Training Module on Water Source Sustainability in Birbhum

BY SIGMA FOUNDATION

For Water For People India

A. INTRODUCTION

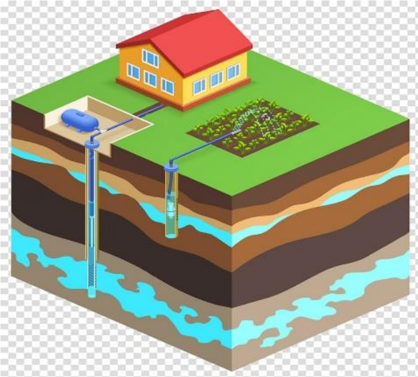
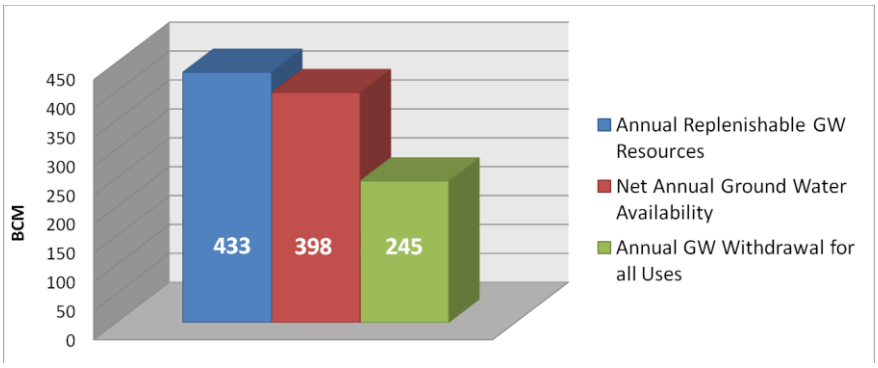


Figure 1. Groundwater Availability

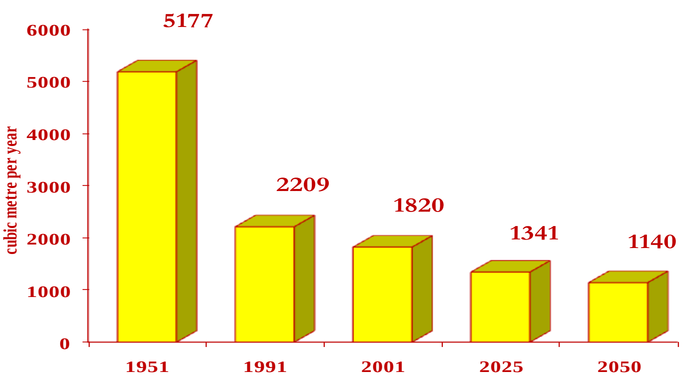
Groundwater has been considered as a valuable resource to fulfil the water requirements of various sectors including irrigation, domestic use and industries. Groundwater also has better widespread availability, drought protection capacity and high production capacity than surface water. During the last few decades, the steadily increasing demand for groundwater in different economic sectors has created long-term crisis of groundwater resource. India is the second most populous country in the world, with a population exceeding 1.2 billion and has an agriculture-based economy. It has 2.45 % of the total land area of the world, 16% of the world population and is estimated to be endowed with about 4% of its water resources. Annual average rainfall in the country is 1170 mm, which corresponds to annual precipitation, including snowfall of about 4000 billion cubic meters (bcm). Out of this, about 1869 bcm is estimated as the average annual potential flow in rivers. On account of various constraints, only about 1122 bcm of water is assessed as the annual utilizable water, having surface water resources component of 690 bcm and ground water component of 433bcm. As a result, in this present situation, the available groundwater resource fails to meet the demands of the growing population. Therefore, it is high time to think about the management and restoration of the groundwater resource for sustainable development



