CHAPTER 1:

INTRODUCTION

1. Introduction

Here, the introduction to mining and related problems has been discussed. The coalfields of Jharia and the acute problems it suffers from, is described in details. All the aspects of mining including some social problems have also been addressed.

1.1. An overview

Coal remains the world's largest source of electricity, contributing about 40% of global electricity production (World Energy Council, 2013). It is at present the world second largest source of primary energy and is, far and wide, expected to replace oil within a few years. China firmly holds the first place among coal producing countries followed by the United States, followed by India and Australia. However, over three-quarters of global coal consumption was accounted by five countries: China, the United States, India, Russia, and Japan. India is the world's third largest energy consumer, and its energy use is projected to be more than OECD (Organisation for Economic Co-operation and Development) Europe combined and approaching that of the United States by 2040 due to rapid economic development, urbanization and expanding manufacturing base.

India is rapidly expanding its coal-fired electricity generation capacity, with around 113 gigawatts of new capacity in addition to the 205 gigawatts of existing capacity (World Coal Association, 2015). In 2012, coal-fired electricity accounted for 60 percent of India's installed capacity and 71 percent of its electricity generation. The major deposits of hard coal are in the eastern half of India, ranging from Andhra Pradesh, bordering the Indian Ocean, to Arunachal Pradesh in the extreme northeast: the eastern States of

Chhattisgarh, Jharkhand, Orissa and West Bengal together account for about 77% of reserves (Table 1.1).

Table 1.1 State wise Estimated Reserves of Coal in India as on 31.03.2010 (Office of Coal Controller, Ministry of Coal)

State/Union territories	Proved	Indicated	Inferred	Total	Distribution (%)
Andhra Pradesh	9.26	9.73	3.30	22.02	7.95
Arunachal Pradesh	0.03	0.04	0.02	0.09	0.03
Assam	0.35	0.04	0.00	0.39	0.14
Bihar	0.00	0.00	0.16	0.16	0.06
Chhattisgarh	12.44	30.23	4.01	46.68	16.86
Jharkhand	39.48	30.99	6.34	76.96	27.80
Madhya Pradesh	8.51	11.27	2.22	21.99	7.94
Maharashtra	5.36	2.98	1.97	10.31	3.72
Meghalaya	0.09	0.02	0.47	0.58	0.21
Nagaland	0.01	0.00	0.31	0.02	0.11
Orissa	19.94	32.07	12.73	0.32	23.95
Sikkim	0.00	0.06	0.04	66.31	0.04
Uttar Pradesh	0.87	0.20	0.00	0.10	0.38
West Bengal	11.75	13.03	5.07	1.06	10.78
All India total	109.80	130.65	36.36	28.33	100.00
Distribution (%)	39.67	47.20	13.13	267.21	

India needs to sustain an 8–10% economic growth rate, over the next 25 years, to eradicate poverty and meet its human development goals. Thus an increase in its primary energy supply by 3–4 times is required (Maiti, 2013). Total indigenous coal production is expected to grow from the current level of around 407 Mt (2005–2006) to around 1,086 Mt by 2024 as per the draft Coal Vision document.

1.2. Coal consumption

As nations develop, they want secure, reliable and affordable sources of energy to strengthen their economies. Thus, coal is a logical choice in many of these countries because it is widely safe, available and relatively cheap (Coal in India, 2012). Coal's role in delivering energy access for development of poor countries is well pronounced. India is the world's third-largest coal consumer behind China and the United States; and the share of coal in India's electricity mix has been rising. The power sector accounts for more than 70 percent of India's coal use and supported a five-fold increase in coal use in electricity generation over the past few decades. As such, the power sector is clearly central to the coal outlook in India. India's steel production has increased by around 25 percent over the past five years to around 83 million tons in 2014. The cement industry, the second largest globally after China, is also a major coal user, accounting for around 5 percent of total coal use. Other industrial sectors, including brick manufacture, consume small quantities of coal. However, coal mining occupies the large area for overburden soils around the mines which become harmful to the environment, especially to the land making it unsuitable for any productive purpose (Coal in India, 2012).

