CIA Study for Mining Projects

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CIA Definition

The United States Council on Environmental Quality (CEQ) definition of cumulative impact:

"the impact on the environment which results from the incremental impact of the action when added to **other past, present and reasonably fore- seeable future actions**, regardless of what agency or person undertakes such other actions."

Concepts

- This is not a new type of impact
- Recognition of the complex ways in which individual projects and activities interact and combine with each other over time and distance
- Address cumulative impacts within EIA by 'thinking cumulatively' considering the temporal and spatial boundaries of the assessment; and the interaction amongst the project and the past and future projects and activities
- To some extent, baseline studies cover the impacts of past and present activities. However, consider cumulative impacts resulting from the interactions amongst the environmental impacts of the proposed project with those of future projects and activities

Tasks within EIA framework to address cumulative impacts

	resources ■ Assess the impacts of all actions on the resources
3. Identification of mitigation measures	■ Recommend mitigation measures
4.Evaluation of significance of cumulative impacts	■ Evaluate the significance of residual impacts by comparing against regulatory or other thresholds
5. Follow-up	■ Monitor the cumulative impact through regional monitoring

d the interactions among the environmental ıpacts of the project, and past and future pro- :ts and activities. To a limited extent, EIAs :eady address cumulative environmental ıpacts. For example, most examine the base- ıe environmental conditions, which include e cumulative environmental impacts of past d existing projects and activities. However, sideration should also be given to the

A practical framework based on which ar analyst can address cumulative impacts fo mining projects is built upon the practica approaches and primary EIA methodologies t identify and assess the cumulative impacts Though, the framework is primarily aimed a CIA of mining projects, it can very well b applied to other projects with little modifica tion

Scoping: Identify significant issues of concern

Checklist of project components of an opencast mine

MENTAL MANAGEMENT

rating cumulative
oncerns into EIAs

Table 1: Assessment framework

Basic EIA steps	Broad CIA steps
1. Scoping	■ Identify significant issues of concern associated with the

Scoping: Identify significant issues of concern (Contd.)

Questionnaire checklist for identifying project-related and cumulative impacts

The first column of the checklist should consider the environmental impacts resulting from the project, looking at:

Physical environment landform

Landslide and land subsidence; soil erosion; change in existing topography

Land use

Alteration of existing or proposed land use of an area; impact on, or destruction of, wet land

Air

Impact on air quality due to gases, particulate etc

Surface water

Change in quantity of surface water; alter flow due to construction; destruction of streams; effects on water quality parameters

Groundwater

Alter the rate or direction of groundwater flow; alter the quality or quantity of groundwater; impact on recharge area or recharge rate

Solid waste

Impact existing landfill capacity

Noise and vibration

Expose people or wildlife to noise; ground vibrations

Contd.

Scoping: Identify significant issues of concern (Contd.)

Biological flora

Change to the diversity or productivity of vegetation; impact on rare or endangered plant species; reduce acreage or create damage to any agricultural crop; impact forests

Biological fauna

Reduce habitat or the numbers of unique, rare or endangered bird or animal species; entrapment or impingement of animal life; impact on existing fish population; barrier to the migration or movement of animal or fish; cause emigration resulting in human-wildlife interaction problems

Recreation

Impact on fishing, boating, picnicking etc; creation of recreation opportunities

Aesthetics

Impact on scenic views; impact on unique physical features; impact on monuments

Contd.

Scoping: Identify significant issues of concern (Contd.)

Archeological
Impact on destruction of historical, archeological, cultural and palaeontological sites or objects
Health and safety
Potential health hazards; risk of accidents from explosion, release of oil, radioactive materials, toxic substances etc
Socio-economy
Changes in income level; education; health care; change in existing cultural pattern; alteration of location or distribution of human population in the area; change in housing
Transportation
Changes in existing pattern of movements of men and materials

The second column in the checklist would note whether these results would happen and the third column would note the affected resources. The fourth column would note whether other past, present or future non- project actions can affect any of the above

Scoping: Identify significant issues of concern (Contd.)

If the identified impact satisfies any of the criteria under A, then it would be deemed significant, else significant is to be judged based on criteria under B

A. An impact will be deemed to be significant if it has any of the following possible attributes:

- Displacement or danger to any designated or protected environmental feature
- Affecting many people
- Cause for some proven chronic health effect

B. If the impact does not have any of the possible three attributes as above, consider the following questions:

- Will there be a large change in environmental condition?
- Will the impact extend over a large area?
- Will it affect many receptors other than people (fauna, flora, facilities etc.)?
- Will the impact be unusual or unique in the area?
- Will the impact be permanent rather than temporary?
- Will it be difficult to avoid, reduce, or mitigate the impact?
- Will it cause cumulative impact?

