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Groundwater Fluctuations in Sub Basin of Krishna River, Western Maharashtra, India

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Abstract - Water is the most important resource of a country and of the entire society as a whole since no life is possible without water. Water may occur in nature in liquid, solid as well as in gaseous form. All these forms of water are very useful to mankind. About 97% of the total available water on earth is contained in oceans, and is, hence, saline or salty in nature. The amount of fresh (sweet) water actually available is only about 3 % of the total quantity of water on the earth. Looking to the above, the reality is that there is essentially very less fresh water on the planet today and with development and population increase need for water increases day by day, so planning should be done for restoring the available water for the need of future generation. The proper conservation, maintenance, and careful use of water resources, along with developing additional storages, may considerably reduce the chances of water famines for future generations to come. In addition to these measures, we may have to find out means and ways for increasing the available usable water by developing artificial rain technology, easier ways to desalt sea water at cheaper rates, recharging the unconfined aquifers by constructing small check dams on small rivulets.

Here, an attempt is made to study the ground water fluctuations in the Yerala river basin, located in Sangli and Satara district situated in Maharashtra state, India. Ground water table in the Yerala river basin decrease from 8 to 1.5 m Below Ground Level (BGL) during period of 2001 to 2010.

Keywords - Water resources, ground water fluctuation, groundwater table.

I. INTRODUCTION

Groundwater is a globally important and valuable renewable resource for human life and economic development. It constitutes a major portion of the earth's water circulatory system known as hydrologic cycle and occurs in permeable geologic formations known as aquifers i.e. formations having structure that can store and transmit water at rates fast enough to supply reasonable amounts to wells. Its importance stems from its ability to act as a large reservoir of water that provides "buffer storage" during periods of drought.

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 however, increasingly threatened by over-abstraction which has insidious long-term effects. Scarcity and misuse of groundwater pose a serious and growing 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 can be mainly attributed to highly

heterogeneous lithology and variability & regional variation of rainfall.

In Maharashtra around 82% of rural population is dependent on agriculture & around 85% of rural and to some extent urban population too dependent on groundwater. Earlier, the use of groundwater was insignificant in the State. Subsequent to 1972, occurrence of frequent droughts, development of cheap drilling devices and availability of relatively low cost institutional finance, and energization led to proliferation in irrigation wells within the State. Maharashtra is one of the most well endowed states in the country in respect of rainfall, but it may soon become a state where large parts of it face perennial water shortage, if urgent institutional, policy and technological initiatives are not taken to address both the quantity and the quality issues of groundwater. A serious concern about increasing water scarcity is being expressed by experts, several agencies dealing with water. Most of the discussions at national and state level as well as local level are centered on demand side projections and supply side shortfalls and estimates for large scale investments for resource development.

Limitations on the availability of financial resources with the government, private sector investments is pointed as an answer together with policy changes to facilitate this. However, the fact that good governance and better management practices and partnership with the community could bring better and sustainable benefits, which needs to be adopted and implemented by the planners and policy makers. More has to be done to empower local communities to manage their own water resources and rebuild a new relationship with water in society.

Large area of Maharashtra is occupied by hard rocks and because of variations in their basic characteristics and physiography and variability in the rainfall along with that there are limitations on the occurrence of groundwater. Though there is unanimity about this, there is still a considerable difference of opinion among the scientists about the precise degree of these limitations. Now a day's total demand for water from the groundwater domain is increasing. The main reason for this is the self reliance being experienced by users of groundwater. But as this is leading to relentless withdrawal, and as the status as to the total availability of groundwater is of dubious nature, it is urgently necessary to give more serious thought to groundwater planning and to channelize it in a new direction. Taking into consideration variation of rainfall in Maharashtra, which is the most influential factor in groundwater estimation, it will be imperative henceforth to estimate freshly every year the groundwater resources.

In rural context, groundwater provides the mainstay for agricultural irrigation and will be the key to providing additional resources for food security. In urban centers groundwater supplies are important as a source of relatively low cost and generally high quality municipal and private domestic water supply. The annual utilizable groundwater resource of India is estimated as 396 km³ per year. This accounts for about 80% of domestic water requirement and more than 45% of the total irrigation requirement of the country.

