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**Technical Report Series**

# DISTRICT GROUNDWATER BROCHURE
# JUNAGADH DISTRICT

# GUJARAT


**Compiled**

**By**

**Babu Nair, Scientist-D**


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**Government of India**

**Ministry of Water Resources**

## Central Ground Water Board

**West Central Region**

**Ahmedabad**

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# 534.3JUNAGADH DISTRICT AT A GLANCE

| SL No. | Items | Statistics | |
|---|---|---|---|
| 1 | General Information | | |
| | i) Geographical Area (Sq Km) | 8848 | |
| | ii) Administrative Divisions<br>Number of Taluka<br>Number of Villages (Inhabited) | <br>14<br>1032 | |
| | iii) Populations (As per 2011 census) | 2,743,082 | |
| | iv) Normal Annual Rainfall (mm) | **900** | |
| 2. | GEOMORPHOLOGY | | |
| | Major Physiographic Units | Hilly & plain | |
| | Major Drainages | Ozat | |
| 3. | LAND USE ('000ha) | | |
| | **a)** Forest area<br>**b)** Net area sown<br>**c)** Cultivable area | 178<br>535<br>534.3 | |
| 4. | MAJOR SOIL TYPES | Black soil, medium black soil | |
| 5. | AREA UNDER PRINCIPAL FOODGRAIN CROPS<br>Wheat | Area in '000 ha<br><br>188.1 | |
| 6. | IRRIGATION BY DIFFERENT SOURCES<br>(Areas and numbers of structures)<br>(Dir of Agri, Guj State, Gandhinagar) | No. | Area ('000ha) |
| | Borewells | | 1095 |
| | Dugwells | | 73 |
| | Canals | - | 11 |
| | Net Irrigated area ('000 ha) | 195 | |
| | Gross Irrigated area ('000 ha) | 220 | |
| 7. | NUMBERS OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-08-2013)<br>No of Dug Wells<br>No of Piezometers | | |
| 8. | PREDOMINANT GEOLOGICAL FORMATIONS | | |
| | Predominant geological formation is Deccan traps. Others are Gaj Beds, Miliolitic Limestone, Alluvium | | |
| 9. | HYDROGEOLOGY | | |
| | ➢ Major Water Bearing Formation<br>Depth to water level during 2013 - Range<br>Pre-monsoon (May13) 2 (min) to 20 (max) m bgl<br>Post-monsoon (Nov 2013) 5 (min) to 20 (max) m bgl | | |
| 11 | GROUND WATER QUALITY | Potable | |
| 12. | DYNAMIC GROUND WATER RESOURCES (2011)- in mcm | | |

| | | |
|---|---|---|
| | Total Annual Ground Water Recharge | **137227.56** |
| | Net Annual Ground Water Draft | **80225.40** |
| | Projected Demand for Domestic and industrial Uses upto 2025 | **9203.00** |
| | Stage of Ground Water Development | **61.54** |
| 16 | MAJOR GROUND WATER PROBLEMS AND ISSUES | |
| | i) Declining Groundwater levels/ Piezometric heads in user aquifers<br>ii) Increasing depth of tubewells<br>iii) Increasing instances of high fluoride<br>iv) Groundwater contamination due to unplanned construction and poor technical design of tube wells<br>v) Awareness amongst villagers on water conservation techniques<br>**vi)** Demand supply management | |

