केन्द्रीयभूमिजलबोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारतसरकार

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

The Dang District
Gujarat

पश्चिममध्य क्षेत्र, अहमदाबाद

भारत सरकार

West Central Region, Ahmedabad
Government of India

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Ministry of Jal Shakti
Government of India

Report

On

AQUIFER MAPPING AND GROUNDWATER MANAGEMENT PLAN, THE DANG DISTRICT, GUJARAT STATE

CENTRAL GROUNDWATER BOARD
WEST CENTRAL REGION
AHMEDABAD

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AQUIFER MAP AND MANAGEMENT PLAN
THE DANG DISTRICT
GUJARAT

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Table of Content

List of Figures

List of Tables

AQUIFER MAPPING AND MANAGEMENT PLAN OFTHE DANGDISTRICT

1.1 INTRODUCTION

The Dangs is one of the most delightful districts of Gujarat and is located high in the Saputara hills, the original home of the 'adivasis', and the tribal population of Gujarat. In ancient Indian Scriptures Dang is known as ‘Dand Aranyaka’, meaning Bamboo Fore. The Dang district is situated in the southeast part of Gujarat state and lies between 200 33’50” to 210 04’ 52” North latitudes and 730 27’58” to 730 56’38” East longitudes. To the north and west of Dang lies Surat and Navsari districts of Gujarat whereas to its east and south are the districts of the Maharastra state The Dang district has three talukas, i.e., Ahwa, Subir, and Wadhai taluka comprised of 311 Villages. The district headquarters is located at Ahwa and other major towns are Wagad and Saputara. The district occupies an area of 1766 km² and has a population of 228291 (Census, 2011). It is the most backward districts of Gujarat and is 100% rural. The administrative map of the district is given at Fig.-1 The district is hilly, with a few high hills in the east and south, and the rest of the district is occupied by a mass of flat-topped low-lying hills. It has four main valleys formed by Gira, Purna, Khapri and Ambika rivers. These valleys have extensive slope towards the western side and contains compact forest areas with luxuriant vegetation. Purna and Ambica, are the two major rivers of the Dang. The other rivers are Khapri, Gira and Ghoghal. All the rivers are flowing from east to west into the Arabian Sea. The area experiences dry climate in winter between November to March and thereafter humidity increases. The monsoon sets during the month of Jun and lasts till October. Average annual Rainfall of the area (2011) is 1635 mm.

The district is covered by Deccan lava flows belonging to the basaltic plateau which are uniform in composition. Geologically, the entire district is occupied by Deccan trap Basalt, which is hard in nature. These are having less cracks, fissures, and joints. Basalt are poor aquifers. Lateritic soils cover almost the whole district except for two pockets one in the west and other in the east, having deep black and red sandy soils. The land of the district is fertile and rocky. Maize, Rice, Groundnuts, Nagli (raggi), Euphorbia, etc. are the major cultivations. Wheat, Black Gram, Udad, etc. are also grown in the area.

The 73 % area of Dang district is covered under Reserved & Protected Forest. The entire tract of the forest is compact and continuous. The reserved forest is found only on larger hills capped with reddish to grey soils, while the protected forests occupy the gently sloping

hillocks, plateaus, flat and undulating low lying areas covered with thick column of fertile soils. Within the protected forests certain areas have been subjected to intermittent and rotational cultivation. Some areas in the reserved forest spread over in manatee compartments are leased out for cultivation in different years under special circumstances.

In spite of high rainfall, the district experiences problem of drinking water in summer season. This is due to steep slopes causing heavy runoff. Drinking water sources are mainly hand-pumps, wells and regional water supply schemes. In general, the quality of water good and potable. The district is free from Fluoride problem. The average depth of the bores is 90 m., for hand pumps and the most frequent depth range is 60 - 120 meters for HP and borewells.

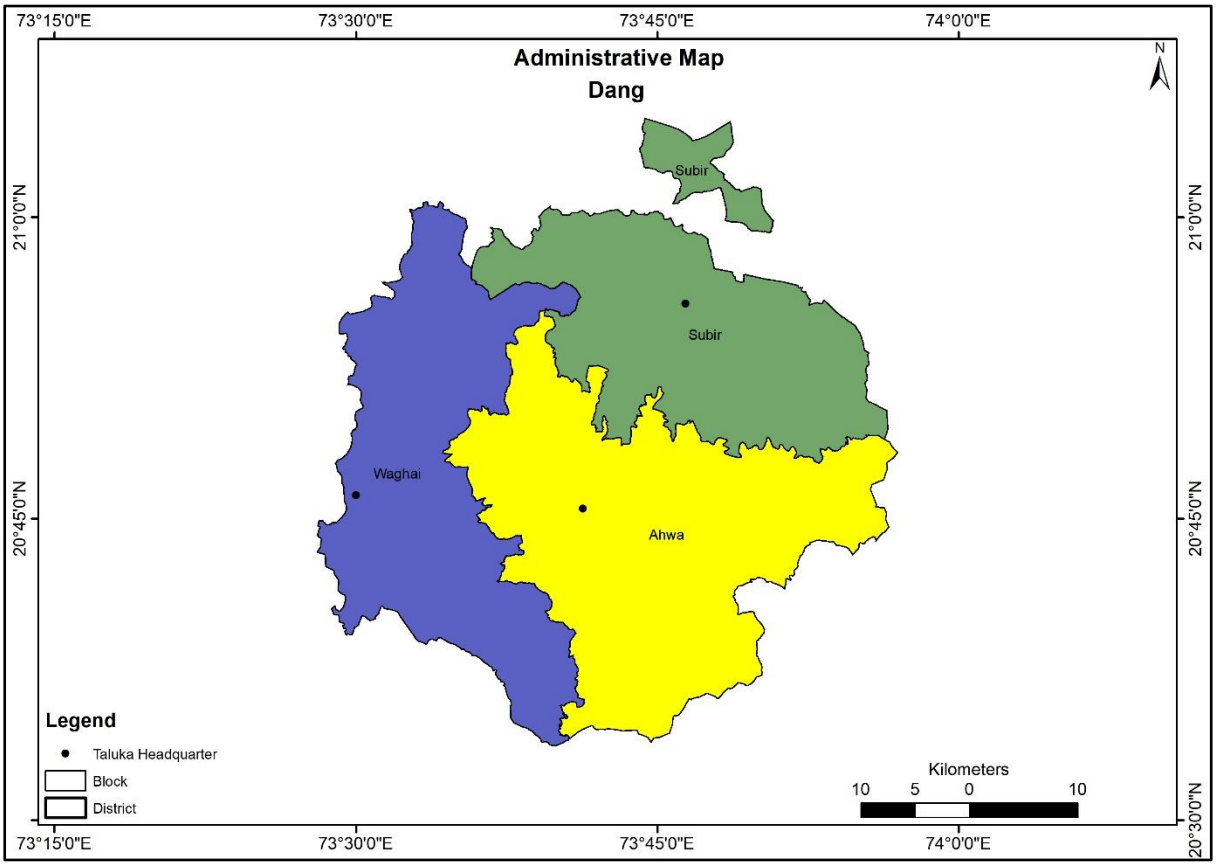

Figure 1 Index map of The Dang district

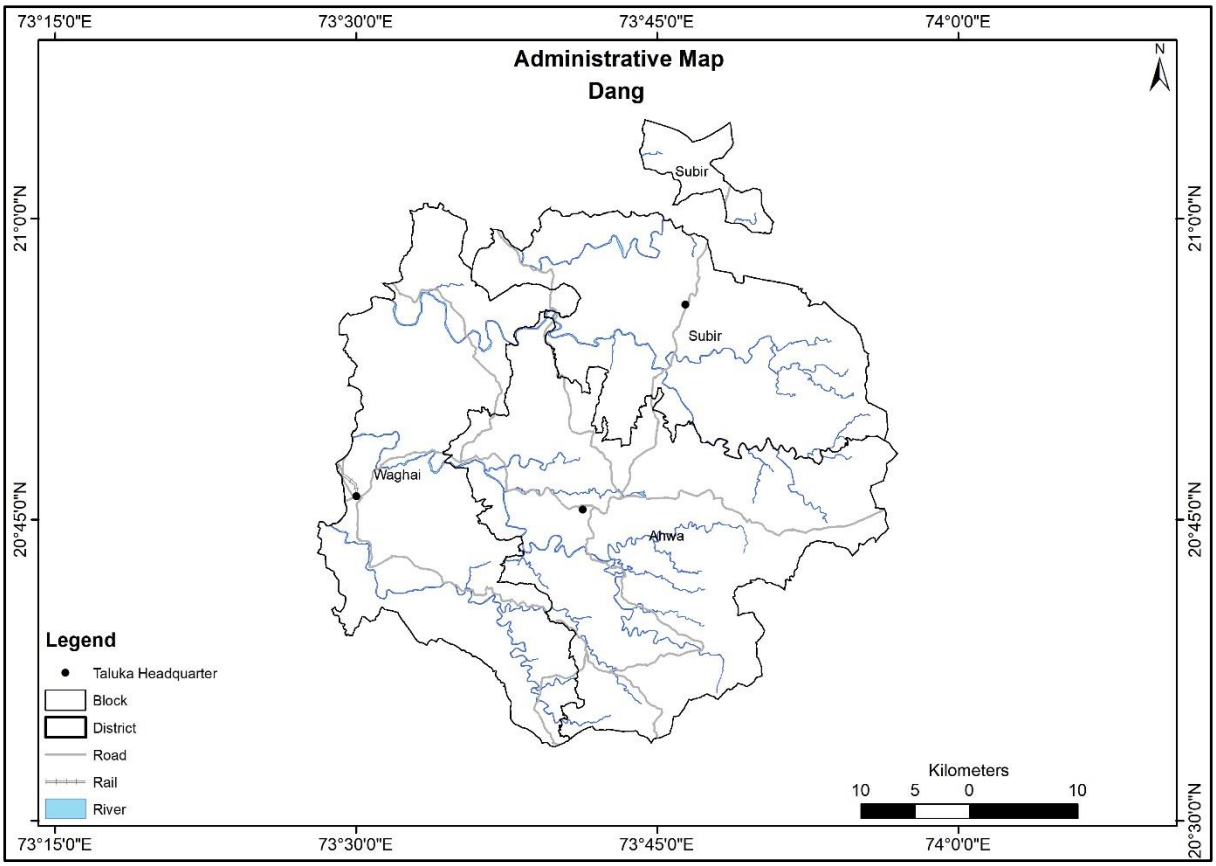

Figure 2 Administrativemap of The Dang district

1.2 OBJECTIVE

The aquifer mapping implemented is primarily based on the existing data that are collected, compiled, analysed and interpreted from available sources. In order to represent the heterogeneity of ground water system, the complexity of aquifer system on map is simplified based on the availability of data for generation of information to be depicted in Aquifer maps broadly representative of the area. The data gap analysis carried out helped in to propose/generate additional data from new data-collection activities such as exploratory drilling, geophysical investigations, water level measurements and groundwater quality analysis. By integrating and analysing the existing data and the data generated, regional hydrogeological maps, thematic maps, water quality maps, cross-sections, 2-D and 3 –D aquifer dispositions and maps of the potentiometric head were generated. Theses maps were utilized for defining the aquifer geometry and assessment of ground water resources and planning possible interventions for improvement in groundwater scenario.

1.3 SCOPE OF THE STUDY

Scope of the study is limited to the extent defining the geometry of aquifer system in space i.e., lateral and vertical disposition of aquifer system, based on existing available data. Defining characteristics of aquifer system wherever available and its significance in development and management of ground water resources in terms of quantity and quality of groundwater of the area depicting ground water regime in Two- and Three-dimension form for understanding & quantification of ground water resources in space, demand and supply of ground water and its use in the area. Identification of issues related with development and use of ground water to meet the competing water demand and its depiction for addressing the issue. Groundwater management strategies for addressing the issues by introducing management intervention (on demand and supply side) into the system.Finally, it is the user, whose participatory approach and perspective of ground water development, use and management based on available Aquifer information system as a stakeholder is envisaged.

1.4 APPROACH AND METHODOLOGY

Methodology involves creation of database for each of the principal aquifer. Delineation of aquifer, Aquifer Geometry and their characteristics, integration of Hydrogeological, geophysical, geological, hydrochemical data on GIS platform, identification of issues, manifestation of issues and formulation of strategies to address the issues by possible interventions at local and regional level.

The activities of the Aquifer Mapping can be grouped as follows

1.4.1 Data Compilation & Data Gap Analysis

One of the important aspects of the aquifer mapping programme was the synthesis of the large volume of data already collected during specific studies carried out by Central Ground Water Board and various Government organizations with a new data set generated that broadly describe an aquifer system. The data were collected from the available sources, analysed, examined, synthesized and interpreted. Predominantly non-computerized data was converted into computer-based GIS data sets and on the basis of available data, data gaps were identified.

1.4.2 Data Generation

There is a strong need for generating additional data to fill the data gaps to achieve the task of aquifer mapping. This was achieved by multiple activities such as exploratory drilling, geophysical techniques, hydro-geochemical analysis, remote sensing, and hydrogeological surveys to delineate multi aquifer system.

1.4.3 Aquifer Map Preparation

On the basis of integration of data generated from various studies aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out details of Aquifers, these are termed as Aquifer maps providing spatial variation (lateral & vertical) in reference to aquifer extremities (i.e., quality & quantity).

1.4.4 Aquifer Management Plan Formulation

A suitable strategy for sustainable development of the aquifer in the area has been formulated. All the above activities under the ground National Aquifer Mapping programme is depicted/elaborated in presented in **Figure 2**.

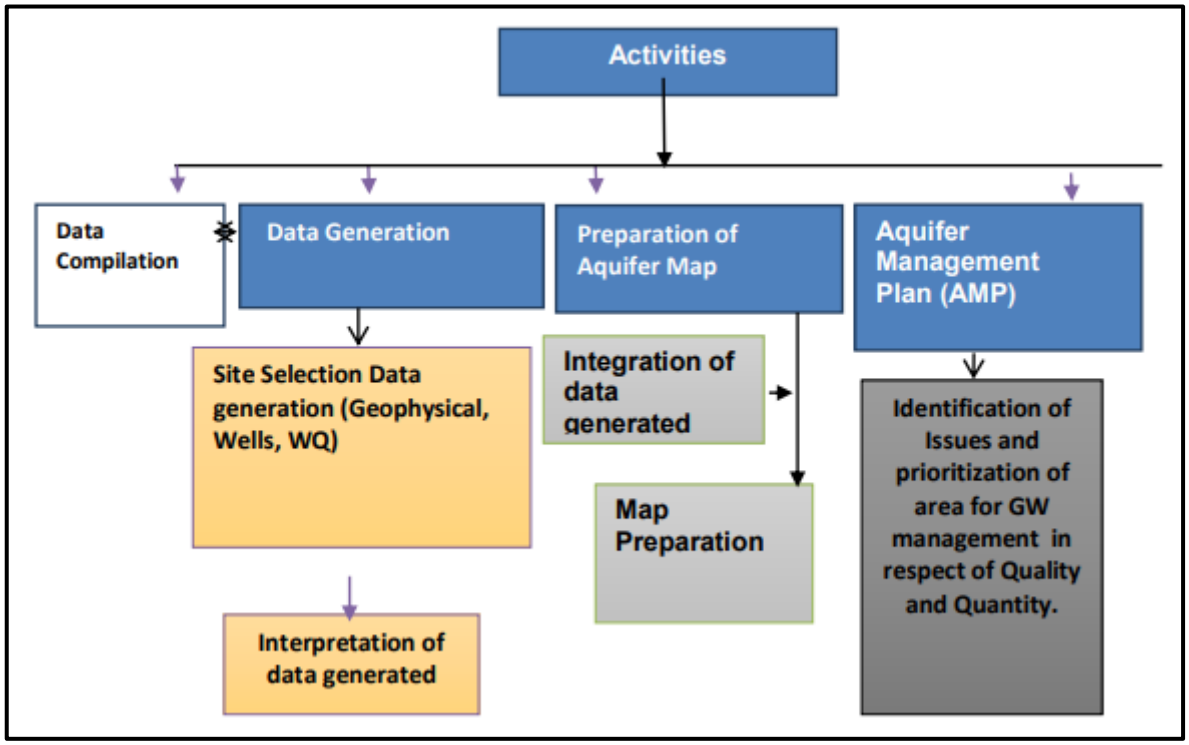

Figure 3 Activities under National Aquifer Mapping Programme

Activities:
Step 1: No activity needed
Step 2: Data generation

Step 3: Aquifer map preparation
Step 4: Preparation of management plan

1.5 LOCATION AND AREAL EXTENT

The Dang district is situated in the southeast part of Gujarat state and liesbetween 200 33'50" to 210 04' 52" North latitudes and 730 27'58" to 730 56'38" Eastlongitudes. To the north and west of Dang lies Surat and Navsari districts of Gujaratwhereas to its east and south are the districts of the Maharastra state The Dang districthas three talukas, i.e., Ahwa, Subir, and Wadhai taluka comprised of 311 Villages. The district headquarters is located atAhwa and other major towns are Wagad and Saputara. The district occupies an areaof 1766 km² and has a population of 228291 (Census, 2011). It is the most backwarddistricts of Gujarat and is 100% rural. The district is hilly, with a few high hills in the east and south, and the rest ofthe district is occupied by a mass of flat-topped low-lying hills. It has four mainvalleys formed by Gira, Purna, Khapri and Ambika rivers.

1.6 ADMINISTRATIVE UNITSAND POPULATION

The district comprises of 311 villages, 70 Panchayats and Three talukas. The total population of the district is 228291 of which male population constitutes about 113821 (49.86%) and female population is 114470 (50.14%). The population density is 129 per square kilometer. The villages are small in size. The average population of the villages is 600 persons and the village consists on an average of 117 households. The Dangs is the most backward districts of Gujarat and is 100% rural. The overall literacy rate of the district was 75.16%. The following table gives the population details. Ahwa taluka comprises maximum population 101189 (44.32 %) of the district whereas Subir taluka has minimum population 55368 (24.25 %) in the district. The Waghai taluka have population of 71734 (31.42%). The district consists of 308 inhabited villages and 03 towns.

Table 1 Demographic features of the Dangs

The Dang District Population									
Taluka	Total Population			Rural Population			Urban Population		
	Toal	Male	Female	Toal	Male	Female	Toal	Male	Female
Ahwa	101189	50237	50952	83217	41529	41688	17972	8708	9264
Subir	55368	27515	27853	55368	27515	27853	0	0	0
Waghai	71734	36069	35665	65019	32666	32353	6715	3403	3312
District Total	**228291**	**113821**	**114470**	**203604**	**101710**	**101894**	**24687**	**12111**	**12576**

Source: Agriculture Census Division, DAC, District- The Dang

1.7 DATA ADEQUACY AND DATA GAP ANALYSIS AND DATA GENERATION

Central Ground Water Board has carried out systematic and reappraisal hydrogeological surveys, exploratory drilling under groundwater exploration programme and ground water regime monitoring etc. Chemical quality of ground water of phreatic aquifer is monitored for pre-monsoon period.

1.8 PREVIOUS WORK

In 1949 Sir C.S. Fox visited the district in connection with drinking waterproblems of Dang Villages. He has concluded that surface water must be stored as thelava flows are fine textured and un weathered.Geological Survey of India carried out geological mapping of the areabetween 1973 and 1976 (S/Shri B.K. Mohinty and A.K. Roy). Systematichydrogeological surveys carried out by Shri G.S. Mittal of CGWB in the year 1978 -79.Ground water exploration studies by test drilling in the district was first takenup in 1987-88 when four EW, down to 90m depth were drilled. Thereafter, 15boreholes (12 EW & 3 OW), in the depth range of 146 to 202m were drilled in 1989-90. Hydrogeological studies and exploratory drilling carried out in the district broadlyindicated the presence of unconfined and semi-confined aquifer system to theexplored depth of 200m.

PHYSIOGRAPHY AND DRAINAGE

2.1 PHYSIOGRAPHY/GEOMORPHOLOGIC FEATURES AND LAND FORMS

Entire area is a part of Deccan Trap country, and exhibits rugged and terracedtopography with flat topped conical hills, small plateau and steep sided narrowvalleys. The highest elevation of the area is 1055.52 m (Sanjan hill) and lowest111.55 m near Dongarda village.

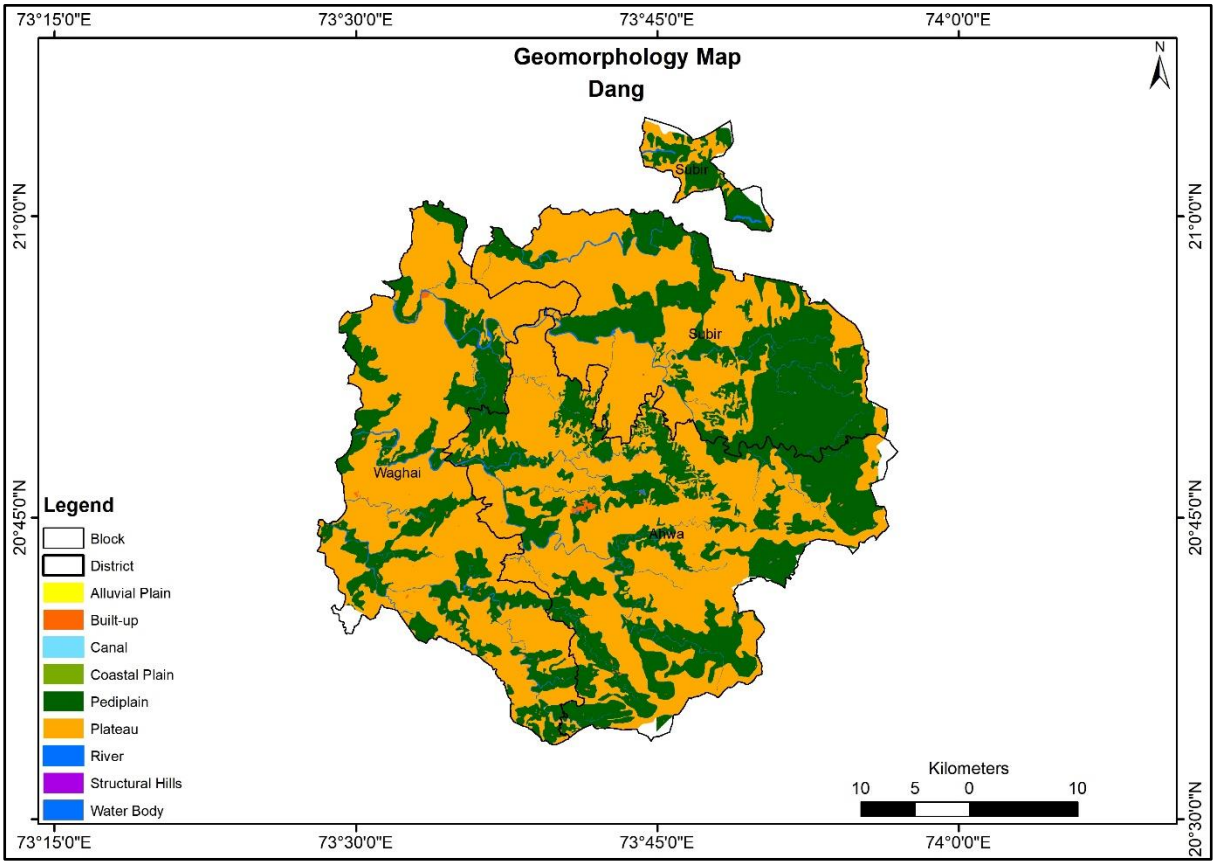

Figure 4 Geomorphological map of The Dang distict, Gujarat state

The topgraphic map shows that the elevation of the district is maximum towards the eastern side (red color) and the elevation decrease towards the western side. The maximum part of Ahwa and Subir taluka is at higher elevation whereas maximum part of Waghai taluka is at lower elevation.

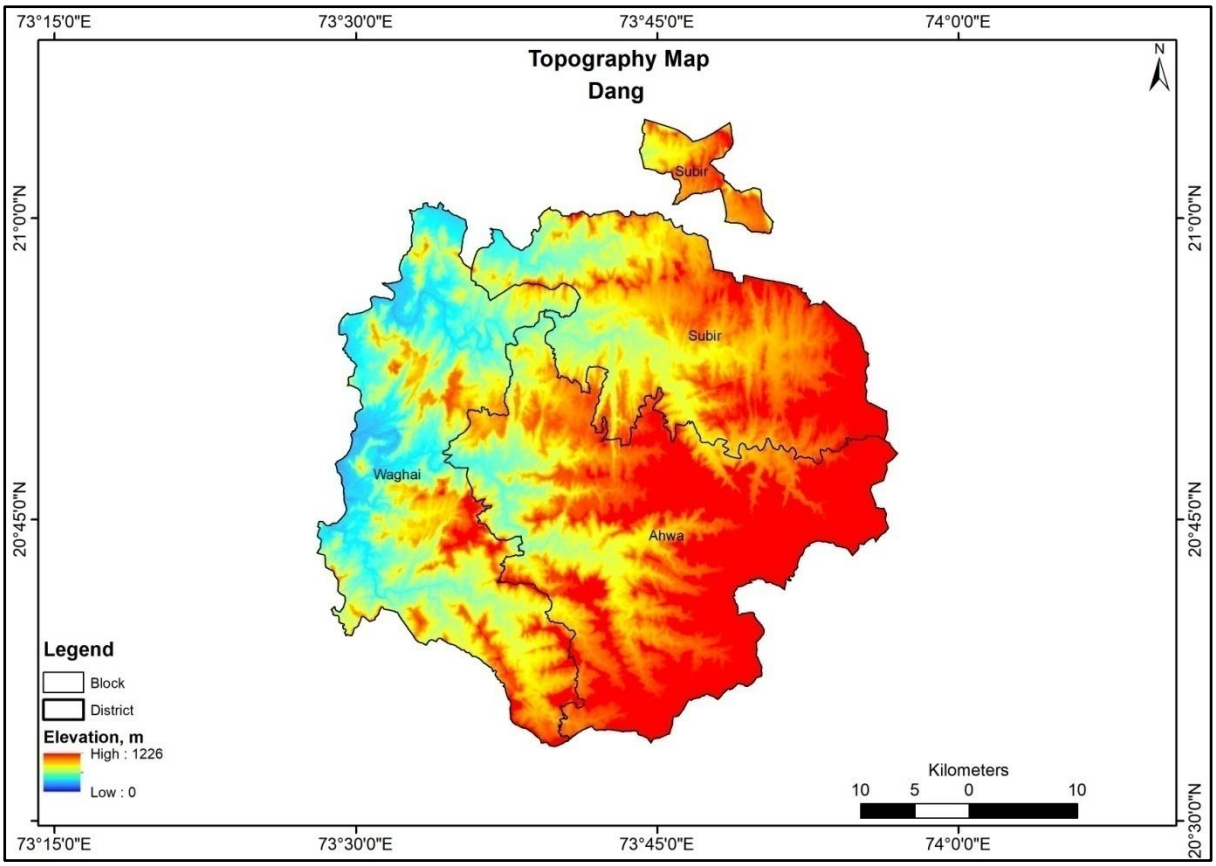

Figure 5 Topographic map of The Dang distict, Gujarat state

2.2 DRAINAGE

Purna, Ambica and Khapri, are the three major rivers draining the district ofthe Dang. The other rivers are Gira and Ghoghal. Almost all the streams areephemeral but they become perennial before emerging out of Dangs on north-westernside. All the rivers are flowing into the Arabian Sea. The Purna river rising in the hills of the Salher, it passes through Chinchli Mahal, Kalibel andBorigaotha. The river after leaving the boundary of the district flows through the Vyara talukaof Surat district and finally meets the Arabian Sea in the Navsari taluka of the Bulsar district. The Ambika River Rising in the Kem hills which are situated near Bondarmal (The Dangs District) andShribhuvan (Maharashtra) villages, the Ambika River flows past the villages of Rambhas andWaghai. After through this district the river flows through Bulsar and finally meets itself inthe Arabian Sea near Bilimora. The Dhodhad river Rising in the Davad hills of the Western Ghats, the river passes by the villages ofPipaldahad, Ghana and Uga in the district. It finally empties itself in river Purna nearLavchali.

