Conservation and Management of Biological Resources in Himalaya

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IMPACT OF COAL MINING ON ECOSYSTEM HEALTH IN JAINTIA HILLS, MEGHALAYA

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During recent times Meghalaya has emerged as an important coal producing state of the country. The state has 640 million tonnes of coal reserve belonging to Jaintia group of Eocene age. The coal is found associated with sandstone and shale facies of Shella formation. Coal occurs as thin seams (thickness varying from 0.3 to 1.5 m) or as impersistent lenticular bodies. The coal seams being comparatively thin and generally close to surface, the mining is done manually by a method known as rat-hole-mining. It this method small tunnels are dug into seams and coal is brought out in wheel carts or baskets, the coal is dumped near the mine head to be transported by trucks to other areas. As a result of mining, large areas are deforested and huge amount of mine tailings and overbudens are dumped on the unmined land making the land unsuitable for the growth of plants and unfit for agriculture and other uses.

Coal contains a significant amount of iron disulfides in the form of pyrites (FeS_4 or Fool's Gold). The exposure of pyrite to atmospheric oxygen brings about an oxidation process in which pyrite is converted into ferric sulphate and sulphuric acid in the presence of bacteria. The acid thus formed, lowers the pH of the soil. Water bodies get contaminated with the mine drainage and leachates from the coal dumps, tailings and overburdens which are found scattered all along the landscape of the mining area. The mine drainage and leachates also contain high concentrations of metals such as Fe, Cu, Cd, Hg, and Zn. Trace elements namely, Titanium, Rubidium, Strontium, Zirconium, Niobium, Barium, Cerium, Lead and few others have also been reported in high concentrations in the coals of Jaintia Hills. The acid and metal ions adversely affect the fertility of soils and make the water bodies dead and devoid of any life. The production of coal has picked up rapidly during recent past. The total annual production in 1970 was only 39,000 tonnes which reached to 713,000 tonnes in 1983. At present, it is estimated that the production of coal from Meghalaya is to the tune of 1500,000 t/year.

Because of peculiar landholding system and as the area falls under the 6th Schedule of Indian Constitution, very little governmental control can be exercised on the land. The coal mines belong to the land owners who do the mining operations according to their convenience. Mining is considered as cottage industry and is operated under customary rights not covered by mining rules and/or legislations. No environmental acts and rules can be enforced in these areas. As a result, in most parts of the state coal is being indiscriminately mined and in most unscientific manners, causing large scale damage to the natural systems like land, water, air and vegetation influencing the life of the people in the coal mine areas in various direct and indirect ways. Degradation of agricultural and non-agricultural land, decline in biodiversity, pollution of air and water are some of the visible effects of coal mining in the Jaintia Hills. In addition, indirect effects on human health, decline in agricultural productivity, spurt of a variety of economic activity related to coal mining, and emergence of a number of socio-economic problems due to migration of labour force from outside the region and sudden and steep hike in the income and purchasing power of the mine owners has adversely affected the socio-economic fabric of the area.

This paper analyses the effects of the coal mining on various components of the ecosystem and suggests the possible management options for the ecorestoration of these degraded ecosystems.

2. Study Area

The study was conducted at three sites in the coal mining areas of Jaintia Hills district of Meghalaya. The control site was at Thadlaskein, which is 55 Km from Shillong. The other two experimental sites were at Bapung, 87 Km form Shillong, and Sohsrich 80 Km from Shillong on Shillong-Silchar National Highway. All these stations are situated at an altitude between 1350 and 1425 m. The climate of the area is subtropical monsoonal. The average rainfall is 3500 m and mean maximum and minimum temperatures are 24°C and 15°C, respectively. Three-fourth of the total rain falls between May and October (Fig. 1 & 2).

3. Soils

It has been observed that the soils of the area are most adversely affected due to the mining activity. The top soils (0-10 cm) have generally become more acidic than the sub-soil (10-20 cm). The soil acidity is generally more during dry seasons as compared to rainy season. While in the control sites the soil pH varies between 5 to 6.5, the pH of soils of abandoned paddy fields and mine spoils was at times between 2.42 and 2.84. The organic carbon content in contaminated soils was many a times higher than the control soils and it varied between 2.5 and 5.0%. This is due to inflow of organic substances from the mines or contamination of soils with coal particles emanating from the mines or coal dumps. The abandoned sites however had a very low content of soil organic carbon. In general, the concentration of nitrogen, phosphorus, potassium, calcium and magnesium

