# "Physico-chemical Characteristics of Sub Surface Water of Haripur area - Hazara (NWFP)"

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**Summary**: The level of pollution in water samples from Haripur area of Hazara were investigated by measuring the quality of subsurface water collected from 13 localities of the area. 18 physical and chemical parameters were measured and the values were compared against standards for ascertaining the suitability of water for human consumption. Parameters values for most of the samples were found to be within the permissible limits but some values were very close to the maximum permissible limits and therefore, appropriate measures should be undertaken to control further contamination of water, otherwise, the water would no longer be safe for the inhabitants of the area in the near future.

## Introduction

The problem of water quality control has received special attention in the wake of fast urbanization and rapid industrialization, because of which both underground and surface water resources face an ever greater importance. The seriousness of the situation has been recognized in developing countries where agricultural and industrial activities has started causing an undeliberated exposure of water sources to potentially harmful chemicals fed directly or indirectly to water bodies through seepage of surface run-offs [1].

In view of the specific uses of various water sources certain physico-chemical parameters have been used to define the quality of public utility water [2]. The available sources of drinking water for the inhabitants in rural as well as in the urban areas, of NWFP are mainly ground and surface water. Ground water forms only about 0.6% of the total volume of water in the hydrosphere while the terrestrial surface water constitutes less than 0.02% [3,4].

Efforts has been made in the past to evaluate and characterize water of different localities for human consumption. Water of Peshawar area has been evaluated by some authors [5]. Studies on local public utility water drawn from some areas of Punjab have also been reported [6]. Studies on the water samples collected from the Nowshera Industrial area of NWFP has been undertaken by Noor *et al.*, [7] Khan *et al.*, have reported the quality of water from Peshawar, Nowshera, Mardan, Abbotabad, Kohat and D.I. Khan [8]. Physico-Chemical parameters of the drinking water from various localities of NWFP have also been reported by Bangash *et al.*, [9]. Nitrate and Nitrite contamination of subsurface water in some areas of NWFP has been reported by Mumtaz *et al.*, [10]. In the past, no, studies on water quality have been reported on the area under investigation. The present studies may indicate the adverse effect of the industrial and agricultural activities in the area on water quality and the data would provide guidelines for planning and the implementation of water quality control measures.

## Results and Discussion

*Physical properties*

These include the properties like temperature, colour, odour, taste, turbidity, suspended solids or settleable solids. Almost all the samples of water collected were found to be colourless, odourless, tasteless with no significant turbidity, suspended solids or settle able salts. The results are shown in Table-1.

*pH*

The maximum limit of pH for domestic water supply is 5-9 [11]. pH is a measure of acid-base equilibrium achieved by various dissolved compounds, salts and gases. The pH of the samples collected from various localities of the area varies

Table-1: Physical parameters of water samples from Haripur area of Hazara

| S.No. | Locality | Source | Colour | Odour | Taste | Turbidity | Temp.(°C) | Suspended Solids (mg/l) |
|---|---|---|---|---|---|---|---|---|
| 1. | Noor Colony I | Tube Well | Colourless | Odourless | Tasteless | Clear | 18 | Nil |
| 2. | Noor Colony II | " | " | " | " | " | " | " |
| 3. | Chowki Police I | " | " | " | " | " | " | " |
| 4. | Chowki Police II | " | " | " | " | " | " | " |
| 5. | G.H. School 2 | " | " | " | " | " | " | " |
| 6. | Afzalabad | " | " | " | " | " | " | " |
| 7. | Roshanabad | " | " | " | " | " | " | " |
| 8. | Mohallah Khoo | " | " | " | " | " | " | " |
| 9. | Lady Garden | " | " | " | " | " | " | " |
| 10. | Tanki Chishma | " | " | " | " | " | " | " |
| 11. | Eid-gah | " | " | " | " | " | " | " |
| 12. | Alhamra Cinema | " | " | " | " | " | " | " |
| 13. | Hattar Road | " | " | " | " | " | " | " |

