A Geographical Analysis of Water Quality in Kalady Panchayat, Kerala, India

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Abstract: The paper entitled 'A Geographical Analysis of Water Quality in Kalady Panchayat' is an evaluation of potability of surface and ground water in Kalady panchayat. Water quality is a major issue in this fast growing world. Water quality becomes a problem due to population explosion, socio-economic growth and poor management of natural resources in the 21st century. Surface water namely rivers, ponds, lakes etc have been contaminated at an alarming rate due to the dumping of waste materials in a meaningless way. The paper reveals improper waste disposal system, dumping wastes in public water resources in an unsustainable manner in the study area. Ground water was the major source of drinking water in the early years but now due to over exploitation it is also contaminated and exhausted. In turn, humans are affected by the poor quality of water in the form of health impacts. The paper gives general introduction with water quality and its global, Indian and Kerala scenario and the major reasons for poor quality of water. Since the study is supported by the concept that 'water quality has a major health impact', a brief statement about medical geography is also included. Medical geographical aspect is a sub division in the discipline of geography that explains about the influence of local conditions upon the human health. 'Statement of the problem' and the 'significance of the study area' that are explains about the present problem of investigation in the study area.

Keywords : Ground water, Grid sampling, Health impact factor, Medical geography Eutrophication ,Water quality.

Introduction

A major life giving factor on earth is water and it supports wide variety of activities. Water is pure in its natural form whether it is underground or surface water except in sea. But as the human population increases, as people needs a better standard of living, as economic activities continue to expand in scale and diversity and as landuse/landcover changes, the demand on water and its quality arise and continue to grow. So water quality is an emerging problem in the modern world. Kerala is blessed with large number of rivers; even then, the state is facing water scarcity in the midst of plenty due to water quality and quantity. Kalady panchayat in Ernakulam district of kerala is also facing the water quality problems due to landuse/landcover changes. Kalady town lies in the flood plain of Periyar River and once it was an area dominated by paddy cultivation. But now, many of the paddy lands have been reclaimed and some are remaining as uncultivated or cultivated by other crops. The uncultivated paddy fields become dump place for waste materials of degradable and non-degradable. Kalady is very near to Cochin International Airport and so it is in the pressures of development. Water quality in Kalady is undesirable in its colour, taste and odour. So the present study attempts to evaluate the water quality of Kalady in three seasons namely; pre-monsoon, monsoon and post-monsoon.

Main objectives

The present study may evaluate the water quality and thereby checks the possibility of health impacts due to poor water quality in Kalady panchayat. The water quality parameters include physic-chemical and micro-biological characteristics of water also be considered.

Methodology

Grid sampling method is used for collecting samples from wells and 12 samples were collected from wells. 13 samples were collected from streams, ponds and Periyar River together. Therefore, 25 samples were collected from surface and ground water and they were collected in three seasons. So, total 75 samples were collected for water quality analysis in the study area. The water quality parameters selected for water quality analysis include physical, chemical and micro-biological characteristics. The physic-chemical factors are temperature, pH, turbidity, TSS (Total suspended solids), Electrical conductivity (EC), TDS (Total dissolved solids), DO (Dissolved oxygen), BOD (Biological oxygen demand), total hardness, total alkalinity, chloride, sulfate, phosphate, nitrate, nitrite, silicate, sodium, potassium and iron. The micro-biological indicators used for water quality analysis were total coliforms, fecal coliforms and fecal *streptococci*. Physical and chemical parameters were analyzed by using the standard procedure used in the laboratory (APHA method). Standard plate count method was used for analyzing micro-biological characteristics.

Study area

Kalady Panchayat lies in the major watershed Periyar and form parts of sub watersheds 14P24a, 14P24b and 14P25a. The area is between 10º 09'10''N and 10º 11'50"N latitudes and 76º 21' 05" E and 76º 27' 31"E longitudes. Periyar River borders southern part of Kalady Panchayat. Kalady is an important rice producing center and so rice mills aroused here and clustered near the town. There are four stone crushers and a bone mill lies adjacent to these rice mills. The waste generates from these manufacturing units, markets and hotels are simply drains to surface water bodies. The tributary streams of Periyar River flows through Kalady look like sewage water. Some wells in the study area are not in use due to its orange colour and oily appearance on the water surface.

Materials and Methods

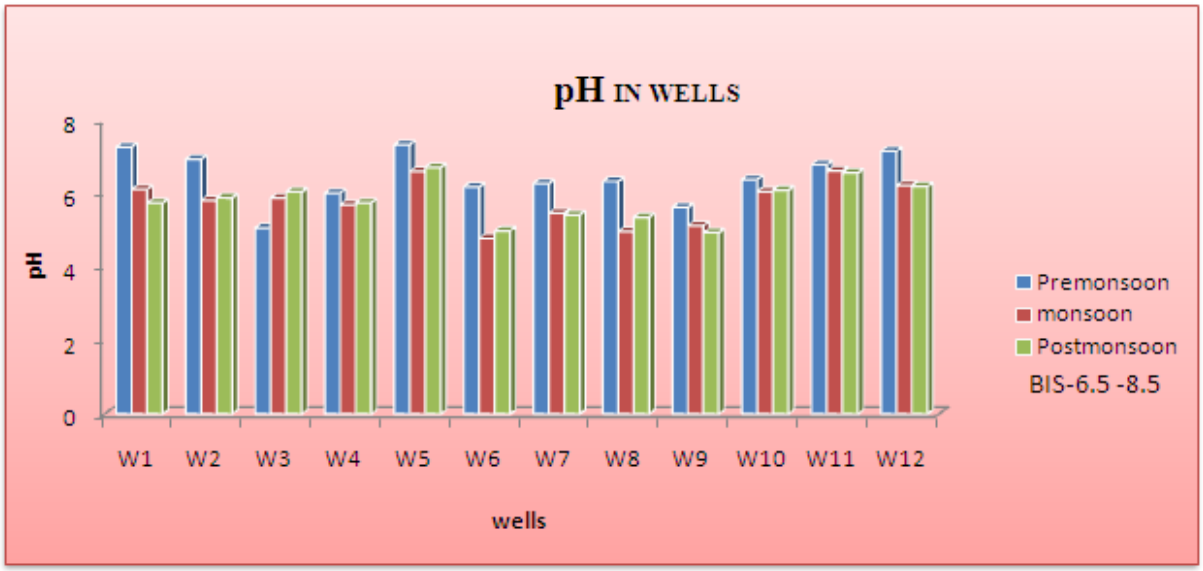
Water sources in the study area were divided into surface water and underground water. Under ground water includes wells and surface water includes streams, ponds and Periyar River. Wells were indicated by the letter 'W', streams by 'S', ponds by 'P' and river by 'R'. Grid sampling method was used to take samples from ground water. Random sampling method was used to take samples from surface water. 12 samples from ground water and 13 samples were taken collectively from surface water (9 samples from streams, 2 samples from ponds and 2 samples from Periyar River). Total 75 samples were collected in three seasons namely pre-monsoon, monsoon and post-monsoon. Pre-monsoon samples were collected just before south west monsoon on 27th may 2014. Monsoon samples were collected on 30th July 2014 and post-monsoon samples were collected on 29th September 2014. In the case of interval of sampling, systematic sampling method was used both in surface and ground water.

