

25/3/14

IN THE SUPREME COURT OF INDIA  
(CIVIL ORIGINAL JURISDICTION)  
WRIT PETITION (CIVIL) NO. 435 OF 2012

IN THE MATTER OF :

GOA FOUNDATION

.... Petitioner

VS.

UNION OF INDIA & ORS.

.... Respondents

Interim Report no. 2

Subject: Interim Report no. 2 of Expert Committee for Macro EIA study on the ceiling of annual excavation of iron ore from State of Goa.

This Hon'ble Court desired the Expert Committee to submit its Interim Report by 15/3/2014 vide its order dated 17/02/2014 with regard to the conduct of a Macro EIA Study on the ceiling of annual excavation of Iron Ore from the State of Goa considering its Iron Ore resources, its carrying capacity on the principles of sustainable development and inter-generational equity and all other relevant factors. In the context of the said order, following report, in continuation of its first interim report of 14 Feb, 2014, is submitted for kind consideration.

BACKGROUND NOTE

Goa is a small state in the Indian Union which spreads over 3700 km<sup>2</sup> between latitude 14° 53' 54" and 15° 40' 00" N and longitudes 73° 40' 33" and 74° 23' 13" E (ISM 2014) in the mid-west coast of India. The coordinates of the area given in different publications showed substantial variation (TERI, 1997). The Western Ghats fringes from the coast line, which runs over 105 km distance.

Re,

**Landscape Ecology:** Administratively, the State has two districts (north & south Goa) each having 6 talukas, with Panaji as the capital. The State of Goa is unique in having diverse ecosystems, the montane/hill ecosystems, the riparian ecosystems, the wetlands, the estuarine ecosystem, the stagnant water bodies and marine ecosystem within distance of 50 km, all of which are linked. In other words, the State of Goa has highest ecological integrity and unique hottest hotspot within the Western Ghats. About 113 endemic species have been reported (Joshi & Janarthanam, 2004). Goa has (i) Western Ghats hill ranges along the eastern fringes extending to Maharashtra and Karnataka with wide range of altitudes (600-1000 m above mean sea level) with highest elevation of 1,167 m (Sonsogar), (ii) "Central rolling and undulating plains", and (iii) long beach stretch and coastal plains and estuaries in the western region. Physiographically the terrain of the State can broadly classified into three types: (i) the western coastal estuarine plains with tablelands, (ii) the central undulating region (midlands) and (iii) the Western Ghats, and these three types merge in the far south of the state. The area is drained by 9 independent rivers originating from western ghats (East) and discharge their contents into Arabian Sea (West) and all of them form estuaries with tidal waters, reaching several kilometre inland making navigation possible. The two major rivers are Mandovi river and Zuari river which form extensive riverine plains and the rivers also form extensive estuaries harbouring luxuriant mangroves. These two river basins form 69% of the total geographical area of the State and form the Lifeline of Goa.

The climate of Goa is tropical with average annual rainfall ranging from 2,700 mm to 3,500 mm distributed among 120 days during June to September. The temperature ranges between 15 °C to 33 °C and relative humidity ranges from 70% to 90%.

Besides surface waters, Goa has two aquifer systems that are source for ground water: (i) the top Laterite layer which holds ground water as unconfined aquifers, (ii) powder ore formations, which are porous (30 to 35%), permeable and completely saturated with water and are separated by impermeable clay layers and thus prevents incursion of saline waters.



