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Geo-environmental Impact Assessment of Soil Quality Using the Physico-Chemical Parameters of Sankari Regions Salem District Tamilnadu India

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Abstract

Soil is one of the important components of the environment that affects the growth and development of plants. Soil testing is one of the chemical processes in which the suitability of essential nutrients is determined before sowing the crops so that the demand for remaining nutrients can be fulfilled artificially by applying fertilizer in the field. A physicochemical study of soil is based on various parameters like soil pH, Electrical Conductivity (EC), Aluminum (Al), Iron (Fe), Sodium (Na), Phosphorus (P), Potassium (K), Manganese (Mn), Calcium (Ca), and Magnesium (Mg). Ten representative samples were obtained and analyzed for their alkalinity content, pH, electrical conductivity, organic carbon, sodium, and potassium. Ten soil samples were collected at a depth of 0-20 cm and analyzed for soil that was neutral to slightly alkaline. Soil pH ranges from 7.16 to 8.34, electrical conductivity from 62 to 138, aluminum oxide from 0.4 to 0.26, iron oxide from 7.7 to 12.7, sodium oxide from 9 to 31, potassium oxide from 14 to 58, manganese oxide from 2.2 to 14, calcium oxide from 32 to 188, and magnesium oxide from 6.1 to 61. This information will help the farmers know the number of fertilizers to be added to the soil to increase production.

Keywords: Soil samples • Environment • Fertilizer • Physicochemical parameters

Introduction

Soil is the most fundamental basis of life, as most of the requirements of life come from it. Copious expansion of life is found in an area that has fertile soil. Soil fertility has a connection with civilization in past history worldwide. The quick rise in the world's population demands the increase in the production of fuel, food, and fiber quantities from lands. Studies on the soil nutrient availability across landscapes have become a crucial point of ecological study [1]. Landscape position and land use may be the dominant factors of soil properties under a hill-slope and small catchment scale, landscape positions influence runoff and soil erosion and consequently soil formation Soil nutrient availability is a significant aspect of crop production control. The rapidly increasing human populations and their needs/uses of the land for various agricultural activities have brought about extensive land use changes and soil management practices throughout the world. The yield of agricultural production is highly determined by soil quality. Plants, just like other living beings, need food for their growth, development and reproduction [2].

The challenge for agriculture in the world today is to meet the world's increasing demand for food in a sustainable way and declining soil fertility and mismanagement of plant nutrients have made this task more difficult. A soil is known to be rich for agriculture depending on its nutrient content, amongst other physico-chemical factors such as soil pH. Thus, assessing the quality of soils (nutrient content) used for agricultural production is paramount for the maintenance of optimum growth conditions needed by plants for maximum yields [2].

Soil test-based nutrient management has emerged as a key issue in the effects of increasing agriculture productivity in recent years. Agriculture development has changed from conventional farming methods to more intensive practices using chemical fertilizers and pesticides with irrigation facilities. Continuous use of chemical fertilizers slowly changes soil properties; ultimately, the production in the long run is reduced. It has resulted in the leaching of chemicals into the surface and groundwater. Due to increasing demand for crops, crop practices of monoculture crop patterns have further contributed to deteriorating water as well as soil quality. Then Soil and water are the most important natural resources in the cultivation of crops. The main objectives of the study were to assess the present status of soil. The physicochemical properties like pH, Electrical Conductivity (EC), Organic Carbon (OC), available Nitrogen (N), Phosphorus (P) and Potassium (K) of soil samples from seven different sampling sites were analyzed.

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Materials and Methods

Description of the study area

The present study area, Salem district, south India, has been chosen for conducting the study. The study area is located between latitude 110 29'56.59" N to 110 30'15.92" N and longitude 770 51'19.50" E to 770 51'40.49" E. The areal extent of the selected study area is 65.25 Km^2. The limestone mines and the surrounding areas are well connected by roads. Physiographical, the area is characterized by plain topography with a gentle slope, which consists of mainly limestone associated with gneiss with hard rock formation. The climate of the area belongs to a tropical wet and dry climate. The average annual rainfall of the study area is 950.5 mm. The southwest and northeast monsoons together account for approximately 85% of the rainfall (Figure 1).

