Aarhat Multidisciplinary International Education Research Journal (AMIERJ)
(Bi-monthly) Peer-Reviewed Journal Vol No 1 Issues III ISSN 2278-5655
2012 Sep

VADOSE ZONE AND GROUNDWATER TABLE STUDIES IN DUBDUBI BASIN SOLAPUR DISTRICT, MAHARASHTRA, INDIA.

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Abstract

Groundwater levels for pre and post monsoon for five years have been monitored at 42 observation wells in the Dubdubi basin of Solapur district Maharashtra. The data has been used to prepare pre and post monsoon water table maps and delineation of vadose zone. Further favorable zone for artificial recharge have been demarcated.

Key words:- pre and post monsoon water levels, vadose zones, favorable zones for artificial recharge.

1. Introduction

Hydrogeological investigations provide information for planning, delineation, evaluation, exploitation and management of groundwater resources. The main input, rainfall, plays an important role in fluctuation of water table. A change of groundwater level plays an important role for groundwater storage in an area. Ravisankar and Mohan (2005) represented that average pre and post monsoon water table level was 6m bgl to 2m bgl with an average water table fluctuation of 4m in the Battra and the Kalu rivers flowing through Deccan basalts. Sable (2008) have also given the relationship between rainfall and water level fluctuation and lag time for rise and fall of water level after the rain fall event.

Ground water province is a region having similar characteristics in the mode of occurrence of groundwater. Deccan volcanic province is one of the eight Indian groundwater basins as classified by Talyar (1956). Phatak (1989) based on the dissimilarities observed in drainage characteristic, climate and availability of moisture, type of regolith and quality of ground water also gave a similar classification. Thigale (2004) recommended different groundwater provinces in Deccan basalts based on topography, drainage, degree of weathering and climate for the area between 73^0 and $75^030'$ east longitude and 16^0 and 22^0 north latitude.

Vadose zone is that part of the aquifer which is unsaturated and lies between ground surface and watertable. This zone is potential for recharge. Thicker the vadose zone more is the scope for recharge. The vadose zone fluctuates depending upon the availability of water. Therefore vadose zone and groundwater distribution studies carried out in the Dubdubi basin located on survey of India toposheet no. 47 O/14, 47 O/15, 56 C/3, on the scale of 1:50,000, lies between latitude $17^0$21' to 17^0 14' N and longitude 76^0 00' to 76^0 11' E. Covering an area of 450 sq. Km as shown in figure1.

2. Geology:

Four lava flows consisting of three distinct horizons are observed in the Dubdubi basin, the lower one is basal clinker followed by massive part which is hard and compact and upper horizon is characterized by vessicles and cavities filled by secondary minerals. Massive traps, fractured and jointed at places, act as water conduits. The thickness of both (lower) first and second flow is 21 M. The third flow is 46 M thick. This is overlain by fractured basalts of the younger flow i.e. fourth flow. However a massive portion of the oldest flow and the vesicular portion of the youngest flow are not represented in the basin. The general gradient of lava flow is 1:550 to 1:800 toward south east. Exposures of alluvium having a thickness range of 4 to 7 M are the quaternary formation exposed in the basin along the streams. The lava flows are separated by red bole as marker bed, this is also observed elsewhere in Deccan Basalts (Adyalkar, 1984).The geological succession in the Dhubdhubi Basin is given in table 2 (Sabale 2008), location map is given in Fig. 1 and Geological map in Figure 2.