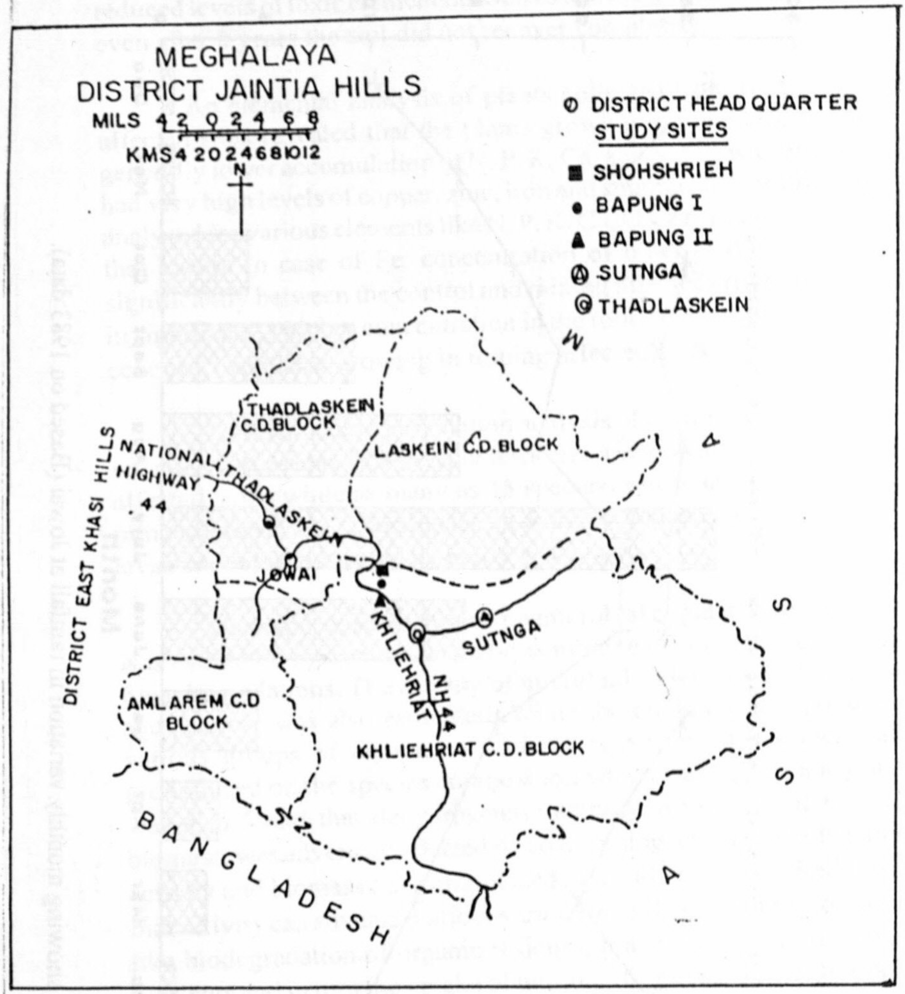

Fig. 1. Location of study sites in Jaintia hills district.

