Research Article

Mitigation of drinking water security by adopting innovative measures in district Jalna, Maharashtra

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Abstract

The present paper is mainly deals with innovative measures implemented for mitigation of drinking water scarcity in Jalna district of Maharashtra. The problem of interrupted water supply during water scarcity period has been solved by adopting innovative measures, which has been implemented according to demarcation of groundwater potential zones at various locations which are technically feasible and economically viable. The pits and trenches of certain dimensions has been excavated in the groundwater potential zones in the submergence area of medium and minor irrigation projects, the district area has been divided into four zones. According to zoning of the area drinking water scarcity problem has been sloved and efficiently implemented. These innovative structures has supplied 2 to 5 MLD water for filling of tankers in each of the zone, ultimately the drinking water scarcity problem of Jalna district has been solved.

Key word: Drinking water scarcity, Groundwater, Potential zone, Trenches, Jalana.

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INTRODUCTION

Jalna district is one of the seventh districts of Aurangabad Administrative Region. Prior to the year 1981, Jalna was one of the tahsil of Aurangabad district. It has been formed as a separate district with effect from 1st May 1981 bifurcating it from Aurangabad district. It has been declared as one of the backward districts of Maharashtra State. Earlier, Jalna district comprises of 5 talukas. Recently 3 more talukas viz. Badnapur, Ghansavangi and Mantha have been formed.

About Study Area

Jalna district receives only 43.13% rainfall during year 2012 – 13 which, causes the depletion of groundwater levels in the area. Subsequently supply of drinking water has been interrupted. To provide every rural habitation with adequate water for drinking, cooking and other domestic basic needs on a sustainable manner, is the basic requirement. And it should meet certain minimum water quality standards and be readily and conveniently accessible at all times and in all situations. Jalna district lies between 19^0 15' and 20^0 32' North latitude and 75^0 45' East longitude approximately. It is surrounded by Jalgaon district in the North, Aurangabad district in the West, Buldhana and Parbhani districts in the East and Beed district in the South. The North to South length of district is 150 Kms. And that of East to West is 110 Kms. The district consists of 8 talukas viz., Jalna, Ambad, Partur, Bhokardan, Jafrabad, Badnapur, Ghansavangi and Mantha. As per the 2001 Census. The Jalna district has a total area of 7788 sq. kms. out of the total district area, rural area comprises of 99.55% and urban area of 0.45%.

Physiography and Drainage

The most important river in Jalna district is Godavari, which flows for about 60 kms along the Southern boundary of the district. Its principle tributaries are Dudhana, which flow from Central part of the district and Galhati, which passes through Ambad tehsil. The river Purna, which is one of the tributaries of Godavari

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flows through the Northern part of the district. The other tributaries of Purna and Khelna are Girija and Dudhana respectively. Jalna district is situated in the upper Godavari Basin. The central hill range known as Jalna Hill is an upland, plateau and is drained by Purna river and its tributaries. Southern portion is comparatively low land, flat area terminating at Bank of Godavari River in the South. District slopes towards south. And all drainages shows dendritic drainage pattern. The dendritic drainage pattern is prominent over the district area.

Climate And Rainfall

The climate of the district can be divided into three seasons as: a) Moderately warm wet season during June to Sept., b) Cool dry season from Oct. to Feb., and c) Hot dry season from March to May. The average temperature of the district is ranging from 20^0C during winter to 41^0C during summer. During greater part of the year, the climate is quite pleasant. It receives rainfall mostly from South-West monsoon. Rainfall is not uniform in all parts of the district. The average rainfall ranges between 663 mm to 745 mm. The rainfall record shows that the district has two regions on the rainfall pattern. The first comprises Bhokardan, Jafrabad and Jalna talukas with rainfall of about 685 mm to 745 mm. favorable for khariff cropping. That of second region comprises Ambad and Partur talukas with rainfall of about 700 mm. or more favorable for rabbi cropping. Rainfall is not uniform in all parts of the district (Table 1) The average annual rainfall in the area is 702.66 mm. About 83% of the rainfall occurs during June to September and July is the rainiest month.