Sufficient details on these factors should be provided in the scoping checklist to state why the impact is considered to be significant or insignificant.

Scoping: Identify spatial boundary

- Boundaries cannot be prescriptive and must be determined on a case-to-case basis
- Boundaries of different resources will also be different based on availability of data and presence of natural boundary
- A useful concept is to find out a project impact zone
- Make a list of resources that may be affected by the project actions within that zone
- Determine the geographic areas occupied by the resources outside the project impact zone
- In most of the cases, the largest of the areas will be the appropriate area for CIA
- Examples of geographic areas for CIA-

MENTAL MANAGEMENT

Scoping: Identify temporal boundaries

- Past depends on availability of information and historical use of the area
- Baseline information catches the effect of past to a great extent
- Five years is a reasonable future time boundary beyond which there may be too much of uncertainty about future project proposals

Scoping: Identify other actions contributing to cumulative impacts

- Environmental impacts of other existing or past projects and activities that may combine with the environmental impacts of the project in question should only be considered
- Future projects which are approved or are in the approval process should be included
- Also include those activities which do not require formal approval but may be relevant to assessment if there is reasonable uncertainty that these will take place
- When there is insufficient information about future projects and activities best professional judgment should be applied
- It is not necessary to predict the impacts of future projects activities in detail, but to the extent that is feasible and reasonable under the circumstances

Analysis of impacts

Define baseline conditions for the important regional resources

- Data on the status of important natural, cultural, social, or economic resources and systems. Wherever possible, they should be characterised by the use of appropriate accepted indices. This information can be combined with GIS to describe and characterise the environmental baseline for sites or regions.
- Data that characterise the stress factors. Data on stress factors, that is the actions (both existing and proposed) that may cumulatively affect the resources, should be compiled.
- Description of pertinent regulations and standards. Regulations and standards (for example, air or water quality criteria) can influence developmental activity and the resultant cumulative stress on resources, ecosystems and human communities. They also shape the manner in which a project may be operated and the amount of emissions that can be released.

Analysis of impacts (Contd.)

Assess the impacts of all actions on the resources

- The analysis of cumulative impacts should focus on assessing effects on selected resources.
- Several approaches are available to assist in the assessment. However, no single approach should be used.
- Rather, the analyst must select an appropriate approach or assessment 'tool' from a collection or 'toolbox' of approaches.
- Wherever possible, the magnitude of impacts should be quantified, for example percentage of habitat loss or increase in a particular pollutant.
- If cause-and-effect cannot be quantified, qualitative evaluation procedures can be used.

Identification of mitigation measures

- At the early stages of the assessment there will not be detailed information on the type and location of mitigation measures for a project.
- Past experience or research should be able to give a good under-standing of the measures that are likely to be implemented when considered together with the information on the project and environment.

Evaluation of significance

- After taking into account any appropriate mitigation measures, the likelihood and significance of the cumulative environmental effects must be determined.
- Significance shall be based on magnitude, geo- graphic extent, duration and frequency, and where quantitative evaluation is possible, specific criteria for significance should be explicitly identified and described.
- If quantitative evaluation is not possible, qualitative assessments can be carried out and the impacts can be ranked as high, medium, low, etc. according to some set criteria.

Follow up

A follow-up program should monitor:

- The accuracy of the environmental assessment with regard to its assessment
- The effectiveness of any mitigation measures.

Follow-up program to monitor cumulative environmental effects may be appropriate when:

- The project is likely to cause new or different cumulative environmental effects.
- The project involves new or unproven mitigation measures whose ability to reduce cumulative environmental effects is uncertain
- An otherwise familiar or routine project is proposed for a new or unfamiliar environmental setting

