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

KODERMA DISTRICT
JHARKHAND

मध्य पूर्वी क्षेत्र, पटना
Mid Eastern Region, Patna

भारत सरकार
Government of India
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जल संसाधन, नदी विकास और गंगा संरक्षण विभाग

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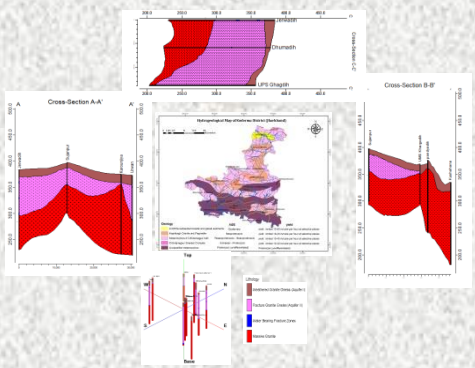
Central Ground Water Board

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN , KODERMA DISTRICT, JHARKHAND STATE

जलभृत नक्शे तथा भूजल प्रबंधन योजना कोडरमा जिला, झारखंड



Principal Author

Atul Beck, Assistant Hydrogeologist

Supervision

Dr Sudhanshu Shekhar, Scientist-D

राज्य एकक कार्यालय, रांची
मध्य- पूर्वी क्षेत्र, पटना,
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REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF KODERMA DISTRICT, JHARKHAND, 2020-21

CONTRIBUTORS'

Principal Author

Atul Beck, Assistant Hydrogeologist

Supervision

Dr Sudhanshu Shekhar, Scientist-D

Hydrogeology, Groundwater Exploration GIS maps and Management Plan

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

Geophysics

B. K. Oraon, Scientist-E

Chemical Analysis

Ms Manasi Bhatttarjee, Scientist-B
Dr Suresh Kumar, Assistant Chemist

Guidance

T.B.N. Singh, Regional Director
Rajeev Ranjan Shukla, Scientist-E & OIC

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Sh Atul Beck, AHG

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

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REPORT ON
NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN OF KODERMA DISTRICT IN JHARKHAND STATE

1.0 INTRODUCTION:

The vagaries of rainfall, inherent heterogenity & 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 programme. 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, which is continued till 2023. In pursuance of AAP 2019-2020, CGWB State Unit Office, Ranchi, has carried out Aquifer mapping and Management Plan in Dhanbad district of Jharkhand State with the aim of delineation and characterization of aquifers and its quantity, quality and sustainability of ground water in aquifers. The study is a part of the fulfillment of National Aquifer mapping and Management Plan. The aquifer maps and management plans will be shared with the Jharkhand Govt 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:

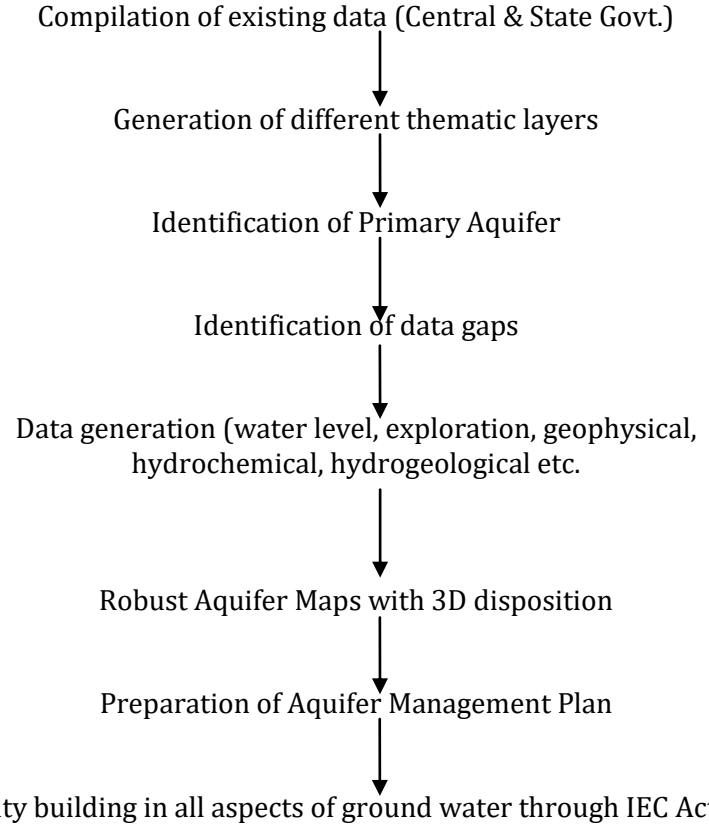
a). Identifying the aquifer geometry
b). Aquifer characteristics and their yield potential
c). Quality of water occurring at various depths
d). Assessment of ground water resources
e). Preparation of aquifer maps and
f). Formulation ground water management plan.

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 in hard rock terrain 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 (Location, Extent and Accessibility)

Koderma district was created on 10th April 1994, subsequent to the bifurcation of Hazaribagh district. Earlier it was a subdivision in the Hazaribagh district. It was created as a Subdivision in 1973. The district has been famous for rich mica deposits and is also known as Abhrakh Nagri. It is essentially an under-developed , thinly populated district having varied but limited endowment of natural resources. Koderma district is located in the northern part of North Chhotanagpur Commissionary and is bounded by Nawada and Gaya district of Bihar state in the north west and west, Chatra and Hazaribag districts in the south

west and Giridih district in the east . It is located between 24º 15' 58.4'' to 24º 48' 56.5" N Latitude and 85º 17' 07" to 85º 56' 22.58" E Longitude. It is covered under Survey of India Toposheets nos. 72H/6, 7, 9, 10, 11, 13,14 & 15. It comprises geographical area about 1496.70 sqkm. Certain rivers/nadies form natural border of Koderma district viz. Mohana in south west, Leriya in southern, Barsoti nadi in south eastern, Jamui in the eastern, Jharna nadi in north west and Tillaiya nadi in central southern border. Koderma district has one Sub-division, Kodarma itself and 6 (Six) developmental administration the district is divided into 6 (Six) developmental blocks namely: Koderma, Jainagar, Chandwara, Markachho, Domchanch and Satgawan. There are 717 (Seven Hundred Seventeen) Villages and 109 (One Hundred Nine) Panchayats. The administrative set up of Koderma district is given in Table 1.

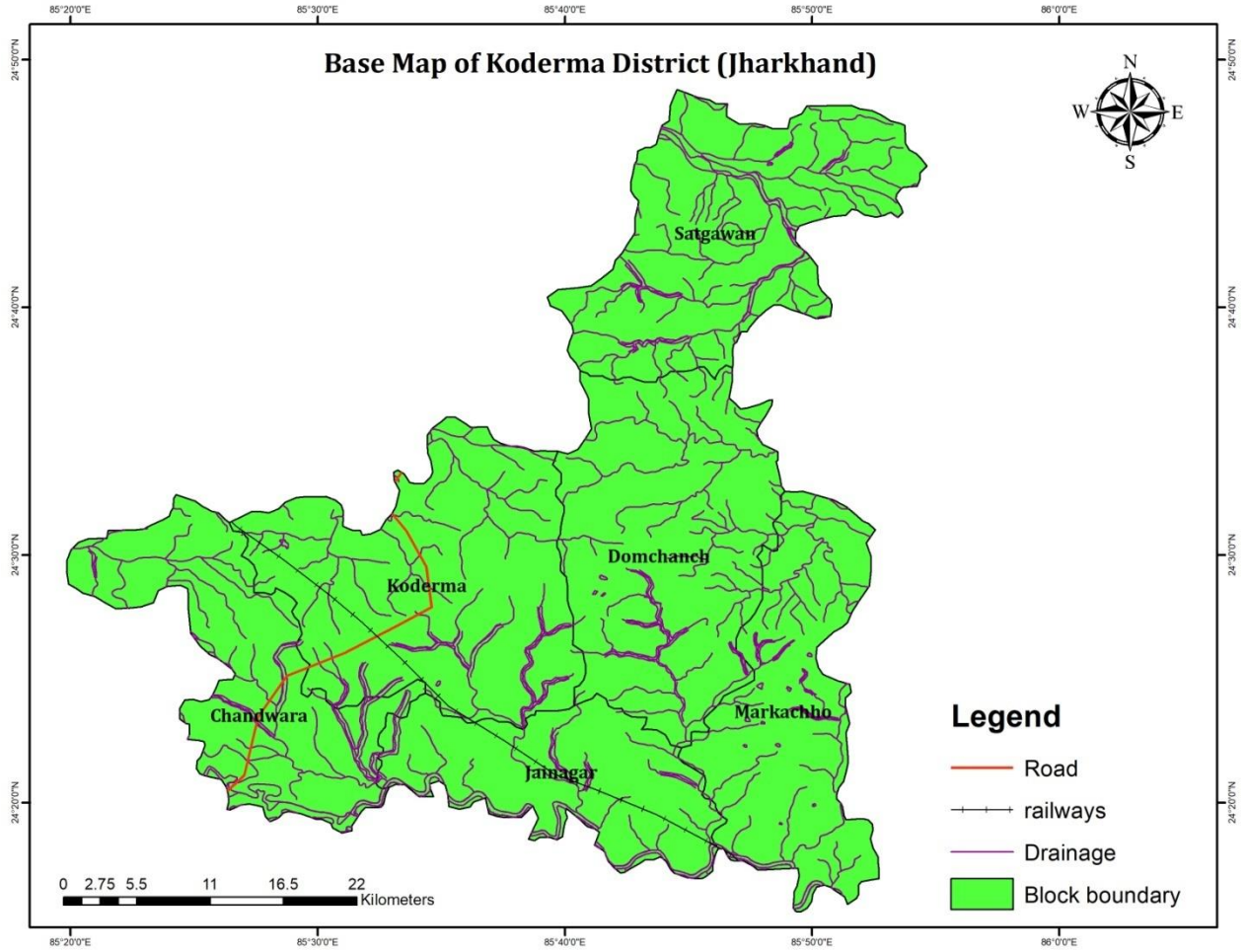


Fig.1 Base Map of Koderma District

Table – 1 Administrative set up of Koderma District

S.No.	District Name	Geographical area (Sq. Km)	Gram Panchayats	Village	No. of Tehsil	Name of Tehsil
1.	Koderma	1497	109	717	6	Koderma, Jainagar, Chandwara, Markachho, Domchanch and Satgawan

1.4 Demography: The census report 2011 states that total population of Koderma district has 716,259 whereas Male population is 367,222 and female population is 349,037. Based on the census - 2011 District wise population details are given in Table 2.

Table-2 Koderma population details

Sl. No.	District	Male	Female	Population Growth	Population Density/km2	Total
1.	Koderma	367,222	349,037	43.42%	282	716,259

1.5 Data Availability, Data Adequacy and Data Gap Analysis

1.5.1Data Availability:-

Central Ground Water Board has carried out exploratory drilling in the district and drilled 14 exploratory and 3 observation wells and 01 Piezometer by departmental (14 no's) and through outsourcing (03no's) as on March 2022 to know the sub–surface geology, depth and thickness of water bearing formation with their yield and determining the different aquifer parameters and variable lithology in the area. In addition of that, eight numbers of permanent observation well (HNS) of Central Ground Water Board located in the district are being monitored (4 times in a year) before ground water regime and to assess the chemical quality of ground water.

1.5.2 Data Adequacy and Data Gap Analysis:

The available data of the exploratory wells drilled by Central Ground Water Board, SUO, 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 summarized details of required, existing and data gap of exploratory wells, ground water monitoring and ground water quality stations is given in table –3.

Table – 3: Data adequacy and data gap analysis

Exploratory data				**Geophysical data**				**GW monitoring data**				**GW quality data**			
Req.	Exist.	Gap	Generation	Req.	Exist.	Gap	Generation	Req.	Exist.	Gap	Generation	Req.	Exist.	Gap	Generation
18	3	18	18					10	8	10	10	10	8	10	18

1.6 Climate and Rainfall

The calendar year may be divided into three main seasons in the district of Koderma. The winter season starts form November to February. The summer season is from March to May and the rainy season is from June to October. In winter early mornings and nights are cold. Night temperature falls down to 5 degree or even lower. To the contrast summer is hot and unpleasant, the temperature rising up to 44 degree C. The annual average rainfall is 1126 mm. Koderma region receives more rainfall and it gradually decreases in east direction. Having humid and sub humid tropical monsoon type of climate characterize the climatic zone of Koderma. In normal year 40-60 mm of rain is received as pre monsoon shower that help farmer to start land preparation. About 80% of the rain is received during mid June to first week of October. Further, 100 mm of rain is received during October and November. Winter rain during December to February is very helpful for Rabi cultivation.

