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Received: 03-04-2022

Accepted: 22-12-2022

Published: 28.12.2022

**Citation:** Randhir D. (2022). Developing Strategies for Sustainable Development in Bauxite Mining Areas of Western Maharashtra. Geographical Analysis. 11(2): 1-10. <https://doi.org/10.53989/bu.ga.v11i2.22.5>

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Funding: None

Competing Interests: None

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Published By Bangalore University,  
Bengaluru, Karnataka

ISSN

Print: 2319-5371

Electronic: XXXX-XXXX

# Developing Strategies for Sustainable Development in Bauxite Mining Areas of Western Maharashtra

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## Abstract

The government has leased 33 bauxite mining projects in the Western Maharashtra. In Kolhapur 16, Raigad 7 and Ratnagiri 5 mines are found. 25 villages in Kolhapur district and 52 villages in Raigad and Ratnagiri districts are the mining affected villages. In the Western Maharashtra 76,97,076.5 sq. meter and average up to 5.7 meter depth of Land has been excavated. Total volume of excavated landmass is 41,029,443 m<sup>3</sup>. Bulk density of mine land materials of Konkan region is 1670 kg/m<sup>3</sup> and in Sahyadri it is 1676 kg/m<sup>3</sup>. In the Western Maharashtra 68,696,115.41 tons of earth materials has been excavated. Stripping ratio of bauxite mines of India is 1.281. Out of total earth materials 41,217,669 tons of waste generated because of bauxite mining in Western Maharashtra. 27,478,446 tons of bauxite has been derived from 28 mines. Bauxite production and waste materials generated by each mines operated in the western Maharashtra were computed. It is suggested that the waste materials to be used for development of bauxite mining sites after their closure. From the mines of Konkan 1,15,61,446 tons and Sahyadri 2,96,56,222 tones waste dump materials has been created. Leveling and creation of waste dump material layer on Mine Land area is the key aspect. On an average, the soil layer of the Sahyadri region mines is 3.5 meters and Konkan region mines is 3.2 meters can be created. The total area of all the bauxite mines in the Western Maharashtra is 769.71 hectares. A total of 307883 mango trees can be planted in this area. Out of this, 16472 metric tons of mangoes can be produced. The Production cost of these mangoes will be approximately Rs. 124451721. The total production of mangoes will be 411023885 rupees. After deducting the cost of production from the total product, the net profit is Rs. 286571395.

**Keywords:** Bauxite Mining; Sustainable Development; Strategic Development

## Introduction

Mining is the activity, occupation, and industry concerned with the extraction of valuable minerals or other geological materials from the earth. It contributes greatly to economic development and has long-lasting environmental impacts. We appreciate economic devel-

opment through mining activity, but it is also important to understand negative externalities for mitigating factors through sustainable manner. The concept of Sustainable development is applicable to the mining site also. According to WCED, 1987, "Humanity has the ability to make development sustainable to

ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs". Bauxite is one of the raw materials with high economic significance for production of aluminium; it is mined in surface operations in tropical and subtropical climates. The activity has been seen in the western Maharashtra.

Bauxite mines and its affected areas in Maharashtra have been included in the present research work. It has been tried to study the impact of bauxite mining activity on the physical, social and economic environment of the study area. The existing strategies of sustainable development have been studied to formulate strategies for the area under study. Few strategies have been developed in order to protect the mining affected areas of the Western Maharashtra for their future sustainable development in the present research work. If bauxite mining companies and government shall adopt these developed strategies, it will be beneficial to mining affected villages, governments, and the overall environmental conservations. In Maharashtra bauxite deposits are found in some districts in the West. It includes western districts of Kolhapur, Raigad, Ratnagiri, Sindhudurg, Satara and Thane. Bauxite mining has been seen illegally practiced at many places in these districts. In the present research work, only the government-approved bauxite mines have been selected for study. Government approved bauxite mines of Kolhapur, Raigad and Ratnagiri districts and its impacted area is the study area of present research work.

