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Quality of Soil in Gossaigaon Sub-Division and Its Impact on Environmental Degradation

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Abstract

People on Earth are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of water and soil. Due to increased human population, industrialization, use of unwanted amounts of fertilizers and man-made activities, water and soil is highly polluted with different harmful contaminants. Natural water and soil contaminates due to weathering of rocks and leaching of soils, mining processing etc. It is necessary that the quality of drinking water and soil should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from variety of water borne diseases. The study area, Gossaigaon sub-division of Kokrajhar district, Assam lies on the north bank of the Brahmaputra river and is slowly sloping towards south from the foothills of Bhutan upto an average height of 42 MSL. The tributaries of the Brahmaputra- Sankosh, Ripu, Dambra, Burachara, Gadadhar, Gurufella, Madati, Hel, Gongea are flowing southward which have their sources in the Himalayas. In this paper an attempt has been made to assess the quality of soil of 10 different stations by considering the parameters like Colour, Temperature, pH value, Conductance, Alkalinity, Dissolved Oxygen, Hardness, TS, TDS, Chlorine, Fluorine, Sulphur, Nitrogen, Phosphorous, Iron, Calcium and Magnesium, Sodium, Potassium, Zinc, Nickel, Lead and Copper which have direct correlation with human health.

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Keywords

Alkalinity;
Conductance;
Dissolved Oxygen MSL;
Temperature.

Introduction

The importance of the soil resource has been simply analysed by the Chinese saying that the soil is the mother of all things. It is the foundation of all life as it has many functions such as providing a medium for plant growth, water supply regulation, wastes recycling, providing a habitat for organisms and supporting human infrastructure. To maintain other resources such as water, air and wildlife habitat as well as to support and sustain crop, range and woodland production these functions are essential.

The monitoring of the soil propertyis essential to achieving sustainable land use because the soil

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resource is a very much vital constituent of our environment. Due to management influences to identify changes in soil quality and in the process gathers important data to use in model validation the AESA Soil Quality Benchmark Program measures soil parameters on a yearly basis. All development of forest and agricultural productions depends upon physico-chemical parameters of the soil used for it. The need of soil testing is increased due to different practices carried for their output and interest of the public in the calibre of products obtained from it.

Aims and Objective

The development of the concept of land quality is traced by this report and explores the use of soil chemical and physical properties attributes as the determinants of soil quality and present challenges. To help the people in this locality to know about the quality of Soil, as majority of the people are engaged in Agriculture for their sustenance.

- To determine the physical parameters such as pH and conductance of a soil sample.
- To determine the elements of soil samples in the area.
- To take the measure to improve the quality of soil for agricultural purpose.
- To differentiate the quality of soil for the cultivation.
- To fulfil the deficiency of the soil fertility.

The Study Area

The Gossaigaon Sub-Division

Geographically, Gossaigaon Sub-Division is located in the North-Western part of Kokrajhar District of Assam. It is bounded by Bhutan in the North, Dhubri District in the South, West Bengal and river Sankosh in the West and Hel River in the East. The Sub-Division has 1035.73 square k.m of geographical area with 319 revenue villages and 143 forest villages. River like Sankosh, Ripu, Gadadhar, Gurufela, Madati and Hel are the important river which are flowing from the foot hills of Bhutan towards South and touching the forest belts.

The Gossaigaon Sub-Division is geographically an interesting zone for study, having a numbers of beels and rivers.

Geographically the area lies roughly between 26°20´ N to 26°35´ N latitude and 89°46´ E to 90°10´ E longitude.

Table 1: List of Sample Number and Sampling Stations

Sample No.	Sample Stations
I	Gossaigaon
II	Kachugaon
III	Bhawraguri
IV	Srirampur
V	Jaraguri
VI	Chakma
VII	Tulshibil
VIII	Fakiragram
IX	Sherfanguri
X	Patgaon

Table 2: Guideline values (WHO) soil parameters

Parameters	Guideline level
Temperature	Acceptable
pH	6.5-8.5
Conductance	1400μScm^{-1}
Nitrogen	2.2 lbs/1000sq.feet
Phosphorous	0.1mg/kg
Potassium	150kg/ha
Calcium	500ppm
Magnesium	30mg/gm
Sodium	200mg/kg

Methodology

Collection of Samples and Sampling Stations

- Soil samples were collected in polyethylene containers. Before use, the containers were cleaned with chromic acid solution, rinsed several times with distilled water and dried thoroughly. The containers were filled up to tightly tie up to prevent agitation during transportation and to minimize with air.
- The soil samples were collected from ten different spots of Gossaigaon Sub-Division. The Sampling stations are given below.

