



# Study of Ground Water Level Depletion in Durg-Bhilai Twin City, Chhattisgarh, India

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## To Cite this Article

Dr. Prashant Shrivastava and Ritesh Tamrakar. Study of Ground Water Level Depletion in Durg-Bhilai Twin City, Chhattisgarh, India. *International Journal for Modern Trends in Science and Technology* 2021, 7, pp. 33-39. <https://doi.org/10.46501/IJMTST0711007>.

## Article Info

Received: 15 October 2021; Accepted: 03 November 2021; Published: 05 November 2021

## ABSTRACT

Durg Bhilai Twin cities are one of the fast growing cities of Chhattisgarh state. Approximately more than 75 new housing projects are in existence in this area. Due to increasing population, rapid urbanization has been taken place in these twin cities. As a result requirement of underground water has also been increased. Water level in the wells are showing deep depletion in last decade. Keeping all these views in mind Chhattisgarh State Planning Commission Raipur has sanctioned a Minor Research Project to study this burning problem of Ground water scarcity. During the study, Geological study, Land use land cover study and Hydrogeological study of the study area has been done in detail. On the basis of study it has been concluded that there are several factors which have a direct impact on depletion of groundwater level in any area. The main factors are hydrogeological properties of rocks, overexploitation of groundwater, Wastage of water in agricultural fields and washing of vehicles, machine, floors etc. Establishment of new big housing projects and colonies play adverse role in the storage of groundwater. The deepest groundwater level was found is 55.65 m. in Surya Vihar and 55.20 m. in Smriti Nagar Bhilai and the shallow groundwater level was found in 1 metre depth in Anand Vihar Borsi Durg. The northern Portion of the area like Smriti Nagar Junwani and western portion like Rishabh Complex are not suitable for ground water development whereas in Eastern Portion like Kumhari, Charoda and Southern portion like Talpuri, Risali and Padmanabhpur are good for future ground water development in the study area.

## INTRODUCTION

Durg- Bhilai twin city are situated in the western part of Durg district of Chhattisgarh and is bounded on the north by Dhamdha Block east by Patan Block, in the west by Rajnandgaon district of Chhattisgarh, in the south and south east by Balod district. The area lies between 21°04N and 21°37N latitude and 81°16E and 81°40E longitudes. Geomorphologically area indicates presence of structural plains. The total population of Durg Block as per census 2011 is 1126731. The study area receives rainfall mainly from south west monsoon. It sets in third week of June and continued till

Mid-September with heaviest shower in month of July and August, the average annual rainfall of the study area in 1200mm.

Groundwater is a valuable resource both in Chhattisgarh and throughout India. When surface water such as water tanks, rivers are scarce inaccessible, ground water supplies many of the hydrologic needs of people everywhere. In Durg Bhilai twin City it is the source of drinking water for about half the total population and nearby all rural population. Similarly, it fulfills the requirement of agriculture sector. Many

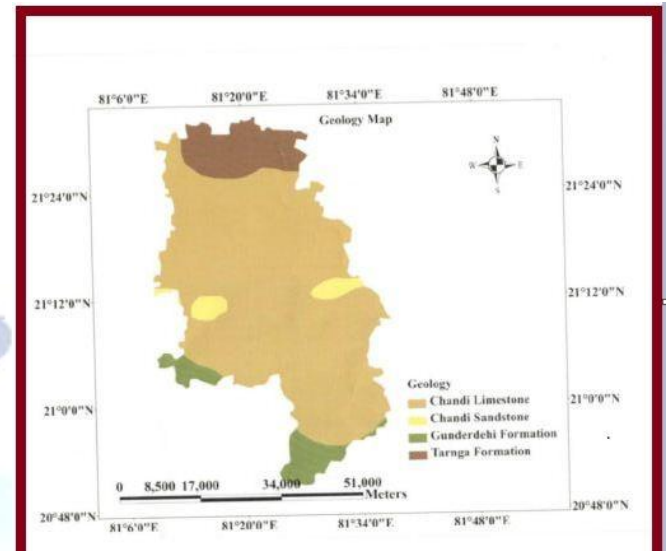
localities of Durg Bhilai twin City are experiencing groundwater depletion.