# DISTRICT GROUNDWATER BROCHURE
# JUNAGADH DISTRICT

# GUJARAT

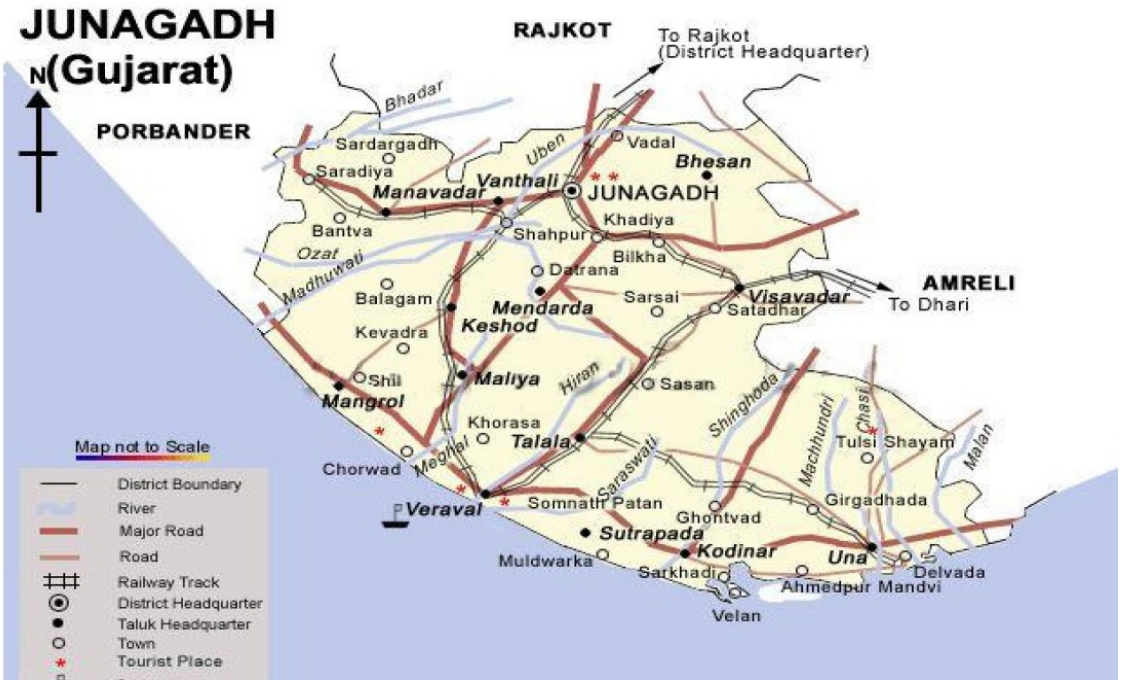
## INTRODUCTION

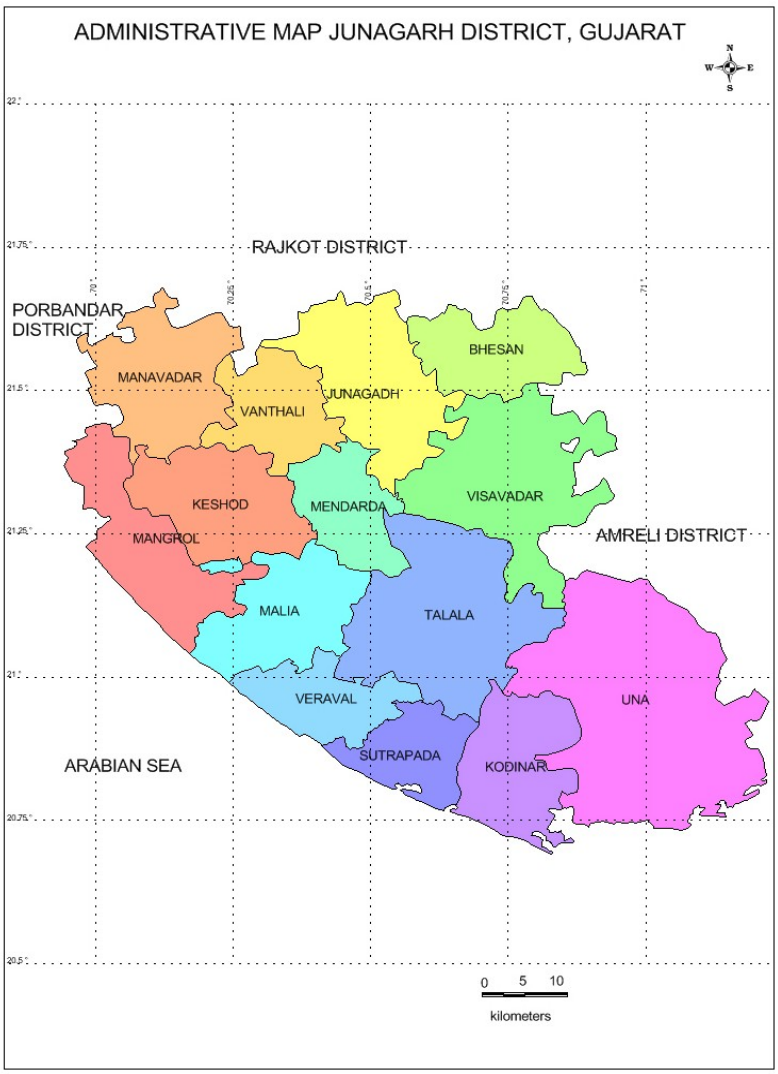
Junagadh district is located on the Kathiawar peninsula in south western Gujarat with the city Junagadh as its administrative headquarters. It lies between 21$^{O}$ 31' and 23$^{O}$29' north and 70$^{O}$27' and 71$^{O}$90' east longitudes. The district is bordered by Rajkot District on its north, Porbandar District on its North west, Amreli District on its East and by the Arabian Sea on its South and West. The district has a population of 2,743,082 of which 33.04 % is urban (Census 2011). The present report deals with the salient features of the hydrogeological conditions in the district and also outlines the ground water development vis-à-vis the water requirement for irrigation, domestic and industrial needs.

### Location, Extent and Accessibility

Junagadh district is located on the Kathiawar peninsula in south western Gujarat with the city Junagadh as its administrative headquarters. It lies between 21$^{O}$ 31' and 23$^{O}$29' north and 70$^{O}$27' and 71$^{O}$90' east longitudes. The district is bordered by Rajkot District on its north, Porbandar District on its North west, Amreli District on its East and by the Arabian Sea on its South and West. The administrative Map of the district is given in Figure-1. The area of the district is 8831 sq. km. It has 14 talukas having 1034 villages. The district has fairly good network of roads and all the Taluka headquarters are connected with all weather roads. The district headquarter, Junagadh, is connected with Ahmedabad through a National Highway-8C . The district is also connected by broad gauge railway line.

# District - Junagadh






## Demography

The population of the district according to the census of 2011 is 2,743,082. There was change of 12.05 percent in the population compared to population as per 2001 Census. The initial provisional data released by census India 2011, shows that the population density of Junagadh district for 2011 is 311 people per sq. km. In 2001, Junagadh district density was at 277 people per sq. km.

Average literacy rate of Junagadh in 2011 is 75.80 compared to 67.78 of 2001. Gender wise, male and female literacy are 84.38 % and 66.86 % respectively. For 2001 census, same figures stood at 78.74 and 56.43 in Junagadh District. Total literate in Junagadh District are 1,842,818 of which male and female were 1,046,981 and 795,837 respectively. The Sex Ratio in Junagadh is 953 per 1000 male in 2011 Census compared to 2001 census figure of 955. The average national sex ratio in India is 940 as per latest reports of Census 2011 Directorate. In 2011 census, child sex ratio is 903 girls per 1000 boys compared to figure of 898 girls per 1000 boys of 2001 census data.

## Soil

The soils in the district are formed from sedimentary rocks and partly from volcanic rocks. They are generally calcareous, rich in potassium content but comparatively deficient in nitrogen and humus.

The main types of soils occurring in the district are Black soil, Medium black soil, Alluvial soil and in low-lying and coastal area, calcareous and brackish soils. The black soils is found in parts of Vanthli, Manavadar and Keshod talukas excepting the Ghed areas. Most of the villages of Jnagadh, Bhesan, Una, Kodinar, Talala, Malia and Visavadar talukas have medium black soil. The alluvial soil is found in the low-lying areas popularly known as "Ghed" in parts of Keshod and Mangrol talukas, these areas remain inundated during monsoon. Though the soil of this tract is fertile, water logging conditions prevent effective utilization of the land. In parts of Mangrol, Veraval and Sutrepada talukas the soil is alluvial and calcareous. The brackish soils are mostly found near the coastal belt of Mangrol, Maliya, Veraval, Sutrapada, Kodinar and Una talukas are represent the generation of the coastal alluvial soil due to ingress of the sea water. The area popularly known as "Lili Nagher" is the tract of fertile soil extending from Veraval – Patan to Una.

# Land Use, Cropping Pattern and Irrigation

## Land Use

The economy of Junagadh district is mainly agriculture based with more than 60 % of area under cultivation. The Land use pattern of the district is given below:

**Land Use Pattern in Porbandar district**

| S No. | Particulars | Total Area ('000ha.) |
|---|---|---|
| **1.** | Geographical area | **884.8** |
| **2.** | Cultivated area | **534.3** |
| **3.** | Forest area | **176.0** |
| **4.** | Land under non- agricultural use | **45.5** |
| **5.** | Permanent pastures | **89.0** |
| **6.** | Cultivable wasteland | **8.8** |
| **7.** | Land under Misc. Tree crops and grooves | **0.00** |
| **8.** | Barren & un-cultivable Land | **132.9** |
| **9.** | Current fallows | **17.0** |
| **10.** | Net sown Area | **535.0** |
| **11.** | Area sown more than once | **150.0** |
| **12.** | Gross cropped Area | **685.0** |

(Source; (Source; Statistical Handbook)

## Cropping Pattern

Major crops being grown in the district are Groundnut, Wheat, Gram, Cotton, sugarcane, Bajri and Jowar, , Pulses. Groundnut is the most important crop of the district with about 61% of total cultivated area under this crop. Second most important crop in the district is wheat grown on about 30% of the cultivated land. The calendar being adopted for major crops in the district is as given in table.

**Crop Calender**

| S. No | Crop | Months of Sowing | Months of Harvesting |
|---|---|---|---|
| 1. | Bajri | June – July | August – September |
| 2. | Jowar | June – July | September – October |
| 3. | Wheat | October – November | February – March |
| 4. | Groundnut | June – July | September – October |
| 5. | Cotton | June – July | November – December |
| 6. | Sugarcane | October-November | October-November |

Source: Census Handbook 1991

## Irrigation

The net irrigated area in Junagadh district is 195000 ha., the gross irrigated area is 220000 314000 ha area is rainfed. Bore wells(56.0% of the total irrigated area) and Open dugwells (37.4% of the total irrigated area) are the primary sources of irrigation in the district. A very small area is irrigated by canals and tanks/ponds (6.1%). As per the MI census 2000-01, there are 103607 dugwells and 6987 tubewells in Junagadh district. Irrigation potential created through these dugwells is 405541 ha and potential utilized is 340282 ha.

