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RAPID ENVIRONMENTAL IMPACT ASSESSMENT FOR AN IRON ORE MINING AREA

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वर्तमान में पर्यावरणीय प्रभाव निर्धारण की विधियाँ, धारणात्मक व्यवस्थित, व्यावहारिक व अन्य सीमाओं द्वारा ग्रसित हैं। इन्हें कम करने के लिए एक रैपिड इम्पैक्ट एसेसमेंट मेट्रिक्स (RIAM) प्रणाली का विकास किया गया है। यह विश्लेषण की प्रक्रिया से संबंधित एक पारदर्शी व स्थायी रिकार्ड उपलब्ध करता है। इसका सरल व संरचनात्मक आकार द्रुत एवं सही तरीके से चुने गए संघटकों का गहराई से पुन:विश्लेषण उपलब्ध कराता है। यह विधि आँकड़ों के गुणात्मक एवं परिमाणात्मक मूल्यांकन को भी स्वीकृति प्रदान करता है। यह विधि प्रत्येक पर्यावरणीय पैरामीटर पर विचार करने की अनुमति देती है। प्रभावित होने वाले क्षेत्र, प्रभाव का विस्तार एवं इसकी मात्रा में बदलाव स्थायी है या अस्थायी है, अथवा प्रतिवर्त्ती है या योगवाही है, तथा समय के अन्तराल के साथ क्या प्रभाव का संचयी असर होने की संभावना है, आदि का आर॰ आई॰ ए॰ एम॰ (RIAM) के परिणामों में लेखा चित्रीय लचीला प्रतिपादन इसे एक शक्तिशाली साधन बना देता है। इस आलेख में एक लौह अयस्क खनन क्षेत्र में पर्यावरणीय प्रभाव निर्धारण विधि के प्रयोग से संबंधित विषय के अध्ययन के साथ आर॰ आई॰ ए॰ एम॰ विधि का विस्तृत रूप से वर्णन किया गया है।

INTRODUCTION

Environment impact assessment (EIA) is an useful predictive exercise tool required for assessing the environmental capacity of the project under consideration. EIA is generally defined as an attempt to evaluate the consequence of a proposed action on each of descriptor in the environmental inventory. Environmental inventory is a complete description of the environment as it exist in an area where a particular proposed action is being considered. Identification of major impact of the environment forms the guideline to prepare the necessary plan for environmental management. Directives are identified with respect to the manner of handling the impacts in terms of environmental protection, conservation and preservation (Mehta, 1990). On the basis of the directives, different components of the environmental management plan are evolved and implemented (Sahu, 1988; Dhar, 1990; Dhar, 1995; McDonald and Brown, 1995).

In India, EIA notification has been issued in 1994 under the Environment Protection Act 1986 (Ministry of Environment and Forests, 1994). By this notification it has made compulsory for all the proponents of new mining projects of major minerals with leasehold of more than 5 ha size or expansion of the existing ones to seek environmental clearance from the Ministry of Environment and Forests (MOEF), Government of India before starting of the project or undertaking its expansion. The same is also applicable for prospecting exploration of major minerals in areas above 500 ha as per notification on 17th June, 1996.

The current system of obtaining environmental clearance starts with getting of 'no objection certificate' from the Sate Pollution Control Board (SPCB), carrying out of an EIA, preparation of Environmental Management Plan (EMP) and arranging a Public Hearing through the SPCB (Marwaha and Datey, 1997). For the latter, the SPCB has to be provided with 20 copies of summary of project report with details of impact on air and water quality as required for getting consent under the Air (Prevention and Control of Pollution) Act 1981 and the Water (Prevention and Control of Pollution) Act 1974 and other related information (Chaulya, 1998). The concerns expressed in the Public Hearing has to form a part of the application to MOEF for environmental clearance through Environmental Appraisal Committee (EAC). Detail procedure is given in the Gazette notification dated 10th April, 1997 (The Gazette of India, 1997). An comprehensive pro-forma has also been published in 1998 for appraisal of EIA/EMP reports.

EIA METHODS

Impact identification brings together project characteristics and baseline environmental characteristics with the aim of ensuring that all potentially significant environmental impacts (adverse or favourable) are identified and taken into account in the EIA process. A wide range of methods have been developed.

In choosing a method, the analyst needs to consider more specific aims, some of which conflict:

i) to ensure compliance with regulations;

ii) to provide a comprehensive coverage of a full range of impacts, including social, economic and physical;

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iii) to distinguish between positive and negative, large and small, long-term and short-term, reversible and irreversible impacts;

iv) to identify secondary, indirect and cumulative impacts as well as direct impacts;

v) to distinguish between significant and insignificant impacts;

vi) to allow comparison of alternative development proposals;

vii) to consider impacts within the constraints of an area's carrying capacity;

viii) to incorporate qualitative as well as quantitative information;

ix) to be easy and economical to use;

x) to be unbiased and to give consistent results and

xi) to be of use in summarizing and presenting impacts in the EIS.