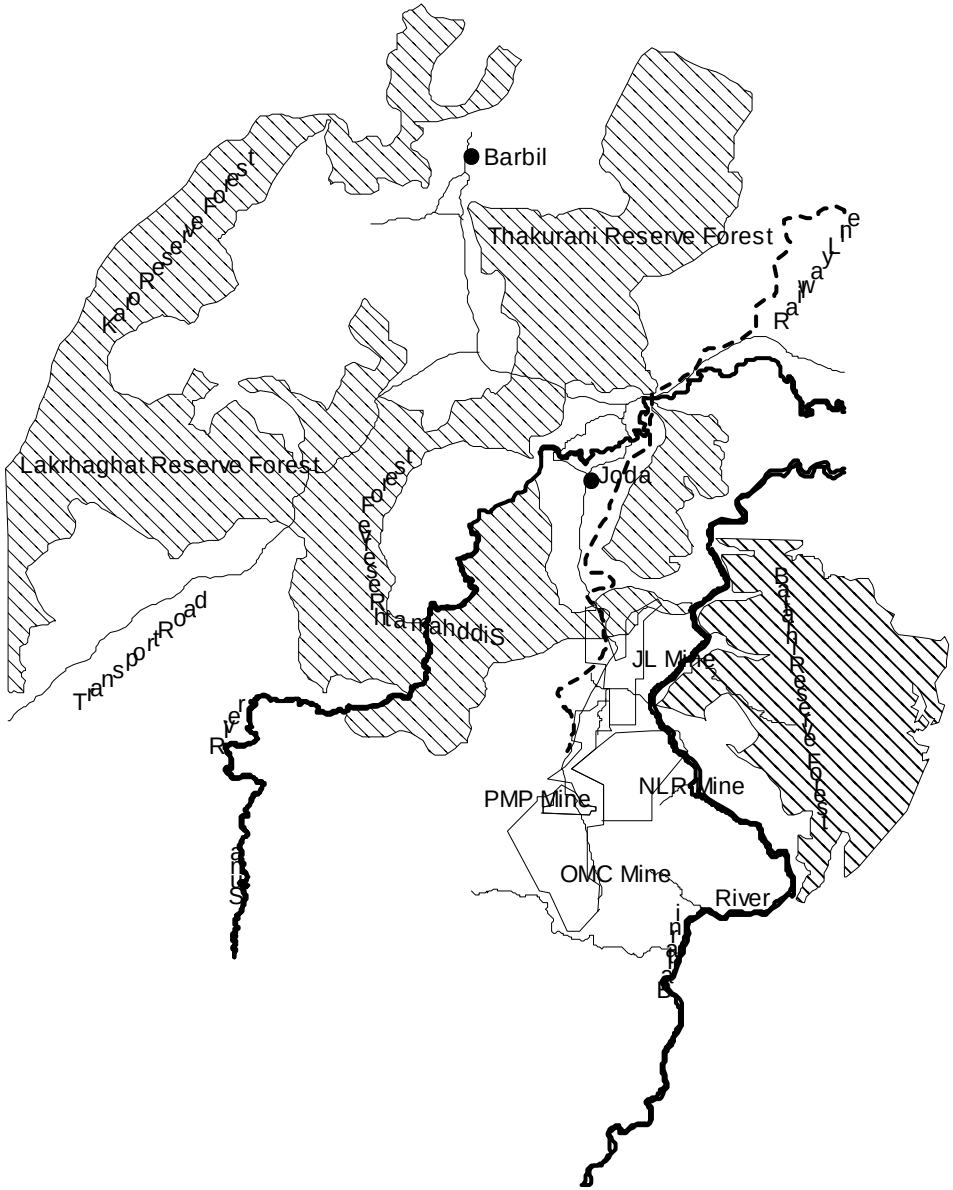
Follow up (Contd.)

- Where there is some uncertainty about the conclusions of the assessment of cumulative environmental effects
- Project scheduling or operational details are subject to change such that the cumulative environmental effects could be different from those described in the EIA.
- Follow-up programs should take account of using and supplementing existing programs that monitor cumulative environmental effects

Case Study- Jilling Langalota Iron Ore Mine (JL)

- JL was an operating mine. However, it was assumed to be new mine for which EIA would be required
- The basic purpose was to illustrate the developed methodology for CIA
- The mine is located in Keonjhar district of Orissa, sharing lease boundaries with OMC, PMP, and NLR mines. These mines were assumed to be other future projects
- Work was entirely based on secondary information and no primary data was generated. Some data were also assumed

Location



LOCATION OF JL MINE

0.0 2.5 5.0 7.5 10.0 12.5 km

Scoping

- The scope of the primary assessment was limited to the impacts arising from the construction, operation and closure of the mine itself along with the associated ore handling and transportation operations.
- The principal sources of SPM in a mining area are the emissions from various working areas in the mines.
- Operation of the other mining projects in the vicinity and associated operations such as increased frequency of ore transportation were considered to be those that may contribute to cumulative impacts with no consideration given to non-mining activities