The high ecological diversity harbours biologically rich forest ecosystems which occupy 125,473 ha (i.e. 34.8%) of the geographical area of the State (Government of Goa, 1995), but the State Forest Department records 39% of the area occupied by forests (1, 42, 400 ha) which includes 122,400 ha Government Forest and 20,000 ha of Private Forest. The Forest Survey of India (2011) recorded the green cover of the state as 2219 sq km. Four talukas (Sanguem, Sattari, Canacona and Quepem) encompass 94% of the total forest area. The predominant forest types are (i) west coast tropical thorn forest, (ii) Cane brakes, (iii) wet bamboo brakes, (iv) west coast semi-evergreen forest, (v) moist bamboos brakes, (vi) lateritic semi-evergreen remuneration forest, (vii) slightly moist teak forest, (viii) southern moist mixed deciduous forest, (ix) southern secondary moist **mixed deciduous** forest, (x) mangrove scrub, (xi) mangrove forest, (xii) lateritic thorn forest, (xiii) South Indian subtropical hill savannah (grassland) and (xiv) western subtropical hill forest. The Lateritic plateaus harbour savannah/grasslands and thorn forests that are rich in endemism and mining areas are mostly confined to these lateritic thorn forest and savannah. There are seven national parks and wild life sanctuaries covering 755.53 sq. km area which constitute 20% of geographical area of the State.

The soils of Goa mostly belong to inceptisols, ultisols, alfisols and entisols. About 2/3 of Goa is covered by Laterite which ranges in thickness from 2 to 25 m with maximum thickness along the West Coast and minimum along the Ghats in the east. Outcrop of rocks and Laterite crust are associated with the soils. The Laterite is usually vermicular and cavernous but it is pisolitic. According to TERI (1997) the soils of dumps and agricultural fields in mining area showed pH of 6.0 to 6.64 and hence nearly neutral but ISM report showed values ranging from 3.5 to 5.4 (average pH of 4.24) suggesting that soils are acidic. Both the reports analysed the chemical and physical properties of soils such as NPK, organic water, Fe, Mn, Cu, Co, and other metals.

The economy of Goa depends upon tourism and Iron Ore Mining, besides agriculture, horticulture and minor industries. The contribution of different sectors to

the economic growth was highlighted in the State Economic Survey 2013-14, wherein it was mentioned that the growth rate of the Gross State Domestic Product (GSDP) fell to 8.47% in 2012-13 as compared to a growth rate of 22.10% in 2011 due to banning of mining which showed negative growth rate of 68.33% in 2012-13. There was an increase in the growth rate (10.02%) in Tourism industry in 2013-14, as compared to 2006-2007 but the growth rate 0.57% in agriculture slowed down automatically. Fishing also showed a decline of 13.80%.

The historical perspective of Iron ore mining in Goa was presented by the Directorate of Mines & Geology, Government of Goa. Mining was done right from the Portuguese regime and about 810 concessions were granted. About 700 sq. km i.e. less than 20% of Goa's land constitute the mining belt and is mostly concentrated in four talukas; Bicholim, Sattari, Sanguem and Quepem. The different mineral resources found in Goa are Manganese, Bauxite and Iron. Iron ore would constitute 99% of the mineral produced by the State and accounts 13% of the Iron ore produced in India and 35% of country's export of iron ore.

The Iron Ore of Goa is hermitite in nature towards north and tends to become martite to even magnetic in the central and southern lands of the mining belt. The total iron ore in Goa is estimated at 1.15 billion tons and the potential resource is about 3.0 billion tons. During last 40 years more than 500 MT were excavated.

The production of Iron ore was jumped from 14.6 million tons in 1941 to 51.17 million tons in 2010-11. In 1980's the production was about 10 MT/annum. The quantum jump in iron ore production in Goa was essentially due to steep rise in exports of fines and other low grade ore of 42% Fe content to China. This has led to massive negative impacts on all ecosystems leading to enhanced air, water, and soil pollution affecting quality of life across Goa. This is evident by three important reports i.e. (i) Area wide Environmental Quality Management (AEQM) Plan for the Mining belt of Goa by Tata Energy Research Institute, New Delhi and Goa (1997), and it was submitted to the Directorate of Planning, Statistics, and Evaluation, Government of Goa, (ii) Environmental and Social Performance Indicators and Sustainability Markers in Minerals Development: Reporting progress towards



improved Ecosystem Health and Human Well-being. Phase-III by TERI and International Development Research Centre, Ottawa, Canada (2006) and (ii) the Regional Environmental Impact Study of iron ore mining in Goa region sponsored by MoEF, New Delhi (2014) by Indian School of Mines. Besides the above three main Reports, a number of scientific research papers on the impact of iron ore mining on the environment and ecology of diverse ecosystems were published by scientists working at Goa university and NIO.

