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Spatial Subsurface apparent resistivity distribution using different current electrode (AB/2) configurations (VES) and GIS in the miniwatershed, Ahmednagar, Maharashtra, India.

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Abstract:

The main objective of the present study is to identify suitable locations for artificial groundwater recharge structures with Vertical Electrical Sounding (VES) and Geographic Information System (GIS) in the SA-2 mini-watershed area located in the Sina river basin, Ahmednagar district, Maharshtra. Seventy two Vertical Electrical Soundings were carried with Schlumberger configuration, a comprehensive overview of the VES results for the nine separations AB/2= 6, 10, 15, 20, 30, 50, 60, 80 and 100m have brought out the spatial resistivity variation in the study area. The Apparent resistivity maps to evaluate the qualitatively subsurface resistivity distribution and proposed recharge structures in different geological formations.

Thematic layers such as Geology, Geomorphology, Land use land cover and Drainage were integrated with water levels data to prepare the recharge structures map. The artificial recharge structures are proposed like recharge shaft, recharge pit, recharge trench, check dam and percolation tank in the study area.

In addition to the qualitative analysis of apparent resistivity data in few locations revealed that resistivities of 100-200 Ωm and above 200 Ωm correspond to hard rock formations, indicates hard massive basalt. Apparent resistivity maps show AB/2= 60, 80 and 100m indicates low recharge zone. North, east, and west side of the miniwatershed area covered exposed rocks and hilly terrain shows high resistivity range. Moderate recharge structures resistivity range shows 50-80 Ωm and 80-100 Ωm and Geologically vesicular/amygdolidal basalts.The apparent resistivity maps shows AB/2= 20,30 and 50m indicates moderate recharge zone. Apparent resistivity maps show AB/2= 6, 10,15m indicates good recharge structures. The water bearing formation resistivity range is 30-50 Ωm. Middile part of the miniwatershed area shows along the river good recharge structures. This phenomenon is dependent of lithology 30% of the area indicates that weathered rocks and vesicular /amygdaloidal basalts are moderate to good aquifers indicates only central portion are

considered good recharge structures. These recharge structures zones were categorized as high, moderate, and low.

(**Key words**- Groundwater, VES, Schlumberger method, Recharge structures, Aquifer and potential zones, Iso resistivity map, Interpretation, GIS).

Introduction:

Groundwater is one of the essential sources in our life. Groundwater is an important source of water for various purposes like domestic, agriculture and industries. Groundwater need to be managed carefully in drought prone and hard rock areas. Groundwater has become crucial not only for targeting of groundwater potential zones, but also for monitoring and conserving the important resource. Besides targeting Groundwater potential zones, it is also important to identify suitable sites for artificial recharge structures. The recharge rate is low in hard rock areas therefore the balance is disturbed and hence it is called for artificial recharge. The basic methodology of the electrical resistivity survey depending upon the groundwater resistivity and the properties of the porous rocks. The present study Seventy two vertical electrical soundings (VES) were carried out in the hard rock terrain in the eastern part of Ahemednagar district. The study area consists fourteen villages of miniwatershed area SA-2 (1/4&2/4).The entire fourteen village’s area in the semi critical zone. The villages are in command area. The farmers are irrigated with crops. The farmers are cultivated crops under open wells and bore wells other than rainfall. The average rainfall is 623 mm annual/year. This is very less in the central Maharashtra region especially in the Ahmednagar district (as per IMD).

Study Area:

The miniwatershed study area SA-2 (1/4) & (2/4) is located at a distance of about 10km to from the Ahmednagar district Head quarter in the north direction. The Ahmednagar is largest district and central part in Maharashtra. The study area lies between latitude N19º07’30” to 19^{0}15’00” and longitude E 74º40’00” to74^{0}52’30” and falls in the Survey of India Toposheet No.47 I/12 and 47 I/16.The location map of the study area as shown in Fig.1. Both the miniwatersheds have spread around 180 sq.km covered fourteen villages as shown in Fig.1.(Pimplegaonmalvi,Pokardi,Shendi,Jeur,Manjarsumba,Dongargaon,Imampur,Burhanagar, Nagapur, Dangarwadi, Pimplegaon Ujjini,Vadagaon Gupta,Bahirwadi and Sasewadi).

The miniwatershed is located in the Sina river basin of Ahmednagar district, Maharashtra, India. The area is mostly covered with basaltic hard rock terrain and drought prone area. The entire catchment is a sub basin of Sina river which is a tributary of Bhima River that drains eastwards to Krishna river.Fig.2.The area is located on moderately sloping terrain. It is bounded by hilly ranges towards north, north east and east, while rest of the area shows relatively plain surface. The southern boundary is marked by Sina River which meets Bhima River that further goes to Krishna River. The elevation ranges are 668 to 820 m mean sea level (MSL). The drainage shows typically dendritic pattern of Deccan volcanic province. The river flows is from upper regions in the north towards low lying area in the south west.

