Section: Research Paper

Sustainable Growth of Mining Industry of Goa and its environmental Effects – A Geographical Perspective

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ABSTRACT

Sustainable Mining is the process of taking out minerals from the earth crust without much damage to ecology environment on the earth. Mineral is an inorganic substance, which is freely occurring in the nature. The significance of mining industry is rapidly increasing over the years in this modern age of machinery to meet growing needs of population of the world. Prior to liberation of Goa from Portuguese rule, only a few small industrial units existed in the state The major economic activity was confined to the mining of Iron ore and manganese ore. Mining has been the important element in the economy history of modern Goa. It still plays an important role in employment generation and earning foreign exchange to the state. The state of Goa is richly endowed with Iron Ore and Bauxite are the most explored minerals. The mining covers approximately 700 sq.km almost 19% of total geographical area in the state carried out in Bicholim taluk of North Goa district and Salcete, Sanguem taluk and Quepem taluk of South Goa district. Mining and associated activities have greatly affected the natural landscape in and around these areas which is characterized by the presence of pits and waste rejects and dust pollution enormously. Therefore the attempt has been made to study in this paper the growth of mining industry and its several environmental and economic consequences in the state of Goa.

Key Words: ***Sustainable, Mining, Iron ore, Bauxite, Waste Rejects, Dust Pollution, and Foreign exchange***

Introduction: Goa, the smallest state of the Indian Union is richly endowed with industrial minerals like iron ore, bauxite, manganese, limestone, dolomite etc.The rich mineral deposits are basically confined to talukas of Bicholim and Sattari in North Goa and Quepem ,Dharbandora and Sanguem in South Goa Goa has a mining area of approximately 700sq.kms. Goa has a rich history of mining dating , from early 20th century to the imposition of the Supreme Court ban on it in October 2012,followed by complete closure in 2018.Mining Methods in Goa was carried on by open-pit or open-cast technique. The open cast technique used in mechanized mining extracted iron/manganese ore by forming benches on hilltop and the slopes.

The entire hill was transformed into 2 geomorphologic entities i.e -a massive crater-like pits and hillocks made of mining rejects. The ore to overburden ratio of iron ore in Goa is 1:3

History of Mining: Before Liberation The existence of minerals was known to the early rulers. A report in the publication *Regimento e Instroces (1636)* revealed that the Viceroy of Goa had communicated to Chief of Revenue in Ceylon about the existence of large quantities of minerals in Goa . But no attempt was made to extract the minerals on account of fear of attracting invaders. In

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1905,the French firm Compagnie des Mines de Fer de Goa undertook prospecting of iron ore deposits around Bicholim. These attempts were based on information provided by the Dutch traveler H. V. Linschotion.In 1906,a company from Bombay, M/s.D.Lamb &Co. started mining manganese ore at Sancorderm In 1909,Sir L.L.Fernor of the Geological Survey of India visited Goa and studied the Bicholim deposits . In 1910,a French company named Companhia Minerio de Ferro was established at Bicholim .

Just before the end of the Portuguese regime, the mining industry was well mechanized in terms of exploration, beneficiation and transportation. The contributory factors were: 1.Grant of mining concessions for an unlimited period.2.Low taxation on mineral ore exported. 3. Nominal duty on imported mining machinery. 4. No export duty on exported ore . After Liberation, all new grants of mining leases were made under the Mines and Minerals Act, 1957.

Review of literature

Generally mining activities have adverse impacts on the local environments, from aesthetic to environmental. Work by Davis and White (1981) implies that the dispersion of contaminated materials will not only impact sediments and waters around a site but also has the potential of affecting the food-chain M.Yellishetty V. Karpe, EH Reddy, KN Subhash… - Resources (2008) - Elsevier environmental pressures, increased international competition for marketing the low-grade **ores** and diminishing … is worthwhile for the industry to consider the option of recycling **mine** waste … Further, such an effort by the Goan **iron ore mining** industry will displace the laterite mining. S. Sinha, RN Bhattacharya, R Banerjee - Resources Policy, (2007) – Elsevier Mining often brings certain irreversible changes to the surrounding environment. Different types of natural resources mostly surround the mines. Degradation of natural resources around the active mining zone may adversely affect the local economy.

