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The Quantitative and Qualitative Scenario of Groundwater Resource through Holistic Approach in Sakari-Uslapur-Ghutku Triangular Portion of Block-Takhatpur, District Bilaspur [CG]

[1]Dr. P K Gupta, [2]Rishi Kumar Gupta

[1]Professor, [2]Founder
[1]Department of Civil Engineering, [2]Chartered Engineers
[1]Dr. C V Raman Institute of Science & Technology Raman University, Kota, Bilaspur, Chhattisgarh, India
premkg14[at]gmail.com, [2]Chartered Engineers, Bilaspur, Chhattisgarh, India, rkgupta.bit[at]gmail.com

Abstract: ***The legal aspect of WATER at National and Chhattisgarh state level has been ascertained with specific reference to ground water resource. The area of study belongs to typical land unit, comprising with urban, rural, institutional and industrial setup of Sakari-Uslapur-Ghutku triangular portion of block Takhatpur, District Bilaspur [CG]. It is the testimony of rapid land-use change pattern; prevailed through-once dominated with rural, paddy field with vegetation cultivation in erstwhile Madhya Pradesh state, about twenty years ago and its impact on surplus utilization of local ground water resource. The stage of ground water extraction in percentage has been 70-90 in March 2017 as SEMI CRITICAL for the area of study. The status of ground water resource in the area of study has been evaluated through holistic approach. The quantitative issue is governed by distribution, mode of occurrence, recharge-discharge condition. It depends upon local geology, hydro-geology and aquifer disposition with its types along-with aquifer parameters and land-use pattern. The qualitative issues have been monitored during pre-monsoon, during monsoon and post-monsoon successively in single year through bore well with the determination of twelve standard water quality parameters. The role of Chhattisgarh state government with respect to overall development of ground water resource has been documented in order to improve ground water extraction stage percentage towards achieving water security for public welfare.***

Keywords: Ground Water, Chhattisgarh, Bilaspur, PWC

1. Introduction

Water is state subject, as mentioned in schedule VII, List II, Entry 17 of the constitution of India. Accordingly, Chhattisgarh state government has commissioned an International Development Consultant M/s Price Waterhouse Cooper [PWC] of London base [U K] for preparation of infrastructure development action plan in Water sector [2]. Chhattisgarh state government has vision to introduce Water Draft Bill for catering the need of digging Bore-well, quality of water supply, conservation of water through watershed management, water harvesting and water recharge-discharge pattern on the basis of recommendations of PWC.

Ground water is the backbone of Nation's agriculture and domestic water security in rural and urban area, with contribution of 62% and 85% respectively. The annual extractable ground water resource as on March 2017 and allied aspects for District Bilaspur [CG] in Billion Cubic Meter [BCM] is as follows [6]:

- Irrigation = 1804.06 BCM
- Domestic = 619.77 BCM
- Industrial = 0.88 BCM
- Total = 2424.71 BCM
- Annual ground water allocation for domestic use as per practice in 2025 = 689.78 BCM
- Net ground water allocation for overall future use in 2025 =3327.51 BCM
- Ground water extraction stage [%] for District Bilaspur [CG] =52.36

The stage of ground water extraction [%] is calculated through following formula:

Existing ground water for all uses multiplied by 100, and divided by Annual extractable ground water resource.

Accordingly, block: Takhatpur of district Bilaspur [CG] has been declared under SEMI CRITICAL by NCCR, CGWB, Raipur, with value in between 70-90 %.

The allocation of water for utilization of domestic purpose has been considered by latest National Water Policy [2012] is 40 liter per capita per day [lcpd]. It has been revised by newly formed Jal Shaki Ministry for Water Resource [Government of India] in July 2019 as 60 lcpd. It has been again reduced as 55 lcpd in December 2019 under Jal Jeevan Mission –Har Ghar Jal.