II. STUDY AREA

The study area lies in west part of Maharashtra state bounded by Latitude 16° 55' to 17° 28' N and Longitude 74° 20' to 74° 40' E. falling in part survey of India topographical sheet no 47 K – 5, 6, 7, 8, 10, 11, 12, 47 L - 9 on the scale 1:50,000 (Fig. 1) it covers total area of 3035 km² includes two districts (Satara and Sangli) in Maharashtra. These districts experiences a tropical wet-dry climate characterized by alternating wet and dry spells. The study area receives rainfall during South-West monsoon from June to September. The distribution of rainfall is not even all over the area. Western part of the river basin, in Karad and Koregaon

taluka area receives heavy rainfall (above 1200mm). While eastern part of the basin comes under rain shadow zone. The average annual rainfall increases from 600 mm in the western side to 350 mm in the east side. The rainfall is scattered. The numbers of rainy days in a season are less. It has been observed that about 20% rainfall is received during post-monsoon and by thunder showers in the month of May. The location of rain gauge stations are shown in (Fig. 2). The temperature may rise up to 42°C in summer and may fall down to 8°C during winter.

The wet and dry seasons generally occur between July and October and between January and May, respectively. The climate of the region is defined as subtropical with hot and dry weather in the summer. The main cause of annual rainfall variability in Western Maharashtra is the changing position of synoptic systems.

2.1. Ground water in the river basin

The quality and availability of groundwater in Maharashtra is variable and depend on rainfall, topography and hydro- geological setting. The river basin is coming under hilly zone of mainland of Maharashtra. On the mainland, the hilly zones in the northeast provide an erratic groundwater scenario. Groundwater accumulates only in secondary porosity. This is mainly due to zone of weathering, joint planes, cracks and fissures. Water table in these rocky areas varies from 5 to 12m below the ground level and the aquifers are mostly unconfined.

2.2. Geology of the region

Geology of the area is dominantly covered by basaltic rock. The area has suffered a lot by tectonic movement in the past as evidenced by varying fold, fault and lineament association with hills located in the western side of study area. Area is covered by the basaltic flows related to Deccan Volcanic activity of Cretaceous to Eocene age. They generally exhibit step like topography and hence are known as Deccan Trap. These flows are very in thickness of individual flow from few meters to 40 meters. They extend for a considerable distance. The basaltic lava flows are almost uniform in mineralogical and chemical composition (Fig. 3).

The basaltic flow can be classified as Compact, fine-grained, massive basalt and vesicular, amygdaloidal basalt, the vesicles are filled with secondary minerals like Quartz, chalcedony and calcite etc. Comparatively soft, friable and break more easily. The boundaries of basalt flows have been identified on the basis of presence of red beds, change in jointing and weathering pattern, ropy surface etc. Another criteria which can be

used for the identification of various basaltic flows is the development of lat surface at various altitudes. These flat surfaces may be taken as flow tops. Basaltic flows are often separated by red to brown colored clayey rock known as 'red beds'. The thickness of red bed varies from few centimeters to more than 2 meters. It also gradational relationship with the top section of underlying flow. These rocks possess negligible primary porosity but are cause to be porous and permeable due to secondary porosity by fracturing and weathering.

In high rainfall are and under good drainage condition on weathering of basalt, laterite is formed. During weathering process silica, alkalies and alkaline earths have been leached away leaving behind alumina, iron, manganese and titanium. Laterite shows vermiculite or pisolitic structure. Alluviums deposited are more or less stratified deposits of gravel, sand, silt and calys deposited by streams and river. In these districts alluvial deposits are well developed along the bank of the main rivers. They vary in thickness from few meters along Warna, Morna, Yerala, Agrani, Man and Bor rivers to 10.00 to 30.00meters along Krishna river. These deposits commonly show features like graded bedding, current bedding and cross bedding. AT the base of these deposits fine graded sand and silt is present along with kankar nodules locally known as Mann.

III. METHODOLOGY FOR GROUND WATER STUDY

To study the ground water of the region, water level in different wells located in the basin has been taken. There are about 14 wells situated around the river Yerala (Fig. 4). To know the overall behavior of groundwater table fluctuation pre-monsoon and post-monsoon water levels with respect to ground level have been observed. The data collected for the year 2001 to 2010. These pre and post monsoon water levels are plotted and are compared with the overall fluctuation of weighted mean rainfall. Rainfall at Dahiwadi, Kadegaon, Koregaon, Palus, Tasgaon, Vaduj and Vita gauging stations collected for year 1998 to 2010. Vaduj and Vita are in the heart of basin while Dahiwadi, Koregaon and Palus are outside the basin boundary. For finding the Weighted Mean Rainfall (WMR) for the basin, the map of scale 1: 50000 selected. The river basin boundary marked on the map. Location of raingauge stations are shown in the map (Fig. 2). The Table 1, which include the 14 well locations serially shown in the next following pages. Similarly graphs for the same are shown.

