"MITIGATION OF DROUGHT USING MODELING STUDIES FOR GROUNDWATER HARVESTING IN SUS BASIN, SOLAPUR DISTRICT MAHARASHTRA, INDIA."

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ABSTRACT:

Electrical resistivity and Lineament density models are prepared for Sus basin, a tributary of Bhima River, the main feeder of Krishna River. The basin covers parts of Pandharpur, Mohol and Madha talukas of Solapur district Maharashtra, India. Located on toposheet no. 47 O/5 and 47 O/6 on the scale of 1:50,000 lies between ($17^0 41'$ to $17^0 58'$ N Latitude $75^0 20'$ to $75^0 30'$ E Longitude) Covering of an area of 350 sq.km. Lineament density, resistivity and isopach models has been developed. These models are useful for the demarcation of suitable sites for artificial recharge and also the harvesting structure.

***Keywords**: – hydrogeology, resistivity, lineament, demarcation.*

1 Introduction:-

Geological and geophysical (electrical resistivity) models are prepared in the Sus basin, from Solapur District ($17^0 41'$ to $17^0 58'$ N Latitude $75^0 20'$ to $75^0 30'$ E Longitude).Sus basin occupies part of Pandharpur, Mohol and Madha talukas covering an area of 350 sq.km location map shown in fig.1

Subsurface flow pattern has been developed by Narayanpethkar et al. (2006). A study on groundwater harvesting has been done with the help of resistivity distribution of Dubdubi basin by Sable et.al. (2009). Subsurface resistivity structures for groundwater studies have been produced by

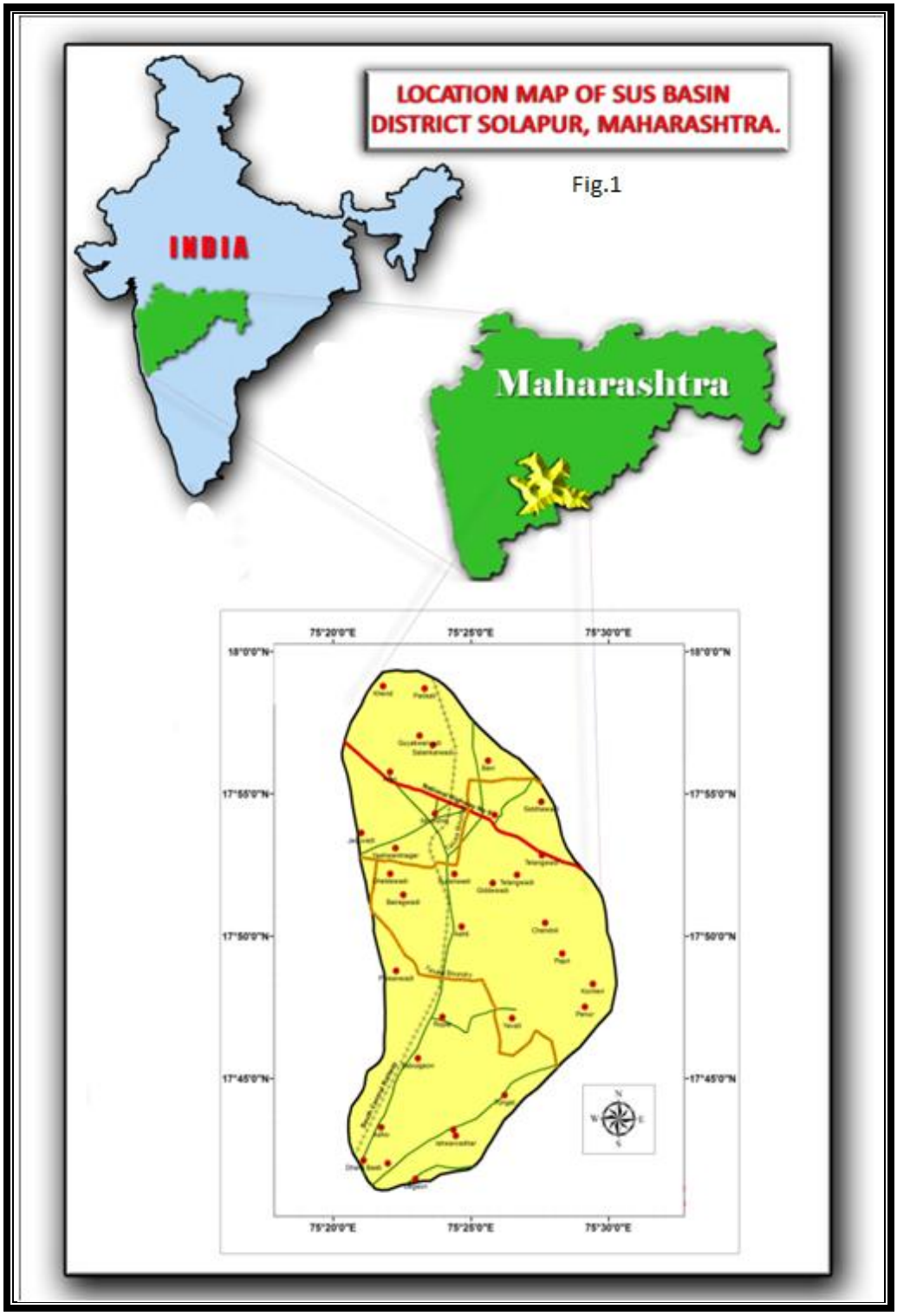
Narayanpethkar et al. 2009. A multistoried aquifer study with the help of resistivity technique has been proposed by Narayanpethkar et al. 2013. Referring to these studies an attempt has been made to get distribution of electric resistivity at different horizons and interpreted in terms of hydrogeological set up in the present correspondence, for the Sus basin.

