SOCIO-ECONOMICS AND ENVIRONMENTAL IMPACT STUDIES DUE TO MINING AT BELLARY-HOSPET SECTOR

Thesis

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

SHANTH AVERAHALLY THIMMAIAH

DEPARTMENT OF MINING ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA
SURATHKAL, MANGALORE –575025
KARNATAKA, INDIA

AUGUST 2012

SOCIO-ECONOMICS AND ENVIRONMENTAL IMPACT STUDIES DUE TO MINING AT BELLARY-HOSPET SECTOR

Thesis

Submitted in partial fulfillment of the requirements for the degree of

of

DOCTOR OF PHILOSOPHY

SHANTH AVERAHALLY THIMMAIAH

DEPARTMENT OF MINING ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA

SURATHKAL, MANGALORE –575025

KARNATAKA, INDIA

AUGUST 2012

SOCIO-ECONOMICS AND ENVIRONMENTAL IMPACT STUDIES DUE TO MINING AT BELLARY-HOSPET SECTOR

Thesis Submitted

By

SHANTH AVERAHALLY THIMMAIAH
Ph.D Research Student
Reg. No. 050613MN05P01

Under the Guidance of

Dr.-Ing. Y.VENKATESWARA RAO
AND
Dr. CH. SURYANARAYANA MURTHY

DEPARTMENT OF MINING ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA
SURATHKAL, MANGALORE –575025
KARNATAKA, INDIA
AUGUST 2012

D E C L A R A T I O N

I hereby declare that the research thesis entitled "**SOCIO-ECONOMICS AND ENVIRONMENTAL IMPACT STUDIES DUE TO MINING AT BELLARY-HOSPET SECTOR"** which is being submitted to the National Institute of Technology Karnataka, Surathkal for the award of the Degree of **Doctor of Philosophy** in Mining Engineering is a bonafide report of the research work carried out by me. The material contained in this research thesis has not been submitted to any University or Institution for the award of any degree.

Signature of the Research Scholar
Register Number: **050613MN05P01**
Name of the Research Scholar: **Shanth Averahally Thimmaiah**
Department of Mining Engineering

Place: NITK, SURATHKAL

Date:

C E R T I F I C A T E

This is to certify that the Research Thesis entitled "**SOCIO-ECONOMICS AND ENVIRONMENTAL IMPACT STUDIES DUE TO MINING AT BELLARY-HOSPET SECTOR"**, submitted by **Shanth Averahally Thimmaiah (**Register Number: 050613MN05P01) as the record of the research work carried out by him, is accepted as the Research Thesis submission in partial fulfillment of the requirements for the award of degree of Doctor of Philosophy.

Research Guide(s)

Signature with date
Dr-Ing. Y.Venkateswara. Rao
Seal:

Signature with date
Dr. Ch.S.N. Murthy
Seal:

Chairman-DRPC
(Signature with Date and seal)

DEDICATED

TO

PARENTS & MOTHER EARTH

ACKNOWLEDGEMENT

This thesis is the end of my journey in obtaining my Ph.D. I have not travelled in a vacuum in this journey. This thesis has been kept on track and been seen through to completion with the support and encouragement of numerous people including my well wishers, my friends, colleagues and my family members. At the end of this journey, I would like to thank all those people who made this thesis possible and an unforgettable experience for me. At the end of my thesis, it is a pleasant task to express my thanks to all those who have contributed in many ways to the success of this study and made it an unforgettable experience for me.

Teachers, ….they challenge you to grown, help you to learn new skills and facts you ought to know, they know just what you need to find success in all you do – some teachers make a difference, teachers just like whom I had during this endeavor. At this moment of accomplishment, I would like to express my deep sense of gratitude to my Research Guide **Dr-Ing. Y.V. Rao,** Professor, Department of Mining Engineering, NITK, Surathkal, whose expertise, understanding, and patience, encouragement has added considerably to my experience. I appreciate his vast knowledge and skill in many areas (e.g., vision, aging, ethics, interaction with participants), and his assistance in writing, which have on occasion made me "GREEN" with envy.

I wish to express my deep sense of gratitude to my Internal Guide, **Dr. Ch. S. N. Murthy,** Professor, Department of Mining Engineering, NITK, Surathkal, for his able guidance and useful suggestions, which helped me in completing this thesis, in time.

It is my immense pleasure to extend the thanks to **Dr. M. Aruna**, Head, Department of Mining Engineering, NITK, Surathkal for encouraging and supporting at times in this journey, in spite of his busy schedule.

I take immense pleasure in thanking **Dr. Swapan Bhattacharya**, Director, NITK-Surathkal, for having permitted me to carry out this thesis work.

I would like to thank the members of my DRPC committee members **Dr. M.B. Saidutta,** Professor & Head, Department of Chemical Engineering & **Dr. M.N. Srihari,** Professor, Department of Civil Engineering, NITK, Surathkal for the assistance/guidance they provided at all levels of the research project.

At times, our own light goes out and is rekindles by a spark from another person, I further express my deep gratitude to **Dr. D.R. Ravi**, Deputy Environmental Officer, Karnataka State Pollution Control Board, for his precious guidance and in valuable help throughout the thesis including the help/guidance extended during the preparation of the report. He provided me with direction, technical support and became more of a mentor and friend. It was though his, persistence, understanding, kindness that I completed this journey and was encouraged to take this task. I doubt that I will ever be able to convey my appreciation fully, but I owe him my eternal gratitude.

I am extremely thankful to **Mr. C. D. Prabhakar Reddy,** Chief Executive and staff of M/s. Transit Surveys, Bellary, **Sri. H. K. Anand,** Scientific Officer, Department of Ecology, Environment & Forest, Government of Karnataka, and **Sri. Shreekant. R.L** Department of Mining, NITK, Surtkal for their continual encouragement and support.

I further remember the cooperation and the support extended by **Mr. Kantharaj K,** Director, Geology & Mining Planning and other Colleagues of M/s. METAMORPHOSIS for completing this endeavor- which is tough in its own way.

Very special thanks to **Dr. V. R. Sastry, Dr. Harsha Vardhan, Dr. K. Ramachandar** and **Sri. Chandrahas Rai,** Department of Mining Engineering, **Prof. D. Venkat Reddy,** Professor, Department of Civil Engineering, NITK, Surathkal, for their continual encouragement, support and cooperation during this process and to the office staff for all the instances in which their assistance helped me along the way.

I would also like to thank my family, especially the contribution and support by my wife **Mrs. K. S. Sreelekha** & my lovely daughter **Prakruti Shanth** for the support they provided me through out my entire life and in particular, I must acknowledge my wife and best friend, without whose love, encouragement and assistance, I would not have finished this thesis.

In conclusion, I recognize that this research would not have been possible without the assistance of the field staff of **METAMORPHOSIS** and express my gratitude to those agencies.

Last but not the least, I would like to pay high regards and encouragement by my beloved brother **Sri T. Ramachandrappa, Smt. Shashirekha,** mother-in-law and other family members including **Mrs. M.S Poornima**, for a source of inspiration throughout my research work and lifting me uphill to this phase of life, I owe everything to them.

ABSTRACT

The Earth's natural ecosystem is the fundamental part of our life-support system and is the basis for providing marketable goods to human and other living organisms. The Economic activity and the environment are inter-related, as all the economic activities are performed on the goods supplied by natural environment. The degradation of the environment relates to an interface between the goods and services that are provided directly or indirectly by the environment to the economy.

The natural environment has always been exploited to fulfill human needs. The green revolution and industrial revolution has caused serious threat to sustainable development of both developed and developing countries. The urge of attaining rapid industrialization and the immediate transfer of benefits to local communities subdued environmental concerns of sustainable development. These inturn have led to the degradation of air, water and land, directly affecting the livelihood and human health.

The environmental damage increases, as the economic activity increases, in view of the fact that the association between economy and the environment are multiple, complex and important. The identification and quantification of socio economic impact of environmental pollution caused due to increased mining activity is necessary in the broader economic analysis. The assessment of their monitory and non-monitory impacts helps in measuring benefits and costs of various production alternatives. The effect of pollution due to mining activity shall be quantified as a part of environmental assessment. They are included in the economic analysis as project cost to prevent the overall impact on the human being.

There are various legislative measures and standards were put in place, with reference to the mining operations. Therefore present study was envisaged with the objective to identify and evaluate the impacts of mining activity on Social, Economical and Environmental Aspects of the area, to formulate suitable matrix for the measurable parameters with reference to iron ore mines and to develop a management tool for the existing operating mines in the study area.

The data collected on the ambient air quality in the selected stations of study area reveals that increase in iron ore production has significantly contributed for deterioration of air quality combing with the transportation of ore without dust containment measures. The analysis has revealed that SPM concentration has reached as high as 310 $\mu g/nm^3$ whereas RSPM has 160 $\mu g/nm^{3,}$ which is five times higher than the AAQM standards.

The detailed data collected on socio-demographic status of the study villages reveals that the villages have lacuna in terms of having basic facilities like hospitals, schools, community centers, training centers etc, which contributes for up-liftment of living standards of the people. The study has also revealed that the respondents have incurred high “out of pocket” expenditure towards treatment for the diseases which are induce due to exposure for environmental pollutants either in the working mine leases or during transportation. This health cost is high in the study area of Siddapura and Jaisinghpur due to more number of leases vis-à-vis increase in workers working in these mines. The health data collected from the respondents have revealed, significantly more number of respondents are suffering from dust allergy, skin allergy in the study area, where there are mines and are working as workers in those mines, contributing for higher health cost incurred through treatment.

The analysis of environmental management model suggests that the mining companies to implement effectively the principles of systematic & scientific method of mining adopting technical and biological reclamation techniques such as engineering measures viz-a.viz construction of scientifically designed soil erosion control measures.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

APL: Above Poverty Line

AAQS: Ambient Air Quality Standard

ADB: Asian Development Bank

BOD: Bio-chemical Oxygen Demand

BPL : Below Poverty Line

CO : Carbon Monxide

COI: Cost of Illness

CPCB: Central Pollution Control Board

CSE: Centre for Science & Environnent

CSR: Corporate Social Responsibility

COD: Chemical Oxygen Demand

DO: Dissolved Oxygen

DGMS: Directorate General of Mines Safety, 1955

EF: Exceedence Factor

EMS: Environmental Management System

EP: Environmental Policy

GDP: Gross Domestic Product

HEMM: Heavy Earth Moving Machineries

IMD: Indian Meteorological Department

IS: Bureau of Indian Standard

IBM: Indian Bureau of Mines

MMA: Mines and Minerals (Regulation & Development) Act 1957

MoEF: Ministry of Environment & Forest

MCR: Minerals Concession Rules 1960

MCDR: Mineral Conservation and Development Rules, 1988

MSL: Mean Sea Level

MTPR: Million Ton Per Annum

NEERI: National Environmental Engineering Research Institute

NBSS: National Bureau of Soil Survey and Land Use

NO_x: Oxides of Nitrogen

OB: Over Burden

OMS: Output per Man per Shift

OPP: Ore Processing Plant

PM: Particulate Matter

PPV: Peak Particle Velocity

RF: Reserve Forest

R&D: Research & Development

R&R: Rehabilitation and Resettlement

PAPs: Project Affected People

PPV: Peak Particle Velocity

QII: Qualitative Impact Index

RDS: Respirable Dust Samplers

ROM: Run Off Mines

RPM: Respirable Particulate Matter

SI: Severity Index

SPM: Suspended Particulate Matter

SPCB: State Pollution Control Boards

SO_2: Sulphur di Oxide

TPD: Tones Per Day

TERI: Tata Energy Research Institute

TDS: Total Dissolved Solids

URTI: Upper Respiratory Tract Infection

WHO: World Health Organization, 2005

WTP: Willingness To Pay

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

The Earth's natural ecosystem is the fundamental part of our life-support system and is the basis for providing marketable goods to human and other living organisms. Natural Ecosystems are productive engines of this planet and they sustain us by providing essential functions like air and water purification, climate control, nutrient cycling, and soil production /conservation and etc. In every respect, the human development and human survival, is closely associated with systematic productivity of natural ecosystems.

The Economic activity and the environment are inter-related, as all the economic activities are performed on the goods supplied by natural environment. The degradation of the environment relates to an interface between the goods and services that are provided directly or indirectly by the environment to the economy. Hence, it is necessary to regulate the economic activity, so that the balance is achieved among the environment, economy and the other social goods (Karpagam, 1991).

The natural environment has always been exploited to fulfill human needs, but during this century, the scale of demand has grown so large, that earth's ecosystem has degraded and gets damaged. During the past hundred years, the natural environment has prone the stresses imposed by a population explosion and growth in world economic output. With world's population projected to increase by 9 billion during 2050, from the current 6 billion, the potential for doing irreparable environmental damage is obvious.

Green Revolution and industrial revolution has caused serious threat to sustainable development of both developed and developing countries. Modern industries have extracted natural resources as raw materials for their production process. These processes have also extracted energy from the environment. Such production process have resulted in discharge of large quantity of wastes into the environment in the form of air toxicants, waste water, hazardous waste etc. the extraction of raw materials from the ecosystem and the emissions of pollutants causes severe threats to the natural environment and reduces the quality of human life. The urge of attaining rapid industrialization and the immediate transfer of benefits to local communities subdued environmental concerns of sustainable development. These inturn have led to the degradation of air, water and land, directly affecting the livelihood and human health. Impacts are categorized in terms of human health, human welfare (i.e gains or losses apart from those associated with health), including environmental viz ecological consequences like extinct of animal species, loss of biodiversity and climate change, acid rain etc (Asian Development Bank, 1996, Freeman M III, (1979),PP18-23).

The Economists analyze the problem of environmental degradation as a form of external effects/externality. Coase's (1960) defines the externality as 'The problem of social cost' which has an eternal life. They are un-reimbursed costs and un-charged benefits accruing to people as a result of some one else's action. So they are side effects of any production or technological process. The Social cost is the total of all the cost associated with an defined economic activity. It includes both costs borne by the economic agent and also the costs to be borne by the society at large. Environmental Pollution is an example of a social cost that is seldom borne completely by the polluter, thereby creating a negative externality.

The environmental damage increases as the economic activity increases, in view of the fact that the association between economy and the environment are multiple, complex and important. Earlier, the economic activity and economic development were considered in isolation with the natural environment. However, it is affected by the human induced changes due to the indiscriminate discharge of different pollutants in to the environment (Bhattacharya, 2001).

The identification and quantification of socio economic impact of environmental pollution caused due to increased mining activity is necessary in the broader economic analysis. The assessment of their monitory and non-monitory impacts helps in measuring benefits and costs of various production alternatives. The effect of pollution due to mining activity shall be quantified as a part of environmental assessment. They are included in the economic analysis as project cost to prevent the overall impact on the human being.

1.1 MINING AS AN INDUSTRY

The Minerals are valuable natural resources and are finite and non-renewable. They constitute the vital raw materials for many industries and are a major resource for development. Management of mineral resources has, therefore, to be closely integrated with the overall strategy of development. Controlled exploitation of minerals is to be guided by long-term national goals and perspectives.

India is the leading producer of some of the minerals with diverse and significant mineral resources. Of the 89 minerals produced in the country, 4 are fuel minerals, 11 metallic, 52 non-metallic and 22 minor minerals. India is the largest producer of mica blocks and mica splitting and ranks third in the production of coal and lignite, barytes and chromite, fourth in the iron ore, sixth in bauxite and manganese ore, tenth in aluminium and eleventh in crude steel. Iron-ore, copper-ore, chromite ore, zinc concentrates, gold, manganese ore, bauxite, lead concentrates, and silver account for the entire metallic production. Limestone, magnesite, dolomite, barytes, kaolin, gypsum, apatite, steatite and fluorite account for 92 percent of non-metallic minerals.

The mineral wealth of India, comprises an adequate range of useful products that are necessary for the industrial development of the country and they constitute one-quarter of the world's known mineral resources. The reserves of coal and iron ore are ample, the country is deficient in respect of vital minerals like ores of copper, tin, lead, zinc, nickel, cobalt, sulphur and petroleum. The minerals like aluminum, refractoriness, abrasives, limestone etc is fairly adequate and the country has considerable reserves of minerals like titanium and thorium and mica.

India possesses large quantities of high grade iron ore for the development of heavy industry. About two-thirds of its iron ore deposits lie in a belt along Orissa and Jharkhand border. Other hematite deposits are found in Madhya Pradesh, Karnataka, Maharashtra and Goa. Magnetite iron-ore is found in Tamil Nadu, Jharkhand and Himachal Pradesh.

Until recently, mineral exploration and their utilization in the country received little attention. Except for coal, iron ore and petroleum, the majority of minerals were extracted for the purpose of bulk export without any dressing, processing and fabrication. These exports brought small return to the country. Nearly a hundred minerals are produced or mined in India, of which nearly 30 may be considered as important and are capable of material development in future with the expansion of industries.

The minerals constitute the back-bone of economic growth of any nation. The extraction of minerals like coal, iron-ore, copper, lead-zinc has been going on in India from time immemorial. The GDP contribution of the mining industry varies from 2.2 percent to 2.5 percent only, but going by the GDP of the total industrial sector, it contributes around 10 to 11 percent. The Indian Mining Industry provides job opportunities to around 700,000 individuals. However, the first recorded history of mining in India dates back to 1774 when English Company was granted permission by the East India Company for mining coal in Raniganj. Thereafter, with progressive industrialization, the demand for minerals has increased constantly and hence the production of various minerals gradually went up. After India became independent, the growth of mining under the impact of successive Five Year Plans has been very fast. There are ambitious plans in coal, metalliferous and oil sectors to increase production of minerals during the 8th Five Year Plan and thereafter.

In India, over the years, a national mineral policy has evolved. The policy addressed certain new aspects and elements like mineral exploration in the sea-bed, development of proper inventory, proper linkage between exploitation of minerals and development of mineral industry, protection of forests environment and ecology from the adverse effects of mining, enforcement of mining plan for adoption of proper mining methods and optimum utilization of minerals, export of minerals in value-added form and recycling of metallic scrap and mineral waste.

The Mines and Minerals (Regulation and Development) Act, 1957 lays down the legal framework for the regulation of mines and development of all minerals other than petroleum and natural gas. The Central Government has framed the Mineral Concession Rules, 1960 for regulating grant of licences and mining leases in respect of all minerals other than atomic minerals and minor minerals. The State Governments have framed the rules with regard to minor minerals. The Central Government has also framed the Mineral Conservation and Development Rules, 1988 for conservation and systematic development of minerals. These are applicable to all minerals except coal, atomic minerals and minor minerals.

