Experimental Study on Water and Soil Near Coir Industrial Area

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Abstract— **Groundwater quality management and soil conservation are major environmental challenges. Proper monitoring of pollutants from different sources of groundwater is quite laborious which sometimes leads to analytical errors also. The physical and chemical parameters such as TDS, pH, concentrations of Nitrate, Dissolved Oxygen, Sodium, Potassium and Phosphorous of the study area have been taken for deciding the characteristics of ground water of the study area. Also study and analysis of the soil sample is done to find out the physical and chemical parameters of the soil of the study area for determining the effect of minerals present in the soil sample that may affect the groundwater. A standard comparison or analysis is done by using the standard limits as prescribed in International and Indian Standards (WHO and BIS respectively) with the experimental test results obtained. A statistical analysis is done by using IBM SPSS Logistics software for Correlation and Regression.**

Keywords- Groundwater quality, WHO, Coir Industry, SPSS

I. INTRODUCTION

Water is a natural resource that every human being on Earth requires for satisfying his or her needs. Water that occurs below the ground and is brought to the land surface by wells or springs is referred to as groundwater. Groundwater is a significant part of the hydrologic cycle, containing 21% of Earth's freshwater [1]. Groundwater comprises 97% of fresh water not tied up as ice and snow in polar ice sheets, glaciers, and snowfields. This greatly exceeds the amount of water in streams, rivers, and lakes Soil is a product of several factors: the influence of climate, relief (elevation, orientation, and slope of terrain), organisms, and the soil's parent materials (origin minerals) interacting over time [2]. It continually undergoes development by way of numerous physical, chemical and biological processes, which include weathering with associated erosion.

The site selected for this experimental study is Mondaikadu and it is a panchayat town in Kanniyakumari District in Tamil Nadu. It is located $8^0$9'47" latitude and $77^0$16'48.09" longitude. Coconut husk is immersed in a pond for a period ranging from six months to one year for coir production process. During this process, effluent is generated from the retting yard is acidic. Due to the oxidation of the organic matter, chloride, Hardness nutrients and low pH with foul smell of hydrogen sulphide are the characteristic feature of retting yards [3]. This leads to contamination of groundwater and soil. Hence the study is conducted for the assessment of groundwater and soil in that area.

This study is reported to identify the sampling locations so as to collect the samples from well and soil and to study the physical, chemical and biological characters of water and soil and to compare the variations of the water quality by statistical approach and to compare with WHO and BIS standards. Also it is suggest the suitable conservation strategies for water quality conservations. The selected study area is Mondaikadu, it is a Coastal region of Kanniyakumari District with a population of about 12,349 persons [4]. Agriculture, coir making, fishing are the main occupations of this area [5]. For coir making, coconut husk is immersed in a pond for about 6 months to 1 year. The pond used for retting purposes is called as retting yard. During this process, the retting pond will produce a lot of organic, inorganic and biological effluents which produces a foul smell[5].

II. SAMPLING AND ANALYSIS

Five samples of groundwater were collected near the site, retting water sample was collected from the retting yard, and soil sample was taken very nearly to the retting yard. Groundwater of the five samples was collected at a distance of 25 m, 15m, 10m, 5 m and 7m respectively. Retting water was collected from the retting pond. The soil was collected from a distance of 1 m from the retting pond. The water tests were carried out in the Environmental Engineering Laboratory and the soil sample was tested at the Agricultural Department. The unstable parameters such as turbidity, pH and temperature are tested using a digital meter at a sampling point itself. Other parameters such as TDS, Calcium, Phosphorous, Nitrate, Sodium, Phosphate and Potassium are analyzed in the Environmental Engineering standard laboratory as per APHA standards [6]. Soil tests were carried out in the Agricultural Soil Testing Laboratory for the determination of pH, Nitrogen, Phosphorous, Potassium, Iron, Manganese, Zinc and Copper.

III. RESULT AND DISCUSSION

3.1 Water quality Parameters

Groundwater samples analyzed in the Environmental Engineering laboratory, physical test such as Colour and Odour were identified directly and given in a table 1. Other parameters are tested by a digital meters. The various concentrations of physical and chemical parameters are given in a table2.

