Research Article

Aquifer level groundwater management through community participation in district Jalna, Maharashtra

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Abstract

Groundwater is an important natural resource, crucial to rural and agricultural development in Maharashtra. In the State about 70% of the rural population depends on groundwater for drinking and agricultural use. The incidences of crop failure and decline in agriculture production are common in the State. Development of groundwater resources is mainly for agriculture use and uncontrolled extraction of groundwater has resulted in severe scarcity of water, both for drinking and irrigation. In absence of any effective policy measures, groundwater in many parts of the State are plagued with water scarcity, in-equitable distribution of water and environmental degradation. Presently groundwater rights are attached to the land of the farmer and as such there is no control on groundwater extraction. It has been recognized that farmers need to be provided with knowledge on the availability of groundwater resources and decide how to manage it through self regulatory measures. The Aquifer Level Groundwater Management has focused on the management of groundwater by the community and has achieved the behavioral change leading to voluntary self regulations for reducing extraction and misuse of groundwater. In the present case, government agencies and non govt. organizations has shared the technical data with the community and provided input to improve their skill to collect technical data such as rainfall and groundwater level and has nurtured the community institutions for local governance of groundwater use.

Keyword: Community, Giriji Bhujal Vyavasthapan Sangh, GPLC, Groundwater, GWMA, Management, Piezometer.

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INTRODUCTION

Geologically about 83% of the State is covered by Deccan trap rock formation of upper cretaceous to lower Eocene age. The ultimate irrigation potential from groundwater in the State is estimated at 4.1 million hectares of which 3.39 million hectare has been created and utilized by 2011-12. Groundwater Surveys and Development Agency (GSDA) has divided the entire State into 1531 Watershed units for assessing groundwater potential. The latest groundwater estimation by GSDA during 2011-12 revealed that the annually replenishable groundwater recharge in the state is 32150 Million cubic meters (MCM) of which 1027 MCM (3%) is being utilized for drinking and industrial purpose and 16150 MCM (50%) is utilized for Agriculture purpose. The groundwater estimation indicated that groundwater in 76 watershed units from 13 districts is over extracted and in 4 watershed units groundwater utilization has reached a critical stage. This situation is manifested in progressive decline of water level at a rate of 0.21 meter per year. Present case study mainly deals with the aquifer level Groundwater management through community participation in eight numbers of villages of Jalna District. Where, Groundwater level committee (GPLC's) and Groundwater management association (GWMA) called Girija Bhujal Vyavasthapan Sangh has played important role in consultation with Groundwater Surveys

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and Development Agency (GSDA), Technical Support Group (TSG) and Support Organization (NGO) which has facilitated for Groundwater budgeting, crop water action plan and Groundwater management.

Study Area

The aquifer level management study area selected covers part area in Bhokardan and Badnapur talukas of Jalna district and extends over 8 villages i.e. Talani and Lodhewadi from Badnapur Taluka and Talegaon, Pimpri,Khadgaon, Ita, Ramnagar and Latifpur from Bhokardan taluka (Fig.1) where total area of the aquifer is 5674.74 hectares.

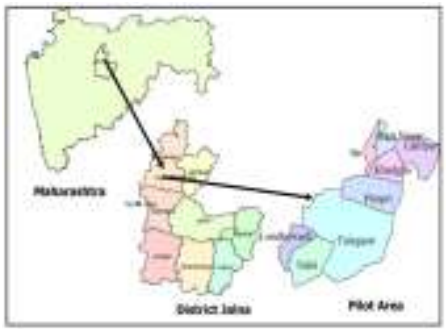

Figure 1: Location Map of the Aquifer area

Demography

The demographic information of aquifer area in Badnapur and Bhokardan taluka of Jalna District is summarized in Table. 1 and population in 8 villages as per 2011 census are given in Table 2, where density of population is 125 persons per sq km.