1.2 DESCRIPTION OF PRINCIPAL ORES OF IRON

The Hematite and magnetite are the most prominent of the iron ores found in India. Of these, haematite is considered to be the most important Iron ore because of its high grade quality and is used in a number of steel and sponge iron industries. Indian deposits of haematite belong to pre-Cambrian iron ore series and the ore is within banded iron ore formations occurring as massive, laminated, friable and also in powdery form. The major deposits of iron ore are located in Jharkhand, Orissa, Chattisgarh, Karnataka and Goa States.

1.2.1 Haematite

Haematite is the most abundant iron ore and is the main constituent of iron & steel industry. It occurs in a variety of geological conditions throughout the world. It is the red oxide crystallizing in hexagonal system. The fine-grained haematite is deep red, bluish red, or brownish red and may be soft and earthy ocherous, compact or highly porous to friable, or granular, or may form dense hard lumps. Considerable siliceous or argillaceous impurities are common. Fine-grained red haematite may occur in smooth reinform masses in botryoidal or stalacitic shapes, or may be columnar, fibrous, radiating or platy etc. The coarse crystalline haematite is steel grey with bright metallic to dull grey lustre and occasionally, coarse crystals have a deep bluish to purplish iridescent surface. The coarse-grained haematite is known as specularite or specular haematite and may form blocky or platy crystals with a strong icaceous parting. The cherry red streak is difficult to observe on this variety. The composition of haematite is Fe_2O_3. Ideally, haematite contains 69.94 percent iron and 30.06 percent oxygen.

The specific gravity varies from 4.9 to 5.3 (when it is pure, i.e. 69.9 percent Fe_2O_3) but the ores in the field generally have less specific gravity. The hardness varies from 5.5 to 6.5 for hard ore and is much less for softer varieties. Haematite is feebly magnetic, but a variety termed magnetite is found in many ore bodies in small quantities having magnetic properties closely akin to those of magnetite. The iron content of the ore and physical characteristics vary from place to place in different types of ores. The characteristic of the iron ore with its iron content and in bulk densities / tonnage factors mined in some important regions of India is given in the **Table 1.1** below.

Table No. 1.1 Characteristic of Important Haematite Deposits in India

Sr. No.	Type of ore	Iron Content	Bulk density/tonnage factor (ton/m3)
1.	**Singbhum-Keonjhar-Bonai Deposits**		
	Massive Ore	65 - 69.9 %	4.5 - 5
	Laminated Ore	55 – 65 %	3.5 – 4.8
	Blue Dust	65 %	3.3 – 3.4
	Laterite Ore	52 %	2.3
2	**Goan Deposits**		
	Massive bedded Ore	59 – 62 %	3 – 3.4
	Platy Ore	58 – 62 %	3 – 3.2
	Brecciated Ore	56 – 62 %	2.8 – 3.2

Sr. No.	Type of ore	Iron Content	Bulk density/tonnage factor (ton/m3)
	Mixed Ore	45 – 59 %	2.5 – 3.0
	Biscuity Ore	59 – 65 %	2.9 – 3.1
	Concretionary Ore	57 – 62 %	3.1 – 3.4
	Laterite	40 – 50 %	2.3 – 3.3
	Blue Dust or Powdery Ore	58 – 66 %	2.8 – 3.0
	Bellary – Hospet Depositsa		
	Lumpy Ore (Massive & Laminated)	67 – 69 %	3 – 3.5
	Blue Dust Average	65 %	3.8
	Bailadila Deposits		
	Massive Ore and Massive & Laminated	67 – 68.26 %	4.69 – 5.11
	Laminated Ore	63.47 %	3.4 – 4.19
	Laterite Ore	47.46 %	3.46 – 3.65

1.2.2 Magnetite

It is the most common species in the magnetite series and is the second most important iron mineral of economic importance. It is black magnetic oxide of iron crystallizing in the isometric system and has hardness of 5.5 to 6.5. Its specific gravity is 5.17 and magnetic attractability 40.18 compared to 100 for pure iron. It occurs as fine or coarse grained masses or in octahedral or less commonly decahedral crystals. It occurs as veins and stringers in igneous rocks and as lenses in crystalline schist. Large deposits are considered to be the results of magnetic segregation and its low grade deposits occur as disseminations in metamorphic and igneous rocks. It also occurs as a replacement product in sedimentary or metamorphic rocks. It is found as placer deposits as “black sand” in beach deposits and as banded layers in metamorphic and igneous rocks.

1.2.3 Goethite and Limonite

These minerals are hydrated oxide of iron, forming a part of the complex group in which proportion of the various radicals can undergo considerable variations. Their colour is brown to ocherous yellow, but may be black or dark brown to reddish brown and they are often called “brown iron ores”. Their specific gravity varies from 3.3 to 4.3 and hardness is 5.5. They may contain 10 to 14.5 percent combined water and are converted into haematite or magnetite on calcinations. These are secondary minerals, being the product of alteration, they occur as thick cappings formed by weathering and hydration of the underlying ore body. When silica is leached out, iron content improves by 10 to 15 percent. These minerals form flakes and needles generally of small dimensions occurring as inter growths with the original constituents.

1.2.4 Siderites

Siderite, also called "spathic ore", is a carbonate of iron. Its colour is ash grey to brown with yellow and red stains resulting from oxidation and hydration. Its specific gravity is 3.8 and hardness varies from 3.5 to 4. It crystallizes under rhombohedral division of the hexagonal system. It occurs as sedimentary or replacement deposits.

1.3 MINING TECHNIQUES

The Mining techniques can be divided into surface mining (or manual mining) and sub-surface (underground) mining (or mechanized mining). Surface mining is more common, and produces 98 percent of metallic ores. Processing of placer ore material consists of gravity-dependent methods of separation, such as sluice boxes. Only minor shaking or washing may be necessary to disaggregate (unclump) the sands or gravels before processing. Processing of ore from a lode mine, whether it is a surface or subsurface mine, requires that the rock ore be crushed and pulverized before extraction of the valuable minerals begins. After lode ore is crushed, recovery of the valuable minerals is done by one, or a combination of several, mechanical and chemical techniques.

1.3.1 Surface or Manual Mines: consists of digging tunnels or shafts into the earth to reach buried ore deposits. Ore, for processing, and waste rock, for disposal, are brought to the surface through the tunnels and shafts. Sub-surface mining can be classified by the type of access shafts used, the extraction method or the technique used to reach the mineral deposit. Drift mining utilizes horizontal access tunnels, slope mining uses diagonally sloping access shafts and shaft mining consists of vertical access shafts. Mining in hard and soft rock formations require different techniques.

Other methods include shrinkage stope mining, which is mining upward creating a sloping underground room, long wall mining which is grinding a long ore surface underground room and pillar for removing ore from rooms, while leaving pillars in place to support the roof of the room. Room and pillar mining often leads to retreat mining i.e removing the pillars which support rooms, allowing the room to cave in, loosening more ore. Additional sub-surface mining methods include hard rock mining which is mining of hard materials, bore hole mining, drift and fill mining, long hole slope mining, sub level caving and block caving.

1.3.2 Sub-surface or Mechanized Mines: is done by removing (stripping) surface vegetation, dirt, and layers of bedrock in order to reach buried ore deposits. Techniques of surface mining include; Open-pit mining, which consists of recovery of materials from an open pit in the ground, quarrying or gathering building materials from an open pit mine, strip mining which consists of stripping surface layers off to reveal ore/seams underneath, and mountaintop removal, commonly associated with coal mining, which involves taking the top of a mountain off to reach ore deposits at depth. Most (but not all) placer deposits, because of their shallowly buried nature, are mined by surface methods. Landfill mining, finally, involves sites where landfills are excavated and processed.

This method of mining is generally confined to float ores. Mining of reef ore is also being done manually on a small scale. The float ore area is dug - up manually with picks, crowbars and spades, and the material are manually screened to separate + 10 mm float ore, which is then stacked up. The waste is dumped back into the pits. Generally, the recovery of float ore ranges from 30 to 50 percent or at times even more. As regards to reef ore workings, holes of 0.6 m deep and 35 - 40 mm diameter are drilled with hand-held Jackhammers with a spacing of about 0.6m and each hole is charged with 150 - 200 g gunpowder or special gelatine cartridges. Usually Jackhammer drills are operated with the help of portable air compressors. The quantity of ore removed per kg of gunpowder is 2.5 - 3 tones. The blasted ore is manually loaded into trucks for transportation. Cost of mining and OMS (output per man per shift) varies from mine to mine. Presently, OMS in manual iron ore mines for producing 10 - 30 mm lump is about 1.5 - 2.0 tones. This method of mining is prevalent in the two important zones of the Indian iron ore sector namely, Barajamda (Bihar & Orissa) and Bellary – Hospet (Karnataka). Establishment of centralized crushing & screening plants will not only increases the production from manual mines, but also helps in optimal utilization of resources.
In this method, the mining of ore / overburden is carried out by shovel-dumper combination. The mining is invariably done by systematic formation of benches by drilling and blasting. The loading operations are also fully mechanized and transportation is facilitated by maintaining mine haul roads. Further, ore handling, washing and screening operations are mechanized. The degree of mechanization and the size of the machinery vary with the material required to be handled by the mines.

Generally in iron ore mines, the benching will be started from top of the hill and as the ore at the top gets exhausted, it is carried downwards,. Except in uniform deposits, if the direction of the bench is along the strike of the beds, it encounters different beds of ores as the working face advances, resulting in considerable fluctuations in the grade, unless many benches are worked simultaneously at different depths. This, in turn, requires a large number of smaller machines which create their own problems of supervision, maintenance, etc. It is therefore, commonly preferred to open - up benches, so that more uniform grade of the ore is produced.

The height of the benches depends on several factors, such as output requirement, shape, size and depth of occurrence of ore, geological disturbances, hardness and compactness of ore, type and size of the machinery proposed to be deployed, availability of finances, etc. The bench height generally adopted in fully mechanized mines varies between 8 and 14 m. The length of the face is also dependent on various factors, such as contours of deposit, output required, variation in grade and blending requirements, capacity of loading machinery, etc. and varies between wide limits from as small as 60 m to as large as 400 m. The width of the bench is governed by the size of the largest machinery deployed and varies, i.e. three times of the width of the dumper.

As an universal practice, iron ore is dislodged by drilling blast holes according to a particular pattern which depends on the bench height, the hole diameter, the drilling machinery deployed, nature of rock and the types of explosives used. These blast holes are vertical, but can be inclined for obtaining better blasting results. The rotary drill is used normally in the size from 150 to 250 mm. Thus, the depth and diameter of the holes allow expanded drilling patterns in general and help in reducing generation of fines in softer ores. On the other hand, in hard ores or in strata where the hard bands are present, they can give poor fragmentation and toe formation. The poor fragmentation leads to lower rate of loading and increased wear and tear on the loading machinery. Investigations by comparing the performance with 100 mm and 50 mm diameter blast holes, have shown that the digging rate of the shovels was 50 percent higher with small diameter blast holes. Drilling with 150 mm diameter blast holes has been the common practice in Indian iron ore mines. But higher rate of production makes the incumbent to adopt greater bench heights and larger diameter holes. The greater bench heights permit the use of large shovels, which in turn can handle larger boulders and permit larger spacing and burdens. All the drills are equipped with dry dust extraction system or wet drilling arrangements, sound proof cabin, dust hood at the collar of the hole to prevent air pollution due to drilling in the major iron ore mechanized mines in India. However, in Bellary – Hospet of Karnataka, the wet drilling practice is absent as the rainfall is less than 750 mm per annum and there is a scarcity of water.

As mechanized open cast iron ore mines becoming larger, deeper and more capital intensive, continuing efforts are being made to improve upon the open cast mining activities through advances in the equipment size/ design and practices and also through introduction of innovative techniques. Significant results have been achieved through increasing size of stripping and hauling units, which apparently has reached a plateau, efforts on further improvements are being spear headed through new concepts in equipment utilization by restoring to automation and control. The application of high capacity continuous surface mining techniques to harder formations, new concept of high angle belt conveying system, in-pit crushing systems (mobile and semi-mobiles), high capacity dumpers, automatic truck dispatch system, non-electric blast initiation systems etc. and developments in the area of bulk explosive systems hold out almost unlimited opportunities for upgrading the performance of opencast iron ore mining in India.

The reserves of high grade iron ore are limited. Therefore, it would be necessary at this stage to ensure conservation of high grade ore by blending with low grade ores. As a matter of policy, only low and medium grade iron ore, fines and temporary surplus high grade iron ore (+67 % Fe) need to be exported. The R&D efforts are needed for developing necessary technologies for utilizing more and more fines in the production of steel as a measure of conservation of iron ores. With the present high capacity of iron ore mines, total utilization of iron ore has become the need of the hour so as to obtain maximum returns. In most of the mechanized mines more than 50 to 60 % fines are generated. Blue dusts in these mines are to be fully utilized to make different value added products. Blue dust can also be used as additive in concentration of iron ore fines to the extent of 20-40 % for use in steel plants. Further, in the iron ore mines where wet processing of the ore is done, around 10-20 % of ROM is lost as slime, depending on the nature of ore feeds and in this context, coarse fines can be recovered up to 5 % by introducing hydro-cycloning and slow speed classifiers in wet circuit system, even though, the Fe content of such fines will be slightly low which can be blended.

1.4 SOCIO- ECONOMIC IMPACTS OF MINING

The mining operation is a short-term activity with long-term effects. As most of the mine lease area is situated in the forest land, carrying out mining activity in this area causes forest degradation. It is estimated that, mining is threatening the existence of about 38% of the world's primary forests. The impact of mining and associated activities on the society assumes a great importance, as all the activities of the human beings are for the benefit of the society. As soon as the mineral deposit is discovered and proved, and its mining potential is established, the impacts on the society starts with the increase in the land value, increase in the migration of people for working in the mines, establishment of mineral specific industries and establishment of associated business etc. The mining and associated activity causes the following impacts on the society.

1.4.1 Displacement of People: For mines, it is required to clear the surface of existing structures along with the vegetation, not only in the area designated for mining purposes, but also in a large area nearby which is required for making external dumps and placing associated activities. Therefore, all the people living in this area gets displaced.

1.4.2 Loss of Livelihood: The people living in the designated areas depend generally on the land for their livelihood. Since, the land is taken for mining in mining areas and associated activities, the people lose their livelihood.

1.4.3 Changes in Population Dynamics: Invariably the managerial, skilled and semi-skilled manpower required for mining and associated activities come from outside, as such trained manpower in usually not available in ethnic population. In addition, people migrate for business/trade come to the mining areas. Thus, the population dynamics of the area undergoes a major change over the years resulting in dilution of the ethnic population and their culture and religion, reduction in sex ratio etc.

1.4.4 Cost of Living: Societies dependent on agriculture and forests usually have a lower level of economic growth. The development of industrial and other associated activities in such areas increases the level of the economic activities manifolds. Increased industrial and economic activities generate more money and increases the buying power of the people who are directly and indirectly associated with these activities. This leads to an increase in the cost of living, which adversely affects the other people, including ethnic people, who are not associated with these activities.

1.4.5 Water Scarcity: Mining by open cast methods damages the water regime and thus causes a reduction in the overall availability of water in and around the mining areas. In the sedimentary deposit mining areas the water table and aquifers are damaged and thus the availability of water from these sources reduces.

1.4.6 Health Impacts: Health and well being of the people living in and around the mining area gets affected due to discharge of different pollutants in to the air and water, noise and also due to vibrations. In fact, the society in the mining complexes has to bear the various costs of abating environmental pollution imposing social cost. The people working in the mines and associated industries get affected by various health problems, e.g. skin diseases, lung diseases, deafening etc.

1.4.7 Infrastructural Facilities: The mining and associated activities in the mining areas bring about infrastructural development, i.e. roads are constructed, schools and hospitals are established, and communication facilities are developed etc., which tend to improve the quality of life of the people around.

1.4.8 Employment Opportunities: The mining and associated activities offer opportunities of employment to the ethic population. The Project Affected People (PAPs) are given jobs and are trained for self employment as a result of the provisions in the Rehabilitation and Resettlement (R&R) Schemes. People also get employment in the other developmental activities and also the mineral based activities in and around the mining area.

1.4.9 Increase in Aspiration: The ethnic people of the mining area, with the advent of mining and associated activities are exposed to various developments and this tends to increase their aspirations. In fact, this is necessary for the overall community development in the mining area.

1.5 ENVIRONMENTAL IMPACTS OF IRON ORE MINING

It is recognized that minerals and metals are the mainstay of the economic development and welfare of the society. However, their exploration, excavation and mineral processing directly infringe upon and affect the other natural resources like land, water, air, flora and fauna, which are to be conserved and optimally utilized in a sustainable manner. The mineral sector in India is on the threshold of expansion with more and more open cast iron ore mines being opened-up in different states. Under such scenario, systematic and scientific excavation of iron ore, compatible with environment is essential for survival of our future generation.

Mining is site specific activity, excavation is bound to be done at a place where mineral actually exist. Hence, the mining changes the land use pattern of the area and becomes redundant once mineral is exhausted completely. In the process, mining affects all the components of environment and the impact are permanent /temporary, beneficial/harmful, repairable/irreparable, and reversible /irreversible. Mines especially open cast iron ore mines, due to its own peculiarities, can cause disturbance in ecology, resulting in various pollution problems. The environmental problems are more significant in India, as most of the iron ore mines located on top of hills and in dense forest areas.

The environmental problems associated with the iron ore mining are diverse. The removal of vegetation, top soil, overburden/waste and ore, brings about the inevitable natural consequences, which manifest in many ways, deforestation, climatic change, erosion, air and water pollution and health hazards. Iron ore mining and processing of ore, affects the environment in myriad ways causing:

- Land disturbance and change in land use pattern
- Affecting floral and faunal habitat
- Disturbing the natural watershed and drainage pattern of the area
- Disturbing the aquifer causing lowering of the water table
- Air pollution due to dust and noxious fumes
- Water pollution due to surface run off from different areas of mines, spoil dumps, seepages/overflow from tailings dam leads to siltation of surface water bodies and blanketing the agricultural fields.
- Noise and ground vibrations due to blasting.

The magnitude and significance of these impacts on environment and ecology due to mining depends on the size and scale of mining activity in conjunction with the topography & climatic conditions of the area, the nature of mineral deposits, method of mining & capacity of mines, agricultural activities in the region, forest reserves etc.

1.5.1 Impact on Land

The land is required not only for the mine excavation, but also for laying approach / haul roads, for establishment of beneficiation plant, ore handling & dispatch units, waste dumps, tailing ponds etc. Land is also required for ancillary facilities and statutory buildings (workshops, stores, offices, canteen, and crèche). In addition to these, residential colony and related welfare amenities like school, hospital, shopping centre, recreation centre etc. also require land.