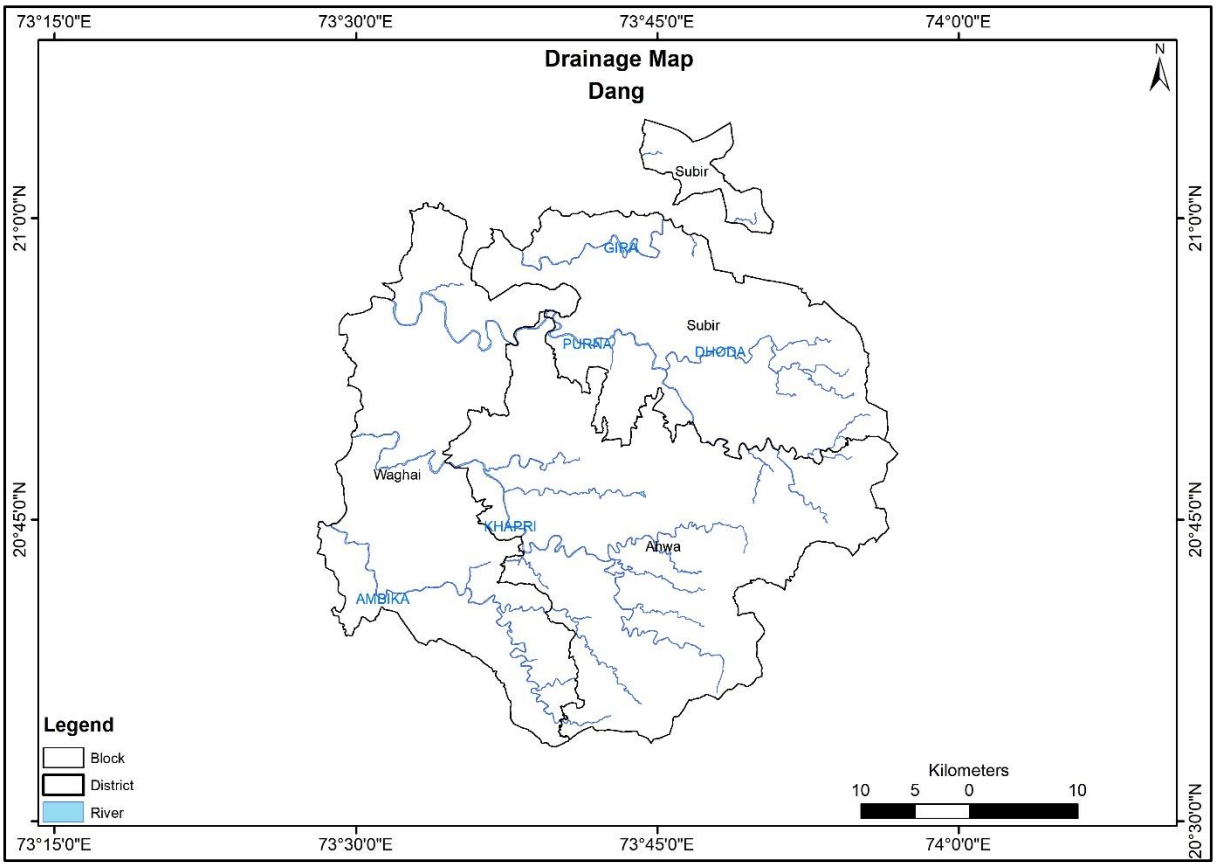

Figure 6 Drainage map of The Dang district, Gujarat state

SOIL, LANDUSE, AGRICULTURE, IRRIGATION AND SURFACE WATERRESOURCES

3.1 SOIL

Lateritic soils cover almost the whole district except for two pockets one in thewest and the other in the east, capped by deep black and red sandy soils. Basaltic lavaflows are covered with blackclayey to loamy soil. It is in general about a meter inthickness. The color of soil turns red due to high iron content at some places.Depth of soil is shallow to moderate (0 to 25 cm) in hilly forest, 45 to 150 cms (deep to very deep) in predominant slope and flood plains alluvial areas. The soil slope is 3.5 percent on hill, 0.1 percent in plateau and 1.3 percent in mid land flood plains.

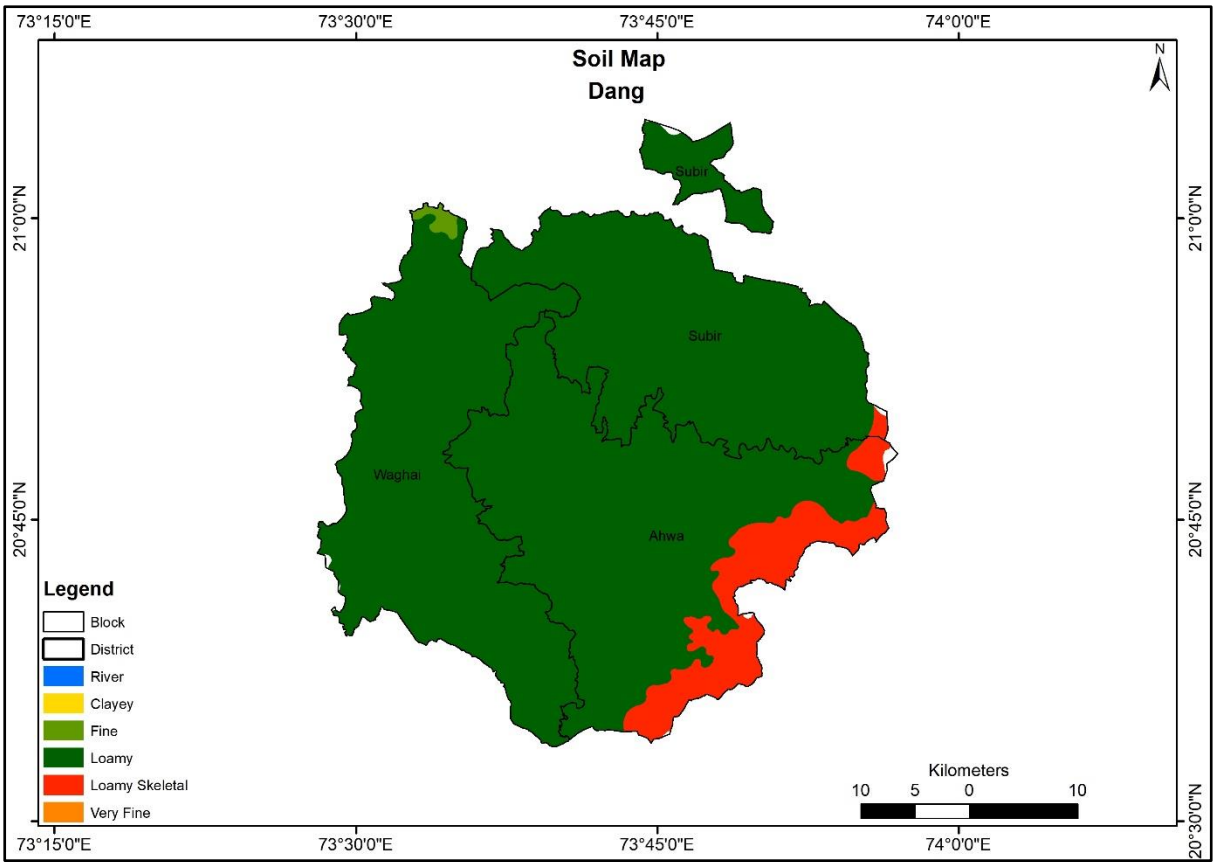

Figure 7 Map showing the soil texture in The Dang district of Gujarat district

3.2 LAND USE

Land Utilization Pattern for the district in 2021-22 is given in **Table 3**. During 2021-22, Forest area reported is 103400 ha. and total geographic area is 176600 ha.

Table 2 The Dang District Land use classification

Land Utilization according to 2021-22 (Ha)												
Taluka Name	**Total geographical area**	**Area under Forest**	**Land in non-agricultural use**	**Barren and uncultivable land**	**Permanent pastures & other grazing lands**	**Land under deciduous trees and shrubs**	**Cultivable waste land**	**Other fallow**	**Current fallow**	**Net area sown**	**Area sown more than once**	**overall planting area (11+12)**
1	2	3	4	5	6	7	8	9	10	11	12	13
Ahwa	69200	39500	3500	3500	200	500	3500	900	700	21400	1300	22700
Subir	51100	28500	300	1000	100	200	100	100	0	20600	1300	21900
Waghai	52100	35400	0	400	0	0	100	0	100	15900	1400	17300
District Total	**176600**	**103400**	**3900**	**4900**	**300**	**700**	**3700**	**1100**	**800**	**57900**	**4000**	**61900**

Source: Agriculture Census Division, DAC, District- The Dang

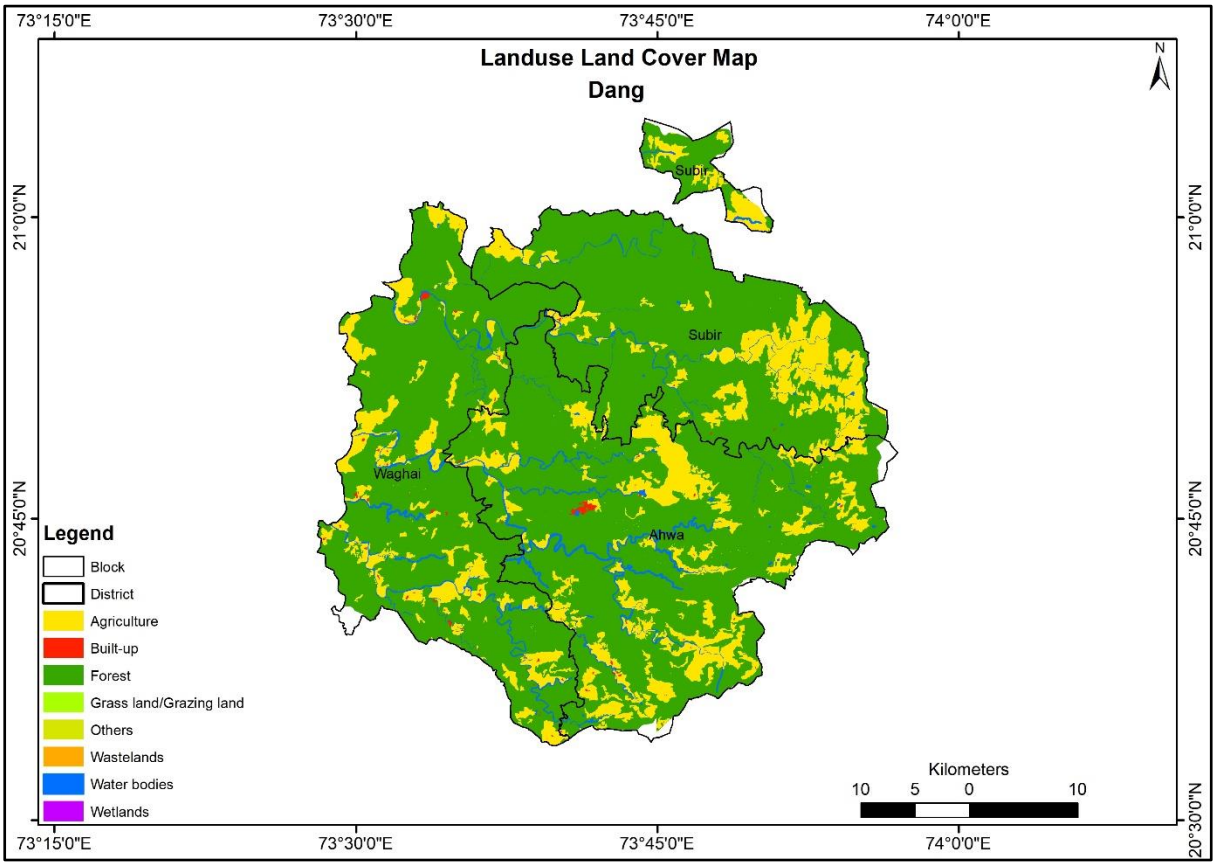

Figure 8 LanduseLand Cover map of The Dang district, Gujarat state

3.3 AGRICULTURE

Emerging from the traditional system of slash and burn agriculture, subsistence farming is the primary source of livelihood for the tribal population of the Dang. Subsistence farming is being carried out here much due to the kind of poverty levels that exist in the district and also the inability to take risks due to higher degrees of vulnerability. Shifting cultivation is not practiced due to high pressure on land. Adar represents the tradition of slash and burn is currently limited to nurseries to grow saplings of rice, ragi and varai. Due to lack of irrigation facilities, low productivity and physical features of the land, the time for agricultural activities is limited to monsoon. The quality of land is poor and 66% of the agricultural land is situated on slopes, where irrigation is difficult. The elevated land and wide spread deforestation have been cause for increase in erosion, which is strongly affecting the agricultural productivity. Due to the high degree of slope and the high annual rain fall, the soil is also washed away thus depriving the land of the precious top soil. Repeated instances during every monsoon have depreciated land of its quality. This has put the limitation on the agricultural potential and also for the production of cash crops. Some cash crop like

groundnut is being cultivated, but only for consumption purpose rather than for commercial use. Due to the low agricultural productivity, the lack of land for cultivation and the limited opportunities for irrigation, the majority of the population migrates during the winter and summer months to be engaged in agricultural labour and construction work.

Due to very small holding and very low productivity of the land, most household live by maintaining diversified pattern of occupations. No single activity provides sufficient resource to ensure their livelihood. Agriculture in the district is predominantly rain fed and monsoon cropped. Thepercentage of net irrigated area against net sown area in the Dang district is about 22.63%.

3.3.1 Crop Calendar

Month of sowing and harvesting of various crops in the district for the year 2021-22 are given below.

Table 3 Crop calendar of The Dang

Crop Calendar- 2021-22			
S.N.	**Crop**	**Month of Sowing**	**Month of Harvesting**
1	Paddy	June-July	October-November
2	Corn	June-July	September
3	Sorghum	June-July	October-November
4	Pigeon Pea	June-July	November-December
5	Peanut	June	October
6	Beans	June-July	October-November
7	Wheat	October-November	March-April
8	Others	July-August	November-December

Source: Agriculture Census Division, DAC, District- The Dang

3.4 IRRIGATION

The irrigation facilities are not well under developed owing to technologicaland environmental factors. Hence, The Dang is pre-dominantly dependent on rain fedagriculture and has the lowest percentage of irrigated land in Gujarat.The area irrigated by different sources in the district during 2021-22 are presentedin **Table 5**.

Table 4 Irrigation classification of The Dang district (source wise)

Land Irrigation area from different sources (Ha)- 2021-22						
Taluka Name	**Canal**	**Pond**	**Dugwell**	**Other**	**Total**	**Percentage of**

						net irrigated area against net sown area
Ahwa	0	2800	1200	2900	6900	32.24
Subir	0	900	1000	1800	3700	17.96
Waghai	0	900	800	800	2400	15.09
District Total	**0**	**4600**	**3000**	**5500**	**13100**	**22.63**

Source: Agriculture Census Division, DAC, District- The Dang

Table 5 Irrigation classification of the Dang district (Crop wise)

Crop Wise Irrigation (Ha) - 2021-2022		
S.N.	**Crop**	**Irrigation Area**
1	Total Cereals	570
2	Total Pulses	834
3	Total Oil Seeds	708
4	Other non-edible crops	634

Source: Agriculture Census Division, DAC, District- The Dang

3.5 IRRIGATION PROJECTS: MAJOR, MEDIUM AND MINOR

In the talukas covering under the Dang district, the major or medium schemes are summarised in table 7.

3.6 SURFACE WATER RESOURCES

The major source of the surface water is the perennial flows in Ambika, Khapri and Purana rivers. There are two major irrigation projects, one on River Sharpa Ganga at Saputara and the other on a tributary of Khapri River at Bhisia. The salient features of these projects are given below.

Table 6 Major and medium irrigation scheme

S.N.	Major Scheme (Gross Command area, km^2.)	Storage (MCM)
1	Saputara (0.56)	0.636
2	Bhisia (3.51)	0.707

CLIMATOLOGY

4.1 RAINFALL

Entire Dang district falls under South Gujarat (Heavy Rainfall) Sub Zone. Thedistrict has, in general dry tropical climate except during the monsoon season where itexperiences high precipitation, high evaporation and large daily fluctuations intemperature. The period from June to September constitute the southwest monsoonseason. October and November may be termed the post monsoon or retreatingmonsoon season. The cold season starts from December and last upto Februaryfollowed by hot season from March to May. Moisture incursions occasionally takeplace, sometimes initiating dry summer or dust storms. Some of the storms anddepressions from the Arabian Sea in the latter half of the summer and in the post monsoon season affect the district and its neighborhood causing widespreadrains and gusty winds. The annual mean maximum and minimum temperaturerecorded at Ahwa for the past few decades stands at 45 ˚C and 10˚C respectively.District receives heavy rainfall in monsoon season, but outside the monsoon there ishardly any shower. The average annual rainfall is given in the **Table 7**. The decadal mean annual rainfall (2012-2021) is maximum in Waghai taluka (2243.5 mm) and the minimum in the Subir taluka (1810.1 mm). Likewise long term mean annual rainfall (1972-2021) is also same as decadal annual rainfall i.e., Waghai taluka has maximum (2213.4) and Subir taluka has minimum (2126.7). The Dang district is not declared as drought prone in the year 2021-2022.

Table 7 Annual Rainfall of The Dang district (1967-2021) in mm

Year	Ahwa	Subir	Waghai
1961	1687	1687	1687
1962	1234	1234	1234
1963	1804	1804	1804
1964	1898	1898	1898
1965	1879	1879	1879
1966	1713	1713	1713
1967	2160	2160	2160
1968	1665	1665	1665
1969	2119	2119	2119
1970	2062	2062	2062
1971	1797	1797	1797
1972	1300	1300	1300
1973	1944	1944	1944
1974	1725	1725	1725
1975	3436	3436	3436

1976	1948	1948	1948
1977	974	974	974
1978	1556	1556	1556
1979	1826	1826	1826
1980	2358	2358	2358
1981	1836	1836	1836
1982	2388	2388	2388
1983	2182	2182	2182
1984	2329	2329	2329
1985	2359	2359	2359
1986	1923	1923	1923
1987	1832	1832	1832
1988	3121	3121	3121
1989	2045	2045	2045
1990	1828	1828	1828
1991	1909	1909	1909
1992	1935	1935	1935
1993	3105	3105	3105
1994	4534	4534	4534
1995	1630	1630	1630
1996	1105	1105	1105
1997	2903	2903	2903
1998	3754	3754	3754
1999	2294	2294	2294
2000	1593	1593	1593
2001	2200	2200	2200
2002	1850	1850	1850
2003	1957	1957	1957
2004	2642	2642	2642
2005	3825	3825	3825
2006	2624	2624	2624
2007	1860	1860	1860
2008	2611	2611	2611
2009	1568	1568	1568
2010	1760	1760	1760
2011	1665	1665	1665
2012	1636	1636	1636
2013	2397	2397	2397
2014	1764	1764	1764
2015	1453	1453	1453
2016	2248	2248	2248
2017	1591	1591	1591
2018	1702	1577	3452
2019	2587	2661	4219

2020	1644	1507	1841
2021	2034	1267	1834
AVG. (2012-2021)	1905.6	1810.1	2243.5
Long-term AVG. (1972-2021)	2145.8	2126.7	2213.4

Table 8 District-wise Monthly Rainfall

Taluka	**District-wise Monthly Rainfall (2021)**						
	June	**July**	**August**	**September**	**October**	**November**	**Total**
Ahwa	287	604	288	606	193	55	2034
Subir	131	350	225	444	85	32	1267
Waghai	251	573	400	563	25	22	1834
District Average Rainfall	223	509	304	538	101	35	1712

Source: Agriculture Census Division, DAC, District- The Dang

GEOLOGY

The geological formations in the area are of Cretaceous-Eocene age, represented by the succession of predominantly basaltic lava flows, associated with basic intrusions. Recent alluvium deposit of clay and sand occur along Purna River. The general sequence of the rock formations is as follows:

Age	Formation
Quaternary	Clay and Sand (Alluvium)
Cretaceous to Eocene	Deccan Trap (Basalts)

Geologically, the district is composed of Deccan trap Basalt which is hard in nature. There are less cracks, fissures, and joints. Basalt acts as poor aquifers.Deccan lava flows are the major geological horizon occurring between 700-1000 m above mean sea level. The basalts are predominantly of 'pahoe' type in which 10 flows have been delineated within the elevations of 700 m and 1000 m above mean sea level. In the area starting from Saputara Ghat section to Chinchili Grakhadi side Ghat section the individual flows are as thick as 70 m to less than 10 meters.

Based on the lithology, the individual lava flows may broadly be divided intothree units viz;

1. The basal unit comprises chilled greyish colored basalt containing pipeamygdales. They are generally filled with zeolites, chalcedony and chertyminerals.
2. The middle unit comprises fine to medium grained basalt and is very hard andcompact.
3. The upper unit consist of vesicular basalt, which is medium to coarse grainedand soft in nature. The diameter of vesicles very between one to five mm. Thevesicles are rounded or oval shaped and generally filled with zeolites, quartzetc.

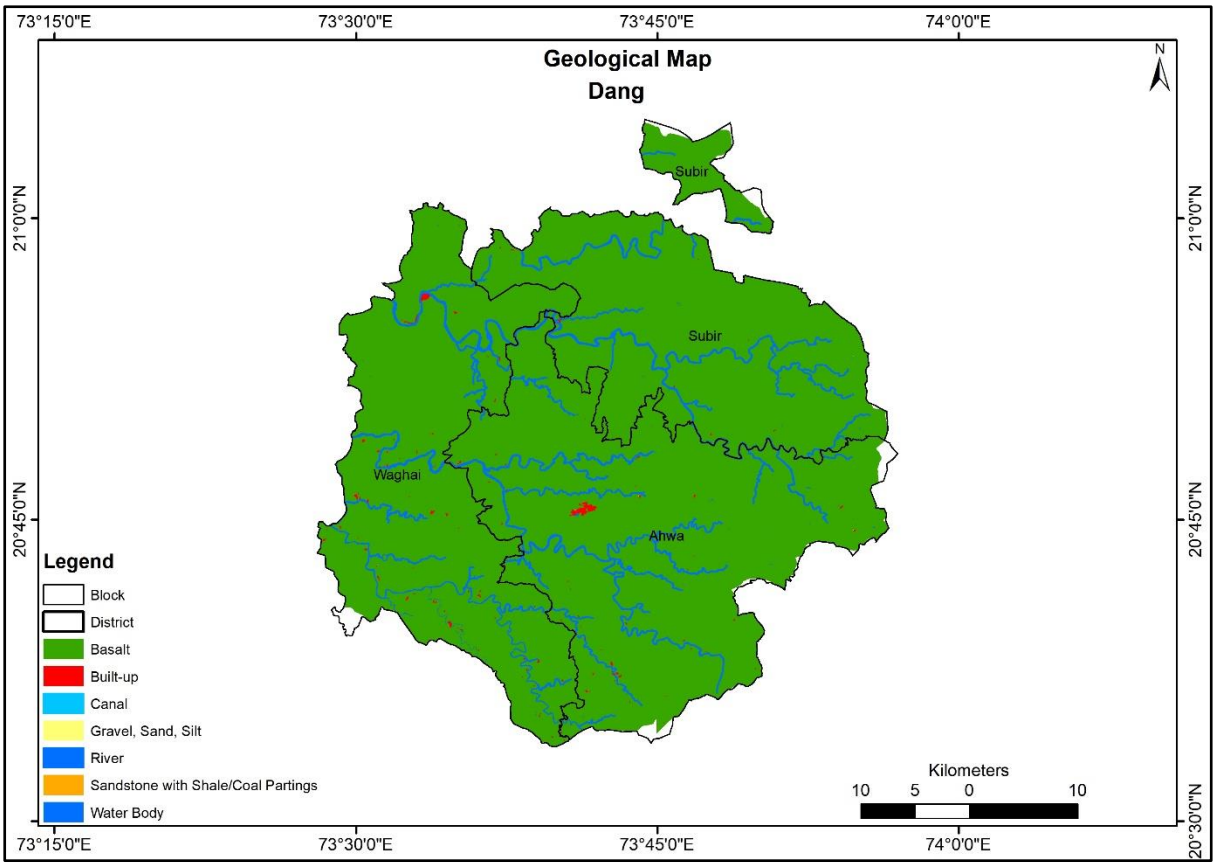

Figure 9 Geological map of The Dang district, Gujarat state

HYDROGEOLOGY

Ground water occurrence is governed and controlled by the contrasting water bearing properties of different lithological units. In this area different units of basaltic lava flows form the major aquifer system. Ground water occurs under phreatic condition. The unconfined aquifer is the most extensive aquifer comprising of weathered and fractured volcanic rocks in the district. The areal extent and thickness of weathered mantle is highly variable. Thickness of the weathered mantle ranges from less than 1 m to about 8 m followed by very common spheroidal weathering.

In Basalts, the weathered zones, jointed and fractured units in the interflow junctions consisting of vesicular horizons form the potential aquifers. Ground water occurs under water table conditions in the weathered, fractured and vesicular horizons of traps. Depth of open wells range between 18 to 20 m with water levels in the range of 2 to 12 m. bgl. The southern portion of the area is crisscrossed by dykes which control the movement of groundwater in the formation.

The specific yield of the wells tested varies from 0.0 – 26 percent in weathered basalt and 0.11 to 1.14 in semi weathered to massive basalt. Yield of the wells constructed in weathered and amygdaloidal/zeolitic basalt varies from 15 to 1200 lpm and 20 to 165 lpm in semi weathered to massive basalt.

The specific capacity of the wells varies from less than 25 lpm/m to 250 lpm/m. Optimum yield of the well ranges from 15 to 1200 lpm. Transmissivity of the basalt ranges from 15 m2/day to 152 m2/day.

In 16 Exploratory wells were drilled in the district four wells were drilled upto 90 m depth and 12 wells in the depth range of 145-200 m. All the boreholes were drilled in the Deccan Trap Basalt. These wells have yielded negligible to 450 lpm for the drawdown in the range of 6-60m. Out of the 16 exploratory wells, 6 wells yielded more than 100 lpm and 4 wells were hydraulically failure. Electrical conductivity of the water ranged from 350-800 µs/cm.

DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

Collection and compilation of data for aquifer mapping studies is carried in conformity with Expenditure Finance Committee (EFC) document of XII plan of CGWB encompassing out various data generation activities (**Table9**).

Table 9 Brief activities showing data compilation and generations

S.N.	Activity	Sub-activity	Task
1	Compilation of existing data/ Identification	Compilation of Existing data on groundwater.	Preparation of base map and various thematic layers, compilation of information on Hydrology, Geology, Geophysics, Hydrogeology, Geochemical etc. Creation of data base of Exploration Wells, delineation of Principal aquifers (vertical and lateral) and compilation of Aquifer wise water level and draft data etc.
		Identification of Data Gap	Data gap in thematic layers, sub-surface information and aquifer parameters, information on hydrology, geology, geophysics, hydrogeology, geochemical, in aquifer delineation (vertical and lateral) and gap in aquifer wise water level and draft data etc.
2	Generation of Data	Generation of geological layers (1:50,000)	Preparation of sub-surface geology, geomorphologic analysis, analysis of land use pattern.
		Surface and sub-surface geo-electrical and gravity data generation	Vertical Electrical Sounding (VES), bore-hole logging, 2-D imaging etc.
		Hydrological Parameters on groundwater recharge	Soil infiltration studies, rainfall data analysis, canal flow and recharge structures.
		Preparation of Hydrogeological map (1:50, 000 scale)	Water level monitoring, exploratory drilling, pumping tests, preparation of sub-surface hydrogeological sections.
		Generation of additional water quality parameters	Analysis of groundwater for general parameters Including fluoride.
3	Aquifer Map Preparation (1:50,000 scale)	Analysis of data and preparation of GIS layers and preparation of aquifer maps	Integration of Hydrogeological, Geophysical, Geological and Hydro-chemical data.
4	Aquifer Management Plan	Preparation of aquifer management plan	Information on aquifer through training to Administrators, NGO's, progressive farmers and stakeholders etc. and putting in public domain.

7.1 DATA GENERATION

In order to establish the three-dimensional disposition of aquifer system in the area, the existing data of litho logical logs and Electrical logs of Exploratory wells studies carried out and used in prepare a hydro geological cross section, Fence diagram and 3D Model. The data has been analysed using Rockworks 16 software and is presented below in the Hydrogeological cross sections A-A' to D-D' and Solid Model of the district showing the depiction of Aquifer Groups and Aquitard up to 90 m. The stratigraphic sections depicting unconfined aquifer, Confined Aquifer for weathered aquifer & fractured aquifer for Basaltic rock are placed at **Figures (10 to 13)**. Fence Diagram and 3D Solid Model of district is depicted in **Figure 14** and **Figure 15**, respectively.

Table 10 Data integration in respect to The Dang district

Type of Data & source	**No of Wells**
Aquifer Disposition	
CGWB	**27**
Long term Fluctuation	
CGWB+GWRDC	**44+16**
Decadal Analysis water Level	
CGWB+GWRDC	**27+7**
Analysis of water Quality	
CGWB	**42**

7.2 CONCEPTUALIZATION OF AQUIFER SYSTEM IN 2D

A total of 25 exploratory wells and piezometers lithologs are utilized to decipher the subsurfacegeometry of the aquifer by using Rockworks 16 software prepared hydro geological crosssections, Fence diagram and 3D Model up to the depth of 90 mbgl. And six hydrogeologicalcross sections (2D) are drawn in different direction to cover entire area as per the availability ofdata point in the district and represented in figure 10 (A-A') to figure 13 (D-D').

