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ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 08, Issue, 09, pp.5803-5811, September, 2017

RESEARCH ARTICLE

ASSESSMENT OF GROUND WATER QUALITY IN ANANTNAG DISTRICT OF KASHMIR VALLEY (J&K)

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ARTICLE INFO

Article History:
Received 06th June, 2017
Received in revised form
29th July, 2017
Accepted 04th August, 2017
Published online 27th September, 2017

Key words:

District Anantnag, SAR,
Percent sodium,
Physico- chemical analysis,
Kashmir, Fluorosis.

ABSTRACT

The present research investigation has been carried out to assess the ground waterquality of district Anantnag of Kashmir (J and K) India for drinking and irrigational purposes. A total of twelve sampling sites (three sites from each tehsil) in the study area were selected for water quality analysis. The sampling sites were named as Janglaatmandi, Sopat, Dialgam, Shakerpora, Larkipora, Shahabad, Zalangam, Hillar, Damhal, Nowgam, Sundu and Gopalpora.For assessing water quality in the study area, 12 parameters namely, pH, electrical conductivity, total hardness, alkalinity, calcium, magnesium, sodium, potassium, chloride, nitrate and fluorides were considered. SAR values showed a range of 0.52 to11.69 meq/L. The maximum concentration of SAR11.69 meq /L was recorded at Damhal site and minimum concentration of 0.52 meq /L was recorded at Dialgam site. The calculated values of SAR integrated with the Electrical Conductivity indicated that the ground water in the study area can be utilised for irrigation purpose without any threat of imposition of any hazard (saline or alkaline hazard) to crop soils. Thus, the analytical data from the study area confirms that ground water present in the study area is suitable for domestic and irrigational purposes excluding a few locations.

INTRODUCTION

The valley of Kashmir has been bestowed with ample fresh water resources in the form of glaciers, lakes, springs, rivers/streams and groundwater. These water resources are used for irrigation, hydropower generation and recreational purposes. Glaciers cover an area of about 4000 square kilometres in J and K (Cogley, 2009). Springs in J and K are mostly concentrated in District Anantnag, South Eastern Kashmir, along the foothills of Pir-Panjal range (Jeelani, 2005). Most of the major springs are karst springs and controlled by limestone lithology (Jeelani, 2007). Some of the important springs are *Andernag, Verinag, Kokernag, Achabalnag, Kounsarnag, Martandnag, Cheshmashahinag, Khir-Bhawaninag* etc. The Kashmir region has also a number of thermal springs (Jeelani, 2004), possessed with chemical affinity containing iron and sulphurated hydrogen include Malaknag at Anantnag town, Gandaknag at Sadarkotbala etc.

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River Jhelum is the principle river of the valley, originates from the glaciers of Western Himalayas and numerous springs of District Anantnag (Mehmood *et al.,* 2017). Groundwater potential of the valley as estimated by the Central Groundwater Board is 2400 million cubic meters per year and the current exploitation is only 2.4 million cubic meters per year. Thus, the irrigational and domestic water supply can be met by developing the groundwater resources of the valley. The importance of ground water for the existence of human society cannot be overemphasized. Ground water is the major source of drinking water in both urban and rural areas. It is the major source of drinking water in India. Even in advanced countries such as Germany and Netherlands about 70% of drinking water comes from ground water (Duynisveld *et al.,* 1988).Kashmir valley has rich deposits of ground water in both confined and unconfined aquifer system, but its occurrence is highly uneven due to diverse geological formations (Singh and Sharma. 1999). Although groundwater development in Kashmir valley is at its early stage, but its demand is expected to increase over in future due to population pressure and urban sprawl. Ground water crisis is not the result of natural factors, but it has been caused by human actions. During the past two decades, the water level has been falling rapidly due to an increase in extraction and dry weather conditions especially during autumn, giving rise to drought like situation. This has decreased not only the level of surface waters but also reduced the discharge from many perennial springs (Bhat *et al.,* 2010) and in some areas springs and wells have even dried completely. Despite its vastness and significance, in Kashmir, the information available about ground water resources is scanty. The notable ones being (Jeelani, 2004; Panditet *al.,* 2005). In view of the widespread and large-tapping of groundwater along in south Kashmir and dearth of literature on ground water quality of Kashmir, it was decided to assess the physico-chemical characteristics of ground water of Anatnag district to obtain first-hand information about its usefulness and suitability for drinking, irrigation and other domestic purposes.

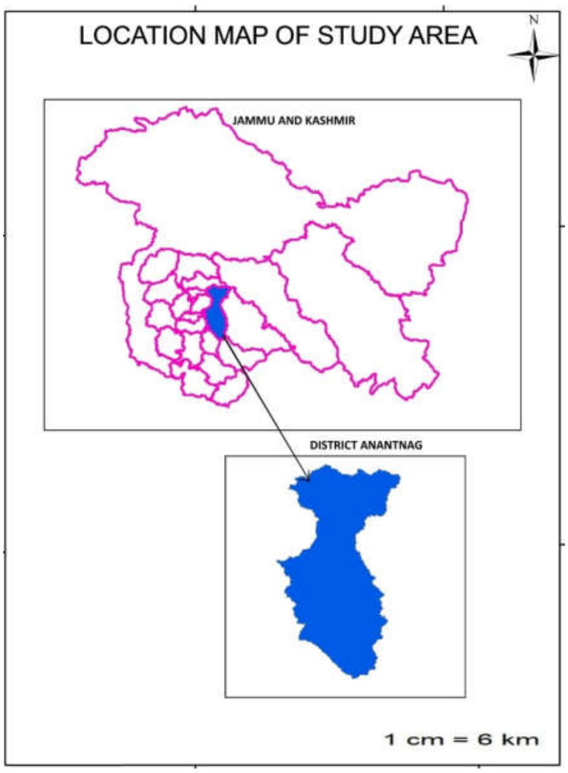
Study area description

Anantnag district is southern-most district of Kashmir province separated from the Jammu Province by the mighty Pir- Panjal Range and connects both the regions by the famous Jawahar Tunnel.

