International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

The Climate-Resilience and Profitability of Farming Systems Studying detail Hydrogeology of the Watershed BM-01, Tuljapur, Osmanabad, Maharashtra, India

Megha Shinde (Daga)[1], Chandrakant P. Bhoyar[2]

[1]Assistant Geologist, GSDA, Osmanabad, Maharashtra, India

[2]Senior Geologist, GSDA, Survey Section, Pune, Maharashtra, India

Abstract: ***Rainfall variability causes serious threats such as flood and drought which has severe impact on crop production, productivity, availability of water and biodiversity. The present study based on the climate-resilience and profitability of farming system studying the detail hydrogeology of the Tuljapur taluka especially in the watershed BM-01. This paper present the brief hydrogeological review on the Water level, Rainfall, existing water conservation structures and cropping pattern of the studied area which can be useful for applications of the groundwater management plan of the said watershed and similar studies can be adopted worldwide to maintain water level depletion also.***

Keywords: Groundwater, demand and supply, water level, Rainfall, water conservation structures, Watershed, crops, farmers, geology, hydrograph

1. Introduction

The global population is increasing rapidly and expected to touch the 9.5 billion mark by 2050 from the current 7.2 billion. The management of the groundwater resources is a challenging task worldwide against the backdrop of the growing water demand for industrial, agricultural, and domestic uses and shrinking resources. Moreover, this task has been hampered significantly due to declining/rising groundwater levels, rainfall pattern and associated contamination. A broad range of solutions could be considered to address the aforementioned problems of groundwater management strategy. Groundwater is a major component of public water supply and water use in the Osmanabad district. The groundwater systems underlying present study area is phreatic and dynamic, thus responds to the balance between supply (precipitation) and demand (draft). Anthropogenic activities, such as excessive groundwater extraction for irrigation, domestic purposes are created a condition of lowering of water levels in an aquifer. These effects might manifest themselves locally, but can extend over larger areas limited to the area occupied by aquifer due to intensive extraction of groundwater. Moreover, changes to the landscape occurring from alteration of the land cover can also have a significant influence on aquifer water levels by changing the ability of precipitation to recharge the subsurface. Apart from anthropogenic activity, there is large-scale climatic effect that affects adversely on the groundwater regime of Osmanabad district. So the Groundwater estimation and recharge plan is needed to implement in the studied area.

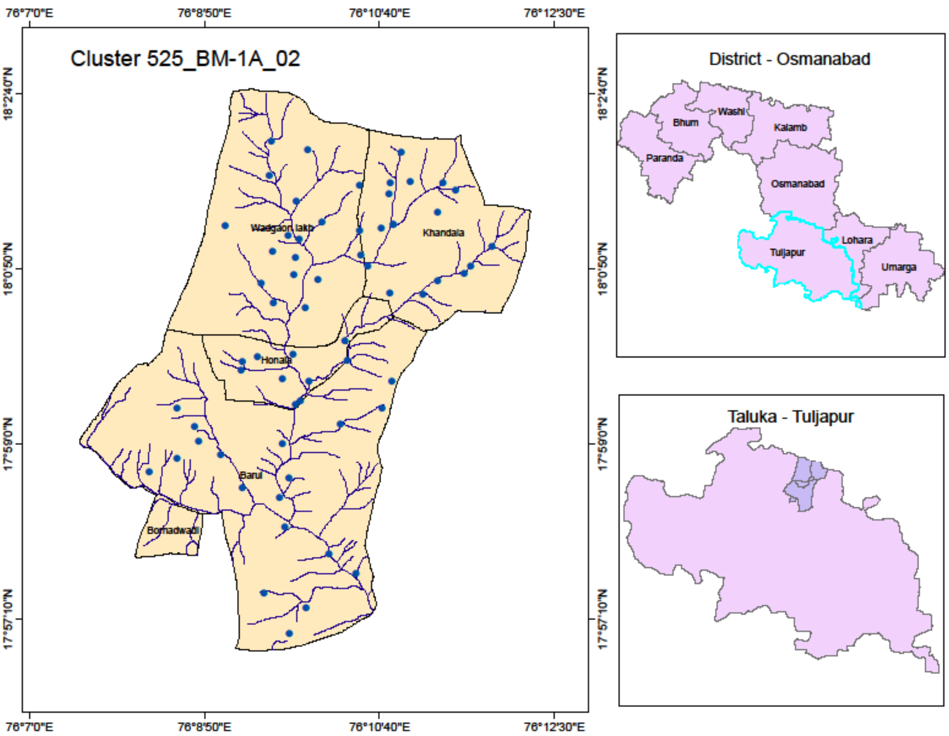
Groundwater is a natural resource with both ecological and economic value and is of vital importance for sustaining life, health and integrity of ecosystems. This resource is increasingly threatened by over-extraction which has insidious long-term effects. Scarcity and misuse of groundwater pose a serious threat to sustainable development and livelihood. The availability of groundwater is extremely uneven, both in space, time and depth and so will be the case in future. The uneven distribution of groundwater in the district especially BM-01 watershed can be mainly attributed to highly heterogeneous lithology and regional variation of rainfall. Because of variations in their basic characteristics; physiography and variability in the rainfall, there are limitations on the availability of groundwater. Though there is unanimity about this, there is still considerable difference of opinion among the scientists about the precise degree of these limitations. In order to assess the availability of groundwater and to ensure maximum accuracy in groundwater estimates, the Central Government and state government has, from time to time, appointed committees comprising groundwater experts and Geoscientist and has laid down guidelines for this purpose. The total demand for water from the groundwater domain is increasing day by day. The main reason for this is the self reliance being experienced by users of groundwater. But as this is leading to inexorable withdrawal, and as the status regarding total availability of groundwater is of uncertain nature, it is imperative to give more serious thought and a new direction to groundwater planning and management in Osmnabad district of Maharashtra. The present study provide the basic data base for Groundwater planning in Watershed BM-01 of Tuljapur Taluka for future study.