2. Geology of study area –

Three lava flows of upper Cretaceous to lower Eocene age belonging to Deccan trap formation,

Sahyadri group and Indrayani Stratigraphic unit are exposed in the Sus basin. The older (first flow in the basin) shows exposures of weathered vesicular unit (with secondary zeolitic minerals).The thickness of this unit is 10-12 meters and occupies southernmost portion of the basin around Narayanchincholi, Degoan and Ishwarvatar villages. The massive basaltic unit of this flow is not exposed in the basin.

The second flow consists of basal clinker, massive basalt / fractured / jointed basalt, vesicular / zeolitic and red bole of 4, 16, 10 and 1 meter thicknesses respectively. This flow is exposed along Babulgoan and south of Aran. The youngest (third) flow overlay the second flow with four meter thick basal clinker as base and exposed at Yeshvantnagar and south of Aran. This is overlain by massive basalt unit of 15m thickness, over this fractured and jointed basalt unit of 10m thickness, is exposed at Solankarwadi and Shiddhewadi in northern portion of the Sus basin. This is overlain by weathered basalt (15m) in the northern most part of the basin around Padsali. The flows are nearly horizontal. The Geological succession in the Sus basin is given in Table 1 and geological map in fig.2


LOCATION MAP OF SUS BASIN
DISTRICT SOLAPUR, MAHARASHTRA.
Fig.1
INDIA
Maharashtra
75°20'0"E
75°25'0"E
75°30'0"E
18°0'0"N
17°55'0"N
17°50'0"N
17°45'0"N