The district with its headquarters at Anantnag forms the southern part of Kashmir valley and is located between 33017’20” and 34015’30” North latitude and between 74030’15’’ and 740 35’00’’ East longitude and is covered by Survey of India Degree sheet no. 43. The district has a total geographical area of 3,984 sq km, comprising of 605 villages (605 inhabited). Administratively, the district is divided into 04 tehsils (Anantnag, Kokernag,Shangus and Dooru) and 12 blocks (Achable, Breng, Dachnipora, D. H. Pora, Khovripora, Qazigund, Qaimoh, Shahabad, Shangus, Devsar and Pahloo). Hydro-geologically, the district is divided into two distinct and well-defined aquifer systems, viz., hard rock or fissured aquifer constituted mainly by semi-consolidated to consolidated rock units and soft sedimentary or porous aquifer constituted mainly by unconsolidated sediments. The unconsolidated sediments comprising of fluvio-glacial and lacustrine deposits of Karewas and recent alluvium, terrace deposits and alluvial fan deposits constitute the porous aquifer system of the district. The sediments consist of sand, gravel, cobbles, pebbles, boulders interlayered with thick clay beds forms the prolific aquifer system. The depth of the tube wells ranges from 19.50 m at Khannabal to 300.29 m at Vessu.

Table 1. Details of sampling sites

S.No	Tehsil	Sites	Latitude	Longitude	Altitude (m)	Depthof GW table(ft)	Usage
1	Anantnag	Janglat	33º.43`N	75º.9`E	5254	23	Domestic/ Irrigation
		Sopat	33º.35`N	75º.10`E	5714	29	Domestic
		Dialgam	33º.40`N	75º.10`E	5382	35	Irrigation
2	Dooru	Shankerpora	33º.33`N	75º.13`E	5921	32	Domestic
		Larkipora	33º.38`N	75º.10`E	5515	37	Domestic/ Irrigation
		Shahabad	33º.34`N	75º.13`E	5975	44	Domestic/ Irrigation
3	Kokernag	Zalangam	33º.34`N	75º.18`E	6669	55	Domestic
		Hillar	33º.38`N	75º.14`E	6407	51	Irrigation
		Damhal	33º.33`N	75º.21`E	6036	46	Domestic/ Irrigation
4	Shangus	Nowgam	33º.42`N	75º.17`E	5670	24	Domestic
		Sundu	33º.40`N	75º.13`E	5495	15	Irrigation
		Gopalpora	33º.43`N	75º.12`E	5580	25	Domestic/ Irrigation



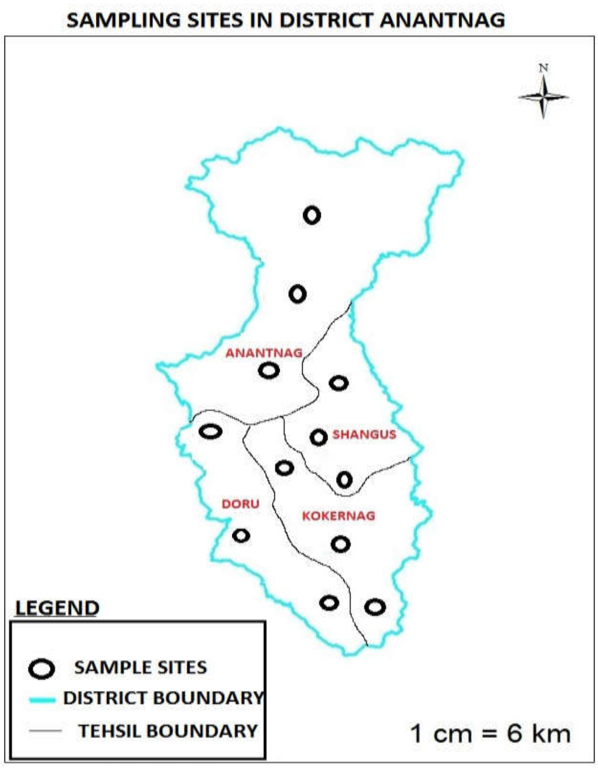


Fig. 1. Study Area with sampling sites

The water table occurs under artesian conditions at some areas. The yield of the tube wells ranges from 150 Litres per minute (lpm) at Marhamma to 1928 lpm at Ladarmal. The depth to water level ranges from 2.50 m agl (artesian free flowing) at Charsoo to 6.48 m Khannabal. (CGWB, 2011).The area under study lies within the coordinates of $33^0$17'20" and $34^0$15'30" North latitude and between $74^0$30'15'' and $74^0$35'00'' East longitude).

In order to depict the quality of ground waters of the study area, following four Tehsils of district Anantnag were chosen:

- Anantnag
- Dooru
- Kokernag
- Shangus

MATERIALS AND METHODS

The present investigation on the ground water of district Anantnag was conducted from March to June 2014.Sampling was done once a month. Representative groundwater samples were collected from 12 sampling sites. The water samples were collected in clean two liter polythene bottles, which were first cleaned by rinsing with distilled water. Prior to sample collection, bore wells were flushed for about 5-10 minutes to obtain the representative groundwater samples. The physico-chemical analysis was carried out as per the standard methods (APHA, 2005). While temperature wasanalyzed on spot, other parameters were analyzed within 24 hrs of sampling following the standard methods.