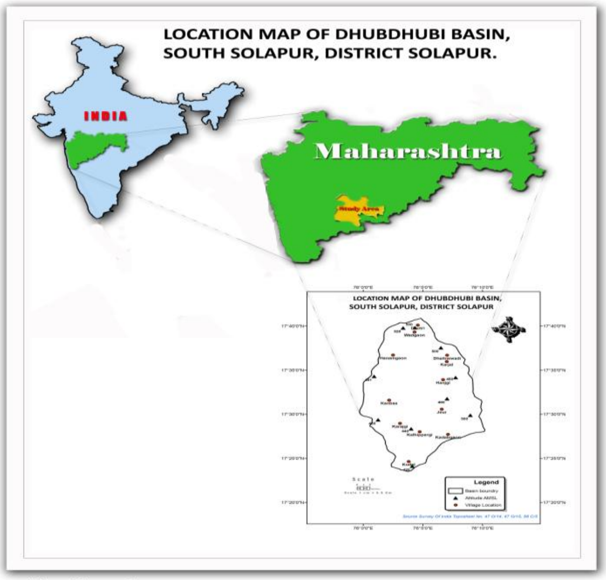


Fig No .1

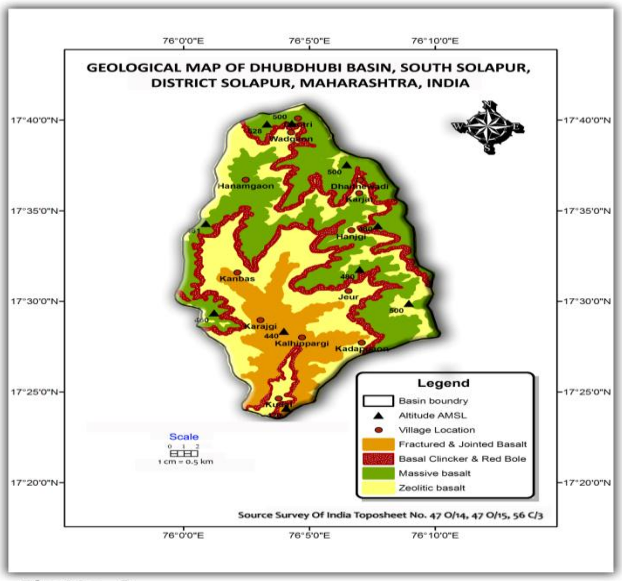


Fig No .2

Table No. 1. Geological succession in the Dhubdhubi Basin (Sable 2008)

Age	**Formation**	**Group**	**Stratigraphic Unit**	**Litho unit**	**Thickness in meters**	**Flow number in the Basin**
QUATERNARY	**ALLUVIUM**			Poorly sorted sediments	4-7	
U P P E R C R	**D E C**	**S A**	**I N D**	Massive Basalt Fractured/ Jointed Basalt Basal Clinker (weathered)	5 9 8	IV

E T A C E O U S TO E O C E N E	**C A N T R A P**	**H Y A D R I**	**R A Y A N I**	Red bole Zeolitic Massive / Fractured Basalt Basal Clinker	1 22 19 4	III
				Red bole/ Zeolitic Massive Basalt Basal Clinker (weathered)	1 12 8	II
				Red bole Zeolitic (weathered)	1 20	I

3. Groundwater level contour map studies

Groundwater level elevations were monitored monthly at 42 observation wells, representing aquifers form different geomorphological and lithological variations. In order to compare pre-monsoon and post-monsoon water levels, water table contour maps have been prepared for the months of May 2003 to May 2007 for five years as pre-monsoon water levels. Similarly for the months of November 2002 to 2006 representing post-monsoon effects. These have been shown in fig. 3 to 11 the watertable fluctuates over several meters during the year as a result of natural groundwater flow and recharging process. In the uplands, fluctuations are from 5m to 10m. Whereas the average water table fluctuates at lowlands, approximately from 2 to 4 meters.

Water level heads influence groundwater movement under natural conditions through the interconnected pores and cracks below the phreatic surface. Generally in the Dhubdhubi basin maximum head loss of the system, for post monsoon lies between 95 m to 120 m. the head loss increases from basin boundaries. However, it broadly forms a step like appearance towards the valley parts in the southern portion of the basin.

Lateral flow system boundaries are formed by the water table highs and lows within the basin. The different general groundwater flow systems observed form pre- and post-monsoon water level contour maps are:

3.1 Pre-monsoon water levels

The pre-monsoon water levels have been shown in fig.3 to 7. In general the water levels are increasing from south to north, and the water level contours from central part of the basin to north have NW-SE trend (fig. 3 to 7).

On the south the contours show closures at Kalhippargi and Kudal (fig. 3 and 4), perhaps due to over pumping. The contour closures during May 2007 (fig. 7) in areas covering Dindur, Tirth and Chapalgaonwadi on the northeast part of the basin may also be due to over pumping.

The pre-monsoon water levels show broadly the following features and trends:

(i) On the north and the central region of the basin, the contours trend NW-SE, excepting a closure over a small region in the northwest part as shown in fig. 3, in the central part (fig. 6) and in a large area near Dindur, Tirth and Chapalgaonwadi (fig. 7).

(ii) The water levels as observed from the contour maps are undulating in the central region for all the five years.

(iii) There are regions of overpumping in the southern parts in areas around Kalhippargi and Kudal.

(iv) The flow pattern of the groundwater shows a north-south trend in general. However, since the transmissivity of the central portion is low, the groundwater circumvents the central part both on the west and on the east. This pattern is for all the five years (2003-2007).

(v) The areas in and around the general groundwater flow direction, namely Hanamgaon, Auj, Kanbas, Karjgi, Jeur, Kalhippargi, Walsang etc. are favourable for groundwater development.

