ASSESSMENT OF GROUND WATER QUALITIES OF DIFFERENT REGIONS

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Abstract: Drinking Water Security has become a challenge for the country, specifically in rural areas. With ever growing population demand is bound to grow and in recent times climate change has aggravated the problem more. In this work, samples of water were collected from six different regions. Over the due course of time various parameters regarding the water quality were analysed& the Indian Standards: 10500 (Drinking water specifications) was referred to in order to check the acceptability of water. The parameters which were analysed are as follows: Alkalinity, pH, Total Dissolved Solids, Chloride Content and Hardness.

INTRODUCTION

GROUND WATER

Ground water is the water that seeps through rocks and soil and is stored below the ground. The rocks in which ground water is stored are called aquifers. Aquifers are typically made up of gravel, sand, sandstone or limestone. Water moves through these rocks because they have large connected spaces that make them permeable. The area where water fills the aquifer is called the saturated zone. The depth from the surface at which ground water is found is called the water table. The water table can be as shallow as a foot below the ground or it can be a few hundred meters deep[2].Heavy rains can cause the water table to rise and conversely, continuous extraction of ground water can cause the level to fall.The project was based on testing the quality of ground water. Six different samples were collected from 'Kangra in Himachal Pradesh, Aasan village near Panipat Thermal Plant, Israna, Ganaur, our institute PIET and Delhi'.

WATER QUALITY

Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water[1].Different properties were analysed& compared during the course of the project.

Some of the properties analysed are as follows –

- Total Dissolved Solids
- pH
- Alkalinity
- Hardness
- Chloride content

LITERATURE REVIEW

- In 1944, Bhore Committeewas appointed to look after hygiene and health in rural India; it recommended that the pure water supply should be provided to every inhabitant of the town or the village within a period of 35 years.
- In 1972-73 with the launch of Accelerated Rural Water Supply Programme (ARWSP). During the period 1972-1986, the major thrust of the ARWSP was to ensure provision of adequate drinking water supply to the rural community through the Public Health Engineering System.

- Started with the launching of Technology Mission in 1986-87, renamed in 1991-92 as Rajiv Gandhi National Drinking Water Mission. Stress on water quality, appropriate technology intervention, human resource development support and other related activities were introduced in the Rural Water Supply sector.

EXPERIMENTAL INVESTIGATION& METHODOLOGY

Alkalinity

Alkalinity is the capacity of water to resist changes in pH that would make the water more acidic. (It should not be confused with basicity which is an absolute measurement on the pH scale.) Alkalinity is the strength of a buffersolution composed of weak acids and their conjugate bases. It is measured by titrating the solution with a monoprotic acid such as H_2SO_4 until its pH changes abruptly, or it reaches a known endpoint where that happens. Alkalinity is expressed in units of mg/L which corresponds to the amount of monoprotic acid added as a titrant in millimoles per litre.

Experimental work

Apparatus:

- pH meter

Reagents for alkalinity H_2SO_4 (0.02N);

- Methyl Orange Indicator;
- Phenolphthalein Indicator)

Procedure:

- Collect 50 mL water sample in two conical flasks.
- Add 3 drops of phenolphthalein indicator, titrate the 50 mL sample with 0.02N sulfuric acid and estimate phenolphthalein alkalinity (phenolphthalein indicator will change color, from pink to clear).
- Use the same sample,add 1-2 drops of methylorange indicator.
- Titrate the 50 mL sample with 0.02N sulfuric acid and estimate total alkalinity (methyl orange indicator will change color, end point is orange).
- Amount of acid used at this starting is used to react with the hydroxide, carbonate, and bicarbonate and it constitutes of total alkalinity.

Formula used:-

Phenolphthalein Alkalinity = P x 1000 / ml of sample
(mg/l as $CaCO_3$)
Methyl orange Alkalinity = T x 1000 / ml of sample
(mg/l as $CaCO_3$)

Observation and calculations:-

S.no	Places	Vol. of sample used in ml	Burette Reading		Volume of H_2SO_4 used in ml	Alkalinity in mg/l
			Initial	Final		
1	Aasan	50ml	0 0 0	33.3 32.7 33.9	33.13	662.6
2	Israna	50 ml	0 24 48	24 48 72.5	24	480
3	Ganaur	50 ml	0 7.5 13.7	7.5 13.7 20.5	6.83	136.6