2. Background of the study area

Osmanabad is drought prone district in the Marathwada Region of Maharashtra State. It is situated in the southern part of the State abutting Andhra Pradesh in south and lies between north latitudes 17°37'to 18°42' and east longitude 75°16'to 76°47'. The total area of the district is 7569 sq. km.

and falls in parts of survey of India degree sheets 47 N & O and 58B &56C. It is located about 600 meters above the sea level. It is bounded by Solapur district to the South-West, by Ahmednagar district to North-West, by Beed district to the North and by Latur district to the East. The famous **Tulja bhavani** temple at Tuljapur is situated in Tuljapur block in Osmanabad district. Sina River flowing towards south-south east before joining the Bhima River, a tributary of Krishna River, drains the western part. The Bori River flows through Tuljapur block and join the Sina river further south in Solapur district. Based on geomorphological setting and drainage pattern, the district is divided into 41 watersheds.

The watershed BM-01 in Tuljapur Taluka of Osmanabad district is one of the study areas identified for to enhance the climate-resilience and profitability of smallholder farming systems in project area in Nanaji Deshmukh Krushi Sanjeevani Prakalp, Mumbai and to frame groundwater recharge plan for the study area. Groundwater being the main source of irrigation in the area for providing protective irrigation during dry spells of rainy season and for rabbi and perennial crops also, the study of groundwater system, its behavior, recharge and withdrawal, and possibilities of groundwater recharge is undertaken in this study area. The studied watershed consists of 5 villages namely, Barul, Bornadwadi, Honala, Khandala, Wadgaon Lakh having census number 561544, 561546, 561546, 561545 and 561539 respectively. The cluster is located in quadrant B-1, C-3, B-3 of the Topo sheet no.56C/1, B/4 with latitudes extending from N17^{0} 58’ 30” to N18^{0} 00’ 50” and longitudes extending from 76^{0} 09’ 45” E to 76^{0} 00’ 00”E. The area is included in mini watershed no BM-01 (3/11). As per the Groundwater Resource Estimation (GWRE) 2019-20, the watershed is categorized as Safe with Stage of extraction 55.90% respectively. Total area of all included villages (in Ha) is 4664, Total Cultivable area of the study area (in Ha) is 4431, Total population (Human) of the Study area 6398, No. of Households in the Study area is 1441, No. of Land Holder in the Study area-1673, Average land holding size per house hold of the Study area to 1 to 2 Ha, Total no. of Dug wells-529 Bore wells-703 Farm ponds-12 in study area. Total cattle population of the study area-4954, Dairy, Goat farming, Poultry Agriculture allied business, No. of drinking water supply sources in all villages, Dug Well-not seen, Hand Pump-19, PWS-DW-06, and PWS-BW-15. All of three villages are depended on Groundwater for drinking water supply. Total Domestic water requirement for Human (7453 × 365× 60 lpcd) as per GEC 2015 is 0.3838/Day TCM, and 140.11/ Annum in TCM. On the other hand, total Domestic water requirement for Cattle is (6939 × 365 × 30 lpcd) is 0.148/day in TCM, and 54.24/ Annum in TCM. Total Domestic water requirement for 3 villages are 0.5318/ day in TCM and 194.35 / Annum in TCM.



Location Map of the of Study area BM-01, Tuljapur Taluka

3. Methods and Methodology

In order to study the area, baseline data collected from the villages, secondary data from different state government departments. The detail hydrogeological field survey has been carried out in the month of May-Sept 2019.

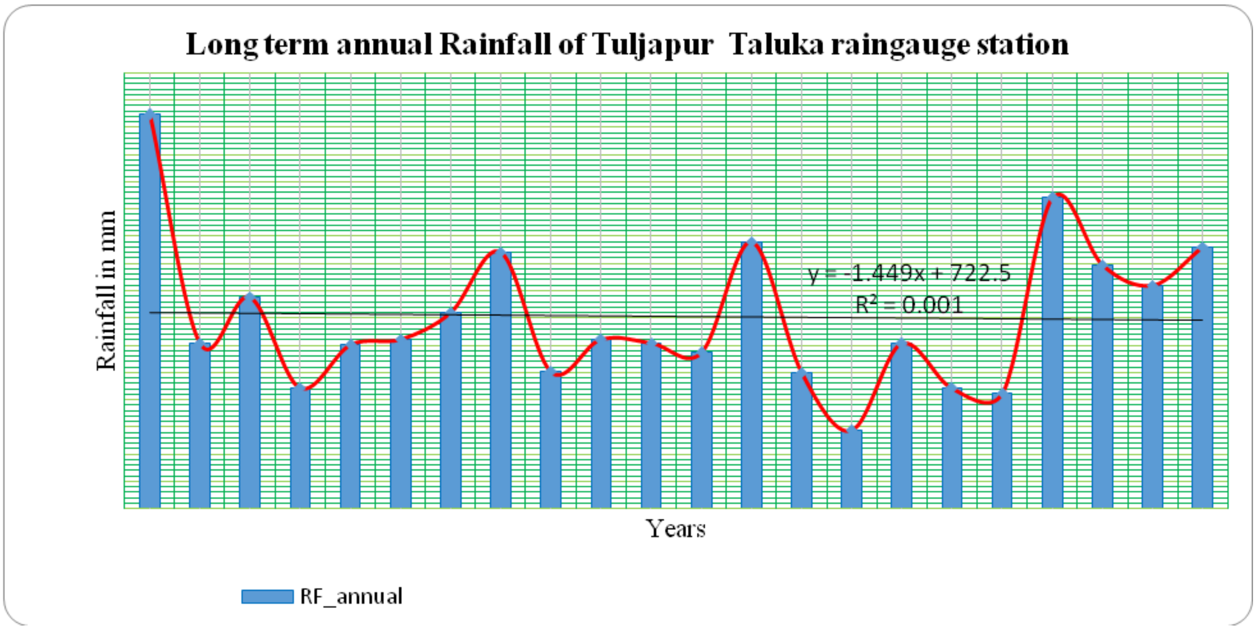
Table 1: Statues of Existing Water conservation structures

