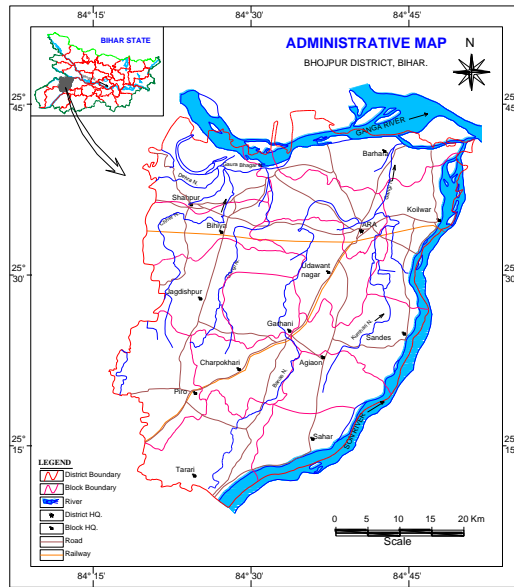




भूजल सूचना पुस्तिका

भोजपुर जिला, बिहार

Ground Water Information Booklet Bhojpur District, Bihar State



केन्द्रीय भूमिजल बोर्ड
जल संसाधन मंत्रालय
(भारत सरकार)
मध्य-पूर्वी क्षेत्र
पटना

Central Ground water Board
Ministry of Water Resources
(Govt. of India)
Mid-Eastern Region
Patna

सितंबर 2013
September 2013

| | | |
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GROUNDWATER INFORMATION BOOKLET

BHOJPUR DISTRICT

DISTRICT AT A GLANCE

| Sl. No. | | Statistics |
|---------|--|--|
| 1. | GENERAL INFORMATION | |
| | I. Geographical Area (Sq. Km.) | 2395 |
| | Administrative Divisions | Ara sadar Jagdishpur Piro |
| | II. Population (As per 2011 Census) | Rural: 2331450 Urban: 388705 |
| | III. Average Annual Rainfall (mm) | 1080 |
| 2 | GEOMORPHOLOGY | |
| | Major Physiographic Units | 1. Younger Alluvium with Newer Flood Plains 2. Older Alluvium with Older Flood Plains |
| | Major Drainages | Ganga, Dharmawati, Gaura Bhagar, Gangi Nadi |
| 3 | LAND USE | |
| | a) Forest Area | Nil |
| | b) Net Area Sown | 1820 sq. km (DoSE, Bihar, 1998-99) |
| | c) Cultivable Area | 1870 sq. km (DoSE, Bihar, 1998-99) |
| 4 | MAJOR SOIL TYPES | Sandy loam, Loam, Clayey loam |
| 5 | AREA UNDER PRINCIPAL CROPS | |
| 6 | IRRIGATION BY DIFFERENT SOURCES (Areas and Number of Structures) | |
| | Dugwells | 2323 (1993-94 MI Census) |
| | Tubewells/Borewells | 14481 (1993-94 MI Census) |
| | Tanks/ponds | Nil |
| | Canals | 740 sq. km (DoSE, Bihar, 1998-99), 6 nos. |
| | Other Sources | 470 sq. km (DoSE, Bihar, 1998-99) |
| | Net Irrigated Area | 1480 sq.km (DoSE, Bihar, 1998-99) |
| | Gross Irrigated Area | 1750 sq.km (DoSE, Bihar, 1998-99) |
| 7 | NUMBER OF GROUND WATER MONITERING WELLS OF cgwb (2011) | |
| | No. of Dugwells | 08 |
| | No. of Piezometers | Nil |
| 8 | PREDOMINANT GEOLOGICAL FORMATIONS | Alluvium (younger & older), Vindhyan hard rocks |
| 9 | HYDROGEOLOGY | |
| | Major water bearing formations | Alluvium |
| | Pre-monsoon Depth to water level during 2011 | 5.35 – 8.2 m bgl |
| | Post-monsoon Depth to water level during 2011 | 1.6 – 8.2 m bgl |
| | Long term water level trend in last 10 yrs(2001 –2011) in m/yr | No Significant Decline |
| 10 | GROUND WATER EXPLORATION BY CGWB (As on 31-03-2013) | |
| | No. of well drilled (EW,OW, PZ, SH, Total) | EW=7, PZ=13, Total=21 |
| | Depth Range (m) | 35 – 300 m bgl |
| | Discharge (m/s) | 150 – 200 m ³ /hr |
| | Storativity (s) | 0.067 x 10 ⁻⁴ |
| | Transmissivity (m ² /day) | 4769 – 15886 m ² /day |