4	Delhi	50 ml	0 13 25.9	13 25.9 39.1	12.95	259
5	PIET	50 ml	0 13 26.4	13 26.4 39.2	13.06	261.2
6	Kangra(H.P.)	50 ml	0 16.2 31.5	16.2 31.7 37.6	16.85	317

Table 3.1

Observation graph:-

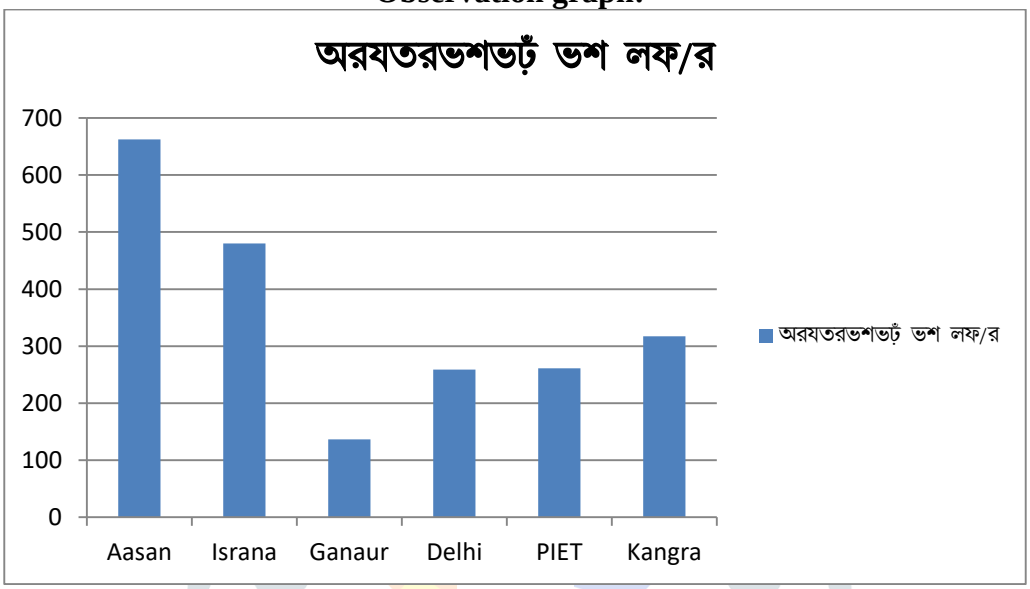

Fig.3.1.2

3.2Chloride content

Naturally, chlorides are found as salts such as sodium chloride (NaCl), potassium chloride (KCl), and calcium chloride (CaCl2). Chlorides are leached from different rocks into soil and water due to weathering. The chloride ion is generally mobile and is shifted to oceans or closed basins. It is found that chloride concentration in groundwater and drinking-water is consistently increasing, but there have been a few exceptions. Chloride levels in unpolluted waters are generally below 10 mg/litre and sometimes even below 1 mg/litre. Chloride in water may be significantly increased by treatment processes in which chlorine or chloride is used.

Experimental work

Chemicals Required:

- Potassium Chromate, Silver Nitrate

Apparatus Required:

- Conical flask, burette, pipette

Procedure:

- Take 100 ml sample in conical flask
- Determine the pH of sample if pHis not between 7 to 8 adjust it.
- Add two drops of potassium chromate indicator and titrate it with silver nitrate till color changes from yellow to brick red
- Record the ml of silver nitrate used
- Take 100 ml of distilled water and repeat the above procedure.
- Record the ml of silver nitrate used as blank.

Formula used:-

Chloride content (mg/l) = (A-B) x 1000 / ml of sample

Where

A -mlof $AgNO_3$ used with sample

B - mlof $AgNO_3$ used with distilled water

Observation & calculations:-

S.no	Sample	Volume of sample used in ml	Silver Nitrate Test		Volume used in ml	Chloride Content (mg/l)
			Initial Reading	Final Reading		
1	Aasan	100 ml (sample) 100 ml (distilled)	0 5.3	5.3 5.7	5.3 0.4	49
2	Israna	100 ml (sample) 100ml (distilled)	0 2.6	2.6 3.0	2.6 0.4	22
3	Ganaur	100 ml (sample) 100ml (distilled)	0 0.9	0.9 1.3	0.9 0.4	5
4	Delhi	100 ml (sample) 100 ml (distilled)	0 1.5	1.5 1.9	1.5 0.4	11
5	PIET	100 ml (sample) 100 ml (distilled)	0 0.5	0.5 0.9	0.5 0.4	1
6	Kangra (Himachal)	100 ml (sample) 100 ml (distilled)	0 1.2	1.2 1.6	1.2 0.4	8