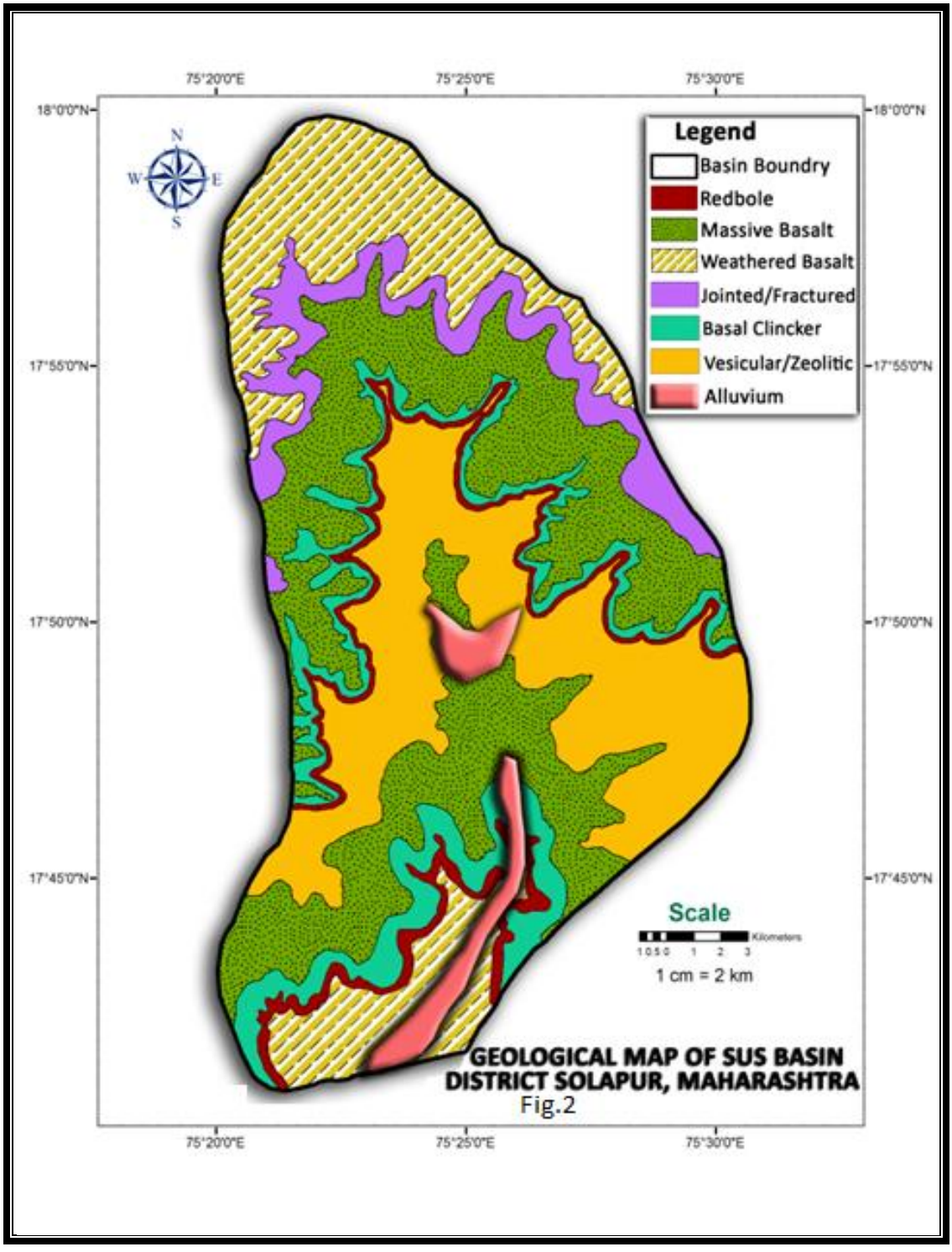

75°20'0"E
75°25'0"E
75°30'0"E
18°0'0"N
17°55'0"N
17°50'0"N
17°45'0"N
N
W
E
S
Legend
Basin Boundry
Redbole
Massive Basalt
Weathered Basalt
Jointed/Fractured
Basal Clincker
Vesicular/Zeolitic
Alluvium
Scale
Kilometers
1 0.5 0 1 2 3
1 cm = 2 km
GEOLOGICAL MAP OF SUS BASIN
DISTRICT SOLAPUR, MAHARASHTRA
Fig.2

Table No. 1 Stratigaphic Successions Of The Deccan Basalts From The Sus Basin

Age	Formation	Group	Stratigraphic Unit	Litho unit	Thickness in meters	Flow number in the Basin
QUATERNARY	ALLU-VIUM			Poorly sorted sediments	6	
UPPER CRETACEOUS TO EOCENE	DECCAN TRAP	SAHYADRI	INDRAYANI	Weathered Basalt	15	
				Fractured/ Jointed	10	III
				Massive Basalt Basalt	15	
				Basal Clinker	4	
				Red bole	1	
				Zeolitic	10	II
				Massive / Fractured	16	
				Basal Clinker	4	
				Red bole	1	I
				Zeolitic	8	

3. Electrical resistivity studies:-

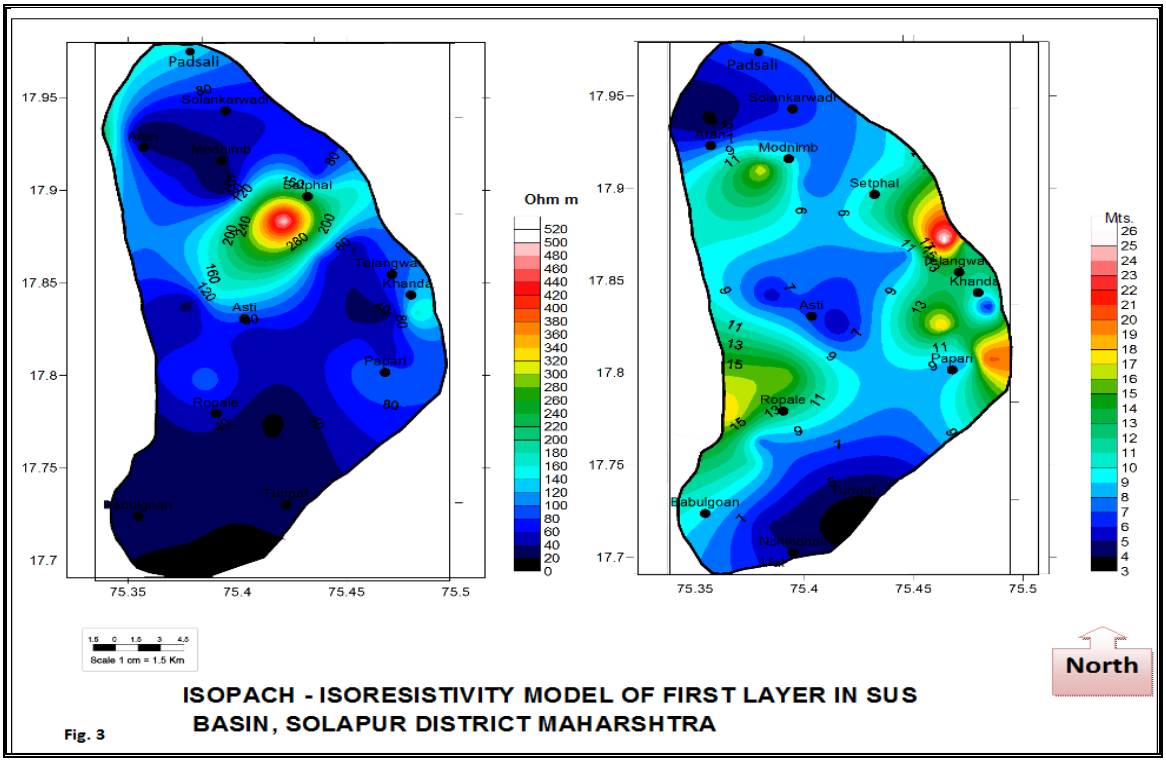
Electrical resistivity soundings have been carried out using the Wenner electrical resistivity configuration in Sus basin in a grid. Resistivity of each layer is calculated and thickness of each layer is also derived. On the basis of resistivity values three zones that is less than 40ohm m, 40-60 ohm m and above 60 ohm m has been demarcated as feasible, moderately feasible and unfeasible zones respectively. The zones 40-60 ohm m has been demarcated as sites for groundwater harvesting.