The impact of mining activities on pollution of air, water, land, soil quality, vegetation including forest ecosystems, and on human health and habitation has become a matter of serious concern<sup>(1)</sup>. Mining and its subsequent activities have been found to degrade the land to a significant extent and overburden removal from the mine area results in a very significant loss of rain forest and the rich top soil<sup>(2)</sup>. Land degradation is one of the significant impacts arising out of mining activity which is mainly in the form of alteration of land structure due to excavation, stacking of top soil and loss of land due to dumping of mine waste and overburden soil<sup>(3)</sup>. According to the data generated by the Indian Bureau of Mines, average stripping ratio for bauxite mines in India is 1:1.2<sup>(4)</sup>. Mining activities around the world have been accompanied by land expropriation and environmental degradation that harm the livelihoods and health of local communities<sup>(5)</sup>. The main air quality problem with mining is dust particles<sup>(6)</sup>. Mining either open cast or underground, destroys landscape and forest ecosystem. The waste materials that remain after the extraction of ores are dumped on the surrounding land, thus causing loss of topsoil, nutrients and supportive micro flora and vegetation<sup>(7)</sup>. "The exact effects of bauxite mining are quite specific to the site; it involves some habitat destruction, soil erosion, loss of biodiversity, or water pollution. These effects can be rationally short term and followed by regrowth, or severe and permanent. Open cast

mining includes the removal of the top layer of soil in order to get at the ores underneath. The resultant soil erosion means that it may be very difficult for vegetation, whether natural or crops, to re-establish itself"<sup>(8)</sup>.

Opencast mining affects all landscape components and functions, after initiation of mining, the ongoing landscape development is disrupted, the original ecosystems are removed, the original topography is significantly changed, the fundamental ecological relations are irreversibly disturbed, and biodiversity is rapidly reduced<sup>(9)</sup>. Opencast mines can affect the underground aquifers in the surrounding areas and significantly impact on water resources, result in significant impacts on local water bodies<sup>(10)</sup>. Mining and its associated activities not only uses a lot of water but also affects the hydrological regime and often affects the water quality<sup>(11)</sup>. The open cast bauxite mining activity is has adverse local impacts on land use practices and socio-economic activities as well as it initiated environmental degradation in the region due to deforestation, loss of biodiversity, wasteland generation, dust and noise pollution, pressure on local resources, and soil erosion<sup>(12)</sup>. Bauxite mining is one such major open cast mining activity which has significant negative impact on the local environment, major threats of this activity are dust pollution, vegetation loss, forest fragmentation and biodiversity loss negative impact on water resources, generation of wastelands and social impact<sup>(13)</sup>. Due to bauxite mining activity there is deficiency in nutrients such as Organic Carbon, Nitrogen, Phosphorus, Potassium, Calcium and Magnesium, with deteriorated physical soil parameters namely field capacity and water holding capacity, as compared to the soils from the adjoining forest, agriculture and plateau grassland sites<sup>(14)</sup>.

Using a mathematical model to assess the sustainability of proposed bauxite mining in Andhra Pradesh, India from a quantitative-based environmental impact assessment, results indicate that the current proposed bauxite mining operation in Andhra Pradesh is deemed to be unsustainable<sup>(15)</sup>. Opencast mining impacts are felt at every stage of the mining cycle, from exploration to mine closure, large amounts of vegetation, soil and rock that have to be removed to expose the mineral and are, very often, highly detrimental to fragile ecosystems and local communities dependent on them<sup>(16)</sup>. The impact of mining activities leads to deterioration in the physical, chemical, and biological quality of the environment affects human health and flora and fauna, the negative impacts on the landscape and the human environment can effectively be permanent<sup>(1)</sup>. Physicochemical properties of mine soil relates the presence of toxic heavy metals, high concentration of heavy metals (Cd, Pb, Zn, etc.) from mines may constitute major health risk to the local population and aquatic life; by contaminate surface water, groundwater and adjacent lands<sup>(17)</sup>. Opencast mining is more damaging to the environment as it causes deforestation and creates big holes and large overburden dumps on the earth's surface, it can also

lead to air, water and noise pollution, hydrologic disturbance, involuntary displacement of persons, disturbance to wildlife, and can pose a hazard to the public during and after mining<sup>(18)</sup>. 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<sup>(19)</sup>.

