Comprehensive Study on Raniganj Coalfield Area, India: A Review

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ABSTRACT

Raniganj coalfield, one of the crucial mining zones in India in terms of its age and production, mostly extracts coal by surface mining method depending on the under-surface. This paper presents a review on Raniganj coalfields regarding the environment, soil, vegetation, forests, habitat diversity, water quality, water regime, aquatic ecosystems, livelihood and human health. This study shows with the help of various researches that under surface coal mining is susceptible to coal fire and land subsidence while surface mine adversely affects the water, land and ambient air. Both processes are accountable for the life of the local community in the mine adjacent regions. Contrastingly mine excavating, directly and indirectly, enhances the local economy and job opportunities but negatively affects the natural and social behaviour of the local inhabitants. Coal that meets more than 60% of energy in India nevertheless needs technologies for the extraction of coal in a cleaner and more efficient manner.

Key words: Ambient air, Human health, Raniganj coalfield, Surface mining, Under surface mining

Introduction

Coal is the chief and most plentiful fossil fuel in India. Simultaneously due to expanded population growth, economic boom and a quest for enhancing the quality of life, the energy requirement is rising constantly in our country. Mining has not only satisfied the uplifting energy demand of industry but also played a significant role in the economic sustainability of the country (Chaulya and Chakraborty, 1995; Adedoyin et al., 2020; Ashwarya, 2020; Kumar and Majid, 2020; Paliwal et al., 2021). The power industry is the largest consumer of coal subsequently followed by iron, steel and cement sections in the last four decades. Other smaller consumers are textile industries including jute and jute products, fertilizer, brick and paper. Coal mining and its utilization are implemented with substantial environmental challenges as it remarkably and regularly generates inevitable effects upon the terrestrial and aquatic world (Calkins, 2008; Griffin and Hammond, 2019; Farooquee et al., 2020; Giggs, 2020; Tongia et al., 2020). The Raniganj coalfield was established on 31st January 1973 as a coal mining site in a chunk of Damodar basin constituting Gondwana sediments. The coalfield was possessed by various small-scale private companies which were nationalized in 1973. It is the province of coal mining and the richest coal-yielding area in India (Suttner and Dutta, 1986; Hota, 2010; Jha et al., 2014; Mendhe et al., 2017; Kumar and Singh 2020; Srivastava et al., 2020). However, in this coalfield, various mining activities release diverse harmful substances such as carbon dioxide, sulphur dioxide, nitrogen oxide additionally particulate matters of dust & ash and adversely damage the native envi-
Environment as it destroys vegetation, causes comprehensive soil erosion and alters microbial communities. Under surface mining causes exhaustion of groundwater in many colliers as well as subsidence etc. resulting in the destruction of soil and land (Agarwal and Sunita, 1991; Adhikari et al., 2013; Goswami, 2015; Mondal et al., 2020; Dhar and Dutta, 2020). In this mining area numerous mining activities, developmental projects, abandoned open cast mine pits create various livelihood but contribute toxicity into the atmosphere and it adversely affects human health (Bebbington and Williams 2008; Daozhong et al., 2011; Adimalla et al., 2020; Otamonga and Poté, 2020; Chakraborty et al., 2021).

This study has critically evaluated and discussed the impact of coal mining on the Environment, Soil, Vegetation, Forests, Habitat Diversity, Water quality, Water Regime, Aquatic ecosystems, Livelihood and Human health in Raniganj coalfield, India.

Materials and Methods

The Raniganj coalfield, India, an enormous reservoir of semi-coking and coking coal is surrounded by the latitudes 23°22' to 23°52'N and longitudes 86°36' to 87°30'E the major portion of which is sandwiched between Damodar and Ajoy river and a little portion lies on the south of Damodar river, west of Barakar River and north of Ajoy river. It covers an area of 443.50 km² (171.24 sq mi) in West Bengal and Jharkhand, India (Chatterjee and Pal 2010; Singh and Yadav 1995; Boruah et al., 2019).

