground water extraction (%)	13.15
Category	Safe
3.2 Chemical Quality of ground water & contamination	
3.2.1 Variation in Major and Minor elements	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer varies from 71 to 721 µS/cm. TDS has been observed between	

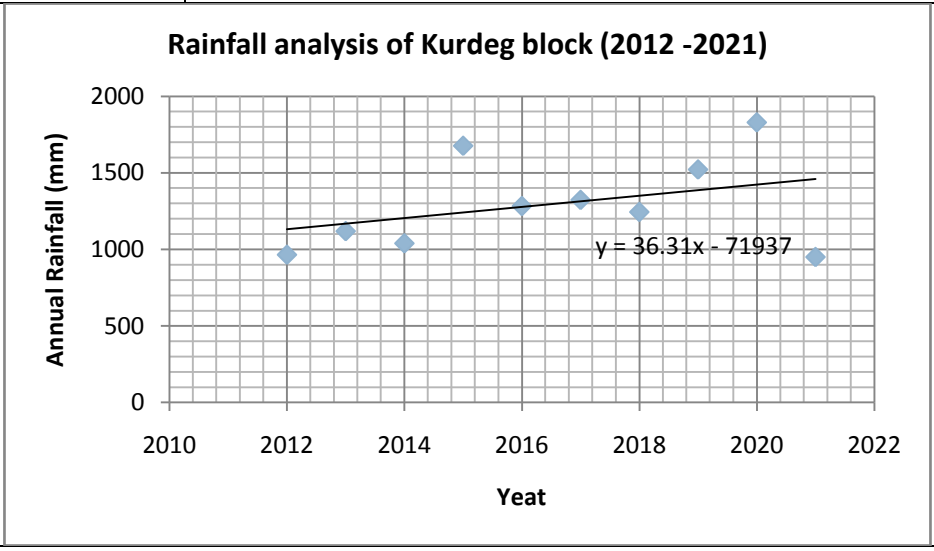
46.15 to 468.65 mg/l. Total hardness value ranges from 35 to 200 mg/l. Similarly, the Chloride value observed between 3.55 to 95.72 mg/l while the Sulphate value varies from 8.65 to 37.64 mg/l. Nitrate value ranges from 3.05 to 28.12 mg/l. Fluoride value found between 0 to 0.32 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.	
Semi – confined/ confined Aquifer (Aquifer – II)	
The EC value of the deeper aquifer varies from 143 to 752 µS/cm. TDS has been observed between 92.95 to 488.8 mg/l. Total hardness value ranges from 40 to 330 mg/l. Similarly, the Chloride value observed between 3.54 to 106.35 mg/l while the Sulphate value varies from 6.33 to 44.92 mg/l. Nitrate values observed between 0.24 to 28.85 mg/l. Fluoride value varies from 0 to 0.82 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.	
3.2.2 Suitability for irrigation	
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 10.38 to 47.58 while RSC value observed between -0.30 to -1.08. SAR value ranges from 0.07 to 2.09 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 15.44 to 48.98 while RSC value observed between - 0.45 to 0.41. SAR value ranges from 0.55 to 1.80 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation
3.3 Other issues	
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 13.15%.	
4. Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 13.15%. To enhance the ground water development from the present 13.15 % to 50% stage of development, recommended for construction of 3244 dug wells (10 -20 m depth; 2 to 4 m diameter) and 788 bore wells (up to 150 m depth) for creating additional irrigation potential 1622 ham through dug wells and 946 ham through bore wells.	
5. GROUND WATER RESOURCE AND ENHANCEMENT	
5.1 Proposed number of artificial recharge structures	The average post monsoon depth to water level observed less than 3 m (2.39 mbgl). Hence, artificial recharge structures not proposed.
5.2 Demand side management	
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)	

8.7 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, KURDEG BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES		
Block Name		Kurdeg
Geographical Area (Sq. km.)		262.30
Hilly Area (Sq. km.)		93.80
Population (2011)		47984
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1295.83 mm
Standard deviation		299.93
Coefficient of variation (in %)		23.15
Long term rainfall analysis (2012 – 2021)	Normal = 60%, Excess = 20%, Moderate drought = 20%, Rising trend of 36 mm/year	



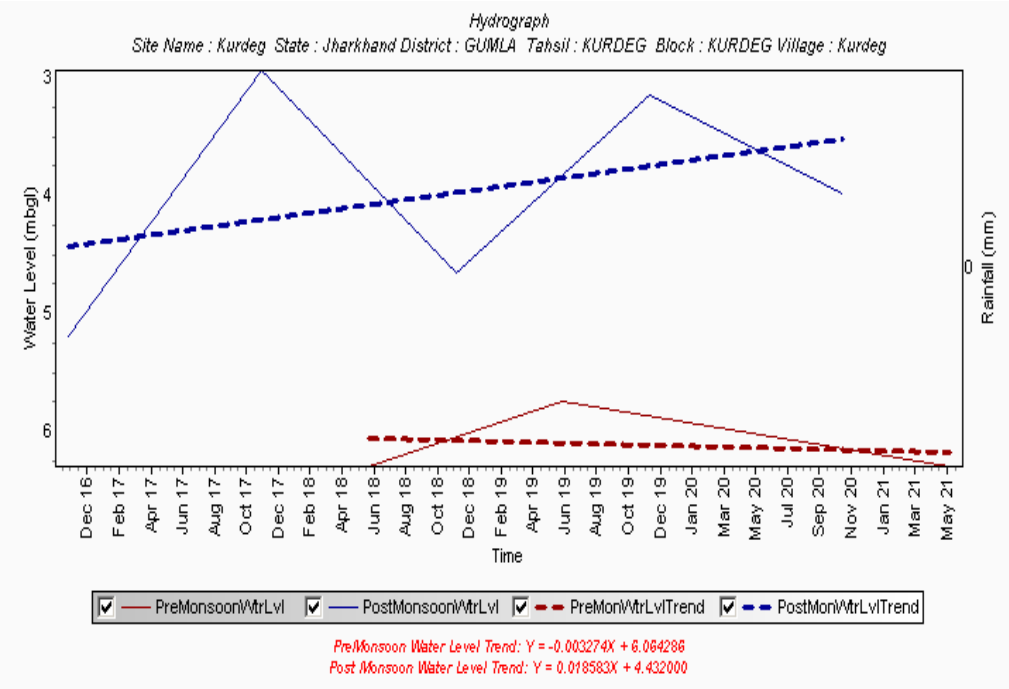
1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	26.75 Sq. km.	
Net area shown	65.03 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	1.26 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	44.01
	Ragi	0.41
	Oil seeds	4.50
	Maize	0.70
	Pulses	6.54
	Vegetable	9.21

1.3 Ground water availability (2020)	
Net ground water availability for future use (MCM)	9.27
Current annual ground water extraction for all uses (MCM)	1.89
Annual extractable ground water for recharge (MCM)	11.16
Stage of ground water extraction (%)	16.92
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon	Post monsoon

	May 2021)	(November 2021)
	6.10 – 7.80 mbgl.	3.50 – 4.67 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	1.63 – 4.20 m.	

1.5 Hydrograph& water level trend analysis



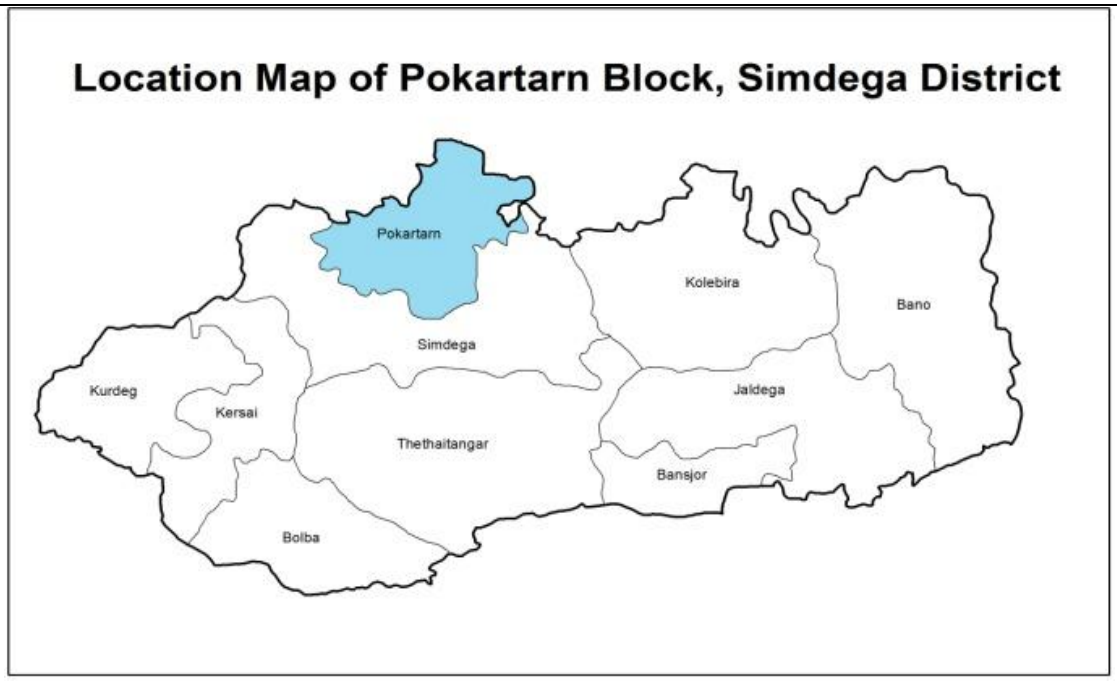
Note: Water level trend data not analyzed.

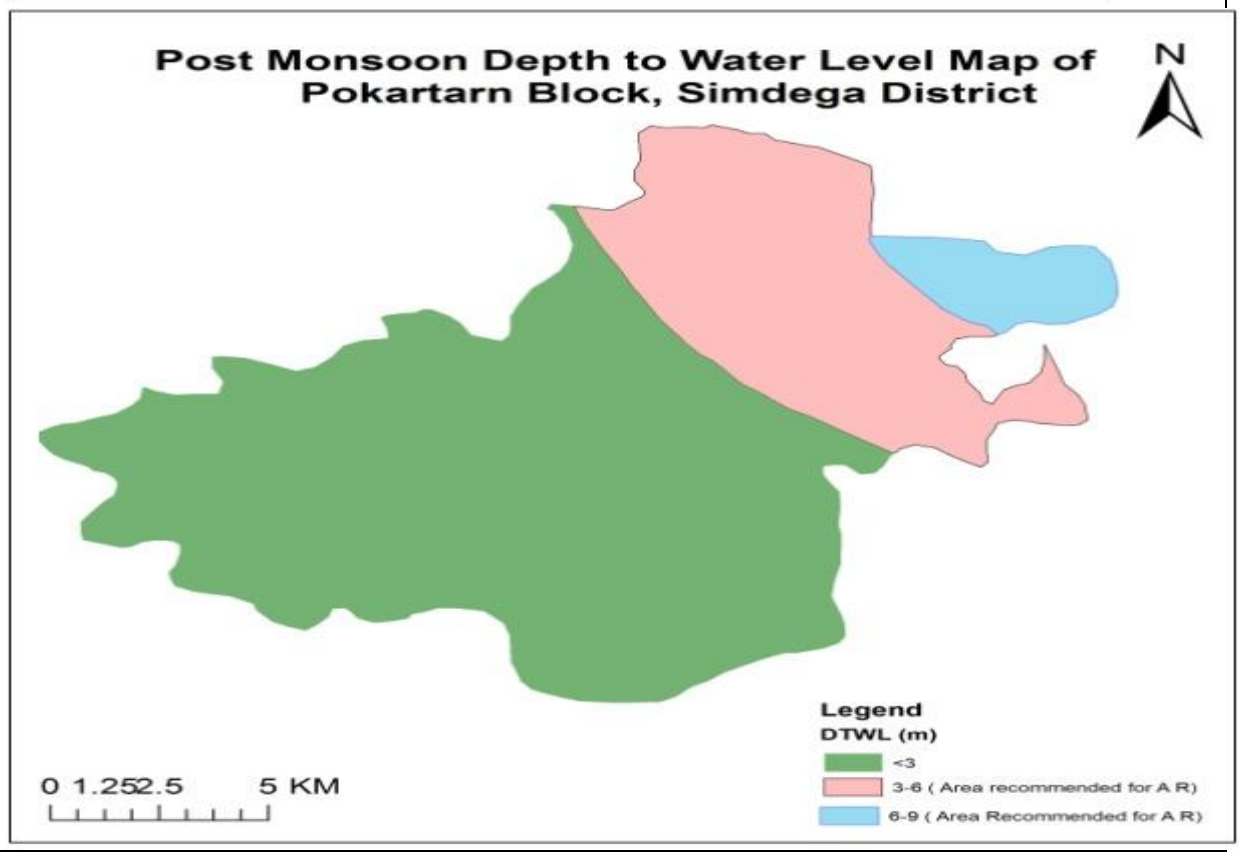
2.0 AQUIFER DISPOSITION	
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II
2.2 Cross section: Not a single well has been constructed in this block.	
3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	11.16
Current annual ground water extraction for irrigation (MCM)	1.25
Current annual ground water extraction for domestic (MCM)	0.63
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	1.89
Net ground water availability for future use (MCM)	9.27
Stage of ground water extraction (%)	16.92
Category	Safe
3.2 Chemical Quality of ground water & contamination	
3.2.1 Variation in Major and Minor elements	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer varies from 376 to 936 µS/cm. TDS has been observed between 244.4 to 608.4 mg/l. Total hardness value ranges from 130 to 345 mg/l. Similarly, the Chloride value	