Surface mining, geology-soil-plant stability circuit is disrupted and flora-fauna-hydrological relations and soil biological systems are drastically disturbed<sup>(20)</sup>. Surface mining drastically changes the topography of the area and transfers relatively stable land forms into more erosive ones, in mine spoils, geomorphic system is in disequilibrium due to destruction of the balance between landforms and processes which accelerate erosion rates<sup>(21)</sup>. In the process of open-cast mining, several changes occur in physical, chemical, and microbiological properties of soil as result of mining and storage<sup>(22)</sup>. Carelessness and inappropriate planning, bauxite mining affects the physiographical environment of the study area<sup>(23)</sup>. Open cast mining destroyed the soil structure, increased the soil acidity, made the soil nutrient deficient and increased the heavy metal toxicity<sup>(24)</sup>. Bauxite mining in respect of air, water, noise and land pollution, irreparable loss to the natural status of ecosystem and biodiversity of the present study area<sup>(25)</sup>. Opencast mining in huge forest areas results into loss of biodiversity, loss of nutrient qualities and microbial activities of the soil system, it can release huge amount of mining wastes to the upper part of the land surface as overburden dump materials<sup>(26)</sup>. Anthropogenic interventions in the form of opencast bauxite mining alter "critical" parameters of the natural environment and lead to destabilization of the environmental balance of forest ecosystems as well as cause changes in geomorphological processes<sup>(27)</sup>. Air pollution is a common environmental problem in all mines and quarries, especially open-cast operations; it spreads beyond mine sites, thus affecting the buffer zone to a large extent<sup>(7)</sup>.

Sociologically there are several negative effects regarding the rehabilitation, resettlement, loss of lives, loss of livelihood, loss of cultural heritage, aesthetics, health, and loss of tourism, parks, and sanctuaries<sup>(28)</sup>. Mining being a temporary economic activity it leaves long-term social, economic and environmental footprints<sup>(13)</sup>. One of the most significant impacts of mining activity is the migration of people into a mine area, mainly in remote parts of developing countries where the mine represents the single most important economic activity<sup>(29)</sup>.

## Study Area

The study area consists of bauxite mining sites of Western Maharashtra. It includes three districts which are Kolhapur, Raigad and Ratnagiri. In Western Maharashtra over-

all twenty-eight bauxite mines have been observed. Out of those, sixteen are located in the Sahyadri especially in Kolhapur whereas twelve are located in the Konkan especially in Raigad and Ratnagiri. In Maharashtra Bauxite deposits are found in Kolhapur, Raigad, Ratnagiri, Satara, Sindhudurg and Thane districts. But the most of the mining lease have been in operation more than two decades at three districts of western Maharashtra. In Kolhapur district Shahuwadi (10 mine), Radhanagari (03 mine), Chandgad (04 mine) and Bhudargad (01 mine); In Raigad district Shrivardhan (06) and Pen (01); In Ratnagiri district Dapoli (03) and Mandangad (03) (IBM, 2014). These are the major bauxite mining sites of western Maharashtra. All government sanctioned bauxite mines and its affected area of western Maharashtra is the study area of present research work.

## Aims and Objective

The focus of the study is to assess the nature of bauxite mining in the area and to evaluate its impact on the general environment of the study area. Considering the severity of the impacts it is proposed to outline strategies for sustainable future development of the area. Following objectives are set to accomplish this.

1. To understand the impact of bauxite mining on the physical environment.
2. To assess the effect of mining activity on the socio-economic system of the area.
3. To evaluate existing mining policy with respect to rehabilitation of the mining area
4. To develop strategies for future sustainable development in the area.

## Materials and methods

Present research work is based on the primary data, secondary data as well as laboratory work. The information about bauxite mining projects, which were leased by government of Maharashtra in western region, obtains from Indian Bureau of Mine, Nagpur and district collector office of Kolhapur<sup>(30)</sup>. The villages which fall within 2 km area from mine have been decided as mining affected area for field observation. An attempt has been made to collect information about bauxite mines of western Maharashtra that how much area have been excavated through satellite images and field observation. Depth of the each mine have obtained through Environment Impact Assessment Report, Inspection Report of bauxite mines and field visit<sup>(31-34)</sup>. With the help of excavated land area and its depth overall how much volume of landmass excavated is identified of mines of Western Maharashtra is calculated.

At the place of mine, excavated earth materials have been measured in order to find out how much earth materials has