| | | | |
|-----------|---|--------|---|
| 11 | GROUND WATER QUALITY | | Arsenic in Shallow Aquifers in younger Alluvial in parts of the district. |
| | Presence of Chemical constituents more than the permissible limit (e.g.EC, F, As, F) Type of Water | | |
| 12 | DYNAMIC GROUND WATER RESOURCES (2009) IN mcm | | |
| | Annual Replenishible Ground Water Resources | 752.85 | |
| | Net Annual Ground Water Draft | 317.56 | |
| | Projected Demand for Domestic and Industrial Uses up to 2025 | 63.08 | |
| | Stage of Ground Water Development | 44.2 % | |
| 13 | AWARENESS AND TRAINING ACTIVITY | | Mass awareness programme organized at Shahpur block campus. No. of participants was 350. |
| 14 | EFFORTS OF ARTIFICIAL RECHARGE AND RAINWATER HARVESTING | | |
| | Projects Completed By CGWB (No. Amount Spent) | Nil | |
| | Projects Under Technical Guidance of CGWB (Numbers) | Nil | |
| 15 | GROUND WATER CONTROL AND REGULATION | | |
| | No. of OE Blocks | Nil | |
| | No. of Critical Blocks | Nil | |
| | No. of Blocks Notified | Nil | |
| 16 | MAJOR GROUND WATER PROBLEMS AND ISSUES | | Arsenic contamination of ground water in the blocks adjoining to river Ganga; Shahpur, Behea, Barhara, Ara and Koilwar. |
| | Note: Latest available data may be incorporated | | |

1.0 INTRODUCTION

1.1 Location, Area and Administrative Details

Bhojpur district is one of the thirty-eight districts of Bihar state and its administrative headquarters are located in Ara town. It is a part of Patna division. Prior to 1972 the district of Rohtas was part of Bhojpur. In 1972 it (Rohtas) was bifurcated and declared as a new district. The district is known for its rich language - Bhojpuri. It played a major role in India's struggle for independence. Veer Kunwar Singh of Jagdishpur was the leader of the mutineers during the first war of independence in 1857, called the Sepoy Mutiny by the British. The fighting was so severe that two of the five Victoria Crosses ever awarded to civilians by the British were awarded during this battle.

Bhojpur district (Plate I) falls within $25^{\circ} 00''$ to $25^{\circ} 30''$ N and $84^{\circ} 15''$ to $84^{\circ} 45''$ E, the area is bounded by the river Son in the east, Dharmawati-Gangi rivers in the west, Vindhyan hills in the south and the river Ganga in the north (Figure 1). The district is spread over a total geographical area of 3395 sq km. Total population of the district stands at 2720155 with the urban and rural populations of 2331450 and 388705 respectively (census 2011). The decadal population growth of the district is calculated to be 477011 (2001-2011). The district has three Sub Divisions namely Ara Sadar, Jagdishpur and Piro. The blocks of the district include Ara Sadar, Udwantnagar, Jagdishpur, Koilwar, Sahar, Barhara, Sandesh, Shahpur, Charpokhari, Piro, Tarari, Bihia, Agiawon and Garhani.

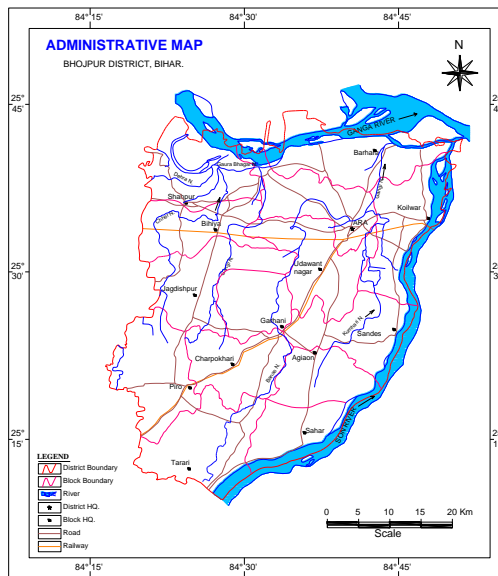


Figure 1: Administrative map of Bhojpur district, Bihar with block boundaries road (rail) networks.

1.2 Basin/Sub-Basin and Drainage

The district is located in the Ganga basin in its central parts and the river Ganga forms the northern boundary of the district. The river Sone is the other major drainage flowing at the eastern boundary of the district (Figure 2). It originates from the Maikals range of Amarkantak high lands in the elevated plateau of central India. After flowing northerly and easterly directions for about 592 km in a hilly terrain, it debouches onto the Gangetic alluvial plains. The river flows in northeast direction in a NE-SW trend and confluences with Ganga in the northeast corner of the Bhojpur district at Babura.

The Dharmawati Nadi, also known as Dehra Nadi, meets Gaura Bhagar, which is supposed to be an oxbow left over portion of meandered Ganga, and this finally meets Ganga near Tribhubani. The Gangi Nadi originates near Nagraon and extends North West after having several meanders to meet Gaura Bhagar which finally meets Ganga.

