

Environmental Impact Assessment of Opencast Mining- a Comparative Study between Terrace land Mining, Hill Slope Mining and Riverbed Mining

*Garima Chaturvedi ¹

¹ SENR, Doon University, Dehradun

*gchatur22@gmail.com

Abstract- Mining activity causes significant effect on the mine area. In order to reclaim and sustain natural ecosystem it is necessary to carry out baseline environmental studies and then according to it predicting the possible impacts followed by appropriate mitigation plans. This paper contains comparative study of physical environment (Air, Water, Soil and Noise) in Terrace land Mining, Hill Slope Mining and Riverbed mining of minor minerals. This study finds out the mining method with the maximum environmental impact and the most suitable method of mining.

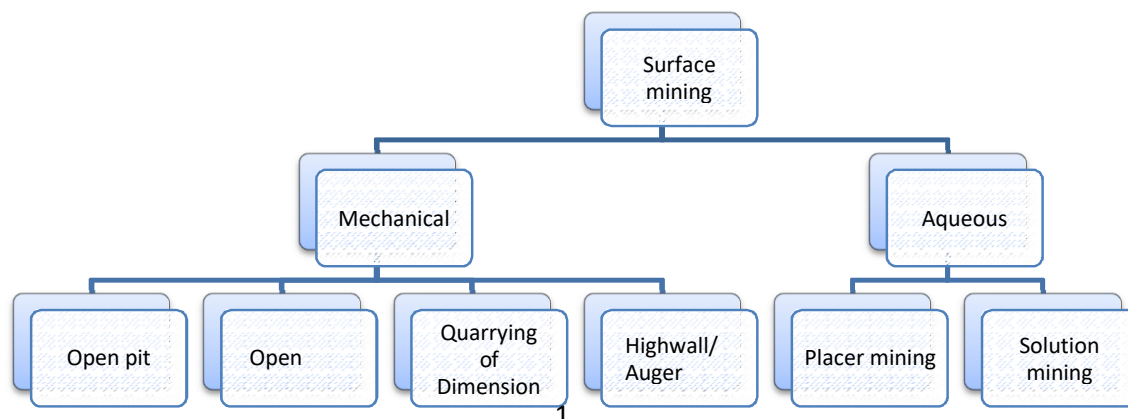
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Introduction- As per the current environmental scenario sustainability is the key issue for the development. Natural Resources are the main source of raw material for any industry. Primary sectors of economy such as mining industry are struggling with the concept of sustainability. As to meet the growing needs of human, depletion of natural resource has become a major focus of government all around the world and hence concept of sustainability has come into existence. Several laws have been made for achieving this purpose.

In a view of sustainability, the concept of EIA was first enforced in the USA. First EIA is carried out in India for the River Valley Projects in 1970s and then became a tool for assessing the impact of any development project by Govt. Apart from basic advantages of sustainability, assessment and mitigating of possible impacts EIA also has significant advantages like the public hearing, stakeholder's participation, enhancing positive impact of project etc.

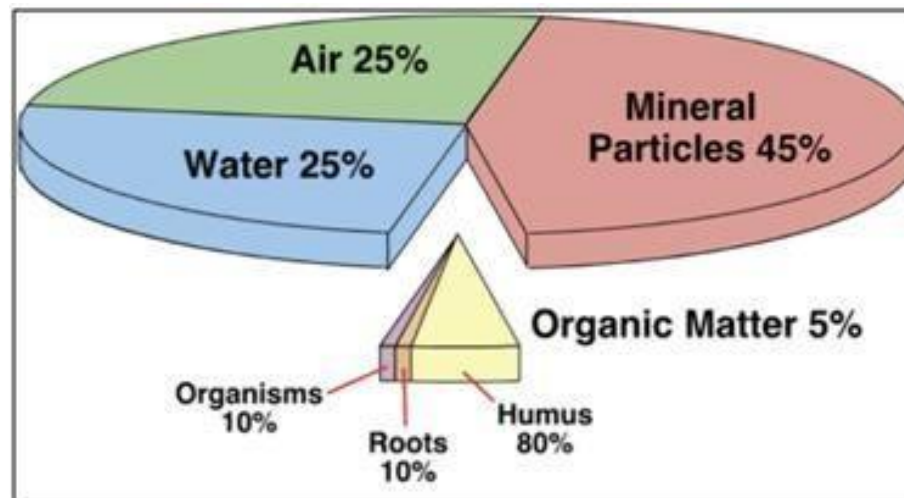
As far as mining concern it has two categories which are Surface mining and Underground mining. These two categories further divided into various subcategories (*J. Yamatomi and S. Okubo University of Tokyo, Japan*).

