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Study of Chemo-metric Parameters of Different Water Samples

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Abstract:

The analysis of chemo-metric parameters of groundwater from fourteen different locations of District Ambala, Haryana was carried out. The chemo-metric parameters namely pH, electrical conductivity, Total Dissolved Solids, dissolved oxygen and salinity were determined. Each parameter was compared with the standard desirable limits prescribed by World Health Organization (WHO), Bureau of Indian Standard (BIS) and Indian Council of Medical Research (ICMR) to assess the quality of ground water. Systematic calculation was made to determine the correlation coefficient 'r' amongst the parameters. Significant value of the observed correlation coefficients between the parameters was also carried out. It is concluded that the water quality of water supply systems in different locations of Ambala is of medium quality and suitable suggestions were made to improve the quality of water.

Introduction:

Water is the most precious gift of nature and one of the substances essential for sustenance of life. It influences the economic, agricultural and industrial growth of the mankind. Several fundamental rights especially those guaranteeing the rights to food, health and development cannot be attained without guaranteeing access to clean water. Water, being essential for the growth and maintenance of our bodies, is considered as one of the nutrients, although it yields no calories; it enters into structural composition of the cell and is an essential component of diet. It is necessary for all metabolisms in the body and contributes to heat regulation by perspiration. Ground water is the major source of drinking water in both urban and rural areas. Increasing population and its necessities have led to the deterioration of surface and sub surface water. The domestic sewage and industrial waste are the leading causes of ground water pollution [1, 2].

Quality of ground water is the resultant of all processes and reactions that act on the water from the moment it is condensed in the atmosphere to the time it is discharged by a well or a spring and varies from place to place and with the depth of the water table [3]. Many diseases are caused by the inability of the environment to supply the mineral needs of man and animals in adequate. Sometimes these nutritional abnormalities occur as simple deficiencies or excesses. Many investigations have found a correlation between cardiovascular deaths and water composition [4-6]. The disorder of teeth and bones is due to consumption of fluoride-rich water.

Chemicals that are toxic and might be found in drinking water may cause either acute or chronic health effects. An acute effect usually follows a large dose of a chemical and occurs almost immediately. Examples of acute health effects are nausea, lung irritation, skin rash, vomiting,

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dizziness, and, in the extreme, death. The levels of chemicals in drinking water, however, are rarely high enough to cause acute health effects. They are more likely to cause chronic health effects, effects that occur after exposure to small amounts of a chemical over a long period. Examples of chronic health effects include cancer, birth defects, organ damage, disorders of the nervous system, and damage to the immune system. The possible health effects of a contaminant in drinking water differ widely, depending on whether a person consumes the water over a long period, briefly, or intermittently. Impurities in drinking water that are regulated and have an adverse health impact are grouped into six categories: inorganic chemical contaminants, volatile organic chemical contaminants, synthetic organic chemical contaminants, microbiological contaminants, radiological contaminants, and disinfection by-products.

Ambala was constituted as a district in the year 1847, and was formed by merging the jagir estates of hitherto independent chieftains whose territories had lapsed or had been confiscated by the British Indian Government. Ambala air force base is one of the oldest and largest airbases that were inherited from the British by the Indian Air Force. The district is very strategically located and serves as a gateway to Haryana for States of Punjab, Himachal Pradesh, Jammu & Kashmir, and Union Territory Chandigarh. Five national highways (NH 1, 22, 65, 72 and 73) pass through Ambala. NH1 (Delhi-Amritsar-Attari/Pakistan Border) is the most important highway to Delhi for the areas of north of Haryana. NH22 starts from Ambala and links NH1 to Shimla and beyond right up to China border at Shipkila. NH65 also starts at Ambala and links NH1 to Hisar and onwards to Jodhpur and Pali in Rajasthan. Ambala is a divisional headquarters of the Northern Railway Zone and is an important railway junction. The Ambala Cantonment railway station was founded on the junction of the Delhi-Kalka and Ludhiana-Saharanpur lines. Ambala is a major railway junction and is extremely well connected by the rail and road network.