RESULTS

The quality of ground water as determined by its chemical constituents is of great importance in determining the suitability of a particular ground water for a certain use. The physico-chemical characters of ground water play a significant role in assessing water quality. The results of physico-Chemical parameters of ground water samples are given as Water temperature remained low throughout the study period at all sites of ground water. The temperature of ground water fluctuated from a minimum of 13.40C at Sopat site in the month of March to a maximum of 20.50C at Hillar site in June. The average value ranged from 14.40C±0.7 at Sopat site to 20.10C ±0.4 at Hillar site (Fig. 2). In the four-month study period, all the sites depicted neutral to alkaline pH with values very close to 7, except at Hillar site 6.4 and 6.5, in the month of May and march respectively. During investigations highest pH 8.2 was recorded at Larkipora site in the month of March and lowest value 6.4 at Hillar site in the month of May. The average value ranged from 6.7±0.5 at Hiller site to 7.7 ±0.5 at Dialgam site (Fig. 3). The lowest conductance value 430µS/cm was recorded at JanglaatMandi site in the month of April and highest value of 1150 µS/cm was recorded at Shahabad site in the month of June. The average value ranged from 455 µS/cm ±67.8 at JanglaatMandisite to 957.5 µS/cm ±199.0 at Shahabad site (Fig. 4).

During the present study, the alkalinity of ground water samples was due to the bicarbonates. The alkalinity has been found in the range of 42 to 140 mg/L, with lowest value of 42 mg/L at Dialgam site in the month of March and highest value of 140 mg/L at Shahabad site in the month of May. The average value ranged from 44.5mg/L ±32 at Dialgam site to 104.2 mg/L ±28.3 at Sopat site (Fig. 5).

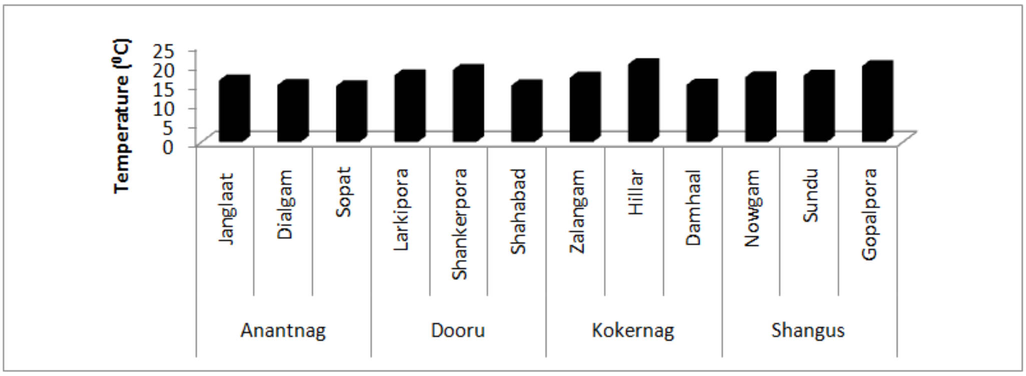


Fig.2. Average water Temperature (^{0}C) at different sampling

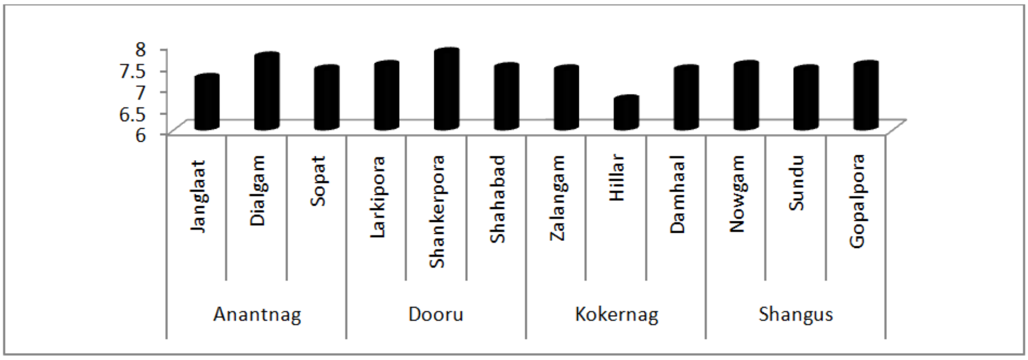


Fig. 3. Average variation in pH at different sampling sites

It is a measure of variable complex mixtures of anions and cations. In fresh water, the principle cations that impart hardness are Ca and Mg.