2. Area of Study

The triangular portion in between Sakari-Uslapur-Ghutku of block-Takhatpur in district Bilaspur [CG] is the area of study with geographic coordinates Latitude N 22 DEGREE 07 MINUTE 08 SECOND to N 22 DEGREE 09 MINUTE 09 SECOND &Longitude E 82 DEGREE 04 MINUTE 30 SECOND to E82 DEGREE 95 MINUTE 12 SECOND. It corresponds to Survey of India topographic sheet no.64 J/4 and illustrated as Fig.1. Uslapur and

Ghutku are two adjacent railway stations on Bilaspur-Pendra section of SECR.

Ghokane nalla is the main surface drainage for the area of study with several surface water bodies in the form of ponds widely used for domestic and cultivation purposes. Ghokane nalla behaves as gaining stream. The surface elevation varies in between 270 m to 255 m average M S L with regional slope from north to south direction.

Figure 1: Location Map for area of study

It has monsoon rainfall- 1170 mm [87 % of annual] and remining-172 mm [13%] during non-monsoon season. The maximum rainfall of 272 mm has been recorded during monsoon season in single day at Sakari. The National Hydro-geological Station for monitoring of ground water along observation well through Digital Water Level Recorder was at Sakari, under supervision of CGWB &State Water Resources Department during January, May, August & November months from 1996 to 2015. It is approachable through Bilaspur-Takhatpur State Highway along-with Uslapur, Ghutku railway station.

3. Evolved Methodology & Objectives

The evolved methodology is based upon conventional approach as Relevant Literature Review with scrutiny of available latest reports of Central Ground Water Board, Ministry of Jal Shakti [Government of India] and Hydrology project II [World Bank Scheme] of Chhattisgarh State Water Resource Department.

The objectives for the area of study are as follows:

- Evaluation of terrain characteristics
- Appraisal of geology
- Assessment of hydro-geology

4. Relevant Literature Review

The term 'GROUND WATER' is commonly used for water occurrence & distribution below the ground surface in an area. It occurs in two distinct zones namely: vadose zone and saturation zone, with respect to above and below local ground water table respectively. The ground water belonging to vadose zone is not extractable as in the form of soil moisture due to capillary action and is utilized for germination of seed and other biotic substances. The ground water belonging to saturation zone is extractable and available through percolation, - utilized for our all practicable purposes. It is due to disposition of ground water bearing strata having sufficient porosity, permeability and allied aquifer parameters and hence called aquifer. There are four types of aquifer broadly as unconfined, semi-confined, leaky and confined with depth penetration from the ground surface and underlined by impermeable geological formation [7].

The quantitative aspect of groundwater in aquifer is governed by geologic structure, aquifer geometry, extent, hydraulic gradient and recharge-discharge characteristics. The vast quantity of ground water is available along multi layer aquifer system in alluvial deposit of sedimentary terrain, pertaining to favorable watershed. The limited to promising availability of ground water in hard rocky terrain is associated with weathered formation, fractured strata and geological faults.

The ground water quantity has relationship with land-use pattern in terms of specific yield, ground water level fluctuation, ground water potential [MCM] and rain water potential as natural recharge [MCM]. These parameters have been studied for six prevailing dynamic land-use namely: Institutional, Commercial, Rural settlement, Urban built up land, Agricultural land and Industrial land

in part of NOIDA, and the result is summarized in Table 1[8].

Table 1: Relationship in between dynamic land-use pattern and ground water quantitative parameters

S N	Land- use/ quantitative parameters of Ground water	Institutional	Commercial	Rural	Urban	Agricultural land	Industrial land
1	Specific Yield[%	20	14	16	18	12	3.0
2	Ground water level [m] Fluctuation	40	02.8	3.2	3.6	2.4	5.0
3	Ground water Potential[MCM]	28.8	21.2	9.8	42.8	9.3	
4	Rainwater Potential[MCM] NaturalRecharge	09.8	13.2	21.4	04.6	25.6	1.6

The qualitative aspect of ground water in aquifer depends upon hydro-geo-chemistry, contamination and potable characteristics. It is governed by tolerance to permission limit of water quality parameters, as prescribed by regulatory standard, monitored in three seasons- pre-monsoon, during monsoon and post-monsoon along observation wells.