Table 3.2

Observation graph:-

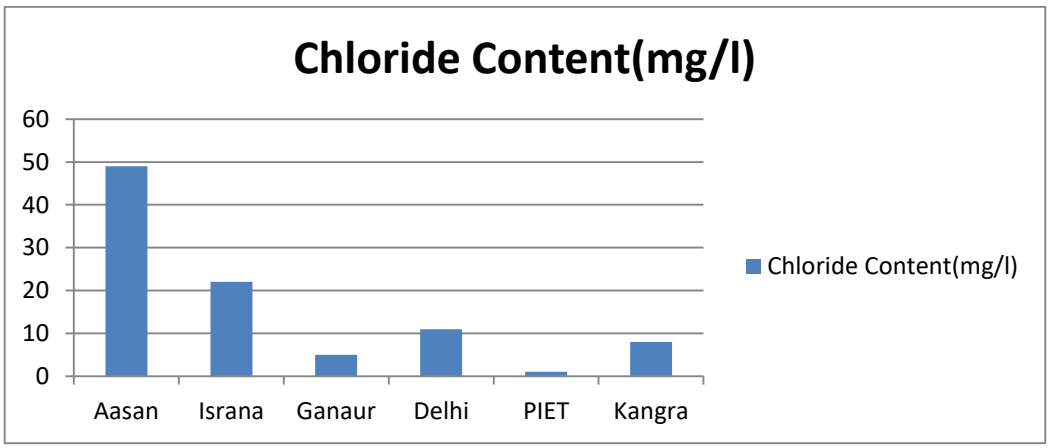

Fig.3.2.2

PH

PH is basically a measure of the acidity or basicity of an aqueous solution. Solutions having pH less equal to 7.Primary pH standard values are found out by using a concentration cell with transference, simply by measuring the potential difference between a standard electrode such as the silver chloride electrode & hydrogen electrode. Measurement of pH for aqueous solutions can be done with a pH meter or a glass electrode. We can also find the value of pH by using indicators.

pH measurements have significant importance in the field of biology, environmental science, chemistry, medicine, oceanography, food science, agriculture, nutrition ,civil engineering, chemical engineering, forestry, water treatment & water purification and many other applications.
Mathematically, it can be said that pH is the negative logarithm of the activity of the hydrogen ion.

Experimental work

Apparatus Required:

- pH meter ,beakers

Chemical used:

- pH 7 buffer solution, pH 4 buffer solution.

Procedure:

- All the samples are taken in the beaker one by one.
- The pH value is recorded for the entire sample using the pH meter.

Observation table:-

S.no	1	2	3	4	5	6
Places	Aasan	Israna	Ganaur	Delhi	PIET	Kangra (Himachal)
pH value	7.57	7.60	8.00	7.96	7.87	7.70

