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Physico-Chemical Assessment of Surface and Ground Water for Drinking Purpose in Nawabshah City, Sindh, Pakistan

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Abstract: The work reports the analysis of groundwater and surface water samples, were collected from different towns of Nawabshah City during the end of year 05 Dec, 2013 to 30 Jan, 2014. Sixty five groundwater and sixty surface water samples (water supply scheme) were collected from different parts of the Nawabshah city. Different physico-chemical parameters of water samples were measured at the field and in the laboratory. The conductivity, salinity and Total dissolved solids (TDS) were measured with Orion 115 conductivity meter at the field. pH was recorded with Orion 420A pH meter. Total hardness, chloride and alkalinity were determined by titration with standard EDTA, silver nitrate and hydrochloric acid. Sulfate was determined by turbidity meter as BaSO4 using Hitachi spectrophotometer. The metal ions Na, K, Ca and Mg were determined with Varian Spectr. AA-20 atomic absorption spectrometer with standard burner head and air acetylene flame at conditions recommended by the manufacturer. The results were varied within the ranges; pH 6.64-8.87, EC 240-10170 µS/cm and TDS 158-6050 mg/l, alkalinity 56-1225 mg/l, total hardness 84-1695 mg/l, chloride 32-1852 mg/l, sulfate 25-2170 mg/l. The concentration of essential metals was found in the ranges; Na 34-1725 mg/l, Ca 26-515 mg/l, Mg 13-430 mg/l, K 2-92 mg/l respectively. The analysis revealed that a number of ground water samples (70%) confirm their majority of parameters above the maximum permissible limits prescribed by WHO. Therefore the ground water of Nawabshah city may not be considered as safe to be used for dinking purpose. However, out of 60 samples only four surface water samples may be used for drinking purpose.

Keywords: Canal Water, Water Supply Schemes, Ground Water, Physical, Chemical

1. Introduction

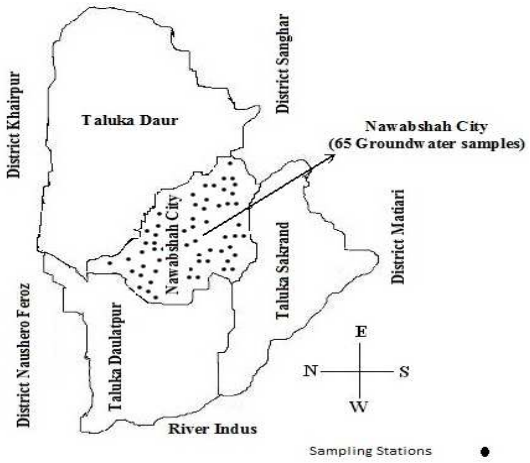
Nowadays Safe drinking water is a major issue mostly in developing countries (1), drinking of polluted water generate serious health issues, may be consumption of contaminated water is a cause of high death rate in developing countries. Most of the cities of world use underground water for their daily use, which is contaminated by sewage. Over all the Word approximately 800 million peoples not getting adequate water supply (2). Water in developed countries used after proper filtration procedure but in developing countries it is inverse, lake of filtration plants leads to use contaminated water to peoples which affected severally. Diarrhea is common in Pakistan due to utilizing contaminated water. Water which safe for drinking purpose called potable water. Water gets polluted by two major sources i.e. point sources and non point sources.

The water in the Indus basin is of variable quality (3-5). It is not saline near sources of recharge, i.e. rivers and major canals but gradually becomes saline with depth as the distance from the recharge source increases (6). Poor microbial quality of drinking-water is the most pressing issue. No urban water supply meets WHO drinking-water quality guidelines (7). The major reasons for this are the intermittent supply through leaking pipes and cross connections with

nearby sewer lines (8). People of the district mostly use underground water for drinking purpose, except some towns, where the water supply schemes provide surface water for drinking. The water we drink should meet some national and international standards. It is also predicted that in future Pakistan will face water challenges (9-11). Chemical composition of surface and groundwater is one of the major factors to which the suitability of water for industrial, domestic and agricultural purpose depends (12). The pollution of groundwater results from all the processes and reactions which the water faces from the moment it condensed in the atmosphere to the time it is discharged by a well or hand pump and varies from place to place with depth. Major portion of the rural Inhabitants depend upon the groundwater due to unavailability of water treatment and supply of potable water. 40% of the deaths in Pakistan are caused by water borne diseases directly or indirectly (13).