The ground water has been extensively used for Domestic purpose [drinking and water supply], Irrigation purpose [cultivation of crop and vegetables] and Industrial sector. The recharge of ground water is governed by several factors as [a] Normal rainfall [natural], [b] Rain water harvesting cum roof top harvesting [artificial] for unconfined aquifer and [c] Inherent to palaeo- drainage along confined aquifer. The discharge of ground water depends upon: Number & types cum density of existing wells, operating condition of pumps and its types and non-recoverable draw down condition.

5. Result & Discussion

The supply & demand chain of desired quantity and quality of drinking water to public [domestic purpose] and irrigation practices has been under stressed condition since 1990 in entire India. The area of study is in SEMI CRITICAL stage for ground water extraction since 2015 on account of excessive ground water withdrawal, increasing fast rate number of successful bore-wells and poor recharge characteristics. The précised reasons for such prevailing stage have been studied analytically through fulfilling the desired objectives and as follows:

Evaluation of terrain characteristics:

The terrain characteristic of an area is composite view of local geomorphology, land-use, topography, drainage, socio-economic set up and human settlement with living standard.

The area has two geomorphologic units namely: Flood plain & Structural plain. The flood plain is around Gokane nalla with shrinking agricultural land and poor condition of village ponds [land-use]. The structural plain is away from Gokane nalla and associated with built up area to environmental sensitive zone with concrete jungle [land-use]. The dynamic land-use pattern has been recently observed in the area of study. It was dominated by paddy field [agricultural land], village ponds [surface body], rural settlement and Ghutku and Uslapur, as small railway stations in M P state. But within the span of about fifteen years in CG state large scale socio-economic development has been occurred. The area is covered through commercial activities, residential colonies, coal washery plants, college cum school, which has put more stress on groundwater extraction. There are presently seven land-use pattern namely: Institutional, Commercial, Agricultural, Rural, Urban, Industrial and Waste land cum shabby ponds.

The area has three topographic units namely: Low lying area around 240 m average mean sea level, Moderate altitude zone corresponding to 260 m average mean sea level and Higher altitude zone more than 270 m average mean sea level. The regional slope is from north to south direction. The drainage reveals the gaining nature of Gokane nalla. The ground water flow direction is from higher to low lying area towards nalla bed. The Gokane nalla possess overflow condition during heavy rainfall due to large scale disposal of contaminated material through residential colonies, leading to deteriorating water quality with increasing thickness of nalla bed.

The area has well developed socio economic set up with concentration of improved version of Uslapur railway station for stoppage of all passenger trains on Bilaspur-Pendra section by SECR, Coal transportation siding yard, Railway training hostel, residential colonies with all standard amenities by urban settlement. It leads to more utilization of water than prescribed standard and related water quantity demand for domestic purpose. Ghutku railway station and surrounding area has more water quantity demand for industrial purpose on account of coal washery plant.

Appraisal of geology:

The area of study has rock formation of Proterozoic period-Raipur group of Chhattisgarh super-group. It has two litho units namely: Tarenga & Hirri. The Tarenga litho unit consists of cherty shale, calcareous shale along-with pebbly conglomerate; occurring at shallow depth. It is more susceptible to weathering. The Hirri litho unit consists of dolomite with cavernous to stromatolite. It is intercalated with black shale, gypsum layer along bedding plane. The deeper horizon has columnar shape wide

opening with in stromatolite and mud cracks [4].The presence of gypsum layer enhances Electrical Conductivity as source of sulfate contamination, making un-potable nature of water at certain places.

Assessment of hydro-geology:

The systematic hydro-geological investigation along-with surface to sub-surface exploration for specific area provides the geometry of ground water bearing horizon along with recharge-discharge characteristics, analysis of ground water samples with use of software for hydro-geo-chemical interpretation. The vertical and horizontal extension of ground water bearing horizon may be termed as aquifer disposition.

