

# Development and Environment

Editors

**ZAHID HUSAIN and S. K. BARIK**



# DEVELOPMENT AND ENVIRONMENT

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DEVELOPMENT OF GEOENERGY RESOURCES  
AND ITS IMPACT ON ENVIRONMENT AND MAN  
OF NORTHEAST INDIA

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## Preface

North-East India Council for Social Science Research, the premier social science research organization of 30 years standing, held a seminar on Environmental and Sociological Implications of Mining of Coal, Limestone and Uranium and Exploration of Oil and Natural Gas in North East India on 5-6 June 2003. The present volume contains some of the selected papers presented to the seminar. North East India is endowed with huge mineral resources including limestone, coal, natural gas and uranium. Coal is found in all the states of North East India. But except in Assam and Meghalaya coal mining has not been undertaken elsewhere. Mineral resources are largely untapped. In Assam coal mining is done by Coal India Limited. In other states, coal mining is done by private mine owners in most unscientific way causing much environmental hazards, sociological damages and demographical imbalance in the mining areas. Hydrocarbon exploration is mostly done in upper Assam and in adjoining Nagaland and Arunachal Pradesh. Till now maximum petroleum explorations are conducted in the plain areas where geology is favourable. The exploration and exploitation of oil resources should be made in such a way that meet the present need without compromising the needs of the coming generations. Operational activities interact with the environment through long term physical, chemical and biological changes. Pollution control measures should be taken at every stage of exploration and exploitation of hydrocarbon resources of North East India.

Uranium is the basic raw material for the nuclear programme of the country. With the formulation of Atomic Energy Programme in 1948, the search for uranium had commenced. The exploitation of this valuable material is now being carried out by the Uranium Corporation of India Limited (UCIL). The technology

adopted by the UCIL is comparable with the best practiced any where in the world. Domiasiat Project in West Khasi Hills district of Meghalaya may bring about a positive development in the social and economic scenario of West Khasi Hills. The project is likely to generate economic opportunities for the people of Meghalaya. The adoption of state of the art technology with environmental monitoring mechanism adopted by the UCIL minimizes health hazards. Nuclear energy will stage as a major source of power which could be made safe and dependable source of energy of the future. But it has to be handled with care by strictly following the International Atomic Energy Agency regulations and as adopted by Atomic Energy Regulatory Board of the country.

We take this opportunity to thank His Excellency the Governor of Meghalaya Mr. M.M. Jacob, Professor G.D. Sharma, Vice-chancellor, Nagaland University, Dr. R. Gupta, Chairman Uranium Corporation of India, Mr. H.K. Mazhari and Dr. S.Q. Hoda, Regional Director, Atomic Minerals Directorate for Exploration and Research who contributed much to the success of the seminar.

We congratulate Dr. Zahid Husain and Dr. S.K. Barik for editing the volume and Regency Publications, New Delhi, for expeditious publication of this volume.

4 June 2004  
Shillong-793003

B. Datta Ray  
Secretary,  
North-East India  
Council for Social  
Science Research

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# Social and Environmental Impact Assessment of Opencast Mining in Meghalaya: A Case Study of Jaintia Hills

*B.P Sahu and N.P. Goel*

Meghalaya is bestowed with rich natural vegetation along with large reserve of mineral resources (coal, limestone and sillimanite). Out of these coal is the most important and widely spread mineral resource. It is known for its high calorific value and low ash contents. Large deposits of coal are found in West Darrangiri, Siju, Langrin and Balphakram in Garo Hills; Mawlong-Shella in East Khasi Hills and Bapung, Sutnga, Khlieriat, Rymbai, Ladrymbai, Jarain, Kongong, Mookhep, Lakadang, Musiang Lamare and Ioksi areas of Jaintia Hills. Jaintia Hills district has got the distinction of being the largest coal-producing district as it contributes about 70 per cent of the coal produced in the state.

Mining of coal in Meghalaya is done both in the organised and unorganised sectors. Under the organised sector, coal is mined by Mawmluh Cherra Cement Ltd and Coal India Limited. Mining in the organised sector is done by mechanised and semi-mechanised open cast method. Unorganised mining is done by a number of local tribes.

## **Topographical Features**

Jaintia Hills is the eastern most district of Meghalaya and covers a geographical area of 3819 sq. km. It is bounded by Assam

(north and east), Bangladesh (south) and Khasi Hills (west). Jaintia Hills gently slopes down to Brahmaputra Valley of Assam in the north, Bangladesh in the south. It has four major rivers, Umnga, Myntdu, Myntang and the Lukha. Out of 3819 sq. km., Khliehriat Block covers 2115 sq. km., the present area of the study. It covers 17.03 per cent of total area of Meghalaya.