These reports and publications substantiates that the mining, particularly the enhanced level of annual production contributed to adverse impacts on the ecological systems, socio economics of Goa and health of people of Goa leading to loss of ecological integrity. This is due to enhanced levels of pollutants, particularly RSPM and SPM, sedimentation of materials from dumps and iron ore in rivers, estuaries and shallow depth (20 m) of sea water, agricultural fields, high concentration of Fe and Mn in surface waters and their bioaccumulation. Litigations in the Court were initiated by Civil Society against iron ore mining in Goa, large scale damage to diverse ecosystem and also about mining in protected areas and illegal mining. A PIL (No.1/2008 dated 16<sup>th</sup> June 2008) at High Court of Bombay at Goa led to the assessment of the depletion of groundwater sources and land degradation in Sirigaon village (Goa) and mitigation measures by NEERI (2009). The Supreme Court also directed to close down 10 working mines located within the protected areas. The Shah Commission also reported illegal iron ore mining in Goa and the total encroachment was of the tune of 547 ha.

A petition was filed by Goa Foundation against Union of India & others at Supreme court on 25<sup>th</sup> September 2012 based on the Shah Commission Report which was placed in Parliament on 7<sup>th</sup> September 2012 wherein large scale illegal mining and violation/ misuse of regulations were reported. The Petition is pending in the Supreme Court for judgement. The Hon'ble Supreme Court constituted an Expert Committee (vide interim order of 11/11/2013 and order of 18<sup>th</sup> November, 2014 with the following members to "conduct a Macro Level EIA study on what should be the ceiling of annual excavation of Iron Ore from the State of Goa considering its iron ore resources and intergenerational equity and all other relevant

factors." The members are "Professor C.R. Babu, (Ecologist), Dr. S.D. Dhiman, (Geologist/Hydro geologist), Professor B K Mishra (Mineralogist), Professor S. Parameswarappa (Forestry), Shri Parimal Rai (nominee of the Government of Goa) and Shri A.K. Bansal (nominee of the Ministry of Environment and Forests, Government of India).

The Committee met 4 times at Goa and had made field visits to mines and also to some of the ecosystems impacted. The Committee, during their deliberations, interacted with officials of relevant departments of the Government of Goa and various stakeholders including petitioner, labour unions, and associations of miners and transporters and staff of the Country and Town Planning, farmers, academics and scientists.

This Interim report gives briefly the approaches followed, the significant observations made and a set of recommendations. The mission of the Expert Committee, as defined in Hon'ble Supreme Court order, is to find out what will be the maximum rate of annual production of iron ore in Goa keeping in view of the following:

- (i) Least adverse environmental impacts on diverse ecosystems – Western Ghats, wildlife and wildlife sanctuaries, forest, agricultural, riparian, estuarine, marine and town/urban ecosystems (Macro-EIA).
- (ii) No damage to irreplaceable heritage, whether natural or manmade. This would include in particular species in the Western Ghats and aquifers (Macro-EIA).
- (iii) Fully meeting the requirements of "Weak sustainability", i.e., any commonly owned asset that is degraded damaged or lost as a result of the mining and related activities must be replaced by assets of equivalent value – Intergenerational Equity.
- (iv) Ensure long-term sustainable livelihoods to local communities (sustainability).
- (v) A mechanism such as establishment of an Ecological Centre that ensures remediation/restoration of mined out areas and



ecological damage to the commons outside mining leases and monitoring of ecosystem health (Macro-EIA and sustainability).