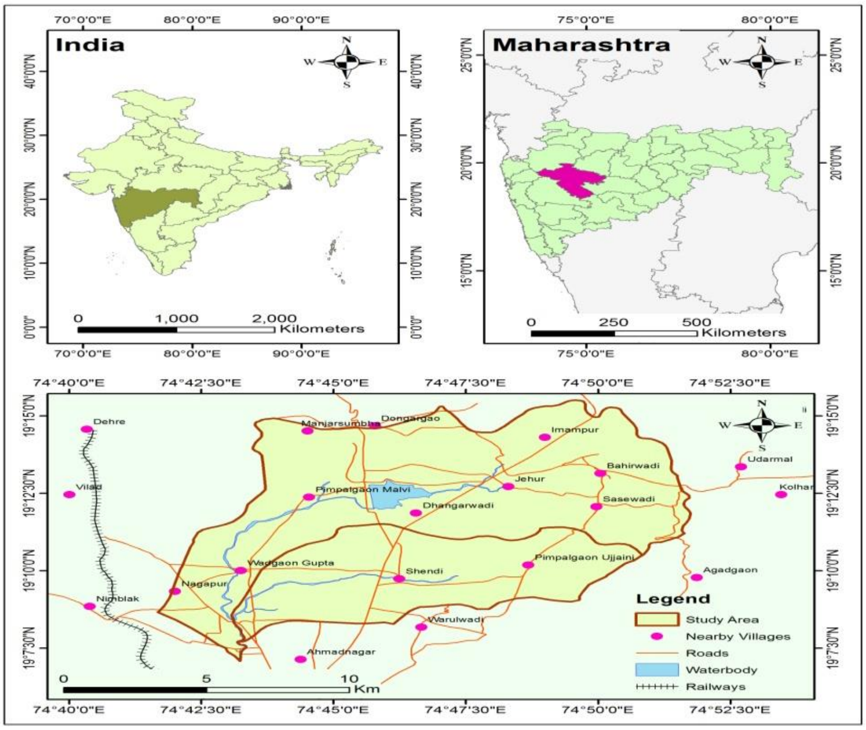


Fig: 1. Location Map of the study Area

Geology of the Area:

The mostly district forms part of the great Deccan trap basalts and the trap rock is distinctly stratified. Throughout Ahmednagar the trap rock is distinctly stratified and, as in the rest of the Deccan, the alternative belts of basalt and amygdaloids preserve a striking parallelism to each other. The basaltic rock formation is intruded by dykes. The lava-flows are almost horizontal in disposition but local gentle tilting, undulations and minor flexures are rarely seen. Compound lava (Pahoehoe) flows are seen in the northern part of the district and in the southern part it is simple (aa-Lava Type) in nature. The Pahoehoe Lava -- Surfaces are smooth, billowy, or ropy.
aa lava -- Surfaces are fragmented, rough, and spiny, with a "cindery" appearance as shown in fig.2(a).

The study area is predominantly occupied by the pahoehoe flows of Deccan Trap of Sahyadri Group of Cretaceous to lower Eocene age. These flows are represented by massive portion at bottom and vesicular portion at top and are separated from each other by red bole. The geomorphologically the area consists of moderately dissected plateau and megacryst flows. The geological section of the area is as follows.

- Top soil
- Weathered/ Fractured/Jointed basalt
- Vesicular/amygdaloidal basalt
- Compact/ Massive basalt.

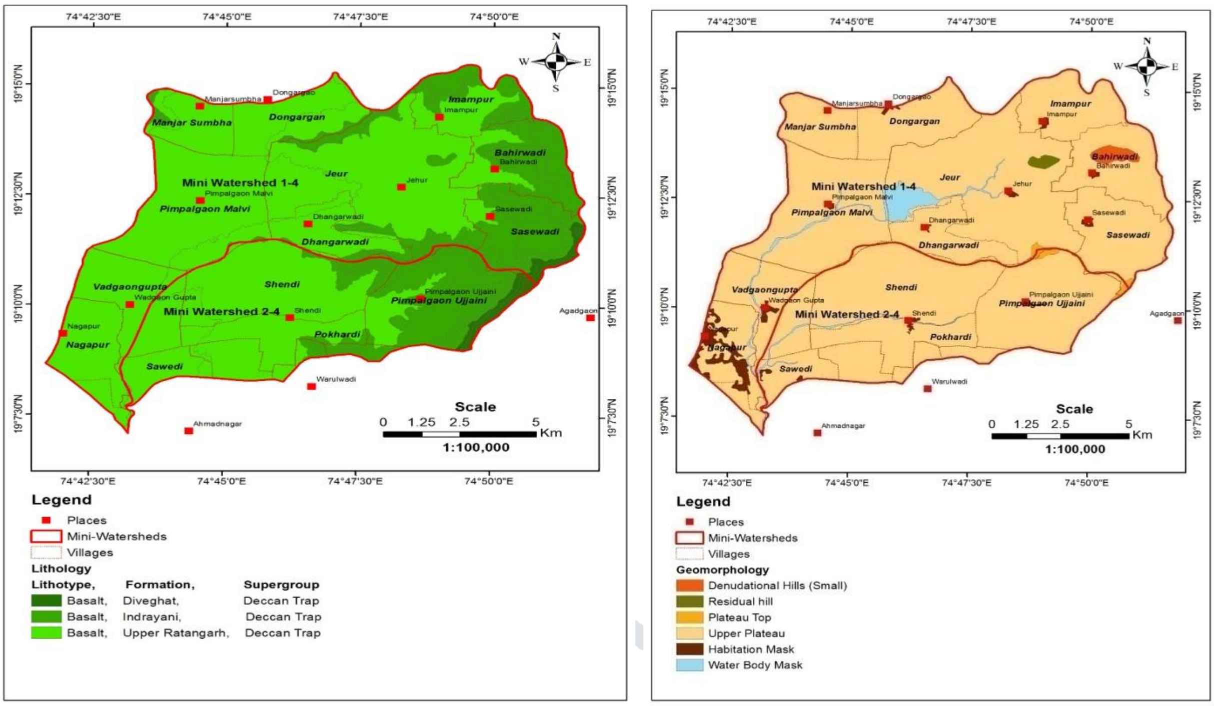


Fig.2. (a) Geological map of the study area Fig.2. (b) Geomorphology of the study area

Geomorphology

There are various land forms in Ahmednagar district. There are Sahyadri ghats in the western part of the district. They are called Kalsubai, Adula, Baleshwar and Harishchandragad hill ranges. Kalsubai, the highest peak in the Sahyadris, lies in Ahmednagar district. Harishchandragad, Ratangad, Kulang and Ajuba are some other peaks in the district. We see the Vitaghat on the way to Randha falls and the Chandanpuri ghat on the Pune-Sangamner road.