### Geology of the Study area

Geologically Durg Bhilai twin cities exhibit lithology of Archean to Proterozoic age mainly occupied by limestone, sandstone and shale. These formations are named as Chandi limestone, Chandi sandstone, Gunderdehi Formation and Tarenga Formation.

**(A) Chandi Formation** - Chandi Formation occupying about 87% of the Durg Block about 503 Sq. Km. area in Durg Block. It Comprises a thick sequence of organic limestone, sandstone and shale stromatolitic limestone and Dolomite has a gradational contact with the underlying Gunderdehi shale. The limestone in pink to light grey in color with extensive development of stromatolitic structure and is thickly bedded minor shale parting are present. Stromatolites are grey to brown in colour with intercolumnar space filled with argillaceous carbonate material. In middle horizon of this formation stromatolitic limestone and flaggy limestone are associated with green calcareous shale. The green shale is friable and splintery, calcareous and at places itself contains columnar stromatolitic structure inclined to bedding plane. Upper horizon predominantly pink to purple, medium to coarse grained dolomitic limestone with characteristic development of stromatolites. The rock has a molted appearance due to dolomite crystals. It is generally massive in look and is associated with purple to grey shale intercalations. Towards upper part, the rock gradually changes and devoid of stromatolitic structure. The rock is also gypsiferous containing gypsum in mg cavities.

**(B) Gunderdehi Formation**- Gunderdehi formations occupy area of about 43 sq. Km on part of Durg-Bhilai twin city. Gunderdehi formation is primarily an argillaceous sequence consisting of a very thick succession of purple shale attaining the maximum thickness of about 250m. Associated of thin band of



siltstone of greenish and pale grayish colors are seen in the upper portion. The shale's forming high grounds generally are capped by laterite with a thickness ranging from 3-9 meters. The upper most portion of shale contain thin bands of stromatolitic limestone of 20 to 30 cm. thick band and contact between the two has been inferred as disconformity.

**(C) Laterite** - Laterite occurs as small cappings over the sandstone, limestone and shale and its contact with underlying formation in always sharp. The lateritic capping over the sandstone in generally very hard and massive, while on the lime stone it gradually passes into pisolitic ones with lesser amount of clayey material. The laterite on shale is soft and clayey and more ferruginous.

**(D) Aluminum** - The aluminum deposits in the area are mainly confined to all along the flood plains of Sheonath Tandula and Kharun rivers. The thickness of aluminum varies from 5-15m. These are comprised mostly by gravels, coarse to fine sand, clay, silt and Kanker. The colour varies from brown to dark grey. Aluminum consisting of fine to medium grained sand derived from catchment.

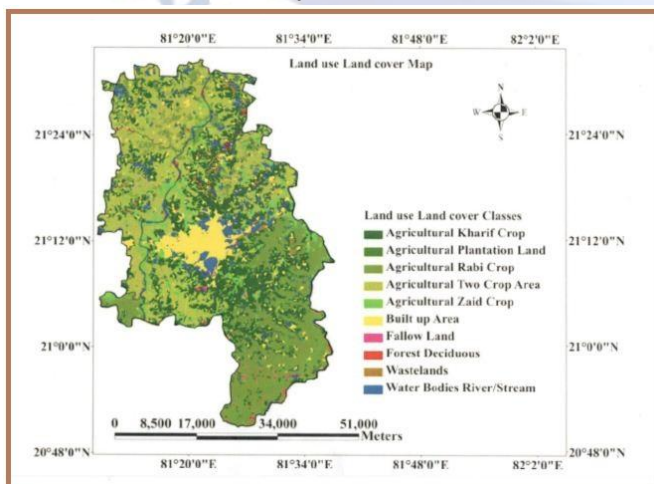
### Study of Land Use - Land Cover change in the Durg-Bhilai Twin City study area