observed between 28.36 to 88.63 mg/l while the Sulphate value varies from 10.78 to 63.87 mg/l. Nitrate value ranges from 6.74 to 28.25 mg/l. Fluoride value found between 0 to 0.74 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.		
Semi – confined/ confined Aquifer (Aquifer – II)		
The EC value of the deeper aquifer varies from 169 to 1127 µS/cm. TDS has been observed between 109.85 to 732.55 mg/l. Total hardness value ranges from 55 to 500 mg/l. Similarly, the Chloride value observed between 7.09 to 95.72 mg/l while the Sulphate value varies from 9.45 to 63.9 mg/l. Nitrate values observed between 2.28 to 29.10 mg/l. Fluoride value varies from 0.15 to 0.25 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.		
3.2.2 Suitability for irrigation		
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)	
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 23.11 to 36.69 while RSC value observed between -0.37 to 0.73. SAR value ranges from 0.75 to 1.12 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 13.42 to 31.51 while RSC value observed between - 0.28 to 0.11. SAR value ranges from 0.64 to 0.74 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation	
3.3 Other issues		
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 16.92%.		
4. Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 16.92%. To enhance the ground water development from the present 16.94 % to 50% stage of development, recommended for construction of 1636 dug wells (10 -20 m depth; 2 to 4 m diameter) and 300 bore wells (up to 150 m depth) for creating additional irrigation potential 618 ham through dug wells and 360 through bore wells.		
5. GROUND WATER RESOURCE AND ENHANCEMENT		
Area of block (Sq. km.)	262.30	
Area suitable for artificial recharge (Sq. km.)	242.16	
Type of aquifer	Hard rock/Soft rock	
Area feasible for artificial recharge in Sq. km.(Post monsoon water level> 3 mbgl)	242.16	
Average annual monsoon rainfall	1295.83 mm	
Average post monsoon water level	3.92 mbgl.	
Thickness of unsaturated zone	0.92 m.	
Sub-surface storage space	4.46 MCM	
Surface water requirement @ 75% efficiency	5.93 MCM	
Source water availability = 30% of Rain fall x area	94.14 MCM	
Non-committed runoff = 50% of runoff	47.07 MCM	
Surface water available for recharge = 30% of Non-committed water.	14.12 MCM	
Surplus water available (MCM)	8.19	
Proposed structures	Percolation tank (Average gross capacity – 0.188 MCM *2 filling = 0.38 MCM), 30%	Nala Bund/Check dam / Gully Plug (Average gross capacity – 0.024 MCM* 3

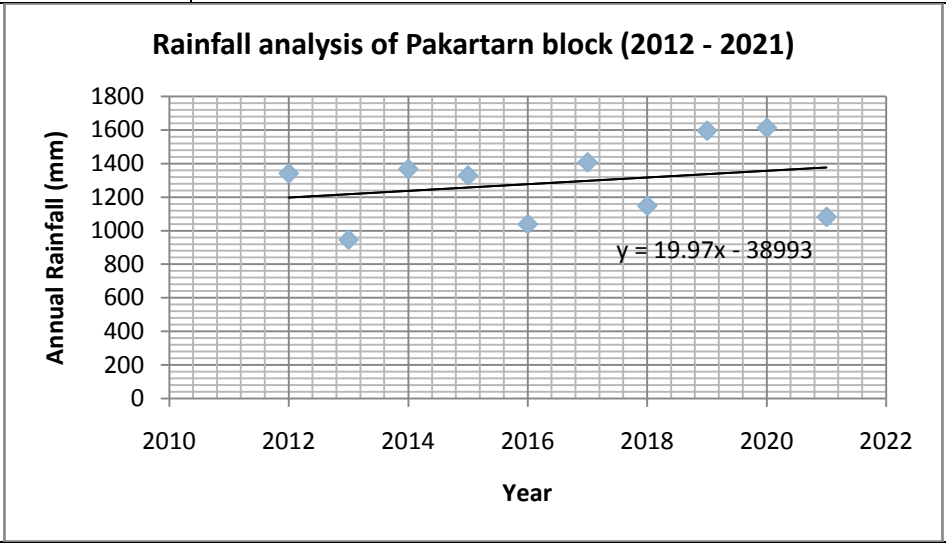
	of water available for recharge	filling = 0.072 MCM), 30% of water available for recharge
Proposed number of structures	19	98
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	7.22	7.06
5.2 Demand side management		
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)		

8.8 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, PAKARTARN BLOCK, SIMDEGA DISTRICT, JHARKHAND





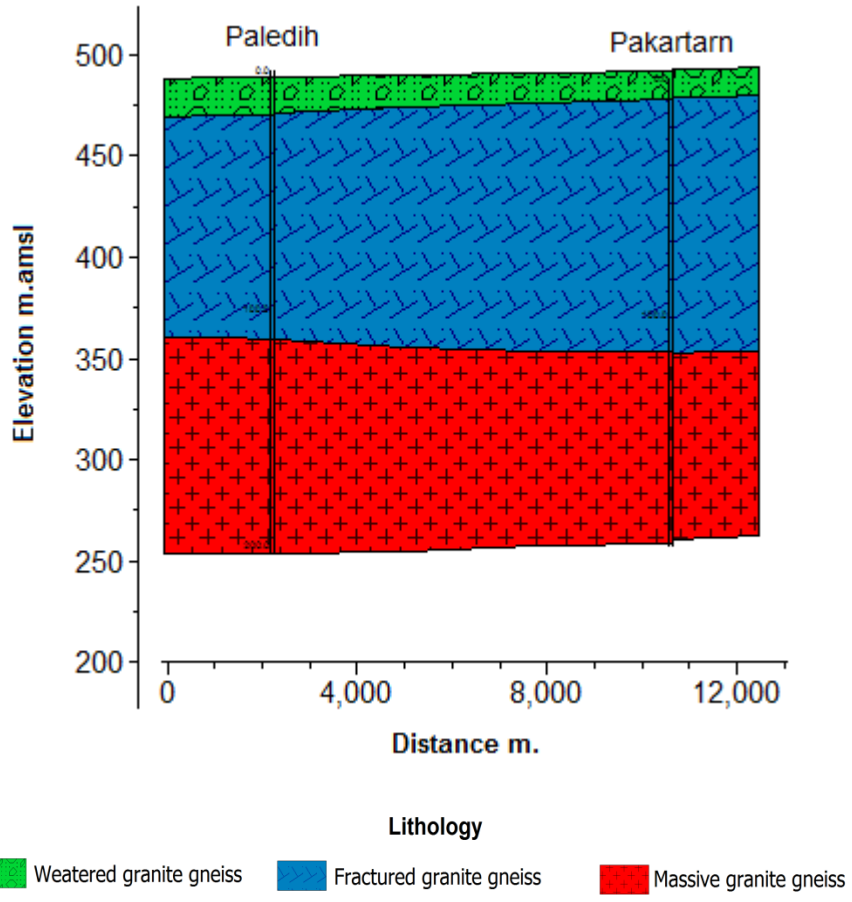
1.SALIENT FEATURES		
Block Name		Pakartarn
Geographical Area (Sq. km.)		301.31
Hilly Area (Sq. km.)		33.66
Population (2011)		37507
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1285.86 mm
Standard deviation		227.58
Coefficient of variation (in %)		17.70
Long term rainfall analysis (2012 – 2021)	Normal = 80%, Excess = 10%, Moderate drought = 10%, Rising trend of 20 mm/year	



1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	36.24 Sq. km.	
Net area shown	70.07 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	0.64 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	60.94
	Ragi	1.32
	Oil seeds	2.79
	Maize	0.09
	Pulses	2.69
	Vegetable	3.70

1.3 Ground water availability (2017)	
Net ground water availability for future use (MCM)	15.60
Current annual ground water extraction for all uses (MCM)	1.13
Annual extractable ground water for recharge (MCM)	16.94
Stage of ground water extraction (%)	6.78
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	4.10 – 10.00 mbgl.	1.00 – 7.32 mbgl.
Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	2.68 – 3.10 m.	
1.5 Hydrograph& water level trend analysis: Hydrograph network station not located in the block.		
2.0 AQUIFER DISPOSITION		
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II	
2.2 Cross section: Two exploratory wells have been constructed in Pakartarn block. The yield of these two wells found 0.13 lps. The depth of fractures zones ranging from 102.00 to 131.50 mbgl. The lithological cross section of selected three wells is shown in below		



Lithological cross section of Pakartarn block

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	16.74
Current annual ground water extraction for irrigation (MCM)	0.64
Current annual ground water extraction for domestic (MCM)	0.49

Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	1.13
Net ground water availability for future use (MCM)	15.60
Stage of ground water extraction (%)	6.78
Category	Safe

3.2 Chemical Quality of ground water & contamination

3.2.1 Variation in Major and Minor elements

Phreatic Aquifer (Aquifer - I)

The EC value of the phreatic aquifer varies from 118 to 468 µS/cm. TDS has been observed between 76.7 to 304.2 mg/l. Total hardness value ranges from 45 to 155 mg/l. Similarly, the Chloride value observed between 10.64 to 60.27 mg/l while the Sulphate value varies from 7.54 to 11.17 mg/l. Nitrate value ranges from 8.20 to 27.74 mg/l. Fluoride value found between 0 to 0.21 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.

Semi – confined/ confined Aquifer (Aquifer – II)

The EC value of the deeper aquifer varies from 157 to 210 µS/cm. TDS has been observed between 102.05 to 136.50 mg/l. Total hardness value ranges from 65 to 75 mg/l. Similarly, the Chloride value observed between 14.18 to 21.27 mg/l while the Sulphate value varies from 9.55 to 12.29 mg/l. Nitrate values observed between 0.21 to 25.05 mg/l. Fluoride value varies from 0.45 to 1.07 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose.

3.2.2 Suitability for irrigation

Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 24.25 to 35.11 while RSC value observed between -0.30 to -0.67. SAR value ranges from 0.40 to 1.25 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 21.62 to 31.28 while RSC value observed between - 0.19 to -0.49. SAR value ranges from 0.41 to 0.76 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation

3.3 Other issues

3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 6.78%.

3.3.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: Central Ground Water Board has constructed 2 exploratory wells. Yield of both the wells found only 0 .13 lps. One to two sets of water bearing fracture zones have been encountered within 200 m drilling. Thickness of the fracture zones found between 0.50 to 1.50 m only.

4. SUPPLY SIDE MANAGEMENT PLAN

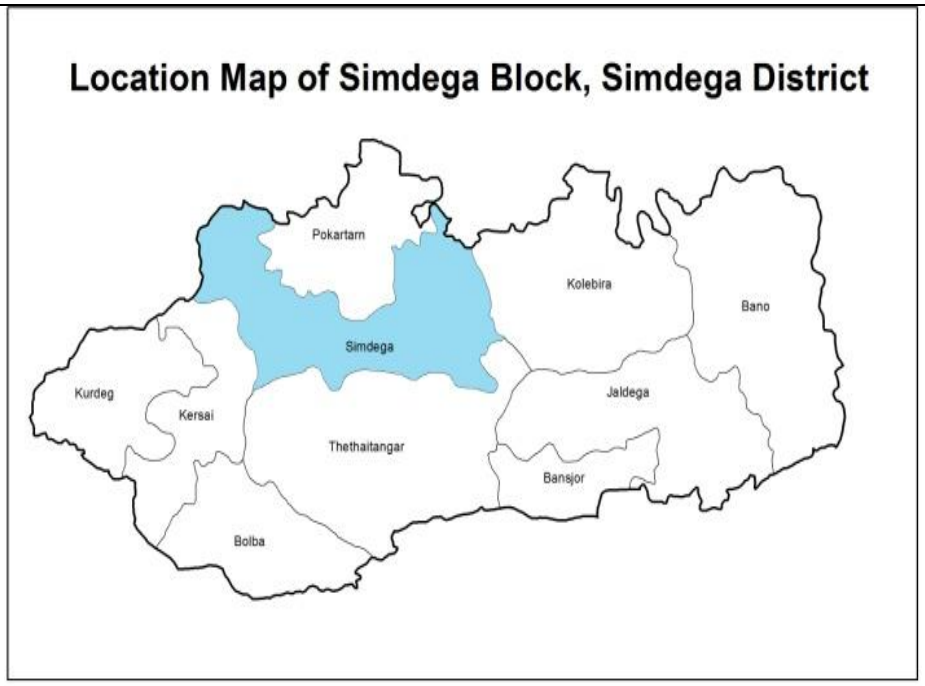
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 6.78%. To enhance the ground water development from the present 6.78 % to 50% stage of development, recommended for construction of 2080 dug wells (10 -20 m depth; 2 to 4 m diameter) and 505 bore wells (up to 150 m depth) for creating additional irrigation potential 1040 ham through dug wells and 606 ham through bore wells.