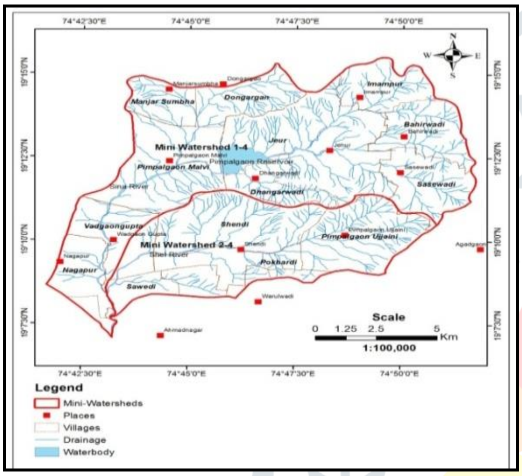
There are three physical divisions as fallows; Western Hilly Region, Central Plateau Region, The region of northern and southern plains Western Hilly Region: Akole taluka and of Sangamner taluka are included in this region. The hill ranges of Adula, Baleshwar and Harishchandragad lie in this region and various high peaks are found in the same region. Kalsubai of height of 5427 feet, the highest peak in the Sahyadris, lies in this Region.

Central Plateau Region: Parner and Nagar talukas and parts of Sangamner, Shrigonda and Karjat talukas are included in this region. The Region of Northern and Southern plains: This region includes northern Kopargaon, Rahata, Shrirampur, Rahuri, Newasa, Shevgaon and Pathardi talukas this is the region of the Godavari and the pravara river basins. Parts of the southern talukas of Shrigonda, Karjat, and jamkhed are also included in this physical division. This region covers basins of the Ghod, Bhima and the Sina rivers as shown in fig.2 (b).

The study area covered with plains, undulating lands with mesas and buttes to dissected hills with escarpments and narrow valleys. The highest elevation in this area accounts to 650 m above mean sea level (AMSL) to the east at pimplegaon ujjini, while the lowest elevation accounts to 482 m AMSL in the plains close to Pokardi, towards south of study area. The Sina River dissects the study area into western and southern plateau regions, and is a sub-basin of Bhima tributary of the Godavari river basin. The study area consists of moderate to dense network of dendritic drainage pattern and portrays a slight structural control over the alignment of drainage channels because of the lineaments criss-crossing the area.

Hydrogeology of the Area:

The major part of the district is underlain by the basaltic lava flows, which were formed by the intermittent fissure type eruptions during of upper Cretaceous to lower Eocene age. The Deccan Trap has succession of 19 major flows in the elevation range of 420 to 730 m above mean sea level (amsl). These flows are characterized by the prominent units of vesicular and massive Basalt. The Alluvium of Recent age also occurs as narrow stretch along the course of major rivers deposited over the Traps as shown in fig.2(c).



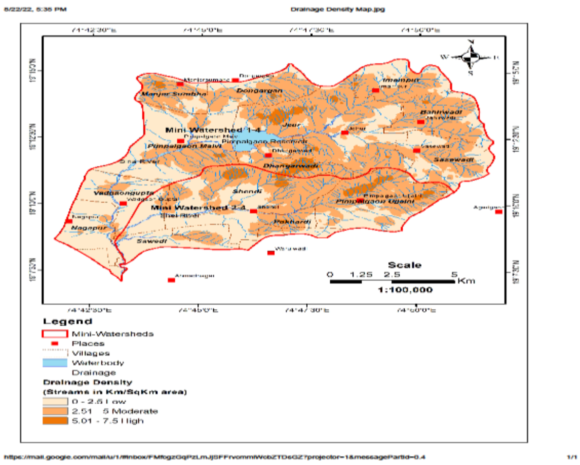


Fig .2. (c) Drainage map of the study area Fig.2.(d) Drainage density

Deccan Trap Basaltic Hard Rocks:

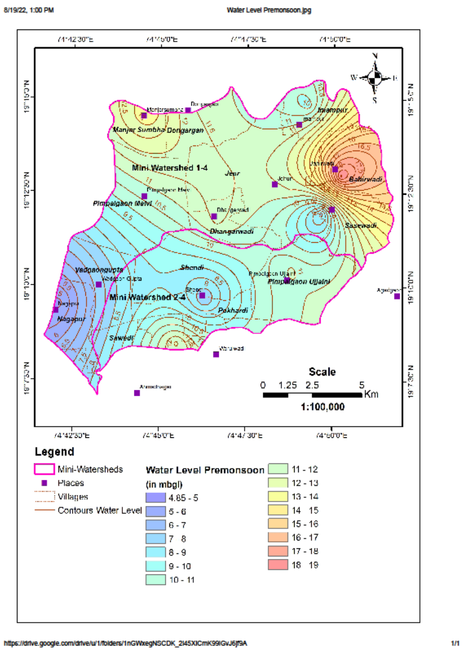
Deccan Trap Basalt Deccan Traps occupy about 95% area of the district and it occurs as basaltic lava flows which are normally horizontally disposed over a wide stretch and give rise to table-land type of topography also known as plateau. These flows occur in layered sequence ranging in thickness from 15 to 50 m. Flows are represented by massive portion at bottom and vesicular portion at top and are separated from each other by marker bed known as red bole. The thickness of weathering varies widely in the district form 5 to 25 m bgl.The weathered and fractured trap occurring in topographic form the main aquifer in the district.