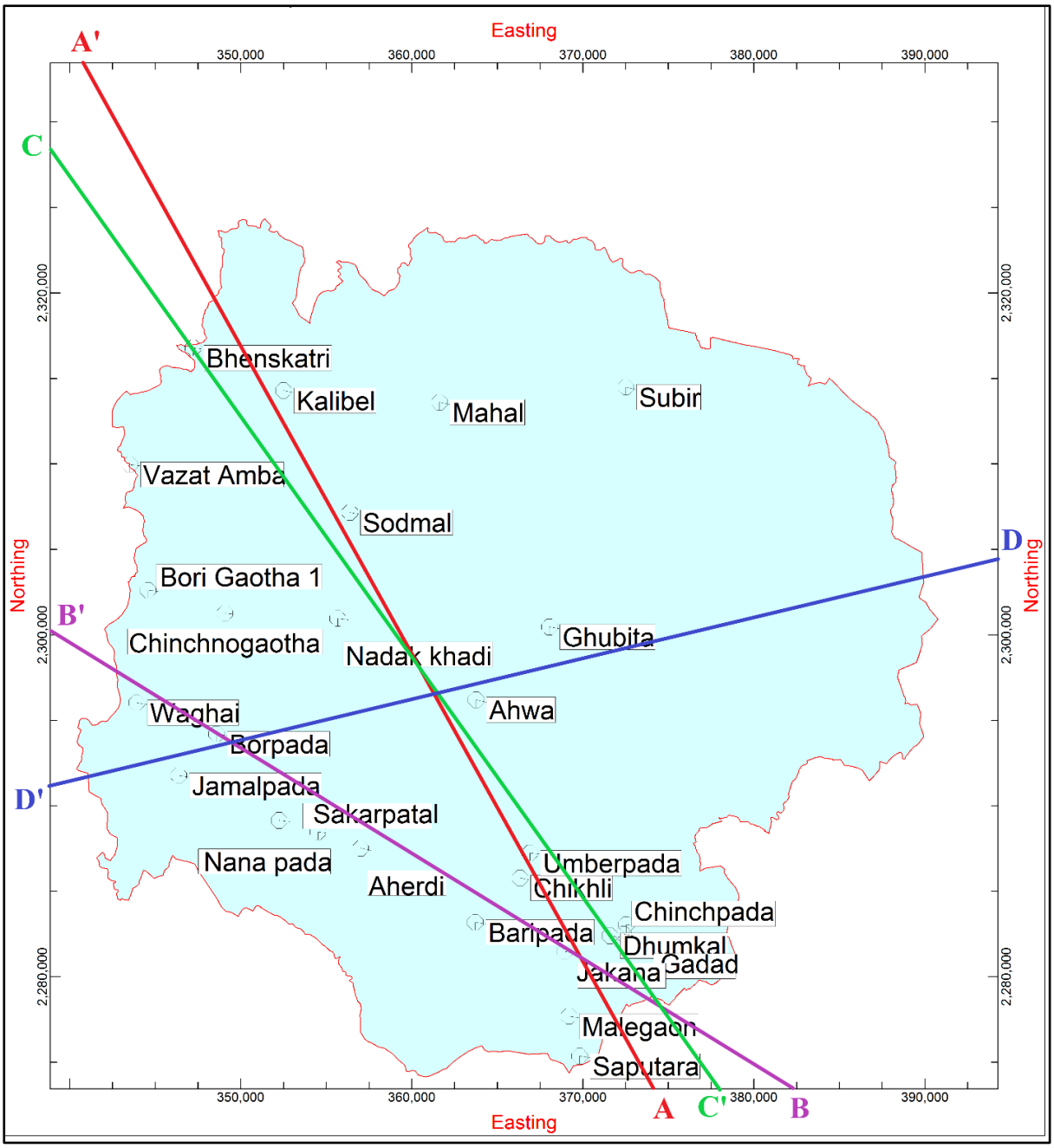

Figure 10 Map showing drawn section lines

1. Section A-A' is drawn roughly SE-NW direction and in between Saputara and Bhenskatri, passing through Baripara, Ahwa, Sodmal, and Kalibel. Section is represented Stratigraphically; from section it is deciphered that that Hard rock formation (weathered & fractured) forms the major aquifer system in the district and rested on massive rock along drawn section line.
2. Section B-B' is drawn roughly SE-NW direction and in between Malegaon and Waghai, passing through Baripara, Chikhali, and Borpada. Section is represented

Stratigraphically; from section it is deciphered that that Hard rock formation (weathered & fractured) forms the major aquifer system in the district and rested on massive rock along drawn section line.

3. Section C-C' is drawn roughly NW-SE direction and in between Bhenskatri and Dhumkal, passing through Kalibel, Sodmal, Nadak Khadi, Ahwa, Umberpada, and Chikhli. Section is represented Stratigraphically; from section it is deciphered that that Hard rock formation (weathered & fractured) forms the major aquifer system in the district and rested on massive rock along drawn section line.
4. Section D-D' is drawn roughly NE-SW direction and in between Subir and Jamalapada, passing through Ghubita, Ahwa, and Borpada. Section is represented Stratigraphically; from section it is deciphered that that Hard rock formation (weathered & fractured) forms the major aquifer system in the district and rested on massive rock along drawn section line.

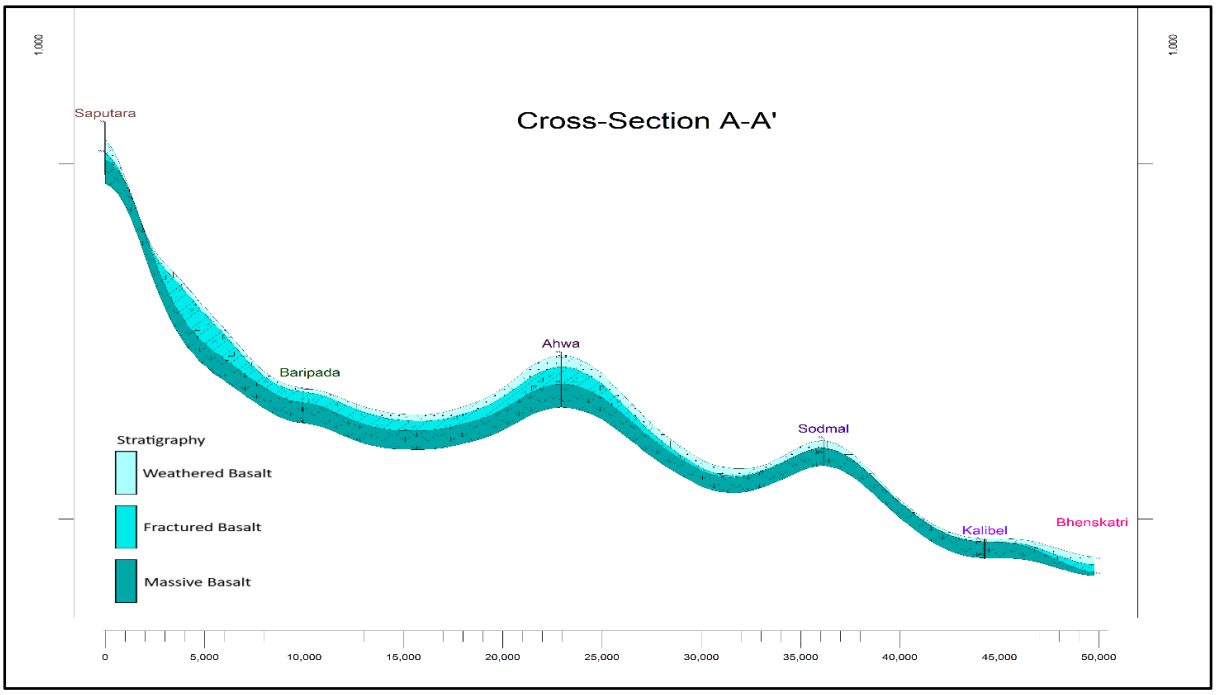

Figure 11 Hydrogeological cross section between Velavadar and Lakhanka (A-A')

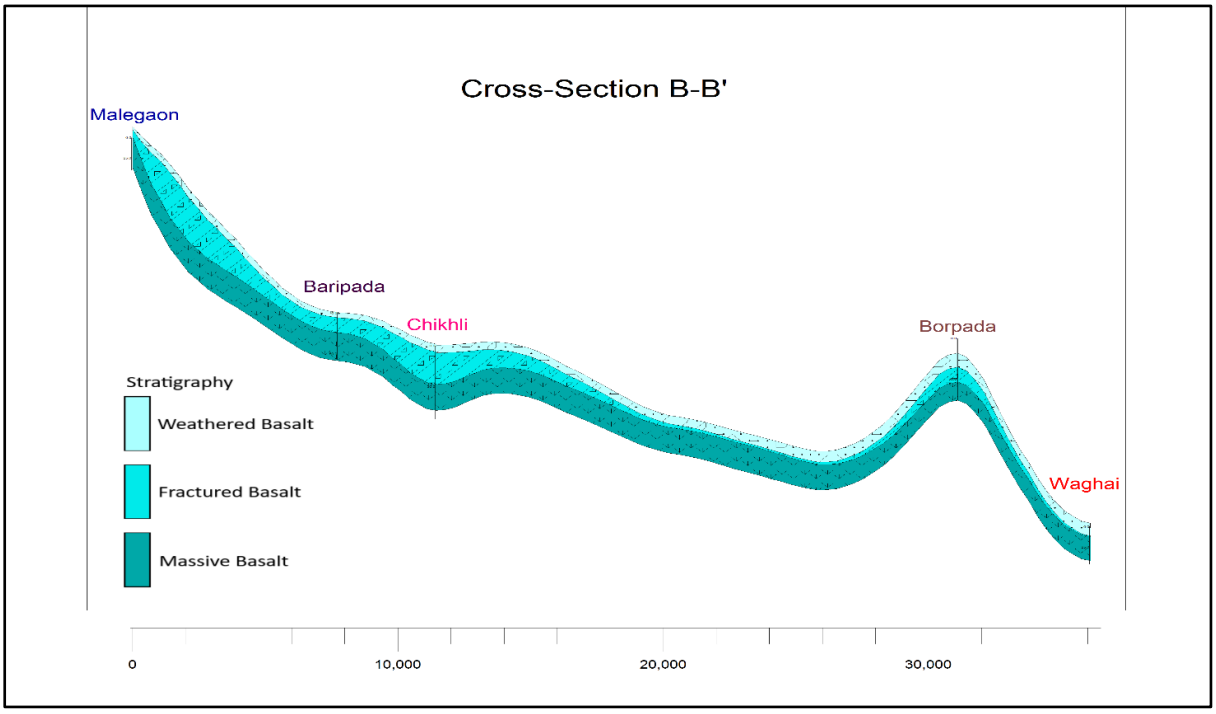

Figure 12 Hydrogeological cross section between Malegaon and Waghai (B-B')

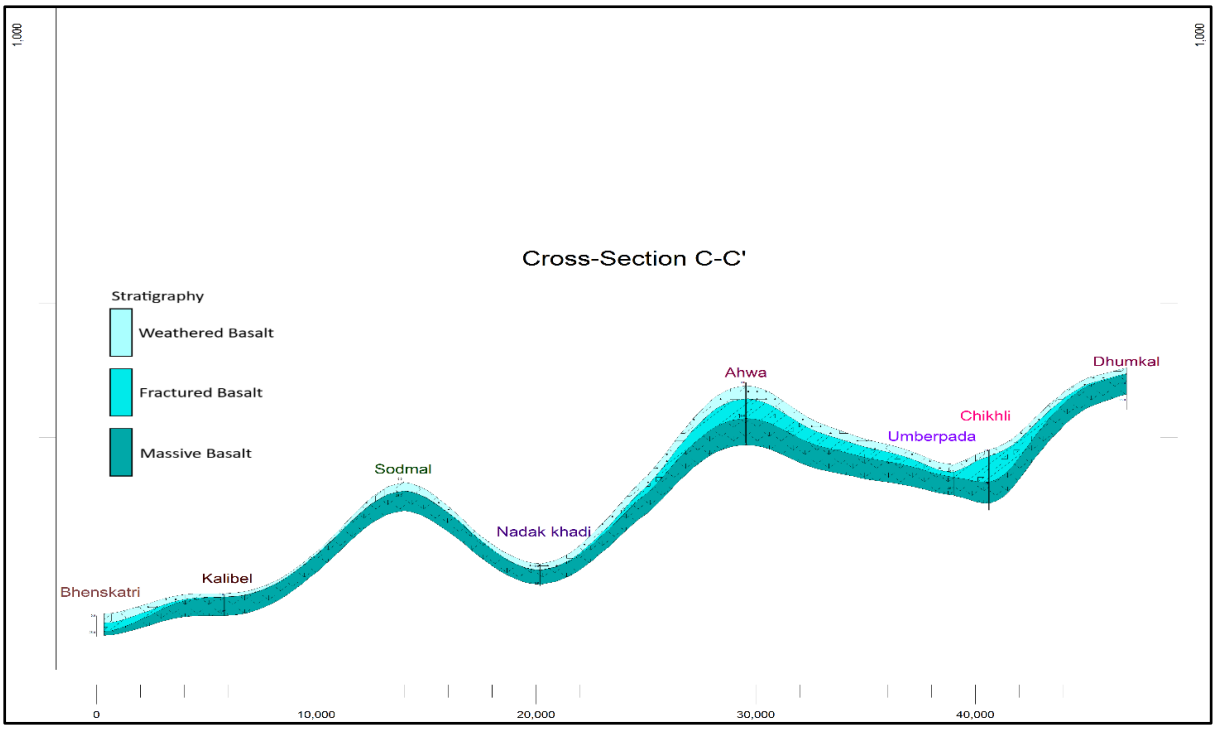

Figure 13 Hydrogeological cross section between Bhenskatri and Dhumkal (C-C')

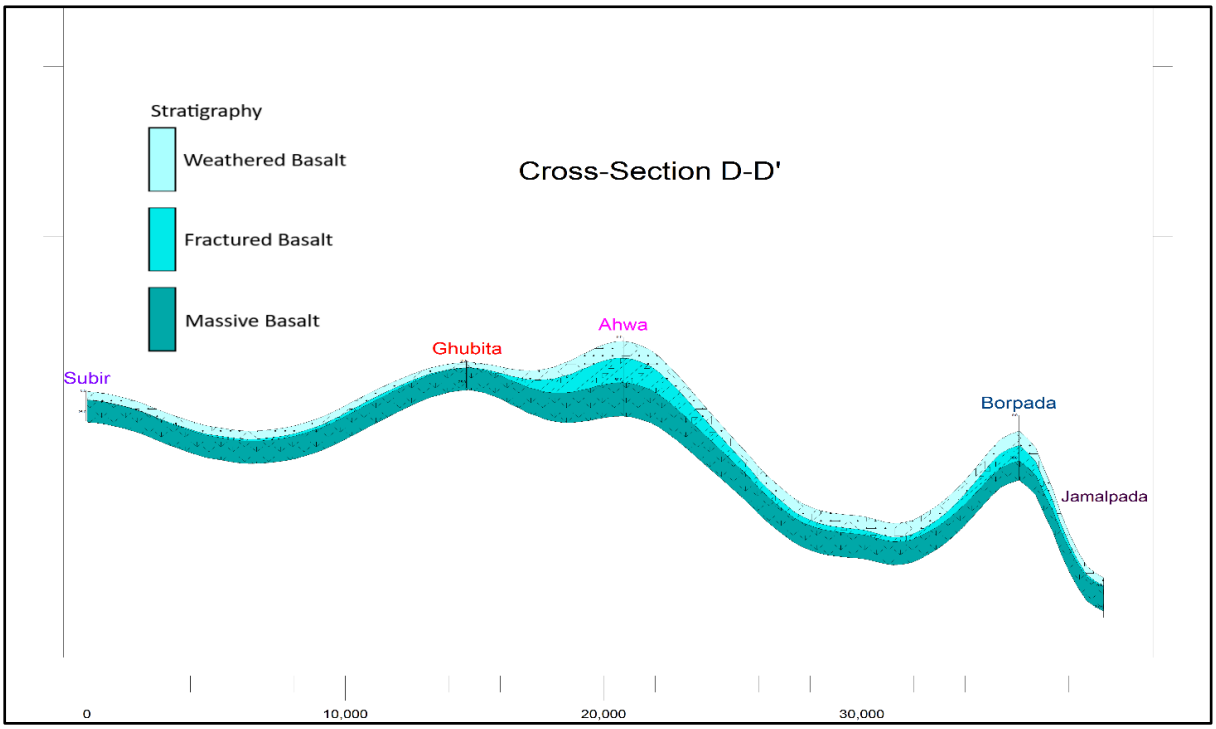

Figure 14 Hydrogeological cross section between Subir and Jamalpada (D-D')

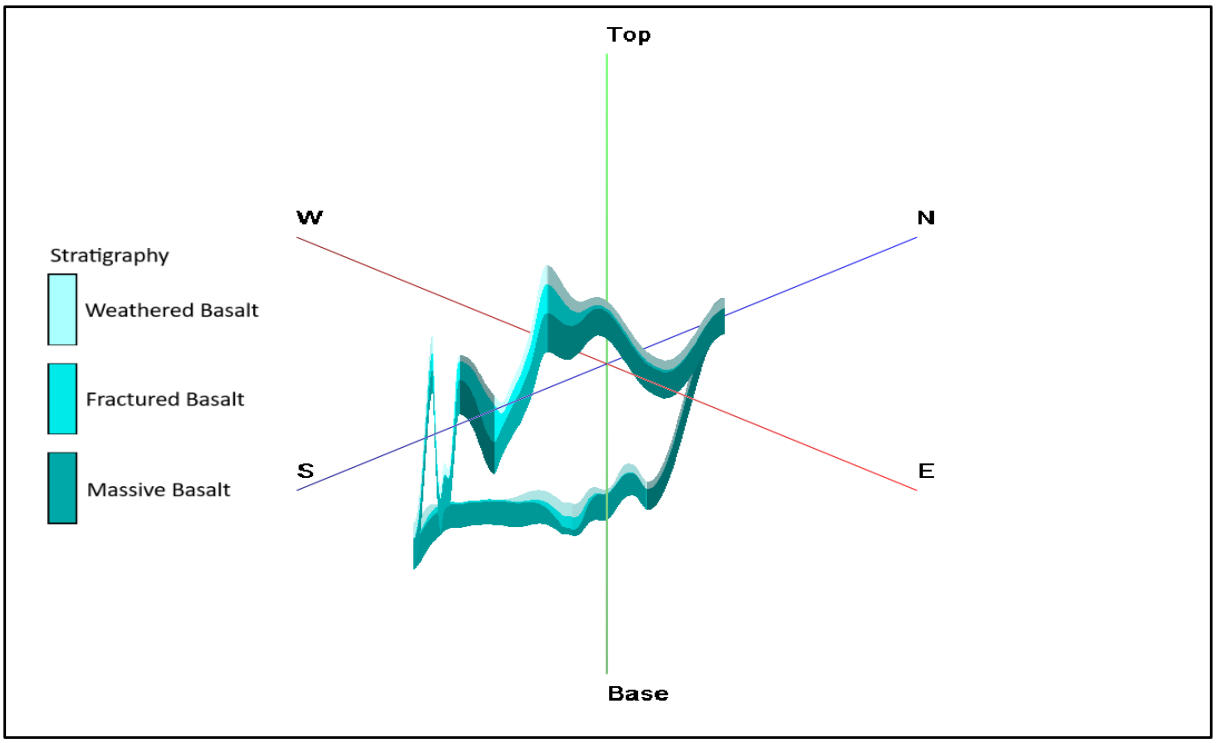

Figure 15 Fence diagram of The Dang district

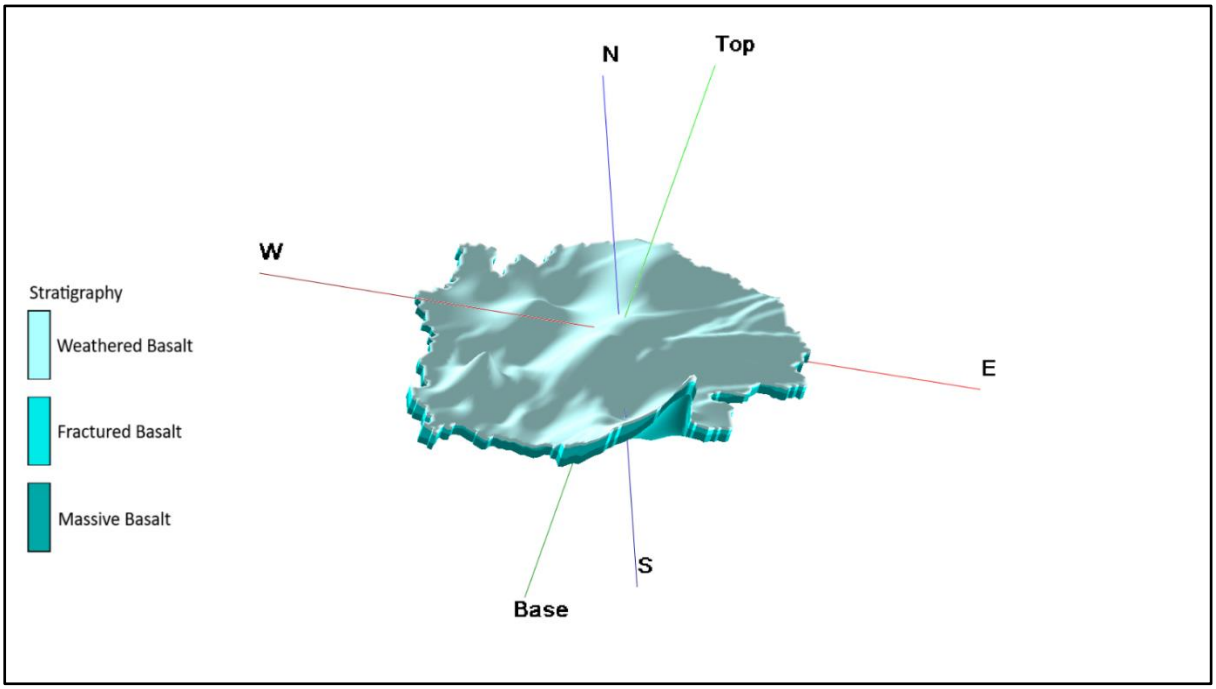

Figure 16 Aquifer disposition/ model of The Dang district

Table 11 Aquifer characterization and disposition of the Dang district

Aquifer Characterisation and Disposition (The Dang)										
Stratigraphy	**Aquifer Nomenclature**	**Lithological**	**Depth of occurrence**	**Thickness**	**Water Level (mbgl)**	**Quality**	**Discharge**	**Transmissivity**	**Nature of Aquifer**	**Remarks**
						EC				
		Characteristics	**Aquifer**	**Range**	**Range**	**Range**	**Range**	**Range**		
			(mbgl)	**(m)**	**(mbgl)**	**mg/l**	**lps**	**m^2/day**		
Cretaceous	**Weathered Basalt**	Deccan trap basalt (vesicular and amygdaloidal)	0 to 50	0 to 50	0.65 to 12.54	319 to 1755	0.18 to 0.702	79.34 to 181.74	Phreatic	Good quality
	Fractured Basalt	Deccantrap basalts, both massive and amygdoidal or vesicular type.	6 to 57	6 to 57		327 to 974	0.01 to 1.6	63.43 to 346.51	Phreatic	Good quality

GORUNDWATER SCENARIO

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6-60m. Out of the 16 exploratory wells, 6 wells yielded more than 100 lpm and 4 wells were hydraulically failure. Electrical conductivity of the water ranged from 350-800 µs/cm. Hydrogeology of the Dang District is summarized in the **Figure 16**.

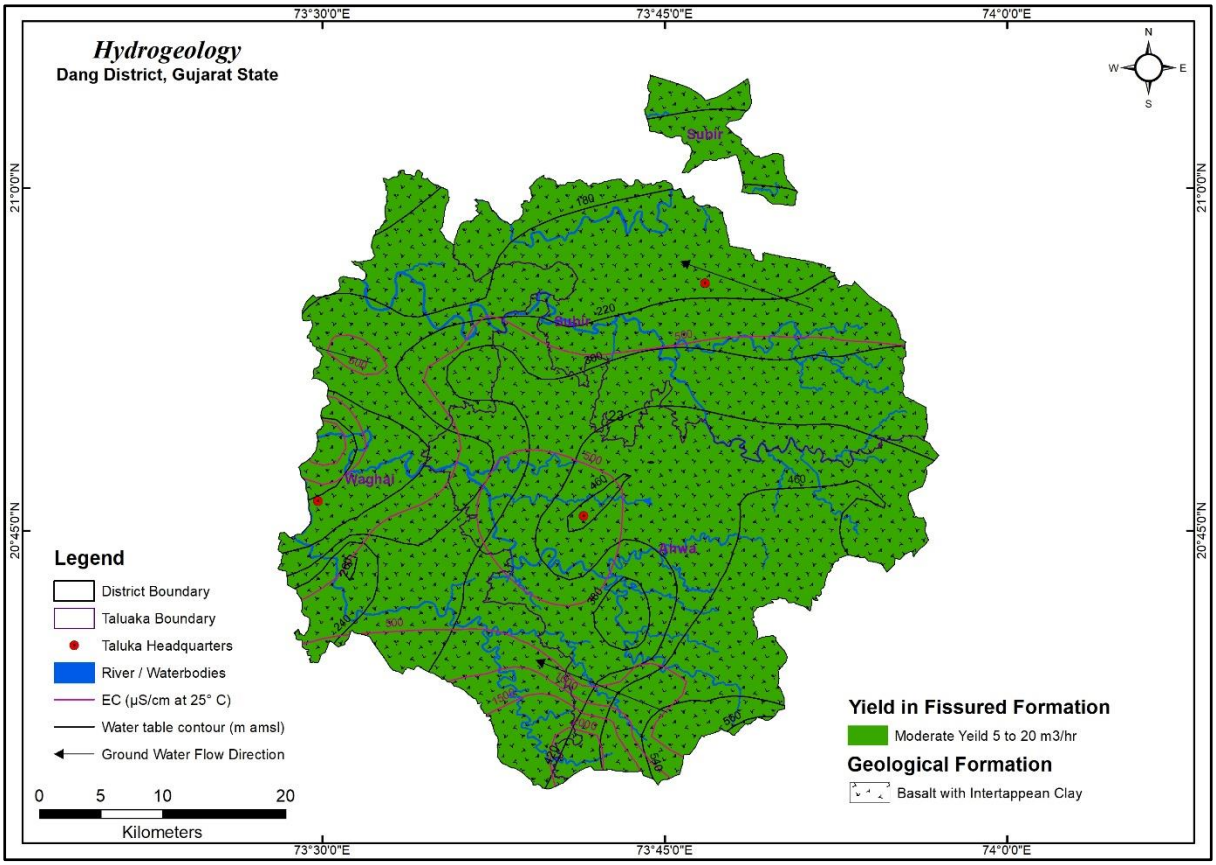

Figure 17 Map showing the Hydrogeological setup of The Dang District

GROUNDWATER REGIME MONITORING

Ground water regime monitoring is the basic component of groundwater management, and it is carried out in the Dang district four times a year, during January, May, August and November through National Hydrograph Network Stations (NHS) and also for NAQUIM studies Pre-Monsoon and Post-Monsoon (2022). Depth to water level map of pre monsoon and post monsoon period and annual fluctuation of water level are prepared with data of NHS.

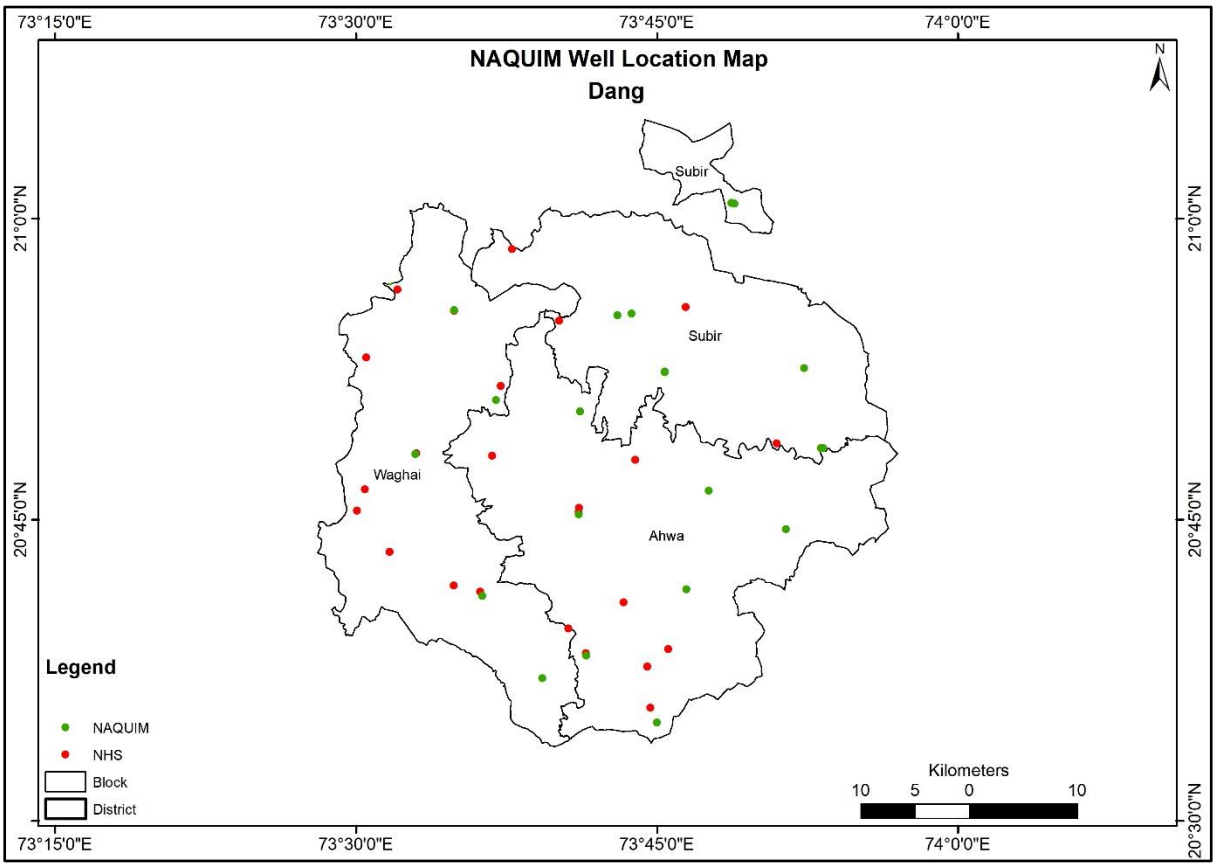

Figure 18 National Network of Hydrograph Stations of The Dang District

9.1 BEHAVIOUR OF WATER LEVELS

The behaviour of water levels was studied based on the water level data collected from theNational Network of Hydrograph Stations (NNHS). The water level data of May 2022 andNovember 2022 was used for preparing the depth to water level maps. The seasonal fluctuationin water levels was calculated between May and November 2022. Total 50 nos. of monitoringstations including 16 nos. monitoring station of Gujarat Water Resources DevelopmentCorporation (GWRDC) were taken during preparation of maps.