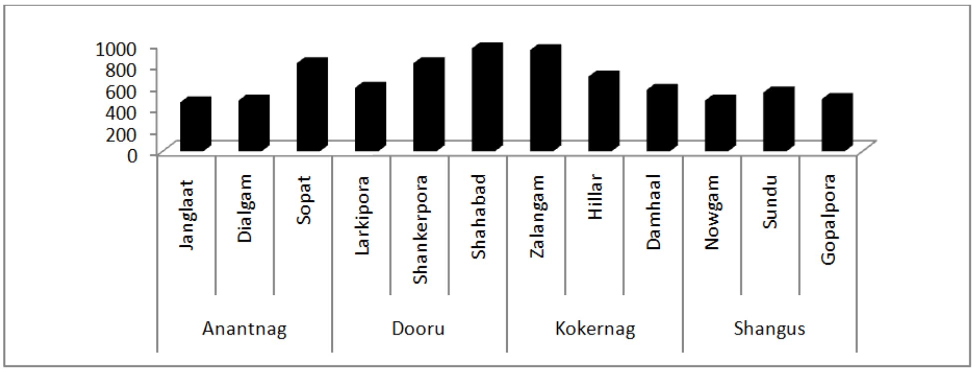


Fig. 4. Average variation in Conductivity (µS/cm) at different sampling sites

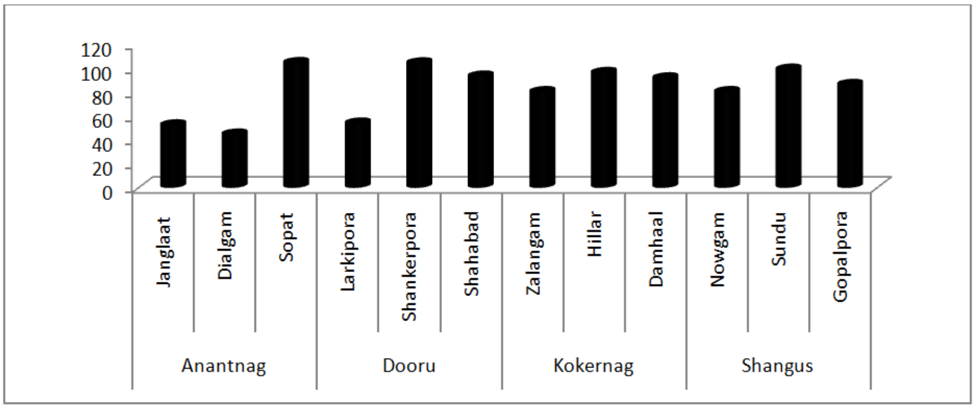


Fig. 5. Average variation in Alkalinity (mg/L) at different sampling sites

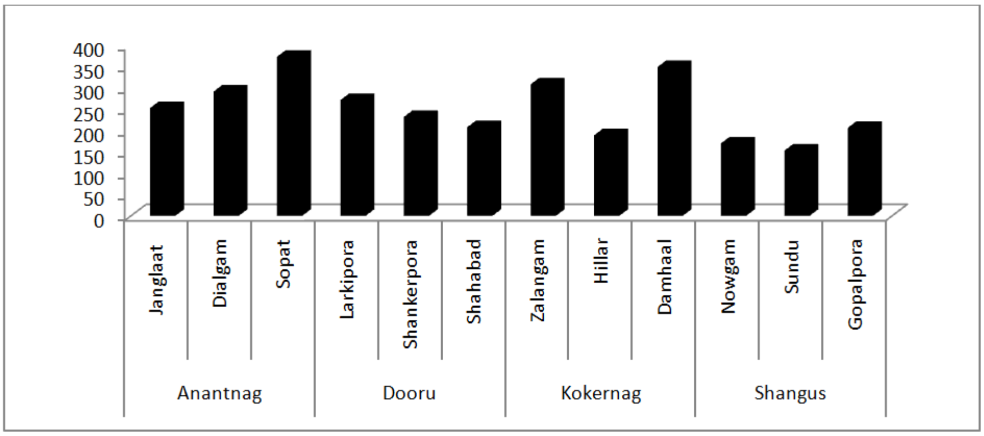


Fig. 6. Average variation in Total Hardness (mg/L) at different sampling sites

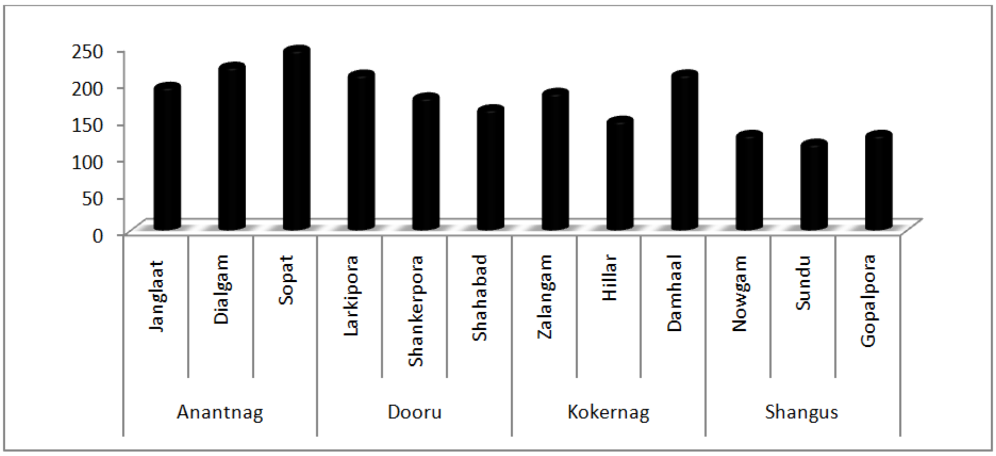


Fig. 7. Average variation in Ca (mg/L) at different sampling sites

The total hardness of the ground water samples varied from 144 to 380 mg/L. The maximum value of 380 mg/L was recorded at Sopat site in the month of June and minimum value of 144 mg/L at Sundu site in the month of May. The minimum average value ranged from 152.5 mg/L ±5.9 at Sundu site to a maximum value of 372.5 mg/L ±5.7 at Sopat site (Fig. 6). One of the most pronounced minerals, the concentration of which was observed to vary from 115.2 to 247.2 mg/L. The maximum concentration of 247.2 mg/L was recorded at Sopat site in the month of June and minimum concentration of 115.2 mg/L was recorded at Sundu site in the month of June. The minimum average value ranged from 117.6/L ±1.5 at Sundu site to 245 mg/L ±2.1 at Sopat site (Fig. 7).