Table 1: Details Of Rainfall District Jalna

Taluka	IMD Normal Rain fall	Annual Avg. RF	RF-2005	RF-2006	RF-2007	RF-2008	RF-2009	RF-2010	RF-2011	RF-2012	RF-2013	RF-2014	Average of 10 years
Ambad	707.7	712.90	773.8	682.0	532.0	642.0	595.9	832.3	504.00	315.58	760.97	144.40	578.30
Badnapur	685.4	663.60	590.0	821.0	727.0	725.0	547.0	639.7	501.10	345.40	618.00	153.60	566.78
Bhokardan	663.6	745.70	624.0	934.0	507.0	577.5	508.0	716.2	560.50	290.25	785.42	197.70	570.06
Ghansawangi	707.7	707.70	744.0	694.0	482.0	530.6	598.3	851.1	489.90	229.56	539.58	102.70	526.17
Jafrabad	745.7	685.40	739.0	817.5	667.0	669.5	551.0	885.0	748.80	324.20	956.55	136.00	649.46
Jalna	685.4	685.40	757.0	1055.0	585.0	692.0	628.0	915.1	607.40	348.42	823.71	150.00	656.16
Mantha	712.9	707.70	790.0	692.0	564.0	474.0	505.3	917.5	486.30	320.00	860.25	104.00	571.34
Partur	712.9	712.90	754.0	754.0	557.0	392.0	631.4	963.0	597.60	429.90	968.60	148.60	619.61
	702.7	702.66	721.48	806.19	577.63	587.83	570.61	839.99	561.95	325.41	789.14	142.13	592.24

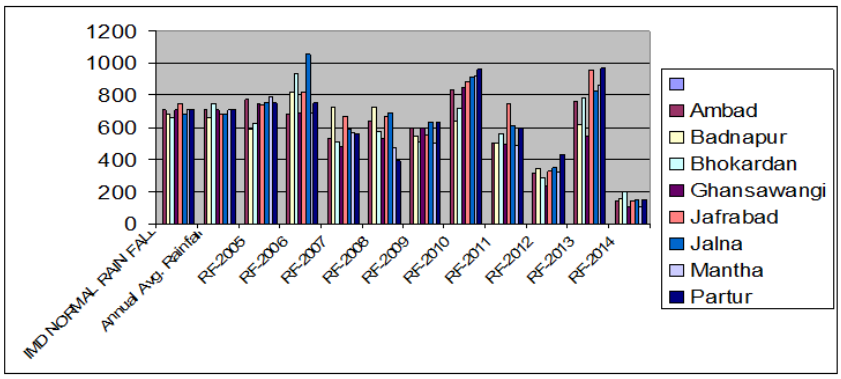

Figure 1: Taluka wise Rainfall pattern over Jalna District

Temperature

The only meteorological observatory in the district is at Jalna. The temperature and other meteorological data at this station has been taken as representative of the conditions over the district as a whole. The cold weather commences towards the end of November when the temperatures begin to fall. December is the coldest month with the mean daily minimum temperature at 12.6° C (54.7° F) and the mean daily maximum temperature at 29.3° C (84.7° F). The temperatures are slightly higher in January and February. May is the hottest month with the mean daily maximum temperature at 41.9°C (107.5°F). The relative humidity is high during the south-west monsoon season ranging between 60 per cent, and 80 per cent. After September, the humidity decrease gradually and in the cold season and summer the air is generally dry. In the summer which

is the driest part of the year the relative humidity, specially in the afternoons, is less than 30 per cent.

GEOLOGY

The basaltic lava flows belonging to the Deccan Traps occupy about 98% area of the district. The formation is very thick comprises scores of lava flows of 5 to 25 meters in thickness. Each flow comprises a lower zone of 40 to 70 % hard, massive basalt which is a devoid of primary porosity and permeability. Whereas, the upper zone of 30 to 60 % is vesicular zeolitic basalt which has which has limited primary porosity. However, the formation generally has secondary porosity and permeability acquired due to weathering, jointing, shearing, and fracturing. These structural and composite characteristics are repeated in all the lava flows of the area, and they forms a multiple aquifer system. (Fig. 4) The local alluvia packets along banks, flood plains and meanders of main rivers, has been observed having extent over 1 to 20 Km. with thickness ranges from 5 to 20 m. It comprises bands and lenses of sands, gravels and boulders in a matrix of clays. These granular zones form aquifers in which groundwater occurs under phyreatic and semi confined conditions (CGWB,2001,2001a,2001b).