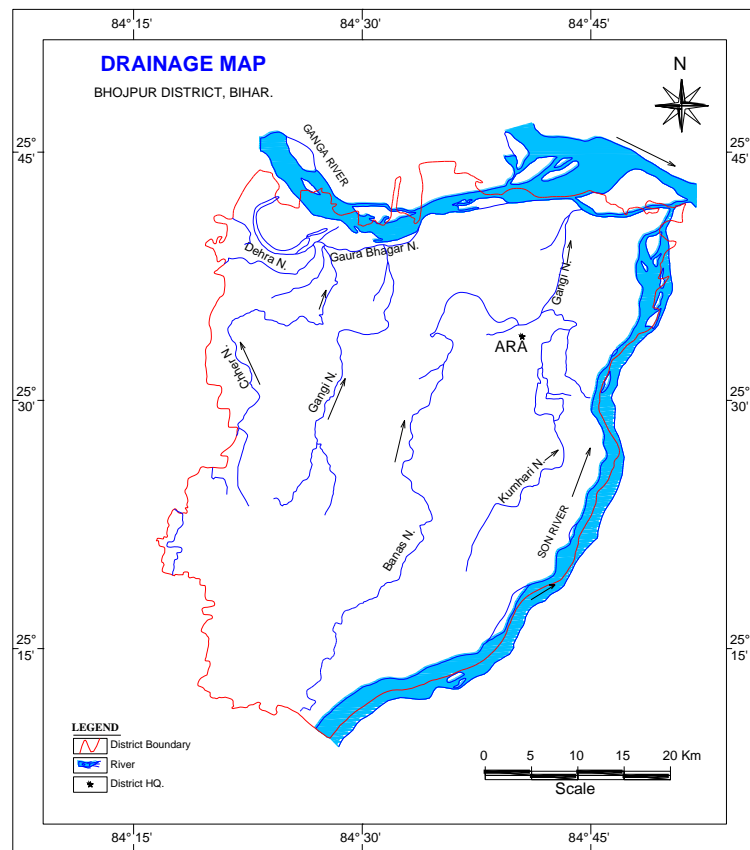


Figure 2: Drainage map of Bhojpur district, Bihar.

1.3 Landuse, Agriculture and Irrigation Practices

As per the record of Directorate of Statistics & Evaluation, Bihar, the net and gross area cropped in the district of Bhojpur are 1910 sq km and 2200 sq km respectively. It has no forest

cover. The other fallow land and the current fallow land are 30 sq km and 100 sq km respectively. The district has 10 sq km as cultivable waste land.

Agriculture is the main livelihood of more than 80% population in the district. The agriculture calendar starts from July and continues up to June of the succeeding year, before the onset of the monsoon every year. Thus a calendar year is divided into four agricultural seasons, viz., Bhadai, Aghani, Rabi and Garma as given below:

Table 1 Agricultural Seasons in Bhojpur, Bihar

| Kharif | | Rabi | |
|-------------------------|-------------------|---|--|
| Bhadai (April-Aug/Sept) | Aghani (June-Oct) | Rabi (Nov-March/Apr) | Garma (March-Apr/June) |
| Paddy, maize | Paddy, pulses | Wheat, pulses, maize, spices and oilseeds | Paddy, maize, pulses, vegetables, millet |

The district is provided with a well-developed unlined canal network (Sone canal command area) in the form of surface water availability together with readily and easily available ground water within shallow depth. The flood zone of Barhara, Shahpur and Koilwar is well cropped with Rabi crop only.

The area with good perennial irrigation provisions are dominated with paddy crops as given below:

Table 2 Cropped area in different sub- divisions of Bhojpur, Bihar

| Sl no. | Block | Gross cropped area (ha) | Percentage of paddy to gross cropped area |
|--------|------------|-------------------------|---|
| 1 | Ara sadar | 30931 | 68 |
| 2 | Pirro | 40315 | 52 |
| 3 | Jagdishpur | 44099 | 37 |

As per the data of Directorate of Statistics & Evaluation, Bihar the gross area irrigated by canals, tube wells and other sources stands at 840 sq km, 350 sq km and 560 sq km respectively. The net areas irrigated by the same sources are 740, 280 and 470 sq km respectively. This indicates that the irrigation through tube wells constitute about 20% and 18.8% of the gross and net area irrigated in the district.

1.4 Studies/Activities carried by CGWB

In Bihar, Bhojpur is the first district in which arsenic was found to be present in ground water (shallow tube wells) beyond permissible limit. Afterwards CGWB has undertaken intensive exploration drilling programme in the district in order to delineate aquifer wise arsenic concentration and arsenic free water zones for community water supply purpose. A total of seven tube wells have been constructed at highly arsenic contaminated areas of Paharpur, Bariswan, Behea, Bharauli, Nargada Narayanpur, Karnamepur and Shahpur (Plate IV) of the district Bhojpur. These areas fall in the vicinity of the river Ganga in its Newer Alluvium zone. Besides these, water samples are being collected from hand pumps (shallow tube wells) and dug wells at regular intervals in order to assess the development of arsenic in a response to the water table fluctuation. Water levels from some particular dug wells, known as Hydrograph Network Stations, are being taken four times in a year. These data reflect any change in ground water regime in the dug wells in a response to the monsoonal pattern (shallow aquifer) and are used to estimate the ground water resource available in the district for irrigation, drinking and industrial purposes.