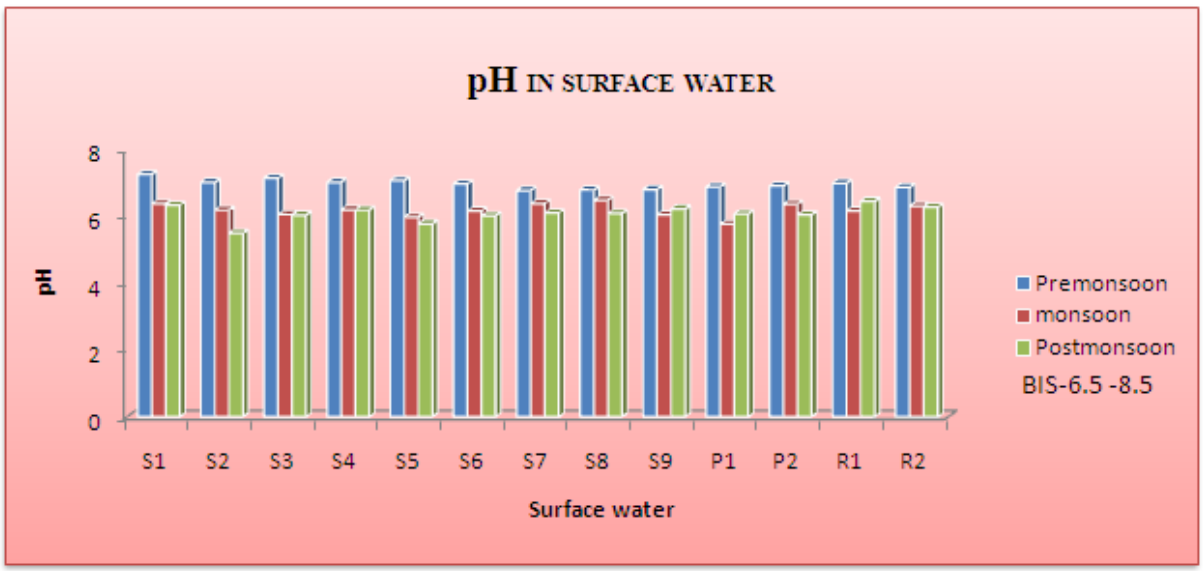
The collected samples were analyzed for physic-chemical characteristics namely pH, turbidity, DO (Dissolved oxygen), total hardness, chloride, nitrate, and iron. The procedure used for chemical analysis was American Public Health Association (APHA) methods. For analyzing micro-biological aspects namely total coliforms and fecal coliforms, standard plate count method was used. The results were compared with BIS (Bureau of Indian Standards) limit for drinking water.

Results and Discussion

The results obtained from the physic-chemical and micro-biological analysis of water are as follows

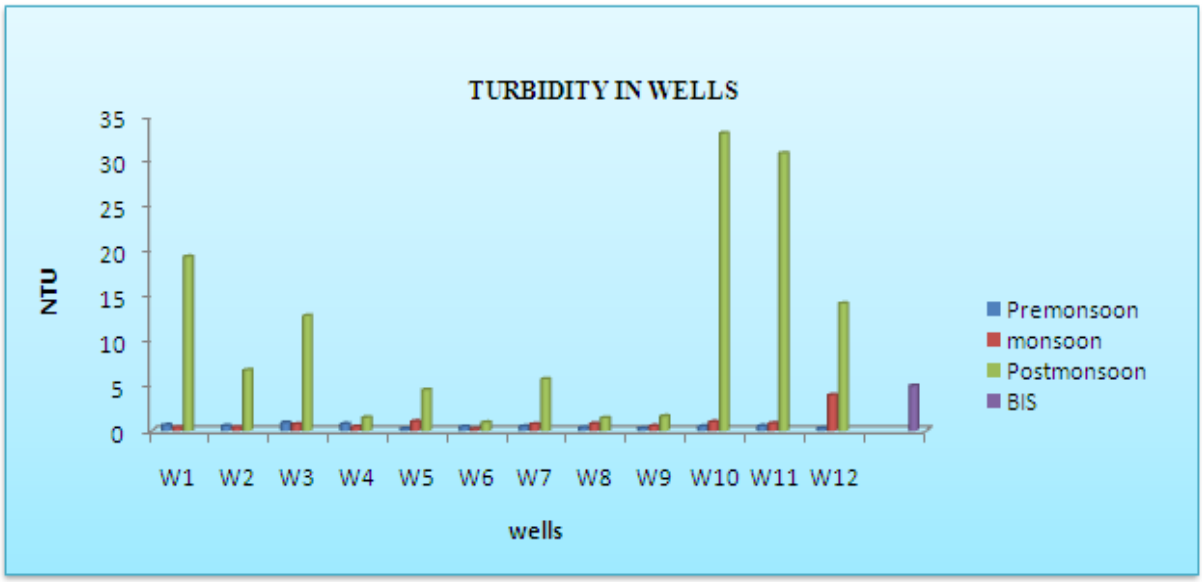
pH. pH indicates the intensity of acidity or alkalinity of water on a scale ranges from 0-14. Each number represents a 10-fold change in the acidity/alkalinity of water. Polluted water has pH value lower or higher than 7 based on the nature of the pollutant. The BIS limit for pH is from 6.5 to 8.5. pH values of W5 and W11 are well within the BIS limit of 6.5 to 8.5 in three seasons. All other locations have pH value less than 8.5 but some of them have values less than 6.5 which may cause tuberculation of water supply systems (k. Sundara kumar 2010). They show slightly acidic in nature. The lowest pH value was 4.78, in W6. W1, W2, W3, W4, W6, W7, W8, W9, S2, S5 and P1 have pH value less than 5 in one or more seasons. Corrosion and metallic taste are the peculiarities of lower pH. Surface water shows pH within the limit compared to wells (Bhagirathi Behera et.al 2012).