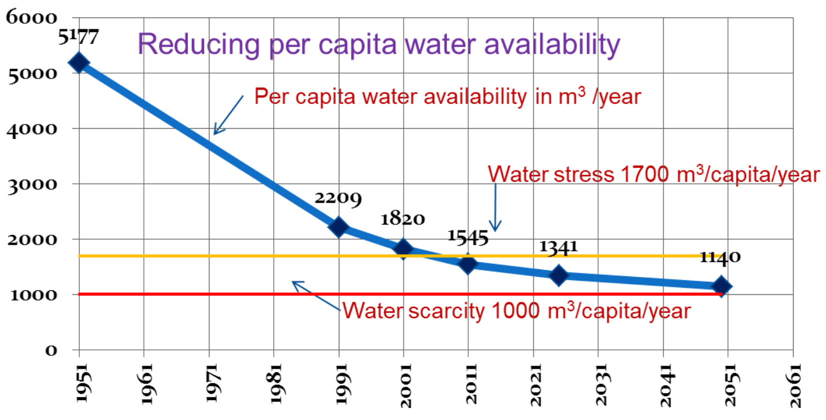
B. PER CAPITA WATER STATUS AND AVAILABILITY

On account of rapid economic and demographic change, the water demands in all the sectors are increasing. According to the projections by National Commission on Integrated Water Resources Development (NCIWRD) the irrigation sector alone is going to need additional 71 bcm by 2025 and 250 bcm of water by 2050 compared to the demands of 2010 (Press Information Bureau 2013). Similarly, other sectors are very likely to have increased water demand. While a considerable amount of water requirement is met by ground water, a long-term analysis of water recharge in both

Figure 2. Per Capita Water availability



pre-monsoon and post- monsoon seasons shows lowering of water table due to limited recharge. If this trend continues, India is going to face huge water deficit in future, especially in the irrigation sector.



C. BIRBHUM DISTRICT

The climate on the western side is dry and extreme but is relatively milder on the eastern side. During summer, the temperature can shoot well above 40 °C (104 °F) and in winters it can drop to around 10 °C (50 °F). Rainfall is higher in the eastern areas as compared to the western areas. In case of Rainfall, an increasing trend of yearly rainfall and shifting pattern of rainfall distribution are observed in the said zone as a whole. The average yearly rainfall of 2000-2010 increased by 81 mm as compared to the average of period 1990-2000[1]. But the area receives the major share of rainfall during the monsoon season and the rest of the year it remains dry. As a result, in summer months part of the district is prone to draught situation.

Figure 3. Distribution of Rainfall

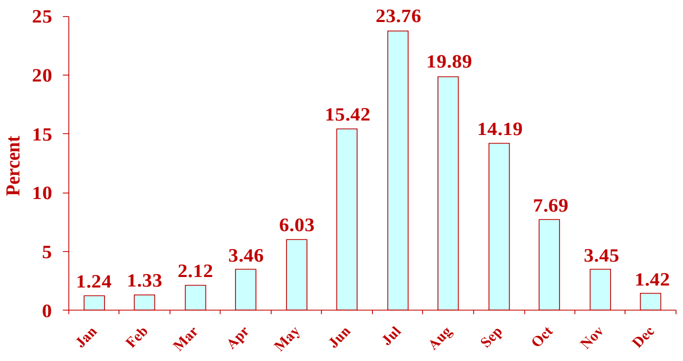
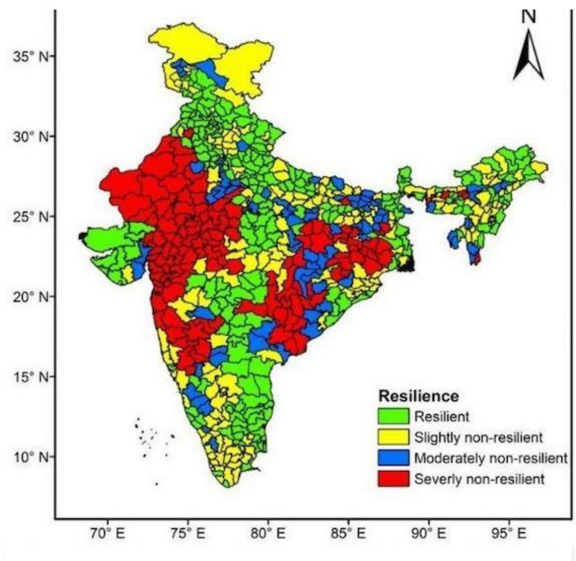