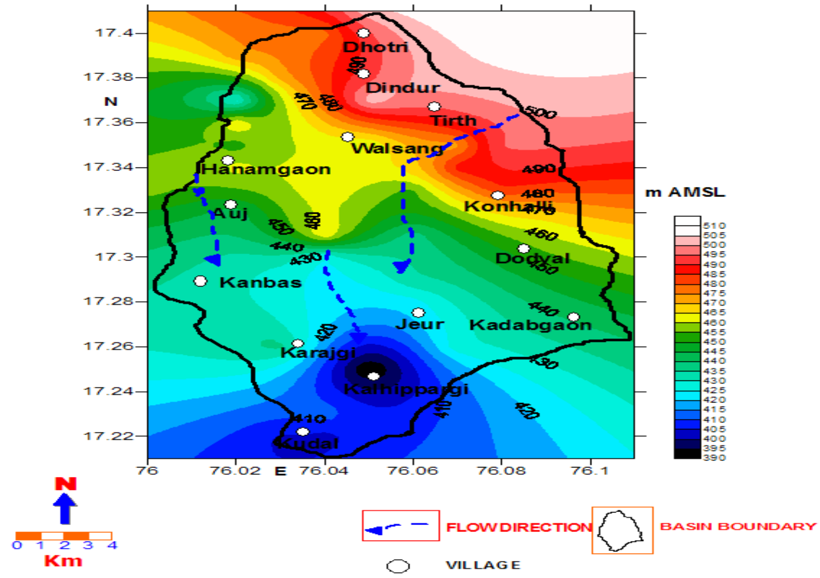


Fig. No. 3

PRE-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR MAY 2003 IN DHUBDHUBI BASIN, SOLAPUR DIST. MAHARASHTRA CONTOUR INTERVAL: 5 m.

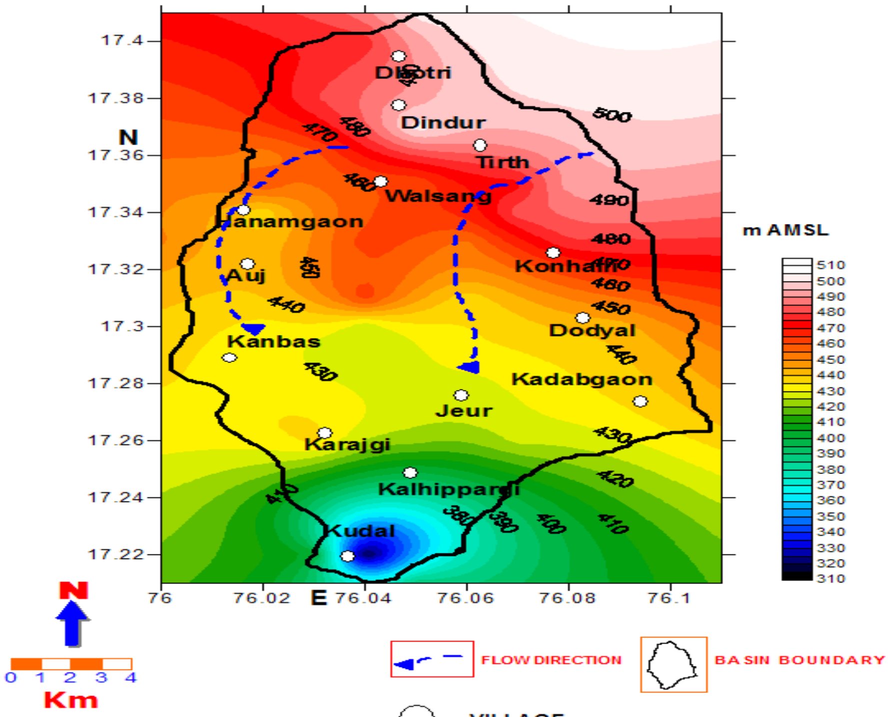


Fig. No. 4

PRE-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR MAY 2004 IN DHUBDHUBI BASIN, SOLAPUR DIST. MAHARASHTRA CONTOUR INTERVAL: 5 m.

