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Monitoring and Assessment of Soil Quality near Kashlog Limestone mine at Darlaghat District Solan, Himachal Pradesh, India

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Abstract

Limestone mining for an area is an economic activity but may lead to degradation of soil quality. Opencast mining operations involved displacement of large amount of overburden/rock mass materials to excavate the limestone for many purposes. In mining areas the soils are affected by various mining operations i.e blasting, drilling and storage of overburden dump materials, clearing of land, construction of ancillary facilities and movement of vehicles. It is essential to determine the potential of soil in the area and identify the impacts of urbanization, industrialization and mining on soil quality. Present study is carried out to determine the soil characteristics, Impact of mining, industrialization and more importantly from agricultural point of view. Soil samples collected from ten locations were analyzed for physic- chemical characteristics. From the data it is observed that the concentration of total iron in 2 samples were above the permissible limit of 5.77%. Potassium levels were under the category very high whereas the levels of Phosphorus were reported to be in the category of less to medium. Higher potassium content of all the samples may be due to using fertilizers containing potassium. Cacium and magnesium levels are also higher than the prescribed safe limit in few samples.

Key Words: Pollution, urbanization, industrialization, mining and fertilizers

Introduction

Land is the most important basic natural resource. It is complex and dynamic combination of geology, topography, and hydrology, soil and flora fauna and influences every sphere of human activity. Mining activity exerts a long lasting impact on landscape, eco-system and socio-cultural-economic considerations. Impact of mining on land environment gets reflected in land-use pattern of the respective area because the more the land gets exposed to erosion by losing its green cover or by getting disturbed otherwise due to mining and related activities, its water resources gets damaged, soils get contaminated, part or total of flora and fauna gets lost, air and water gets polluted and the more damages go on proceeding in accelerated rates and the cumulative effects push the land towards degradation. The environmental degradation affects the flora and fauna of the region to a large extent. Due to lack of proper planning and negligence of mining regulations an appreciable amount of environmental degradation and ecological damage to soil occurs (Dhar, 1993). The magnitude and significance of impact on environment due to mining varies from mineral to mineral and also on the potential of the surrounding environment to absorb the negative effects of mining, geographical disposition of mineral deposits and size of mining operations.

General Description of the Study Area

The study area is located at Kashlog and Mangu villages Arki Tehsil, Solan District, Himachal Pardesh. It falls between latitude 31^0 13' 50.5" to 31^0 15' 28" North and longitude$76^0$55'38.5" to 77^0 0' 9.5" East and located on survey of India topo sheet no. 53A/15, 53A/16 and53E/3,4 and at an elevation of 1280-1740 m above mean sea level. The limestone mine is located at about 10 km north off the national highway (NH-88) joining Shimla and Bilaspur. The existing mine spreads over the area of 4.88 sq.km. Temperature of the area varies between 1.9^0C in winters to 24.3^0C in summers. Mean annual rainfall is 1480.6m.

Materials and Methods

A scientific, well tested and technically sound methodology is followed for performing the soil analysis. Ten soil samples were collected from the various selected sites near Kashlog limestone mine in the month April 2011 during study period representing premonsoon season. At each location soil samples were collected from three different depths ie. 30 cm, 60 cm and 90 cm below the surface and homogenized. The samples were collected and transferred to laboratory in a good quality; air tight and clean plastic bags, for the analysis. The analysis was carried out in the Department of Geology and Environmental Science Panjab University Chandigarh. The soil samples were first air dried, cleaned, crushed and passed through 2 mm mesh sieves and then analyzed in the laboratory for various physical and chemical characteristics. The soil samples were analyzed for various oxides such as SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O5 & MnO and parameters like pH and EC.

Solution A and B were prepared from the soil samples following the rapid methods of Shapiro and Brannock (1962) and Hounslow and Moore (1966) for the determination of major elemental oxides. The Solution A was used for the determination of SiO_2 and Al_2O_3 whereas Solution B was employed for the analysis of, Fe_2O_3 (Total Iron), MgO, CaO, Na_2O, K_2O, TiO_2, P_2O5 & MnO. The weight % of SiO_2, Al_2O_3, Fe_2O_3 (Total Iron), TiO_2, P_2O5 & MnO was determined by using Hilger and Watt UV spectrophotometer whereas Na_2O and K_2O by Eel flame photometer. MgO and CaO were determined by using titration methods. The pH and EC of the soil was determined electrometrically using a pH meter and conductivity meter. USGS Rock standards were used for the calculation of weight percentage.