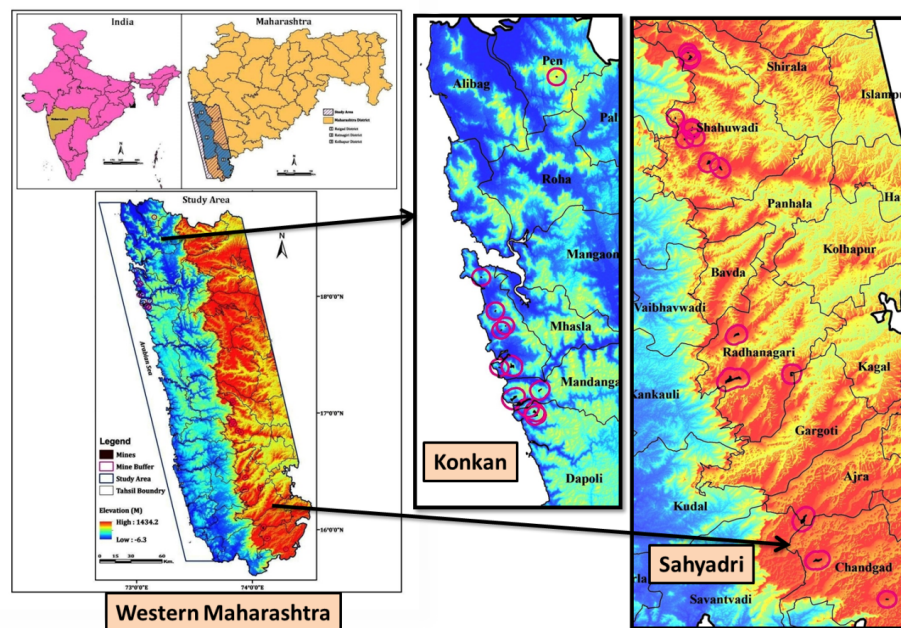


Fig. 1. Study area map

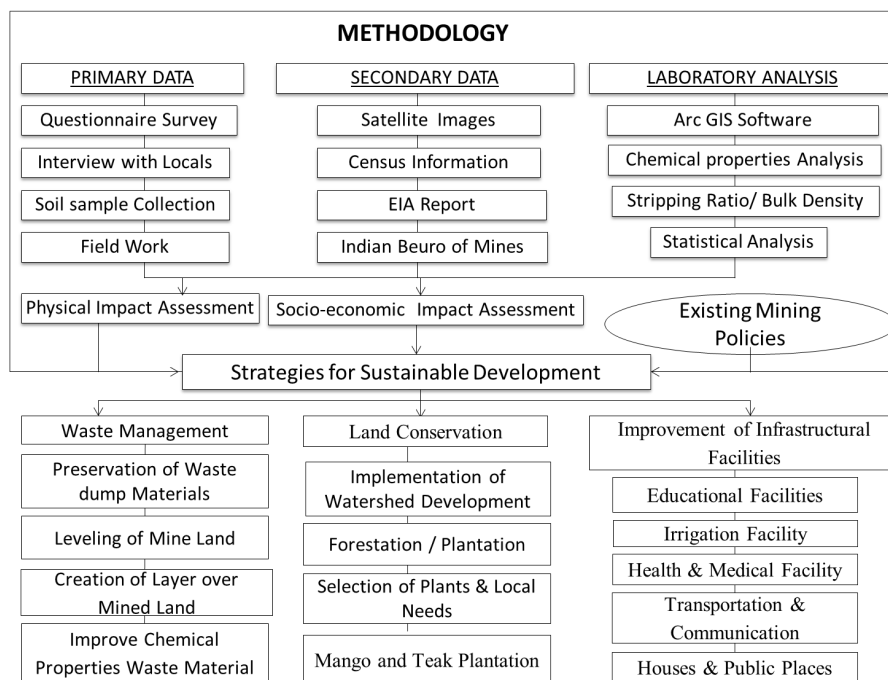


Fig. 2. Methodology



been excavated from each bauxite mine. For this purpose, bulk density of mined land material is checked out in the laboratory. Out of total earth materials, how much it is measured as wastage, have been found out through stripping ratio<sup>(1)</sup>. In Maharashtra the amount of Bauxite produced in last ten years has been obtained from Indian Minerals Year book<sup>(35)</sup>.

With the help of volume of land mass, total excavated earth materials, stripping ratio of Indian bauxite mining sector, the mine-wise production of bauxite has been calculated. Mine-wise bauxite production has been calculated through Stripping Ratio and the mine wise cumulative value of all mines in the state of Maharashtra indicates total production. As per census 2011, LULC information of each bauxite mining affected village has been collected and analyzed together and actual mining area (excavated area) has been included. We get information of impact on forest or its fragmentation due to bauxite mining through literature review, field observation and questionnaire survey.