Table 3.3

Observation graph:-

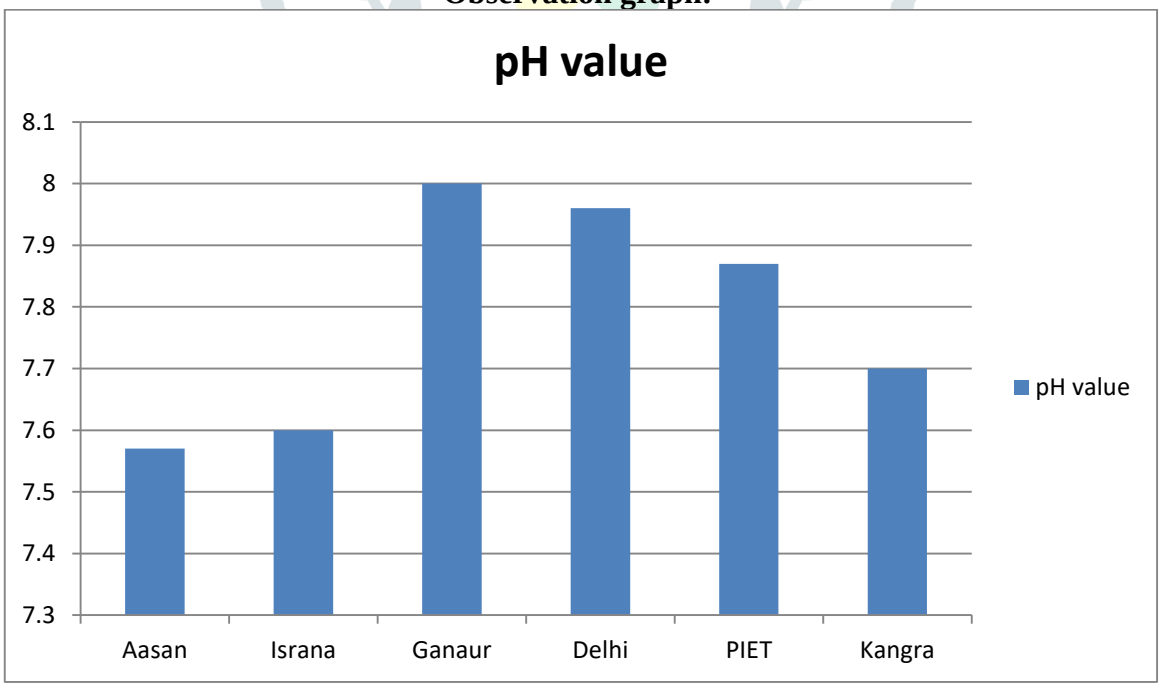

Fig.3.3.4

3.4 Total dissolved solids (TDS)

A measure of the combined content of all organic and inorganic substances contained in a liquid in molecular, ionized or micro-granular suspended form is called Total Dissolved Solids (TDS).

The solids should be small enough to survive filtration through a filter which has two micrometer pores. We generally discuss TDS for fresh water systems only , as salinity consists of some of the icons contributing in the definition of TDS, the Study of the water quality for streams,rivers and lakes is the most important application of TDS ,although TDS is not a primary pollutant ,TDS is used as indication of aesthetic characteristics of drinking water and as an indicator of the presence of a broad array of chemical contaminants[7].

Agricultural and residential runoff are primary sources of TDS in receiving waters ,and so are leaching of soil contamination and point source water pollution discharge from industrial plants.

Calcium, phosphates,nitrates, sodium,potassium, sulphates, and chloride comprise few of the important chemical constituent.

Experimental work

Apparatus:

- TDS meter

Procedure

- Take water sample in meter container
- Put TDS meter in that container.
- Note down the reading shown on the screen.

Fig.3.4.1

S.no	1	2	3	4	5	6
Places	Aasan	Israna	Ganaur	Delhi	PIET	Kangra(Himachal)
TDS value	227	307	134	488	275	350

