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Analytical Study on Salinity of Pre and Post Monsoon Ground Water from Daund - Pune District

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ABSTRACT

Groundwater chemistry has been investigated in Daund-Pune district to analyze the related hydrogeochemical processes for the formation of salinity in groundwater. In addition to drinking, groundwater is primarily for the irrigation resource. Specifications of chemicals parameters pH, EC, TDS, Ca_2+, Mg2+, Na+, K+ , CO_2 , HCO_3 , Cl−, SO_2 and NO_3 , F− and SiO_2, are taken into consideration. Evapo-tanspiration contributes to salt deposition in the soil / weathered area. These salts are added to the water table by infiltrating water. This inference is supported by a positive relationship between depth and water table and TDS with season. The consequences of human activity such as intensive and long-term irrigation, irrigation-return-flows, use of unregulated fertilizers and salt sediment reuse serve to increase groundwater salinity more. The value of the groundwater therefore decreases towards the flow direction, while the surface water of post-Monsoon shows higher levels of TDS, Na+ , Mg2+, Cl−, SO_2 4 and NO_3. The research can help to understand the aquifer system hydrogeochemical characteristics and take effective management action to reduce the low groundwater quality for environmental sustainability.

Key words: Salinity, Ground Water, Daund - Pune district

1. INTRODUCTION

The salinity risk in semi-arid groundwater areas is well known and the salinity of the soils during droughts and poor precipitation years is also known. The bulk of today's problems with groundwater quality are caused by pollution and overuse, or by combination of the two. In India, rapid urbanization and industrialization have led to a sharp increase in waste generation. In and around large towns and various industry hubs, the issue is more severe. Groundwater is the only supply of potable water in many of these regions, hence vulnerability of a large population to the threat of using contaminated water. Studies were carried out with various scientists from various regions on inland salinity contamination of aquifers focusing on causative factors of salinity problems (Kumar et al 2005).

Sections of the district of Pune come under the Maharashtra state rain shadow region. Long-term rainfall data suggest that the eastern, southern, southeast, central and northwestern portion of the district (around Indapur, Baramati, Jejuri, Daund, Talegaon, Dhamdhare, Alandi, Shirur, and Bhor) is affected by drought in about 50% of the area. Thus these areas are classified as areas prone to drought. The decadal pre-monsoon water level pattern (2002-11) shows water levels dropping down to 0.56 m / year by 30% of the district's GWMW (spring waters) while in the post-monsoon season, 37% of GWMW are seen in the decline to 0.27 m / year. In the semi arid areas of the Daund Tehsil, however, very few studies have been carried out based on the causative factors of salinity. The source of salinity in the groundwater from the basaltic region was therefore traced. The main objectives of this study is to establish salinity levels and causative factors of groundwater salinity in Daund Tehsil.

2. METHODOLOGY

Daund Tahsil (i.e. Daund taluka) is included in the study area [Figure-1] . In the eastern part of the district of Pune is Daund, covering 1288,04 square kilometres, with a population of 3,41 388. Daund's geographical position is 18.47 ° N 74.6 ° E, and at the western edge of the Deccan plateau is about 514 m above sea level. Tahsil's population density is 265 people per square kilometer. The Tahsil consists of 102 villages and one urban area. Daund's climate is usually hot and dry, with poor rainfall. In Taluka, three prominent lakes such as Warvand, Kasurdi and Motoba exit. The region comes under the drought category of 400 to 500 mm rainfall. Monsoon generally starts in June, with peak precipitation in July (133.29 mm) and lowest in December (0.85 mm). The highest average temperature in May (42^0C) and the lowest in January (20.4^0C) are observed.