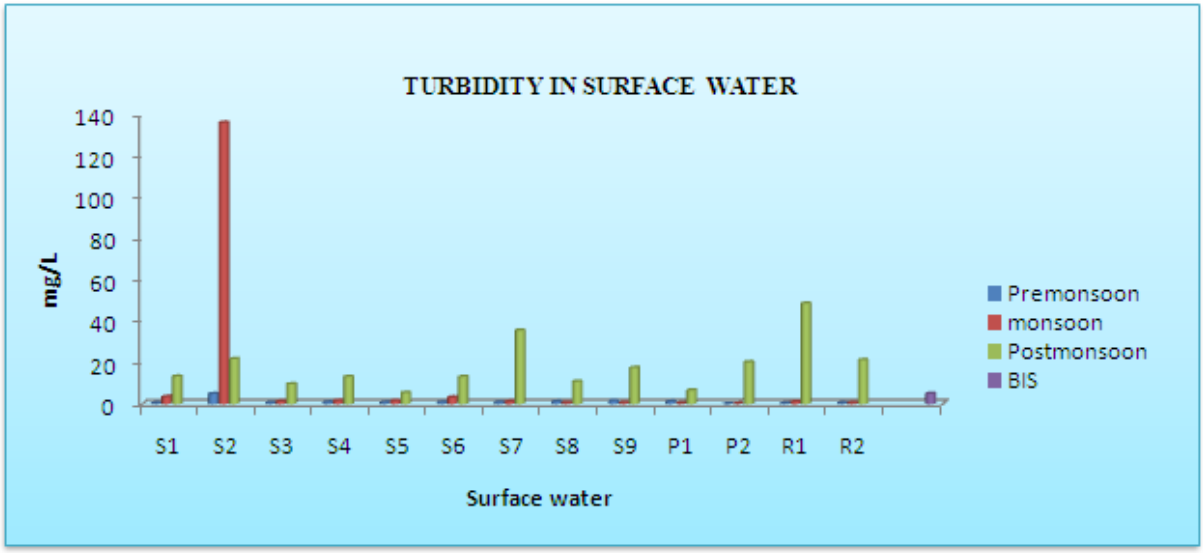




Turbidity. Turbidity is an expression of optical property, wherein light is scattered by suspended particles present in water and is measured using a Nephelometer. Suspended particles such as clay, silt, finely divided organic and inorganic matter; plankton and other microscopic organisms cause turbidity in water. Turbidity affects absorption properties and aesthetic appearance in a water body. The desirable limit of Bureau of Indian Standard (BIS) for turbidity in drinking water is 5 NTU (Nephelometric Turbidity Unit). Turbidity rises the temperature, makes water warmer, and thereby reduces oxygen. Higher turbidity causes gastrointestinal diseases. The suspended solids may act as shields for the virus and bacteria while chlorination.

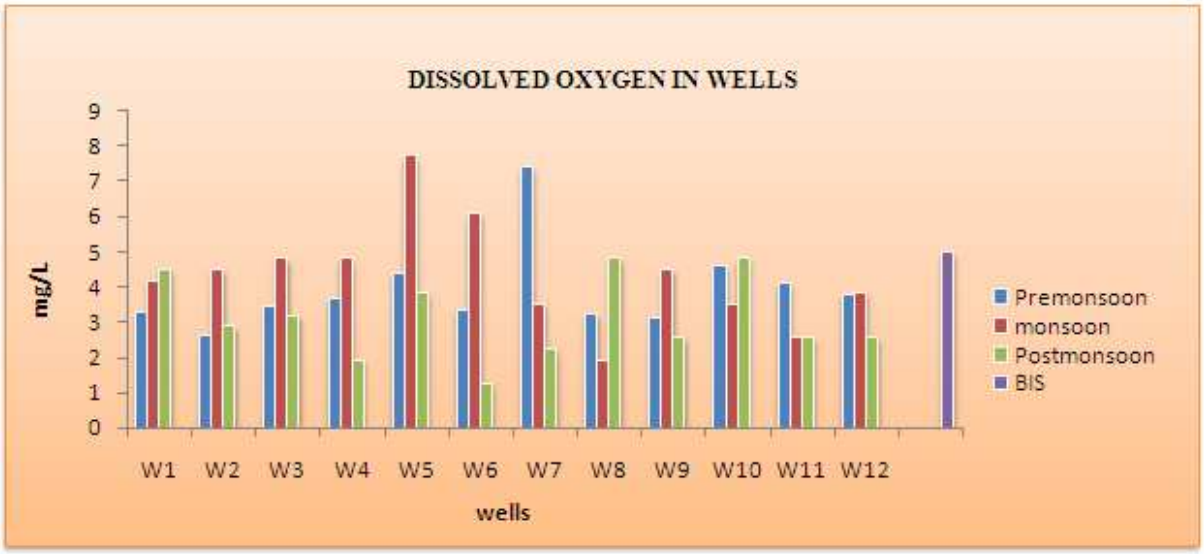
Turbidity is within the limit of 5 NTU in W4, W5, W6, W8 and W9. All other locations have values more than 5 NTU. Surface water shows high turbidity and the maximum value is 136 NTU in S2. Turbidity is generally high in post-monsoon season even though highest turbidity is reported in monsoon period. Special care must be taken before supplying the water to the public (k. Sundara kumar 2010).