Table -4 Rain fall Pattern block wise Rainfall Data :

Block Satgawan

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Normal Annual rainfall (mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8
Average Monthly Rainfall (mm)	10.2	0.0	8.8	9.2	0.0	139.2	306.4	277.8	92.8	0.0	0.1	0.2	844.4
Average rainy days	1	0	1	2	0	7	13	11	4	0	0	0	39

Rainfall Data : Block Chandwara

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Normal Annual rainfall(mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8
Average Monthly Rainfall (mm)	24.0	0.0	18.5	45.4	0.0	143.6	260.6	271.1	27.4	0.0	0.0	0.0	766.6
Average rainy days	1	0	3	3	0	13	6	15	3	0	0	0	54

Rainfall Data : Block Koderma

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Normal Annual rainfall (mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8
Average Monthly Rainfal (mm)	10	2.8	18	47.6	5.4	129	286.4	230.6	24	0.0	0.0	0.0	753.8
Average rainy days	1	1	3	4	1	7	17	16	4	0	0	0	54

Rainfall Data : Block Domchanch

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Normal Annual rainfal (mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8
Average Monthly Rainfal (mm)	10	2.8	18	47.6	5.4	129	286.4	230.6	24	0.0	0.0	0.0	753.8
Average rainy days	1	1	3	4	1	7	17	16	4	0	0	0	54

Rainfall Data : Block Markacho

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Normal Annual rainfall(mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8
Average Monthly Rainfall(mm)	2.2	0.0	20.2	54..4	0.0	91	218.8	144.4	38.4	0.0	0.0	0.0	515
Average rainy days	1	1	3	6	0	11	14	11	3	0	0	0	50

Rainfall Data : Block Jainagar

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Normal Annual rainfall (mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8
Average Monthly Rainfall (mm)	10.4	4.2	2.8	77.8	0.0	143.3	337.7	292.6	32.6	0.0	0.0	0.0	901.4
Average rainy days	1	1	1	8	0	15	18	15	4	0	0	0	63

Rainfall Pattern of Koderma District

Normal Annual rainfall (mm) of the District													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Normal Annual rainfall (mm)	21.4	29.5	13.7	70.4	26.2	140.8	245.7	305.2	196.5	62.8	10.3	3.3	1125.8

1.7 Physiography

Koderma district is the part of Chotanagpur plateau. Physiography of the Koderma district shows that overall slope towards the northern part. Minimum elevation is 116m in the northern part of the Satgawan Block of Koderma district and the Maximum elevation occurs in the east-central and the south-western part of the district. The highest peak is Debour Ghati (670 meter) that is the state boundary of Jharkhand and Bihar. The area exhibits undulating topography comprising hills, hillocks, mounds and plains. Valley fills with low to moderate frequency of lineaments, pediplains with moderate frequency of lineaments and pediplains are major geomorphological units of the district. Northern part of the district is occupied by Koderma Reserve forest. Jainagar, Markacho blocks are covered by pediplain. Upper part of Chandwara block consists of dissected plateau and lowest part by pediplain. Satgawan block is covered by pediplain in upper parts, ridges and valley in middle parts and erosional valley in lower parts. Physiographically, Koderma plateau is specific and is the northern projection of the peninsular table land which forms part of the Chhotanagpur plateau. The elevation ranges from 116m mean sea levels to highest 670m mean sea level.

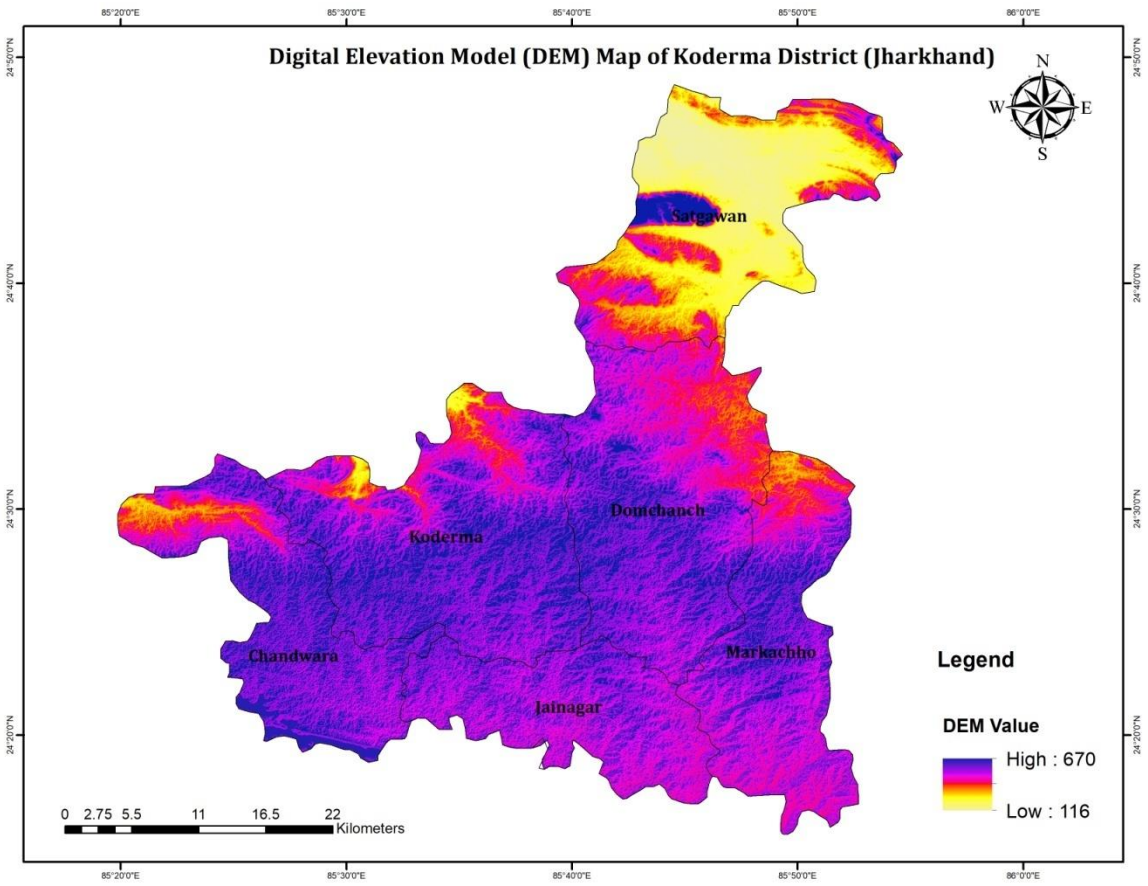


Fig.2 Physiography of Koderma District

1.8 Geomorphology :

The area exhibits undulating topography comprising hills, hillocks, plains and mounds. Northern part of the district is occupied by Koderma Reserve Forest. The rock at the edge of this plateau has been cut deeply by innumerable streams. There are a number of rills & gullies of various type such as figure or shoe-lace gullies. Barakar River flows from W to E in the southern part of the district of Koderma and supports Telaiya Hydel project, a multipurpose dam construction on it. River flows from West to East Poanchkhara, Keso, Akto, Gurio, Gukhana Nadi are the main tributaries of the Barakar river. Sakri river is the main river in the northern part of the district which flows from south & east to north west. Ghggnna Naddi, Chhotanari Nadi are the tributaries of Sakri river.

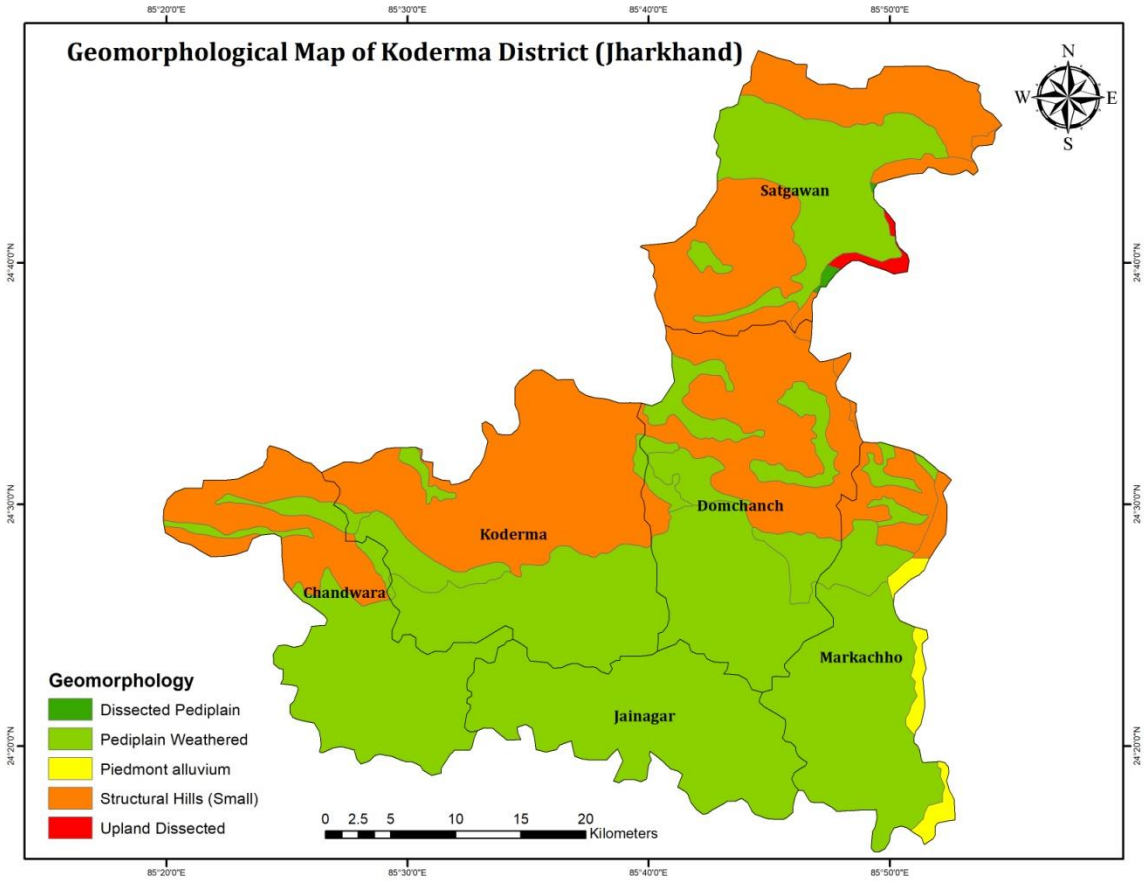


Fig. 3 Geomorphological map

The main geomorphic features and landforms are as follows.

Alluvial Plains: - These are found near the river tracts and consist of gravels, sands, silt, etc.

Structural Hills: - These are linear or arcuate hills showing definite trend lines and covered with thick forests developed. Found in north- western, north-central and eastern part of Koderma district.

Pediplain (W):- These are developed over granite gneiss and Meta sediments. High frequencies of lineaments are found. These are found in Koderma, Jainagar, Markacho,some parts of Koderma,Chandwar and Domchanch block of Koderma district.

Dissected Pediplain:- Dissected pediments are mainly occurs in northern part of Satgawan block of Koderma district.

1.9 Land use

Land use is a function of four variables, land, water, air and man, each plays in its own role in composing its life history. The human circumstances are mainly responsible for dynamism in agriculture landuse or changing cropland occupancy. Therefore, efficient cropland occupancy, say cropping pattern, implies the most successful use of agriculture land, consequent upon development of irrigation facilities and application of modern methods of farm technology. The key to the most important aspect of landuse lies in the relation of population to land. Details of land use pattern is given below in Table 5 and land use map is shown in figure 4

Table 5 – Details of Land use

Year	Reporting Area	Forest Area	Area under Non-agricultural use	Barren & uncultura ble land	Permanent pastures & other grazing land	Land under misc. tree groves not included in Net area sown	Cultura ble waste land	Fallow land other than Current fallow	Current fallow	Net area sown
2009-10	389427.94	190114.88	22385.29	24435.32	5127.73	2409.55	7799.05	38549.24	63755.32	33224.86
2010-11	389427.94	190114.88	23612.63	22823.80	10983.50	3940.05	8489.43	32473.72	45070.76	42790.07
2011-12	389427.94	190114.88	23612.63	19157.14	10983.50	3940.05	8489.43	32473.72	2399.64	87491.02
2012-13	389427.94	190114.88	23993.90	22568.45	4482.14	3259.52	8281.34	45212.52	46767.56	45047.50
2013-14	389427.94	190114.88	24555.39	21978.41	4285.54	3604.90	8448.64	47680.38	42178.14	49858.58
2014-15	389427.94	190114.88	25130.03	21403.80	4097.56	25130.03	8619.32	50282.94	38039.10	25130.03