Table 1: Demographic Information of the Aquifer Area

Sr. No.	Subject	Details
1	District	Jalna
2	Taluka	Bhokardan and Badnapur
3	Coordinates East Longitude	75°36′41″ to 75°42′51″
4	North Latitude	20°01′53″ to 20°08′12″
5	Morpho index	Bc
6	Geographical area in Sq.Km	**56.75**
7	Altitude range	704 -560 m above msl
8	Total number of village	8
9	Total number of Grampanchayat	6
10	Population (2006)	8953
11	Men Women Ratio	51 : 49
12	Scheduled caste Percentage	11.2
13	Scheduled Tribe Percentage	0.2
14	Population Literate Percentage	49.36
15	Land Holdings	2719
16	Awareness Level	Moderate
17	Transport Facility	MSRTC up to Talegaon, Latifpur, Ramnagar, Ita
18	Weekly Bazar	Talegaon
19	Nearest market for agricultural Project	Jalna and Aurangabad
20	Present Way of Marketing agriculture products	Krishi Utpanna Bazar Samiti
21	Total No. of Wells	567
22	No. of Wells with Electric Pump	484
23	No. of Wells with Oil Engine	81
24	No. of Disused Wells	196

Table 2: Population status of the Aquifer area

Sr. No.	Name of Village	Geographical area (Hectare)	Number of households	Total population
1	Talegaon	2378.75	589	3267
2	Latifpur	801.38	160	1000
3	Pimpri	776.51	167	870
4	Khadgaon	370.36	126	703
5	Ita	171.00	169	837
6	Ramnagar	195.30	88	525
7	Talani	633.00	131	576
8	Lodhewadi	340.88	90	424
	Total	**5674.18**	**1520**	**8202**

Source: Census 2011

Physiography and Drainage

The study area is part of Godavari basin in Jalna district of Maharashtra. The Aquifer area exhibits more or less flat to slight undulating topography, however isolated hillocks and dissected plateau occurs in the southern part of the area. The general slope of the area is from NE to SW. The outcrops frequently occur in form of hillocks and plateau rising about 20 m to 100 m above ground level. The hills are moderately to steeply sloping and a part of which is affected with wind activity, sand deposited on hill slope is further recycled by the water flowing from the top of hills. The affected area gradually becomes the part of sandy arid plains and buried pediments. Girja is the major river flowing through the area. However numerous ephemeral streamlets originates from the hillocks occur in the area. The major part of northern and central part of the project area is devoid of drainages. The small streamlet ranging from 1st to 4th order occurs in the southern, eastern and western parts of the area. The drainage pattern is of dendritic type in which water flows outwards form the central elevated portion.

Climate and Rainfall

The area is characterized by semi-arid climatic conditions, low and erratic rainfall with high evapo-transpiration rates. The temperatures range between 13°c and 42°c and average wind velocity 13.4 to 18.3 km/hr. Aquifer area receives most of the rainfall between July and October. The normal annual rainfall in the area is 657.7 mm. Annual rainfall as recorded between 2001 and 2013 (Table 3).

Table 3: Rainfall data in the Aquifer Area

Year	Annual Rainfall in mm	Rainfall Percentage	Rainfall (Deficit/ Excess as percentage)
2001	710	104.23	+ 4.23
2002	743	109.07	+ 9.07
2003	634	93.07	- 6.93
2004	529	77.66	- 22.34
2005	627	92.04	- 7.96
2006	934	137.11	+ 37.11
2008	611	92.88	-7.12
2009	444.81	67.63	- 32.37
2010	657.11	99.91	- 00.09
2011	481.09	73.14	-26.85
2012	297.76	45.32	-54.68
2013	735.50	111.83	+11.38

Source: India Meteorological Department (IMD) and GSDA, Jalna

Geology and Hydrogeology

The entire study area is underlain and surrounded mainly by basaltic lava flows belonging to the Deccan volcanic province that flooded during upper cretaceous to Eocene age in the Deccan plateau. The Deccan traps sequence consists of multiple layers of solidified lava flows. The prominent geological units observed in study area are the horizontally disposed basaltic lava of dark grey in color. The lava flows are horizontal and each flow has distinct two units. The upper layers consist of vesicular and amygdule zeolitic basalt whiles the bottom layer consists of massive basalt. Groundwater occurrence and movement in the area is influenced by its rock formations. Groundwater potentially depends upon porosity and permeability (both primary and secondary) of rock formations. Ground water in Deccan Traps Basalt occurs under water table condition in weathered, jointed, fractured and vesicular zones of the flow exposed at the surface. Ground water occurs under confined conditions in Jointed, brecciated or fractured and vesicular zones of lower flows. The vesicular and zeolitic basalts are highly susceptible to weathering as interconnected vesicles form conduits from weathering agents (CGWB, 2010)

METHODOLOGY

The aquifer level management is based on farmer's data management, which mainly deals with factors like rainfall, water level, groundwater accounting and crop water budgeting in the present aquifer area.