In West Bengal, the coalfield area mainly spreads in Paschim Bardhaman district whereas Birbhum, Bankura and Purulia districts have occupied the northern, southern and south-western edges respectively. In Jharkhand, Dhanbad and Santal Pargana districts occupied the western portion of the coalfield. In this coalfield, more than 90 % area is excavated by Eastern Coalfield Limited (ECL), a subsidiary of Coal India limited (CIL) and a small area is mined by Bharat Coking Coal Limited (BCCL), also a subsidiary of Coal India Limited (CIL) & SAIL-IS and has total coal reserves of 49.17 billion tonnes that makes it the 2nd largest coalfield in India in terms of reserves (Murthy et al., 2010; Mukhopadhyay et al., 2010; Mohanty et al., 2018; Mandal et al., 2021).

A certain keyword-based hunt methodology was applied for preparing this review so that all the papers assembled were typically informative and indicative. Google scholar was the chosen portal and custom search was accepted for every decade 1980-1990, 1991-2000, 2001-2010 and 2011-2021. The initial search terms used were Raniganj coalfield, coal mining in Raniganj coalfield, in Raniganj coalfield.
coal mining and its impacts and impact of coal mining in Raniganj coalfield etc. Then the selected papers were downloaded from keyword search, there after sorted and analysed. The sub references of all the papers were also considered.

**Results and Discussion**

**Environmental pollution—an inevitable impact of mining**

Mining activities of Raniganj coalfield like most of the Indian coal mines have serious impact on environment. In this coalfield, coal is mainly mined using two methods - underground and surface or opencast mining. A vast amount of waste material is generated by several mining activities. If proper care is not taken for waste disposal, mining activity will affect the surrounding atmosphere, the water, land and ambient air and in turns the life of the local community in the adjacent regions (Bose et al., 1986; Ghosh, 1987; Sengupta, 2001; Sadhu et al., 2012; Goswami,

**Deterioration of the quality of soil for mining activity**

Continual coal mining activities in Raniganj coalfields have created acute threat to the soil quality of nearby agriculture fields and have generated a long-term effect on the vital component of the natural ecosystem of the soil. Contended heavy metals like As, Co, Cu, Be, Cr, Mn, Pb, and Ni are significantly higher in opencast mine soil, whereas Cd PAHs contents are higher in underground mine soil (De et al., 1985; Casshyap and Kumar, 1987; Das and Chakrapani, 2011; Masto et al., 2015; Vishwakarma et al., 2020).

In this framework researchers have noticed that the range of moisture content, bulk density, electrical conductivity and pH are moderate in this mining site, where plants have normal growth, but the concentration of nitrogen, organic carbon, organic matter, and available phosphorus have been found inferior as a contrast to normal soil, thus, brought about deterioration of soil quality, hence it is found that mining soil is not suitable for plantation, vegetation or agricultural purposes. High salinity, % Na, sodium absorption ratio, residual sodium carbonate, and excess Mg that restrict its suitability for agricultural uses is reported (De and Mitra, 2002; Singh et al., 2010; Yaseen et al., 2012; Yaseen et al., 2015; Rehman et al., 2020).

Illegal coal mining activities have resulted in maturing hollows, pits, shafts, rat holes, galleries, etc., that created great threat of land subsidence, fire, water flooding leading to severe degradation of the environment, health and safety issues of the local inhabitants (Hota, 2010; Bharti et al., 2016; Rehman et al., 2020; Srivastava et al., 2020).
Adverse impact on Vegetation, Forests, Habitat Diversity

The main effects of excess mining are pollution, deforestation and imbalance of ecology. The removal of coal/minerals from nature repeatedly makes awkward nature, which adversely influences the biological system and condition. On the other hand the informal and unscientific mining serves as a veritable danger the outcomes of which results in decrease in forest cover, soil loss and decrease of all-inclusive biodiversity. These transformations causes modification in nutrition, depletions of resources and trophic interactions (Almas et al., 2004; Ghose, 2004; Rai et al., 2010; Singh et al., 2011; Pawar et al., 2014; Kumar et al., 2015; Saikat et al., 2020).