As we know due to human activities, the Earth surface is being significantly altered in some manner and it will continue in the future as well. We can see the profound effect upon the natural environment this is the impact of man's presence on the earth and his use of land thus resulting into to an observable pattern in the land use land cover onetime. To understand the influence of

men's activities on natural resource base over time viewing the Earth from space is now crucial. Observation of the earth from space provide information of human utilization of the landscape in situations of rapid and unsecured of human utilization of the landscape in situations of rapid Land use change. Following is a change statistics during the period of 2010-2020.

S. No.	Land Use Land Cover 2011 April	Land Use Land Cover 2021 April	Change Value	Area(Sq. Km.)
1.	Agriculture	Builtup	Agriculture to Builtup	2.59
2.	Agriculture	Wasteland	Agriculture to wasteland	57.94
3.	Agriculture	Water body	Agriculture to water body	0.67
4.	Wasteland	Builtup	Wasteland to Builtup	34.39
5.	Wasteland	Agriculture	Wasteland to Agriculture	3.11
6.	Wasteland	Water body	Wasteland to Water body	6.02

After study of 10 years' data from 2011 to 2021 it is found that 34.39 Sq. Km. wasteland and 2.59 Sq. Km. agriculture land is converted in to builtups and settlement area, it happens due to increasing population and their need of shelter, as the population increase agriculture land which is situated near city area become destroy for settlement and industrial purpose. In Durg-Block 57.94 Sq. Km. agriculture area converted into a wasteland and 3.11 Sq. Km. wasteland converted in agriculture land and one of the positive result seen related to water resources is 0.67 Sq. Km. area of agriculture land and 6.02 Sq. Km. of wasteland converted into water body.



### Hydrogeological Study of the area i.e. Durg- Bhilai Twin City

Hydrologically Durg Bhilai twin city can be assorted into Pre-Cambrian sedimentary province. It includes Chhattisgarh supergroup of rock of upper Proterozoic age of marine origin. This province occupies whole study area incorporating Durg Block. As mentioned earlier it mainly consist of arenaceous, argillaceous, calcareous rock and are lead by limestone /dolomite and calcareous shale. In this formation ground water appears under water table, semi confined and confined condition. The weathered cavernous and fractured part of the formation established the aquifers in the area.

These formations are most latent in regards to the ground water yield and development. In this province, cavernous zones sometimes initiate just after soil horizon particularly in the stratified calcareous rocks along the bedding. These caverns implement good channels for ground water movement when for from residual days but many times the solution channels are replete with residual clay and cause hindrance to ground water movement. All the Formation in the study area is productive (Singh & Shivastava 2017)

### Well inventory data collection, preparation of groundwater contour map and its interpretation

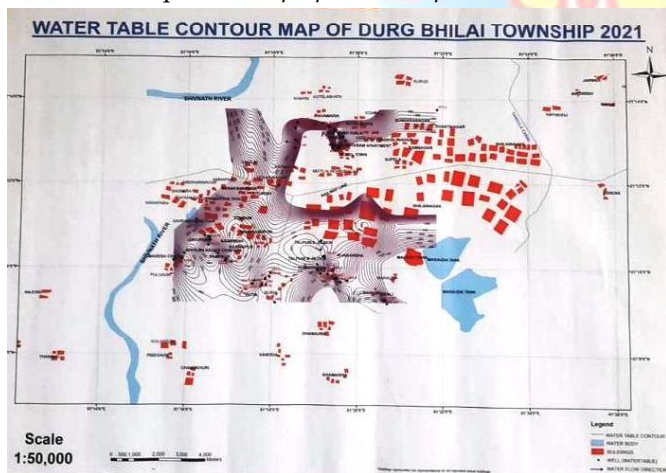
Well inventory is a method of analyzing the well cuttings and inner surfaces of open dug wells to know about the surface geology, structure, seepage zones, and fluctuation of water levels rate of recovery after pumping and the geo-environmental setting of the Wells in a region.