Literature Review:

Kumar et al., [7] studied that the disposal of untreated water from industries results in the depletion of dissolved oxygen. Abbasi et al., [8] carried an extensive study of the modeling of Buckingham Canal Water Quality. Tatawati et al., [9] have studied the ground water quality of Jaipur City, Rajasthan. Gupta et al., [10] analyzed the water samples from Kaithal City. M. Jha and S. Tignath, [11] have studied the assessment and impacts of surface water environment in and around Jabalpur city, Madhya Pradesh. Sharma et al., [12] have studied the industrial wastewater and ground water, and pollution problem in ground water. V. Singh et al., [13] have analyzed the wastewater of Jaipur city, which is used for agricultural purpose. Singh et al., [14] have analyzed the physio-chemical parameters of water samples from District Jind, Haryana, India. Prem Singh et. al. [15] have studied the industrial waste water and ground water and pollution problem in it. The objective of these investigations is to determine the hydrochemistry of the ground water and to classify the water in order to evaluate the water suitability for drinking, domestic and irrigation uses and its suitability for municipal, agricultural and industrial use.

Sampling:

Main objective of the present investigations is to determine the hydrochemistry of different water samples and to classify water in order to evaluate the water suitability for drinking, domestic and irrigation uses and for municipal, agricultural and industrial use. Ground water samples collected from fourteen different locations of District Ambala were analyzed for their chemo-metric parameters. The different sampling locations are given in Table 1. Samples were collected in good quality polythene bottles of two-liter capacity. The bottles were well rinsed before sampling and tightly sealed after collection and labeled in the field. Sampling was carried out without adding any preservative.

Chemo-metric Method of Analysis:

Chemo-metric analysis can be used to monitor water quality and provide useful information for regulatory organizations, such as regional councils and governmental bodies. Chemo-metric analysis technique is used worldwide for the determination of various parameters e.g., pH, electrical conductivity, total alkalinity, total dissolved salts, total hardness, chlorides, calcium, magnesium, fluoride, chemical oxygen demand, biological oxygen demand and salinity, etc. The degree of trace element pollution and the suitability of groundwater for drinking purpose has been assessed. The chemo-metric analysis of water samples was carried out for various quality parameters such as temperature, pH, electrical conductivity, Total dissolved solids (TDS), Dissolved Oxygen (DO) and salinity as per standard procedure described "Standard methods for the examination of water and waste water American public Health Association (APHA)" [16]. The temperature was measured while collecting the samples. These parameters were determined using the digital portable analyzer kit (Electronics India, Panchkula, India) at S.D. College (Lahore) Ambala Cantt.

Table 1: Sampling Locations of Ambala

Sr. No.	Sampling Locations	Code	Sources
1.	Vill. Subhri	V1	Hand pump
2.	Vill. Sarsheri	V2	Hand pump
3.	Vill. Rampur	V3	Tube well
4.	Ambala City	V4	Hand pump
5.	Vill. Tandwal	V5	Hand pump
6.	Vill. Mojgarh	V6	Hand pump
7.	Barara	V7	Hand pump
8.	Vill. Ugala	V8	Tube well
9.	Vill. Ghelri	V9	Hand pump
10.	Vill. Rajokheri	V10	Hand pump
11.	Dhulkot	V11	Tube well
12.	Vill. Dhkola	V12	Hand pump
13.	Vill. Boh	V13	Tube well
14.	Vill. Rampur (Kalpi)	V14	Hand pump

Temperature:

Cool water is generally more palatable than warm water, and temperature will impact on the