Soil samples (0-15 cm) were collected from 3 mining sites of Kolhapur (Udgiri- Shahuwadi), Raigad (Bagmandala-Danda- Shrivardhan) and Ratnagiri (Sakhari- Mandangad) districts. 5 samples from Agricultural Land (AL), 5 from Forest Land (FL) and 5 from Mine Land (ML). In all 15 samples from each mining site were collected. A total of 45 samples were collected and analyzed in Krishi Vigyan Kendra, Babhaleshwar (Rahata, Ahmednagar district). Soils were completely air-dried and passed through 2 mm sieve and stored in properly labeled plastic bags for analysis. The processed soil samples were analyzed for basic soil parameters (pH, EC, OC, and CaCO<sub>3</sub>) and for macronutrients (N, P, K) by using standard procedures<sup>(36)</sup>. The available Fe, Mn, Cu and Zn in soil samples were extracted with a DTPA solution (0.005 DTPA +0.1M triethanolamine, pH 7.3 as outlined by Lindsay and Norvell (1978). The concentration of micronutrients in the extract was determined by atomic absorption spectrophotometer (ECIL, AAS- 4129)

Forest Fragmentation, Dust Pollution, Soil Erosion, Impact on Water Resources, Impact on Environment, Impact on Wild Lives, Sound Pollution, Impact on Atmosphere, Economic Status of the People, Employment Status of the People, Educational Facilities, Water Sources, Health / Medical Facilities, Infrastructural Facility of affected area, Transportation Communication Facility, Irrigation Facilities, Livelihood such aspects related to physical as well as Socio-economic impact assessment of bauxite mining activity on mining affected areas of Western Maharashtra have been identified through Questionnaire Survey, Field observation, and Interviews with locals and experts.

Existing sustainable development policies of different mining sectors have been discussed through literature review which includes the world mining policies, Indian mining policies and the mining policies adopted by the mining compa-

nies in the state of Maharashtra have been discussed<sup>(31–34)</sup>. Sustainable development strategy for present study area is developed with the help of result obtained from the above methodology, field observation and questionnaire outputs.

## Results

### Bauxite Mining

The government has leased 33 bauxite mining projects in Western Maharashtra. Shahuwadi (9), Shrivardhan (7), Dapoli (4), Mandangad (3), Chandgad (3), Radhanagari (2), Bhudargad (1), Pen (1), Sawantwadi (1) and Satara (1) mine have been leased on for bauxite excavation. But actual 16 bauxite mines are found in Kolhapur districts of the Sahyadri whereas in districts of the Konkan region especially, Raigad 7 and Ratnagiri 5 bauxite mines are found.

### Mining Affected Villages

Villages come within 2 km radius from the bauxite mine are the mining affected villages. Twenty five villages in Sahyadri region of Kolhapur district and fifty two villages in Konkan region of Raigad and Ratnagiri districts are the mining affected villages. Total mining affected village area of Western Maharashtra is 46232 hectares (46,23,20,000 Sq.Mtrs).

### Mine Area

In the Western Maharashtra 76,97,076.5 Sq. Mtrs. of Land has been excavated for bauxite mining. Out of this, in the Konkan region, total 22,08,702 Sq. Mtrs. and Sahyadri 54,88,375 Sq. Mtrs. of land has been excavated.

### Mine Depth

In the Western Maharashtra average up to 5.7 meters depth of Land has been excavated. In the Konkan region average up to 5.33 meters and Sahyadri 5.8 meters depth of land has been excavated.

### Mine Volume

Total volume of excavated landmass 41,029,443 m<sup>3</sup> of land has been excavated in Western Maharashtra. Out of this, in the Konkan region 11,538,370 m<sup>3</sup> and Sahyadri 29,491,072.5 m<sup>3</sup> of land has been excavated from last few decades.

### Bulk Density

Bulk density of mine land materials of Konkan region is 1670 kg/m<sup>3</sup> and in Sahyadri it is 1676 kg/m<sup>3</sup>.

## Excavated Earth Materials

In the Western Maharashtra 68,696,115.41 tons of earth materials has been excavated. Out of this, in the region of Konkan 19,269,078 tons and Sahyadri 49,427,037.5 tons of earth materials has been excavated.

## Stripping Ratio

The ratio of overburden excavated to the amount of mineral removed is called stripping ratio. Stripping ratio of bauxite mines of India is 1.281. It means out of total earth materials 54.55 % waste dump materials and 45.45% bauxite has been excavated<sup>(1)</sup>.

## Waste Earth Materials

Out of total earth materials 41,217,669 tons of waste generated because of bauxite mining in Western Maharashtra. Mines of Konkan 11,561,446 tons and Sahyadri 29,656,222 tones waste dump materials has been generated.

