iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** X **Month of publication:** October 2018

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue X, Oct 2018- Available at www.ijraset.com

An Integrated Study on the Geology & Geohydrology for suitable Prerequisite of Artificial recharge in Bhordi Basin of Jalna District, Maharashtra

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Abstract: Water is the essence of our planet earth. It is the most reliable source to urban as well as rural area for drinking, irrigation, industries etc. The study area is facing a huge water scarcity problem in summer season every year. This problem affects economic development as well as plants and animal in the area; hence this work can help to overcome the problem of water scarcity in study area. The available surface water resources are inadequate to the entire water requirements for all purposes. The resource can be optimally used and sustained only when quantity and quality of groundwater is assessed. A possible solution for such problems is integrated study using geology & geohydrology should be carried out in Bhordi Basin of Jalna District. There is an urgent need for artificial recharge of groundwater by augmenting the natural infiltration of precipitation into subsurface formation by some suitable method of recharge.
Keywords: Groundwater, Artificial Recharge, Infiltration

I. INTRODUCTION

The Bhordi Basin is facing water scarcity problem because of high yielding of groundwater for Drinking, Domestic & Agriculture purpose. Rainfall, geography & geology play major role in the groundwater resource availability & sustainability. The high, steep hilly ranges, isolated hillocks, undulation etc. give rise to high run off. The predominance of hard rock formation in the form of basaltic lava flows facilitates the run off rather than natural recharge due to the poor groundwater storage & low transmission capabilities. Hence study area faces water scarcity problem despite of sufficient rainfall only due to high run off & very low recharge condition. To overcome these conditions geological & geohydological study of the area is carried out & on the basis of that suitable sites for artificial recharge will be suggested.

A. Study Area

The study area fall in Longitude $75^{0}48'$ to $75^{0}51'$ E & Latitude $19^{0}59'$ to $20^{0}1'$ N of Maharashtra, District Jalna & Badnapur Taluka having maximum elevation of 659 m & Minimum of 480.75m.

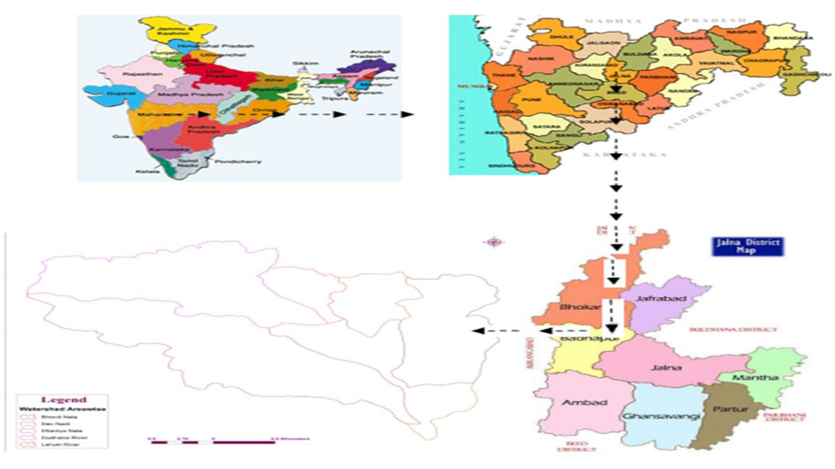

Fig 1 – Location Map of Study Area

B. Climate & Rainfall

The study area has a sub-Tropical climate, in which the bulk of rainfall is received from the southwest monsoon, between June to September. The average annual rainfall of the district ranges between 650 to 750 mm. The study area often experiences drought with rainfall recording as low as 400 to 450 mm. The rainy season is followed by winter, which last up to February, during which the minimum temperature ranges between 9 to 10 c and maximum temperature ranges between 30 & 31C. The winter is followed by hot summer, which continues up to June. The maximum day temperature ranges between 42 & 43 C's during summer.

C. Ground Water Potential Of Study Area

The major part of the study area forms the moderately dissected basaltic plateau, which has moderate to poor groundwater potential. The northern part forms the highly dissected basaltic plateau; the ground water potential is expected to be poor. Good potential pockets for groundwater exploitation are expected along the lineaments. The narrow alluvial deposits along the basin also form potential zones for groundwater exploitation. The area is suitable for groundwater exploitation through dug wells.