### Mineral and Other Resources

The district has rich mineral resources. A large quantity of coal deposit is found in the district. The total coal deposit in the district has been estimated at 39.30 million tonnes. The area covered under coal deposits account to 57.9 sq. km. The district is also rich in limestone, which is found in Lumshnong, Nongkhlieh, Nongtalang, Sutnga, Lakadang and Syndai areas. Besides these, the district is also rich in good quality of clay, which is suitable for brick manufacturing, mainly in Larnai.

### Demographic Features

The total population as per the 2001 Census is 29,56,92 constituting 12.82 per cent of the total population of the state. It recorded a marginal increase in population to the extent of 0.40 per cent over the past decade (1991–2001). Among all the seven districts, it ranks third in population. The sex ratio is 980 females per 1000 males as per 2001 Census. In terms of population density, it ranks 5th among all the districts with 77 persons per sq. km. The literacy rate is 53.00 per cent with 50.52 per cent male literates and 55.51 per cent female literates.

The total number of the workers in the district according to the Census 2001 is 126631 (42.8%). Out of which main workers are 95023 (32.1%), marginal workers are 31608 (10.7%) and non-workers are 169061 (57.2%). When divided on the basis of category, 60365 (47.7%) persons are engaged as cultivators, 36037 (28.5%) are engaged as agricultural labourers, 1383 (1.1%) work in household industry and 28846 (22.8%) categorised as other workers.

### Land and People

People of Indo-Mongoloid race belonging to Monkhmer group occupy the Jaintia Hills. In Myanmar, they are known as Mons. The economy of the Jaintia people is based on *jhuming*, agriculture and allied activities in which 76.2 per cent of the working populations are engaged. They are more advanced in wet paddy cultivation because of the availability of flat valley lands. Besides agriculture, the people are well versed with iron works, weaving and pottery. Over the years increase in population has affected their social life. Many of the coalfields are habitats of tribes and other vulnerable section of society who derive their living from land and forest. With acquisition of land and loss of forest cover, they either lose their livelihood or are marginalized. There was involuntary displacement leading to loss of livelihood and resource base because of mining activities. There was a transition from shifting to settled agriculture because of its unsuitable form. However they remain scattered away from the developmental measures initiated by the government. There was no comprehensive rehabilitation or resettlement policy for the displaced tribes.

### Migrant Population in Khlieriat

The present area of study comprises of Nepali, Bangladeshi along with Biharis, Assamese, Bengalis and others. The main purpose of migration is for work in coalmines. They are mostly poor, having no permanent place for their settlement. The other people found in the area are Khasi, Pnar, Kachari, Naga, Mizo and Garo. They are dependent on commercial economy based on coal mining and agricultural economy (*Jhum* and wet cultivation). Due to increase in mining areas and high wage in coal mining, there is a marked shortage of labourers for agricultural activity. They also engage themselves in animal husbandry (pig, cow, goat, ox, and chicken).

### The Present Scenario

Coal mining in Khliehriat started in the year 1975. Out of 250 households, 110 households have their own coalfields (1996). Mines here are not owned by the government but by the local