Soil sampling locating in the study area

The soil samples taken 0-20 cm in depth were collected from different locations in the vicinity of the cement plant, stone quarrying, mining, agricultural and non-agricultural soil within the study area. Each soil sample was air dried for three days and pooled together in an equal proportion to obtain a composite sample. After composite samples were grinded with a clean porcelain mortar and pestle, soils were ground and passed through a 0.2 mm sieve and were used for the analysis (Figure 2).

Soil of water: A major part of soil water is runoff or percolating water. Water in soil is in the form of soil moisture, which contains various solutes and dissolved gases. The amount of water in the form of soil moisture is estimated to range from 0.001 to 0.0005% of the total water content of the earth. The concentration of these solutes and gases differs according to their solubility, the conditions of formation of soil, water content, organics, and gases.

Soil of air: The air in the soil is not uniform in nature but a mixture of nitrogen, oxygen, and carbon dioxide. The concentration of nitrogen remains constant (79%) while oxygen and nitrogen in soils that are rich in flora and fauna due to the respiration of plants and soil organisms and the reduced diffusion of gases (Table 1).

Results and Discussion

Determination of pH

The pH measures the relative concentration of hydrogen ions in the solution. The soil pH was determined by a potentiometric pH meter using a 1:2.5 soil water suspension ratio. The value of pH shows that it lies on the alkaline side (Figure 3).

The pH of this soil is greater than 7. Alkalinity is a measure of saline or salt-effected soil. If the pH is less than 6.0, then the soil type is acidic. The soil pH ranges from 7.16 to 8.822 with an average value of 7.786. Its type is normal soil and greater than 8.5, then it is said to be an alkaline type of soil.

Determination of Electrical Conductivity (EC)

The Electrical conductivity is an important property of the soil. It indicates the total soluble salt content of the soil. The value of conductivity is the measure of ions present in the soil sample. During this process, the cations of the clay or colloidal matter are exchanged in equivalent quantities with the cations of soil and salt solutions (Figure 4). This process of exchange of cations between soil and a salt solution is known as cation exchange. The cations like Ca, Mg, Na, & K and anions such as CO_3, HCO_3, & PO_4. The conductivity values can vary with the chemical properties of the soil. The EC values of soil from the study area ranges from 62 to 138 m mho/cm with an average value of 94.50 m mho/cm.

Determination of Aluminum Oxide (Al_2O_3)

The data of analyzed soil samples generally shows that alumina comprises a relatively appreciable amount of soil chemistry. However, its concentration in the study area is extremely low; it ranges from 0.4% to 0.26%, with an average value of 3.656%. The lower alumina content may be attributed to the low content of sandy loam. Generally, alumina follows an inverse trend in that it makes up the sandy soil (Figure 5).

Determination of Iron Oxide Fe_2O_3

The concentration of Fe_2O_3 in soil samples ranges from 2.12% to 6.86%, with an average value of 4.583%. Its prescribed safe limit is 5.77% (Figure 6). The lowest iron oxide content of two soil samples may be due to the existing reducing conditions of these soils, which convert the iron oxide to the ferrous form to facilitate its mobility to deeper layers. A lack of it in the soil can have serious consequences for crop growth and yield. The remaining eight samples show an almost adequate amount of iron oxide in the study area.

Determination of Manganese Oxide (MnO)

The data of the analyzed soil samples MnO is one of the micronutrients present in the soil. It promotes the formation of organic nitrogen complexes and

Table 1. Results of soil analysis of the study area.

S. No	Sample Number	pH	EC	Al_2O_3	Fe_2O_3	Na_2O	P_2O_5	K_2O	MnO	CaO	MgO
1	S-1	7.83	62	0.8	2.12	0.58	5	31	5.4	18.0	1.11
2	S-2	7.42	98	0.5	3.14	0.32	11	38	14	5.2	3.76
3	S-3	7.16	74	0.4	4.72	0.76	11	46	2.5	18.8	1.75
4	S-4	7.21	125	0.9	6.17	2.6	4	21	5.1	7.4	1.30
5	S-5	8.82	138	0.11	5.40	1.3	6	22	2.2	5.6	0.70
6	S-6	7.75	91	0.14	4.12	0.94	3	42	9.1	3.2	2.71
7	S-7	7.93	65	0.6	4.08	0.83	33	26	1.5	4.4	0.94
8	S-8	7.71	108	0.15	4.21	2.1	3	58	3.5	4.6	0.78
9	S-9	8.22	87	0.17	6.86	1.2	2	14	11	11.2	2.03
10	S-10	7.81	97	0.26	5.01	1.07	16	18	4.6	6.8	2.19