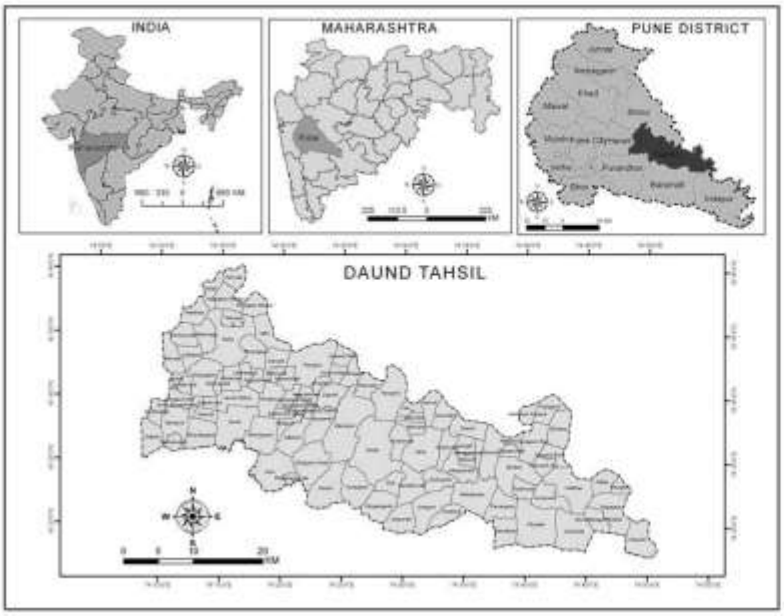

Fig.1- Map of Daund Tehsil (Study area)

Sampling and field investigations

In the present study, a total of 44 sampling sites have been selected to collect the groundwater samples. In two different seasons, a random grid sampling process has been conducted to represent all areas of Daund Tehsils: the pre-monsoon (June 2016) and the post-monsoon (Oct 2016). Although in two different seasons 88 water samples were taken from dug wells and bore wells. Samples was obtained in one liter of polyethylene bottles for physical and chemical examination. When the water level was measured, well depth, pH and EC were recorded. The water level of the well was determined in meters by weighing the tape. At the same time, GPS measurements for the precise latitude and longitude requirements of the individual sampling site have been obtained.

Sample Analysis

The samples collected were immediately transferred to the laboratory and placed in the refrigerator at 4 ° C until further use. The study began on the basis of a variable preferences as set out in APHA (1995). The physico-chemical parameters analysed included pH and electrical conductivity for water samples. Normal volumetric methods estimated total alkalinity (TA) such as HCO_3, calcium (Ca_2+), magnesium (Mg_2+), total hardness (TH), chloride(Cl-). The Turbidometry Method (SO_4), Phosphate (PO_4) by Stannus Chloride Method, Nitrate (NO_3) by UV visible Spectrophotometer, has been estimated for Sulphate (SO_4). The flame photometric method of sodium (Na+) and potassium (K+) was used. 82 water samples from wells were studied from Daund Tehsil to consider the geo-chemical process associated with salinity problems in two separate seasonal water samples.

3. RESULTS AND DISCUSSION

Literature survey shows a good number of available studies on groundwater chemistry to evaluate the spatial distribution of hydrogeochemical parameters and to assess seasonal variations in groundwater chemistry (Karro et al., 2007, Kale and Pawar 2006, Morgan and Jankowski, 2004, Pawar et al 2008) Multivariate statistical techniques can help simplify, arrange, and provide practical interpretation of large data sets (Laaksoharju et al., 1999, Davis 1986,). In this experiment multivariate statistical techniques (principal component analysis (PCA) and cluster analysis (Danielsson et al 1999) were used to approximate trace element concentrations in the Daun tehsil groundwater samples (Table.3, Table.4a, Table.4b, Figure.3a , Figure.3b, Figure.4a, Figure.4b). Daund tehsil subterranean water samples were investigated to understand the effects of rainy season in the drought and rock mineralizations associated with salinity. Physio-chemical study of water samples was carried out to understand the impact of rain and drought on the groundwater and rock's mineralization.

