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Water Quality Analysis From The Coal Mine Areas

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INTRODUCTION

Meghalaya, one of the seven states of north-eastern region of India is rich in mineral resources such as coal, limestone, sillimanite, uranium etc. Coal is one of the most exploited minerals in the state with an estimated reserve of 619 million tonnes (Directorate of Mineral Resources, 1974). Coal and limestone are mainly found in Khasi Hills, Garo Hills and Jaintia Hills of the state. The total coal reserve of Meghalaya is about 560 million tonnes. The total coal and limestone reserves in Jaintia hills have been estimated to be about 40 and 1,050 million tones, respectively. These reserves are mainly situated in Sutnga, Lakadong, Musiang - Lamare, Khliehriat, Ioksi, Ladrymbai, Rymbai, Bapung, Jarain, Shkentalang, Lumshnong and Sakynphor. Mining operations in Meghalaya is being done mainly with the most traditional and unscientific methods and have led to massive environmental degradation. It affects the land, water and community health, particularly when the ecological and occupational considerations are not given due importance. Extraction of coal in Jaintia hills is done by primitive mining method commonly known as 'rat-hole' mining. In this method, the land is initially cleared by cutting and removing the ground vegetation, and then pits ranging from 5 - 100 m^2 are dug vertically in the ground to reach the coal seam. Thereafter, horizontal tunnels are made into the seam for extraction of coal, which is brought back to the pit by using a conical basket or a wheelbarrow. The entire process of mining is done manually employing small implements. While digging the pits, the pieces of soil and rocks above the coal seams are thrown haphazardly outside the pit creating coal mine spoils that cause large-scale destruction to the surrounding agricultural cropland and vegetation, often beyond replenishment. The prevailing land ownership system encourages this kind of unscientific mining operation in tlie area (Lyngdoh et al. 1992; Das Gupta 1999; Swer and Singh 2005).

Water draining from mining areas are often seriously affected by run-off from operating and abandoned mine workings. Effluents typically consists of acid mine drainage (AMD), eroded material from mine tailing deposits and waste from ore processing operations (Salomons 1995). AMD is a result of complex and interactive suit of physical, chemical and biological processes operating within the waste material. Acid mine drainage originating from mine and coal spoils, leaching of heavy metals and organic enrichment by various anthropogenic activities are the main sources of water pollution which has serious implications on aquatic life, agricultural activity and availability of potable and irrigation water in the area.

REVIEW OF LITERATURE

Mining operations, which involve minerals extraction from the earth's crust tends to, make a notable impact on the environment, landscape and biological communities of the earth (Down & Stocks, 1997 and Bell *et al.* 2001). Unscientific mining of minerals poses a serious threat to the environment, resulting in reduction of forest cover, erosion of soil at a greater scale, pollution of air, water and land and reduction in biodiversity (UNESCO, 1985). The problems of waste rock dumps become devastating to the landscape around mining areas (Goretti, 1998).

Direct disposal of wastes causes deterioration of water quality and loss of productivity of aquatic bodies (Mishra 1992; Mishra and Tripathi 2001; Mishra and Tripathi 2003). In mining areas, water showed a drastic change in pH, salinity, acidity, and toxic elements, which significantly impact water quality and natural ecosystems, and it has become a serious environmental problem around the world (Dudka and Adriano 1997; van Green et al. 1999). Swer and Singh (2004) studied the deposition of silt at the bottom of rivers and streams flowing in mine areas of Jaintia hills, Meghalaya and found that siltation due to mining severely affect the water quality.

Ibandarisuk Lyngdoh and Highland Kayang, Microbial Ecology Laboratory, Department of Botany, NEHU, Shillong, study on the Impact of Coal Mine Drainage on Water Quality and Microbial Ecology of Streams in Jaintia Hills, Meghalaya during 2012. It is evident from the analysis of the different parameters that the water qualities are deteriorating due to coal mine drainage which found their way into the streams. The pollution level in some of them has reached the toxic level, making their waters unfit for human use. This can also be indicated by the decline of fungal and bacterial species diversity when compared to the reference site. The rapid and unscientific mining activities in and around the streams of Jaintia Hills, the corresponding rise of untreated mine wastes which flows into the water bodies, the streams and also rivers may be subjected to even more pronounced effects than those described in this study, limiting their future use for domestic, recreational, agricultural and industrial purposes. Any remediation efforts will have to consider the implementation of anti-pollution measures in the form of solid waste disposal at designated sites away from water courses and slopes, and the development of educational programs aimed at raising awareness of the pollution problem and the need for its prevention. Our findings suggest that further studies characterizing the streams in the polluted sites and a more detail study on microbial taxa may help to develop scientific criteria for pollution monitoring and in developing remediation strategies in the coal mine affected sites.