3.1 Graphical Analysis

The out-put of all study is summarized in terms of graphs. These graphs include the Water levels measured with respect to ground at pre and post monsoon period stage, number of years and Weighted Mean Rainfall.

IV. RESULTS AND DISCUSSION

In general the depth to water level in Kadegaon, Khatav, and Tasgaon talukas ranges from 1.2 to 21.5 m B.G.L. (Below Ground Level). In low laying areas along river banks mainly in central and north-eastern parts of the taluka, the water table is shallow between 2 to 8 m BGL. The depth of water level in southwestern parts of the taluka varies between 6.5 to 21.5 m BGL. In general the depth of water levels broadly follows the surface topography and the drainage pattern in the area. Ground water table in the catchment of Yerala river was increase from 8 to 1.5 M below Ground Level (BGL) during period of 2001 to 2010.

V. CONCLUSIONS

The ground water fluctuations have been derived for the entire Yerala river basin and it has been decreasing 1.5 to 8 m below ground level where as rainfall intensity was slightly increasing. Due to lack of water harvesting structures rainfall directly converts into runoff.

REFERENCES

Fig. 1 : Location map

Fig. 2 Location of Rain gauge Station

Fig. 3 Geology map

Table No.1 Ground Water Fluctuations

Well No.1 in Dahiwadi

Year	WMR Rainfall in mm	Pre- Monsoon WLS in m	Post- Monsoon WLS in m	Seasonal Variation in m
2001	357.6	41.6	28.6	13
2002	353	43.9	35.8	8.1
2003	371	42.8	43.6	-0.8
2004	533.5	43.3	19.4	23.9
2005	670	43.5	7.05	36.45
2006	632	28.3	10.4	17.9
2007	532.3	25.9	10.1	15.8
2008	593.2	38.9	9.5	29.4
2009	977.1	35.5	7.7	27.8
2010	745.1	36.4	8.8	27.6

Well No.2 in Hanmant Vadiye

Year	WMR Rainfall in mm	Pre- Monsoon WLS in m	Post- Monsoon WLS in m	Seasonal Variation in m
2001	425	8.8	6.1	2.7
2002	388.04	6.8	5.2	1.6
2003	288.23	8.7	9	-0.3
2004	736	7.9	4	3.9
2005	920	5.75	2.2	3.55
2006	1038.4	4.8	2.8	2
2007	820	4.4	2.5	1.9
2008	710	4.65	4.6	0.05
2009	758	3.8	2.6	1.2
2010	635	4.6	3.8	0.8

Well No. 3 in Jakhangaon

Year	WMR Rainfall in mm	Pre- Monsoon WLS in m	Post- Monsoon WLS in m	Seasonal Variation in m
2001	518.6	8.9	6.3	2.6
2002	398.1	8.7	6.6	2.1
2003	175.3	9.02	9.12	-0.1
2004	907.7	9.27	4.45	4.82
2005	582.7	6.5	0.32	6.18
2006	716.98	5.87	2.52	3.35
2007	542.01	7.2	4.3	2.9
2008	479.66	6.2	1.6	4.6
2009	1006.1	6.5	1.7	4.8
2010	759.6	7.6	2.5	5.1

Well No. 4 in Kankatre

Year	WMR Rainfall in mm	Pre- Monsoon WLS in m	Post- Monsoon WLS in m	Seasonal Variation in m
2001	518.6	18.2	6.9	11.3
2002	398.1	25.8	8.6	17.2
2003	175.3	26.13	26.13	0
2004	907.7	24.83	1.75	23.08
2005	582.7	4.3	1.38	2.92
2006	716.98	5.53	0.73	4.8
2007	542.01	6.05	5.9	0.15
2008	479.66	6.1	2	4.1
2009	1006.1	11.95	3.1	8.85
2010	759.6	12.6	4.2	8.4

Well No.5 in Karanje

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	705	35	28.5	6.5
2002	497	48.3	18.5	29.8
2003	299.3	70	70	0
2004	806	70	24.1	45.9
2005	848	42	12.8	29.2
2006	555	44.2	12.9	31.3
2007	826	30.9	11.8	19.1
2008	787	44.6	35	9.6
2009	795	44.7	34.4	10.3
2010	805	45.1	33.2	11.9