S1-Devannagoundanur, S2-Chinnagoundanur, S3-Karumapurathanur, S4-Sankari, S5-ICl Colony, S6-ICL Plant, S7- Veerachipalaiyam, S8- Kasthuripatti, S9-Sanniyasipatti, S10-Padaiveedu

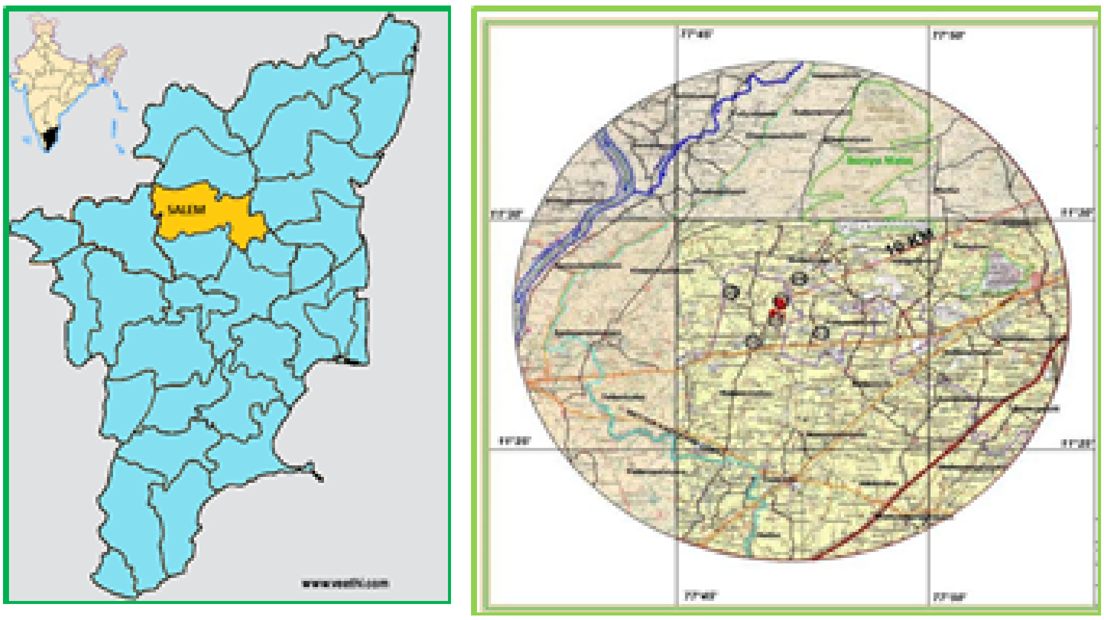

Figure 1. Location map of the study area.

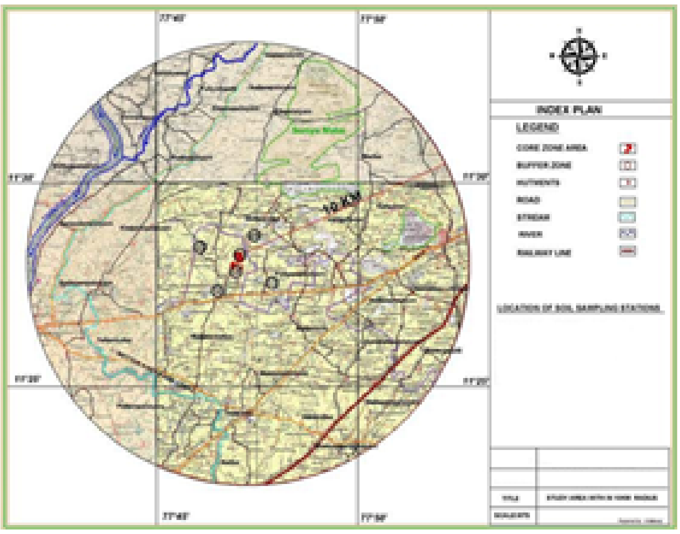

Figure 2. Soil sample locations of the study area.