K. Sarma and S.P.S. Kushwaha study on Coal Mining Impact on Land Use/Land Cover in Jaintia Hills District of Meghalaya, India Using Remote Sensing and GIS Technique. The present study was undertaken to analyze the process of human-induced landscape transformation in the coal mined affected areas of Jaintia Hills district of Meghalaya, northeast India by interpreting temporal remote sensing data using geographic information system. The study revealed that most of the areas were dominated by grassland/non- forest in all the time sequence period of the study. The area under forest cover had decreased about 12.5% and there was about three fold increase in mining area since 1975 to 2007. The area under settlement showed an increasing trend, however, cropped area showed a decreasing trend in time sequence. The total forest area lost during the study period was 43.38 km2, while an increase of 3.23 km2 was recorded in open forest area from 1975-2007. The change analysis of land use/land cover showed that there was decrease in dense forest to open forest and dense forest to mining areas in temporal series. The present study revealed that mining activities were detrimental to the vegetation. Thus, it is advisable that such activities have to be strictly regulated to avoid further damage and scientific mining has to be taken up in a proper manner to minimize the damage to the vegetation. Appropriate rehabilitation measures using those plants which may grow need to be taken up in the mine-affected areas (Sarma, 2005). The present change analysis can be useful to find out the change in different land use/land cover pattern in mine affected areas and it will be also helpful to delineate the vegetation areas under risk due to mining activities. The findings of the study could be useful while formulating the Management Plan for the district.

Dr. Wansah Pyrbot and Prof. R.C.Laloo (2014) Ecology Laboratory Department of Botany North Eastern Hills University Shillong a research study on Toxic Elements of River Myntdu in Jaintia Hills District Meghalaya, according to the finding the quality of river has deteriorated year by year due to the continuous discharge of domestic waste and coalmine seepage from various drains to the tributaries of Myntdu River. The influx of untreated acidic mine drainage and solid and liquid waste into river and streams can severely degrade both habitats and water quality and often produce an environment devoid of most aquatic life and unfit for healthy habitation. Therefore, comprehensive river water quality monitoring program is becoming a necessity in order to safeguard public health and to protect the valuable and vulnerable freshwater resources.

Dr.Hygina Siangbood and Papiya Ramanujam a research study on the Effect of Anthropogenic Activities on Algal assemblages in Umiew river, Meghalaya (2014) Algal Ecology Laboratory, Centre for Advanced Studies in Botany, North Eastern Hill University, Shillong, Meghalaya. The present paper deals with the response of algal assemblages to the changes in water quality resulting in Umiew river, the main source of water supply in the region. The river is undergoing changes at a very fast pace due to deposition of agricultural wastes and remains of lime and sand quarrying at different points. From the present study, the analyzed river water indicated that the water in river Umiew is low in nutrients and oligotrophic. The algal assemblages of Umiew river with dominance of Bacillariophyceae and Chlorophyceae and with many desmids species confirmed the oligotrophic nature of the river water. Agricultural activities along the catchment increased the nutrient concentrations particularly nitrogen which influenced the algal assemblages of the river positively whereas quarrying of lime stone increased the calcium content and turbidity in the river and favour the growth of Bacillariophyceae group.

Sumarlin Swer and O.P.Singh a research study on Water Pollution in Coal Mining Areas of Jaintia Hills, Meghalaya and its Impact on Benthic Macro invertebrates in Jaintia Hills District, Meghalaya. According to their finding the colour of rivers and streams of coal mining areas was observed to be brownish to reddish orange. River Waikhyrwi of Sutnga and Thwai-Kungor of Bapung exhibited brownish colour while that of rivers Rawaka, Kmai-um and stream Metyngka were reddish brown. On the other hand, the colour of Ummynkseh and Umkyrpong was brownish orange and light orange respectively. The formation of iron hydroxide (discussed later) due to acid mine drainage is the main cause for the change in water colour. Consequently, the rivers and streams of the area showed low pH, high conductivity, high concentration of sulphates, iron and many toxic heavy metals, low Dissolved Oxygen (DO) and high BOD. All these parameters characterize the degradation of water quality and diminish the life supporting function of the water. As a result, there is a drastic depletion of aquatic life, particularly of aquatic animals in the area. AMD (Acid Mine Drainage) is the greatest environmental problem of the mining sector. The AMD is generated both by active and abandoned mines and is a serious liability, especially to our water bodies. It has the potential for long-term, devastating impacts on water and land and their flora and fauna. 'The AMD is formed when pyrite is exposed and reacts'--with air and water to form sulphuric acid and dissolved iron. Some or all of this iron can precipitate to form the red, orange or yellow sediments in the bottom of streams containing mine drainage. The acid runoff further dissolves heavy metals such as copper, lead, mercury into ground or surface water. The rate and degree by which acid mine drainage proceed can be increased by the action of bacteria.