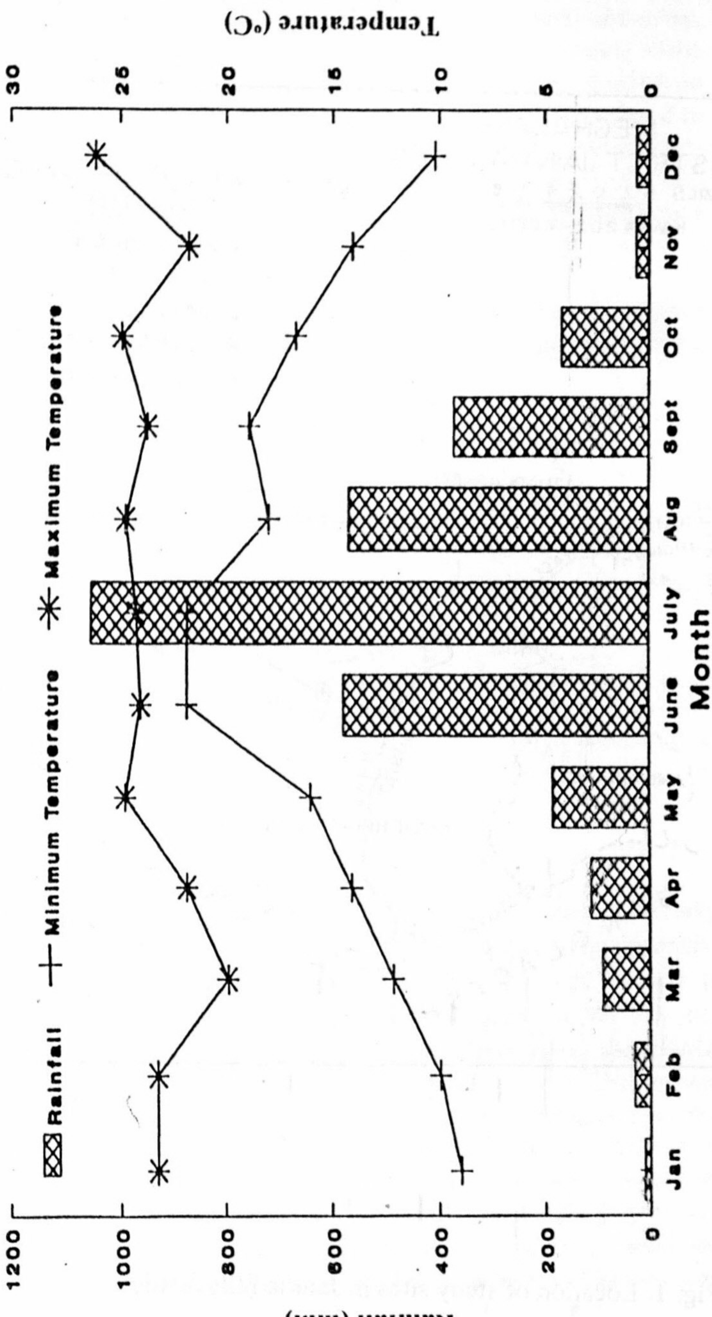

Fig.2. Climatic diagram showing monthly variation in rainfall at Jowai (Based on 1983 data).

was lower in abandoned paddy fields and mine spoils. Iron and sulphur content was significantly higher in mine affected soils as compared to the controls. Estimations of nutrient contents of soils of paddy fields abandoned over a period of time (1-8 years) indicated a trend of recovery in terms of reduced levels of toxic elements as well as lowering of soil acidity. However, even after 8 years the soil did not recover completely.

An elemental analysis of plants collected from control as well as affected sites revealed that the plants growing in mine affected sites had generally lower accumulation of N, P, K, Ca, and Mg. However, these plants had very high levels of copper, zinc, iron and sulphur. The paddy plants were analysed for various elements like N, P, K, Ca, Cu, Zn, Fe and S. It was found that except in case of Fe, concentration of other elements did not vary significantly between the control and mining affected crops. Iron was found in significantly higher concentration in the root, stem as well in the inflorescence of rice plants growing in mining affected soils.

Studies related to vegetation analysis of the mine affected areas have revealed that as may as seven plant species are sensitive and do not grow on affected soils while as many as 15 species were found exclusively on the mine affected sites. The vegetation composition is being altered and large areas are being colonised by hardy weedy species.

The impact of coal mining on microbial population and their activity was estimated by qualitative and quantitative enumeration of bacteria and fungal populations. The activity of microbial enzymes like dehydrogenase, and esterase was also estimated. While the effect on total populations of various groups of organisms was not significant, the effect was more pronounced on the species composition which was significantly altered. It was also found that dehydrogenase activity, a measure of heterotrophic biomass, was adversely affected by coal mining which shows that microbial activity and biomass have diminished in the affected sites. Reduced microbial activity can adversely affect various microbe-mediated processes in soil like biodegradation of organic residues, mineralization, transformation of nutrients and in turn the uptake of nutrients by plants. Esterase activity was also lower in the affected soils indicating that the organic esters are either less abundant in these soils or they are not being hydrolyzed at optimum rate.

4. Water

The stream water is characterised by low pH ranging between 3.7 to

4.5 and high concentrations of dissolved iron. Most streams show very low level of autotrophic activity as evident by distinctly high content of carbon dioxide in the water of contaminated streams. The stream waters are characterised by high levels of specific conductivity, free carbon dioxide, total hardness, sulphate, total iron and silicate contents. The affected streams also exhibited very low phytoplankton species richness (5 taxa as compared to 22 in control) represented by three members of cholorophyceae and two members of bacillariophyceae. Similarly, only five taxa of zooplankton were found in affected streams as against much higher numbers in the unaffected streams (two protozoa, two rotifera, and one copepoda).

Another deleterious effect of rat-hole-mining is evident in the form of drying and disappearance of perennial streams in many mining areas. Due to large scale tunnelings and hilly topography, most water now moves through these underground tunnels. This has resulted into scarcity of clean and potable water which has become the major environmental problem in the region. While drinking water is often brought from distant places, water for all other domestic uses such as bathing, washing etc. are generally collected from mine pits and polluted temporary pools and streams.

5. Socio-economic Analysis

Mining operations have affected almost all aspects of life and activity of people of the region. The people associated with coal mining can be divided into two main groups: the workers who extract or dig coal from the mines and /or supervise the works, and the owners of the mines. While most of the workers are outsiders coming form Nepal, Assam and West Bengal, all the mine owners are local tribals. The daily earning of a mine labour is about Rs. 100. Most labourers (75%) belong to the age class of 20-30 years. Most labourers (about 80%) live single and their living conditions are extremely deplorable and unhygienic. Depending on the size of the mines, 20-100 diggers may work together in a single mine. There exists a great disparity between income of a mine worker and a mine owner. An average worker earns about Rs. 2500/ month while on an average a mine owner earns about Rs. 50,000 a month which at times may be as high as Rs. 240,000. In Jaintia Hills, according to an estimate about 10,000 persons are engaged in mining activity as labourers and may be another 2000-3000 persons are employed in mining related activities, like transportation, implement making, marketing, and other service sectors.