Source: D.S.O.Office, Koderma

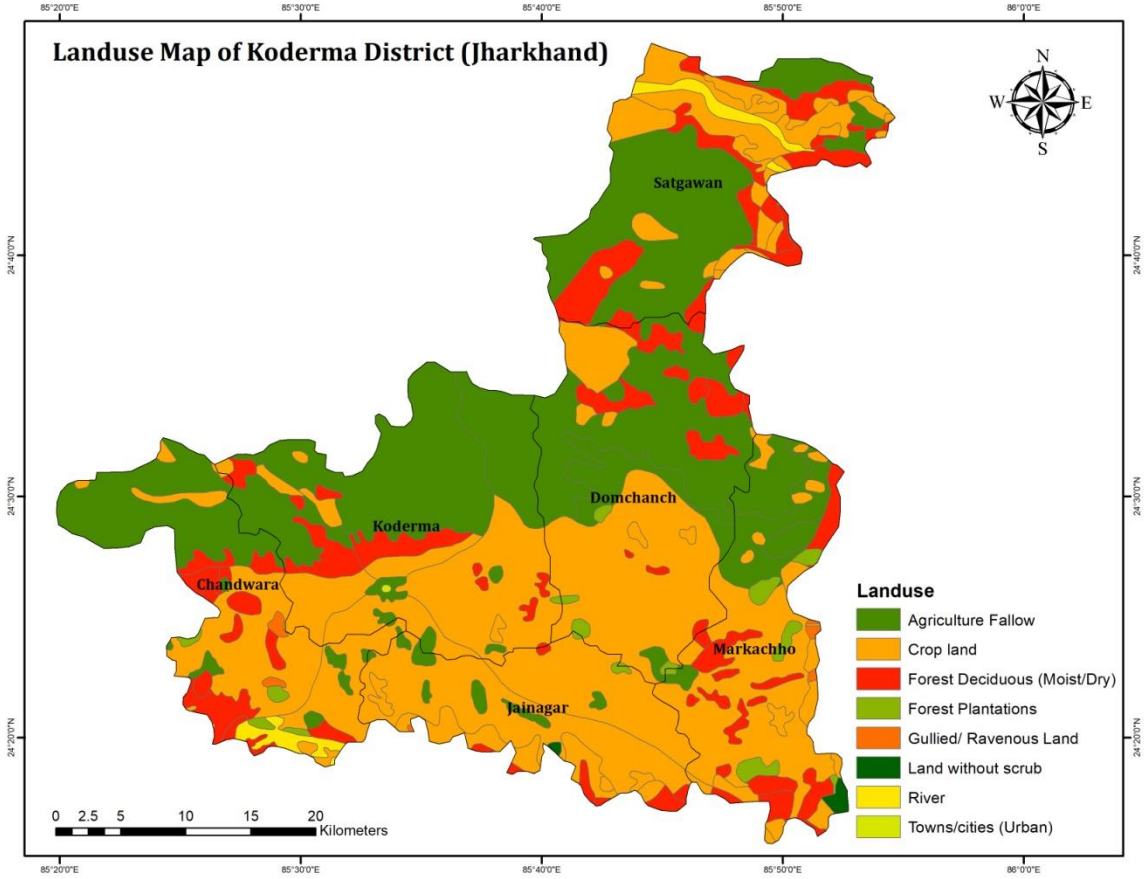


Fig.4 Land use Map

1.10 Soil

The soils of the study area can be broadly grouped into the soil developed in different formation like granite gneiss of Archean age, and alluvial plain. Texturally the soils have been classified into four classes as :-

Stony and Gravelly: These are low grade soils having a large admixture of cobbles, pebbles and gravels generally found at the base of the hills.

Sandy Soils : It is found near the stream beds containing 60% sand and are easily drained. These are poor in respect of fertility and require heavy maturing.

Loamy Soils: These consist mostly of detritus of decomposed rocks and vegetables matter. It is suitable for cultivation. Normally these are found in valleys near the hills.

Clayey Soils: These soils are found near tank beds. It is sticky soils. Their water bearing capacity is very high. The area is very fertile but yielding capacity improved with addition of sand, lime and organic manures etc.

1.11 Hydrology and Drainage

The hydrological condition of the study area is governed by two major river basin/sub-basins, which is mentioned below:

S. no.	Name of River Basin/Sub Basin
1.	Damodar River Basin
2.	Barakar River sub-basin

Damodar River Basin:

Damodar River basin plays a vital role for ecological balance and provides the life supporting system of large number of flora and fauna since millions of years. From prehistoric time human civilization evolved along this river basin. The main tributary of Damodar is Barakar which also originates in Hazaribagh District in Chotanagpur plateau. These two rivers form large upper catchment of the basin with an area of 17500 sqkm in the undulating plateau with their numerous drainage networks.

Barakar River sub-basin:

The total geographic area of the basin is 7026 sq km, of which 453.23 sq km falls in Koderma and 695.7 sq km in Koderma district. The Barakar river originates from the hills of Hazaribagh and runs almost parallel to river Damodar in about 200km length in the eastern direction and join the river Damodar near dishergarh town. The important tributaries of the river Barakar are the saghar, the barkar sakri, barsati khero, usri chikri .

The Kodarma district falls under lower Ganga basin .By and large, the drainage density is high in hilly and undulating tracts followed by moderate to low density in plains. Invariably, short slope areas between high hills and plain displayed very high drainage density qualifying for severely gullied and ravinous areas.The relief in general is normal in plains, excessive in hilly and undulating areas; whereas, valley fills show subnormal relief. In scattered intermountain valley areas occasionally ponded relief is commonThe study area has dendritic drainage pattern which is structurally controlled and typical characteristrict of gneissic rock type. The Flow direction of drainage pattern is towards eastern part. Major river in this part is Damodar and Barakar. Drainage map of the area is shown in figure-5.

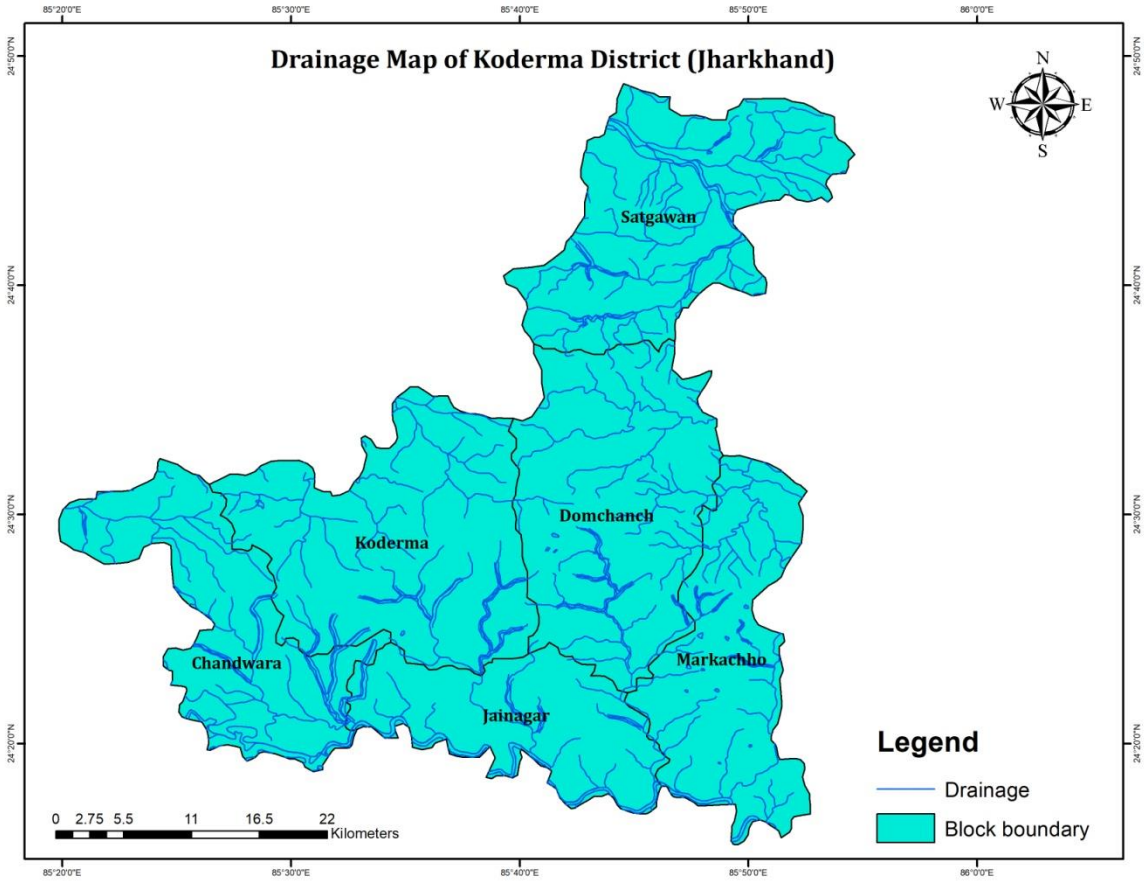


Fig.5 Drainage map of Koderma district

1.12 Irrigation

The koderma district has poorly developed irrigation facilities. According to the fifth minor irrigation census data of Koderma district total 3059 ha is irrigated by minor irrigation schemes whereas 2368 ha is irrigated by ground water schemes and 691 ha is irrigated through surface water schemes. The details of total numbers of sources and area irrigated by different schemes is given in *(Table 6 ,7)*

Table 6 Details of irrigation sources

	Total Number of Sources							
	Ground Water				**Surface Water**			
Dug well	**Shallow Tube well**	**Medium Tube well**	**Deep Tube well**	**Total**	**S. Flow Scheme**	**S. Lift Scheme**	**Total**	**Grand Total**
4435	102	57	32	4626	663	212	875	5501

Table 7 Details of area irrigated by minor irrigation schemes

Area Irrigated by Ground Water Schemes (Ha)					Area Irrigated by Surface Water Schemes (Ha)				
Kharif	Rabi	Perennial	Others	Total	Kharif	Rabi	Perennial	Others	Total
1204	880	200	84	2368	399	213	52	27	691

1.13 Cropping Pattern

In koderma district agriculture and mica mining is the main occupation of the people. The cropping pattern is generally influenced by varied soil type and different climatic conditions. The principal crops of the area are Paddy, maize, pea, green gram, groundnut, urd, wheat, chickpea and arhar. The horticulture crops are Cauliflower, cabbage, tomato, Brinjal, L. finger, cucumber etc.

1.14 Geological setup

The entire district is underlain by the rocks of wide variety of geological formation ranging in age from Archean to Recent. The main being Archean proterozoic, pemocarboniferous and recent.. In koderma district most of the areas are covered by biotite-granite gneiss, phyllite mica-schist, Intrusive granite, pegmatite veins, Amphibolite hornblende schist, Quartzite and alluvium. Sporidic occurrence of Dolerite, Quartz pegmatite veins and Quartzites are also found. Thin deposits of alluvium are found along the course of rivers.

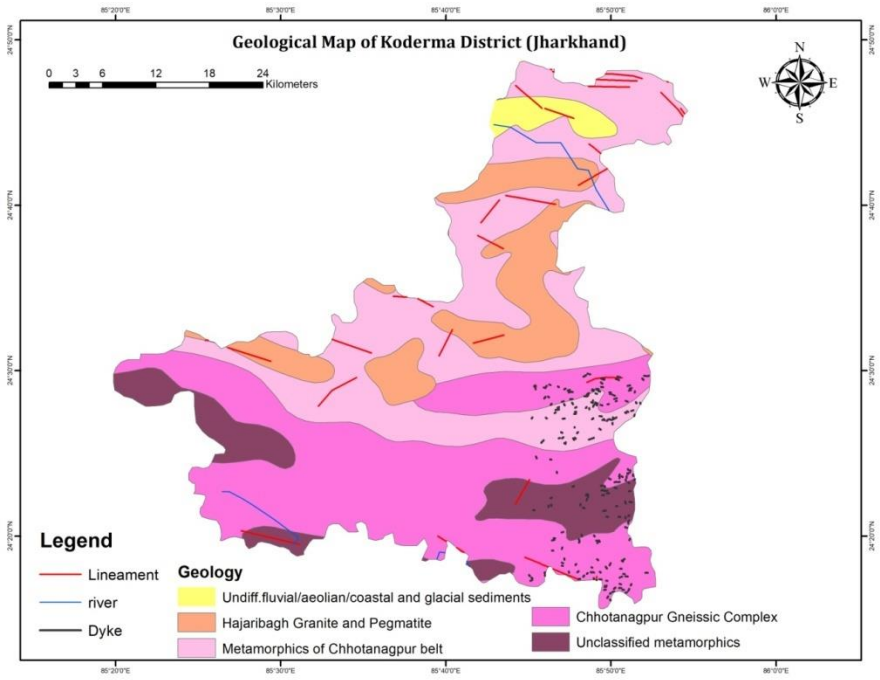


Fig.6 Geological map of Koderma district

In Koderma district most of the areas are covered by biotite-granite gneiss, phyllite mica-schist, Intrusive granite, pegmatite veins, Amphibolite hornblende schist, Quartzite and alluvium. In koderma block Phyllite-mica schist and Intrusive granite are the main rock types. In Satgawan block, central portion of the block and adjacent to Sakri river alluvium is the main formation. Southern portion of the district is covered by Intrusive granite, Phyllite –mica schist and quartzite while the northern portion of the block has Quartzite, Amphibolite hornblende schist and gneisses are observed.

2. DATA COLLECTION AND GENERATION

The primary Data such as water level, quality, geophysical data and exploration details, available with CGWB has been collected and utilised as baseline data. The Central Ground Water Board has established a network of observation wells under National Hydrograph Network programme to study the behavior 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. For other inputs such as hydrometeorological, Landuse, cropping pattern etc were collected from concerned state and central govt departments and compiled. There is no aquifer-wise data available from State or any other agencies.