In post-monsoon tests there was a slight increase in PH attributed to the rain water drainage from Basalt rocks. Approximately 5 percent of the samples during pre monsoons exceeded 1000 µS / cm EC and 56 percent during post monsoons exceeded the allowed limit, which may be due to the monsoon mineralization. Plagioclase feldspar and evaporative minerals are the primary sources of sodium in natural water. However, sodium precipitates and certain clay minerals and zeolites that also lead to sodium in natural waters are found in the soil.

The origins of potassium in natural waters are substances produced by the weathering of igneous and metamorphic rocks of silicate minerals such as orthoclase, biotites, leucite and nepheline. Dolomite is the main source of magnesium in soil, sedimentary minerals, olivine, biota, hornblende and augite, and serpentine, talc, diopside and tremolite. In their analysis, Pawar et al.(2008) reported the weathering of minerals such as apatite, willastonite, fluorite and various feldspar, amphibolite and pyroxene group members as the major source of calcium in natural waters. Big Cation levels of Ca_2 +, Mg_2 +, Na+

and K+ provide an understanding of groundwater mineralisation and of the effect of precipitation on the area of study. Samples display Mg_2+ > Na+ > Ca_2+ > K+ (range from 93-896 > 54-396 > 19-197 > 0.2-391) with low pre-monsoon (i.e. June 2016) and higher mineralization due in the after-moon cycle (i.e. October 2016) as opposed to Mg $_2$ + > Ca $_2$ + > K+ (range 2-2128> 54-445 > 34-600 > 0.2-391).

The concentration of cation shows some variation due to precipitation, but not as expected. This could be because of the low monsoon rainfall (i.e. June2016). In post-monsoon tests, the average Mg_2+ rose from 363 to 581 but due to less precipitation in June 2016, the average Na+ didn't change much. As a result of the drought and less mineralization, the mean anion concentrations in the descending order of groundswater samples are HCO_3->Cl->So_4->NO_3-(ranged between 40-700>11-559>15-838>0-40>027-0.388) in June 2016 with the same descending order in Oct 2016 (ranged between 200-1000>30-872>11-285>4-78).

Carbonate and bicarbonate in natural water are sources such as atmospheric CO2, soil biota CO2 or the activity of sulfate reducers and other bacteria in deeper forms and different carbonate rocks and minerals. Leaching from the upper soil surface in the semi-arid zone is an important source of SO_4-in soil. The major Cl-sources in Daund groundwater are concentrations of chloride evaporations, which are constituted by rain and dry runoff from the atmosphere, particularly in semi-arid areas. Phosphate reaches the soil by weathering rocks such as apatite, which are less soluble. Although all igneous rocks contain a small amount of soluble nitrate, most nitrates is made from chemical products from industry and agriculture.

Multi variations:

Variable	Mean		St Dev	
	Jun 2016	Oct 2016	Jun 2016	Oct 2016
PH	7.683	7.454	0.287	0.268
Conductivity	505.1	1149	239.8	702
Alkalinity	443.6	647.1	142.2	169.9
Acidity	20.00	6.562	11.98	3.314
Ca^{2+}	85.79	158.1	54.01	123.7
Mg^{2+}	364.9	540.2	182.1	298.7
Chloride	201.6	236.4	137.4	196.9
Sulphate	150.5	136.4	135.2	74.0
Na^{+}	193.1	188.6	96.6	97.3
K^{+}	23.3	14.87	67.8	29.63
Phosphate	0.1348	0.2146	0.0845	0.0849
Nitrate	21.13	42.49	12.38	20.27

Table.3- Descriptive Statistics : PH, Conduc, Alkalinity, Acidity, Ca^{2+}, Mg^{2+}, Chloride,… (ppm)

Eigen value	7.786	1.862	1.411	1.001	0.877	0.671	0.549	0.370	0.192	0.164	0.092	0.021
Proportion	0.399	0.155	0.118	0.083	0.073	0.056	0.046	0.031	0.016	0.991	0.000	0.002
cumulative	0.399	0.554	0.672	0.755	0.828	0.884	0.930	0.961	0.977	0.991	0.998	1.000