9.1.1 Depth to Water Level (Pre-monsoon)

Pre monsoon depth to water levels of the Dang district is shown in the (**Figure 18**), which depict that water levels in most part of the district ranges in between 05m bgl to 10m bgl.Small patches in Ahwa and Subir taluka have water level ranges above 20m bgl. Likewise, around the above said patches and at the SW boundary of Waghai taluka, the water level ranges between 10-20m bgl. Shallow waterlevel is observed at the boundary side of Ahwa, Subir and Waghai taluka of the district.

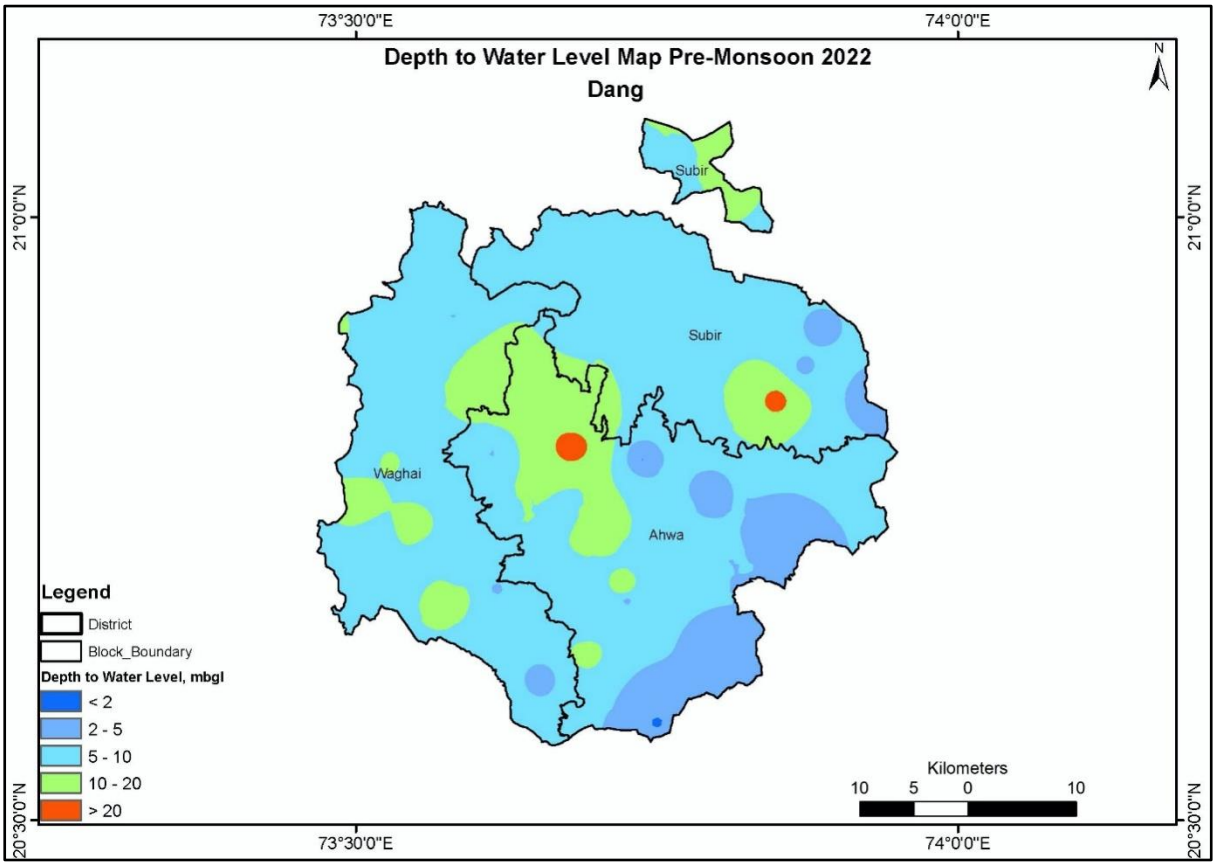

Figure 19 Pre-monsoon (May 2022) depth to water level of The Dang District

9.1.2 Decadal Average Depth to Water level (2013-2022)

The decadal average depth to water levels between 2013-2022 for pre-monsoon of the Dang district is shown in the (**Figure 19**), which depict that water levels in the district ranges between 02m bgl to above 40m bgl. Small patches at the peripheral region of Ahwa and Waghai taluka have water level ranges above 40m bgl. Likewise, around the above said patches small portion of Waghai and Ahwa taluka have decadal water level range between 20-40m bgl. Most of the region of the district has decadal water level range between 5-20m bgl.

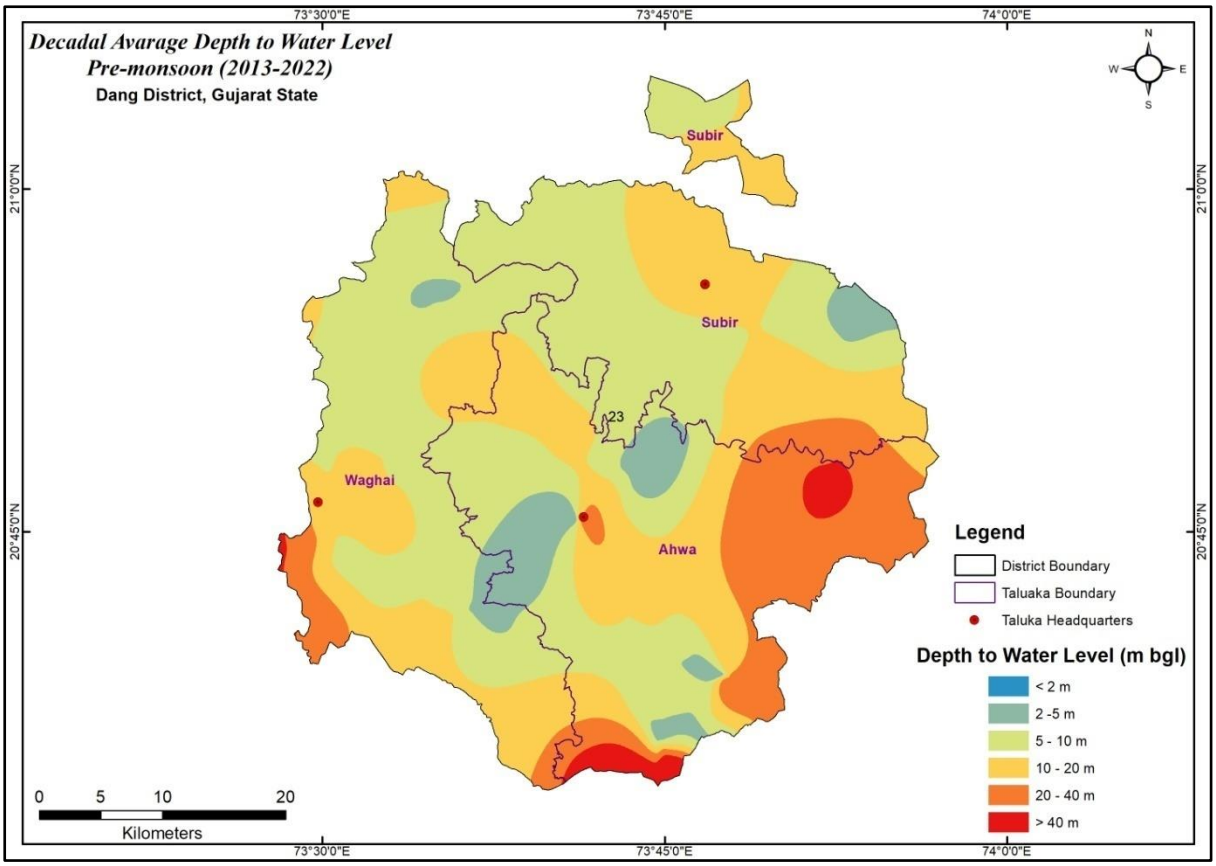

Figure 20 Pre-monsoon decadal average depth to water level of The Dang District, (2013-2022)

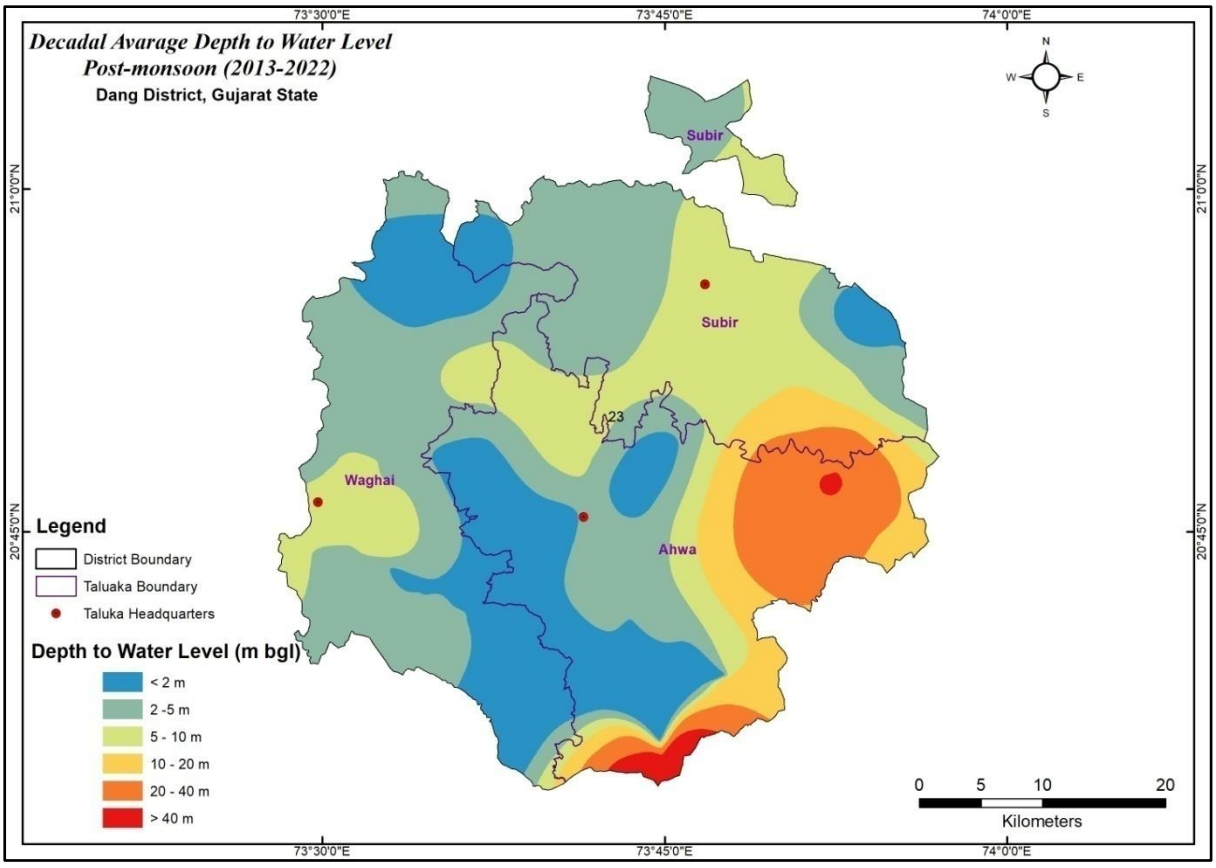

Figure 21 Post-monsoon decadal average depth to water level of The Dang District, (2013-2022)

9.1.3 Water level Fluctuation

The fluctuation of water levels between Pre-monsoon (May, 2022) and Post Monsoon (November, 2022) shows in **Figure 19**. The district has registered rise in water levels i.e., >4m.Small patches in NE boundary and northern boundary of Ahwa taluka have reported rise in water level in between 0-2m.

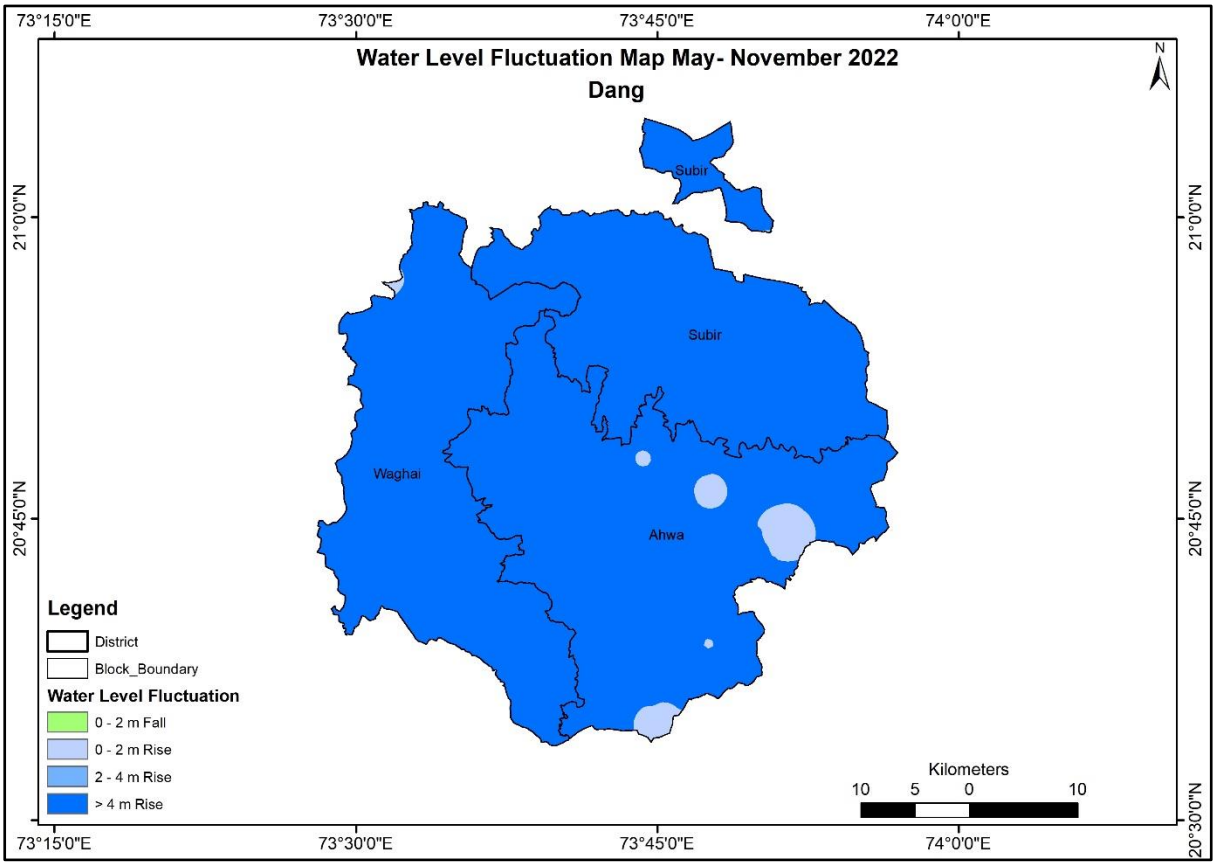

Figure 22 Water Level Fluctuation in the Dang District

9.1.4 Decadal water level trend (2012-21)

Decadal trend of ground water level for the period of 2012 to 2021 has been prepared and presented in **figure-20**. From map its depicted that most part of the district shows rising trend which ranges between 0-100 cm/year. The southern boundary region of Ahwa and Waghai as well as some patches in both taluka shows falling trend. Small area in NE boundary of Subir taluka shows falling trend.

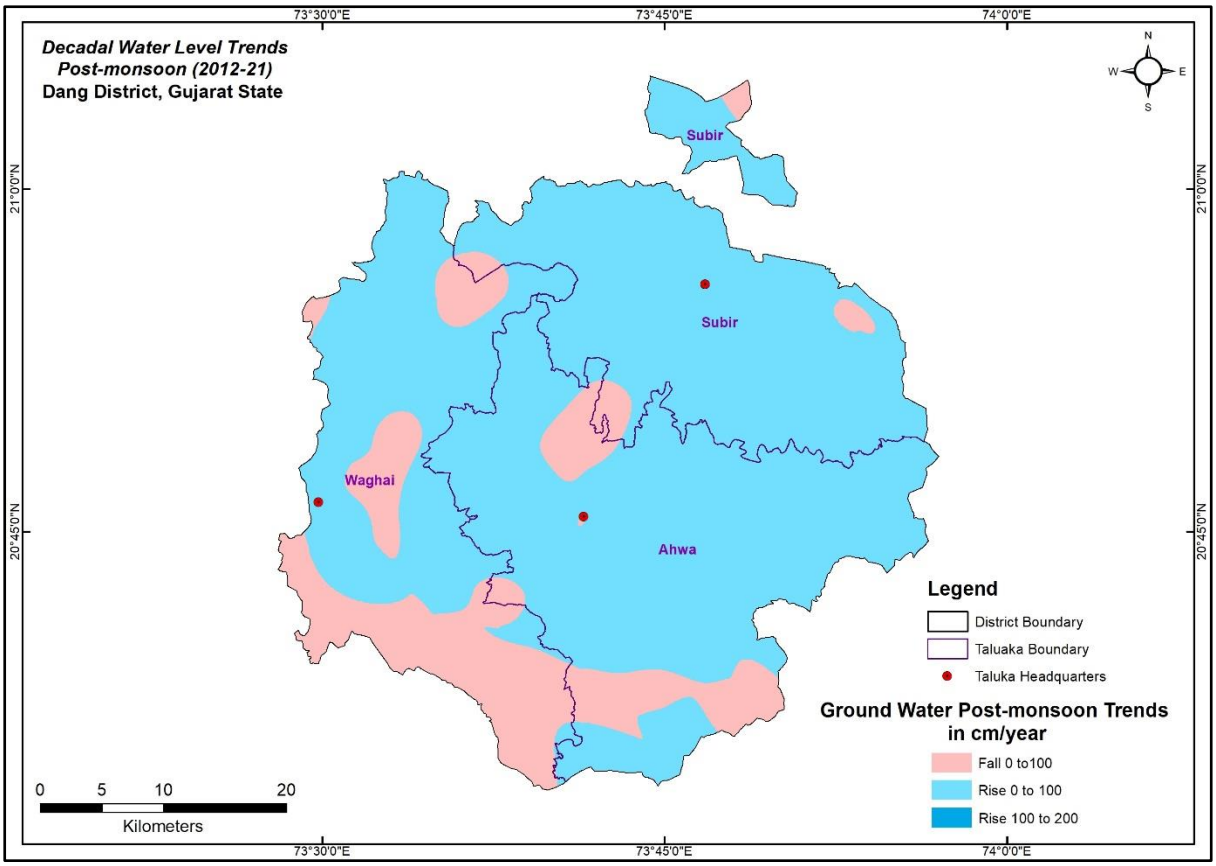

Figure 23 Ground water decadal trend post-monsoon (2012-2021), Dang district, Gujarat

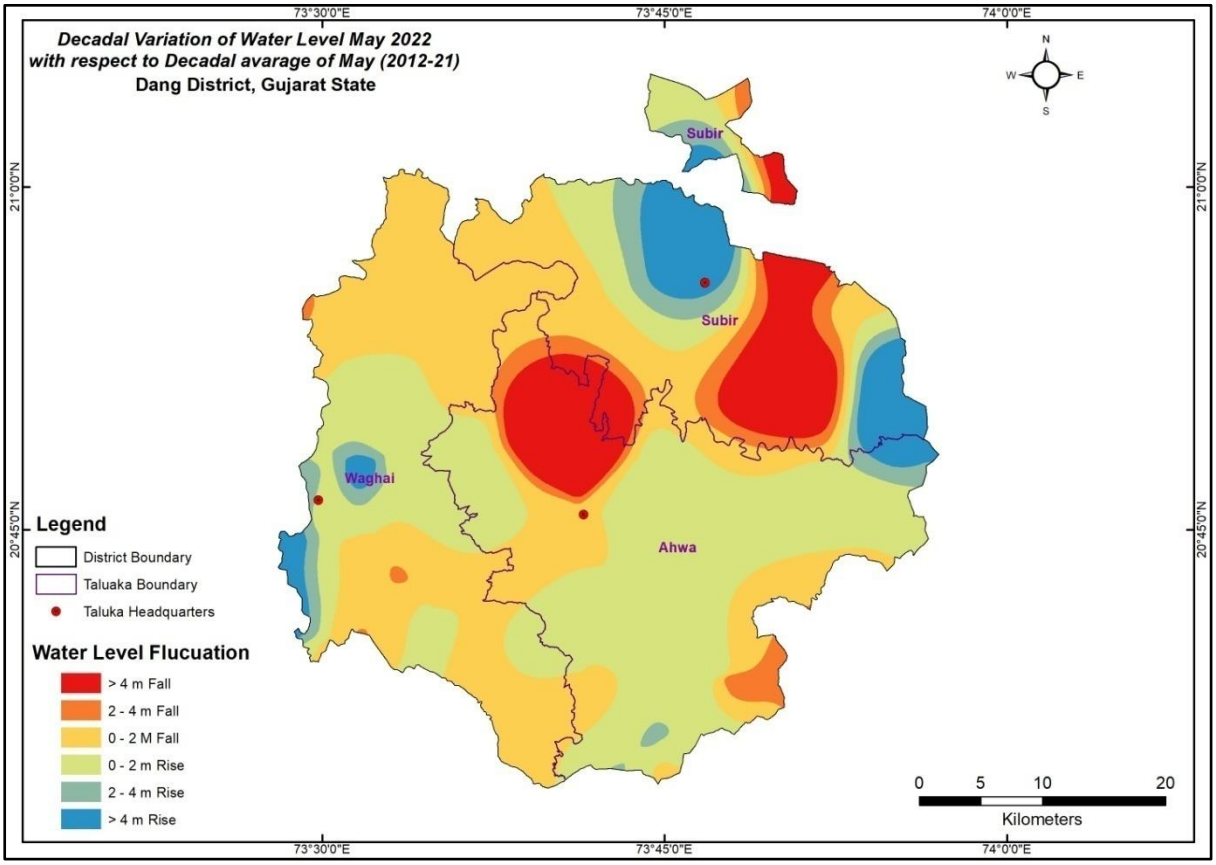

Figure 24 Annual variation of water level w.r.t. Decadal average water level of pre-monsoon, Dang district

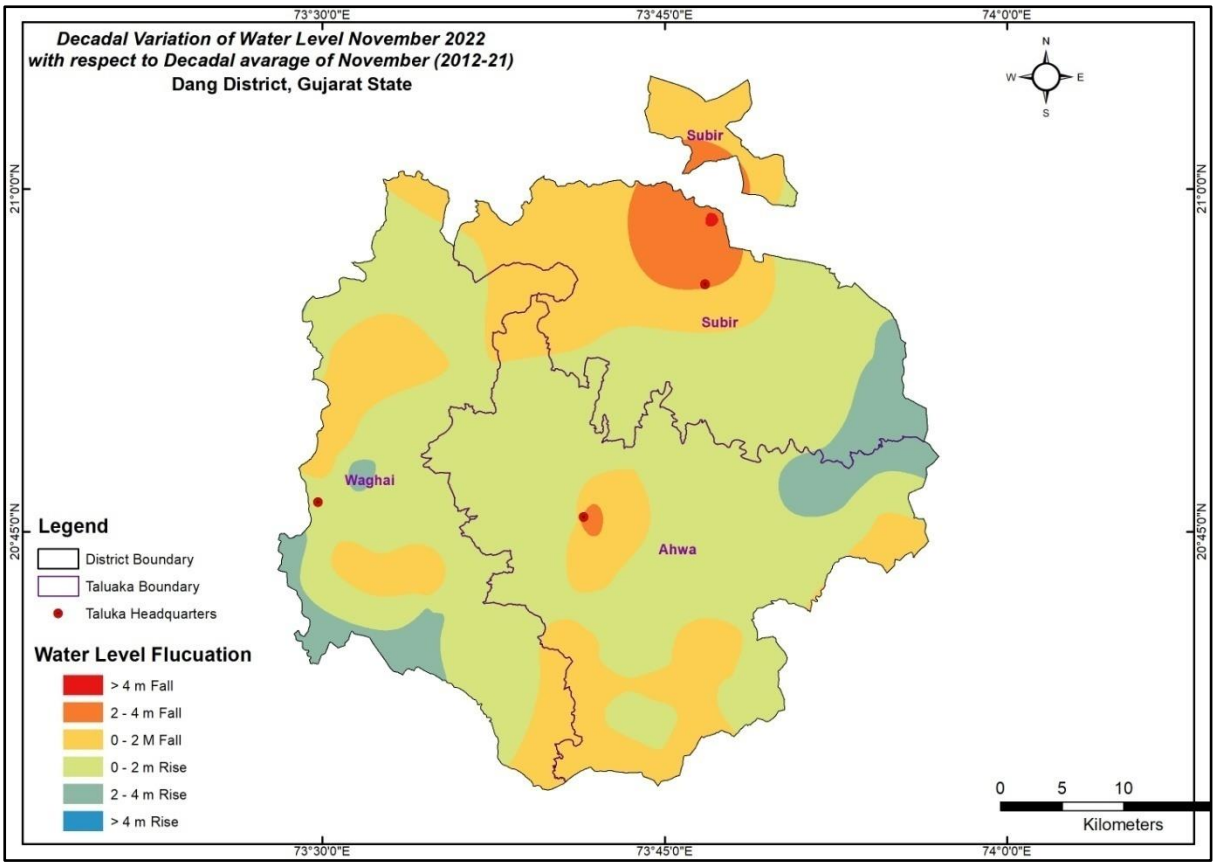

Figure 25 Annual variation of water level w.r.t. Decadal average water level of pre-monsoon, Dang district

9.1.5 Annual variation of water level with respect to Decadal average water level of pre-monsoon

Decadal variation of ground water level (May, 2022) with respect to Decadal average water level (May, 2013-2022) for the period of 2012 to 2021 has been prepared and presented in **figure-21**. From map it depicted that most of the region of Waghai and Subir taluka shows fall in water level. The mid region of the district and the region in the east in Subir taluka shows fall in water level which is above 4m. The northern and eastern pperiphery of Subir and western peripheral region region of Waghai taluka shows rise in water level which is above 4m.

9.2 DECADALWATER LEVEL TREND AND HYDROGRAPH

From the analysis of the water level trend of the Dang district from 2013 to 2022, it is observed that, during pre-monsoon, the water level has a rise of 0.0001632m/yr (Umberpada) to 0.464784m/yr (Chikhli) and also has a fall of 0.034176 m/yr (Sodmal) to 0.849168m/yr (Jakna). Similarly, from the analysis of the post-monsoon data of 2012 to 2022, the water

level has a rise of 0.002004m/yr (Malegaon) to 0.242064 m/yr. (Borigaontha) and and also has a fall of 0.004188m/yr (Chinchigaontha) to 0.061152m/yr (Sakarpatal) in the district. Pre-monsoon and Post-monsoon long-term rising and declining trend of water level of various hydrograph stations established by CGWB are also studied in graphic form. Majority of the hydrographs are showing rising trends during the pre- and post-monsoon period with some fall in trends in both the seasons.