### **Approaches Followed:**

To achieve the above mission defined by the Hon'ble Supreme Court of India, the following approaches were followed.

- (I) Collection of available secondary data from different sources on different facets of iron ore mining in Goa right from Portuguese time till date.
- (II) Interaction with different stakeholders, and scientists and academics working in Goa University, NIO and Central Ground Water Board. The committee also met and interacted with the Chief Minister of Goa.
- (III) Analysis of data collected to find out the patterns of spatial and temporal changes in environmental and ecological variables including health and socioeconomics across diverse ecosystems (terrestrial, riparian, estuarine, and marine ecosystems) and generation of maps with different layers (data sets) on GIS platform.
- (IV) Study of different ecological economics models to find out the appropriate capping on the annual rate of iron ore production keeping in view of its sustainability and intergenerational equity.

### **Analyses and observation**

Due to Paucity of time and lack of data the Committee did not examine all the variables in environmental and ecological variables across diverse ecosystems but only those variables for which data sets were available have been used.

## **Assessment of sustainability of Iron ore mining in Goa.**

There are many models available for assessing sustainability and intergenerational equity. Only weak sustainability concept i.e., a natural resource can be converted into an asset of equal value, is widely accepted today. A strong sustainability concept i.e., a natural resource cannot be converted into any other asset, is not accepted by many.

The Committee adopted Folchi model which has been used by others, particularly relating to Iron Ore extraction. The procedure followed and the observations made are presented below. It may be noted that there are many limitations, in the procedure followed particularly the smaller number of variables used which may not reflect the total negative and positive impact of mining on environment and ecology of the area and the model does not take into account the intergenerational equity. It needs to be further refined and also other weak sustainability models have to be tested for intergenerational equity. The output generated by Folchi method is suggestive.

### **Impacts on Environment and Ecology:**

Based on the studies carried out by TERI (1997, 2006), and ISM (2014), clearly demonstrated that high rates of annual production from 2006 till the closure of mines did, indeed, had higher negative impacts on air, water, soil quality, health, socioeconomics in terms of loss of agricultural productivity. In fact the sedimentation rates of Mandovi estuaries was enhanced to 1.21 to 2.0 cm/year after 1980 as compared to that of 0.31 cm/year before 1980; in fact, the higher sedimentation rate in the upper portions of the cores was found to correspond to increased depositions of finer sediment components, metals and magnetic minerals which might be due to mining in the catchment of the river. Magnetic and chemical analyses indicate an enrichment of magnetic particles and heavy metals in the upper portion of all the cores and decreasing pattern with depth suggesting anthropogenic loading during recent past; Mn and Fe were found higher in the upper portions of the cores. Such deposition also occurred in mangroves affecting mixing of fresh and saline water



(K.T. Singh et. al., Palaeogeography, Palaeoclimatology, Palaeoecology, 397:61-76, 2014).

Even in late 1980s and 1990s there has been substantial evidence that mining has already contributed to changes in land use, demographic pattern, enhanced levels of air, water and soil pollution, water shortages and adverse impacts in clusters where mining activity was undertaken (TERI 1999). The report also mentioned in some in some mine areas the air quality is bad/poor and suggested a number of remedial measures.

The studies undertaken by TERI (2006) on "Environmental and social performance indicators and sustainability markers in mineral development" Reporting progress towards improved ecosystem health and human well-being the report clearly demonstrate that mining enhances health risks by exposure to air pollution and it is high in mining clusters and transport corridors than in control areas with 90% of the population exposed to RSPM levels higher than 150 micro grams/m<sup>3</sup>; the population in mining cluster and transport corridors showed higher respiratory problems than the control groups; the corridor was mostly highly polluted; mining led to lowered soil productivity, reduce water holding capacity of water bodies leading to shortage of water; changes in land contours causing water logging and affecting irrigation; inadequate compensation paid to farmers due to crop losses; sanitization of agriculture fields due to overflow in high tide and conversion of such fields into mangroves; presence of barren dumps; and uptake of Fe, Mn, Zn, Cr, and Ni by horticultural and agricultural crops. The report also gives some recommendations to mitigate the negative impact of mining on health, socioeconomics, and land degradation.

