

## Impact of Coal Mining on Soil Characteristics of Simsang River, Meghalaya, India

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### Abstract

This paper deals with the studies on soil quality parameters of Simsang River, Meghalaya affected by acid mine drainage of coal mines from January 2014 to December 2015. It has been observed that the soil quality in mostly affected areas of the River have relatively low pH ( $4.6 \pm 2.91$ ), low nutrients (nitrogen, phosphorus and potassium) content, organic carbon ( $0.77 \pm 2.86$ ) and which has decreased gradually from coalmine unaffected and affected areas of the river. Certain heavy metals in high concentration (Fe, Zn, Pb, Ni and Mn) were also detected from soil of the River.

**Keywords:** Coal mining; Meghalaya; Soil; Simsang river

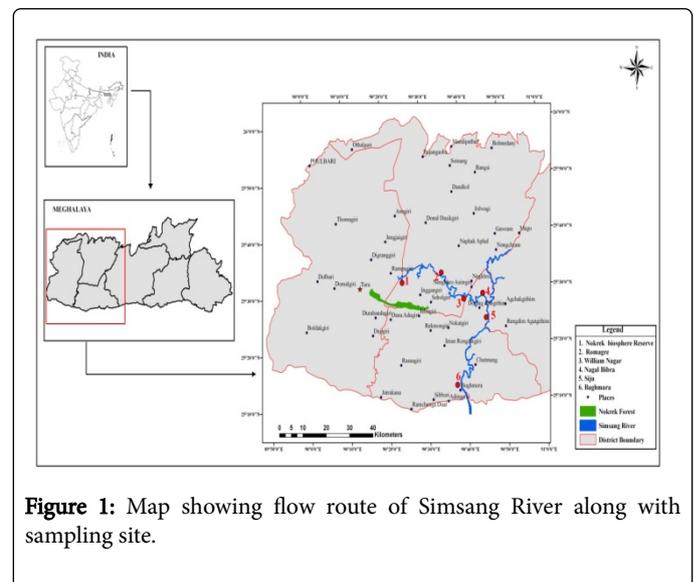
### Introduction

The Simsang River is the longest River of the Garo hills which is also known as Someswari River in Bangladesh. It originates from Nokrek peak (now declared as Nokrek Biosphere Reserve) located about 1412m MSL [1]. However, from last few decades the river has witnessed huge ecological damage due to influx of acid mine drainage (AMD) of coal mining which in turn immensely impacts on the surrounding environments, though coal contributes greatly to the economic development of the state. AMD consists of many interrelated problems; the pyrite in the rock gives rise to low pH and coal mining may cause soils to be contaminated by heavy metals [2]. High metal concentration in the coal mining areas may lead to its bioaccumulation in fish tissue which leads to fish mortality [3]. Topsoil is an essential component for land reclamation in coal mining areas [4]. The topsoil is very badly damaged if it is not mined out separately in the beginning, with a view to replacement for due reclamation of the area. Hence, it is a major concern to know the current conditions of the soil quality of Simsang River which flows around the coal field of Garo hills. Coal mines and its effects on soil characteristics of a river has not been undertaken till now, so this type of investigation will provide a baseline data for such type of study.

### Materials and Method

Six study sites were (from upstream to downstream) selected (Figure 1); near Nokrek biosphere reserve (S<sub>1</sub>, (longitude 90°23′59″E and latitude 25°31′21″N) free from coal mining activities), near Rombagre, (S<sub>2</sub>, (longitude 90°34′21″E and latitude 25°32′41″N) free from coal mining activities and local villagers declared 1<sup>2</sup> km of the river as fish sanctuary), williamnagar (S<sub>3</sub>, (longitude 90°39′43″E and latitude 25°27′36″N) coal dumping are found regularly at the bank of the river and as well as municipal wastes are also found dumping regularly in the site), Nangalbibra (S<sub>4</sub>, (longitude 90°44′39″E and latitude 25°28′22″N) maximum coal mining activities are practiced in the hills of vicinity), near siju, (S<sub>5</sub>, (longitude 90°45′22″E and latitude

25°23′46″N) coal mining activities are practiced and the area where caves are found in the nearby hills) and Baghmara (S<sub>6</sub>, (longitude 90°37′9″E and latitude 25°12′1″N) coal dumping activities are found at the bank of the river and transportation of coal through boat are found).



**Figure 1:** Map showing flow route of Simsang River along with sampling site.

The collected soil samples were air dried at room temperature and lightly crushed with mortar pastels and passed through 2 mm sieve and stored for laboratory analysis. Various physico-chemical parameters viz. pH, phosphorus, nitrogen, potassium were analyzed following standard analytical procedures [5,6]. The organic carbon content was determined followed after Walkley-Black wet oxidation method [7]. For heavy metal analysis, nitric-perchloric acid digestion method was applied and concentrations were quantified using Atomic Absorption Spectrophotometer (Varian SpectraAA-220 AAS).

