CHAPTER 1

INTRODUCTION

Minerals are the vital raw material for infrastructure, capital goods and basic industries, and hence, are valuable resources. As a major resource for development, the extraction and management of minerals has to be integrated into the overall strategy of the country’s economic development. India is blessed with ample resources of a number of minerals and has the geological environment for many others. The role of minerals and metals in the evolution of human civilization can be gauged from the fact that various stages of civilization have been named with the progress in the usages of minerals and metals at various points of time, such as Stone Age, Iron Age and Bronze Age. The presence of old mine workings and slag heaps testify that mining industry did flourish in olden times in the country.

In the recent past, the basic structural reforms in fiscal, industrial and trade regimes for globalization of economy, initiated by the Government of India in 1991, went on with increasing allowances in foreign direct investments. This scenario resulted into quantum jump in number of applications for reconnaissance permits, prospecting licenses and mining leases for various minerals.

Nevertheless, the development planning in India has always been driven by an obsession to catch up with the developed nations, making the economic development antagonistic to conservation priorities, causing ecosystem degradation and the depletion of biodiversity. Wali (1987) has defined ecosystem degradation as an event of a series of events that results in altering, both spatially and temporally, the relationships of organisms and their habitats from their natural state. Mining, both surface and underground, drastically disturbs ecosystem. Surface mining of minerals creates vast stretches of derelict lands which are technically speaking areas of ‘no value’, or to be more precise, areas of ‘negative value’ which means that whereas the area after mining has on the one hand lost its all ecological and socio-economic yield capability, on the other hand has become a threat to the ecological and socio-economic stability (Soni et al., 1992). Due to surface mining, geology-soil-plant stability circuit is disrupted and
flora-fauna-hydrological relations and soil biological systems are drastically disturbed. Soil is lost both in pedological and biological senses (Jha and Singh, 1992a). It is widely recognized and accepted by industry and regulatory bodies alike that mining and mineral processing activities create damage to the surrounding land, air, and water that cannot be reversed by nature, but requires the aggressive application of carefully planned restoration programmes (Ripley et al., 1996).

The ‘Conference on the Human Environment’ held in Stockholm in 1972, is considered as the official start of international environment awareness. The Brundtland Commission’s 1987 report, *Our Common Future*, compelled both governments and non-governmental organizations throughout the globe to think over the concept of sustainable development seriously. Sustainable development is concerned both with biodiversity and cultural diversity, in so far as it seeks ecosystem-specific and culture-specific responses to peoples’ needs based on environmentally sound resource-use patterns (Clüsener-Godt, 2004). International debate on sustainable development and conservation of biodiversity has gathered speed, focusing on the need to ensure that ‘the needs of the present’ can be met ‘without compromising the ability of future generations to meet their needs’ (Treweek, 1996). The idea of sustainable development explicitly recognizes the limited nature of environmental resources. The United Nations Conference on Environment and Development (UNCED), held in 1992 in Rio de Janeiro, which adopted a global plan of action popularly known as Agenda 21, represented a partial ‘coming of age’ of the international environmental movement. The Johannesburg World Summit on Sustainable Development, in 2002, recognized that poverty eradication, changing consumption and production patterns, and managing the natural resource base for economic and social development are overarching objectives and essential requirements for sustainable development (India, 2010). It is now well recognized that environmental issues are fundamental to both social and ecosystem wellbeing, as well as to sustainable economic development. In 1992, the World Bank’s World Development Report focused on the link between development and the environment and highlighted opportunities for ‘win-win’ policies that are good both for the environment and economic development.
Rehabilitation/reclamation of mines, which may act as a link between development and the environment as far as mining sector is concerned, is now considered an essential element of resource management and is an ongoing activity throughout the life of the operation of mining. Mining is a temporary land use and the mining industry, governmental land use management agencies, and the public have long recognized the need to consider criteria to determine when rehabilitation, reclamation, or restoration is complete and the mine sites can be released back to public management (Gardner and Bell, 2007). Therefore, for leaving better environment for our progeny and having a lesser number of adverse ecological footprints, the exploitation of minerals has to be guided by long term national goals and perspectives. The areas in which minerals occur often have other resources presenting a choice of utilization of the resources. Some such areas are ecologically fragile and some are biologically rich. Therefore, prevention and mitigation of adverse environmental effects due to mining of minerals and rehabilitation of affected areas should be in accordance with the latest internationally acceptable norms, and modern afforestation practices should form integral part of mine development strategy in every instance. National Mineral Policy, 2008 has also envisaged that no mining lease would be granted to any party, private or public, without a proper mining plan including the environmental management plan (EMP) approved and enforced by statutory authorities. EMP should adequately provide for controlling the environmental damage, restoration of mined areas and afforestation according to the prescribed norms.