Table.4-a- Principal component Analysis: PH, Condu, Alkalinity,…. (ppm) – June 2016

Eigen value	4.469	1.989	1.178	1.049	0.909	0.788	0.523	0.380	0.291	0.212	0.122	0.084
Proportion	0.372	0.166	0.098	0.087	0.076	0.066	0.044	0.032	0.024	0.983	0.010	0.007
Cumulative	0.372	0.538	0.636	0.724	0.800	0.865	0.909	0.941	0.965	0.983	0.993	1000

Table.4- b- Principal component Analysis: PH, Condu, Alkalinity,…. (ppm) – Oct 2016

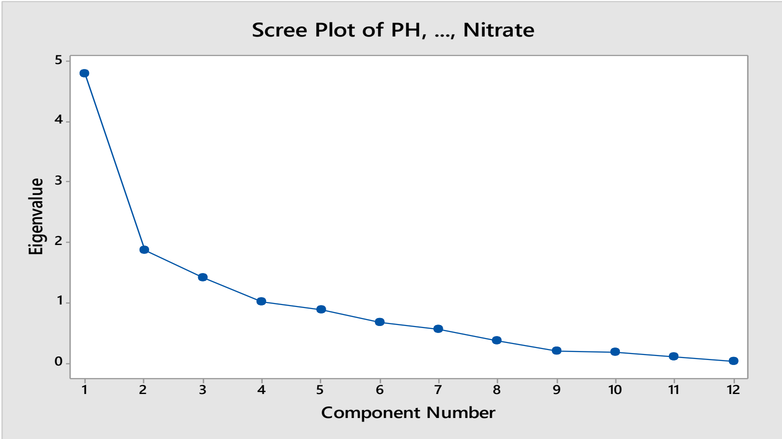

Figure.3-a- Sctterd plot of of PH, conductivity, Alkalinity,…. – June 2016

Figure 3a and Table 4a showed that first four components revealed upto 75.50% of variation in contents of ground water.

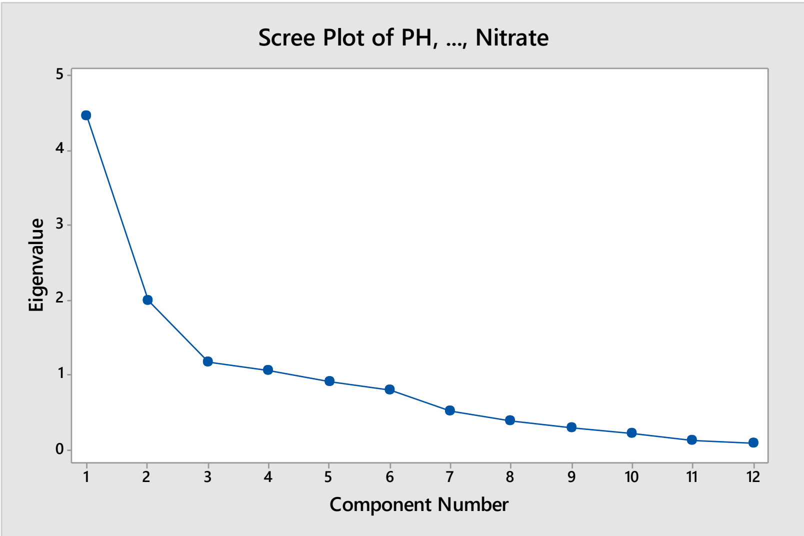

Figure.3-b- Scattter plot of PH, conductivity, Alkalinity,…. – Oct 2016

Figure 3b and Table 4b showed that first four components revealed upto 72.40% of variation in contents of ground water.