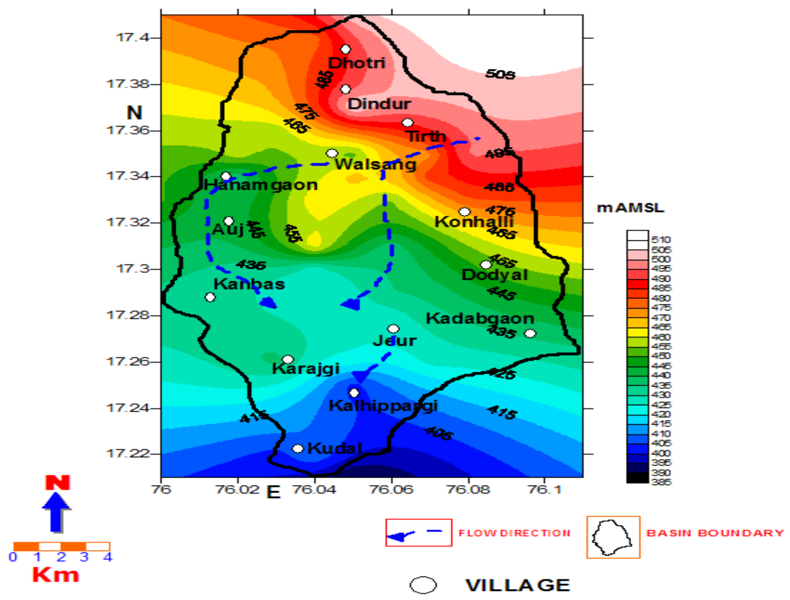
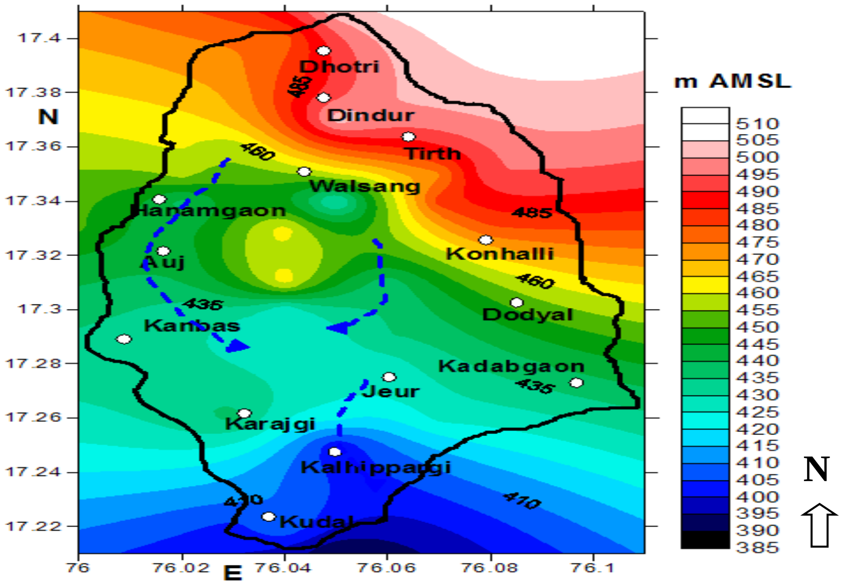


Fig. No. 5

PRE-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR MAY 2005 IN DHUBDHUBI BASIN, SOLAPUR DIST. MAHARASHTRA CONTOUR INTERVAL: 5 m.



PRE-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR MAY 2006 IN DHUBDHUBI BASIN, APUR DIST.CONTOUR INTERVAL: 5 m.

Fig. No. 6

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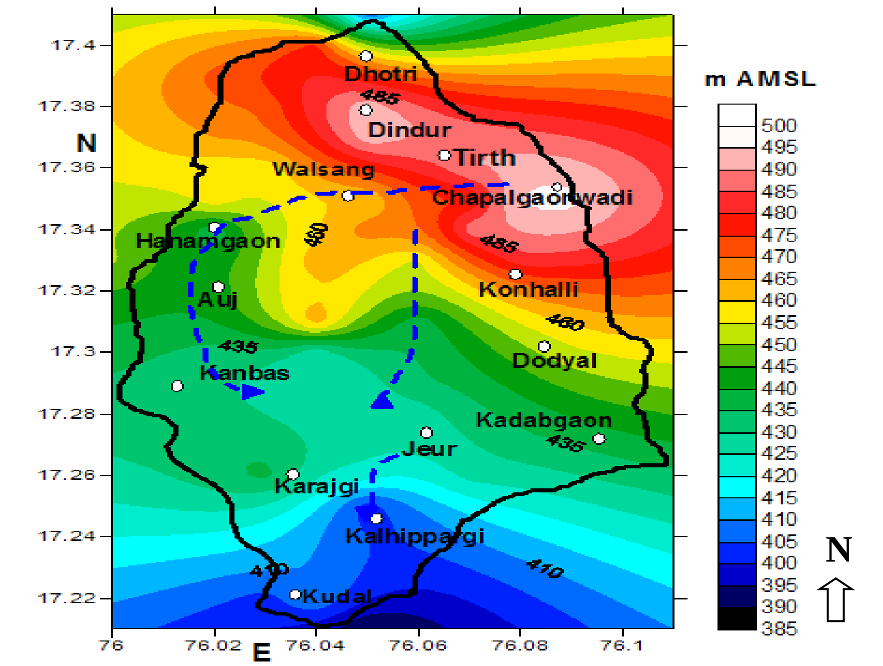

PRE-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR MAY 2007 IN DHUBDHUBI BASIN, ...UR DIST. MAHARASHTRA CONTOUR INTERVAL: 5 m.