Figure 2

Figure 3

Figure 4

Figure 5

Legend:
Figure 2: Drainage map of Study area
Figure 3: Geomorphology of study area
Figure 4: Map of study area
Figure 5: Lineament map of study area

GROUND WATER AVAILABILITY

The topographical features of the area plays an important role groundwater potential of the area. Where presence of hills and high grounds indicates that, rock formation is hard, compact and resistant for weathering. The steep gradient mainly causes rapid run off with little or no infiltration. While, the valleys, depressions and area of lower elevations were carried out as the rock formations were weaker, prone to weathering due to joints, fractures etc. And run off is very less with more infiltration, facilitates groundwater seepage in this area. Groundwater in this area occurs under water table condition in weathered, jointed, fractured and vesicular zeolitic zones of lava flow exposed to the surface. Groundwater occurs under confined conditions in jointed, brecciaed or fractured and vesicular zones of lower flows. Vesicular and zeolitic basalts are highly susceptible to weathering which tends to good porosity and permeability and constitute potential aquifers.

Groundwater level monitoring system

The Groundwater Surveys and Development Agency, Jalna has set up water level monitoring system which comprises 110 observation wells and 14 Piezometers for monitoring groundwater level in the Jalna District. (Table 2).

Table 2: Talukawise Groundwater Level (SWL) Monitoring network of Jalna District

Sr. No.	District	Taluka	Total No. of Observation wells	Total No. of Piezometers	Total no of monitoring stations	Remarks
1	2	3	4	5	6	7
1	Jalna	Ambad	13	02	15	
2		Badnapur	12	01	13	
3		Bhokardan	25	03	28	
4		Ghansawangi	13	01	14	
5		Jafrabad	13	01	14	
6		Jalna	15	05	20	
7		Mantha	10	01	11	
8		Partur	09	0	09	
Total			**110**	**14**	**124**	

The analysis of last 10 years static water level (SWL) during pre monsoon period indicates that there is declined trend of groundwater level during year 2004 to 2013. During the year 2013 maximum groundwater level of the area has been recorded 11.32 m. (bgl) while that of minimum 8.28 m. during the year 2007 (Table 3).

Table 3: Showing long term Pre-monsoon water levels (SWL)

Sr. No.	Taluka	Average Pre Monsoon water level									
	Taluka	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Ambad	10.94	9.21	8.90	8.09	9.63	9.73	9.11	9.80	10.39	11.07
2	Badnapur	12.60	12.30	12.10	9.98	10.40	9.97	10.31	11.59	11.85	13.06
3	Bhokardan	9.44	9.75	10.01	7.99	9.08	9.99	8.82	9.80	10.88	11.58
4	Ghansawangi	11.94	8.73	8.51	8.08	10.80	11.57	9.98	10.35	10.87	13.50
5	Jafrabad	8.55	10.22	7.95	7.97	10.04	9.68	9.08	9.37	10.12	11.10
6	Jalna	9.26	8.78	8.02	7.43	9.06	9.44	8.60	9.75	9.23	9.84
7	Mantha	9.43	10.02	8.32	7.90	8.70	9.22	8.92	7.79	9.10	10.10
8	Partur	11.4	11.33	9.12	8.80	10.37	11.12	9.63	10.00	11.01	10.32
		10.45	**10.04**	**9.12**	**8.28**	**9.76**	**10.09**	**9.31**	**9.82**	**10.43**	**11.32**

The post monsoon groundwater level trend indicates that there is declined in SWL by 5.33 m. during 2010 to 2012. (Table 4).