D. Geology Of Bhordi Basin

Deccan traps are a thick pile of basaltic flows, horizontally disposed and apparently more or less uniform in composition. Each individual flow is a typical section, which varies from porous weathered base to a massive middle unit, becoming increasingly vesicular towards the top. The groundwater occurs under water table and semiconfined to confined conditions in Deccan Trap Basalt. The vesicular units in different trappean flows range in thickness from 2-8 meters and have primary porosity. However, the nature and density of the vesicles, their distribution, interconnection between the vesicles, and depth of weathering and topography of the area is the decisive factor for occurrence and movement of ground water in these units. Since the zeolitic units in vesicular traps are highly Susceptible to weathering, in massive unit of Deccan Trap Basalt, ground water occurs in weathered mantle, joints, cracks and other weaker zones. The upper portion of the massive traps show persistent spheroidal weathering and exfoliation which helps in retaining more ground water in these rocks in comparison to compact massive unit. The storage of ground water in compact massive unit totally depends upon the presence of joints and their nature, distribution and interconnection.

Four major types of flows constitute the Deccan Trap basalts.

1) *Compact Basalts:* Compact basalt flows are always thick and extensive having tabular forms. The thickness of flow varies from 2 meter to 12 meter. Its top surface is hydro-thermally altered purple to green colour which is vesicular or amygdaloidal and free from jointing. Due to jointing rock has dissected appearance. There may be variation in the pattern of jointing and joint spacing. Joints may be closely spaced or broadly spaced and sometimes may not be interconnected.

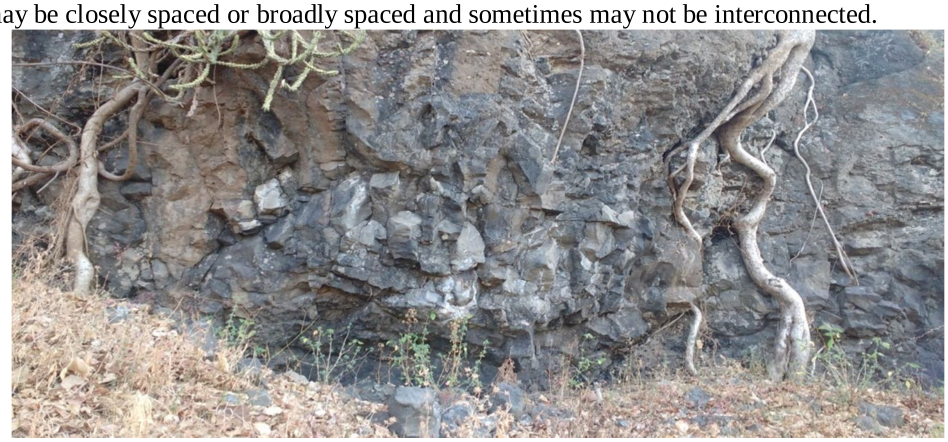

Photo 1 - Compact Basalt

2) *Amygdaloidal Basalt:* On the basis of the thickness and lateral extent amygdaloidal basalt flows are mainly grouped into two categories viz. thin irregular amygdaloidal basalt flows having maximum thickness upto 6 meters and lateral extent upto few kilometres and thicker amygdaloidal basalt flows having thickness upto 15 meters and lateral extent upto few kilometres and average thickness between 5 to 10 meter. Both these flows are characterized by bulbous irregular form, rapidly pinching out, and presence of ropy top surface and pipe amygdales along the bottom of the flow. However, these are un-jointed when fresh and amygdaloidal throughout its thickness. Sometimes middle and bottom portions of these flows are free from vesicles and amygdales in which jointing is developed. Volcanic Breccia it is heterogeneous rock in which angular fragment of different Types of basalt are held together either in red tachylitic matrix or in zeolitic matrix or in grey lava matrix. It has limited field occurrence in the terrain.