## Results and Discussion

Analysis of sediment plays a very important role in assessing the pollution status of the environment [8]. There was fluctuation in the values of different physico-chemical parameters of soil assessed throughout the annual cycle. The pH of soil is the measure of the hydrogen ion activity and depends largely on relative amounts of the absorbed hydrogen and other metallic ions. Thus, it is a good measure of acidity and alkalinity of a soil suspension, and provides a good

identification of the soil chemical nature. The pH of sediment of Simsang River is acidic in nature in two sites, i.e. site 4 and 5.

The organic carbon plays an important role for determining the soil fertility and soil productivity. Estimated value of organic carbon has showed decreasing trend from unaffected areas to affected areas (Table 1). Low organic carbon was because of burning out of organic matter present in the soil, low rate of humification and lack of microbes soil and all are as a result of ongoing coal mining activity.

Parameters	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	S <sub>6</sub>
pH	7.6 ± 0.52	7.4 ± 0.28	8.2 ± 0.93	4.6 ± 2.91	5.2 ± 4.66	6.9 ± 1.21
Organic carbon(Kg ha <sup>-1</sup> )	1.95 ± 0.02	2.02 ± 1.32	2.03 ± 0.12	0.77 ± 2.86	1.04 ± 3.16	2.03 ± 1.43
Nitrogen (Kg ha <sup>-1</sup> )	39.2 ± 2.81	32.3 ± 1.42	20.8 ± 0.82	8.01 ± 6.02	10.96 ± 6.81	22.8 ± 0.006
Phosphorus (Kg ha <sup>-1</sup> )	1.3 ± 0.09	1.8 ± 1.88	1.2 ± 0.53	0.1 ± 0.004	0.2 ± 0.65	1.15 ± 1.38
Potassium (Kg ha <sup>-1</sup> )	4.9 ± 0.05	5.1 ± 1.24	5.2 ± 0.69	3.1 ± 0.06	2.6 ± 1.44	3.98 ± 2.96
Fe (mg kg <sup>-1</sup> )	29.2 ± 7.87	31.9 ± 7.83	38.9 ± 9.33	155.8 ± 73.89	123.5 ± 97.3	28.44 ± 9.05
Zn (mg kg <sup>-1</sup> )	5.23 ± 0.11	8.54 ± 0.55	9.29 ± 2.90	131.8 ± 51.89	127.26 ± 60.1	45.7 ± 0.66
Cu (mg kg <sup>-1</sup> )	0.01 ± 0.06	0.01 ± 1.85	0.03 ± 1.61	10 ± 5.93	7.9 ± 4.8	0.61 ± 1.59
Mn (mg kg <sup>-1</sup> )	1.59 ± 0.07	2.24 ± 0.03	3.87 ± 0.81	76.9 ± 26.91	65.36 ± 25.86	1.98.7 ± 0.92
Pb (mg kg <sup>-1</sup> )	0.31 ± 0.16	.42 ± 0.075	.61 ± 1.93	42.3 ± 19.56	29.7 ± 21.27	1.5 ± 0.81
Cd (mg kg <sup>-1</sup> )	0.09 ± 0.13	0.07 ± 1.32	0.26 ± 0.07	0.7 ± 1.05	0.72 ± 0.57	0.13 ± 0.01

**Table 1:** Mean and standard deviation of certain physico-chemical parameters of soil samples in different study sites of simsang river, Meghalaya.

The available nitrogen content fluctuated throughout the annual cycle. The minimum and maximum value recorded at site 4 and site 1 respectively. Lower value of nitrogen in affected sites is due to loss of organic carbon which contains nitrogen and nitrogen fixing microorganisms in soil.

The soil samples collected from different sampling sites estimated to be very low in phosphorous content compare to its standard value. However, its trend progressively decreases from the monsoon to winter (Table 1). Low phosphorus in soil was due to its presence in insoluble state or due to lack of organic matter in soil.

The analysis of heavy metals in sediment samples helps in the interpretation of water quality [9]. The levels of Fe, Zn, Ni and Pb found in the site 4 and site 5 samples and were significantly higher than other sites, but the levels of Co, Cr and Cd were lower than the permissible limit in all the sites. Also, the concentrations of Fe, Ni, Pb, and Zn were higher in monsoon than the other season following the order Fe > Ni > Pb > Zn. The high concentrations of heavy metals were present in the river sediments due to influx of untreated AMD beside natural sources. In the present investigation, it has been observed that the changes in soil quality were found to be drastic and continually deteriorating and as a result of which some of the areas of Simsang River soil became unfertile.

Though coal mining has negative impacts, coal is an important source of energy. It is not possible to stop the mining but it may possible to minimize the hazardous effects of mining. The government and policymaker should take some proper steps specially local peoples

should take initiatives. Some of the important recommendations include:

- Mining policy must be implemented and applied accordingly in reality.
- Awareness programme should be organized on about the negative impacts or risks of mining activities on human health as well as on the surrounding environment such as on soil and water quality for agricultural purposes.
- Mine drainage water must be run out properly and carefully after treatment of the water.

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