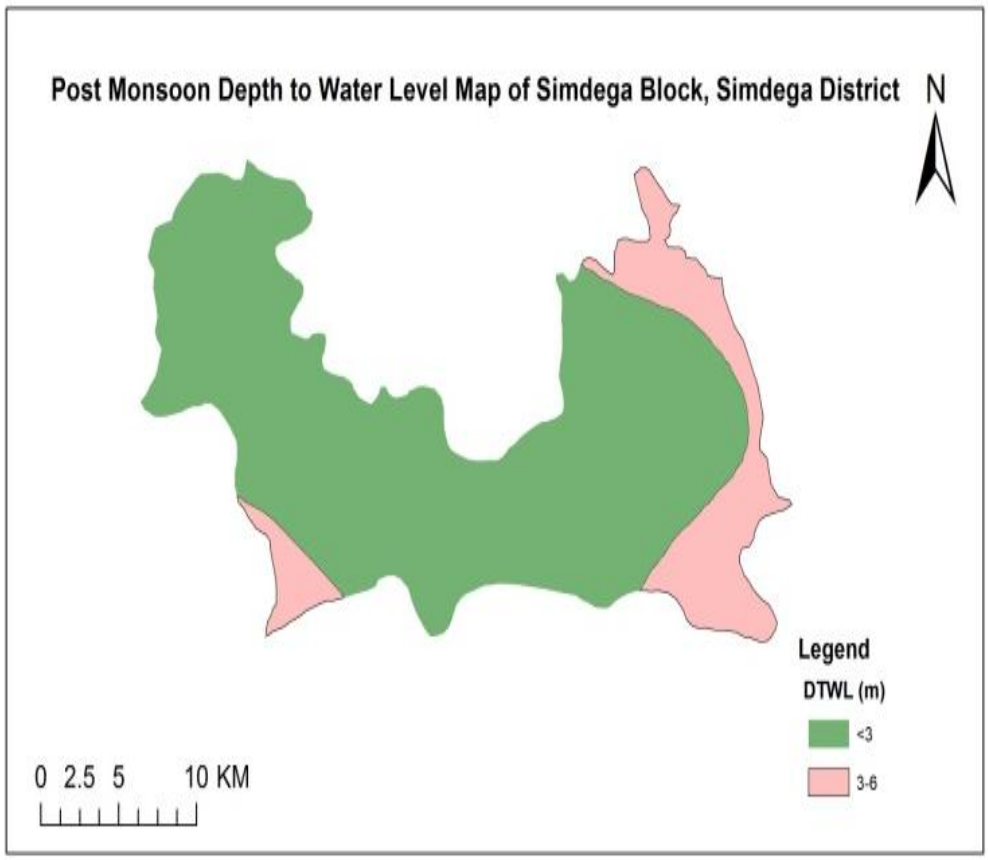
4.2. Ground Water Resource And Enhancement/ Proposed Artificial Recharge structures

Area of block (Sq. km.)	301.31
Area suitable for artificial recharge (Sq. km.)	108.19
Type of aquifer	Hard rock/Soft rock

Area feasible for artificial recharge in Sq. km.(Post monsoon water level> 3 mbgl)	108.19	
Average annual monsoon rainfall	1285.86 mm	
Average post monsoon water level	4.16 mbgl.	
Thickness of unsaturated zone	1.16 m.	
Sub-surface storage space	2.51 MCM	
Surface water requirement @ 75% efficiency	3.34 MCM	
Source water availability = 30% of Rain fall x area	41.73 MCM	
Non-committed runoff = 50% of runoff	20.87 MCM	
Surface water available for recharge = 30% of Non-committed water.	6.26 MCM	
Surplus water available (MCM)	2.92	
Proposed structures	Percolation tank (Average gross capacity – 0.188 MCM *2 filling = 0.38 MCM), 30% of water available for recharge	Nala Bund/Check dam / Gully Plug (Average gross capacity – 0.024 MCM* 3 filling = 0.072 MCM), 30% of water available for recharge
Proposed number of structures	9	45
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	3.42	3.24
5. DEMAND SIDE MANAGEMENT		
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)		

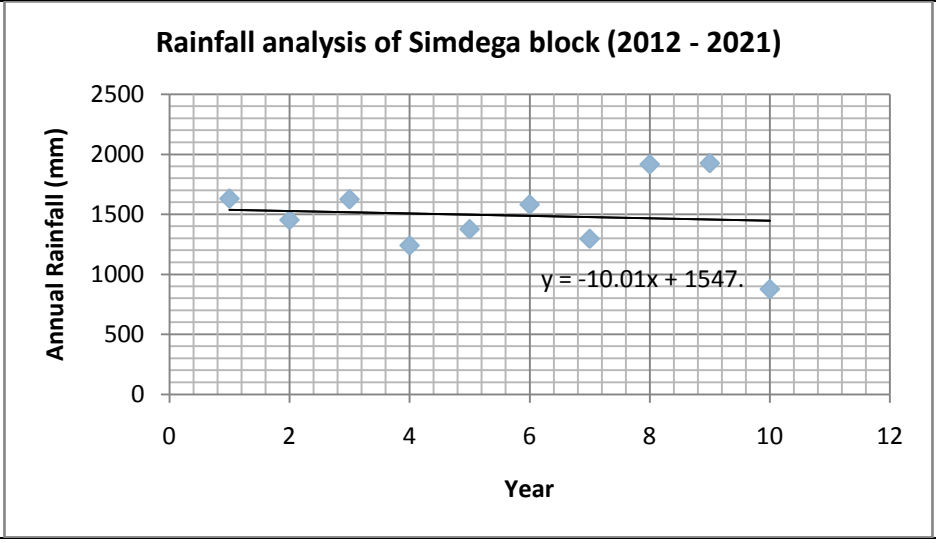
8.9 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, SIMDEGA BLOCK, SIMDEGA DISTRICT, JHARKHAND





1.SALIENT FEATURES

Block Name	Simdega
Geographical Area (Sq. km.)	446.67
Hilly Area (Sq. km.)	49.90
Population (2011)	115075
1.1 Rainfall Analysis	
Decadal average annual rainfall (2012 – 2021)	1492.18 mm
Standard deviation	318.27
Coefficient of variation (in %)	21.33
Long term rainfall analysis (2012 – 2021)	Normal = 70%, Excess = 30%, Declining trend of 10 mm/year



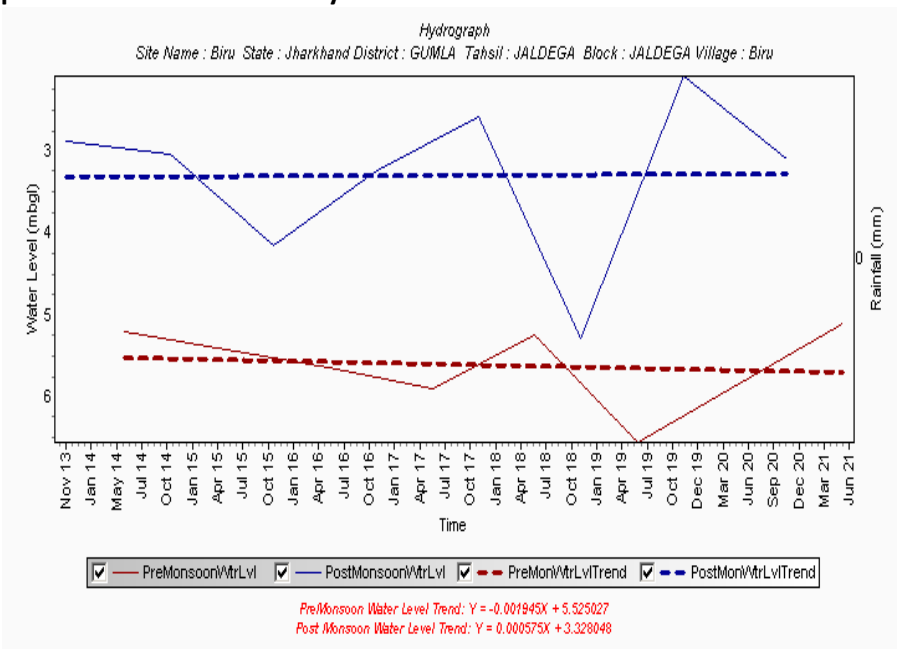
1.2 Land use, Agriculture, Irrigation & Cropping pattern		
Current fallow	92.09 Sq. km.	
Net area shown	98.32 Sq. km.	
Area under irrigation	Surface water	NA
	Ground water	2.5 Sq. km.
Principal crops	Crop type	Area (Sq. km.), 2019 - 20
	Paddy	74.99
	Ragi	3.63
	Oil seeds	4.07
	Maize	0.76
	Pulses	6.89
	Vegetable	7.88

1.3 Ground water availability (2020)	
Net ground water availability for future use (MCM)	30.67
Current annual ground water extraction for all uses (MCM)	4.51
Annual extractable ground water for recharge (MCM)	35.20
Stage of ground water extraction (%)	12.83
Category	Safe

1.4 Water level behavior		
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)
	3.95 – 8.40 mbgl.	1.05 – 2.95 mbgl.

Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	1.60 – 3.70 m.

1.8 Hydrograph& water level trend analysis



Hydrographs located at Biru showing Pre-monsoon declining water level trend @ 0.0230m/year.	Hydrographs located at Biru showing post-monsoon rising water level trend @ 0.0708 m/year.

2.0 AQUIFER DISPOSITION

2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer - II

2.2 Cross section:

Two exploratory wells have been constructed in the Simdega town within half km. distance. Thus, lithological cross section cannot be prepared.

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

3.1 Aquifer wise resource availability and extraction

3.1.1 Phreatic Aquifer (Aquifer - I)

Ground water resource estimation (As on 31st March 2020)

Annual extractable ground water for recharge (MCM)	35.20
Current annual ground water extraction for irrigation (MCM)	2.50
Current annual ground water extraction for domestic (MCM)	2.01
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	4.51
Net ground water availability for future use (MCM)	30.67
Stage of ground water extraction (%)	12.83
Category	Safe

3.2 Chemical Quality of ground water & contamination

3.2.1 Variation in Major and Minor elements

Phreatic Aquifer (Aquifer - I)

The EC value of the deeper aquifer varies from 195 to 860 µS/cm. TDS has been observed between

126.75 to 559 mg/l. Total hardness value ranges from 70 to 319 mg/l. Similarly, the Chloride value observed between 7.09 to 109.90 mg/l while the Sulphate value varies from 11.02 to 42.82 mg/l. Nitrate values observed between 1.05 to 33.94 mg/l. Fluoride value varies from 0 to 0.80 mg/l. Overall ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.

Semi – confined/ confined Aquifer (Aquifer – II)

The EC value of the deeper aquifer varies from 133 to 682 µS/cm. TDS has been observed between 86.45 to 443.3 mg/l. Total hardness value ranges from 45 to 260 mg/l. Similarly, the Chloride value observed between 7.09 to 53.18 mg/l while the Sulphate value varies from 6.82 to 62.11 mg/l. Nitrate values observed between 0 to 26.13 mg/l. Fluoride value varies from 0.16 to 2.18 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose except Fluoride.

3.2.2 Suitability for irrigation

Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 17.61 to 35.36 while RSC value observed between -0.19 to -0.87. SAR value ranges from 0.18 to 1.30 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 26.71 to 41.72 while RSC value observed between - 0.19 to 0.12. SAR value ranges from 0.64 to 1.15 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation

3.3 Other issues

3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 12.83%.

3.3.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: Central Ground Water Board has constructed 2 exploratory and one observation wells. Yield of these wells varies from 0.45 to 3.00 lps. One to three sets of water bearing fracture zones have been encountered within 200 m drilling. Thickness of the fracture zones found between 1 to 1.50 m only.

3.3.3 Fluoride contamination: Fluoride value found beyond permissible limit at villages Simdega (1.86 mg/l), Banabira (1.69 mg/l) and Sewai 2.18 mg/l).

4. SUPPLY SIDE MANAGEMENT

4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 12.83%. To enhance the ground water development from the present 12.83 % to 50% stage of development, recommended for construction of 4090 dug wells (10 -20 m depth; 2 to 4 m diameter) and 994 bore wells (up to 150 m depth) for creating additional irrigation potential 2045 ham through dug wells and 1193 ham through bore wells.