Sr. No.	Name of structure	No.	Total storage capacity in TCM	No. of Fillings	Total annual run off arrested (annual storage) in TCM
1	Cement Nala Bund	17	40.92	1	18.05+10.92
2	Percolation Tank	9	530	1	530
3	Nala deepening	4	24	1	20
4	Storage tank	1	11.00	1	11.00
5	K. T. weir	8	216.8	1	111.4
	Total	39	822.72	1	111.4

There are total 11 farm ponds existed in the cluster. Most of the farm ponds are reported to be constructed during the last 3-4 years. Out of these farm ponds 02 (29.5%) are located along the bank of streams flowing through the cluster and remaining 09 (70.5%) farm ponds are located in inside land away from the streams. It is reported that farm ponds located along the stream bank (29.5%) are filled partially by pumping run off water accumulated or drained through the streams during the rainy season and partially by groundwater pumped either from dug well or bore well; while the remaining 70.5% are filled by groundwater pumped either from dug well or bore well, as there is no scope of that much run off to be generated and accumulated in the field. Thus the farm ponds are mainly filled by groundwater which may be pumped either from dug well or bore well. Total storage capacity of these farm ponds is 31.34 TCM. These farm ponds are filled and refilled as per the availability of water and irrigation timings of the crops. Groundwater pumped from dug well or bore well is stored in farm pond and then supplied to the crop either by gravity flow or by pumping.

Hydrogeological data analysis

Name of nearest is rain gauge station is in Salgara Di Circle of Tuljapur, Taluka where Normal Rainfall is 761 mm, Monsoon RF for Taluka station in year (2019-20) is 612 mm, 75% dependable rainfall for Taluka station is 501 mm, Monsoon RF for *Circle* station in (2019-20) is 1150 mm, Rainy days in (2019-20) for *Circle* station is 57mm. Long term monsoon rainfall over the area is very much fluctuating and shows Drought prone area programme (DPAP) signatures although the normal annual rainfall is nearly 761 mm. Long term monsoon rainfall shows falling trend ([at]2.827 mm/year) for the station.



Run off estimates for the area

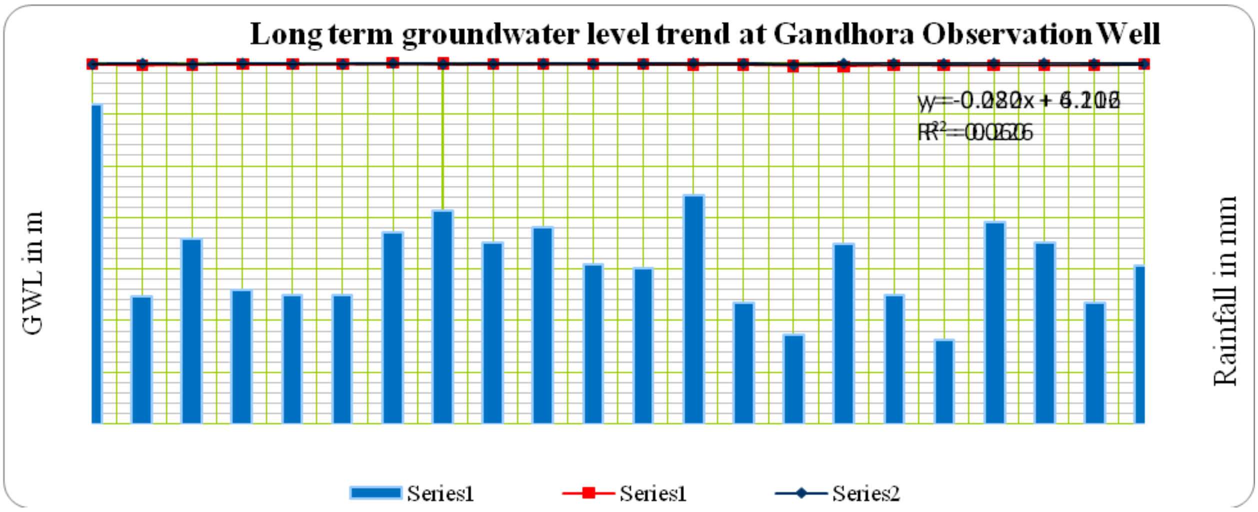
Run off for the study area is estimated by using run off coefficient obtained from Strange's table. The area is covered by black cotton soil (up to 0.30 to 0.50 mbgl) followed by highly weathered basalt up to 2 to 3 m bgl, with slope percent ranging from 0.50 to 2 % (gentle), thus as per Strange's categorization it comes under category of average catchment from run off point of view. As the annual rainfall is very fluctuating 75% dependable rainfall (return period of 1.32 years) which is the most reliable rainfall value, is considered for estimating the run off. Normal rainfall for the area is 761 mm which has dependability of 30%, while 75 % dependable rainfall for the area is 501 mm. As per the Strange's table run-off coefficient for average catchment with rainfall of 521 mm is 12% (0.12). Thus if WCS are planned by using this value, the probability of filling of all the structures will be more. Estimated value of run-off is as;