Many of the methods were developed and have since been discussed, expanded and refined by various researchers namely, Luhar and Khanna (1988); Hundloe et al. (1990); Bannerjee and Rathore (1993); Jones (1993); NEERI (1993); Therivel (1993); Dhar (1994); Chakraborty and Chaulya (1994); Kundu and Bannerjee (1994); Morris and Therivel (1995); Saxena (1995); Leu et al. (1996); Chakraborty and Chaulya (1997); Parasar et al. (1997); Chaulya et al. (1998a); Chaulya et al. (1998b); Hickie and Wade (1998). The simplest involve the use of lists of impacts to ensure that none has been forgotten. The most complex include the use of interactive computer programms, networks showing energy flows, and schemes to allocate significance weightings to various impacts. The methods can be divided into the following categories:

- Checklists,
- Matrices,
- Quantitative methods,
- Networks and
- Overlay maps.

The discussion of methods here relates primarily to impact identification, but most of the approaches are also of considerable (and sometimes more) use in other stages of the EIA process - in impact prediction, evaluation, communication, mitigation, presentation, monitoring and auditing.

Table 1 summarizes the respective advantages of the major impact identification methods. Few of the aforementioned methodologies achieve all three steps of

Table 1 : Comparison of Impact Identification Methods

Methods	1	2	3	4	5	6	7	8	9	10	11
Checklists											
Simple/descriptive/question	✓	✓						✓	✓	✓	✓
Threshold	✓	✓	✓		✓	✓	✓		✓	✓	✓
Matrices simple	✓	✓						✓	✓	✓	✓
Magnitude /time-dependent	✓	✓	✓					✓	✓	✓	✓
Leopold	✓	✓	✓		✓			✓	✓		✓
Weighted	✓	✓			✓	✓		✓			✓
Quantitative TTS/WRAM	✓		✓		✓	✓	✓				
Network Sorensen	✓			✓		✓		✓		✓	
Overlay maps		✓	✓		✓	✓		✓	✓	✓	✓

Note:
1. Compliance with regulations; 2. Comprehensive coverage (social, economic and physical impacts); 3. Positive negative, reversible, irreversible impacts, etc; 4. Secondary, indirect, cumulative impacts; 5. Significant, insignificant impacts; 6. Compare alternative options; 7. Compare against carrying capacity; 8. Uses qualitative and quantitative information; 9. Easy to use; 10. Unbiased, consistent; and 11. Summarizes impacts for use in EIS.

identification, prediction and evaluation. The checklists, matrices, overlays and flow diagrams allow only identification of the impacts and modelling permits only prediction of impacts. Thus, none of these methodologies singly and satisfactorily achieve the necessary three steps.

SHORTCOMINGS OF EXISTING EIA METHODS

The main criticisms of EIA's are, in part, a natural result of the traditional methods used. Concerns are expressed that EIA judgments are subjective, either in whole or in part (NEERI, 1993; Pastakia and Jensen, 1998). This is a consequence of many factors: the lack or inadequacy of baseline data; the time frame provided for data acquisition and analysis; the terms of reference provided for the EIA, and the capacity of the assessors to cover a wide range of issues. Even where quantitative environmental data are available, the overall use of this data requires a subjective judgment of the possible impact, its spatial scale, and potential magnitude. It is this forecasting of events that underpins the subjectivity of the analysis.

A second major criticism relates to the difficulty of ensuring some degree of transparency and objectivity in these qualitative assessments of the impacts of projects (in particular development projects where data may be scarce and implementation may take many years). EIA evaluations need to be reassessed with the passage of time, and the data become available. Wholly subjective and descriptive systems are not easily capable of such revision, dependent as they are on the expertise and experience of the original assessors and on the quality of the descriptive record left behind (Partidauio, 1996; Pardo, 1997; Pastakia and Jensen, 1998).

The historical development of EIA shows that a number of attempts have been made to improve the quality of the EIA analysis by seeding to improve the accuracy of the judgment, resulting in a number of formats being developed for analysis in EIA. Systems were developed that provided numerical values for subjective judgments. The problems with these systems is that the reasons behind a stated value; thus, it is impossible (without direct access to the assessor) to determine the reasoning behind the judgment made. The present EIA methods also do not properly addressed the cumulative impacts of various environmental parameters Smith and Spalling, 1995; Buris and Canter, 1997.