The major impact on the land use during the pre-mining phase is removal of vegetation and resettlement of displaced population. During mining and post-mining phases, drastic changes in landscape with landform take place. The major associated impacts are soil-erosion, loss of top soil, creation of waste dumps and voids, disposal of wastes, deforestation etc. The impacts of iron ore mining on land are as outlined hereunder;

- Topography and land scenario changes due to excavation of open pits and dumping of overburden rock mass in the form of land heaps.
- The land-use pattern undergoes a change due to the use of the land for mining, dumping, and other mining and associated activities.
- The land-use in the surrounding areas may get affected due to the impacts of mining on water regime.
- Leachates from overburden dumps and other rock masses and polluted water from the pits affect the characteristics of the top-soil affecting the land-use.
- In the mines having mineral concentration/processing plants, it is required to make tailing's pond to store the tailings generated from the processing plants. These tailing ponds require massive area and may cause pollution of ground and surface water bodies, if proper care is not taken.
- The drainage pattern of the area undergoes a change due to the alterations in the surface topography due to mining and associated activities.

It is evident from the above that the mining and associated activities can significantly change the land use and drainage pattern of the region. These changes can be minimized by careful planning the surface layout of the mining areas and by integrating the environmental aspects of each and every unit operation of mining activity. Another important aspect of the land management is the planning and design of the land reclamation Programme right from the inception, including the development of the post mining land use planning for optimum utilization of land in an efficient manner and for overall improvement in environmental scenario.

1.5.2 Impact on Ecology

The mining activities like excavation, transportation and processing of ore, disposal of overburden & tailings etc, are posing severe threat for managing the ecology. Over the years the large scale mining operations in the forest areas, have caused substantial impact on the ecosystem like degradation of land, deforestation, displacement of wildlife, effect on aquatic eco-system etc.

The major adverse impacts due to pre-mining and mining phases are loss of habitat, biodiversity, rare flora & fauna, other aquatic life, migration of wildlife and overall disruption of the ecology of the area. Major impacts of iron ore mining on ecology are as follows;

- Removal of vegetation (flora) from the area required for mining and other purposes, and thereby displacement of fauna.
- Pollution of water in the surrounding water bodies due to leaching from overburden dumps, seepage/overflow water from tailings pond and from the other activities. These affect the aquatic ecology of surrounding water bodies.
- Dust in the atmosphere, contributed by mining and associated activities, when deposits on the leaves of the plant in the surrounding area hampers the process of photosynthesis and retards their growth.
- Noise and vibrations due to blasting, movement of HEMM/vehicles and operation of fixed plants and machineries drive away the wild animals and birds from the nearby forests.
- Water scarcity caused due to the impacts of opencast mining on water regime affects the growth of vegetation and agricultural crops in and around the mines.

- Discharge of mine effluents to the nearby surface water bodies, without proper treatment may affect vegetation in the surrounding area.

It is evident that mining and associated activities have considerable impacts on the ecology of the mining and surrounding areas. The ecological impacts are more severe in India as most of the iron ore mines are located in the dense forest areas and on hill tops. By proper reclamation of mined out areas and rehabilitation of waste dumps through massive afforestation with local saplings, the ecological impacts can be minimized.

1.5.3 Impact on Water Regime

Mining and associated activities have quantitative and qualitative impacts on the water regime in and around the mines. These are outlined hereunder;

- All the surface water bodies have to be removed from the area of mining and associated activities.
- All the aquifers, including the water–table aquifer, above the mineral deposit to be extracted, gets damaged and reduces the water holding capacity.
- If there are high pressure aquifers below the mineral deposit, it becomes necessary to pump the water from the aquifers to reduce the water pressure to facilitate mining.
- Water in the nearby water bodies gets polluted due to leaching from the overburden dumps, discharge of pumped mine water, and other activities in the vicinity of the water bodies.
- During rainy season the run off water from the areas surrounding the mines carries with large quantity of the suspended solids into the nearby water bodies.

It is evident from the above that the mining and associated activities changes in ground water flow patterns, lowering of water table, changes in hydrodynamic conditions of river/underground recharge basins, reduction in volumes of subsurface discharge to water bodies/rivers, disruption and diversion of water courses/drainages pattern, contamination of water bodies, affecting the Yield of water from bore wells and dug wells etc. Therefore, it is necessary to plan the mining activities in such a manner that their impacts on the water regime are as minimum as possible.

1.5.4 Impact on Ambient Air Quality

The air quality in the mining areas mainly depends on the nature & concentration of emissions and meteorological conditions. The major air pollutants from mining include:

- Particulate Matter (Dust) of various sizes.
- Gases, such as, Sulphur Dioxide, Oxides of Nitrogen, Carbon Monoxide etc. from vehicular exhaust.

Dusts are the single largest air pollutant observed in the iron ore mines. Diesel power stations, diesel operating drilling machines, blasting and movement of HEMM/vehicles produce NO_x, SO_2 and CO emissions, usually at low levels. Dust can be a significant nuisance to surrounding land users and causes potential health risk. Dust is being produced from a number of sources and through number of mechanisms such as land clearing, removal of top soil (during opening up of new areas), removal of OB/ore, drilling, blasting, crushing & screening, processing of ore, loading & unloading of material on site & subsequent transport off the site etc. In addition to this, wind action affecting stockpiles, dry tailings, exposed mining areas and waste dumps also generate significant amount of dust. Dust emissions from these operations manly depend on moisture content of the ore and type of control measures adopted.

The major gaseous pollutants of concern in iron ore mines are sulphur dioxide and oxides of nitrogen. Sulphur dioxide can cause respiratory problems. Oxides of nitrogen can react in the atmosphere with hydrocarbons to produce photo-chemical smog. In addition to this, the sulphur dioxide and oxides of nitrogen can generate an acid rain harmful to vegetation and materials.

1.5.5 Impact on Ambient Noise

Mining operations usually generate noise during different stages of mining and handling of ores. In open cast mines, noise is due to drilling, blasting, excavation, sizing and transportation of ores. In case of ore processing, noise is due to operations like crushing, screening, washing, storage and dispatch of ores. These noise generating sources can be grouped into two categories viz fixed plant and mobile plant sources. Fixed plant machineries such as crushers, grinders, screens, conveyers, etc., generate noise & vibration. Similarly, the mobile plant used on-site associated with drilling, blasting, loading, haulage or service operations cause noise.

1.5.6 Water Pollution

Water pollution from the mining operations mainly depend on topography of the area, intensity of rainfall, type of ore, method of mining & ore processing facilities provided insitu etc. The major impacts are water pollution from erosion of waste dumps/mining areas, oil & grease, contamination of water bodies due to discharge of mine water/effluents, discharge of domestic sewage, and sedimentation of rivers and other stored water bodies, solid waste disposal sites, etc. The following are the major sources of water pollution from the Iron Ore Mines.

- Effluent generated from the Ore Processing Plant (OPP).
- Pit water discharge from mines operating below water table.
- Surface run-off from various mining areas during monsoon e.g., waste/reject dumps, tailings pond seepage/overflow etc.
- Oil and grease pollution from workshops effluent

1.5.7 Solid Wastes Generation from Mines

The solid wastes generated from the mining operations are topsoil, over burden & inter burden, tailings from ore processing and wastes generated from the maintenance and repair of the HEMM and light vehicles. The wastes generated from the mines and associated activities have been classified into following categories:

- Top Soil.
- Waste / Rejects.
- Tailings from Ore Processing Plant.
- Wastes from Service Facilities.

1.5.7.1 Top Soil: In the mining areas, after clearing the vegetation, the top soil (generally up to 30 cm thickness) is generally stripped and stacked separately. The top soil is vastly superior in quality and contains plant nutrients, microbes and humus, which can be used for stabilization / rehabilitation of waste dumps and reclamation of mined out areas.

1.5.7.2 Mining Wastes/Rejects: As a measure of quality control, generally a cut-off point for iron ore (i.e Fe content) is fixed depending on the type of ore, to ensure ROM feed of acceptable quality to the Ore Processing and handling Plants. All the ores having Fe below cut off point are classified as waste/rejects/sub-grade material, and mined out separately and dumped in designated waste dump areas, keeping in view of the future use.

1.5.7.3 Tailings from Ore Processing Plant: The iron ore extracted from the mines are beneficiated to separate out the valuable mineral content. The prime function of beneficiation of iron ore is to improve the Fe content and to decrease the Alumina / Silica ratio for smooth Blast Furnace operations. The left over residue of the iron ore after the beneficiation in the state of fine particles is mixed with water in a slurry form, known as tailings and are needed to be disposed of in the tailings pond for containment. The disposal of tailings is a major environmental problem, which is becoming more serious with increasing extraction of lower grade deposits. The tailings are usually transported and deposited into a massive pond for containment, which are generally called as tailing ponds / tailing dams.

1.5.7.4 Wastes from Service Facilities: There are three types of wastes, being generated from the service centers viz, metallic, non-metallic and oil contaminated wastes. The metallic wastes generated in the workshops mainly iron & steel scrap, are collected & stored and sold. The nonmetallic saleable wastes like, tyres, tubes etc. are also stored separately and sold. The oil contaminated wastes like waste cotton, oily muck oil filters etc., are categorized as hazardous wastes. In some of the big mines, secured hazardous waste landfills are provided for disposal of these wastes. In most of the mines these are being dumped or burned.

1.6 DESCRIPTION OF THE STUDY AREA

The Bellary district in Karnataka lies between North Latitude 14^0 30’ and 15^0 50’ and East Longitude 75^0 40’ and 77^0 11’. The mineral bearing area lies in Bellary district, Karnataka State comprising the parts of Bellary, Hospet and Sandur Talukas (North Latitude 14^0 55’-15^0 20’ and East Longitude 76^0 20’-76^0 55’). It runs from Bellary South-East to Hospet North-West that stretches over 60 km in length and 15 km across its widest point with a general slope towards North. The highest elevation is 1161.29 m above MSL (Mean Sea Level) in S.M. Block of Sandur Range and lowest is 490.73 m above MSL in Bellary Range.

The Bellary – Hospet region forms a part of the ‘Sandur Schist Belt’, referable as, the “Dharwars”, a group of Precambrian schistose rocks of Mysore. The lithological units include green stones which are the metamorphosed basic igneous rocks occupying the valley regions, with phyllite – quartzite’s forming the canoe-shaped amphitheater of hills, trending NNW—SSE and enclosing Sandur. The phyllites are locally shaly and the quartzites are of the nature of banded hematite jaspers, and banded hematite quartzite’s, inter-banded with each other. The banded hematite jaspers, the important source rocks for the iron ores in the area are prominent in the northern and western part of the ranges, where as the associated shale’s become prominent in the southern and eastern parts of the area. The iron ores form a capping over the quartzite’s and shale’s and overlie a sequence of manganiferous phyllitic rocks. Lateralization is widespread in most of the flat topped ridges.

Structurally, the Sandur hills form a tightly folded synclinorium, plunging gently to NNW and the hill ranges broadly delineate the folded limbs of synclines, with close repetition of strata due to minor folds. The strike of the ore bodies is generally parallel to the trend of the hill ranges; the dips are often steep, being vertical at number of places. Opposing dips towards NE and SW are found as in the Ramandurg and NEB ranges respectively. Bellary-Hospet-Sandur deposits are one of the four major known concentrations of high-grade iron ore occurrences with-in the country. The iron ore deposits of NEB range form a part of the Bellary-Hospet-Sandur group of iron ore deposits and occupy the Northern tip of Sandur Synclonorium. These deposits lie on the Northern flanks of Sandur basin.

Mining of Iron & Manganese ore started way back in 1950’s in Bellary-Hospet-Sandur Region. It started with low scale and supplied to local steel plants. Subsequently with liberalization of the economy, due to demand from various countries like China, Korea and Japan etc and better market rate the production of all grades has increased progressively increased over the last few years. From 2003-04 onwards the production from this sector increased drastically to meet the global market. Production of iron ore from this sector and details of individual mines are given in **Figure 1.1** & **Figure 1.2** and **Table 1.2**.

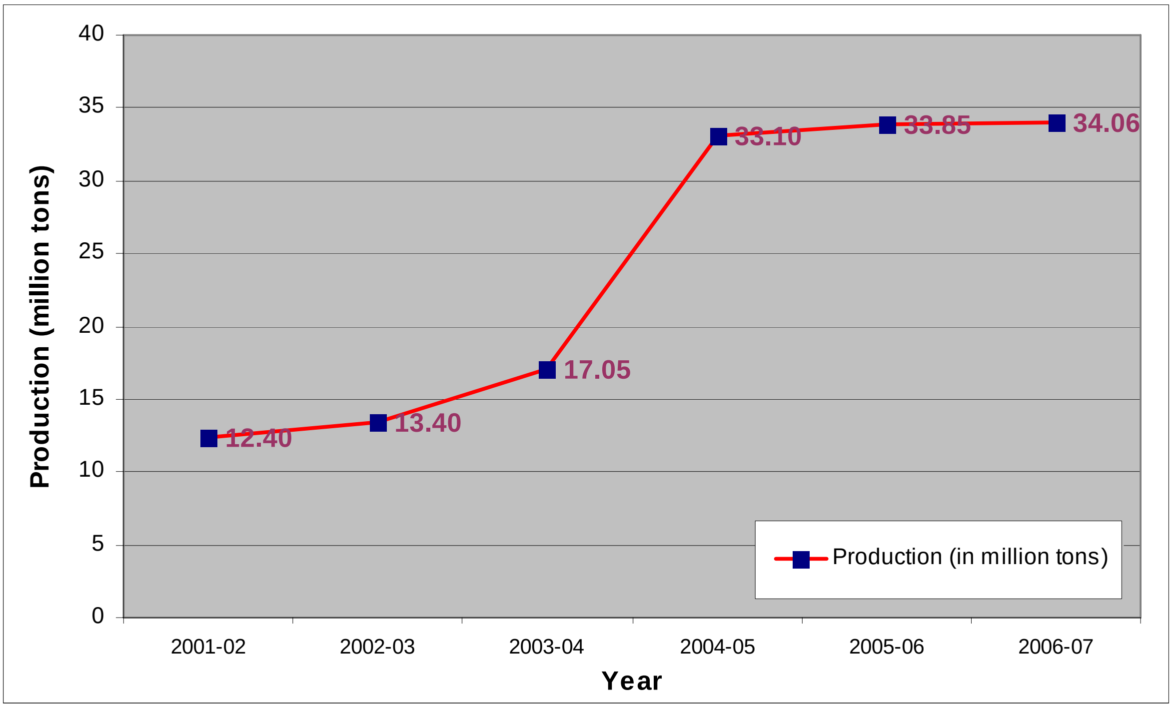


Fig. 1.1: Year-wise Production in Bellary-Hospet-Sandur Sector *(source: department of mines & geology)*

Fig 1.2.:Year-wise Production in the Study Area of 10km Radius *(source: department of mines & geology)*

Table 1.2: Existing Mining Lease in the Study Area (10 Kms)

Sr. No	Mining Lease	Total Extent in Ha.	Area cleared under F(C) Act 1980/ renewed in Ha.
1.	M/s. Lakshminarayana Mining co.,	175.63	105.22
2.	M/s. P.B.S.& Sons	44.11	44.11
3.	M/s. G.G. & Bros.	42.90	32.38
4.	M/s. G.G. & Bros.	18.21	15.10
5.	Smt. Mehrunissa.	13.19	13.19
6.	M/s. Trident Minerals	32.77	32.77
7.	M/s. Auro Minerals.	30.76	30.76
8.	M/s. Balaji Mines & Minerals Pvt. Ltd.	22.66	16.72
9.	M/s. Muneer Enterprises.	36.42	36.42
10.	M/s. S.B. Minerals.	44.52	44.52
11.	M/s. R.M.M.P.L.	24.28	24.28
12.	M/s. Shanthipriya Minerals (P) Ltd.	80.74	80.74
13.	M/s. Zeenath transport Co.,	44.13	44.13
14.	M/s. Zeenath Transport Company.	36.42	36.42
15.	M/s. Chowgle & Co.,	459.73	110.00
16.	M/s. Mysore Minerals Ltd.,	621.21	78.50
17	M/s. Smiore	--	85.00
18.	M/s. S.V. Srinivasulu.	149.79	60.00
19.	M/s. P.V.S. & Sons	123.84	50.00
20.	M/s. Mineral Syndicate.	2.12	--
21.	M/s. Associated Mining Co.	16.19	--
22.	M/s. S. B. Minerals	40.47	--
23.	M/s. Aswathnarayana Singh & Co.	129.50	52.00
24.	M/s. P.V.S.	25.05	--
25.	M/s. K. Brahmananda	80.74	--
26.	M/s. V.M. (P) Ltd.	20.23	--
27.	M/s. Dalmia International.	330.96	--
28.	M/s. H. T. Minerals.	159.85	--
29.	M/s. Kannhyalal Dudheria.	30.76	--
30.	Sri. S. A. Thwab	31.56	--
31.	M/s. Savitrabai Nagan Gowd	55.59	--
32.	M/s. V.N. Jayaram.	157.00	--
33.	M/s. V. N. Jayaram.	202.35	--
34.	M/s. G. G. Bros.,	63.13	--
	Grand Total	**3346.81**	**992.2**

From the above figures, we can observe that there is drastic increase in annual production from the year 2003-04 onwards. It is widely accepted that operation of a sector like mining is bound to have significant negative impacts in the region if appropriate management measures were not internalized. Though various legislative measures and standards were put in place with reference to the mining operations, adherence to the same by mine operators was drawn severe criticism from various corners of the society. Therefore this study was envisaged.

1.7 OBJECTIVES OF THE PRESENT RESEARCH WORK

- To identify and evaluate the impacts of mining activity on Social, Economical and Environmental Aspects of the area,
- To formulate suitable matrix for the measurable parameters with reference to iron ore mines,
- To develop a management model for the existing operating mines in the study area.

1.8 METHODOLOGY OF THE PRESENT STUDY

The study on socio-economic & environmental impact due to unexpected increase in iron ore production of various grades due to demand from various countries was conducted in the Bellary–Hospet-Sandur range of Bellary District, Karnataka, by considering 10 km radius as the study area in the region. The entire 10 km radius was divided into four quadrants for better understanding. The environmental parameters like air, water, soil and noise were monitored from summer 2001 to winter 2006-07.