RUN OFF ESTIMATION		
1	Total catchment area (Cluster area) in Ha	4664.00
2	Aquifer area in Ha	4664.00
3	non aquifer area in Ha	0.00
4	Average annual rainfall in mm	761.00
5	75% dependable rainfall in mm	501.00
6	Average slope of area in %	1 to 2
7	Run off coefficient for the area in %	0.11
8	Run off yield from the area in TCM	2570.33
9	Utilizable Run off for harvesting in TCM = 65% of Row 8 (35% left as riparian rights of the downstrea	1670.71
10	Run off booked for existing WCS structures and farm ponds in TCM	881.36
11	Run off ultimately available for harvesting (9-10)	789.35
12	No. of fillings assumed	2.00
13	Approximate water storage capacity that can additionaly be created (50% of 11)	394.68

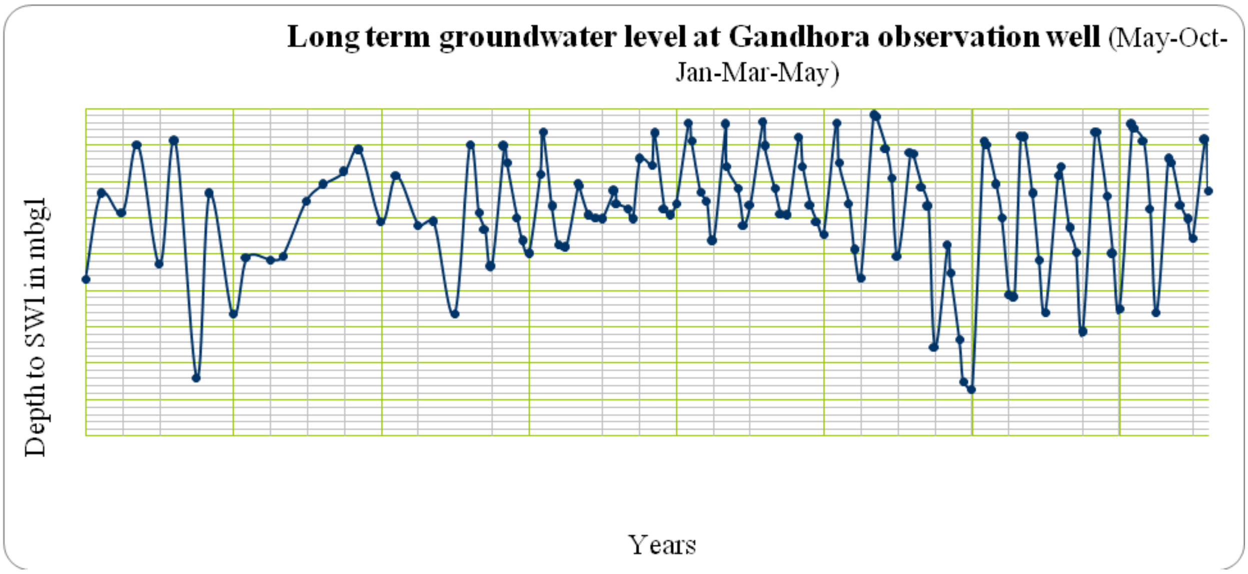
If the annual rainfall is more than the considered value with uniform temporal distribution, as in the case of year 2018 and 2019 the runoff coefficient will be more i. e.20 % for 780 to 800 mm. So the run off will naturally be more, but dependability of such rainfall and hence the run off is very less.

c. Long term groundwater level trend analysis

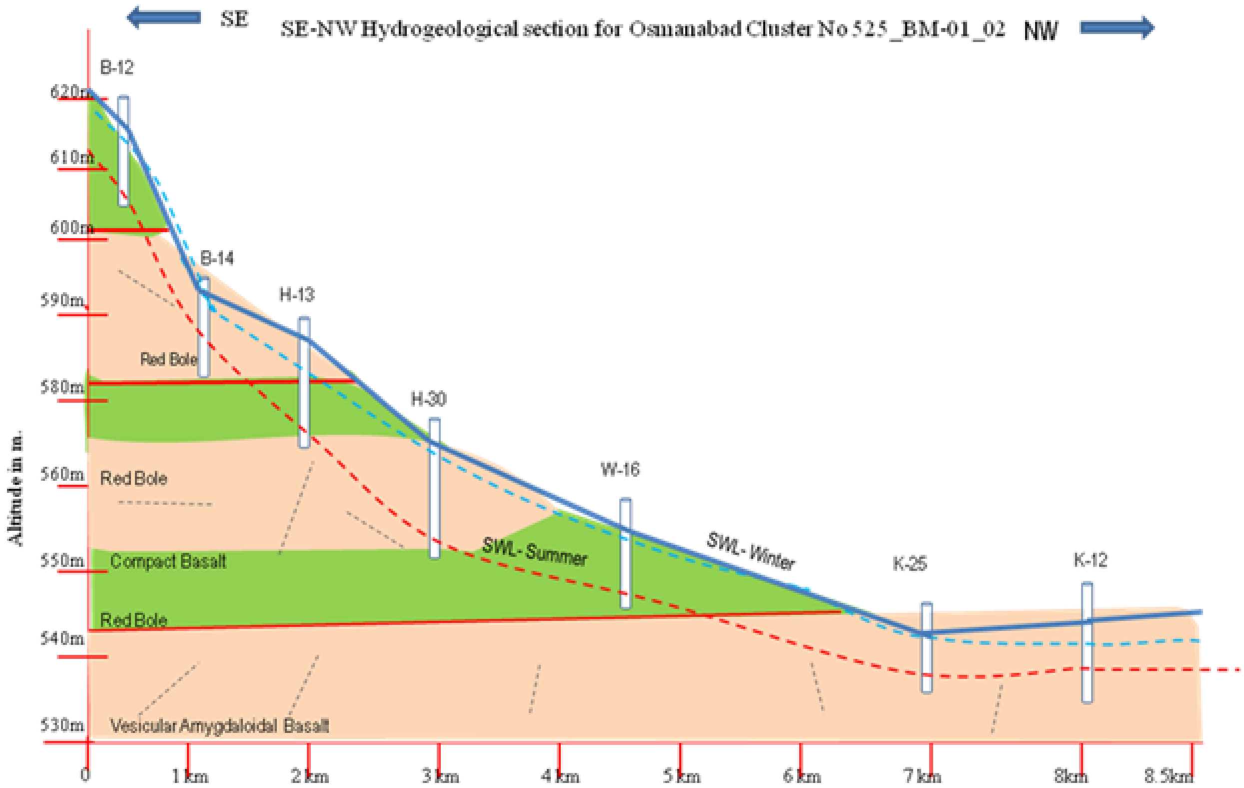
Nearby Observation well (OBW) to the area is Gandhora, which is located due south-west of the area at a distance of 12 Kms. Long term pre monsoon (summer) groundwater level shows the *falling* trend ([at]7.97cm/year) in the area, whereas post monsoon (winter) groundwater level shows the *rising* trend ([at]4.1 cm/year) in the area. This indicates that total groundwater recharge occurred by all means during the rainy season is being extracted during the non-monsoon season for all purposes; the main purpose is the irrigation.