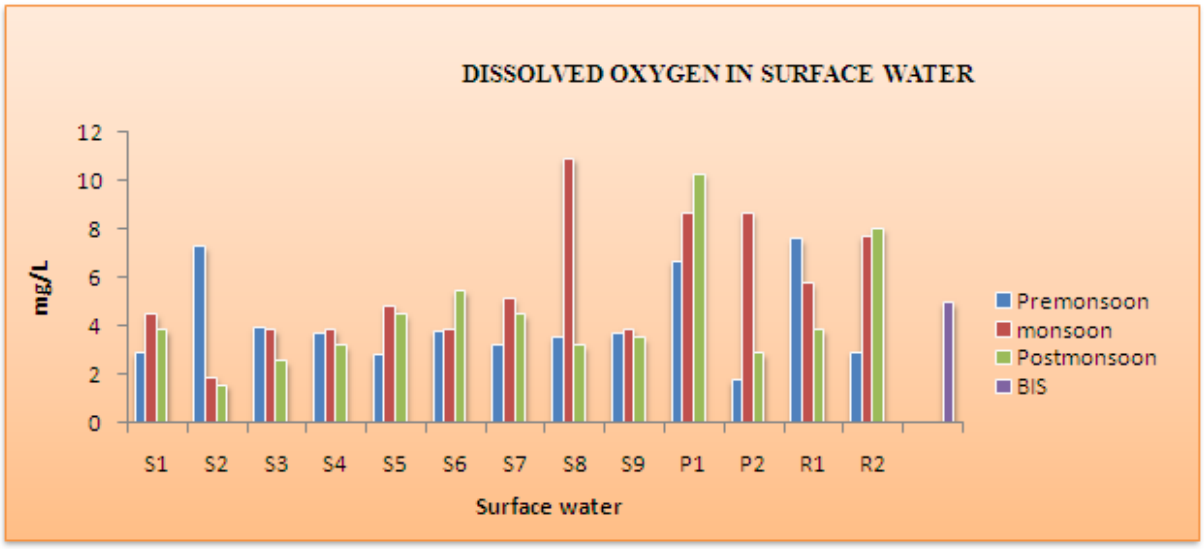




Dissolved Oxygen. Dissolved Oxygen in water is an important characteristic in water analysis because it serves as an indicator of the physical, chemical and biological activities of the water. The two main sources of dissolved oxygen are diffusion of oxygen from air and photosynthetic activity. Diffusion of oxygen from the air depends on the solubility of oxygen, water movement, temperature, salinity, etc. As the amount of dissolved oxygen drops below normal levels in water bodies, the water quality is harmed and creatures begin to die off. Bacteria in water can consume oxygen as organic matter decays. Thus, excess organic material in water body can cause an oxygen-deficient situation to occur. The BIS limit for DO is 5mg/L.

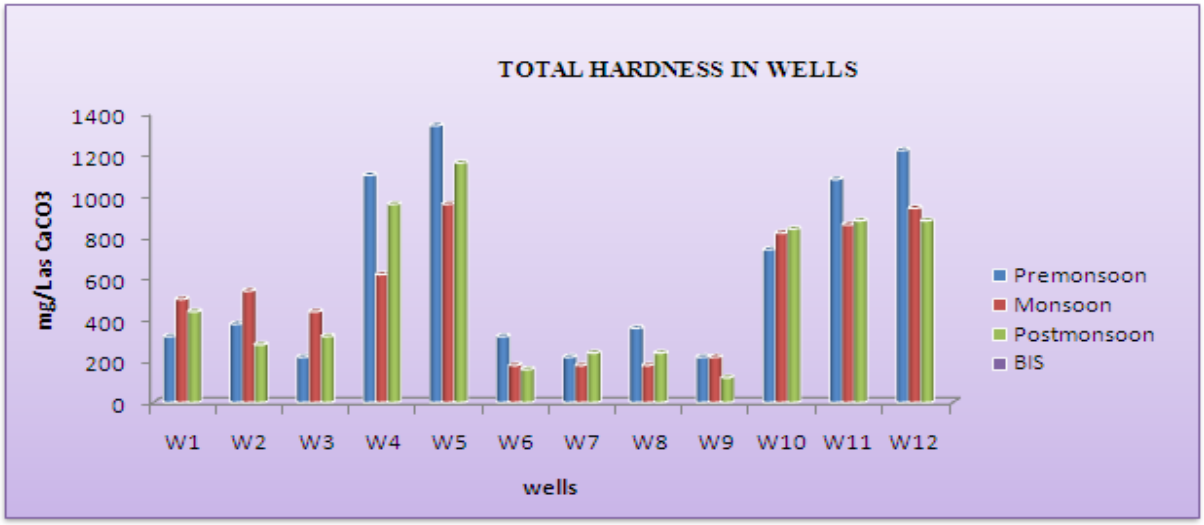
The sample location P1 in surface water satisfies this limit in three seasons. All other types of water show lower DO in one or more season. The lowest DO value is 1.29 which is in W6 (Bhagirathi Behera et.al 2012).

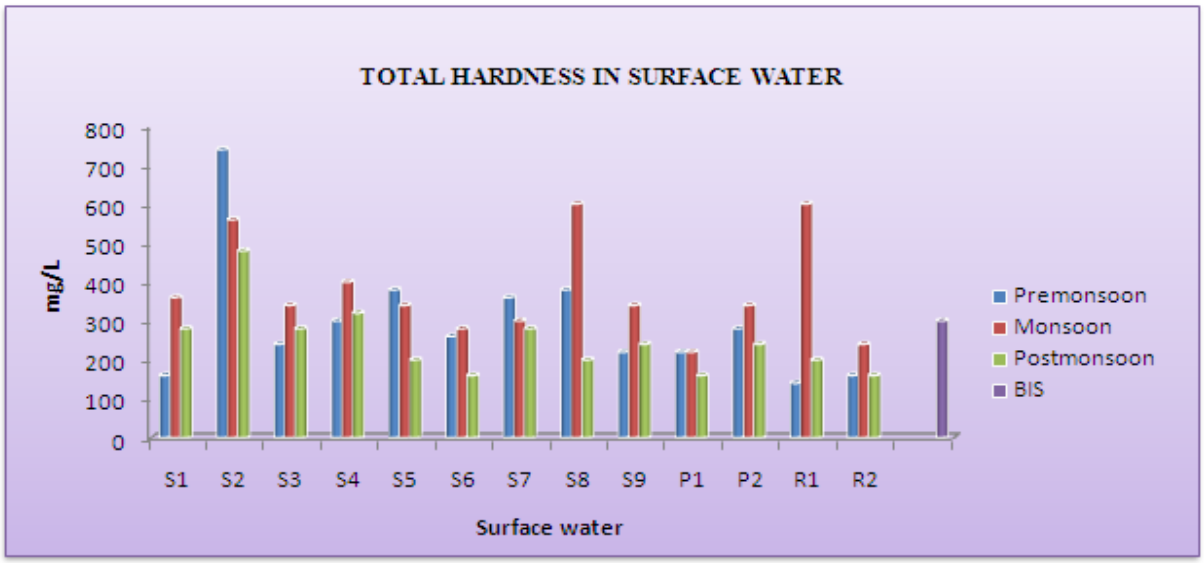




Total Hardness. Total hardness is defined as the sum of calcium and magnesium concentrations, both expressed as $CaCO_3$ in mg/L. Carbonates and bicarbonates of calcium and magnesium cause temporary hardness and sulphates and chlorides cause permanent hardness. Hardness of water prevents lather formation with soap rendering and makes it unsuitable for bathing and washing. When hard water is heated in a home water heater, solid deposits of calcium carbonate can be formed. The BIS limit for total hardness is 300mg/L.