The concentration of magnesium was observed to vary from 5.34 to 35.28 mg/L. The maximum concentration of 35.28 mg/L was recorded at Damhaal site in the month of May and minimum concentration of 5.34 mg/L was recorded at Nowgam site in the month of March. The average value ranged from 8.5 mg/L ±1.7 at Sundu site to 31 mg/L ±1.1 at Sopat site (Fig 8). Sodium is important for both domestic and agricultural and domestic use of water. In the present study, the concentration of Na varies from 2 to 53mg/L. The maximum concentration of 53 mg/L was recorded at Damhal site in the month of May and minimum concentration of 2.0 mg/L was recorded at Dialgam site in the month of March, April and June. The average value ranged from 2.5mg/L ±17.8 at Dialgam site to 35.25 mg/L ±6.1 at Sopat site (Fig. 9). The nitrite-nitrogen of ground water samples ranged from 14 to 146 µg/L. The minimum value 14 µg/L was found in the month of March at Zalangam site and the maximum value 146µg/L was reported in June at Zalangam site. The average value ranged from 15.75 µg/L ±47.8 at Larkipora site to 104.25µg/L ±24.9 at Shankerpora site (Fig. 10). The Orthophosphate-Phosphorus of ground water samples ranged from 11 to 146µg/L. The maximum concentration of Orthophosphate-Phosphorus 146 µg/L was recorded at Zalangam site in the month of June and minimum

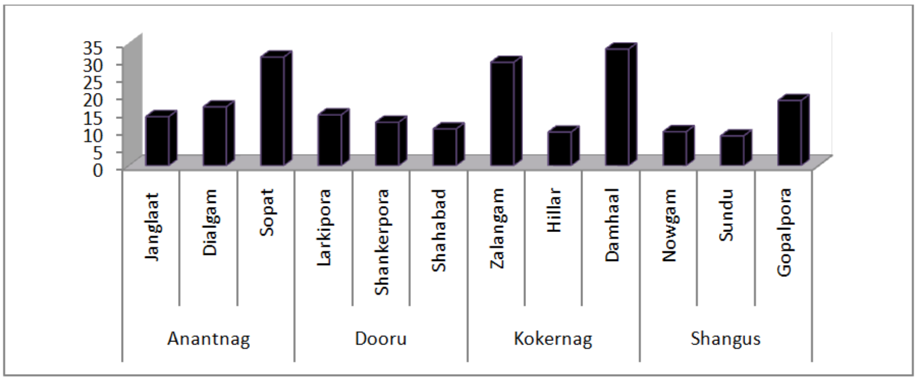


Fig. 8. Average variation in Mg (mg/L) at different sampling sites

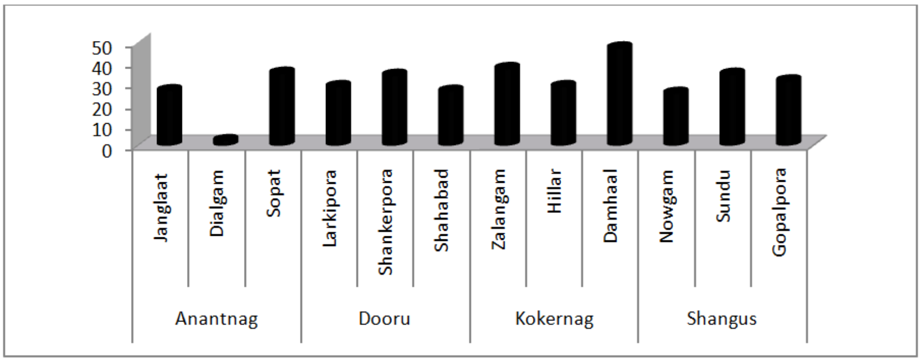


Fig. 9. Average variation in Na (mg/L) at different sampling sites

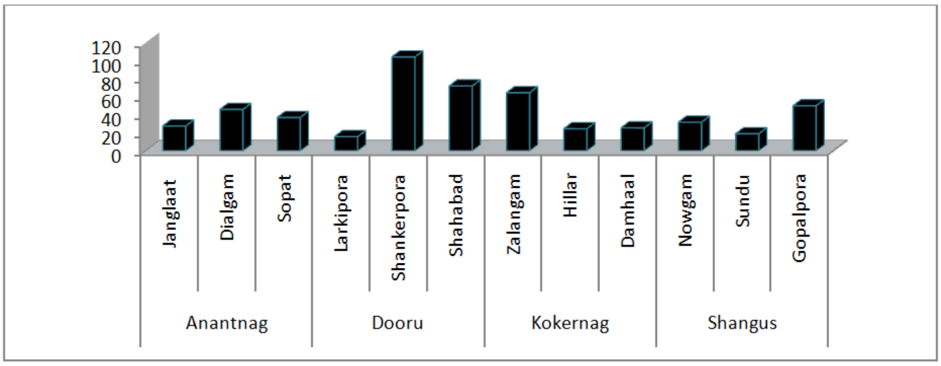


Fig. 10. Average variation in Nitrate-N (µg/L) at different sampling sites

concentration of 11 µg/L was recorded at Larkipora site in the month of June. The average value ranged from 104.25 µg/L ±24.9 at Shankerpora site to 15.75µg/L ±47 at Larkipora site (Fig. 11).

The Fluoride concentration of ground water samples ranged from 0.1 to 1.9mg/L. The maximum concentration of Fluoride 1.9 µg/L was recorded at Sopat site in the month of June and