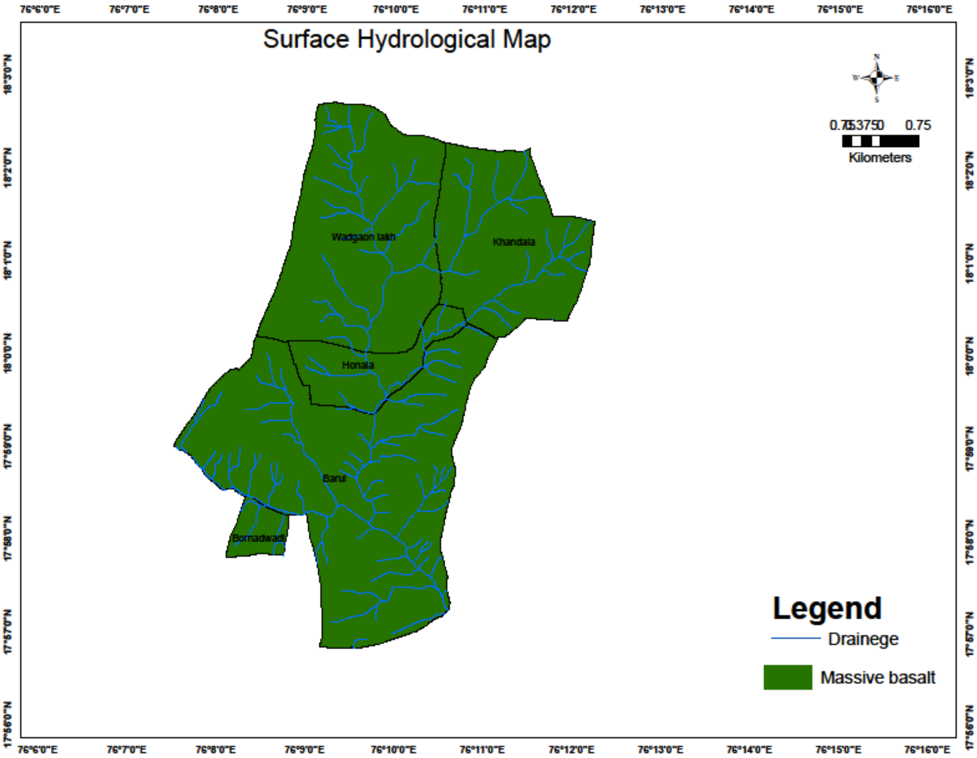


Based on the actual field work done in the area, the total no. Dug wells in three village are 254 and Bore wells are 302 which are used for irrigation purpose, Out of 254, 65 dugwell and 6 borewells are actual surveyed at the time of field course. Average depth of the Dugwells are ranging in between 15to 25 m and for borewells are 100-150 m, Average static water level (in m bgl) in Winter is 3-7m, and in summer is 8-17m. Average annual Groundwater level fluctuation is about 6m (3-9m).

