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Saline Water Intrusion In Bhima River Basin, Pandharpur, Maharashtra

Nishad Patki[1], V.R.Ghodke[2], and N. J. Sathe[1]
[1]Department of Civil Engg., Sinhgad College Of Engineering, Pune, India
[2] Dept. of Applied Geology, School of Earth Sciences, Solapur University, Solapur, India.

ABSTRACT: *The ground water behaviour in the Indian sub-continent is highly complicated due to the occurrence of diversified geological formations with considerable litho-logical and chronological variations, complex tectonic framework, climate-logical dissimilarities and various hydro-chemical conditions. Occurrence of groundwater in hard rock terrain is mainly controlled by structures, landforms, litho-logy and recharge conditions. The Deccan Trap area in Maharashtra generally comes in this category. The study area considered is the Bhima Basin (Nira-Narsinghpur to Pandharpur) where ground water is a major source of usable water due to drought conditions. Electrical resistivity distribution at different depth horizons for Bhima River basin in Solapur District, Maharashtra has been studied and represented by contour maps at different electrode spacing. These are correlated with local Geology & Geochemistry for semi quantitative interpretation to detect potential zones of saline intrusion in the groundwater.*
Keywords: *Groundwater, Lithology, Geochemistry, Pandharpur, Electrical Resistivity.*

I. INTRODUCTION

Electrical Resistivity distribution studies were made for Bhima basin between Narsinghpur to Pandharpur in Solapur District, Maharashtra located on the Toposheets 47O/1, 47O/4 & 47O/5. The area is considered along meanders of Bhima river, and is selected by keeping 3 km buffer distance on both side of flood plain. The Bhima Basin consists of unclassified basaltic lava flows representing Indrayani stratigraphic unit of Sahyadri group of Deccan Trap formation of Upper Cretaceous to Lower Eocene age. Stratigraphic succession as observed in Bhima Basin is shown in Table 1.

Weathered zeolitic/fragmentary litho unit is exposed near Babulgaon and is overlain by red bole of 1m thickness, around Umbre representing oldest flow in the basin. The thickness of the flow is 21m. IInd flow consists of lower 8m thick weathered basalt clinker and starts between Mire and Umbre Velapur. This is overlain, by fractured/massive basalt of 12m thickness around Sanghvi, Nandur, Khondapur villages. 1m thick red bole graded into zeolitic/vesicular basalt is exposed at Taratgaon. It is marker bed between IInd and IIIrd flow.

Table 1: Stratigraphic succession

Age	Super Group	Group	Stratigraphic Unit/ Formation	Litho Unit	Thickness in Meters
Quaternary			Alluvium	Poorly Sorted Sediments	4 – 7
Upper Cretaceous to Lower Eocene	DECCAN TRAP	SAHYADRI	INDRAYANI	Massive Basalt Fractured / Jointed Basal Clinker (Weathered)	5 9 8
				Red bole Zeolitic Massive Fracture Basal Clinker (Weathered)	1 22 19 4
				Red Bole / Zeolitic Massive Basalt Basal Clinker (Weathered)	1 12 8
				Red Bole Zeolitic (Weathered)	1 20