Secondary health data collected from hospital situated in 5 selected villages around the major mine lease area. The data was used to analyze the health effects of increase in iron ore production and to establish the link between increase in iron ore production on socio economic status of the people, both in the positive and also in the negative side. Primary data for the present study was collected by conducting public survey using structured questionnaire covering 50 households of 5 selected villages in the mine lease area of Bellary-Hospet. A control group of 50 house hold was selected in the Hospet town representing similar socio- economic characteristics of the study area. The detailed socio economic profile of the households in the study area and in the control group household are analyses and presented in Chapter 4). A public survey was also undertaken along with the socio economic and morbidity survey to find out the factors affecting the willingness to pay for reducing the environment pollution in the villages around the mine lease area, associated with increase in iron ore production.

1.9 LIMITATIONS OF THE STUDY

The important limitation of the study lies with the data of various environmental parameters like, air quality data, water quality, noise monitoring data and soil quality data in the selected villages, as these parameters are not being regularly monitored in these villages. Selected parameters are considered to evolve with the health impact of increased iron ore production on the people who are residing in the villages, since long and also on the workers, who works in the mine lease area, even though there are other parameters which can significantly contribute for overall socio-economic status of the villagers.

Only selected heath alignments were considered for measuring health impact due to deterioration of air quality as well as water quality in the region due to non-availability of long term data. Only health impact due to Particulate Matter (PM) was considered for measuring the health impact due to air pollution, as several studies have shown that these pollutants can cause/aggravate the respiratory diseases in the population. Even though other pollutants like NO_x and SO_2 can significantly contribute for the problem, it was not considered due to non-availability of long term data either in the mine lease area or in the selected villages.

The study confines to measure the socio-economic & environmental impacted in the selected 5 villages around the mine lease area of Bellary- Hospet-Sandur Region, even though the production has increased in all the mine lease area spread across the whole district during this period. The detailed epidemiological studies were not carried out due to resource and time constraints.

Morbidity data was collected from the people of this area, as the hospitals have not maintained the required data in the required format, hence the perceptions about the disease conditions may vary between individuals in the study area. This is likely to be an influencing factor for either under reporting or over reporting of ailments (Gumber and Breman (1998).

Estimation of air pollution level in the study area is carried out during 3 seasons in selected places with in the village and 24 hours weighted average is taken for the analysis, which may not represent the actual concentration of the air quality, as minimum of 104 monitoring shall be done in a year to take the annual average.

1.10 CHAPTER SCHEME OF THE THESIS

The second chapter describes the literature survey conducted in different parts of the world as well as with in the country along with the detailed methodology of the present study. Chapter 3 concentrated on the detailed description of the study area. Chapter 4 analysis the secondary data on various socio-economic parameters and health impact on the people in the study area. Chapter 5 gives the analysis of primary data including socio economic profile of the study and control group households, while Chapter 6 presents the summary, conclusions and the policy implications of the present study along with the scope for further research in the field.

CHAPTER 2

LITERATURE REVIEW

2.0 GENERAL

The minerals resources are not only common resources of all in the current 'nation state', but also in the 'inter-generational state'. The extraction of mineral resources has three major implications. First, these mineral resources are exhaustible resources, hence as we go on with extraction activities, we leave less and less for the future generation. Second, the mining activities make the top soils just not useable due to land conversion and degradation. This is a serious problem of irreversibility, apart from the problem of dealing with the over-burden dumps. Third is a human and social problem interms of health impact.

The Mining is considered as one of the important economic activities, which have the potential contributor to the development of economies. At the same time, the environmental and health impacts of mining on surrounding people has been a major concern to governments, the general public and stakeholder organizations and individuals. The earlier studies have revealed that, mining activities have resulted in land degradation leading to limited land available for local food production and other agricultural purposes. In addition, environmental pollution has affected water resources in the mining area, apart from contributing for air and noise pollution in the surrounding area.

India is the land of high population density (324/sq km in 2011) and large section of poor population lives in the mineral rich areas or forests. According to the Forest survey of India, the average forest cover in tribal Districts of the country is 37 percent (Chandra Bhushan, 2008). The livelihood dependency of this section of population on forest resources is quite high. Hence there is a serious question on land conversion for mining, due to the problem of rehabilitation and adaptation. As per the CSE's report 2008, between 1950 to 1991, out of all the developmental projects, the mining has displaced the second highest number of people i.e around 25.5 lakh people. More importantly, less than 25 per cent of these displaced people have been resettled, of all the people displaced by mining, about 52 per cent were tribals.

It is not only the matter of land conversion, but, also the depletion of mineral resources as they are exhaustible, or leaving the land un-usable for any alternative use as a common property resources. Already, out of 306 million hectare of land available for any utilization, 104 million hectare of wastelands has been kept for future generation. According to NBSS, by 2007, out of 328.6 million hectare of geographical area, as much as 148.6 million hectare of geographical area is already degraded (under categories such as water and wind erosion, salinity, alkalinity, acidity and other complex problems). Large portion of these degradations are due to mining activities.

According to the available statistics, between 1980 to 2009 as much as 1,00,870 hectares of forest lands have been approved for mine lease (as per information provided by the Ministry of Environment and Forest (and as per the submission by Kanchan Chopra Committee, 2006) about 5, 73,164 hectares of forest lands have been converted during the period from 01.01.2001 to 19.04.2006 for various purposes other than forest use, including mining. This implies that, about 216 mining projects were granted forest clearance annually – as against 19 clearance annually during 1980 -97 (an estimated total of 1.64 lakh hectares of forest land has so far diverted for mining in the country (CSE, 2008)).

Further, the total contribution of the mining sector to Indian GDP is just about 2 percent annually, much of which comes from fuels. According to the CSE (2008) report for every 1 percent of the mining sector's contribution to the country' gross domestic product (GDP), the activity displaced three to four times more people than all development projects put together. The mining of major minerals generated about 1.84 billion tonnes of waste in 2006 – most of which has not been disposed of properly. The coal is the main culprit, every tonne of coal extracted generates three to four tonnes of waste (CSE, 2008).

The Karl Marx in Das Capital, has stated that values of minerals, has value only to the extent labour involved to extract out to the surface from the earth's crust. It means that, only the labour cost of mining will account for its value "all those things which labour merely separates from immediate connection with their environment, are subjects of labour spontaneously provided by the Nature". Such are the fish which we catch, water, timber which fell in the virgin forest and ores which we extract from their veins. If on the other hand, the subject of labour has, so to say, been filtered through previous labour, we call it raw material; such that, ore already extracted and ready for washing. All raw material is the subject of labour, but not every subject of labour is raw material; it can only become so, after it has undergone some alteration by means of labour',[Karl Marx, p.174]). He ignored the in-situ or intrinsic value of nature altogether.

Today, while the labour cost of iron ore production is of the order of RS. 50 per ton, its export price is around Rs. 4000 (the average value of iron ore mineral varies from Rs. 764/ton for low grade to Rs. 3719/ton for high grade lumpy ore during 2010). Herald Hoteling (1931), has stated that, for any optimal and efficient rate of extraction, mineral price trends should have followed the social discount rates. But the world of development driven by openness of economics has made minerals extraction lot more attractive than preservation. The recent trend in mineral prices is strikingly high as compared to any index of social discount rate or even the sectoral growth rate (the WPI [with 1993 – 94 = 100] for all the minerals taken together has increased from 119 in 2001 - 2002 to 608 in 2009 - 2010, registering about 50 percent increase annually, where as the growth of the mineral production has been around 5 percent annually)

Much later, Herald Hoteling (1931) has proposed a direct link between the rate of mineral extraction and its pricing, again to warn about over exploitation of minerals. There are very serious questions about the current rate of mineral extraction and exhaustibility. Our current balance of resources (Hematite and Magnetite) is about 25,249 million tonnes. Against this, the current rate of annual extraction is on the order of 215 million tonnes by about 316 miners reporting in 2007 (but has crossed over 300 MT by 2010*) (To contextualize these figures, we need to remember that India started large-scale iron ore mining only in the first decade of 20th century when Jamshetjee Tata started the first steel mill in Jamshedpur in 1907).

Pigou (1920) has first analyzed the impact of pollution by distinguishing between the private cost and the social cost. He clearly highlighted the private and social cost, stating that, suppose if a firm’s production process generates a spillover or an externality that directly affects other economic agent, then the marginal social cost of production will diverge from the marginal private cost and the firm will produce too much, if the spillover is unpleasant.

Further several studies have been conducted on assessment of impacts by mining activity on environmental, social and economic status of the surrounding villages. One such study by Gaven Hilson, 2000, has examined a sustainable development in mining and provided guidelines seeking to operate more sustainability. The study has revealed that sustainable development have significant role to play in mining. Since the mining operations have the potential impact on environmental entities and has vide range of stake holder groups, there is an opportunity for the industry to operate more sustainably specially with improved planning, implementation of sound environmental tools and cleaner technologies. The extended social responsibilities to stake holder groups, the formation of sustainability partnership and improved training, a mine can improve performance in both the environmental and socio-economic arenas and thus contribute enormously to sustainable development at the mine level.

Further, Bismarck kwakuasare, 2001, has conducted a study on socio-economic and environmental impacts of mining in Botswana wherein it was assessed that the presence of mine has led to rapid growth of the population through migration which has outstripped the ability and capacity of the town social services such as housing to cope with the high number of migrants. The study has also revealed that the increase in mining activity has increased the air pollution from the mine and has impacted on the human health, soil, water and the vegetation in the area.

Gavin Hilson, 2002, has carried out a study on small scale mining and its socio –economic impacts in developing countries wherein it was concluded that though the small scale mining activity has adversely impacted human quality of life through health related problems apart from damaging the environment, it plays a pivotal role in alleviating poverty in the developing world and contributes significantly to national revenues and foreign exchange earnings. The study also revealed that because most of the small scale mines deploy low technology and employ poorly trained unskilled people, it is difficult for the sector to improve on its own. It is concluded that government and regional organization could accomplish much in the way of improved sustainability in the small scale mining industry.

Frank Montavon, et, al., 2006, has carried out a study to verify the corporate reporting of environmental management practices and firm performance for a mining industry by using comprehensive environmental and business performance from 45 corporate reports. The result indicates that the relationships between environmental management practices and the firm performance are based on the traditional data and strongly indicates that EMPs are associated with the firm performance.

Janewbold, 2006, has conducted a case study on influence of environmental movements in policy making activities in Chile. This study has considered large scale mining sector and overall environmental performance affects environmental management system. The results have revealed that improvements in environmental performance are the accepted norms, safety has the highest priority and sustainability is a part of mining industry. It is safe to use the best available technology and must demonstrate care and consideration for the environment and communities.

Heledd Jenkens, 2006, have carried out study on corporate social responsibility in the mining industry to explore the trends in social and environmental issues. The study was carried out in world’s ten largest mining companies. It was observed that for mining, one out come of the CSR agenda is the increase in need of individual companies to justify their existence. It is concluded that to assess the progress towards sustainability and to improve corporate strategies, holistic approach is essential, if all the mining companies want to be truly engaged in the perceived for greater CSR and sustainable outcome.

Kitula A, 2006, has conducted a study in Geita district of Tanzania on the environmental and socio-economic impacts of mining on the local livelihoods and it was found that the interventions can help in reducing the negative impacts of mining and the statutory authorities can provide technical support to local operators to improve the regulations thereby reducing the illegal mining activity.

Further it was also concluded that socio-economic benefits such as development of social and economic infrastructure, manufacturing and construction industries, commercial and public sector activities have improved significantly. Employment creation has improved significantly, but the income levels of the people are generally low.

A study by Tungalag A et, al., 2008 on land degradation analysis in the Ongi River basin has revealed that there is a vegetation decrease due to mining activity in the study area. The study was carried out by measuring vegetation indexes and concluded that the large mining activity has also contributed to the deterioration and loss of regional bio-diversity and increased level of land degradation.

A study by Zobrist J et, al., 2009 have conducted a case study in Certej river catchment, western Carpathians, Romania wherein metal mining activities have created a beneficial economic development apart from long lasting heavy metal pollution of waters and sediments. The results have indicated that the input of acid mine water has drastically increased the heavy metal concentration.

The study on socio-economic status shows that mining has provided major source of income and about 45 percent of the house holds were partly/completely dependent on financial compensation as a result of mine closure (Zobrist et al 2009).

Another study by Vanessa Petkova et, al., 2009 on mining activities in Australia and its social impact on the communities have shown that the mining boom has been generating social and economic impacts, the pattern of the impacts appears to vary across the communities depending on the size of the impact, community structure and history, and the extent to which a non resident work force is involved. The study has used a qualitative social impact assessment technique on six communities in the Bowen Basin in Queens Land following the increase in the coal prices between 2003-2008.

Emmanuel K Boon, 2009, have conducted a study on Corporate Social Responsibility in the mining sector at Ghana and have concluded that despite the huge revenue generated from mining activity, there is growing unhappiness among the population as regard to the real benefit accrued among the mining communities. The study has also provided a concise account of the growth and development of mining industry in Ghana and assessed the impact of corporate social responsibility policies and practices of the major mining companies in the country.

2.1 MINING AND ENVIRONMENTAL DEGRADATION

The mining activities are carried out in various stages, each of them involving specific environmental impacts. Broadly speaking, these stages are:

2.1.1 Deposit Prospecting Phase: During this phase, the preparation of road for accessing mining area, topographic and geological mapping, establishment of camps and auxiliary facilities in the mining area, geophysical works carried out in the mining area, hydro-geological research, opening up of reconnaissance trenches and pits, taking of different samples for analysis etc will contribute of environmental degradation in the form of air pollution, noise pollution and the vegetation loss.

2.1.2 Exploitation Phase: During the exploitation phase, the impact on the environment depends on the method of mining used. In forest zones, the process of deforestation of the land, with the consequent elimination of vegetation (which is greater in the case of opencast mines) has short, medium and long-term impacts. Deforestation not only affects large number of habitat of endemic species (many doomed to extinction), but also the maintenance of a constant flow of water from the forests area towards other ecosystems and urban centers. Deforestation of primary forests causes a rapid and fluid runoff of rainwater, increasing flooding in rainy season, because the soil cannot contain the water, as it does when it is covered by forest and the roots of thick trees can act as capillary to take to runoff water to the ground strata.

In addition to the area disturbed by the excavation, the damage caused by mines on the surface due to the consequent erosion and silting (sedimentation of the watercourse beds) has become more serious due to accumulation of heaps of rock residues (known as tailings), that usually form great mounds, sometimes larger than the area given over for excavation.

The enormous consumption of water required by mining activities generally reduces the water table around the mining area, hence drying up of wells and springs. The water contaminated by the acid drainage, that is, exposure to air and water of the acids formed in certain types of ore, particularly sulphuric acids, as a result of mining activities, which in turn react with other exposed minerals. A self-perpetuated dumping of acidic toxic material will remain in the environment in different forms for hundreds or even thousands of years. Furthermore, the small particulates of heavy metals with time separates from the waste and are disseminated by the wind, deposited on the soil and in the beds of watercourses and slowly integrating the tissues of living organisms, such as fish.

Hazardous chemicals are also used at various stages of metal processing industry, such as cyanide. The concentrated acids and alkaline compounds, although significantly controlled, usually end up, in the toxic waste water discharge, which joins the natural stream (if properly not managed), through topographical drainage system. The alteration and contamination of the water cycle has very serious side effects that affect surrounding ecosystems, especially for the fragile forest ecosystem and on the general people.

Air pollution is being caused by the dust generated by mining activities. Serious causes of illness in the form of respiratory alignments in the people and asphyxia of plants and trees.

Furthermore, release of gases and toxic vapour takes place like sulphur dioxide (responsible for acid rain in the atmosphere) is produced because of metal treatment, and carbon dioxide and methane, two of the main greenhouse gases causing climate change-- are also released, due to the burning of fossil fuels and the creation of artificial lakes for the hydroelectric dams, built to provide energy for the casting ovens and refineries.

Further, in the case of underground mines, mining activities consume enormous quantities of wood for their construction and as a source of energy for mines with charcoal-fuelled casting ovens. When mining operations are carried out in remote zones, mining activities imply major works such as road building (opening access to the forests), ports, mining villages, the deviation of rivers, construction of dams and energy generating plants. The deafening sound of the machinery used in mining and the blasting can also causes major impacts, as they create conditions that may become unbearable for the local populations and the forest wildlife.

It is argued that mining is vital for industrialization, because it provides raw material and sources of energy. However, the present disproportionate concentration of investment on mining, marginal for industrial production, refute the sector's social justification for its activities. Mining comes along with its promise of wealth and jobs, but millions are victims to the high social costs that it brings with it, appropriation of the land belonging to the local communities, impacts on health, alteration of social relationships, destruction of forms of community subsistence and life, social disintegration, radical and abrupt changes in regional cultures, displacement of other present and/or future local economic activities. All this is added to the hazardous and unhealthy working conditions of this type of activity.

2.2 MINING AND ITS HEALTH IMPACT

The fundamental link between man and land (including forest and water bodies) are ignored. The very first Principle of Rio Declaration in 1992, which reads as ‘Human beings are at the centre of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature.’ is totally ignored.

Health is defined as a state of complete physical, mental and social well being of an individual, and not merely the absence of disease and infirmity (World Health Organization, 2005). An alteration in the living cells of the body which jeopardizes survival in the environment results in diseases. Health problems arise from a variety of man's activities including industrial process, farming, mining, migration and others.

The following paras, reviews the literature on the impact of mining on the health of both mine workers and the people within the surrounding communities of the mines.

Gerking and Staley (1992) looked into the morbidity health effects of air pollution on 824 adult workers of St Louis in USA. They analyzed the cost incurred by the people to prevent the adverse health effects of pollution and used WTP approach to find out whether the population affected by chronic illness and years of having the disease influenced the result. They found that the WTP were very low because the area was not severely affected by the ill effects of air pollution.

Abubacker (1994) studied the industrial air pollution on human health due to cement industries in Tiruchanapalli District of Tamilnadu. The study found that, the workers reported respiratory and skin disease more frequently. This was based on the primary survey of the workers and it was asked that whether they had suffered with any respiratory related disease in past one month.

Larson et, al., (1999) undertook a combined health risk assessment, cost effective analysis and benefit–cost analysis for direct particulate emissions from 29 stationary source in the city of Volgograd, Russia. Annual particulate related mortality risk from these stationary sources is estimated to be substantial and was in the range of 960 – 2667 additional deaths per year in this city of 1 million populations. The cost per life saved was also very low in spite of several emission reduction projects. The total net benefit to the city of implementing five of the six identified projects, leading to a 25 percent reduction in mortality risk, are estimated to be US$ 40 million.