## Bauxite Production

27,478,446 tons of bauxite has been derived from 28 mines. Out of these 7,707,631 tones in Konkan bauxite mines and 19,770,818 tones in Sahyadri bauxite mines.

## Changes in LULC

Land use land cover pattern of bauxite mining affected areas has been seen changed due to mining activity. Total mining affected village area is 46,231.54 hectares; out of these 34,196.15 hectares in Konkan region and 12,035.39 hectares of land in Sahyadri regions. In Chandgad tehsil 160.5 hector (4.1%), Shahuwadi tehsil 150.3 hector (1%), Ajra and Radhanagari tehsil 210.3 hectares (09%), Shrivardhan 61 hector (0.7%), Pen 6 hector (0.2%), Dapoli 88.3 hector (3.2%), Mandangad 65.6 hector (2.4%), Bhudargad 27.6 hector (0.8%) areas have been excavated which resulted in the changes in the land use and land cover pattern of the study area. Almost 56% area is under forest and net sown area. Almost 1.6% LULC area means 770 hectares of land has been changed because of bauxite mining activity in Western Maharashtra. Out of these 371.2 hectares area in Konkan and 398.4 hectares area of Sahyadri region has been changed.

## Impact on Soil Properties

Soil basic parameters, Macronutrients and Micronutrients average results show Mine Land (ML) soil properties are affected because of opencast bauxite mining activity as compare to surrounding soil properties. Nutrients level of ML is lower than the Agricultural Land (AL) and Forest Land (FL).

## Dust Pollution

It is another important impact of bauxite mining affected areas of Western Maharashtra because of accumulation of dust increases in the atmosphere, on the leaves of trees, houses and its surroundings, it effects on the lives of human being and animal beings. Sometime bauxite companies do not cover bauxite during transportation. They do not sprinkle water regularly in mining area as well as roads in order to reduce dust pollution.

## Soil Erosion

Due to bauxite mining a large scale of land is excavated and during this process fertile soil layer is removed and kept aside. By using enormous machines like bulldozers for either mining activity or road constructions, 1 to 2 meter soil layer have been removed and excavation for bauxite mining takes place thereafter. The most of places of bauxite mines which come under the Sahyadri range are under forest or rocky land. For bauxite minerals; such rocky lands have been removed through powerful machineries. The occupied land for bauxite excavation is turn into barren. According to local people such land will not be of any use, Such land is not useful either for sustainable development of villages or its temporary development because its excavation made it infertile. It has been reported by mining companies that they have planted trees around bauxite mines and mining affected areas in order to reduce Soil Erosion.

## Impact on Water Resources

The water level has decreased which has affected public wells, hand-pump of bore wells. The most of overland flows at mining places have disappeared. Turbidity increased because of merging dust and soil into streams and deposits into nearby water bodies. Underground water is polluted. The taste of underground water has been changed a lot. Watershed development programmes are not implemented in this area. Water which is used for mining activity has been drawn out from local water resources which resulted water scarcity in summer and people have to suffer a lot in order to get water.

## Impact on Environment

The life of rural mostly depends on the natural resources. Water sources including ponds, streams, vegetation, fertile lands, grass lands, crops according to climates and local occupations are real resources of the said regions, these resources have been got affected by various ways. Because of bauxite mining activity the area is degraded. It is seen that there is environmental degradation such as deforestation, soil erosion, land degradation, impact on water resources; sound pollution, air pollution and wild life decrease are the problems. That environmental degradation of bauxite mining

affected area is only occurred because of bauxite mining.

### Impact on Wild Lives

The almost all bauxite mines of Kolhapur districts are either in forest or nearby forest areas. There is Chandoli sanctuary near bauxite mines of Shahuwadi tehsil. Before the beginning of bauxite mining activity the existence of wild life was common but after the initiation of mining activity number of wild animals and birds have reduced. The mining activity has lead to imbalance in the ecosystem of the area. Addition in drivers, damaged roads and transportation during nights are the reasons of increasing accidents. Most of the roads lead through forest towards mines. While cross such roads wild animals are hit by vehicles which results in their death by accidents.

### Population Characteristics

Total mining affected villages in Western Maharashtra are seventy seven. Out of these, twenty five are in the Sahyadri and sixty two are in Konkan. The total number of households in the affected villages of Western Maharashtra are 12816 and the population is 53553. In the Sahyadris, total households are 5098 with 24,352 population. On the other hand in the Konkan, there are 7718 households with 29,201 population. The sex ratio of the bauxite mining affected villages revealed that there are 28,946 women and 24,607 men. In the Sahyadri region, 12,468 women and 11,884 men, whereas in the Konkan, there are 16,478 women and 12,723 men.