## Previous work

Systematic hydrogeological surveys covering the coastal areas and parts of Manavadar taluka were carried out by the Central Ground Water Board during the years 1976, 1978 to 1980 and 1985 to 1987. Reappraisal hydrogeological surveys (RHS) were carried out during 1985-86 and 1998-99. RHS with emphasis on salinity ingress in the coastal areas around Mangarol-Chorwad was carried out during the year 2001-02. Seven borewells were drilled in the coastal parts of the Junagadh district under the All India Ground Water Exploration Programme of Exploratory Tubewells Organisation (ETO) during 1958-60. In the early eighties (1980-85), Central Ground Water Board, with the assistance from United Nations Development Programme (UNDP) implemented a programme to study the feasibility of artificial recharge

in the coastal areas. During the programme, detailed hydrogeological studies were carried out, one exploratory well and ten observation wells were also constructed. 15 piezometers were constructed under Hydrology Project (CGWB) during 1998-2000. Twenty four exploratory wells ranging in depth from 189 to 500 m bgl were drilled in hard rock areas of the district under accelerated exploration programme (CGWB) during 2003-04.

## Hydrometeorolgy

The district has a semi arid climate. Extreme temperatures, erratic rainfall and high evaporation are the charactistic features of this type of climate. The average rainfall recorded in Junagadh district is 900mm. Long term mean monthly climatological parameters (IMD 1951-80) like maximum and minimum temperatures, relative humidity, wind speed and rainfall are given in Table-1 and depicted in Figure-1.

There are many rain gauge stations being monitored by different state government agencies. The Water Resources Investigation Circle (WRI) under the department of Narmada Water Resources, Govt. of Gujarat, monitors most of the rain gauges stations and also collects and compiles the rainfall data collected by different agencies.

IMD Climatological Data of Veraval station, Junagadh

| | | | | | |
|---|---|---|---|---|---|
| Station: | Veraval | | District: | Junagadh | |
| Altitude: | 8 | m AMSL | HA | 11 | **0.7370788** |
| Latitude: | 20°54' | N | Longitude: | 70 22' | E |

| Month | Max Temp (Deg.C) | Mini Temp (Deg.C) | Humidity (%) | Wind Spd. Kmpd | Sunshine (Hours) | Solar Rad. (MJ/m2/d) | Eto (mm/d) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|---|
| January | 28.8 | 14.0 | 55.5 | 242.4 | 9.70 | 18.5 | 4.8 | 0.6 |
| February | 29.7 | 15.1 | 63.5 | 258.3 | 10.30 | 21.3 | 5.2 | 1.7 |
| March | 31.5 | 18.5 | 70.0 | 291.9 | 9.90 | 23.0 | 5.8 | 0.4 |
| April | 32.0 | 21.8 | 76.0 | 318.4 | 10.50 | 25.4 | 6.0 | 0.0 |
| May | 31.8 | 25.5 | 81.0 | 337.9 | 10.30 | 25.5 | 5.8 | 1.5 |
| June | 31.6 | 27.1 | 83.5 | 447.6 | 7.40 | 21.0 | 5.1 | 159.5 |
| July | 30.1 | 26.1 | 87.0 | 560.8 | 4.00 | 15.8 | 3.9 | 300.5 |
| August | 29.2 | 25.3 | 87.5 | 465.2 | 4.30 | 16.0 | 3.7 | 182.6 |
| September | 30.3 | 24.4 | 83.5 | 311.3 | 6.20 | 18.0 | 4.2 | 97.0 |
| October | 33.3 | 22.0 | 73.5 | 226.4 | 9.40 | 20.8 | 5.2 | 26.6 |
| November | 33.1 | 19.1 | 61.5 | 205.2 | 9.70 | 18.9 | 5.0 | 6.1 |
| December | 30.4 | 15.9 | 56.5 | 217.6 | 9.50 | 17.5 | 4.6 | 1.0 |
| **Total** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **777.5** |
| **Average** | **31.0** | **21.2** | **73.3** | **323.6** | **8.4** | **20.1** | **4.9** | **119.6** |

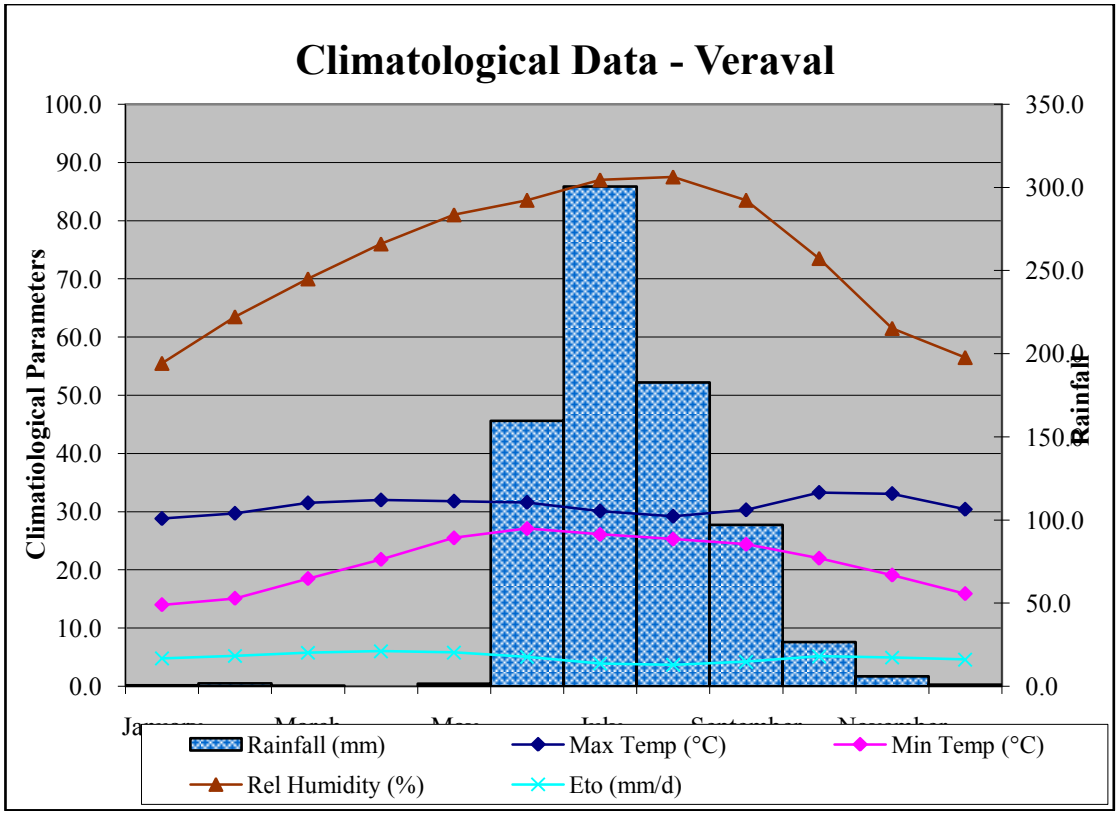



Figure- 2 Climatological Data – Junagadh IMD station

**Wind**

Light winds, mainly from southern and south-western directions blow during summer. In winter light winds blow from north-west and north-east. During monsoon however, moderate to heavy wind prevail from south and south-western directions. Mean wind speed ranges from 8 km/h during winters to more than 20 km/h during summer and monsoon.