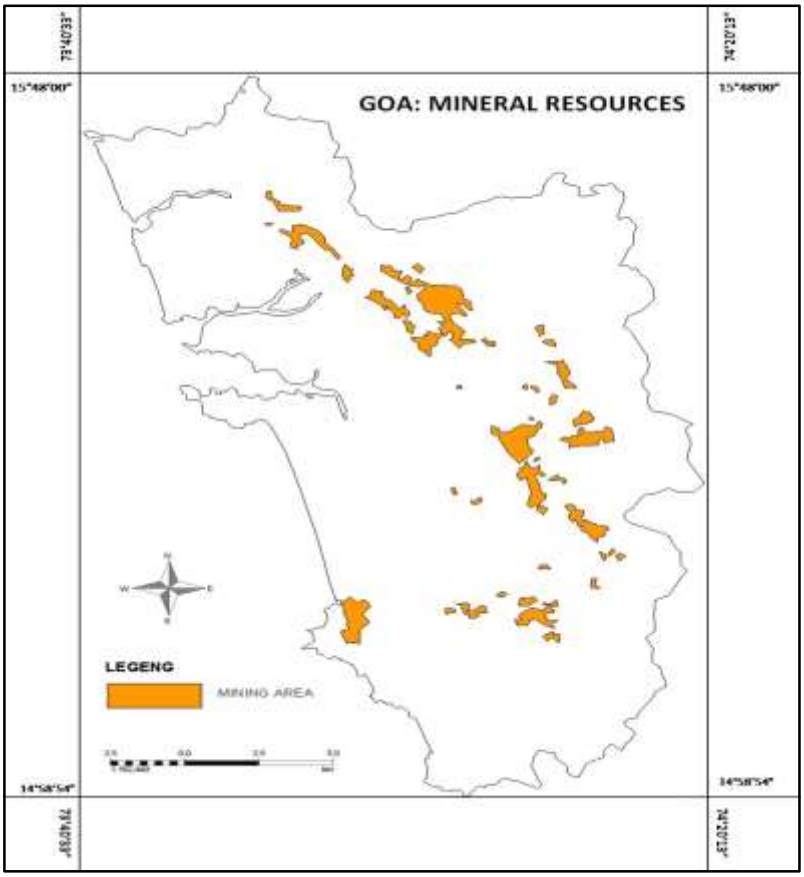
The study area: -Goa is one of the small states of India located between latitudes 15° N 48° 00″ to 14° 53′ 54″ N and longitude 74° 20′ 13″ E to 73° 40′ 33″. It has 3702 sq.km. Experiencing tropical oceanic climatic condition with varied seasons. Accordingly, its climate is balanced and moist throughout the year, supporting a total population of 14,57,468 with average literacy rate 87.48 as per the 2011 census. Liberated from the Portuguese colonial rule on 19th Dec1961

MAP-1 GOA- Administrative Divisions.

Objectives of the Study: 1. To Study the growth of mining activity in Goa since pre –liberation.
2. To Study various impacts of mining in the study area.

Sources of Data and Methodology. : The secondary data has been collected from Department of mines and Indusries, Govermnt of Goa, The Mineral Ore Exporters Association Of Goa,Daily news papers, Research articles Periodicals Journals and Primary data through Questionaire in mining affected areas. The necessary data which is collected from various sources has been used and analysed with the help of text, pictures tables and maps.

Map-2 GOA – MINERAL RESOURCES



The mining activities are concentrated in Northern central and southern zone. Usagao River is the dividing line between Northern and central zone, and Sanguem River between the central and southern zone. The maximum area under mining is in Sanguem taluka followed by Bicholim, Sattari and Pernem. Major Iron ore deposits are mainly hematite and occupy really 1/5th of state and occur in. Bicholim Sanvordem area, Pale area, Shirgao Kale area and Sanguem and Quepem area. Nearly 800 million tons of Iron deposits have been estimated in Goa. Regular mining operations along with export of iron and manganese ore started after World War II in 1951 .The German geologist Dr.Oertal produced the first geological map of Goa (1954-1957) Thereafter, Portuguese administration put in force a mining law known as Do Regulamento Das Minas no Ultramar-decree dated 20th September 1906, on the basis of which mining concessions were granted to private parties in Goa. In total 786 concessions were granted , each not more than 100 hectares . A single party could not have more than 5 concessions in contiguity .These concessions were granted in perpetuity and were hereditary in nature .After the Government of India imposed economic blockade on Goa on 1st April 1954,the Portuguese gave an impetus for export of iron ore as foreign exchange was needed to import consumer goods

The following table shows the production of Iron, Manganese are and Bauxite during the period 1998-99-2008-09.