Well No.6 in Khatav

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	518.6	27.8	14.5	13.3
2002	398.1	28.2	18.6	9.6
2003	175.3	29.54	28.32	1.22
2004	907.7	19.82	5.5	14.32
2005	582.7	28.7	3.82	24.88
2006	716.98	23.22	6.02	17.2
2007	542.01	24.3	6.1	18.2
2008	479.66	25	6.5	18.5
2009	1006.1	28.5	7.64	20.86
2010	759.6	27.8	6.8	21

Well No.7 in Lalgun

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	518.6	13.8	8.6	5.2
2002	398.1	7.9	6.9	1
2003	175.3	8.12	8.28	-0.16
2004	907.7	12.2	7	5.2
2005	582.7	8.25	5.3	2.95
2006	716.98	6.55	4.9	1.65
2007	542.01	6.9	7.15	-0.25
2008	479.66	7.65	7.3	0.35
2009	1006.1	9.4	8.7	0.7
2010	759.6	10.4	6.8	3.6

Well No.8 in Nimsod

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	705	8.5	5.4	3.1
2002	497	7.2	6.1	1.1
2003	299.3	6.75	7.65	-0.9
2004	806	3.9	4.6	-0.7
2005	848	8.4	2.9	5.5
2006	555	7.5	2.6	4.9
2007	826	7.25	7.15	0.1
2008	787	8.1	1.7	6.4
2009	795	9.75	2.8	6.9
2010	805	10.5	4.2	6.3

Well No.9 in Pusesawali

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	518.6	10.1	8.7	1.4
2002	398.1	12.4	10.7	1.7
2003	175.3	8.75	12.9	-4.15
2004	907.7	9.75	1.15	8.6
2005	582.7	10.6	9.65	0.95
2006	716.98	12.1	1.65	10.45
2007	542.01	10.3	2.1	8.2
2008	479.66	9.75	1.4	8.35
2009	1006.1	9.6	1.7	7.9
2010	759.6	9.8	2.6	7.2

Well No. 10 in Saholi

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	425	18.5	11.5	7
2002	388.04	19.7	16.8	2.9
2003	288.23	50.85	43.05	7.8
2004	736	51.55	27.15	24.4
2005	920	20.75	7.95	12.8
2006	1038.4	18.95	8.85	10.1
2007	820	17.85	8.95	8.9
2008	710	24.05	24.15	-0.1
2009	758	20.55	18.22	2.33
2010	635	22.1	17.4	4.7

Well No. 11 in Tasgaon

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	404.6	6.8	4.8	2
2002	399.3	8.7	4.8	3.9
2003	167.4	6.95	5.87	1.08
2004	546.4	6.9	3.75	3.15
2005	574.1	5.1	3.05	2.05
2006	729.1	5.35	2.35	3
2007	769.5	4.15	1.95	2.2
2008	467.7	8.55	1.95	6.6
2009	591.3	3.55	1.65	1.9
2010	552.5	4.5	2.8	1.7

Well No.12 in Vita

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	705	7.5	4.6	2.9
2002	497	8.2	6.9	1.3
2003	299.3	8.1	5.65	2.45
2004	806	8.95	1.75	7.2
2005	848	5.8	2.5	3.3
2006	555	6.7	2.9	3.8
2007	826	6.05	1.65	4.4
2008	787	6.6	1.6	5
2009	795	6.5	6.55	-0.05
2010	805	7.9	4.8	3.1

Well No. 13 in Walkhad

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	705	15.6	14.2	1.4
2002	497	12.4	6.7	5.7
2003	299.3	14.9	10.5	4.4
2004	806	19	1.55	17.45
2005	848	15	2.85	12.15
2006	555	12.4	2.15	10.25
2007	826	9.25	2.35	6.9
2008	787	11.7	0.95	10.75
2009	795	20.1	3.1	17
2010	805	19.4	4.7	14.7

Well No.14 in Wasagade

Year	WMR Rainfall in mm	Pre-Monsoon WLS in m	Post-Monsoon WLS in m	Seasonal Variation in m
2001	404.6	13	10.5	2.5
2002	399.3	12	10.8	1.2
2003	167.4	11	11.2	-0.2
2004	546.4	11	10.9	0.1
2005	574.1	10	10.5	-0.5
2006	729.1	7.8	11	-3.2
2007	769.5	8	10.9	-2.9
2008	467.7	11	11.9	-0.9
2009	591.3	11	10.6	0.4
2010	552.5	14	8.7	5.3

Fig. 4 Graphical analysis