Figure 1: Location of study area

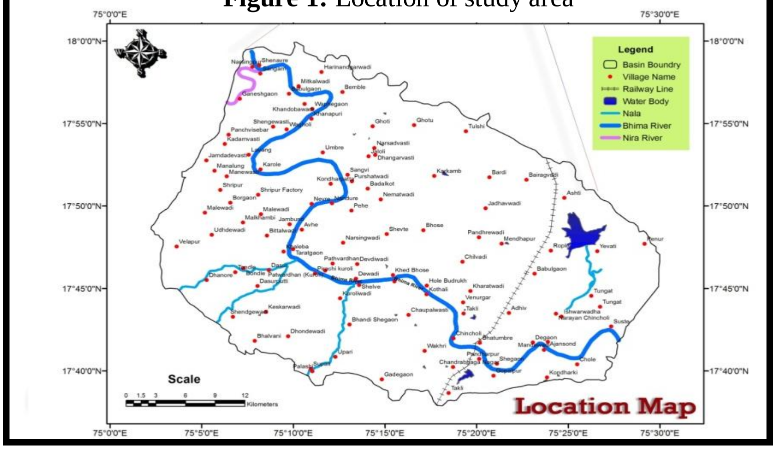

Figure 2: Map showing study area- villages

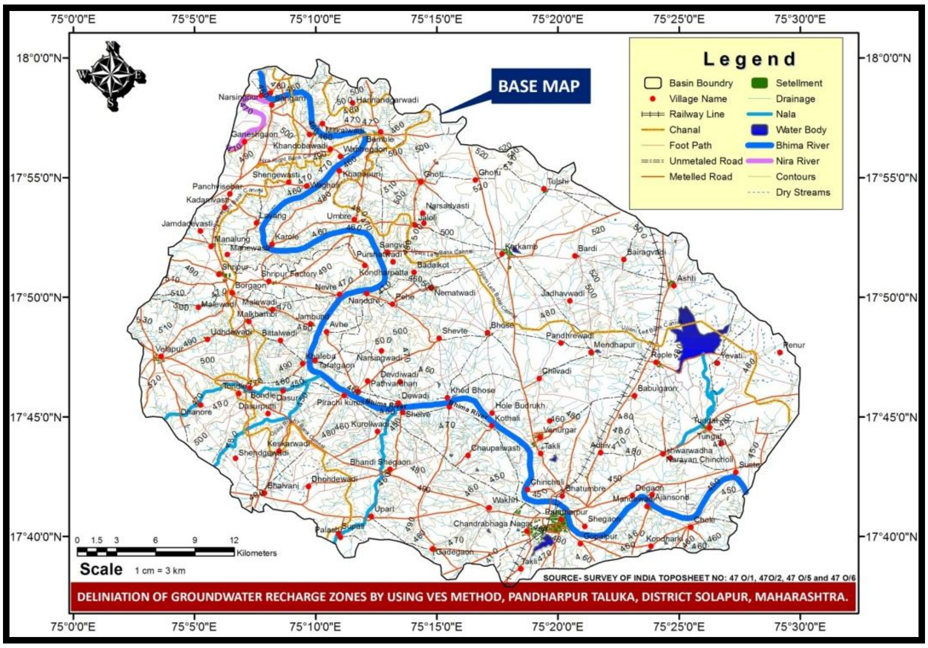

Figure 3: Base map

II. METHODOLOGY

II.1 ELECTRICAL RESISTIVITY STUDIES

Extensive use of electrical resistivity method for groundwater exploration is exploration is extensively used because of direct relation between electrical conductivity and groundwater, simple field operations and improved interpretation techniques. Depth of the occurrence of groundwater and location of well sites can be determined more precisely by electrical resistivity method. However, these studies besides mapping and delineation of potential areas on small and regional scales, help geologists for the determination of hydraulic characteristics of aquifers (Senthil Kumar, Gnanasundar & Elango 2001), characterization of lineaments to locate groundwater potential zones, (Subhash Chandra et.al. 2006), flow pattern of groundwater (Narayanpethkar, Vasanthi and Mallick 2006) and estimation of natural recharge. Electrical resistivity studies have also been used to study groundwater pollution (Natkar et.al. 2008) and to carry out groundwater modeling and to estimate groundwater recharge (Narayanpethkar, Gurunadha Rao and Mallick, 1993, 1994)

II.2. RESISTIVITY CONTOUR MAP

The Resistivity distribution over the entire area would qualitatively correspond to variations of the resistivity at different depths. This is achieved by increasing electrode spacing. More the electrode spacing, deeper is the current penetration. This can be used to establish litho-logical correlation.