Alberini & Krupnick (2000) compared Cost of Illness (COI) and Willingness to Pay (WTP) estimates of the damages from minor respiratory symptoms associated with air pollution using data from a study in Taiwan. A Contingent valuation survey was conducted to estimate WTP to avoid minor respiratory illness. Health dairies were analyzed to predict the likelihood and cost of seeking relief from symptoms and missing work. The ratios of COI to WTP were similar to those for the US, despite of the differences between the two countries. The WTP values have exceeded by 1.61 to 2.26 times depending upon the air pollution level.

According to the study conducted by Stephens and Ahern (2001), mining remains one of the most perilous occupations for causing both short term injuries and fatalities and long term impacts such as cancers and respiratory conditions such as silicosis, asbestosis and pneumoconiosis.

Tungalag A et, al., (2008) have also carried out a study to determine the vegetation condition in Ongi River Basin of Magnolia, where in it was concluded that Ongi River Basin's vegetation loss has increased to 12,000 sq. km, since 1998 and it is showing a decreasing Trend.

Another study in Tarkwa area, according to health data obtained from Korle-Bu Hospital by FOE – Ghana during 2001, increase in the mining activity has contributed for increase in health impact related diseases such as malaria, diarrhoea, upper respiratory tract infections, skin disease, acute conjunctivitis. The area has the highest incidence of malaria in the Region. Skin rashes are widespread particularly among communities living along rivers and streams which regularly receive discharged cyanide waste waters and other metal bearing liquid wastes from nearby mining (Akabzaa and Darimani, 2001).

The studies on mining and health have revealed that deep mining/ sub surface mining produces severe harms for employees in terms of their risks of high blood pressure, heat exhaustion, myocardial infarction and nervous system disorders. The studies are generally conducted on health risks related to dust pollution due to dust exposure (Stephens and Ahern, 2001). The biostatistics obtained from (FOE-Ghana) showed a high prevalence of upper respiratory tract infection (URTI) in the area, which medical experts link the mining activities with the associated environmental pollution (Awudi, 2002). Clinical symptoms similar to arsenic poisoning have been observed in patients and have been associated with aerial pollution from mineral procession by the AGC (Awudi, 2002).

Vanessa Petkova et, al., (2009) have carried out a study to assess post development impact of mining on six communities in the Bowen basin in queens land, where in it was concluded that significant impact of new mining developments from recent boom have increased the mobility of local residents, where in increasing proportion of economic stimulus from mining is flowing out of the towns. Housing shortages and price spikes have also limited the potential for flow on economic development and created a pressure on non-mining business and socio-economic groups.

2.3 ENVIRONMENTAL MANAGEMENT SYSTEM IN MINING

It is necessary to establish a complete environmental management system to analyze and to improve the performance. The environmental management system can be adopted fro a mining industry to improve the overall efficiency of the various stake holders and to reduce the burden on the environment.

- **Recycling:** The recycling of different raw materials at various stages helps for cost savings and for optimum/efficient usage of raw materials. Recycling can also improve a firm's image, which helps to improve growth.
- **Proactive waste reduction:** This measures the degree of proactive approaches for reducing waste in different processes and or the elimination of waste before it is produced. This environmental management system focuses on cost reduction.
- **Remanufacturing:** This is the degree to which the firm rebuilds a product, where some of the parts or components are recovered or replaced. This lowers the cost of the structures.
- **Environmental design:** This measure is concerned with the use of environmentally conscious design processes. This is in line with Porter's idea of innovation offsets, as it may be the case that uses environmentally sensitive design processes for product innovation and to increase the firm performance.
- **Specific design targets:** If the industry uses specific targets for achieving environmentally conscious designs, it would have scored higher on this measure. Interestingly, this measure could be tied to the three operational measures. This is because a firm may choose to set a design goal that a certain percent of product content needs to be remanufactured or recycled.
- **Surveillance of the market for environmental issues:** This measure identified those firms that look for opportunities in the future related to environmentally friendly practices. This will be applicable for a more proactive approach to environmental issues, which is somewhat in contrast to the prescriptions offered by Rondinelli and Vastag (1996). This is most likely allied with the idea of a demand-based mechanism. In this, the firm is actively seeking out opportunities to fulfill future demand that is based on environmentally friendly products or processes.

Hence there is a significant and positive relationship between efficient environmental management plan and the measures of performance. An additional contribution from the efficient environmental management plan is to have “win-win” hypothesis using an innovated data source. This demonstrates that the ranges of EMPs are available to improve the overall performance of the organization in the field of environmental protection and conservation of natural resources. These practices are positively associated with multiple firm performance measures. The following paras explains different section of the environmental pollution caused by the mining industry and the efficient environmental management plan which can be adopted to reduce environmental pollution that caused by the mining industry.

2.3.1 Effluent from Ore Processing Plant

In most of the mechanized iron ore mines, ore is being processed either in dry or in wet circuits depending on the quality of ore feed. Ore having high alumina and silica are generally being processed in the wet circuit system with the intention to improve the quality of the ore and to remove the impurities for smooth blast furnace operation. In wet circuit, the ore is being crushed, scrubbed, washed, wet-screened, classified etc and the water requirement for this purpose is in the range of 1 m3 per tonne for adding at various stages for runoff of mines (ROM).

The effluent generated from the ore washing activity mainly consists of suspended solids with dissolved heavy metals. The effluent is initially treated in the clarifier to recover the coarser particles as ore fines. The overflow of the clarifier, mainly consist of finer solids i.e. tailings and is sent to thickener for solid liquid separation. After settling of the tailings at the bottom of the thickener, clarified overflow water (about 60 %) is reclaimed and recycled to the system. Underflow tailings are discharged to Tailings Pond for further solid - liquid separation. Clarified water from the Tailing Pond are also reclaimed and recycled back to the system in most of the major iron ore mines in India. In some mines, where there is no provision of reclaiming water from the pond, the clarified water is discharged through a weir. The treated water after recovery of the tailing is discharged on land fro irrigation or used on the haulage road for water sprinkling for dust suppression.

2.3.2 Pit Water Discharge from Mines

The water will be accumulated in the mine pit for iron ore mines, which are operating below water table or just above the confined aquifers and the same is required to be pumped out regularly to facilitate the mining operation. The pit water is normally laden with suspended solids, derived from within the pit and generally used for ore washing purposes or discharged to the nearby water bodies. However, pumping of pit water creates a cone of depression around the mine area, which give rise drying of nearby wells and springs in the neighboring villages. A large percentage of iron ore is located below the water table and a number of mines are now operating below water table. In most of the big mines, the pit water is being discharged to the exhausted pits and is being utilized for ore washing purpose.

2.3.3 Surface Runoff

The most important environmental aspect of mining industry is the surface runoff from various areas during monsoon, as most of the iron ore mines in India are located in hill tops with steep slopes or in dense forest areas, and in areas with high rainfall. Surface run off from the mining and other areas gets laden with aluminous lateritic soil from mine benches, exposed outcrops etc. As the iron ore contains only traces of sulphur, the surface run off water does not get acidic, but become highly turbid due to loosening of soils by the mining activities. Direct discharge of the surface runoff to the natural nallas will certainly affect the water quality of the nallas as well as rivers in the region. Major sources of runoff from the mines are as follows;

- Waste dump areas
- Ore handling and stockpile areas
- Mine proper and haul roads
- Other areas like workshops, garages, service centers etc.

The sedimentation tanks have been provided for treatment of the surface runoff or diverting to the tailings ponds. In addition to this, garland canal/drains around the waste dumps along with retaining walls & toe bunds and check dams across the nallas were provided to arrest the runoff, besides establishing vegetation cover over the waste dumps.

2.3.4 Effluent from Workshops and Garages

The mining area generally has workshop and garages for repair of the heavy earthmoving vehicles and other mining equipments. The effluent generated from these workshop and auto garages mainly consists of oil and suspended solids. Separate effluent treatment plants have been provided for treatment of these effluents in most of the big iron ore mines. The effluent is treated in series of sedimentation tanks with oil traps. As the effluent generation is very low, these treated effluents are discharged to the nearby lands where it is evaporated.

2.3.5 Vibration & Air Blast from Mining Operation

Vibration and air blast are among the most significant issues for communities located near the mining industries. The vibration and air blast from blasting causes fear of structural damage. This fear occurs because people are able to detect vibration at levels which can cause superficial damage to buildings and structures of heritage value.

Vibration is the term used to describe the reciprocating motion in a mechanical system and can be described by the frequency and amplitude of the oscillations. When an explosive charge is detonated in a confined drill hole, tremendous amount of pressure and temperature develops with in a very short time interval. The process melts, flows, crushes and fractures surrounding rocks. After some distance from the explosion site, inelastic process ceases and elastic effect starts. The excess explosive energy, not utilized in shattering the rock is transferred to elastic zone and thus propagates the disturbance away from the explosion site. The disturbance is known as seismic wave or ground vibration. It is generally measured as Peak Particle Velocity (PPV) in mm/ sec at a specified frequency.

The use of explosives creates airborne pressure fluctuations (air blast) over a vide frequency range. When in the higher frequency range, this energy is audible and is perceived as “noise”. At frequencies of less than 20 Hz, the sound energy is inaudible, but it is capable of causing objects to vibrate such as rattling of loose windows and crockery. Low frequency waves (<6HZ) causes more damage to structure particularly in case of multi-storied buildings.

Damage caused by ground vibration dependents on the frequency of ground motion. In order to safeguard the nearest residential buildings and other important structures, various countries have set the limits for blast vibrations depending upon the socio-economic values of life. All the vibration standards are based on the resultant peak particles velocity (PPV) of ground vibration, as this is accepted as the best criterion for assessing levels of damage due to vibration. In India, DGMS prescribed 10 mm/sec as the safe limit of ground vibration at the foundation level of the structures within a distance of 300m, depending on dominant excitation frequency and nature/construction of the building.

2.3.6 Dust Control in Opencast Mines

The open cast mining operations and its allied activities, has enormously modified the exploration of minerals from the earth’s crust, due to the use of modern technology, but from these process, large amount of dust, gases etc are emitted into the atmosphere. These pollutants have harmful consequences not only on the mine workers, but also, on the human settlements, agricultural lands and livestock in the nearby areas depending upon the regional meteorological conditions.

Air pollution is defined as “the presence of any substance in the atmosphere in such a concentration that may be or tend to be injurious to human beings or other living creatures or plants or to the atmosphere itself”. Air is an important commodity for every kind of life and vegetation, as it protects life on earth from the hostile environment of outer space. But the very presence and activities of human beings disturb the natural atmospheric system.

2.3.6.1 Sources of Dust/Air Pollution in Open Cast Mines.

In open cast mining area, dust is generated due to various mining and its allied activities. A brief account of these activities is given in the **Table 2.1** below.

Table 2.1: Sources of Dust Generation from the Mining Area

Sr. No.	Activity	Sources
1	Removal of vegetation	• Uprooting/felling of tress/plants/grass. • Operation of diesel equipment.
2	Removal and handling of top and sub-soil	• Dozing and scraping. • Transportation of soil to the respective location. • Storage of soil. • Operation of Heavy Earth Moving Machinery (HEMM’s).
3	Drilling & Blasting	• Drilling operation. • Generation & dispersion of dust into the open atmosphere after blasting.
4	Handling of overburden	• Excavation of mined mineral and loading of overburden / rejection. • Transportation of overburden / rejection to the predetermined dump location. • Movement of tippers / dumpers in the mining area.
5	Crushing & Screening	• Crushing & screening of ROM to the required sizes.
6	Transportation by belt conveyors	• Loading on to the belts. • Transportation.
7	Reclamation	• Backfilling of worked out mining area. • Dust from haulage and other roads

2.3.6.2 Dust Control in Mining Area

Mining operations invariably is associated with emissions of particulate matter (dust) and gaseous pollutants. Dust problems in mining areas can be controlled by adopting the following three principal approaches

- **Dust suppression:** The Water spraying by using water tankers is the most important method of dust suppression. This prevents the dust from being airborne. To facilitate wetting of dust particles, chemical agents can be mixed with water to reduce surface tension of water. Mine benches, haulage roads, loading & dumping locations are to be regularly sprinkled with water, so as to avoid air pollution due to mining operations and movement of heavy earth moving vehicles in the mining area. Nozzles of spray should be fitted at the vulnerable points such as crusher; belt transfer points etc and the nozzles of the spray banks should be designed suitably to give fine mist of water. The water consumption in open cast mining areas varies with the size of operation, method of operation, temperature and relative humidity of the area as well as the type of chemical agents being used as surfactant.

- **Dust extraction:** The Dust extraction is a very effective way of controlling dust. The area of dust generation is covered and hoods are used to collect the dust and to control the air borne dust in the duct network. The collected dust laden air is then taken to suitable control equipment, which separates dust from air, and a relatively clean air escapes through the stack. A fan is operated to deliver air at a pressure great enough to overcome the resistance of the duct system. The crushing and screening plants are to be operated in a fully enclosed area.

2.4 INFLUENCE OF SOCIO ECONOMIC PARAMETERS ON THE MINING

With mining activities picking up in quantum and extent of reach, it has exerted several influences. These can be divided into direct and in-direct.

2.4.1 Direct Influences

With mining operations starting up, there were several opportunities opened up to cater to the needs of mining industry, both in skilled, semi-skilled, and un-skilled categories. As previously mentioned, literacy levels are generally not high in the mining regions and hence, most of the population could fulfill the demand for un-skilled jobs only. Some members of the local community could cater to the semi-skilled operations such as machines operators etc. Further, migration to the local urban settlements in search of the employment opportunities as the opportunities in the agricultural farm sector was not sufficient. With opening of the mining sector, there is demand for the workers and some members of the village have shifted their profession to mine based jobs, this results in higher employment generation in the mining area. Further, there is slight improvement in the overall infrastructure facilities such as shops, communication, road network, transpiration facilities etc.

2.4.2 Indirect Influences

With employment either directly in mines or indirect employment due to mining operations, there is change in the income levels at household levels. This increase in income has realized in terms of education to children, purchasing household amenities, higher spending on food/recreation etc, investment in household assets etc.

2.5 JUSTIFICATION AND SIGNIFICANCE OF THE PRESENT STUDY

Mining activities are indispensable in the economic development of any country endowed with mineral resources. This is due to the economic benefits that are made available to countries, are involved in the extraction of mineral resources, both internal and external. Internally, there is creation of employment and revenue generation. Externally, a substantial foreign exchange is available to such countries.

Acknowledging the economic contributions of mining, however, several economies have lost sight of environmental and health effects associated with mining activities. Studies undertaken to look into the environmental and health effects of mining have found that mining activities are more hazardous to economic development than a blessing. Accordingly, several mining companies in the country claim to have responded to this by instituting and implementing several measures to reduce the negative environmental and health effects of their activities on the people. Some of these measures are capable of reducing the negative health impacts of mining on the environment and surrounding communities is a matter of great concern.

The significance of this research work lies in the fact that it seeks to undertake a thorough and broader outlook into the environmental and health effects of mining on surrounding communities, both negative and positive, and recommend policy directives to improve the already instituted health policies by the mining communities as well as from the government in the region, as well as reducing the rate of hazardous health effects of the mining activities that may be identified in Sandur- Hospet region. Findings and recommendations will serve as guide to other mining companies in the country. **Table 2.2** gives the phases of the Environmental system in the mining sector.

Table 2.2: Phases of the Environment System in the Mining Sector *(source: charbel jose et, al, 2008)*

Sr. No.	Phases	Definition
1.	Environmental policy	The Environmental policy is a declaration of an organization, when its intention and principles related to its global environmental performances are shown, as well as its structure for action and the definition of its environmental objectives and targets (6). For daily and Huang (9), top management has to guarantee that the environmental policy: (a) is appropriate to the magnitude of the environmental impacts of the company's activities: (b) respects the current legislation (c) carries out effective revision of the environmental objectives and targets (d) agrees with the continuous search for pollution prevention and global environmental performance: and (e) Is documented, implemented and communicated to all employees and to the public in general.
2.	Planning	In this phase, a plan is formulated in order to follow the environmental policy in the following items: (a) legal demands (b) environmental objectives and targets: (c) identification of the environmental aspects; and (d) Structuring of the program of environmental management.

Sr. No.	Phases	Definition
3.	Implementation and operation	Effective implementation requires that an organization develops the empowerment of its resources and the necessary mechanisms for implementing its policy, its environmental objectives and targets. For Daily and Huang (9), there must be an optimal integration among the physical, human and financial resources that are going to support the effectiveness of the environmental policy of a company.
4.	Checking and corrective actions	In this phase: (a) the environmental performance is measured and monitored (b) corrective actions are carried out (c) the activities of the environmental management system are registered; and (d) the environmental auditors check the whole process (9)
5.	Management review	The analysis has to consider an eventual need of changing the policy, the objectives and other elements of the EMS, in view of the results of the audit of the management system, changes in circumstances and commitment to continuous improvement (6). According to Seiffert (1). It is recommended that top management carry out a review of the EMS at least twice a year.

2.6 SAMPLING DESIGN

In this study, the methods of sampling were a combination simple random, stratified and purposive sampling. The reason for this was that the data included different variables of the target population in terms of place of work, distance from the mines, socio-economic characteristics of the respondents and differences in perception towards mining activities and its effects on the environment.

After purposively selecting the study communities based on their proximity to the mine sites, One Hundred Fifty (150) people were randomly selected for the administration of a detailed questionnaire using the interview method to ensure a hundred percent completion rate.

The justification of the sample size lies in the fact that time and resources available to the researcher were not enough to cover the entire area with a population of about 195,000. In all, there are 52 villages in the municipality. This divides the total population into approximately, 3750 people per village. Five villages were chosen based on their relative proximity to mine sites or containment points (Table 1.1). T (30) respondents were sampled in each village for questionnaire administration. This was done to know variations in responses regarding mining effects on the localities by distance from the mines. This distribution gives a total of One hundred fifty (150). Since the five villages chosen for this survey were not concentrated at one area, but were scattered across the municipality, the views gathered from the total sample of One hundred fifty (150) respondents effectively represented the views of the entire population. **Table 2.3** gives details of the mining industries situated around the study villages and the distance of these mines from the villages along with the licensed production capacity.