The Iron ore export has increased from Rs. 18.31 crores in the year 1961 to Rs 7316.00 crores in the year 2008-09. More than 60% of the Iron ore exported from the country is from Goa alone. The value of ore exported from Goa is now more than the tax and non-tax revenue of the state, which indicates the importance of this industry to the economy importance of the state.

Table-1: Export of Iron Ores from Goa (2004-05- 2008-09)

Types of ore	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009
Iron Ore	1552171	12172925	15862763	15737701	17371039	23727937	21705667	25440925	30738191	31327805	32720536
Manganese ore	17581	11706	9811	11946	8837	9433	7439	5773	3560	1454	1080
Bauxite	37170	32179	31950	58990	59694	81488	41934	28323	111,097	111259	463150

Source: Mineral Ore Exporters Association of Goa (2010)

Table – 2: Iron ores in MT

Year	Iron ores in million tonnes	Value in Rs (crores)
2004-05	24.46	2792.58
2005-06	27.03	3422.67
2006-07	33.49	4591.81
2007-08	32.23	6700.00
2008-09	36.00	7316.00
2012-13	53.00	10000.00

There is good demand for Goan mineral ore from European countries and Asian countries. Goa has been able to export sufficient quantities of Iron ore to the needy countries of the world like Japan, Netherlands, China, Belgium.

Role of Mormugao Port Trust (MPT) in Development of Mining in Goa

Mormugao port, a proto type Natural harbour is situated on the west coast of India in the state of Goa at the mouth of the river Zuari, MPT which handles roughly of the country is considered to be Iron ore loading port in India. The total iron ore export from Mormugao which stood at more than of 52.000 tons in the year 1946-47 rose to 15.754 million tones in the year 1993-94. However this highest figure of the total Iron Ore exports from Mormugao surpassed 22.095 million tons in the year 2003-04. It further went up touching the highest export figure of 36.00 million tons in the year

2008-09 valued at Rs.7316/- crores earned by the state. Never before Goa had exported this amount of Iron ore outside the country and earned good amount of foreign income

Table: 3. Leading Mine Operators in Goa

1.	Sesa Goa	-	4,24,000 sq meters
2.	Chowgale Mines	-	2,20,000 sq meters
3.	Formento Mines Cr	-	1,20,000 sq meters
4.	Resource International	-	60,000 sq meters
5.	D.B.Bandodkar Mines	-	50,000 sq meters
6.	V.S.Dempo	-	30,000 sq meters
7.	Timblo Mines	-	20,000 sq meters

8.	Salagaonkar Mining Industry	-	17,000 sq meters
9.	V.G.Quenim.	-	5,500 sq meters

Source: Mineral ore exporters Association Goa-(2010)

Economic and socio-cultural environmental effects.

Economic effects:

Generated job opportunities: The inhabitants of the mining talukas were largely dependent on agriculture and forestry for their livelihood. But with the mining industry, there was a complete change in the occupational structure. Mining being a labor intensive industry , generated large scale direct and indirect job opportunities in the mining talukas The industry provided direct employment to over 8000 workers in the mines. The wage scales paid in the mining industry were invariably high compared to other sectors of Goan economy .The monthly salary bill was estimated to be around 5 crores . While way of indirect employment , roughly around 2.5 lakh people were engaged in other activities related to mining.

Boost to ancillary services; Mining in Goa gave an impetus to ancillary services such as barge construction and maintenance workshops, truck operators ,garages, grocery stores , canteens, bars, etc.For eg. The business of letting trucks to mining companies to transport mineral ore and rejects flourished. 12546 trucks out of 20000 trucks registered in the State are linked to mining .Many households also rented their room to migrant laborers .

Generation of foreign exchange; The mining industry in Goa was a 100% export oriented industry. In 2009-10,Goa exported 45 million tons of iron ore. Goa exported iron ore chiefly to China, Japan, Romania, South Korea, Middle East and small quantities to European countries. Annually it generated 1000 crores of foreign exchange.

Contribution to GDP and per capita income: At its peak in 2009-10,mining contributed over 17% to Goa's Gross State Domestic Product .The economic survey showed that Goa earned Rs.244.9 crore just as royalty in 2016-2017.The income earned by the mining industry was absorbed in the Goan economy and constituted the single most important factor in raising the per capita in the State .

Halt to out–migration: After Liberation ,many people were migrated to urban areas to take advantage of the job opportunities and better facilities. However, in the mining talukas of Bicholim , Sattari , Quepem and Sanguem ,as the mining operations were carried out essentially in rural areas , it contributed towards halting the normal exodus to urban areas by job seekers .