Storage and Preservation of Samples

- Soil temperatures of different samples were measured at the time of collection of the samples.
- The parameters viz. pH and Conductance were determined within short period from collection.

For determination of the other parameters, the storage and preservation of the samples were done following standard procedure (APHA, 1995).

- Guidelines values of soil quality parameters are given in the following Table -2

Table 3: Soil quality parameters selected for this study

Sl No.	Physicochemical	Parameters	Methodology
1.		Temperature	Mercury thermometer
		pH	Digital pH meter
		Conductance	Digital Conductometer
2.	Major Anions	Carbon	Titrimetrically
		Nitrogen	Titrimetrically
		Phosphorous	Spectrophotometrically
3.	Major Cations	Sodium	Flame photometrically
		Potassium	Flame photometrically
		Calcium	Titrimetrically
		Magnesium	Titrimetrically

Result and Discussion

The result of discussion of soil quality is presented in tabular as well as diagrammatical forms and their significances are thoroughly discussed. The soil quality is examined in the basis of the experimental data.

Table 4: Temperature, pH and conductance values of the Soil samples

Samples No.	Temperature (In ^{O}C)	Ph	Electrical Conductance (Ds/M)
I	1.8	6.65	0.02
II	1.8	6.57	0.03
III	1.7	6.63	0.06
IV	1.7	6.69	0.02
V	1.6	6.55	0.01
VI	1.6	6.60	0.01
VII	1.6	6.68	0.03
VIII	1.6	6.67	0.01
IX	1.6	6.78	0.03
X	1.5	6.69	0.02

Physical Parameters

Temperature

The temperature measurements of the soil sources are enlisted in the Table-4.

The value of temperature ranges from 1.5˚C to 1.8˚C, well under the maximum permissible value due to the absence of thermal pollution in the part of Gossaigaon.

The variation is purely seasonal.

At higher temperature chemical relations becomes faster (Kataria, 2000).

Soil scientist considers a very important soil physical property is temperature and within the soil it controls many chemical and biological processes. Simply the soil temperature is the measurement of the warmth

or heat of the soil. To measure the soil temperature a mercury thermometer is used. To get an accurate reading of the soil temperature the thermometer's probe was pushed as deep into the soil as possible. For planting most plants,ideal soil temperatures are within the range 65˚ to 75˚F. For bioactivity the average soil temperatures range from 50˚ to 75˚F. These values are favourable for normal life functions of earth bio data that ensure proper organic matter decomposition, increased nitrogen mineralization, uptake of soluble substances and metabolism.

pH

pH values of the soil samples are listed in the Table -4

The values of pH of the samples range from 6.55-6.78. The highest value was recorded in the sample no.VIII at Fakiragram and the lowest value was recorded in the sample no.V at Jaraguri.

The Acidity or alkalinity of soil can be indicated by soil pH and is measured in pH units. pH of soil can be defined as the negative logarithm of the hydrogen ion concentration. Rangeof pH scale is from 0 to 14. pH of natural water is principally governed by the carbon dioxide, bicarbonate- carbonate equilibrium and generally lies in the range 6.5-8.5. (Belan F. 1988).

WHO and ICMR have recommended the maximum permissible limits of pH to be 6.5-8.5. In the present study no sample was found to have pH well below the lower limit. However, the observed variation in the pH might be due to the peculiarity of soil characteristics or other unknown causes. The values of pH of most soils are between 3.5 to 10. The natural pH of soils in higher rainfallareas typically ranges from 5 to 7, while in dry areas the pH range is within 6.5 to 9. According to their pH values soils can be classified: 6.5 to 7.5-neutral, below this level as acidic and above this level as basic.

Generally the ideal pH range is in between 6.0 to 7.0 for crops. With the help of liming pH of soil can be increased. When soil pH is too high then it can create problems for plant health and growth. For many plants high alkalinity soil makes it harder for plants to drink in nutrients from the soil, when it can limit their optimal growth.