1.1 Laws and statutes governing mine spoil rehabilitation/reclamation

The environmental awareness is an ancient culture of this country. However, in India, the impetus came after Stockholm declaration in 1972 and various Acts and Rules governing protection of environment were promulgated thereafter.

Directives for the State and its citizens have been laid in Articles 48A and 51A of The Constitution of India for protection and improvement of the environment and safeguarding the forests and wildlife of the country,
For regulating the development of mines and minerals in the country, the Mines and Minerals (Development and Regulation) Act (MMDR Act), 1957, the Mineral Concession Rules (MCR), 1960 and the Mineral Conservation and Development Rules (MCDR), 1988 were promulgated.

Sections 12 and 18 of the MMDR Act, 1957, Rules 22(5) (iv) & 22 A (1) of the MCR, 1960 and Rules 31 to 41 of the MCDR, 1988 are of interests for the present subject of ecological rehabilitation after mining. Similarly, Sections 3, 5, 9 and 15 of the Environment (protection) Act, 1986 are concerned with the protection and improvement of the environment. In January, 1994, a notification under Environment (Protection) Act, 1986 was issued making it mandatory to have environmental impact assessment done before clearing new developmental projects and expansion of ongoing projects.

Principles 3 and 4 of the Rio Declaration on Environment and Development, of which India is one of the signatories, envisage the right of development with equitability in meeting the needs of present and future generations, constituting environmental protection as an integral part of the development processes.

1.2 Problems in mine-spoil rehabilitation

Where land has been destroyed by mining or a similar activity, what is left is something exceedingly basic - just the raw materials, the skeleton from which a soil can be formed and which with plants and animals, will develop into an ecosystem (Bradshaw, 1987). During a mine's operational stage, irrespective of whether it is an underground or open pit mine, the main impact upon local land surfaces arises from the disposal of waste materials (Ripley et al., 1996). Bradshaw (1987) is of the view that the basic principles of land and ecosystem restoration are the same as the basic principles of ecological succession, although in many situations primary rather than secondary succession is dealt with. However, in both the circumstances, factors determining the development of ecosystem from very skeletal beginnings and factors restricting the development are of interest.

Ecosystem development can be quantified in two dimensions, structure and
function. In natural succession there is an increase in both dimensions. When ecosystems are degraded by mining or other operations, there is reduction in both dimensions, perhaps almost to zero. The first option with such degraded or derelict ecosystem is to do nothing, in which case it may recover slowly by natural process, though it may also degrade further by erosion or landslip. The second option is to try to build back exactly what was there before. If this is successful then what is achieved is “restoration”. If it is not completely successful then what is achieved can be termed “rehabilitation”. The third option is “replacement”, in which an alternative to the original ecosystem is produced (Ibid., 1987).

Fig. 1.1: Options with degraded or derelict ecosystems

(Source: Bradshaw, 1987)

Surface materials exposed by mining activities frequently appear sterile, lacking in humus and living matter, and sometimes may be extremely toxic and entirely unsuitable for plant life. In this situation two avenues are open. The first is to rely on the
natural processes of weathering, leaching and erosion, but the time required for stabilization and revival of the ecosystem by natural processes could span several human lifetimes, possibly disrupting surrounding ecosystems in the meantime. The second option is to reclaim the site through an active programme involving a combination of techniques including revegetation (Ripley et al., 1996). It is, therefore, desirable that on completion of the mining operations, the mined areas should be returned to a form suitable for further use. In the context of sustainable development, this should conform to the surrounding landscape from ecological, economic and social point of view.