1.3. Environmental impacts of mining

Apart from the environmental problems like air, water, noise and vibration, habitat loss and social issues related to the displacement of the inhabitants, the loss of soil fertility is immense particularly in the case of open cast mining which gives rise to big hillocks called overburden dumps (Martinez Orozco et al., 1993). These dumps disturbed the soil profiles which have loose rock and soil components. If open casting is to be done continuously, for the same seam, in the same area then dumps cannot be restored as the seam lying below has to be mined immediately one after the other. This problem is even acute when there is coal seam fire. Major coal deposits are under thick forest cover and more than 85% of coal is extracted by opencast method (Maiti, 2013). The causes of land degradation are due to the removal of vegetation cover and topsoil, excavation, and dumping of overburden, subsidence, and mine fire, etc during the mining operations (Hüttl and Bradshaw, 2000). The overburden removal in Coal India Limited (CIL) alone increased from 500 million cubic meters (Mm^3) in 2003–2004 to 682 Mm^3 in 2009–2010 (CIL, 2011). Overburden dumps created the accommodation of mine waste which has major effects on surrounding environment like the deterioration of aesthetics, reduction in land productivity and complete destruction of landform and habitat. It acts as continuous sources of dust pollution, water pollution and siltation. They often collapse and thus create a lot of nuisance in the mining area. These dumps release particulate matter PM 2.5 in the air.

The most serious impact of mining is the land degradation and destruction of ecosystem as a whole. Therefore, development of vegetation cover is essential to stabilize the dumps and minimize pollution and improve visual aesthetics to the surrounding population in such dumps and denuded areas. However, these dumps are physical, nutritionally and biologically poor. The natural succession on these lands also takes longer duration (Wali, 1987; Jha and Singh, 1992). Dutta and Agrawal (2003) proposed for the establishment of an economically feasible and permanent cover of vegetation on the mine spoils. But the soil environment of these dumps is hostile towards the plant growth (Singh and Singh, 2006). In acidic dumps, along with elevated metal concentration and other adverse factors like high stone content, lack of moisture, higher compaction, shortage of soil-forming materials and organic matter also cause problems (Maiti, 2003). Development of vegetation cover is the cheapest and easiest options, but it has to be ensured that vegetation cover is self-sustained in long term. There are several processes by which self-sustaining vegetation cover which could be developed in the mine-degraded land, starting from careful design of slope to selection of tree species that spread and reproduce under severe conditions; adding soil ameliorant, mulching, geo-netting of the area and proper maintenance (Maiti, 2010).

1.3.1. Legislation regarding mine closure

In India, mineral deposits are governed by various statutes like The Mines and Minerals (Development and Regulation) Act (1957), The Mineral Concession Rules (1960), The Mineral Conservation and Development Rules (1988), The National Mineral Policy (1993) and The Granite Conservation and Development Rules (1999). These statutes also prescribe statutory guidelines for the restoration but either very vaguely or without reference to conservation needs (Maiti, 2013). There are no legal provisions for key issues of monitoring amelioration practices.

1.4. Dump reclamation practices in India

There is always a need to excavate the overlying waste materials to reach the coal seam and dump overburden (OB) materials outside the mining areas. These are known as external OB dumps. External OB dumps are necessary of any opencast mining, but once created, they seem to become external to the interest of mining industry despite posing a substantial threat to the environment. The MoEF (Ministry of Environment, Forest, and Climate Change) stipulated that slope of the OB dumps should not exceed 28 degrees (Maiti, 2006). In India, those dumps are concurrently reclaimed once it is inactive. Sometimes, OB materials are dumped on abandoned quarry (if it is available). The success of any biological reclamation depends on climatic conditions, nature of spoils, types of plant species, nature of dumps, proximity to seed banks (nearby vegetation) and types of amendments used. As all these factors are very much site-specific and depend on geo-mining conditions, systematic bioremediation of these dumps and creation of a database of particular types of set-up shall be used during the mine closure planning process.

Nowadays, maximum efforts are given for in-pit dumping (Maiti, 2013). The height of dumps is reduced, and excavated area is concurrently filled up, and there is an opportunity to restore the area to its original topography (i.e. popularly called as AOC, approximate original contour). Open casting also generates large ditches. These large water bodies are sometimes useful for the community for storage of irrigation water, pisciculture or used for day-to-day purpose. The banks must have a gentle slope and must be afforested. In Eastern Coalfields Limited, some of the water bodies are presently being used by the local community for irrigation, washing, bathing and even for pisciculture. Of course, in these water bodies, no planned or commercial pisciculture is practiced because of depth or may be leasing problems or protection from theft or the community commonly shares the water body. Another case is that of Shallow Voids. At mines where the stripping ratio is low, OB materials may not fill the void created due to the mining operation. In such case, concurrent reclamation practices may be adopted. The backfilling sequence has to be planned in details and inspected by mine management frequently to ensure compliance. This practice is carried out at Piparwar mine of NK area of CCL. Sometimes, it is used as dumping ground or could be used as disposal sites for fly ash (Maiti, 2013).