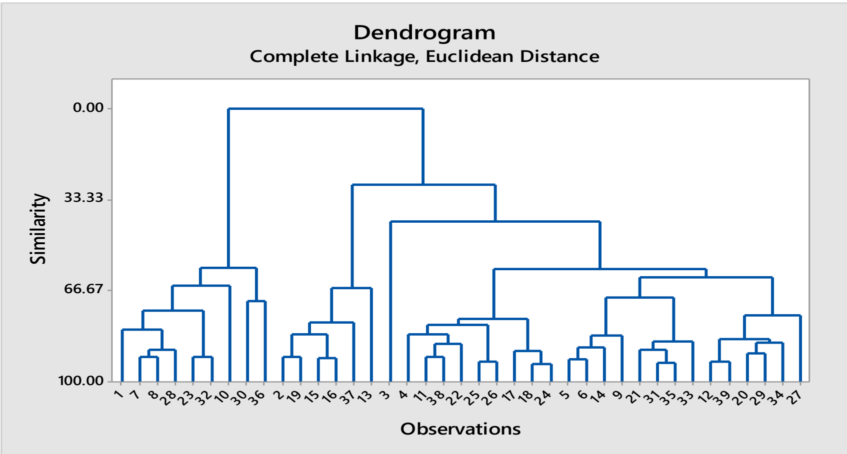

Figure.4-a-- Dendrogram Complete linkage, Euclidean distance – June 2016

Figure 4a showed the grouping of sites with similar kind of contents of ground water of different cites of pre monsoon season.

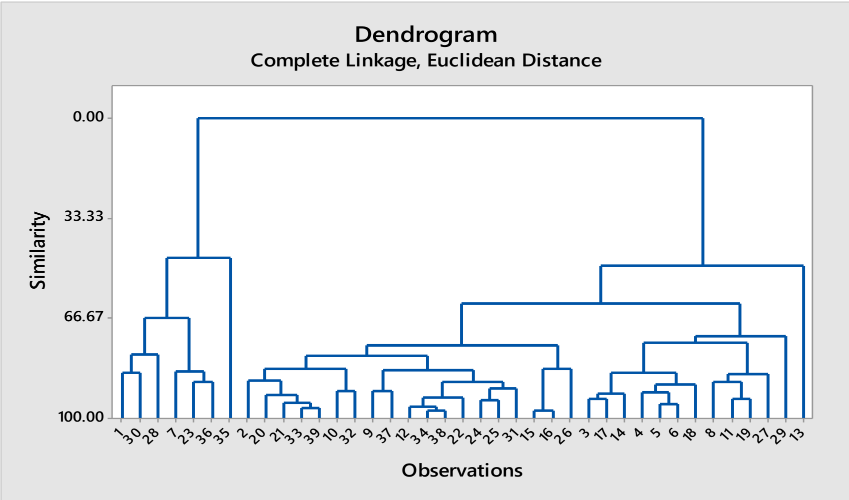

Figure.4-b- Dendrogram Complete linkage, Euclidean distance – Oct 2016

Figure 4b showed the grouping of sites with similar kind of contents of ground water of different cites of post monsoon season.

4. CONCLUSIONS

The research in Daund-Pune, India, reveals that specific hydrogeochemical processes are related to salinity production. Ground-water is brackish in form of $Na+$ and $Cl-$ion supremacy. Compositional and mineral saturation states show dissolution of soil salts, dissolution of NaCl and $CaSO_4$, precipitation of $CaCO_3$ and the ion exchange of Ca_2+ for adsorbed $Na+$, the dominant monitoring of the associated hydrogeochemical processes. Evapotranspiration induces salt layer formation by moving the salt from groundwater to the soil / weathered zone. These salts are the source of ions for infiltrating water to enter the groundwater system, assisted by the favorable interplay between TDS and water table depth over season. Extensive drainage, freshwater wastewater reuse, irrigation / return stream and agricultural fertilizer production are the main human actions responsible for increasing groundwater concentrations. So, the soil water has greater salinity along the flow path and in the soil after moonsoons, with higher concentrations of $Na+$, Mg_2+, $Cl-$, SO_2 4 nad $NO-$ 3 ions. The research led to better understanding the hydrogeo-chemical characteristics of the area in order to effectively manage and use freshwater resources properly for improve people's living conditions.

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