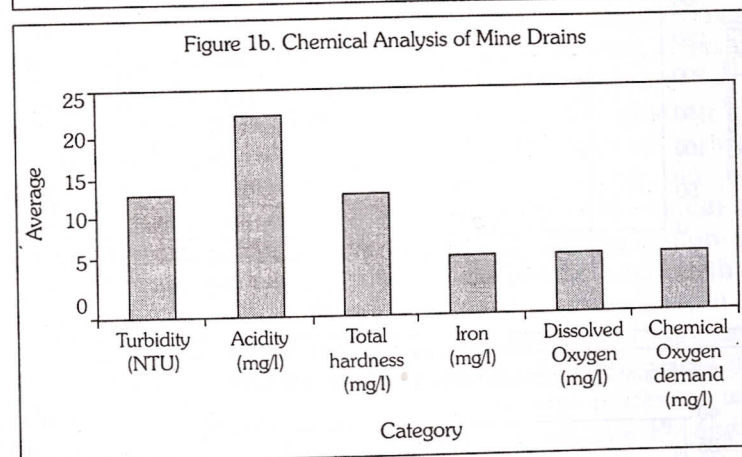
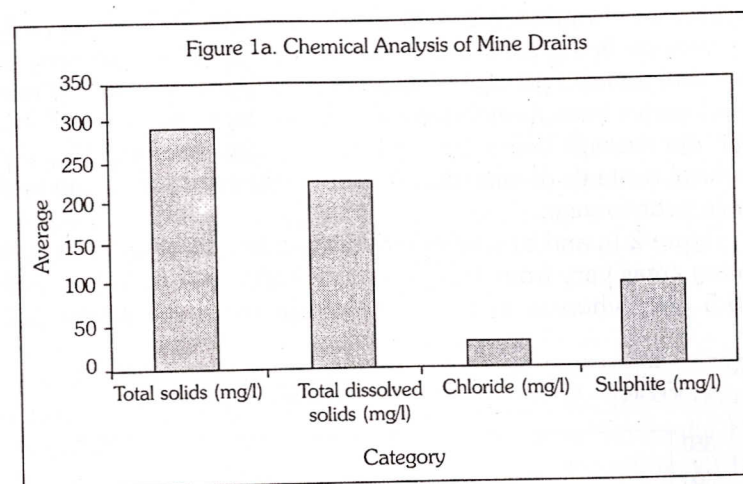
people. The state government for the purpose of coal mining collects certain amount of tax. Coalmines near the road are costly and those located far away are relatively cheap because of the difficulty in transportation.

Here coal occurs few metres deep in the form of thin seam lying along the bedding planes of the host rock. These conditions encourage the private miners to adopt small-scale, unsystematic, underground and open cast mining. Again these unsystematic, unscientific and indiscriminate mining activities are carried out with old skill and techniques, which are labour intensive and inefficient. This Unscientific method is popularly called as — 'Rat-hole mining'. The tools used for mining are hoes, crabbers, hammer, chisel, trolleys, basket, lantern and candles. After extraction, the degraded lands are abandoned with no back filling or restoration measures.

The labourers employed are generally temporary or casual or contractual. The skilled labourers are employed for only 3 days inside the mines (more money and more risk). And others those who are unskilled are employed outside the mines to carry the extracted coal to the nearest storage point. The latter are obviously paid less than the former. The labourers working inside the mines get Rs. 400 to Rs. 600 per day whereas those work outside get Rs. 120 to Rs. 130 depending upon the amount of work done.

### Chemical and Physical Properties of Coal

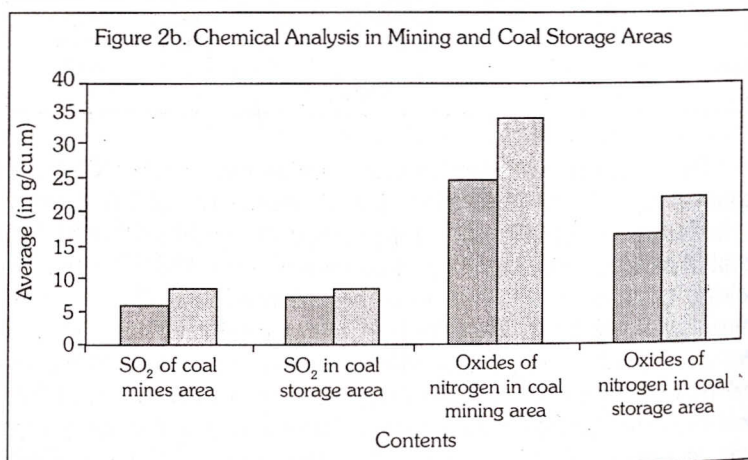
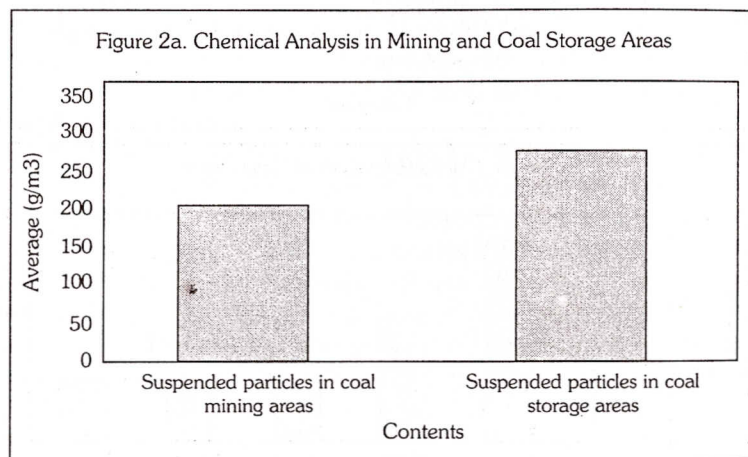
The characteristics of the coal deposits of Jaintia Hills district varies in terms of seam thickness, physical properties and chemical properties. The seam thickness of top layer varies from a minimum of 0.1 m to a maximum of 3.50 m, middle layer from 0.3 m to 0.6 m and bottom layer from 0.3 to 1.2 m from location to location. In terms of physical properties the coal found in the district may be hard or lumpy and bright, soft or hard, bright and also at times jointed. The chemical analysis reveals that the moisture content varies from 0.44–9.20 per cent, ash content from 1.3–24.7 per cent, carbon content from 41.3–59.9 per cent, sulphur from 0–5 per cent. In terms of its calorific value it is as high as 6944 kcal/kg. It also contains traces of U-238, Th-232, U-235, Ra-228 and K-40 as radioactive elements.