2.1 Data collection,Compilation and Data Generation

2.1.1 Data collection &Compilation

The data collection and compilation for various components was carried out as given below

i. Hydrogeological Data: Water level data of 18 monitoring station (key wells and NHS) historical water level trend of monitoring wells were collected and compiled representing Aquifer-I.

ii. Hydrochemical Data: To evaluate the quality of ground water, 18 samples were collected from dug wells representing shallow aquifer (Aquifer – I)

iii. Geophysical survey**:** VES were carried out to identify the weathered zone resistivity and its thickness as wells as find out deeper fracture zone and different layer of basaltic formation.

iv. Exploratory drilling**:** 21 wells drilled in hard rock area of the district through departmental rigs as well as throughout sourcing private rig.

v. Hydrometeorological Data: Last ten years (2001 – 2022) monsoon rainfall data for each of the block from the office of District Agriculture Department, Palamu.

vi. Land use and cropping pattern data**:**The data of land use and cropping pattern from the office of Director Statistics, Ranchi.

vii Thematic Layers**:** The following thematic layers were also generated which supported the primary database and provided precise information to assess the present ground water scenario and also to propose the future management plan.

1. Drainage
2. Geomorphology
3. Geology & structures

The thematic layers such as drainage and geomorphology have been described in Chapter – I.

2.1.2 Data Generation:

After taking into consideration, the data available with CGWB on ground water monitoring wells (GWMW), ground water quality, geophysical survey and ground water exploration, the data adequacy was compiled and Koderma district

2.2 Hydrogeology:

Ground water occurs under phreatic condition in weathered Granitic formation and under semi-confined to confined condition in fractured Granite-Gneiss

2.2.1 Ground Water in Aquifer-I (Weathered Granite-Gneiss/Alluvium):

Ground water occurs under phreatic/ unconfined to semi-confined conditions in Aquifer-I which is represented by weathered granite-gneiss and Alluvium. Ground water occurs in unconfined state in shallow Aquifer-I tapped by alluvium, laterites, and weathered granite (Upto 30 m depth) , however in some cases depth varies from more than 30m. Yield of the wells in Aquifer-I ranges from 0.8 to 3 lps in this formation. Weathered zones of granites and gneisses are the most productive zone for ground water development in shallow aquifer. The depth of weathering varies from place to place, which influences the aquifer characteristics.

2.2.2 Ground Water In Aquifer-II (Fractured Granite-Gneiss)

Ground water occurs under Semi-confined to confined condition in Aquifer-II represented by Fractured/Jointed granite-gneiss, upto the explored depth of 200 mtr depth. Generally extent of Aquifer-II in Precambrian formation ranges from **30-140m**. Granites and Gneisses are the most predominant rock types among all other rocks falling under the consolidated unit. Tectonic disturbances in granitic rocks are pronounced and fissures and joints etc are also well developed. These rocks are traversed by numerous veins of quartz and pegmatite. Fracture porosity plays an important role but with varying degree, in different parts of the area depending upon the pattern and intensity of joints and fractures. The potentiality and yielding property of these aquifers vary considerably. Bore wells can be constructed tapping the deep-seated fractures and joints.

Potential Fractures in Aquifer-II

Total 21 Number of boreholes has been constructed by CGWB (inhouse/ outsourcing) in the district under groundwater exploration programe upto maximum depth of 200 m. On the basis of field investigations and results of exploratory wells drilled in the district, salient findings are summarized as:-

- Overall in the district the major potential fractures zones are found upto 120m.
- In general in fractured/jointed/fissured formations, discharge of well has been found in the range of 1-16 m3/hr.
- High yielding wells having potential fractures encountered at J.J.College Koderma-13.2 m3/hr, Gulwadhab-12.6 m3/hr, Khargadih-16.2 m3/hr)

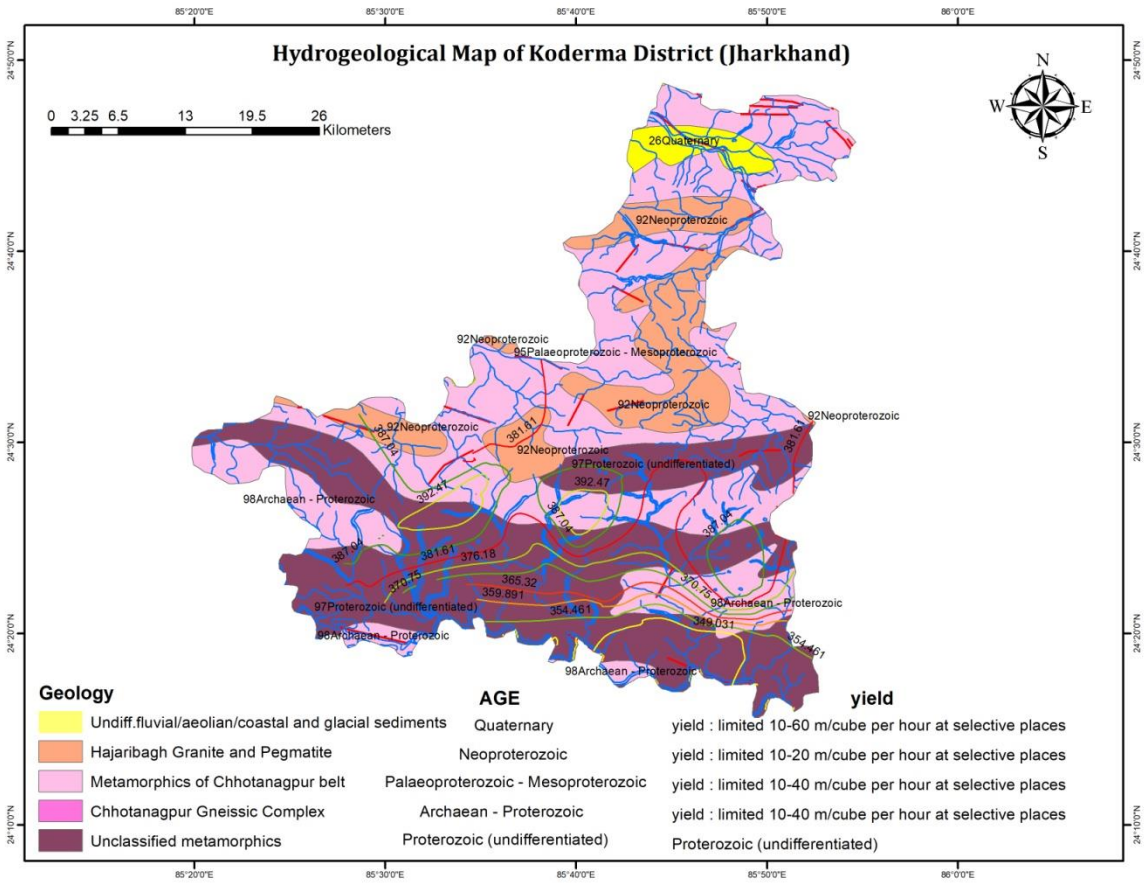


Fig.7 Hydrogeological map of Koderma district

2.2.3 Ground water Dynamics

***2.2.3.1 Ground water Monitoring Wells*:** Water level and water quality is being monitored from 18 dug wells to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. Location of key wells are shown in *Annexure-II*

2.2.3.2 Water Level Scenario – Aquifer – I (Shallow Aquifer):

Ground water regime is monitored through 18 dug wells in the study area. With the field data, maps were prepared for visual interpretation of the behavior of the ground water levels. Depths to ground water level were demarcated into various zones in the ranges of less than 2 m, 2-5 m, 5-10 m, 10-20 m. The description of depth to water levels during pre-monsoon and post monsoon is as follows:

Depth to Water level May 2019:

Depth to ground water level during May 2019 ranges from 5.05 mbgl to12.50 mbgl. Minimum depth to water level 5.05 mbgl recorded at Kanobigha in Koderma district and maximum depth to water level 12.50 mbgl recorded at Domchanch block in Koderma district. Depth to water level map May 2019 is shown in ***figure 8.***

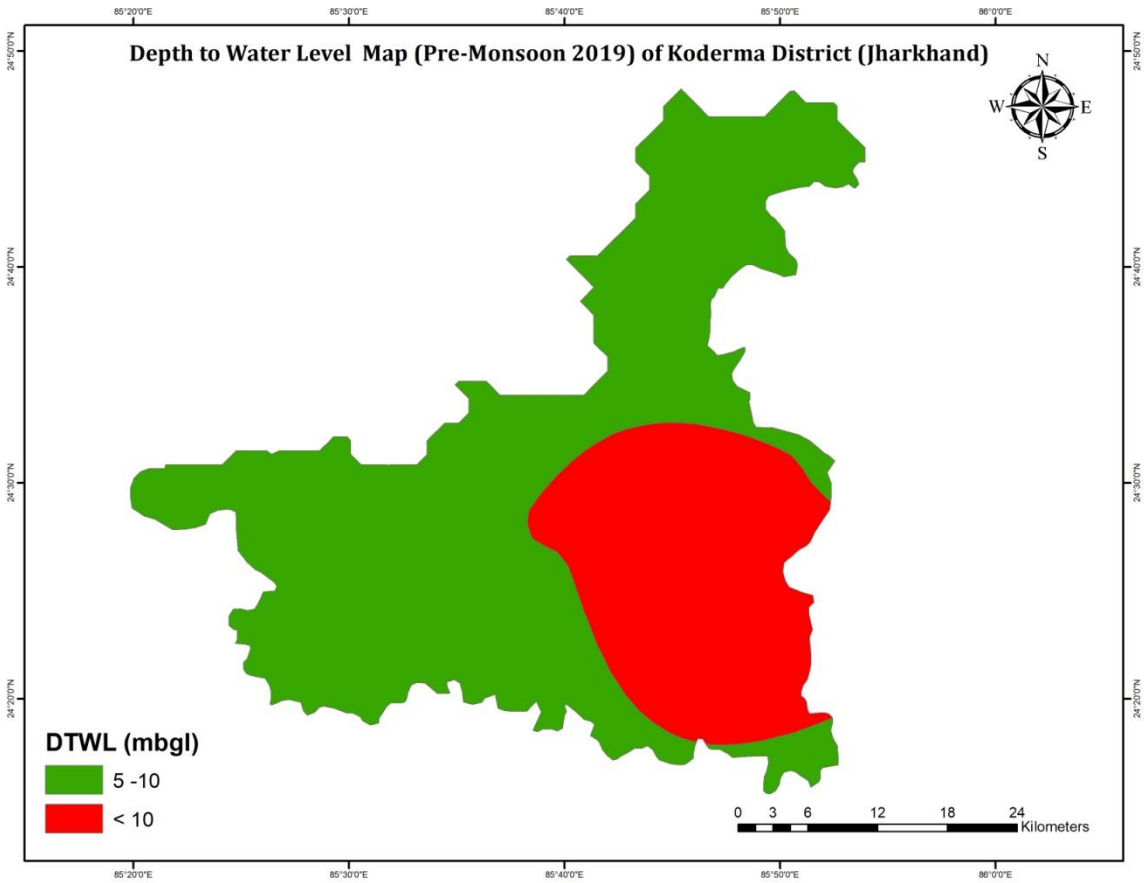


Fig.8 Depth to water level Map (pre-Monsson-2019)

Depth to Water level November 2019:

During month of November 2019 (post-monsoon) depth to water level varied from 1.22 m bgl to 12.00 m bgl. Minimum depth to water level 1.22 mbgl recorded at Chandwara block of Koderma district and maximum depth to water level 12.00 mbgl recorded at Koderma block of Koderma district. Depth to water level map November 2019 is shown in ***figure 9.***