Farmer's data management

Rainfall: Members of GWMA - GPLC and other volunteer groups in the villages have been trained in measurement off daily rainfall and recording this in the register. GWMA regularly supervise this work, rainfall data during the year 2007 to 2012 shows average rainfall 549.98 (Table 4) while trend of rainfall during year 2010 to 2012 shown in Fig.2

Table 4: Details of village wise rainfall Data

Talni	Lodhewadi	Talegaon	Pimpri	Khadgaon	Latifpur	Ita	Ramnagar	Year
336.5	327	378	311.8	296	279.5	280	282.4	2007
709.3	760.34	491.44	472.63	472.58	765.5	667.61	588.86	2008
468.5	462.5	466.4	465.3	473.8	439.4	450.9	453.2	2009
643.9	636.95	670.3	692.6	671.9	693.4	661.37	676.5	2010
513.46	504.26	480.09	490.67	465.59	468.1	457.75	468.86	2011
351.18	348.94	274.75	281.81	285.82	282.48	276.37	280.11	2012
604.568	607.998	552.196	542.962	533.138	585.676	558.8	549.986	Avg.

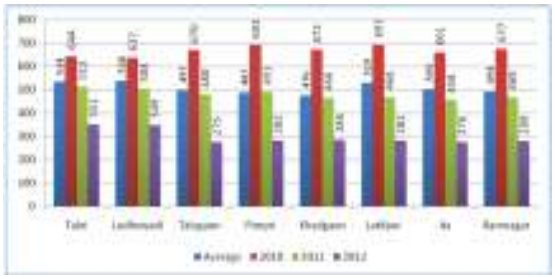

Figure 2: Yearly Rainfall Trend in the Aquifer Area

Water Level Monitoring

GWMA - GPLC have been trained to measure water levels in the wells and monitor the changes. GSDA has already prepared formats for measurement and recording of water level in the wells every month and provided to GPLC's and GWMA. The water levels in 10 piezometers recorded every month and this data supplied to GWMA. The groundwater level trend has been used for calculating groundwater recharge annually and its availability during different seasons. (Fig.3). The water level fluctuations shows maximum depletion in water level in year 2012.

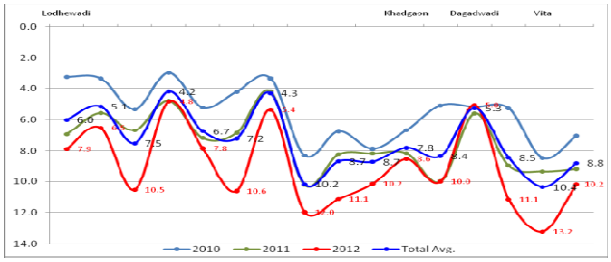

Figure 3: Groundwater Level Trend in Aquifer Area

Groundwater Accounting

A member of GWMA and GPLC has awareness about calculation of groundwater recharge from rainfall and requirement for drinking and agriculture use. This exercise need to be continued and carried forward to enable the community to calculate groundwater recharge and allocation of groundwater for drinking and agriculture. GSDA has prepared guidelines in local language for calculating groundwater recharge and estimating groundwater withdrawal. These are provided to the community. However it is necessary to organize training program for GWMA - GPLC and train them in the calculation of groundwater recharge every year.