The average turbidity of mine drains was 12.69 NTU. The total solids of mine drains are in between 104.6 mg/l to a maximum of 469.9 mg/l, the average being 293.98 mg/l. The total dissolved solids average was found to be 228.77 mg/l. The acidity of mine drains lies between 5.6 mg/l to 102.3 mg/l, the average being 22.1 mg/l. The average total hardness of mine drains was 12.53 mg/l. The chloride content of mine drains varied from a minimum of 18.4 mg/l to a maximum of 58.2 mg/l and the average being 32.17 mg/l. The average sulphate content was found to be 108.2 mg/l. The iron content of mine drains

varies from a minimum of 0.8 mg/l to a maximum of 11.2 mg/l, the average being 3.75 mg/l. The average dissolved oxygen in mine drains was 3.86 mg/l. The chemical oxygen demand of mine drains varies from a minimum of 1.9 mg/l to a maximum of 7.6 mg/l, the average being 3.8 mg/l. Here it may be noted that the chemical contents of mine drains varies from month to month and hence year to year.

Figure 2 (a and b) reveals that the suspended particles in coal mining areas vary from 155 g/m<sup>3</sup> to 289 g/m<sup>3</sup>, the average being 206.5 g/m<sup>3</sup> whereas in the coal storage areas the suspended



particles were more to the extent of 202–334 g/m<sup>3</sup> the average being 286 g/m<sup>3</sup>. The SO<sub>2</sub> content in coal mining areas varies from 42 g/m<sup>3</sup> to 8.8 g/m<sup>3</sup> the average being 6.25 g/m<sup>3</sup> where as in the coal storage areas the SO<sub>2</sub> were more to the extent of 5.6–8.4 g/m<sup>3</sup> the average being 7.1 g/m<sup>3</sup>. Similarly the Oxides of nitrogen in coal mining area vary from 14.4–33.8 g/m<sup>3</sup>, the average being 24.85 g/m<sup>3</sup> and from 12.5–21.7 g/m<sup>3</sup> in the coal storage areas, the average being 16.5 g/m<sup>3</sup>.

### Effect on Water Resources

Coal mining is responsible for depleting ground water resources for a period of 5 to 6 years upto a depth ranging from 500 m to 1 km. It thus creates a massive biotic pressure. In Jaintia Hills, mining activities have resulted in lowering of ground water table in surrounding areas. Soil erosion from active mining areas and fresh dumps tends to silt the drinking water sources, rivers and streams and choke it. It has disturbed the natural flow of surface and ground water. Acid Mine Drainage (AMD) originating from mines, spoils, coal dumps and exposed rocks also affects water bodies. In some of the mines, water seeping out from various geological formations are acidic (low pH value) and contains sulphate and iron leading to contamination and pollution of water bodies. This water has polluted both the surface and the ground water. This has further resulted in mechanical change in landscape with degradation of agricultural and non-agricultural land. It was also found that at places there is acute shortage of potable water and in some places the water contained traces of heavy metals like Cu, Zn, Mn, Pb and Se. Pollution of nearby water sources due to seepage from dump site, soil erosion and soil wash-off from mine areas have a serious effect on the health and hygiene of people settled in low lying areas. This has also led to increase toxicity in plants. Jaintia coal is associated with high concentration of sulphide minerals, which produces H<sub>2</sub>SO<sub>4</sub> when it comes in contact with water. Most of the mines are submerged under water because of the heavy rainfall in Jaintia Hills. It affects springs, water from hand pumps, streams, river, etc. Effluents being toxic and carcinogenic in nature have a severe impact on the health of the inhabitants, especially for those people who are living in low-lying areas.