Figure 4. Draught Prone areas of India



The Birbhum district is lithologically a diversified block. The western part of the district is composed of basaltic and granite hard rocks, and the eastern part is composed of alluvial deposits. As a result, the occurrence of groundwater is different in the two sides of the district. It is

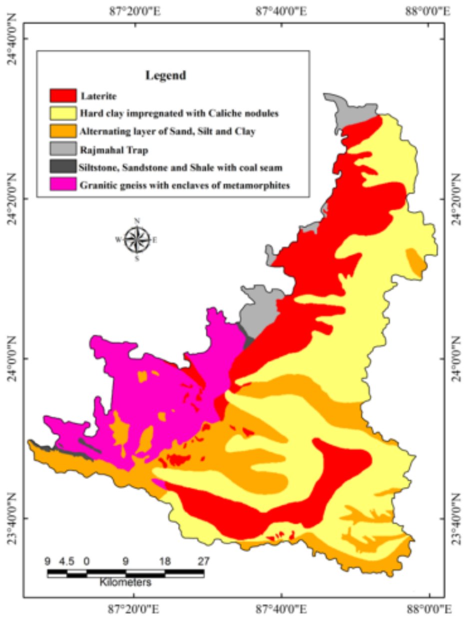
[1] Observed Rainfall Variability and Changes over West Bengal State. CLIMATE RESEARCH AND SERVICES, INDIA METEOROLOGICAL DEPARTMENT

obvious from the study that the eastern part of the district is more potential in terms of groundwater availability than the western part. Presently, temperature during summer increases up to 45 °C which results in shortage of water for irrigation. So, the farmers are forced to use more groundwater and there is day by day increase in draft.

D. GEOLOGY

The crystalline metamorphic rocks of Archaean to Proterozoic age occupy the southwestern part of the district The Gondwana Supergroup, overlying this basement is represented by thick piles of pelitic and psamitic sedimentary rocks containing coal seams belonging to Barakar. Barren Measure. Raniganj and Dubrajpur Formations ranging from Permian to Jurassic in age. Patchy occurrences of Gondwana formation are exposed mainly along the Ajoy river in Khoiraasol-Dubajpur-Illambazar tract and Md Bazar area. The Gondwana is overlain by Rajmahal trap (basalt) occurring in the northern and north-western part of the district. The north and also the central part of the rest of the area is occupied by laterite and lateritic soil.

Figure 5. Geological Map of District



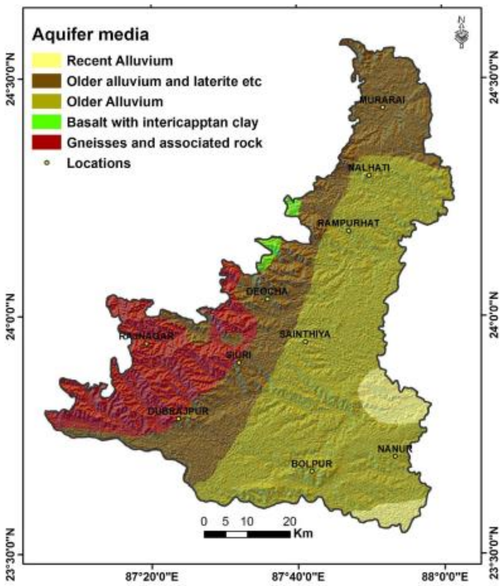
E. GROUNDWATER SCENARIO

Hydrogeology

In the western part of the district, underlain by Archaeans, Traps and Gondwanas, groundwater occurs under water table condition in the weathered zones (6 to 12m thick) and under semi-confined to confined conditions in the zone of secondary porosities, in general within 55 mbgl and places also down to 70 mbgl. Groundwater is generally being developed through open wells in the weathered zone and the discharges can only meet the domestic needs but is not sufficient enough for any large-scale development of ground water[2].