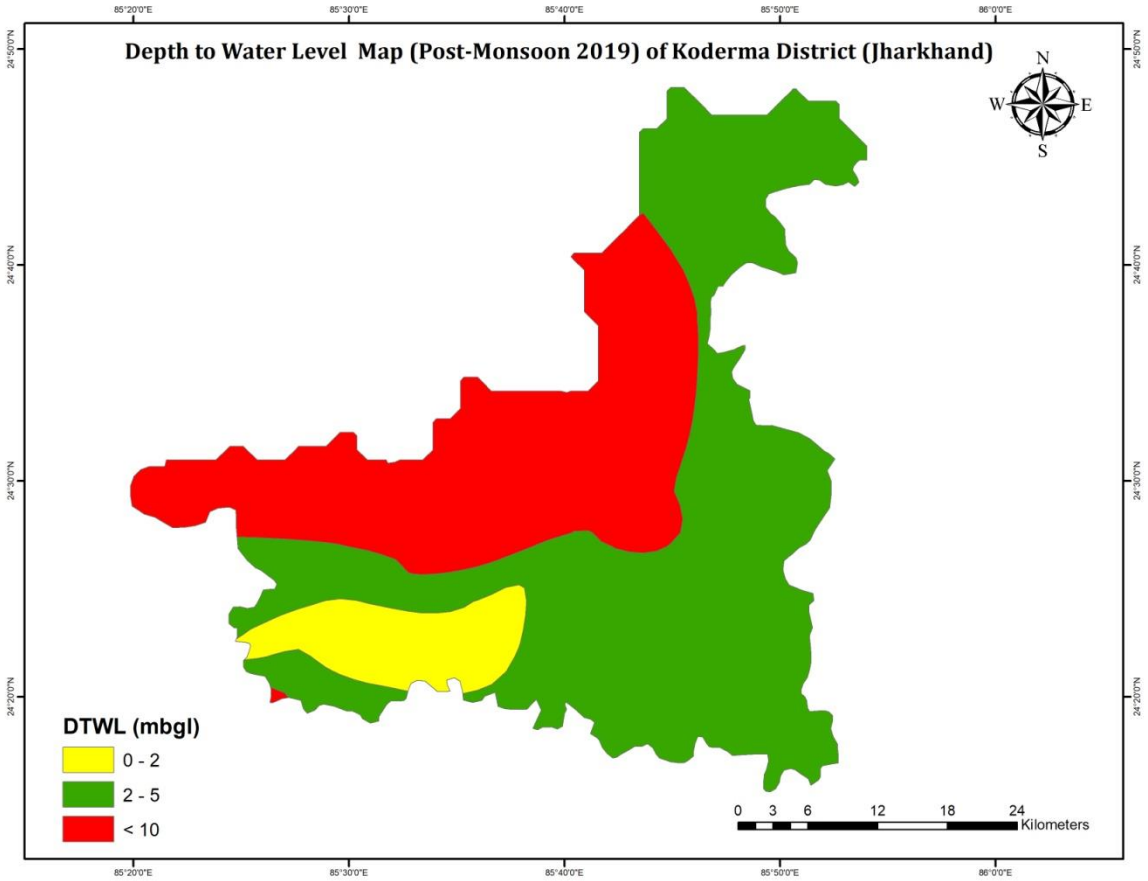


Fig.9 Depth to water level Map (post-Monsoon-2019)

2.3 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 18 monitoring wells which represent the quality of phreatic/ shallow zone i.e Aquifer I. The analytical results of water samples from dug wells are given in Annexure-. 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.

2.3.1 General Range of Chemical Parameters

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 to many health problems. An overview of Hydro-chemical data of (phreatic aquifer) hydrograph monitoring wells existing in Koderma district is tabulated below in table no.8 and the detail of water quality analysis is given in Annexure-III . Hydro-chemical data of (phreatic aquifer) monitoring wells existing in Koderma district is tabulated below in Table-8.

Table 8 Details of Hydro-chemical data of hydrograph monitoring wells

S.No.	Constituents	Minimum	Maximum	BIS (2012)	
				Desirable	Permissible
1.	pH	7.13	7.87	6.5-8.5	No relax.
2.	EC	403	1980		
3.	TDS (mg/l)	261.95	1287	500	2000
4.	HCO3 (mg/l)	135.3	442.8	200	600
5.	Cl (mg/l)	14.18	340.32	98	1000
6.	TH (as CaCO3) mg/l	124	755	300	600
7.	Ca (mg/l)	38	182	75	200
8.	Mg (mg/l)	2.43	86.26	30	100
9.	Na (mg/l)	15.54	167.84	200	-
10.	K (mg/l)	0.64	6.9	200	-
11.	NO3 (mg/l)	0.3	116	45	No relax.
12.	F(mg/l)	0.224	1.87	1.0	1.5
13.	SO4(mg/l)	11.22	112.45	200	400

Hydrogen ion concentration (pH):

The pH of water indicates that whether the water is acidic or alkaline. The hydrogen (pH) is a measure of the hydrogen ion concentration in the water. The measurement scale of pH ranges from 1 to 14 with a pH of 7 indicating as neutral condition environment. The value of pH lower than 7 indicate acidic and more than 7 indicates alkaline. The pH of ground water in Koderma district ranged in between 7.13 to 7.87. The ground water of the study area can be assessed as slightly alkaline to neutral in nature. Minimum 7.13 PH value observed in Koderma block whereas Maximum PH value 7.87 recorded in Dardahi village of Markacho block of Koderma district.

Electrical Conductivity (EC):

Electrical conductance is the ability of water to conduct electric current and it depends on, the concentration of ion, nature and types of ions and temperature. BIS has recommended desirable limit for Total Dissolve Solid (TDS) as 500 mg/l corresponding to EC value approximately as 750 µS/cm at 25°C which is extendable to permissible limit as 2000mg/l. TDS corresponding to EC value is about 3000 µS/cm at 25°C in absence of alternate source of water.

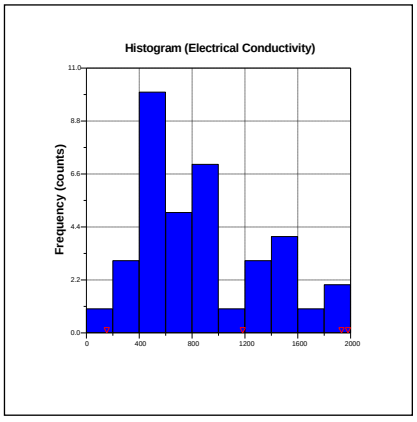


Fig.10 EC map of Koderma district

The electrical conductivity of ground water in Koderma district ranges in between 403 to 1980µS/cm at 25°C. Minimum 261.95 µS/cm at 25°C EC value observed in Phulwaria village of Domchanch block whereas Maximum 1980 µS/cm at 25°C EC value recorded at Jainagar village of Jainagar block of Koderma district.

Carbonate and Bicarbonate (Alkalinity):

Presence of alkalinity in water is the capacity to neutralize a strong acid due to the presence of carbonate, bicarbonate and hydroxide of magnesium and calcium. The concentration of bicarbonate ranged in between 135.3 to 442.8 mg/l. Minimum concentration of bicarbonate 135.3 mg/l value has been recorded in Ghaghdiha village of Jainagar block whereas Maximum concentration 442.8 mg/l value has been recorded in Jhumritiliya village of Koderma block of Koderma district.

Chloride:

Chloride in ground water can be geogenic in deep aquifers or caused by industrial or domestic wastes and pollution from brine. The BIS has set 250 mg/l chloride ions as acceptable limit and 1000 mg/l as permissible limit in the absence of alternate source in drinking water. In Koderma district Chloride concentration ranges in between 14.18 to 340.32 mg/l. Minimum concentration value of chloride 14.18 mg/l has been recorded in Kalidih village of Satgawan block whereas Maximum concentration value of chloride 340.32 mg/l has been recorded in Domchanch village of Domchanch block of Koderma district.

Fluoride:

Fluoride occurs in low concentration in natural water. It is an essential element to maintain normal development of teeth and bones. The consumption of low fluoride concentration prevents the dental caries. The higher concentration of fluoride consumption causes mottling of teeth and skeletal fluorosis. The BIS has set the maximum concentration of fluoride in drinking water is 1.5 mg/l as permissible limit. The fluoride concentration in Koderma district ranged in between 0.0224 to 1.87 mg/l. The maximum concentration 1.87 mg/l of fluoride has been recorded in Phulwaria village of Domchanch block of Koderma district.

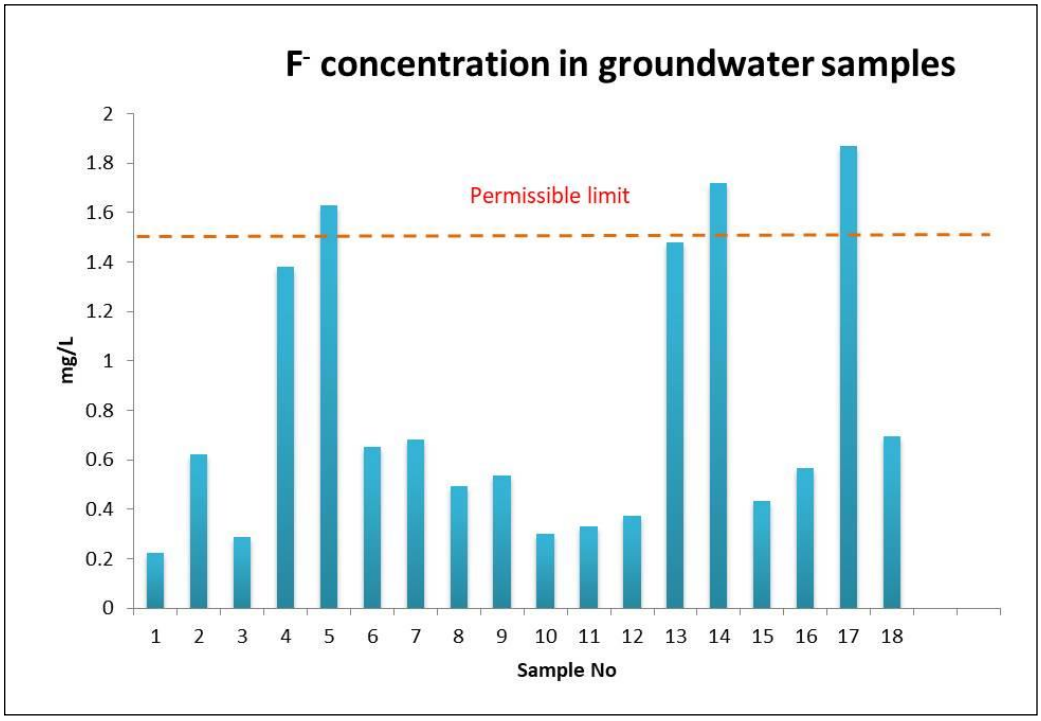


Fig.11 Fluoride Conc. map of Koderma district

Nitrate:

Nitrate is the end product of oxidation process of nitrogen in the environment and its higher concentration in ground water is an indication of pollution from human and animal wastes, nitrogenous fertilizers and industrial wastes. Nitrate is a non-essential constituent of ground water. The BIS has set a acceptable limit of nitrate concentration in drinking water as 45 mg/l with no relaxation. The consumption of nitrate more than 45 mg/l is harmful for human being, particularly to infants as it may cause blue baby syndrome. In Koderma district nitrate concentration in ground water ranges in between 0.3 to 116 mg/l. The maximum Nitrate concentration has been recorded at Dasrokhurd village of Markacho block of Koderma district.

Sulphate

The concentration of sulphate in drinking water set by BIS as acceptable limit is 250 mg/l and 400 mg/l permissible limit in absence of alternate source. Higher concentrations are undesirable taste because of laxative effects. Sulphates in groundwater are released by natural deposition of calcium sulphate, magnesium sulphate, or sodium sulphate. These natural sources can be applied as soil conditioners. The ground water of study area recorded sulphate concentration ranges in between 11.22 to 112.48 mg/l.

Total Hardness:

As per Bureau of Indian Standard (BIS): 10500-2012 (Drinking Water), the acceptable limit of total hardness is 300 mg/l and permissible limit is 600 mg/l in absence of alternate sources. Total hardness of ground water in the study area ranges in between 124 to 755 mg/l. The maximum TH concentration has been recorded at Jainagar village of Jainagar block of Koderma district.

Sodium:

Sodium does not find freely in nature because it is very active element. It always combines with other elements. In human body, sodium helps in maintaining water balance. The higher sodium intake may cause congenial heart diseases, hypertension and also kidney problem. In Koderma district, water samples observed sodium concentration ranges in between 15.54 to 167.84 mg/l.

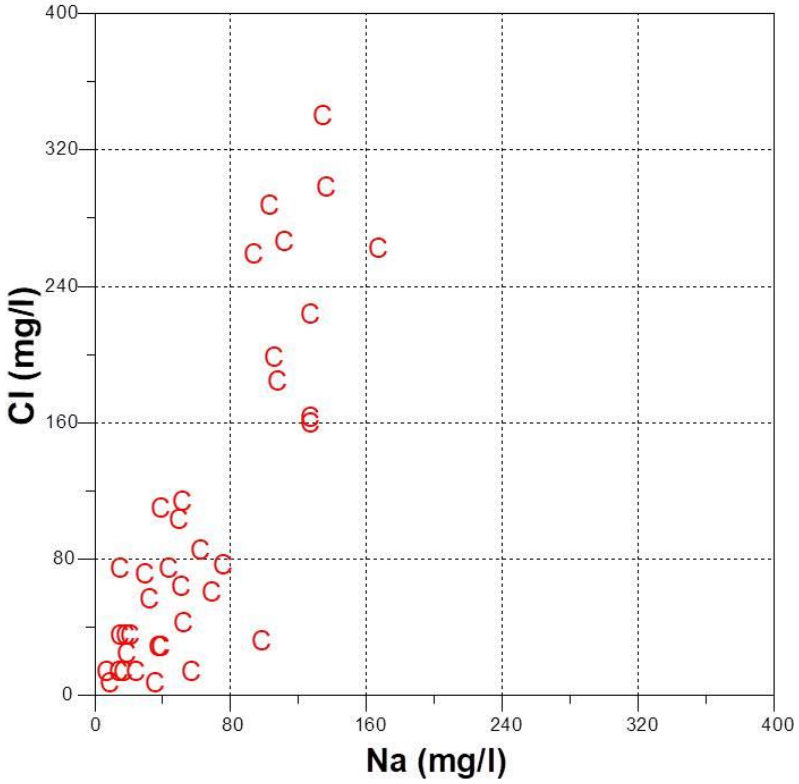


Fig.12 Sodium Chloride map of Koderma district

Potassium:

The common sources of potassium are minerals of igneous, metamorphic and sedimentary rocks. Potassium concentration in water is generally very low. BIS has not given any guideline for potassium concentration in drinking water. In the study area of Koderma district, Potassium concentration observed in water samples ranged in between 0.64 to 6.9 mg/l.