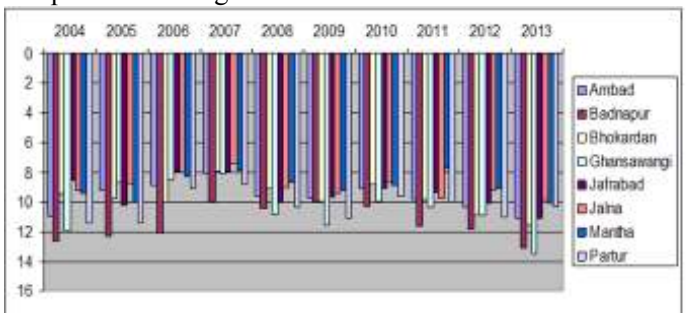

Figure 6: Long term trend of static wate

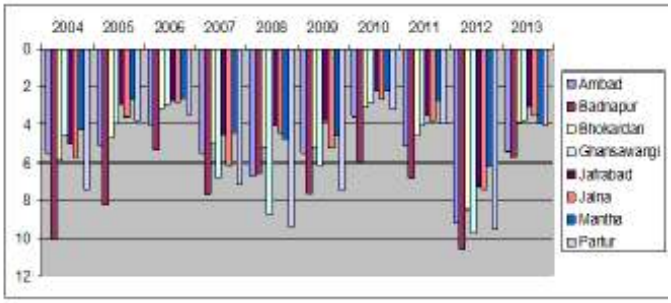

Figure 7: Pre-monsoon water levels (SWL)

Table 4: The pre monsoon groundwater level trend

Sr. No.	Taluka	Average Post Monsoon water level									
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	Ambad	5.48	5.08	4.05	5.47	6.73	5.48	3.57	5.14	9.23	5.44
2	Badnapur	10.10	8.26	5.39	7.74	6.64	7.65	6	6.84	10.59	5.74
3	Bhokardan	5.88	4.74	3.13	5.05	5.19	5.18	3.1	4.56	8.53	3.88
4	Ghansawangi	4.55	3.98	2.92	6.85	8.76	6.16	2.9	4.07	9.70	3.78
5	Jafrabad	5.04	2.96	2.71	4.53	4.07	3.79	2.26	3.54	7.25	3.02
6	Jalna	5.72	3.58	2.84	6.1	4.43	5.27	2.63	3.79	7.42	3.56
7	Mantha	4.24	2.65	2.59	4.44	4.76	4.57	2.23	2.70	6.24	3.99
8	Partur	7.40	3.76	3.5	7.21	9.44	7.5	3.19	3.99	9.58	4.08
		6.05	**4.38**	**3.39**	**5.92**	**6.25**	**5.70**	**3.24**	**4.33**	**8.57**	**4.19**

Groundwater Availability in the District Area

As per GEC 97 methodology assessment of the Jalna district has been carried out, which shows that groundwater recharge from all the sources is 96845 Ham. And withdrawal for all purposes carried out is 45160 Ham. Hence net groundwater availability for futuristic planning is 91967 Ham. (Table,5). It means that planning and management of available groundwater for all purposes is to be decided at Grampanchayat level using concept of village water account (GSDA,2007-08).

Table 5: Groundwater Assessment as per GEC-97 of the year 2007-08

Sr. No.	Taluka	No. of Wells	Total Recharge (Ham)	Net Groundwater availability (Ham)	Total Draft (Ham)	Talukawise Category	Category of all watersheds included in district (numbers)
1	Ambad	5660	13121	12465	5784	Safe	GP-17, Semi critical
2	Badnapur	4515	6057	5738	4579	Safe	Safe
3	Bhokardan	8595	14917	14172	8780	Safe	GP-12,GP15 Semi critical
4	Ghansawangi	5276	18111	17196	5377	Safe	Safe
5	Jafrabad	5592	9539	9062	5722	Safe	GP-12, Semi critical

6	Jalna	6961	13276	12612	7054	Safe	GP-33,GP34 Semi critical
7	Mantha	3296	9347	8869	3410	Safe	Safe
8	Partur	4369	12477	11853	4454	Safe	Safe

Surface Water Status of The District

Tanks and Ponds: Water is one of the important resources for the entire development. There is no major irrigation project in Jalna district. However, an area of about 51710 hectares in Jalna district is being irrigated by Jayakwadi project which is one of the major irrigation project situated in Paithan taluka, Aurangabad district. There are 7 medium irrigation projects and 57 minor irrigation projects in Jalna district. However, there is shortage of water during summer seasons. Ghansangvi taluka had the maximum irrigated area whereas Mantha taluka with the least irrigated area.