Fig. No. 7

3.2 Post-monsoon water levels

The post-monsoon water levels from November 2003 to November 2006 have been shown in fig. 8 to 11. As in the case of pre-monsoon periods, here too, the water level increases from the south to the north.

The following features are generally observed from the water level contours:

(i) The water level contours for 2003, 2004 and 2005 have NW-SE trends in the north and the central regions, and are more or less E-W on the southern part.

(ii) The water level contours for 2006 on north east (near Dindur and east of Tirth) and in the south (around Kalhippargi and west of Kudal) show strong closures. This pattern is different from the previous three years. This could be due to over pumping for growing winter crops, or faster movement of groundwater.

(iii)The groundwater flow pattern is once again from north to south, and again avoiding the central part with low transmissivity. The rocks in the central part are most probably dense and hard. To sum up, the post-monsoon groundwater flow pattern is

(a) North of Dhotri – Hanamgaon - NE-SW and then NS in November 2005 (Fig. 10).

(b) Tirth- Walsang- Hanamgaon- E-W in November 2005 (fig. 10) and In November 2006 (fig.11).

C) Central part of the basin- then N-S (fig. 10 and fig.11).

(c)Karajgi-Kalhippargi to further South NW-SE (fig. 10) in 2005.

(d) Kadabgaon-Kalhippargi and further South- E-W and changing to NE- SW.

The post-monsoon contours of November 2006 show contour closures near Kalhippargi and Kudal, trending NE-SW and represent formation of groundwater trough, may be because of heavy pumping in the adjacent region.

Pre-monsoon groundwater contours show nearly same lateral flow-system boundaries. However, May 2003 and May 2004 contour maps show contours at Kalhippargi and Kudal, similar to that of post-monsoon contours of November 2006, resulting from heavy pumping. The pre-monsoon water level contours of May 2005, 2006 and 2007 show normal opening in the southern tip of the basin representing the out flow.

Three different sets of closely spaced contours passing through:

1) Dhotri, Dindur, Tirth, Konhalli: originating in the north and running Parallel to the NE basin boundary.

2) Hanamgaon-Achegaon-Dodyal: originating north of Hanamgaon undulating and merging with the first set near Dodyal near eastern margin of the basin. These closely spaced contours nearly bisect the basin in the EW direction passing through the central portion of the basin.

3) SW of Karajgi - south of Jeur and merging with above two sets at south of Kadabgaon.

The portions between these three sets of closely spaced contours represent even but broadly spaced contours. Therefore, areas around Walsang, Hanamgaon, Auj, Kanbas, Karajgi, Jeur, South of Kadabgaon, Kalhippargi and Kudal are favourable for groundwater development.

It has been observed that the groundwater flow systems are parallel to the surface water streams and corroborate with the findings of Narayanpethkar et.al. (2006) elsewhere in the basaltic terrain. The surface water streams are gaining streams during pre- and post-monsoons. However, in the heavy pumping area streams become loosing streams as noticed by contour closures forming groundwater troughs, as observed around at Kalhippargi and Kudal region during post-monsoon period of 2006 and pre-monsoon of 2003 and 2004