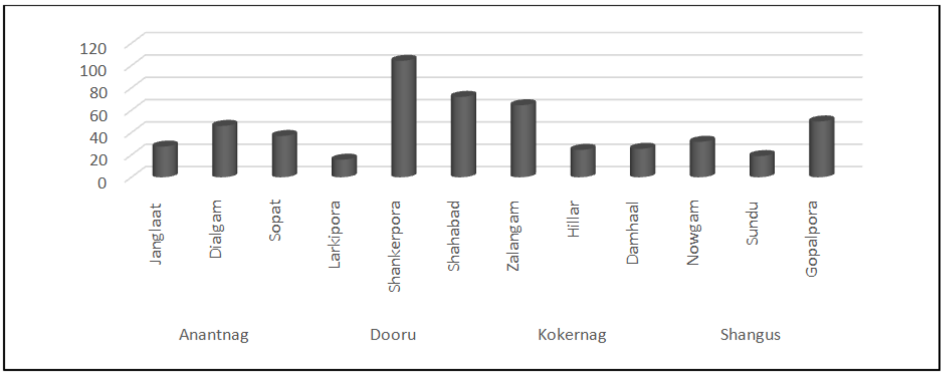


Fig. 11. Average variation in Ortho-Phosphate (µg/L) at different sampling sites

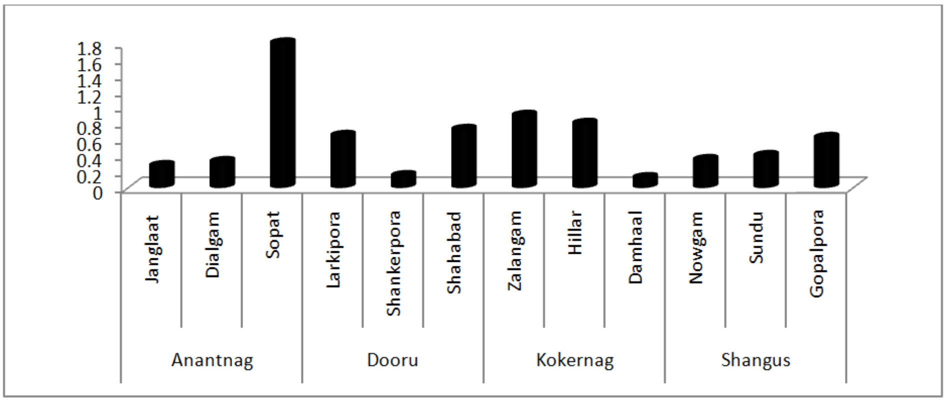


Fig. 12. Average variation in Fluoride (mg/L) at different sampling sites

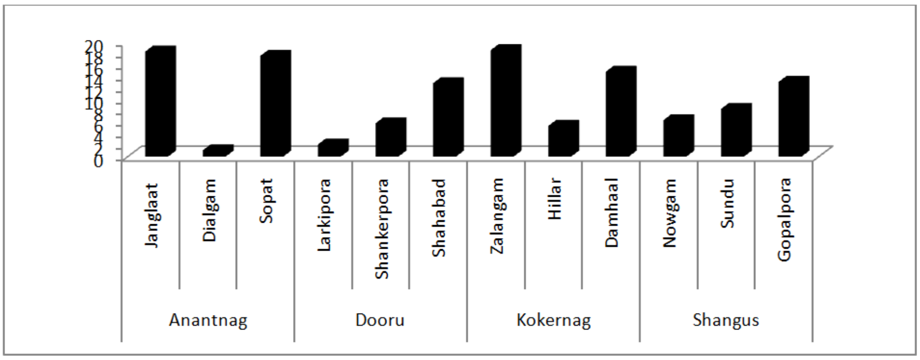


Fig. 13. Average variation in Potassium (mg/L) at different sampling sites

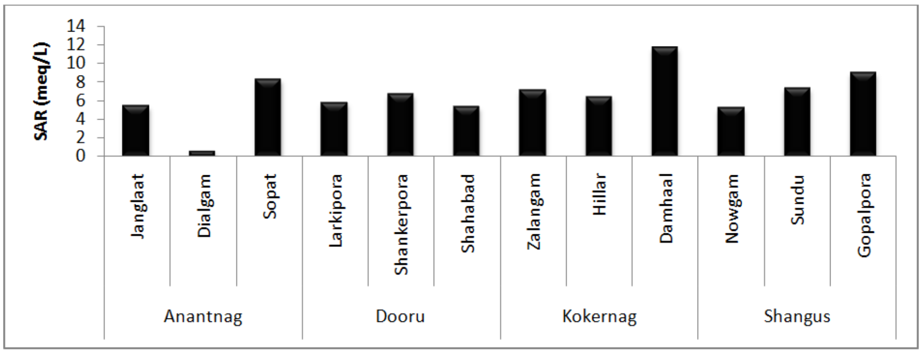


Fig. 14. Sodium Adsorption Ratio (SAR) (meq/L) at different sampling sites

minimum concentration of 0.1mg/L was recorded at Damhal site in the month of March, April and June. The average value ranged from 0.125 mg/L ±0.2 at Damhal site to 0.725mg/L ±0.1 at Sahahabad site (Fig 12). Potassium is usually found as ions in natural waters. The concentration of potassium under the present study ranges from 0.3 to 28.0 mg/L. The maximum concentration of 28.0 mg/L was recorded at Zalangam site in the month of June and minimum concentration of 0.3 mg/L was recorded at Dialgam site in the month of May. The average value ranged from 1.07 mg/L ±2.3 at Dialgam site to 18.00 mg/L ±10 at Zalangam site (Fig. 13).

the accumulation of dissolved solids from the upland areas by rain water and leaching of dissolved solids from effluents through the alluvial deposits. (Ravindra and Garg, 2007). The pH is a measure of the hydrogen ion concentration in water. The pH value of water indicates whether the water is acidic or alkaline. The slightly acidic pH (6.5) at the Hiller Kokernag may be due to the microbial load decomposition in soil and water, while Neutral to Alkaline pH (>7) may be due to limestone rich lithology of the valley, liberating Ca and Mg into the solution (Yongjin *et al*., 2006). Alkalinity refers to the quantity and kinds of compounds which collectively shift the