**Potential Evapo-transpiration**

Potential Evapo-transpiration (PET) has been calculated from other climatological data using Penman method. The PET is maximum during summer months. It ranges from 4.0 mm/d during August to 6.6 mm/d during April. The average monthly PET is about 5.3 mm/d.

## Geomorphology

The inland parts of the district is made up of an undulating plain broken by hills and considerably dissected by various rivers and streams. The Girnar, a circular hill massif made up of intrusive rocks rises to impressive heights, the highest peak, i.e., Girnar-Gorkhnath peak attains a height of 1117 m amsl, which is also the highest peak in the state. Numerous dykes protruding above the basaltic surface forms linear ridges. This undulating part is fringed by coastal plains towards west and south. Physiologicall, the distric can be divided into three distinct units, viz.,

| | |
|---|---|
| (a) | Hilly terrain with dense forests |
| (b) | Undulating plains intersected by rivers and streams |
| (c) | The coastal areas |

The physiography of the coastal area can be further sub-divided into:

| | |
|---|---|
| | Coastal Plains |
| | Coastal depressions |
| | Gheds |
| | Inland depressions |
| | Coastal depressions |
| | Coastal ridges |

## Drainage

The district Junagadh is drained by a number of rivers. The principle among them is Ozat. Other important fivers include Madhuvanti, Noli, Meghal, Hiran, Saraswati, Singarva, Ingavadi, Rupen and Machhundri. The Ozar river originates near village Merwada of the Bhesan taluka. After flowing through the district for a distance of 157 km, it debauches into the Arabian sea. The important tributaries of the Ozat river are Uben, Bhandukia, Jhanjheshri, Fulsar and Lol. These rivers originate in the central plateau region of Saurashtra and meanders in a radial pattern through the plains to meet the Arabian sea. The narrowness of the river mouths and sand bars at their mouth impedes the flood water, causing inundation particularly in Ghed and in coastal depressions. When the sand bars are broken by the accumulated water in the Ghed area, tidal water enters and accumulate in the lower parts of Gheds and at places in coastal depressions.

## Geology

### General Geology

Major part of the district excepting coastal area is occupied by the deccan traps. The following sequence of rock formations is found in Junagadh district (after geological Survey of India):

| Period | **Age** | Lithology |
|---|---|---|
| Quaternary | **Holocene** | Blown sand, Soils, alluvium, Fluvio-marine deposits |
| Tertiary | Pleistocene | Miliolite Limestone |
| | Pliocene to Miocene | Gaj Beds |
| | Lower Eocene | Laterites |

| | | |
|---|---|---|
| Tertiary to Up. Mesozoic | Eocene to upper Cretaceous | Deccan Traps and associated rocks with intrusives and dykes |

## Hydrogeology

Hydrogeologically, the district area can be broadly grouped under hard rocks comprising of "Deccan Traps" and soft rocks comprising of "Tertiary and Alluvium". Nearly 80% of the area is underlain by the Deccan Traps, 19% by the Teratiaries nd the rest by Alluvium. Hydrogeological conditions in various litho-units are described below.

### Deccan Trap (Hard Rock):

These are essentially basaltic flows having a general horizontal to near horizontal disposition over large area. The basaltic flows do not have any primary porosity in the lower massive portion, but the top vesicular portion has some primary porosity because of the vesicles formed due to the escaping gases. Both the massive and vesicular portions have no primary permeability, as the vesicles are seldom interconnected. The secondary porosity and permeability developed due to fracturing and jointing provides passage for infiltration, storage and movement of ground water. The weathered zone extends to about 20m bgl in the surface flows. Weathered flow contacts extend to greater depths. The permeability of these zones are further intensified by fracturing and jointing. These inter flow zones and fractured and jointed zones have given rise to stratified aquifer systems, which is responsible for occurrence of water even at greater depths. Weathering of basalts, which extend down to 20m and the fractured basalts beneath the weathered mantle have given rise to water table aquifers down to 40m bgl. The depth of water level in the basaltic area ranges from 3.30 m bgl to 25.40 m bgl during the pre monsoon period while during the post monsoon period the water levels ranges from 0.06 to 17.50 m bgl. The yields of the wells tapping the weathered basalts are in the range of 20-100 m3/day, while the yield in wells in which the inter flow zones have been tapped range from 100-400 m3/day. The bore wells drilled in the district have yields ranging from 100-500 m3/day.

### Supratrappean and Gaj Beds

Ground water in these series occur both under confined and water table conditions. The upper granular bed of the series consist of limestone and grits form a good aquifer for shallow ground water. Dugwells and dug cum bore wells within the depth range of 20-25 m blg are constructed. The depth of the water level in the Gaj aquifer ranges from 5 to 15 m bgl during pre-monsoon. The yield of the wells ranges from 4 to 312m3/day and an average yield of 66m3/day.

**Miliolitic Limestone**

Ground water occurs under Phreatic conditions. These milliolite limestone acts as a good reservoir for shallow ground water. The depth of the water level in milliolitic limestones is generally about 5 m bgl. Open dug wells are about 10m deep. The yield of these wells range from 100-200 m3/day.