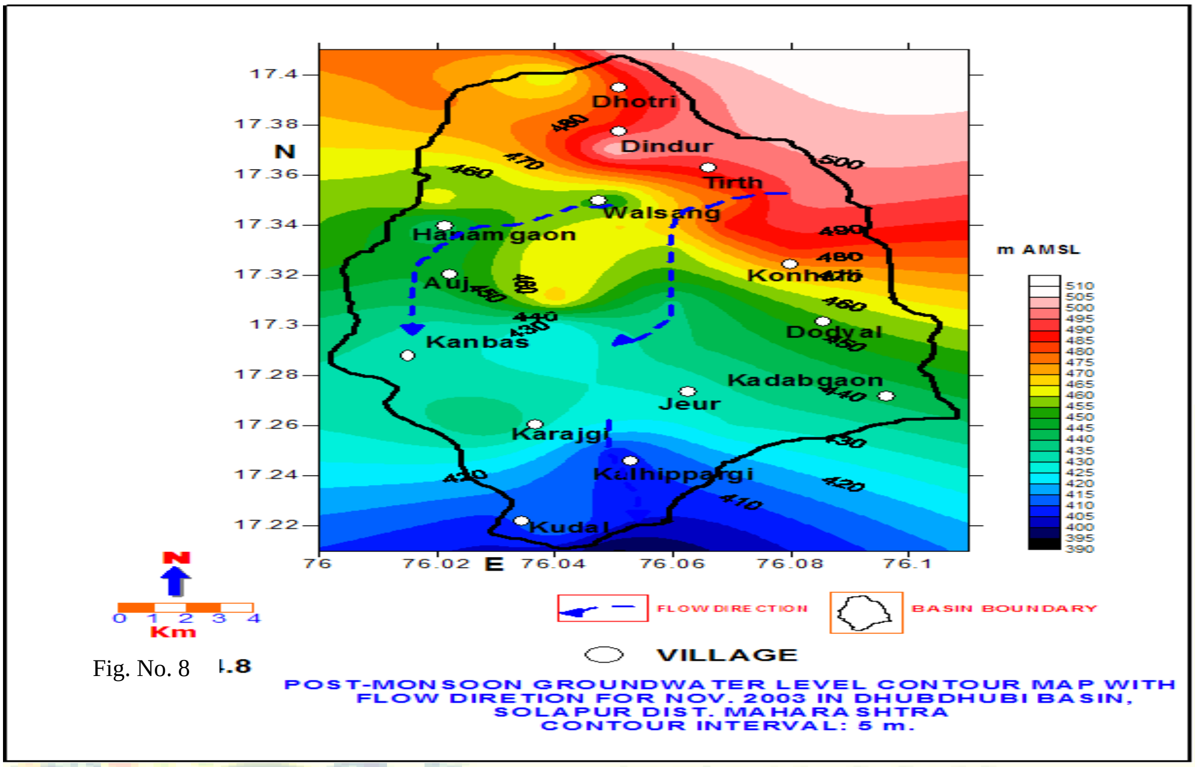

Fig. No. 8

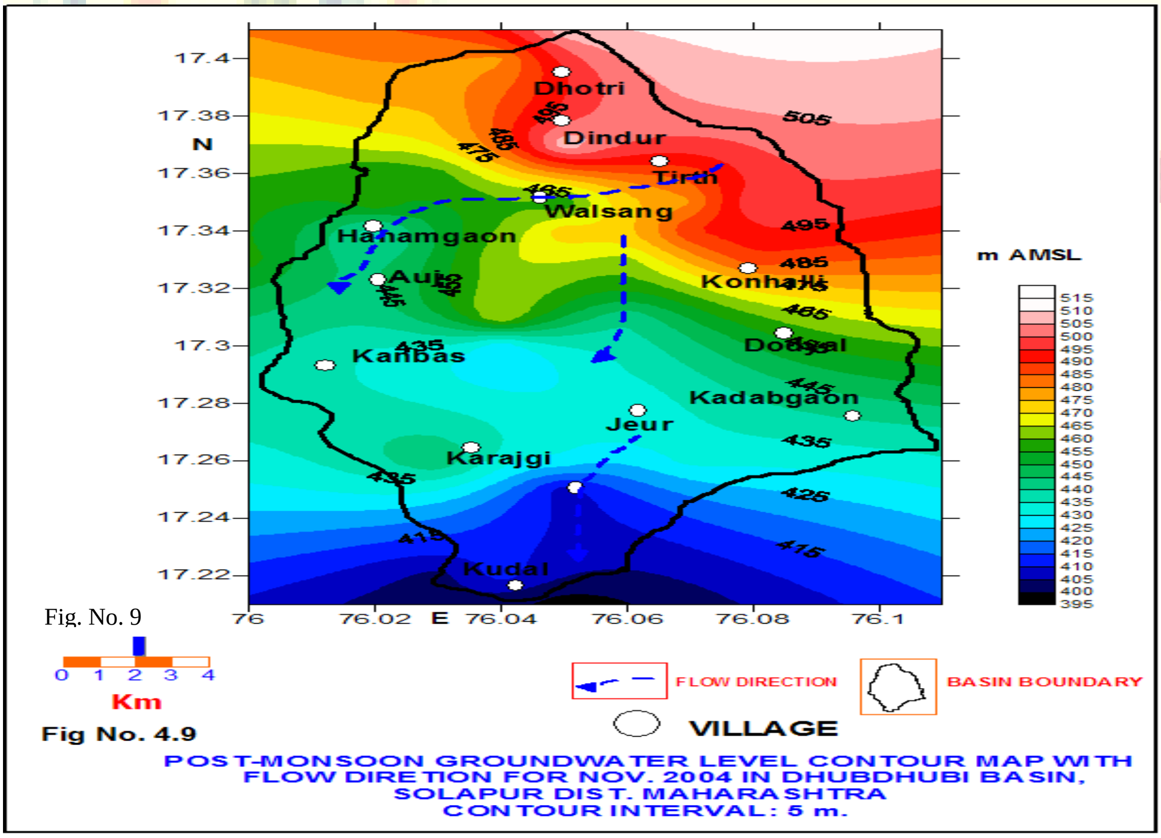

Fig. No. 9

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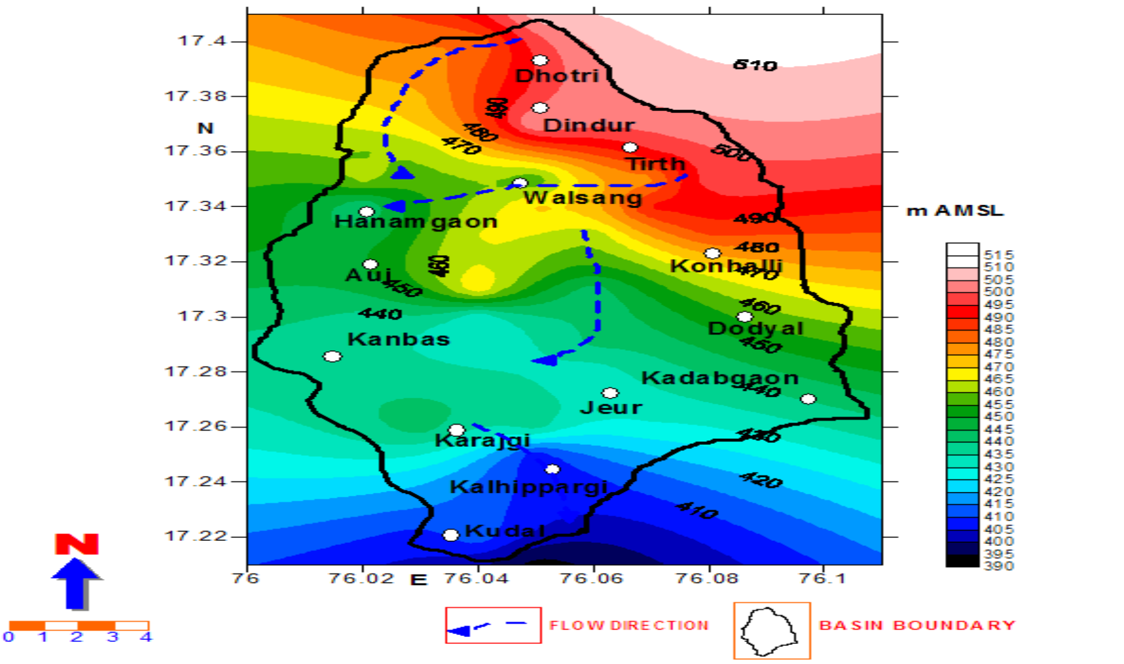

Fig. No. 10

10

POST-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR NOV. 2005 IN DHUBDHUBI BASIN, SOLAPUR DIST. MAHARASHTRA
CONTOUR INTERVAL: 5 m.