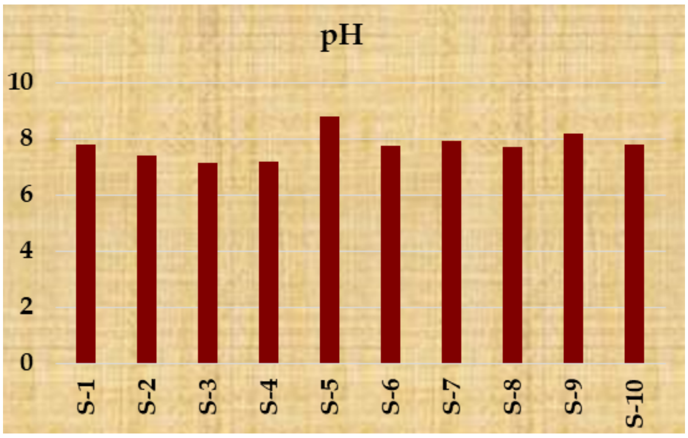

Figure 3. Physico-chemical parameters of pH.

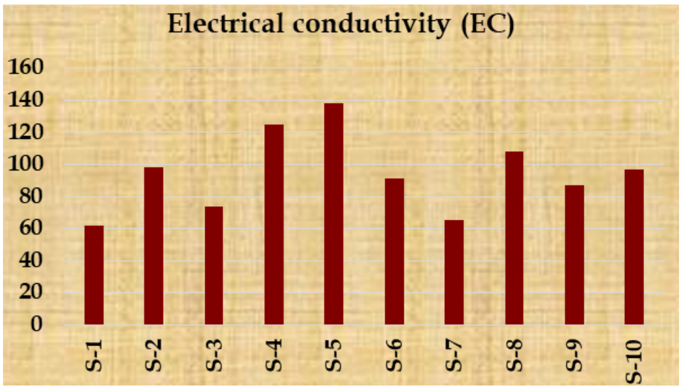

Figure 4. Physico-chemical parameters of EC.

humid substances. In the study area, its concentration varies from 1.5% to 14%, with an average value of 5.89% (Figure 7).

Determination of Potassium Oxide (K_2O)

The data of the analyzed soil samples Potassium is required by plants in approximately the same or slightly larger amounts as nitrogen. It is generally estimated by measurement of the water-soluble and exchangeable forms. Hence, the quantities of this cation extracted in most soil test procedures are simply referred to as exchangeable K. Available K levels in the soils of the region are important for determining the appropriate rates of supplemental K to apply. The concentration of potassium oxide varies from 14% to 58% with an average value of 31.6%, which is much higher than the prescribed safe limit of 1.5%. This may be due to the excessive use of potassium containing fertilizers (Figure 8).

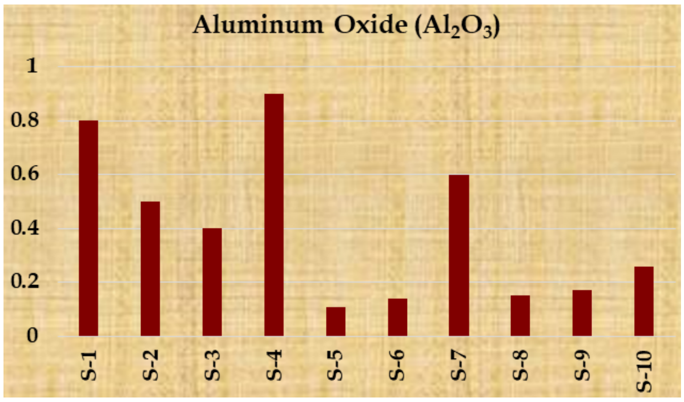

Figure 5. Physico-chemical parameters of Aluminum Oxide (Al_2O_3).

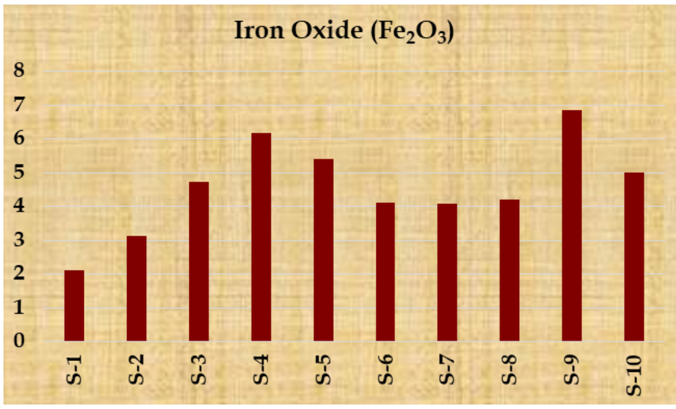

Figure 6. Physico-chemical parameters of Iron Oxide Fe_2O_3.