Checklist for identification of project components

Will the project involve the following major activities?	Yes/No	Details of action	Stage of occurrence
Land acquisition and creation of new land use	Yes	Land acquisition will lead to change of land use within the lease area	Construction
Removal of vegetation	Yes	A small portion of forest land on the northern part of the lease will be removed	Operation
Demolition of important structures	No	No such structures exist	
Impoundment, culverting, realignment or other changes to the hydrology of the water courses	No	No such changes will be required	
Closure/diversion of existing transport route or creation of new transport route	No	The road to the area exists	
Closure/diversion of other utilities or creation of new utilities such as power line, pipeline	Yes	Power line will be constructed from Banspani	Operation
Ground water removal	Yes	Ground water will be drawn for drinking and cleaning purposes	Construction/operation
Civil construction work for surface or underground structures	Yes	Office and other buildings will be constructed	Operation
Provision of civic amenities such as housing, school, medical facilities, water	Yes	Power, housing, water supply and a small medical facility shall be provided at the mine	Construction/operation
Provision of direct or indirect employment opportunities	Yes	The project will involve creation of direct and indirect jobs	Construction/operation
Surface run off	Yes	Rainwater will flow down the hill mainly towards the East	Construction/operation
Topsoil and subsoil removal and storage	Yes	Soil will be removed and stored separately outside the ultimate pit limit	Operation
Overburden removal and loading at pit	Yes	Overburden will be removed by drilling and blasting. Blasted OB will be loaded into dumpers by shovels	Operation
Ore removal and loading at pit	Yes	Ore will be removed by drilling and blasting. Blasted OB will be loaded into dumpers by shovels	Operation
Disposal of solid waste	Yes	Solid waste will mainly come from the colony	Operation
Disposal of liquid effluents	Yes	Effluents will mainly generate from workshop	Operation
Overburden transportation from pit	Yes	Overburden transportation will be limited from the working pits to the dumps	Operation
Ore transportation from pit	Yes	Ore will be transported from pit to OHP and from OHP to railway siding	Operation
Overburden dumping	Yes	Separate overburden dumps will be created	Operation
Ore storage	Yes	Ore storage facility will be maintained beside the OHP	Operation
Operation of ore handling plant	Yes	An OHP will be in operation	Operation
Operation of other ancillary equipment	No	No other ancillary equipment will operate other than the dozers	
Tailings disposal	No	No tailings will be generated	
Reclamation	Yes	Backfilling of the waste will cover a portion of the excavated pit and vegetation will grow over it	Closure
Post-mining use of the site	No	No such planning has been done	

Scoping (Contd.)

Identified project components

- change of land use within the lease area;
- removal of a small portion of forest in the northern part of the lease;
- construction of a power line from Banspani to the mine site;
- groundwater removal for washing and drinking purposes;
- construction of office and other buildings;
- provision of water supply, medical as well as welfare facilities;
- provision of direct and indirect job opportunities;
- surface run off from the hills;
- removal and storage of top soil outside the ultimate pit limit;
- overburden (OB) removal by drilling-blasting and loading at pit;
- ore removal by drilling-blasting and loading at pit;
- disposal of solid waste generated at the colony;
- disposal of liquid effluents generated from the workshop;
- overburden transportation from pit to dumps;
- ore transportation from pit to railway siding via ore handling plant (OHP);
- dumping of OB;
- ore storage facility;
- operation of OHP;
- backfilling of the waste to cover a portion of the depression and revegetation;

Checklist for possible environmental impacts

Will the project actions result in any of the following impacts?	Yes/no/maybe and reasons for the same	If yes or maybe, the resource or area to be affected	Other past, present, or future actions that may contribute to the impact	Is the impact likely to be significant? Why?
Physical environment landform				
Landslide and land subsidence	No: available information does not support this			
Erosion of soil due to increased wind, flood, removal of vegetation	Yes: removal of vegetation and topsoil removal aided by natural precipitation may cause erosion of soil	Lease area	Topsoil removal at other mines may contribute to soil erosion	Yes: t he rate of erosion may be substantial and th impact is cumulative
Change in existing topography	Yes: existing topography of the area will change temporarily	Lease area	Working at other mines will change the local topography	Not likely: although the effect may be large, regional, and cumulative, i will be temporary
Land use				
Alteration of existing or proposed land use of an area	Yes: land use within the lease area will be affected, as land will be acquired for mining purpose	Lease area	The combined effect of all the mines will result in change of existing land use in the entire area	Not likely: the change may be regional and cumulativ but does not interfere with future land use planning ir the area
Impact on or destruction of, wetland	No: no wetland exists in the area			
Air				
Impact of air quality due to gases, particulate etc	Yes: air quality in the surrounding area may deteriorate due to particulate emissions from a number of activities	Area lying within the air quality impact zone	The villages within the cumulative air quality impact zone will experience cumulative impact	Yes: the magnitude of the impact may be large and may extend regionally or affect many receptors; however, mitigation of the impact is possible with known environmental management solutions