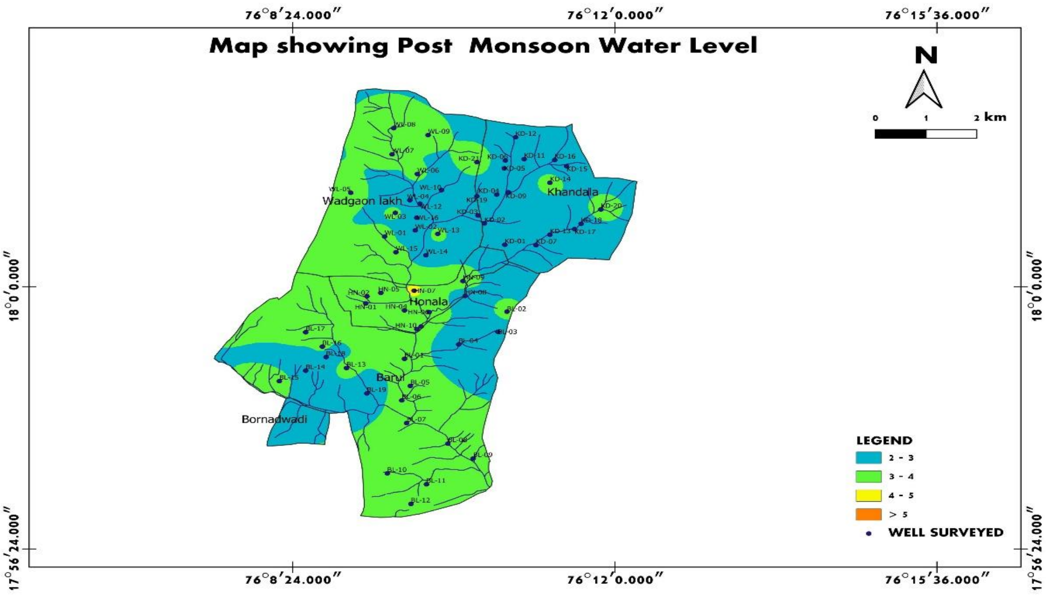


Geological traverses and well inventories:
The entire district is underlain by the Basaltic lava flows of upperCretaceous to lower Eocene age. The shallow Alluvial formation of Recentage also occurs as narrow stretch along the major rivers flowing in the areabut it does not play much important role from ground water point of view. The complete studies area is divided into the grid of 600 x 400 m. for observations of surface and sub-surface hydro geology and groundwater level measurements. Each grid comprises the area of 24 Ha, thereby dividing the complete area of 4664 Ha into the 194 grids. There are 254 dug wells and 302 bore wells in the cluster as per revenue record. One well (DW/BW) from each grid is surveyed and observed so as to cover the complete representation of the area. Accordingly 65 dug wells and 06 bore wells were observed during the field survey. Drainages were also traversed simultaneously for mapping of surface geology and water conservation structures.

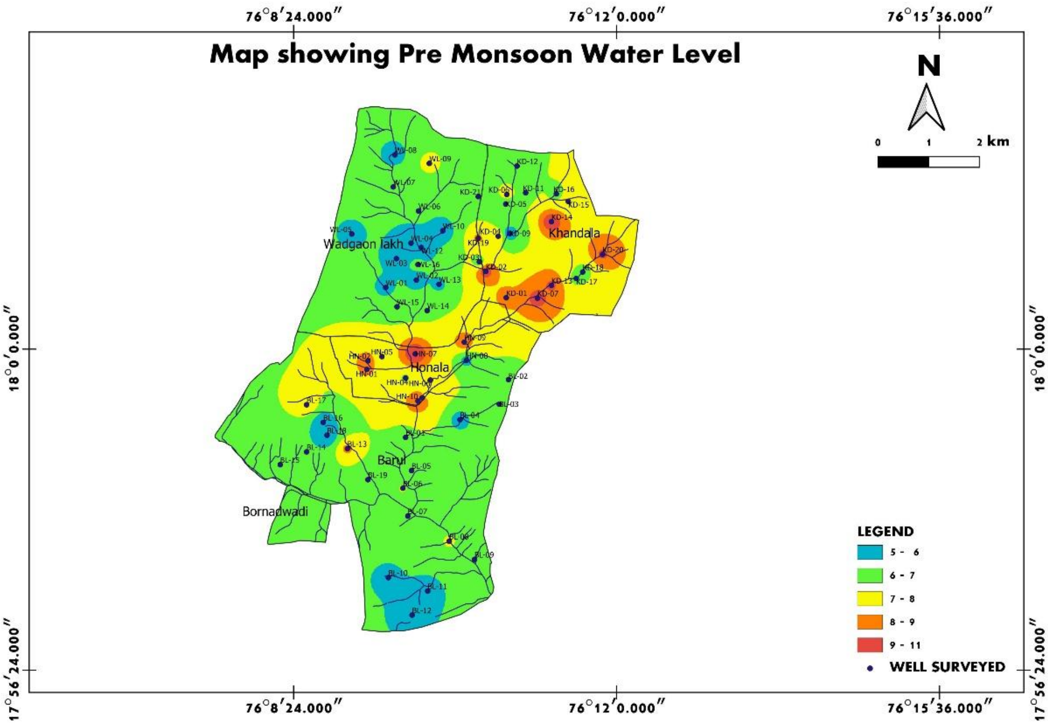




There are two aquifers are encountered in the area, one is shallow phreatic, depth ranging from 7-16m, which shows Altitude range in between 705-725 mbgl, thickness of aquifers observed in the area average 8 m, Saturated thickness of shallow aquifer in winter 8-10m and in summer 1-2m which shows three Basalt flows having average thickness of 13 to 15 m. The flows are of simple nature as the boundaries are clearly differentiated at some depths and locations by means of Red bole. Each flow has two sub units as, the vesicular amygdaloidal basalt (VAB) and the compact basalt (CB). Red bole layer or chilled margins separate the flow from each other. Weathered and sheet jointed vesicular amygdaloidal basalt (VAB) and compact basalt acts as an aquifer in the area. Vertical and sub vertical joints are also observed in the VAB and CB sub units but are not prominent enough to provide potential specific yield to the aquifer. Therefore average specific yield of the shallow aquifer in the study area is around 1.3 % (0.013) as obtained by dry season specific yield method. Below phreatic aquifer about 45-55m depth, there is another aquifer observed that is Semi confined aquifer which shows Vesicular amygdoidal basalt (VAB) and Compact Basalt (CB) with sheet joints, which shows altitude range in between 645-635 mbgl, Thickness of aquifers observed in the area average 5m, and areal extension of both aquifers observed are 4172 H. Depth to groundwater level in winter 2019 (Post mosoon) varies from 3 to 13 m bgl. However the depth to GW level between 3 to 7 m. bgl is more common. . It indicated in the diagram given below.