Table 2.3: Distribution of Sample

Sr. No.	Name of the Village	Mine Name	Distance from the Village
1	P.K.Halli	M/s. Naganahalli Hussian Pera (Kardikulla Range)	3.0 Km
		M/s. Gogga Mines (Kardikulla Range)	3.5 Km
		M/s. Pattikonda Balasubha Setty & Sons (Kardikulla Range)	4.0 Km
		M/s. Banashankari Mine (Kardikulla Range)	3.0 Km
		M/s. Dalmia (NEB Range)	2.5 Km
		M/s. Laxmi Narayana Mines (NEB Range)	3.0 Km
		M/s. Sree Balaji Mineral (NEB Range)	2.0 Km
		M/s. Mahalaxmi Mineral (NEB Range)	2.5 Km
2	Joga	M/s. Shanthi Priya Mines	7.0 Km
3	Vaddrahalli	M/s. Kariganoor Minrela & Mining Industry	10 KM
		M/s. RBSSN Das	11 KM
4	Siddapura	M/s. Zenath Transport Company (Ramghad Range)	1.5 Km
		M/s. Ramghad Minerals Mines Pvt ltd., (Ramghad Range)	2.0 Km
		M/s. Sree Srinivasa Mineral (Ramghad Range)	2.5 Km
		M/s. Ilyl Mines (Ramghad Range)	3.0 Km
		M/s. Kannaiahlala Dhudheriya Mines (Ramghad Range)	3.5 Km
		Sree Krishna Minerals Pvt Ltd., (Ramghad Range)	3.7 Km
		M/s. SB Mineral (Ramghad Range)	3.9 Km
		M/s. K.M Pravathamma (Ramghad Range)	3.0 Km
		M/s. Laxmi Narayana Mines (NEB Range)	2.0 Km
		M/s. Balaji Mines (NEB Range)	2.5 Km
5	Jaisinghpura	M/s. S V Srinivasalu Mines (NEB Range)	2.5 Km
		M/s. S V Raghavalu Mines (NEB Range)	3.0 Km

Table 2.4: Number of Operating Mines with Average Distance from the Study Area

Village	Number of operating mines around	Average Distance from the Study Area
Siddapura Village	10	2.72 km
Papinayakanahalli Village	8	3.82 km
Jaisingpura Village	2	2.75 km
Vaddarahalli Village	2	6.2 km
Joga Village	1	7.0 km

It is evident from **Table 2.3 & Table 2.4** Siddapura Village is surrounded by highest number of mining area (10 Nos), followed by Papinayakanahalli Village (8 Nos), Jaisinghpura Village (2 Nos) and Joga Village (1 Nos). This was done purposely by the researcher to know the variation (if any) in the environmental degradation due to increase in the iron ore production in the recent times. It also helps to measure the impact among different socio-economic, demographic groups within and across the villages situated around the selected mine lease area. This was also done to find out response variations from respondents regarding the effects of mining activities on their respective communities.

2.7 ANALYTICAL FRAME WORK OF THE PRESENT STUDY

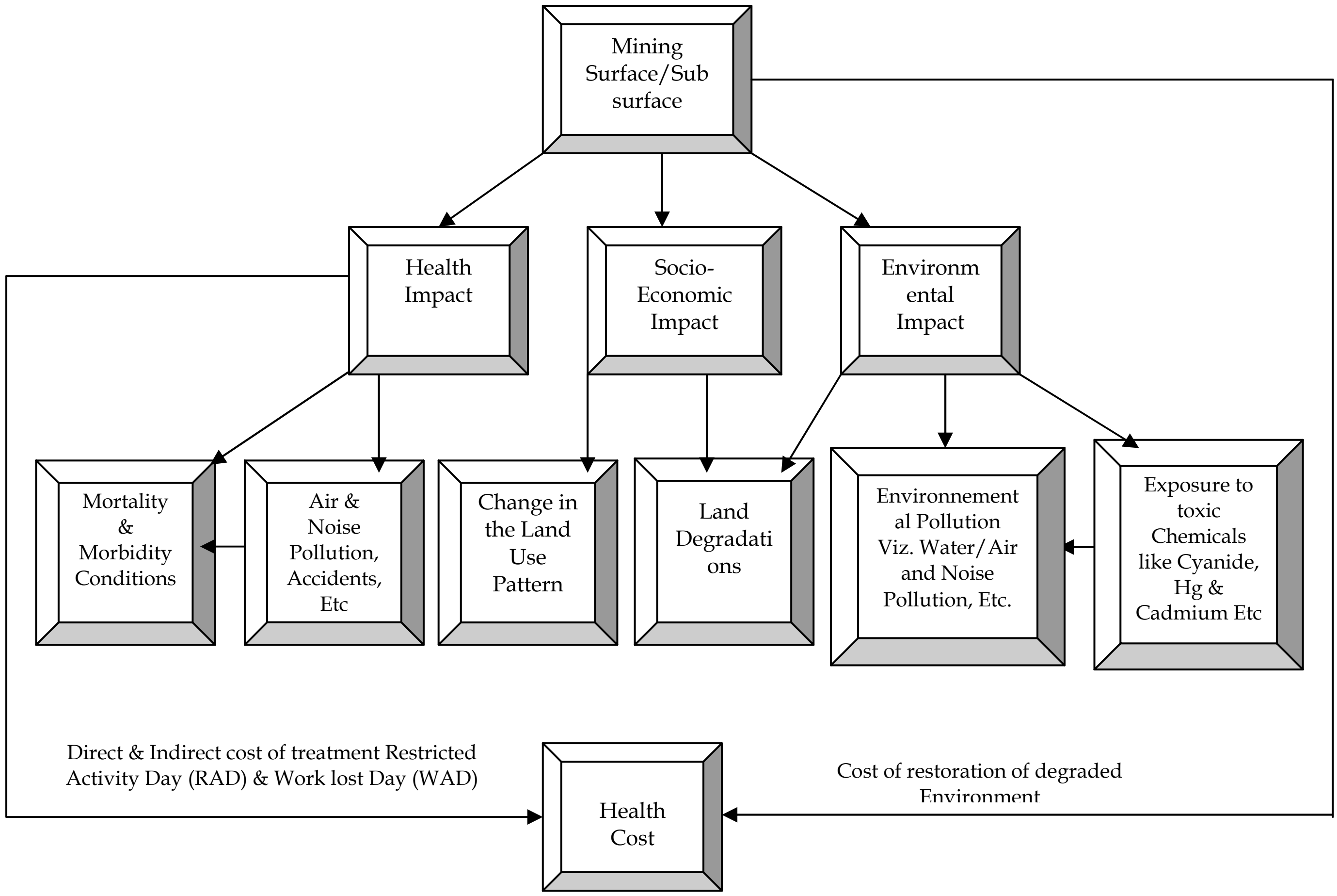


Fig. 2.1: Interlinking of Mining, Environment and the Health Impacts

The conceptual framework shows the impact of increased iron ore mining on the quality of the surrounding environment, socio- economic status and the health of people. The impact of mining activities on the environment is very remarkable. First of all, mining activities require acquisition of large tracts of land. Both deep and surface mining degrade the land surface since there is destruction of the entire forest. Consequently, land for farming and other agricultural purposes is lost.

Furthermore, spillages of chemicals such as cyanide, mercury and other toxic materials into the nearby streams cause water pollution, destroying the quality of water bodies, resulting on the extinction/loss of aquatic life. Exposures of such chemicals are also harmful to human health. Apart from this, the gaseous and other toxic vapour produced from heavy machines and equipments used, as well as other chemicals are sources of air pollution to the environment.

On health, several health implications are associated with mining activities. Mining activities such as blasting of rocks lead to air and noise pollution that affect the people within the surrounding areas. These sometimes lead to incidence of upper respiratory tract infections such as cancer, cough or cold and asthma. There are also the incidence of malaria, diarrhoea, acute conjunctivitis and accidents all of which result in morbidity and mortality conditions in the mining areas. In response to these, mining authorities provide health facilities such as clinics, hospitals, and health education to all the employees and to surrounding villagers. According to the literature that was reviewed, the compounding environmental and health cost and damages due to mining activities are far outweigh their economic and social benefits, the magnitude of which cannot be quantified. Hence, high health costs are incurred as a result of increased mining activities.

2.8 HYPOTHESES OF THE PRESENT STUDY

From the above literature review, the following Hypotheses can be drawn for the present study

1 An increase in the iron ore production in the mines around Sandur- Hospet region has lead to increase in Environmental impact in the region in terms of deterioration of air quality, water quality, creating noise pollution within the surrounding villages.

2 A deterioration of overall environmental quality has resulted in increase in illness attributed to environmental degradation among the villagers.

3 The in crease in number of patients suffering from set of environmental attributable illness has resulted in additional economic cost to the people of the villages interms of treatment cost.

CHAPTER 3

DESCRIPTION OF STUDY AREA

3.0 GENERAL

Industrialization has contributed immensely to the economic development of the world, but in its wake, it has also caused environmental degradation. Since humans have to live within their environment, the process of development should be ‘sustainable’, so that environmental quality is maintained within safe limits. The value of emphasizing sustainability is essentially to integrate industrial development with environmental management in the development process. It is only through an integrated effort of the environmental aspects into the planning and management of industrial development, which makes significant progress towards a sustainable society. Solutions to the complex inter-related problems implicit in sustainability require a holistic approach that is beyond the individual economic interests (TERI Report 1997).

The state of Karnataka is fairly well endowed with a wide variety of minerals. Apart from gold, it has resources of a few other valuable minerals, like iron and manganese and deposits of chromium (NEERI Report 2002). The iron ore reserves at Bellary –Hospet-Sandur belt has high grade Fe content and therefore the iron ore from this region is being blended with low grade iron ore from other region for export to various countries. The mining of iron and manganese ore has started way back in 1950’s in Bellary-Hospet-Sandur region. Initially, it was started on low scale and was supplied to local steel plants in the region. With the liberalization of the economy, opportunities for export of fines to countries like China, S. Korea and Japan, have increased drastically since 2003-04. Further, local demand for iron ore has also increased due to establishment of large number of steel plants in Bellary-Hospet region of the state.

3.1 GEOLOGY OF THE STUDY AREA

The Bellary district in Karnataka lies between North Latitude 14^0 30’ and 15^0 50’ and East Longitude 75^0 40’ and 77^0 11’. The mineral bearing area lies in Bellary district, comprising of the parts of Bellary, Hospet and Sandur Talukas (North Latitude 14^0 55’-15^0 20’ and East Longitude 76^0 20’-76^0 55’). It runs from Bellary South-East to Hospet North-West, which stretches over 60 km in length and 15 km across its widest point with a general slope towards North. The highest elevation is 1161.29 m above MSL (Mean Sea Level) in S. M. Block (Swamy malai Blcok) of Sandur Range and lowest is 490.73 m above MSL in Bellary Range.

The Bellary – Hospet region forms a part of the 'Sandur Schist Belt', referable as, the "Dharwars", a group of Precambrian schistose rocks of Mysore. The lithological units include green stones, which are the metamorphosed basic igneous rocks occupying the valley regions, with phyllite – quartzite's forming the canoe-shaped amphitheater of hills, trending NNW—SSE and enclosing Sandur. The phyllites are locally shaly and the quartzites are of the nature of banded hematite jaspers, and banded hematite quartzite's, inter banded with each other. The banded hematite jaspers, the important source rocks for the iron ores in the area are prominent in the northern and western part of the ranges, where as the associated shale's become prominent in the southern and eastern parts of the area. The iron ores form a capping over the quartzite's and shale's and overlie a sequence of manganiferous phyllitic rocks. Lateritisation is widespread in most of the flat topped ridges.

Structurally, the Sandur hills form a tightly folded synclinorium, plunging gently to NNW and the hill ranges broadly delineate the folded limbs of synclines, with close repetition of strata due to minor folds. The strike of the ore bodies is generally parallel to the trend of the hill ranges; the dips are often steep, being vertical at number of places. Opposing dips towards NE and SW are found as in the Ramandurg and NEB ranges respectively.

Bellary-Hospet deposits are one of the four major known concentrations of high-grade iron ore occurrences within the country. The iron ore deposits of NEB range form a part of the Bellary-Hospet group of iron ore deposits and occupy the Northern tip of Sandur Synclonorium. These deposits lie on the Northern flanks of Sandur basin.

As explained in the introduction, 5 villages within the range of 10 KM radius from the Bellary- Hospet – Sandur region was considered as study area, including 1 Control village, where there are no mines surrounded and very bleak movement of iron ore loaded vehicles with in the village. The following paras describe the general socio-demographic and environmental characteristics of the study area.

3.2. DETAILS OF STUDY AREA

The research study area is considered as 10 km radius as shown in **Figure 2**, comprising of following villages;

Table 3.1 Details of Study Villages

Quadrant I	Quadrant II	Quadrant III	Quadrant IV
Kakubal village	Dowlatpur village	Susheelanager village	Jaisinghpur village
Joga village	Dharmapur	Siddapur village	Papinayakanahalli village
Gundlavaddigere village		Ramgad village	
Bylavaddigere village		Vadrahalli village	

Even though there are 12 villages in the radius of 10 KM, the primary survey was carried out in 5 villages viz Jaisingpur Village, PK Halli village, Joga Village, Siddapur village and Vaddarahalli Village. The vaddarahalli village has been considered as reference village as there are no operating mine lease area. The analysis of the individual study villages are explained in the following paras.

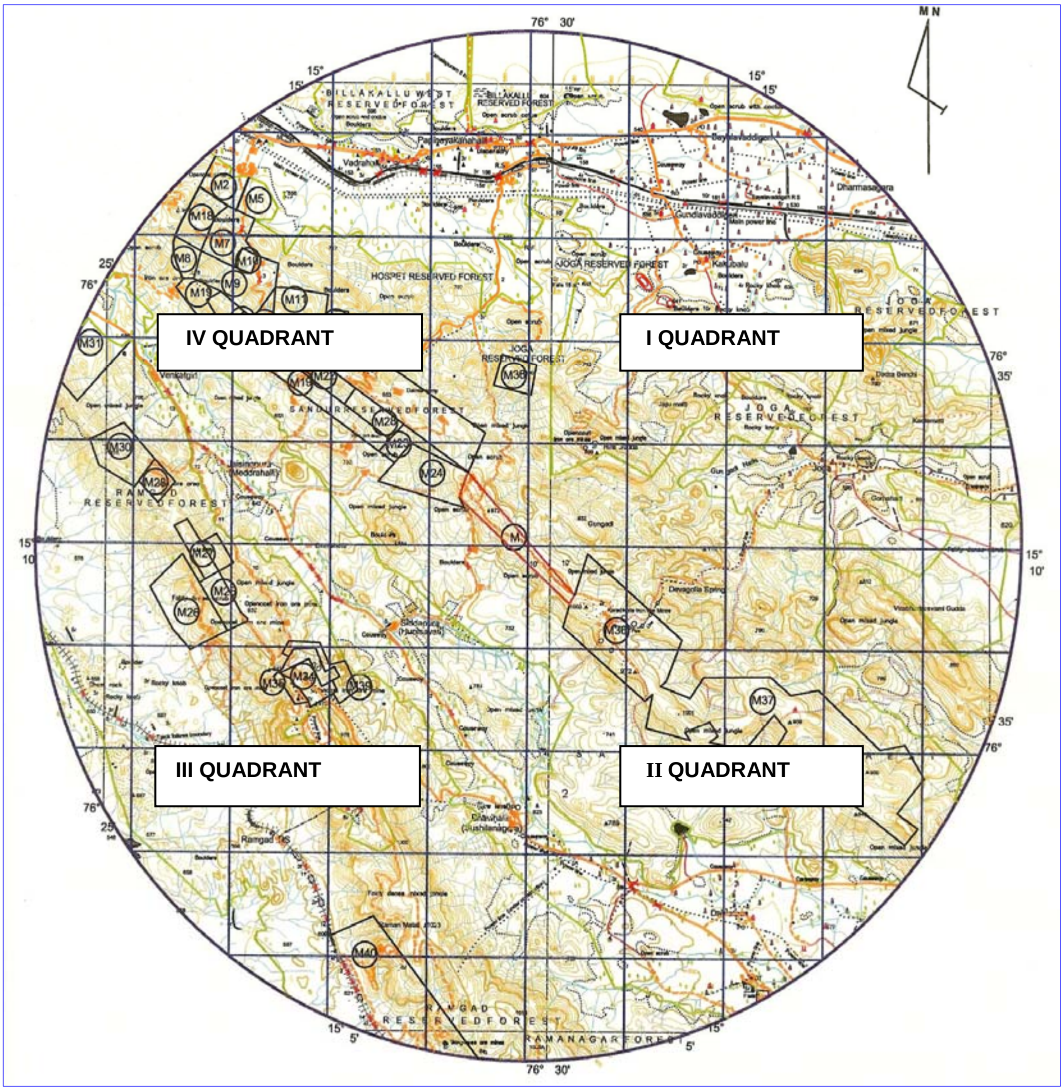


Fig. 3.1: Details of Study area

3.2.1 Jaisingpur Village

The following **Table No 3.2** describes the general characteristic of the Jaisingpur village.

Table 3.2: General Socio-demographic & Environmental Characteristics *(source: census & IMD)*

Sr. No.	Parameters	Details in numbers	
1	Distance from the nearest city in Kms	9	
2	Total Geographical Area (Ha.)	385	
3	Total Cultivable Area (Ha.)	345	
SOCIO-DEMOGRAPHIC DETAILS			
1.	No. of house holds	466	
2	Total Male Population	920	1814
3	Total Female Population	894	
4	Total SC Population	915	
5	Total ST Population	245	
6	Total Others Population	654	
7	No of Literates	549	
8	No of Literates - Up to Primary School	429	
9	No of Literates - Up to Higher Primary School	65	
10	No of Literates - Up to High School	23	
11	No of Literates - Up to Pre-University and above	32	
12	No of Schools	1	
ENVIRONMENTAL CHARACTERISTICS			
1.	Average Rain Fall	505 mm	
2	Temperature		
3	Minimum Temperature	25	
4	Maximum Temperature	37	
5	Relative Humidity		
6	Minimum Relative Humidity	30	
7	Maximum Relative Humidity	77	
8	Wind Speed	8 m/s	
9	Predominant Wind Direction	SE to NE	
10	General Soil Texture	Clayee	
11	Water Holding Capacity in %	45	
12	Iron Content as Fe in %	10.53	

The above table clearly describes that the total population of the village is 1814, out of which the male population is 920 and 894 female. The village has 466 household and gets an average rain fall of 505 mm. The village experiences a maximum temperature of 37 and minimum temperate of 24. The predominant wind direction is SE - NE and the average wind speed is 8 m/s. The general soil texture is Clayee with water holding capacity of 45 %.