Photo 2 – Weathered Amygdaloidal Basalt

3) *Volcanic Breccia:* In the Deccan Traps vesicular basalts are rare as most of them have been converted into amygdaloidal basalts by the filling of vesicles by secondary mineral. True vesicular basalts with open gas cavities are rare and the amygdaloidal basalt is widespread. As the vesicular basalt is unjointed fresh and compact they are quite impervious.

Photo 3 – Volcanic Breccia

4) *Red Tachylitic Basalts:* Tachylitic basalts are basaltic glass formed due to rapid cooling and chilling of the lava. It has very much closely spaced mutually perpendicular with three sets of joints. Tachylitic basalts have different shades of colour, such as red, green, brown and black. However, red color is very common. They occur as thin band and pockets and lenses between the lava flows and also as irregular, thin intrusion in the top portion of the flow, when Tachylitic bands occur between the flows their thickness varies from a few centimetres to sometimes upto 3 m. The peculiarity of the Tachylitic basalts is that, in confined condition, below the cover of rock, it occurs as quite hard, red colour rock. But only on exposure to atmospheric conditions, it disintegrates and crumples into powder like material due to opening of joints, hence on surface red colour soil occur.

Photo 4 – Red Tachylitic Basalt

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
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E. Geology of the study area

The entire study area comprises 11 flows out of which 5 flows are thick to broadly jointed Aphanitic compact basalt, 5 flows are Weathered to Sheet Jointed Amygdaloidal Basalt & one flow of thin band of Red tachylitic Basalt as follows:-

1) *Flow No. 01:* The flow is irregular sheet jointed amygdaloidal basalt with small to medium sized amygdales filled with silica and zeolites. Flow is deeply weathered and has developed closely spaced sheet jointing. Thickness of the flow is 15 ft the flow starts from RL 1600 to RL 1615 ft.
2) *Flow No. 02:* The flow is thick compact Aphanitic, hard, black, massive basalt which is broadly jointed. Thickness of the flow is 55 ft. Flow start from RL 1615 to RL 1670 ft.

Photo 4:- Compact Aphanitic Basalt

3) *Flow No.03:* The flow is thick, weathered amygdaloidal basalt due to high weathering sheet jointing is observed in the flow. Thickness of the flow is 40 ft. The flow starts from RL 1670 to RL 1710 ft.
4) *Flow No. 04:* The flow is thick compact Aphanitic, hard, black, massive basalt which is unjointed. Thickness of the flow is 35 ft. Flow start from RL 1710 to RL 1745 ft.
5) *Flow No. 05:* The flow is irregular sheet jointed amygdaloidal basalt. Flow is deeply weathered and has developed closely spaced sheet jointing. Thickness of the flow is 35 ft the flow starts from RL 1745 to RL 1780 ft.
6) *Flow No. 06:* The flow is thick compact Aphanitic, hard, black, massive basalt which is broadly jointed. The top portion of the flow is hydrothermally altered Thickness of the flow is 55 ft. Flow start from RL 1780 to RL 1835 ft.
7) *Flow No.07:* The flow is thin band of Red tachylitic basalt having thickness of 2 ft. This flow is hard & glassy. The flow Starts from RL 18335 to RL 1837 ft.
8) *Flow No.08:* The flow is sheet jointed amygdaloidal basalt which is porous & permeable due to development of sheet jointing. Thickness of the flow is 23 ft. from RL 1837 ft. to 1860 ft.

Photo 5:- Weathered Amygdaloidal Basalt

9) *Flow No.09:* The flow is compact Aphanitic broadly jointed basalt which is hard, compact & impermeable having thickness of 29 ft. from RL 1860 ft 1889 ft.
10) *Flow No. 10:* The flow is irregular sheet jointed amygdaloidal basalt. Flow is deeply weathered and has developed closely spaced sheet jointing. Thickness of the flow is 21 ft the flow starts from RL 1889 to RL 1910 ft.
11) *Flow No.11:* The flow is compact Aphanitic broadly jointed basalt which is hard, compact & impermeable having thickness of 47 ft. from RL 1910 to ft 1957 ft.