Therefore, it may be stated that existing EIA methodologies suffer from conceptual, methodological, procedural and other limitations (Maudgal, 1990; NEERI, 1993; Bannerjee, 1995; Lawrence, 1997).

IMPROVEMENT TO TRADITIONAL EIA METHODS

The problem of recording the arguments that lead to a conclusion in a subjective judgment can be addressed by defining precisely how that judgment will be made. For the subjectivity of judgment to become transparent, it will be necessary to define very carefully how the analysis should be carried out and the criteria by which judgments are made. This requires that the criteria for judgment can be identified and accepted in all forms of EIA.

Many of the criteria used at present to determine what impacts may occur as a result of a development project are well known and accepted by most workers in the field of EIA. For instance, in any EIA, it is always necessary to consider the area likely to be affected; the degree or magnitude of the impact; whether the change is permanent or temporary in nature; whether the affect may be reversed; whether an impact may, with other effects, be synergistic; and whether there is any likelihood for a cumulative effect to develop over time.

All these criteria form areas of judgment common to most EIA's today. If, however, these criteria and scales are laid down prior to the analysis and are common to all EIA judgments, then a system for understanding the arguments by which conclusions are reached can be recorded. This understanding of the universal nature of environmental evaluation is at the heart of the Rapid Impact Assessment Matrix (RIAM) concept, which is described herewith.

RAPID IMPACT ASSESSMENT MATRIX

The RIAM concept has been defined by Pastakia and Jensen (1998). The RIAM method is based on a standard definition of the important assessment criteria, as well as the means by which semi-quantitative values for each of these criteria can be collated, to provide an accurate and independent score for each condition. The impacts of project activities are evaluated against the environmental components, and for each component a score (using the defined criteria) is determined, which provides a measure of the impact expected from the component.

The important assessment criteria fall into following two groups:

(A) Criteria that are of **importance to the condition**, that *individually can change the score obtained*, and

(B) Criteria that are of **value to the situation**, but *should not individually be capable of changing the score obtained.*

The value assigned to each of these groups of criteria is determined by the use of a series of simple formulae. These formulae allow the scores for the individual components to be determined on a defined basis.

The scoring system requires simple multiplication of the scores given to each of the criteria in group (A). The use of multiplier for group (A) is important, for it immediately ensures that the weight of each score is expressed, whereas simple summation of scores could provide identical results for different conditions.

Scores for the value criteria group (B) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values group (B) are fully taken into account.

The sum of the group (B) scores are then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition. The process for the RIAM in its present form can be expressed as follows:

$$(a1) \times (a2) = At \qquad \text{———(1)}$$

$$(b1) + (b2) + (b3) = bT \qquad \text{———(2)}$$

$$(aT) \times (bT) = ES \qquad \text{———(3)}$$

Where, (a1) and (a2) are the individual criteria scores for group (A); (b1), (b2) and (b3) are the individual criteria scores for group (B); aT is the result of multiplication of all (A) scores; bT is the result of summation of all (B) scores; and ES is the environmental score for the condition.

Assessment Criteria

The judgments on each component are made in accordance with the criteria and scales shown in Table 2. The description of assessment criteria are as follows:

i) Group A

Importance of condition (A1) : A measure of the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect.

Magnitude of change/effect (A2) : Magnitude is defined as a measure of the scale of benefit / dis-benefit of an impact or a condition.

ii) Group B

Permanence (B1) : This defines whether a condition is temporary or permanent, and should be seen only as a measure of the temporal status of the condition (e.g. an embankment is a permanent condition even if it may one day be breached of abandoned; whilst drainage line is a temporary condition, as it will be removed).

Reversibility (B2) : This defines whether the condition can be changed and is a measure of the control over the effect of the condition. It should not be confused or equated with permanence (e.g. : (i) an accidental toxic spillage into a river is a temporary condition (B1) but its effect (death of fish) is irreversible (B2); a sewage treatment work is a permanent condition (B1), the effect of its effluent can be changed (reversible condition) (B2).

Cumulative (B3) : This is a measure of whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions. The cumulative criterion is a means of judging the sustainability of a condition, and is not to be confused with a permanent/irreversible, but noncumulative as the animal can be considered to have already passed its breeding capabilities. The loss of post larval shrimp in the wild, is also permanent and irreversible, but in this case cumulative, as all subsequent generations that the larvae (as adults) may have initiated will also have been lost.

Environmental Components

RIAM requires specific assessment components to be defined through a process of scooping, and these environmental components fall into one of four categories, which are defined as follows:

- *Physical/Chemical (PC)* : Covering all physical and chemical aspects of the environment.
- *Biological/Ecological (BE)* : Covering all biological aspects of the environment.
- *Sociological/Cultural (SC)* : Covering all human aspects of the environment, including cultural aspects.
- *Economic/Operational (EO)* : Qualitatively to identify the economic consequences of environment change, both temporary and permanent.