2.0 CLIMATE AND RAINFALL

Warm and humid climate prevails in the district. The temperature touches 39⁰C on an average during the months of April and May, and that of the minimum 6.3⁰C during the month of January.

The monsoon starts mostly from the mid of June and continues up to the end of the September. From seventy years (1901- 1970) annual rainfall data it has been observed that the normal rainfall of the district is at 1080 mm/yr. The annual rainfall of the district varies within 1025.2 to 1106.2 mm. About 85.46 % of the total annual rainfall is received during monsoon period and the rest (only 14.54 % approximately) comes in the months of November to May of non-monsoon period.

3.0 GEOMORPHOLOGY AND SOIL

3.1 Geomorphology

Bhojpur district is mainly covered with alluvium (Plate IV) and hard rocks of Vindhyan Supergroup are situated at the southwestern side beyond the district boundary. The north and northeast parts of the district are covered with Newer Alluvium and younger flood plains (diara formations) while the central and southern parts are covered with Older Alluvium and older flood plains. The entire area of the district has a general slope towards the north and northeast. The general

elevation with respect to mean sea level is 50-90 m. The gradient is 0.6 m/km approximately from south to north.

The north and northeast area of the district is pitted with oxbow lakes, meander scars with point bars left over by old Ganga channels. The local small rivers follow little yazoo pattern before entering the meander belt of river Ganga and flow few kilometers parallel to the southern levee of river Ganga.

3.2 Soil

The district in general possesses alluvium soil. The soils are of poorly drained type. The area adjoining the rivers Ganga, Sone, Dharmawati, and Gangi consists of sandy loam, loamy sand and sand, whereas, the area away from the river channels consist of silty sand to sandy silt. The soils in general are fine textured away from the river course and rivulets and coarse textured along their courses. The soils of coarse textured have got mixed with silt and fine sand due to the mixing of canal water being used perennially for irrigation.

4.0 GROUND WATER SCENARIO

4.1 Water Bearing Formations

The district Bhojpur is occupied by Quaternary Alluvium (Figure 3), which makes the potential aquifers. Beyond the major clay zone (within 100 – 130 m bgl) up to 250 – 300 m bgl, a total of 100 – 120 m thick aquifer with fining upward character from very coarse sand to fine to medium sand is found along the northern part of the district. Above the major clay zone (100 – 130 m bgl) are found medium to coarse sand zones up to an average depth of 30 m bgl. From 0 to 30 m bgl are found clay, silty clay, sandy clay zones with occasional fine sand layers, which sustain the dug wells in the area. In the southern parts of the district away from present river courses, which have remained unexplored, the thickness of above potential aquifers is expected to be decreasing and the sand/clay ratio would be also decreasing.

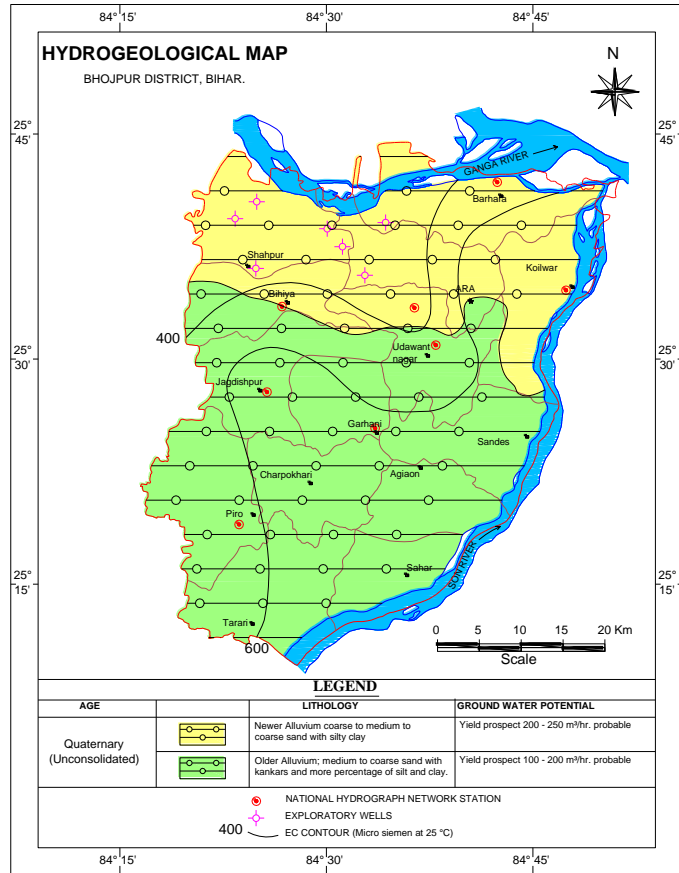


Figure 3: Hydrogeological map of Bhojpur district, Bihar showing Newer and Older Alluvium (Quaternary) with their yield potential. Electrical conductivity of groundwater has been represented by contours.