Table-2: pH, TDS, Total hardness and alkalinity in water samples from Haripur area of Hazara (Expressed in mg/l)

| S.No. | Locality | Source | pH | TDS | T.H as $CaCO_3$ | Ca as $CaCO_3$ | Mg as $CaCO_3$ | $CO_3$ Alk. as $CaCO_3$ | $HCO_3$ Alk as $CaCO_3$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Noor Colony I | Tube Well | 7.21 | 380 | 264 | 140 | 124 | Nil | 344 |
| 2. | Noor Colony II | " | 7.15 | 415 | 280 | 160 | 120 | " | 368 |
| 3. | Chowki Police I | " | 7.30 | 150 | 140 | 100 | 40 | " | 200 |
| 4. | Chowki Police II | " | 7.20 | 340 | 268 | 172 | 96 | " | 292 |
| 5. | G.H. School 2 | " | 7.31 | 360 | 280 | 188 | 92 | " | 304 |
| 6. | Afzalabad | " | 7.28 | 350 | 260 | 148 | 112 | " | 292 |
| 7. | Roshanabad | " | 7.23 | 340 | 240 | 108 | 132 | " | 264 |
| 8. | Mohallah Khoo | " | 7.21 | 450 | 352 | 232 | 120 | " | 352 |
| 9. | Lady Garden | " | 7.13 | 425 | 312 | 216 | 96 | " | 340 |
| 10. | Tanki Chishma | " | 7.05 | 305 | 216 | 152 | 64 | " | 268 |
| 11. | Eid-gah | " | 7.16 | 200 | 180 | 110 | 70 | " | 280 |
| 12. | Alhamra Cinema | " | 7.00 | 440 | 328 | 208 | 120 | " | 360 |
| 13. | Hattar Road | " | 6.80 | 350 | 248 | 170 | 78 | " | 330 |
| | Mean | | 7.156 | 323.46 | 259.07 | 161.84 | 97.23 | 0.0 | 307.23 |
| | Std. Dev. | | ±0.14 | ±114.20 | ±57.69 | ±41.85 | ±27.72 | 0.0 | ±47.91 |

TDS = Total Dissolvd Solids
T.H. = Total Hardness
Alk. = Alkalinity

from 7.00 - 7.31 (Table-2) and therefore lie within the permissible range.

*Chemical properties*

*Total dissolved solids*

It is a measure of all the soluble salts and its concentration beyond the permissible limit may cause cardiac diseases and Toxemia in women in pregnancy [12]. The maximum permissible limits for TDS according to WHO standards is 500 mg/L (Table-4). High concentration of dissolved salts can adversely affect the aquatic population and may render the water unfit for drinking, washing and irrigation purposes. Its values ranges from 290 - 440 mg/l and therefore regarded as safe for human consumption but the values of some samples are close to the maximum permissible limits.

*Total hardness*

Total hardness is a measure of the polyvalent metallic ions mainly calcium and magnesium dissolved in water. According to American Public health Standards, the total hardness should not exceed 500 mg/L [12] whereas the maximum permissible limits for calcium and magnesium hardness are 250 and 150 mg/l [12], as calcium carbonate, respectively. The total hardness in all the samples collected from various localities of Haripur varies from 192 - 350 mg/L. The calcium and magnesium content ranges from 108 - 232 mg/L 80 - 132 mg/L, respectively and are regarded to be within the permissible limits. Excessive concentration of total hardness causes stomach disorders and difficulties in washing the clothes. It should be noted that some values in the present study are very close to the maximum permissible limits.

Table-3: Chlorides, sulphates, nitrates, nitrites, sodium and potassium in water samples from Haripur area of Hazara (Expressed in mg/l)