Will the project actions result in any of the following impacts?	Yes/no/maybe and reasons for the same	If yes or maybe, the resource or area to be affected	Other past, present, or future actions that may contribute to the impact	Is the impact likely to be significant? Why?
Surface water				
Change in quantity of surface water	No: no surface watercourse will be harnessed			
Alter flows due to construction	No: no surface water system will be diverted			
Destruction of streams	Maybe: some small natural drains within the leasehold may be disturbed	Top and slope of the hills	The other mines may contribute to such impact in the area	No: the change will be very nominal, affecting only a part of the plateau; it will not affect many other resources
Effect on water quality parameters	Yes: surface run off and effluent water will flow mainly down the hill slopes and join the Baitarani river system carrying suspended particles; moreover, the soil erosion may also increase the sediment load in the streams	Baitarani river system	The other mines may contribute to the pollutant load on the river system	Maybe: the change may be substantial, affecting the regional water quality, though some mitigation is possible with practicable management systems
Ground water				
Alter the rate and direction of ground water flow	No: water table occurs well below the quarry floor level			
Alter the quality of ground water	No: ground water is unlikely to be affected by seepage and leaching of minerals due to the presence of an impervious layer			
Alter the quantity of ground water	Maybe: the daily requirement of water will be met entirely from the ground water withdrawal	Water table in the area	Ground water withdrawal at other mines may affect groundwater availability in the area	Maybe: the change may be substantial, extend regionally, affect many people, and may be cumulative in nature
Impact on recharge area or recharge rate	No: ground water recharge area will not be affected			

Will the project actions result in any of the following impacts?	Yes/no/maybe and reasons for the same	If yes or maybe, the resource or area to be affected	Other past, present, or future actions that may contribute to the impact	Is the impact likely to be significant? Why?
Biological fauna				
Reduce habitat or the numbers of unique, rare or endangered species of bird and animals	No: the area is not inhabited by such wildlife			
Entrapment or impingement of animal life	Yes: noise and vibrations may affect the animal life in the forest	Reserve forests in the area	Similar effects from the other mines	Not likely: the combined level of noise and vibrations in the forests is likely to be low, localized, and easy to mitigate
Impact on existing fish population	No: no fish breeding area exists nearby			
Create barrier to the migration or movement of animal or fish	Yes: transportation through railways and road may create barrier to the migration route of elephants	Reserve forests in the area	None, as transportation of ore from other mines will be through the same route	Not likely: the effect is local, easy to mitigate, and non-cumulative
Cause emigration resulting in human–wildlife interaction problem	Yes: habitat reduction and barrier to their migration routes may cause elephants to emigrate into the villages	Villages in the area	None, as transportation of ore from other mines will be through the same route	Not likely; habitat reduction is small, localized, and non-cumulative

Will the project actions result in any of the following impacts?	Yes/no/maybe and reasons for the same	If yes or maybe, the resource or area to be affected	Other past, present, or future actions that may contribute to the impact	Is the impact likely to be significant? Why?
Noise and vibration				
Expose people or wildlife to noise	Yes: some of the surrounding villages and the animal life in the forests will be exposed to noise from the operations of various machines in the mine and trucks on the transport road	Noise impact zone surrounding the mine and transport road	Extraction and transport operations of other mines will affect some the receptors	Yes: the change may be substantial, affecting many receptors, extending regionally and may cause cumulative impacts in certain areas
Ground vibrations	Yes: blasting will induce ground vibrations in the area	Structures in the nearby villages	Though blasting will be carried out at other mines the effects are not synergistic	Not likely: with modern blasting technology the effect is likely to be small, localized, easy to mitigate, and non-cumulative
Biological flora				
Change to the diversity or productivity of vegetation	No: the vegetation removal is not likely to change the diversity or productivity of vegetation in the forestland			
Impact on rare or endangered plant species	No: no such species exist			
Reduce acreage or create damage to any agricultural crop	Yes: some part of the lease area is agricultural land, and the effect of particulate deposition and degradation of water quality in the Dalko nalla may result in a reduction in the crop production	Agricultural land in the villages lying within the project impact zone	Similar impacts from the other mines may also affect the agricultural land	Not likely: the effect of deposition on the crop yield is expected to be low, and it will not affect other resources, will not be difficult to mitigate at source
Impact forests	Yes: vegetation removal will cause reduction in the forestland	Forestland North of the lease	None: other mines will not be located in forestland	No: the change is very small, localized, easy to mitigate, and no potential for cumulative impacts