Depth to groundwater level in summer 2020 (Pre-Monsoon) varies from 6 to 18 m bgl. However the depth to GW level between 8 to 12 m. bgl is more common. It indicated in the diagram given below.



The study areas of BM-01 are occupied mainly by succession of basaltic lava flows belonging to Deccan trap with small alluvial patches of recent age. Flows are thick and extensive. Each lava flow is separated by the occurrence of red bole which shows time gap between two flows. The rock formations are made up of less fractured massive cap rock followed by vesicular zeolitic basalt. The upper less fractured massive basalt varies in depth from 4 meters to 12 meter and is moderately weathered up to 2 to 4 meters. The Black Cotton Soil (BC) is about 0 to 3 m thickness; underlying 3 to 6 m highly weathered and fractured basalt. This is followed by 6 to 12 m fractured and brecciated flow which is followed by jointed and massive basalt. The Balaghat plateau with slope towards southwest and south has varied topography consisting of hills, plains and undulating topography near river banks. The main water bearing formations (Aquifer) of the area are predominantly weathered, fractured and jointed massive basalt and Vesicular zeolitic portion. Due to presence of alternate flows with units of vesicular and massive basalt, the Deccan trap acts as multi-aquifer system. The massive fractured jointed basalt is predominantly acting as major aquifer system at shallow depth.

4. Discussion and Conclusion

The present study discuss about the brief hydrogeological study on the Water level, Rainfall, existing water conservation structures and cropping pattern of the studied area which can be useful for applications of the groundwater management plan of the said watershed and similar studies can be adopted worldwide to maintain water level depletion also. It is found that, there are more scope for the new dugwell and borewell as watershed fall in the safe category. (GW assessment 2019-20).

The Groundwater management plan has been proposed to manage the ground water resources to arrest further decline in water levels. The management plan comprises two components namely supply-side management and demand side management. The supply side management is proposed based on surplus surface water availability and the unsaturated thickness of aquifer whereas the demand side management is proposed by use of micro irrigation techniques and change in cropping pattern. Priority is to be given for demand side management measures such as drip and sprinkler type of irrigation in the farms. Good management of crops is also needed and supported by artificial groundwater recharge techniques. Similarly the convergence of the Government of India (GoI) and Government of Maharashtra (GoM) schemes of watershed development or artificial groundwater recharge need to be promoted in these areas. Unlike the land resource, groundwater is a dynamic resource. Concepts like Village level Watershed Water Account, Village level Water Safety and Security, Basin/ Sub-basin Water Auditing, Aquifer delineation and its management etc will have to be popularized and made a basis for equitable distribution of ground water. There should be annual GW budgeting on regular basis, need to plan cropping as per GW availability. There are water conservation and groundwater recharge structures should be proposed in the study area, like Recharge Shafts, Recharge Trenches with shaft, Gabbion, K. T. weirs repair, and simultaneously existing water conservation structures should be repaired and maintained to maintain existing groundwater scenario in the study area. IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory ground water management in studied area.

It would also be necessary to plan and control the use of groundwater under the prevailing conditions. Publication and distribution of annual reports and related programmes for creating awareness amongst the community and for educating them to maintain the groundwater level will have to be undertaken regularly. This will enable avoiding scarcity in future, as well as the hectic activity and excessive expenditure that has become characteristic of summer months (February to up to onset of monsoon) in the specially Marathwada region of Maharashtra. The present study discussed about the optimum planning of GW recharge and need to control the irrigation draft less than the recharge. Optimum use of water saving practices. There should be annual GW budgeting on regular basis, need to plan cropping as per GW availability in terms of Supply and demand side interventions should done in Osmanabad and similar areas. Our result open an exciting new avenue of study focused on the water level trend, rainfall pattern, Geology and hydrogeological setup. In this study an attempt has been made to formulate and adopt a long-term policy to protect groundwater by preventing pollution and overuse. This policy should be comprehensive and implemented at all appropriate levels. It should be consistent with other water management policies and be duly taken into account in other sectorial policies.

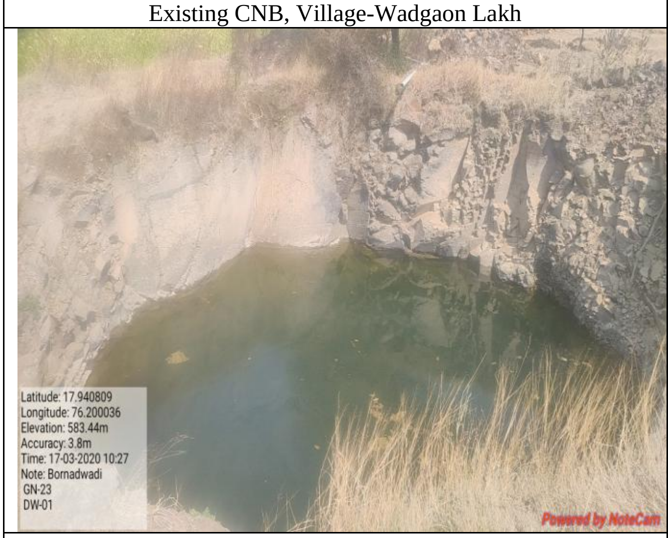
Acknowledgement

The authors express their sincere thanks to the Hon. Commissioner, Ground Water Surveys and Development Agency, Pune, Collector Osmanabad, District agricultural department and Nanaji Deshmukh Krushi Sanjeevani Project, Mumbai Maharashtra, India for providing valuable literature for this paper. The authors also show their gratitude to the editors and the anonymous reviewers for their insightful review and useful comments which have led to widespread improvement to the early versions of the paper.