**Alluvium**

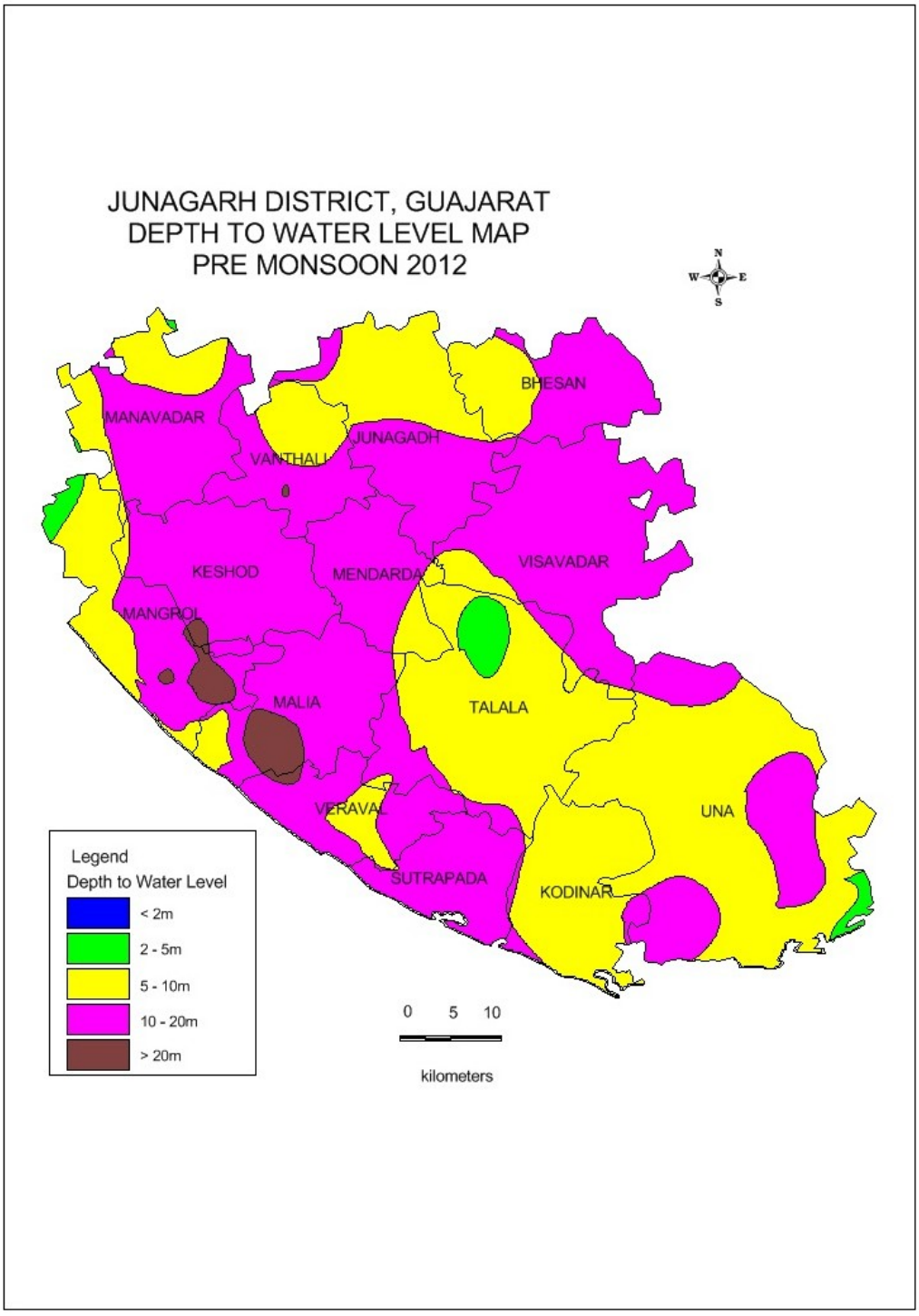
Ground water occurs under unconfined conditions. The thickness of the alluvium is not more than 20m. Because of its clayey nature, percolation of rain water is very poor resulting in poor yields. The depth of water level ranges from 2 to 10 m bgl during the pre-monsoon period. The yield of these wells hardly ecceeds 100 m3/day.

## Water Levels

### Pre-monsoon period (May 2012)

The map depicting the depth to water level (Figure 5.2) has been prepared based on water level data for May 2012 collected from NHS observation wells of CGWB.

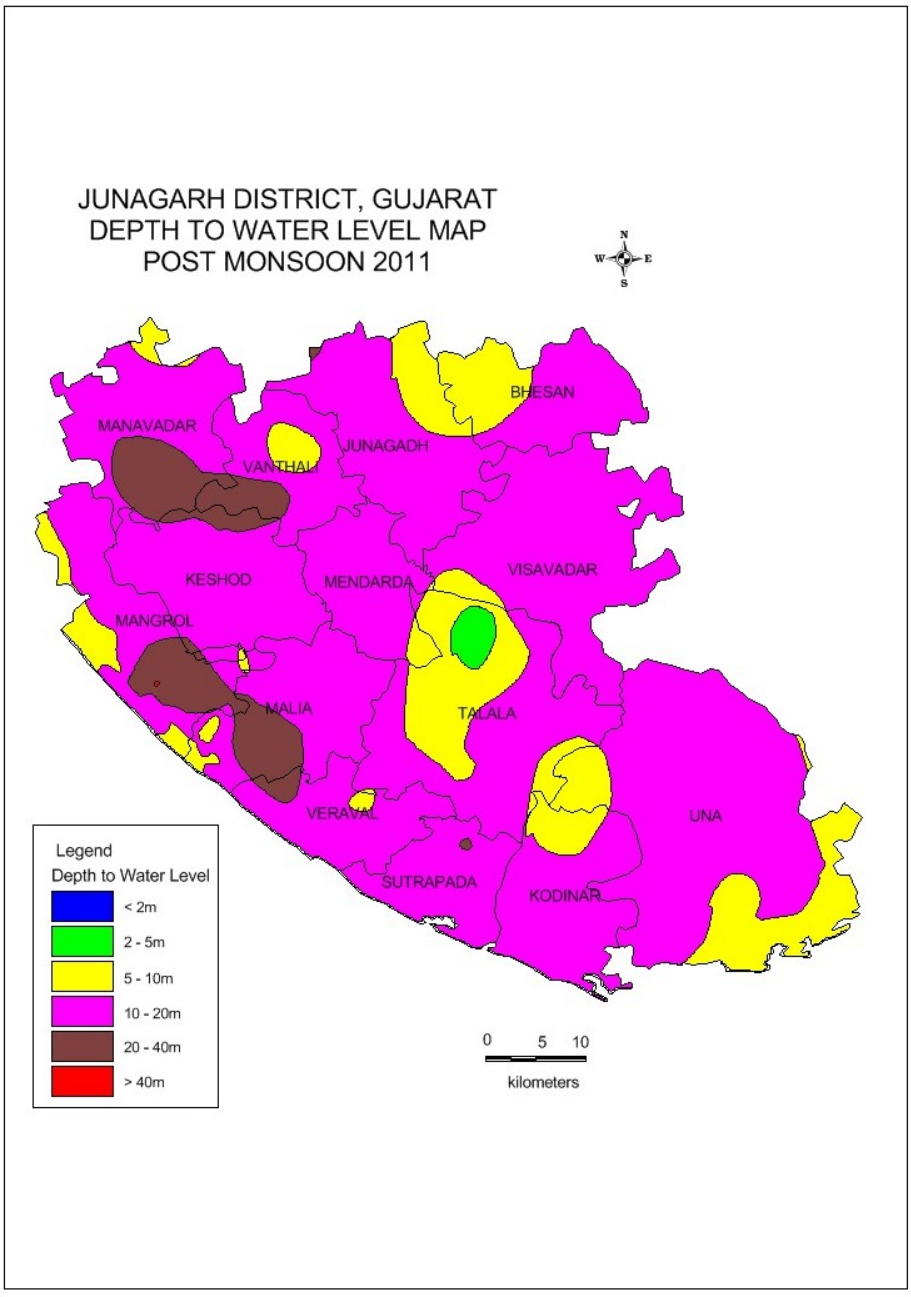
The depth to water levels in Junagadh district ranged from less than 2 mbgl to more than 20 m bgl. However the water levels in Junagadh are relatively shallow and range from 5 m bgl to 20 m bgl over most of Junagadh district. Isolated pockets of shallow wter levels were observed in the eastern extreme of Una talukas, northern parts of Talala taluka and the western extreme of Mangrol taluka. Isolated pockets of deeper water levels were observed in Mangarol and Malia talukas.