2.3.2 Suitability of Ground Water for Drinking Purposes: -

The suitability of water is evaluated on the basis of electrical conductivity which represents salinity and also the concentration of Fluoride and Nitrate ions. The classification of water on the basis of EC it is found that 83 % wells have EC values less than 1500 µS/ cm at 250C. Regarding fluoride, in 72 % wells its concentration was found less than desirable and permissible limit i.e 1 to 1.5 mg/l for drinking water. The nitrate was observed more than permissible limit of 45 mg/l in 38% wells. Perusal of the analytical data reveals that there is no specific trend observed for distribution of higher values of EC, fluoride and nitrate in the ground water and higher values may be due to local pollution/

geogenic sources. As such in general the quality of ground water in the study area is good and suitable for drinking.

2.3.3 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 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:

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

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 tabulated in table which is showing that all the water samples (100%) of aquifer– I (dug wells) pertain to excellent class.

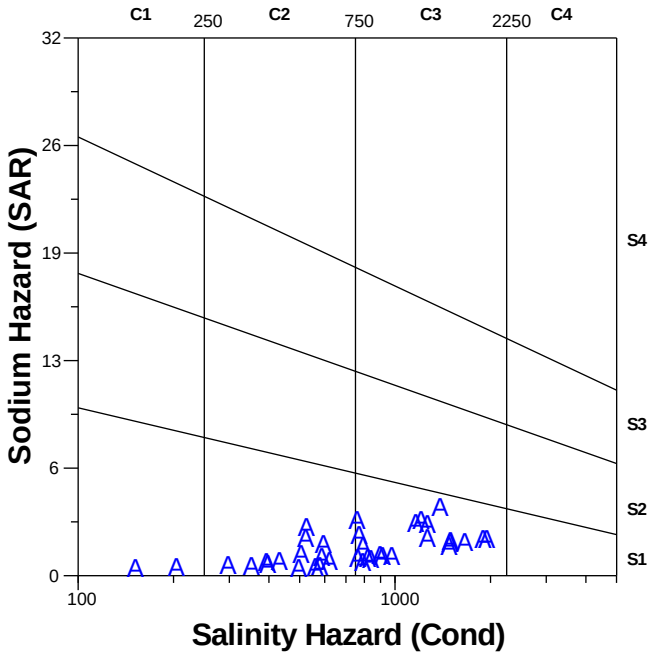


Fig.13 SAR map of Koderma district

Piper Diagrame for Classification of irrigation Waters

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 (HCO3-2) plus carbonate (CO3-2), chloride (Cl-), and sulfate (SO4-2). 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.

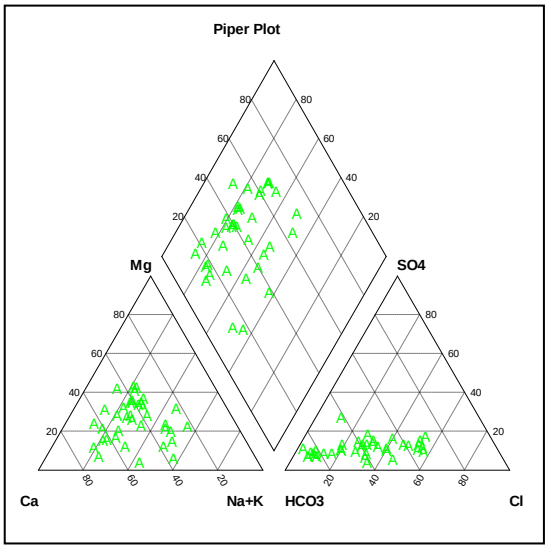


Fig.14 : Piper Diagram

2.4 Ground Water Exploration: The exploratory data particularly includes the information on sub–surface geology, hydrogeological information and geometry of aquifer in hard rocks terrain. Based on exploration data, prepared litholog of exploratory wells & observatory wells, identified the potential fracture zone encountered within 200 m depth in granitic terrain. To assess the potentiality of the deep fractured rock, 21 exploratory/Observatory wells were drilled in Koderma district. The drilling results have indicated that granite gneiss of different colour 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 Koderma district is presented in Annexure –I

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 and as discussed in details

3.1 Aquifer Disposition

3.1.1 Hydrogeological Cross Section: To study the aquifer disposition in detail, hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' and B-B'. X and Y axis represent Elevation in MSL and Horizontal distance respectively.

Hydrogeological cross section A-A':

Hydrogeological cross section A-A' represents the area in North to South western part of the district. The data of 4 exploratory wells i.e. Jeruadih, Sujanpur, Karonjiya and Urwan have been utilised (figure 15). In section A-A' one three set of fracture zone has been encountered in different exploratory wells and out of 04 exploratory wells Jerwadih well has got 03 set of fracture zone upto depth of 86 mbgl. The maximum discharge found in Urwan EW with discharge i.e 2.5 lps. The discharge range varies from 01.2-2.5 lps. The Aquifer-I bottom ranges from 3.2-16m representing weathered Granite-Gneiss while Aquifer-II ranges from 19-86 mbgl representing fractured granite gneiss .Hydrogeological cross section of A-A' is shown in figure-15

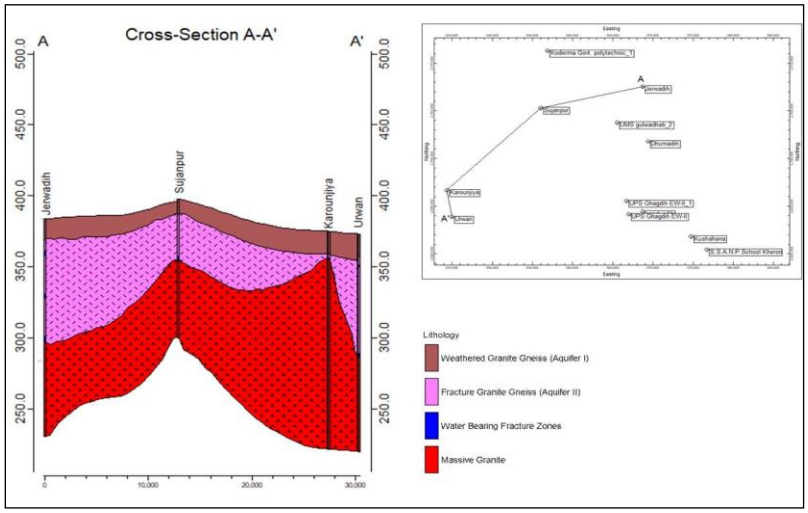


Figure 15-: Hydrogeological cross section along A-A'

Hydrogeological cross section B-B':

Hydrogeological cross section B-B' represents the area in Northern western to South eastern Part of Koderma district. The data of 04 exploratory wells i.e. Sujanpura, Khargadih, Pandyadih and Khushanha wells have been utilised (figure 16). Out of 04 exploratory wells only 02 exploratory well has got fracture zone upto depth of 42 mbgl. The Aquifer- I bottom ranges from 05-12.00 mbgl representing weathered Granite-Gneiss/Laterites, while

Aquifer-II ranges from 12-42mbgl representing fractured granite gneiss. Generally 1-2 sets of fracture zones were encountered. Well yield varies from 1.3 to 4.5 lps.

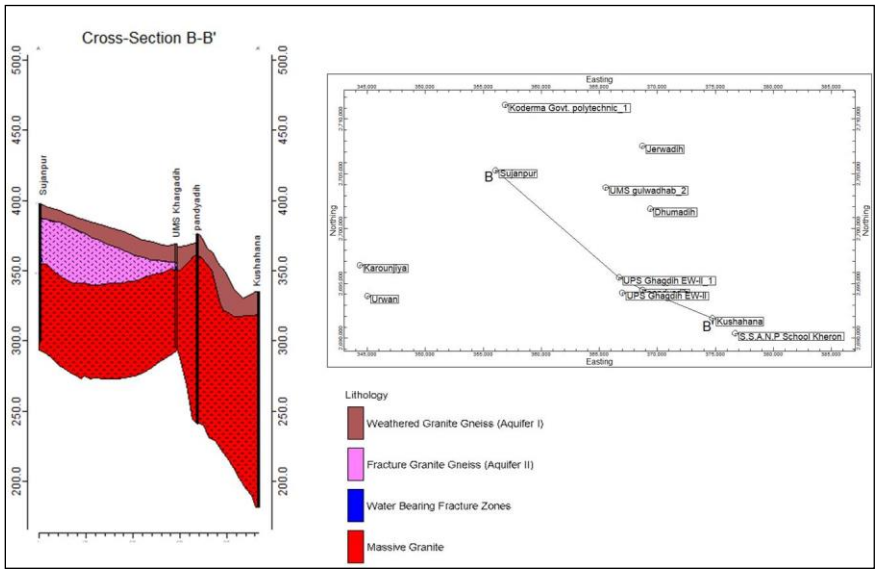


Figure 16-: Hydrogeological cross section along B-B'

Hydrogeological cross section C-C':

Hydrogeological cross section C-C' represents the area in Northern to South Part of Koderma district. The data of 03 exploratory wells i.e. Jerwadih, Dhumadih and UPS Ghagdih wells have been utilised (figure 17). Out of 03 exploratory wells all three well has got 1-3 set of fracture zone upto depth of 92 mbgl. Well yield varies from 1.2 to 3.5 lps.

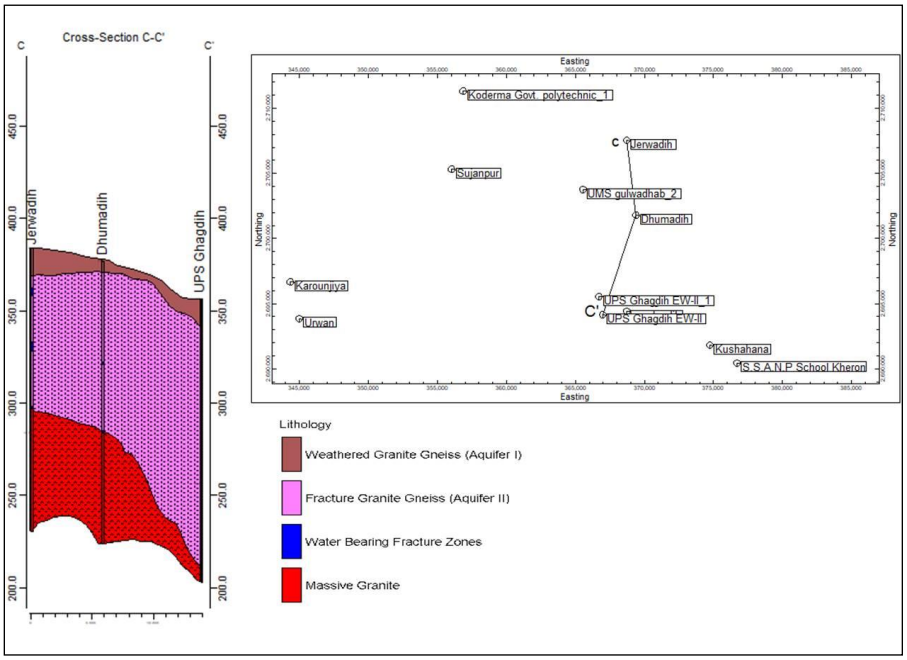


Figure 17-: Hydrogeological cross section along C-C'

3.1.2 3-D Aquifer Disposition

The 3-D map in hard rock area of the district showing spatial disposition and vertical extent of Aquifer-I(weathered granite-gneiss/weathered) indicating its depth of weathering while the Aquifer–II (fractured granite-gneiss) showing occurrence of fractured rock thickness is presented in different stratigraphical model of hard rock in Koderma district (figure-18). Based on the drilling data of exploratory wells maximum thickness of Aquifer - I (weathered zone) in hard rock area is 25.4 m. The depth of Aquifer – II (fracture zone) ranges from 12 to 150.00 mbgl. Three dimensional sub-surafce Stratigraphical models with Aquifer disposition in hard rock areas of Koderma district have also been prepared based on exploratory driiling data which is shown in figure 18