A number of factors cause pollution of surface as well groundwater including urbanization and industrialization. The quality of groundwater in Drinking Water Quality of Pakistan is deteriorating day by day (14-20). A serious problem appears due to stagnant management of effluent water which becomes penetrating into the soil with the passage of time and can become a part of natural and ground water (6, 21-25).

Lot of work has been carried out on the quality of ground water of different parts of Pakistan (26). Mostly the water of all the sources in Pakistan is polluted (27). The drinking water of different regions of country also contaminated including Peshawar (28, 29), Karachi (30), Lahore (31), Muzaffargarh (32) and Tharparkar (33), but no any reasonable work is reported on the quality of underground water of Nawabshah city.



Map 1. *District Nawabshah and ground water sampling stations.*

The quality of water in domestic use must be tested to know the extent of its pollution and its suitability for human consumption. It is useful to examine the above highlighted problems in an environmental frame work in which the quantity and quality of water resources is a major concern. The object of this study is to assess the drinking water quality in various drinking water sources used in Nawabshah city. In Nawabshah both the underground and surface (Municipal whole water quality of the city and compare it with the standards of World Health Organization. Over all focus of this study was drinking water quality of the city.

2. Materials & Methods

Samples were collected from the municipal water supply and underground water in pre sterilized polyethen bottles, before the collection of samples bottles were washed with sample water twice. All the reagents used were of analytical grade and all the glass ware used was washed properly with double distilled water before use. The metal standard solutions were prepared by dilution from 1000 ppm stock solution of each metal.

2.1. Detection of Physical Parameters

Different physico-chemical parameters of water samples were measured at the field and in the laboratory. The homogenized sample was transferred to a clean 1 L clean plastic bottle. The temperature of air on meter above the surface of water was recorded with mercury thermometer, conductivity, salinity and total dissolved solids (TDS) were measured with Orion 115 conductivity meter at the field. pH was recorded with Orion 420A pH meter.

2.2. Detection of Chemical Parameters

Hardness, chloride and alkalinity were determined by titration with standard EDTA, silver nitrate and hydrochloric acid respectively. Sulfate was determined by turbidity meter as $BaSO_4$ using double beam Hitachi 220 spectrophotometer.

2.3. Detection of Metallic Ions

The essential metal ions (Na, K, Ca and Mg) were determined with Varian Spectra AA-20 atomic absorption spectrometer with standard burner head and air acetylene flame. The analysis was carried out in triplicate with integration time 3 seconds and delay time 3 seconds. The concentration of metal ions (Na, K, Ca and Mg) was determined after appropriate dilution of the sample containing 1ml concentrated nitric acid per 250 ml. The SAR values were calculated using the formula, SAR = Na/ (Ca+Mg) 1/2/2.

3. Results and Discussion

The work reports the analysis of groundwater and some surface water samples from Nawabshah city, located at the center of Sindh province. The results of physical and chemical parameters of the water samples were found in the following ranges. pH 6.64-8.87, TDS 158-6050 mg/L, chloride 32-1852 mg/L, alkalinity-M 56-1225 mg/L, hardness 84-1695 mg/L, SO_4 25-2170 mg/L, The concentration of essential metal ions (Na, Ca, Mg and K) was found in the ranges of 34-1725 mg/L, 26-515 mg/L, 13-430 mg/L and 2-92 mg/L respectively. The

results revealed that the majority of ground water samples (40 out of 65) of the study area were not suitable to be used for drinking purpose; on the other hand, 40 water samples based on sodium adsorption ratio (SAR) were found suitable to be uses for irrigation purpose.

In all the natural ecosystems water acts as the primary transport medium for dissolved and particulate matter and determines as well, the rate at which these fluids are added or removed from the system. A complete identification of hydrological characteristics is hence essential for understanding biological, chemical and physical processes that operate within the ecosystem.