II.3 SOIL & WATER SAMPLING

Soil samples are collected at an optimum density of 1 every 2 km^2. These are collected using a hand held dutch soil auger and are taken from the surface (5 – 20 cm) and from a depth of 35 – 50 cm. Each sample is made up of a composite of material from auger flights taken from five holes distributed within an area of approximately 20 m x 20 m.

Eighteen water samples were collected from River basin and surrounding dug wells of the study area and was analyzed for major ion chemistry employing standard methods (APHA, 1995). The groundwater samples were collected in non-recycled polyethylene bottles (2 lit. capacity) and numbered sequentially. The temperature groundwater in the study area varies from 24 to 28 degrees centigrade. The ground water is colorless and odorless. The ground water in this study area is slightly saline and acidic to alkaline in nature.

III. ANALYSIS & OBSERVATIONS

Resistivity contouring has been done with Wenner configuration for different electrode spacing a = 5, 10, 25, 50 & 75m. This provides the variation of resistivity at 5 different horizons carried out at 18 locations. Table 2 shows the apparent resistivity values at the 18 locations at different electrode spacing.

Table 2: Apparent Resistivity Values for different electrode spacing at 18 locations in the selected area

S. No	Village Name	Long	Lat	a=5	a=10	a=25	a=50	a=75
1	Malegaon	75.161	17.98	23.55	22.294	2.355	34.6185	41.5237
2	Nira Narsingpur	75.135	17.969	21.509	21.086	42.9395	51.653	50.5147
3	Babhulgaon (North Side)	75.16	17.944	9.42	12.32	14.3	15.7	15.5
4	Babhulgaon	75.172	17.954	11.43	14.29	16.23	16.34	20
5	Babhulgaon (South Side)	75.169	17.941	1.9468	2.80402	2.7789	4.553	6.5233
6	Wagholi	75.161	17.91	34.226	24.806	26.69	37.052	25.434
7	Mire	75.137	17.869	4.6315	8.478	18.94	22.13	28.67
8	Near Mire	75.146	17.853	3.45	12.22	21.12	43	45.36
9	Near Shiripur Sugar Factory	75.149	17.849	12.32	14.28	23.13	27.45	31.98
10	Near Shiripur Sugar Factory dump area	75.144	17.85	11.2	14.18	13.27	20.26	31.2
11	Sangvi	75.215	17.865	31.086	33.284	65.84	60.288	54.165
12	Nandur	75.203	17.835	79.128	90.746	71.435	54.008	59.5815
13	Pirachi Kuroli (North)	75.195	17.768	72.22	46.786	40.82	28.26	32.97
14	Pirachi Kuroli (South)	75.203	17.765	55.421	55.892	35.953	27.004	32.499
15	Shelve	75.23	17.25	120.89	94.2	41.605	34.4	32.97
16	Khotali	75.287	17.742	15.072	17.427	36.3062	37.366	38.151
17	Chincholi	75.315	17.699	67.196	67.824	43.489	29.83	31.725
18	Pandharpur	75.337	17.678	79.756	91.698	53.38	34.53	23.55