The thickness of alluvium increases from west to east from < 20m to about 80 m in the eastern part of the district. In area, underlain by Alluvium, groundwater occurs under unconfined conditions in the shallow aquifers. At deeper depths, it occurs under semi-confined to confined conditions.

Figure 6. Aquifer Map of District



During pre-monsoon period major part of the area, depth to water level is in the range of 5 to 10 mbgl. During post monsoon period in major part of the hard rock terrain depth to water level has

[2] CGWB. Groundwater Information Booklet, Birbhum District, West Bengal

been found to be in range of near ground level to 5 mbgl and in the alluvial terrain particularly in the northern part of the district found to be mainly in the range 5 to 10 mbgl while in the southern part it was mainly in the range of 2.0 to 5.0 mbgl. Seasonal water level fluctuation between pre-monsoon and post-monsoon period is found to be mainly in the range of 2.0 to 4.0 m. Broadly the groundwater flow direction is easterly to south easterly.

Groundwater Quality

Groundwater in 7 blocks, namely, Khoyrasol, Rajnagar, Sainthia, Suri-II, Mayureswar-I, Nalhali-I and Rampurhat-I, is affected sporadically by high concentration of fluoride in groundwater i.e. more than the permissible limit (>1.5 mg/) in the following depth ranges in different types of hydrogeological formations[3]:

- In fractured granite within 50.0 to 80.0m depth.
- In Gondwana sediments within 30m depth.
- In basalts within 50.0 to 80.0m depth.
- In alluvium within 50.0 to 60.0m depth.

In Khoyrasol and Rampurhat-1 blocks concentration of fluoride in groundwater has been reported to be as high as 15.9 mg/lit and 17.9 mg/lit respectively.

Groundwater Resources

The dynamic ground water resources of Birbhum district had been estimated jointly by CGWB and SWID, Govt of West Bengal following the norms laid down by GEC 1997 methodology

In the Birbhum district, the net annual availability of groundwater is 1.07 million Hectare Meters (ham) and the annual rechargeable amount is 0.11 million ham. So, it is obvious that availability of ground water is less than the amount of water recharged. On the other hand, the annual groundwater draft is 0.036 million ham, and out of these 0.032 million hams is used for irrigation purpose and 0.0038 million ham is used for domestic and industrial sector (CGWB 2014)[4]. According to the projected report of CGWB, the demand for domestic and industrial uses will increase up to 0.0075 million ham by 2025. In 1996–1997, the proportion of the irrigated area to total cultivated area in this district had been 79.51%, but it increased to 87.73% by 2014–2015 (Bureau of Applied Economics & Statistics 1997, 2014)[5].

Categorization of blocks. All blocks are categorized under Safe, except 4 blocks, namely, Nanoor, Nalhati-II, Murarai-II & Ramputhat-II are under Semi critical category.

In terms of quality of the groundwater, three blocks of Rampurhat subdivision viz. Murarai-II, Nalhati-II, Rampurhat-II have been considered as semi-critical block, as these are very much affected by fluoride contamination and there is a long-term trend of water level fluctuation (CGWB 2009)[6].