The results of physico-chemical parameters of water samples reveal the varying nature of the underground water of the Nawabshah city. The difference in the quality of groundwater may be due to topography of soil; different earth beds and effect of recharge sources (canals etc) on underground water.

3.1. pH

The pH of water samples varied between within the range 6.95-8.87. Sixty three samples confirm pH within the safe guidelines of 6.5-8.5 prescribed by WHO for drinking water, while only two samples were above the limits of WHO. These two samples were collected direct from Gajra (canal) running through Nawabshah city and from a hand pump located near to Gajra (canal). The high values of pH may be due to human activity (domestic and industrial waste) and water logging respectively. The waters with pH below 7.0 are termed as acidic and acidity in water is due to the presence of dissolved carbonic acid. It increases the solubility of different materials including metals ions like Na, K, Ca and Mg. Twenty samples indicated pH below 7.0 but indicated within the permissible limit of 6.5.

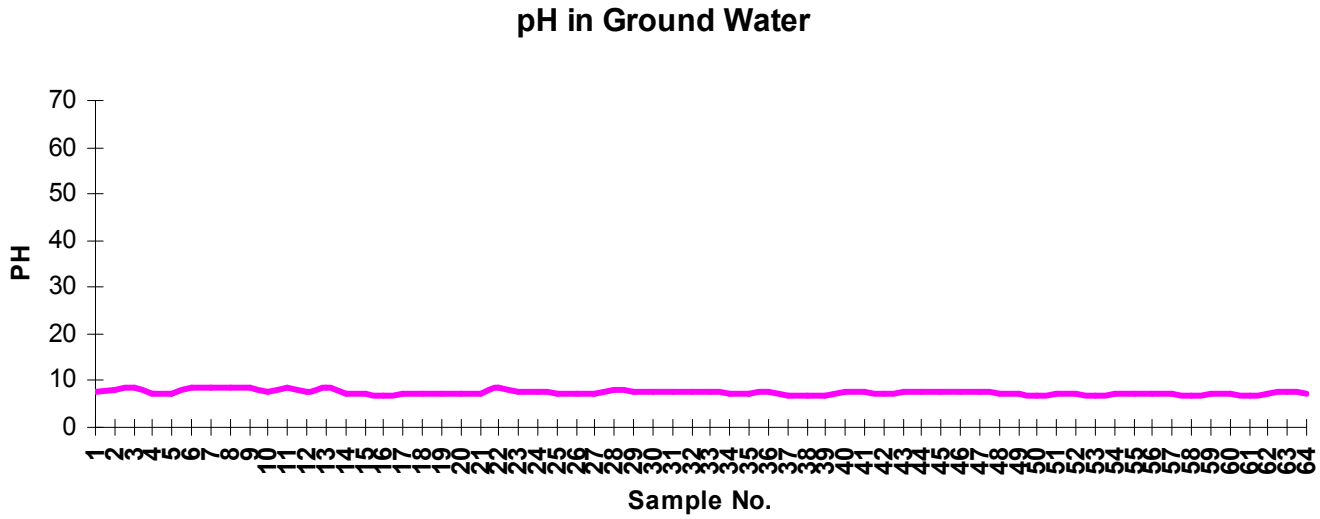


Figure 1. *pH in Ground Water.*

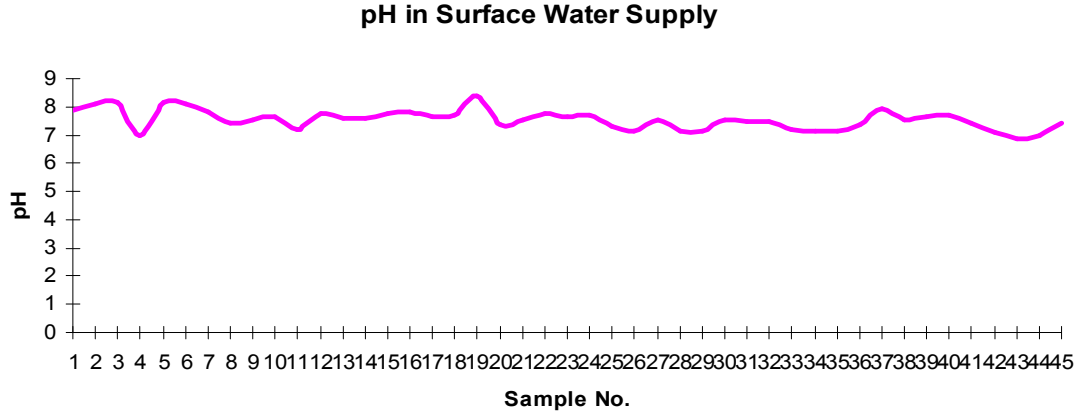


Figure 2. *pH in Surface Water Supply.*

3.2. Total Dissolve Solids (TDS)

The TDS varied between within the range 158-6050 mg/L. A lot of variation was observed in TDS of water samples, only 10 samples were observed within the limits (500 mg/L) of WHO for drinking water. The variation in TDS may be due to different earth beds and recharge sources. Generally the water samples have high values of TDS making them unsuitable for drinking purpose. The water samples with elevated values of TDS may cause several health problems to

living organisms and adversely affect the fertility of soil, if used for irrigation purpose.