F. Thematic Layers

The thematic maps like DEM, Contour, Drainage and Geomorphology maps of Bhordi basin are prepared as shown in fig. 2, 3, 4 and 5. These maps are prepared by using Remote Sensing and GIS techniques. DEM Map shows 3D elevation of the area. Contour Map shows the maximum and minimum elevations of the study area. Geomorphology map shows the physical features present in the are which helps to know the geography of the area.

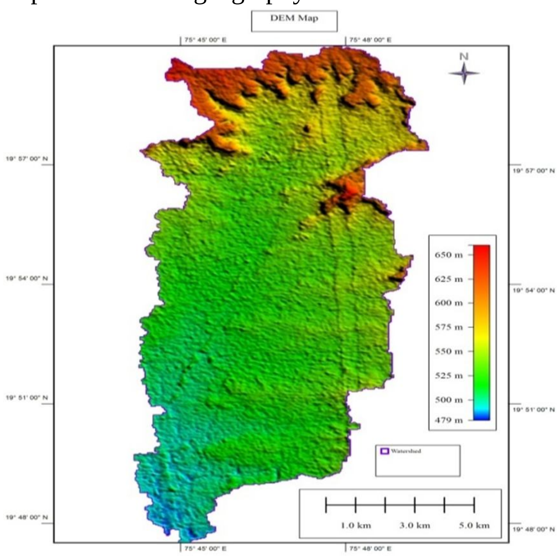


Fig 2 – DEM Map of Study Area

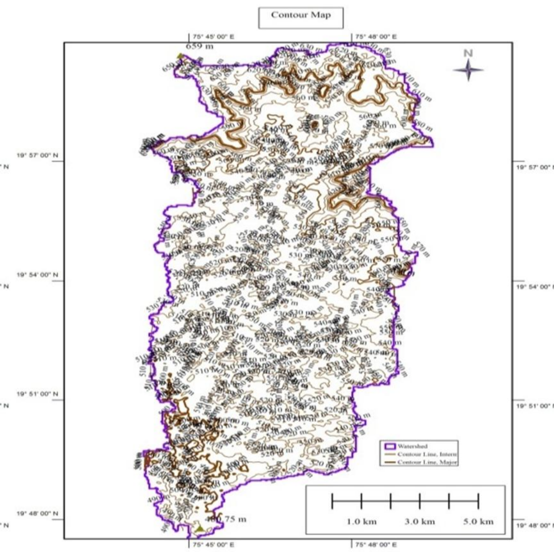


Fig 3 – Contour Map of Study Area

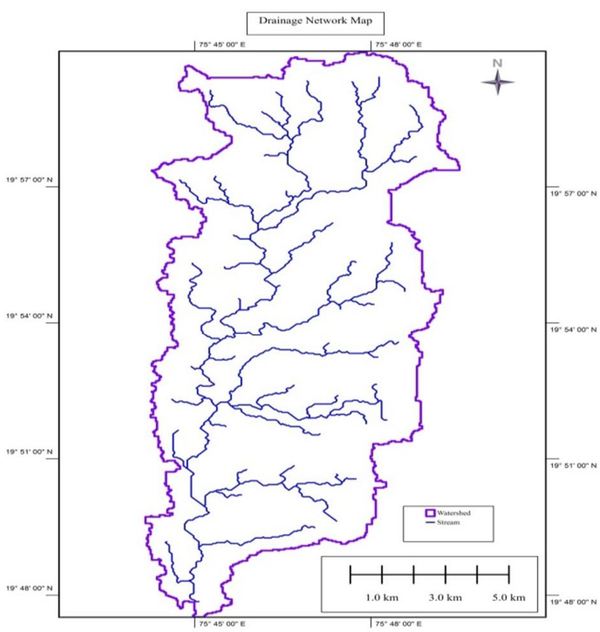


Fig 4 – Drainage Map of Study Area

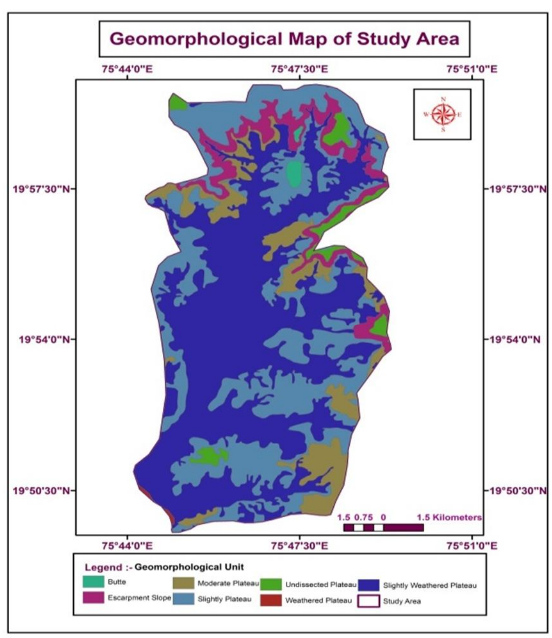
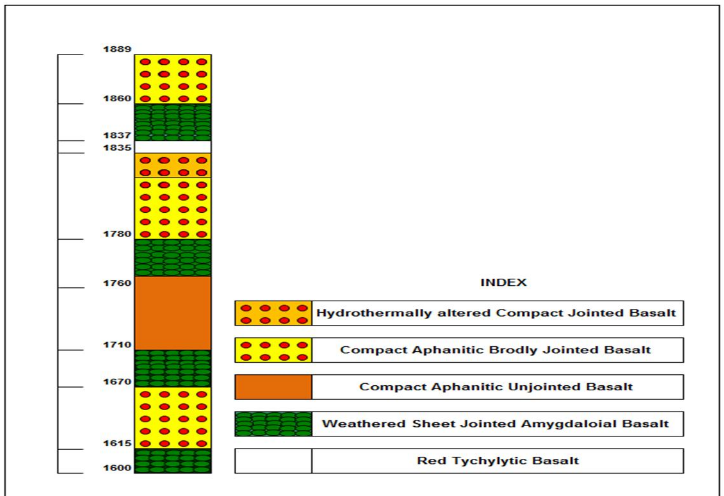


Fig 5 – Geomorphology Map of Study Area Area



Litholog of Study Area

II. GEOHYDROLOGY OF BHORDI BASIN

Ground water occurs in the open spaces of basalt such as joints, fractures and spore spaces etc. The capacity of basalt to hold groundwater depends upon porosity, permeability of rock which depends on spore spaces, joint spacing and jointing pattern. If joints are closely spaced and interconnected, rock is highly permeable and can transmit water. If the joints are broadly spaced, permeability is less and such rock holds small quantity of water. These joints become watertight at some places and not allow further percolation of water. Top portion of compact basalt flow up to certain depth is always hydrothermally altered, vesicular and amygdaloidal. This portion is unjointed when fresh. But due to heavy weathering sheet jointing is developed in it. On the other hand amygdaloidal. Basalt is free from jointing. It is susceptible to weathering if it contains mineral chlorophyte. Due to weathering it always develops sheet jointing through which heavy percolation is possible only up to shallow depth. Top portion of amygdaloidal basalt is gray and hydrothermally altered. It is very hard and tough when fresh. Hence possibility of percolation in it depends on thickness of weathered zone. Basaltic lava flows create the bulk and constituent which are most important aquifers. Openings within or between the flows are responsible for high permeability in general.