Fig. 3. Forest of mines adjacent site in Raniganj coalfield

Saikat et al., (2020) reported an aggregate of a maximum of 21 shrub species belonging to 17 families in this mining area and its total density was 7.6 in. The maximum noted was in Clerodendrum infortunatum. The densities recorded by the said researches were acceptably correlated with some of the other research findings Malakar and Gupta (2019) recorded 19 tree species where Leucaena leucocephala and Ziziphus jujube, Shorearobusta were found dominant species based on their substantial values. Moreover, expansion in species richness and colonization of native species were also detected with rehabilitated ages at chronosequence sites. So their study specified that changes in soil variables are related to succession, whereas functional/structural changes in vegetation are interconnected to the accumulation of soil texture, organic matter and enhanced microbial effects. Sarma (2002, 2005) noticed a distinct trend of distribution of plants in Raniganj coalfield area and also in Meghalaya Nokrek biosphere reserve (Mishra et al., 2008; Jhariya et al., 2012, 2016; Kumar et al., 2011, 2015; Malakar and Gupta, 2019; Saikat et al., 2020).

Water quality, Water Regime, Aquatic ecosystem and fields of using pit-water

Mine waters are extremely complex in nature and generally vary in composition. These are almost neutral, alkaline, moderately acidic, and exceptionally acidic in nature. The concentrations of metals, metalloids, acidity, and alkalinity, Cl", F" and SO24 contaminated the rivers, water bodies, surface, and underground water (Rawat et al., 1981; Singh 1988; Plumlee et al., 1999; Nordstrom, 2011; López et al., 2019). On the other hand pit lakes are formed when open cast mines pit are filled with water, either through groundwater recharge, surface water diversion, or functioning pumping. There are about 78 old opencast coal pits surrounding 260 hectares of expanse containing a total volume of 4,41,700 m3 presently transformed into pit-lakes becoming a potential aquatic resource for this mine area. Different studies on limnological parameters show that mine pit water is high in conductivity, total suspended solids, total dissolved solids, biochemical oxygen demand, chemical oxygen demand, Salinity, nitrate nitrogen, sulphates, etc. At the same time, Water Quality Index (WQI) outcomes indicate that almost all the pit-lakes in Raniganj coalfield show poor to unsuitable water quality. Most of the researchers suggested that mine water of the coalfield is not satisfactory for first-hand use in drinking & domestic purposes and requires proper treatment before its utilization. The evaluation of pits’ water for irrigation uses shows that the water is good to allowable quality and can be utilized for irrigation purposes. Nevertheless, high values of salinity, SAR, RSC, % Na and Mg-hazard at certain areas restrict its acceptability for agriculture uses. (Ghosh, 1990; Tiwary and Dhar, 1994; Singh et al., 2009; Singh et al., 2010; Pal et al., 2013; Palit et al., 2014; Mondal and Palit, 2019).

Within this frame of reference in an aquatic ecosystem primary productivity is the estimation of the net yield of new biomass during a certain time by photosynthesizers which are existing at the basis of a food chain in an ecosystem. Indirectly it expressed the phytoplanktonic population and ecological condition of an aquatic ecosystem. The zooplankton community forms a vital relationship in the food chain from primary to tertiary levels in an aquatic
Fig. 4. Mine stagnant water and water body of the Raniganj coalfield

ecosystem. Fish production is also depending on zooplankton load. The diversity and number of zooplankton suggested the quality of water and ecological status of this water body. Pal et al., (2013) reported that values of primary productivity were varying from 150 to 610 mg C m⁻³ hr⁻¹ (average 310 ± 110 mg C m⁻³ hr⁻¹) and during the post rainy seasons higher productivity values were observed. Zooplanktonic load in pit water was noticed in the range of 2.0 to 6.0 U L⁻¹ (average 4.0 ± 1.0 U L⁻¹) similarly higher zooplankton load was found during the monsoon seasons. Less abundance of the zooplankton load in mine pit lakes in this mines area was also reported by several workers (Canton and Ward, 1981; Canton, 1982; Slusarczyk, 2003; Chatterjee et al., 2008; Kosík et al., 2011; Palit and Kar, 2019).