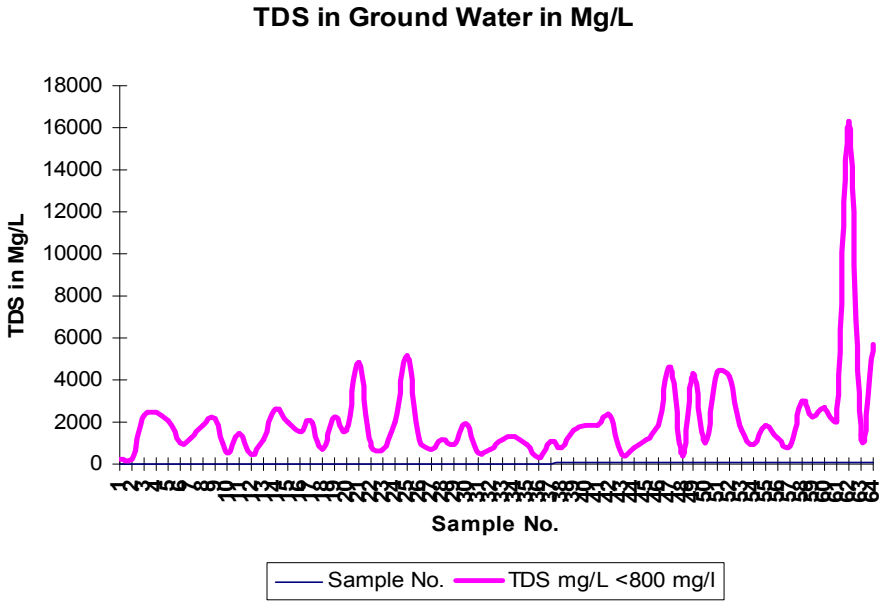


Figure 3. *TDS in Ground Water.*

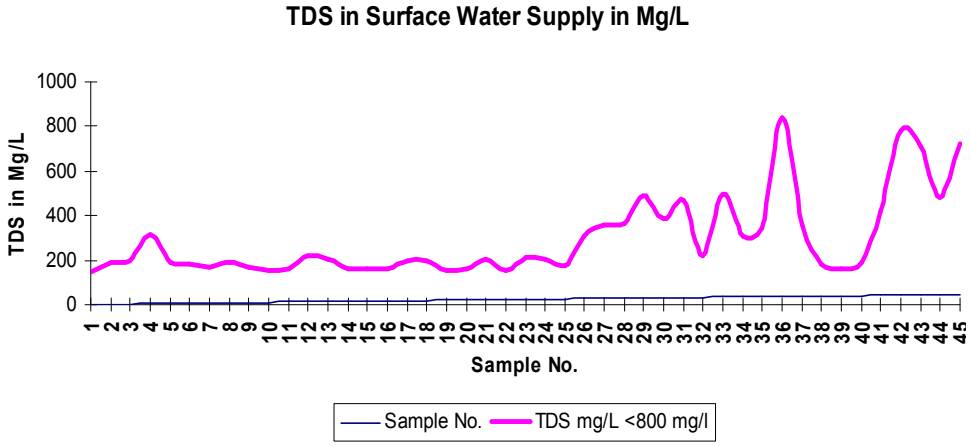


Figure 4. *TDS in Surface Water Supply.*

3.3. Bicarbonates and Hardness

The contents of bicarbonate and hardness fluctuated varied between within the range 56-1225 mg/L and 84-1695 mg/L respectively. A parallel behavior of bicarbonate with hardness was noted. Hardness of 25 samples was within the safe limits prescribed by WHO for drinking water and six samples indicated their hardness above 700 mg/L may be due to geological reasons. The water with elevated hardness than the WHO guidelines may cause gastric problems, dehydration, gas trouble, kidney stone and heart problems.10

3.4. Chloride and Sulfate

The concentration of chloride varied between within the range 32-1752 mg/L. Nearly half of the samples (35 samples) showed their chloride concentration above the regulations (250 mg/L) set by WHO. The chloride in water is present in combination with sodium, calcium and magnesium. Sources of chloride are mostly human waste, mineral rocks, irrigation discharge and industrial effluents like dying and bleaching materials. The water samples with higher concentration of chloride may have toxic effects to health.

The Sources of sulfate in surface and subsurface water are mainly calcium sulfate and sodium sulfate. The sulfates entering in water bodies come from dissolution of minerals containing sulfides and thiosulfates. Sulfate contributes to the permanent hardness to water. The elevated level of sulfate in water causes bad taste of water and also shows corrosive action (34). Sulfate was found between 25- 2170 mg/L. Some of the water samples (20 samples) indicated their sulfate contents above the limits of WHO. These samples were collected from Kazi Ahmed road of Nawabshah city. A parallel trend was found in the concentrations of chloride and sulfate in water samples (35).

The concentration of essential metal ions (Na, Ca, Mg and K) was varied between the ranges of 34-1725 mg/L, 26-515

mg/L, 13-430 mg/L and 2-92 mg/L respectively.