| S.No. | Locality | Source | $Cl'$ | $SO_4''$ | $NO_3'$ | $NO_2'$ | $Na^+$ | $K^+$ |
|---|---|---|---|---|---|---|---|---|
| 1. | Noor Colony I | Tube Well | 24 | 77 | 1.7 | Nil | 28.2 | 2.2 |
| 2. | Noor Colony II | " | 16 | 61 | 1.5 | " | 26.9 | 2.6 |
| 3. | Chowki Police I | " | 10 | 84 | 1.9 | " | 9.0 | 1.7 |
| 4. | Chowki Police II | " | 24 | 54 | 0.8 | " | 12.8 | 1.7 |
| 5. | G.H. School 2 | " | 14 | 84 | 1.3 | " | 12.0 | 2.0 |
| 6. | Afzalabad | " | 16 | 92 | 2.1 | " | 18.1 | 2.4 |
| 7. | Roshanabad | " | 10 | 73 | 1.8 | " | 9.2 | 2.2 |
| 8. | Mohaliah Khoo | " | 30 | 73 | 1.7 | " | 21.5 | 3.0 |
| 9. | Lady Garden | " | 26 | 65 | 1.2 | " | 18.3 | 2.4 |
| 10. | Tanki Chishma | " | 10 | 61 | 1.5 | " | 16.3 | 2.7 |
| 11. | Eid-gah | " | 12 | 54 | 1.3 | " | 12.4 | 1.8 |
| 12. | Alhamra Cinema | " | 22 | 69 | 1.6 | " | 15.3 | 4.3 |
| 13. | Hattar Road | " | 20 | 48 | 1.8 | " | 21.5 | 2.5 |
| | Mean | | 18.00 | 68.84 | 1.55 | 0.0 | 17.04 | 2.42 |
| | Std. Dev. | | ±6.78 | ±113.26 | ±0.34 | ±0.0 | ±6.18 | ±1.69 |

*Alkalinity*

Alkalinity is a measure of buffering capacity of water that tends to elevate the pH of water above a value of 4.5. The alkalinity of water is important because it determines the amount of chemicals need to be added to accomplish coagulation and softening processes. The maximum permissible limits of $CO_3^{-2}$ and $HCO_3^{-1}$ alkalinities according to WHO standards are 30 mg/L and 500 mg/L respectively (Table-4). The $CO_3^{-2}$ alkalinity represent the amount of soluble carbonates present in water, whereas the $HCO_3^{-1}$ alkalinity is a measure of bicarbonate alkalinity. The $CO_3^{-2}$ value has been found to be zero in almost all the samples of water examined whereas $HCO_3^{-1}$ values ranges from 268 to 368 mg/l. All these values are within the permissible range.

*Chlorides*

The maximum permissible limit for chlorides in drinking water according to WHO Standards is 250 mg/l (Table-4). Chlorides are present in small amounts and are highly soluble in water. Chlorides remain unaffected by biological processes and the usual concentration is 10 mg/l. It has been recommended that individuals suffering from heart and kidney diseases should restrict consumption of water with high chloride concentration. In the present study, the chloride values ranges from 10-30 mg/l (Table-3) and are within the permissible limits. A linear relationship was also observed between total dissolved solids (TDS) and chloride content, as shown in Fig. 1.

Table-4: Potable Water Quality Standards (WHO, 1984)

| Analytes | WHO Standards |
|---|---|
| Colour | Colourless |
| Odour | Odourless |
| Taste | Tasteless |
| Temp. (°C) | 12 |
| pH | 6.5 - 9.5 |
| Total Dissolved Solids (mg/l) | 500 |
| Suspended Solids (mg/l) | 5 |
| Chlorides (mg/l) | 200 - 250 |
| Nitrates (mg/l) | 45 |
| Nitrites (mg/l) | 0.1 |
| Calcium(mg/l) | 250 |
| Magnesium (mg/l) | 150 |
| Sulphates (mg/l) | 200 - 250 |
| Sodium (mg/l) | 200 |
| Potassium (mg/l) | 12 |
| $HCO_3'$, Alkalinity (mg/l) | 500 |
| $CO_3'$ Alkalinity (mg/l) | 30 |
| Total hardness (mg/l) | 500 |

*Sulphates*

Sulphates are the important factor for ascertaining the suitability of water and its presence in higher concentration is an indication of permanent hardness of water in the form of sulphates as magnesium, sodium and calcium sulphate. The excess of sulphate in the form of magnesium sulphate causes diarrhoea and gastrointestinal disorders. The maximum permissible limits for sulphate is 250 mg/l (Table-4). In all the samples studied, the sulphate content was observed in the range 48 - 92 mg/l which is regarded as safe for human consumption. A