### Effect on Air Quality

Air pollution arises mainly from activities associated with open cast mining, coal transportation, and coal preparation. Mining activities generate suspended particulate matter. In Khlieriat, the main pollutant is air borne dust particles (soil and coal particles). The suspended particulate matter contains silica (5%) of the dust and at work place the particles are around 3000 micrograms/m<sup>3</sup> (permissible limit 200 micrograms/m<sup>3</sup>). It has been observed that 95 per cent of the dust generated in open cast coal mines settles within 100 m of the source. The presence of SO<sub>2</sub>, NO<sub>2</sub>, CO is found to be negligible. All the dust generated by coal mining is fugitive and near ground level. It usually becomes dangerous in windy conditions. The air quality shows concentration of suspended particulate matter far exceeding the national ambient air quality standards.

### Socio-Economic Issues

Many of the coalfields are habitats of tribes and other vulnerable section of society who derive their living from forestland. With acquisition of land and loss of forest cover, they either lose their livelihood or are marginalized. This has led to involuntary displacement leading to loss of livelihood and resource base for the tribes. As of today there is no comprehensive rehabilitation or resettlement policy. On the other side it has opened up avenues for employment opportunities, better roads, transport services, banks, hospitals and schools. Because of all these activities, there has been large-scale migration of labourers from outside the state.

Table 1. Place of Migration

| Place of Migration | Number | Percentage |
|--------------------|--------|------------|
| Sonitpur           | 9      | 18.00      |
| Karbi Anglong      | 18     | 36.00      |
| Phulbari           | 10     | 20.00      |
| Kokrajhar          | 13     | 26.00      |
| Total              | 50     | 100.00     |

Table 1 reveals that in the study area, the migrants belong to the state of Assam as contrary to the review of literature. It is also interesting to know that all the respondents belong to Sonitpur, Karbi Anglong, Phulbari and Kokrajhar districts of Assam. The maximum per centage of migrants was recorded from Karbi Anglong district (36%) followed by Kokrajhar district (26%) the two most disturbed districts as of today. The other two districts contributed 20 and 18 per cent respectively of the migrants to the study area.

Table 2. Educational Qualification of the Respondent

| Educational Level   | Number | Percentage |
|---------------------|--------|------------|
| Illiterate          | 2      | 4.00       |
| Class 1 to Class 5  | 17     | 34.00      |
| Class 5 to Class 8  | 15     | 30.00      |
| Class 8 to Class 10 | 16     | 32.00      |
| Matric and above    | Nil    | Nil        |
| Total               | 50     | 100.00     |

It has been inferred that 34 per cent of the workers had read up to class 5, followed by those who had education beyond middle (32%) and those who had education between classes 5 to class 8 is 30 per cent (Table 2). Only 4 per cent of the respondents were illiterate while none of the respondents had education beyond matric.

Table 3. Number of Family Members Engaged in Coal Mining

| Members     | Number of Families | Percentage |
|-------------|--------------------|------------|
| Self        | 25                 | 50.00      |
| 2           | 13                 | 26.00      |
| 3           | 6                  | 12.00      |
| 4           | 2                  | 4.00       |
| 5           | 4                  | 8.00       |
| 5 and above | Nil                | Nil        |
| Total       | 50                 | 100.00     |

Table 3 gives an account of the number of family members engaged in mining activities. Out of the total respondents, 50 per cent respondents of 25 families had migrated alone and hence

the lone family member working in the mines. As against this, 26 per cent respondents of 13 families have 2 working members followed by 8 per cent respondents with 5 family members, 12 per cent respondent with 3 family members and only 4 per cent respondents with 4 family members worked in the coal mines.

**Table 4. Number of Years of Working in the Coal Mines by the Respondent**

| Years       | Number of Respondents | Percentage |
|-------------|-----------------------|------------|
| 0-1         | 4                     | 8.00       |
| 1-2         | 19                    | 38.00      |
| 2-3         | 11                    | 22.00      |
| 3-4         | 3                     | 6.00       |
| 4-5         | 2                     | 4.00       |
| 5 and above | 11                    | 22.00      |
| Total       | 50                    | 100.00     |

Table 4 reveals no clear-cut trend of working in the coalmines. Maximum number of workers (38%) worked in the mines from 1-2 years, followed by 22% respondent with 2-3 years of experience and an equal number of respondent worked for 5 and more years. Very few respondents worked in the mines for 0-1year, 3-4 years and 4-5 years.