The collection of inventory data has been done in the study area Durg Bhilai twin City. The collected well inventories include height of parapet, total depth of well, Diameter of well, GPS co-ordinate of the wells in latitude longitudes.

During the collection of the well Inventory data some of the points have been taken into consideration-

- Dug well or tubewell has been regularly use by the people. It is important in the point of view that the amount of water is continuous replenished by the way which make it sure that water table in well is directly affected by the water level of the aquifer

- The distribution of Dugwell/tubewell should cover the entire study area. It is important because the proper distribution of well/tubewell is necessary to interpolation of mid value in the process of preparation of groundwater contour.
- The water level depths of Dugwell/tubewell were collected using water table indicator instrument.
- After collecting the very inventory data from study area, all data is tabulated in the table.
- The height of the parapet is subtracted from the data to know the actual depth of water from the stone surface.
- The R.L. (Reduced level) from mean sea level in meter of groundwater table is measured for water table depth by subtracting the depth of water table (DTW) from MSL (mean sea level) height of well. The results are shown in the table.
- The field photographs were collected from field during by collection of well inventory data.
- After collection of all well inventory information ground water table contour map is prepared.
- Well inventory data from 64 tubewells from Durg Bhilai twin city have been collected and water table contour map has been prepared. (Map No.3 )



**On the basis of interpretation of groundwater table Contour map following interpretation has been drawn-**

- The deepest groundwater level was found is 55.65 m. in Surya Vihar and 55.20 m. in Smriti Nagar Bhilai and the shallow groundwater level was found in 1 metre depth in Anand Vihar Borsi Durg.
- In some areas nearest to Tandula Canal and Talpuri area Padmanabhpur, Borsi, because of continuous recharge of groundwater through these water bodies, underground water level is increased. This area is not facing any acute problem of water scarcity.
- In the Northern portion of the study area i.e. Smriti Nagar, Surya Vihar Junwani and Model town, water table Contour map indicates steep slope, therefore problem of water scarcity in summer season has been noticed in the area. In most of the tubewells in the above mentioned area the Depth of ground water level in Surya Vihar tower-1 phase-2 (55.65 m.) Surya Vihar Shankar Garden Bhilai (20.65m.), Chauhan Town (12.45m.), Lotus Arcade, Junwani Bhilai (14.95m.) Dream Home office Block Smriti Nagar Bhilai (55.31m.) Chauhan Green Valley (9.35 m) building, Smriti Nagar Bhilai (15.12m) respectively.
- Similarly, in the areas like Rishabh Nagar complex, near Ganjpara Durg, groundwater mound has been observed in the water table contour map. It indicates that flow direction of water is towards all the directions from Rishabh Nagar complex. Due to this, the water table in this area is 20.15 m in the Mahesh colony, Rishabh OXYX in front of Mahesh colony indicates 12 m gwl, Rishabh South City (14.32 m.) and Rishabh Prime City (8.22m.). As shown in the water table map of the study area the highest RL value of the Rishabh Nagar complex is 340 m, which is surrounded by the Contours of lower value like 330,320,310 meter Consecutively. Flow direction of groundwater is also shown in the map. Therefore, as for as groundwater development is concerned Smriti Nagar Junwani, Surya Viharis not suitable. District Administration and Builders have to consider this point seriously in future.
- In the areas of like Kasaridih in Durg, there is a structure like ground water basin has been observed in the map, which represents that the groundwater is flowing towards Kasaridih from nearby areas like Padmanabhpur, Potiya, Civil lines. So we can interpret that the Kasaridih area is suitable for further ground water development.
- The considerable spacing in the area between water table contours in the Padmanabhpur, Borsi, Vidyut Nagar area indicates gradual slope of ground water. These areas are suitable for further ground water development in future.
- In Talpuri Housing Board Colony, Block-A and Block b area as per the water table contour map indicates groundwater basin structure. It is mainly due to huge