Boost to Mormugao port: Mormugao port greatly benefitted from mining in Goa .The ore produced in the mining talukas of Goa via barges plying through river Zuari and Mandovi was brought to Mormugao and Panaji port for export. Iron ore accounted for about 90% of the traffic of the Mormugao port. In fact, the Mormugao Port Trust was financially maintained by the Goan mining industry

Contribution to Sales Tax The mining sector consumed about 80000 kilo liters of oil and fuel. Local sales tax was highest on this item. Thereby the mining sector accounted for a sizable portion of the total tax revenue of the State.

Boost to navigation: The minerals were transported from the mining areas to the Mormugao port via barges plying through river Zuari and river Mandovi.In total 336 barges operated in the State,60 being owned by mine owners and 286 owned by private parties .The inland waterway system helped to reduce the cost of transportation of the ore.

Investment in economic and social infrastructure: To facilitate mining, the government developed transport facilities in mining talukas. This in general benefitted the local economy .The mining companies invested a part of the earnings generated through mining into educational and health care facilities in the State. E.g. Chowgule College, Dempe College, SMRC etc. As part of their Corporate

Social Responsibility, the large mining companies provided educational support by way of books , uniforms and scholarships for the children of the employees .The mining companies made loan arrangements for the local people to buy trucks and other mining machinery ,and then hired them on contract to carry on the mining activity .

The state of Goa is suffered from illegal mining estimated at about Rs 3,000 crore,annually, the loss by way of damage to the environment. Approximately above 12000 people living in the villages in four talukas in North and South Goa have lost their souce of livelihood. Their agriculture lands have been destroyed by mining silt and water sources have been contaminated.

Loss of Agriculture: Mining has caused irreversible damage to agriculture in Goa. Many workers left the fields to work on mines. Reduction of cultivable land on account of encroachment by mines. The large scale siltation of agricultural land and orchards by mining rejects, mineral particles and pollution by acids have reduced the fertility and thereby productivity. The accumulation of silt also reduced the water- holding capacity of the soil. Reduced availability of irrigation due to siltation of water bodies. Flooding of fields in the khazan land due to breaking of estuarine khazan land bunds by barge traffic movement in the rivers. Many helpless farmers were compelled to switch over to other economic activities unable to cope with mining companies The mining created a serious impact on villages surrounded by the mines. i.e. in the village of Mayem, in Bicholim taluk when fields were productive, they grew rice, chilli, kokum, beans, mango etc and coconut trees. Mining and farming have been the major occupations of the village. Due to excavation process, two types of materials washed into the fields, one is the overload, the top soil that is removed when digging for the ore and the rejected material that forms massive hillocks over time and gets washed away into the fields as silt during the monsoon season. The wastes have a high amount of calcium, which prevents the soil from absorbing iron, and you end up with paddy with yellowing and brownish leave.

Environmental effects:

Impact on land- Mining caused large scale degradation of land in Goa, which can be categorized into 3 types.1.Land excavated to extract the ore, resulting in huge gaping pits.2. Land used for dumping. On account of high ore to overburden ratio (1:3), every year around 30 million tones of rejects were generated and stacked in large dumps .3.Land degraded due to siltation by mining activity.

Pollution of Ground water and surface water resources: Mining has been a major water polluting agent in Goa. Ten large mines are located in the Zuari basin and 27 in the Mandove basin .The ore to over burden ratio is 1:3 , thereby large volume of mining reject was generated, which was recklessly dumped in the vicinity of the rivers and nallahs .Heavy monsoon runoff loaded with the rejects and mineral particles entered into the water systems. Siltation is acute in river Mondovi, Zuari, Khandepar etc.The water bodies were polluted by oil and grease from the 300 barges transporting ore to the Mormugao port. Huge quantity of grease was released into the rivers from the engineering workshops located along the river banks . The discharge of bilge water into the rivers compounded the problem .Washing and cleaning of the trucks transporting the ore and rejects was another source of water pollution Another reason was draining of the acids present in the dynamites used on the mines into the rivers. Excessive pumping of ground water by mines also , resulted in lowering of water table below sea level. Wells and springs dried up in villages near the mines, causing serious water problems for the people .e.g. in Rivona , Codli etc

Effect on Selaulim Dam and water works-15 illegal mining leases were in the catchment of the reservoir. Three illegal mines were operating around the Selaulim dam area. The depth of the reservoir was reduced by 15 feet by the ore dumped along the Selaulim dam .The dissolved oxygen in the water was very low1.8 mg/litre. Levels of iron and manganese were 10 times more than

permissible limit. The mining has also affected the Salaulim dam on the river in Sangeum taluka, which supplies drinking water to half the state's population, besides providing water for irrigation and to industries.