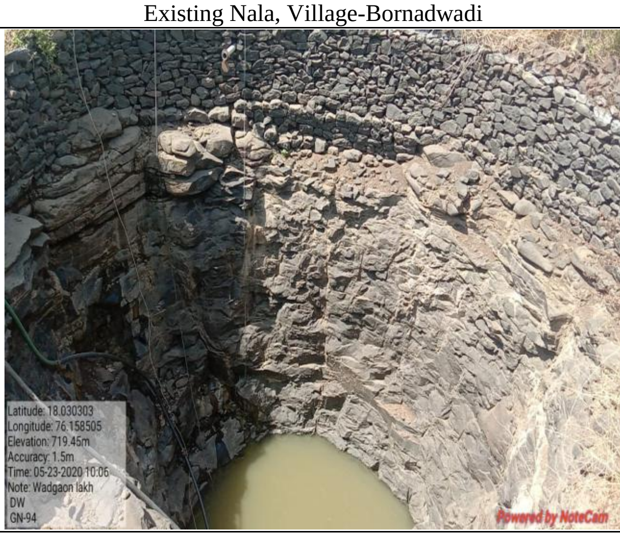
Field Photographs of the watershed BM-01, Tuljapur Taluka, Osmanabad

Existing CNB, Village-Wadgaon Lakh

Existing Nala, Village-Bornadwadi



Dug well section, Village-Bornadwadi



Deep Groundwater Level-unlined well, villa-Honala

	
Unlined Farm Pond, Village-Wadgaon Lakh	Dug well Section, Village-Barul

References

[1] Deole C. D., Kurwalkar U. S.1987, Economic Viability of dry farming technology in drought prone area of Osmanabad District (M. S.) Economic Affairs 32 (1): 65-72

[2] B. G. Dhokarikar, "Groundwater resource development in basaltic rock terrain of Maharashtra" in, Pune: Water Industry Publication, pp.275, 1991.

[3] Sawant P. T., Suryawanshi R. A., 1998, Hydrogeological studies of Terna River basin, Latur-Osmanabad District, Maharashtra, Journal of Applied Hydrology 11 (1): 36-48

[4] Groundwater Assessment report on Osmanabad, CGWB, Nagpur 2011-12

[5] Gosain, A. K., Rao, S. and Arrora, A. (2011) Climate change impact assessment of water resources of India. Current Science.101 (3): 356-371

[6] Groundwater Surveys and Development Agency, Water Supply and Sanitation Department, Government of Maharashtra. “Hydrogeological Report of Osmanabad District” Sept 2010, pp 3-8.

[7] Central Ground Water Board, Ministry of Water Resources, Government of India., Report on “Groundwater Scenario in Major cities of India”.2011, pp 143-149.

[8] District Census Handbook of Osmanabad 2011, Directorate of Census Operations Maharashtra Series-28, Part XII-B

[9] Groundwater Surveys and Development Agency, Water Supply and Sanitation Department, Government of Maharashtra. “Hydrogeological Report of Osmanabad District”. Sept 2012, pp 3-7.

[10] J. G. Mulla, Vidya Pradhan, Syed Asif, Sayyed Hussain and MazaharFarooqui, Hydro-Geochemical Evaluation of Ground Water, Tuljapur, Dist. Osmanabad *J. Curr. Chem. Pharm. Sc,* 2 (1), 2012, 81-85,

[11] Detailed Guidelines for Implementing the Groundwater Resources Estimation Methodology 2015, Central Ground Water Board Ministry of Water Resources Government of India 2017.

[12] Mushtaq Ahmad Jabir Shaikh, Farjana Birajdar, Mapping of Water Scarce Zones of Osmanabad District by Analysis of Groundwater Levels and Rainfall, IJIET, Vol5, Issue-2, 2015

[13] Nitin P. Patil SWRDM-2012 Proceeding of International Conference Status Of Groundwater In The Part Of Godavari River Basin In Osmanabad District Water & Land Management Department, Dr. BabasahebAmbedkarMarathwada University, Sub Campus, Osmanabad.

[14] Prashant Patil, Vidya Chougule, V H Mali-Jadhav), An Assessment of Meteorological Drought n Maharashtra: A case study of Osmanabad District (2004-2013) October 2018, Review of Research 8 (1): 1-15

[15] Ganesh Jadhav Feb 2020 An assessment of ground water recharge and pre monsoon-post monsoon fluctuation of water table in Osmanabad district of Maharashtra, Sambhaji College Murud Dist Latur,

[16] Megha Shinde (Daga), Chandrakant Bhoyar, Ramesh Gudepu, Jan 2023. Brief Hydrogeological Studies of Watershed MR-03, (3/7), in Context of Groundwater Estimation, Washi, Osmanabad, Maharashtra, India, Int. Jour. of Inn. Sci. and Res. Tech., Vol 8, Issue 1,

[17] Ramesh Gudepu, G. Udayalaxmi, Megha Shinde (Daga), Jan 2023, Spatial Subsurface apparent resistivity distribution using different current electrode (AB/2) configuration (VES) snd GIS in the miniwatershed. Ahmednagar, Maharashtra, India, JETIR Vol-10, Issue1

[18] Megha Shinde (Daga), Chandrakant P Bhoyar, Feb-2023, Brief Hydrogeological Studies of Watershed MR-21, in Context of Groundwater Estimation and Groundwater Recharge Plan, Osmanabad, Maharashtra, India, IJAR

[19] Mandale V, Jedhe S, Khadtare, January-March, 2019. Spatio-temporal Trends of Rainfall and Rainy Days in the Marathwada Region of Maharashtra State, Climate Change, 5 (17),