water body named as Talpuri and Thagda Dam. Due to continuous recharging of water from all the sites, groundwater basin structure has been developed. In this area 210m. RL water table contours are surrounded by 220 and more. This indicates groundwater flow direction towards Talpuri A-Block and B-Block. Distance between the contour lines also indicates gradual slope. Therefore, Talpuri area is suitable for further groundwater development.

- As for as the area Risali Bhilai and Borsi Bhata Durg are concerned groundwater table Contour are nearer to each other, which represents steep ground water slope in the area. Because of this phenomenon, there is a considerable fluctuation in groundwater table in summer and rainy season. This area is not suitable for groundwater development in future and can face acute shortage of groundwater.
- Similarly, Titurdih and Shankar Nagar locality of Durg district is also good for groundwater point of view because as per the groundwater contour map of the area, flow direction is towards in this area from outside. The value of groundwater contour ranges from 450 to 300 meter in the area. So further activities related to groundwater development can be done in the area.
- Mohan Nagar locality just near to Durg Railway station is not suitable according to groundwater availability point of view. In this area flow directions of groundwater are going away from Mohan Nagar to other locality. Distance between the groundwater contours is not very nearer, therefore it represents gradual slope in the Mohan Nagar area. Because of this gradual slope movement of groundwater towards outside direction from Mohan Nagar will be comparatively slow and minimize the groundwater scarcity problem in the Mohan Nagar area.
- In Bhilai township area in Ruabandha, the groundwater flow direction is from east to west. Therefore, groundwater basin like structure is formed near Ruabandha. St. Thomas College, BSP colony, NHPC Colony localities also have sufficient quantity of water as per the groundwater table map. Groundwater from the Maroda tank side also flows towards Ruabandha in the sector area. But due to steep ground water slope in the Risali Market area faces acute shortage of water in summer season.

- In the area like Kutela Bhata, Kohka, Farid Nagar, Vaishali Nagar RamNagar, Sundar Nagar, Shanti Nagar of Bhilai, there is a acute shortage of groundwater, because according to groundwater table map, water table Contours are very nearer to each other and hence represents steep slope in this areas. The chance of future groundwater development in the area are very less.
- In Civic center and sector 6 Market and nearby areas water table Contour are at considerable distance indicating gradual slope. Therefore, further groundwater development can be done in this area. Groundwater basin like structure is formed in Civic Centre and nearby areas. Flow of groundwater from all the directions is coming towards Civic Centre and nearby areas as a depression point. So the chance of availability of groundwater in Civic Centre and nearby areas are more.
- Motilal Nehru Nagar Bhilai also faces acute shortage of groundwater in summer season because a groundwater mound (Hill) structure has been observed in Nehru Nagar area. The direction of groundwater flow is towards all the directions from the center point i.e. Nehru Nagar. As a hydrological principle flow directions of groundwater is always from higher value contour lines to lower value contour line and is perpendicular direction from the groundwater table contour.

### **Discussion, Conclusion and Recommendations**

As mentioned earlier Durg Bhilai twin cities are fast growing cities of Chhattisgarh. Because of industrial and commercial growth, population of this twin city is increasing day by day. Due to this population pressure, there is an increase in the number of housing projects, colonies, individual bungalows, markets, schools, business complex etc. Ultimately all these factors have a direct impact on groundwater kingdom of the study area. We all know that geologically Durg Bhilai twin city is underlain by laterite, limestone, sandstone and in some parts shales too. Geological study of the study area is very much required because underlying rock play important role in the infiltration of surface water into the groundwater. If the rocks are Porous and Permeable, then they provide easy pathway for infiltration of surface water and which ultimately recharge groundwater storage. If the rocks are only

Porous but not permeable and then will act as a aquiclude formation. Which is not favourable for the increase in the ground water storage.