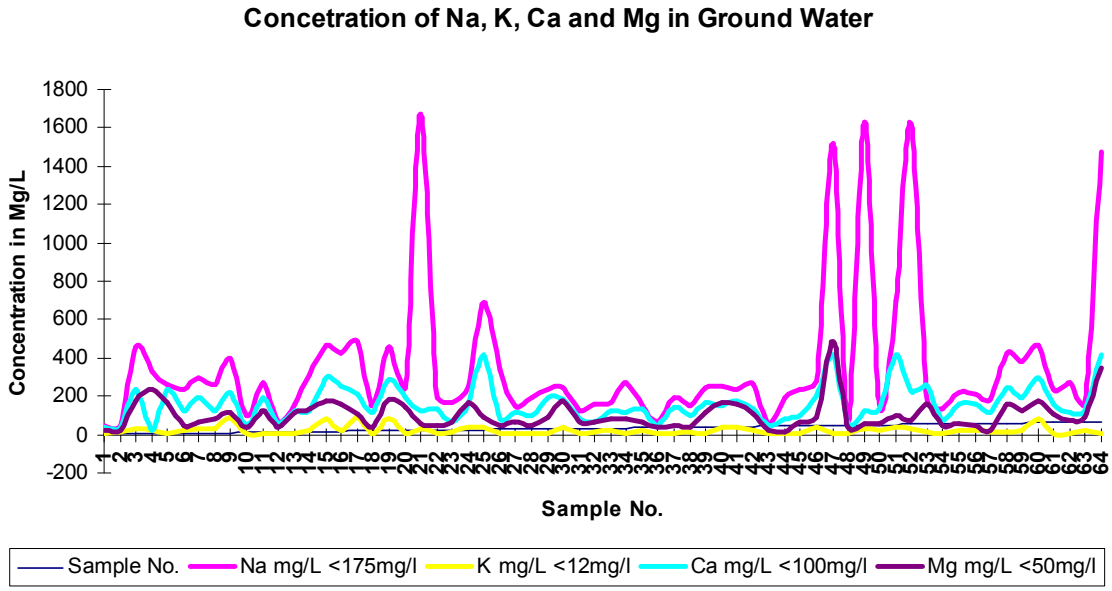


Figure 5. *Concentration of Na, K, Ca and Mg in Ground water.*

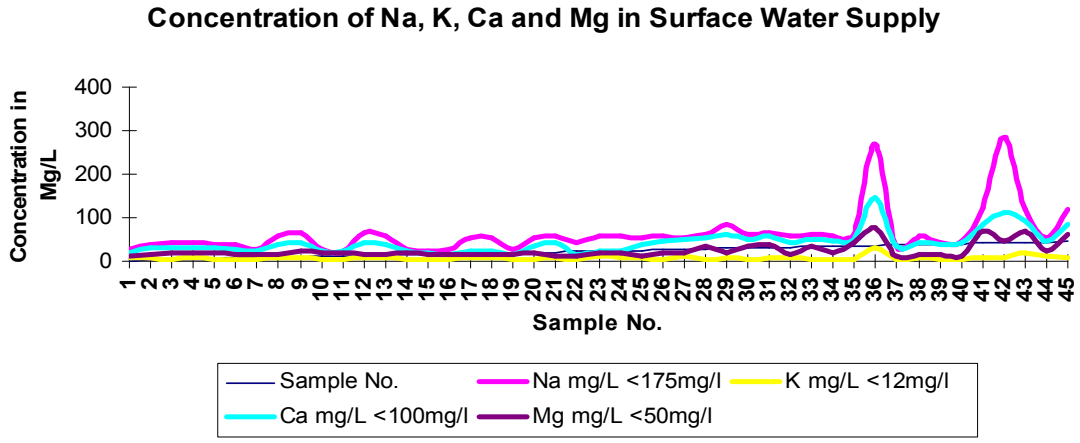


Figure 6. *Concentration of Na, K, Ca and Mg in Surface Water Supply.*

3.5. Chemistry of Metal Elements

The concentration of major metal ions Na, K, Ca, and Mg varied with high concentration of ground samples. The concentration of major metal ions follows following decreasing order:

$$Na > Ca > Mg > K$$

Sodium is present in all natural waters. The presence of sodium in water depends upon the anions present in that system and the temperature. The high concentration of sodium impart taste to the water and make it unfit for everyday use and leads to cardiovascular diseases and high blood pressure (36). Concentration of Na in water samples of the study area varied as 34-1725 mg/L. The Na ion concentration of the 25 samples was found with in the safe guidelines of 200 mg/L set by WHO for drinking water. All the rest of the samples indicated high values of Na ion concentration than WHO limits.

Potassium plays an important role in the metabolism process of animals and, it is an important micronutrient for living organisms (plants and animals). The WHO threshold of potassium for drinking water is 12 mg/L. The potassium concentration of the water samples studied was varied between 2-92 mg/L, including 40 samples with K ion concentration within the permissible limits.

Calcium and magnesium are abundant in rocks and soil, particularly lime stones and dolomites. They are relatively soluble and dissolve in surface water and then enter into ground water. There are no health concerns associated with calcium and magnesium, but the water containing these metals may contribute towards human dietary needs, however, their high concentration may cause scaling of pipes. The concentrations of Ca and Mg ions in the water samples of the area were found in the ranges of 26-515 mg/L and 13-430 mg/L respectively. Ca in 40 samples and Mg in 45 samples were found to be within the permissible limits of WHO. The rest of the water samples were observed very

hard with high concentrations of Ca and Mg.