The ISM report on environmental impact studies of iron ore mines in Goa, (2014), also substantiates that mining negatively impacted air, water, soil quality, biodiversity, hydrology, agriculture, socioeconomics, transport, fisheries, estuaries and water resources. The report also suggested a number of remedial/mitigation measures for each sector. The ISM report also states large scale degeneration of forests and listed 5 endangered mammals including tiger and leopard, birds and plants.



The taxonomic and phyto-geographical investigations on endemic plants of Western Ghats with special reference to Goa by V.C. Joshi (Ph.D. thesis, submitted to Goa University) give the details of endemic species and many of them are rare and these species could be adversely affected due to mining and other anthropogenic activities. The thorn forests and grasslands of lateritic plateaus, where mining of iron ore is common are the home of many endemics. Many unique endemic and rare species have been described by Janarthnam and his students (2004, 2007, 2009, 2013) from time to time. This suggests these habitats may have may have several 100s of species which are not yet known to science and hence require preservation of these unique habitats.

Parulekar et. al. (1986) clearly demonstrated that the mining led to (i) more than 20% reduction in calm production, (ii) near extinction of resident fauna, (iii) appearance of low diversity bottom fauna consisting of tolerant but vagrant species and (iv) irreversible ecosystem instability leading to total extinction of estuarine life. These impacts were caused by reduced DO levels, high TDS, and blanketing of bottom deposits by mine rejects washed from dumps. All the above changes were recorded between 1972-73 to 1982-83. This means that there was no management of over burden dumps (OBDs) and no vegetation cover.

Rivonkar and his students also studied the taxonomy and ecology of fishes and other marine taxa in estuaries and shallow waters of Goa (194, 2013, 2010, 2012, 2009) and found seasonal anomalies due to changes in land use patterns and the resulting run off. Pai and his students also studied diversity in butterflies and 200 plankton species in fresh water bodies in and around Goa (1999, 2011).

### **Impacts on Hydrogeology:**

Patterns of spatial and temporal changes in ground water and surface waters were analyzed. The significant observations are summarized below:

The patterns of temporal changes in surface waters during 1981-2012 suggests that there is a decrease in the flow rates during lean periods suggesting the negative impacts of mining in the catchment. This may be due to drying up of streams and



springs due to mining and also increase in the infiltration rates to the ground water system.

It has been shown that ground water in the wells close to mines showed higher turbidity and Fe content as compared to that found in the wells located away from mines; the Fe content was higher than the permissible limits. The Fe and Mn contents in Salaulim reservoir water were higher than permissible limits (TERI 2012). The report also recommended some mitigation measures.

Major aquifer systems in Goa are Laterite, alluvium, metasedimentaries, metagreywacke, metavolcanic-basalt, granites, and gneisses, etc. These aquifer systems are delineated based on the data of hydro-geological survey and ground water explorations of CGWB.

Ground water levels are being monitored in both dug wells and piezometers at 102 sites (four times a year) and water samples for quality determination once a year by CGWB since 1980. Depth to water level in general varies of annual replenishable dynamic ground water resources of Goa based on the data for the year 2008-2009, the stage of ground water development is only 33% indicating enormous scope for future development.

#### **Open-cast Mining & Ground Water:**

Generally laterite forms the major unconfined aquifer within and outside the mining area. In the mineral belt, ore body forms the deeper aquifer and is not uniformly distributed. Depending upon the depth of mines, in some mines only upper unconfined aquifer is encountered and some are intercepting both the aquifers i.e. unconfined and confined. Mines are located both on the ridges and valley areas. The mines located on the ridges/hills reduce the ground water recharge and result in reduction in ground water potential down streams or low topography/valley areas. Mines located in valley areas cuts both the aquifers and ground water flows into mine pits.