## Post-monsoon period (November 2012)

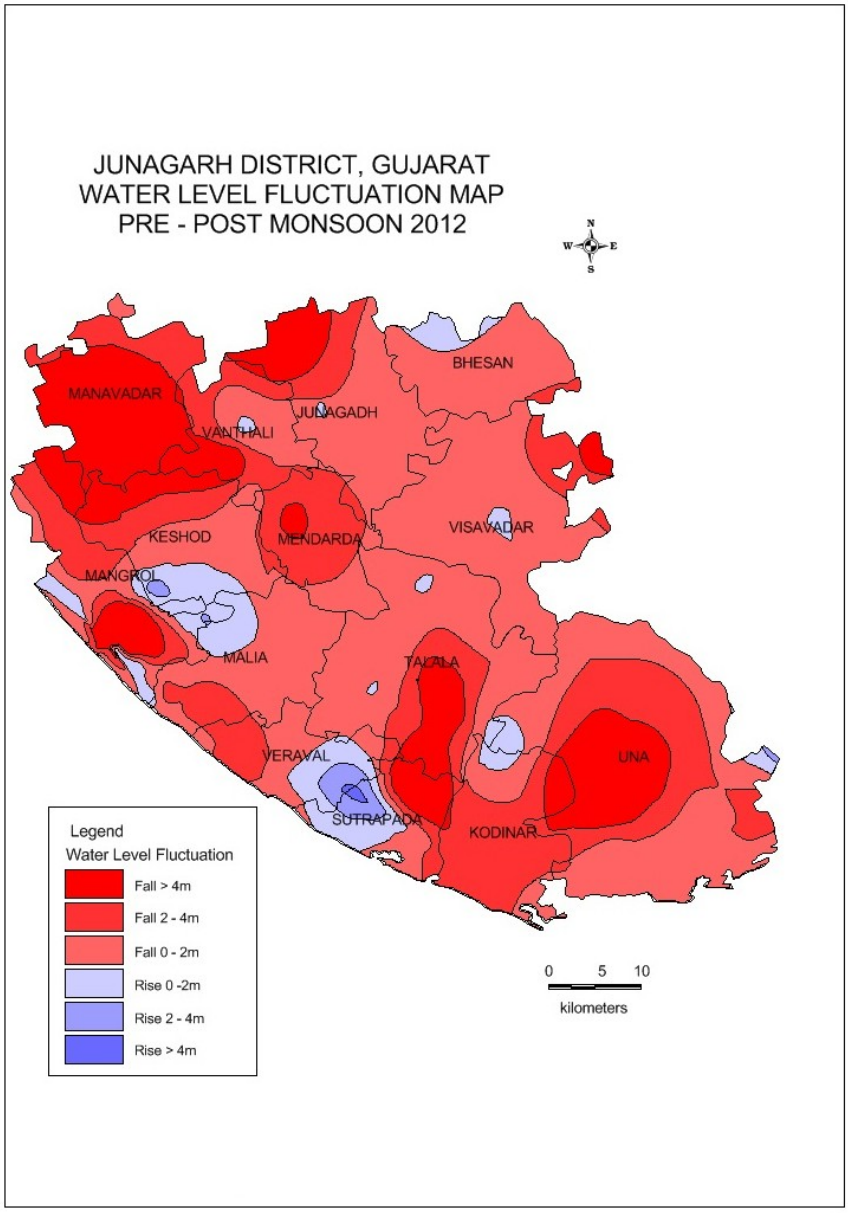
The depth to water level ranges from 10 to 20 m bgl over most of the Junagadh district during the post monsoon period. Isolated patches of water levels of 5-10 m bgl are observed in the eastern extreme of Una taluka, near the northern extreme of Kodinar taluka , northern and central part of Talala taluka, central part of Vanthali taluka and northern parts of Junagadh taluka and few other places. Deeper water levels in the range of 20-40 m bgl are observed in a patch Manavadar-

Vanthali-Keshod and Mangrol-Malia talukas.




## Rise And Fall In Water Levels

The water levels generally show a fall when compared to the premonsoon water levels. The fall in general ranges from 0 m upto >4 m. Fall in water levels of > than 4 m is seen in the central parts of Una talukas, central parts of Talala taluka, central part of Mendarda taluka, most of the Manavadar talukas and northern extreme of Junagadh taluka. Isolated patches of rise in water levels are also observed spread sporadically across the district.




## Ground water resources

The Ground Water Resources and Irrigation Potential of the district were estimated during 2011 in collaboration with the Government of Gujarat using the methodology suggested by "Ground Water Estimation Committee (GEC-97)". The ground water resources for different Talukas of the district are given in the Table 8.1 below.

## Ground Water Recharge and Ground water draft

The Total Annual Ground Water Recharge in the district is 137227.56 mcm and ranges from 3803.23 mcm (Sutrapara) to 15425.80 mcm (Una). The Total Annual Ground Water Draft in the district is 80225.40 mcm and ranges from 2426.00 mcm (Sutrapara) to 9055.30 mcm (Visavadar).

## Level of Development & Ground Water Balance

The Total Ground Water Availability for future irrigation after projecting the demand for domestic and industrial use up to 2025 in the district is 47806.79 MCM. It ranges from 1060.06 MCM (Sutrapara) to 5601.81 MCM (Una). The overall category of the district is also "Safe". The Stage of ground Water development in the district ranges from 55.51% (Mendarda) to 67.22% (Vanthali). All talukas in the Junagadh district are of "Safe" category.

Ground Water Resources As on 2011 (in mcm)

| S. No. | Taluka | Total Annual Ground water Recharge | Annual Ground Water Draft | | | Projected Demand for Dom. & Ind. Use up to 2025 | Ground Water Availability for future Irr. |
|---|---|---|---|---|---|---|---|
| | | | Irrigation | Dom. & Ind. | Total Draft | | |
| | Bhesan | 8031.53 | 4093.60 | 224.00 | 4317.60 | 301.00 | 3235.35 |
| | Junagadh | 12153.70 | 5819.20 | 720.00 | 6539.20 | 966.00 | 4760.81 |
| | Keshod | 11818.05 | 6265.20 | 534.00 | 6799.20 | 716.00 | 4245.95 |
| | Kodinar | 12347.40 | 6824.50 | 600.00 | 7424.50 | 804.00 | 4101.53 |
| | Maliya | 9399.05 | 4989.90 | 439.00 | 5428.90 | 588.00 | 3351.20 |
| | Manavadar | 8539.01 | 4834.40 | 386.00 | 5220.40 | 517.00 | 2760.66 |
| | Mangrol | 5652.34 | 2538.20 | 572.00 | 3110.20 | 767.00 | 2064.53 |
| | Mendarda | 8670.41 | 4373.20 | 199.00 | 4572.20 | 268.00 | 3595.69 |
| | Sutrapafa | 3803.23 | 2056.00 | 370.00 | 2426.00 | 497.00 | 1060.06 |
| | Talala | 11634.40 | 6645.70 | 386.00 | 7031.70 | 518.00 | 3888.98 |
| | Una | 15425.80 | 7720.70 | 1001.00 | 8721.70 | 1332.00 | 5601.81 |
| | Vanthali | 8045.11 | 4842.80 | 295.00 | 5137.80 | 395.00 | 2405.06 |
| | Veraval | 7005.31 | 3698.70 | 742.00 | 4440.70 | 995.00 | 1961.35 |
| | Visavadar | 14702.21 | 8654.30 | 401.00 | 9055.30 | 539.00 | 4773.80 |
| | | **137227.56** | **73356.40** | **6869.00** | **80225.40** | **9203.00** | **47806.79** |