Benefit of local livelihood by the coalmines

The requirement of coal has increased countrywide mining activities, which assist to enhance the prosperousness of the national capital. The extension of settlements in the coal sector was followed by rashes of relocation among workers. The settlement of Raniganj in West Bengal, in the beginning, witnessed the migration of subaltern classes’ people from its adjacent districts and states. In this coalfield, especially rural regions are often affected by this composite nature of mining. The local livelihood

Fig. 4. Cultivated land and Abandoned open cast coal pit maintain the livelihood of Raniganj coalfield
experiences most by mining-induced rearrangement and land procurement. At different times different researchers from various mining sites in this coalfield find out that the rural societies are affected positively as well as negatively by the mining activities. Owing to the expansion of mining, acquisition of land has contributed monetary and job recom-
penses to the local land losers that directly and indirectly boost up the local economy but the job opportunities are very much restricted to the landowners. From the E.C. Ltd., monetary reimbursement has aided to increase the physical capital among the communities in this coalfield. In contrast natural and social capitals are negatively affected by the mining and associated activities (Bhengara, 1996; Das and Mishra, 2015; Banerjee and Mistri, 2019; Das, 2020; Mondal and Mistri, 2021).

Conversely, different studies on the Raniganj coalfield area explored that community’s livelihood was potentially benefited by abandoned O.C.P.s e.g. irrigation (Table 1), O.C.P.s’ water is utilized for various purpose like bathing, cooking, washing clothes and also for miscellany cultivation. Several researchers’ observation cited that about 10%, 60% and 90% of rich, middle-class & poor households respectively use the O.C.P.’s water for their domestic purposes. About 10% of the rich households and 60% and 80% middle-class and poor households respectively take fishes collected (Table 1) from O.C.P.s as food. 74% poor households collect fuel woods and wild fruits of the forest nearby the O.C.P.s (Table 2, Figure 1) (Samanta, 2001; Singh, 2008; Sinha et al., 2017; Palit and Kar, 2019; Palit and Chaudhury, 2020; Mandal et al., 2021).

**Impact of mining activity on Human health of coalfield area**

Coal mining activity of Raniganj coalfields, a large-scale producer of coal adversely affects the human health of the mining area as the surface and underground activity – two chief processes are causing air pollution, a major reason of health hazard. In mining site, some activities like drilling, blasting, loading-unloading of materials, overburden, etc. fabricate several fine particles which remain suspended in ambient air and create respiratory diseases. Several earlier studies have specified that the air pollution due to PM is very high in the workplace of

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name</th>
<th>Scientific name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Channa punctatus</em></td>
<td>Lata</td>
<td><em>Oryza sativa</em></td>
<td>Rice</td>
</tr>
<tr>
<td><em>Clarias batrachus</em></td>
<td>Magur</td>
<td><em>Allium cepa</em></td>
<td>Onion</td>
</tr>
<tr>
<td><em>Oreochromis niloticus</em></td>
<td>Nilontica</td>
<td><em>Raphanus sativus</em></td>
<td>Radish</td>
</tr>
<tr>
<td><em>Labeo calbasu</em></td>
<td>Calbaus</td>
<td><em>Daucas carota</em></td>
<td>Carrot</td>
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<tr>
<td><em>Catla catla</em></td>
<td>Catla</td>
<td><em>Solanum melongena</em></td>
<td>Brinjal</td>
</tr>
<tr>
<td><em>Labeo rohita</em></td>
<td>Rui</td>
<td><em>Brassica oleracea capitata</em></td>
<td>Cabbage</td>
</tr>
<tr>
<td><em>Labeo bata</em></td>
<td>Bata</td>
<td><em>Brassica oleracea italica</em></td>
<td>Broccoli</td>
</tr>
<tr>
<td><em>Hypophthalmichthys molitrix</em></td>
<td>Silver carp</td>
<td><em>Brassica oleracea</em></td>
<td>Cauliflower</td>
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<tr>
<td><em>Cirrhinus mirgala</em></td>
<td>Mrigel</td>
<td><em>Capsicum annuum</em></td>
<td>Chili</td>
</tr>
<tr>
<td><em>Aristichthys nobilis</em></td>
<td>Bighead Carp</td>
<td><em>Cucumis sativus</em></td>
<td>Cucumber</td>
</tr>
<tr>
<td><em>Cyprinus carpio</em></td>
<td>American Rui</td>
<td><em>Allium sativum</em></td>
<td>Garlic</td>
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<tr>
<td><em>Ctenopharyngodon idella</em></td>
<td>Grass Carp</td>
<td><em>Lycopersicon lycopersicum</em></td>
<td>Tomato</td>
</tr>
<tr>
<td><em>Amblypharyngodon mola</em></td>
<td>Mourala</td>
<td><em>Zea mays</em></td>
<td>Sweet corn</td>
</tr>
<tr>
<td><em>Puntius sophore</em></td>
<td>Punti</td>
<td><em>Solanum tuberosum</em></td>
<td>Potato</td>
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</tbody>
</table>
opencast mines in Raniganj coalfield. In these circumstances, researchers sort out that all effects on human health through particulate matters (PM) are pursuing the time of subjection and quantity of particles in such type concentration. In addition, pollutants like sulfur dioxide (SO$_2$), nitrogen dioxide (NO$_2$), carbon dioxide (CO$_2$), etc., are also the most principal emissions during coal mine fires. Due to dryness the winter season is noticed to be the most hazardous among all the seasons in the year concerning respirable ambient air (Baldauf et al., 2001; Chattopadhyay, 2001; Collins et al., 2001; Peplow and Edmonds, 2002; Younger and Wolkersdorfer, 2004; Gautam et al., 2012).