3.1 Isopatch Isoresistivity Models:-

Thickness of each layer is estimated using the electric resistivity sounding data. The thickness and resistivity of each layer have been used to know the lateral variations; by constructing isopach and isoresistivity contour maps for the Sus basin, the observations are given in following paragraphs:

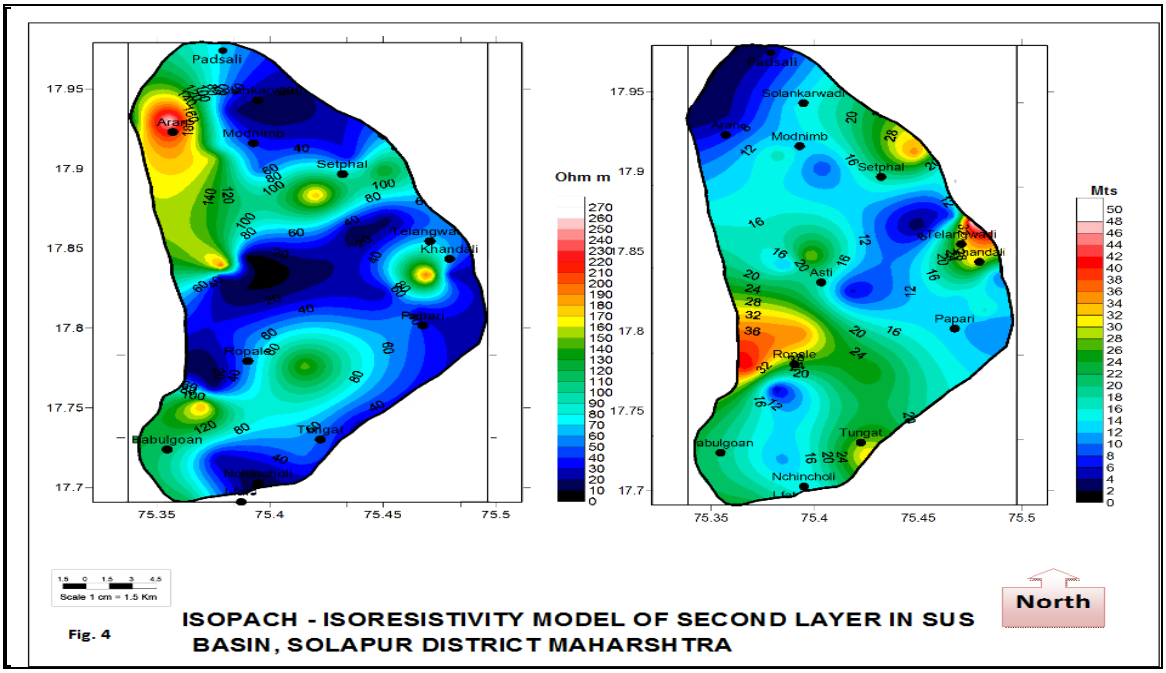
The first layer thickness in northern part of Sus basin vary between 5 and 9m and resistivity of this layer at Solankarwadi and Padsali is between 60 and 80 ohm m representing moderately weathered and jointed basaltic rock. While around Aran, Modnimb and Shetphal resistivity values are 200 to 500 ohm m often shown by compact massive basalt (fig.no.3). The central and eastern part of the basin were the thickness of first layer varies between 5 and 14 m around Telangwadi, Asti, Kandali and Papri with resistivity between 40 and 70 ohm m indicating the weathered basalts grading in to fractured rock formation. Southern portion of the basin has first layer thickness from 5 to 13 m around Babulgoan, Tungat, Narayanchinhcoli, and Ishwarvathar and the resistivity range between 20 and 40 ohm m this area represents highly weathered zone.

Fig. 4 shows the second layer isopach and isoresistivity model respectively. It is observed that in the north, thickness of second layer is less than 8 m around Solankarwadi, and Padsali, resistivity is from 20 to 40 0hm m around Solankarwadi and Padsali, while near Aran, Modnimb and Setphal thickness varies from12m to 16m and resistivity values increase from 80 to 250 ohm m representing massive basalts. Central portion shows variation in thickness from 12 to 20 m and its resistivity is 60 to 100 ohm m representing jointed and fractured basalt.