The observation wells/monitoring wells are generally not located either within or outside mine areas to observe the impact of the mining on ground water. However, a few studies have shown depletion of ground water resources and

degradation in Sirigaon village of Goa in 2009 (NEERI EIA study). The results indicated drying of the dug wells immediately after the rainy season. With the removal of the top of lateritic formations and underlying clayey layer for excavations of iron ore body leads to drying up of springs, wells, and even streams.

Laterite forms the unconfined aquifer varying in thickness to about 30 m. This aquifer is highly permeable and gets recharged immediately after the rains and does not hold groundwater for longer period and invariably dries up immediately after the rains because of outflow of natural ground water outflows. Generally this aquifer is developed by constructing dug wells for both domestic and agricultural purposes. The older formations, (older to Laterite), also form the aquifer with poor to moderate yield depending on the nature of weathering.

Another important aquifer in mining area is the iron ore itself consisting of blue dust including chert, manganeseiferous gravel and sand. These aquifers are long and narrow and confined to within clay layers. Ground water occurs under semi-confined and confined conditions.

### **Intergenerational Equity and Sustainability**

A number of sustainable models for natural resources have been proposed. The most widely used model is Hartwick's rule (2011) model on weak sustainability, and it has also been followed for intergenerational equity and sustainability. For example, Dasgupta-Heal-Solow (DHS) proposed by Dasgupta and Heal (1974) and Solow (35) was also used. Martinet (2010) introduced a "Criterion for characterizing sustainability with indicators and thresholds acting as constraints and interpreted the thresholds as minimal rights to be guaranteed to all generations and defined sustainable trajectories as those satisfying all the constraints all the time." Hartwick's (2011) rule, "For sustainability prescribes reinvesting resource rents thus keeping the value of net investment equal to zero." Mukhopadhyaya and Shyamsundar (2011) in their paper "on economic growth and ecological sustainability in India" mentioned the following: "the wealth increase in India has taken place by transforming natural wealth into produce and intangible capital. There is evidence that most states in India may be mining natural capital which may lead to unsustainable growth path. At micro-level that economic growth has led to environmental degradation and



negatively affected welfare. They also suggested that the gains from produced and intangible wealth may be less beneficial relative to the cost of depleting natural capital and hence sound reforms in environmental governance offer an opportunity for balancing growth to make it more sustainable." Mukhopadhyay and Kadekodi (2011) also mentioned that the national council applied economic research (NCER) reported that the mining benefits outweigh the cost they impose an inaccurate conclusion based on over evaluation of social benefits and undervaluation of social cost. They suggested that state policy must be cautious while allowing activities that may cause irreversible damages to Goa's natural wealth. A number of papers on weak sustainability also explain the need for creation of permanent funds out of earnings from mining to ensure intergenerational equity and sustainability. In fact, CAMPA is a kind of such fund created for forestry activity. Many countries have initiated creation of such funds based on Hartwick's rule. Although the committee did not use the weak sustainability model for intergenerational equity for iron ore mining in Goa, critical evaluation of published papers suggest that there is a need to create such permanent fund for Goa out of earnings of mining of iron ore with appropriate regulatory measures.