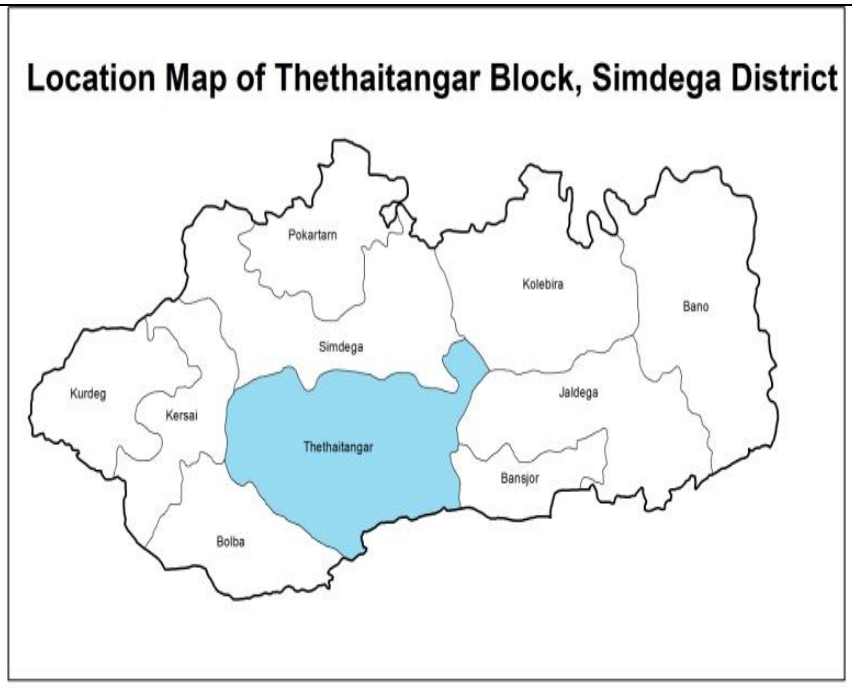
4.2Proposed number of artificial recharge structures

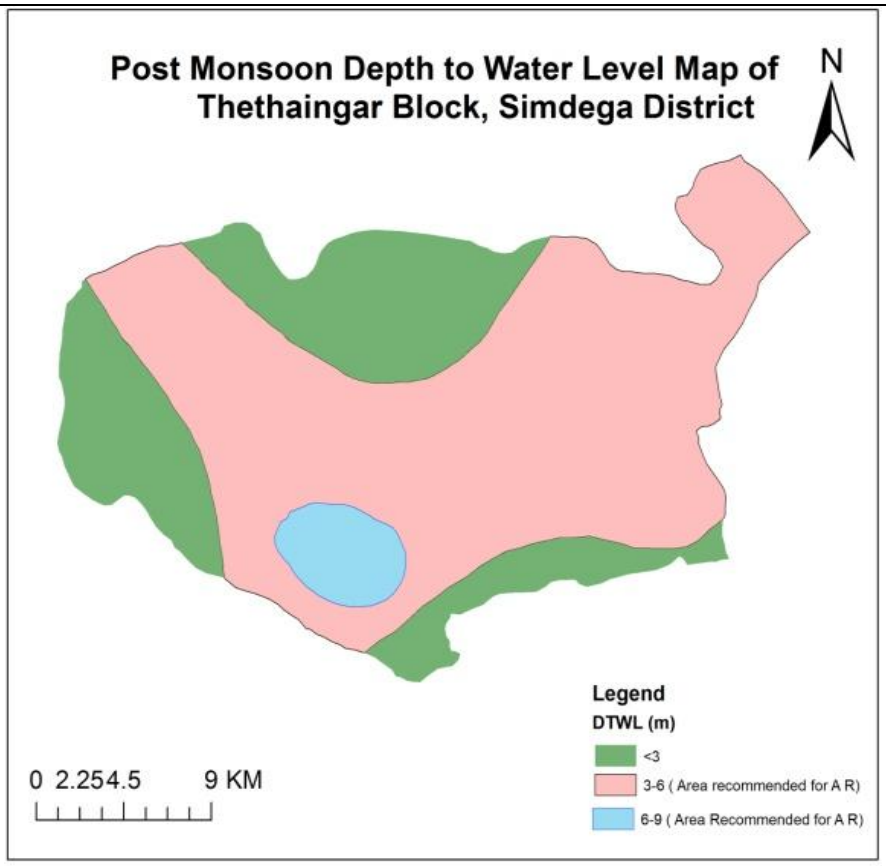
Proposed number of artificial recharge structures	The average post monsoon depth to water level observed less than 3 m (1.88 mbgl). Hence, artificial recharge structures not proposed.

5. DEMAND SIDE MANAGEMENT

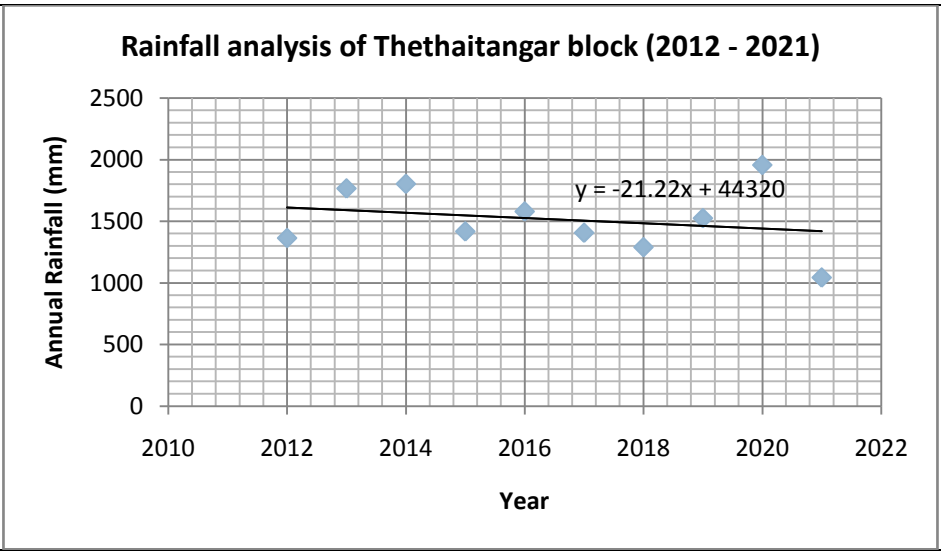
- Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.),
- Crop choice management and diversification(Promoting less intensive crops)
- Promoting treated municipal waste water for irrigation and construction use

8.10 AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, THETHAITANGAR BLOCK, SIMDEGA DISTRICT, JHARKHAND

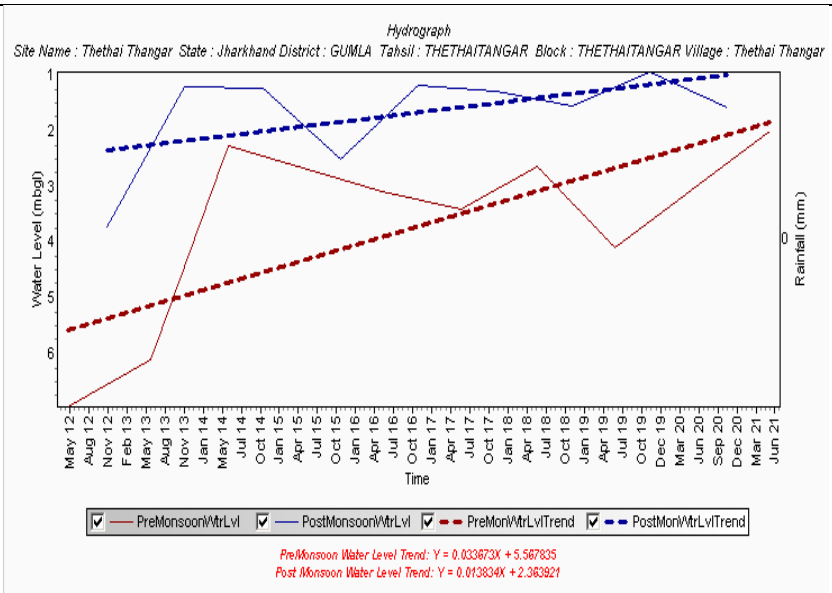


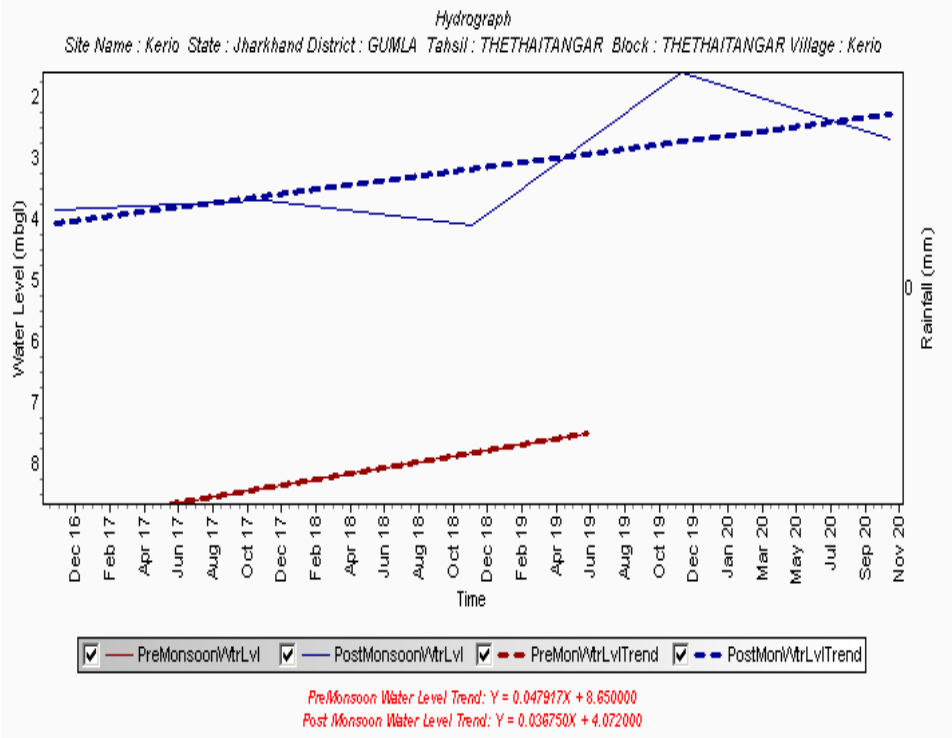


1.SALIENT FEATURES		
Block Name		Thethaitangar
Geographical Area (Sq. km.)		624.15
Hilly Area (Sq. km.)		40.00
Population (2011)		87458
1.1 Rainfall Analysis		
Decadal average annual rainfall (2012 – 2021)		1515.49 mm
Standard deviation		271.36
Coefficient of variation (in %)		17.91
Long term rainfall analysis (2012 – 2021)	Normal = 80%, Excess = 10%, Moderate drought = 10%, Declining trend of 21 mm/year	

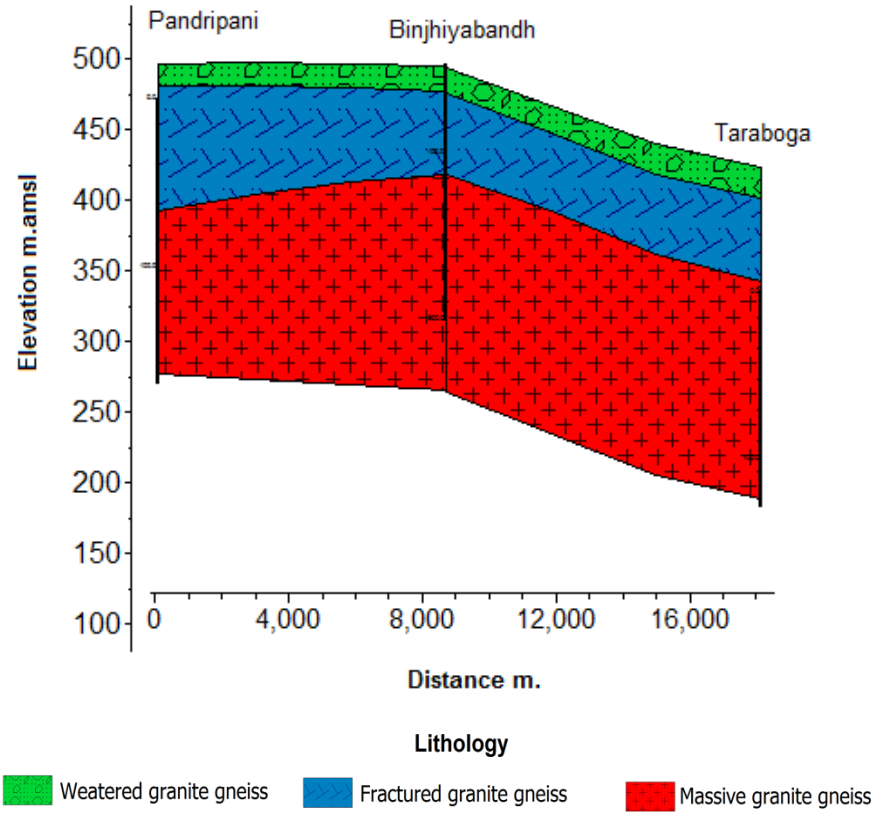


1.2 Land use, Agriculture, Irrigation & Cropping pattern			
Current fallow	139.32 Sq. km.		
Net area shown	110.34 Sq. km.		
Area under irrigation	Surface water	NA	
	Ground water	5.05 Sq. km.	
Principal crops	Crop type	Area (Sq. km.), 2019 – 20	
	Paddy	84.63	
	Ragi	6.36	
	Oil seeds	2.49	
	Maize	0.27	
	Pulses	9.85	
	Vegetable	4.66	
1.3 Ground water availability (2020)			
Net ground water availability for future use (MCM)		32.48	
Current annual ground water extraction for all uses (MCM)		6.21	
Annual extractable ground water for recharge (MCM)		38.70	
Stage of ground water extraction (%)		16.04	
Category		Safe	
1.4 Water level behavior			
Phreatic aquifer	Pre – monsoon May 2021)	Post monsoon (November 2021)	
	3.40 – 10.50 mbgl.	1.20 – 7.47 mbgl.	
Seasonal water level fluctuation between pre monsoon and post monsoon (2021)	1.05 – 4.51 m.		
1.5 Hydrograph& water level trend analysis			