1.5. History of mining in Jharia

Jharia Coalfield is quite large coal field located in the east of India in Jharkhand. Jharia represents the largest coal reserves in the country, having around of 19.4 billion tons of coking coal reserves. Jharia is a notified area and one of eight blocks in Dhanbad district of Jharkhand state in India. Jharia is also the fifteenth largest town of Jharkhand (Times of India, 2006). Jharia is famous for its rich coking coal resources. It plays a very important role in the economy and development of Dhanbad City and is considered as a part of Dhanbad City. The mining activities in Jharia started in 1894 and intensified in 1925. Then it was monopolized by the Europeans. Seth Khora Ramji Chawda was the first Indian to own coal mines and founded Khas Jharia, Golden Jharia, Fatehpur, Balihari, Khas Jeenagora, East Bagatdih Collieries with their brothers Teja Ramji Chawda, Jetha Lira Jethwa, Akhoy Ramji Chawda, Pachan Ramji Chowra. These events took place between 1894 and 1910 (Jethwa, 1998).

There were more than 50 mines owner from Mistri community of Kutch, who took on lease the coal mining fields from Raja of Jharia to start collieries at various locations namely, Khasjharia, Jamadoba, Balihari, Tisra, Katragarh, Kailudih, Kusunda, Govindpur, Sijua, Loyabad, Joyrampur, Bhaga, Matadih, Dhasar, Bhuli, Bermo, Mugna, Bokaro, Bugatdih, Putki, Pandiri, Rajapur, Jeenagora, Gareria, Chirkunda, Bhowrah, Sinidih, Kendwadih, Dumka etc. The others of pre-First World War years were Khannas, Agarwallas, Kesabji Pitamber, Haithibhai Patel, Chaturbhai Sangjibhai, Kalyanji Mavji, Roys, Banerjees and Singhs. After the First World War, other communities from Kutch, Gujarat, Marwar and Bengal followed. Prominent personalities among them were Amritlal Morarjee, Kriparshankar Worah, Jatashankar Dossa Chanchani, Amritalal Ojha, Lala Karamchand Thapar, Kalyanji Mavji, T.K. Khanna, Ramjush Agarwalla, J.K. Agarwalla, Kesabji Pitamber, Haithibhai Patel, Chaturbhai Sangjibhai. After Second World War and independence of India, Jharia coal mines owner prospered beyond imagination but in 1971 the coal mines were nationalized by Indira Gandhi by the act of parliament. A major chunk of this coal bearing region including Raniganj and Paraskole was with the Jharia miners like Chanchani and Worah, Podars, Agarwallas, Mistris of Kutch etc. Although, after the nationalization of the coal mines in 1971-73, all of them lost their mines and assets and a decline in the fortune of the coal mining community began (Jetwa, 1998).

1.6. Jharia rehabilitation and resettlement

The government has already spent money to move settlements away from the mines, and those costs are forecast to reach $1 billion (Ferris, 2015). Jharia Rehabilitation and Development Authority (JRDA) have been established in December 2004, for implementation of Rehabilitation and Resettlement of Non-BCCL people residing in fire and subsidence affected areas of Jharia Coalfield. JRDA will be acquiring 468.60 acres of land, spread over six sites in three blocks of Dhanbad under the urgency clause of Land Acquisition, Rehabilitation and Resettlement Act, 2013, which stipulates seven-time compensation of the land's market value to owners. The three blocks where JRDA will build flats to rehabilitate those displaced by the fire under the Rs 7,028-crore Jharia master plan are Baliapur, Topchanchi, and Baghmara. Bharat Coking Coal Limited (BCCL), which operates from the coal capital and is the custodian of some 103 active and abandoned mines, including the ones leading to the underground fire, will provide Rs 175.6 crore for these plots to JRDA (The Teleghaph, 2015).