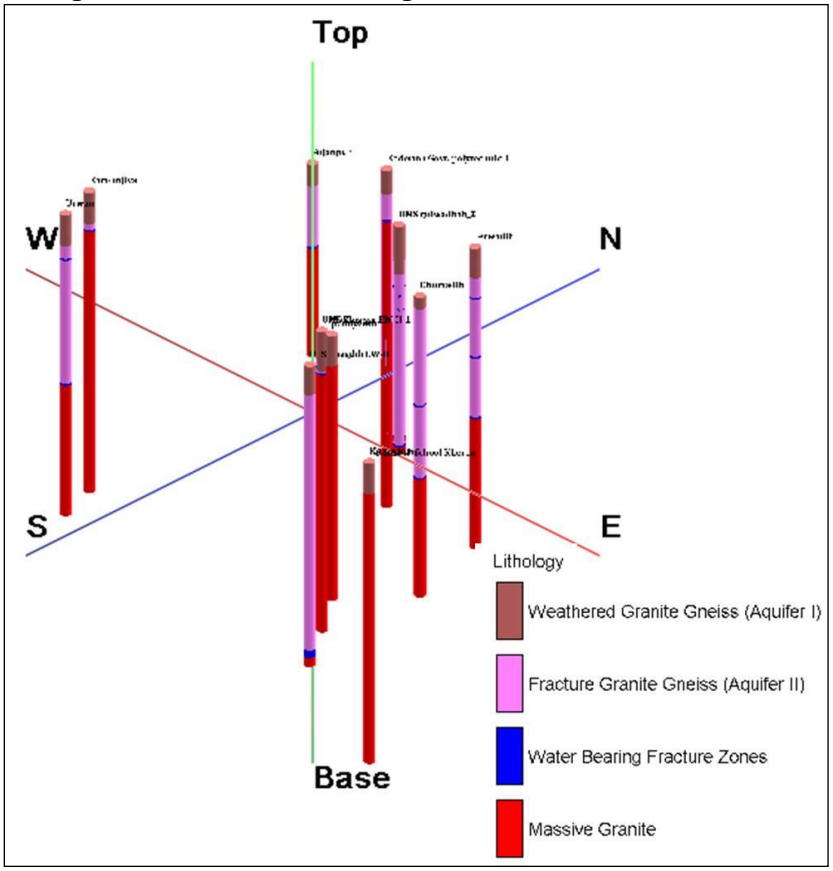


Figure 18-: Three dimensional strip-log of EW drilled in granite

Hydrogeological cross section of A-A' B-B' ' shown in figure- 16, 17 has been prepared based on exploratory well data of CGWB.The inferred imaginary line between fractured rock zone and massive rock zone depicted in Fig 16, 17 are also based on exploratory data. This is a regional model of hydrogeological cross setion. The heterogeneity of hard rock aquifer being high, the hydrogeological cross sections drawn by inferring the continuity of fracture zones in the second aquifer is tentative. Any additional data from the area in future may change the geometry of aquifer that can consider as well.

3.2 Aquifer Characteristics:-

The sustainability of ground water Resources are better understood by the aquifer properties. The table depicts the aquifer characteristics in Koderma district.

Table 9:- Aquifer characteristic of Koderma district

Type of aquifer	Formation	Depth range of the aquifer (mbgl)	SWL (mbgl)		Thickness (m)	Yield (lps)	Aquifer parameter	
			Pre Monsoon (2019)	Post Monsoon (2019)			T (m2/day)	Sy/S
Aquifer - I	Weathered Granite gneiss	6-25	12.50	12.0	6-25		--	--
Aquifer - II	Fractured Granite gneiss	25-140			0.5-1	0.25-4.5	-	

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

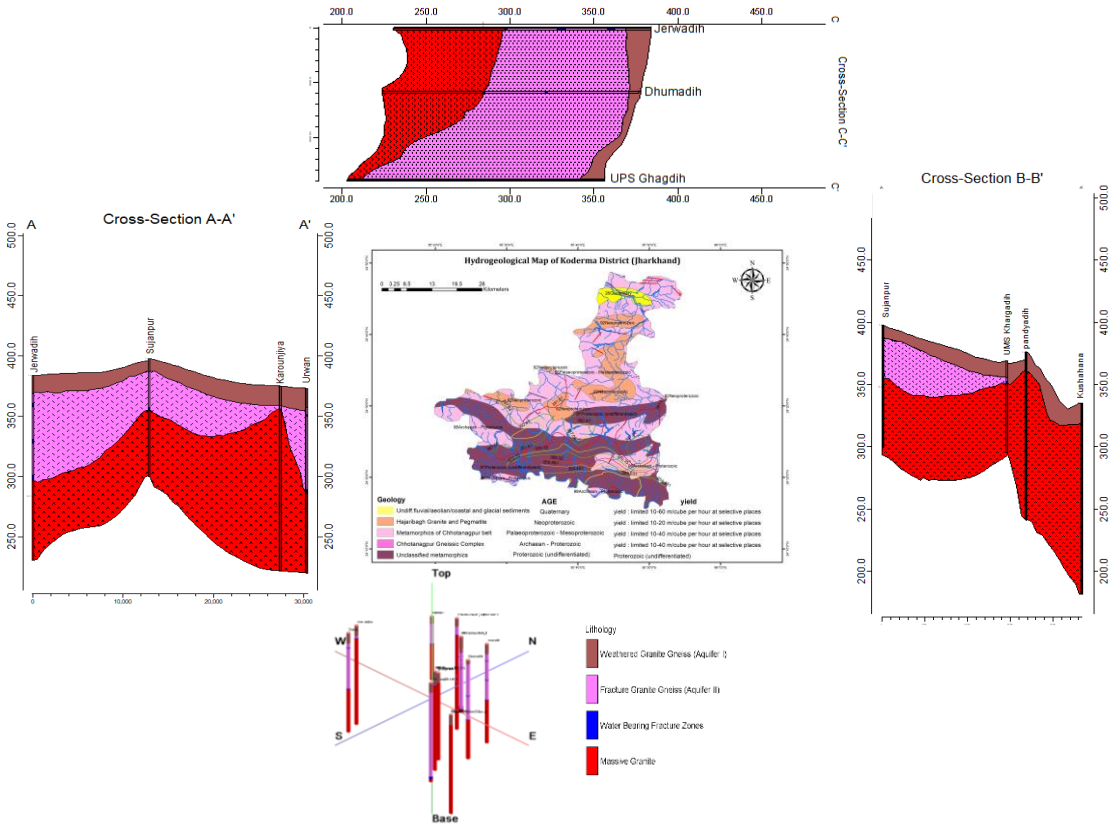


Fig.19 Aquifer map of Koderma district

4.0 GROUND WATER RESOURCES

Ground Water Resource of the area has been estimated block wise with base year as on March-2020. In the present report GEC 2020methodology has been used and based on this, 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 waterbalance 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

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The dynamic Ground Water Resources as on 2020 has been assessed by CGWB, SUO, Ranchi in association with State Ground Water Directorate, Jharkhand based on GEC, Methodology 2020. The summarized details of Annually Replenishable or Dynamic Ground Water Resources of Koderma district are in Table 10.

Table 10: Details of Ground Water Resource of Koderma District (As on March -2020)

S.No.	**Items**	**Ground water in ham**
1	Annual extractable ground water recharge	6404.84
2	Current Annual Ground Water Extraction for irrigation	2504.375
3	Current Annual Ground Water Extraction for domestic	1108.24
4	Current Annual Ground Water Extraction for industrial	20.29
5	Current Annual Ground Water Extraction for All uses	3632.89
6	Annual GW Allocation for Domestic use as on 2025	1115.95
7	Net Ground Water Availability for future use	2764.23
8	Stage of development	56.72

The block wise Dynamic Ground Water Resource of Koderma District - (As on March -2020) is given in *Annexure- IV*

5.0 GROUND WATER RELATED ISSUES

5.1 Identification of Issues:

The major ground water related issues of the Koderma are grouped into following broad categories:

- Quantifying aspects (limited fracture thickness)
- Low ground water development
- Quality aspects

A variety of nature's factors affect the quantity and quality aspects of ground water over space and time. The major ground water related issues are discussed as follows;

5.1.1 Quantity Aspects:

Ground water potential at any area mainly depends on the topography, rainfall, and geology. Because of plateau topography and Chotanagpur granitic gneiss complex as the litho-units occurring in the study area, the ground water potential is not uniform and it changes from one area to another.

Thus the availability of water resource is not uniformly distributed over space and time. This resource depletes often in summer, Therefore reduction of bore well's yield in lean period. The area is covered by Chotanagpur granite gneiss complexes where ground water potential of deeper aquifer is very less and limited thickness of fracture/joints are encountered in exploratory well drilling program.

5.1.2 Low ground water Development:

The study area experiences low ground water development in two blocks only. In the southern, central, western and some part of eastern area the ground water resources are underutilized. Ground water related issues and problems are not getting scientific attention of the Government, planners and stakeholders. The plan and policy of the water resources department are mostly related to the surface water only. There is urgent need to pay attention towards ground water also. The need of GW development and irrigation potential creation is required in underutilized area of Koderma district.

5.1.3 Quality Aspects:

The ground water quality of the study area is potable and is suitable for irrigation, however at few localities contamination in ground water due to geogenic cause. The major problems and issues related to the quality is fluoride and nitrate. In three location concentration of Fluoride having more than permissible limit i.e 1.5 mg/l and in six location Nitrate conc. more than permissible limit of 45 mg/l has been found in shallow aquifer of Koderma district.

6.0 MANAGEMENT STRATEGIES

As discussed in previous chapter, the major ground water related issue in Koderma is related to quality aspects of high fluoride and Nitrate and low ground water potential development and low ground water development in parts of the areas due to various hydrogeological reasons. To overcome these, it is imperative to have a robust ground water resource development plan for the district. Various Management strategies to overcome the ground water related issues are;

6.1 Supply side Interventions:

At present as per Ground Water Resource Estimation 2020, the stage of ground water extraction is very low i.e., 56.72 % 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 interventions envisage Ground Water Resource Development Strategy & 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.

6.1.1 Ground Water Resource Development Strategy

Ground water management strategies for the study area, we have to prepare separate plan for over-exploited blocks, Critical and Semi-critical blocks and safe blocks based on the ground water resource availability and draft condition of the area. The Annual extractable ground water recharge in the Koderma district is 6404.84 ham and Current annual GW extraction for all uses is 3632.89 ham, making stage of ground water development 56.72 % as a whole for the study area .Although there are less scope of ground water development, however only two blocks i.e Domchanch and Markacho block having Stage of development less than 60% so, there is little scope for GW development.

Considering the net ground water availability for future use, unit draft of different structures like Dug wells/Shallow Tubewell/Borewell, feasible structure has been determined for further ground water development in the district

Table 11 Proposed number of dug wells/Shallow Tubewell/Borewell

District	Assessment unit	Net ground water availability and future irrigation development (ham)	future irrigation potential available (ha)	60% of future irrigation potential created (ha)	Proposed number of ground water structure (Dug wells)	Proposed number of ground water structure (Shallow tube wells)
Koderma	Domchanch	751.86	1670.8	1002.48	300	100
	Markachho	311.95	693.2	415.92	249	24

Development of ground water for the safe blocks in Koderma district requires thorough understanding of the heterogeneity of the formations, e.g degree of weathering, thickness of fracture zones and depth of occurrences of the aquifer. It is necessary that proposed Additional ground water abstraction structure may be constructed in phases with proper

site selection/ Hydroegeological/Geophysical Investiagtions etc 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.

6.1.2 Artificial recharge to ground Water

Recently in 2020, artificial recharge to Ground Water master plan 2020 of Jharkhand state has been prepared. The identification of feasible areas for artificial recharge to ground water in Koderma district has been carried out based on depth to water level (post-monsoon) and ground water level trend. The computation of unsaturated zone available, surface water requirement and source water availability for Artificial recharge and proposed numbers of different types of artificial recharge structures feasible in Koderma district has been worked out. Based on the study 962 No of Nala Bund/Check Dam/Gully Plus and 153 No of Percolation tanks can be constructed after proper site selection. In addition, Roof Top rainwater harvesting system may also be installed in buildings. 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.

6.2 Demand side management:

It is always essential to address the issue of constraining demand for groundwater abstraction since this will normally contribute more to achieving the groundwater balance. The concept of real water savings is critical in this regard. The main demand side interventions may be: -

1. Promote improved irrigation technologies (drip or sprinkler irrigation, etc.)
2. Crop choice management and diversification (promote less intensive crops like pulses and horticulture)
3. Promote treated municipal waste water for irrigation and construction use.
4. Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.)

7.0 SUMUP

- The district of Koderma spread over an area of 1496.70 sq. km, . Koderma district has one Sub-division, Kodarma itself and 6 (Six) developmental administration the district is divided into 6 (Six) developmental blocks namely: Koderma, Jainagar, Chandwara, Markachho, Domchanch and Satgawan.

- Physiography of the Koderma district shows that overall slope towards the northern part. Minimum elevation is 116m in the northern part of the Satgawan Block of Koderma district and the Maximum elevation occurs in the east-central and the south-western part of the district. The highest peak is Debour Ghati (670 meter) that is the state boundary of Jharkhand and Bihar. The area exhibits undulating topography comprising hills, hillocks, mounds and plains.