S. Jeeva (2007) Department Of Botany North- Eastern Hill University, Shillong a research study on Impact of Mining on Plant Diversity and Community Structure of Aquatic and Terrestrial Ecosystems of Jaintia Hills, Meghalaya reported that Mining operations have a number of irreversible impacts on the surrounding environment and ecosystems. The more obvious impacts are deforestation, changes in soil and water regimes and enhanced rates of erosion. Mining operations alter ecosystem structure and function of both aquatic and terrestrial ecosystems. Environmental problems associated with mining have been felt severely because of the region's fragile ecosystems and rich biological and cultural diversity. Large scale denudation of forest cover, scarcity of water, pollution of air, water and soil and degradation of agricultural lands are some of the conspicuous environmental implications of coal mining. Besides, a vast area have become physically disfigured due to haphazard dumping of overburden, caving in of the ground, and subsidence of land. The impact of mining on vegetation, soil and water quality of Jaintia Hills of Meghalaya was significant. The most severe environmental impact of mining activity is degradation of water quality. The water in the downstream of the coal mining area was highly acidic, on the contrary in limestone mining area it was found to be alkaline. The hardness of water, calcium and magnesium content also changed due to mining activity. Chloride content increased due to mining. The impact of AMD was more acute during rainy season. These changes make the water polluted unusable even for agricultural purposes. Low DO and high BOD were recorded especially in the downstream of the mining sites. The results indicate that mining alters the biological and physicochemical properties of water in the aquatic ecosystems of the mining areas.

Mining operations in Meghalaya is being done mainly with the most traditional and unscientific methods and have led to massive environmental degradation. It affects the land, water and community health, particularly when the ecological and occupational considerations are not given due importance. Extraction of coal in Jaintia hills is done by primitive mining method commonly known as 'rat-hole' mining. In this method, the land is initially cleared by cutting and removing the ground vegetation, and then pits ranging from 5 - 100 m2 are dug vertically in the ground to reach the coal seam. Thereafter, horizontal tunnels are made into the seam for extraction of coal, which is brought back to the pit by using a conical basket or a wheelbarrow. The entire process of mining is done manually employing small implements. While digging the pits, the pieces of soil and rocks above the coal seams are thrown haphazardly outside the pit creating coal mine spoils that cause large-scale destruction to the surrounding agricultural cropland and vegetation, often beyond replenishment. The prevailing land ownership system encourages this kind of unscientific mining operation in the area (Lyngdoh et al. 1992; Das Gupta 1999; Swer and Singh 2005).

Bondita Goswami (2008), a research study on Remediation for Rice Cultivation on Soil Affected by Coal Mining in Jaintia Hills, Meghalaya, North-Eastern Hill University, Shillong in Environmental Science according to his finding the mining activity has deteriorated the soil quality of the area. As a consequence, many farmers have abandoned the farming activity. Agricultural fields have been adversely affected by acidification of soil as well as by deposition of coal and sand particles on soil surface. Significant increase in soil acidity has negative impact on soil fertility, biological activity and plant productivity. Moreover Rice is the major agricultural crop grown in Jaintia Hills district followed by maize, potato, minor cereals, oilseed crops and vegetables. As the fertility status of crop fields are deteriorating due to both physical and chemical degradation caused by waste products of coal mining areas including Acid Mine Drainage (AMD), it was felt to evaluate the overall scenario of agricultural production in Jaintia Hills district and to find out some remedial measures so that the crop sustainability can be maintained by improving the existing situations and farmers of the area can earn better economic return from their agriculture.

Subhasish Das Gupta (1999) researches study on Studies on Vegetation and Microbiological Processes in Coal Mining Affected Areas in Bapung, Jaintia Hills District, Meghalaya. The study revealed that coal mining has adversely affected the soil, vegetation and soil microorganisms in the coal mining affected areas of Jaintia Hills district of Meghalaya. Such habitats do not permit proper plant growth and development and it take several years for the mine spoils to restore naturally. The study also reveals that fertilizer amendments could be tried for accelerating the ecorestoration of these coal mine spoils. The present study indicates that under the conditions prevailing in the Jaintia Hills area, the mine spoils are likely to recover over a span of time, to the level of the undisturbed site. The study also reveals that fertilizer amendments could be tried for accelerating the ecorestoration of these coal mine spoils. The present study indicates that under the conditions prevailing in the Jaintia Hills area, the mine spoils are likely to recover over a span of time, to the level of the undisturbed site.