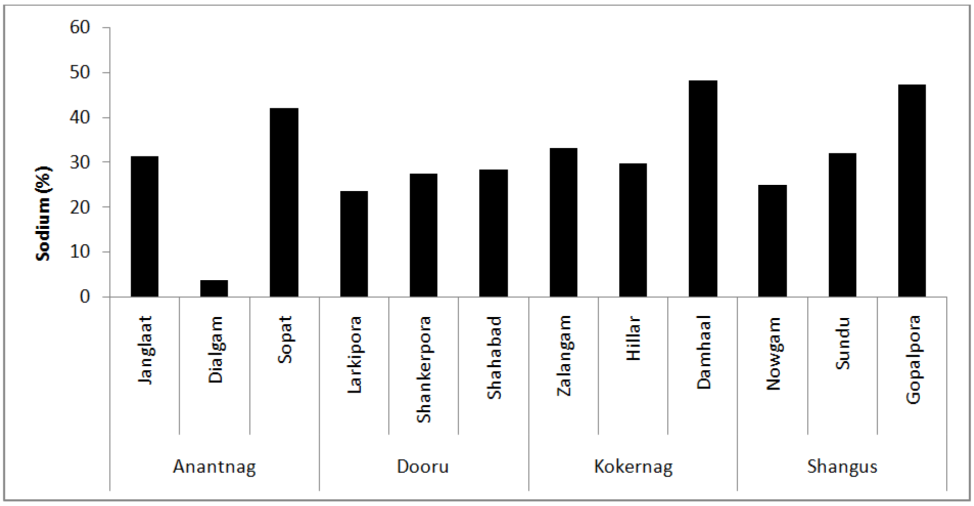


Fig.15. Percent Sodium at different sampling site

Sodium adsorption ratio

The sodium adsorption ratio of ground water samples recorded a range of 0.52 to 11.69 meq/L. The maximum concentration of sodium adsorption ratio 11.69 meq /L was recorded at Damhal site and minimum concentration of 0.52meq /L was recorded at Dialgam site (Fig. 14). The percent sodium of ground water samples ranged from 3.83 to 48.4%. The maximum concentration of percent sodium 48.4 was recorded at Damhal site and minimum concentration of 3.83 was recorded at Dialgam site (Fig. 15).

DISCUSSION

Ground water chemistry differs depending on the source of water, the types of rocks, topography, climate, the degree to which it has been evaporated and mineral it has encountered. The groundwater quality may yield information about the environments through which the water has circulated. The temperature range (13.4 to 20.5^{0}C) suggested that most of the sites contain water of shallow type as near surface ground. Direct influences on the groundwater temperature includes all heat inputs to the groundwater through the sewage network, district-heat pipes, power lines and such underground structures as auto and metro tunnels, underground garages etc. Anthropogenic heat generation such as domestic heating, industry and transportalso contribute to enhance ground water temperature (Miller, 1997). Conductivity is a measure of the ability of water to conduct an electric current. It is used to estimate the amount of dissolved salts. It increases as the amount of dissolved mineral (ions) increases. The larger variation in electrical conductivity is mainly attributable to lithological composition and anthropogenic activities prevailing in this region (Khodapanah *et al*., 2009). Higher conductivity at Shahabad and Zalangam sites may be due to

pH into the alkaline range (pH over 7). Bicarbonates, carbonates and hydroxides are mainly responsible for alkalinity (Cole, 1983). Alkalinity in waters is due to any dissolved ions that can accept or neutralize protons. In the present ground water samples, alkalinity was mainly contributed by bicarbonates which is a characteristic feature of valley lithology. Its concentration remained moderate (42 mg/l to 140 mg/L). Large amount of alkalinity may impart a bitter taste, harmful for irrigation as it damages soil and hence reduces crop yields (Yongjin *et al*.2006). The most common problem associated with ground waters is hardness, largely associated to calcium or magnesium rich lithology. Hard water causes no health problems, but can be a nuisance as it may form soap curds on pipes and other plumbing fixtures. During the present study, total hardness values indicated that these ground water sources fall between hard (136 to 300mg/L) and very hard (>300mg/L) as per Shrivastava *et al.,* 2009and are not fit for domestic purposes. High hardness values may be due to the presence rich deposits of limestone and is very common in the valley. Among cations, calcium was dominant followed by magnesium. The major source of Ca and Mg in the valley ground waters may be due to the lacustrine deposits as limestone, calcite, gypsum and dolomite. The dominance of Ca ion over Mg ion is attributable to the abundance of these rocks in the study area (Sawyer and McCarthy 2007). Sodium on the other hand is another important cation for both domestic and agricultural purpose. Its concentration in the present study is quite appreciable, which might have resulted to cation exchange of calcium and magnesium ions by mineral water interaction. The main problem with sodium is its conservative nature once it enters into the system and its effect on the physical properties of soil. The concentration of potassium was recorded low at majority of the sites, thus contributing very little towards the quality of ground water. However, at certain sites its concentration was high, may be due to the use of fertilizers. The overall cationic composition at the study sites depicted the sequence Ca>Mg>Na >K. Nitrogen is a major constituent of the earth's atmosphere and occurs in many different gaseous forms such as elemental nitrogen, nitrate and ammonia. Natural reactions of atmospheric forms of nitrogen with rainwater result in the formation of nitrate and ammonium ions. While nitrate is a common nitrogenous compound due to natural processes of the nitrogen cycle, anthropogenic sources have greatly increased the nitrate concentration, particularly in groundwater. The largest anthropogenic sources are septic tanks, application of nitrogen-rich fertilizers to turfgrass, and agricultural processes. Levels of nitrates in groundwater in some instances are above the safe levels proposed by the EPA and thus pose a threat to human health. Particularly in rural, private wells, incidence of methemoglobinemia appears to be the result of high nitrate levels. Methemoglobinemia, or blue baby syndrome, robs the blood cells of their ability to carry oxygen. Due to the detrimental biological effects, treatment and prevention methods must be considered to protect groundwater aquifers from nitrate leaching and high concentrations. Treatment through ion-exchange and other processes can rehabilitate already contaminated water, while prevention, such as reduced dependence on nitrogen-rich fertilizers can lower the influx of nitrates. Higher concentration of nitrogen compounds at majority of the sites may be related to domestic sewage, plant debris, animal excreta and the use of nitrogenous fertilizers for agricultural use (Voznaya, 1981). Phosphorus is an essential nutrient for plant and animal growth. The high concentration of total phosphorus especially at Shankerpora Kokernag site indicated that domestic wastes and fertilizers from agricultural use have entered the ground water system (HEC, 1972). The phosphorus also passes through cycles of decomposition and photosynthesis.