To use the evaluation system described, a matrix is produced for each project option, comprising cells showing the criteria used, set against each defined component. Within each cell the individual criteria scores are set down. From the formulae given previously, ES number is calculated and recorded.

To provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. Ranges are defined by conditions that act as markers for the change in bands. Table 3 gives the ES values and range bands used in RIAM. The final assessment of each component is evaluated according to these range bands.

Table 2 : Assessment Criteria

Criteria	Scale	Description
A1 : Importance of condition	4	Important to national/ international interests
	3	Important to regional/ national interests
	2	Important to areas immediately outside the local condition
	1	Important only to the local condition
	0	No importance
A2 : Magnitude of change/ effect	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change/status quo
	-1	Negative changes to status quo
	-2	Significant negative disbenefit or change
	-3	Major disbenefit or change
B1 : Permanence	1	No change/not applicable
	2	Temporary
	3	Permanent
B2 : Reversibility	1	No change/not applicable
	2	Reversible
	3	Irreversible
B3 : Cumulative	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic

Once the ES score is set into a range band, these can be shown individually or grouped according to component type and presented in whatever graphical or numerical form the presentation requires.

Table 3 : Conversion of Environmental Scores to Range Bands

Environmental Score	Range Bands	Description of Range Bands
+72 to + 108	+E	Major positive change/impacts
+36 to + 71	+D	Significant positive change/impacts
+19 to + 35	+C	Moderately positive change/impacts
+10 to + 18	+B	Positive change/impacts
+1 to + 9	+A	Slightly positive change/impacts
0	N	No change/status quo/not applicable
-1 to - 9	-A	Slightly negative change/impacts
-10 to - 18	-B	Negative change/impacts
-19 to - 35	-C	Moderately negative change/impacts
-36 to - 71	-D	Significant negative change/impacts
-72 to - 108	-E	Major negative change/impacts

Scoping

Generic Questionnaire Checklist for addressing and/or summarizing the cumulative environmental impacts of projects has been developed by Canter and Kamath (1995) and subsequently modified for Indian mining conditions as listed in Table 4. The same selective parameters have been considered for RIAM study of the present mining area. The scoping includes 45 physical/ chemical (PC), 13 biological/ecological (BE), 35 social/ cultural (SC), and 14 economical/operational (EO) components.

CASE STUDY

Description of the Study Site

A case study for environmental impact assessment by utilising RIAM method has been conducted for the Bicholim iron ore mining area at North Goa, India. The mine is owned by M/s Dempo Mining Corporation Limited, Panjim, Goa. Bicholim iron ore mine is located in Bicholim taluka of North Goa (between 15° 35' to 15° 36' 22" N latitude and 73° 54' 43" to 73° 55' 42" E longitude). The mining area comprises of five continuous

Table 4 : RIAM Analysis Matrix

Components		A1	A2	B1	B2	B3	ES	RB
Physical/Chemical (PC) Environment								
Landform :								
PC1	fractures on geologic strata	1	-1	3	3	2	-8	-A
PC2	landslides and land subsidence	0	0	1	1	1	0	N
PC3	seismic activity	0	0	1	1	1	0	N
PC4	compaction ad settling	0	0	1	1	1	0	N
PC5	deposition (sedimentation, precipitation)	0	0	1	1	1	0	N
PC6	erosion of soils due to increased wind, floods, removal of vegetation	1	-1	2	2	2	-6	-A
PC7	impact to unique physical features (due to destruction, modification, or covering)	0	0	1	1	1	0	N
PC8	impact to agriculture	2	-1	2	2	2	-12	-B
PC9	change in existing topography (ground contours, shorelines, river banks)	1	-1	2	2	2	-6	-A
PC10	extensive use of existing mineral resources	1	-1	2	2	2	-6	-A
PC11	disposal of waste material	1	-1	2	2	2	-6	-A
PC12	excessive fields and radiation	0	0	1	1	1	0	N
PC13	change in hydrology (water table, gradient, infiltration)	1	-1	3	3	3	-9	-A
PC14	impact on air quality (due to gases, particulates and fugitive dust)	2	-1	2	2	2	-12	-B
PC15	air pollutant emissions which will exceed standards or cause deterioration of ambient air quality	2	-1	2	2	2	-12	-B
PC16	objectionable odors	0	0	1	1	1	0	N
PC17	changes in climate due to alteration in humidity, air movement, or temperature	0	0	1	1	1	0	N
PC18	emissions of hazardous air pollutants (VOCs, SOCs and other toxics)	0	0	1	1	1	0	N
PC19	acid rain	0	0	1	1	1	0	N
Water:								
PC20	changes in the quality and quantity of surface water	1	-1	2	2	2	-6	-A
PC21	discharge of wastewater to potable drinking water systems	0	0	1	1	1	0	N
PC22	alter flows due to construction	0	0	1	1	1	0	N
PC23	increase tendency to flooding	0	0	1	1	1	0	N
PC24	salinate water bodies	0	0	1	1	1	0	N
PC25	unsightly appearance of water bodies	0	0	1	1	1	0	N
PC26	eutrophication	0	0	1	1	1	0	N
PC27	increase in temperature and turbidity due to impoundment	0	0	1	1	1	0	N
PC28	destruction of streams	0	0	1	1	1	0	N
PC29	considerable effects on conventional water quality parameters (that is, DO, fecal coliforms, pH, BOD_5, NO_3, PO_4, temperature deviation, turbidity, total solids)	0	0	1	1	1	0	N
PC30	alter the rate or direction of ground water flow?	2	-1	3	3	3	-18	-B
PC31	alter the quality and quantity of ground water	2	-1	2	2	2	-12	-B
PC32	introduce pollutants to ground water due to land application of wastes	0	0	1	1	1	0	N
PC33	contamination of public water supplies	0	0	1	1	1	0	N