Hydrographs located at Thethaitangar showing Pre- monsoon rising water level trend and 0.3983 m/year respectively.	Hydrographs located at Thethaitangar and Kereya showing post- monsoon rising water level trend @ 0.0375 and 0.1739 m/year respectively.
2.0 AQUIFER DISPOSITION	
2.1 Numbers of aquifers	Granite gneiss – Aquifer – I, Aquifer – II
2.2 Cross section: Five exploratory and two observationwells have been constructed in Thethaitangar block. The yield of these wells found 0 to 12.30 lps. The depth of fractures zones ranging from 9.00 to 131.00 mbgl. The lithological cross section of selected three wells is shown in below	



Lithological cross section of Thethaitangar block

3. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES	
3.1 Aquifer wise resource availability and extraction	
3.1.1 Phreatic Aquifer (Aquifer - I)	
Ground water resource estimation (As on 31st March 2020)	
Annual extractable ground water for recharge (MCM)	38.70
Current annual ground water extraction for irrigation (MCM)	5.05
Current annual ground water extraction for domestic (MCM)	115
Current annual ground water extraction for industrial (MCM)	0
Current annual ground water extraction for all uses (MCM)	6.21
Net ground water availability for future use (MCM)	32.49
Stage of ground water extraction (%)	16.04
Category	Safe
3.2 Chemical Quality of ground water & contamination	
3.2.1 Variation in Major and Minor elements	
Phreatic Aquifer (Aquifer - I)	
The EC value of the phreatic aquifer varies from 107 to 490 µS/cm. TDS has been observed between 69.55 to 318.5 mg/l. Total hardness value ranges from 55 to 215 mg/l. Similarly, the Chloride value observed between 7.09 to 67.36 mg/l while the Sulphate value varies from 5.28 to 19.39 mg/l. Nitrate value ranges from 4.10 to 24.60 mg/l. Fluoride value found between 0 to 0.80 mg/l. Overall	

ground water quality of shallow aquifer (Aquifer – I) is suitable for domestic purpose.		
Semi – confined/ confined Aquifer (Aquifer – II)		
The EC value of the deeper aquifer varies from 201 to 470 µS/cm. TDS has been observed between 130.65 to 305.50 mg/l. Total hardness value ranges from 65 to 175 mg/l. Similarly, the Chloride value observed between 10.64 to 49.63 mg/l while the Sulphate value varies from 6.87 to 35.05 mg/l. Nitrate values observed between 1.74 to 13.77mg/l. Fluoride value varies from 0.17 to 3.87 mg/l. In general, ground water quality of deeper aquifer (Aquifer – II) is suitable for domestic purpose except Fluoride.		
3.2.2 Suitability for irrigation		
Phreatic Aquifer (Aquifer - I)	Semi – confined/ confined Aquifer (Aquifer – II)	
Sodium percentage of ground water of shallow aquifer (Aquifer –I) varies from 12.97 to 54.74 while RSC value observed between -0.49 to 0.62. SAR value ranges from 0.61 to 1.81 and falling in excellent water class. The ground water of shallow aquifer (Aquifer – I) is suitable for irrigation.	Sodium percentage of ground water of deeper aquifer (Aquifer –II) varies from 26.61 to 35.13 while RSC value observed between – 0.18 to 0.22. SAR value ranges from 0.75 to 1.22 and falling in excellent water class. The ground water of deeper aquifer (Aquifer – II) is suitable for irrigation	
3.3 Other issues		
3.3.1 Low ground water development: Low ground water development is the one major issue of the block. Based on Ground water resource assessment as on 2020 stage of ground water development is only 16.04%.		
3.3.2 Fluoride contamination: Fluoride value found beyond permissible limit at villages Paikpara (2.59 mg/l) and Lathakhamhan (3.87 mg/l).		
4. SUPPLY SIDE MANAGEMENT		
4.1 Ground Water Development Strategies-Construction of Tube well/Bore well based on available safe resources: As per Dynamic Ground Water Resource estimation 2020, the stage of ground water development is only 16.04%. To enhance the ground water development from the present 16.04 % to 50% stage of development, recommended for construction of 4332 dug wells (10 -20 m depth; 2 to 4 m diameter) and 1053 bore wells (up to 150 m depth) for creating additional irrigation potential 2166 ham through dug wells and 1264 ham through bore wells.		
4.2. Ground Water Resource And Enhancement/ Proposed Artificial Recharge structures		
Area of block (Sq. km.)	624.15	
Area suitable for artificial recharge (Sq. km.)	434.34	
Type of aquifer	Hard rock/Soft rock	
Area feasible for artificial recharge in Sq. km.(Post monsoon water level> 3 mbgl)	434.34	
Average annual monsoon rainfall	1515.49 mm	
Average post monsoon water level	3.49 mbgl.	
Thickness of unsaturated zone	0.49 m.	
Sub-surface storage space	4.26 MCM	
Surface water requirement @ 75% efficiency	5.66 MCM	
Source water availability = 30% of Rain fall x area	206.71 MCM	
Non-committed runoff = 50% of runoff	103.35 MCM	
Surface water available for recharge = 30% of Non-committed water.	31.00 MCM	
Surplus water available (MCM)	25.34	
Proposed structures	Percolation tank (Average	Nala Bund/Check dam /

	gross capacity – 0.188 MCM *2 filling = 0.38 MCM), 30% of water available for recharge	Gully Plug (Average gross capacity – 0.024 MCM* 3 filling = 0.072 MCM), 30% of water available for recharge
Proposed number of structures	41	216
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	15.58	15.55
5. DEMAND SIDE MANAGEMENT		
• Promoting Micro irrigation Technique (drip or sprinkler irrigation, etc.), • Crop choice management and diversification(Promoting less intensive crops)		

Annexure - I

LAST TEN YEARS (2012 TO 2021) ANNUAL RAINFALL DATA ANALYSIS OF SIMDEGA DISTRICT

Block: Simdega (2012 – 2021)

Average annual rainfall (mm):1492.18

Standard deviation: 318.27

Coefficient of variation (in %): 21.33

Year	Annual rainfall (mm)	Departure %	Category
2012	1631	9.30	Normal
2013	1453	- 2.63	Normal
2014	1625.1	8.91	Normal
2015	1240.5	-16.87	Normal
2016	1375.9	-7.79	Normal
2017	1581.5	5.98	Normal
2018	1295.5	-13.18	Normal
2019	1917	28.47	Excess
2020	1926.8	29.12	Excess
2021	875.5	41.33	Excess

Block: Kurdeg (2012 – 2021)

Average annual rainfall (mm):1295.83

Standard deviation: 299.93

Coefficient of variation (in %): 23.15

Year	Annual rainfall (mm)	Departure %	Category
2012	965.9	-25.46	Moderate
2013	1119.7	-13.59	Normal
2014	1040.2	-19.73	Normal
2015	1677.1	29.42	Excess
2016	1283.5	-0.95	Normal
2017	1323.6	2.14	Normal
2018	1245	-3.92	Normal
2019	1522.3	17.48	Normal
2020	1830	41.22	Excess
2021	951	-26.61	Maderate

Block: Bolba (2012 – 2021)

Average annual rainfall (mm): 1085.81

Standard deviation: 219.98

Coefficient of variation (in %): 20.26

Year	Annual rainfall (mm)	Departure %	Category
2012	955.4	-12.01	Normal
2013	1052	-3.11	Normal
2014	1367.2	25.92	Excess
2015	1310.1	20.66	Normal
2016	1143.1	5.28	Normal

2017	1401.4	29.06	Excess
2018	919.2	-15.34	Normal
2019	1034.5	-4.73	Normal
2020	962.9	-11.32	Normal
2021	712.3	-34.40	Moderate

Block: Thethaitangar (2012 – 2021)
Average annual rainfall (mm):1515.49
Standard deviation: 271.36
Coefficient of variation (in %): 17.91

Year	Annual rainfall (mm)	Departure %	Category
2012	1364.2	-9.98	Normal
2013	1766.7	16.58	Normal
2014	1803.8	19.02	Normal
2015	1417.8	-6.45	Normal
2016	1579.7	4.24	Normal
2017	1407	-7.16	Normal
2018	1290	-14.88	Normal
2019	1525.1	0.63	Normal
2020	1956.8	29.12	Excess
2021	1043.8	-31.12	Moderate

Block: Bano (2012 – 2021)
Average annual rainfall (mm): 1080.02
Standard deviation: 287.90
Coefficient of variation (in %): 26.66

Year	Annual rainfall (mm)	Departure %	Category
2012	695.7	-35.58	Moderate
2013	792.9	-26.58	Moderate
2014	1189.4	10.13	Normal
2015	1205.8	11.65	Normal
2016	1324.7	22.66	Normal
2017	1337.3	23.82	Normal
2018	1017.8	-5.76	Normal
2019	1187.5	9.95	Normal
2020	1437.1	33.06	Excess
2021	612	-43.33	Moderate

Block: Jaldega (2012 – 2021)
Average annual rainfall (mm):1058.31
Standard deviation: 278.01
Coefficient of variation (in %): 26.27

Year	Annual rainfall (mm)	Departure %	Category

2012	1202	13.58	Normal
2013	999.3	-5.58	Normal
2014	1391.1	31.44	Excess
2015	1085.4	2.56	Normal
2016	1170.7	10.62	Normal
2017	1283.9	21.32	Normal
2018	784.5	-25.87	Moderate
2019	973.7	-7.99	Normal
2020	1249	18.01	Normal
2021	443.5	-58.09	Severe

Block: Kersai (2012 – 2021)
Average annual rainfall (mm):1229.03
Standard deviation: 379.56
Coefficient of variation (in %): 30.88

Year	Annual rainfall (mm)	Departure %	Category
2012	932.8	-24.10	Normal
2013	657.8	-46.48	Moderate
2014	1022.4	16.81	Normal
2015	1393.5	13.38	Normal
2016	1241.7	1.03	Normal
2017	1448.8	17.88	Normal
2018	1310.1	6.60	Normal
2019	1809.3	47.21	Excess
2020	1695.7	37.97	Excess
2021	778.2	-36.68	Moderate

Block: Pakartarn (2012 – 2021)
Average annual rainfall (mm):1285.86
Standard deviation: 227.58
Coefficient of variation (in %): 17.70

Year	Annual rainfall (mm)	Departure %	Category
2012	1340.5	4.25	Normal
2013	945.1	-26.50	Moderate
2014	1366.7	6.29	Normal
2015	1327.9	3.27	Normal
2016	1037.8	19.29	Normal
2017	1406.1	9.35	Normal
2018	1147.4	10.77	Normal
2019	1594.3	23.99	Normal
2020	1612	25.36	Excess
2021	1080.8	15.95	Normal

Block: Kolebira (2012 – 2021)
Average annual rainfall (mm): 1072.65

Standard deviation: 320.39
Coefficient of variation (in %): 29.87

Year	Annual rainfall (mm)	Departure %	Category
2012	498.1	-53.56	Severe
2013	873.8	18.54	Normal
2014	1390.6	29.64	Excess
2015	956.1	10.87	Normal
2016	964.3	10.10	Normal
2017	1484.9	38.43	Excess
2018	1092.9	1.89	Normal
2019	1397.6	30.29	Excess
2020	1457.4	1.42	Normal
2021	1010.8	5.77	Normal

Block: Bansjor (2012 – 2021)
Average annual rainfall (mm): 1190.45
Standard deviation: 255.32
Coefficient of variation (in %): 21.45