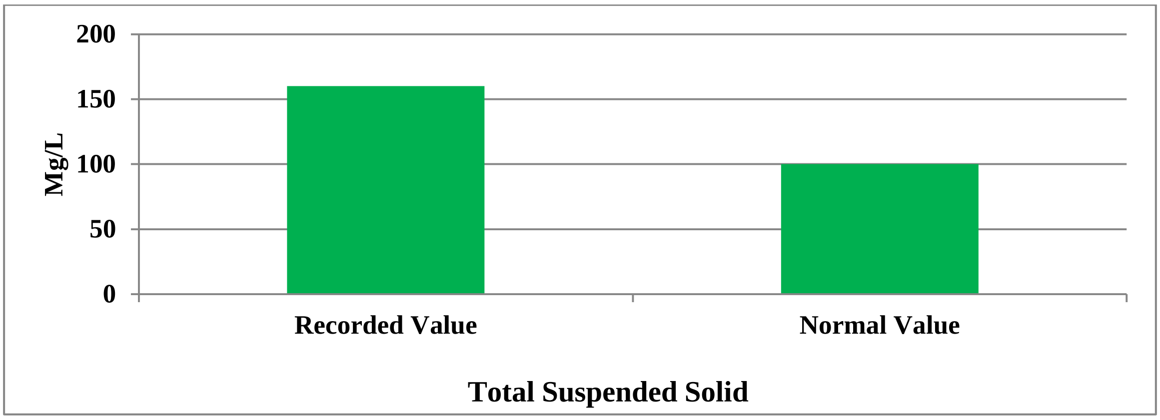
STUDY AREA AND METHODOLOGY

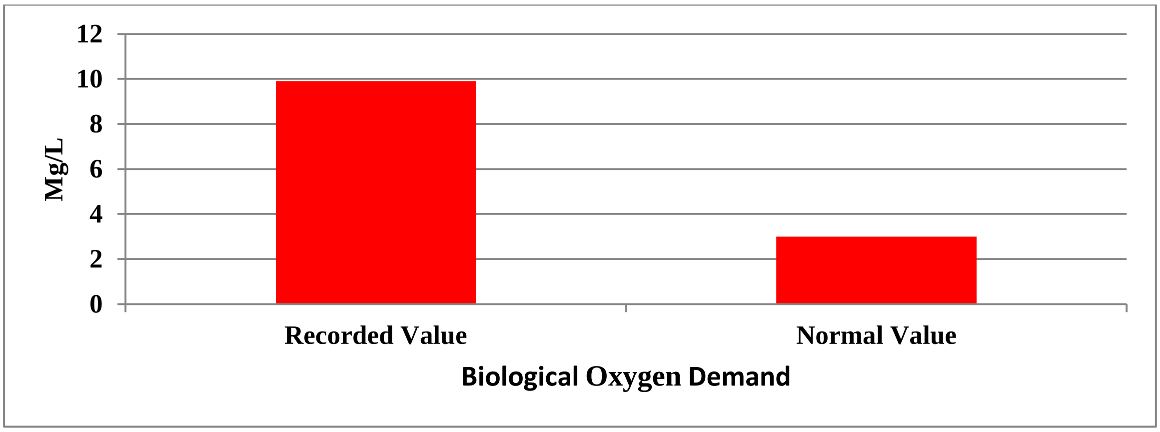
Meghalaya Institute of Natural Resource (MINR) under the Meghalaya Basin Development Authority (MBDA) during April 13-17, 2014 jointly conduct water quality analysis of pH, Total Soluble Solid (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Colour at Laitryngew River Sohra with Clover Organics Pvt Ltd, Dehradun. The team visited the unorganised coal mines in this area popularly and aptly called 'Rat Hole Mining' (Fig: A). The water sample was collected and analysed at the state pollution control Board and Clover Organic laboratory Dehra Dun follow the standard method of water quality analysis.