PC34	impact to recharge area or recharge rate	1	-1	3	3	3	-9	-A
PC35	make ground water vulnerable to contamination (due to wells, boreholes, cracks, etc.)	0	0	1	1	1	0	N
PC36	impact on or construction in a wetland or inland flood plain	0	0	1	1	1	0	N
PC37	thawing snow, ice and permafrost	0	0	1	1	1	0	N
PC38	impact to a wellhead protection zone	0	0	1	1	1	0	N
PC39	impact on fisheries	0	0	1	1	1	0	N
Solid Waste								
PC40	generation of significant solid waste	1	-1	2	2	2	-6	-A
PC41	impact existing landfill capacity	0	0	1	1	1	0	N
Noise:								
PC42	increase existing noise levels	1	-1	2	2	2	-6	-A
PC43	expose people or wildlife to excessive noise	0	0	1	1	1	0	N
PC44	vibrations	0	0	1	1	1	0	N
Hazardous waste:								
PC45	generation, transport, storage, or disposal of regulated hazardous wastes	0	0	1	1	1	0	N
BIOLOGICAL/ECOLOGICAL (BE) ENVIRONMENT								
Flora:								
BE1.	change to the diversity or productivity of vegetation (namely trees, shrubs, grass, crops, microflora and aquatic plants)	1	-1	2	2	2	-6	-A
BE2.	impact to riparian habitat\	0	0	1	1	1	0	N
BE3.	impact to rare or endangered plant species	0	0	1	1	1	0	N
BE4.	introduce new plant specie into the are or create a barrier to the normal replenishment of existing species	0	0	1	1	1	0	N
BE5.	reduce acreage or create damage to any agricultural crop	2	-1	2	2	2	-12	-B
BE6.	impact on forests	0	0	1	1	1	0	N
Fauna								
BE7.	reduce the habitat or numbers of unique, rare or endangered species of birds or animals	0	0	1	1	1	0	N
BE8.	affect to land animals, benthic organisms, insects and microfauna	1	-1	2	2	2	-6	-A
BE9.	attraction, entrapment or impingement of animal life	0	0	1	1	1	0	N
BE10.	impact to existing fish, wildlife habitat, and nesting areas	0	0	1	1	1	0	N
BE11.	introduction of new species of animals into an area or create a barrier to the migration or movement of animals or fish	0	0	1	1	1	0	N
BE12.	cause,emigration resulting in human wildlife interaction problems	0	0	1	1	1	0	N
BE13.	affect to food chain	0	0	1	1	1	0	N
SOCIOLOGICAL/CULTURAL (SC) ENVIRONMENT								
Landuse:								
SC1.	Substantially altering existing or proposed land use of an area	1	-1	3	2	2	-7	-A
SC2.	impact to wilderness qualities and open-space qualities	0	0	1	1	1	0	N
SC3.	impact to or destruction of wetlands	0	0	1	1	1	0	N

Contd...................