Observation table:-

Table 3.4

Observation graph:-

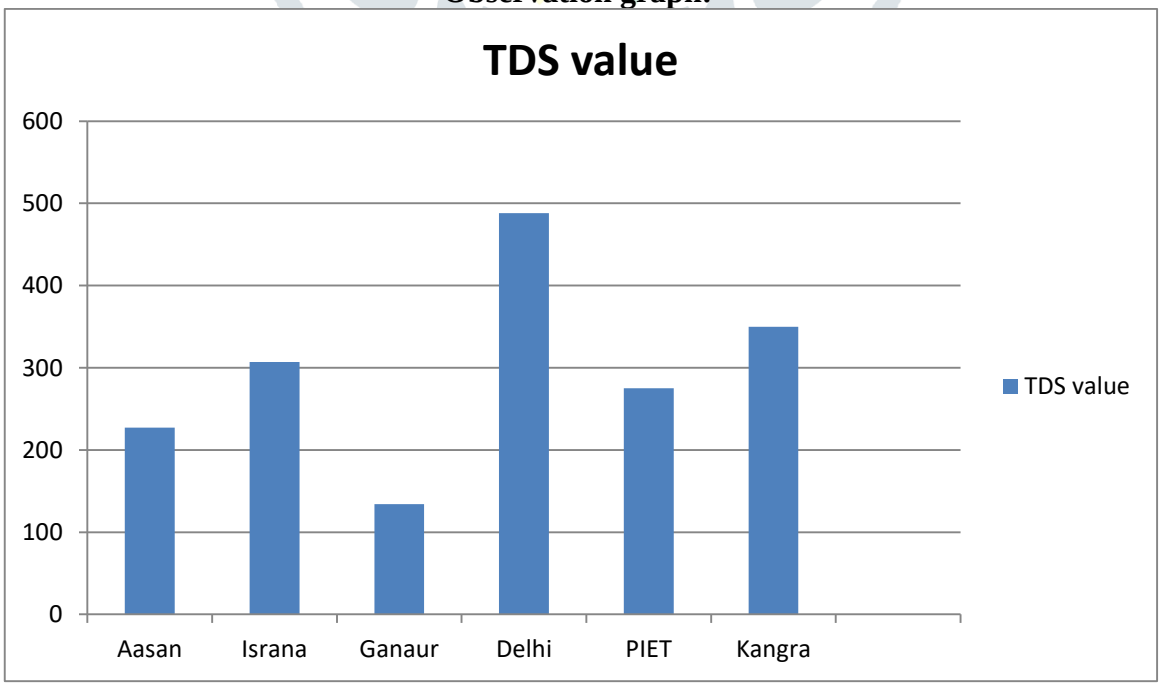

Fig.3.4.2

3.5 Hardness

Apparatus required:

- Beaker, pipette, burette, conical flask

Reagents :

- Eriochrome Black T indicator , EDTA solution , Ammonia buffer

Procedure:-

- Take 20ml of sample in conical flask
- Add 5ml buffer solution and 2 drops of Eriochrome Black T indicator
- Now titrate it against EDTA solution till color changes from wine red to blue. Record the ml of EDTA used.
- Take 20 ml of boiled sample.
- Repeat the above procedure and record ml of EDTA used[8].

Fig.3.5.1

Formula used:-

Total Hardness (mg/l) as $CaCO_3$ = (ml of EDTA used x 1000)/ ml of sample

Permanent Hardness (mg/l) as $CaCO_3$ = (ml of EDTA used x 1000)/ ml of sample

Temporary Hardness (mg/l) as $CaCO_3$ = Total – Permanent

Observations and calculations for total hardness:-

S.no	Places	Vol. of sample used in ml	Burette Reading		Volume of EDTA used in ml	Total hardness (mg/l)
			Initial	Final		
1	Aasan	20ml	0 14 30	14 30 48	16	800
2	Israna	20 ml	0 11 21	11 21 22.1	10.7	535
3	Ganaur	20 ml	0 7.6 16	7.6 16 24	8.0	400
4	Delhi	20 ml	0 12 22	12 22 35.1	11.7	585
5	PIET	20 ml	0 3 7	3 7 11.1	3.7	185
6	Kangra(H.P.)	20 ml	0 8 16.3	8 16.3 24.9	8.73	436.5

Table 3.5.1

Observation and calculations for permanent hardness:-

S.no	Places	Vol. of sample used in ml	Burette Reading		Volume of EDTA used in ml	Permanent hardness (mg/l)
			Initial	Final		
1	Aasan	20ml	0	14.8	14.8	740
2	Israna	20 ml	0	8.73	8.73	436.5
3	Ganaur	20 ml	0	5.46	5.46	273
4	Delhi	20 ml	0	10.56	10.56	528
5	PIET	20 ml	0	3.1	3.1	155
6	Kangra(H.P.)	20 ml	0	8.3	8.3	415

Table 3.5.2

S.no	1	2	3	4	5	6
Places	Aasan	Israna	Ganaur	Delhi	PIET	Kangra(Himachal)
Temporary hardness (mg/l)	60	98.5	127	57	30	21.5