ISOPACH - ISORESISTIVITY MODEL OF FIRST LAYER IN SUS BASIN, SOLAPUR DISTRICT MAHARSHTRA

Fig. 3



ISOPACH - ISORESISTIVITY MODEL OF SECOND LAYER IN SUS BASIN, SOLAPUR DISTRICT MAHARSHTRA

Fig. 4

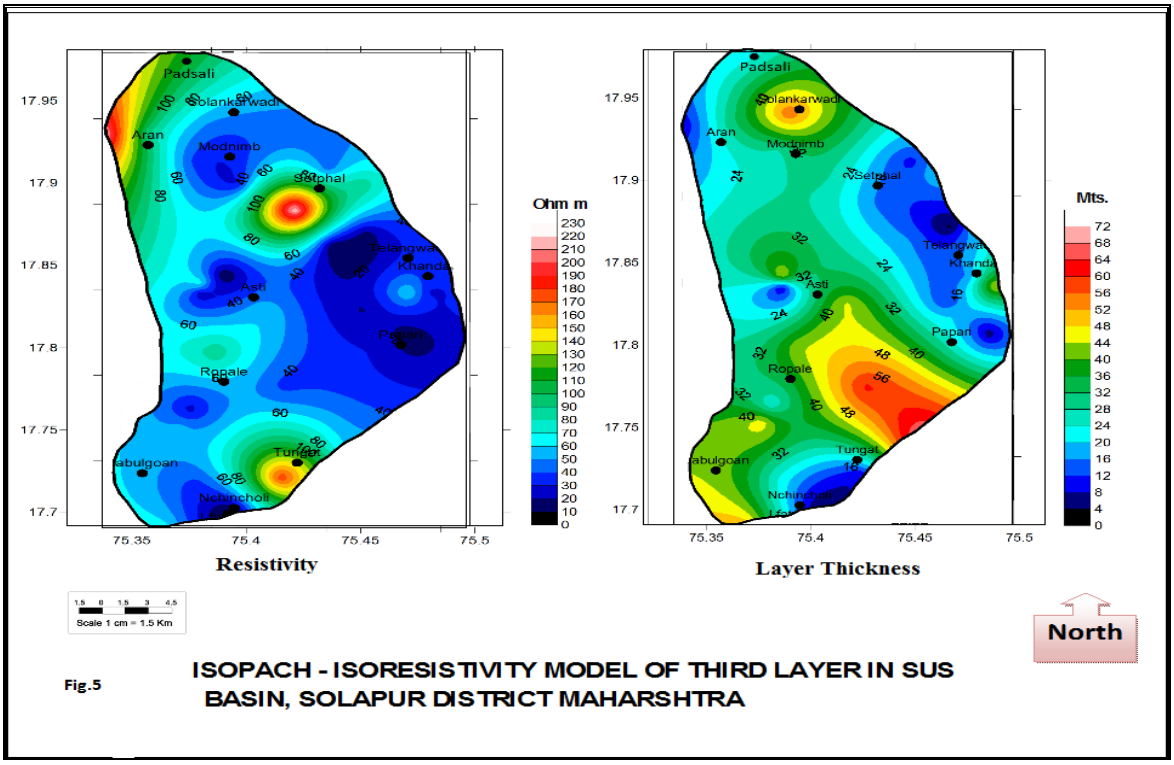


Fig.5 ISOPACH - ISORESISTIVITY MODEL OF THIRD LAYER IN SUS BASIN, SOLAPUR DISTRICT MAHARSHTRA

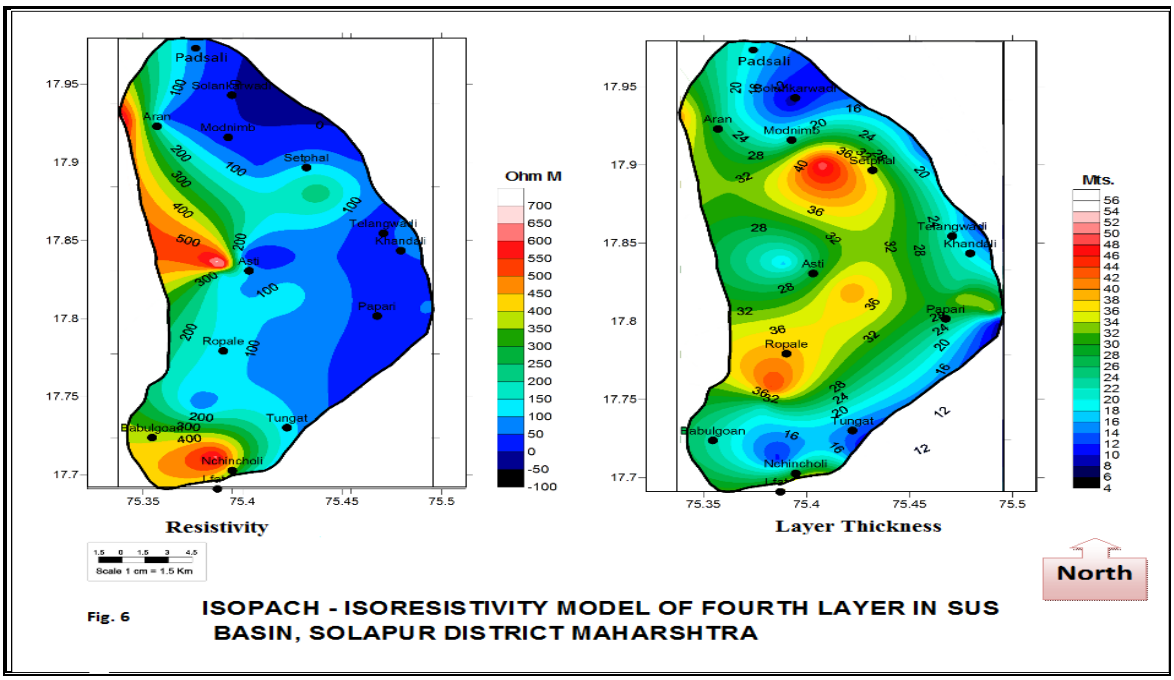


Fig. 6 ISOPACH - ISORESISTIVITY MODEL OF FOURTH LAYER IN SUS BASIN, SOLAPUR DISTRICT MAHARSHTRA

The eastern portion of the basin, around Telangwadi and Khandali and west of Rople, resistivity is 80 ohm m for 32m thick second layer. Southern portion of the basin has second layer thickness between 12 to 20 m and the resistivity is 20 ohm m around Narayanchincholi and Ishwarvathar and gradually increases to 40 ohm m around Tungat, further north in the central portion of the basin the resistivity increases to 80 ohm m indicating that alluvium, highly weathered formation is grading into jointed and fractured rock respectively.

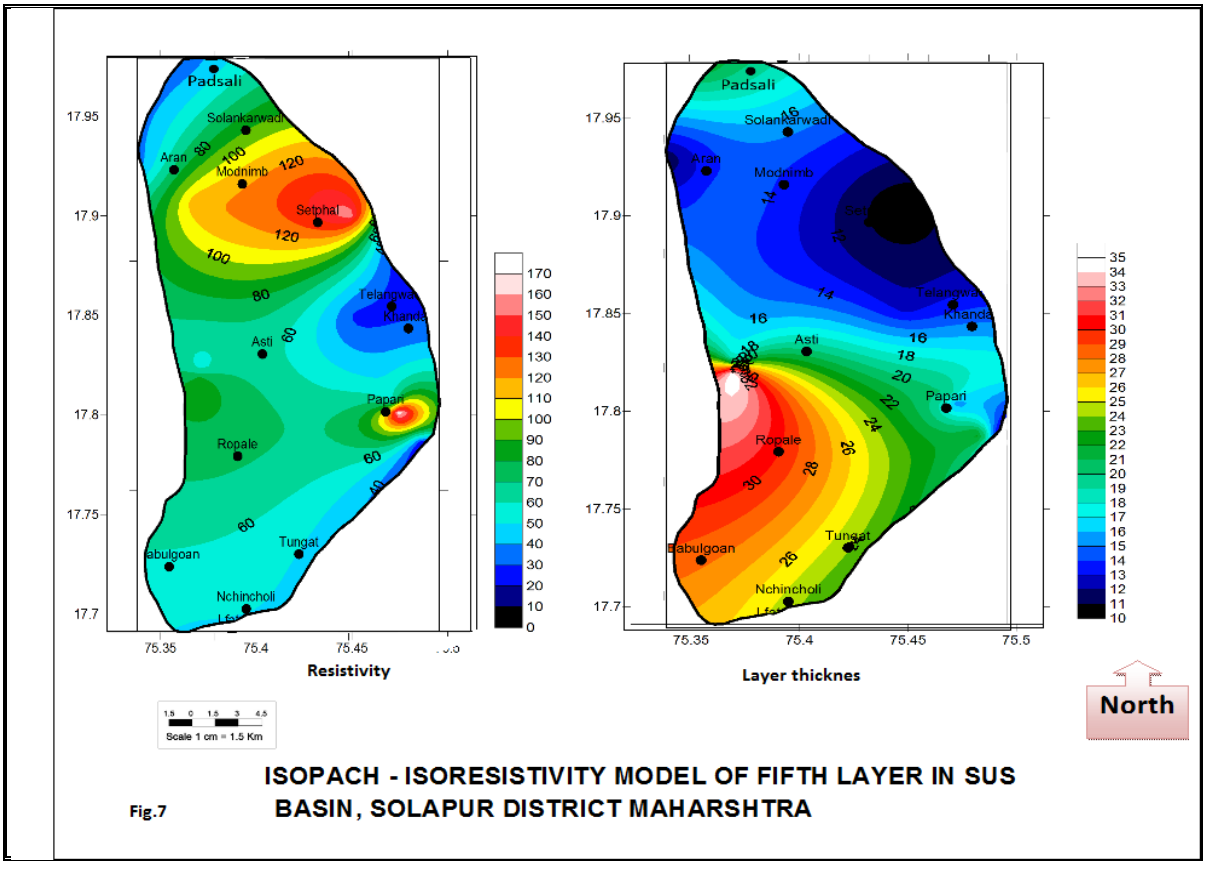
The isopach map indicate that in the northern portion of the Sus basin the third layer thickness is between 20m and 48m, with 40 to 50 ohm m resistivity, around Solankarwadi. This is the suitable third layer site for groundwater occurrence and development. 20 to 24m thick and high resistivity (130 to 210 ohm m) is found around Aran. An elongated depression is present along the eastern margin of the basin from Setphal to Papri. The thickness of third layer in this portion is 4 to 16 m with resistivity 80 to 100 ohm m, indicating presence jointed and massive rock. Near Asti, in the central portion of the basin, the thickness is 32 to 40 m with 40 ohm m resistivity value; this layer is productive zone for water. The southern region of the basin the thickness is 12 to 36 m around Babulgoan, Tungat, Narayanchincholi, and Ishwarvatar. Resistivity values at Babulgoan are around 30 to 40 ohm m therefore it is good water yielding horizon. However, around Narayanchincholi and Ishwarvatar the resistivity becomes 80 to 100 ohm m representing fractured and jointed basalts and act as poor aquifer. The third layer isopach and resistivity distribution is shown in the fig. 5. Fig.6 represents fourth layer thickness and its resistivity distribution model. In northern portion fourth layer thickness is varying between 12 to 20 m aroundSonlakarwadi, Padsali, Aran and Modnimb and the resistivity around Padsali and Solankarwadi is 20 to 50 ohm m representing highly weathered to unweathered vesicular and zeolitic basalts.