There are 3 mines surrounded by this village. The name of the mines operating with in the 5 KM radius of the village along with the extent of mine lease area with aerial distance from the study village is shown below **Table 3.3.**

Table 3.3: Existing Operating Mines *(Source: IBM)*

Sr. No.	Name of the Mine	Extent of Mine Lease area	Aerial distance from the Village in KM
1	Mine -1	36.42	3
2	Mine -2	14	2.5
3	Mine -3	149.73	2.75

The month wise iron ore production carried out by these mines is since from 2002- 2008 is shown in the **Table 3.4** below;

Table 3.4: Month-wise Production Details Since from 2002-2008 (*Source: IBM)*

	Number of Mine Leases - 3					
Year/Month	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**
Apr	87495	10367	94350	140056	20953	43316
May	77345	9076	96769	139194	20824	43050
Jun	65046	9018	79834	118509	17729	36652
Jul	75078	10784	80832	119990	17951	37110
Aug	75045	9018	72577	107735	16118	33320
Sept	69801	9123	93252	138426	20709	42812
Oct	70597	9813	89723	133187	19925	41192
Nov	74987	8918	89814	133322	19945	41234
Dec	74387	9017	102515	152176	22766	47065
Jan	71287	9201	95257	141402	21154	43733
Feb	66459	9218	97117	144163	21567	44587
Mar	67087	7123	99616	147873	22122	45734

3.2.1.1: Ambient Air Quality Status:

The ambient air quality was monitored near Gram Panchayat Office and the data was monitored for 8 days in a month for 3 seasons (9 months in a year excluding monsoon). This monitoring location falls in the fourth quadrant and located on Hospet-Sandur state highway. There are 3 iron ore mine leases are under operation around this village. Various mining companies of NEB range & Ramgad range are utilizing the road, which passes through this village. Season-wise monitoring for various environmental parameters were carried during

Summer, Post-monsoon & Winter. The ambient air quality data was compiled and the results are shown in the **Figure 3.2 to Figure 3.4.**

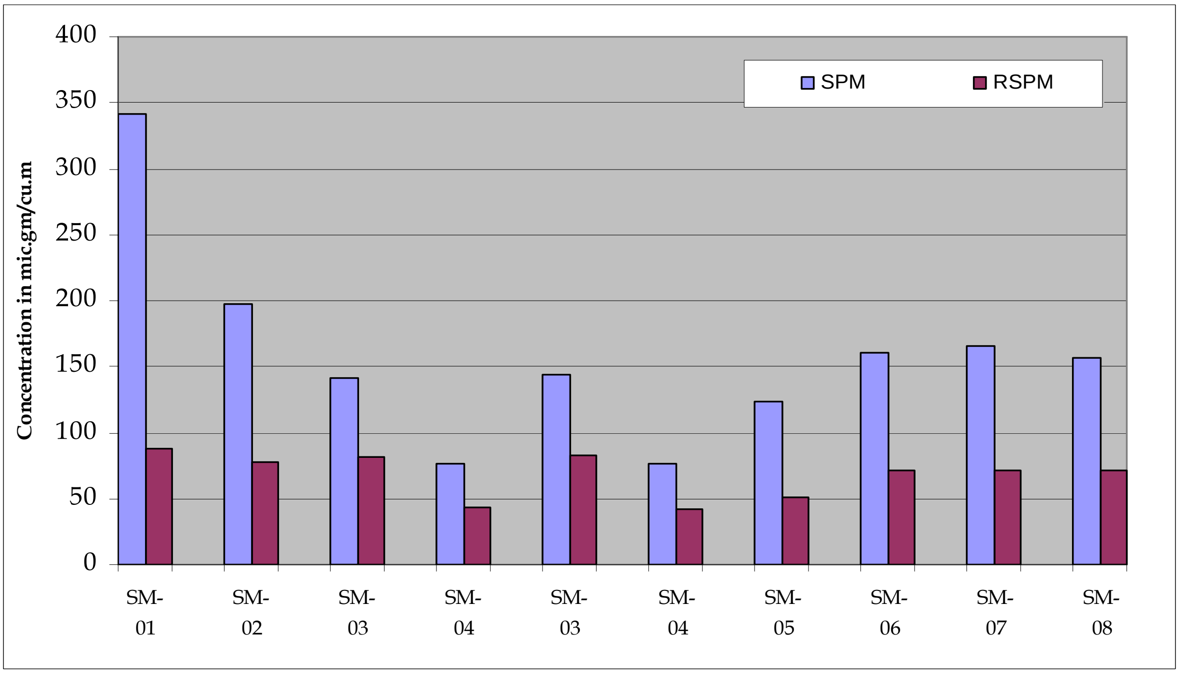


Fig. 3.2: Pollutant Concentration in Jaisinghpur Village during Summer

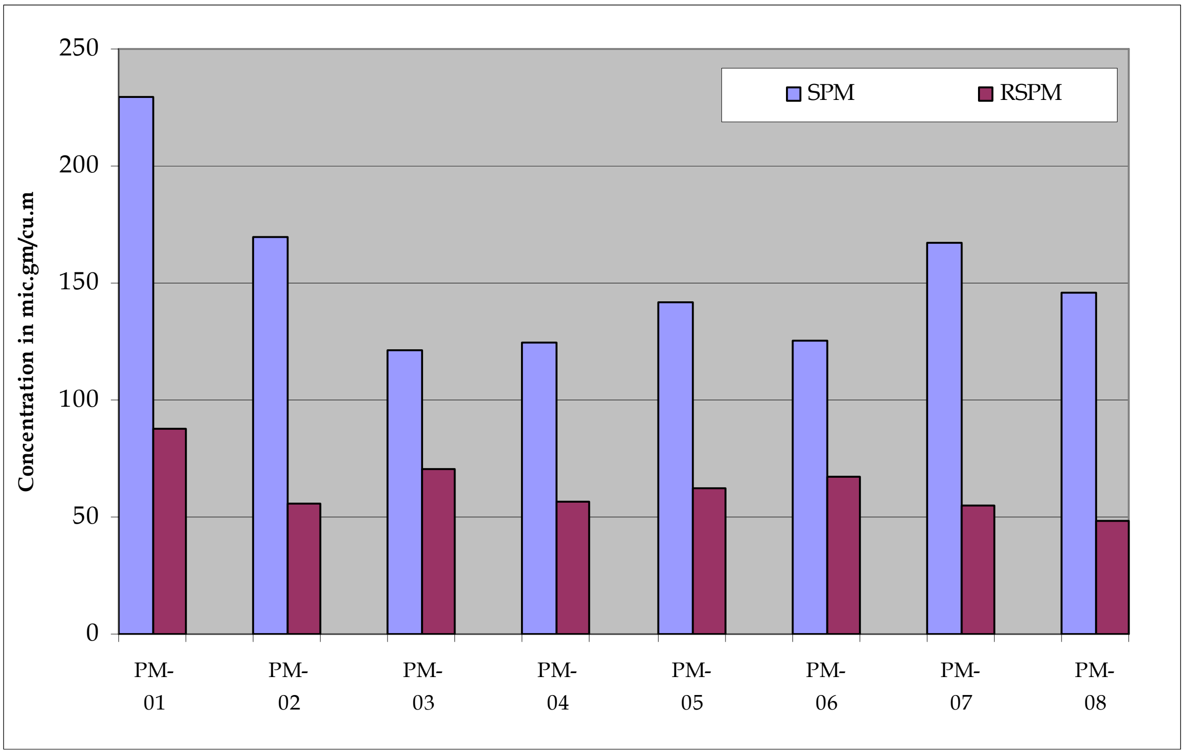


Fig. 3.3: Pollutant Concentration in Jaisinghpur Village during Post-Monsoon

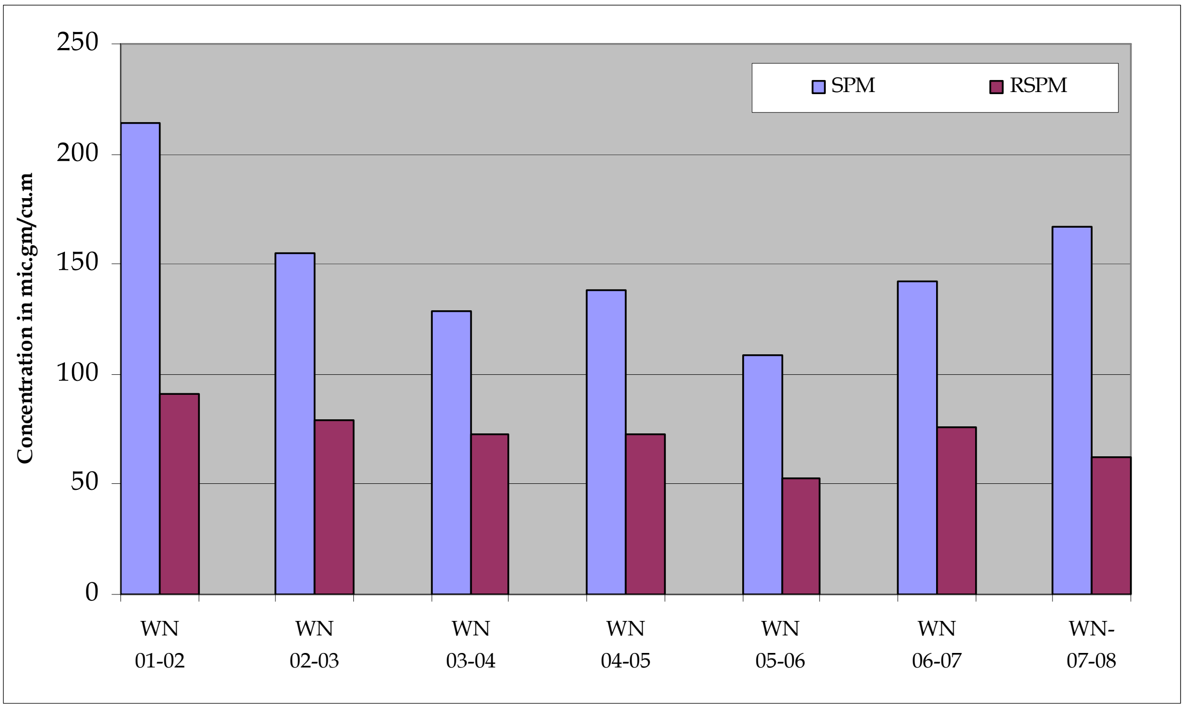


Fig. 3.4: Pollutant Concentration in Jaisinghpur Village during Winter

3.2.1.2: Water Quality Status:

There are no surface water bodies in and around the village. The main source of water is from the bore well situated at Gram Panchayat Office. The ground water quality was analyzed for three seasons taking regular water samples. The details of ground water analysis for the year (taking in to consideration of all the 4 seasons- summer, monsoon, post monsoon and winter) are shown in the following **Table 3.5.**

Table 3.5: Status of Ground Water Quality

Sr. No	Parameters	Results in Winter	Limits IS:10500
1.	Colour (Hazen Units)	Colour less	5
2.	Ambient Temperature ^{o} C	20.7 to 28.7	--
3.	Total Dissolved Solids (mg/l)	640 to 980	500
4.	DO	2.9 to 4.8	-
5.	pH	7.0 to 7.8	6.5 to 8.5
6.	Turbidity (NTU)	0.2 to 10.8	5
7.	Total Suspended Solids (mg/l)	4 to 35	-
8.	BOD for 3 days at 27 ^{o} C	<1	-
9.	COD (mg/l)	<1 to 6	-
10.	Total Iron as Fe (mg/l)	0.21 to 0.40	0.3

Sr. No	Parameters	Results in Winter	Limits IS:10500
11.	Dissolved Phosphate as P (mg/l)	BDL	-
12.	Sodium as Na, mg/l	40 to 90	-
13.	Potassium as K, mg/l	4 to 20.6	-
14.	Calcium as Ca (mg/l)	90 to 180	75
15.	Magnesium as Mg (mg/l)	42 to 95	30
16.	Total Hardness as CaCO3 (mg/l)	440 to 830	300
17.	Chloride as Cl (mg/l)	123 to 240	25
18.	Fluoride as F (mg/l)	0.4 to 1.4	1
19.	Sulphate as SO4 (mg/l)	50 to 104	2200
20.	Nitrate as NO3 (mg/l)	3.35 to 15	45
21.	Alkalinity as CaCO3, mg/l	285 to 750	200
22.	Acidity as CaCO3, mg/l	0.14 to 1.62	--

3.2.1.3 Soil Quality Status

Soil quality assessed through collecting a set of soil samples which represents various land uses within the study area. The analysis of soil samples shows there is no considerable impact on quality of soil even though the mining and its allied activities are from 1950's including drastic increase in annual production from the year 2003-04 onwards. The following **Table 3.6** depicts the quality during different years.

Table 3.6 Soil Characteristics

Sl. No.	Particulars	Results				
		S1	S2	S3	S4	S5
1.	pH (1:2 aqueous solution)	7.1	7.22	6.33	7.35	7.88
2.	Electrical Conductivity (millimhos/cm)	625	550	420	575	760
3.	Nitrogen as N, kg/ Hec	387	265	455	480	420
4.	Phosphorous as P2O5, kg/Hec	54	39	48	94	64
5.	Potassium as K2O2, meq/Hec	220	210	374	405	563
6.	Chloride as Cl (%)	11	10	13	15	17
7.	Iron as HCL Soluble, %	8.2	11.98	10.84	11.88	8.21
8.	Organic matter (%)	0.86	0.66	0.73	0.84	1.06
9.	Sand, %	18	37	20	16	30
10.	Silt , %	37	21	38	43	30
11.	Clay, %	45	42	42	41	40
12.	Texture	Clay	Clay	Clay	Clay	Clay
13.	Water holding capacity, %	52	55	57	55	45

S1 - Agricultural land, S2 - Forest land, S3 - Agricultural land
S4 - Forest land, S5 - Agricultural land

3.2.1.4 Noise Quality Status

Noise quality in the villages has been assessed through monitoring the noise level. Based on the noise level survey, the ambient noise at different villages has increased slightly due to movement of iron ore through tippers/trucks. **Table 3.7** shows the average values of the noise monitored in the selected places of Jaisinghpur village.

Table 3.7 Details of Noise Level

Sr. No.	Period	Average Noise Level in dB (A) Max.	Min.
1	2001	64	53
2	2002	68	47
3	2003	59	40
4	2004	67	47
5	2005	68	48
6	2006	71	51
7	2007	68	49
8	2008	58.6	44.6

3.2.2 Papinayakanahalli Village

This village located on Bellary-Hospet-Honnavar Highway no 63. There is a railway siding facility in this village. In view of the facility lot of iron ore companies utilize the railway yard for their movement of ore to the various ports from where the exports to different countries. This highway also being used by various mine owners for transportation of iron ore through road to various locations. Apart from the mining area. There is one railway siding facility where in the iron ore produced from NEB range is being handled. Hence there is heavy movement of vehicles and handling of heavy earth moving machinery caused fugitive emission in the area finally contributing fro deterioration of air quality in the area. The following **Table No 3.8** describes the general characteristic of the village.

Table 3.8: General Socio-demographic & Environmental Characteristics (*source: cences & imd)*

Sr. No.	Parameters	Details in numbers	
1	Distance from the nearest city in Kms	12	
2	Total Geographical Area (Ha.)	672	
3	Total Cultivable Area (Ha.)	587	
SOCIO-DEMOGRAPHIC DETAILS			
1.	No. of house holds	904	
2	Total Male Population	2433	4795

Sr. No.	Parameters	Details in numbers	
3	Total Female Population	2362	
4	Total SC Population	1407	
5	Total ST Population	864	
6	Total Others Population		
7	No of Literates	2108	
8	No of Literates - Up to Primary School	1314	
9	No of Literates - Up to Higher Primary School	417	
10	No of Literates - Up to High School	349	
11	No of Literates - Up to Pre-University and above	28	
12	No of Schools	2	
ENVIRONMENTAL CHARACTERISTICS			
1.	Average Rain Fall in mm	496.8	
2	Temperature		
3	Minimum Temperature	21.8	
4	Maximum Temperature	40.1	
5	Relative Humidity		
6	Minimum Relative Humidity	23.3	
7	Maximum Relative Humidity	88.7	
8	Wind Speed in m/sec	6.92	
9	Predominant Wind Direction	SE-NW	
10	General Soil Texture	Sandy Clay	
11	Water Holding Capacity in %	50	
12	Iron Content as Fe in %	7.43	

There are 4 mines surrounded by these villages. There are 4 mines surrounded by this village. The name of the mines operating with in the 5 KM radius of the village along with the extent of mine lease area with aerial distance from the study village is shown below **Table 3.9.**

Table 3.9: Existing Operating Mines

Sr. No.	Name of the Mine	Extent of Mine Lease area in Ha	Aerial distance from the Village in KM
1	Mine -1	175.63	8.00
2	Mine -2	80.74	7.00
3	Mine -3	24.28	6.75
4	Mine-4	44.52	6.50

The month wise iron ore production carried out by these mines situated in the vicinity of PK Halli village are since from 2002-2008 is shown in the **Table 3.10** below;

Table 3.10: Month wise Iron Ore Production Details Since 2002-2008

Year/Month	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Apr	92,987.00	10871	118661	161394	88843	169019
May	93,286.00	9112	117931	160401	88296	167979
Jun	80,187.00	8739	110405	136564	75175	143016
Jul	77,056.00	9678	101660	138271	76114	144804
Aug	74,593.00	8349	91278	124149	68341	130015
Sept	70,234.00	8347	117280	159516	87809	165053
Oct	72,312.00	8813	112842	153479	84486	160731
Nov	75,397.00	8234	112956	153635	84572	160893
Dec	75,983.00	8645	128930	175361	96351	183646
Jan	72,569.00	8321	119802	162946	89697	170644
Feb	70,176.00	8345	112141	166127	91448	173976
Mar	71,785.00	9176	125284	170402	93802	178453

From the table, it is clear that, there is a significant increase in annual production of iron ore in the recent years. Such an increase in iron ore production is likely to have a significant effect on the environment. Therefore it is important to study the impact on the environment due to this unexpected increase in annual production of iron ore in this region. An attempt has been made in this paper to make a comparative assessment of this unexpected increase in annual production of iron ore on the environment. It is worth mentioning here that till date no such studies have been conducted in this region to the knowledge of the authors.