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acceptability of a number of other inorganic constituents and chemical contaminants that may affect taste. High water temperature enhances the growth of microorganisms and may increase taste, odour, colour and corrosion problems. In analysis of the physicochemical quality of pipe water samples, temperature is considered as a critical parameter. It has an impact on many reactions, including the rate of disinfectant decay and by-product formation. As the water temperature increases the disinfectant demand and by product formation, nitrification, microbial activity, algal growth, taste and odour episodes, lead and copper solubility increases. Moreover, sand calcium carbonate precipitation also increases. Impinging solar radiation and atmospheric temperature brings about spatial and temporal changes in temperature, setting up convection currents and thermal stratification. Temperature plays a very important role in wetland dynamism affecting the various parameters such as alkalinity, salinity, dissolved oxygen, electrical conductivity etc. In an aquatic system, these parameters affect the chemical and biological reactions such as solubility of oxygen, carbon dioxide, carbonate, bicarbonate equilibrium, increase in metabolic rate and physiological reactions of organisms, etc. Water temperature is important in relation to fish life. The temperature of drinking water has an influence on its taste. Standard thermometer was used for taking temperature in degree centigrade (°C) at the sampling locations.

pH Estimation:

pH is one of the most important operational parameters for water treatment such as disinfection or coagulation-flocculation and pH adjustment is a common practice in water treatment. Because, dissociation is poor at pH < 6, at pH 6 to 8.5 a nearly complete dissociation of HClO occurs. Thus for disinfection with chlorine, control of pH is critical. As a consequence, an increasing pH of the potable water requires rising amounts of chlorine for the same disinfection efficacy. The microbial activity of chlorine is greatly reduced at high pH, probably because at an alkaline pH, the predominant species of chlorine is OCl-. Equilibrium concentrations of HClO and OCl- depend on the pH of the water. If the pH of the water is high, chlorine is less effective in killing pathogens.

Electrical Conductivity (EC):

Conductivity reflects mineral salt contents of water and is an expression of its ability to conduct an electric current. As this property is related to the ionic content of the sample which is in turn a function of the dissolved (ionisable) solids concentration, the relevance of easily performed conductivity measurements is apparent. In itself conductivity is a property of little interest to a water analyst but it is an invaluable indicator of the range into which hardness and alkalinity values are likely to fall, and also of the order of the dissolved solids content of the water.

Total Dissolved Solids (TDS):

Dissolved solids are solids that are in dissolved state in solution. Water samples with high dissolved solids generally are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer.

Dissolved Oxygen:

Oxygen dissolved in water is a very important parameter in water analysis as it serves as an indicator of the physical, chemical and biological activities of the water body. The two main

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sources of dissolved oxygen are diffusion of oxygen from the air and photosynthetic activity. Diffusion of oxygen from the air into water depends on the solubility of oxygen, and is influenced by many other factors like water movement, temperature, salinity, etc. Dissolved oxygen is calculated by many methods.

Salinity:

Salinity is a measure of the content of salts in soil or water. Salts are highly soluble in surface and groundwater and can be transported with water movement. Large salt deposits are a natural feature of vast areas of the Australian landscape, stored deep in soils or as surface salt deposits and salt lakes. This natural distribution of salt in the landscape is referred to as 'primary salinity'. In normal circumstances, the deep roots of native plants absorb most water entering the soil before it reaches the salt contained in groundwater below the plant root zone. However, widespread vegetation clearance, poor land use, irrigation and industrial practices have made it easier for salt to be transported to the soil surface or to waterways. The additional salt from these altered land use and management practices is referred to as secondary salinity.

Primary salinity is produced by natural processes such as weathering of rocks and wind and rain depositing salt over thousands of years. Secondary salinity has occurred with widespread land clearing and altered land use, and may take the form of dryland salinity or irrigation-induced salinity. Dryland salinity occurs when deep rooted native plants are removed or replaced with shallow-rooted plants that use less water. As a result of this vegetation imbalance, more water passes through soil to groundwater, raising the water table and bringing salt to the surface where it can be left behind as the water evaporates. Irrigation induced salinity occurs when excess water applied to crops travels past the root zone to groundwater, raising the water table and salt to the surface. Salt may also be transported across groundwater systems.

Results and Discussions:

Characterization of the chemo-metric parameters of groundwater from fourteen different locations in Ambala, Haryana (India) is reported in Table 2. The results are better presented in the Figures 1 to 5. The experimental results are compared with the standard limits [16-18] recommended by the World Health Organization (WHO), Indian Council of Medical Research (ICMR) and Bureau of Indian Standards (BIS). Considerable deviations are observed in the water quality parameters from the standard limits.