Table 3: Soil Sample Analysis

Village	BOD	K	HCO_3	pH	Mg	Ca	Na	COD	Cl	TH	CO_3	SO_4
Malegaon	0.9	1.46	90	7.52	61	144	143	149	250	500	40	80
Nira Narsingpur	0.8	0.82	70	7.82	78	188	188	176	180	380	20	75
Babhulgaon (North)	1	1.35	100	7.57	110	330	230	220	330	420	90	90
Babhulgaon (Centre)	1.2	2.8	120	7.68	170	213	210	213	310	480	130	88
Babhulgaon (South)	0.7	2.4	90	7.38	120	190	255	290	290	510	160	78
Wagholi	1	0.14	140	7.82	104	145	176	225	70	760	280	65
Mire	0.7	0.25	120	7.69	136	205	219	205	80	420	60	55
Near Mire	1	0.17	120	7.62	55	198	133	195	760	500	120	30
Shiripur Sugar Factory	0.8	2.9	70	7.04	310	350	280	301	410	370	110	98
Shiripur (dump area)	1.1	2.6	130	7.9	330	332	298	316	480	390	60	110
Sangvi	0.7	0.12	20	7.59	90	180	178	208	210	300	60	75
Nandur	0.9	0.1	120	8.09	98	132	178	188	110	210	60	79
Pirachi Kuroli (North)	1.2	0.12	20	7.04	74	165	153	176	110	220	50	72
Pirachi Kuroli (South)	0.8	0.37	120	8.08	40	184	164	195	155	130	30	75
Shelve	1.1	0.45	220	7.83	88	129	145	205	100	160	220	77
Khotali	0.9	0.22	100	7.33	74	192	110	220	100	210	20	82
Chincholi	0.8	0.37	90	7.08	49	140	166	190	180	230	10	88
Pandharpur	1	0.37	100	8.13	110	315	132	188	100	310	20	75

Table 4: Water Sample Analysis

Village	BOD	K	HCO_3	pH	Mg	Ca	Na	COD	Cl	TH	CO_3	SO_4
Malegaon	0.85	1.3	78	6.9	57	137	135	141	241	493	39	78
Nira Narsingpur	0.73	0.78	67	7.3	75	183	185	173	178	370	19	72
Babhulgaon (North)	0.9	1.32	98	7.37	101	325	222	218	328	417	80	83
Babhulgaon (Centre)	0.8	2.3	115	7.2	160	210	200	207	301	476	128	80
Babhulgaon (South)	0.6	2.0	86	7.1	118	186	250	287	284	500	151	70
Wagholi	0.8	0.10	136	7.2	97	138	167	219	64	756	278	59
Mire	0.6	0.20	115	7.2	128	198	200	197	78	400	54	50
Near Mire	0.8	0.10	116	7.2	46	186	131	188	756	491	117	26
Shiripur Sugar Factory	0.8	2.1	65	7.0	297	344	275	290	394	368	92	88
Shiripur (dump area)	0.95	2.02	128	7.2	327	329	290	310	478	389	59	100
Sangvi	0.64	0.1	16	7.1	83	177	170	200	200	298	58	70
Nandur	0.85	0.1	117	8.0	90	127	168	180	100	200	57	69
Pirachi Kuroli (North)	1.0	0.1	17	7.0	69	160	149	168	100	200	48	68
Pirachi Kuroli (South)	0.7	0.28	118	8.0	37	178	158	188	150	128	29	70
Shelve	0.9	0.42	217	7.2	80	120	138	200	96	155	217	69
Khotali	0.8	0.19	97	7.1	68	189	101	217	98	200	18	80
Chincholi	0.7	0.2	88	7.0	39	138	156	188	178	229	9	80
Pandharpur	0.9	0.21	94	8.1	99	300	128	176	93	239	18	70