### Economic Status of the People

Agriculture is the main occupation. Bauxite mining has affected this occupation. Per capita income of local people and living standards have not increased because of bauxite transporters. Small hotel business did not develop as expected. People have taken loan from banks for buying trucks for bauxite transport. They are trapped into debt because of unsuccessful bauxite transportation or after closing mines. Since people use bauxite transportation trucks for their daily commute, the private transport operators have lost their business. Bauxite Company does not support economically for religious, cultural and sports activities in said area which was promised by them at the time setting up of mines. Locals are not aware of the financial provisions for development of environmental planning. People are unaware of details of bauxite mining in the area. Illegal mining activity has also flourished in the area.

### Educational Facilities Status

Parents do not care educate of their children. Social and Government policies do not help for the educational quality improvement. Public library is not available in the village. Daily newspapers are not available. In bauxite mining affected

regions of Western Maharashtra, there are 108 nursery schools, 119 Primary schools, 44 intermediate schools, 11 secondary school and 08 government secondary schools. It is noted that Junior and senior colleges are not seen in bauxite mining affected regions of Western Maharashtra. As Junior and senior colleges are not found in bauxite mining affected regions of Western Maharashtra, youth of the region has to migrate for higher education but due to economic crises most of youth cannot afford higher education which has resulted in lower rate of higher education of youth in mining affected regions.

### Health / Medical Facilities Status

Very few public places are seen which are not regularly kept clean for example; school, temple, lanes, drinking water sources, grampanchayat area, paths within town, social temple, drainage etc. People from bauxite mining affected area are superstitious. Health of inhabitants and mine workers is severely affected because of mining activity. Health check-up camp are not organize regularly. Locals / Mine workers suffer from Asthma, Skin diseases and crumbling of eyes but government health facilities for better living of people are not enough.

### Production of Bauxite in the State of Maharashtra

As far as the bauxite excavation proportion of last eleven years is concerned, bauxite was excavated in large quantity till 2014-15. In 2016-17 the bauxite price were the highest. So far as the ratio of bauxite excavation is concern till 2014-15, bauxite excavation production had been raising but in the later production decline but the prices kept on increasing.

### Existing Mining Policies at International Level

Worldwide the mining industry faces sustainable development challenges at to mitigate this challenges they under take a number of sustainability initiatives and programs. In order to contribute for sustainable development, actions have been undertaken at global and national levels for evoking the framework of comprehensive sustainable development strategic for the mining industry. This framework offers codes, guidelines and indicators to the mining industry, government and stakeholders ensures transparent and accountable enforcement.

### Sustainable Development Strategies for Indian Mining Sector

A working definition for 'Sustainable Development' in the mining sector was outlined, based on consultation with sector experts, secondary sources on the subject and the Indian context. The definition provided the frame work and boundaries

for the Environment Resource Management (ERM) team to analyse and prioritize issues while developing the Sustainable Development Framework (SDF). “Mining that is financially viable; socially responsible; environmentally, technically and scientifically sound; with a long term view of development; uses mineral resources optimally; and, ensures sustainable post-closure land uses. Also one based on creating long term, genuine, mutually beneficial partnerships between government, communities and miners, based on integrity, cooperation and transparency”

### Mining Policies of Bauxite mining Company operated in Western Maharashtra

According to the mining companies the mining activities in Western Maharashtra will lead to the sustainable development of the nearby areas. The mining and allied activities will provide direct and secondary employment opportunities for local people. This will lead to the improvement of economic status of the nearby villages. During the active mining period, the pollution will be controlled within permissible limits by way of adopting various control and mitigation measures. In the post mining stage, the mine lease area will be developed into an afforested area and surface water reservoirs. This will improve the aesthetics of the area. Mine closure plans are prepared by most mining companies primarily to meet the legal requirements under MCDR 1988. What will happen to the mining area or to the people living near a mining project when the minerals are exhausted do not seem to enter into the calculus of these closure plans. All the working mines have IBM-approved mining plans, and mining schemes as well as progressive mine closure plans which are reviewed annually. Bank guarantee is provided to IBM in respect of these plans. However, there is rarely consultation with the local communities either at the stage of preparation of a mine closure plan or its review. The most mining companies claim that since the mines are still operational, no initiatives are required on this count except to the meet the legal requirements under MCDR <sup>(31–34)</sup>.