In Raniganj coalfields the rate of discharge of greenhouse gas is increasing gradually (0.4% per annum) to the frightening level and has become detrimental to local residents. The air quality in the vicinity of the said coalfield, moreover in the mine’s ambience, is very much negatively altered, which is judged by the yardstick of Air Quality Guideline Levels laid down by the WHO. Generally, it is noticed that the mining workers and local inhabitants are affected by breathlessness, asthma, bronchitis, chronic obstructive pulmonary disorders (COPD), black lung disease (permanent scarring of the lung), cardiovascular disorders, irritation to the eye, nose, throat, skin, diabetic, hypertension, kidney problems, liver problems, poor visibility, etc., (Schins and Borm, 1999; Goswami, 2014; Samanta, 2015; Neogi et al., 2018; Dash et al., 2020).

**Conclusion**

The Raniganj Coalfields has been the lion’s share source of coal in India for more than 200 years. The extractive operation undeniably has brought wealth and employment opportunities, but concurrently has led to comprehensive environmental destruction and erosion of traditional values in the community. Coalmines both opencast and underground processes brought about titanic damage to the flora, fauna, forests, hydrology, and soil biological properties of the systems. Simultaneously it severely affects human health. Across the mining area it is explored

**Table 2.** % of the families from different classes continuing their livelihoods by utilising abandoned O.C.P.’s resources.

<table>
<thead>
<tr>
<th>Nourishing their livelihood by using O.C.P.’s resources</th>
<th>% of Livelihoods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigating their cultivated lands</td>
<td>Poor</td>
</tr>
<tr>
<td>Fish farming</td>
<td>73</td>
</tr>
<tr>
<td>Drawing from selling the fuelwood collected from the nearest forest</td>
<td>75</td>
</tr>
<tr>
<td>Utilize the grasses nearby the O.C.P.’s as the fodder for cattle</td>
<td>96</td>
</tr>
<tr>
<td>Utilize O.C.P.’s water for their diversified cultivation</td>
<td>54</td>
</tr>
<tr>
<td>Drawing from wild fruits collected from the forests nearby of the O.C.P.’s</td>
<td>31</td>
</tr>
<tr>
<td>Drawing from the visitors of the O.C.P.’s by providing different services</td>
<td>16</td>
</tr>
</tbody>
</table>

Source: Families’ economic classes as described in Census India, 2011
that communities’ livelihood potentially gained from abandoned mine pit-lakes. At the end of the discourse the authors suggest that implementation of rigid environmental contamination control through better contamination control technology, greater and significant public awareness and sincere supervision of competent authority should be ensured to have a clean coal mining. It is also thought that solar power, wind energy, heat mining, biofuel, biogas etc. should be adopted as energy resources to reduce our dependence on coal in future.

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Conflict of interest

The authors declare no conflict of interest.

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