Year	Annual rainfall (mm)	Departure %	Category
2012	838.9	-29.53	Moderate
2013	996	16.33	Normal
2014	1141	4.15	Normal
2015	1052.4	11.60	Normal
2016	1241.8	4.31	Normal
2017	1412.9	18.69	Normal
2018	1392.1	16.93	Normal
2019	1592.4	33.76	Excess
2020	1382.2	16.10	Normal
2021	854.8	-28.20	Moderate

Annexure - II

DETAILS OF KEY WELLS ESTABLISHED FOR NATIONAL AQUIFER MAPPING STUDY OF SIMDEGA DISTRICT, 2021 –22

Well No.	Village	Block	Owner	Location	Co-ordinates	Type of well	Geology	Lifting device	MP (magl)	Depth (mbgl)	Diameter (m.)
1	Konsode (Bazar Toli)	Bano	Late Ranjit Lakra	NHO owner, about 07 km from Bano on Kamdara road, LHS of road	22.69449 84.89232	Dug well	Granite Gneiss	Rope & bucket	0.05	5.70	4.60
2	Bano	Bano	Md. Alam	NHO owner on Bano-Kolebira road, RHS of road	22.64537 84.90819	Dug well	Granite Gneiss	Rope & bucket	0.42	7.30	4.60
3	Lachragarh	Kolebira	Bhim Sen Panda	HNO owner, Trijunction of Bano-Kolebira- Jaldega road (LHS)	22.69805 84.71500	Dug well	Granite Gneiss	Rope & bucket	0.30	9.70	2.70
4	Jaldega	Jaldega	Late Pramanand Jain	Near old Bank of India & market area, LHS of Jaldega block to Simdega road	22.57022 84.81185	Dug well	Granite Gneiss	Rope & bucket	0.30	8.60	2.15
5	Bansjor (Sahara Toli)	Bansjor	Manoj Kujur	NHO owner, entrance of the village (LHS)	22.42537 84.71361	Dug well	Granite Gneiss	Rope & bucket	0.36	10.00	1.70
6	Kulamara (Dumarmunda)	Bansjor	Michel Kullu	NHO owner, LHS of Jamdih – Gangu Toli road	22.45456 84.64695	Dug well	Granite Gneiss	Rope & bucket	0.30	6.00	4.95
7	Gangu Toli	Jaldega	Alphonse Topno	Near house of owner, LHS of Jaldega – Simdega road.	22.55159 84.73208	Dug well	Granite Gneiss	Rope & bucket	0.30		
8	Hatinghode	Bano	Jay Kishore Bhuinya	LHS of Bano – Manoharpur road, NHO owner	22.60177 85.05907	Dug well	Granite Gneiss	Rope & bucket	0.40	7.80	1.15
9	Orga	Jaldega	Govt.	Near temple / papal tree of market area, LHS of road	22.45793 84.91499	Dug well	Granite Gneiss	Rope & bucket	0.42	12.88	2.00
10	Gerda (Tiwari Toli)	Bano	Govt.	Near papal tree & Mobile Tower, RHS of village	22.47944 84.99441	Dug well	Granite Gneiss	Rope & bucket	0.45	6.95	3.00

Well No.	Village	Block	Owner	Location	Co-ordinates	Type of well	Geology	Lifting device	MP (magl)	Depth (mbgl)	Diameter (m.)
				road							
11	Kohipat	Bano	Dev Prasad Sahu	NHO owner, RHS of Ghat Bazar – Hurda road.	22.51070 85.05386	Dug well	Granite Gneiss	Rope & bucket	0.25	9.45	3.00
12	Paro (Naw mile)	Bano	Asyani Topno	NHO owner, 15 km from Boano on Manoharpur road (RHS of road)	22.67534 85.03237	Dug well	Granite Gneiss	Rope & bucket	0.50	6.70	3.40
13	Amba Toli	Kolebira	Arjun Mistry	About 06 km from Kolebira on Bano road (RHS), opp. to PHC, NHO owner	22.68240 84.73865	Dug well	Granite Gneiss	Rope & bucket	0.30	7.90	3.45
14	Kolomdega	Jaldega	Late Baldev Sahu	About 09 km from Jaldega on Simdega road (RHS), near temple.	22.56957 84.77529	Dug well	Granite Gneiss	Rope & bucket	0.50	7.10	3.10
Well No.	Village	Block	Owner	Location	Co-ordinates	Type of well	Geology	Lifting device	MP (magl)	Depth (mbgl)	Diameter (m.)
15	Lomboi	Jaldega	Sursen Jojo	NHO owner, RHS of Jaldega – Pandripani road.	22.53546 84.66717	Dug well	Granite Gneiss	Rope & bucket	0.00	7.60	4.30
16	Pandripani (Karanj Toli)	Thetai-tangar	Govt.	About 0.5 km (RHS) of Pandripani ckowk on Jaldega road.	22.54872 84.51829	Dug well	Granite Gneiss	Rope & bucket	0.70	8.60	1.85
17	Biru	Simdega	Uday Sahu	About 12 km from Simdega on Kolebira road (RHS), after crossing the PHC	22.68459 84.55049	Dug well	Granite Gneiss	Rope & bucket	0.50	10.00	3.25
18	Kolebira	Kolebira	Govt.	Within the PWD I.B.	22.69785 84.69371	Dug well	Granite Gneiss	Rope & bucket	0.65	10.00	3.55
19	Putri Toli	Kolebira	Govt.	Near the trijunction, RHS of Basia – Simdega road	22.76132 84.73676	Dug well	Granite Gneiss	Rope & bucket	0.55	7.00	3.15
20	Baribiringa	Jaldega	Budhwa Jojo	Well is located at Sarjom Toli & before market	22.52722 84.87277	Dug well	Granite Gneiss	Rope & bucket	0.35	5.70	2.70

Well No.	Village	Block	Owner	Location	Co-ordinates	Type of well	Geology	Lifting device	MP (magl)	Depth (mbgl)	Diameter (m.)
				area on Jaldega – Orga road (RHS)							
21	Mama Bhagina (Barla Toli)	Jaldega	Jolen Barla	RHS of gangu Toli – Jamdih road near solar pump water	22.52025 84.70725	Dug well	Granite Gneiss	Rope & bucket	0.25	9.75	4.15
22	Kereya	Thethai-tangar	Late francis kandulna	Well is located at Thethaitangar – Bansjor road (RHS)	22.45277 84.57944	Dug well	Granite Gneiss	Rope & bucket	0.00	9.05	3.20
23	Devbahar	Thethai-tangar	Ilisiyus Soreng	RHS of Joram – Raiboga (Odissa) road, opposite to solar pump water supply tank	22.42942 84.53771	Dug well	Granite Gneiss	Rope & bucket	0.00	6.20	3.50
24	Thethaitangar	Thethai-tangar	Govt.	Well is located at back side of tank the Govt. quarter on LHS of Thethaitangar – Bolba road	22.49944 84.50434	Dug well	Granite Gneiss	Rope & bucket	0.37	7.50	2.40
25	Taraboga	Thethai-tangar	Govt.	LHS of Thetaitangar – Bolba road	22.46545 84.43237	Dug well	Granite Gneiss	Rope & bucket	0.50	6.70	3.20
26	Koronjo	Bolba	Mission Church	Near Samudaik Bhawan & church	22.42947 84.41641	Dug well	Granite Gneiss	Rope & bucket	0.45	12.65	3.20
27	Bolba	Bolba	Govt.	Well is located within the campus of Police station, Bolba	22.43047 84.34710	Dug well	Granite Gneiss	Rope & bucket	1.25	9.00	3.20
28	Khanda Nishan	Bolba	Krishna Singh	NHO owner, 13 km from Bolba – Kersai road (RHS)	22.49187 84.25267	Dug well	Granite Gneiss	Rope & bucket	0.40	8.50	6.00
29	Kersai	Kersai	Govt.	In front of Tahsil Kutchery near Jharkhand rajya gramin bank.	22.52941 84.23121	Dug well	Granite Gneiss	Rope & bucket	0.50	9.30	2.50
30	Paikpara (Bhandar Toli)	Thethai-tangar	Govt.	LHS of Simdega- Rengari – Kersai road near	22.55822 84.33402	Dug well	Granite Gneiss	Rope & bucket	0.50	10.70	2.40

Well No.	Village	Block	Owner	Location	Co-ordinates	Type of well	Geology	Lifting device	MP (magl)	Depth (mbgl)	Diameter (m.)
				Panchayat Sachiwalay							
31	Lathakhamhan	Thethai-tangar	John Soreng	LHS of Simdega – Rengari road, NHO owner, 11 km from Simdega	22.54981 84.43058	Dug well	Granite Gneiss	Rope & bucket	0.40	5.55	3.25
32	Simdega	Simdega	Govt.	In front of Teacher's training school	22.58833 84.49166	Dug well	Granite Gneiss	Rope & bucket	1.00	10.82	3.90
33	Belgarh	Simdega	Biren Kachhuwa	NHO owner on Simdega – Jokbahar road (RHS)	22.60020 84.56649	Dug well	Granite Gneiss	Rope & bucket	0.36	6.45	3.40
34	Dumardih (Bhelwa Toli)	Kurdeg	Dauratiya Tigga	NHO owner, RHS of Kurdeg – Kutmakachhar road.	22.54244 84.04119	Dug well	Granite Gneiss	Rope & bucket	0.30	10.40	1.90
35	Kurdeg	Kurdeg	B. Mahto	Well is located at back side of block campus, in irrigation quarter near Airtel mobile tower	22.56638 84.13305	Dug well	Granite Gneiss	Rope & bucket	0.50	7.10	5.00
36	Gariyajor	Kurdeg	Arun Minz	NHO owner at entrance (RHS) of the village	22.61614 84.10394	Dug well	Granite Gneiss	Rope & bucket	0.00	8.10	2.10
37	Kinkel	Kersai	Philip Kujur	NHO owner, RHS of Simdega – Kurdeg road.	22.62602 84.23166	Dug well	Granite Gneiss	Rope & bucket	0.45	6.65	2.50
38	Banabira	Simdega	Kanhaiya Singh	NHO owner, RHS of Sewai – Banabira road	22.70182 84.28654	Dug well	Granite Gneiss	Rope & bucket	0.40	6.10	2.50
39	Sewai	Simdega	Manoj Kumar Gupta	LHS of Simdega – Kurdeg road before market	22.65103 84.31568	Dug well	Granite Gneiss	Rope & bucket	0.30	6.90	4.60
40	Ludi Bahar	Simdega	Anup khess	NHO owner, RHS of Simdega – Kurdeg road.	22.64020 84.41935	Dug well	Granite Gneiss	Rope & bucket	0.30	7.00	6.00
41	Kobang	Pakartarn	Dewan Sahu	About 200 m RHS of road on agriculture field	22.71364 84.45402	Dug well	Granite Gneiss	Rope & bucket	0.00	6.60	3.30
42	Kurushkela	Pakartarn	Mission Church	RHS of Simdega – Tamra – Palkot road within the Church campus	22.78964 84.52521	Dug well	Granite Gneiss	Rope & bucket	0.40	12.10	4.40

Annexure - III

WATER LEVEL DATA OF KEY WELLS OF NATIONAL AQUIFER MAPPING STUDY AREA OF SIMDEGA DISTRICT, JHARKHAND, 2021 –22

Well No.	Village	Block	Water level (mbgl)		Water level fluctuation (m)
			May 2021	Nov. 2021	
1	2	3	4	5	6
1	Konsode (Bazar Toli)	Bano	7.25	2.46	4.79
2	Bano	Bano	5.75	3.13	2.62
3	Lachragarh	Kolebira	6.58	3.09	3.49
4	Jaldega	Jaldega	6.65	2.80	3.85
5	Bansjor (Sahara Toli)	Bansjor	7.50	6.24	1.26
6	Kulamara (Dumarmunda)	Bansjor	3.30	2.20	1.10
7	Gangu Toli	Jaldega	7.65	1.82	5.83
8	Hatinghode	Bano	4.25	1.93	2.32
9	Orga	Jaldega	7.25	2.52	4.73
10	Gerda (Tiwari Toli)	Bano	3.90	2.35	1.55
11	Kohipat	Bano	8.09	4.06	4.03
12	Paro (Naw mile)	Bano	5.00	1.97	3.03
13	Amba Toli	Kolebira	3.25	1.08	2.17
14	Kolomdega	Jaldega	4.80	1.50	3.30
15	Lomboi	Jaldega	5.77	3.18	2.59
16	Pandripani (Karanj Toli)	Thetaitangar	5.70	3.01	2.69
17	Biru	Simdega	5.10	2.30	2.82
18	Kolebira	Kolebira	7.95	4.76	3.19
19	Putri Toli	Kolebira	4.08	0.64	3.44
20	Baribiringa	Jaldega	2.20	1.35	0.85
21	Mama Bhagina (Barla Toli)	Jaldega	9.30	3.93	5.37
22	Kereya	Thetaitangar	8.20	3.69	4.51
23	Devbahar	Thetaitangar	3.40	2.35	1.05
24	Thethaitangar	Thetaitangar	5.30	3.20	2.10
25	Taraboga	Thetaitangar	6.20	3.67	2.53
26	Koronjo	Thetaitangar	10.85	7.47	3.38
27	Bolba	Bolba	5.80	2.32	3.48
28	Khanda Nishan	Bolba	6.40	2.63	3.77
29	Kersai	Kersai	5.92	2.58	3.34
30	Paikpara (Bhandar Toli)	Thetaitangar	7.80	3.36	4.44
31	Lathakhamhan	Thetaitangar	4.25	1.20	3.05
32	Simdega	Simdega	8.40	2.25	6.15
33	Belgarh	Simdega	4.55	2.95	1.60
34	Dumardih (Bhelwa Toli)	Kurdeg	7.80	3.60	4.20
35	Kurdeg	Kurdeg	6.30	4.67	1.63