Low level of pH causes corrosion of plant equipment, piping in the distribution system an increases metal concentration in water introducing metal ions such as Zinc, Copper, Cadmium, Lead etc. (Abbas N., Subramaniam V.1984).

Conductance

The values of the conductance of the soil samples are given in Table -4 and the values are range from 0.01dS/m to 0.06dS/m.

The highest value was recorded in sample no. III, Bhawraguri and the lowest values are recorded in sample nos. V, VI, and VIII at Jaraguri, Chakma and Fakiragram.

The maximum permissible limit of electrical conductance of soil as recommended by WHO (1993) is 1400μScm^{-1}. In the present study all conductance measurements were recorded below the permissible limit of WHO.

The soil electrical conductivity (EC) is a measure of the amount of salts present in soil. For soil health it is a good indicator. With several soil physical and chemical properties it is an indirect measurement that correlates very well. EC is the ability of a matter to conduct or transmit an electrical current and commonly expressed in units of milliSiemens per meter (mS/m). Optimum EC levels in the soil ranges from 110-570mS/m. Very low EC levels indicate low available nutrients and too high EC levels indicate an excess of nutrients.

Temperature, amount of fertilizers, salinity, moisture level, irrigation and types of soil are the several important factors that affect the EC value of the soil. The conductance of a sample corresponds to the concentrations of inorganic ions. Higher conductance refers to higher mineralisation may be caused because of perfect entrapment, ground water recharge and solubilisation of minerals from underground soil structure (Jain, 1998).

Nitrogen-Nitrate

The concentrations of nitrate-nitrogen present in the soil samples are furnished in the Table-5. The range of nitrate concentration is found to be 71.25 to 228kg/ha. The highest amount of nitrogen is present in the sample no. IX at Sherfanguri and the lowest

amount of nitrogen is present in the sample no.II at Kachugaon.

Naturally from N-fixation by soil bacteria and legumes and through atmospheric deposition in rainfall Nitrogen is added to soil. By other organic materials or fertilizers manure additional nitrogen is typically supplied to the crop. The plant cannot grow taller or produce enough food without enough nitrogen in the plant. The most common sources of nitrogen addition to soils are common fertilizers, plant residues, animal manures and sewage. NH_4-N concentration of 2-10 ppm is common. In cold, wet soils or in soils irrigated with a water supply,levels above 10 ppm NH_4-N may occur which is high in NH_4-N concentration.

Nitrate, although not harmful as such may be converted to dangerous nitrate by certain bacteria in the body which reacts with the haemoglobin of red blood cells by inhibiting their capacity to carry oxygen (N.C. Ghosh and S.M. Seth, 1994). Infants, particularly up to six months of age, are more susceptible to this condition as their gastric juice has low pH, for which a suitable environment is created for bacteria that convert nitrate to nitrite. Thus excessive nitrate may affect infants adversely causing methemoglobinemia or "blue baby disease" (Bio inorganic Chemistry- Hussain Reddy). Besides blue disease, nitrate leads to potential formation of carcinogenic nitrosamine, WHO has recommended an amount of 2.2lbs/1000 sq.ft NO_3 (10 mg/L NO_3-N) in soil. (N.Kumaraswamyetal.1997).

The present study did not record any concentrations of this parameter above the permissible limit.

Phosphorous-Phosphate

The phosphate-concentrations in the samples are presented in Table-5. In the present study the highest amount of phosphorous is found in the sample no.IV Srirampur and the lowest amount is found in the sample no. II at Kachugaon.

Table 5: Nitrogen and Phosphorous

Sample No.	Nitrogen(kg/ha)	Phosphorous(kg/ha)	Carbon (%)
I	143.0	49.6	0.30
II	71.25	40.3	0.15
III	114.0	43.0	0.24
IV	235.0	77.1	0.60
V	202.5	52.8	0.45
VI	143.0	49.9	0.30
VII	156.75	50.2	0.33
VII	156.75	51.1	0.33
IX	228.0	74.6	0.57
X	114.0	45.2	0.40

In the soil phosphate is found in organic compounds and in minerals. For nutrition of plants it is required and is an essential macro element. It participates in metabolic processes such as photosynthesis, energy transfer and synthesis & breakdown of carbohydrates. Adequate phosphorous levels promote root growth and winter hardness, stimulate tillering and hasten maturity. Primary role of phosphorous in plants is to store and transfer energy which is produced by photosynthesis for the use in growth and reproductive processes.