Components		A1	A2	B1	B2	B3	ES	RB
SC4.	impact to Special Management Areas	0	0	1	1	1	0	N
Recreation:								
SC5.	impact to hunting, fishing, boating, swimming, camping and hiking, picnicking and holiday resorts	0	0	1	1	1	0	N
Aesthetics:								
SC6.	impact to scenic views and vistas	1	-1	2	3	2	-7	-A
SC7.	impact to landscape design	0	0	1	1	1	0	N
SC8.	impact to unique physical features	0	0	1	1	1	0	N
SC9.	impact to parklands and reserves	0	0	1	1	1	0	N
SC10.	impact to monuments	0	0	1	1	1	0	N
SC11.	presence of misfits (out of place)	0	0	1	1	1	0	N
Archaeological sites:								
SC12.	impact to or destruction of historical, archaeological, cultural and paleontological sites or objects	0	0	1	1	1	0	N
Health and safety:								
SC13.	health hazard or potential health hazards	0	0	1	1	1	0	N
SC14.	exposure of people to potential health hazards	0	0	1	1	1	0	N
SC15.	risk of accidents due to explosion, release of oil, radioactive materials, toxic substances, etc.	0	0	1	1	1	0	N
Cultural patterns:								
SC16.	change existing cultural patterns (or life style)	2	1	2	2	2	12	B
Local services:								
Need for new or altered services in any of the following areas:								
SC17.	health care	2	1	2	2	2	12	B
SC18.	police	0	0	1	1	1	0	N
SC19.	fire protection	0	0	1	1	1	0	N
SC20.	education	2	1	2	2	2	12	B
SC21.	churches/temples/masjid	0	0	1	1	1	0	N
SC22.	child care	2	1	2	2	2	12	B
SC23.	other services	1	1	2	2	2	6	A
Public utilities:								
Need for a new or altered to the following utilities:								
SC24.	electricity	2	1	2	2	2	12	B
SC25.	natural gas	0	0	1	1	1	0	N
SC26.	potable water	0	0	1	1	1	0	N
SC27.	wastewater treatment and disposal?	2	1	2	2	2	12	B
SC28.	storm water control	0	0	1	1	1	0	N
SC29.	solid waste collection and disposal?	0	0	1	1	1	0	N
SC30.	communication systems	2	1	2	2	2	12	B
SC31.	transmission pipelines	0	0	1	1	1	0	N
SC32.	other utilities	2	1	2	2	2	12	B

Population:								
SC33.	alteration of location or distribution of human population in the area	2	-1	2	2	2	-12	-B
SC34.	change to demographic characteristics in the area	0	0	1	1	1	0	N
SC35.	change to housing and household	1	1	2	2	2	6	A
ECONOMIC/OPERATIONAL (EO) COMPONENT								
Economic:								
EO1.	adverse effect on local or regional economy	2	1	2	2	2	12	B
EO2.	changes in per capita income	2	1	2	2	2	12	B
EO3.	changes in the standard of living?	2	1	2	2	2	12	B
EO4.	employment	2	2	2	2	2	24	C
Transportation:								
EO5.	change to existing rail, road, waterway and/or air traffic	0	0	1	1	1	0	N
EO6.	increase in movement	1	-1	2	2	2	-6	-A
EO7.	increase in accident and traffic hazards	0	0	1	1	1	0	N
EO8.	affect to transportation network	1	1	2	2	2	6	A
EO9.	construction of new roads	0	0	1	1	1	0	N
EO10.	change in existing patterns of movement of men and materials	2	-1	2	2	2	-12	-B
Natural resources:								
EO11.	deplete natural resources	1	-1	2	3	2	-7	-A
EO12.	destruction of natural resources	0	0	1	1	1	0	N
Energy:								
EO13.	substantial use of fuel or energy	0	0	1	1	1	0	N
EO14.	increase in demand for existing sources of energy	0	0	1	1	1	0	N

Table 5: Summary of RIAM Scores

Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	0	5	10	30	0	0	0	0	0
BE	0	0	0	1	2	10	0	0	0	0	0
SC	0	0	0	1	2	22	2	8	0	0	0
EO	0	0	0	1	2	6	1	3	1	0	0
Total	0	0	0	8	16	68	3	11	1	0	0

leases. These leases are situated on a SE-NW oriented upland. Surface elevations vary from 156.98 to 15 m above reduced mean sea level (R.L.). Open pit mining of iron ore is carried out by shovel and dumper combination. Drilling and blasting are avoid by ripper dozer. Average annual production of iron ore and waste generation of Bicholim mine are 2 and 4 million tonnes, respectively.

The climate of the area is tropical humid. The temperature and humidity in the area ranges between 24 - 38°C and 58 - 89 %, respectively. High level of rainfall is recorded during monsoon season (June - September) and annual rainfall ranges from 2500 to 4000 mm.

For the study, the leasehold area of around 479 ha has been considered as core zone and surrounding villages has been demarcated as buffer zone. The total study area consists of thirteen villages. Geology of the area is dominated by Bicholim formation with iron ore deposits and the host rock is hematite-sericite schist, biotite-quartz schist and phyllite. The soil is laterite with sandy loam in texture.