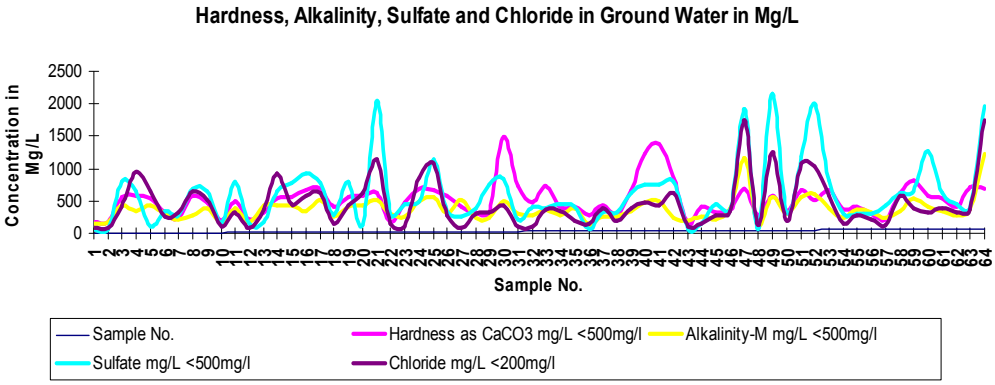


Figure 7. *Hardness, Alkalinity, Sulfate and Chloride in Ground Water in Mg/L.*

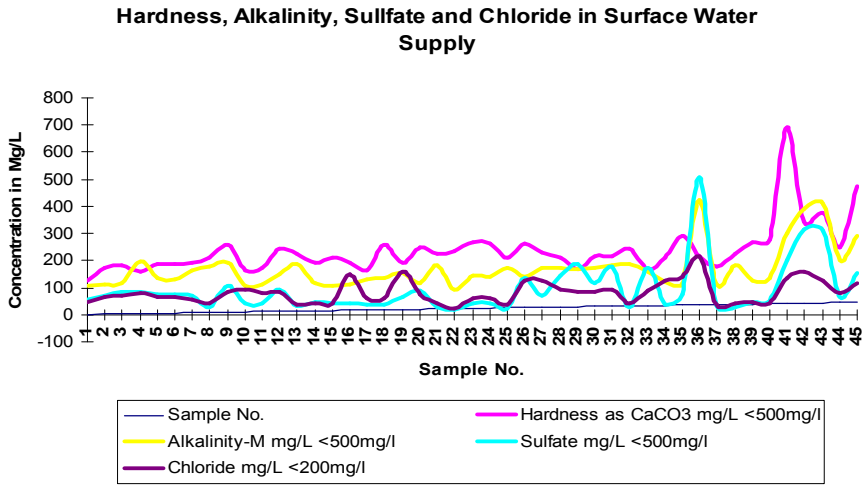


Figure 8. *Hardness, Alkalinity, Sulfate and Chloride in Surface Water Supply Mg/L.*

3.6. Sodium Adsorption Ratio (SAR)

Sodium adsorption ratio (SAR) was calculated to check the suitability of the waters to be used for irrigation purpose. The results revealed that determined 125 samples, only (60 surface water and 40 under groundwater) were suitable for irrigation with SAR value below 6 and remaining 25 samples were unsuitable for irrigation with SAR value above 6, all these 25 samples were under groundwater samples "Figure 9".

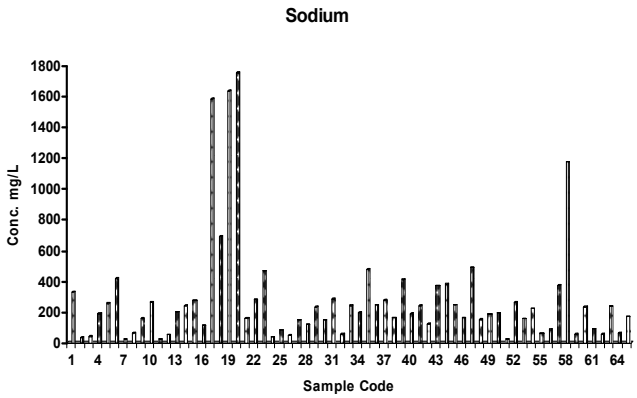


Figure 9. *Graphical representation of Na ion concentration of water samples.*

4. Conclusion

The analysis revealed that a number of ground water samples (70 %) showed their majority of parameters above the maximum permissible limits prescribed by WHO. Majority of the sites (all ground waters) were highly contaminated with toxic metals. The higher the concentrations of metals in ground water may be a concern for human health of Nawabshah city. Therefore the ground water of Nawabshah city may not be considered as safe to be used for dinking purpose. However, out of 60 water supply scheme samples, only 4 water samples may be used for drinking purpose and remaining all the water samples were contaminated.

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