Ground Water Resources And Development

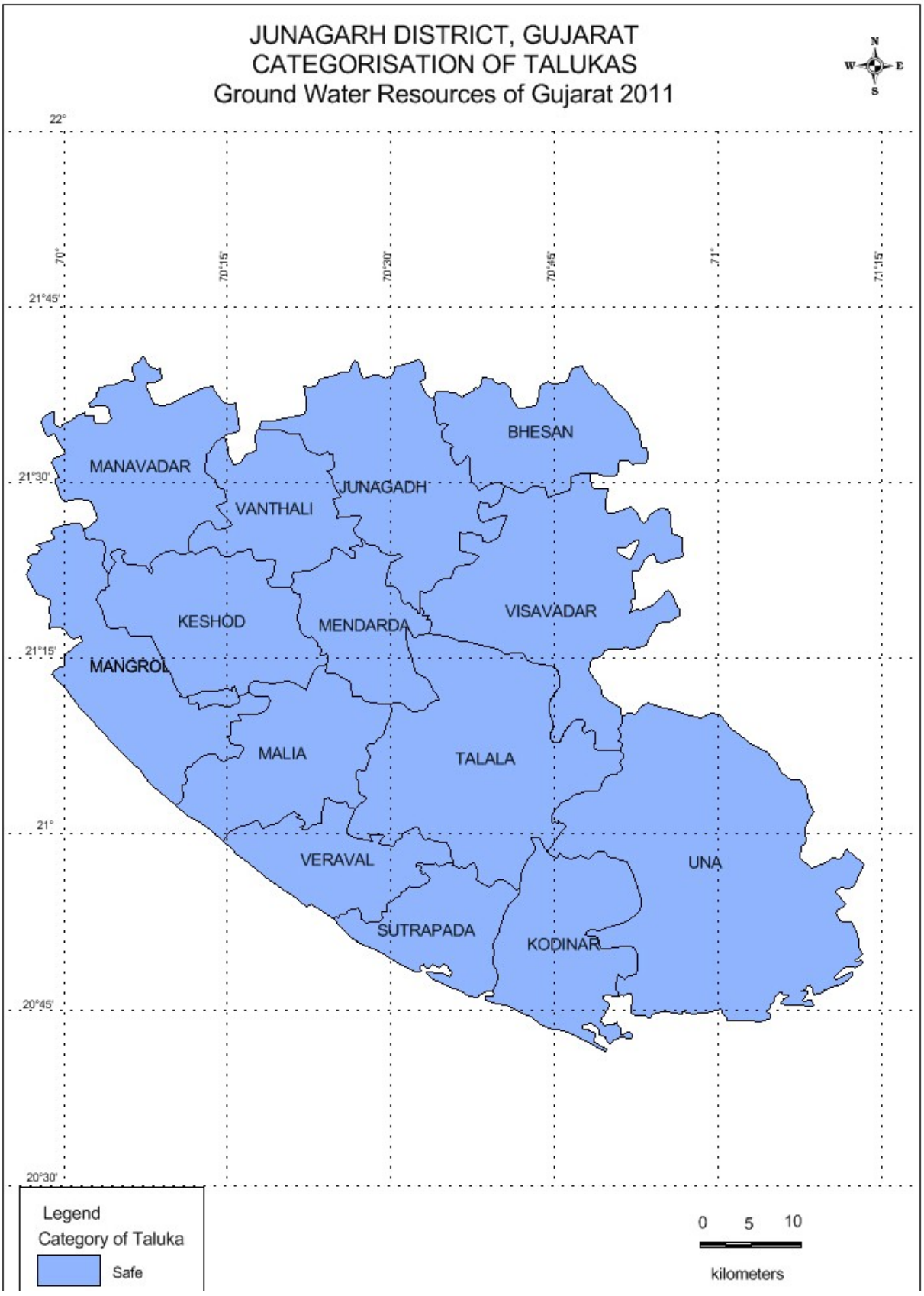
| S. No. | Taluka | Level of Ground Water Development (%) | Category |
|---|---|---|---|
| 1. | Bhesan | 56.59 | Safe |
| 2. | Junagadh | 56.64 | Safe |
| 3. | Keshod | 60.56 | Safe |
| 4. | Kodinar | 63.29 | Safe |

| | | | |
|---|---|---|---|
| 5. | Maliya | 60.80 | Safe |
| 6. | Manavadar | 64.35 | Safe |
| 7. | Mangrol | 57.92 | Safe |
| 8. | Mendarda | 55.51 | Safe |
| 9. | Sutrapafa | 67.15 | Safe |
| 10. | Talala | 63.62 | Safe |
| 11. | Una | 59.52 | Safe |
| 12. | Vanthali | 67.22 | Safe |
| 13. | Veraval | 66.73 | Safe |
| 14. | Visavadar | 64.83 | Safe |
| | Total | **61.54** | **Safe** |

# Hydrochemistry

## Quality of Shallow Ground Water

The quality of ground water in the shallow aquifer has been studied based on the chemical analysis of water samples collected from NHS during May 2012. The statistical analysis of the chemical data is presented in Table 9.1.


JUNAGARH DISTRICT, GUJARAT
CATEGORISATION OF TALUKAS
Ground Water Resources of Gujarat 2011
N
W
E
S
22°
70°
70°15'
70°30'
70°45'
71°
71°15'
21°45'
21°30'
21°15'
21°
20°45'
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BHESAN
MANAVADAR
JUNAGADH
VANTHALI
KESHOD
MENDARDA
VISAVADAR
MANGROL
MALIA
TALALA
VERAVAL
UNA
SUTRAPADA
KODINAR
Legend
Category of Taluka
Safe
0 5 10
kilometers

Table 9.1 Statistical Analysis of Chemical Constituents (Shallow Aquifer) May 1012

| Constituents | Minimum | Maximum | Average |
|---|---|---|---|
| pH | 7.09 | 8.8 | 7.70 |
| EC (uS/cm) | 624.00 | 9980 | 3103.18 |
| TDS (mg/l) | 418.08 | 6687 | 2079.13 |
| CO3 (mg/l) | 0.00 | 80 | 2.05 |
| HCO3 (mg/l) | 110.00 | 622 | 305.64 |
| Cl (mg/l) | 35.00 | 3191 | 780.64 |
| NO3 (mg/l) | 3.00 | 200 | 58.54 |
| SO4 (mg/l) | 5.74 | 720 | 176.81 |
| F (mg/l) | 0.07 | 1.40 | 0.62 |
| Alkalinity (mg/l) | 90.16 | 510 | 253.94 |
| Ca (mg/l) | 28.00 | 920 | 244.51 |
| Mg (mg/l) | 24.00 | 480 | 101.08 |
| TH (mg/l) | 280.00 | 4150 | 1068.46 |
| Na (mg/l) | 30.00 | 991 | 244.03 |
| K (mg/l) | 0.30 | 66.0 | 10.24 |
| Fe (mg/l) | 0.00 | 3.8 | 0.31 |

It is noticed that the ground water is relatively more saline in southern (Coastal) part comprising alluvium and soft rocks. Occurrence of different chemical constituents in ground water is discussed below:

**Total Dissolved Solid (TDS )**

Total Dissolved Solid is an overall parameter indicating salinity of ground water. The Total Dissolved Solid of ground water varies from 418.08 mg/l (Girgadhara) to about 6687 mg/l (Lohej).