### Social Impact Assessment of Coal Mining

Mining activities have affected almost all aspects of life and activity of people of the region. It has social implications on the migrant labourers, the local labourers and the local community people along with their family and children. There exists a great disparity between income of a mine labourer and income of an agricultural labourer. It was also observed that drinking, washing and bathing in polluted streams, unhygienic living conditions, unhealthy work place environment and long working hours have affected the health of the labourers of the mineworkers. The tables below describe the social assessment of coal mining areas.

Table 5 reveals that the  $\chi^2$  value of 2.64 at 2 df was insignificant at 0.05 level of significance thereby indicating no significant difference in the influx of labourers. It also reveals that there did not exist difference in the opinion of three groups under study

**Table 5. Influx of Labourers from outside to the Mining Areas**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Outside Labourers | 19 (38.00)     | 24.5           | 31 (62.00)     | 33.67          | 50    |
| Local Inhabitants | 12 (24.00)     | 24.5           | 38 (76.00)     | 33.67          | 50    |
| Total             | 49             |                | 101            |                | 150   |

regarding the influx of labourers. Further it was also revealed that the local labourers and the local inhabitants did have a positive attitude towards the influx of labourers for the purpose of mining activities.

**Table 6. Exploitation of Resources**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Outside Labourers | 13 (26.00)     | 14.67          | 37 (74.00)     | 35.3           | 50    |
| Local Inhabitants | 14 (28.00)     | 14.67          | 36 (72.00)     | 35.33          | 50    |
| Total             | 44             |                | 106            |                | 150   |

Table 6 shows that the value  $\chi^2$  of 0.86 at df 2 was not significant at 0.05 level of significance, thereby indicating an insignificant difference of opinion towards exploitation of local resources for the purpose of mining. Further it was also revealed that a greater percentage of respondents from the three categories answered in negative towards exploitation of local resources because of mining activities.

**Table 7. Improvement of Local Economy**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Local Labourers   | 48 (96.00)     | 45.33          | 2 (4.00)       | 4.67           | 50    |
| Outside Labourers | 43 (86.00)     | 45.33          | 7 (14.00)      | 4.67           | 50    |
| Local Inhabitants | 45 (90.00)     | 45.33          | 5 (10.00)      | 4.67           | 50    |
| Total             | 136            |                | 14             |                | 150   |

Table 7 shows that the  $\chi^2$  of 3.07 at df 2 was not significant at 0.05 level of significance, thereby indicating an insignificant difference of opinion regarding improvement of local economy

by the three groups under study. Further, it was revealed that a greater percentage of respondents answered in positive towards their opinion regarding improvement of local economy because of coal mining activities.

**Table 8. Social Disparity**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Outside Labourers | 33 (66.00)     | 29.67          | 17 (34.00)     | 20.33          | 50    |
| Local Inhabitants | 26 (52.00)     | 29.67          | 24 (48.00)     | 20.33          | 50    |
| Total             | 89             |                | 61             |                | 150   |

Table 8 shows that the  $\chi^2$  value of 3.07 at df 2 was not significant at 0.05 level of significance, thereby indicating an insignificant difference of opinion regarding social disparity by the three groups under study. Further, it was revealed that a greater percentage of respondents answered in positive towards their opinion about social disparity between the local and outside labourers.

**Table 9. Outside Labourers are more Economically Better off than Original Inhabitant Labourers**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Outside Labourers | 42 (84.00)     | 40.00          | 8 (16.00)      | 10.00          | 50    |
| Local Inhabitants | 37 (74.00)     | 40.00          | 13 (26.00)     | 10.00          | 50    |
| Total             | 120            |                | 30             |                | 150   |

Table 9 shows that the  $\chi^2$  value of 3.91 is not significant at 0.05 level of significance at 2 df indicating an indifference of opinion between the three categories under study. The table also revealed that there was a general agreement among the three categories of respondents that outside labourers are more economically better off than original inhabitant labourers, which might be the reason of discontentment, and disparity among them.

Table 10 shows that the  $\chi^2$  value of 3.53 was not significant at 0.05 level of significance at 2 df there by indicating an insignificant difference of opinion regarding easy source of money by the local people because of the mining activities. All the respondents agree that mining activities have opened up avenues for earning.