METHODOLOGY

The average rainfall of the District is 702.66 mm. Jalna District receives only 43.13% rainfall during year 2012, consequently the groundwater level declines 4.50 m (bgl) which indicates there will be inadequate water supply from all existing water supply sources during forthcoming months. There is only one alternative to supply water to the villages by means of tanker only. It is planned to supply water through tankers to 710 habbitations of the district covering 81,000 population of the rural area of district. The District Administration has planned to import water from out of District area probably by means of railway line which requires about 25 crores of expenditure which is not viable technically as well as economically. The surface water storage in 7 medium irrigation projects and 57 minor irrigation projects is also almost zero or below seal level. Hence the drinking water supply to the district during scarcity period is depends only on water supply through tankers in various part of the District. But there is great problem of availability of water for filling of tankers for water supply. Groundwater surveys and Development Agency has investigated Jalna District Area for demarcation of groundwater potential zones in the catchment and sub surface area of 7 medium irrigation projects and 57 minor irrigation projects localized in the various taluka of the Jalna District. There are two major projects in the nearer districts named Khadakpurna Irrigation Project located in Buldhana District near border of the Jafrabad Taluka District Jalna. And lower Dudhna Project at the border of Tluka Partur in District Parbhani. It has been decided to construct Pit Cum Trenches at two to three places in the sand belt of lower Dudhna and Khadakpurna Project area in the river bed for supply of tankers to the water scare area of Jalna District, for supply of tankers the zoaning is scheduled to supply 169 villages. Which includes 69 villages from Jalna Taluka, 21 villages from Partur Taluka, 21 villages Ghansawangi Taluka, and 58 from Mantha Taluka. This zone covers about 60 km of radius having average 202x2 trips about 48.40 lakhs ltr per day for population 242420 in above four talukas. The trenches in Khadakpurna project area covers 107 villages from Bhokardan Taluka, 39 from Jafrabad Taluka and 21 from Jalna Taluka. Mainly bhokardan and Jafrabad taluka and Jalna taluka. This zone also covers about villages located in radius of 60 km and propose to supply 156 x 2 Tankers which requires about 46.80 lakh ltr/day for population of 234000 souls@20 ltr/day (Fig.5). Considering topography, groundwater potential zones and radial distance of the area, the entire district has been divided in 4 zones for execution and monitoring of the drinking water scarcity plan. These proposals requires about 113+180 =293 lakh Rupees which is very less than the original proposal of supply of water by means of railway i.e. 25 crores. By means of adopting innovative measures there is saving of 88% of the original cost.

Zone No.1 Khadakpurna: Tq. Jafrabad and Bhokardan which covers 198 villages in the radious of 65 km from the trench in Khadakpurna river.

Zone No. 2 Lower Dudhna Dam: Tq. Mantha, Partur and Ghansavangi which covers 222 villages in the adious of 60 km from the trench in Khadakpurna river.

Zone No. 3 Ghanewadi and Pirkalyan: Tq. Jalna, Ambad and Ghansavangi which covers 181 villages in the adious of 60 km from the trench in Khadakpurna river.

Zone No. 4 Badnapur and Jalna: Tq. Badnapur and Jalna which covers 79 villages in the adious of 76 km from the trench in Khadakpurna river.

Figure 8: Zoning of the Jalna District for Tanker water supply

CONCLUSION AND RECOMMENDATIONS

During the year 2012 there was deficit rainfall in the Jalna District due to which the static water level in the area has been declined by 450 m. due to which the water supply of area has been interrupted. The surface storage in 7 medium irrigation project and 57 minor irrigation project is below seal level or almost dry after rainy season which subsequently affect yield of source for Pipe water supply schemes of the villages. Ultimately there was no availability of Groundwater as well as surface water for mitigation of drinking water scarcity of the jalna district. All the sources in district area become defunct due to inadequate water availability. The District administration has planned to overcome drinking water scarcity in the entire district during which it has been decided that there is only one alternative to provide water supply to the district area by means of railway line. In which water imported from outside of the district area and distributed by means of railway network and tankers through road network. All the innovative measures suggested by groundwater surveys and development agency has been proved very effective for mitigation of drinking water scarcity. By implementation of these measures there is saving of money, man power and creation of additional infrastructure. These proposals requires about 113+180 =293 lakh Rupees which is very very less than the original proposal of supply of water by means of railway i.e. 25 crores. By means of adopting innovative measures there is saving of 88% of the original cost. The scheme is very economic and efficient for drinking water scare area, which may be replicated in the various part of the same district and in another district of the marathwada region. It has been proved very effective measure for mitigation of drinking water scarcity in the other parts of marathwada region namely Aurangabad, Latur, Osmanabad and Beed.

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