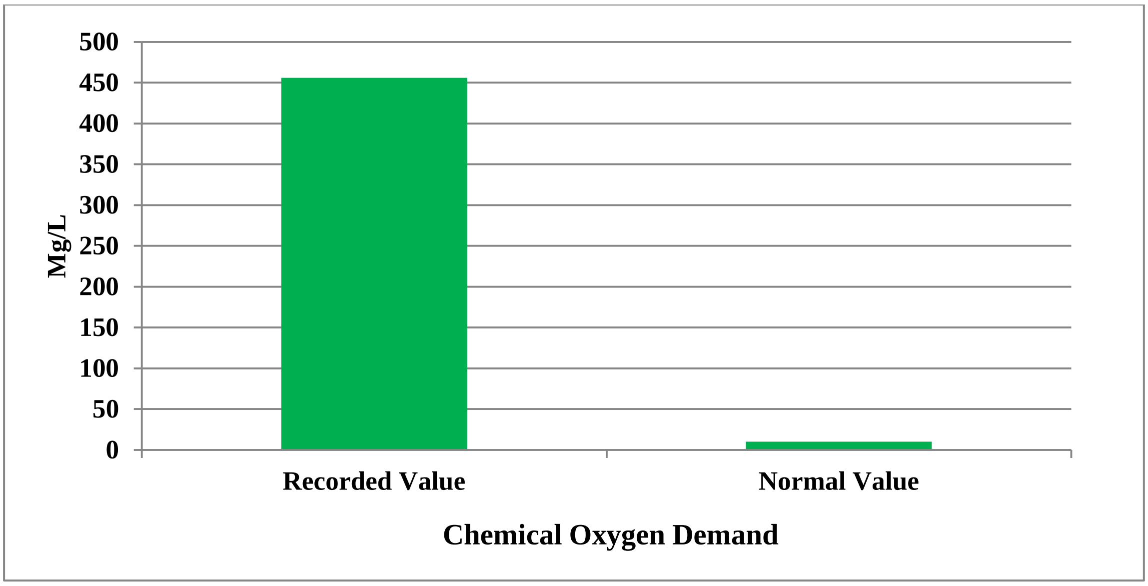
Fig: A. Picture depicted the rat hole mining at Laitryngew village Sohra

RESULT AND DISCUSSION

The result of the various parameters of Laitryngew River has been depicted in the following graph. The pH was recorded at 5.3, the low value of pH was indicated with mildly acidic and it may be due to contamination of mine spoil particle which easily dissociates and lowers the pH by increasing the cations. The Total Suspended Solid (TSS) was recorded at 160 mg/L which is significantly higher than the normal value of 100 mg/L. The high TSS may be due to carried over sand and silt. The Biological Oxygen Demand (BOD) of water sample was found to be at 9.9 mg/L whereas the Chemical Oxygen Demand (COD) was recorded at 456 mg/L. These are also significantly higher than the normal value of 3 mg/L and 10 mg/L respectively. The peak value of BOD and COD of the study area it may be due to dissolved mine particles present in the water bodies which are the characteristic of geology of the catchment area and the path of the stream. The water sample was found to be colourless and their sediments it was recorded that it was contains with minutes sand and particles during the study period.







The graph depicted the comparative study of Laitryngew river at Sohra village EKHD

CONCLUSION

The team witnessed indiscriminate exploitation of natural resources like mining of coal, limestone and other minerals in which the highly polluted water contaminates the landmass and water bodies. Mining operations have a number of irreversible impacts on the surrounding environment and ecosystems. The more obvious impacts are deforestation, changes in soil and water regimes and enhanced rates of erosion. Mining operations alter ecosystem structure and function of both aquatic and terrestrial ecosystems. Environmental problems associated with mining have been felt severely because of the region's fragile ecosystems and rich biological and cultural diversity. It is evident from the above that the mining have transformed prime agriculture land into degraded land creating unfavourable habitat conditions for plants and animals. It was found that the number of trees and shrubs species decreased due to mining. It is advisable that such activities have to be strictly regulated to avoid further damage and scientific mining has to be taken up in a proper manner to minimize the damage to the vegetation. Appropriate rehabilitation measures using those plants which may grow need to be taken up in the mine-affected areas (Sarma, 2005). The present change analysis can be useful to find out the change in different land use/land cover pattern in mine affected areas and it will be also helpful to delineate the vegetation areas under risk due to mining activities. The findings of the study could be useful while formulating the Management Plan for the district. Water bodies serve as important sources for drinking water, irrigation and support a rich array of floral and faunal diversity of the locale. Unfortunately rampant mining activities have adversely affected the quality of water of most aquatic ecosystems. Drainage originating from mines, leaching of heavy metals and organic enrichment by various anthropogenic activities is the main sources of water pollution which has serious implications on aquatic life, agricultural activities and availability of potable and irrigation water in the area.