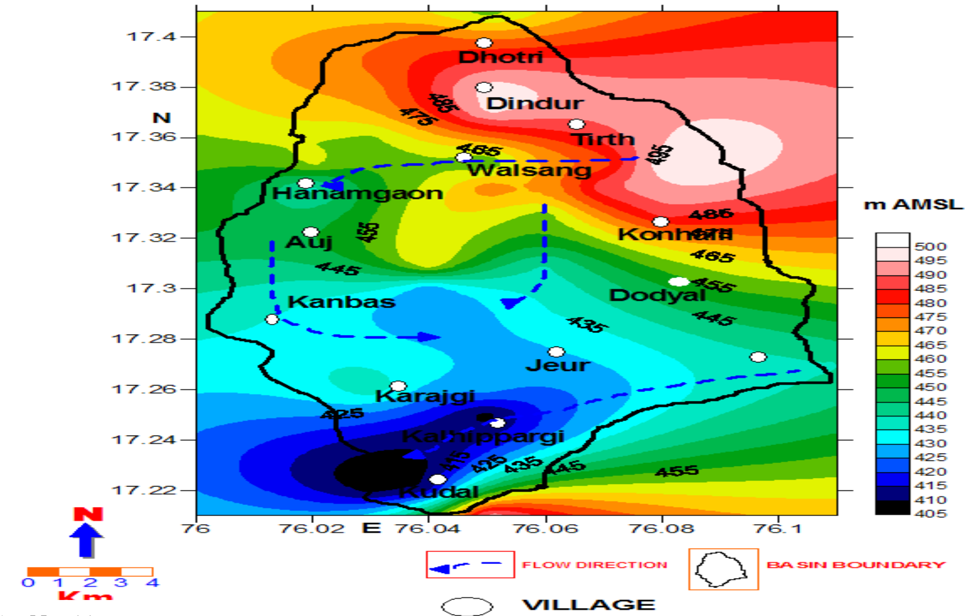

Fig. No. 11

.11

POST-MONSOON GROUNDWATER LEVEL CONTOUR MAP WITH FLOW DIRETION FOR NOV. 2006 IN DHUBDHUBI BASIN, SOLAPUR DIST. MAHARASHTRA
CONTOUR INTERVAL: 5 m.

4. Vadose zone

The thickness of the Vadose zone decides the scope for groundwater harvesting in hard rock terrains, because the pore spaces in this zone undergo restorations during infiltration and recharge and undergo destoration during evaporation and drainage. The volume of saturation involved in the process of change in saturation in vadose zone (Zone of weathering) is far larger than the changes in volume of water involved in the elastic storage of water below the water table. Therefore the dynamic resource in groundwater reservoir is governed by the "Vadose Zone" through which water level fluctuates. Therefore information regarding water saturation, thickness and permeability of vadose zone / weathering zone are to be known before going for recharging schemes. Thus for the Dhubdhubi basin the thickness of the Vadose zone for pre- and post-monsoon period have been observed and presented in table 2.

Table No.2 Thickness of pre monsoon and post monsoon vadose zone

Village	Pre-monsoon vadose zone in meter	Post monsoon vadose zone in meter
Shripanhalli	9	1.85
Kardehalli	8.8	2.25
Hanamgoan	13	4
Dindur	7.5	2
Thirh	8	1
Hiple	7	1
Auj	12.8	5.3
Kanbas	12	5
Kalhipargi	9	2
Karajgi	13	4.1
Shaval	10.3	3.4
Limbichincholi	13.7	6.1
Jeur	11.4	4.65

5. Discussions and Conclusions

In the Dubdubi basin, pre monsoon groundwater contours have three different sets of closely spaced contours passing through Dhotri, Dhindur, Thirth and Konhali.

The groundwater flow system show out flow through normal opening in the southern tip of the basin.

Post monsoon groundwater contours have three set of closely spaced contours with high gradient around south west of Karajgi, south of Jeur and Kadbgoan.

The area around Walsong, Hanamgoan, Auj, Kanbas, Kalhippargi, and Kudal are favorable for groundwater development.

There are four areas in the north center and south portion of the Dubdubi basin with thick vadose zone during pre monsoon and there are three region during post monsoon having more than 5m thick vadose zone, therefore potential zones for artificial recharge. It is estimated that 60% to 62 % of the area in the Dubdubi basin is favorable for artificial recharge.

References:

Narayanpethkar, A.B., Vasanthi A., and Mallick, K., (2006) Electrical Resistivity Technique for Exploration and studies on flow pattern of Groundwater in Multi-aquifer system in the Basaltic terrain of the Adila Basin, Maharashtra. Journal Geological Society of India Vol. 67 pp. 69 to 82.

Pathak, B. D., (1989) Hydrogeology in service of Society, Presidential address (75th Session): Geol. Geog. Section, Ind. Sci. Cong. pp. 17.

Ravi Shankar M.N., and Mohan G., (2005) A GIS based hydrogeomorphic approach for identification of site- specific artificial- recharge techniques in the Deccan Volcanic Province.J. Earth Syst. Sci. 114, No.5 pp. 505 to 514.

Sable S. M. (2008) groundwater harvesting in Dubdhubi basin, Solapur district Maharashtra India. Ph.D. Unpublished Thesis Shivaji University, Kolhapur pp. 175 .

Taylor, G.C. (1959) Groundwater provinces of India. Econ. Geo. Vol. 54 (4) pp. 683 to 697.

Thigale, S.S., (2004) An Excursion Through the watersheds from Konkan Coast to Upland Western Maharashtra. Proc. 91st Ind. Sc. Cong, Part II: Presidential Address pp. 1 to 36.