Probable project-related impacts of JL mine

- soil erosion in the area resulting from removal of topsoil and vegetation aided by natural precipitation;
- temporary change in topography of the area;
- change in land use in the area resulting from land acquisition;
- air pollution, mainly from particulate, in the surrounding villages as a result of a number of activities such as top soil removal and storage, OB and ore removal, loading and transportation, OB dumping, and the operation of ore handling plant;
- destruction of some natural drains resulting mainly from top soil removal;
- deterioration in the water quality of the Dalko nalla and Baitarani river system as the surface run off may carry sediments and workshop effluents may contain oil and grease;
- alteration in groundwater availability due to withdrawal;
- noise pollution from the operation of machines and trucks in the villages and forest areas surrounding the mine and transport road resulting from ore and OB removal, loading and transportation, and operation of the ore handling plant;
- blast-induced ground vibrations;
- damage to agricultural crop productivity in the surrounding villages from particulate deposition in agricultural land and degradation of surface water quality as agriculture is dependent on surface water;
- impact to Baitarani forest lying north of the lease resulting from removal of vegetation;
- impingement on animal life in the forest from increased noise and blast-induced ground vibrations;
- barrier to the migration route of elephants as the ore transportation through the transport route and railway line would run through the forests;
- emigration of elephant community in the villages since the migration route and habitat of the elephants would be disturbed;
- visual impact from vegetation removal, topsoil removal and the external dumps;
- health hazard to the villagers from air pollution and increased noise level;
- risk of accidents as a result of increased traffic movement on the road;
- increase in the income level of the local community from direct and indirect employment;
- access to better health care facilities to the local population;
- alteration in the population distribution in the area as many outside people may be employed.

Probable significant cumulative impacts

- large-scale soil erosion in the hills of the region;
- air pollution in the villages of the area;
- deterioration of the water quality of Baitarani river;
- exposure of villagers to increased noise level;
- potential health hazard to the villagers.

Impact Assessment- Air Quality

- Used ISCST3 air quality prediction model
- The model was run twice, once considering sources from JL mine alone and then considering emission from the other mines as well
- Input to the model were-