Results and Discussions

The analytical data of the soil samples collected from the study area is given below in the table 1. The soil at all the sampling locations were reported to be (coarse) sandy loamy in texture.

pH and Electrical conductivity

Soil pH is a measure of hydronium ion (H_3O+ or, more commonly, H+) activity in a soil suspension. This property influences many aspects of crop production and soil chemistry, including availability of nutrients and toxic substances, activity and diversity of microbial populations, and activity of certain pesticides. pH value of soil samples from the study area varies from 6.8 to 7.6 with an average value of 7.25, which is the medium range of ph and shows that the soil is alkaline in nature. EC varies from 198 to 284 m mhos/cm with an average value of 240.4 m mhos/cm.

Silica (SiO_2) and Alumina (Al_2O)

The data of analyzed soil samples shows that the silica content of the soil varies from 43.96% to74.30% with an average of 52.793%. Higher silica content shows that the soil is coarse sand in texure. Generally alumina makes up a relatively appreciable amount of soil chemistry. But in study area its concentration is very low; it varies from 12.07% to 20.61% with an average value of 16.343 %. The lower alumina content may be attributed to their low content of clay.

Generally Silica and alumina follows an inverse trend in soil as silica is a part of sandy soil whereas alumina makes the clay soil.

Iron oxides (Fe_2O_3) and FeO%

The concentration of Fe_2O_3 varies from 2.14% to 6.77 % with an average value of 4.672%. Its prescribed safe limit is 5.77%. Lowest iron oxide content of two soil samples may be due to the existing reducing conditions of these soils which converted the iron oxide to ferrous form to facilitate its mobility to deeper layers. Its deficiency in soil can cause severe impacts on growth and yield of crops (Marschner 1995). Rest eight samples shows almost adequate amount of iron oxide in the study area. FeO content of soil samples varies from 0.75% to 2.13% with an average value of 1.737 %.(Fig. 3).

K_2O

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 soils of the region are important for determining the appropriate rates of supplemental K to apply. Table 1 show that concentration of potassium oxide varies from 4.1% to 7.8% with an average value of 6.09 % which is much higher than the prescribed safe limit of 1.5 % (Bohn et al 2001). This may be due to the excessive use of potassium containing fertilizers.

Na_2O and P_2O_5

Sodium oxide content of the soil varies from 0.7% to 1.6% with an average value of 1.17 % which is below the safe limit of sodium oxide in soil ie. 1.5% (Bohn et al 2001). Although it is not required by the plants as it inhibits the absorption of Potassium and also disturbs the soil water balance (Pendias and Pendias 1992). Two samples from the study area show little higher values then the prescribed limit (Fig. 3). Phosphorus is unique among the anions in that it has low mobility and availability in soils. The concentration of P_2O_5 is very less in soil that varies from 0.13% to 1.02% with an average value of 0.357 %.

CaO and MgO

Calcium, a structural component of plant cell walls, is most abundant in plant leaves. It is involved in cell growth, both at the plant terminal and at the root tips, and apparently enhances uptake of nitrate-N. The concentration of CaO differs from 2.54% to 7.07 % with an average value of 4.662% which is much higher than the prescribed safe limit of 2.5% (Bohn et al 2001). MgO varies from 0.609 % to 3.06 % with an average value 1.6226. Five samples show the values higher than the safe limit of 1.5 %. About 15-20% of the plant Mg is contained in chlorophyll, without which the plant could not capture energy from the sun for growth and development.

MnO and TiO_2

MnO is one of the micronutrient present in the soil. It promotes the formation of organic nitrogen complexes and humic substances . In the study area its concentration varies from 0.009% to 0.106 with an average value of 0.0245 %. The concentration of TiO_2 varies from 0.5936 % to 1.4616 % with an average value of 0.96712%.