Table 2: Chemo-metric parameters of groundwater from fourteen locations of District Ambala, Haryana (India)

Parameters →

Sample Site ↓ Area Code Source Colour Temperature (C) pH

EC (ms/cm) TDS (ppt) DO(ppm) SALINITY(ppt)

WHO Standards 7-0 - 8.5 - .5-1.5 - -

ICMR Standards		6.5 - 9.2	-	.5-3.0	-	-			
BIS (IS 10500-91)		6.5 - 8.5	-	.5-2.0	-	-			
Vill.-Subhri	V1	H	Colourless	22.5	7.72	0.57	0.37	4.6	0.3
Vill.- Sarsheri	V2	H	Colourless	22.5	7.77	0.49	0.31	5.6	0.2
Vill.-Rampur	V3	T	Colourless	23	8.47	0.40	0.26	5.4	0.2
Ambala City	V4	H	Colourless	22.5	7.50	0.34	0.22	5.9	0.1
Vill.-Tandwal	V5	H	Colourless	23.5	7.42	2.63	1.73	2.9	2.1
Vill.-Mojgarh	V6	H	Colourless	23	7.43	1.56	1.02	6.4	1.2
Barara	V7	H	Colourless	23	7.76	0.95	0.62	5.9	0.7
Vill.-Ugala	V8	T	Colourless	22.5	8.18	0.36	0.23	4.7	0.1
Vill.-Ghelri	V9	H	Colourless	24	7.66	1.97	1.31	5.6	1.6
Vill.-Rajokheri	V10	H	Colourless	23.5	7.72	0.78	0.51	5.6	0.5
Dhulkot	V11	T	Colourless	23.5	8.24	0.65	0.42	4.4	0.4
Vill.-Dhkola	V12	T	Colourless	23	8.75	0.67	0.43	6.2	0.4
Vill.-Boh	V13	T	Colourless	23	8.27	0.64	0.46	6.4	0.4
Rampur(Kalpi)	V14	H	Colourless	23	7.35	2.26	1.49	4.4	1.8

H® Handpump, T® Tubewell

The desirable limit of pH value for drinking water is specified as 6.5 to 8.5. Measured pH value of the water samples ranges from 7.35 to 8.75. pH values show a slightly alkaline trend. The electrical conductivity of the samples ranges from 0.34mS/cm to 2.26 mS/cm. BIS prescribed that the desirable limit of TDS is 500 ppm and the maximum permissible level is 2000 ppm. The TDS value ranges from 0.22ppt to 1.73ppt. The DO values ranges from 2.9ppm to 6.4ppm. The salinity values ranges from 0.1ppt to 2.1ppt.

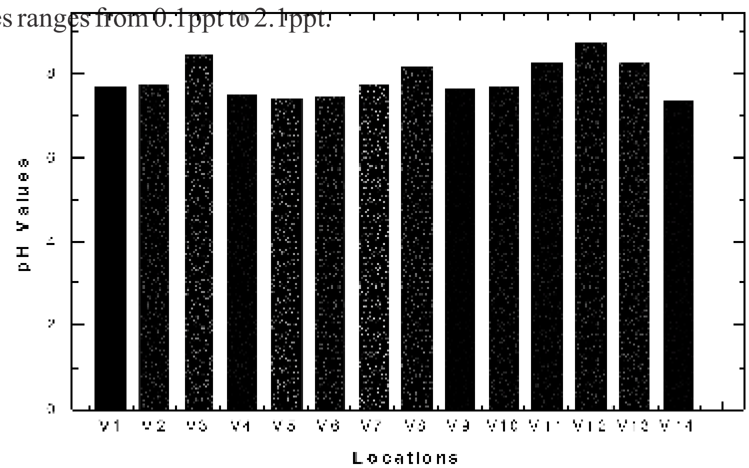

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Figure 1: The pH values for different locations