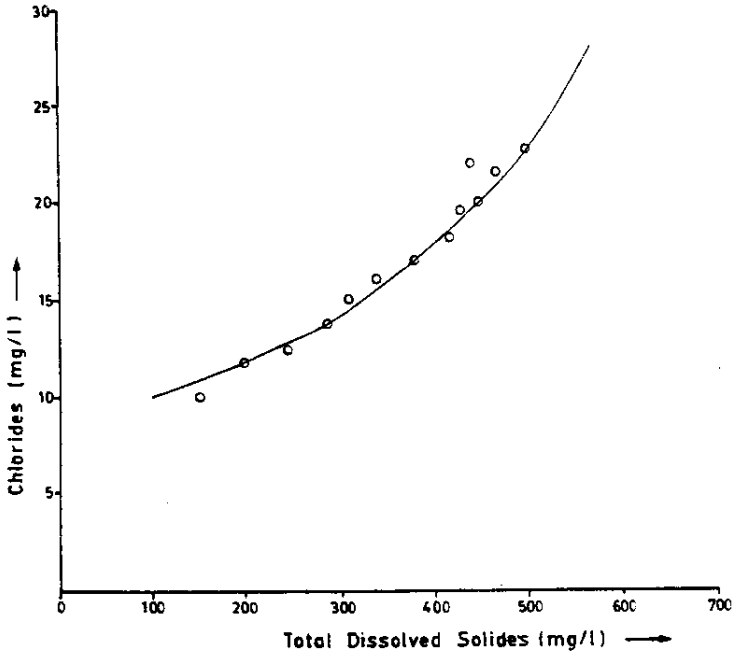


Fig. 1: Relationship of chlorides with total dissolved solids (TDS) in water samples from Haripur.

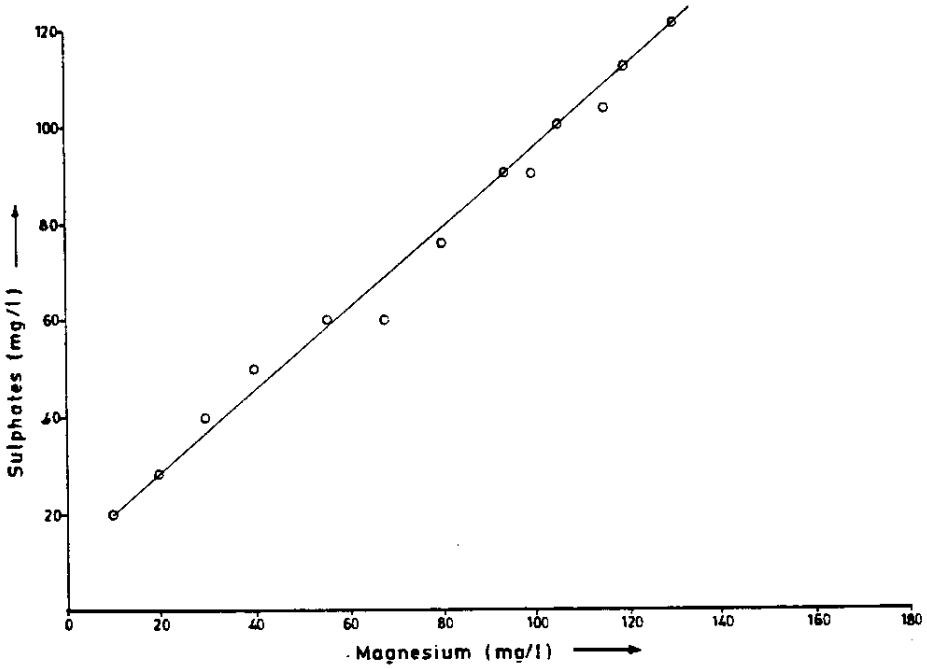


Fig. 2: Relatiohsip of magnesium with sulphate content in waer samples from Haripur.

plot of sulphate content vs. magnesium content of water samples studied show increasing trends in sulphate content with the increase in magnesium content (Fig. 2).

*Nitrates*

Concern has frequently been expressed about the high nitrate content. The nitrate contamination comes from many sources including soil and rock,

agriculture use of nitrogeneous fertilizers, nitrogen fixation by micro-organisms and especially, decomposition of plants and sewage wastes, followed by the leaching of resulting nitrates into ground water. Studies by health agencies have revealed that in water for domestic use, the concentration of nitrate should not exceed 45 mg/l (Table-4). The nitrate content in the water samples studied has been found to be in the range 0.8 - 2.1 mg/l (Table-3), which is within the permissible limits.

*Nitrites*

Nitrites are considered to be the most important factor for ascertaining the suitability of water and its presence is regarded as an indication of biological activity in water. The nitrite ion is formed from the nitrate or the ammonium ions by certain micro-organisms found in soil, water, sewage and digestive tract. The reaction of nitrite with haemoglobin can be hazardous to infants under three months of age [15].