**Hydrogen Ion Concentration (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 7.09 & 8.80 in the district.

**Carbonate (CO3) and Bicarbonate (HCO3)**

The shallow ground water in Junagadh district normally does not contain any Carbonate (except for one sample). The Bicarbonate concentration in district varied between 110 mg/l at Vanthali and 622 mg/l at Bamanwara.

**Chloride (Cl)**

Chloride concentration in the shallow alluvial aquifer varies between 35 mg/l (Sametar) and 3191 mg/l (Lohej). Samples from 11 monitoring stations show Chloride concentration more than 1000 mg/l which is beyond maximum desirable limit of 1000 mg/l as per BIS norms.

**Nitrate (NO3)**

Nitrate concentration in the ground water in district varies between 3

mg/l (Talala) and 200 mg/l (Mendarda). There are thirteen stations where these values are more than the limits as per BIS drinking water standards (45 mg/l).

**Sulphate (SO4)**
In the district area, the sulphate concentration varies from 5.74 mg/l (Porbandar) to 720 mg/l (Miyani).

**Fluoride (F)**
Fluoride concentration in ground water varies between almost 0.07 at Kanek and 1.4 mg/l at Mendarda. High concentration of fluoride exceeding maximum desirable limit of 1(mg/l) is found at Khokharda (1.04), Kodinar (1.25), Mendarda (1.40), Moraj (1.03) and Prempara (1.10).

**Calcium (Ca)**
Calcium concentration in district varies between 28 mg/l (Khokharda) and 920 mg/l (Antroli). The concentration of calcium is more than maximum permissible limits of 200 mg/l (as per BIS norms) at eleven stations.

**Magnesium (Mg)**
The Concentration of Magnesium in areas ranges from 24 mg/l (Mangrol) to 480 mg/l (Kalej). The concentration of magnesium is more than maximum permissible limits of 100 mg/l (as per BIS norms) is recorded at ten stations.

**Sodium (Na)**
Sodium concentration in area varies between 30 mg/l (Ajotha) and 991 mg/l (Sepa).

**Potassium (K)**
The concentration of Potassium in shallow ground water ranges from 0.30 mg/l to 66.0 mg/l (Bamanwara).

**Iron (Fe)**
The Iron concentration in the shallow ground water in the district is generally low, ranging between 0.00 to about 3.8 mg/l which is within the permissible limit.

**Total Hardness as CaCO3 (TH)**
Total Hardness in ground water in the district range between 280 mg/l (Girgadhara) and 4150 mg/l (Kalej). At places especially along the coast a very hard ground water is observed. The total hardness more than maximum permissible limits of 600 mg/l (as per BIS norms) is recorded at seventeen stations.

# Ground water management strategy

## Ground Water Development

The ground water development in Junagadh district is through dug wells, dug-cum-bore wells, borewells and tubewells. The district can be broadly divided into two distinct untis: The major part of the district is covered by hard rock region of Deccan Traps. The development prospects in this region is through dug wells and bore wells. The yield ranges from 80-150 lpm in dugwells and 60-300 lpm in borewells. Figure – 6 shows the possible development regions. The other soft rock formation in the district has limited resources. The discharge i these fornations ranges from 200-300 lpm i the dug well zone and 200-400 lpm in the tube well zones. Analysis of the hydrographs of the pre and post-monsoon and annual and long term trends reveals that the ground water levels reaches to near surface after the monsoons. With this pattern absorbed in major portion of the hard rock regions of the district the further discharge can be carried out during lean period this drawdown/ withdrawal created will be recharged in subsequent rainfall. The areas along the coast has salinity problems with depth only the shallow aquifer is potable.

### Water Conservation and Artificial Recharge

The suitable recharge structures feasible in the district are Percolation tanks/ ponds, Check dams, nalla bunds and gully plugs etc depending on the terrain conditions.

Deccan traps the major aquifer of the district has low to moderate permeability. The moderate permeability allows sufficient infiltration into the ground water reservoir and at the same time allows retention of the water to be stored. Various rainwater harvesting schemes depending of the suitable hydrogeological conditions have been constructed in the district viz check dams, nalla plugs. Deepening the village tank etc have shown good inpact of the recharge structures on the ground water in the district.

# Ground water related issues and problems

1. Aqareness among the people regarding reinwater harvesting and artificial recharge is required
2. Declining groundwater levels
3. Salinity in ground water in the district
4. Fluoride problems in the ground water in the district
5. Unscientific well construction
6. Uniformity in pumping pattern is required
7. Unawareness of the aquifer system
8. Ground water contamination due to inproper well construction
9. Coastal salinity and sea water ingression
10. Demand supply management

**Awareness and Training Activity**

Two mass aqareness programme has been conducted by CGWB at Gadu in 2003 and at Ambuja Cement Foundation, Kodinar in the Junagadh district. Different officers from the various Nagar Palikas of the district attended the programme

One training programme has been organised by CGWB in the Agriculture University, Junagadh

**Area notified by CGWA/SGWA**

Mangrol talukas has been notified by the state GWA

## Recommendations

There is an urgent need for management of resources for sustainable development

Deeper aquifers should be protected and reserved for drinking water supply needs only

Creating aqareness amongst the farmers regarding water consetvation through judicious use of water and adoption of efficient irrigation techniques like drip/sprinkler irrigation

The land holding of the group of farmenrs under public tubewell irrigation should be brought under the provision of the change in crops, irrigation practices and installation of drip/sprinkler irrigation techniques. Soft loan institutional fincances to the farmers and liberal subsidies in equipment are suggested

Planned pumping pattern can be deployed in hard rock regions so that further discharge/withdrawal can be carried out during lean period this drawdown/withdrawal created will be recharged in subsequent rainfall

Planned groundwater pumping pattern to be emphasised

Awareness of the people on aquifer system

Planned pumping pattern in coastal regions. Deterioration of the ground water quality due to sea water inundation/ sea water ingress can be checked by construction of tidal regulators with gates.

Resorting to artificial recharge practices by diverting surplus runoff during monsoon into ponds, percolation tanks, spreading basions abandoned dugwells etc

Taking up artificial reaharge on large scale through appropriated techniques on a regiona scale with active community participation