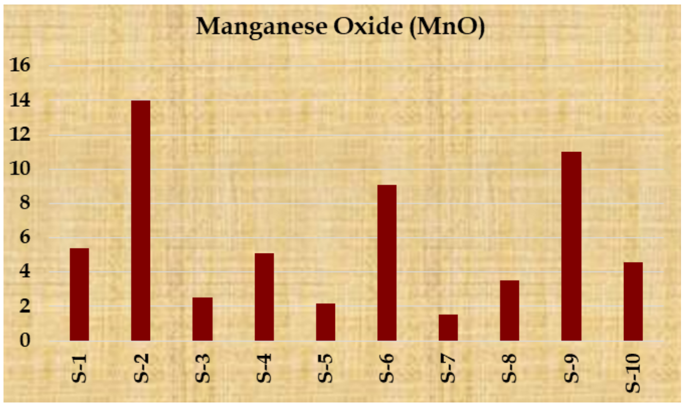

Figure 7. Physico-chemical parameters of Manganese Oxide (MnO).

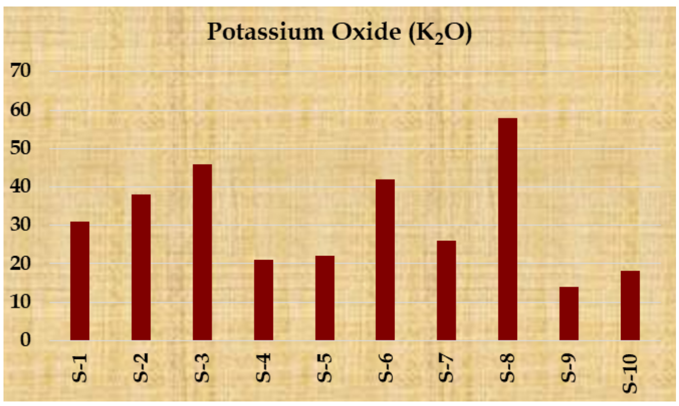

Figure 8. Physico-chemical parameters of Potassium Oxide (K_2O).

Determination of Sodium Oxide (Na_2O)

The data of analyzed soil samples shows that the sodium oxide content of

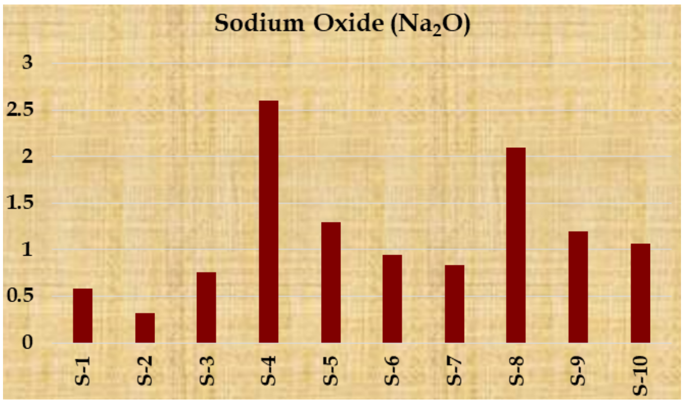

Figure 9. Physico-chemical parameters of Sodium Oxide (Na_2O).

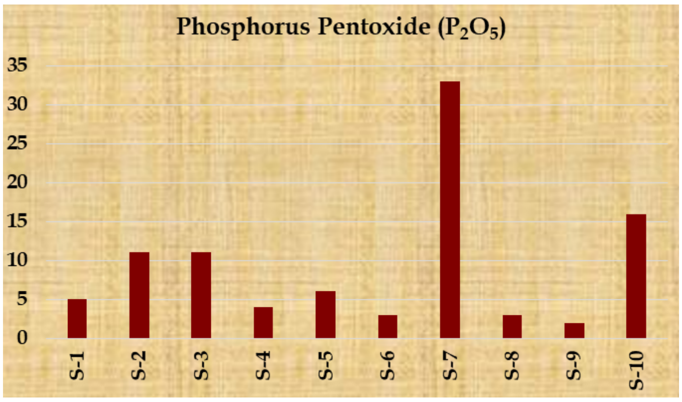

Figure 10. Physico-chemical parameters of Phosphorus Pentoxide (P_2O_5).