Forest and Wildlife; In Goa, deforestation was inevitable, as more than 350 sq.kms of mining concessions and leases were located within the forest areas of the Western Ghats .The NGO- Goa Foundation analyzed the Shah Commission report and found that nearly 11000 hectares of forest were illegally encroached by mining Accumulation of dust on the leaves adversely affected the process of photosynthesis .Illegal mines were operating even within the jurisdiction of wildlife sanctuaries eg. Netravali Wildlife Sanctuary. Incessant digging to extract the ore has taken a heavy toll on reptiles like rock pythons, king cobras , Russell viper, saw scaled viper. Ceylon cat , bed dome's cat and ornate cake snakes earlier found in abundance ,are now rarely sighted. The eco-sensitive area of Bicholim nestled in the foothills of the Western Ghats housing nearly 70% of birds and reptiles found in the Ghats is threatened.

Mining effect on Aquatic Life: Reduced dissolved oxygen concentration, high suspended solids and blanketing of the bottom deposits by mining rejects has resulted in more than 70% reduction in clam and oyster production in the rivers and estuaries of Goa .In river Zuari and Mandovi, the mining activities has adversely impacted the breeding grounds of rock fish and shell fish and thereby the livelihood of the tribal communities dependent on it .

.**Health effects**: Hearing loss and deafness were common among workers on account of lack of security measures against noise levels ranging between 100-140dB.Truck drivers were exposed to the highest RSPM levels, followed by people working on mines. On account of consumption of water polluted by mining, people suffered from digestive disorders and manganismeThe people living in the vicinity of the mines and the trucks transporting the ore often suffered from deafness , headaches and had difficulty to sleep and rest, particularly the elderly . Mining was associated with large scale dust pollution which caused several respiratory ailments among the locals and workers.

Social and health effects: Increase in alcoholism amongst the truck operators and locals on account of the large number of bars set up in the mining areas. Constant risk to the locals by the speeding trucks. Houses of the people exposed to heavy dust pollution. Large scale entry of migrants from neighboring states to work on mines ,created social tensions between the locals and the migrants.People living in the mining areas are constantly suffering from the adverse effects of air noise dust and water pollution..

Finding and suggestions: Survey of A mining Company SESA Group and residents was carried out in the Sanquelim Mining area. The Sanquelim mine is one of the smallest mine in Sesa group. They market more of waste than the ore. In fact this mine has started export of dumps which has value today due to heavy demand from China. People in this area face the problem of dust pollution, health problems and traffic problems. There is a constant tussle between the company and the locals.

According to the households Mining is a harmful activity and has to be stopped but they do not have any source of alternative employment. Dust pollution can be controlled by the company by spraying the water on the roads and permanent traffic control booth to be set up to control the traffic. Many residents do not feel safe to move on the roads due to rash driving of the truckers. Moreover the roads are small and too many trucks on the road.

The profits accrued by the company are to be shared with the community by providing medical facilities to the community as the town lacks in good medical facilities.

Conclusion:

Minerals are inorganic substances freely occurring in the nature. Mining is an important extractive occupation of mankind lead to development of human civilizations in different parts of the

world. Goa is one of the leading producers of iron ore in the country which enables mining one of the most lucrative businesses. It became a leading exporter of minerals like iron ore, manganese. Over exploitation of ore have caused grave environmental damage in the mining belt and surrounding areas. Lack of accountability and un ethical practice of mining adversely impacted **the** state's exchequer worth Rs 30000 crores. As per my personal observation the varied Environmental problems like land degradation, deforestation, water pollution and severe damage to environment i.e. dust pollution resulted from mining activities. Mining has been an important part of the Goan economy. It did give a boost to the economy of Goa.But the whole approach to mining in Goa was ecologically extremely primitive .The price of this development was heavy, for whatever ore was extracted, was exported and only the mine owners benefitted. While the people of Goa had to bear environmental and social costs. Although at the beginning mining industry appeared to be beneficial to the Goan economy, with time it proved that it caused more damage to the society and environment. Mining activity is ephemeral and does not compensate for all the damage caused. It would need Goa, years and years to recover from the damage.

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