Figure 1: Different types of surface mining



Soil Composition- Soil is made up of many components. It is composed of air, water, mineral particles, organisms, Humus and roots. Humus keeps the roots intact. It acts as glue for the soil, keeping it together so that it doesn't fall apart like sand. It also keeps the roots underground.

Figure 1: Soil Composition (<http://www.prescriptionsoilanalysis.com>)



2.0 Purpose of the Study-

As per the rule by Govt. of India, Environmental Clearance is mandatory for 39 (*EIA Notification, 2006, MoEF, India*) type of new and expansion project. So each project need to carry out a detailed EIA study. In case of surface mining, we need to know which type of mining has minimum and maximum impact on its environment.

2.1 Area of Study- We will review the physical environment (i.e. Soil, Ambient Air, Water, and Noise) of Terrace land Mining, Hill Slope Mining and Riverbed Mining of minor minerals.

3.0 Terrace land mining

The Terrace land mining is the type of mining in which mining is done on terrace land where there is little or no influence of water. In Terrace lands mining thick deposit are mined out in benches. The length/ height of the bench vary according to the mineral deposit. Although a thick deposit may require only one bench. It is a multi-benched sideways moving method, the whole mine moves over the reserve from one end to other but not necessarily in a single bench. The number of benches used is usually a function of the excavation depth and the type of machinery used, typically between 10-15 m bench height and 1-32 m benches in terrace (*Hassan Z. Harraz*).

3.1.1 Impact on Soil Quality-

Terrace land the mining is done on benches and mined material is extracted with the help of mechanical and electricity operated machines. Firstly top soils which are rich in humus and have buried seed are extracted and preserved at the dumping site for use in reclamation work.

Removal of vegetation cover is also required if present.

All mining activities are against nature and lead to the change in the topography of that area. However backfilling is somehow reclaims the land. Other than this Mining affects the soil fertility, soil profile, soil texture, binding capacity/ compaction, low soil pH, decreases water filtration and increased percolation of water due to removal of hard rock. All these factors ultimately lead to soil erosion, weathering, denudation and degradation of land.

3.2 Impact on Ambient Air Quality-

Mining operations generally causes release of dust material/particulate matters, and greenhouse gases from vehicles etc. right from the building of access road, mining material extraction, loading, unloading of materials, transportation. However SPM settles down within a short period of time by water sprinkling. Generally hand tools like shovel etc. does not cause much pollution but electrical equipments like electrical operated scraper causes main pollution.

3.3 Impact on Water Environment-

Generally water occurs in two forms i.e. surface water body and Ground water body. For choosing an area for mining purpose, an area having surface water body is avoided. During the mining process the emphasis is given on the distance between the end point of mining and the ground water table so that the percolation can be avoided.

In open cast mining ground water gets enhanced because of removal of the overlying rock burden. This helps in easily percolation of water from surface to the ground. However the filtration rate got decrease and the chances of contamination get increase. Sometimes the mining goes beyond the water table and it is very obvious that the ground water will get contaminated. In the case when mining goes beyond the ground water table and there is a huge amount of ground water is present, and then flood will eventually occur at the mining pit. By removal of overlying rock burden penetration will occur easily but so does evaporation. And the ground water will evaporate very easily. So this over burden removal has both positive and negative impacts.