4.2 Occurrence & Movement of Ground Water

The top layer (within 30 m bgl) is an aquitard, which is mixed with high percentage of sand, silt and kankars. It supports dug wells and shallow hand pumps. In fact it works as an unconfined aquifer. The deeper aquifers are under either semi-confined or confined condition.

The results of exploration indicate that the Transmissivity varies from 4749 m²/day to 15886 m²/day while the Storativity varies within 0.067 to 0.4x10⁻⁴. The discharge varies within 150 to 200 m³/hr with draw down within 3 – 10 m.

4.3 Depth to Water Level

In pre-monsoon 2011 (Figure 4) water level data of the area is ranges between 5.35 to 8.20 m bgl. In post-monsoon period (Figure 5) water level data of the year 2011, ranges between 1.6 to 8.2 mbgl.

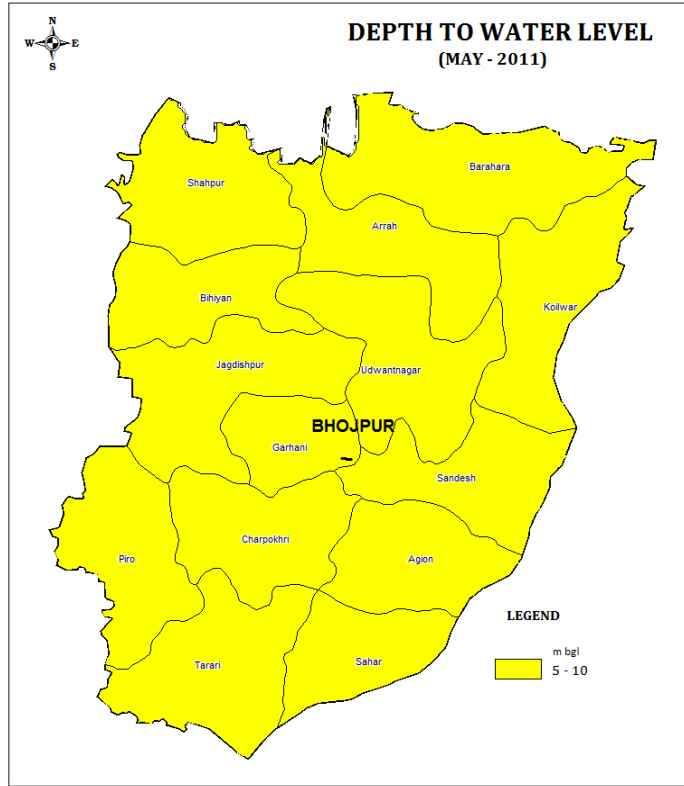


Figure 4: Depth to water level map of Pre- monsoon 2011..

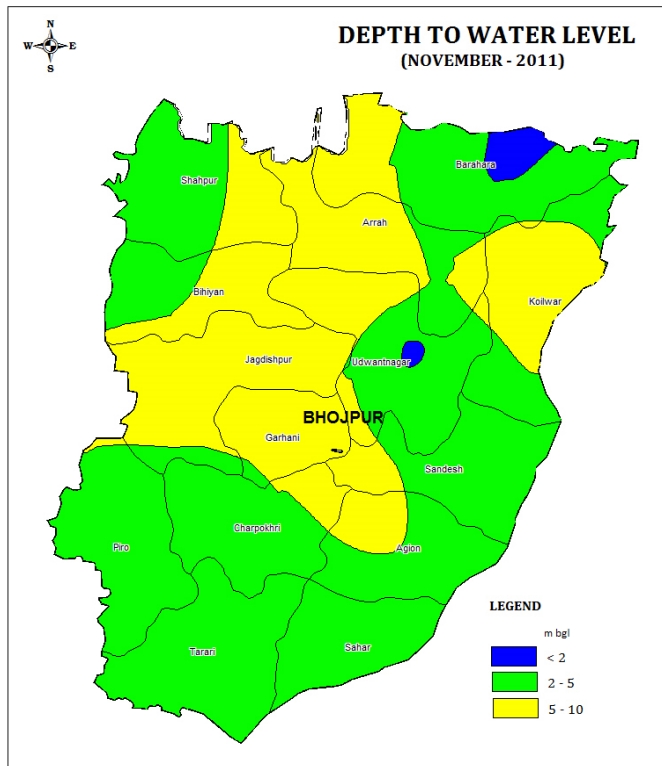


Figure 5: Depth to water level map of Post- monsoon 2011.