Table 12 Decadal Water level trend (2013-2022) The Dang District

Long Term Water Level Trend (2013-2022)							
Sr. No	**District**	**Taluka**	**Location**	**Pre-Monsoon**		**Post-Monsoon**	
				Rise (m/year)	Fall (m/year)	Rise (m/year)	Fall (m/year)
1	**The Dang**	**Waghai**	**Aherdi**	0.34152			0.037056
2	**The Dang**	**Ahwa**	**Ahwa**	0.149028		0.060708	
3	**The Dang**	**Ahwa**	**Ahwa_Pz**	0.18042		0.10518	
4	**The Dang**	**Ahwa**	**Baripada**		0.296952		0.043368
5	**The Dang**	**Ahwa**	**Borigaontha**	0.225504		0.242064	
6	**The Dang**	**Ahwa**	**Chikhli**	0.464784		0.028488	
7	**The Dang**	**Waghai**	**Chinchigaontha**	0.13212			0.004188
8	**The Dang**	**Ahwa**	**Chinchpada**	0.428508		0.048024	
9	**The Dang**	**Ahwa**	**Dhumkal**	0.049452		0.037764	
10	**The Dang**	**Ahwa**	**Ghubita**	0.143328		0.079164	
11	**The Dang**	**Ahwa**	**Jakana**		0.849168		0.04626
12	**The Dang**	**Ahwa**	**Jamalpada**		0.13206	0.090792	
13	**The Dang**	**Subir**	**Mahal**	0.06606		0.03672	
14	**The Dang**	**Ahwa**	**Malegaon**	0.116496		0.002004	
15	**The Dang**	**Ahwa**	**Nadak Khadi**		0.067572	0.1911	
16	**The Dang**	**Waghai**	**Nanapada**		0.285876	0.149136	
17	**The Dang**	**Waghai**	**Sakarpatal**		0.211836		0.061152
18	**The Dang**	**Waghai**	**Sodmal**		0.034176		0.040128
19	**The Dang**	**Subir**	**Subir**	0.014484		0.029952	
20	**The Dang**	**Ahwa**	**Umberpada**	0.001632		0.1434	
21	**The Dang**	**Waghai**	**Vazat Amba**		0.144672	0.051636	
22	**The Dang**	**Waghai**	**Waghai**	0.050172		0.208656	
Minimum				0.0001632	0.034176	0.002004	0.004188
Maximum				0.464784	0.849168	0.242064	0.061152