Soils with extractable phosphorous levels between 150 to 200ppm probably will have problems for 3 to 5 years. Soils with phosphorous levels above 330ppm will require special treatment.

Occasionally phosphate may stimulate excessive or nuisance growth of algae and other aquatic plants, as it is plant nutrient. Algal growth imparts undesirable odour to making it aesthetically unpleasant and interferes with water treatment. If consumed in excess phosphate, may produce phosgene gas in the gastrointestinal tract which on reaction with gastric juice can lead even death to consumers (Dhembare, etal. 1998). WHO has recommended 0.1 mg/kg of phosphate-P in the soil. In the present

study the samples phosphorous were recorded had phosphate concentration below the guideline value.

Organic Carbon

With a current annual increase of 0.88 ppm atmospheric CO_2 concentrations have rises from approximately 280 ppm prior to 1850, to 381.2 ppm in 2006. In the topsoil, soil organic carbon tends to be concentrated. For most upland soils, topsoil ranges from 0.5% to 3.0% organic carbon. To desert areas, soils with less than the 0.5% organic carbon are mostly limited. Soils containing greater than the 12-18% organic carbons are generally classified as organic soils.

The organic carbon- concentrations in the samples are presented in Table-5. In the present study the highest amount of organic carbon is found in the sample No. IV at Srirampur and the lowest amount of organic carbon is found in the sample No. II at Kachugaon.

In general the organic carbon content of WA dry land agricultural soils is between the range of 0.7% and 4%, although for desert soils SOC can be low as 0.3% and as high as 14% for intensive dairy soils. In many ways carbon also improves soil quality. It gives the soil structure, stores water and nutrients that plants need and feeds vital soils organisms.

Major Cation

Sodium

The sodium concentrations in the soil samples are shown in the Table-6. The ranges observed for this parameter is 0.23ppm to 0.80ppm. Saturation extract of sodium measured as 15meq/L and the amount of exchangeable sodium of 130mg/Kg is 7.4% of the total base saturation, well above 2.5% is ok for coastal soils.

The highest value is observed in sample no. IIIat Bhawraguri and the lowest concentration observed in sample no. VIII at Fakiragram.

Sodium though not health hazard for general population, may adversely affect the cardiac and kidney patient and impart a bitter taste to water at higher concentration (Tebbutt, 1998). Moreover at very high concentration sodium becomes toxic to plants and corrosive to metal surface. WHO has laid down a limit of 130mg/L of sodium in soil on the basis of taste threshold of its compound (WHO, 1993). The present record did not record any such high values of sodium concentrations.

For most field crops, 20 to 30 ppm is adequate and the optimum level will vary with crop production and soil conditions. Desirable level is 40 to 60 ppm for good production of most crops. Sodium is one of the many types of cations that are bound clay particles. It is a cation (Na^+) that is held loosely on clay particles in soil. Soil is said to be sodic when sodium makes up more than about 5% of all cations bound to the clay particles.

Potassium

The potassium content of soil samples are enlisted in the Table-6. The values of potassium were found to be fluctuating within the following range 69.35kg/ha to 129.16 kg/ha.

Table 6: Sodium, Potassium, Calcium And Magnesium In The Soil Samples

Sample No.	Sodium(ppm)	Potassium (kg/ha)	Calcium (meq/100g)	Magnesium (meq/100g)
I	0.78	86.82	1.2	1.0
II	0.64	70.16	1.0	0.8
III	0.80	77.82	1.2	1.0
IV	0.42	71.50	0.8	0.6
V	0.45	95.02	0.8	0.6
VI	0.49	97.98	1.0	0.8
VII	0.31	120.69	0.6	0.4
VIII	0.23	69.35	0.6	0.4
IX	0.69	129.16	1.0	0.8
X	0.54	85.01	0.8	0.7

The highest contents of potassium were found at in sample no. IX at Serfanguri and the lowest contents of potassium were found at sample no. VIII at Fakiragram.