1.2.1 Physical characteristics of the mine spoil

Mining waste may be composed of particles ranging from boulders to clay, and hence, its texture varies considerably. Depending on local climates, both fine and coarse soils may be disadvantageous with respect to root growth and water holding capacity. Heavy machineries used during mining subject the overburden material to a variety of compaction. The most suitable soil texture for any site depends, to a large extent, upon the type of vegetation that is desired (Jha and Singh, 1992a).

1.2.2 Chemical characteristics of the mine spoil

Although physical characteristics are significant in the limitation of plant growth, in many cases it is the chemical environment of mine waste that is the main limiting factor. Mine spoils are usually low in macronutrients with their limited availability at low pH levels. Severe shortages of nitrogen can be expected in most, if not all, mine wastes. Phosphorus and potassium are generally inadequate as well. Micronutrients may or may not be present in the wastes, but required quantities are usually so small that deficiency is uncommon. The problems of infertility, high or low pH, and the presence of toxic elements, particularly metals, are interrelated, and thus making the situation more complex for a healthier plant growth (Juwarkar et al., 2001). The availability of both nutrients and toxic elements changes with pH. Generally, at low pH levels, the availability of nutrients is decreased and the availability of heavy metals is increased.
because of the greater solubility of metal sulphides. The high concentration of dissolved salts may have direct osmotic effects as well (Ripley et al., 1996). Jha and Singh (1992a) have reported that at very high pH, most of the nutrients (e.g., phosphorus) are again unavailable.

1.3 Revegetation of mine spoils

The most frequent problem with reclamation/rehabilitation of mining wastes is the absence of organic and living components. In addition, mine waste may have very different chemical and physical properties from naturally occurring soils and be totally unsuited to plant growth. Therefore, careful selection of suitable plant species at various stages of revegetation is very essential. A widely accepted vegetation program can be designed after recognition of the factors that are limiting or will limit plant growth, and accordingly selecting plant species and planting techniques that provide the best potential for success, and follow-up programs to assess the long-term success of the operation.

Since the climatic conditions of an area cannot be controlled, reclamation attempts must center on choosing well-adapted plant species. The amount of time required for natural invasion of mining wastes varies, depending upon the type of substrate and climatic conditions, among other factors. Variation within spoils is also common; some portions may be rapidly invaded, while other parts remain unoccupied for long periods (Jonescu, 1979). The goal in many reclamation projects is to develop a stable vegetative cover that requires little or no maintenance. Vegetation can be established in two ways, which can be used separately or together: direct seeding and seedling planting. The choice is dictated by the species used and the site conditions. If both procedures are used simultaneously, care should be taken to reduce competition (Jha and Singh, 1992b).

For restoration of plant diversity, ultimate success would be the return of all plant species at the same frequency and density as the intact forest. This would also restore the vegetation structure of the forest. Provided there were no other ecosystem
impediments (e.g., soil compaction, soil toxicity), it would also eventually return the functional aspects of the forest. Selection of suitable species for reclamation of any mine spoil is a challenging task and requires proper knowledge and consideration of the various ecological aspects of the site as well as the species to be planted. Koraput district of Orissa, being predominantly inhabited by highlanders, has a long history of use of medicinal plant products, mainly sourced from adjoining forests. ‘Disaries’ (traditional medical practitioners) are not uncommon in villages. Nevertheless, fuel wood problem is still a major concern for the lady of the house. Villagers still have a few choices but the fuel wood sourced from nearby forests, for their daily needs of cooking. Therefore, a care should also be taken in selection of species which must take care of the needs of local people. This will also take care of the apprehension of local people’s alienation from the land due to mining. The Integrated Biotechnological Approach developed at NEERI, Nagpur, India has also emphasized on site specific stress tolerant species which are of economic use to the local population as well as of ecological importance to the site (Juwarkar et al., 2001).

Against this backdrop of legal frameworks and moral responsibility of mine spoil rehabilitation and problems there-in, the present study has been carried out with following objectives:

(i) Assessing efficacy of mine rehabilitation plan of National Aluminium Company Ltd. (NALCO) (*through assessment of understory succession and performance of the planted species in terms of their growth);

(ii) Impact of the mine rehabilitation plan on the socio-economy of the local people (*through assessing their importance to the local people so that emphasis may be given for plantation of those species); and

(iii) Prescription of suitable rehabilitation package for exhausted mines.

*From pages 6 to 8 of Synopsis.*