### Future Sustainable Development Opinions of the Local People

Local people have shown to readiness for agriculture by leveling and filing up fertile soil, planting trees, the creation of meadows /grass, lands making playground, possible for erecting nursery, tourist places can be developed, Human settlement and industries, dwelling for wild life and educational institution establishment will be possible.

### Discussion

In order to preserve available waste dump materials it is needed to implement the post mining strategies effectively,

to develop basic Infrastructural Facilities and to implement watershed development programme. Soil Properties are suitable for AL and FL, Climatic and Geomorphic characteristics show that the land is suitable for FL. For afforestation, selection of plants according to local needs, are needed for the improvement of local life. To organize health checkup camp at regular intervals and taking action to preserve the biodiversity of the area is seen important. To allocate certain percentage of funds for local development through total production of bauxite and to increasing awareness of education are needed.

Bauxite production and waste materials generated by each mines operated in western Maharashtra were computed. It is suggested that the waste materials to be used for development of bauxite mining sites of western Maharashtra after their closure. According to the calculation out of total earth materials 2,74,78,446 tons of bauxite and 4,12,17,669 tons of waste have been derived from 28 mines. From the mines of Konkan 1,15,61,446 tons and Sahyadri 2,96,56,222 tones waste dump materials has been created. Leveling and creation of waste dump material layer on Mine Land area is the key aspect. On an average soil layer of the Sahyadri region mines is 3.5 meters, here maximum depth of soil layer is 5.1 meters and minimum is 1.8 meters. On an average soil layer of the Konkan region mines is 3.2 meters, maximum depth of soil layer is 4.2 meters and minimum is 1.8 meters.

Mango Plantation: Mango is one of the important fruit crops in the tropical and subtropical regions of the world. High planting density is a technique that has been widely used in mango orchards worldwide to increase earliness to improve handling and cultural practices and to reduce costs<sup>(37)</sup>. In the density studies in mango, on hectare basis the highest fruit yield (21.4 MT) was produced in closer spacing of 5 X 5m. planting density of 400 plants/ha (5 X 5 m) showed estimated fruit yield of 21.36 MT/ha/year, Rs. 161687 production cost/ha, Rs. 534000 gross returns/ ha, Rs. 372312 net profit/ha<sup>(38)</sup>. The total area of all the bauxite mines in the Sahyadri mountain range is 548.84 hectares. Planting 219,535 mango trees is possible in this area. From these mango trees, there is a total production of 11745 MT of mangoes each year. The production cost of mangoes will be Rs. 88739881. The gross returns of mangoes will be 293079198 and net profit is Rs. 204338769. The total area of the bauxite mine in the Konkan region is 220.87 hectares. A total of 88348 mango trees can be cultivated in this area. From these trees, 4727 metric tons of mangoes will be produced annually. The production cost of mangoes will be Rs. 35711840. Out of this total production will be Rs. 35711840. Due to deduction of the cost of production from this total product, the net income is Rs. 82232626. On the state level, the total area of all the bauxite mines in Western Maharashtra is 769.71 hectares. A total of 307883 mango trees are planted in this area. Out of this, 16472 metric tons of mangoes will be produced. Production cost of these mangoes is Rs. 124451721. The total production



of mangoes is 411023885 rupees. After deducting the cost of production from the total product, the net profit is Rs. 286571395.

## Conclusion

Due to mining, there is a huge natural, social and economic impact on the place of mine and its affected areas. These changes are both in negative as well as positive in nature. Positive result boosting the economic growth in national economy but same is not reflected in mining affected areas. More over negative consequences are observed in and around mines this hampers sustainable development of the mining region after the completion of mining work, it is expected that the area be rejuvenated and ecologically developed for environmental conservation and economic development there is a need for apt sustainable development strategies for mining affected area of western Maharashtra. These research finds its applicability in understanding the complex Man-Environment relationship in the Mining affected areas. The mining industry, the government and the local people must work together to care for future generations through suggested strategies.

Carrying out a detailed survey in the mining areas is very difficult due to inaccessibility in the region of bauxite mining areas of western Maharashtra. Mining companies do not reveal the actual information and there for information has to be collected by primary survey which is a tedious work. The apt and complete information is not available for all bauxite mines of Maharashtra. Illegal mining activities have completed the socio economic scenario and getting information about illegal mining is not possible. Statistical data is also not available for the production of mine-wise bauxite in Western Maharashtra.

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