Baseline air quality data has been collected as per Central Pollution Control Board (CPCB) guidelines with respect to Respirable Particulate Mater (RPM), Suspended Particulate Matter (SPM), Sulphur Dioxide (SO_2), Nitrogen Oxide (NO_x), Carbon Monoxide (CO) and Lead (Pb) in both core and buffer zones. Results have indicated marked seasonal variations in all the monitoring stations with maximum values in winter season for RPM, SPM, SO_2 and NO_x. However, the minimum values has been observed during rainy season. The annual average of the air pollutants' concentration in the buffer zone is within the respective permissible limit except at few places, where values of RPM and SPM concentrations exceed the respective threshold limit.

Mine water effluent analysis has indicated seasonal variations for all parameters with maximum values during monsoon season for Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), total nitrogen and chloride. However, the heavy metals do not exhibit any trend. TDS and Fe content are slightly higher than the respective threshold limit. Drinking water has indicated slightly more residual chlorine and iron content otherwise all parameters are within prescribed limit. Surface water quality of Bicholim, Mapuca and Mandovi rivers has indicated Class B category as per CPCB classification which indicates that assimilative capacity of the rivers flowing into buffer zone is still existed and can be used for out door bathing and organised uses.

Water resource accounting has revealed that the region is having heavy precipitation of average 3000 mm per annum. However, only 10-20 per cent of total precipitation is becoming as utilisable groundwater resource and remaining portion is being lost as heavy runoff, evapotranspiration and subsurface capillary moisture. Hence, people of the region are suffering from scarcity of water during dry period. Closely spaced shallow wells in the region have also aggravated the groundwater scarcity problem due to draw down effects.

Ambient noise monitoring at residential area has indicated no noticeable impact with maximum noise value in day time of winter and summer seasons with very slight variation among the sites. Industrial area exhibited maximum value at day time near the screening plant. The noise level in both residential and industrial areas has exhibited well within the corresponding threshold values as prescribed by CPCB both during the day and night time. Ground vibration study for the operation of heavy earth moving machinery has indicated that peak particle velocity does not cross the stipulated safe limit.

Remote sensing technique has been used to study the landuse. It has indicated that no river, surface water body and forests are present within the lease area. However, a scrub vegetation is present in the study area which is not a declared forests. Mining constitute 39.8% of total lease hold area.

Physico-chemical properties of soil has indicated poor textural class along with impoverished soil nutrients in mine dump area in comparison to adjacent Mayem scrub forest patch. However, the plantation has improved the soil nitrogen and organic matter. The values when compared to rating chart shows low to medium range for nitrogen, medium range for phosphorus and rich in potassium.

The scrub forest area (not a declared forest area) in buffer zone is intermingled with cultivated land with dominance of Aam, Coconut, Sanvar, Onval, Kindal, Santan etc. The core zone does not have any forest land within it. There is no observable threat to endangered species

The faunal diversity at buffer zone includes wild boar, jungle cat, civet cat, black napped hare, squirrel, mongoose, jackal etc. There is no threatened faunal species in the mining lease area observed during the study period.

Population density in the core zone is higher than the Goa state average. The sex ratio in favourable to females in three villages of buffer zone while in other area it is favourable for male. Literacy percentage is below the state average. Female literary is lower than male. House to house survey has indicated scarcity of drinking water facility during summer season.

The Quality of Life index (QOL) is varied from a value of 0.478 to a maximum of 0.566. QOL index in most of the villages are slightly higher than neutral. In Bicholim