Nitrites are more toxic than nitrates and restriction of the daily intake of 0.4mg/kg of body weight is recommended [16]. However nitrites have been used therapeutically as medication for vasodilatation and as an antidote for cyanide poisoning in doses of 30 to 300 mg without severe toxic effects [17]. In drinking water its maximum permissible limit is 0.1 mg/l (Table-4). Almost all the samples collected from various locations of the area were found to contain no nitrite content (Table-3) and therefore are safe from any bacteriological growth.

*Alkali metals*

Sodium and potassium are considered to be alkali ions present in almost all sort of water. Sodium may be found in fairly high concentrations when water is softened by a process in which calcium and magnesium are exchanged for sodium. Its high level is toxic to some plants such as fruit trees and berries which are sensitive to sodium. As sodium is corrosive therefore its high level is also not suitable for use in generators, radiators, turbines or in cooling circuits.

Potassium is definitely an essential nutritional element for humans, animals and plants. It is non toxic but acts as cathartic in excessive concentration. The effect of potassium in drinking water is negligible either to reach minimum requirements or to cause any health problems.

The permissible limits of sodium and potassium in municipal water supplies are 200 mg/l and 12 mg/l respectively [18,19]. The sodium ion concentration closely follows the variation pattern of TDS and chloride contents. In the present study, the sodium concentration varies from 9-28 mg/l (Table-3) and therefore lies within the permissible limits. The potassium content varies from 1.7-4.3 mg/l (Table-3) which is also within the range of the permissible limits.

## Experimental

*Sampling*

Sampling was carried out in dry season. Thirteen sampling points were randomly selected for sampling of water samples in the vicinity of the area. Plastic bottles (1.5 litre capacity) for sampling were carefully cleaned with detergent, washed several times with laboratory tap water, rinsed with HCl, again washed with tap water and finally with distilled water. All necessary precautions [5-13] were observed while filling up the sample bottles with tube-well water and in their transport and storage. Tube-wells selected for sampling in different localities of Haripur were well used by the inhabitants of the area.

*Physical parameters*

Colour was observed by visual method, odour by smelling the sample taste was checked organoleptically while temperature measurements were made with a centigrade thermometer on the spot. The results of physical measurements are shown in Table-1.

*Chemical parameters*

*Reagents*

All the reagents used were of Analor grade (Merck/BDH)

Chemical evaluation for each sample were carried out following the standard methods [13]. The results of chemical analyses are presented in Tables

2 and 3 alogwith their arithmetic means and standard deviations.

pH was determined on the spot by a potable pH meter (Corning). Total dissolved solids were measured by evaporation method. Total hardness including calcium and magnesium were determined by complexometric EDTA titration.The carbonate and bicarbonate alkalinities were measured by titration with M/50 HCl using phenolphthaline and methyl orange respectively as indicators. Chlorides were determined by titration with silver nitrate (0.041 1N) solution using potassium chromate as indicator upto the formation of reddish brown precipitate. Sulphates were measured by back titration with standard (0.01 M) EDTA solution using excess of barium chloride (0.02 M) as precipitating agent for sulphates.

Nitrates were determined by phenoldisulfonic acid method and the yellow colour produced is measured by a UV spectrophotometer (U-2000, Hitachi Japan). Nitrite forms reddish purple AZO dye at pH 2.0 - 2.5 by cooping deoxidized sulfanilic acid with I Naphthylamine hydrochloride. Sodium acetate solution is added as a buffer and the reddish purple colour produced was measured with a UV spectrophotometer as used for nitrate determination. Sodium and potassium were determined by a flame photometer (Model PFP-7, Jenway England). The samples were subjected to the instrument for direct readings from the digital display of the machine and stable values were reported.

## Conclusion

On the basis of 18 physical and chemical characteristics, as evident from the analytical data (Tables 1-3) of potable water samples collected from 13 localities of Haripur - Hazara, it appeared that the samples studied, do not show any distinct pollution. However, the increased industrial and agricultural activities in the area may cause water pollution in the long run. The reported data may form part of the baseline data used for future studies. The present work may also assist future managers and planners to establish certain preventive measures and to suggest potable water quality standards for Pakistan.

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