TABLE 1. PHYSICAL TEST RESULTS

Sample	Colour	Appearance	Odour
S1	Colourless	Clean	Odour Free
S2	Colourless	Colloidal	Odour Free
S3	Colourless	Very Clear	Odour Free
S4	Yellowish Brown	Colloidal	Odour Free
S5	Colourless	Clear	Odour Free
Retting water	Greenish Black	Turbid	Septic Smell

TABLE 2. CONCENTRATION OF PARAMETERS IN WATER SAMPLES

Sample	TDS (mg/l)	pH	Calcium (mg/l)	Nitrate (mg/l)	Fluoride (mg/l)	Phosphate (mg/l)	Sodium (mg/l)	Potassium (mg/l)
S1	30	7.1	71.36	1.5	0.246	0.59	7	2
S2	25	6.77	154.96	1	0.079	0.315	8	2
S3	30	6.1	26.5	0.764	0.509	0.41	5	3
S4	10	5.75	112.14	4.4	0.144	0.39	250	79
S5	10	6	10.19	0.56	0.068	0.29	-14	1
Retting water	45	6.8	101.95	15	0.186	0.395	183	240

a) pH

The normal range for pH in surface water system is 6.5 to 8.5 and the pH range for groundwater system is 6.5 to 8.5. The groundwater samples 3, 4 and 5 are below 6.5, so that these samples are reported as acidic. Hence it is stated that, the acidic water causes a risk for health problems in adults such as cancer, stroke, kidney disease, memory problems and high blood pressure and in children at a greater risk because their rapidly growing bodies absorb the contaminant more quickly. Acid soil, particularly in the subsurface, will also restrict root access to water and nutrients.

b) TDS

The Environmental Protection Agency (EPA) establishes standards for drinking water which fall into two categories -- Primary Standards and Secondary Standards. Primary Standards are based on health considerations and Secondary Standards are based on taste, odour, colour, corrosivity, foaming, and staining properties of water. There is no Primary drinking water standard for total dissolved solids, but the Secondary standard for TDS is 500 mg/l [7]. As per WHO, Water containing TDS concentrations below 1000 mg/litre is usually acceptable to consumers, although acceptability may vary according to circumstances. In the selected site area, TDS is acceptable for drinking water.

c) Calcium

The desired limit for calcium hardness is 300 mg/l and permissible limit is 600 mg/l. Calcium hardness is 175 mg/ l for groundwater sample 1 and hence it is hard water and hardness is within limit and can be used for drinking [8]. Calcium hardness is 380 mg/ l for groundwater sample 2 and hence it is very hard water and hardness is beyond desirable limit and not suitable for drinking Calcium hardness for groundwater sample 3 is 65 mg/ l and hence it is moderate hard water and can be used for drinking. Calcium hardness is 275 mg/ l for groundwater sample 4 and hence it is very hard water and cannot be used for drinking Calcium hardness is 275 mg/ l for groundwater sample 5 and hence it is very hard water and cannot be used for drinking. Calcium hardness is 250 mg/ l for retting water and hence it is very hard water and cannot be used for drinking.

d) Nitrate

The Environmental Protection Agency (EPA) has set the Maximum Contaminant Level (MCL) of nitrate as nitrogen (NO3-N) at 10 mg/L (or 10 parts per million) for the safety of drinking water. Nitrate in water is undetectable without testing because it is colorless, odorless, and tasteless. Domestic wells near potential point sources of contamination, such as livestock facilities or sewage disposal areas, should be tested at least once a year to monitor changes in nitrate concentration. Depending on the location of the well relative to areas where nitrogen fertilizer is applied, follow-up testing to monitor changes from non-point sources may be conducted less often [9]. All drinking water supplies should be checked at least every two or three years to assure that significant increases in nitrogen compounds (nitrate, nitrite, ammonia, and TKN) are not occurring The samples of ground water at the selected sites contain permissible nitrate concentration levels as for drinking water and retting water sample contains 15 ppm which is unfit[10].