Table 3.5.3

Observation graph:-

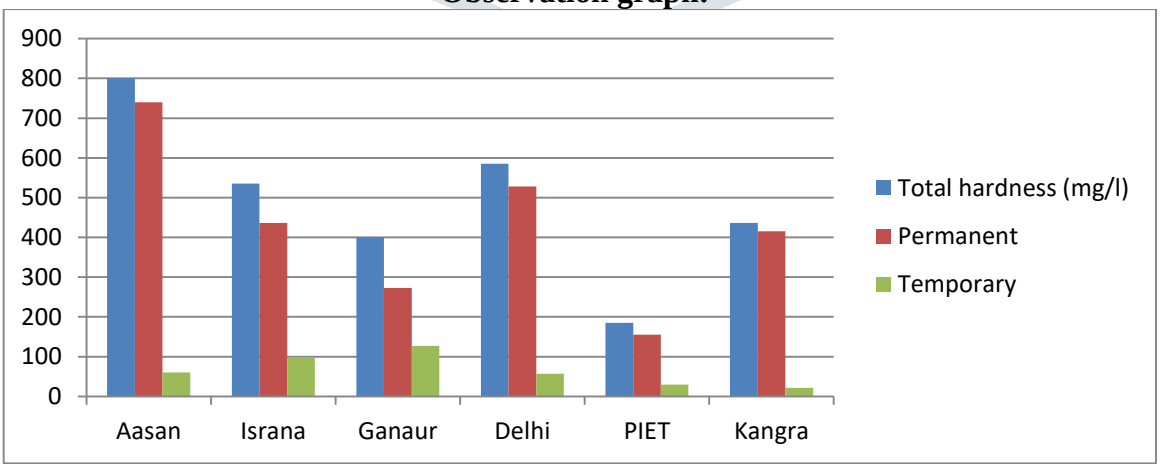

Fig.3.5.2

ANALYSIS OF RESULT AND DISCUSSION

Groundwater quality variation

The results obtained were evaluated in accordance with the standards prescribed by Bureau of Indian Standards under Indian standard drinking water specification IS: 10500:2012

1. **pH**
   The pH of a solution is the negative logarithm of Hydrogen ion concentration in moles per liter. pH values ranged from 6.5 to 8.5[10].

S.no	Places	pH Value	Acceptable limit	Permissible limit
1	Aasan	7.57	6.5-8.5	No relaxation
2	Israna	7.60	6.5-8.5	No relaxation
3	Ganaur	8.0	6.5-8.5	No relaxation
4	Delhi	7.96	6.5-8.5	No relaxation
5	PIET	7.87	6.5-8.5	No relaxation
6	Kangra	7.70	6.5-8.5	No relaxation

Table 4.1

2. **Total Dissolved Solids (TDS)**
   TDS is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants. The TDS values in the present study vary from 200 to 500 mg/l[10].Water with high TDS are of inferior palatability and may induce an unfavorable physiological reaction in the transient consumers and gastrointestinal irritation. Naturally occurring total dissolved solids arise from the weathering and dissolution of rocks and soils.

S.no	Places	TDS(mg/l)	Acceptable limit(mg/l)	Permissible limit(mg/l)
1	Aasan	227	500	2000
2	Israna	307	500	2000
3	Ganaur	134	500	2000
4	Delhi	488	500	2000
5	PIET	275	500	2000
6	Kangra	350	500	2000

Table 4.2

3. **Chloride content**
   In the present study, chlorides content of underground water varied from 1 to 50 mg/l. Chloride concentrations vary widely in natural water and it directly related to mineral content of the water. At concentration above 250 mg/l, water acquires salty taste which is objectionable[10].

S.no	Places	Chloride content (mg/l)	Acceptable limit(mg/l)	Permissible limit(mg/l)
1	Aasan	49	250	1000
2	Israna	22	250	1000
3	Ganaur	5	250	1000
4	Delhi	11	250	1000
5	PIET	1	250	1000
6	Kangra	8	250	1000

Table 4.3

4. **Alkalinity**

The alkalinity varies from 250 to 670 mg/l. Water with high alkalinity is said to be "hard." The most prevalent mineral compound causing alkalinity is calcium carbonate, which can come from rocks such as limestone or can be leached from dolomite and calcite in the soil. Large amount of alkalinity imparts a bitter taste to water.

S.no	Places	Alkalinity(mg/l)	Acceptable limit(mg/l)	Permissible limit(mg/l)
1	Aasan	662.6	200	600
2	Israna	480	200	600
3	Ganaur	136.6	200	600
4	Delhi	259	200	600
5	PIET	261.2	200	600
6	Kangra	317	200	600

Table 4.4

5. **Hardness**

Total hardness is a measure of the capacity of water to the concentration of calcium and magnesium in water and is usually expressed as the equivalent of CaCo3concentration[8]. In the present study, the total hardness of the water samples ranges between 212 and 598 mg/l .The standard limit (200 mg/l) prescribed by BIS[10]. Hard water is useful in the growth of children, if within the permissible limit.