Suitability of water for Drinking purpose

The water samples of the study area did not contain any physico-chemical parameter above the WHO international standards, 2004, except total hardness and Fluoride concentration which were higher than the permissible limits of WHO standards, indicating that these waters are hard and contain significant concentration of fluoride. Hence, the water in the study area could be said to be portable for human consumption with few exceptions. Fluoride exists naturally in water sources and is derived from fluorine, the thirteenth most common element in the Earth's crust. It is well known that fluoride helps prevent and even reverse the early stages of tooth decay. Tooth decay occurs when plaque that sticky film of bacteria that accumulates on teeth breaks down sugars in food. The bacteria produce damaging acids that dissolve the hard enamel surfaces of teeth. If the damage is not stopped or treated, the bacteria can penetrate through the enamel causing tooth decay (also called cavities or caries). Cavities weaken teeth and can lead to pain, tooth loss, or even widespread infection in the most severe cases.

Fluoride combats tooth decay in two ways:

- It is incorporated into the structure of developing teeth when it is ingested.
- It also protects teeth when it comes in contact with the surface of the teeth.

Fluoride has been found to have a significant mitigating effect against dental caries and it is accepted that some fluoride presence in drinking water is beneficial. Optimal concentrations are around 1 mg/l. However, chronic ingestion of concentrations much greater than 1.5 mg/l (the WHO guideline value) is linked with development of dental fluorosis and, in extreme cases, skeletal fluorosis. High doses have also been linked to cancer. Health impacts from long-term use of fluoride-bearing water have been summarized as: <0.5 mg/l: dental caries, 0.5-1.5 mg/l promotes dental health, 1.5-4 mg/l dental fluorosis, >4 mg/l dental, skeletal fluorosis, >10 mg/l crippling fluorosis Dental fluorosis is by far the most common manifestation of chronic use of high-fluoride water. As it has greatest impact on growing teeth, children under age 7 are particularly vulnerable. Fluoride is considered as an essential element though health problems may arise from either deficiency or excess amount. Much of the fluoride entering the human body is obtained from drinking water. Fluoride concentration of 0.4 ppm in drinking water causes mild type of dental fluorosis (Dinesh, 1999). Sopat site samples showed very high concentration of fluoride and as a result the residents are suffering from dental fluorosis. Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric volcanic particles. Fluoride can also come from:

- Runoff and infiltration of chemical fertilizers in agricultural areas.
- Liquid waste from industrial sources

Suitability of water for Irrigational purpose

The suitability of groundwater for irrigation depends on the ionic concentration of Ca, Mg and Na. In fact, salts can be highly harmful. They can limit growth of plants physically, by restricting the taking up of water through modification of osmotic processes. Also salts may damage plant growth chemically by the effects of toxic substances upon metabolic processes. Good quality of waters for irrigation is characterized by acceptable range of sodium adsorption ratio and percent sodium. Sodium concentration plays an important role in evaluating irrigational quality of ground water because irrigation with Na-enriched water results in ion exchange reactions: uptake of Na^+ and release of Ca^{2+} and Mg^{2+}. This causes soil aggregates to disperse, reducing its permeability (Tijani, 1994). All the study sites had very low SAR values, indicating that groundwater samples had excellent quality for irrigation with no danger of exchangeable sodium except Damhal. On the basis of% sodium all sites belong to good water class category (20-50%) except Dialgam (< 20%) which belongs to excellent category (Todd, 2003). Low SAR and %Na may be due to the presence of significant quantities of divalent cations like Ca and Mg which are more strongly bonded and tend to replace monovalent ions like sodium and potassium.

The combination of electrical conductivity and SAR had also been used to determine the suitability of water for irrigation. According to US salinity hazard diagram, almost all sites fall under C_2S_1 category indicating medium salinity and low alkali hazard except Sopat and Shankerpora sites which fall under C_3S_1 indicating high salinity and low alkali hazard. In addition to this Damhaal site has been found to fall under C_2S_2 indicating medium salinity and medium Alkali hazard. These groundwater sources can be used to irrigate all types of soils with little danger of exchangeable sodium but ground water of Sopat and Shakerpora sites which fall C_3S_1 (high salinity) category may not be fit for irrigation purposes.While plotting %Na against electrical conductivity, it was found *that Janglaat Mandi, Dialgam, Sundu, Gopalpora* sites had water quality varying from good to Permissible while others had water quality not fit for Irrigation.

Conclusion

The physico-Chemical features of water are important indicators that provide information about the water quality. The present study revealed that ground water in the aquifers of Anantnag District are fresh and alkaline in nature. The results revealed that varied lithology and anthropogenic activities played an important role in influencing chemistry of the studied ground water sources. The chemistry showed that these waters are hard and highly mineralized. Calcium and magnesium are the dominant cations and bicarbonate is the dominant anion. The excess of alkaline earths imparts hardness to the ground water of the area. During the present study, it was found that the samples of the study area did not contain any physico-chemical parameter above the limits prescribed by World Health Organization International Standards, 2004 except total hardness and Fluoride. Sopat site samples showed very high concentration of fluoride and as a result the residents are suffering from dental fluorosis. Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric volcanic particles. The sodium adsorption ratio of ground water samples recorded a range of 0.52 to 11.69 meq/L. The maximum concentration of sodium adsorption ratio 11.69 meq /L was recorded at Damhal site and minimum concentration of 0.52meq /L was recorded at Dialgam sites. The percent sodium of ground water samples ranged from 3.83 to 48.4%. The maximum concentration of percent sodium 48.4 was recorded at Damhalsite and minimum concentration of 3.83 was recorded at Dialgam site. Thus, the analytical data from the study area confirms; ground water present in the study area is suitable for domestic and irrigational purposes with few exceptions.

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