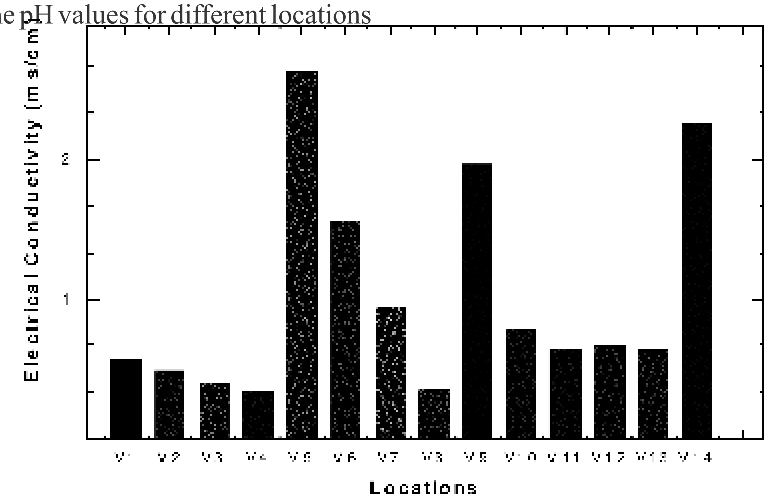
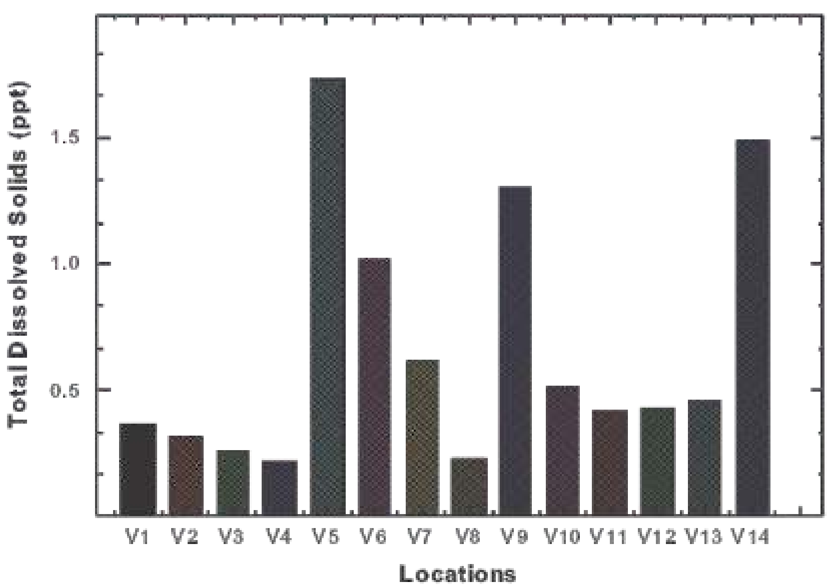


