Restoration of Biodiversity on Mining Wastelands and Carbon Sequestration using Microbe Assisted Phytoremediation Technology

Authors: Sanjeev Kumar Singh[#], Sanyogita R. Verma[⋆] and Asha A. Juwarkar[##]

[#] Principal Scientist, Environmental Biotechnology and Genomics Division, CSIR-National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur-20, India, Email: skr_singh@neeri.res.in

[##] Former Chief Scientist, CSIR-National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur – 440020, India

[⋆] Assistant Professor, Anand Niketan College, Anandwan, Warora, Maharashtra, India
Email: sanyogitaverma15@gmail.com

Abstract

Soil contamination, a very important environmental problem, has attracted considerable public attention in recent decades. Increase in industrialization/urbanization and indiscriminate land use during the past several years has resulted in extensive degradation of agricultural lands and creation of wastelands in India. Out of total 329 million hectares of land in India, more than 170 million hectares are wastelands, of which mining activity contributes about 0.125 million hectares. These wastelands can be exploited by growing plant species, which are ecologically and economically important. To revegetate such ecovulnerable systems is a challenging task and requires multidisciplinary approach. Metalliferous mining and processing, including the dumping of wastes, often produce severe heavy metal pollution. Mining operations leads to a number of environmental problem viz. deforestation, removal of fertile top soil, unstable slopes prone to sliding and erosion, siltation of water bodies due to wash off of mineral overburden dumps, air pollution due to discharge of dust, ground vibration and finally the socio-economic status of local people. Mine spoil dumps; generated due to mining activities, pose physico-chemical and biological constraints for sustainable vegetation. Remedial measures are required to overcome these constraints.

In this endeavour, CSIR-NEERI has developed an ecofriendly and cost effective Microbe Assisted Phytoremediation Technology (MAPT) remediation of mining wastelands. The approach involves selection of suitable plant species (preferable multispecies), isolation and inoculation of site-specific specialized nitrogen fixing strains of *Bradyrhizobium* and *Azotobacter* species and nutrient mobilizing vesicular arbuscular mycorrhizal spores of *Glomus* and *Gigaspora* species in combination with organic amendments (Domestic and Industrial). The MAPT developed has been

commercialized on an area of 250 hectares, at real site field applications for different mining public sector companies to ameliorate the mining wastelands and to encourage revegetation. IBA has been demonstrated at Western Coalfields Limited (WCL), Nagpur; South Eastern Coalfields Limited (SECL), Bishrampur; Mahanadi Coalfields Limited (MCL), Sambalpur; Manganese Ore India Limited (MOIL), Nagpur; Kudremukh Iron Ore Company Limited (KIOCL), Mangalore; Maharashtra State Electricity Board (MSEB), Khaperkheda; Iron mine at Sesa Goa Limited (SGL), Goa; Hindustan Copper Limited (HCL), Malanjkhand; Hindustan Zinc Limited (HZL), Udaipur and National Hydroelectric Power Station (NHPC), Uri etc. **Figure 1** shows the one of barren and revegetated manganese mine spoil dump at Gumgaon, Nagpur. The survival rate of plants on these sites is around 95 – 99%. To achieve sustainable ecosystem multispecies such as *Pongamia pinnata, Azadirachta indica, Tectona grandis, Delbergia sisso, Dendrocalamus strictus, Mangifera indica* etc. are used for plantation. The results indicate that IBA is also an excellent tool for fast restoration and productivity of wastelands. Fast recovery of degraded ecosystems through IBA provides CO_2 sinks, generating fuel, fiber, food, fodder, medicines, etc. These are the foreseen impacts of this approach leading to the development of self – sustainable ecosystem, thereby, mitigating the environmental hazards and improving the environmental health of nearby contaminated sites.

Recently, CSIR-NEERI has installed Eddy Covariance CO_2 flux system for monitoring of Net Ecosystem exchange of CO_2 in the revegated mine land. **Figure 2** shows the eddy covariance system installed in the manganese mine spoil revegetated site at Gumgaon, Nagpur. In the revegetated site, it was estimated that carbon dioxide sequestration potential of the reclaimed mine spoil dump indicated 47.35 t/ha of phytocarbon and 27.32 t/ha of soil carbon. The overall average carbon sequestration rate of reclaimed mine land in Gumgaon is found to be 889.216 KgC/ha/day. The above findings may help the industries to achieve CDM status through afforestation of degraded lands as per the guidelines of United Nations Framework Convention on Climate Change (UNFCCC).

Key words: Mining wastelands; Organic amendment; Mycorrhizae; Biofertilizers; Integrated Biotechnological Approach; Biodiversity, Carbon dioxide sequestration.

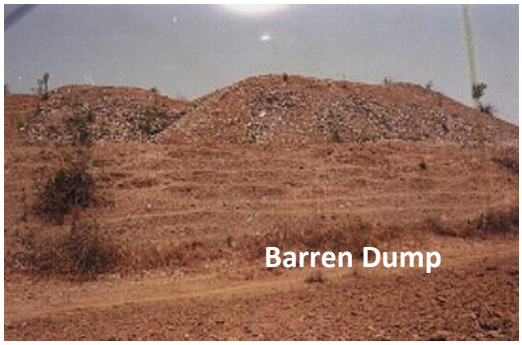




Figure 1. Ecological restoration on manganese mine spoil dump at Gumgaon, Nagpur



Figure 2. Eddy Covariance CO_2 Flux Measuring System installed in Gumgaon, Nagpur

---