A survey of disease incidence among the mine labourers revealed that about 78% of the workers were suffering from one or the other types of sickness. Seventyone per cent respondents reported more than one health problem. The most prevalent diseases were low back pain (55%), general body ache (33%), chest pain (29%), leg pain (27%), abdominal pain (26%), joint pain (25%), gastric troubles (19%), headache (17%), *etc*. Malaria and bronchitis are also common ailments among workers. Malnutrition was common among the miners. Their staple food is rice and pulses, occasionally they consume green vegetables and meat. Almost all minors smoke tobacco and indulge in alcohol drinking. Drinking of and bathing and washing in polluted stream and mine water, unhygienic living condition, unhealthy work place environment, poor nutrition and long working hours are the main causes of poor health and high disease incidence among the miners.

Agriculture has been traditionally the main occupation of Jaintias and Jaintia Hills was considered to be rice bowl of Meghalaya. The rice produced has high nutritive value. It is, however, noted that the agricultural activity is on decline. Some paddy fields affected with mining have become infertile and hence have been abandoned. Also, large areas of cultivable land have been abandoned due to low return as compared to mining. Increasing labour charges and non-availability of agricultural labourers are other disincentives for agriculture in the region. Although no data-base is available, the net agricultural production seems to be on a decline.

The mining is also affecting the landholding system. Traditionally all lands belonged to the community and private landholding was very few. Of late, the private landholdings are on increase. Another, conspicuous social change taking place is fast emergence of nuclear families. A general and overall erosion in the authority of traditional leaders is also apparent. Less and less people are participating in traditional festivals and community rituals. Indulgence in alcoholic drinks, petty quarrels, gamblings, theft and other criminal behaviour is on rise.

6. Ecorestoration

As the mining is done manually and most mines are scattered, the area affected by mining in any particular locality is generally small. Therefore, the restoration of damaged sites needs collective efforts, particularly by the owners of the mines. The restoration of these surface mined ecosystems is technologically feasible and any of the options detailed here under or a combination of them can be applied as the management option for rehabilitation of the damaged ecosystems of Jaintia Hills.

There are three management options for ecorestoration of these areas. The first option is doing nothing and let the natural processes take their own course *i.e.*, neglect. This is also known as natural reclamation. It has been observed in many cases that doing nothing will achieve desirable results as rapidly as by adopting even the best management technique. An inappropriate management intervention can many a time do more harm than the impact that the management was trying to mitigate. However, this option is unpredictable and time taking. Also, this requires complete withdrawal of the society from these areas which may not be possible in practice. The advantages of this option are that it does not require any major input in the form of technology, materials, fund and management and therefore, this option has better chances of success in the present conditions. Also this option is more suitable for those areas where size of disturbance is small, and undisturbed habitats are available nearby, which ensures quicker recovery.

The second option is to reclaim the mined lands to an ecologically improved and more socially acceptable condition. It may require conversion of low lying areas and mine pits into reservoirs which after lapse of a certain period of time and after careful investigation with regard to their recovery levels can be utilized for fisheries and/or recreational purposes. There are a number of examples where this has been practised with success. The abandoned uplands can be revegetated with suitable combination of plant species. The low lands affected with submergence can be converted into play grounds, open space or pastures after leveling the areas with mine overburdens. This option will require involvement of people and can be done through participatory management of resources, involving local socio-political institutions, traditional leaders and governmental agencies. The universities and research institutions will be required to provide technological inputs. This option can be successful in certain areas as it is need based, more predictable and it will involve the local residents in the project planning, implementation and also in the sharing of benefits accruing out of the management programme.

Third option is to restore the mined areas to their original condition. Theoretically, this appears to be the most desirable option, however, it is seldom a success as the time required for achieving the desired goal may be much longer than human life time and the society is often impatient with long term responsibilities. Another impediment with this management option is the lack of information about the predisturbance condition. Also, this option needs inputs in terms of technology, money, management and materials. This option is, however, suitable for areas that have high ecological value, where funds are not a constraint and sufficient information is available about the predistrubance condition of the ecosystem.

The restoration of damaged ecosystems provide an unique opportunity for ecologists to put to use the advances in the field of ecosystem analysis. These ecosystems provide a very interesting experimental areas where the ecologist can practice what they preach. The restoration efforts will require that scientists resource managers, government departments and social institutions work together in a holistic approach and with the active support of local people for the benefit of the society.