e) Fluoride

According to WHO 1984 and Indian standard drinking water specification 1991, the maximum permissible limit of fluoride in drinking water is 1.5 ppm and highest desirable limit is 1.0 ppm. Fluoride concentrations above 1.5 ppm in drinking water cause dental fluorosis and much higher concentration skeletal fluorosis. Low concentration (approximately 0.5 ppm) provides protection against dental caries. India is among the 23 nations around the globe where health problems occur due to the consumption of fluoride contamination water and the extent of fluoride contamination in water varies from 1.0 to 400 mg/l [11]. The sample of ground water and retting water contains permissible fluoride concentration levels below 1 ppm.

f) Phosphate

There is no BIS standard permissible limit for phosphate for drinking water, while WHO (1993) has fixed it to be 0.1 mg/l. If level becomes too high, plant growth can accelerate resulting in the dense growth of algae and plants in the water body. The phosphate concentration of the groundwater samples are beyond safe limits. Phosphorus is a common constituent of agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent [12]. It is an essential element for plant life, but when there is too much of it in water, it can speed up eutrophication (a reduction in dissolved oxygen in water bodies caused by an increase of mineral and organic nutrients) of rivers and lakes.

g) Sodium

Mostly sodium present in groundwater has a concentration of less than 20 mg/l or ppm. And the WHO suggests that the permissible limit is 200 mg/l based on health based guidelines. The samples 1, 2, 3, and 5 are within permissible limits and are fit for drinking. Sample 4 is unfit and sample 6 may contain increased sodium which may affect the environment.

h) Potassium: Potassium permanganate may be used in the drinking-water treatment process. Resulting levels of potassium in drinking-water are relatively low compared with levels resulting from the use of water softeners using potassium chloride. Where potassium permanganate is used in water treatment, concentrations of added potassium can be up to a maximum of 10 mg/l, but normally concentrations would be less than this. Groundwater samples 1, 2, 3 and 5 are within permissible limits. Groundwater sample 4 contains potassium which makes it unfit for drinking purpose.

3.2 **Correlation**

Correlation is a statistical measure that indicates the extent to which two or more variables fluctuate together. A positive correlation indicates the extent to which those variables increase or decrease in parallel; a negative correlation indicates the extent to which one variable increases as the other decreases. During Winter season, there is a linear variation between pH and TDS [12]. Linear variation exists between sodium and potassium; linear variation also exists between concentration of nitrate and potassium.

3.3 **Regression and Curve Fitting**

Regression is a statistical measurement used in finance, investing and other disciplines that attempts to determine the strength of the relationship between one dependent variable (usually denoted by Y) and a series of other changing variables (known as independent variables) [5]. Regression model graphs are obtained as shown in figure 6 and figure 7.

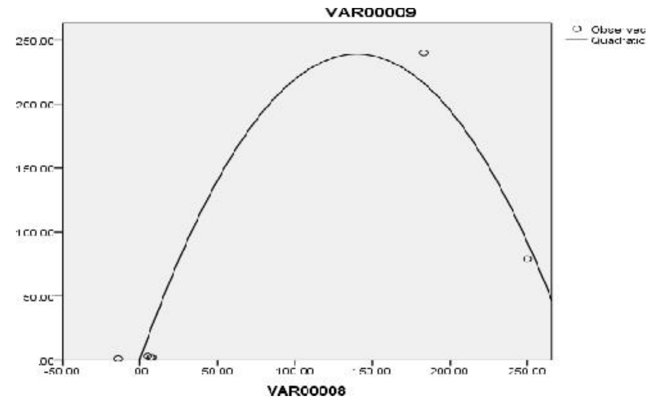

Figure 1. Quadratic Regression between Sodium and Potassium during Winter Season

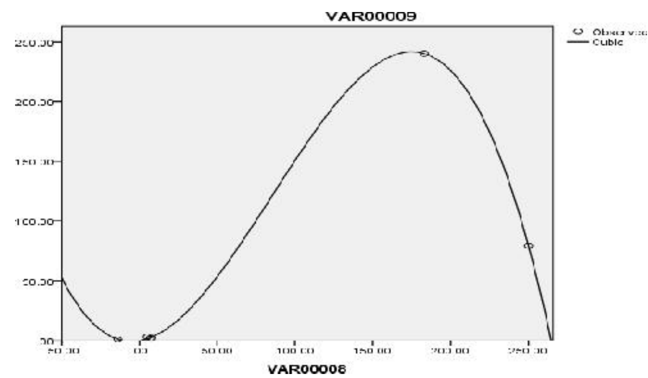

Figure 2. Cubic Regression between Sodium and Potassium

3.4 Soil characters

a. pH: The pH of the soil near the retting yard is 7 which makes the soil fall under neutral category. Soil pH in the range OF 6.0-7.0 is optimal.