4.4 Ground Water Quality

The ground water in the area is suitable for drinking and irrigation purposes except at some places with high magnesium and salinity hazards. The ground water in the blocks of Shahpur, Behea, Koilwar and Ara in the district, adjoining to the river course of Ganga has been reported to be contaminated with unusual concentration of Arsenic. The Central Ground Water Board has taken up special exploratory programme to decipher the extent and range of arsenic contamination in deeper aquifers and the organization is finding out ways to get fresh and arsenic free water in the highly polluted areas.

The general quality of ground water and the distribution of different chemical constituents are given in the following table, which were obtained by chemical analysis of water samples collected from the district.

Table 3 Ground water quality in Bhojpur district, Bihar (refer figure 3 for EC contours).

| Chemical constituents (mg/l) | Deeper Aquifer | Shallow Aquifer | Drinking Water Standard (As per BIS norms) | |
|--|----------------|-----------------|--|------------------------|
| | | | Highest Desirable | Maximum Permissible |
| pH | | 7.1 – 8.2 | 6.5 – 8.5 | No relaxation |
| E.C (Micro-siemens/cm at 25 ⁰ C | 160 - 660 | 198 – 2000 | 500 | 2000 |
| Total Hardness (CaCO ₃) | 130 - 180 | 280 – 380 | 300 | 600 |
| Bicarbonate | 134 - 195 | 10.5 - 586 | 200 | 600 |
| Calcium | 16 - 32 | 3.7 – 42.5 | 75 | 200 |
| Magnesium | 12 - 24 | 19 - 73 | 30 | 100 |
| Chloride | 15 - 25 | 4.7 - 869 | 250 | 1000 |
| Sulphate | 00 - 28 | < 1 - 250 | 200 | Up to 400 if Mg is <30 |
| Nitrate | - | < 1 - 50 | 45 | 100 |
| Fluoride | - | 0.18 – 0.64 | 0.6 – 1.2 | 1.5 |
| Iron | < 1 - 250 | < 0.01 – 0.38 | 0.30 | 1.0 |
| Sodium | - | 21 – 262 | - | |
| Potassium | - | 1.2 – 4.9 | 1.90 - 50 | |

4.4.1 Arsenic in Ground Water

Bhojpur is one of the districts in the state of Bihar, which are affected by arsenic contamination in ground water. This is the district in which arsenic in ground water was first

reported in June 2002 in the village of Semaria Ojhapatti in the state of Bihar. Shahpur, Ara, Behea, Koilwar, and Barhara are among the blocks in the district, which are affected by arsenic (refer figure 5 for arsenic contaminated areas). PHED, Govt of Bihar has conducted a blanket testing for arsenic in the state. The hand pumps where arsenic concentration was found to be more than 50 mg/L (the maximum permissible limit of arsenic in ground water as per WHO norm) during blanket testing were marked with red paint. Arsenic occurs sporadically in hand pumps and it largely depends on the depth of the hand pump and from which formation it taps water. A sudden surge in arsenic concentration in the tube wells is found between the depth range of 12 and 40 m. After 40 m there is a drastic decline in arsenic concentration. In dug wells arsenic concentration is reported as below detection limit (BDL). Central Ground Water Board, MER, Patna has constructed arsenic free deep tube wells at Shahpur, Bariswan, Amrahi Nawada, Nargada Narayanpur, Paharpur, Bharauli and Karnamepur, and handed over to state govt. for the purpose of water supply.

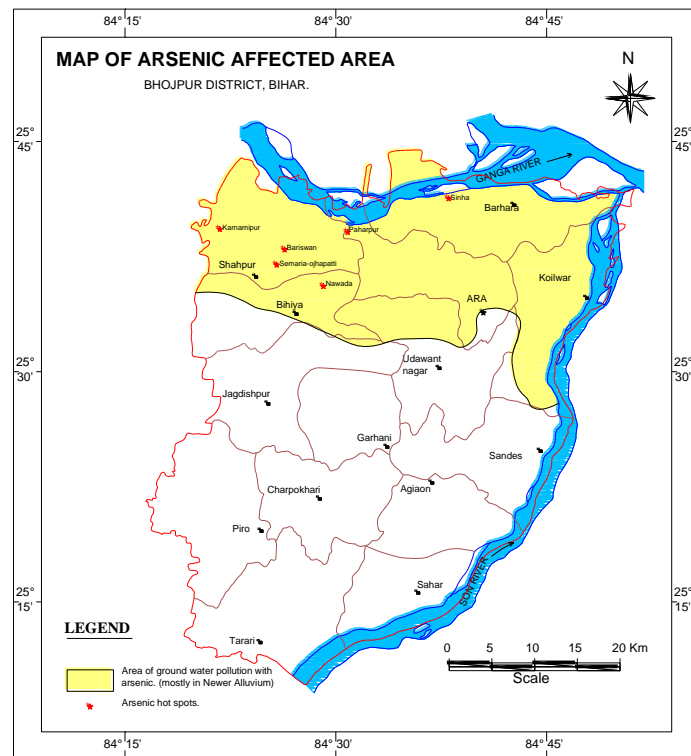


Figure 6: Map of Bhojpur district, showing areas affected with groundwater arsenic along river Ganga