- The area exhibits undulating topography comprising hills, hillocks, plains and mounds. Northern part of the district is occupied by Koderma Reserve Forest. The rock at the edge of this plateau has been cut deeply by innumerable streams. Barakar River flows from W to E in the southern part of the district of Koderma and supports Telaiya Hydel project, a multipurpose dam construction on it.

- The entire district is underlain by the rocks of wide variety of geological formation ranging in age from Archean to Recent. The main being Archean to recent.. In koderma district most of the areas are covered by biotite-granite gneiss, phyllite mica-schist, Intrusive granite, pegmatite veins, Amphibolite hornblende schist, Quartzite and alluvium. Sporidic occurrence of Dolerite, Quartz pegmatite veins and Quartzites are also found. Thin deposits of alluvium are found along the course of rivers.

- Ground water occurs under phreatic/ unconfined to semi-confined conditions in Aquifer-I which is represented by weathered granite-Gneiss Ground water occurs under Semi-confined to confined condition in Aquifer-II represented by Fractured/Jointed granite-gneiss, upto the explored depth of 200 mtr depth. Generally extent of Aquifer-II in Precambrian formation ranges from 30-140m.

- Overall in the district the major potential fractures zones are found upto 120m. In general in fractured/jointed/fissured formations, discharge of well has been found in the range of 0.25-4.5 lps.

- Ground Water quality is generally potable, except few patches of high Flouride and high Nitrate concentration in Ground Water.

- The stage of ground water development in Koderma district is 56.72% and all the block comes under safe category. Therefore, there is very little scope for further ground water development.

- The major ground water related issues in Koderma district are Low ground water potential/ sustainability, High concentration of Flouride and Nitrate in Ground Water etc.

- 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 549 dug wells and 124 shallow tubewell/bore wells in the feasible areas in the district. 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 - 153 percolation tank, 962 Nala Bund/Check Dam/Gully Plug Koderma district, which is Based on Artificial recharge to Ground Water master plan 2020 of Jharkhand state. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.

- 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.

Details of EW/OW/PZ Wells drilled through Department Rigs/ Outsourcing Rig

Annexure-I

Sl No	Location	Block	Co-ordinate	Depth Drilled	Length of Casing pipe	Granular Zone / fracture Tapped	Static Water level	Discharge	Drawdown	Specific Capacity	Transmissivity	Storativity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	lps	m	$m^3/hr/m$	m^2/day		mm		
1	J.J.College Koderma EW	Koderma	240 27' 20" 850 33' 55"	172.52	14.00		2.7	3.6	16.5	0.8	8.5		200	Granite gneiss	Apr-99
2	Tilaiya Block Compound EW	Koderma	240 26' 30" 850 31' 58"	149.45	10.68		6.1	0.41					200	Granite gneiss	May-99
3	Koderma (Gov.Polytechnic) EW-I	Koderma	240 30' 32" 850 35' 14"	172.35	12	134.0-135.0		0.9						Granite gneiss	2015-16
	OW			172.35	10.6	25.0-26.0		1.62						Granite gneiss	2015-16
4	Koderma (Gov.Polytechnic) EW-II	Koderma	240 30' 32" 850 35' 14"	172.35	12			Dry						Granite gneiss	2015-16
5	Sujanpur	Koderma	24.45472 85.57972		11.1	42.0-43.0		1.368							
6	Ghagdih	Jainagar	24.35488 85.68852	153.5	14.5	149.1-150.1		3.5						Granite gneiss	2021-22
7	Ghagdih	Jainagar	24.35488 85.68852	153.6	14.5	148-149		2.5						Granite gneiss	2021-22
8	Gulwadhab	Jainagar	24.44164 85.6734	116.9	24.5	30.5-31.5 39-40 112-113		3.5						Granite gneiss	2021-22
9	Gulwadhab	Jainagar	24.44164 85.6734	116.90	18.4	31-31.5 84-85 112-113		4.5						Granite gneiss	2021-22
	OW	Jainagar	24.44164 85.6734	110.80	18.4	35-36 42-43		4.5						Granite gneiss	2021-22

Sl No	Location	Block	Co-ordinate	Depth Drilled	Length of Casing pipe	Granular Zone / fracture Tapped	Static Water level	Discharge	Drawdown	Specific Capacity	Transmissivity	Storativity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	lps	m	$m^3/hr/m$	m^2/day		mm		
						108-109									
10	Khargadih	Jainnagar	24.36755 85.6857	74.20										Granite gneiss	2021-22
	OW			135.20	12	12-13 18-19		4.5						Granite gneiss	2021-22
11	Kheron	Markachoo	24.3223 85.78479	138.20										Granite gneiss	2021-22
12	pandyadih	pandyadih	24.3575 85.7056	135.2	15.4			dry						Granite gneiss	2021-22
13	Kushahana	Kushahana	24.3346 85.7653	153.5	15.5			dry						Granite gneiss	2021-22
14	Dhumadih	Dhumadih	24.4242 85.7116	153.2	6.05	55 92		0.4						Granite gneiss	2021-22
15	Jerwadih	Jerwadih	24.4761 85.7044	153.5	15	25 55 86		1.2						Granite gneiss	2021-22
16	Karounjiya	Karounjiya	24.3756 85.4653	153.5	16	19		2						Granite gneiss	2021-22
17	Urwan	Urwan	24.3503 85.4719	153.5	15.7	22 86		2.5						Granite gneiss	2021-22

Wells drilled through Out-Sourcing

Sl No	Location	Block	Co-ordinate	Depth Drilled	Length of Casing pipe	Granular Zone / fracture Tapped	Static Water level	Discharge	Drawdown	Specific Capacity	Transmissivity	Storativity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	lps	m	$m^3/hr/m$	m^2/day		mm		
1	GUMO EW	Koderma	24^0 30’ 00” 85^0 30’ 30”	147.12	24.44	27-29 75-77	7.38	0.5	17.6		1		200	Granite gneiss	Feb-05
2	CHOTKI DHAMRAI EW	Chandwara	24^0 21’ 40” 85^0 32’ 00”	130.2	21.62	50-51 65-67 83-85 98-100	5.63	0.9	9.17				200	Granite gneiss	Feb-05
3	CHUTIYARO EW	Koderma	24^0 26’ 20” 85^0 33’ 00”	150	24.49	148-149							200	Mica-schist	Feb-05

Piezometer

Sl No	Location	Block	Co-ordinate	Depth Drilled	Length of Casing pipe	Granular Zone / fracture Tapped	Static Water level	Discharge	Drawdown	Specific Capacity	Transmissivity	Storativity	Dia. of assembly	Formation	Year
				m	m	m	m bgl.	lps	m	$m^3/hr/m$	m^2/day		mm		
1	Sujanpur Pz	Koderma	24^0 27’ 17” 85^0 34’47”	98.15	11.00	42.0-43.0		0.4						Granite gneiss	2015-16

NHS and Key wells of Koderma district **Annexure-II**

District	Block	Village/Location	Long	Lat
Koderma	Chandwara	Urwan	85.468014	24.348572
Koderma	Chandwara	Kanti	85.52236	24.3311
Koderma	Chandwara	Chandwara	85.4875	24.3916667
Koderma	Chandwara	Jhangi	85.518897	24.332296
Koderma	Koderma	Jhumritilaya	85.5263889	24.4305556
Koderma	Koderma	Biradih	85.468998	24.418425
Koderma	Koderma	Kano biigha	85.5833333	24.4541667
Koderma	Koderma	Koderma	85.6	24.4694444
Koderma	Koderma	Pathaldiha	85.625	24.4125
Koderma	Jainagar	Jainagar	85.6444444	24.375
Koderma	Jainagar	Gaghdiha	85.69111	24.35873
Koderma	Jainagar	tetrawan	85.75397	24.32972
Koderma	Domchanch	Domchanch	85.6972222	24.4722222
Koderma	Markacho	Dasrokhurd	85.691477	24.355803
Koderma	Markacho	Markacho	85.837	24.328
Koderma	Markacho	Dardahi	85.815503	24.383356
Koderma	Domchanch	Phulwaria	85.737	24.467
Koderma	Satgawan	Kalidih	85.815503	24.383356
Koderma	Chandwara	Chandwara	85.4875	24.3916
Koderma	Koderma	Jhumri Tilaiya	85.5263	24.4305
Koderma	Koderma	Kodarma	85.6	24.469
Koderma	Domchanch	Domchanch	85.6972	24.4722
Koderma	Jainagar	Jainagar	85.644	24.375
Koderma	Koderma	Pathaldiha	85.625	24.4125
Koderma	Koderma	Kanobigha	85.583	24.4541
Koderma	Tilaya	Buchitar	85.666	24.4338

Annexure – III

CHEMICAL ANALYSIS RESULT OF WATER SAMPLES COLLECTED THROUGH KEY WELLS UNDER NAQUIM STUDY IN KODERMA DISTRICT,

Block	Location	Type of well	pH	EC(µs/cm) at 25^{0}C	TDS	F-	Cl-	HCO3-	CO32-	SO42-	NO3-	PO43-	TH as CaCO3	Ca2+	Mg2+	Na+	K+
					mg/L								mg/l	mg/L			
chandwara	urwan	DW	7.3	853	554.45	0.224	109.89	202.95	ND	58.79	60.3	BDL	320	58	42.525	39.34	2.25
chandwara	Kanti	DW	7.79	604	392.6	0.622	42.54	252.15	ND	37.74	BDL	BDL	155	58	2.43	52.88	5.14
chandwara	Chandwara	DW	7.77	1410	916.5	0.289	262.33	289.05	ND	67.83	71.8	BDL	325	90	24.3	167.84	1.51
chandwara	Jhangi	DW	7.39	783	508.95	1.38	76.72	270.6	ND	41.57	30	BDL	190	46	18.225	75.99	1.18
Koderma	Jhumritilaiya	DW	7.27	1288	837.2	1.63	159.52	442.8	ND	85.6	10.5	BDL	330	76	34.02	127.84	0.68
Koderma	Biradih	DW	7.36	1230	799.5	0.651	223.33	198.65	ND	94.92	73.6	BDL	280	68	26.73	127.61	0.64
Koderma	Kano bigha	DW	7.35	927	602.55	0.68	102.8	319.8	ND	34.91	18.6	BDL	340	72	38.88	50.18	2.08
Koderma	Koderma	DW	7.13	1506	978.9	0.493	258.78	344.4	ND	87.65	25.3	BDL	535	132	49.815	94.25	2.14
Koderma	Pathaldiha	DW	7.77	514	334.1	0.534	28.36	209.1	ND	18.7	27.1	BDL	170	56	7.29	38.58	1.22
Jainagar	jainagar	DW	7.76	1980	1287	0.301	297.78	436.65	ND	112.48	112	BDL	755	160	86.26	136.85	1.55
Jainagar	Gaghdiha	DW	7.37	505	328.25	0.329	74.44	135.3	ND	11.22	32.3	BDL	220	64	14.58	15.54	1.09
Jainagar	Tetrawan	DW	7.77	631	410.15	0.372	70.9	196.8	ND	43.22	9.81	BDL	240	62	20.655	30.11	1.62
Domchanch	Domchanch	DW	7.6	1931	1255.15	1.48	340.32	338.25	ND	90.81	107	0.09	720	182	64.395	135	5.85
Markacho	Dasrokhurd	DW	7.7	1686	1095.9	1.72	265.87	282.9	ND	85.3	116	0.24	615	126	72.9	112.5	6.9
Markacho	Markacho	DW	7.34	834	542.1	0.431	74.34	239.85	ND	63.84	38	BDL	340	80	34.02	44.38	2.7
Markacho	Dardahi	DW	7.87	993	645.45	0.566	113.4	282.9	ND	50.88	32.8	BDL	380	72	48.6	52.23	1.2
Domchanch	Phulwaria	DW	7.76	403	261.95	1.87	35.45	141.45	ND	16.38	13.9	BDL	155	50	7.29	19.03	1.75
Satgawan	Kalidih	DW	7.58	531	345.15	0.696	14.18	282.9	ND	17.09	0.3	BDL	124.177	38	7.09	57.6	1.81

Annexure-IV

DYNAMIC GROUND WATER RESOURCES (2020) KODERMA DISTRICT, JHARKHAND

Sl. No.	District	Administrative Units	Ground water Assessment Sub- Unit	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
				(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Koderma	Chandwara	Non-Command	1472.51	804.63	112.05	0.00	916.68	112.83	555.05	62.25
2	Koderma	Domchanch	Non-Command	1163.41	216.00	183.71	10.57	410.27	184.99	751.86	35.26
3	Koderma	Jainagar	Non-Command	1175.33	553.25	173.23	0.00	726.48	174.44	447.64	61.81
4	Koderma	Koderma	Non-Command	862.70	166.50	416.32	9.73	592.54	419.21	267.27	68.68
5	Koderma	Markachho	Non-Command	542.16	104.75	124.59	0.00	229.34	125.46	311.95	42.30
6	Koderma	Satgawan	Non-Command	1188.73	659.25	98.33	0.00	757.58	99.02	430.46	63.73
	District Total			**6404.84**	**2504.38**	**1108.24**	**20.30**	**3632.89**	**1115.95**	**2764.23**	**56.72**