[3] CGWB. Groundwater Information Booklet, Birbhum District, West Bengal

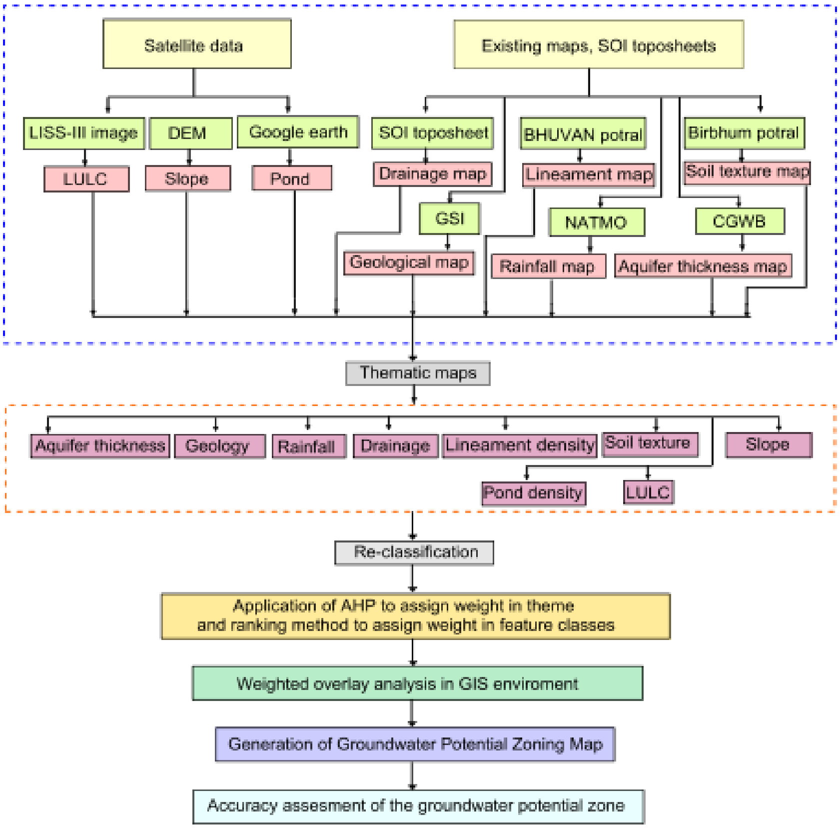
[4] CGWB. (2014). Groundwater Year Book of West Bengal and Andaman and Nicobar Island 2014-15. Ministry of Water Resources, Government of India. http://www.cgwb.gov.in

[5] Bureau of Applied Economics & Statistics. (1997 & 2014). District statistical handbook, Government of West Bengal.

[6] CGWB. (2009). Report of the groundwater resource estimation committee (pp. 8–12). New Delhi: Ministry of Water Resources, Government of India

F. MAPPING OF GROUNDWATER POTENTIAL ZONES

Figure 7. Flow Chart of Methodology



Mapping of potential zones can be defined as a scientific process, wherein a combination of geological, geophysical, hydrological and geochemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. Systematic aquifer mapping helps to improve the understanding of the geologic controls of aquifers, their hydrologic characteristics, water levels in the aquifers and how they change over time, and the occurrence of natural and anthropogenic contaminants that affect the potability of ground water. Aquifer mapping at the appropriate scale can help to prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of our precious ground water resources.

In the present era of methodological revolution, the remote sensing and GIS approaches have been widely incorporated to generate groundwater potential model throughout the world. GIS technique is the most effective tool to integrate voluminous geospatial data in the emerging field of water resource management. On the other side, the remote sensing technology provides multispectral, multi-temporal and multi-sensor data of various parts of the earth surface, which are considered important in assessing groundwater resource management. But remote sensing technology cannot detect groundwater resource availability directly. Rather, other spatial data which may be extracted either from satellite data (e.g., LULC, slope, lineament) or other conventional data (e.g., soil, drainage, aquifer thickness, rainfall, geology) help to identify and extract groundwater potential zones through the process of integration under GIS environment.

G. GROUND WATER MANAGEMENT STRATEGY & RECOMMENDATION

Ground water Table Monitoring

Drinking water schemes depend on the groundwater source. Thus, the development of a security plan crucially depends on the input of groundwater levels, discharge and quality. The water budget calculation should be based on village-level data obtained within the study area. Village-level monitoring of water levels, discharge and quality generates interest within the community and proves to be cost effective.