Village Name	Well No.	Depth	Diameter	Pre & Post Monsoon Data of Depth of Water Tables in Various Villages									
				May-14	Oct-14	May-15	Oct-15	May-16	Oct-16	May-17	Oct-17	May-18	Oct-18
Anwi	1	13.1	7.1	13.1	10.6	12.9	11.1	12.1	11.3	12.9	10.9	12.7	10.9
	2	14.9	4.2	14.3	9.8	13.4	9.6	13.4	8.6	13	10.1	14.3	10.9
	3	13.5	3.1	13.3	9.1	13.2	9.3	13.1	10.6	13	9.6	13.2	11.1
Hiwra	1	13.8	4.6	13.5	8.7	13.1	8.9	13	8.1	13.6	9.2	13.4	10.2
	2	22	10.6	20.9	8.8	14.6	9.1	18.9	10.1	19.1	9.4	20.4	12.6
	3	20	4.3	18.4	12	16.6	14	17.9	11.8	18.6	11.5	18.1	13.1
Rala	1	19.8	5.2	19.4	11.2	19	9.1	19.1	9.6	19.5	10.9	19.1	11.2
	2	20.8	5.2	19.1	12.2	19.2	12.7	20.2	11.9	19.8	12.5	19.7	12.1
	3	27.4	4.6	26.4	15.9	26.1	15.2	26.2	15.7	26.4	16.1	27	15
Najik Pangri	1	24.1	4.6	21.9	15.9	22.3	15.5	22.5	15.3	21.5	16.4	22.9	15.9
	2	19.8	3.9	18.1	12.7	18.9	14.2	19.1	14.9	17.1	13.9	19.1	13.7
	3	19.1	4.2	18.2	11.9	18.5	13.2	18.5	13.7	17.5	14.3	18.7	14.5
Keligavhan	1	14.9	4.2	14.3	7.8	13.4	8.6	13.7	7.8	11.8	9.2	13.4	7.6
	2	19.2	4.9	17	12.6	17.6	11.2	19.2	13.1	17.8	12.9	18.9	12.2
	3	13.5	5.1	11.9	8.9	12.1	8.5	12.5	7.9	11.7	8.1	12.9	8.2

Table 1: - Water Table Data in Dugwells of Study Area

1) *Dugwells located in Compact Basalt Flow:* The water percolates through compact basalt only when joints & fractures are developed in compact basalt. In upper portion of compact basalt joints open up & gradually close towards lower portion but it also varies depending upon the geography of the area. At these places like in the low lying area joints are open up in lower portion also.
2) *Dugwells Located On Amygdaloidal Basalt:* The yielding of dugwell in amygdaloidal basalt depends upon the thickness of aquifer lateral extent of sheet jointed weathered zone. A dugwell can yield more if the thickness of weathered zone is more. But if thickness of weathered zone is less then water diminishes after rainy season.
3) *Dugwells Located In The Top Portion Of Compact Basalt:* Top portion of the compact basalt flow is always hydrothermally altered and amygdaloidal which is hard, compact, homogeneous & watertight in nature. Water percolates only when secondary porosity is developed in the form of sheet jointing due to weathering in the rock.

III. CONCLUSION

Based on surface geohydrological survey and well Inventory survey, data preparation of litholog and geological maps has been prepared indicating various flows occurring in the area. Their geohydrological characters favourable or unfavourable for percolation of water have been discussed here. The groundwater availability quantitatively is limited. Availability of groundwater depends on quantum of rainfall, which percolates into the rocks, but in Deccan Trap availability of the groundwater depends on a numbers of factors. As traps are hard rocks, availability of groundwater is trapped in the fractures and is structurally controlled.

Along with rainfall, geological, geomorphological, geohydrological and infiltration rates are also important parameters for the availability of groundwater. Conventional geological, geohydrological studies, remote sensing and Geographical Information System have been integrate to arrive at optimal solution to the problem of water scarcity in Bhindon village. Geological survey and well inventory survey of various wells have thrown light on geohydrological characters of the rocks presents in the study area.

IV. RECOMMENDATION

The study area comprises of impermeable formation of broadly and some unjointed aphanitic basalt covering about 70-75% of the study area. Due to broadly jointed flow which are not interconnected with each other and some flows are unjointed aphanitic basalt, there is no possibility of percolation of water from this portion of study area. Hence, this portion is not suitable for artificial recharge. This area is an elevated portion and on the steep slope side, runoff of rainwater takes place.

Central & some part of lower portion of the study area consist of amygdaloidal basalt, which is highly weathered and has developed joints. Hence, the possibility of percolation is high. Geographically this central portion of area is a low-lying area. Hence, there is limitation on construction of artificial recharge structure. Hence, 20 to 25 % of the study area i.e. central low-lying area is suitable for artificial recharge structure.

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