Healthy soil may contain potassium in the range from 40 to 80 ppm. For proper growth and reproduction of plants, potassium is an essential nutrient for plant and is required in large amounts. The potassium content in soil may affects the shape of plant, size, color, taste and other measurements attributed to healthy production. In its ionic form K^+ plant absorb potassium. Available potassium levels will be high if a soil is amended with copious amounts of compost and plant goes naturally die and decay. Decaying plant material replenishes soils with a lot of potassium ions. Potassium increases decrease resistance, helps stalks to grow upright and sturdy, improves drought tolerance and helps plant get through the winter. It is a critical nutrient that plants absorb from the soil and fertilizers.

Naturally occurring potassium a constituent of water is found to be an important nutrient and does not have any record found for causing harmful effects on humans. However urinary excretes may full because of reduced potassium intake, (Kataria, 2000). It is the present work, potassium contents of all samples were found to be higher than the respective sodium contents.

Calcium

The concentration of calcium as recorded in water samples are given in the table-6. The variation of calcium contents in the samples are found in the range 0.6meq/100g to 1.2meq/100g. The highest concentration was recorded in the sample nos. I and III at Gossaigaon and Bhawraguri and the lowest concentration was recorded in the sample nos. VII and VIII at Tulsibil and Fakiragram.

To grow all plants need calcium rich soil. For developing the plant cell walls and membranes calcium is used by the plants. It is a non-leaching mineral and will improve water penetrability and reduce soil salinity. The greater is the soil clay content the higher is the calcium level. Higher calcium levels may result for the application of recent limestone. In the recommended range if the soil pH is maintained for the crop growth, deficiency of Ca is very unlikely.

Gypsum or Calcium Sulphate is a good Ca additive for soils that are more alkaline. Powdered lime or Calcium Carbonate is another source of calcium. Too much of Ca additive to the soil may kill plants because it raised the soil pH to levels that plants cannot stand. Most of the sandy soils have calcium concentration below 400 to 500ppm while clayey soils usually test above 2500ppm. The higher the calcium levels, the greater are the soil clay content. There is no such evidence of adverse health effects specially attributed to calcium in water. But this metal contributes to the hardness making water unfit for many of its uses due to scale formation during boiling and resultant excessive energy consumption. Physiologically, calcium in small quantities is neededfor the body though water provides only a small portion of the calcium required by the body (Srinivasetal., 2000). The guideline limit of calcium is 100mg/L (WHO, 1993). In the present study the calcium contents were found well below the guideline level.

Magnesium

The magnesium contents recorded experiments are enlisted in the Table-6. The highest concentration value was found to 1.0 meq/100g in the sample nos. I and III at Gossaigaon and Bhawraguri and the lowest concentration value was recorded in the sample nos. VII and VIII at Tulsibil and Fakiragram and the value is 0.4meq/100g.

Magnesium is a common constituent of natural water and its concentration generally remains lower than that of calcium. Although it is a harmful constituent of soil, it has laxative effects, particularly on new users if present along with sulphate in the soil sample.

A good Magnesium level in soil is 3.6 to 9% of Mg. If the level of Mg in the soil is optimum or above optimum level, a liming material which has less than 3.6% Mg should be used. Lime is not needed for pH adjustment occasionally if soils test below optimum in Mg or Ca. A little excess of Mg is not particularly harmful to us. When growing in soil, excessive amounts of the Mg do not appear quickly. Too much of Mg inhibits the uptake of Ca and the

plantswill display general symptoms of an excess of salts; stunted growth and dark coloured vegetation. In high quantities of magnesium soils the magnesium ions sitting on the clay surfaces have a 50% greater hydrated radius than the calcium which causes these soils to absorb more amount of water. Calcium loosens soil by flocculating particles and increasing pore space while Mg tightens soils by separating particles and decreasing pore space.

The maximum permissible limit of magnesium in drinking water, as prescribed by WHO is 30mg/gm (WHO, 1993). All magnesium concentrations obtained in the present study were at very much less than this limit.

Conclusion

In view of the above results obtained from preliminary investigation on a section of the river bank of Gossaigaon we can perhaps conclude that soil quality of the area is not sufficiently degraded. This may be due to use of less amount of fertilizers and no such big industry is found in the locality. However intensive as well as extensive study regarding nature and amount of various pollutants present are required in order to arrive at a concrete decision involving means to control them and for identifying the various sources of the pollutants.

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Conflict of Interest

The authors do not have any conflict of interest.

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