The ground water occurs under phreatic, semi-confined and confined conditions. Generally the shallower zones down to the depth of 20 m bgl form phreatic aquifer. The water bearing zones occurring between the depths of 20 and 40 m are weathered interflow or shear zones and yield water under semi confined conditions. Deeper semi-confined to confined aquifers occur below the depth of 40 m as the bore wells drilled have shown presence of fractured zones at deeper depths at places. The vesicular portion of different lava flows varies in thickness from 8 to 10 m and forms the potential aquifer zones.

However the nature and density of vesicles, their distribution and inter-connection, depth of weathering and topography of the area are the decisive factors for occurrence and movement of ground water in vesicular units. The massive portion of basaltic flows are devoid of water, but when it is weathered, fractured, jointed or contain weaker zones ground water occurs in it.

The observation wells well inventory data conducted in the fourteen villages. The static water level data maps shows fig 2(d) and 2(e) north eastern part of the area shows water level is high and south west part shows water level is low. That indicates drainage pattern streams accordingly. The river flow direction water levels are high and north east and eastern portion hilly terrain area water levels are low.

Water Level Data Maps



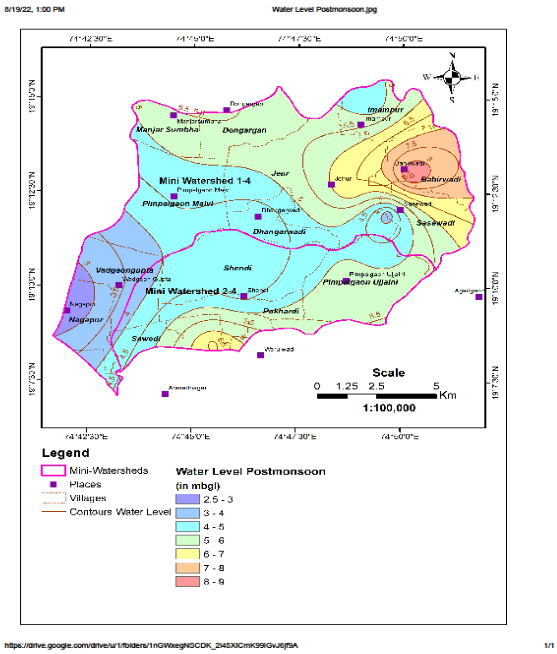


Fig.2 (d) Map shows water level (Pre Monsoon) Fig.2 (e) Map shows water level (Post monsoon)

Land Use Land Cover:

The present study area derived from Satellite map of IRS MRSAC.Mostly area covered with crop land is agriculture and forest land also distributed in the area.Undulated hilly terrain and waste lands also existed in the study area.The sina river flows southwest corner and goes to bhima river and it connects Krishna river.

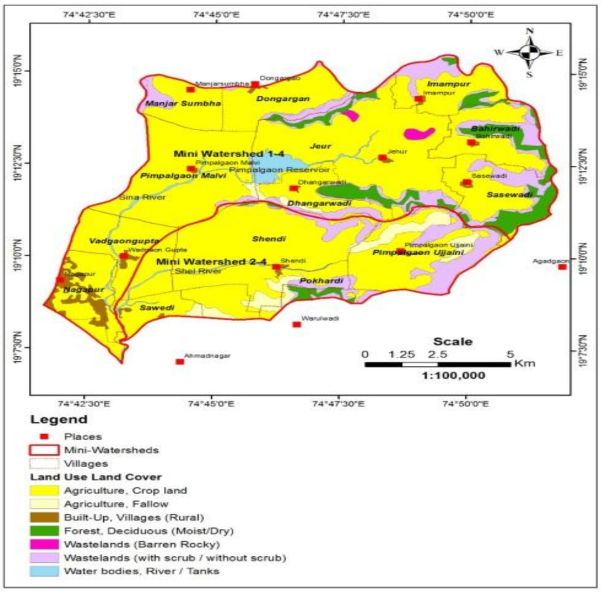


Fig .2 (f) LULC Map of the study area derived from Satellite Map of IRS

Methodology:

The main principle of resistivity method is based on the concept of resistivity. The electrical resistivity may be defined as the resistance offered by a unit cube of material to direct current flowing through it in a direction perpendicular to two of its opposite faces. The unit of resistivity is Ohm-meter.

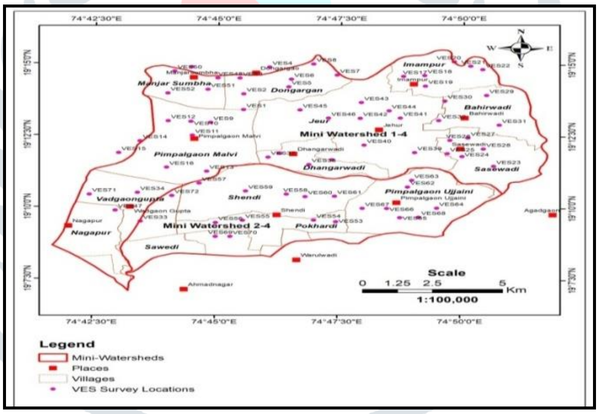


Fig.3.Vertical Electrical Soundings (VES) Location Map

Electrical resistivity method has been used mainly in the search for water bearing formations. A method of tracing changes of resistivity of formations with depth is known as vertical electrical sounding. The Vertical Electrical Soundings (VES) are carried out in the area to understand the subsurface geological formations and layer distribution. Total 72 VES points were carried out randomly near by the open wells in the study area as shown in fig.3. Schlumberger configuration was taken with a maximum half current electrode separation is AB/2=150m. The instrument was used Terrameter SAS 300C (Made in Sweden) in the field. The instrument directly gives the resistance value for each current electrode separation, which when multiplied with the geometric factor, gives the apparent resistivity.