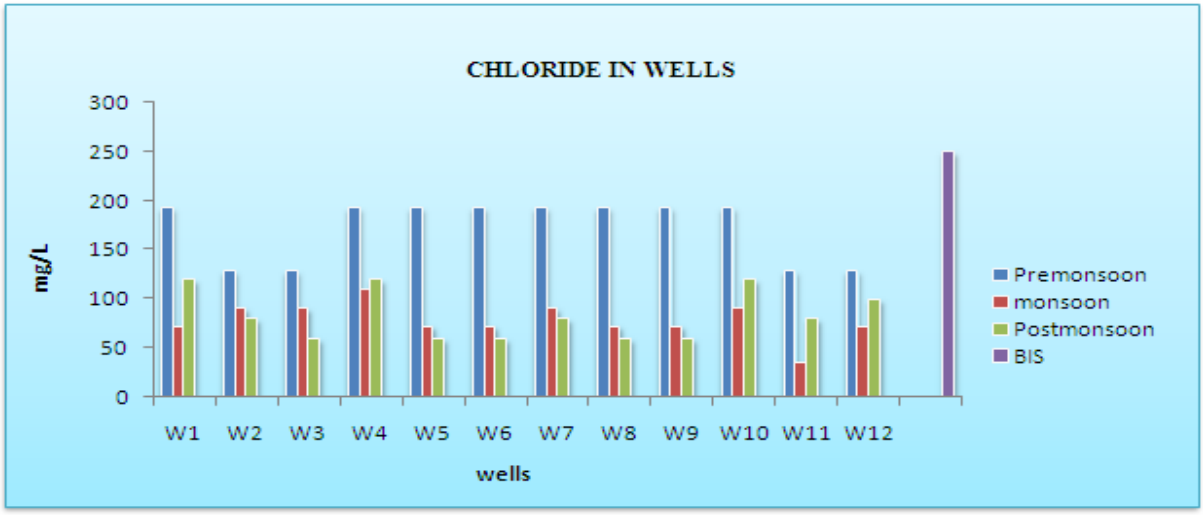
Some water bodies namely W7, W9, S6, P1 and R2 satisfy the BIS limit in three seasons. W6, W8, S1, S3 and S4 slightly exceed the limit in one season. All other water bodies have high concentration of hardness in two or more seasons. Wells show high level of hardness compared to streams and W5 has the maximum value of 1340mg/L as $CaCO_3$. Softening is required to impart palatability to water (k. Sundara kumar 2010)

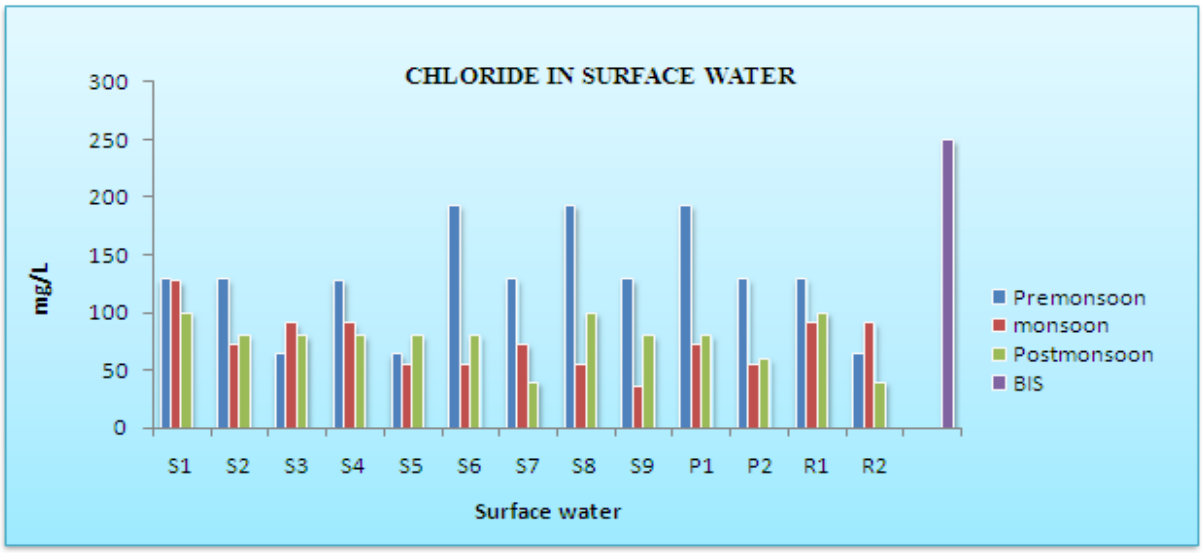




Chloride. High concentration of chloride indicates pollution by sewage, septic tanks, industrial wastes, intrusion of seawater or other saline water. High chloride content has a harmful effect on metallic pipes and structures as well as agricultural plants. BIS limit for sulphate in drinking water is 250mg/L. Chemical contamination from chlorination by-products has resulted in numerous epidemiological studies and the studies show that chlorination is associated with increased cancer risks.

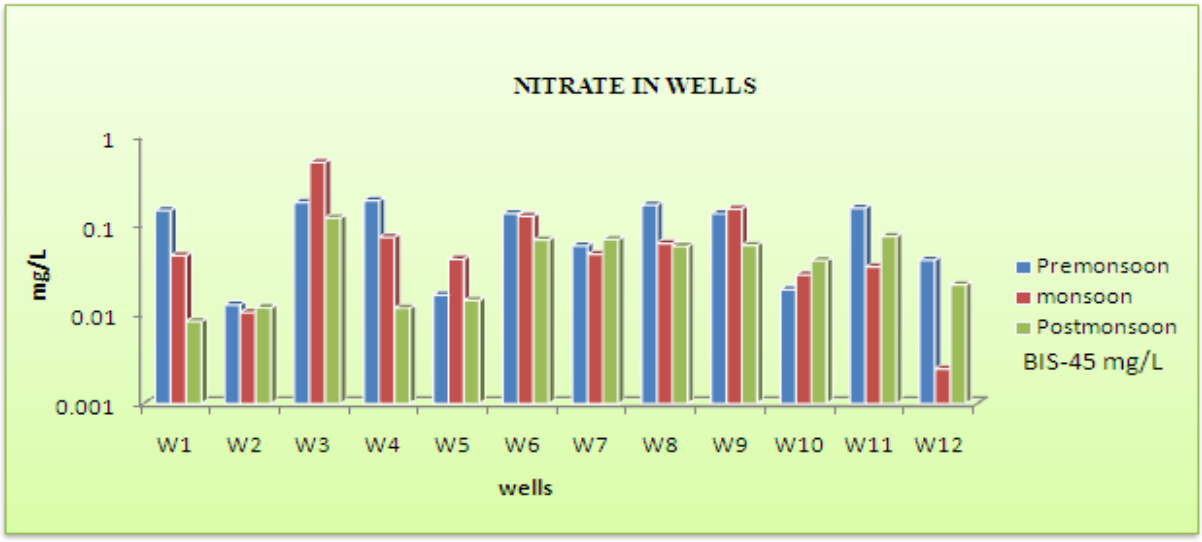
Chloride is within the limit of 250mg/L. Chloride shows comparatively high concentration in pre-monsoon period. Wells have high chloride than streams. High concentration of chloride produces salty taste in drinking water and thus water becomes objectionable for drinking (k. Sundara kumar 2010).