There is also a need for the establishment of multi-disciplinary ecological center in Goa not only to restore the degraded ecosystems but also monitor ecosystem health and to undertake sustainability studies and policy formulation. The state govt. may constitute a group of experts to work out the details for creation of Goa permanent fund and the Ecological

### **Interim Assessment of Sustainability of Iron Ore Mining in Goa**

Here a mathematical model, Folchi method of sustainability as reported by J. Philips (The application of a mathematical model of sustainability, to the results of a semi-quantitative Environmental Impact Assessment of two iron ore opencast mines in Iran, *Applied Mathematical Modelling*, 17(2013), pp. 7838-7854), has been applied to study iron ore mining in Goa. The model's application to the available data has been undertaken for the purpose of determining the potential level of sustainability of

iron ore mining practice. Some modifications have been done to increase the number of impacted factors (IF) under "*environmental pollution (E)*" and "*human needs and interest (HNI)*" category. In this method, IFs and the environmental pollution, and human needs and interest parameters (together referred to as EP) were first identified. The magnitudes of these IFs were then obtained according to the relating mining scenario against each IF. Subsequently, in order to consider the effect of these IFs on environmental parameters, the influence weight of each IF on each environmental parameter was defined as *nil, minimum, medium and maximum*. The impact factors have been quantified and the effects of impacting factors on environmental parameter are set on the basis their relative weight. The Folchi method of sustainability index, S, was then calculated by considering the sum total of effects of the impacting factors on any environmental parameter. If  $S > 0$  then mining at the corresponding production level is considered sustainable. Due to time constraints and limitation of available authentic time series data relating to mineral resources and environmental impact of mining in the State of Goa, the use of this model has been based on the data made available, though there were data gaps which have led to some assumptions and approximations.

The sustainability of iron ore mining in the State of Goa has been studied by the Committee, after having analyzed various relevant existing data from different sources, namely TERI Report 1997, ISM, Dhanbad Report 2013, Pollution Control Board Goa (Annual Report). Also, relevant literature pertaining to sustainability was carefully studied. The Folchi method has been found to be one of the suitable modelling techniques at this stage. According to the model, two key parameters namely 'environment' and 'human needs and interest' with selected variables have been considered. These parameters were evaluated by considering the magnitude of their impact based on available data and mine survey. The model has been applied at different rate of production from 15 to 50 million tons of iron ore mining. Environmental data for different production levels were available from Pollution Control Board, Goa, and for 15 million tons from the TERI Report 1997. Data required for other production levels were obtained by interpolation. The use of Folchi model, based on the data available, indicates that mining at the rate of 20 to 27.5



million tons per annum appears sustainable. In fact, our data shows that mining is sustainable to the tune of 27.5 million tons.

The above figure is similar to the figure of about 20 to 30 million tons of iron ore mining carried out by Goa before the boom in mining took place after the year 2006, and is similar to about 25 million tons as recommended in the report of ISM, Dhanbad, (submitted to the Hon'ble Supreme Court on 17 Feb, 2014 by the Ministry of Environment and Forests, Govt. of India).

## SUMMARY OF RECOMMENDATIONS

Based on the analyses of secondary data available, patterns of spatio-temporal changes observed across the diverse ecosystems and evaluation of available weak sustainability models for intergenerational equity and the application of Folchi model for assessing sustainability of iron ore production through capping, the Committee recommends the following:

1. Goa is unique in having diverse ecosystems viz., terrestrial, riparian, estuarine, marine ecosystems, within a short distance of 50 km. Mining in the catchment area has had adverse impacts on all the ecosystems. Pattern of spatio-temporal changes observed in environmental, ecological, health, and socio-economic variables due to mining demonstrated: (i) increase in pollution levels, particularly dust pollution in air, water, and soil, (ii) higher rate of sedimentation of finer particulate matter in aquatic ecosystems, (iii) higher incidents of health disorders, (iv) higher loss of agricultural productivity, (v) extensive degradation of landscape, (vi) greater impact on hydrological systems and (vii) greater changes in biota of different ecosystems. These impacts are more pronounced during post-enhanced production period than in the pre-enhanced production period. **Therefore, there is a need to regulate mining that ensures minimum damage to ecological systems of Goa and has "weak sustainability". It may not be desirable to start fresh extraction without adequate regulatory and technological measures that**

ensure restoration of degraded landscapes and ecosystems, and minimise future damages to the environment.