Results and Discussion:

The results of the geophysical investigation were presented as apparent resistivity contour maps in terms of Geospatial GIS distribution maps.

VES type curves

The resistivity sounding curve-types obtained from the surveyed area range from 3-layer to 4-layer or 5-layer. The mostly 3-layer curve-types are predominantly in the study area. Figure 4(a,b,c,d) are typical 1D resistivity curves of sampled VES stations showing observed apparent resistivity, calculated apparent resistivity, and computed model. Summary of the formation of layer parameters and classification of the resistivity sounding curves are presented in Table 1. These type-curves, A, KH, AK, and HA can be interpreted in terms of the subsurface lithology (Olayinka et al. 2004).

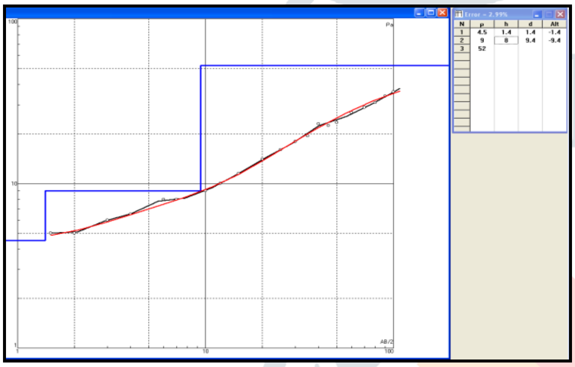


Fig.4. (a)

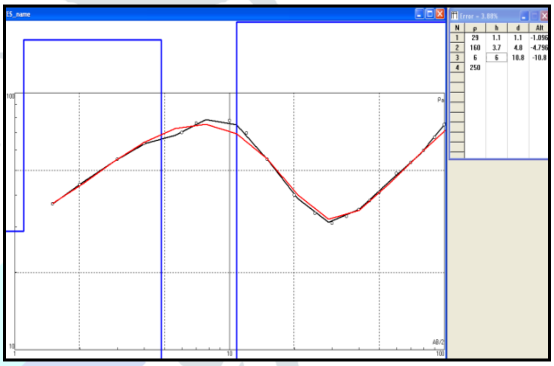


Fig.4 (b)

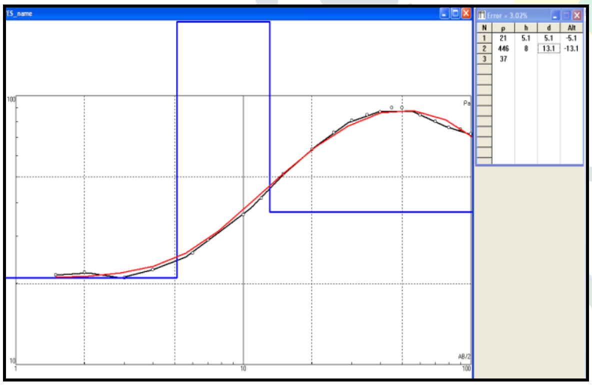


Fig.4 (c)

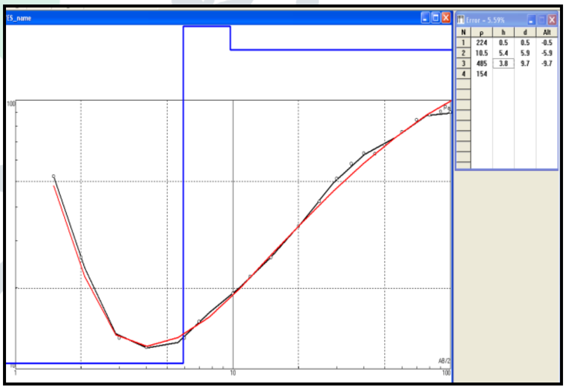


Fig.4 (d)

Figure.4. Some Typical interpreted VES curves in the Study ara (A) A-Type,(b) KH Type,(c)Ak type and (d) HA type curves.