Groundwater is under constant so-called hydrostatic pressure resulting from underground water movement. When untapped, wells maintain a water level known as the water table or piezometric level (the upper limit of the groundwater reservoir). When the groundwater draft exceeds the recharge, the pressure is decreased, resulting in the lowering of the water table. The water level in wells is thus a direct indication of the status of the groundwater resource.

Water-level measurement can be done using different types of equipment. The choice of equipment depends on several factors, including the accuracy or ease of measurement required, type of structure (bore well/open well) and the pumping activity of nearby wells.

Electric Measuring Tape: electric measuring tapes typically consist of a pair of insulated wires whose exposed ends are separated by an air gap in an electrode and contain a source of power in the circuit such as flashlight batteries. When the electrode comes into contact with the water surface, a current flow through the tape circuit indicated by an ammeter-needle deflection, a light and/or an audible signal.

Figure 8. Electric Measuring Tape

Bore well discharge can be measured using several methods. The volumetric method is simple and affordable for rural communities. a calibrated drum with a capacity of 100 or 200 litres can be used together with a stopwatch to measure the discharge of the observation well. ready-reckoning conversion tables can be developed for converting the discharge in terms of litres per minute.

Figure 9. Measuring Drum and Stopwatch

Water Conservation & Artificial Recharge

Basic Requirements of Artificial Recharge

- Availability of non-committed water
  - Surplus monsoon run off.
- Identification of suitable hydrogeological environment.
  - The aquifers best suited for artificial recharge are those aquifers which absorb large quantities of water and do not release them too quickly (vertical hydraulic conductivity- high, while the horizontal hydraulic conductivity -moderate).
- The upper 3 m of the unsaturated zone is not considered for recharging, since it may cause adverse environmental impact e.g. water logging, soil salinity, etc.
- Cost effective artificial recharge techniques.

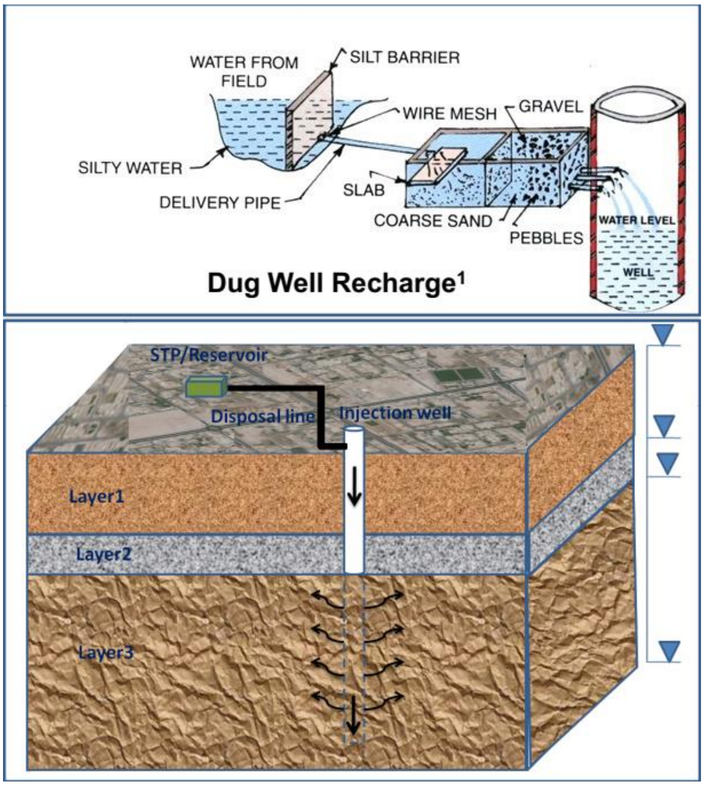
Figure 10. Percolation Tanks

- Rainwater be utilized artificial recharge to groundwater.
- Hydrogeological condition is also important to recharge the groundwater.
- As far as possible selected plain terrain & the recharged water are not drained out in natural conditions through streams/nallas before development of the recharged water.
- Any structure should be constructed on such a terrain where there is ample scope of groundwater development
- while designing the structures, the need of people of downstream side is to be given due consideration.
- Post-monsoon water level should more than 3 mbgl.