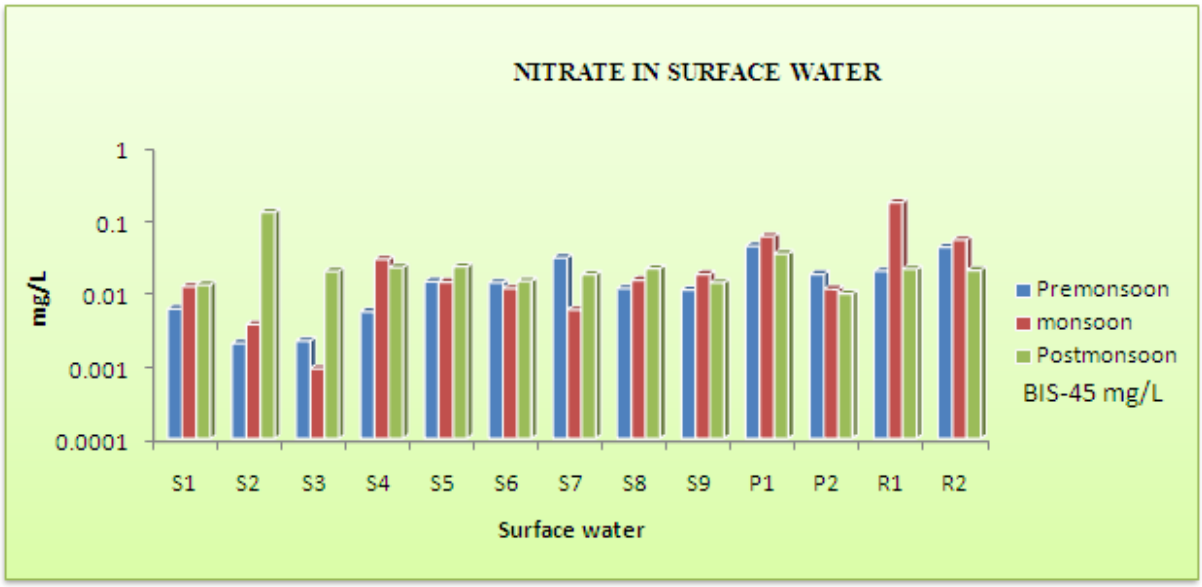




Nitrate. Nitrates are the most oxidized form of nitrogen and the end product of the aerobic decomposition of organic matter. Natural water in their unpolluted state contains only minute quantities of nitrates. The main sources of nitrates are domestic sewage, chemical fertilizers from cultivated lands etc. BIS limit for nitrate in drinking water is 45mg/L. Prolonged intake of high levels of nitrate can cause disease. Nitrite (nitrate is reduced to nitrite) is absorbed in the blood, and hemoglobin (the oxygen-carrying component of blood) is converted to methemoglobin. It can cause brain damage to infants and weak persons.

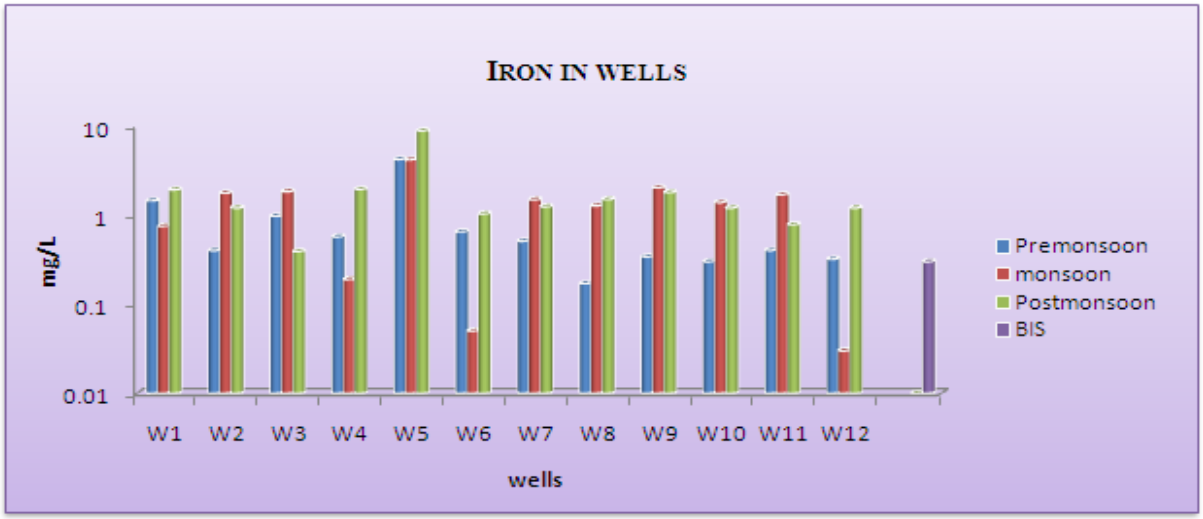
Nitrate is low compared to the BIS limit of 45mg/L. The concentration is almost same in three seasons.