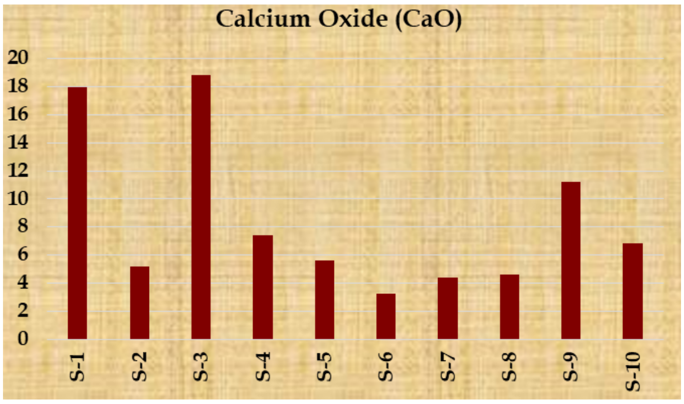

Figure 11. Physico-chemical parameters of Calcium Oxide (CaO).

the soil ranges from 0.32% to 2.6%, with an average value of 1.17%, which is less than the 1.5% safe limit. Although it is not required by the plants, it inhibits the absorption of potassium and disturbs the soil water balance. Two samples from the study area show a little higher value than the prescribed limit (Figure 9).

Determination of Phosphorus Pentoxide (P_2O_5)

The data of analyzed soil samples shows that phosphorus is unique among the anions in that it has low mobility and availability in soils. The concentration of P_2O_5 is extremely low in soil that varies from 2% to 33% with an average value of 9.4%, which is much higher than the prescribed safe limit of 5.2% (Figure 10).

Determination of Calcium Oxide (CaO)

The data of analyzed soil samples of calcium, a structural component of plant cell walls, is most abundant in plant leaves (Figure 11). It is involved in cell growth, both at the plant terminal and at the root tips, and apparently enhances the uptake of nitrate-N. The concentration of CaO differs from 3.2% to 18.8% with an average value of 8.52%, which is much higher than the prescribed safe limit of 2.5%.

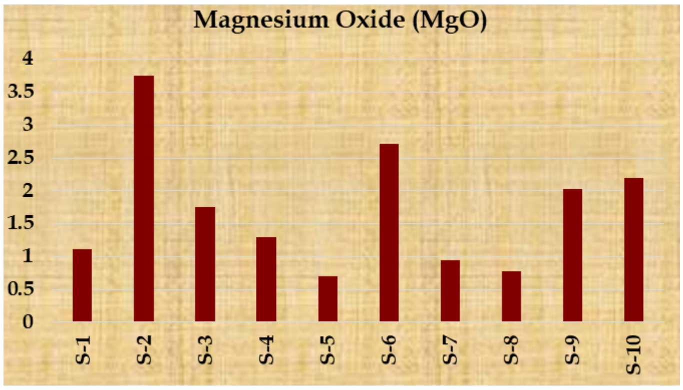

Figure 12. Physico-chemical parameters of Magnesium Oxide (MgO).

Determination of Magnesium Oxide (MgO)

The MgO data of analyzed soil samples varies from 0.708% to 3.76%, with an average value of 1.727%. Five samples show values higher than the safe limit of 1.5%. About 15%–20% of the plant Mg is found in chlorophyll, without which the plant could not capture energy from the sun for growth and development [3-19] (Figure 12).

Conclusion

The physico-chemical analysis of soils in the surrounding of the Sankari limestone mining area, it is concluded that the continuous mining activities have induced land damage. The land-use pattern undergoes a change due to the use of the land for mining, dumping, and other mining and associated activities. The mining waste causes serious pollution in terms of soil quality and causes a long-term disaster to the natural ecosystem. The pH and electrical conductivity were found in a moderate range for plant growth in the sampling sites of the limestone mining area. Potassium levels were reported to be extremely high, whereas phosphorus levels were reported to be low to medium. In a few samples, calcium and magnesium levels were also higher than the prescribed safe limit. Based on the above discussions, it can be concluded that the soil samples evaluated in this study have been found to be partially safe for plantation, vegetation, and agricultural purposes.

Acknowledgement

None.

Conflict of Interest

None.

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