Conclusions

On the basis of physico chemical analysis of soils in the surroundings of Kashlog limestone mining area, it is concluded that the continuous mining activities has 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 wastes causes very serious pollution in terms of soil quality and causes a long term disaster to the natural ecosystem. pH and electrical conductivity have been found moderate in range for plant growth in the sampling sites of limestone mining area. Potassium levels were under very high category whereas the levels of Phosphorus were reported to be in the category of less to medium. Calcium and magnesium levels are also higher than the prescribed safe limit in few samples. From the above discussions it can be concluded that the soil samples evaluated in this study has been found partially safe for plantation, vegetation and agricultural purposes.

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Table 1 Results of soil analysis of samples from study area.

S.No.	Locations	pH	EC	SiO_2	Al_2O_3	FeO	Fe_2O_3	Na_2O	P_2O5	K_2O	MnO	CaO	MgO	Ti O_2
1	Ratoh	7.6	234	50.15	12.07	1.77	2.14	1.1	0.26	4.6	0.01	4.68	1.102	0.594
2	Banog	7.0	222	43.96	20.61	1.33	3.15	1.6	1.02	7	0.106	6.06	3.06	1.030
3	Chakru	7.4	250	60.88	18.46	1.90	4.79	1.6	0.17	7.2	0.008	4.23	1.624	1.025
4	Mangu	7.5	284	59.03	16.95	1.73	6.10	0.7	0.23	6.1	0.026	4.81	1.392	0.963
5	Dhar	7.2	245	68.52	16.12	2.13	5.48	1.4	0.37	5.1	0.018	2.54	0.609	0.711
6	Serjeri	6.9	238	53.45	13.40	2.13	4.16	1.3	0.28	7.8	0.009	4.88	2.175	1.462
7	Chandi	7.2	198	74.30	16.06	1.55	4.11	1.2	0.13	4.1	0.007	3.12	0.783	0.913
8	Kashlog	7.5	228	64.60	16.44	0.75	4.54	1.1	0.17	5.6	0.016	4.16	0.87	0.773
9	Gyana	7.4	255	53.04	14.67	2.09	6.77	1	0.32	6.9	0.024	5.07	2.32	1.154
10	Barsanu	6.8	250	52.01	18.65	1.99	5.48	0.7	0.62	6.5	0.021	7.07	2.291	1.047

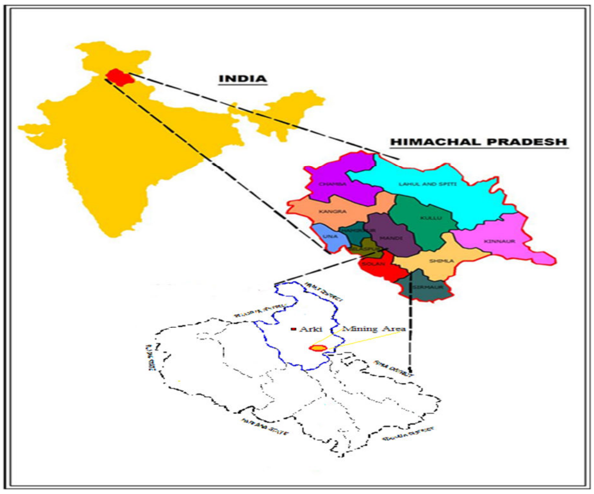

Fig. 1 Showing location of the Study Area

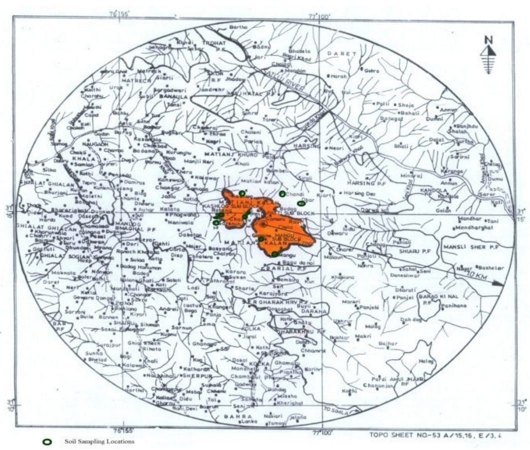

Fig. 2 Soil Sampling Location of the Study

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Area

Fig. 3 Graphs Showing Physico-Chemical parameters of Soil Samples in the Study Area