1.7. Background of the problem

Today, Jharia is famous for a coal field fire that has burned underground for nearly a century. The first coal seam fire was detected in 1916. According to records, it was the Khas Jharia mines of Seth Khora Ramji Chawda (1860–1923). These mines were one of the firsts to collapse in 1930. Two of his collieries, Khas Jharia and Golden Jharia, which worked on maximum 260 ft. deep shafts, collapsed due to underground fires, in which settlements collapsed on 8 November 1930, causing 18 feet subsidence and widespread destruction. The fire never stopped despite sincere efforts by Mines Department and Railway Authorities. In 1933 flaming crevasses lead to migration of many residents. The Bihar 1934 earthquake led to the further spread of fire and by 1938 the authorities had declared that there is furious fire in 42 collieries out of 133 on fire.

In 1972, more than 70 mine fires were reported in Jharia. As known in 2007, more than 400,000 people residing in Jharia were living under danger of subsidence due to the fires. The government has been criticized for a perceived lackadaisical attitude towards the safety of the people of Jharia. Heavy fumes emitted by the fires lead to severe health hazards such as breathing disorders and skin diseases (Henriksen, 2007). Indian

Government reportedly hopes to increase production at the fiery mine, even as representatives from New Delhi discuss the effects of carbon emissions on climate change at the COP21 Summit in Paris. Indian Prime Minister, Narendra Modi has charged officials with solving fire issues at Jharia, in the hope of improving production (CNBC, 2015). More than 37 million tons of coals, worth billions of dollars, have been lost to flames at Jharia, and 1.4 billion more metric tons are inaccessible because they are blocked by fires. Coal fire exists in many coal-bearing countries like USA, South Africa, Venezuela, China and also in India (Mishra et al., 2014). India has the largest prime coking coal resource in the world. Jharia coalfield (JCF) is a treasure trove of the best quality prime coking coal of the country. However, the coalfield is also known for hosting the maximum number of known coal fires among all coalfields in India (Chatterjee et al., 2007). It has been estimated that nearly 50 millions of tons of good quality cooking coal have been lost and about 200 million tones are locked due to fire (CMPDI-NRSA report 1999).

Mining activities started here in 1925 and were run under the private ownership till 1973 when the coal mining industry was nationalized under an act of the Indian Parliament (Ghosh and Ghosh, 1990). During this phase, the private business houses had an eye for maximum output at minimum investment. Hence, environmental protection and reclamation measure was removed from their project planning. This obviously damaged a huge land area in the field and seriously disturbed its land use Condition. The burning of coal leads to the formation of voids due to volume reduction due to the transformation of coal to ashes. The surface displacement related to mine fires, together with mining induced subsidence leads to subsequent subsidence of overlying strata. This subsidence leads to the formation of cracks and fissures leading to the creation of ventilation paths through which oxygen circulates and further supports the internal combustion thus aggravating underground coal mine fires (Jiang et al., 2011).

It is observed that during 1990-1996 the net lateral propagation of coal fires in Jharia was generally towards the south and at places towards west, whereas during 1996-2006 it follows the general trends towards north except at few places where it was towards the south (Mishra et al., 2014). These fire blazes emit around 1.4 billion tons of carbon dioxide in a year (Zipfel, 2012). Ashby and Vogel (1993) argue that there are seven major environmental factors and physical characteristics in tree planting success: (1) climate (macro- and microclimate), (2) soil physical factors (texture, organic matter, coarse fragments, surface roughness, compaction and drainage), (3) soil chemical factors (reaction or pH, toxic elements and soil infertility, particularly of nitrogen and phosphorus), (4) competition with herbaceous ground covers, (5) lack of soil organisms, (6) mammals and birds and (7) fire. All the dynamics mentioned here are problems in ecorestoration in Jharia coalfields which make it the utmost important subject of study.

1.8. Objectives of the study

1. To gather baseline data about fertility status of spoil
2. Ecological analysis of the relationship between plants and mycorrhizae
3. Identification of native species for ecological restoration

Baseline data generation of the spoil samples is very important to know the actual deficiencies of the spoil material. The specific nutrients quantities are to be identified so that soil amendments can be judiciously applied. To achieve the first objective, physicochemical analyses of the spoil samples was done. Field observations were also required to know the existing vegetation cover in that dump so that it could be correlated with the fertility status. The second objective defines the percentage of association of the vesicular arbuscular mycorrhiza with the plant roots to correlate it further with plant growth. The mycorrhizal association was expected to promote survival of the proposed plant species in the overburden dumps. The third objective deals with the screening of the plant species based on their growth response to the various treatments. Achievement of this objective was expected reduce the unnecessary cost incurred in planting various plant species which might not survive in the stressful condition. Also, treatments suited for the quick response could be suggested.