Apparent Resistivity VES data Table

VES No	Latitude	Longitude	AB/2 6 M ρ_a Ωm	AB/2 10 M ρ_a Ωm	AB/2 15 M ρ_a Ωm	AB/2 20 M ρ_a Ωm	AB/2 30 M ρ_a Ωm	AB/2 50 M ρ_a Ωm	AB/2 60 M ρ_a Ωm	AB/2 80 M ρ_a Ωm	AB/2 100 M ρ_a Ωm
VES -1	N19^{0}13'24"	E74^{0}45'32"	250	198	200	187	160	114	91	66	58
VES-2	N19^{0}13'57"	E74^{0}45'32"	87	102	119	125	120	98	92	73	67
VES-3	N19^{0}14'30"	E74^{0}45'27"	71	93	113	111	106	76	66	53	59
VES-4	N19^{0}14'53"	E74^{0}46'03"	82	87	100	112	119	125	110	87	75
VES-5	N19^{0}14'12"	E74^{0}46'27"	15	23	34	44	60	67	68	72	68
VES-6	N19^{0}14'28"	E74^{0}46'30"	26	36	51	63	81	90	85	76	71
VES-7	N19^{0}14'37"	E74^{0}47'26"	35	30	31	33	40	40	40	42	42
VES-8	N19^{0}15'00"	E74^{0}46'57"	36	27	31	32	35	42	43	44.5	45
VES-9	N19^{0}12'57"	E74^{0}44'52"	8	9	12	14	18	24	27	31	36
VES-10	N19^{0}12'59"	E74^{0}44'28"	15	13	14	16	22	25	28	34	39
VES-11	N19^{0}12'30"	E74^{0}44'30"	4	7	9	11	16	20	24	27	30
VES-12	N19^{0}13'00"	E74^{0}44'00"	14	18	20	22	27.5	37	41	47	54
VES-13	N19^{0}11'15"	E74^{0}44'48"	37	31	31	31	35	38	38	39	40.5
VES-14	N19^{0}12'18"	E74^{0}43'26"	11	17	24	31	43	55	62	71	79
VES-15	N19^{0}11'53"	E74^{0}43'00"	21	19	25.5	31	36	39	39	43.5	44
VES-16	N19^{0}11'23"	E74^{0}43'59"	63	59	94	142	176	211	230	240	253
VES-17	N19^{0}14'35"	E74^{0}48'47"	29	38	47	53	56	49	47	47	47
VES-18	N19^{0}14'37"	E74^{0}49'13"	23	34	41	50	51	57	59	60	59
VES-19	N19^{0}14'15"	E74^{0}49'14"	38	50	42	38	32	39	41	43	44
VES-20	N19^{0}15'06"	E74^{0}49'49"	113	114	115	107	74	47	46	47	49
VES-21	N19^{0}14'57"	E74^{0}50'09"	46	41	45	46	51	49	54.5	53	54
VES-22	N19^{0}14'50"	E74^{0}50'24"	74	86	94	103	133	82	82.5	72	67
VES-23	N19^{0}11'28"	E74^{0}50'39"	70	67	56	54	56	60	68	73	73
VES-24	N19^{0}11'48"	E74^{0}50'00"	13	19	26	34	51	68	76	88	90
VES-25	N19^{0}11'54"	E74^{0}49'42"	45	50	49	50	64	89	95	109	110
VES-26	N19^{0}12'22"	E74^{0}49'45"	26	37	49	54	54	51	56	49	47
VES-27	N19^{0}12'27"	E74^{0}50'07"	184	214	234	243	231	131.5	104	80	62
VES-28	N19^{0}12'04"	E74^{0}50'26"	70	78	55	40	31	41	48	59	75
VES-29	N19^{0}13'56"	E74^{0}50'29"	48	81	109	122	136	110	102	96	82
VES-30	N19^{0}13'44"	E74^{0}49'38"	8	10	12	15	20	27	30	36	39
VES-31	N19^{0}12'54"	E74^{0}50'245 "	29	30	35	42	63	98	104	105	100
VES-32	N19^{0}13'03"	E74^{0}49'31"	10	13	15	18	22	29	32	35	37
VES-33	N19^{0}09'30"	E74^{0}43'28"	104	124	144.5	160	170	149	140	112	98
VES-34	N19^{0}10'30"	E74^{0}43'24"	19	28	35	41	52	59	62	69	70
VES-35	N19^{0}11'40"	E74^{0}47'21"	19	14	16	17	21	30	32	34	36
VES-36	N19^{0}11'53"	E74^{0}46'17"	11	12	14	15	21	35	40	49	53
VES-37	N19^{0}11'45"	E74^{0}46'03"	40	32	30	37	41	38	43	49.5	53
VES-38	N19^{0}11'30"	E74^{0}46'53"	18	21	24	27	32	34	37	41.5	44

VES-39	N19⁰11'56"	E74⁰49'02"	9	9	12	14	18	26	29	33	34
VES-40	N19⁰12'11"	E74⁰48'00"	14	17	20	22	27.5	31	31	32	34
VES-41	N19⁰13'08"	E74⁰48'44"	27	26	27	29	32	39	40	43	45
VES-42	N19⁰13'07"	E74⁰47'55"	13	16	19	22	28	32.5	34	38	42
VES-43	N19⁰13'40"	E74⁰47'56"	19	18	20	21	25	30	31	34	38
VES-44	N19⁰13'23"	E74⁰48'30"	26	22	23	24	25	36	37	39	42
VES-45	N19⁰13'24"	E74⁰46'41"	62	61	62	61	54	51	50	52	53
VES-46	N19⁰13'07"	E74⁰47'16"	28	33	34	35	37	40	41	42	45
VES-47	N19⁰09'53"	E74⁰42'57"	10	15	20	24	32	38.5	39	43	47
VES-48	N19⁰14'30"	E74⁰45'00"	12	12	14	15	19	26	30	36	40.5
VES-49	N19⁰14'53"	E74⁰44'28"	62	84	105	116	145	144	121	96	78
VES-50	N19⁰14'44"	E74⁰44'07"	123	122	152	165	156	135	124	107	101
VES-51	N19⁰14'06"	E74⁰44'48"	166	306	265	254	276	110.5	94	79	65
VES-52	N19⁰13'58"	E74⁰43'59"	201	193	217	205.5	163	100	75	61	61
VES-53	N19⁰09'31"	E74⁰47'27"	5	6	8	12	13	21	23	28	33
VES-54	N19⁰09'34"	E74⁰47'0"	14	15	18	21	24	27.5	28	31	32
VES-55	N19⁰09'33"	E74⁰45'33"	10.5	11	13	15	19	29	33	40	44
VES-56	N19⁰09'28"	E74⁰45'0"	10	12	18	22	30	42	47	57	64
VES-57	N19⁰10'50"	E74⁰44'39"	21	21	24	24	26	36	40	46	50
VES-58	N19⁰10'28"	E74⁰46'26"	21.5	21.5	22	24	30	30	31	34	38
VES-59	N19⁰10'34"	E74⁰45'36"	59	55	40	35	30	34	37	42	47
VES-60	N19⁰10'23"	E74⁰46'49"	14	16	20	22	25	31	35	41	45
VES-61	N19⁰10'24"	E74⁰47'25"	25	28	32	34	37	40	42	46	45
VES-62	N19⁰10'44"	E74⁰48'54"	5	6	8	10	13	18	20	22	23.5
VES-63	N19⁰10'58"	E74⁰48'59"	98	152	178	185	156	104	91	69	62
VES-64	N19⁰10'0"	E74⁰49'30"	95	98	123	139	167	191	182	163	148
VES-65	N19⁰09'40"	E74⁰48'45"	67	68	79	85.5	90	79	75	59	51
VES-66	N19⁰09'59"	E74⁰48'29"	17	20	23	23	23	26	28	33	35
VES--67	N19⁰09'59"	E74⁰47'59"	6	7	14	12	16	19	22	22	28
VES-68	N19⁰09'41"	E74⁰49'08"	65	76	95	113.5	121	155	158	147	131
VES-69	N19⁰08'59"	E74⁰45'00"	5	6	7	8	11	16	19	23	28
VES-70	N19⁰08'59"	E74⁰45'18"	4	7	9	11	13.5	19	22	26	31
VES-71	N19⁰10'26"	E74⁰42'25"	9	13.5	19.5	25	37	59	63	73	76
VES-72	N19⁰10'24"	E74⁰44'06"	6	7	9	12	17	24	28	35	42