2. Mining disrupts the aquifer system affecting the surface water drainage flows, recharging pattern, ground water flow behaviour, ground water quantities, etc. Consequently, it is essential to map the aquifer dispersion/distribution in relationship to mining while preparing the mining plans for the management of water resources. **Aquifer mapping is, therefore, a must for sustainable ground water, and water management in mining belt. This will also help for monitoring of saline incursion into fresh water aquifer.**
3. Open cast mining results in the creation of large deep mine pit (voids), and cuts and/or removes the aquifers. Consequently, rain water and ground water discharges are stored in these pits. The water in the mine pits is another source for potable water. **It should be sustainably utilised in coordination with local bodies/water resource department. It is also recommended that wells should be created within the mine pits during their back filling operations to recharge and extract the ground water.**
4. Present mining practices results in drying up of water sources including springs and streams due to cutting of aquifer systems and deepening of mine pits. **In the mining belt and adjoining forest areas, rain water is to be harvested, conserved, and recharged to ground water for sustainability of aquifers and revival of springs and reservoirs. Such a strategy will offset the loss of water due to mining.**
5. Critical evaluation of the published information on "weak sustainability" that allows the use of earnings from non renewable resource like iron ore for creating assets in the permanent fund for intergenerational equity and sustainability for all times to come. **It is strongly recommended that the permanent fund (which may be suitably named like Goan Iron Ore Permanent Fund), be created with such regulatory mechanisms that**



ensures intergenerational equity. To work out details for setting up the proposed permanent fund, an expert group may be constituted by the State.

6. There is a large scale degradation of landscape and other ecosystems, due to past mining. These ecosystems should be restored back to their natural state, scientifically. Further, it is necessary to monitor ecosystems health during mining and analyse the impacts of mining from time to time, and undertake appropriate mitigation measures. **The committee recommends a multi-disciplinary ecological centre in Goa to be established by imposing a cess on the mining activity.**
7. Beneficiation and pelletization of low grade iron ore will definitely add value to the existing low grade iron ore. The Committee recommends that the feasibility of setting up of pelletization and sintering plants for utilisation of the low grade iron ore must be explored.
8. Mining of iron ore in Goa is presently carried out by private miners. Taking into account the extent of environmental and ecological damage, caused by private miners and to maximise the state earnings, the committee is of the opinion that **the State may explore the possibility of setting up a Mineral Corporation or a Govt. public limited company.**
9. Human induced disturbances such as road construction, mining activities close to forest, grazing in forest areas, fire wood extraction, and annual forest fires led to invasion of forests and protected areas by alien invasive species such Lantanna, Eupatorium, Parthenium, and others. **Preparation of a management plan may be ensured to eradicate these invasive species which resulted in loss of native species, failure of regeneration of forests, alteration in community structure and composition and loss of food base to wild life.**

10. To eliminate the element of subjectivity, due to the time constraints and limitation of available authentic time series data relating to mineral resources and environmental impact of mining in the State of Goa, this Committee suggests that mining be permitted to be carried out at the level of 20 million ton per annum with adequate monitoring of impacts on different ecological and environmental parameters, which will also help this Committee in its future appraisal.

11. Till the scientific study by this Committee is completed, which may take about 12 months more, the mining activity at levels as directed by the Hon'ble Supreme Court, be strictly monitored and regulated by the Department of Mines and Geology and Goa State Pollution Control Board of the State of Goa, in consultation with other statutory bodies such as Indian Bureau of Mines, Ministry of Environment and Forests (Govt of India) and others.



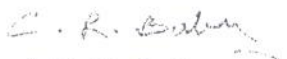
Prof. B K Mishra



Dr. S. C. Dhiman



S. Parameswarappa



Prof. C. R. Babu



Arun K. Bansal



Parimal Rai

Date: 14 March, 2014

Place: Porvorim, Goa