Source data- open pits, haul roads, transport roads

Receptor data- villages

Meteorological data

Air Quality Impact Zone

- Basic Gaussian Plume model was assumed

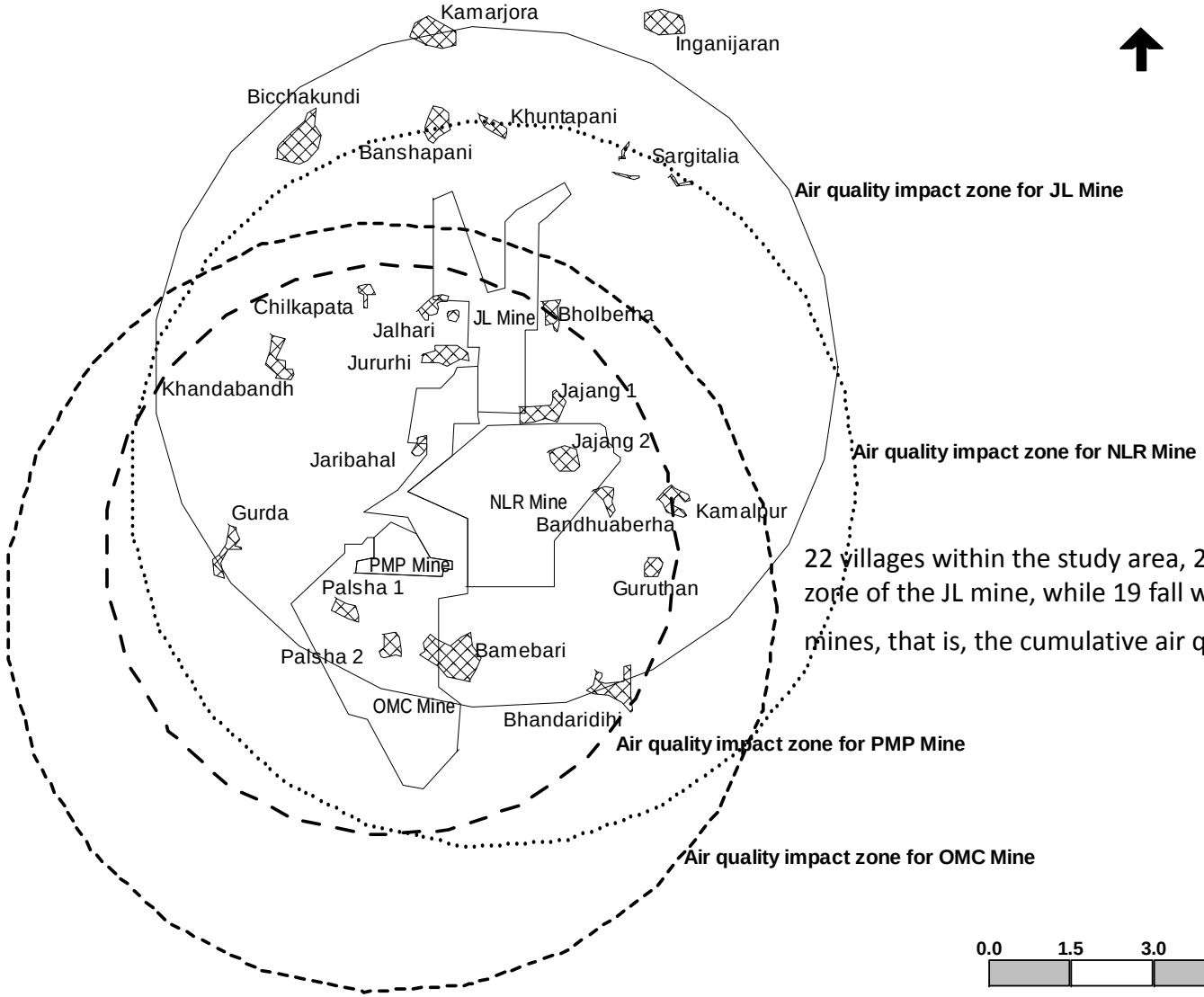
$$C_{(x,y,z)} = [QK/(2\pi u\sigma_y\sigma_z)][\exp\text{-}0.5(y/\sigma_y)^2]$$
$$[\exp\text{-}0.5((z-H)/\sigma_z)^2 + \exp\text{-}0.5((z+H)/\sigma_z)^2]$$

- Emission rate from the mine was calculated from SPM Emission Factor Equations fro different unit operations of the opencast mine

Drilling	$E = 0.0325\ [\{(100-m)su\}/\{(100-s)m\}]^{0.1}\ (df)^{0.3}$
Overburden loading	$E = [0.018\{(100-m)/m\}^{1.4}\ \{s/(100-s)\}^{0.4}\ (uhxl)^{0.1}]$
Coal/mineral loading	$E=[\{(100-m)/m\}^{0.1}\{s/(100-s)\}^{0.3}h^{0.2}\{ul/(0.2+1.05u)\}\{xl/(15.4+0.87xl)\}]$
Haul road	$E=[\{(100-m)/m\}^{0.8}\{s/(100-s)\}^{0.1}u^{0.3}\{2663+0.1(v+fc)\}10^{-6}]$
Transport road	$E=[\{(100-m)s\}/\{m(100-s)\}]^{0.1}u^{1.6}\{1.64+0.01(v+fc)\}10^{-6}]$