Analysis of apparent resistivity data

The resistivity of a formation is mainly dependent on the degree of water saturation, amount of dissolved solids, the content of organic matter and grain size, and may vary from a fraction of an ohm-meter (Ωm) to several thousands of Ωm. From qualitative analysis of VES data, it is possible to understand the apparent resistivity distribution in terms of hydrogeological formation in the study area. Maps contoured at an interval of 10 Ωm and 20 Ωm for AB/2 separation of 6m, 10m, 15m , 20 m,30m,50m,60m,80m and 100m.

Apparent resisitivity of AB/2= 6m,10m and 15m separation:

Figure 5 (a,b,c) shows that though range of resistivity for separation of AB/2=6m,10m and 15m apparent resistivity maps indicates low resistivity in the northeast corner to south and southwest direction along the Sina river. The Resistivity range values are 5-20 Ωm and 20-50 Ωm shows weathered/fractured/jointed basalts. The mostly middle portion of the area is plain. The villages are namely imampur, some part of Dongargaon,Jeur, Dangarwadi, Pimplegaonmalvi, Vadagaongupta, Nagapur, Pokardi, Shendi, Pimplegaon Ujjini. Nortwest corner northeast corner and eastern portion the resistivity range is above 80 to100 Ωm and above 100 Ωm,that indicates poor groundwater potential. These areas are covered with hilly terrain.

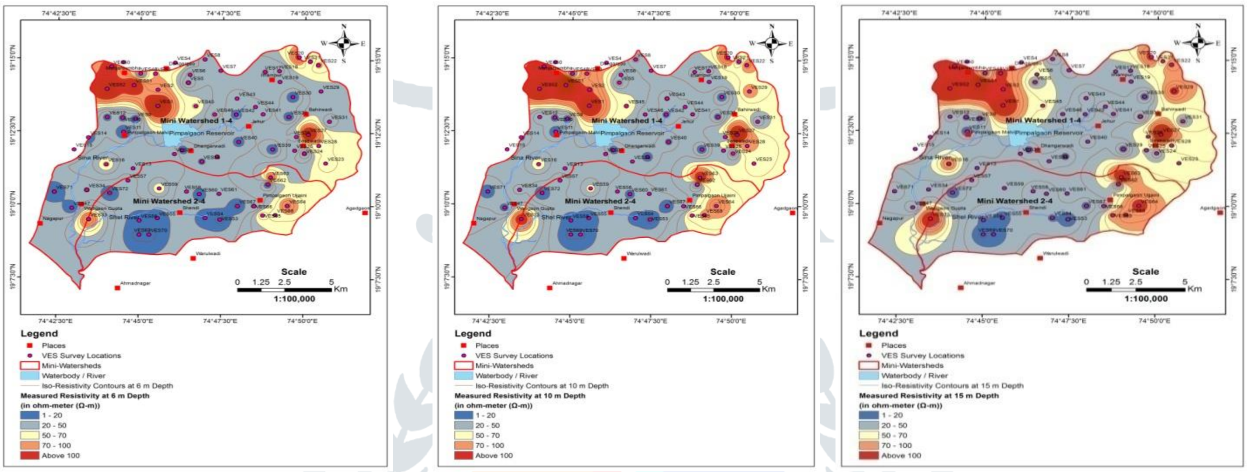
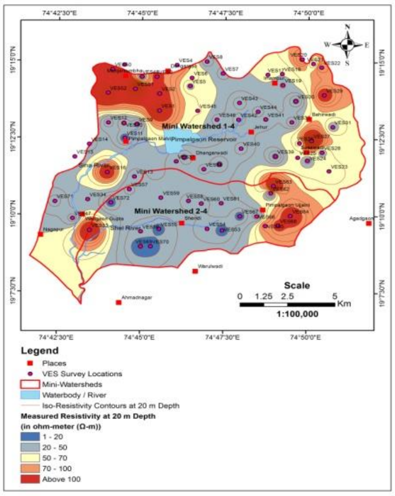
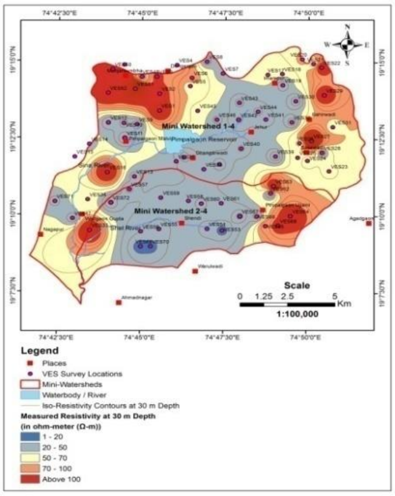


Fig.5. (a) AB/2= 6m (Contour interval 10 Ωm) Fig.5. (b) AB/2= 10m (Contour interval 10 Ωm) Fig.5. (c) AB/2= 15m (Contour interval 20 Ωm)

Apparent resistivity of AB/2= 20m, 30m and 50m separation

AB/2=20m,30m and 50m Iso resistivity maps indicates Resistivity range values are 5-20 Ωm and 20-50 Ωm shows weathered/fractured/jointed basalts. Geologically the middle portion of the area is plain. Western part of the area divided at AB/2=30m depth. North, eastern portion villages and southern villages are poor groundwater potential up to 50m depth. The villages are namely Jeur, Dangarwadi, Pokardi and Shendi villages are shows good groundwater potential. Other villages are poor groundwater potential. These areas are covered with hilly terrain. As shown fig 5(d,e,f).