After the closing of mine the ground water can be contaminated if it is located at the area of ground water recharge catchment area. But this can happen only in the case of coal/ minor mineral (copper, ore) extraction. Boulder, Bajri, Sand mining doesn't have that much impact. However if there is any water body present near the mine area then measures are adopted to avoid contamination in that water body. Generally concern is given to large water body; there is no chance of contamination to seasonal water bodies because there is no mining activity takes place during the monsoon.

3.4 Impact on Noise Environment-

Noise and Vibration generally doesn't have that much significant impact on the environment. But if activities like blasting etc are involved then noise can cause damage. However on humans blasting process doesn't impact much but some sensitive animals like rabbits or birds etc. are really sensitive to noise and vibration.

4.0 Hill Slope Mining

Hill Slope mining is done on the hills with moderate slope. Steep slope hills are not feasible for

mining because steepness does not allow any vehicle or mining operation to execute. In Hill Slope mining overhanging burden (i.e. waste burden above the mining point/ top of the hill) should not be more than 20% otherwise this burden will fall down on the benches and cause slope failure. Usually moderate slope angle (45° angle) is preferred angle.

Hill Slope mining is generally done in steps and each step has some extent of impact on the environment. At primary step vegetation cover removed. Large trees are firstly removed followed by bushy plants, scrubs and stumps. In the second step top soil with grasses, weeds, climbers with buried seeds are removed. The felled timbers either burned or sold out. The hill slope mining is usually done in benches. Mining operation is carried out from top to bottom. The first bench should be of 6*6 meter (length* height) and further benches are made accordingly. The length/ height of the bench can vary in hill slope mining just like terrace land mining.

4.1 Impact on Soil Quality-

For breaking the hard rock blasting techniques are in practice. Blasting has more impact than that of other mining techniques. In the case of Hill Slope mining, blasting not only gives rise to noise levels but also creates vibration which shakes the ground and can lead to landslides. However blasting causes significant impact on environment and is generally prohibited in hill slope mining. However if blasting is required, firstly a number of trial blast with verifying parameters are carried out before adopting it for regular basis.

Mining in hill slopes causes maximum impact on soil. Generally hill slope is covered with the vegetation which binds the soil and prevents the soil erosion. But after removal of vegetation cover, soil is totally exposed to erosion.

4.2 Impact on Water Quality-

Rainfall directly affects the benches. At the time of intensive rainfall the benches degrades tremendously because they are already exposed to soil erosion and soil degradation. It causes deepening of benches and creates more holes and faults in the soil. As a result a bench totally destroys and led to the slope failure. The very first bench which is near to the top of the hill gets affected firstly and subsequently other benches get affected. There is a provision of mine dust to contaminate surrounding open water body. If there is any stream/ water body adjacent to mining site then waste generated from mining is dumped into the river stream which causes significant impact on the stream/ water body. In addition sometimes oil and diesel split from the onsite vehicles causes contamination to water. This contamination includes mixing of oil/ grease, heavy metals and petroleum waste. It not only contaminates surface water body but also degrade ground water quality (leaching). The quality and quantity of ground water may get affected by the surface hydrology, soil texture and terrestrial vegetation.

4.3 Impact on Ambient Air Quality-

Main source of air pollution is mining activity (i.e. Drilling, Blasting, Excavation, Sizing etc.), vehicular transportation, loading and the unloading of mined materials etc. the sources are same as terrace land mining. However the extent of air pollution can change in different mining methods. In hill slope mining the mining process starts from upper portion of the hill and goes downward. Because of vertical mining process and hill topography, the air pollution generation and extension can be more. However, hills are covered with vegetation and it's a well-known

fact that trees are good absorber of air pollution. So in Hill Slope mining air pollution generation is comparatively lesser than terrace land mining but more than riverbed mining.

4.4 Impact on Noise Quality-

Hill Slope mining is more tedious than other mining because it is carried out on hills where challenges are more like lack of access road, vehicle movement difficulty and so on. Hill rocks are generally harder than other land so uses of explosives are acceptable. However permission should receive from the mining department. This blasting not only increases noise level but also generate vibration. The duration of noise generation due to blasting is generally less but it impacts the hearing capacity of workers as well as community around the mining area.