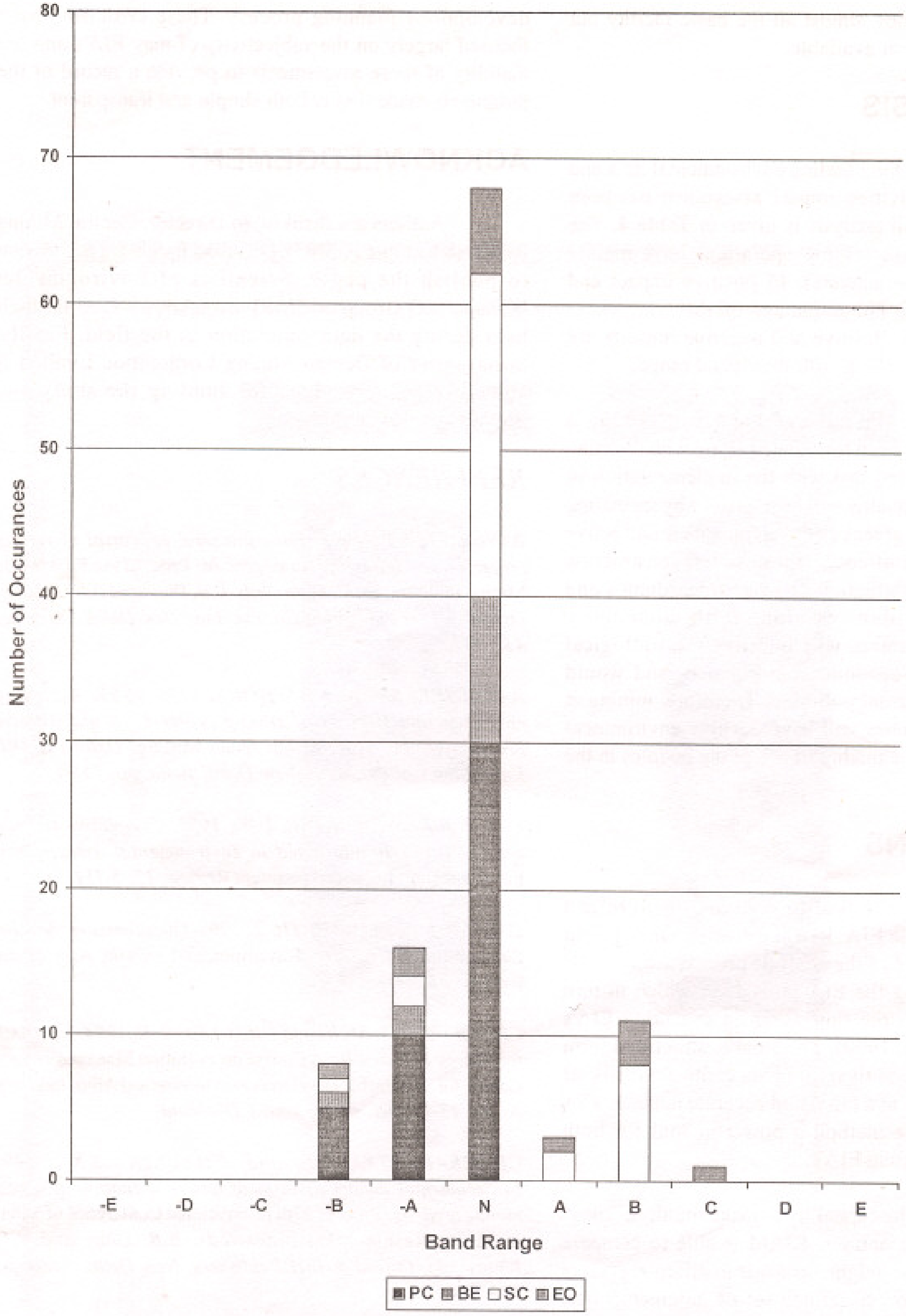

Fig. 1 : Summary of RIAM Analysis

urban area people enjoy almost all the basic facility but sanitation facility is not available.

RIAM ANALYSIS

Considering the baseline environmental data and nature of mining activities, impact assessment has been carried out. The detail analysis is given in **Table 4**. The table indicates that the mining operations have mainly neutral impact (68 parameters), 15 positive impact and 24 negative impact. The summary of the analysis is presented in **Table 5**. Positive and negative impacts are illustrated in **Fig. 1** along with their band range.

To mitigate the adverse impact of mining a management plan has been formulated along with the mine planning. It is expected that with the implementation of EMP, environmental quality will be improved by sprinkling of water in haul road, greenbelt development around active pollution source, use of coagulant in water, construction of settling tank, rehabilitation of overburden dumps and other eco-friendly devices along with community development programme will improve the biological aesthetic and socio-economic environment and would reduce the environmental pollution. Therefore, mining at Bicholim iron ore mines will have positive environment status and improve the quality of life of the peoples in the region.

CONCLUSIONS

The RIAM is a tool to organize, analyze and present the results of a EIA. RIAM provides a transparent and permanent record of the analysis process while at the same time organizing the EIA procedure, which in turn considerably reduces the time taken in executing EIA's (Pastakia and Jensen, 1998). The simple, structured form of RIAM allows reanalysis and in-depth analysis of selected components in a rapid and accurate manner. This flexibility makes the method a powerful tool for both executing and evaluating EIA's.

RIAM has the capability to make multiple "runs" to compare different options. RIAM is able to compare (on an common basis) judgments made in different sectors as the methods follow a defined set of judgment rules. The scales in RIAM allow both quantitative and qualitative data to be assessed.

The flexibility that RIAM provides, coupled with its graphical presentation of the results of the RIAM matrix, makes this a powerful tool for executing and evaluating impact assessments.

RIAM provides the solutions to a number of criticisms that have affected EIA's since their near-universal acceptance as a necessary part of the development planning process. These criticisms have focused largely on the subjectivity of may EIA's and the inability of these assessments to provide a record of the judgments made that is both simple and transparent.

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