**Table 10. Easy Source of Money for Local People**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Outside Labourers | 32 (64.00)     | 31.67          | 18 (36.00)     | 18.33          | 50    |
| Local Inhabitants | 27 (54.00)     | 31.67          | 23 (46.00)     | 18.33          | 50    |
| Total             | 95             |                | 55             |                | 150   |

**Table 11. Spur of Wine/Liquor Shops**

| Categories        | Yes            |                | No             |                | Total |
|-------------------|----------------|----------------|----------------|----------------|-------|
|                   | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Outside Labourers | 43 (86.00)     | 46.67          | 7 (14.00)      | 3.33           | 50    |
| Local Inhabitants | 49 (98.00)     | 46.67          | 1 (2.00)       | 3.33           | 50    |
| Total             | 140            |                | 10             |                | 150   |

Table 11 shows that the  $\chi^2$  value of 6.59 at df 2 is significant at 0.05 level of significance. It was also revealed that a greater percentage of respondent answered in positive towards their opinion regarding Opening of liquor and wine shops because of mining activities.

**Table 12. Spur of Anti Social Activities**

| Categories     | Yes            |                | No             |                | Total |
|----------------|----------------|----------------|----------------|----------------|-------|
|                | O <sub>i</sub> | E <sub>i</sub> | O <sub>i</sub> | E <sub>i</sub> |       |
| Robbery        | 36 (720)       | 33.86          | 14 (28.00)     | 16.14          | 50    |
| Burglary       | 36 (720)       | 33.86          | 14 (28.00)     | 16.14          | 50    |
| Rape           | 41 (820)       | 33.86          | 09 (18.00)     | 16.14          | 50    |
| Murder         | 08 (16.00)     | 33.86          | 42 (84.00)     | 16.14          | 50    |
| Drug Addiction | 26 (52.00)     | 33.86          | 24 (48.00)     | 16.14          | 50    |
| Others         | 40 (80.00)     | 33.86          | 10 (20.00)     | 16.14          | 50    |
| Total          | 229            |                | 121            |                | 350   |

Table 12 shows that the  $\chi^2$  value of 81.06 at 6 df is significant at 0.05 level of significance. Further, it was revealed that a greater percentage of respondents answered in positive towards their opinion regarding spur of antisocial activities because of mining belt in the area.

**Table 13. Influx of Labourers has Created Problems in the Area**

| Categories        | Yes        |       | No         |       | Total |
|-------------------|------------|-------|------------|-------|-------|
|                   | $O_i$      | $E_i$ | $O_i$      | $E_i$ |       |
| Outside Labourers | 19 (38.00) | 16.33 | 31 (62.00) | 33.67 | 50    |
| Local Inhabitants | 12 (24.00) | 16.33 | 38 (76.00) | 33.67 | 50    |
| Total             | 49         |       | 101        |       | 150   |

Table 13 shows that the  $\chi^2$  value of 62.06 at df 2 is significant at 0.05 level of significance, thereby indicating an insignificant difference of opinion regarding influx of labourers creating problems in the area by the three groups under study. Further, it was revealed that a greater percentage of respondents answered in negative towards their opinion regarding influx of labourers creating problem in the area because of coal mining activities.

### Main Findings

The main findings of the present study are as follows:

1. The chemical analysis of mine drains shows the presence of chloride, sulphate, iron, dissolved solids and low pH value.
2. The chemical analysis of mining and coal storage areas shows the presence of suspended particles,  $SO_2$  and oxides of nitrogen.
3. Due to coal mining activities, involuntary displacement has taken place, leading to loss of livelihood. As of today there is no comprehensive rehabilitation or resettlement policy.
4. Regarding the place of migration, it was found that all the workers were from Assam.
5. The educational qualification revealed that more than 96% of the workers were literate.
6. The study revealed that 50% of the respondents had migrated along with their family and the family members work in the mines for earning their livelihood.
7. The study did not reveal a clear-cut trend in the number of years of working in the coal mines. However, it was found that 22% respondents had worked for more than 5 years. The data also shows that there is decreasing trend in the number of workers working in the mines from 1–2 years to 4–5 years. It also revealed that due to hard working conditions, most of the workers leave after working for 1–2 years.

8. The study reveals that influx of labourers from outside does not in any way poses a threat to the local tribals.
9. It was also found that mining activities have increased the exploitation on natural resources.
10. Mining activities has improved the local economy of the area.
11. The social disparity does exist among the local labourers and outside labourers.
12. There is also a feeling that outside labourers are more economically better off than original inhabitants.
13. Mining activities have become an earning source for the local people.
14. Like in other industrial areas, there has been spur of anti-social activities, wines/liquor shops and increase in anti-social elements.
15. Till today, influx of labourers has not created problems in the area of study.