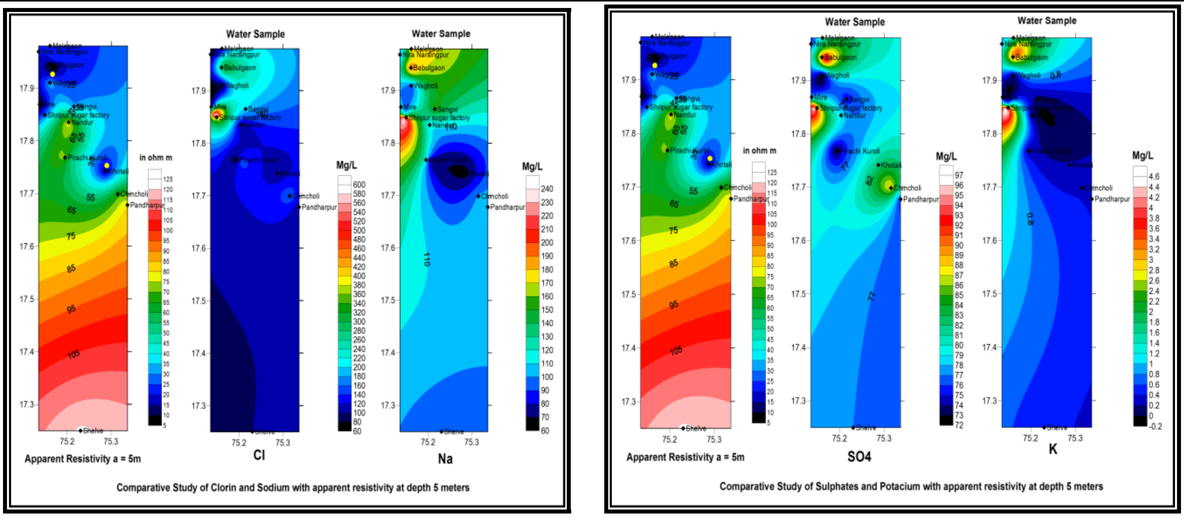

Figure 4:-Comparative diagram for Bhima river basin with reference to resistivity, Cl, Na, SO_4, K

Geochemical data sorted with the interest of the objectives has been tabulated in table no. 3 & 4 which elaborates rise in K, Na, Ca, HCO_3 and Cl & appears to be more in concentration to some specific areas referred with WHO(2004). This increase appears in both the soil and water samples. When sampling was carried out from the Bhima channel periphery it was preferred to have samples from nearby vicinity of the channel. Hence the sample number was restricted to around 18 in number. BOD, COD, pH and TH and elements like K, Ca, Na, K, HCO_3, Cl, Mg, CO_3, SO_4 were considered. To be specific, the village around the Bhima channel namely, Babulgaon, Shiripur, some part of Mire yielded high increase in salinity showing contamination towards the downstream channel. As the samples of water were preferred from open dug wells, they too have shown the same readings in all. In the study area, sufficient amount of groundwater is available for drinking, irrigation and industrial purpose. But agriculture contributes its share of water pollution – From several decades the use of over dose agricultural chemicals (pesticides and fertilizers) has become widespread in the study area, and with massive concentrations of livestock, poultry, and also the resultant waste products. These kinds of activities raise serious concerns to water quality. This intended to work for the sub surfacial investigations of the study area. Hence the electrical resistivity studies were carried out to know the different formation layered below the surface. This is an indirect method to know the resistance pertained by the rocks. This was verified by the observations of the open dug wells in the nearby vicinity followed by some road cuttings or by the river bank errosional features. Comparative studies of resistivity with elements like Cl, Na, SO_4, K reveals that the study region has low resistivity in specified locations, where these elements are more prominent due to which the increase in salinity has been traced in the downstream of channel. Occurrence of zeolitic basalt (Babulgaon), contamination due to untreated industrial waste water (Shiripur Sugar Factory) may be reasons responsible for this rise.

IV. DISCUSSIONS & CONCLUSION

Through the methodology of Geochemical analysis and Geophysical studies related to the study area from Nira Narsinghpur to Pandharpur, a track of more than 42 Km, the information gathered have suggested that Babhulgaon village comprises of more zeolitic basalt with secondary mineralization, due to which it is probable to have increase in salinity in the Babulgaon village area. The area comprises of a thick layer of Zeolites which has to be removed during rainy season by forceful injection of the fresh water by way of tube wells and removal of the same saline increased water to the river channel. Bhima River will lead for dissolution of the salts and due to this process followed for about 6 to 7 years the removal of secondary minerals from the zeolites will help for less concentration of the salts in forth coming years. Towards the Shiripur Sugar Factory, the untreated water of the industry should be treated and it should be left through the networking of bore wells i.e. the permeable rock strata like jointed or fractured basalt, so which will help the soluble pollutants like salts to get settled in the formation itself.

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