S.no	Places	Hardness (mg/l)	Acceptable limit(mg/l)	Permissible limit(mg/l)
1	Aasan	800	200	600
2	Israna	535	200	600
3	Ganaur	400	200	600

4	Delhi	585	200	600
5	PIET	185	200	600
6	Kangra	436.5	200	600

Table 4.5

Final observation table:-

S.no	Places	Hardness (mg/l)	Chloride content (mg/l)	Alkalinity (mg/l)	pH	TDS
1	Aasan	800	49	662.6	7.57	227
2	Israna	535	22	480	7.60	307
3	Ganaur	400	5	136.6	8.0	134
4	Delhi	585	11	259	7.96	488
5	PIET	185	1	261.2	7.87	275
6	Kangra	436.5	8	317	7.70	350

Table 4.6

Final observation graph:-

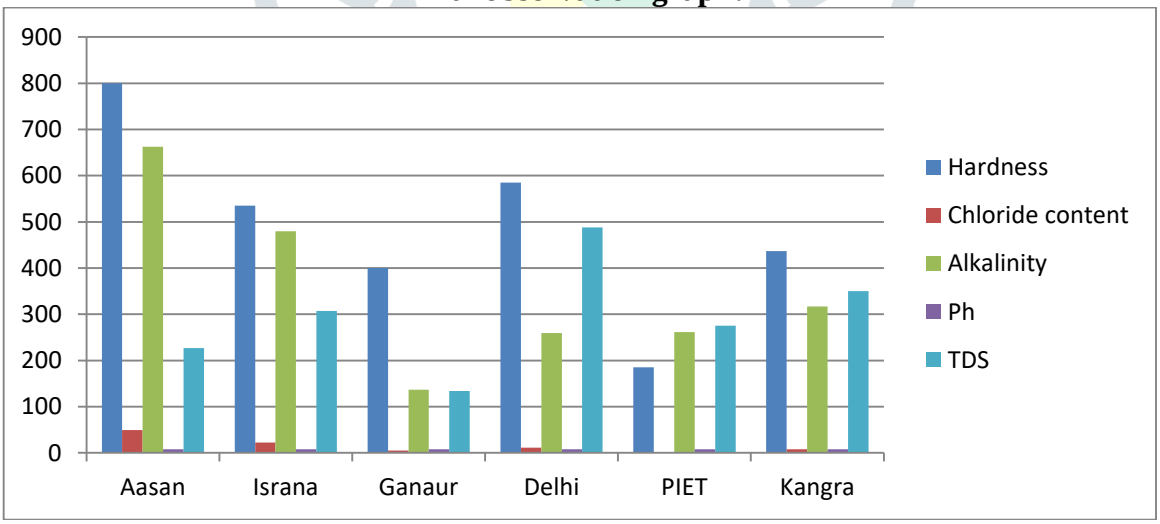

Fig.4.1

CONCLUSION

The present study of underground water samples reveals that about 50% of the area under study comes under moderately polluted category and there is marked variation in groundwater quality. Water sample taken from Aasan village near Panipat Thermal Power Plant was much polluted then other samples and sample from Delhi is not fit for domestic uses. TDS value of Delhi sample is very poor and very near to acceptable limit as compared to other samples. Samples from Gaunar and PIET are much fit for domestic use and does not require any treatment before use. The analytical results shows higher concentration of Alkalinity, hardness, pH, chloride and TDS which indicates signs of water quality deterioration as per BIS standards. The study emphasizes the urgent need for regular underground water quality monitoring to assess pollution activity from time to time for taking appropriate measures in time to mitigate the intensity of pollution activity. Augmenting the groundwater resources by recharging the ground water aquifers through rain water harvesting and thus reducing the high concentration of the chemical parameters is a very important measure. Public awareness program should be initiated to create a sense of awareness to save water around their habitants.

References

[1] c Ah, Kmnmrx SWEETWATER. "Ground-Water Quality." *Ground-water* 2 (1995): 2B.

[2] Mackay, Douglas M., and John A. Cherry. "Groundwater contamination: Pump-and-treat remediation." *Environmental Science & Technology* 23.6 (1989): 630-636.

[3] Kumar, Rakesh, R. D. Singh, and K. D. Sharma. "Water resources of India." *Current science* (2005): 794-811.

[4] Spalding, R. F., &Exner, M. E. (1993). Occurrence of nitrate in groundwater—a review. *Journal of environmental quality*, *22*(3), 392-402.

[5] Anderson, G. K., and G. Yang. "Determination of bicarbonate and total volatile acid concentration in anaerobic digesters using a simple titration." *Water Environment Research* 64.1 (1992): 53-59.