Figure 11. Check Dam

Figure 12. Check Dam

Figure 13. Dugwell and Bore well Recharge



In Birbhum district feasible structure for artificial recharge to ground water are as follows:

In the district where depth water level during post monsoon period more than 3 mbgl and can be high as 15 mbgl, following structures are feasible for artificial recharge of groundwater:

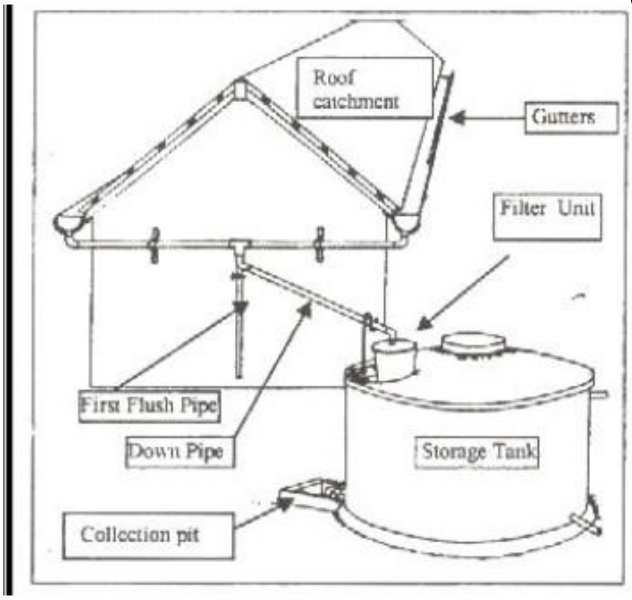
- Water from percolation tanks start percolate groundwater.
- Check dams properly designed for recharge well. In case the check dams are on sloppy streambed, these supported by Gabion structures upstream side to control the velocity of water and accumulation of silt.
- wells after cleaning can be used for artificial recharge to groundwater. However, before recharging water needs to be sand filtered.
- During monsoon period many ponds over flow and this surplus water can be used. Any mentioned structures for artificial recharge to groundwater. In addition, these structures, defunct wells can also be used for recharging the groundwater

Conservation of Rainwater

Rain Water Harvesting is need of the day. Annual rainfall in the district is 1601mm and in normal monsoon sufficient rainfall is available for rainwater harvesting.

In along the boundary and also in the south part of the district where different types of hard rocks are the hydrogeological formations, generally potentialities of these formations are poor and as such wells are the main feasible ground water abstraction structure. With the onset of summer these areas generally face acute drinking water crisis. In this area where the scope of groundwater development is limited, rainwater conservation is the best option to mitigate the crisis of drinking water problem. Conservation can be done from the water that can be available from both the rooftops and also from the lands.

Figure 14. Rooftop Rainwater harvesting



- The water that can be available from roofs can be stored giving considerations to all types of losses in cemented or in PVC tanks. Before conserving, the water should be sand filtered.
- The rainwater that can be available from any land surface can be stored in any ponds and in this case sites as well as designs of ponds are to be finalized considering local hydrogeological as well as terrain conditions.
- In addition to these, the surface water which flows through streams/ nallahs can be conserved with the help of check dams, giving due considerations to the surrounding farmers' lands, local hydrogeological conditions and terrain conditions.
- In undulating terrain gully plugs can be feasible on cultivated lands to conserve limited quantity of water and there by soil moisture can be increased which will be beneficial for crop production

Ground Water Development

In Birbhum district, about half of the district area falls under hard rock terrain and the remaining area is underlain by alluvium. A general strategy, as applicable, in the district is summarized below:

- In hard rock terrain, constituted by hard crystalline rocks, Gondwana sedimentaries/ Rajmahal Traps, the following ground water abstraction structures are feasible:
  - Large diameter dug wells within 12 mbgl can only meet the domestic needs.
  - Considering limited potentialities, attempts are to be made to augment the groundwater resources, especially for the weathered zones. It can be done by rainwater harvesting and considering the terrain conditions
  - Special care is to be taken on the concentration of fluoride in groundwater for drinking purpose, as at some places in Khoyrasol, Rajnagar, Sainthia & Suri-Il blocks, fluoride concentration is above the permissible limit and fluoride contaminated water can be used only after proper treatment.
  - The water conserved in ponds, especially in fluoride affected areas, can be used for drinking purpose after treatment
- In alluvial terrain, thickness of alluvium gradually increases from west to east. In the transitional area the thickness of alluvium is limited within the depth range of 50 to 70 m, and it is very thick in within the depth of 400 m in the eastern part of the district. Here, ground water may be developed through different abstraction structures, considering the availability

of potential and potable aquifers, thickness of potable aquifers, stage of ground water development, etc.

- Shallow tube wells are generally constructed within the depth ranges of about 10 to 50 mbgl.
- In general medium to heavy duty tube wells within 200 mbgl are feasible in the eastern part of the district.
- In the alluvial part of the district. four blocks namely Nathall-ll, Nanoor, Murarai-Il and Rampurhat I are in "Semi-Critical category. These blocks need special attention for augmenting the groundwater resources

H. WAY FORWARD

- ✓ ***Adopt latest groundwater management technology (especially, for GW recharge) at local to national level.***
- ✓ ***Illegal GW extraction at a single house through tube well/pumping well (even lots of real estate housing also) should be stopped.***
- ✓ ***Every single well should be registered at local water department.***
- ✓ ***GW monitoring (quality also) should have at least one every 3 months and even more frequency at Over-Exploited blocks.***
- ✓ ***All well information (well type, coordinate, geological., log, casing, screen, elevation, GWL in mbgl and masl) should be registered at online.***
- ✓ ***More focus on treated STP and industrial wastewaters (e.g., Doha, Qatar)***
- ✓ ***Groundwater awareness program should be introduced at school level (e.g., Australia)***
- ✓ ***Each and every policy should be evaluated by technical committee and also responsible for implementation with no/minimal interfere of politicians. May be introduce some reward schemes for engineer/professional and states.***
- ✓ ***Groundwater-Surface interaction model for regional level and local model for Over-Exploited blocks should be used for strategic decision and planning.***
- ✓ ***Should have better characterization of GW aquifer***

Water/Sanitation/Hygiene

1. How do you define improved water supply in your community?
2. Do you have any idea about the water quality problem in your block? If yes, then please specify.
3. How many blocks are affected with chemical contamination?
4. What is the full form of WASH? Do you think that WASH is important to improve the quality of life?
5. If question 4 is yes then how? Please specify with few lines.
6. What is the current approach of Jal Jeevan Mission?
7. Do you have in-village water supply system in your block? If yes, please specify.
8. Do you have any idea about the groundwater table monitoring? If yes, please explain few steps.
9. What do you mean by artificial recharge?
10. Is there any possibility to develop the ground water in your district (Birbhum)? If yes, please mention few steps?
11. Which benefits did we ger from SBM(G) phase I?
12. Do you have any idea about the components of SBM(G) II? If yes, then please specify the components.
13. Which type of toilet(s) in your GP people generally use?
14. What do you mean by retrofitting of toilet?
15. What is bio-degradable waste?
16. How do you segregate the solid waste at the household level as per Government norms?
17. Do you have any idea about the liquid waste management? If yes, then please categorize it?
18. Do you think that hand washing is very important to protect health from various disease especially COVID-19?
19. How do you classify the hygiene status?
20. What is "KABC Model" stands in context of Menstrual Hygiene?

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