4.5 Ground Water Resources

As per the ground water resource evaluation (31st March 2009), the whole of the district Bhojpur comes under safe category in view of the ground water resource development. The stage of

ground water development (Table 3) varies within the minimum of 21.7 % (Sahar) to the maximum of 73.7 % (Koilar block). Except the Koilar block, all other blocks fall in Safe category i.e below 70 %. As per the net annual replenishable ground water resource as on 31st march 2009 works out to be 75285 ha m. The gross annual draft for all uses works out to be 31756 ha m. Allocation of ground water for domestic and industrial use for 25 years works out to be 6308 ha m. Blockwise stage of ground water development of the district is depicted in Fig. 7. The blockwise resource is given in table 4.

As per the Minor Irrigation Well Census 1993-94 which is being utilized in the ground water resource evaluation of 31st march 2004, the number of deep tube wells (DTW), shallow tube wells (STW) and dug wells (DW) were 69, 14481 and 2323 respectively.

Table 4 Block – wise dynamic ground water resource of Bhojpur District (as on 31st March 2009)

| Sl. No | Assessment Unit/District | Net Annual Ground water Availability | Existing Gross Ground Water Draft for Irrigation | Existing Gross Ground water Draft for Domestic and Industrial Water Supply | Existing Gross Ground Water Draft For all Uses (10+11) | Allocation for Domestic and Industrial Requirement upto year 2025 | Net Ground Water Availability for future irrigation development (10-11-14) | Stage of Ground Water Development (12/9)* 100 (%) |
|------------|--------------------------|--------------------------------------|--|--|--|---|--|---|
| 1 | 2 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | Agiayon | 5094 | 1527 | 210 | 1737 | 310 | 3257 | 34.1 |
| 2 | Ara | 6147 | 2321 | 662 | 2982 | 1071 | 2755 | 48.5 |
| 3 | Barhara | 5998 | 1287 | 334 | 1620 | 493 | 4218 | 27.0 |
| 4 | Behea | 4904 | 2388 | 331 | 2719 | 522 | 1994 | 55.5 |
| 5 | Charpokhria | 3621 | 1214 | 145 | 1359 | 215 | 2193 | 37.5 |
| 6 | Garhani | 3668 | 1148 | 148 | 1297 | 219 | 2301 | 35.3 |
| 7 | Jagdishpur | 9127 | 4627 | 490 | 5117 | 558 | 3942 | 56.1 |
| 8 | Koilar | 3523 | 2217 | 380 | 2596 | 592 | 714 | 73.7 |
| 9 | Piro | 7149 | 3312 | 471 | 3782 | 543 | 3294 | 52.9 |
| 10 | Sahar | 3983 | 693 | 171 | 864 | 253 | 3037 | 21.7 |
| 11 | Sandesh | 4361 | 1534 | 155 | 1689 | 229 | 2598 | 38.7 |
| 12 | Shahpur | 4582 | 2094 | 383 | 2477 | 589 | 1899 | 54.1 |
| 13 | Tarari | 5917 | 2174 | 256 | 2430 | 379 | 3364 | 41.1 |
| 14 | Udwantnaga | 7212 | 2825 | 227 | 3051 | 336 | 4052 | 42.3 |
| Tot | | 75285 | 27395 | 4361 | 31756 | 6308 | 39616 | 44.2 |