### Recommendations

Mining is the oldest activity next to agriculture in Jaintia Hills. It is a known fact that adjoining townships and habitations are exposed to environmental hazards because of mining. There is shrinkage of land availability for agriculture and other land-based activities. It has given a barren look to the surrounding areas. The denudation of forest cover in mining belts is also due to shifting cultivation and other human activities. Therefore, there is urgent need for development of green belt and safety resources around the mining areas, so as to have ecological reclamation of mine spoil areas, containment of acid mine drainage and biological reclamation of the degraded lands.

Open cast mining is generally accused of land degradation. Mining is a temporary use of land. Once the mine is exhausted, the land can be reclaimed for original use/for plantations. The varied species of trees including fruit, medicinal and timber varieties are indeed becoming treasure trove in many mining projects. Mined-out pits can form excellent water bodies recharging the ground water and also can create recreational facilities. They can also provide a source of water to the nearby communities. Greenery developed around mines can become shelter to wild life and can add to bio-diversity of the region. As of data available mines can create a density of around 1500–2000 plants of very useful species per hectare.

The mine owners should abide by the general standards for discharge of effluents to the different water bodies. They should be encouraged to adopt most suitable technology with appropriate pollution control measures. The CBO's should play a major role in disseminating information of suitable ways for rehabilitation of mineral areas and ways and means of bringing back the land resources to productive uses. The government should encourage the people through appropriate public schemes for afforestation. For better management of coal mining activities, Central coal storage yard for sale of coal should be established at suitable locations.

As in the case of Nagaland, emphasis should be in prevention and mitigation of adverse environmental effects due to mining, especially in biologically rich areas. The mining lease should be given only when there is proper mining plan, approved by environmental management authority. To restore the old mining sites into forests, the community and the NGO's should play a major role in protection of vegetation, compensatory afforestation and for conversion of non-forestland to forestland.

To conclude the primary sources of commercial energy in India are coal, oil, natural gas, hydro-electricity and nuclear power. By 2020, demand for energy is forecast to increase by around 75 per cent and fossil fuels are expected to meet 95 per cent of their demand. In case of India around 75 per cent of electricity is generated from coal. Therefore, coal will continue to provide dependable, secure and economic source of energy in India in the coming years.

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#### APPENDIX

**Table 1.1. Chemical Analysis of Mine Drains**

| Mine Drains                   | Min   | Max   | Average |
|-------------------------------|-------|-------|---------|
| Turbidity (NTU)               | 6.0   | 23.0  | 12.69   |
| Total solids (mg/l)           | 104.6 | 469.9 | 293.98  |
| Total dissolved solids (mg/l) | 89.9  | 346.8 | 228.77  |
| Acidity (mg/l)                | 5.6   | 102.3 | 22.1    |
| Total hardness (mg/l)         | 6.2   | 24.8  | 12.53   |
| Chloride (mg/l)               | 18.4  | 58.2  | 32.17   |
| Sulphate (mg/l)               | 18.7  | 221.8 | 108.2   |
| Iron (mg/l)                   | 0.8   | 11.2  | 3.75    |
| Dissolved Oxygen (mg/l)       | 2.9   | 6.7   | 3.86    |
| Chemical Oxygen demand (mg/l) | 1.9   | 7.6   | 3.8     |

Note: The information relates to all the sites of the Jaintia hills and not specifically the present study area.

Source: Meghalaya Pollution Control Board (MPCB), 1992–93.

**Table 1.2. Chemical Analysis in Mining and Coal Storage Areas**

| Contents                                  | Min (g/m <sup>3</sup> ) | Max (g/m <sup>3</sup> ) | Average(g/m <sup>3</sup> ) |
|---|-------------------------|-------------------------|----------------------------|
| Suspended particles in coal mining areas  | 155                     | 289                     | 206.5                      |
| Suspended particles in coal storage areas | 202                     | 334                     | 286                        |
| SO <sub>2</sub> of coal mines area        | 4.2                     | 8.8                     | 6.25                       |
| SO <sub>2</sub> in coal storage area      | 5.6                     | 8.4                     | 7.1                        |
| Oxides of nitrogen in coal mining area    | 14.4                    | 33.8                    | 24.85                      |
| Oxides of nitrogen in coal storage area   | 12.5                    | 21.7                    | 16.5                       |

Note: The information relates to all the sites of the Jaintia Hills and not specifically the present study area.

Source: MPCB, 1992.