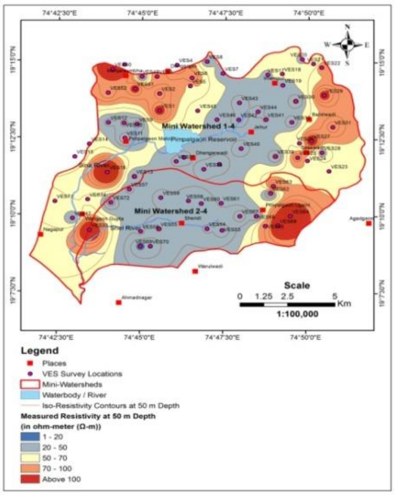
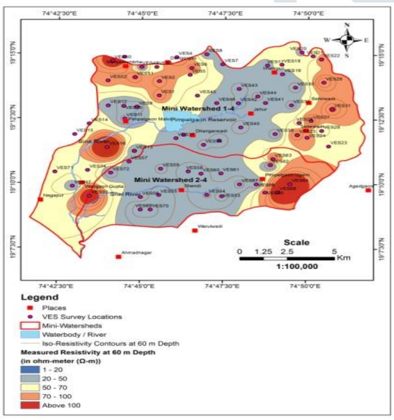


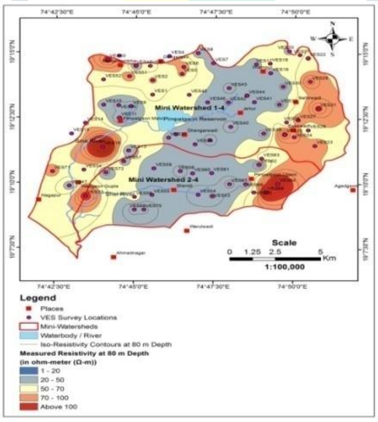
Fig.5. (d) AB/2= 20m (Contour Interval 10 Ωm) Fig.5. (e) AB/2= 30m (Contour Interval 10 Ωm)

Fig.5. (f) AB/2= 50m (Contour Interval 20 Ωm)

Apparent resistivity of AB/2= 60m, 80m and 100m separation

AB/2=60m,80m and 100m Iso resistivity maps indicating Resistivity range values are 5-20 Ωm and 20-50 Ωm shows weathered/fractured/jointed basalts. The good groundwater potential zones mostly in the middle portion of the watershed. Geologically the middle portion of the area is plain. Western part and eastern part of the area completely divided at AB/2=60m depth.North,north eastern portion, western part, and eastern part villages are poor groundwater potential up to 100m depth. The middle of the villages are namely Jeur, Dangarwadi, Pokardi and Shendi villages are shows good groundwater potential zones up to 100m.North,west and eastern villages are poor groundwater potential. These areas are covered with hilly terrain. As shown fig 5(g,h,i).





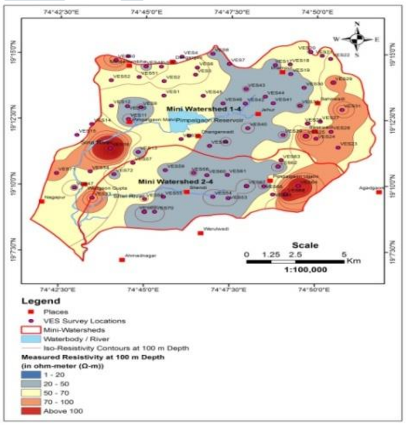


Fig.5. (g) AB/2= 60m (Contour Interval 10 Ωm) Fig.5. (h) AB/2= 80m(Contour Interval 20 Ωm)

Fig.5. (i) AB/2= 100m (Contour Interval 20 Ωm)

Conclusions:

The Apparent resistivity maps showing resistivity distribution of the aquifer layers (weathered layer, fractured/jointed basalt, and vesicular/amygdaloidal and compact/massive basalt) had proven useful in promising mapping areas for groundwater abstraction. In the study area, the groundwater potential is relatively high for exploitation. Northwest, northeast, eastern part, western part and southeastern parts of the study area are showing Low groundwater potential. The middle portion of the area shows high permeable porosity, indicating that they can hold a lot of water, therefore, revealed areas of the excellent groundwater aquifer. The resistivity range is 30 to 50 Ωm.

Based on the Apparent Resistivity maps and GIS thematic layers the entire watershed the middle portion of the area shows good groundwater potential along the Sina River. The catchment area of Sina river premises good groundwater occurred in the area. Jeur, dangarwadi, pokardi and shendi villages are mostly prefer for good groundwater potential in the area.Eastern, Northern and western part of villages are poor groundwater due to hilly terrain. The Good, moderate and low priority groundwater maps are generated in the area.The middile portion of the area proposed to artificial groundwater recharge structures.The recharge shaft,recharge trench,recharge pit,check dam and percolation tanks are proposed in the good and moderate groundwater potential areas.

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