36	Gariyajor	Kurdeg	6.10	3.50	2.60
37	Kinkel	Kersai	5.90	3.25	2.65
38	Banabira	Simdega	3.95	1.35	2.60
39	Sewai	Simdega	5.50	1.80	3.70
40	Ludi Bahar	Simdega	4.40	1.05	3.35
41	Kobang	Pakartarn	4.10	1.00	3.10
42	Kurushkela	Pakartarn	10.00	7.32	2.68

Annexure - IV

DETAILS OF WELLS CONSTRUCTED IN HARD FORMATION OF SIMDEGA DISTRICT, JHARKHAND

Sl. No.	Location with coordinates	Block	District	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m)	Fractures Encountered (mbgl)		Aquifer	SWL (mbgl)	Dis-charge (lps)
								From	To			
1	Kolebira EW 22^0 39' 12" 84^0 41' 27"	Kolebira	Simdega	83.62	83.62	2.50	3.00 (7" dia.)	15.00 83.00	16.00 83.62	Fractured Granite gneiss	0.30 (magl)	20.00
2	Kolebira OW - I	Kolebira	Simdega	82.00	82.00	2.50	3.50 (7" dia.)	11.00 81.00	12.00 82.00	Fractured Granite gneiss	0.19	16.70
3	Kolebira OW - II	Kolebira	Simdega	84.00	84.00	2.50	3.50 (7" dia.)	14.00 82.50	15.00 83.50	Fractured Granite gneiss	--	16.70
4	Bano EW 22^0 49' 00" 84^0 54' 45"	Bano	Simdega	199.22	199.22	8.00	8.20 (7" dia.)	80.00 144.00	81.00 146.00	Fractured Granite gneiss	6.93	3.00
5	Bano - OW	Bano	Simdega	199.92	199.92	10.00	11.00 (7" dia.)	83.00	84.00	Fractured Granite gneiss	7.05	3.00
6	Banki EW 22^0 40' 15" 85^0 01' 07"	Bano	Simdega	199.92	199.92	7.00	7.50 (7" dia.)	54.00 122.00	55.00 123.00	Fractured Granite gneiss	7.18	0.40
7	Lachragarh EW 22^0 38' 30" 84^0 51' 53"	Kolebira	Simdega	199.92	199.92	11.00	11.50 (7" dia.)	15.00	16.00	Fractured Granite gneiss	5.70	4.50

Sl. No.	Location with coordinates	Block	District	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m)	Fractures Encountered (mbgl)		Aquifer	SWL (mbgl)	Dis-charge (lps)
								From	To			
8	Lachragarh OW	Kolebira	Simdega	146.00	146.00	11.50	12.00 (7" dia.)	144.00	146.00	Fractured Granite gneiss	--	10.50
9	Jaldega EW 22^0 34' 10" 84^0 48' 50"	Jaldega	Simdega	199.92	199.92	13.00	13.50 (7" dia.)	18.00 94.00	20.00 95.00	Fractured Granite gneiss	4.16	0.45
10	Lomboi EW 22^0 31' 46" 84^0 39' 45"	Jaldega	Simdega	192.30	192.30	11.00	11.50 (7" dia.)	45.00	46.00	Fractured Granite gneiss	--	0.45
11	Pandripani EW 22^0 33' 05" 84^0 31' 05"	Thethai-tangar	Simdega	170.94	170.94	8.50	9.00 (7" dia.)	18.00 109.00	19.00 111.50	Fractured Granite gneiss	5.83	5.10
12	Pandripani OW - I	Thethai-tangar	Simdega	169.44	169.44	11.00	11.50 (7" dia.)	18.00	19.00	Fractured Granite gneiss	6.08	0.80
13	Pandripani OW - II	Thethai-tangar	Simdega	116.00	116.00	7.50	8.00 (7" dia.)	22.00 109.00	23.00 111.00	Fractured Granite gneiss	6.40	7.80
14	S. S. High School, Simdega, EW 22^0 36' 42" 84^0 29' 40"	Simdega	Simdega	199.92	199.92	11.00	11.50 (7" dia.)	48.00	49.00	Fractured Granite gneiss	6.30	0.45

Sl. No.	Location with coordinates	Block	District	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m)	Fractures Encountered (mbgl)		Aquifer	SWL (mbgl)	Dis-charge (lps)
								From	To			
15	Officers Colony, Simdega, EW 22^0 37' 08" 84^0 29' 15"	Simdega	Simdega	199.92	199.92	27.50	28.00 (7" dia.)	181.00	182.50	Fractured Granite gneiss	10.40	3.00
16	Officers Colony, Simdega, OW	Simdega	Simdega	199.92	199.92	11.50	12.00 (7" dia.)	31.00 90.00 130.00	32.00 91.00 131.00	Fractured Granite gneiss	3.12	2.80
17	S. S. High School, Joram, EW 22^0 29' 40" 84^0 31' 30"	Thethai-tangar	Simdega	123.72	123.72	18.00	18.50 (7" dia.)	9.00 75.00 130.00	15.50 77.00 131.00	Fractured Granite gneiss	2.15	12.30
18	Pakartarn EW 22^0 42' 35" 84^0 26' 55"	Pakartarn	Simdega	203.00	203.00	5.00	5.50 (7" dia.)	102.00 131.00	102.50 131.50	Fractured Granite gneiss	--	0.13
19	Paledih EW 22^0 42' 32" 84^0 22' 06"	Pakartarn	Simdega	203.00	203.00	18.00	18.31 (7" dia.)	110.00	110.50	Fractured Granite gneiss	--	0.13
20	Unikel EW 22^0 41' 35" 84^0 53' 36"	Bano	Simdega	203.00	203.00	24.50	25.10 (7" dia.)	--	--	--	--	Dry
21	Kuladurum	Bano	Simdega	201.00	201.00	11.00	11.69	91.00	91.50	Fractured	--	0.43

Sl. No.	Location with coordinates	Block	District	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m)	Fractures Encountered (mbgl)		Aquifer	SWL (mbgl)	Dis-charge (lps)
								From	To			
	EW 22^0 45' 06" 84^0 51' 46"						(7" dia.)			Granite gneiss		
22	Taraboga EW 22^0 27' 59" 84^0 26' 04"	Thethai-tangar	Simdega	203.00	203.00	23.50	23.89 (7" dia.)	76.00	76.30	Slightly Fractured Granite gneiss	--	Seepage only
23	Binjhiya Bandh - EW 22^0 31' 46" 84^0 26' 33"	Thethai-tangar	Simdega	201.00	201.00	12.50	12.91 (7" dia.)	16.00	16.50	Fractured Granite gneiss	--	0.13
24	Kereya EW 22^0 27' 22" 84^0 36' 02"	Thethai-tangar	Simdega	201.00	201.00	8.00	8.64 (7" dia.)	--	--	--	--	--
25	Tutikel EW 22^0 39' 12" 84^0 46' 00"	Kolebira	Simdega	135.00	135.00	17.00	17.79 (7" dia.)	134.00	136.00	Fractured Granite gneiss	--	12.19
26	Tutikel OW	Kolebira	Simdega	135.00	135.00	12.00	12.60 (7" dia.)	134.00	136.00	Fractured Granite gneiss	--	7.79
27	Kolebira EW 22^0 39' 12" 84^0 41' 27"	Kolebira	Simdega	201.00	201.00	19.00	19.62 (7" dia.)	48.00	48.50	Fractured Granite gneiss	--	0.78

Sl. No.	Location with coordinates	Block	District	Depth drilled (m)	Depth of Well (m)	Thickness of weathering (m)	Length of casing lowered with dia. (m)	Fractures Encountered (mbgl)		Aquifer	SWL (mbgl)	Dis-charge (lps)
								From	To			
28	Bansjor EW 22^0 25' 26" 84^0 43' 09"	Bansjor	Simdega	177.00	177.00	45.00	45.23 (7" dia.)	54.00 175.00	55.00 176.00	Phylites	--	9.86
29	Bansjor OW	Bansjor	Simdega	180.00	180.00	45.00	51.32 (7" dia.)	55.00 178.00	56.00 179.00	Phylites	--	9.86
30	Huthutwa EW 22^0 31' 56" 84^0 48' 23"	Jaldega	Simdega	201.00	201.00	11.00	11.69 (7" dia.)	--	--	--	--	Dry
31	Binjhiya Pani -EW 22^0 30' 38" 84^0 45' 37"	Jaldega	Simdega	201.00	201.00	20.50	20.84 (7" dia.)	104.00	104.30	Jointed Granite Gneiss	--	Seepage only
32	Gangu Toli EW 22^0 33' 27" 84^0 43' 45"	Jaldega	Simdega	201.00	201.00	14.00	14.74 (7" dia.)	91.00 192.00	92.00 193.00	Fractured Granite gneiss	--	5.94
33	Gangu Toli OW	Jaldega	Simdega	201.00	201.00	11.00	11.69 (7" dia.)	69.00	70.50	Fractured Granite gneiss	--	2.15
34	Auga EW 22^0 24' 50" 84^0 15' 02"	Bolba	Simdega	201.00	201.00	11.50	12.91 (7" dia.)	85.00	86.00	Fractured Granite gneiss	--	0.43
35	Keslai Toli EW 22^0 37' 43" 84^0 16' 23"	Kersai	Simdega	201.00	201.00	20.00	20.53 (7" dia.)	70.00	70.30	Jointed Granite Gneiss	--	Seepage only

Annexure - V

WATER QUALITY DATA OF AQUIFER - I (DUG WELL SAMPLES) OF AQUIFER MAPPING STUDY AREA OF SIMDEGA DISTRICT (2021-22)

Sr. No.	Village	Block	Latitude & Longitude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	F
						← Mg / l →										
1	Konsode	Bano	22.69449 84.89232	7.10	144	93.6	60	18	3.65	5.02	0.89	73.80	7.09	8.29	0.17	BDL
2	Bano	Bano	22.64537 84.90819	7.56	485	315.25	140	48	4.86	46.08	4.38	184.50	46.09	21.49	14.61	BDL
3	Lachragarh	Kolebira	22.69805 84.71500	7.61	721	468.65	200	74	3.65	62.06	1.47	178.35	95.72	37.64	27.61	BDL
4	Jaldega	Jaldega	22.57022 84.81185	7.59	899	584.35	300	94	15.8	64.17	1.5	196.80	127.62	57.97	28.72	BDL
5	Bansjor	Bansjor	22.42537 84.71361	7.25	106	68.90	50	12	4.86	1	2.15	49.20	3.54	10.44	0.67	BDL
6	Kulamara	Bansjor	22.45456 84.64695	7.84	476	309.40	135	40	8.51	54.21	9.18	246.00	17.73	18	4.42	BDL
7	Gangu Toli	Jaldega	22.55159 84.73208	7.67	368	239.20	130	38	8.51	26.45	2.67	147.60	42.54	15.25	6.64	0.17
8	Hatinghode	Bano	22.60177 85.05907	7.57	378	245.70	150	46	8.51	15.77	1.80	123.00	35.45	27.64	19.26	0.43
9	Orga	Jaldega	22.45793 84.91499	7.06	344	223.60	130	32	12.15	27.36	3.37	86.10	53.18	16.13	27	BDL
10	Gerda	Bano	22.47944 84.99441	7.41	455	295.75	180	62	6.07	23.16	17.31	123.00	49.63	26.03	27.32	BDL
11	Kohipat	Bano	22.51070 85.05386	7.56	711	462.15	205	74	4.86	49.12	11.24	123.00	116.99	38.68	27.42	BDL
12	Nawamile Paro	Bano	22.67534 85.03237	7.56	269	174.85	115	34	7.29	9.22	0.97	110.70	24.82	15.01	5.12	1.14
13	Amba Toli	Kolebira	22.68240	7.36	378	245.70	140	36	12.15	27.90	2.11	116.85	42.54	16.63	21.73	0.32