Crop Water Budgeting

Using the knowledge of groundwater availability, GWMA has already adopted a few regulatory measures to reduce groundwater extraction by suitable changes in the cropping pattern and irrigation practices. This ability of GWMA helped them to evolve common approach for sustainable groundwater management, while safeguarding the individual farmer's interests which were not coercive. The Improved knowledge of farmers and calculation of groundwater recharge every year by GSDA has been shared with community, provided clear understanding of groundwater resource availability (Fig. 4). Using the data on rainfall and groundwater recharge, GSDA has provided technical input to GWMA, GPLC and other farmers from the aquifer area to educate them about crop water budgeting and selection of crops suitable to soil and water conditions. This has been supported by *Krishi Vidyan Kendra* with technical inputs from soil and agriculture Scientist and members of TSG. Action plan has been prepared for groundwater budgeting based on groundwater estimation, farmer's choice of crop and soil conditions. The GSDA and TSG members for the first time documented crop water budgeting for rabi season

during 2010 and thereafter GWMA - GPLC had design the crop plan every year adopting similar exercised (Table 5). Thereafter GWMA and GPLC in the aquifer area have decided to prepare the crop plan for Rabi season on October 10, every year after rainy season.

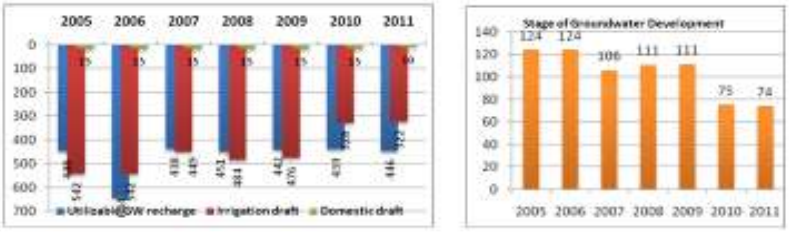

Figure 4: Details of Groundwater Recharge and stage of groundwater development in aquifer

Table 5: Details of cropping pattern

Name	Area under Kharif Crops 2012 (in Hectare)								Total
	Talegaon	Pimpri	Ita	Ramnagar	Talni	Khadgaon	Lodhewadi	Latifpur	
Maiz	500	65	20	30	60	40	40	110	865
Bazara	60	30	3	4	50	30	20	12	209
Cotton	210	25	20	20	35	35	22	30	397
Tur	1	2	1	0	1	1	1	1	8
Jawar	100	8	5	11	9	4	7	15	159
Wheat	25	15	8	15	20	18	18	10	129
Chana	4	5	3	5	5	2	2	2	28
Area Irrigated	**900**	**150**	**60**	**85**	**180**	**130**	**110**	**180**	**1795**

Table 6: Details of Supply Side interventions in aquifer area

Sr. No.	Name of Village	Name of Structure	Storage Capacity In TCM
1	Talni	Cement Nala Bandh	1.57
2		Recharge Trench	0.35
3		Recharge Tank	0.55
4	Talegaon	Cement Nala Bandh	1.20
5		Recharge Trench	0.35
6		Cement Nala Bandh	1.60
7		Cement Nala Bandh	1.48
8		Cement Nala Bandh	1.60
9		Cement Nala Bandh	1.60
10		Cement Nala Bandh	1.48
11	Khatgaon	Cement Nala Bandh	1.30
12		Cement Nala Bandh	1.40
13		Cement Nala Bandh	1.40
14		Cement Nala Bandh	1.57
15		Earthen Nala Bandh	0.80
16	Latifpur	Cement Nala Bandh	1.20
17		Cement Nala Bandh	1.20
18		Cement Nala Bandh	1.40
19		Recharge Tank	0.55
20	Ramnagar	Cement Nala Bandh	1.40
21		Cement Nala Bandh	1.40
22		Earthen Nala Bandh	0.80
23		Cement Nala Bandh	1.57
24		Recharge Trench	0.35
25		Cement Nala Bandh	1.30
26		Cement Nala Bandh	1.30
27	Lodhewadi	Recharge Tank	0.55
28		Earthen Nala Bandh	0.70
29		Cement Nala Bandh	1.30
30	Ita	Cement Nala Bandh	1.55
Total Capacity			**33.77**

Resources Management Strategies

The aquifer level management strategies involves supply side management and demand side management which is essential for planning of natural resources which is available in the aquifer area. These interventions are mainly related to provide some water conservation and groundwater recharge structure along with self governing regulations by committee which plays very important role in planning and management of the natural resource.

Supply side management

Considering the aquifer level water balance study, 30 no. of various water conservation cum recharge structures like Cement Nala bandh, Mati nala bandh, village tank etc. has been constructed by GPLC / GWMA in aquifer area (Table 6). Where the technical support has been given by GSDA and Technical Support Group. (TSG) where 33.77 TCM storage has been created in aquifer area by means of supply side intervention (Table 6 and Fig. 5).