There are several factors which have a direct impact on depletion of groundwater level in any area. The main factors are hydrogeological properties of rocks, overexploitation of groundwater, Wastage of water in agricultural fields and washing of vehicles, machine, floors etc. Establishment of new big housing projects and colonies play adverse role in the storage of groundwater. In the Durg- Bhilai twin city, under this project we have studied borwells of approximately 64 newly developed colonies or housing project.

The present land use land cover change study gives direct picture of groundwater utilization in the study area. If we compare land use land cover change with the situation of one decade before, then we found that in Durg Bhilai twin City in area like Talpuri was used as agricultural field by Chhattisgarh Seed Development Corporation. after the construction of Talpuri Housing Board colony, Block A and Block B, there are hundreds of flats and individual bunglows are constructed. Thousands of people are residing in the Talpuri Colony at present. Because of this urbanization, there is tremendous impact on good water storage. As a standard rule, normally each adult people require 140 litre of water per day for his/her Daily routine activities. We can imagine that how much water consumption is done by the president of Talpuri colony every day. We can fortunate that there are two huge water bodies Talpuri and Thagda Dam are situated just nearby Talpuri residential Blocks. Due to continuous groundwater recharge by these surface water bodies, depletion of groundwater level can be minimized.

The area like Smriti Nagar, Pushpak Nagar, Nehru Nagar, Surya vihar and nearby areas, Model town, Chouhan town, Dream Home, Chouhan Green Valley area, steep slope in groundwater is observed in water table contour map prepared during the study. On the basis of well inventory data of the study area, it is found that Water table contours, which are very nearer to each other indicates that flow direction of groundwater is towards other direction from this Junwani and nearby area like Smriti Nagar. This indicates that in summer season, this area will suffer by acute storage of groundwater. The measured groundwater level in Durg Bhilai twin City is found in Surya vihar (55.65m) Smriti

Nagar Bhilai (55.20m.). The shallow ground water level is found in Anand vihar Borsi (1m).

Similarly, in the commercial and residential complex area of Durg city like Rishabh Nagar and Ganjpara, Ground Water Mound structure has been observed on groundwater table map prepared by us. In this area also, flow direction of groundwater is towards all directions from Rishabh Nagar complex. The depth of groundwater table in Mahesh colony is found 20.15 m and in Rishabh South City (14.32m.) Reduced level (RL) of Rishabh Nagar complex is 340m which is surrounded by the contours of lower value 330, 320 meters. Therefore, this area is not suitable for groundwater development in future.

In the densely populated area of Durg like Kasaridih, Padmanabhpur, Potia, Kelabadi Vidyut Nagar, Civil lines, there is a flow direction of groundwater towards these localities. So we can conclude that these localities are suitable for future ground water development.

The most popular area of Bhilai i.e. Civic Centre and sector 6 Markets and nearby areas, water table contours are at considerable distance indicating gradual slope. Groundwater Basin structure in formed near Civic Centre area. Therefore, further groundwater development can be done in these areas.

In the area like Kutela Bhata, Kohka, Farid Nagar, Vaishali Nagar Sundar Nagar, Shanti Nagar Bhilai, there is acute shortage of groundwater. In these areas, groundwater table map indicating steep slope in groundwater. The chances of future groundwater development are are very less in above mentioned localities.

In areas like Ruabandha, Risali sector because of presence of Maroda water tank, ground water condition is satisfactory. The flow direction of groundwater is also towards this area. So infuture water development activities can be done in this area.

### **Acknowledgement**

The principal investigator is highly thankful to Chhattisgarh State Planning Commission Raipur for providing financial support for the present study. Similarly principal investigator is also very much grateful to the Honorable Vice Chancellor and Registrar of Hemchand Yadav University, Durg Chhattisgarh for their constant support and manifold help.

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