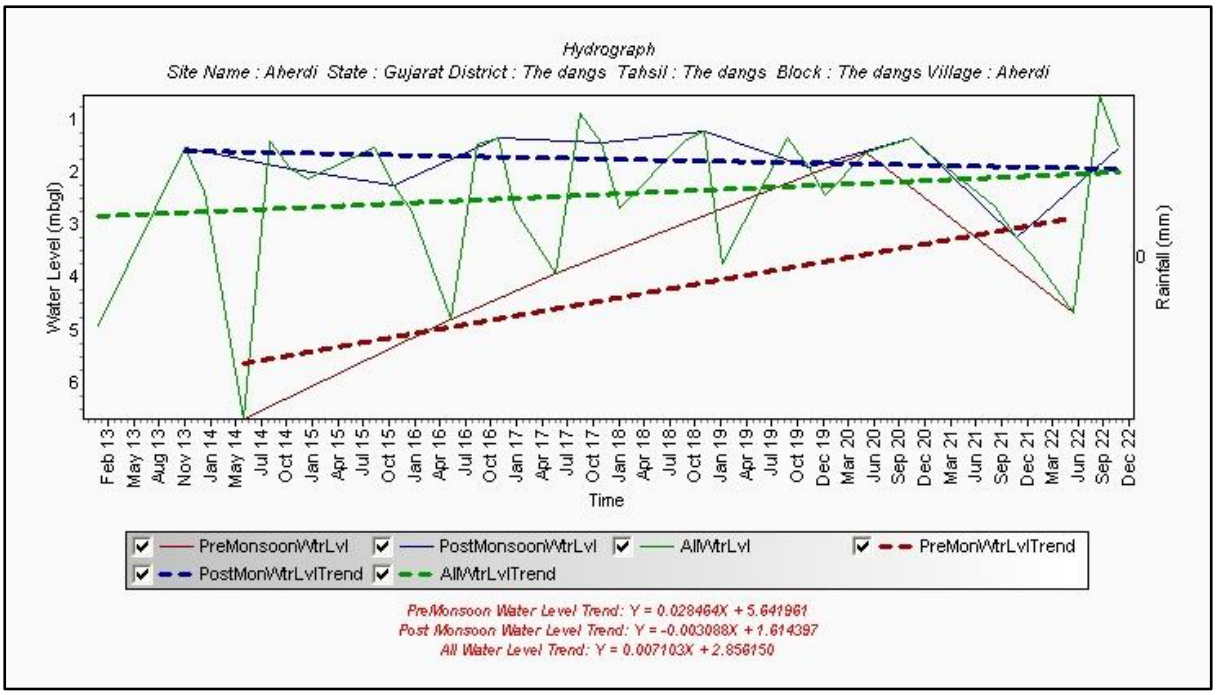

Figure 26 Hydrograph of Aherdi NHS well in Dang District

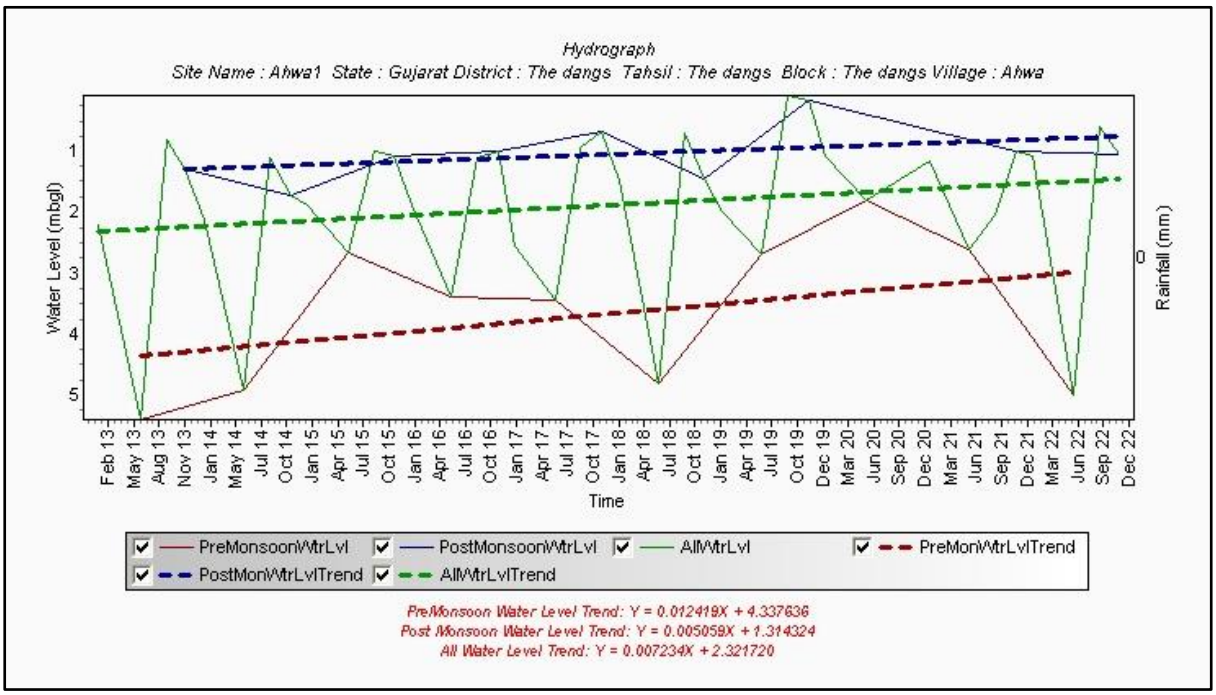

Figure 27 Hydrograph of Ahwa NHS well in Dang District

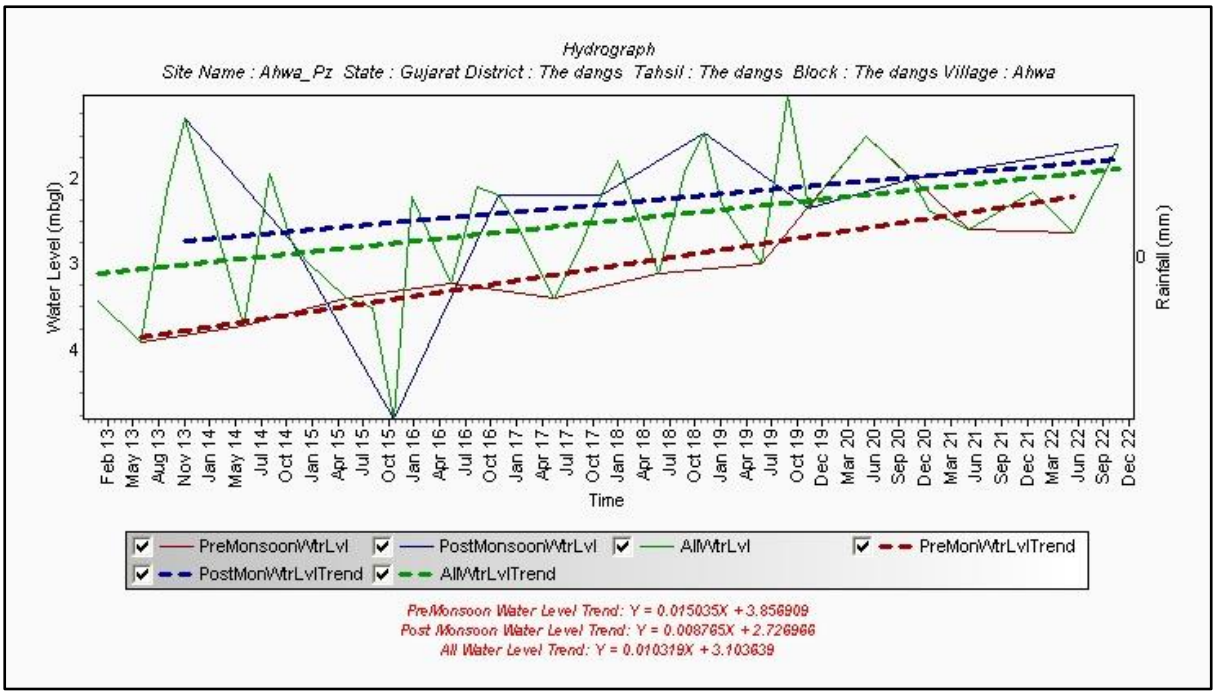

Figure 28 Hydrograph of Ahwa_PzNHS well in Dang District

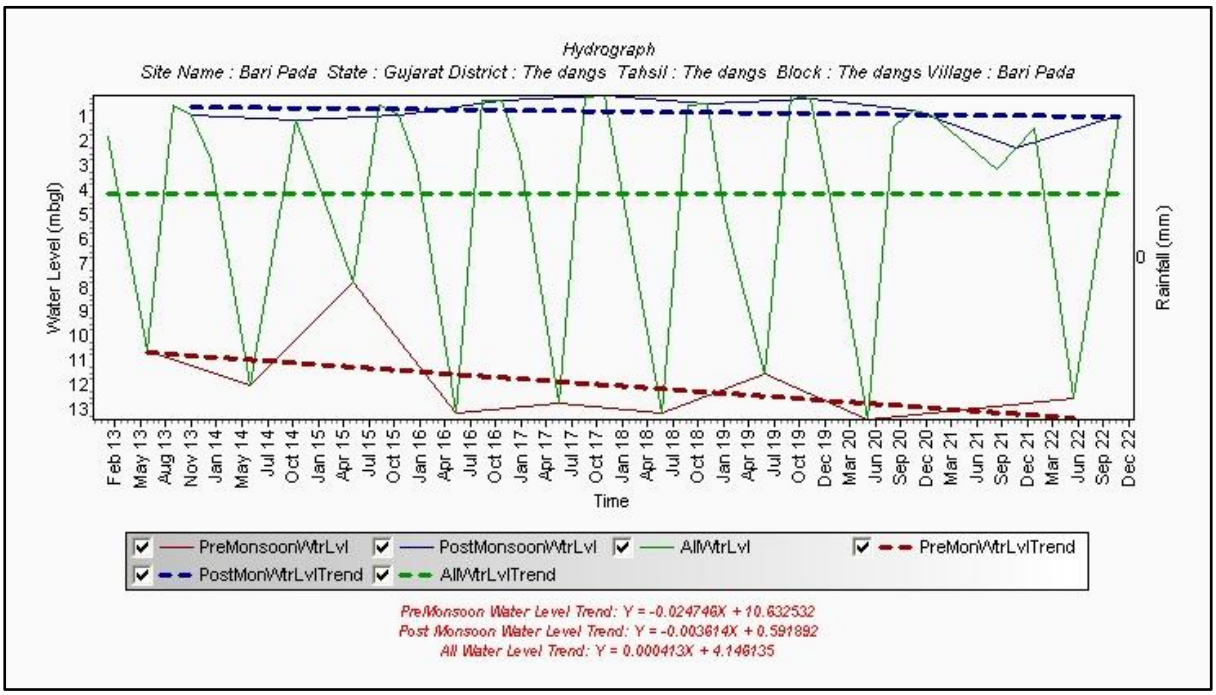

Figure 29 Hydrograph of Baripada NHS well in Dang District

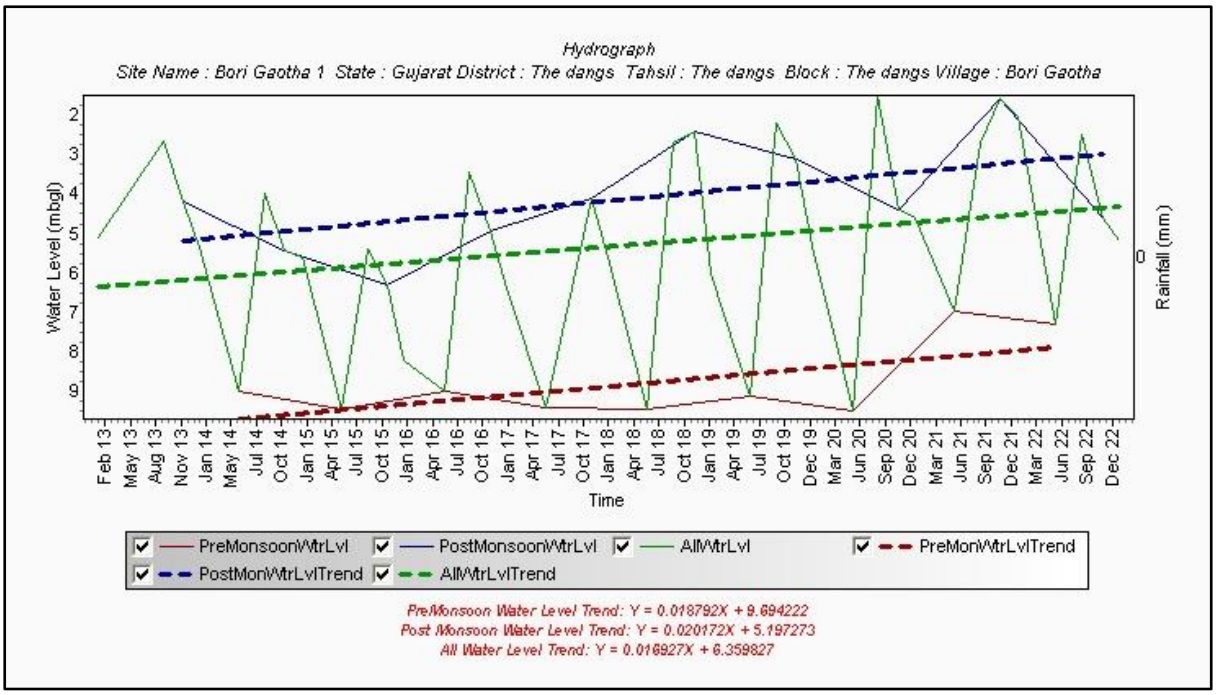

Figure 30 Hydrograph of BorigaontaNHS well in Dang District

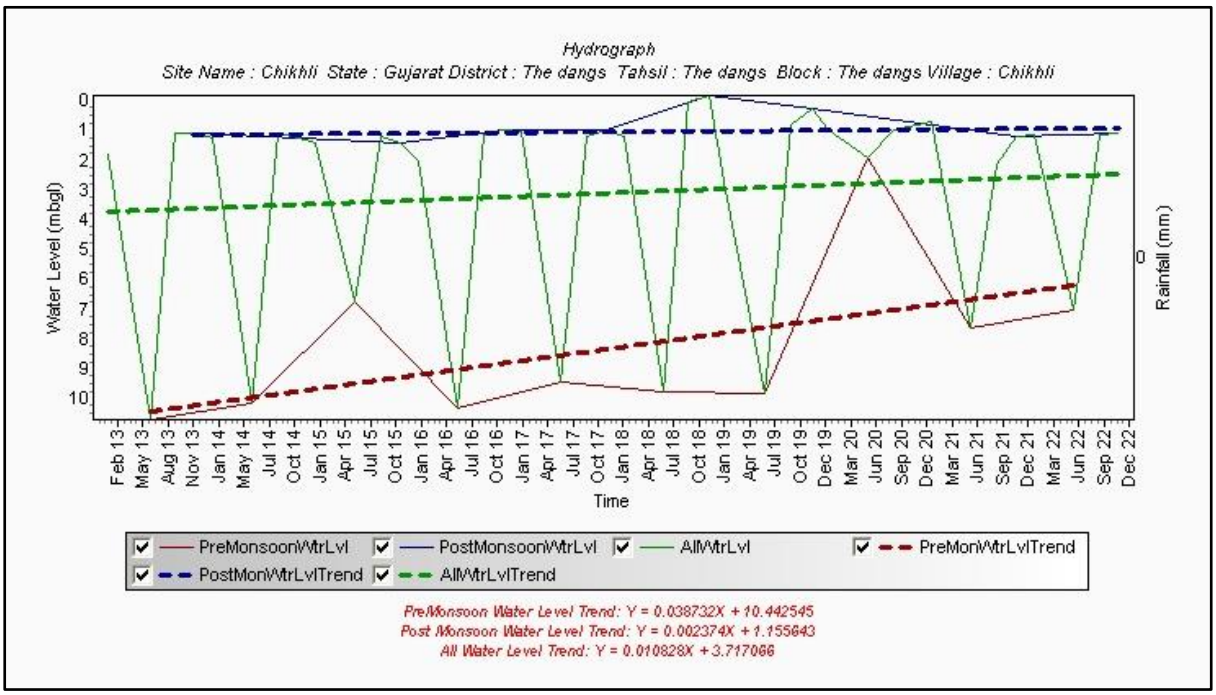

Figure 31 Hydrograph of Chikhli NHS well in Dang District

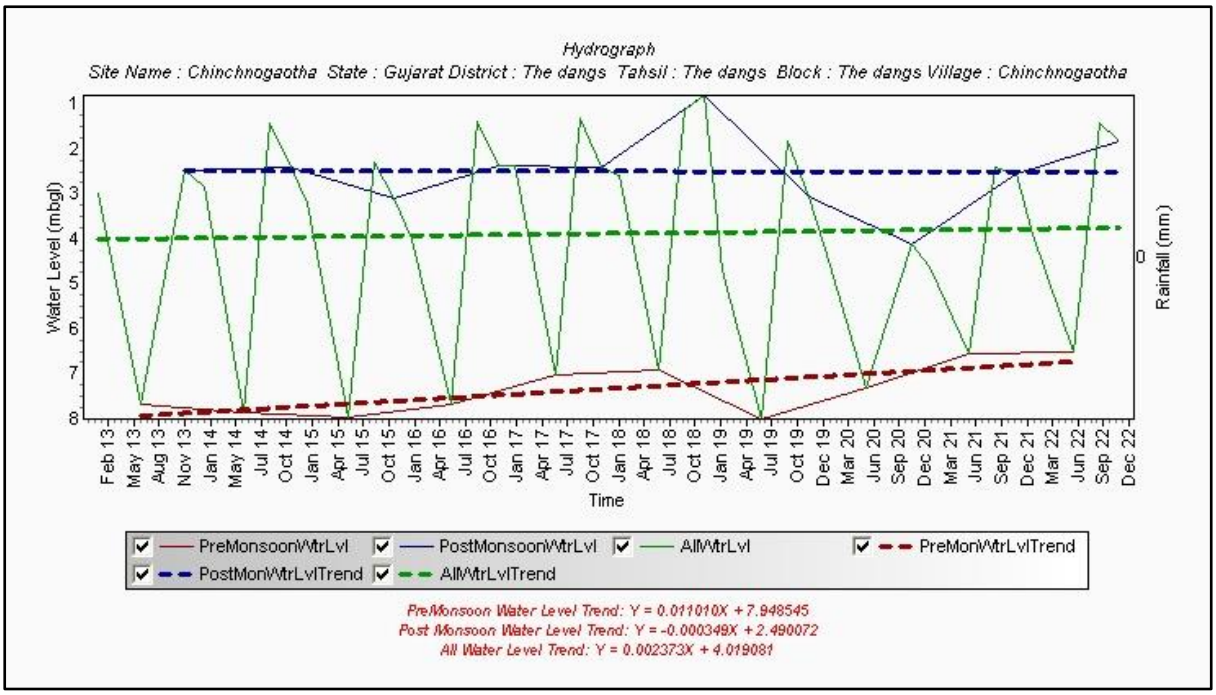

Figure 32 Hydrograph of ChinchigaonthaNHS well in Dang District

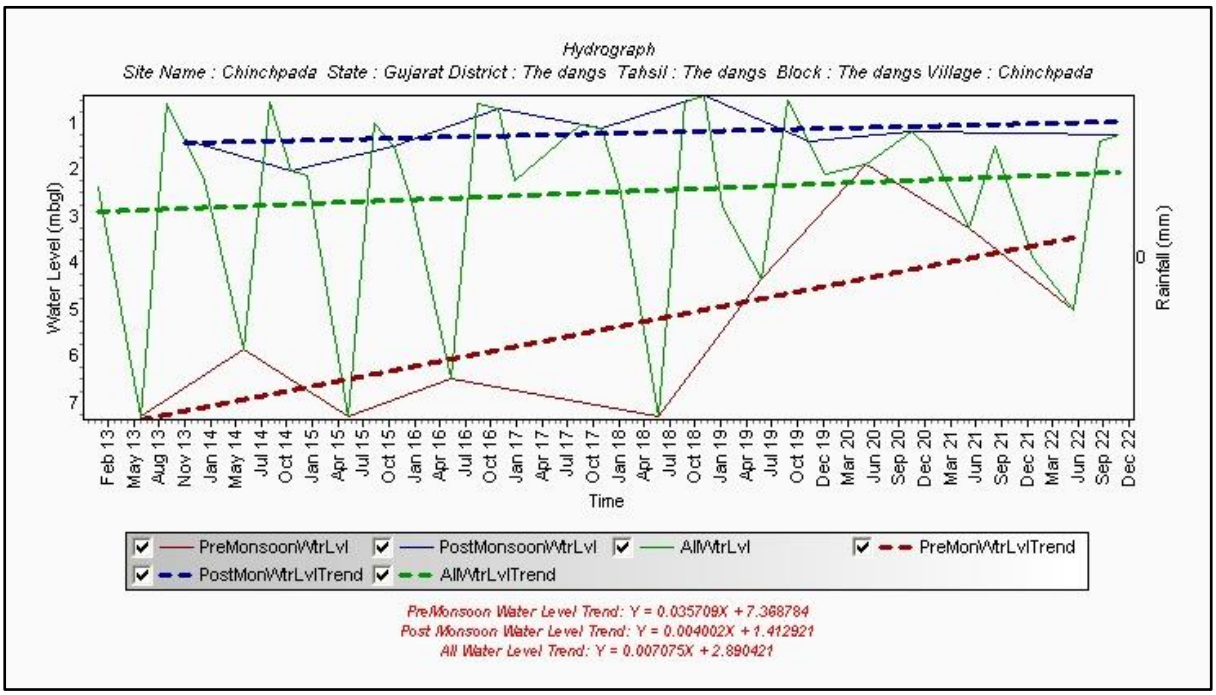

Figure 33 Hydrograph of ChinchpadaNHS well in Dang District

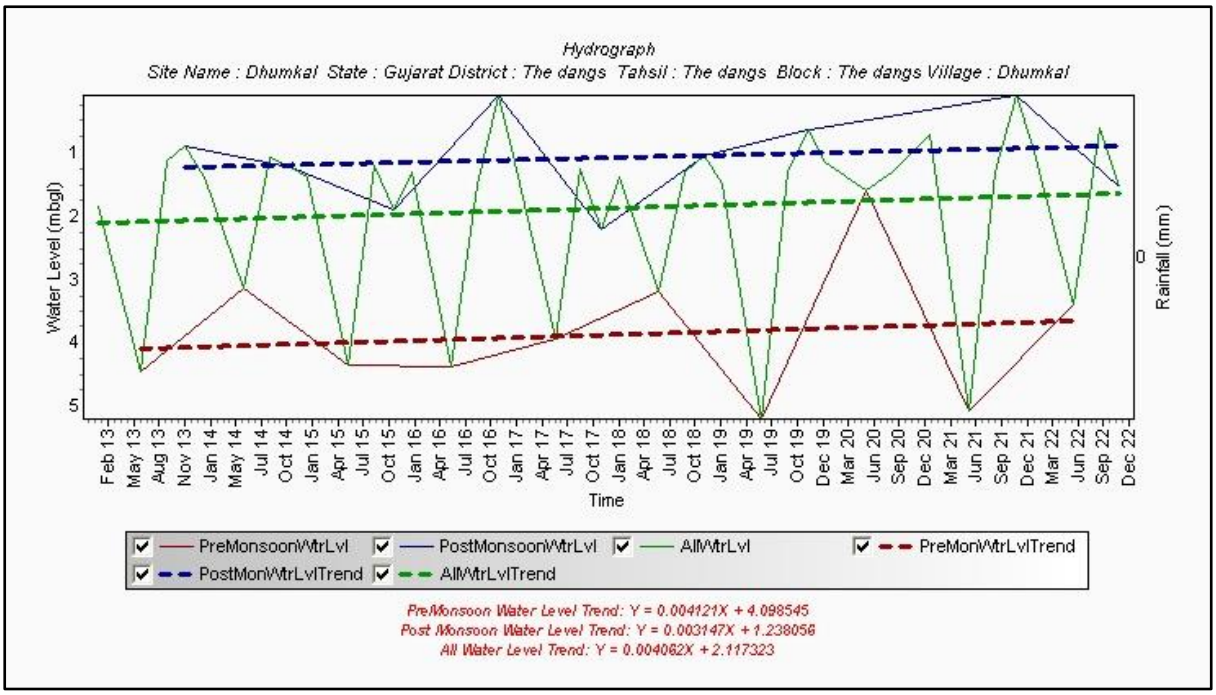

Figure 34 Hydrograph of DhumkalNHS well in Dang District

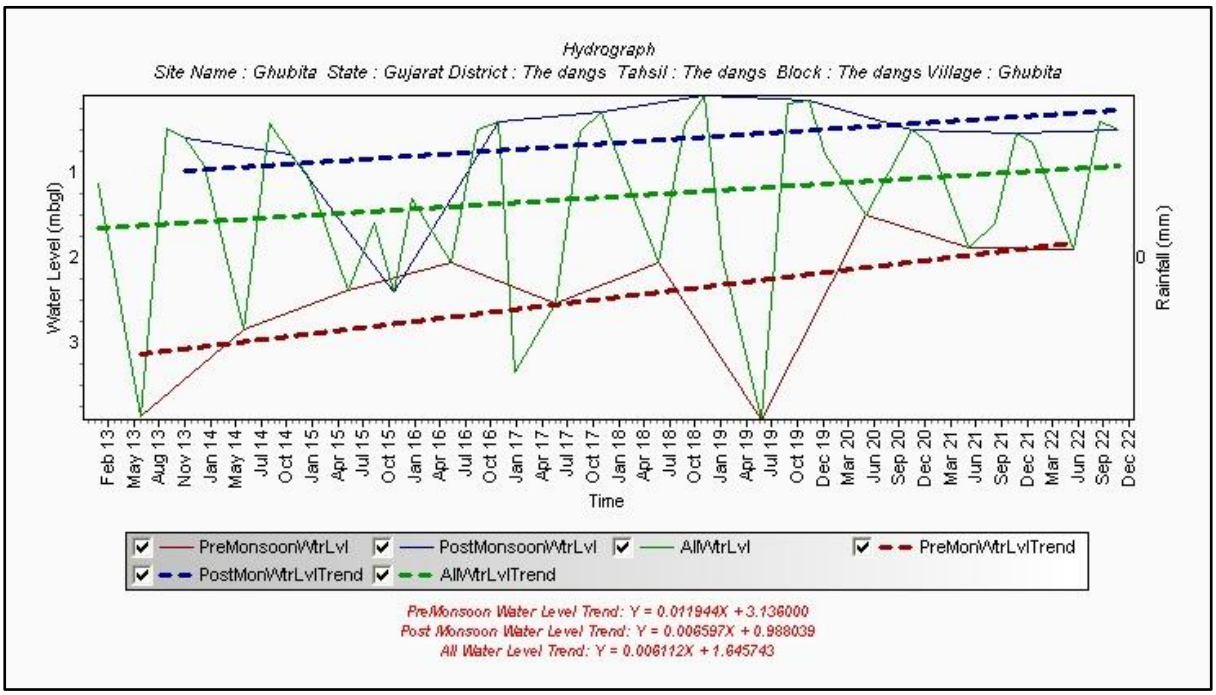

Figure 35 Hydrograph of GhubitaNHS well in Dang District

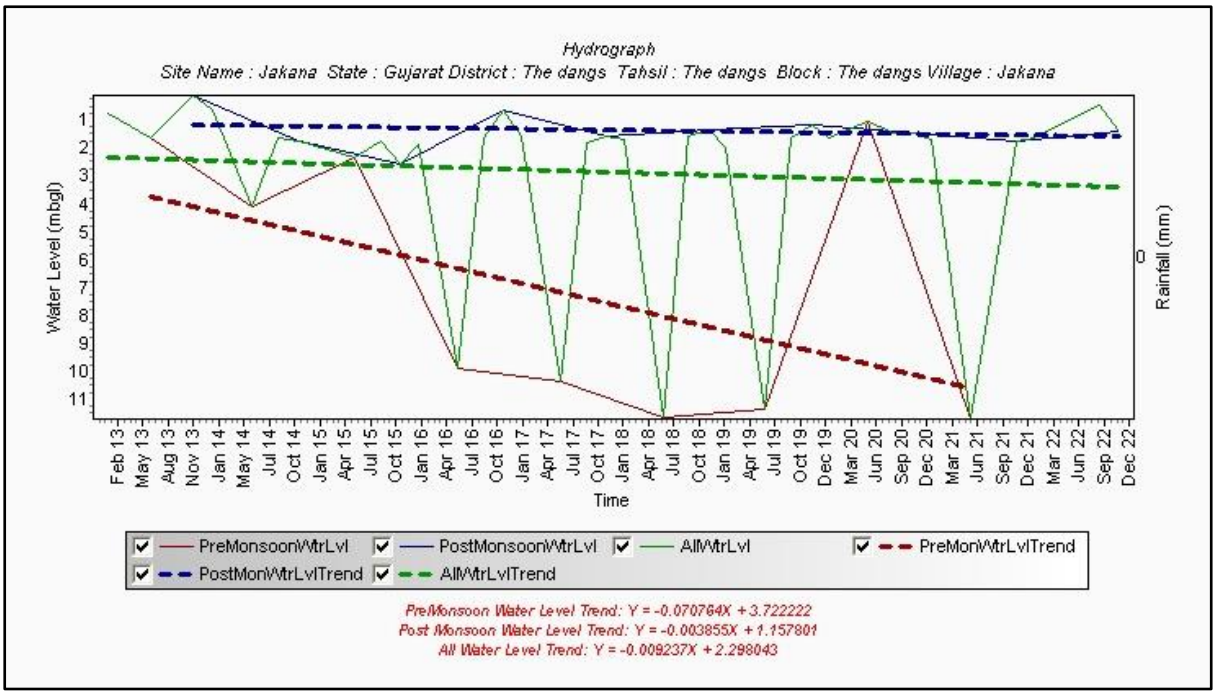

Figure 36 Hydrograph of JakanaNHS well in Dang District

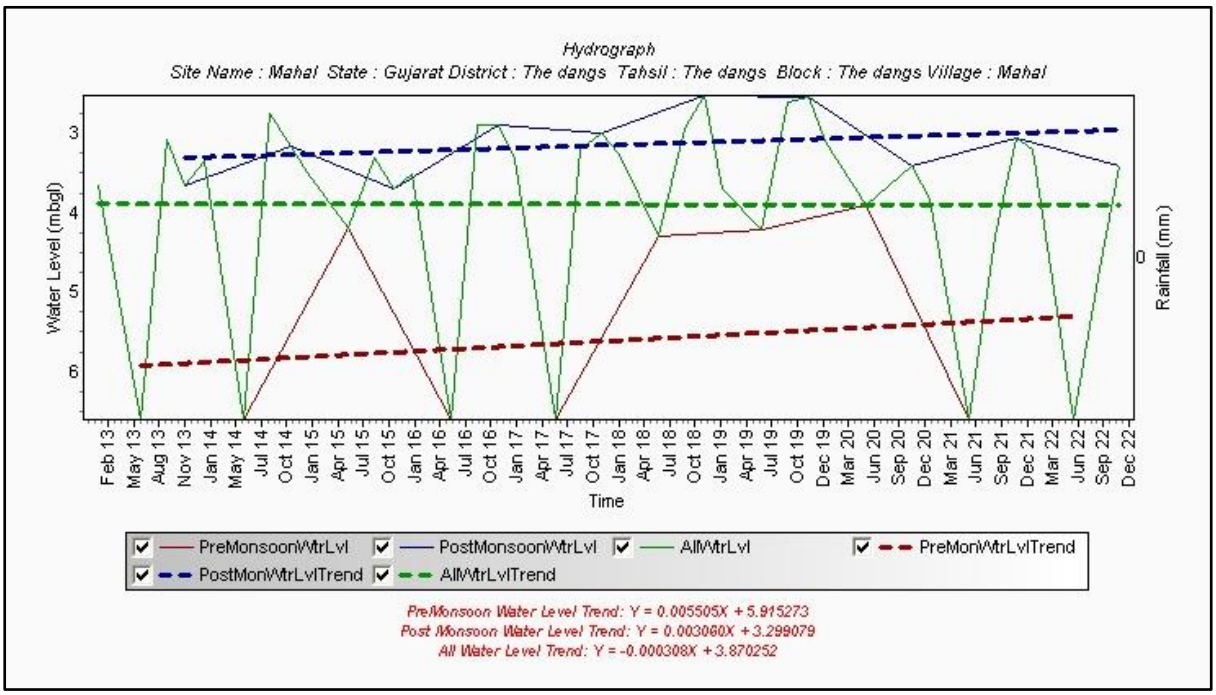

Figure 37 Hydrograph of MahalNHS well in Dang District

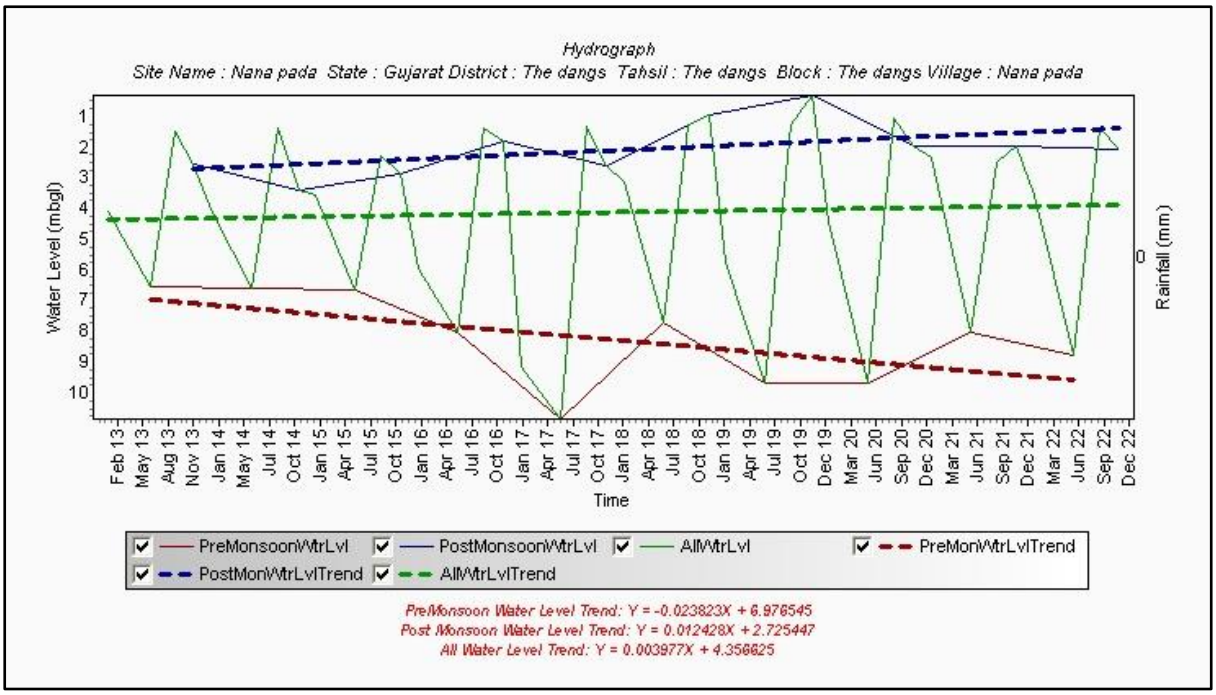

Figure 38 Hydrograph of NanapadaNHS well in Dang District

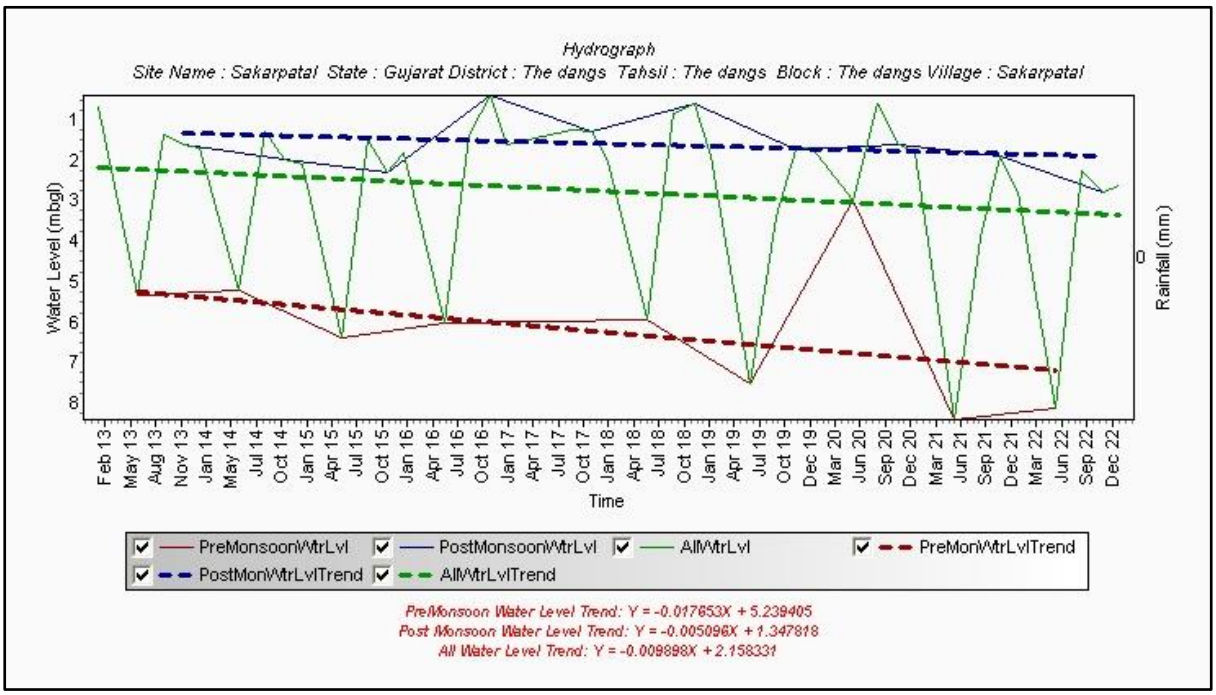

Figure 39 Hydrograph of SakarpatalNHS well in Dang District

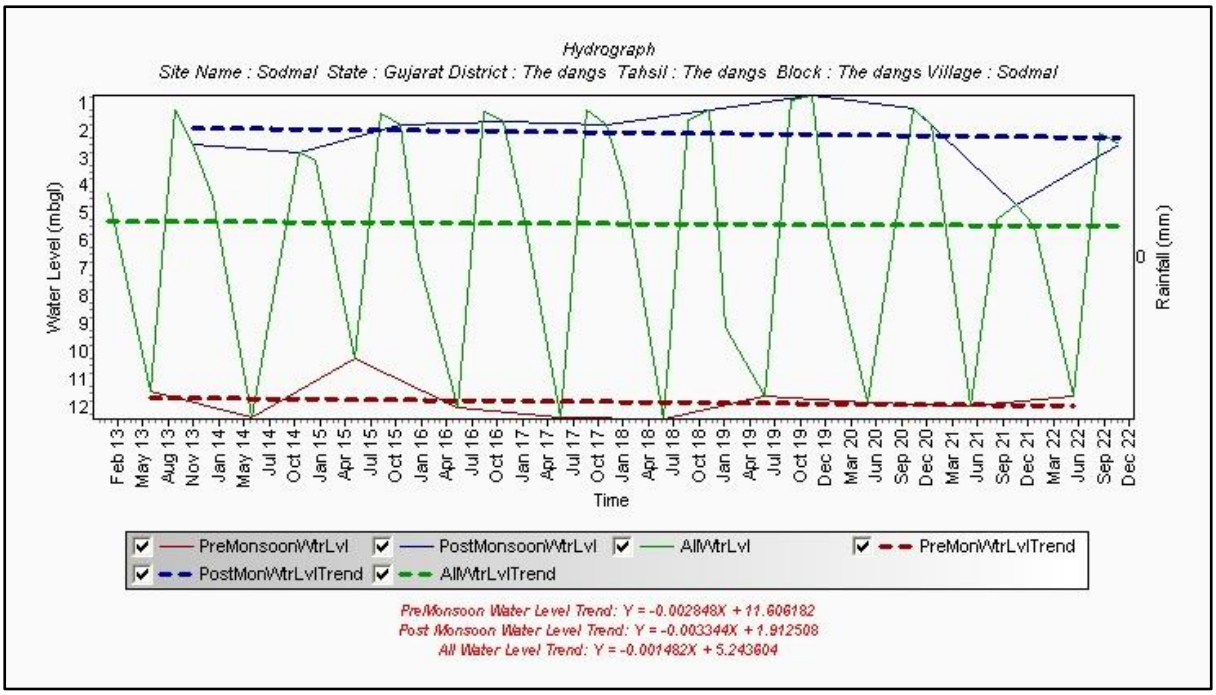

Figure 40 Hydrograph of SodmalNHS well in Dang District

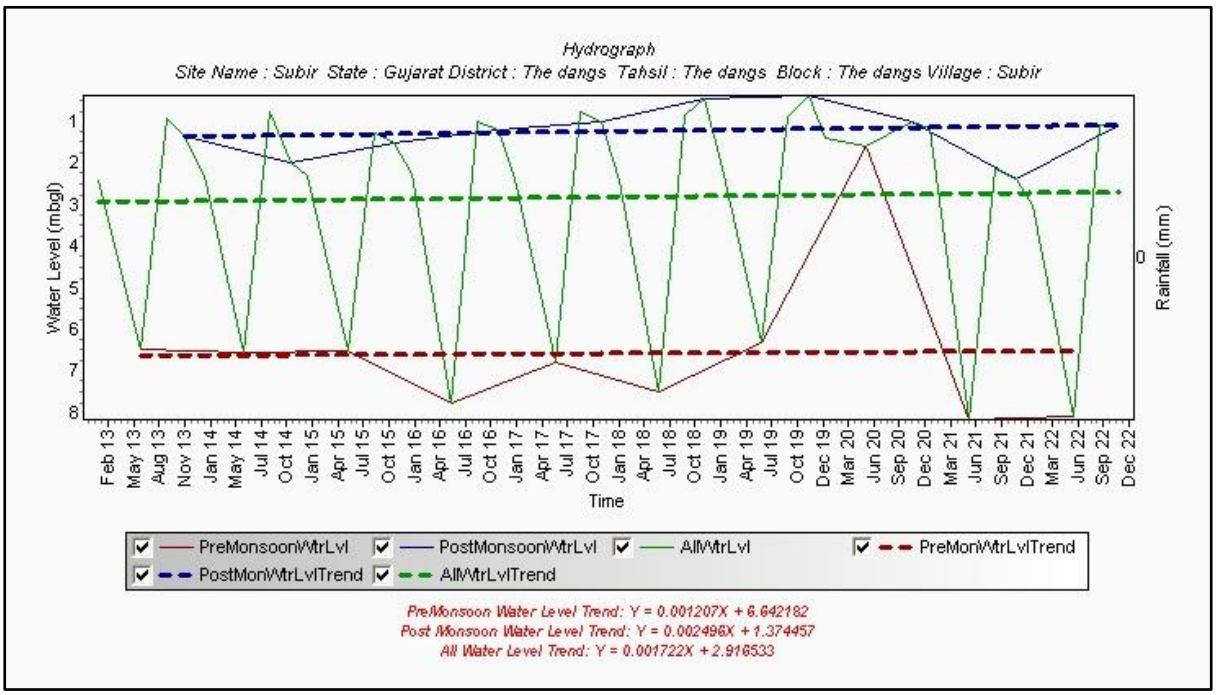

Figure 41 Hydrograph of SubirNHS well in Dang District

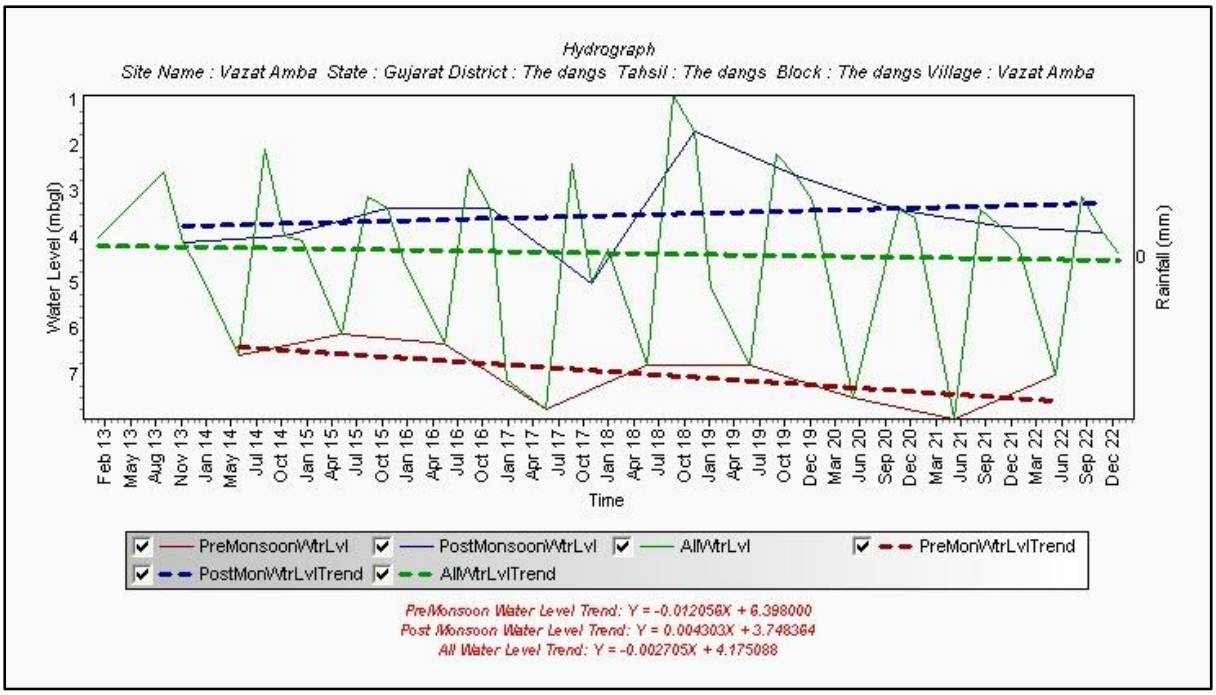

Figure 42 Hydrograph of Vazat AmbaNHS well in Dang District

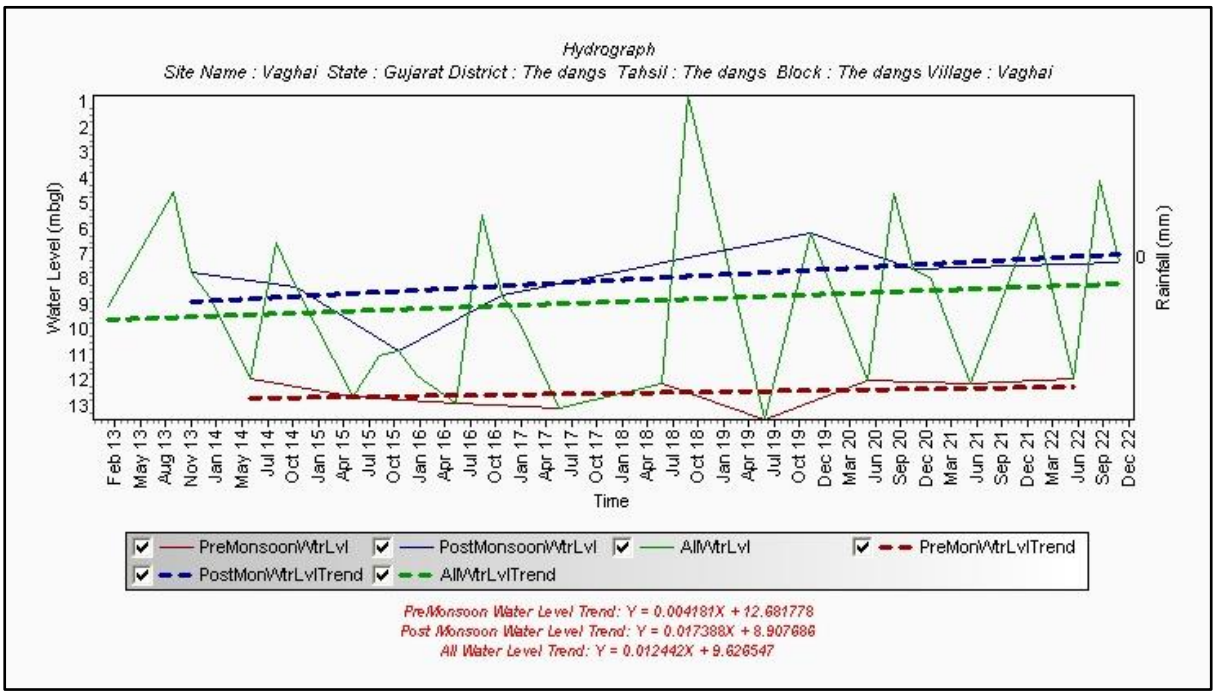

Figure 43 Hydrograph of Waghai NHS well in Dang District

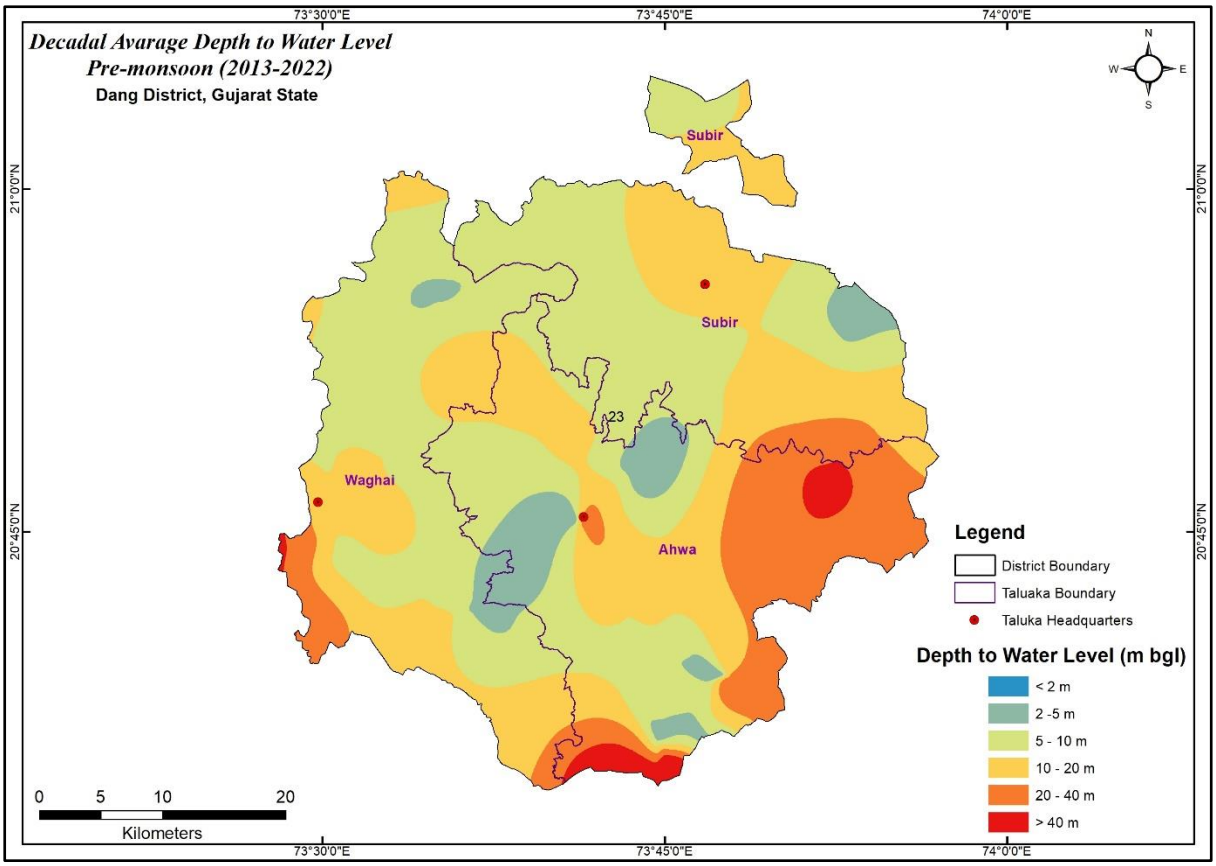

Figure 44 Decadal average depth to water level pre-monsoon (2013-2022)

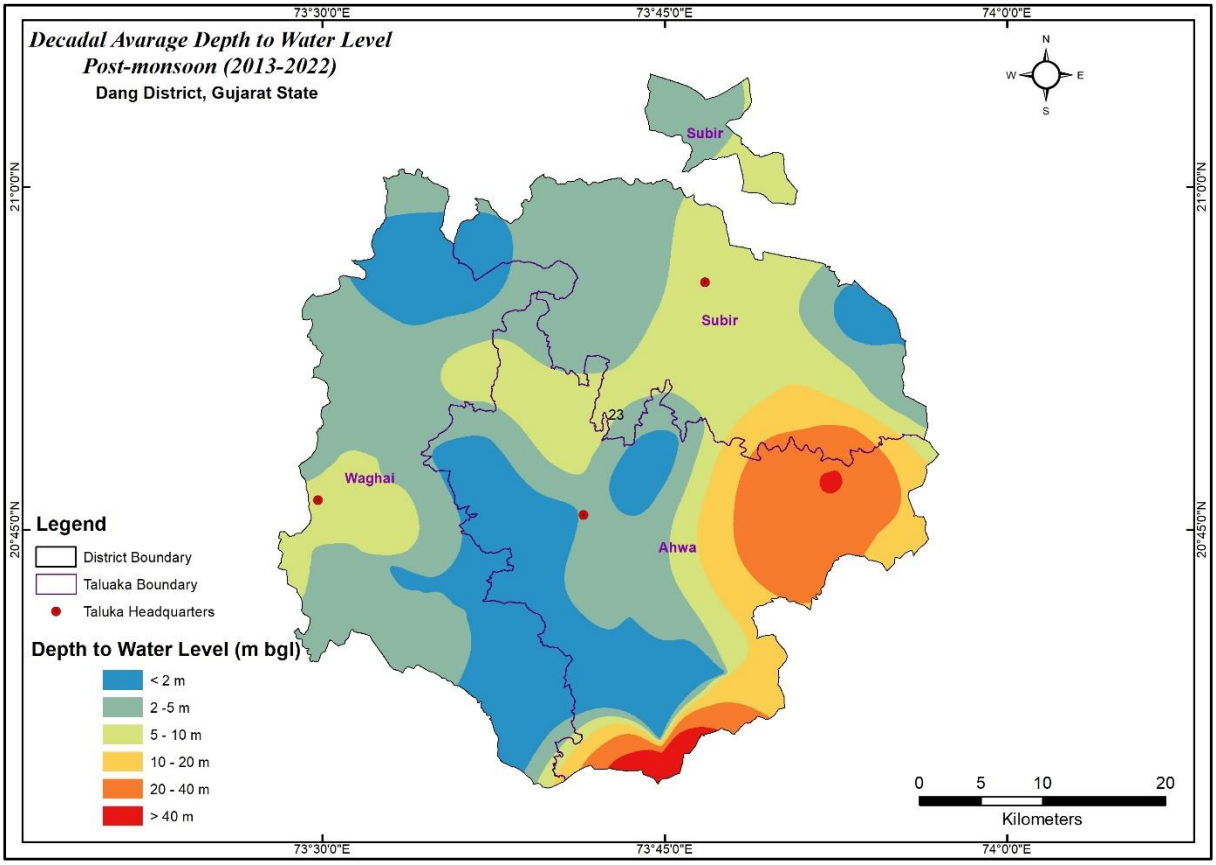

Figure 45 Decadal average depth to water level post-monsoon (2013-2022)

9.3 WATERTABLE AND GROUNDWATER MOVEMENT

The elevation of water table in Pre-monsoon 2022 is observed higher along eastern boundary of the district and it decreases as we move towards the western direction of the district. The highest water table contour elevation is observed in eastern boundary od the district i.e., 450 amsl to 650 amsl (**Figure 41**). The overall trend of flow direction of the district is towards NW direction.

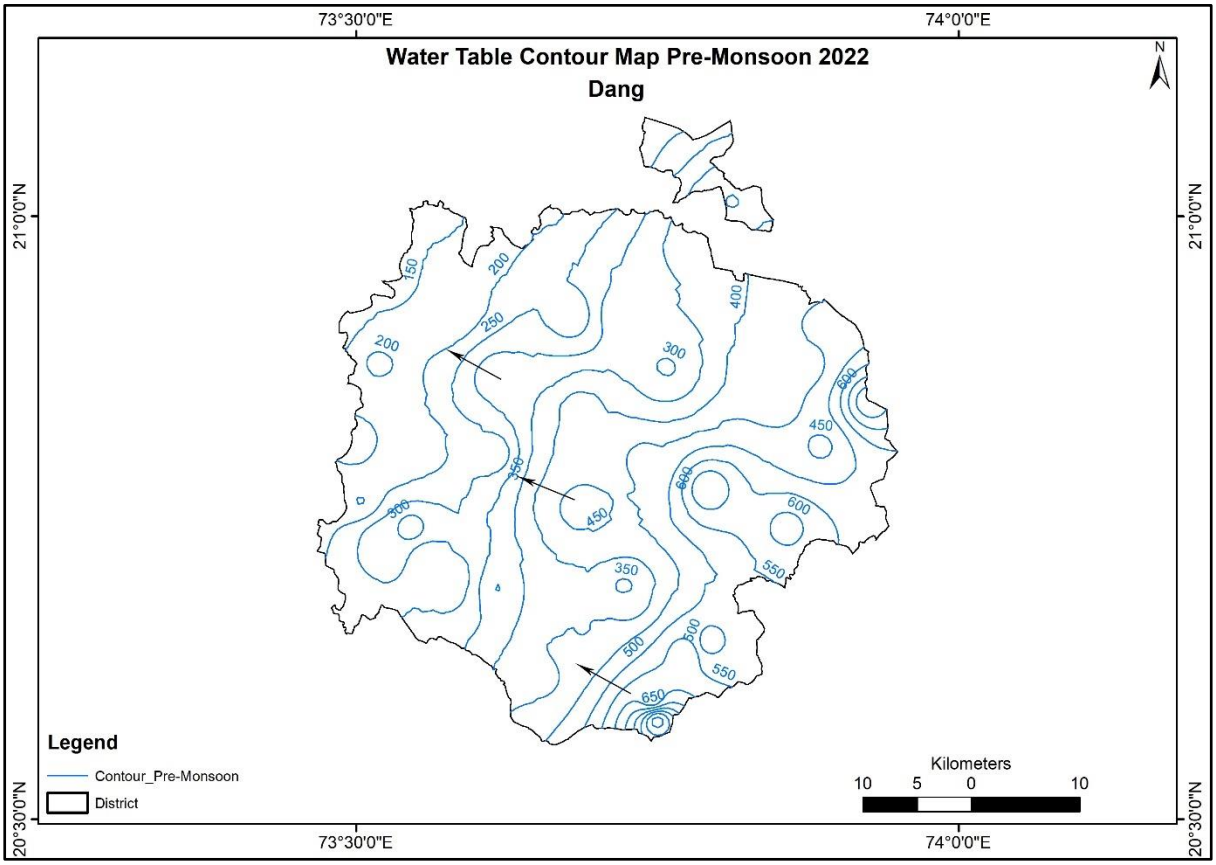

Figure 46 Water table contour map (Pre-monsoon_2022)

GROUND WATER RESOURCE POTENTIAL

The ground water resources of the district were calculated as2022 in collaboration with the Government of Gujarat using the GEC-2015 methodology suggested by Ground Water Resource Estimation Committee (GWRE-2022). These resources were computed after reorganization of the districts, talukas of the district are considered as Assessment Unit (AU) and total area of 1766 km^2 are taken as area of assessment of the district including 3 talukas. Computed resource is presented in tabulated (**Table13**) and graphically represented as below.