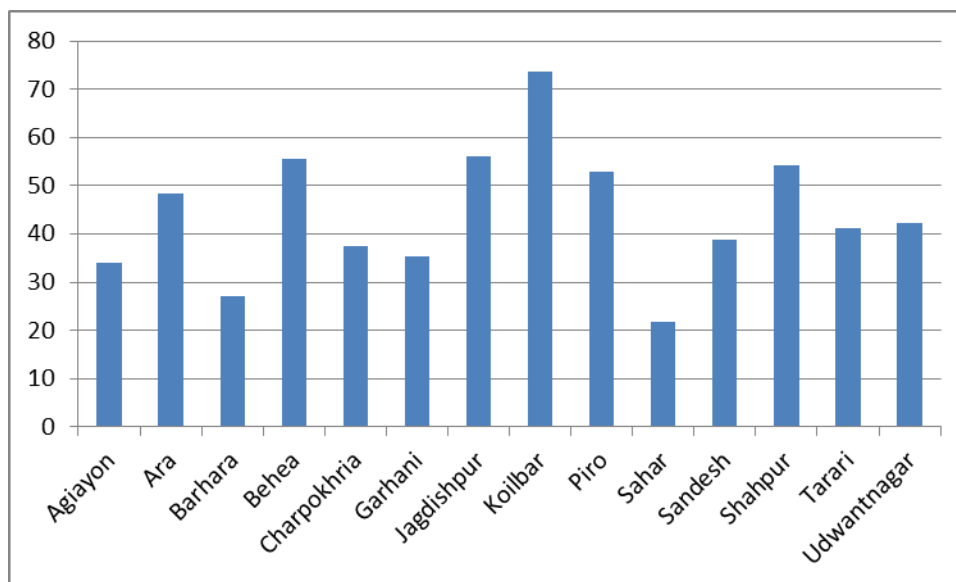


Fig. 7 Blockwise stage of ground water development of Bhojpur District

5.0 GROUND WATER MANAGEMENT STRATEGY

5.1 Ground Water Development

As per the resource evaluation (31st March 2009) the average utilization of ground water in the district is less than 44.17 %, which means none of the blocks in the district comes under semi-critical/critical or over exploited category. The present infrastructural facilities yield only 27395 ha m of ground water for irrigation and there is a vast surplus replenishable ground water potential of 39616 ha.m to be tapped.

5.2 Design and construction of Tube Wells

The entire area in the district of Bhojpur is highly potential with plenty of ground water available at shallow depth. It is reported that the shallow tube wells/ dug wells often yield a discharge of about 20 m³/ hr without any significant draw down within 4 – 5 hours of pumping.

- a) *Shallow tube wells*- along diara areas and marginal alluvium tracts.

Table 5 Details of well construction criteria along diara areas and marginal alluvium tracts

| | |
|---|--|
| Depth of well | : 30 to 50 m bgl |
| Diameter of well assembly (casing/screen) | : 76 to 102 mm |
| Length of screen | : Less than 15 m |
| Slot size | : 1/64'' (0.04 cm) to 1/32'' (0.08 cm) |

b) *Deep tube wells*

The proposed model design of deep tube wells in Bhojpur district is given in the following table;

Table 6 Details of well construction criteria for the deep tube wells in Bhojpur district, Bihar

| Sl. No | Discharge (m ³ /hr) | Depth of the well (m bgl) | Proposed well assembly |
|--------|--------------------------------|---------------------------|---|
| 1 | 150 | 150 | Dia. Of pipe Housing – 14'' Length (m) 30 |

| | | | | |
|---|-----|-----------|-----------------|-----|
| | | | Slot pipe – 8” | 30 |
| | | | Blank pipe – 8” | 90 |
| 2 | 200 | 200 - 250 | Housing – 14” | 35 |
| | | | Slot pipe – 8” | 50 |
| | | | Blank pipe – 8” | 115 |

The slot size of 1/16” (0.15 cm) has generally been utilized in the deep tube wells constructed by CGWB in the district. The slot size should be recommended depending on the grain size of the granular zones as given below;

Table 7 Slot size in different size of formation sand.

| | |
|-----------------------|--------------------------------------|
| Fine sand | : 1/64” (0.04 cm) to 1/32” (0.08 cm) |
| Medium to coarse sand | : 1/16” (0.15 cm) |
| Gravel | : 1/8” to 1/16” |

Both the shallow as well deep tube wells should be artificially packed with gravels of size ranging within 2 – 3 – 4 mm and a bail plug of 2 – 5 m should be provided in order to maximize the yield and life of the well.

5.3 Water Conservation and Artificial Recharge:

No such water conservation and artificial structure has been constructed in the district so far.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS:

People residing along the Ganga belt suffer from the arsenic contamination in ground water.

7.0 MASS AWARENESS AND TRAINING PROGRAMME:

One mass awareness programme has been carried out in the Shahpur block campus in the district.

8.0 AREA NOTIFIED BY CENTRAL GROUND WATER AUTHORITY/ STATE GROUND WATER AUTHORITY

Since all blocks of the district come under safe category from ground water development point of view, hence no area is notified either by Central ground water authority or State ground water authority till date.

9.0 RECOMMENDATION

- Though there has been a considerable development in ground water potential demarcation in the Younger Alluvium belt in the northern part of the district, a lot is yet to be done in the southern Older Alluvium areas.
- There is ample scope of large- scale ground water development in the area to meet the requirement for agriculture sector. Exploitation of ground water can be done through Shallow tube wells and bamboo boring to meet the requirement of small and marginal farmers while deep tubewells can be operated through farmers cooperative.
- Energisation of pump needs to be taken which can help in increasing irrigation potential and cropping intensity.
- Drinking water demand in the arsenic affected areas can be met from the deeper aquifers (depth more than 80 m).