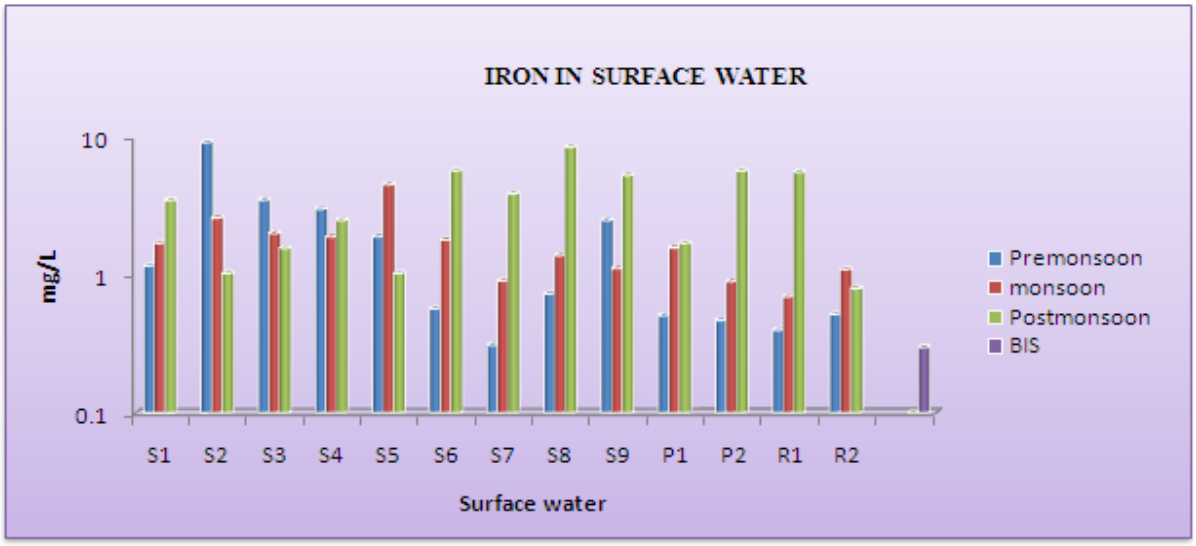




Iron. Iron is an abundant element in the earth's crust, but exists generally in minor concentrations in natural water. Laterite soil has high iron content and this may leads to high iron content in natural water. It is found in the +2 *(ferrous)* and +3 (*ferric)* states depending on the oxidation-reduction potentials of the water. The ferric state of iron imparts orange stain to any settling surfaces, including laundry articles, cooking and eating utensils, and plumbing fixtures. Prolonged consumption of drinking water with high concentration of iron may leads to liver (haermosiderosis), heart and kidney diseases.

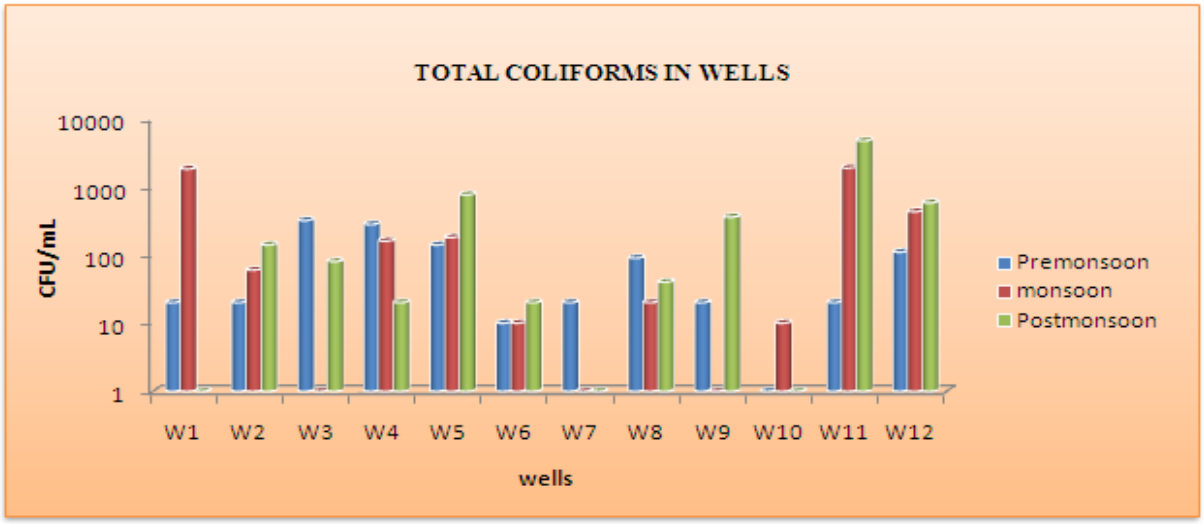
Iron contamination is high in the study area. Many of the wells and surface water have iron content higher than the BIS limit of 0.3mg/L. Iron must be removed to avoid the growth of iron bacteria and rusting problems in the distribution system (Bhagirathi Behera et.al 2012).

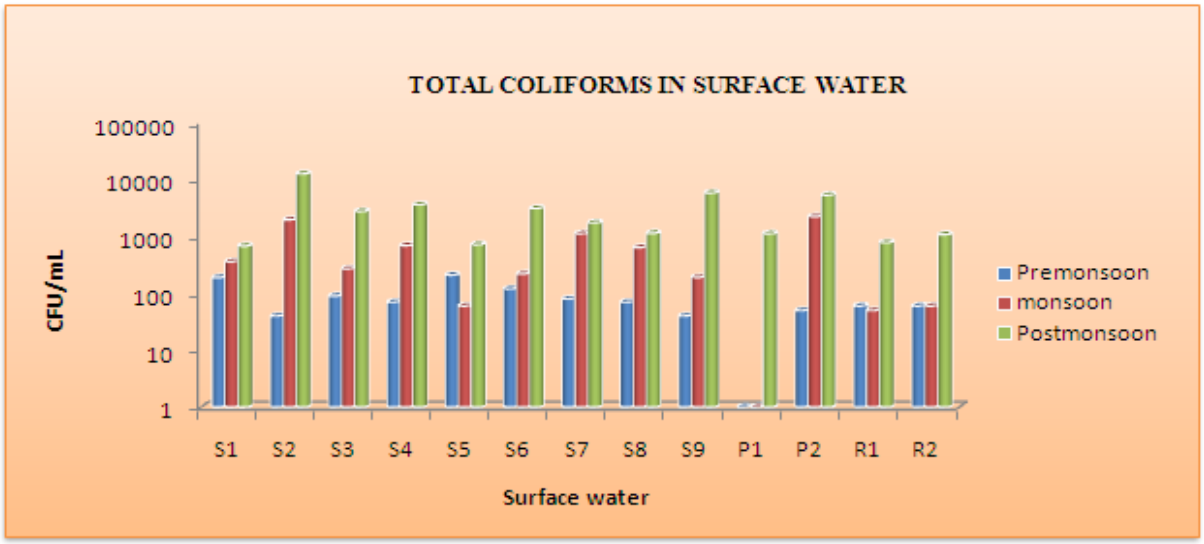




Total Coliforms. Coliforms are bacteria that are present in the digestive tracts of animals, including humans, and are found in their wastes. The most basic evidence of bacterial contamination in water is the identification of total coliforms. It is not likely to cause illness, but its presence indicates that water supply may be vulnerable to contamination by more harmful microorganisms.