Table 13 Taluka wise Ground Water resources, Availability, Utilization and Stage of Ground Water Development

Taluka Wise Ground Water Resources, Availability, Utilization and Stage of Ground Water Development- 2022															
DISTRICT- DANG															
Taluka	ANNUAL REPLENISHABLE GROUND WATER RESOURCES (Ham)				Total Annual Ground water Recharge (3+4+5+6)	Environmental Flows (ham) (5% of 7 for WTF & 10% of 7 for RIF)	Annual Extractable Ground water Resource (ham)	ANNUAL GROUND WATER DRAFT (Ham)				Allocation of Ground Water Resource for Domestic Utilisation for projected year 2027 (ham)	Net Annual Ground Water Availability for Future Use (ham)	Stage of Ground Water Extraction (%)	Categorization of Assessment Unit
	Monsoon		Non Monsoon												
	Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources				Irrigation	Industrial	Domestic	Total Draft (10+11+12)				
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
AHWA	11528.66	260.09	0.00	277.21	12065.96	1206.60	10859.36	740.60	27.65	215.61	983.86	235.82	9855.29	9.06	safe
SUBIR	8949.67	357.96	0.00	351.47	9659.10	965.91	8693.19	233.10	15.28	128.08	376.46	140.08	8304.73	4.33	safe
WAGHAI	11461.23	274.14	0.00	392.94	12128.31	1212.83	10915.48	1215.90	19.83	134.32	1370.05	146.91	9532.84	12.55	safe
District Total	**31939.56**	**892.19**	**0.00**	**1021.62**	**33853.37**	**3385.34**	**30468.03**	**2189.60**	**62.76**	**478.01**	**2730.37**	**522.81**	**27692.86**	**8.96**	**safe**

Note: The Annual Groundwater Draft (mcm) for Domestic and Industrial uses (2017)

Taluka	ANNUAL GROUND WATER DRAFT (mcm)			Projected Demand for Domestic and Industrial uses up to 2025 (Ham/Yr)
	Irrigation	Domestic And Industrial uses	Total Draft	
Ahwa	3.1	1.7	4.9	205
Waghai	1.2	1.2	2.4	141
Subir	1.7	0.9	2.6	109
District	6.1	3.9	10	205

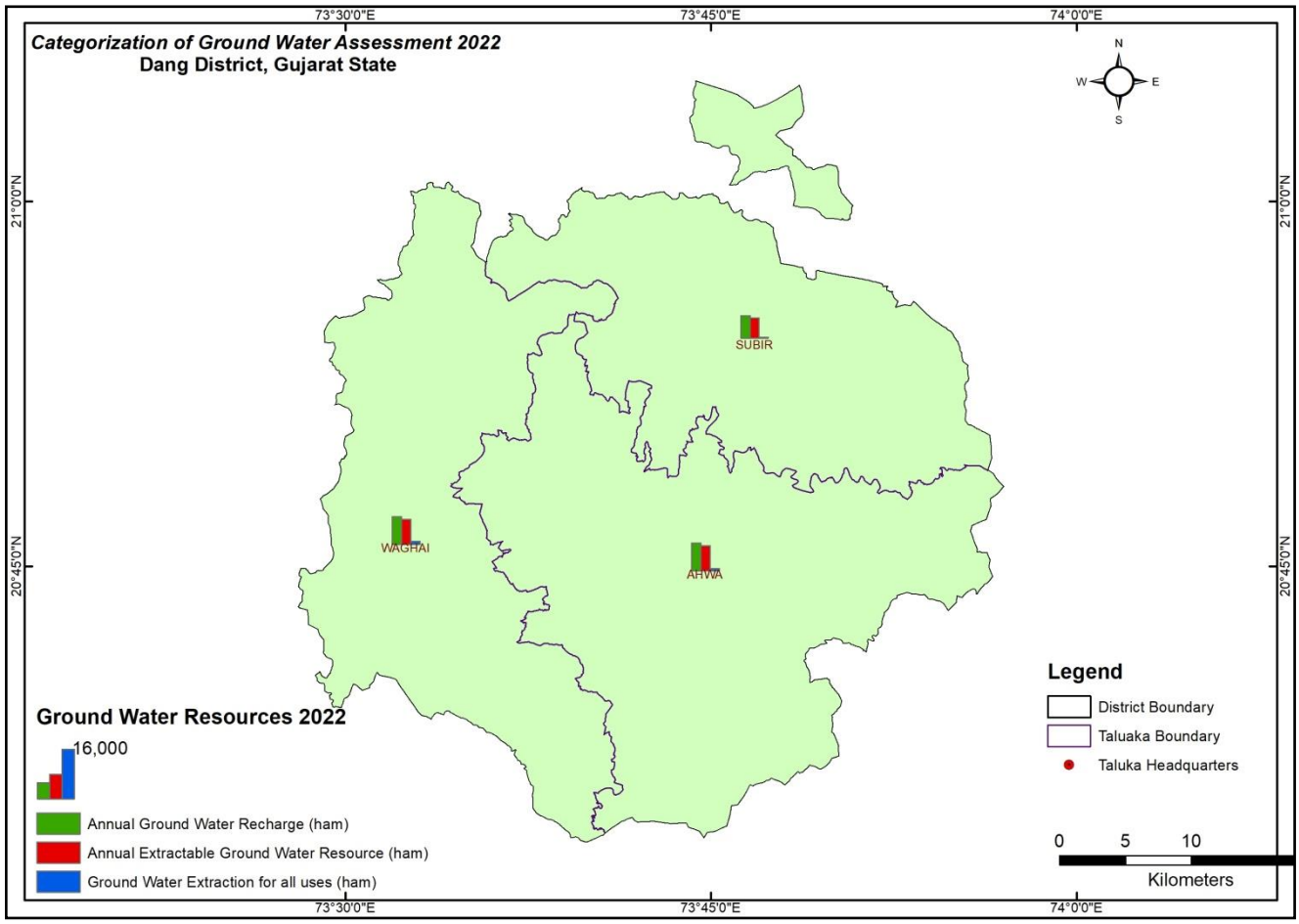

Figure 47 Groundwater resource of The Dang district

10.1 GROUND WATER RECHARGE

Total Annual Ground Water Recharge from Rainfall and other sources for both monsoon and non-monsoon season for the district is 33853 ham. And ground water recharge in talukas variesfrom 9659.1 (Subir taluka) to 12128.31 ham (Waghaitaluka).

10.2 NET GROUND WATER AVAILABILITY

Annual Extractable Ground Water Resource/ Net Ground Water Availability of the district is 30468.03 ham which computed after deducting total environmental flows of 3385.34 ham from total annual ground water recharge.

10.3 ANNUAL GROUND WATER DRAFT

The gross ground water draft for all uses (i.e., Irrigation, Domestic and Industrial uses) in the district is 2730.37 ham. The existing gross ground water extraction for all uses varies from 376.46 ham (Subir taluka) to 1370.05 (Waghaitaluka). According to annual groundwater draft, 2022, approximately 80.19% of ground waterextractions are used for Irrigational purposes, remaining 19.81% are being extracted mainly forDomestic and Industrial purposes.

10.4 PROJECTED DEMAND FOR DOMESTIC AND INDUSTRIAL USE UP TO 2027

As per the annual Ground Water Resource Potential, 2022, the total Projected demand of ground water for Domestic and Industrial uses in the district is522.81 ham. Projected demand for domestic uses varies from 140.08 ham (Subir taluka) to 235.82 (Ahwa taluka).

10.5 GROUND WATER AVAILABILITY FOR FUTURE IRRIGATION

Net ground water availability for future use in the district is 27692.86 ham. Taluka wise it variesfrom 8304.73 (Subir taluka) to 9855.29 (Ahwa taluka).

10.6 STAGE OF GROUND WATER EXTRACTION

As per the Ground Water Resource Estimation (GWRE-2022), the stage of Ground Water extraction of the district is 8.96% which categorized as Safe. Whereas in taluka it varies variesfrom 4.33% (Subirtaluka) to 12.55% (Waghaitaluka) and all the 03 talukas of the districtare categorized as SAFE.

HYDROCHEMISTRY

Groundwater in the district is in general potable and fresh, both in phreatic and confined aquiferswithin200 m depth.

Thechemicalqualityofgroundwaterinshallowaquiferofthedistricthasbeenanalysedbasedon the water samples collected during National Hydrographs Monitoring Stations (NHS) and NAQUIM in

May2022 form CGWB were incorporated, and presented in **Table14**. The ground water is in generalalkalinein nature.

Table 14 Statistical Analysis of Chemical Constituents of Ground Water in The Dang District, May 2022

Constituents	Minimum	Maximum	Average
pH	7.5	8.47	8.1
EC (µs/cm at25°)	257	974	465.4
TDS (ppm)	172	653	311.8
CO3 (ppm)	0	24	1.6
HCO3 (ppm)	110	405	197.8
Cl (ppm)	7	227	37.1
F (ppm)	0	0.6	0.2
SO4 (ppm)	3	249	18.5
NO3 (ppm)	0.47	40	8.6
Alkalinity (ppm)	90	250	164.9
TH (ppm)	100	300	191.3
Ca (ppm)	28	96	49.8
Mg (ppm)	0	54	16.3
Na (ppm)	11	104	25.0
K (ppm)	0.1	4.2	0.6
Sio2 (ppm)	31	92.6	63.2
SAR	0.33	2.9	0.8

11.1 HYDROGENIONCONCENTRATION (PH)

The pH is an indicator of acidity of the water. The shallow ground water in the district is generally alkaline with pH more than 7. The value of pH ranges between 7.54 (Jakhana site) & 8.47 (Mahal village) in the district.

11.2 ISOCONDUCTIVITY MAP

As per the BIS standards [IS 10500: 2012] for drinking water, acceptable limit and permissible limit of Total Dissolve Solid (TDS) are 500 mg/l and 2000 mg/l respectively.

Iso conductivity Map of the district shown below in (**Figure 48**), TDS in the district is mostly lie within Permissible limit. It ranges between 172 mg/l (Grakhadi village) to 653 mg/l (Ahwa site). A patch in the Ahwa has TDS 653 mg/l which is above acceptable limit. Except from Ahwa site the whole district has TDS below 500 mg/l.

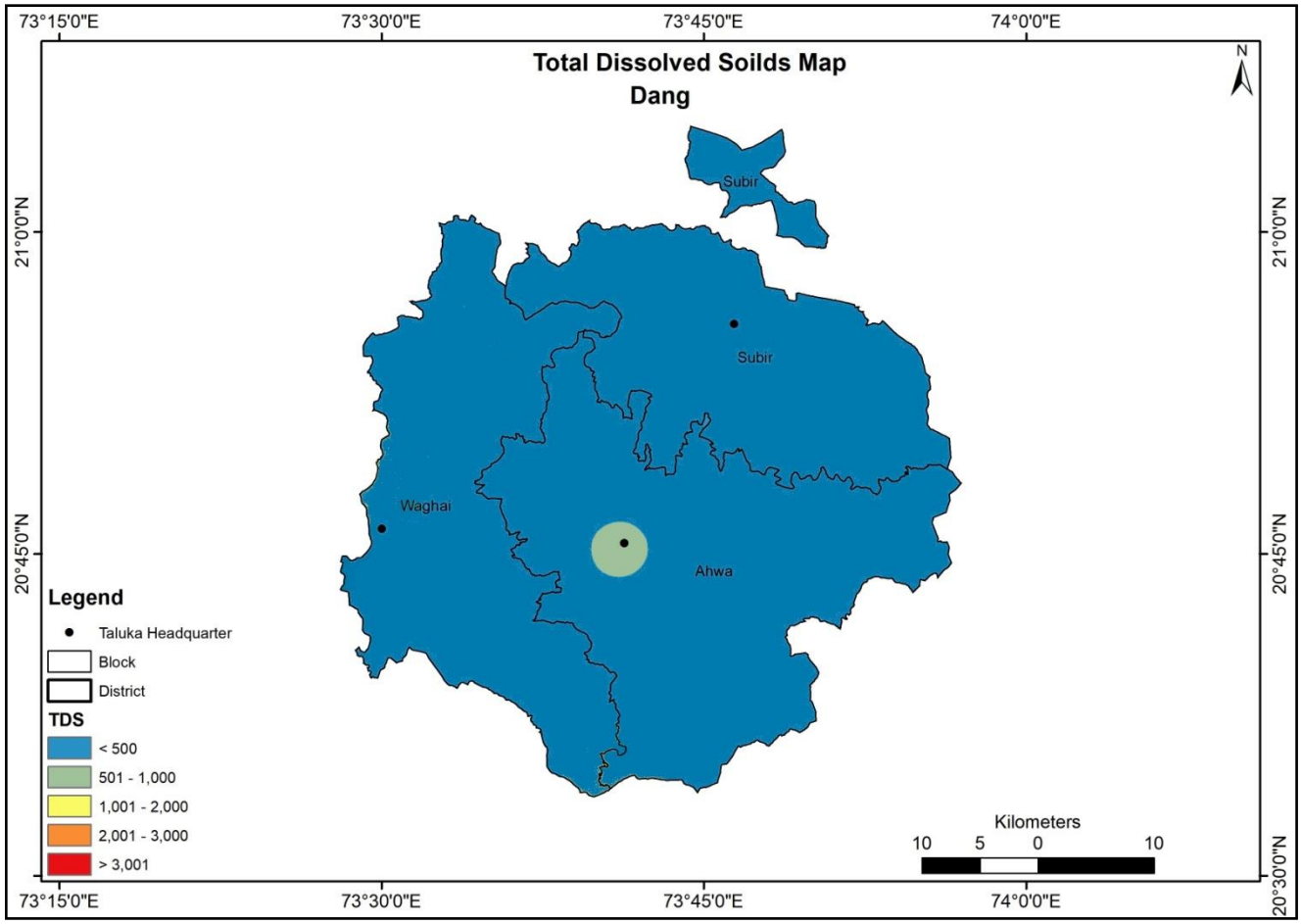

Figure 48 Map showing Taluka wise Total Dissolved Solid (TDS) values of The Dang District.

11.3 ELECTRICAL CONDUCTIVITY (EC)

The electrical conductivity is a measurement of how easily a material allows electric current to flow through. Electrical conductivity of the water ranged from 257-974 µs/cm. The electrical conductivity is minimum in Garghadi location, i.e. 257 mg/l and maximum in Ahwa location, i.e. 974 mg/l.

11.4 CARBONATE (CO_3) AND BICARBONATE (HCO_3)

Carbonate and bicarbonate anions contribute to alkalinity due to their basic nature. The carbonate concentration in district are varies in between zero mg/l (3 locations) to 24mg/l (Lavchali village). Similarly, Bicarbonate concentration in district is varies between 110 mg/l (Gadhvi village) to 305 mg/l (Kalivel site).

11.5 CHLORIDE (Cl)

As per the BIS standards [IS 10500: 2012] for drinking water, acceptable limit and permissible limit of Chloride (mg/l) are 250 mg/l and 1000 mg/l respectively. It is depicted from the map shown in

Figure49, the entire Dang district has chloride concentration below acceptable limit whch ranges between between 7 mg/l (Gadad village) to 227 mg/l (Ahwa site).

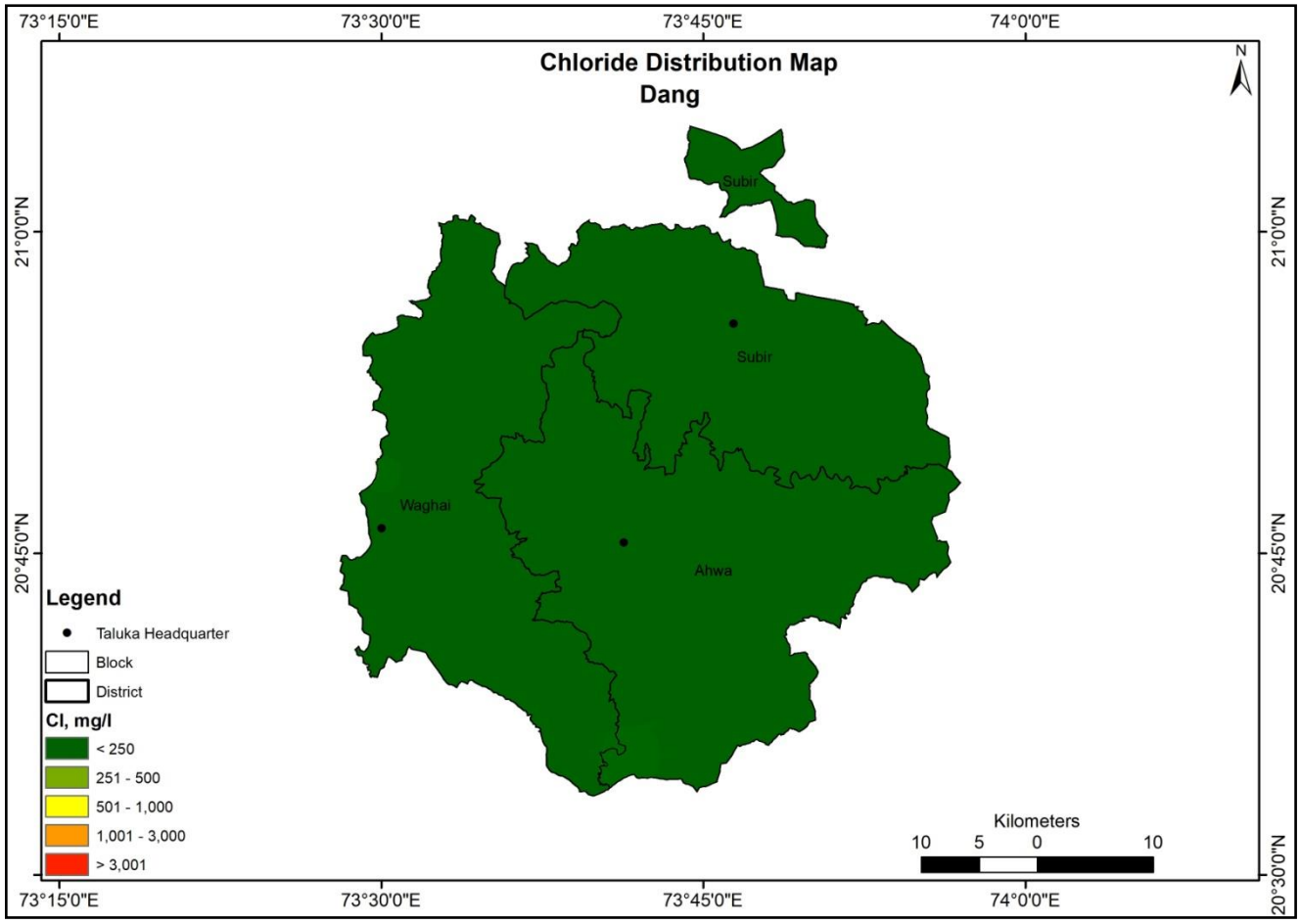

Figure 49 Map showing Taluka wise Chloride (Cl) concentration in The Dang District

11.6 NITRATE (NO_3)

As per the BIS standards [IS 10500: 2012] for drinking water, acceptable limit is 45 mg/l(maximum)and there is no relaxation in permissible limit.

Nitrate concentration in the ground water in district varies between 0.47 mg/l (Bardipada village) and 40 mg/l (Bijurpada village). All the stations of the Dang district show nitrate concentration well below the acceptable limit (**Figure 46**).

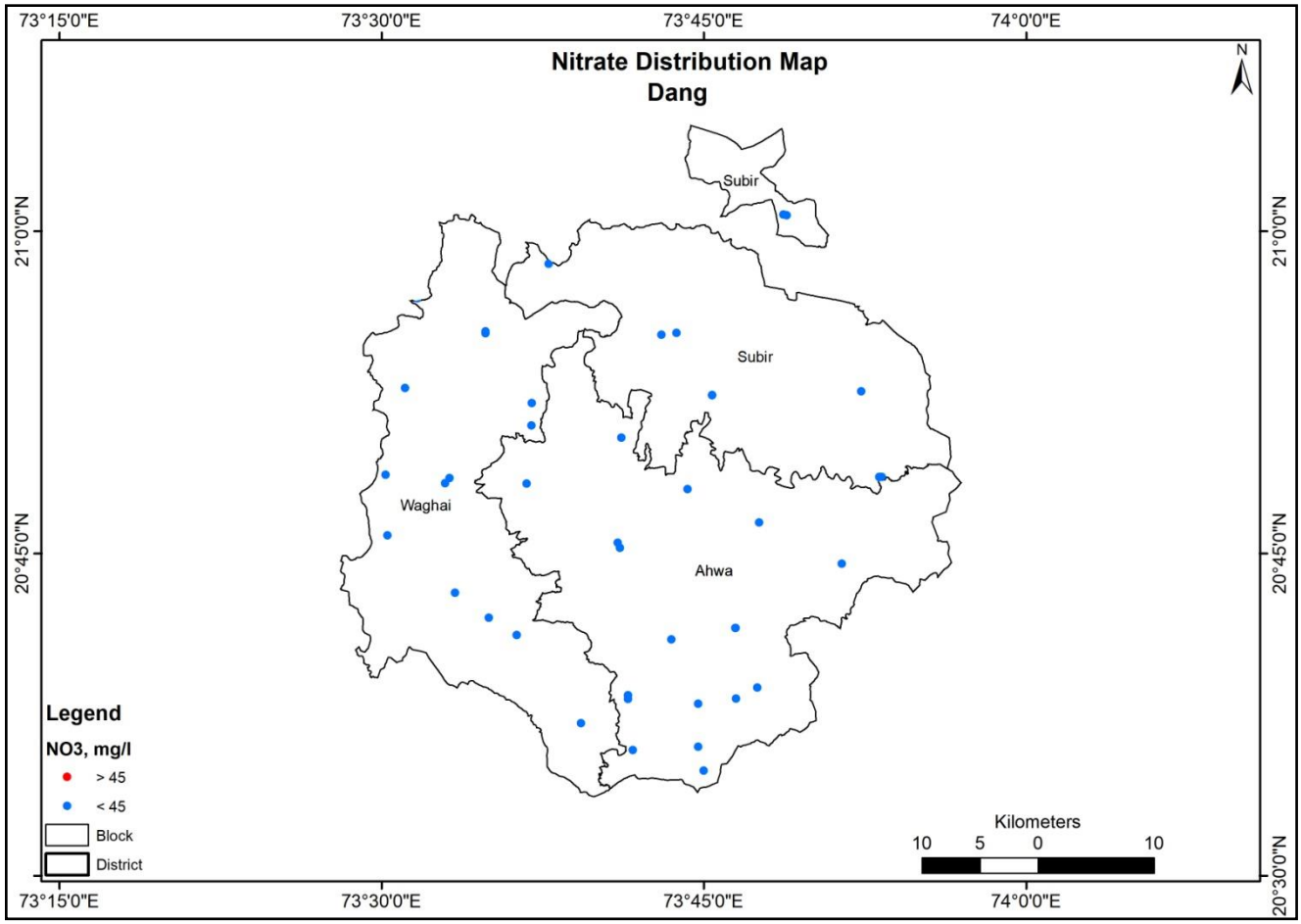

Figure 50 Map showing Taluka wise Nitrate (NO3) concentration in the Dang District

11.7 SULPHATE (SO_4)

In the district, Sulphate concentration varies from 3 mg/l (Garkhadi village) to 249 mg/l (Ahwa location).

11.8 FLUORIDE (F)

As per the BIS standards [IS 10500: 2012] for drinking water, Acceptable limit and Permissible limit of Fluoride (mg/l) are 1 mg/l and 1.5 mg/l respectively. Fluoride concentration in the Dang district varies between zero mg/l (4 locations) and 0.6 mg/l (Chinchgaontha village). There is only one isolated locations where Fluoride concentration is more than acceptable limit as presented in **Figure 51**.

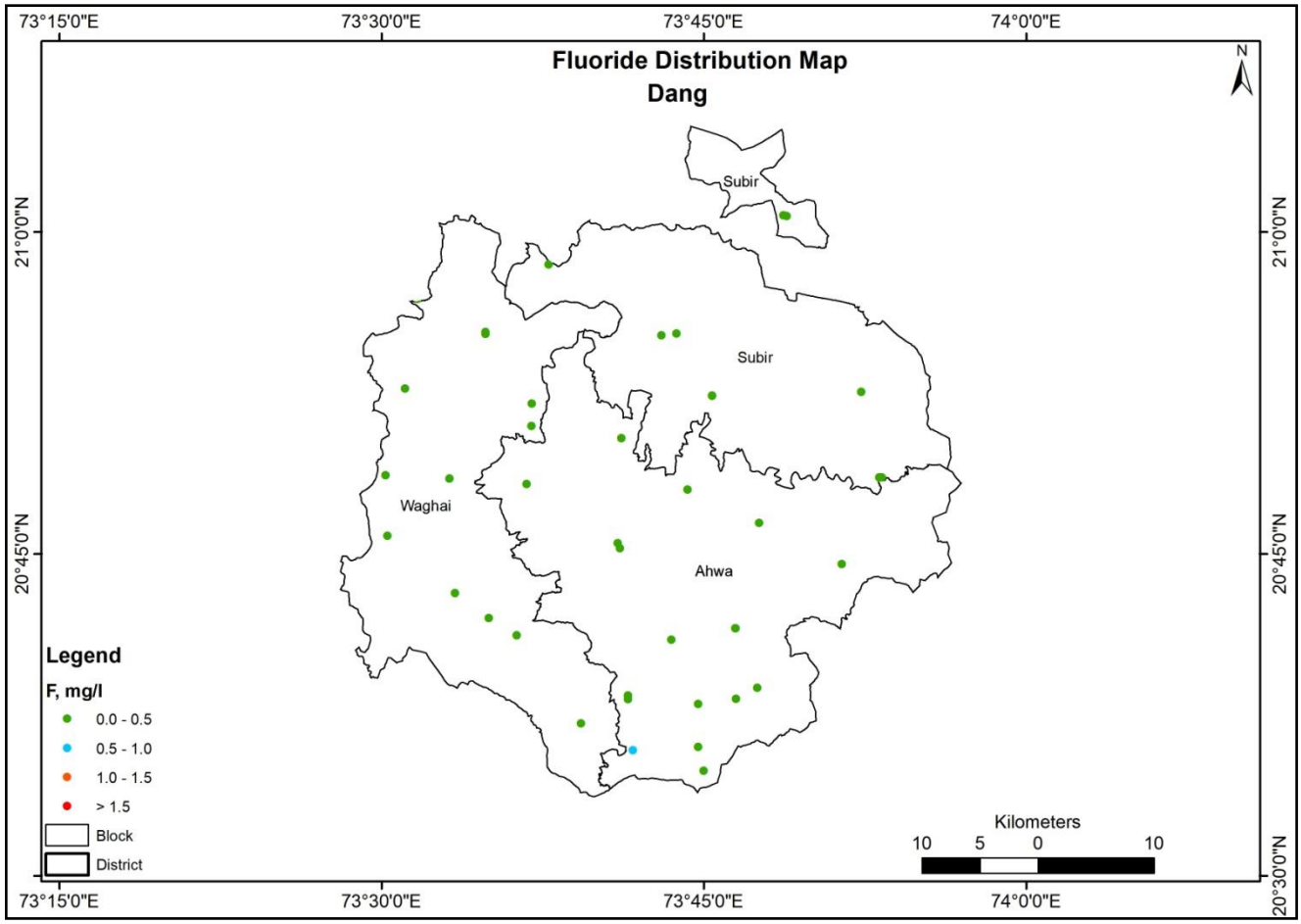

Figure 51 Map showing Taluka wise Fluoride (F) concentration in the Dang District

11.9 CALCIUM (Ca)

Calcium concentration in district varies between 28 mg/l (4 locations) and 96 mg/l (Ahwa location). The concentration of calcium is found within permissible limits inthe district (permissible limit as per BIS norms is 200mg/l).