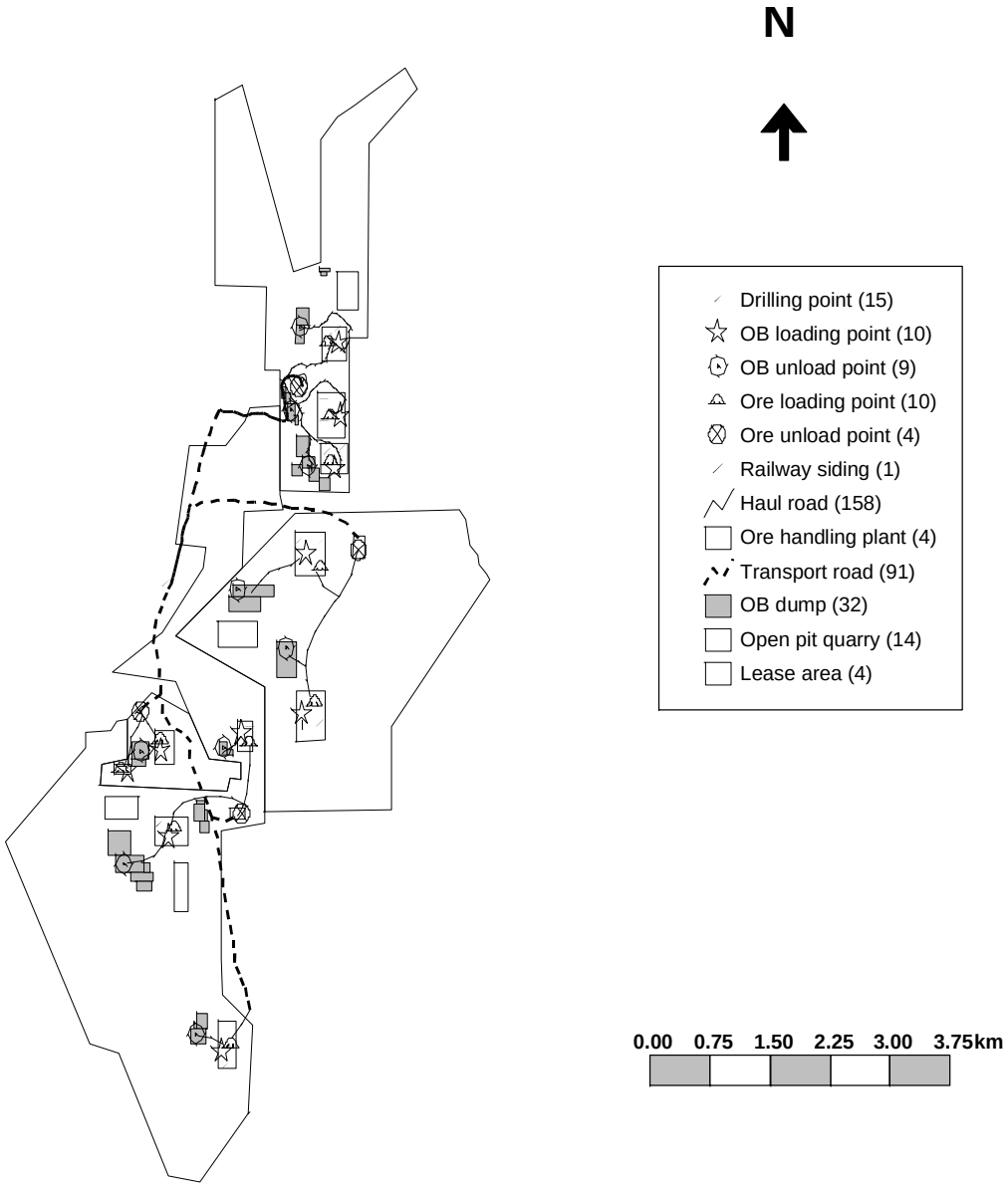
- The distance at which SPM concentration reaches 10 µg/m3 was chosen as the radius of Air Quality Impact Zone

Air Quality Impact Zone (Contd.)



22 villages within the study area, 21 lie within the air quality impact zone of the JL mine, while 19 fall within the impact zones of all the mines, that is, the cumulative air quality impact zone.

Impact Prediction- Sources of Emission



Predicted SPM Concentration

Name of village	**From JL mine alone** (micrograms/m^3)	**All mines combined** (micrograms/m^3)
Banshapani	15	109
Khuntapani	299	409
Sargitalia	5	19
Chilkapata	9	82
Jalhari	179	277
Bholberha	51	72
Jururhi	260	348
Khandabandh	71	76
Jaribahal	55	226
Jajang 1	42	634
Bandhuaberha	6	13
Kamalpur	4	5
Gurutuan	3	7
Bhandaridihi	1	5
Bamebari	0	254
Palsha 1	2	245
Gurda	5	64
Jajang 2	10	33
Palsha 2	3	58

Thank You

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Publications out of this work:

- Incorporating cumulative impact concerns into EIAs, ***Mining Environmental Management***, March 2003
- A methodology for cumulative impact assessment of opencast mining projects with special reference to air quality assessment ***Impact Assessment and Project Appraisal***, September 2004