Sr. No.	Village	Block	Latitude & Longitude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	F
						← Mg / l →										
			84.73865													
14	Kolomdega	Jaldega	22.56957 84.77529	7.21	118	76.70	45	12	3.65	7.26	0.29	43.05	9.27	7.36	3.06	BDL
15	Lomboi	Jaldega	22.53500 84.66666	7.41	231	150.15	85	22	7.29	18.62	1.19	92.25	21.27	10.80	7.18	BDL
16	Pandripani	Thetaitangar	22.54872 84.51829	7.21	145	94.25	65	16	6.08	3.55	1.53	49.20	8.63	5.28	12.06	BDL
17	Biru	Simdega	22.55138 84.73000	7.51	218	141.70	95	32	3.65	3.86	9.29	104.55	7.09	12.35	1.05	BDL
18	Kolebira	Kolebira	22.70500 84.68361	7.11	563	365.95	150	54	3.65	58.68	6.50	116.85	81.53	28.27	28.12	BDL
19	Putri Toli	Kolebira	22.70500 84.68361	7.11	71	46.15	35	8	3.65	1.02	1.43	24.60	3.55	8.65	3.05	0.24
20	Baribiringa	Jaldega	22.52722 84.87277	7.71	485	315.25	240	90	3.65	12.43	1.79	276.75	21.27	24.79	3.24	0.15
21	Mama Bhagina	Jaldega	22.52025 84.70725	7.00	151	98.15	70	16	7.29	2.21	7.07	55.35	10.64	14.96	7.68	0.18
22	Kereya	Thetaitangar	22.45277 84.57944	7.41	267	173.55	60	20	2.43	31.92	2.38	104.55	24.82	15.38	11.71	0.32
23	Devbahar	Thetaitangar	22.42942 84.53771	7.51	258	167.70	75	24	3.65	24.87	1.05	129.15	14.18	11.41	4.10	0.81
24	Thethaitangar	Thetaitangar	22.49944 84.50434	7.21	174	113.10	55	18	2.43	10.45	1.06	79.95	10.64	10.31	4.37	0.68
25	Taraboga	Thetaitangar	22.46545 84.43237	7.10	274	178.10	115	38	4.89	15.07	1.72	73.80	28.36	15.83	24.60	BDL
26	Koronjo	Bolba	22.42947 84.41641	7.75	487	316.55	190	68	4.86	25.72	3.73	252.15	24.82	19.39	8.00	0.23
27	Bolba	Bolba	22.43 84.34722	7.47	609	395.85	215	76	6.08	37.70	12.74	166.05	77.99	23.39	28.69	0.14
28	Khanda Nishan	Bolba	22.49187 84.25267	7.71	389	252.85	195	74	2.43	2.19	3.03	196.80	17.73	20.05	5.72	0.95

Sr. No.	Village	Block	Latitude & Longitude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	F
						← Mg / l →										
29	Kersai	Kersai	22.52941 84.23121	7.71	1307	849.55	330	86	27.95	133.23	1.73	202.95	255.24	48.67	28.08	0.33
30	Paikpara	Thetaitangar	22.55822 84.33402	7.64	490	318.50	215	52	20.65	25.36	1.33	178.35	67.36	14.13	4.68	0.34
31	Lathakhamhan	Thetaitangar	22.54981 84.43058	7.21	107	69.55	35	10	2.43	11.17	0.19	43.05	7.09	10.05	3.64	0.18
32	Simdega	Simdega	22.58833 84.49166	7.07	456	296.40	165	46	12.15	38.36	5.25	147.60	50.90	11.02	33.94	0.17
33	Belgarh	Simdega	22.60020 84.56649	7.41	321	208.65	120	40	4.86	11.53	15.17	104.55	39.00	22.41	17.32	BDL
34	Dumardih (Bhelwa Toli)	Kurdeg	22.54244 84.04119	7.61	376	244.4	130	48	2.43	31.67	4.97	202.95	28.36	10.78	6.74	BDL
35	Kurdeg	Kurdeg	22.56638 84.13305	7.64	413	268.45	165	62	2.43	22.00	1.30	178.35	31.91	22.58	15.49	0.75
36	Gariyajor	Kurdeg	22.61614 84.10394	7.65	936	608.40	345	90	29.16	48.12	2.83	295.20	88.63	63.87	28.25	0.34
37	Kinkel	Kersai	22.62602 84.23166	7.42	618	401.70	235	86	4.86	29.79	2.76	215.25	65.02	22.65	18.74	1.03
38	Banabira	Simdega	22.70182 84.28654	6.87	195	126.75	70	16	7.29	11.65	3.20	67.65	17.73	14.50	18.14	0.10
39	Sewai	Simdega	22.65103 84.31568	7.56	860	559.00	319	120	4.56	48.14	1.13	289.05	109.90	42.82	26.40	0.80
40	Ludi Bahar	Simdega	22.64020 84.41935	7.47	563	365.95	215	70	9.72	32.79	3.13	246.00	60.27	18.04	6.38	0.70
41	Kobang	Pakartarn	22.71364 84.45402	6.73	468	304.20	155	44	10.94	35.56	5.03	147.60	60.27	7.54	27.74	BDL
42	Kurushkela	Simdega	22.78964 84.52521	6.67	118	76.70	45	10	4.86	6.18	0.74	36.90	10.64	11.17	8.20	0.21

Annexure - VII

WATER QUALITY DATA OF AQUIFER - II (HAND PUMP SAMPLES) OF AQUIFER MAPPING STUDY AREA OF SIMDEGA DISTRICT (2021-22)

Sr. No.	Village	Block	Latitude & Longitude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	F
						← Mg / l →										
1	Konsode	Bano	22.69449 84.89232	7.31	226	146.90	100	28	7.29	10.97	0.65	116.85	7.09	7.47	0	0.58
2	Bano	Bano	22.64537 84.90819	7.21	216	140.40	95	26	7.29	12.43	1.03	116.85	14.18	9.75	0	1.03
3	Lachragarh	Kolebira	22.69805 84.71500	7.37	752	488.80	330	128	2.43	26.64	1.74	202.95	106.35	33.00	28.85	0.64
4	Jaldega	Jaldega	22.57022 84.81185	7.41	523	339.95	195	66	7.29	24.65	2.34	129.15	67.36	20.49	28.03	0.70
5	Bansjor	Bansjor	22.42537 84.71361	7.51	297	193.05	100	36	2.43	22.14	3.23	147.60	14.18	11.73	3.18	0.25
6	Kulamara	Bansjor	22.45456 84.64695	7.67	387	251.55	130	40	7.29	32.39	4.31	190.65	7.09	18.02	3.05	1.15
7	Gangu Toli	Jaldega	22.55159 84.73208	7.41	411	267.15	175	58	7.29	15.07	2.28	166.05	42.54	12.29	23.86	BDL
8	Hatinghode	Bano	22.60177 85.05907	7.70	523	339.95	255	86	9.72	17.10	4.26	258.30	31.91	12.29	13.56	0.53
9	Orga	Jaldega	22.45793 84.91499	7.10	364	236.60	135	42	7.29	20.61	0.98	79.95	63.81	16.20	24.71	BDL
10	Gerda	Bano	22.47944 84.99441	7.53	358	232.70	175	58	7.29	4.59	3.35	166.05	21.27	9.95	13.44	0.19
11	Kohipat	Bano	22.51070 85.05386	7.41	393	255.45	160	60	2.43	13.13	3.52	153.75	31.91	27.55	0	BDL
12	Nawamile Paro	Bano	22.67534 85.03237	7.61	268	174.20	110	40	2.43	13.18	1.95	129.15	14.18	11.24	4.53	2.30
13	Amba Toli	Kolebira	22.68240	6.91	143	92.95	40	14	1.22	17.13	0.85	73.80	7.09	6.33	0.24	0.78

Sr. No.	Village	Block	Latitude & Longitude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	F
						← Mg / l →										
			84.73865													
14	Kolomdega	Jaldega	22.56957 84.77529	7.11	166	107.90	60	22	1.22	9.61	1.71	73.80	10.64	11.04	2.34	BDL
15	Lomboi	Jaldega	22.53500 84.66666	7.46	365	237.25	145	52	3.65	20.90	2.28	178.35	14.18	20.57	1.26	1.07
16	Pandripani	Thetaitangar	22.54872 84.51829	7.59	446	289.90	160	50	8.51	29.58	1.96	159.90	49.63	18.03	12.92	0.90
17	Biru	Simdega	22.55138 84.73000	6.93	209	135.85	65	24	1.22	20.58	0.69	61.50	28.36	6.82	26.13	0.16
18	Kolebira	Kolebira	22.70500 84.68361	7.41	921	598.65	275	90	12.15	68.72	19.13	307.50	102.81	44.92	27.83	BDL
19	Putri Toli	Kolebira	22.70500 84.68361	7.32	152	98.80	55	16	3.65	9.48	2.98	73.80	3.54	7.29	2.29	0.82
20	Baribiringa	Jaldega	22.52722 84.87277	7.70	54.	351	220	84	2.43	15.10	2.17	270.60	21.36	16.25	9.25	0.18
21	Mama Bhagina	Jaldega	22.52025 84.70725	7.57	370	240.50	130	42	6.08	30.27	5.77	141.45	17.73	29.38	27.30	0.20
22	Kereya	Thetaitangar	22.45277 84.57944	7.67	417	271.05	140	32	14.58	33.04	3.04	184.50	21.27	18.93	8.93	0.66
23	Devbahar	Thetaitangar	22.42942 84.53771	7.54	260	169	100	36	2.43	20.63	1.05	123.00	14.18	6.87	6.87	0.73
24	Thethaitangar	Thetaitangar	22.49944 84.50434	7.17	470	305.50	175	50	12.15	27.78	2.31	178.35	35.45	35.05	13.77	0.57
25	Taraboga	Thetaitangar	22.46545 84.43237	7.00	201	130.65	65	20	3.65	13.97	0.22	86.10	10.64	8.48	4.70	0.42
26	Koronjo	Bolba	22.42947 84.41641	7.11	266	172.90	100	28	7.29	20.93	2.20	147.60	14.18	10.95	2.86	0.17
27	Bolba	Bolba	22.43 84.34722	7.07	552	358.80	195	54	14.58	33.63	2.37	184.50	67.36	23.56	28.62	BDL
28	Khanda Nishan	Bolba	22.49187 84.25267	7.07	280	182	100	28	7.29	18.27	3.39	116.85	24.82	17.06	1.16	0.26

Sr. No.	Village	Block	Latitude & Longitude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	F
						← Mg / l →										
29	Kersai	Kersai	22.52941 84.23121	7.07	187	121.55	70	18	6.08	19.56	0.54	61.50	24.82	7.46	4.14	1.06
30	Paikpara	Thetaitangar	22.55822 84.33402	7.51	380	247	130	44	4.86	29.31	2.01	147.60	28.36	18.42	1.74	2.59
31	Lathakhamhan	Thetaitangar	22.54981 84.43058	7.54	454	295.10	160	62	1.22	30.70	2.10	196.80	21.27	12.25	3.87	3.87
32	Simdega	Simdega	22.58833 84.49166	7.23	169	109.85	65	18	4.86	12.15	0.78	67.65	10.64	9.78	3.45	1.86
33	Belgarh	Simdega	22.60020 84.56649	7.10	133	86.45	45	16	1.22	9.88	0.40	61.50	7.09	7.57	7.56	0.52
34	Dumardih (Bhelwa Toli)	Kurdeg	22.54244 84.04119	6.77	169	109.85	55	20	1.22	10.71	1.54	73.80	7.09	9.45	2.28	0.25
35	Kurdeg	Kurdeg	22.56638 84.13305	7.17	336	218.40	130	36	9.72	19.23	2.43	141.45	28.36	11.59	4.73	0.26
36	Gariyajor	Kurdeg	22.61614 84.10394	7.51	1127	732.55	500	160	24.30	33.22	4.02	393.60	95.12	63.90	29.10	0.15
37	Kinkel	Kersai	22.62602 84.23166	7.51	821	533.65	380	102	30.38	21.53	2.14	221.40	113.44	35.55	27.80	
38	Banabira	Simdega	22.70182 84.28654	7.30	152	98.80	45	12	3.54	14.26	0.67	61.50	14.18	8.97	0	1.69
39	Sewai	Simdega	22.65103 84.31568	7.60	682	443.30	260	54	30.38	42.58	1.62	239.85	53.18	62.11	13.45	2.18
40	Kochedega	Simdega		7.14	204	132.60	75	24	3.54	12.56	0.21	61.50	21.27	11.72	17.59	1.13
41	Kobang	Pakartarn	22.71364 84.45402	6.88	210	136.50	75	20	6.08	15.17	0.87	61.50	21.27	12.29	25.05	1.07
42	Kurushkela	Simdega	22.78964 84.52521	7.17	157	102.05	65	22	2.43	7.65	0.99	67.65	14.18	9.55	0.21	0.45