11.10 MAGNESIUM (Mg)

The Concentration of Magnesium in areas ranges from zero mg/l (Ahwa village) to 54 mg/l (Bardipada village). All the sampling stations in the district has magnesium concentration below the maximum permissible limits of 100 mg/l (as per BIS norms).

11.11 SODIUM (Na)

Sodium concentration in the district varies between 11 mg/l (Bardipada village) and 104 mg/l (Ahwa site).

11.12 POTASSIUM (K)

The concentration of Potassium in shallow groundwater ranges from 0.1 mg/l (Garkhadi village) to 4.2 mg/l (Kasadbari village).

SUSTAINABLEGROUNDWATERDEVELOPMENTANDMANAGEMENT

12.1 GROUNDWATERRELATEDISSUE

12.1.1 LowGroundwaterdevelopment

As per GWRE 2022 the total ground water resources of the district are in order of 33853.37Ham/yearandutilizableresourcesare30468.03Ham/year.Thenetannualdraftsof2730.37Ham/yearleavesabalanceof27692.86Ham/yearofgroundwateravailableforfuturedevelopment.

Stage of Ground water develpoment of the district is 8.96%, however taluka wise it ranges from 4.33% (Subir taluka) to 12.55% (Waghaitaluka).

12.1.2 Pollution (Geogenic and Anthropogenic)

Ground water in both shallow and deeper Aquifers is Potable and fit for domestic, drinking, irrigation and other industrial purposes and Occurrence of Fluoride and TDS beyond acceptable limit (As per the BIS standards [IS 10500: 2012] for drinking water) in Shallow aquifers identified in localized isolated villages, i.e. Chinchigaontha and Ahwa, respectively.

12.1.3 Sustainability

Groundwater in these formations occurs under unconfined conditions. Ground water occurs under water table conditions in the weathered, fractured and vesicular horizons of traps. Depth of open wells range between 18 to 20 m with water levels in the range of 2 to 12 m. bgl.

The specific yield of the wells tested varies from 0.0 – 26 percent in weathered basalt and 0.11 to 1.14 in semi weathered to massive basalt. Yield of the wells constructed in weathered and amygdaloidal/zeolitic basalt varies from 15 to 1200 lpm and 20 to 165 lpm in semi weathered to massive basalt.

The specific capacity of the wells varies from less than 25 lpm/m to 250 lpm/m. Optimum yield of the well ranges from 15 to 1200 lpm. Transmissivity of the basalt ranges from 15 m2/day to 152 m2/day.

In 16 Exploratory wells were drilled in the district four wells were drilled upto 90 m depth and 12 wells in the depth range of 145-200 m. All the boreholes were drilled in the Deccan Trap Basalt. These wells have yielded negligible to 450 lpm for the drawdown in the range of 6-60m. Out of the 16 exploratory wells, 6 wells yielded more than 100 lpm and 4 wells were hydraulically failure.

12.1.4 ReasonsforIssues

The groundwater related issues in the Dang district are

- In the Dang district, the overall stage of groundwater development is low (8.96 %). That is possibly due to physiographical and geological constraints.
- Decadal average monsoon rainfall of the district 1986 mm during SW monsoon, large number of artificial recharge structure is present in the district. The structures need maintenance at regular interval so as to reap the benefit for time to come.
- Heavy rainfall runoff coupled with the hilly terrain and effects of 'Climate change' on rainfall pattern places large dependency on Monsoon.
- Failures of large number of bore wells have been reported in the district. Farmers are forced to go for deeper wells which are leading them to invest more money and secondly the cost of irrigation becomes uneconomical with depth. Erratic power supply is also grave concern for the farmers in the area.
- Flood irrigation technique is in practice in some parts of the area is also the major cause of wastage of ground water as there is no control on the watering depth.
- Sustainable groundwater management strategy to conserve existing resources and preventive actions to control contamination of freshwater resources are essential. Periodic monitoring of ground water should be mandatory

12.2 MANAGEMENTSTRATEGIES

As per the estimate of ground water resources and irrigation potential, there exists a scope forfurther development of ground water resources in major parts of the district. As per GWRE 2022 all the three (03) talukas of the district are under **safe** category. Stage of Groundwater development of the district is 8.96%, however taluka wise itranges from 4.33% (Subir village) to 12.55% (Waghai village).

Thus, further ground water development could be augmented in a judicious way.

12.3 MANAGEMENTPLAN

The uneven distribution of groundwater availability and its utilization indicates that a singlemanagement strategy cannot be adopted and requires integrated hydrogeological aspects alongwith socio-economic conditions to develop appropriate management strategy. The study suggestsnotable measures for sustainable groundwater management, which involves a combination ofvariousmeasuresgiven below.

- GroundwaterdevelopmentPlan

- Supplysidemeasures
- Demandsidemeasures
- Regulatorymeasures
- Institutionalmeasures

12.3.1 GroundwaterDevelopmentPlan

To elevate the stage of ground water development to 11.91% in all blocks, 1853 nos. of Dug wells (15mdepth)areproposedasfeasibleextractionstructures (**Table 15)**. The extraction structures will result as expected annual ground water draft of910.5 Ham whichwillcreate 2023.34haadditional irrigation potentialin thedistrict.

Table 15 Feasible Extraction structures to elevate the Stage of GW development to 11.91% (Hard Rock)

Extraction / Talukas	Feasible Extraction structures to elevate the Stage of GWdevelopmentto11.91%		G.W Draft fromExtractionstructures(ham)	Additional IrrigationPotentialCreated(Ha)
	DW	Total		
Ahwa	654	654	327	726.67
Subir	520	520	260	577.78
Waghai	647	647	324	718.89
District	1853	1853	911	2023.34

12.3.2 Supplysideinterventions

As per Master Plan 2020, surplus surface water of 293.32 mcm non committed is allocated to suggest artificial recharge in district of the Dang. To harvest the surface water the artificial recharge structures are proposed to recharge the aquifer. Expected annual Groundwater recharge is 48.95Ham through check dams of tota l53 nos. are recommended for harvesting the part of available runoff and to recharge the Groundwater as in **Table 16**.

Table 16 Proposed Artificial Recharge and WUE Interventions in the DangDistrict

Recharge / Talukas	Artificial Rechargethrough Check Dam	Additional Recharge fromRecharge interventions(ham)
Ahwa	21	19.3
Subir	13	11.7
Waghai	19	18
District	53	49

12.3.3 Demandsideintervention

Feasible extraction structures are proposed to elevate the stage of ground water development to 11.55%,to avoid further exploitation demand side management is also recommended to restrict the stage ofground water development to 11.09%. An area of 21.0 Ha is proposed for on farm activities (Laserlevelling/Benchterracing/Contourbunding),and443number of farm ponds are recommended which will serve dual purpose of irrigation and recharge togroundwater.Conservation of water from on-farm activities, WUE measures and farm ponds is 138.2 ham.

- **FarmPonds**

A farm pond is a large hole dug out in the earth, usually square or rectangular in shape (**Figure52**),which harvests rainwater and stores it for future use. It has an inlet to regulate inflow and an outlet todischargeexcesswater.Thepondissurroundedbyasmallbund,whichpreventserosiononthebanks of the pond. The size and depth depend on the amount of land available, the type of soil, thefarmer's water requirements, the cost of excavation, and the possible uses of the excavated earth.Waterfromthe farmpondisconveyed tothe fieldsmanually, bypumping,orbyboth methods.

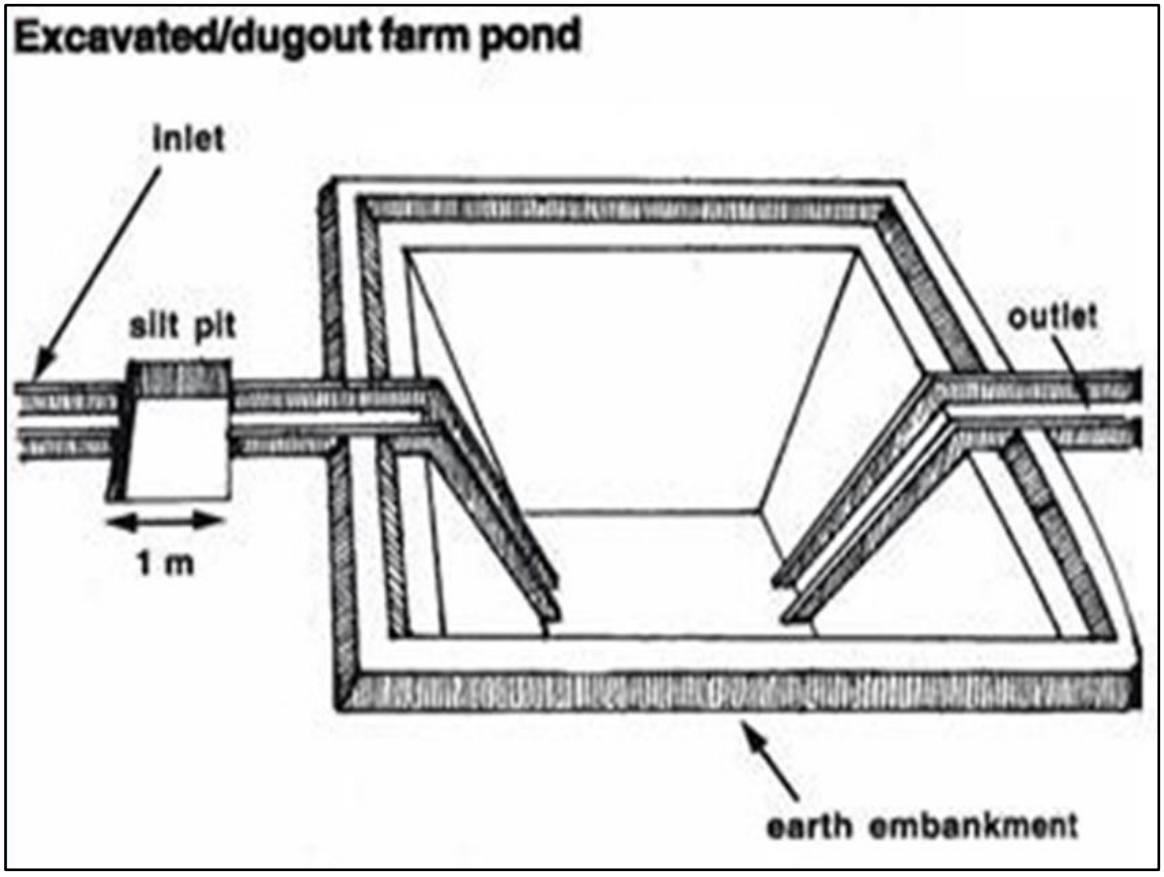

Figure 52 Schematic diagram of Farm Pond

AdvantagesofFarmPonds

- Theyprovidewatertostartgrowingcrops,withoutwaitingforraintofall.
- Theyprovideirrigationwaterduringdryspellsbetweenrainfalls.Thisincreasestheyield,thenumberofcropsin one year,andthe diversityofcropsthatcan be grown.
- Bundscanbeusedtoraisevegetablesandfruittrees,thussupplyingthefarmhouseholdwithanadditional source ofincome and ofnutritiousfood.
- Farmersareabletoapplyadequatefarminputsandperformfarmingoperationsattheappropriatetime,thusincreasingtheirproductivityand theirconfidencein farming.
- Theychecksoilerosionandminimizesiltationofwaterwaysandreservoirs.
- Theysupplywaterfordomesticpurposesandlivestock
- Theypromotefishrearing.
- Theyrecharge thegroundwater.
- Theexcavatedearthhasaveryhighvalueandcanbeusedtoenrichsoilinthefields, levelling land,andconstructingfarmroads.

Table 17 Projected Stage Groundwater Resource and Management plan of The Dang District

Projected Status of Groundwater Resource after implementation of GW Management Plan, The Dang District (Gujrat)																
Block	Net G.W. Availability (Ham)	Additional Recharge from Recharge interventions (ham)	Additional Recharge from RTRWH (ham)	Additional Recharge from Return flow of GW Irrigation	Total Net G.W. Availability after intervention (Ham)	Existing G.W Draft for all purpose (ham)	Conservation of Ground water through Supplemental irrigation (ham)	Conservation of Ground water through WUE, on farm activity & farm ponds (ham)	G.W Draft from Extraction structures (ham)	Net GW draft after interventions (ham)	Present stage of G.W. Development (%)	Projected stage of G.W. Development after construction of extraction structures (%)	Projected stage of GW development after construction of extraction structures & implementation of conservation measures (in %)	Projected stage of GW development after construction of extraction structures & implementation of conservation & Recharge measures (in %)	Projected stage of GW development after all interventions & import of water from distant source	Additional Irrigation Potential Created (Ha)
Ahwa	10859	19.3	0	82	10960	984	29	57	327	1225	9.06	11.98	11.46	11.18		726.67
Subir	8693	11.7	0	68	8772	376	18	42	260	577	4.33	7.26	6.79	6.57		577.78
Waghai	10915	18.0	0	84	11018	1370	26	40	324	1628	12.55	15.40	15.04	14.77		718.89
District	**30468.03**	**48.95**	**0**	**233.46**	**30750.43**	**2730.37**	**72.98**	**138.2**	**910.5**	**3429.69**	**8.65**	**11.55**	**11.09**	**10.84**		**2023.33**

CONCLUSION AND RECOMMENDATIONS

- Common Irrigation Infrastructure- : The rolling and very steeply sloped terrains in the Dang limit the development of surface water harvesting. Hence, the most viable option is the construction of check dams and check walls, followed by a limited opportunity for the creation of ponds. So, artificial recharge structures like check dams is proposed in the district to encounter needed surface runoff.
- To elevate the stage of ground water development to 11.55% in district, 1853no. of Dug wells(15 m depth) are proposed as feasible extraction structures.
- The extraction structures will result as expected annual ground water draft of 910.5Hamwhichwill create2023.33Haadditional irrigation potentialin thedistrict.
- To prevent Over Exploitation, water conservation activities like on farm and farm pond activitiesare recommended.
- 21.0 Ha area is proposed for on farm activities (Laser levelling/Benchterracing/Contourbanding) and 443 no of farm ponds are recommended which will serve dual purpose ofirrigationand recharge toground water.
- Groundwaterreturnflowof233.46Hamisexpectedfromirrigationoffieldsinthed istrict.
- 138.2 ham conservation of ground water through WUE measures, on farm activities&farmpondsisexpected for the district.
- As a conservation measure, farmers should be encouraged and educated to adopt modernirrigation techniques like drip, sprinkler irrigation etc. to effect minimum withdrawal andmaximumutilisation ofgroundwater.
- The water quality in general is good. However fluoride and TDS concentration is observed above acceptable limit of BIS in isolated pockets. Ground water in such areas may be used after blending with surface water.
- Sustainable groundwater management strategy to conserve existing resources and preventive actions to control contamination of freshwater resources are essential. Periodic monitoring of ground water should be

mandatory.

- Takingintoconsiderationoftribaldominationanddroughtpronearea,the‘MassAwarenessProgramme’and'Water Management TrainingProgramme'shouldbe organized in regular basis in the district for awareness on the depletion of groundwaterresourcesandqualityproblems.
- Present supply side interventions are suggested based on availability 293.32 MCM noncommitted source of water is referred by State Government (Reference MasterPlanofArtificialrecharge2020).ProposedenhancementsofpresentGroundwaterdevelopmentstagearesubjectedtoimplementationofrechargeinterventions,availabilityof cultivablelandandyieldof Groundwaterstructures.
- These interventions also need to be supported by regulation, so that the groundwater resources are protected for future generation and also serve as ground water sanctuary in times of distress/drought. IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory ground water management. The PMKSY project in the district worked on slogan Har Khet Ko Pani, Jal Sanchay and Jal Sinchan, and Per drop more drop to Enhance the physical access of water on the farmer and expand cultivable area, to Enhance recharge of aquifers and introduce sustainable water conservation practices.

AnnexureII-Pre- and Post-monsoon_2022 Depth to water level data of the Dang District

STATE	DISTRICT	AGENCY	SITE NAME	LATITUDE	LONGITUDE	SITE_TYPE	AQUIFER_TYPE	WLS_DATE	WATER LEVEL
Gujarat	Dang	CGWB	Aherdi	20°41'30" N	73°37'0" E	DW	Unconfined	10-01-2022	3.6
Gujarat	Dang	CGWB	Aherdi	20°41'30" N	73°37'0" E	DW	Unconfined	30-05-2022	4.67
Gujarat	Dang	CGWB	Ahwa_Pz	20°45'32" N	73°41'10" E	BW	Unconfined	10-01-2022	2.15
Gujarat	Dang	CGWB	Ahwa_Pz	20°45'32" N	73°41'10" E	BW	Unconfined	30-05-2022	2.62
Gujarat	Dang	CGWB	Ahwa1	20°45'30" N	73°41'0" E	DW	Unconfined	10-01-2022	1.1
Gujarat	Dang	CGWB	Ahwa1	20°45'30" N	73°41'0" E	DW	Unconfined	30-05-2022	5
Gujarat	Dang	CGWB	Bari Pada	20°38'24" N	73°41'29" E	DW	Unconfined	10-01-2022	1.45
Gujarat	Dang	CGWB	Bari Pada	20°38'24" N	73°41'29" E	DW	Unconfined	30-05-2022	12.54
Gujarat	Dang	CGWB	Bori Gaotha 1	20°48'39" N	73°30'11" E	DW	Unconfined	10-01-2022	2.05
Gujarat	Dang	CGWB	Bori Gaotha 1	20°48'39" N	73°30'11" E	DW	Unconfined	30-05-2022	7.3
Gujarat	Dang	CGWB	Chikhli	20°39'30" N	73°41'15" E	DW	Unconfined	10-01-2022	1.12
Gujarat	Dang	CGWB	Chikhli	20°39'30" N	73°41'15" E	DW	Unconfined	30-05-2022	7
Gujarat	Dang	CGWB	Chinchnogaotha	20°48'30" N	73°33'10" E	DW	Unconfined	10-01-2022	3.91
Gujarat	Dang	CGWB	Chinchnogaotha	20°48'30" N	73°33'10" E	DW	Unconfined	30-05-2022	6.53
Gujarat	Dang	CGWB	Chinchpada	20°38'15" N	73°46'30" E	DW	Unconfined	10-01-2022	3.9
Gujarat	Dang	CGWB	Chinchpada	20°38'15" N	73°46'30" E	DW	Unconfined	30-05-2022	5
Gujarat	Dang	CGWB	Dhumkal	20°38'45" N	73°47'30" E	DW	Unconfined	10-01-2022	0.9
Gujarat	Dang	CGWB	Dhumkal	20°38'45" N	73°47'30" E	DW	Unconfined	30-05-2022	3.4
Gujarat	Dang	CGWB	Gadad	20°38'15" N	73°46'30" E	DW	Unconfined	10-01-2022	1.2
Gujarat	Dang	CGWB	Ghubita	20°48'0" N	73°44'15" E	DW	Unconfined	10-01-2022	0.65
Gujarat	Dang	CGWB	Ghubita	20°48'0" N	73°44'15" E	DW	Unconfined	30-05-2022	1.91
Gujarat	Dang	CGWB	Jakana	20°38'0" N	73°44'45" E	DW	Unconfined	10-01-2022	1.65
Gujarat	Dang	CGWB	Jamalpada	20°43'54" N	73°31'14" E	DW	Unconfined	10-01-2022	3.6

Gujarat	Dang	CGWB	Jamalpada	20°43'54" N	73°31'14" E	DW	Unconfined	30-05-2022	7.52
Gujarat	Dang	CGWB	Kalibel	20°55'15" N	73°34'50" E	DW	Unconfined	10-01-2022	1.32
Gujarat	Dang	CGWB	Kalibel	20°55'15" N	73°34'50" E	DW	Unconfined	30-05-2022	2.9
Gujarat	Dang	CGWB	Mahal	20°55'0" N	73°40'45" E	DW	Unconfined	10-01-2022	3.2
Gujarat	Dang	CGWB	Mahal	20°55'0" N	73°40'45" E	DW	Unconfined	30-05-2022	6.6
Gujarat	Dang	CGWB	Malegaon	20°36'0" N	73°44'45" E	DW	Unconfined	10-01-2022	0.95
Gujarat	Dang	CGWB	Malegaon	20°36'0" N	73°44'45" E	DW	Unconfined	30-05-2022	2.32
Gujarat	Dang	CGWB	Nadak khadi	20°48'15" N	73°36'45" E	DW	Unconfined	10-01-2022	1.2
Gujarat	Dang	CGWB	Nadak khadi	20°48'15" N	73°36'45" E	DW	Unconfined	30-05-2022	4.86
Gujarat	Dang	CGWB	Nana pada	20°42'0" N	73°35'0" E	DW	Unconfined	10-01-2022	3.58
Gujarat	Dang	CGWB	Nana pada	20°42'0" N	73°35'0" E	DW	Unconfined	30-05-2022	8.8
Gujarat	Dang	CGWB	Sakarpatal	20°43'10" N	73°33'25" E	DW	Unconfined	10-01-2022	2.8
Gujarat	Dang	CGWB	Sakarpatal	20°43'10" N	73°33'25" E	DW	Unconfined	30-05-2022	8.1
Gujarat	Dang	CGWB	Sodmal	20°52'0" N	73°37'0" E	DW	Unconfined	10-01-2022	5.45
Gujarat	Dang	CGWB	Sodmal	20°52'0" N	73°37'0" E	DW	Unconfined	30-05-2022	11.6
Gujarat	Dang	CGWB	Subir	20°55'20" N	73°34'50" E	DW	Unconfined	10-01-2022	3
Gujarat	Dang	CGWB	Subir	20°55'20" N	73°34'50" E	DW	Unconfined	30-05-2022	8.1
Gujarat	Dang	CGWB	Umberpada	20°41'0" N	73°43'30" E	DW	Unconfined	10-01-2022	1.85
Gujarat	Dang	CGWB	Umberpada	20°41'0" N	73°43'30" E	DW	Unconfined	30-05-2022	4.07
Gujarat	Dang	CGWB	Vaghai	20°45'50" N	73°30'16" E	DW	Unconfined	10-01-2022	5.4
Gujarat	Dang	CGWB	Vaghai	20°45'50" N	73°30'16" E	DW	Unconfined	30-05-2022	11.95
Gujarat	Dang	CGWB	Vazat Amba	20°52'42" N	73°31'6" E	DW	Unconfined	10-01-2022	4.15
Gujarat	Dang	CGWB	Vazat Amba	20°52'42" N	73°31'6" E	DW	Unconfined	30-05-2022	7

AnnexureII-Pre-monsoon_2022Water quality data of the Dang District

District	Location	Lat	Long	Source	pH	EC	TDS	CO3	HCO3	Cl	F	SO4	NO3	Alkalinity	TH	Ca	Mg	Na	K	SiO2	SAR
						µs/cm at25°	ppm														
Dang	Nadakchond	20.62	73.65	DW	8.39	537	360	18	195	43	0.02	34	14	190	240	60	22	22	1.1	41	0.63
Dang	Saputara	20.58	73.75	DW	8.25	364	244	0	159	35	0.00	14	8.2	130	170	44	15	13	0.6	43	0.42
Dang	Linga	20.69	73.77	DW	8.26	419	281	0	195	28	0.05	15	9.7	160	180	52	12	17	0.5	72	0.55
Dang	Kalamvihir	20.77	73.79	DW	8.19	445	298	0	171	43	0.07	21	27	140	200	56	15	18	0.7	47	0.57
Dang	Gadad	20.74	73.86	DW	8.14	428	287	0	256	7	0.04	6	12	210	190	52	15	20	3.3	42	0.62
Dang	Garkhadi	20.81	73.89	DW	8.17	370	248	0	159	21	0.10	14	38	130	170	44	15	16	0.5	57	0.52
Dang	Bijurpada	20.88	73.87	DW	8.29	454	304	0	134	50	0.00	33	40	110	200	28	32	17	0.4	57	0.53
Dang	Lavchali	20.87	73.76	DW	8.46	412	276	24	122	35	0.00	24	17	140	180	32	24	19	1.3	67	0.63
Dang	Kasadbari	20.92	73.72	DW	7.97	336	225	0	122	21	0.10	42	7.9	100	140	40	9.7	19	4.2	52	0.70
Dang	Jamla	21.01	73.81	DW	8.22	399	267	0	220	14	0.03	14	8.0	180	180	56	9.7	17	0.7	45	0.55
Dang	Gadhvi	20.84	73.69	DW	8.13	319	214	0	110	28	0.06	15	29	90	140	32	15	16	0.6	60	0.58
Dang	Nanapada	20.69	73.60	TW	8.29	327	219	0	171	21	0.00	7	4.3	140	150	40	12	13	0.2	53	0.47
Dang	Baripada	20.64	73.69	TW	8.1	397	266	0	171	28	0.07	9	13	140	160	44	12	18	0.4	67	0.61
Dang	Linga	20.69	73.77	TW	8.24	421	282	0	207	21	0.15	13	9.5	170	190	44	19	18	0.3	72	0.57
Dang	Ahwa	20.75	73.69	TW	8.12	974	653	0	122	227	0.00	52	5.2	100	240	96	0.0	104	0.6	31	2.92

Dang	Chinchigaontha	20.80	73.55	TW	7.81	587	393	0	207	50	0.61	26	32	170	250	60	24	25	0.4	90	0.69
Dang	Garkhadi	20.81	73.89	TW	8.13	257	172	0	146	7	0.38	3	2.5	120	100	28	7.3	18	0.1	54	0.79
Dang	Lavchali	20.87	73.76	TW	8.05	553	371	0	171	85	0.39	29	7.7	140	200	64	9.7	40	0.2	53	1.22
Dang	Kasadbari	20.92	73.73	TW	7.93	701	470	0	134	106	0.37	47	28	110	220	68	12	55	0.4	43	1.61
Dang	Jamla	21.01	73.81	TW	8.21	445	298	0	220	14	0.43	9	1.9	180	150	44	9.7	32	0.5	56	1.14
Dang	Sarvar	20.85	73.62	TW	8.23	269	180	0	110	28	0.43	8	6.0	90	110	28	9.7	18	0.2	90	0.75
Dang	Kalibel	20.92	73.58	TW	7.88	495	332	0	232	21	0.37	19	12	190	160	48	9.7	45	1.0	54	1.55
Dang	Kalivel	20.92	73.58	DW	8.05	605	405	0	305	35	0.05	22	1.1	250	170	56	7	76	0.6	56.6	2.534
Dang	Sodmal	20.86	73.62	DW	8.15	430	288	0	220	21	0.25	12	1.4	180	200	72	5	14	0.8	77.7	0.430
Dang	Bardipada	20.97	73.62	DW	8.05	649	435	0	268	78	0.17	28	1.3	220	300	36	51	25	0.9	71.2	0.636
Dang	Mahal	20.92	73.67	DW	8.47	651	436	18	183	85	0.22	38	0.6	180	160	60	2	84	0.5	78.6	2.882
Dang	Subir	20.93	73.77	DW	7.90	499	334	0	244	35	0.12	25	0.6	200	240	80	10	15	0.5	60.5	0.421
Dang	Guvitha	20.80	73.73	DW	8.31	401	269	6	207	14	0.20	6	0.6	180	180	40	19	15	0.4	54.8	0.477
Dang	Umbarpada	20.68	73.72	DW	8.03	468	314	0	256	14	0.06	11	0.5	210	220	56	19	14	0.6	63.2	0.405
Dang	Dhumkal	20.64	73.77	DW	8.09	391	262	0	207	21	0.23	7	0.5	170	190	68	5	12	0.2	75.4	0.379
Dang	Jakhana	20.63	73.74	DW	7.54	563	377	0	244	35	0.25	21	1.2	200	250	40	36	15	0.6	72.5	0.412
Dang	Malegaon	20.59	73.74	DW	8.16	396	265	0	183	21	0.17	13	0.6	150	170	48	12	14	0.7	52.9	0.475
Dang	Bardipada	20.64	73.69	DW	7.67	376	252	0	195	21	0.15	7	0.5	160	180	44	17	11	0.2	77.0	0.356
Dang	Chikhali (Samagham)	20.66	73.68	DW	8.20	438	293	0	232	14	0.18	5	0.6	190	200	44	22	11	0.3	65.5	0.338

Dang	Nana Pada	20.69	73.60	DW	8.18	408	273	0	232	14	0.13	7	0.8	190	200	48	19	12	0.2	73.3	0.369
Dang	Sakar Patal	20.70	73.58	DW	8.22	362	243	0	183	21	0.17	10	1.1	150	170	44	15	13	0.2	68.6	0.446
Dang	Jamal Pada	20.72	73.52	DW	8.06	562	377	0	220	43	0.04	28	1	180	250	52	29	12	0.2	69.3	0.330
Dang	Amba Pada (Waghai)	20.76	73.50	DW	8.19	482	323	0	256	21	0.14	13	1.2	210	220	48	24	15	0.2	92.6	0.451
Dang	Chichimagautha	20.81	73.55	DW	7.94	520	348	0	183	57	0.17	27	0.7	150	220	56	19	21	0.2	88.0	0.605
Dang	Nagagkhadi	20.80	73.61	DW	8.09	473	317	0	256	21	0.12	12	1.6	210	130	28	15	60	0.5	76.7	2.301
Dang	Vazat Amba	20.88	73.50	DW	8.02	451	302	0	232	28	0.36	14	5.8	190	210	48	22	16	0.7	68.0	0.492
Dang	Bori Gautha	20.82	73.51	DW	8.15	511	342	0	268	21	0.38	16	8.1	220	250	60	24	15	0.7	66.2	0.412

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