Near Aran resistivity increases to 500 ohm m and that is of hard massive rock basalt. At Setphal the thickness is 48 m and resistivity is between 100 to 150 ohm m indicating hard but jointed rock. Central and eastern portion of the basin where thickness of the fourth layer is 24 to 32 m and resistivity is 50 ohm m around Asti, Rople, Khandali, Papri and Telangwadi represents vesicular/zeolitic layer, which is favorable site for groundwater exploration and development. Around Babulgaon, Tungat, Narayanchincholi and Ishwarvathar in the southern region, fourth layer thickness is 16 to 20 m and resistivity is 50 ohm m often represented by vesicular basalt.

The fig 7 represents thickness and resistivity distribution of fifth layer. A 14m

thick and 80 to 150 ohm m resistivity distribution is observed in the northern area of Sus basin. This indicates presence of hard but jointed and fractured basalt. The central portion has thickness range between 16 and 24m.However, resistivity values near Asti are 40 ohm m and 70 to 80 ohm m around Rople, further the resistivity values at Papri increases to 170m that is vesicular formations grade in to massive basalts. In the southern region of the basin, thickness range between 20 and 28m and the resistivity range between 40 and 50 ohm m respectively. Normally such region is feasible for groundwater exploration and development.

The feasible range of resistivity may also be useful to demarcate favorable locations for artificial recharge by constructing suitable recharge structures on the surface or subsurface to increase groundwater storage to be utilized during scarcity period.



ISOPACH - ISORESISTIVITY MODEL OF FIFTH LAYER IN SUS BASIN, SOLAPUR DISTRICT MAHARSHTRA

Fig.7

Table No.2 Isopach – Isoresistivity model data

Villages	Thickness of layer 1 (m) / Resistivity of 1st layer (Ohm m)	Thickness of layer 2 (m) / Resistivity of 2nd layer (Ohm m)	Thickness of layer 3 (m) / Resistivity of 3rd layer (Ohm m)	Thickness of layer 4 (m) / Resistivity of 4th layer (Ohm m)	Thickness of layer 5 (m) / Resistivity of 5th layer (Ohm m)
Padsali	7-9 / 80	8-12 / 30-40	30-32 / 80-100	10-12 / 50-60	18-20 / 80-100
Aran	4-6 / 200-240	6-8 / 250-270	20-24 / 130-210	30-32 /200- 500	13-14 / 50-80
Modnimb	9 / 280	18-20 / 40-60	36-40 / 50-70	20-22 / 50-100	14-15 /120-150
Setphal	9-10 / 400-500	16-20 / 80-100	8-12 / 80-180	36-38/100-150	10-11/150-170
Telangwadi	14-16 / 40-60	30-32 / 80-100	12-16 / 30-40	24-26 / 1-50	15-16 / 20-30
Khandali	9-10 / 40-60	30-32 / 60-80	20-24 / 40-60	20-22 / 50	14-15 / 40
Papri	9-10 / 40-50	18-20 / 20-40	20-24 / 40-60	26-28 / 50	16-17 /150-170
Asti	5-6 / 68-80	16-20 / 20-40	32-36 / 40	30-32 / 50-100	20-21 / 40
Rople	14-15 / 60-70	28-30 / 20-30	32-36 / 80-100	36 / 50	30 / 70-80
Tungat	3-4 / 30-40	30-32 / 40-80	20-24 / 30-40	12-14 / 50	24 / 40
Babulgoan	9-10 / 30-40	16-18 / 80-120	40 / 40-60	20-22/200-300	26 / 50
Narayanchinch-oli	4-5 / 20-30	12-14 / 10-20	8-12 / 80-100	30-32 / 50	24 / 40
Ishwarwathar	5-6 / 20-30	12-14 / 10-20	12-16 / 80-100	34-36 / 50	24 / 40
Solankarwadi	6-8 / 60-70	14-16 / 20-30	44 / 40-50	10-12 / 20-30	16 / 80-100

4. Lineament Study:-

Lineaments in the Sus basin have been identified and mapped from the toposheets, on the scale of 1: 50,000. Geomorphologically the lineaments often give rise to a network of straight drainage, facilitating weathering. Intersection points of two sets of lineaments are often used to qualitatively interpret the lineament density. In present study a method described by Narayanpethkaret. al. (2001),

to quantify the lineament density has been used for the Sus basin. The lineaments were identified from the drainage which is divided in to 16 blocks of 4km by 4km. The lineament length in each block were measured and added, (table 3) lineament length per square km is estimated and plotted at the center of each block and contoured and presented in the fig. 7 as lineament density model for the Sus basin, and the main features are:

1. The zone showing the highest lineament density of 2km for the area of one square kilometer lies between Babulgoan and Ropale in the south western part of Sus basin.