Figure 2: The electrical conductivity values for different locations



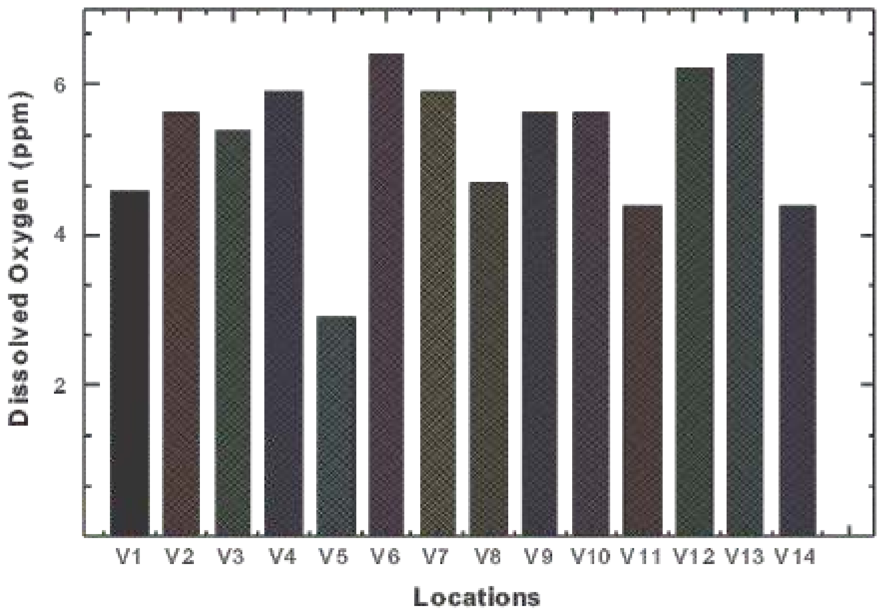


Figure 4: The dissolved oxygen (DO) values for different locations

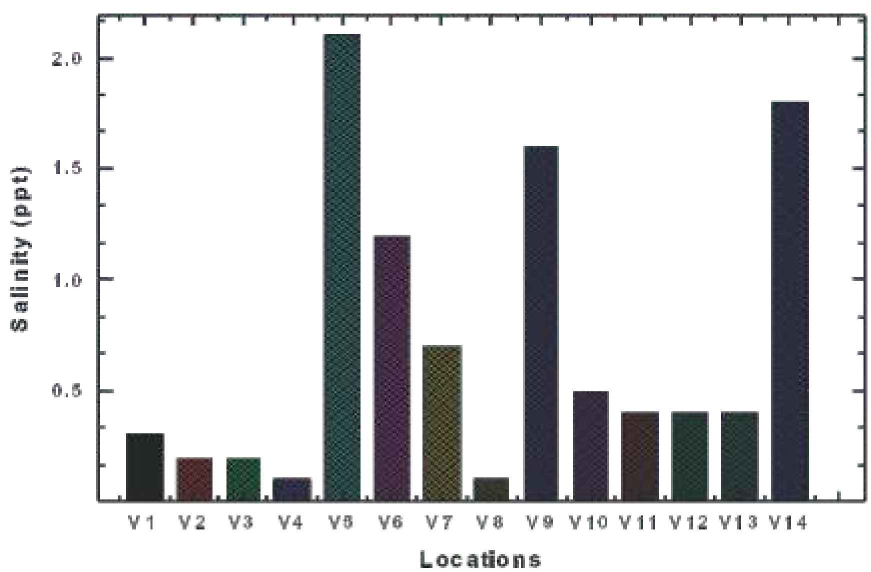


Figure 5: The salinity values for different locations

Figure 3: The total dissolved solid (TDS) values for different locations

Correlation Studies

Study of correlation reduces the range of uncertainty associated with the decision making. The correlation coefficient 'r' was calculated using the relation

The correlation matrix for the water quality parameters are given in Table 3 below:

Table 3: Correlation matrix for the water quality parameters

Parameters	pH	EC	TDS	DO	Salinity
pH	1	-0.59695	-0.59319	0.275033	-0.45603
EC		1	-0.62317	0.261083	-0.29363
TDS			1	0.268854	0.904216
DO				1	0.914129
Salinity					1

*Significant at 5% level, r > 0.575

Conclusions

Groundwater samples from the fourteen villages of District Ambala, Haryana, India were analyzed for the chemo-metric parameters. The quality of drinking water depends on the harmful elements present in it. The pH of water samples ranges in the entire area shows alkaline trend. The average of alkalinity has exceeded the desirable limits which are due to improper drainage system and due to domestic and agricultural activities in the villages. Groundwater of the villages of District Ambala is suitable for drinking and domestic purposes but in some areas there is the need of treatment to minimize the contamination especially alkalinity. It is hard to imagine that one person can make a difference in protecting and conserving water supplies but each individual can really help the environment. However, the hazardous effects of fertilizers, pesticides, animal wastes and sediments have not been detected in the ground water samples. It is advised that the animal waste and domestic waste should not be deposited near the water sources. The use of fertilizers and pesticides in the agriculture should be limited and proper and only the standard quality pesticides should be used.

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