b. Nitogen: Nitrate is the naturally occurring form of nitrogen in soil. This form of nitrogen is created when nitrification, the conversion of ammonium into nitrate occurs. The levels of nitrate in soil vary widely, depending upon the ty6pe of soil, climate conditions, rainfall and fertilizing practices. Plants cannot absorb the excess nitrogen in the soil. Those extra nitrogen levels slowly leaches out of the soil through water runoff; the nitrogen is effectively in the form of nitrates due to microbial conversion when it leaches from the soil[13]. As a result drinking water become contaminated from the nitrate levels. Between harming the plants and the surrounding water supplies, high nitrogen levels around plants need to be closely monitored and amended for natural harmony. Nitrogen deficiency can occur when organic matter with high carbon content is added to the soil. This is known as robbing of soil nitrogen. Nitrogen deficiency can be prevented in the short term by using manure and in long term by building up levels of organic matter in the soil.

c. Potassium: It is an essential plant nutrient and is required in large amounts for proper growth and reproduction of plants. Potassium deficiency, also known as potash deficiency, is a plant disorder that is most common on light sandy soils, because potassium ions (K^+) are highly soluble and will easily leach from soils without colloids. Potassium deficiency is also common in chalky or peaty soils with a low clay content. Use neutral pH water to remove the excess nutrients in the soil. A slight increase in potassium may cause inhibition of calcium.

d. Zinc: Zinc plays a substantial role in many biological processes and is an essential trace for health, it has also been reported to cause contamination of soil. Zinc occurs naturally in air, water and soil but zinc concentrations are rising unnaturally due to addition of zinc through human activities.

e. Iron: Soil and concentration is high, but can become unavailable for absorption if soil pH is higher than 6.5 also iron deficiency can develop if the soil is too water logged or has been over fertilized. High iron levels reduce the availability of manganese.

f. Manganese: Manganese deficiency is a wide spread problem most often occurring in sandy soils, organic soils with the pH above 6 and heavily weathered, tropical soils. In soil manganese reactions are quite complex. The amount of available manganese is influenced by soil pH organic matter content moisture and soil aeration. Manganese availability increases as soil pH decreases. Manganese toxicity is common in acid soils below pH 5.5. On the other hand manganese deficiency is most common in soils with the pH above 6.5. Manganese treatment is recommended if the soil pH is above 7 [14].

g. Phosphorous: Phosphorous availability is controlled by soil pH amount of organic matter, proper component of complex nucleic acid structure of plants which regulates protein synthesis. In acidic soil phosphorous tends to react with Al, Fe, Mn while in alkaline soil dominant fixation is Calcium. Optimum pH range for maximum phosphorous availability is 6-7. Most soil contains less than 1 pound per acre of soluble phosphorous and some soil containing considerably less. Deficiencies of Zn, Fe, Co, Ca is due to phosphorous as it lacks up nutrients.

h. Copper: Soil naturally contain copper in some form or other ranging anywhere from 2-100 ppm and high doses can be harmful. If the drinking water contains higher than normal level of copper health issues like nausea, vomiting, stomach cramps or diarrhea may occur.

TABLE 5 SOIL TEST RESULTS

Parameters	Concentration
pH	7
Nitrogen	80 mg/l
Phosphorous	51.3 mg/l
Potassium	457.95 mg/l
Iron	6.43 mg/l
Manganese	2.23mg/l
Zinc	0.42 mg/l
Copper	4.23mg/l

IV. CONCLUSION

The study has revealed that the retting process carried out in Mondaikaadu has increased the contaminants both in water and the soil. Due to the continuous generation of effluents, the ground water near the retting site have become highly acidic. The main problem in the site has been determined as acidic water. If the process carried out further, it may lead to the increased contaminants both in soil and water. Proper conservation strategies have to be undertaken for soil and groundwater.

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