Figure 5: Photographs of Supply side management




Figure 6: Photographs of Demand side management

Demand side management

The GPLC and GWMA have framed some self regulation under demand side management so as to develop, plan and manage natural resources in the aquifer area. These demand side management activities are listed below.

a. Community agreed to treat groundwater as a common natural resource.
b. Community understood that the knowledge about Groundwater recharge and crop water requirement is necessary and should be calculated before selecting suitable crop plan.
c. Each farmer has restricted the pumping operations to reduce groundwater extraction.
d. Farmers agreed to reduce and ultimately discontinue cultivation of sugarcane in the area.
e. Large and medium farmers agreed to adopt drip and sprinkler irrigation for cotton, wheat, vegetable and horticulture crops cultivated in the area. (Table 8).
f. GWMA has decided to prohibit construction of new irrigation wells.
g. The community has agreed to adhere to the decisions of GWMA and GPLC.
h. The GWMA in consultation with GPLC have decided to diversify the crops and switch over to low water consuming crops. **(Fig 6).** GWMA has resolved to adopt best practices for aquifer level management **(Fig 7)** which involves discontinue cultivation of sugarcane, Increase the area under drip irrigation for cotton crops, partly replace the area under wheat by Mustard and encourage increase in the area under horticulture with drip.

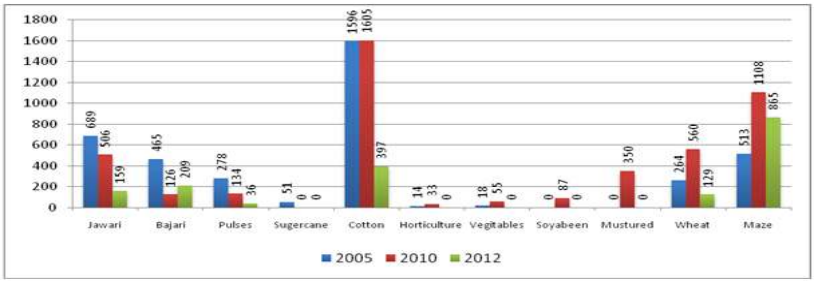

Figure 7: Changing scenario of cropping pattern in aquifer area

About 15 % area under cotton and entire area under horticulture crop is being irrigated with drip and about 18% area under Wheat is irrigated by Sprinkler irrigation system Table 9. GWMA in the aquifer area has made a tie up arrangement with the manufacturers and suppliers of drip and sprinkler irrigation system who have supplied the system without insisting for release of subsidy and full upfront payment of cost by the farmer. This has enthused more farmers to adopt drip and sprinkler irrigation system in the aquifer.

Table 7: Details of cropping pattern under micro irrigation

Year	Cotton		Wheat	
	Total area under cultivation	Area irrigated by Drip	Total area under cultivation	Area irrigated by Sprinkler
2007-08	1595	0	308	0
2008-09	1600	200	560	0
2009-10	1605	200	560	100
2010-11	1626	280	635	180
2011-12	1535	360	480	210
2012-13	397	130	129	0*

Ultimately the Season for 2012 is just initiated; however decrease in total area under irrigation is due to record low rainfall.

CONCLUSIONSAND RECOMMENDATIONS

The most preferred cash crop in the area was sugarcane and was cultivated despite declining water level and inadequate groundwater availability. However the groundwater crisis prompted GWMA to educate the farmers about discontinuing sugarcane as a strategy to reduce groundwater extraction. This has been successfully achieved through continuous dialogues and discussions and since 2007-08 the farmers have discontinued cultivation of sugarcane. Cotton continued to be a major crop in the area. However many farmers have switched over from the flow irrigation to drip irrigation system and have changed the crop geometry from 1 x 1 meter spacing to 1.6 x 0.3 meter spacing. This has reduced the water requirement for cotton in the area. Crop diversification has been adopted by the 40% of the farmers as a part of water saving and reducing groundwater extraction. Area under Bajra has been partly replaced by Maize and areas under Pulses have been partly replaced by Soyabean. Horticulture crop has become more popular. The aquifer level management can be replicated in any area in the sane district or any other district in the Maharashtra.

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