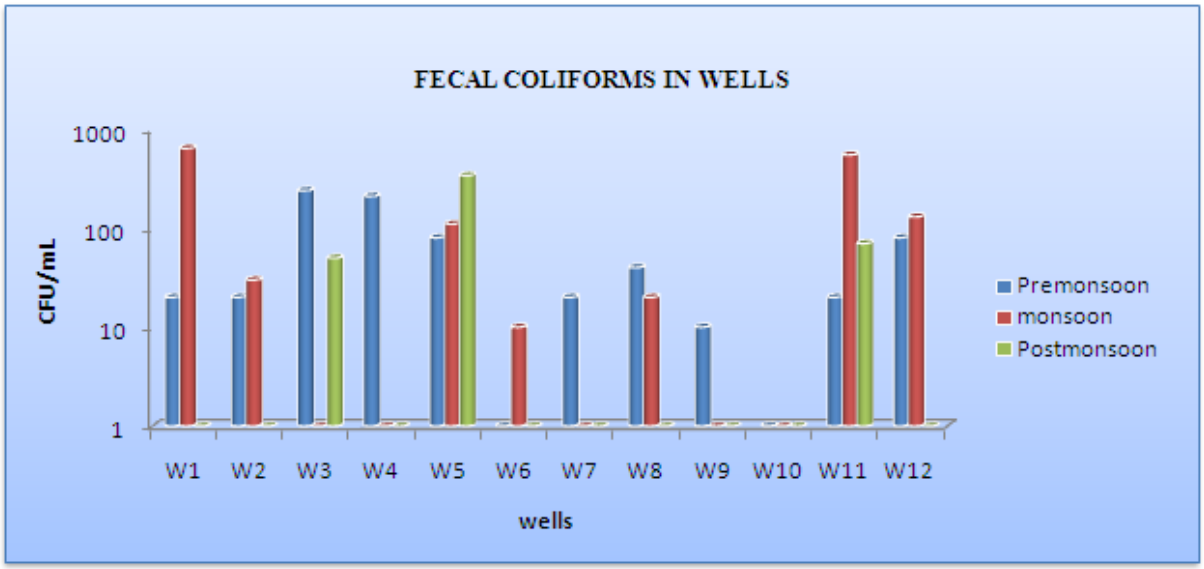
The study area shows coliform contamination both in wells and surface water. In surface water, P1 shows coliform count only in post-monsoon season. Surface water shows coliforms at an increasing rate from pre-monsoon to monsoon and from monsoon to post-monsoon. Maximum growth in wells is in W11 (4700 CFU/mL) and in surface water it is in S2 (12600CFU/mL).

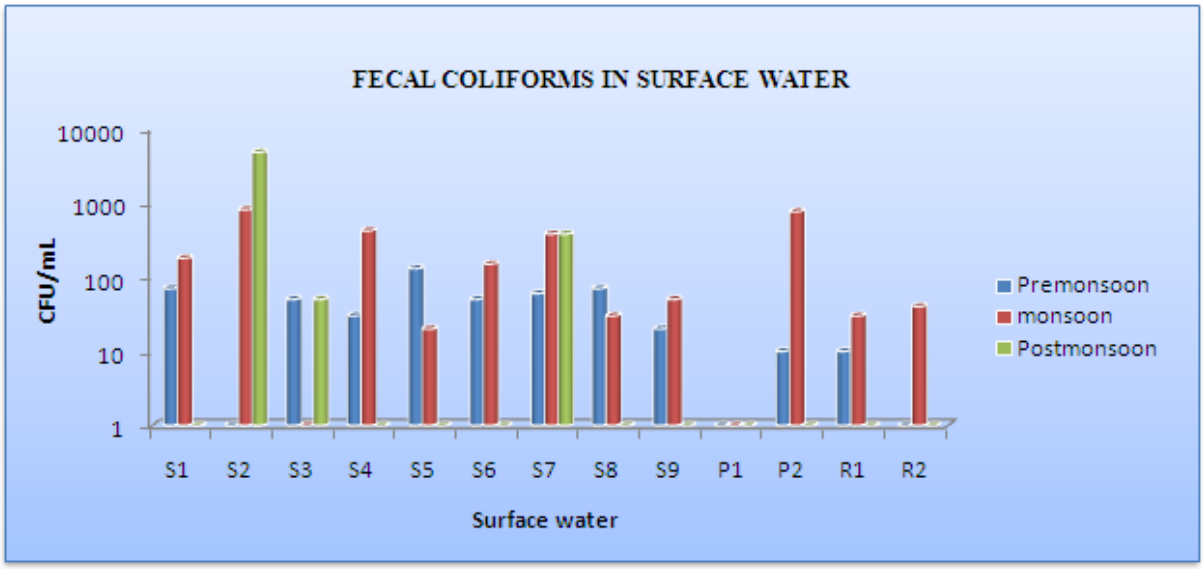




Fecal Coliforms. Fecal coliforms are a subgroup of total coliforms, but it is more fecal-specific in origin. Fecal coliforms are considered a more accurate indication of animal or human waste than the total coliforms. They are considered to be present specifically in the gut and feces of warm-blooded animals.

Fecal Coliforms have no growth in most of the wells and surface water in the post-monsoon season. W10 and P1 have no fecal contamination in three seasons. The amount of fecal coliforms is high in monsoon period. In wells, the maximum count is 640 CFU/mL i.e. in W1. In surface water, S2 has the maximum count of 4800 CFU/mL.





Conclusion

From the foregoing observations of physic-chemical and micro-biological parameters, it is revealed that turbidity, total hardness, iron and microbial growth in the area exceed the BIS limit for drinking water. The inhabitants are of opinion that water quality became poor last 30 years. So the water quality in the area is mainly affected by the landuse/landcover change. The result shows that most of the water resources are not potable. The high level of certain parameters causes some diseases. Certain locations experience high level of contamination. They are due to the influence of local conditions. Generally nutrients show low level that means that there is no chance for the condition of eutrophication. The study concludes monsoon water quality is comparatively good and post-monsoon shows poor water quality in the study area.

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