2. The lowest lineament density 0.4km per square kilometer lies near southern tip of Sus basin near Narayanchincholi and Solankarwadi in the north of the basin. Central and eastern region shows lineament density range between 1km and 1.9km per square kilometer area.

3. Remaining portion of the Sus basin has moderate lineament density.

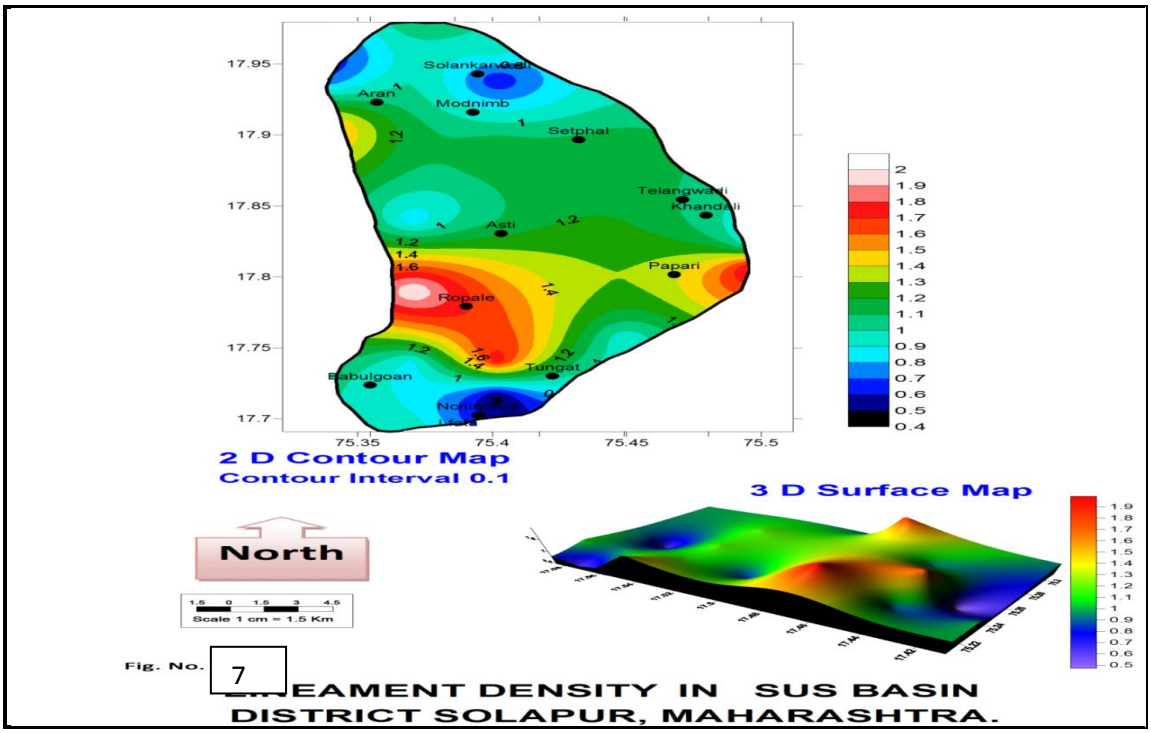


Fig. No. 7

LINEAMENT DENSITY IN SUS BASIN DISTRICT SOLAPUR, MAHARASHTRA.

Table No.3 Leanement Density In Sus Basin

Villages	Latitude	Longitudes	Density in km/sq.km
Degaon	17.42	75.23	1
I.vatar	17.425	75.25	0.46
Bablgoan	17.44	75.23	0.875
N.chincoli	17.44	75.25	1.77
Tungat	17.45	75.28	0.92
Rople	17.47	75.23	2.02
Yevati	17.47	75.25	1.57
Penur	17.475	75.28	1.3
Konheri	17.48	75.31	1.85
Bairagwadi	17.5	75.23	0.82
Asti	17.5	75.25	1.1
Khandali	17.5	75.28	1.2
Papri	17.49	75.31	0.9
Jadhavwadi	17.54	75.21	1.6
Modnimb	17.53	75.23	1.13
Setphal	17.53	75.25	1.2
Telanwadi	17.53	75.28	1.2
Aran	17.56	75.21	0.71
Solankrwadi	17.56	75.23	1
shidewadi	17.56	75.25	0.6
Khend	17.57	75.21	0.6
Padsali	17.57	75.23	1.1

5. Conclusins:-

- Layer wise moderately feasible and feasible areas for groundwater have been demarcated with the help of modeling studies.
- At any location in the basin if one desires to know the groundwater condition it is possible to tell with the above studies.
- Moderately feasible and feasible areas for groundwater development are demarcated.
- Sites for artificial recharge demarcated.

- Lineament density has useful for the selection of sites for the artificial recharge of water.
- Therefore modeling studies for groundwater harvesting Sus basin, Solapur district, Maharashtra, India is a useful tool for groundwater management and satisfies the social cause to overcome water scarcity.

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