The aquifer disposition for area of study reveals two types of aquifer as most common, namely: Pheratic and Semi-confined aquifer in depth range of 05 to50 m from the average ground surface. Pheratic aquifer is also known as unconfined aquifer and occurred in depth range of 05 to 30 m. It is geologically controlled by Tarenga litho unit and tapped through dug wells, hand pumps. It is overlain by soil horizon in association with vodose zone, comprising with poorly consolidated to loosely cemented material.

The Semi-confined aquifer occurs at depth range of 30 to 50 m from the average ground surface. It is geologically controlled by Hirrilitho unit and tapped through bore wells. It is associated with DOUBLE POROSITY SYSTEM. The primary porosity is due to the presence of porous material in litho unit. The secondary porosity is related with structural elements like –presence of joint and fracture in litho unit. The aquifer parameters of Semi-confined aquifer, as obtained through Pumping Test in December 2015 at Ghutku old coal washery plant, provides following information: [4]

- Depth of Bore well = 50 m
- Hydraulic Gradient = 2.31x 10[-3] m/day
- Average ground water level fluctuation = 1-5 m
- Hydraulic Conductivity = 1.79 m/day
- Litho unit encountered = Contact of Tarenga & Hirri
- Measured Draw down = 05 m, after 100 minute of pumping
- Safe distance in between two adjacent wells =110 m
- Discharge rate = 7.2 cubic meter/hour [2LPS]
- It has been expected that Bore well may recover Draw Down within 12 hours of pumping in next day.

The promising to potential confined aquifer of good yield has not been encountered so far, in the area of study. Theoretically, it is controlled by solution cavity to cavernous material in Dolomite litho unit at depth range of 70-80 m and may be tapped through Tube well.

The ground water quality at NHS observational well [Sakari] has been carried out in 2014 and the result is summarized, with seasonal monitoring of 12 standard water quality parameters in Table 2 [9].

6. Conclusion

The National Commission for Integrated Water Resource Development [NCIWRD] has assessed that in India, about 83 % of water is used for irrigation and remaining 17 % for Domestic and Industrial purposes. It is estimated that , the share of water for Irrigation purpose is going to be reduced up-to 69 % by the year of 2050 [5].

In Chhattisgarh state, it is estimated that 43 lakh hectare areas can be irrigated, against existing potential of 13.37 lakh hectare. The long term water resource plan in CG state requires to take-up Four steps namely: Preparatory, Run-up, Execution and Monitoring along-with considering the following facts:

- ✓ Formulation of high level committee with execution power.
- ✓ Formulation of water regulatory body for auditing, budgeting, pricing and revenue collection.
- ✓ Legislation of ground water resource for tapping, recharging and digging.
- ✓ Creation of conditions for attraction of private sector participation.
- ✓ Plan for detailed exploratory drilling followed with authentic to extensive Geophysical survey, Pumping Test, GIS & Remote Sensing and seasonal monitoring of standard quality parameters through latest software cum hydro-geo-chemical interpretation of ground water samples towards precise aquifer mapping with enhancing recharge & reducing discharge aspect [3].
- ✓ Conjunctive use of water-particularly Grey water management for municipal water supply.

Table 2: Ground water quality monitoring during 2014 at N H S Sakari

S N	Name of Parameter	Unit	Pre-monsoon March-May	Monsoon August	Post-monsoon November-December
1	Temperature	Degree Centigrade	19.70	21.00	21.20
2	pH		07.61	06.42	06.89
3	Electrical Conductivity	[mue s]	1633	0825	0890
4	Total Dissolved Solid	mg/Liter	1585	0780	0826
5	Salinity	mg/Liter	01.56	00.74	0.82
6	Hardness as Calcium	mg/Liter	220	080	100
7	Hardness[Magnesium]	mg/Liter	165	050	080
8	Total Hardness	mg/Liter	385	0130	180
9	Dissolved Oxygen	mg/Liter	7.30	06.40	06.80
10	Nitrate	mg/Liter	12.84	03.54	04.43
11	Fluoride	mg/Liter	02.06	00.80	00.86
12	Electrical Potential	m V	450	115	240

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