5.0 River bed mining

Mining of the minor minerals has been increased over the past few years. The industries and all the developmental activities are growing rapidly and lead to increased demand of sand, bajri as a source of construction material. This has resulted in mushrooming of river sand mining activities and exploiting the river bed. Increased demand of sand encouraging illegal mining of sand. At this time the main requirement is to build authority that can prevent all such illegal sand mining and promote sustainable and scientific mining of river bed.

Sand and gravel mining is generally done on active stream, flood plains, dry river bed terrace land etc. Every year thousands of bed materials (sediments, gravel, and sand) are transferred from the high land to low land, from river to ocean. Rivers are so important that the most of the ancient civilization resides on the bank of the river. In earlier days, mining of sand did not create any problem to river ecosystem as the quantity of mining was well within the replenishment limits. However, increase in population and rise in economic and industrial developments for past few decades have aggravated mining of river bed many folds higher than natural replenishments. It really damages the river ecosystems in the world. River bed mining is generally preferred over the other mining method because of ease of mining practice. Other methods of mining involve removal of overburden from the mining site. Sand mining is the type of open pit mining which doesn't requires blasting or drilling or other special mining excavation technique, the mining can be done manually. But beside all the advantages of cheapest method and less input requirement, river bed mining also has some disadvantages like- river bed degradation, river bank degradation, gullies erosion, river buffer zone encroachment, degradation of river quality etc.

5.1 Impact on Soil Quality- River bed mining includes mining at shallow depth which causes more environmental deterioration¹⁵. Most applicable practices of sand/ gravel mining are as follows-

- I. **Dry pit mining:** Pits excavated on dry ephemeral stream beds and exposed channel/ point bars¹⁵,
- II. **Wet pit mining:** This involves mining below the water level of a perennial channel generally during the lean period. This may involve frequent/ partial or full dewatering of working face¹⁵,
- III. **Bar skimming or scraping :** Scraping of top portion of the bar deposits are generally undertaken for sustainable mining of sand/gravel grade material¹⁵,
- IV. **Pits on the adjacent floodplain or river terrace:** In this case dry or wet pitting/ mining are involved depending upon geomorphology of the area. Dry pits are located above the

water table and wet pits are developed below the groundwater table in the area¹⁵.

The soil of the river bed is different than terrace land and hill slope. It is generally composed of boulder, bajri, sand and gravel material. Inter-beds of sand within flood plain deposits act as aquifer systems storing large quantities of ground water¹⁷.

It is now well understood that continued and indiscriminate sand mining can cause serious environmental impacts, particularly if the river being mined is erosional¹⁷.

The mining of weather major or minor minerals has direct relation with the hydrological regime of the area. Removal of overburden causes infiltration of the water and the leach out water might have some form of contamination.

5.2 Impact on Ambient Air Quality-

In river bed mining there is very little emission of air pollutants due to the presence of water. But there is some fugitive air pollution by movement of transporting vehicles, excavators like JCB. The quantity of emissions depends on various aspects like climatic conditions, moisture in the soil, speed of the vehicle, frequency of the vehicles etc¹⁴ Construction of access roads.

5.3 Impact on Water Environment- In the case of wet river bed mining the mining is done on active stream/ water channel. Mining involves excavation of the sand and gravel deposition from the river bed. Excessive mining cause's infiltration of the water and the leach out water might have some form of contamination

5.4 Impact on Noise Environment- Main source of noise generation is only transportation vehicles like truck, tractors etc. other than this no other noise generation sources are there.

6.0 Conclusion- As per above mentioned description and the justification of each mining method, pollution (soil, water, air, noise) is comparatively lesser in river bed mining than other mining methodologies. In the case of soil pollution the generation of soil dust is lesser because the mined out material is moisture rich with lesser contamination potential. Same reason justifies the impact on air and water. In both terrace land and Hill Slope mining, the mined materials are free from moisture which can spread over large area which potentially causes water and air pollution. Noise generates mainly by using blasting, drilling, scrapping and other techniques. In river bed mining no such techniques are practiced, so noise generation is minimum in river bed mining. So river bed mining is most eco-friendly and economical mining method.

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