3.2.2.1 Ambient Air Quality Status

The ambient air quality was monitored near the primary school for all the seasons. the variation of the air quality is show in the fig below Season-wise monitoring was carried out from Summer to Winter and the assessment of the air quality is shown graphically in the following **Figures 3.5 to 3.7.**

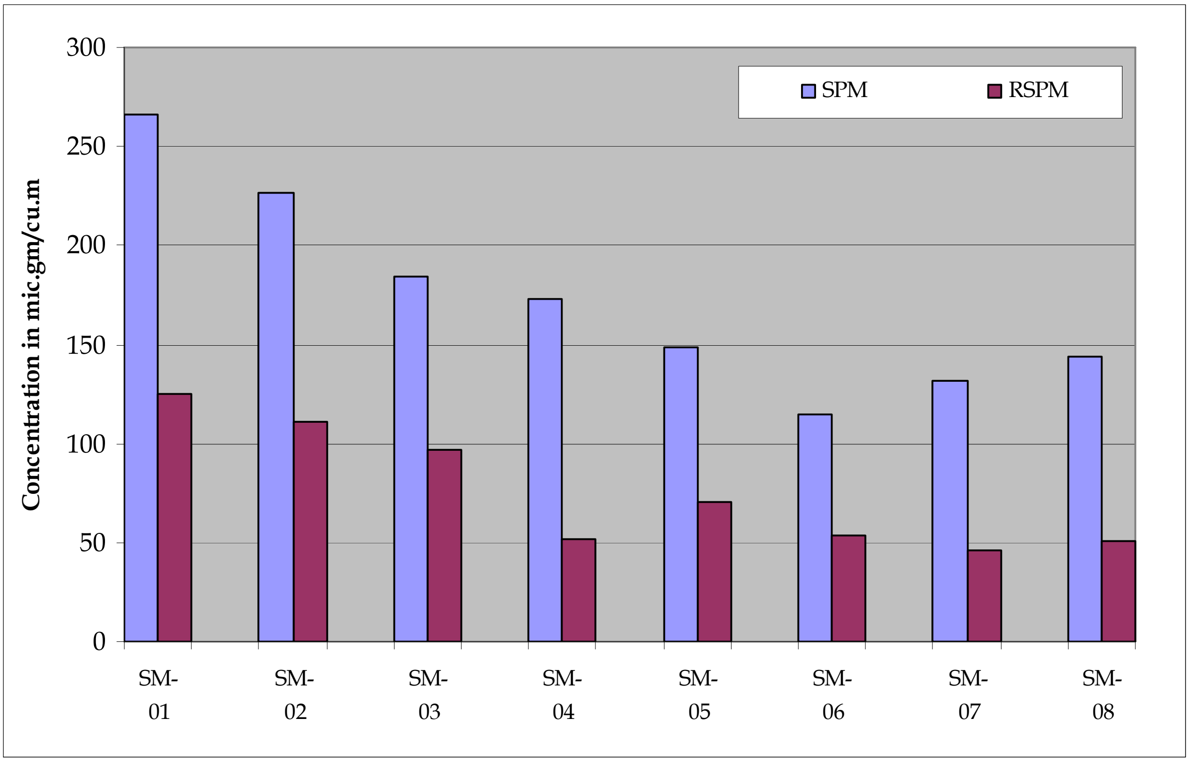


Fig. 3.5: Pollutant Concentration in Papinayakanahalli Village During Summer

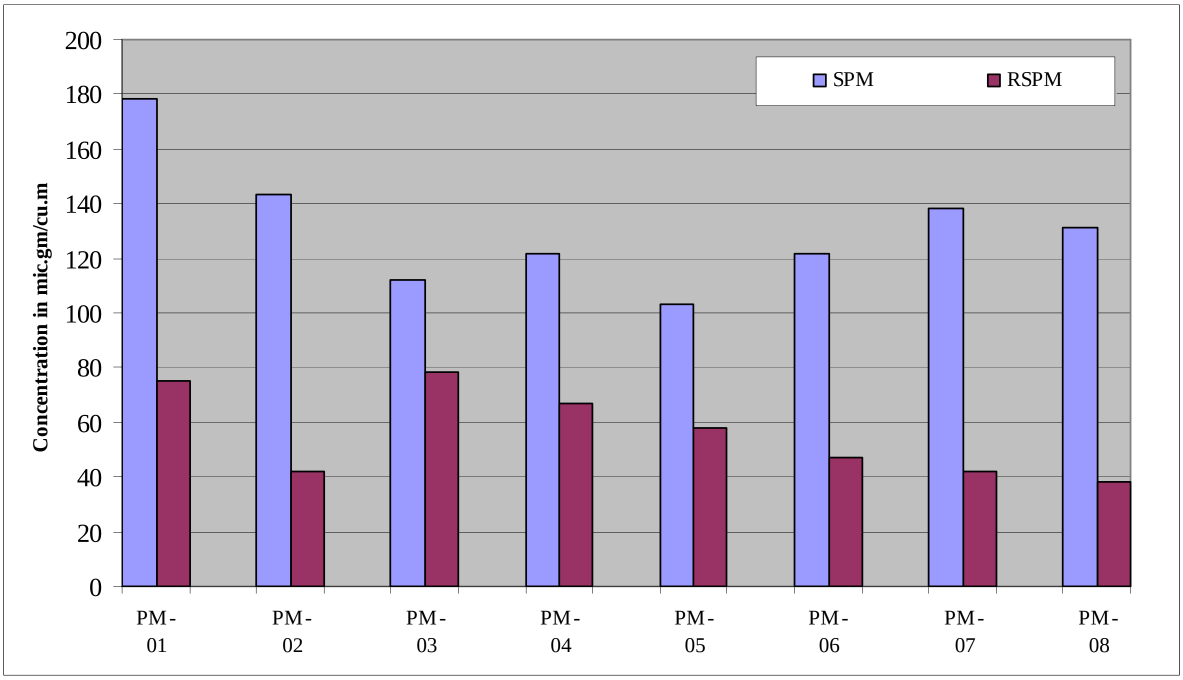


Fig. 3.6: Pollutant Concentration in Papinayakanahalli Village During Post-Monsoon

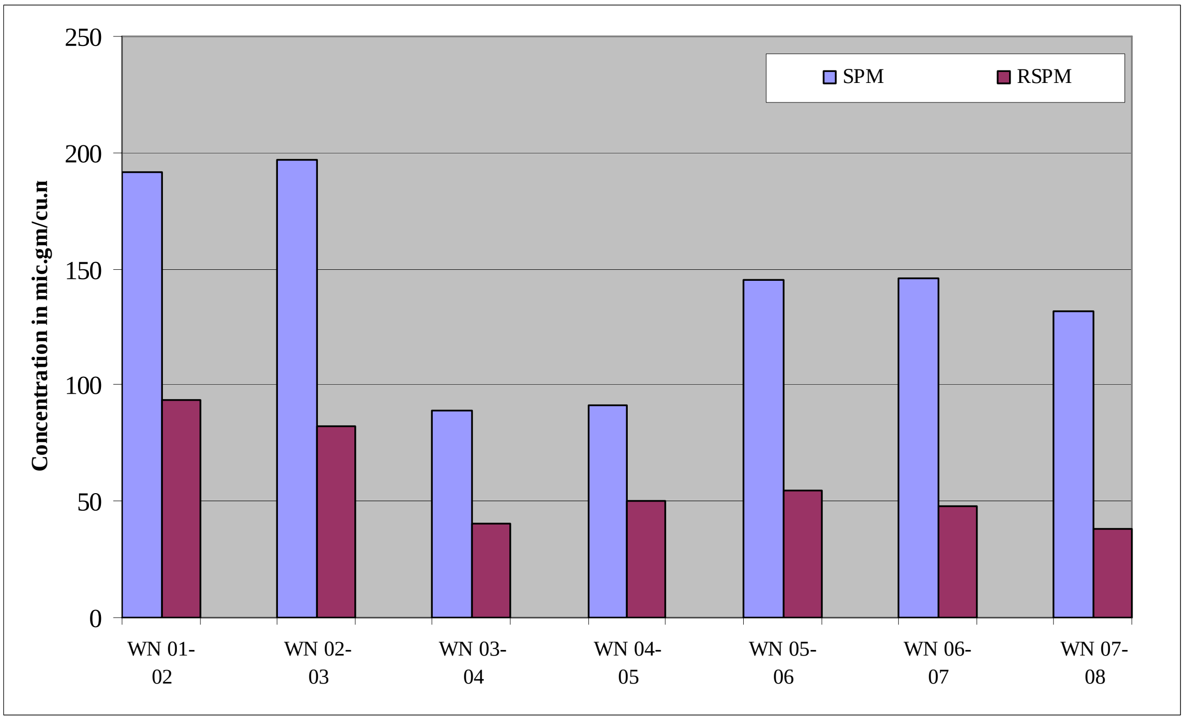


Fig. 3.7: Pollutant Concentration in Papinayakanahalli Village during Winter

3.2.2.2 Water Quality Status

There is a small seasonal nallah flowing in the outskirts of the village. The water sample was collected from the nallah for the purposes of analysis for all the 3 season. The water quality analysis for the specific parameters was carried out in the laboratory. The results of the analysis are tabulated in the following **Table 3.11.**

Table 3.11: Surface Water Quality of Nallah

Sr. No	Parameters	Surface water of nallah
1.	pH	6.8 to 7.7
2.	Total Suspended Solids (mg/l)	11 to 42
3.	Oil & Grease (mg/l)	Nil
4.	Total Iron as Fe (mg/ l)	0.02 to 0.42
5.	Manganese as Mn (mg/l)	Nil
6.	Dissolved Posphate as P (mg/l)	0.02 to 0.42

Apart from the surface water, ground water sample was also collected and analyzed for different parameters. The status of ground water quality is shown in the following **Table 3.12.**

Table 3.12 Status of Ground Water Quality

Sr. No	Parameters	GW2	Limits IS:10500
1.	Colour (Hazen Units)	Colourless	5
2.	Ambient Temperature ^{o} C	23.2 to 28.4	--
3.	Total Dissolved Solids (mg/l)	630 to 760	500
4.	DO	2.8 to 5.8	-
5.	pH	6.8 to 7.4	6.5 to 8.5
6.	Turbidity (NTU)	0.3 to 10	5
7.	Total Suspended Solids (mg/l)	4 to 30	-
8.	BOD for 3 days at 27 ^{o} C	<1	-
9.	COD (mg/l)	<1 to 2.0	-
10.	Total Iron as Fe (mg/l)	0 to 0.26	0.3
11.	Dissolved Phosphate as P (mg/l)	BDL	-
12.	Sodium as Na, mg/l	68 to 120	-
13.	Potassium as K, mg/l	2 to 19.4	-
14.	Calcium as Ca (mg/l)	75 to 120	75
15.	Magnesium as Mg (mg/l)	30 to 74	30
16.	Total Hardness as CaCO3 (mg/l)	365 to 505	300
17.	Chloride as Cl (mg/l)	104 to 165	25
18.	Fluoride as F (mg/l)	0.4 to 1.2	1
19.	Sulphate as SO4 (mg/l)	40 to 92	2200
20.	Nitrate as NO3 (mg/l)	0.5 to 16	45
21.	Alkalinity as CaCO3, mg/l	295 to 450	200
22.	Acidity as CaCO3, mg/l	0.7 to 1.4	--

3.2.2.3 Soil Quality Status

Soil quality assessed through collecting a set of soil samples which represents various land uses within the study area. The analysis of soil samples shows there is no considerable impact on quality of soil even though the mining and its allied activities are from 1950's including drastic increase in annual production from the year 2003-04 onwards. The following **Table 3.13** depicts the quality during different years.

Table 3.13: Soil Quality Characteristics

Sl. No.	Particulars	Results				
		S1	S2	S3	S4	S5
1.	pH (1:2 aqucous solution)	7.24	7.15	7.0	7.25	7.48
2.	Electrical Conductivity (millimhos/cm)	640	540	405	570	745
3.	Nitrogen as N, kg/ Hec	374	250	450	480	410
4.	Phosphorous as P2O5, kg/Hec	51	36	42	88	68

Sl. No.	Particulars	Results				
		S1	S2	S3	S4	S5
5.	Potassium as K2O2, meq/Hec	215	215	378	415	568
6.	Chloride as Cl (%)	13	12	12	17	15
7.	Iron as HCL Soluble, %	7.6	11.46	10.44	12.25	8.0
8.	Organic matter (%)	0.76	0.54	0.79	0.73	0.95
9.	Sand, %	20	34	25	17	32
10.	Silt, %	35	25	42	39	28
11.	Clay, %	45	41	33	44	40
12.	Texture	Clay	Clay	Clay	Clay	Clay
13.	Water holding capacity, %	55	60	54	60	47

S1 - Agricultural land, S2 - Forest land, S3 - Agricultural land
S4 - Forest land, S5 - Agricultural land

3.2.2.4 Noise Quality Status

Noise quality in the villages has been assessed through monitoring the noise level. Based on the noise level survey, the ambient noise at different villages has increased slightly due to movement of iron ore through tippers/trucks. **Table 3.14** depicts the noise quality carried out in the selected places with in the village.

Table 3.14: Details of Noise Level

Sr. No.	Period	Average Noise Level in dB (A)	
		Max.	Min.
1	2001	67	57
2	2002	69	61
3	2003	70	59
4	2004	71.15	56.8
5	2005	67.6	49.3
6	2006	73.5	59.3
7	2007	68.9	48.4
8	2008	67.9	46.9

3.2.3 Joga Village

This village is falls in first quadrant in the study area. There is no much mining activity going on close to this village. However, iron ore carrying trucks are plying through this village. Condition of this village road after movement of trucks has become good to bad. Therefore the monitoring values of various pollutants in this village during different seasons are observed to be at higher side. The following T**able 3.15** graphs show the concentration of various pollutants during summer, post-monsoon and winter seasons.

Table 3.15: General Socio-demographic & Environmental Characteristics *(Source: Census & imd)*

Sr. No.	Parameters	Details in numbers	
1	Distance from the nearest city in Kms	15	
2	Total Geographical Area (Ha.)	451	
3	Total Cultivable Area (Ha.)	260	
SOCIO-DEMOGRAPHIC DETAILS			
1.	No. of house holds	140	
2	Total Male Population	570	1148
3	Total Female Population	548	
4	Total SC Population	11	
5	Total ST Population	959	
6	Total Others Population	148	
7	No of Literates	181	
8	No of Literates - Up to Primary School	141	
9	No of Literates - Up to Higher Primary School	9	
10	No of Literates - Up to High School	31	
11	No of Literates - Up to Pre-University and above	Nil	
12	No of Schools	1	
ENVIRONMENTAL CHARACTERISTICS			
1.	Average Rain Fall in mm	526	
2	Temperature		
3	Minimum Temperature	22.8	
4	Maximum Temperature	39.2	
5	Relative Humidity		
6	Minimum Relative Humidity	14.9	
7	Maximum Relative Humidity	97.8	
8	Wind Speed in m/sec	6.44	
9	Predominant Wind Direction	WE	
10	General Soil Texture	Clayey	
11	Water Holding Capacity in %	40	
12	Iron Content as Fe in %	9.52	

There are 1 mines surrounded by this villages. The name of the mines operating with in the 5 KM radius of the village along with the extent of mine lease area with aerial distance from the study village is shown below **Table 3.16.**

Table 3.16: Existing Operating Mines

Sr. No.	Name of the Mine	Extent of Mine Lease area in Ha	Aerial distance from the Village in KM
1	Mine -1	123.84	3.5

Table 3.17: Month wise Iron Ore Production of the Mine Since 2002- 2008

Year/Month	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Apr	32,769.00	9867	80272	28451	11899	22734
May	12,397.00	10367	79778	28275	11826	22594
Jun	9,010.00	5781	67923	24074	10069	19237
Jul	20,868.00	5398	68772	24374	10195	19477
Aug	8,541.00	3876	61748	21885	9153	17488
Sept	5,018.00	2985	79338	28119	11761	22470
Oct	5,043.00	3128	76336	27055	11316	21619
Nov	2,067.00	2634	76413	27083	11327	21641
Dec	1,089.00	3128	87219	30913	12929	24702
Jan	1,178.00	3078	81044	28724	12014	22953
Feb	1,121.00	3287	82626	29285	12248	23401
Mar	1,023.00	3278	84753	30039	12564	24003

3.2.3.1 Ambient Air Quality Status

The season-wise monitoring for Joga village was carried out from summer to winter and the assessment of the air quality is given in the following **Figure 3.8 to 3.10.**

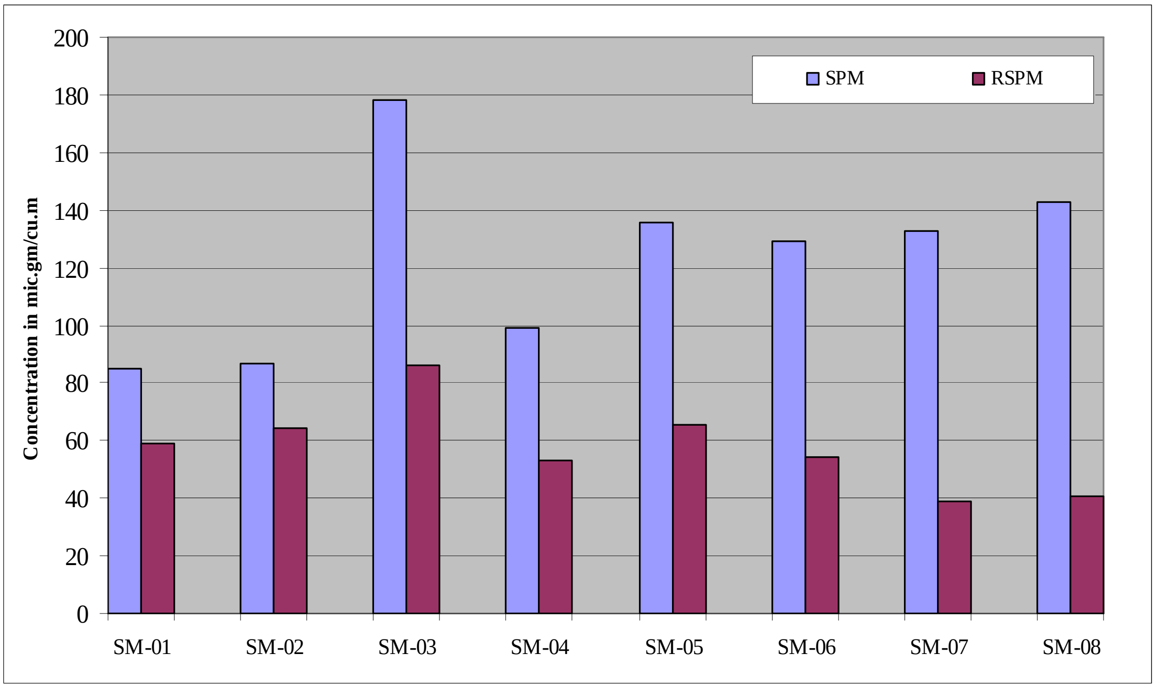


Fig. 3.8: Pollutant Concentration in Joga Village during Summer

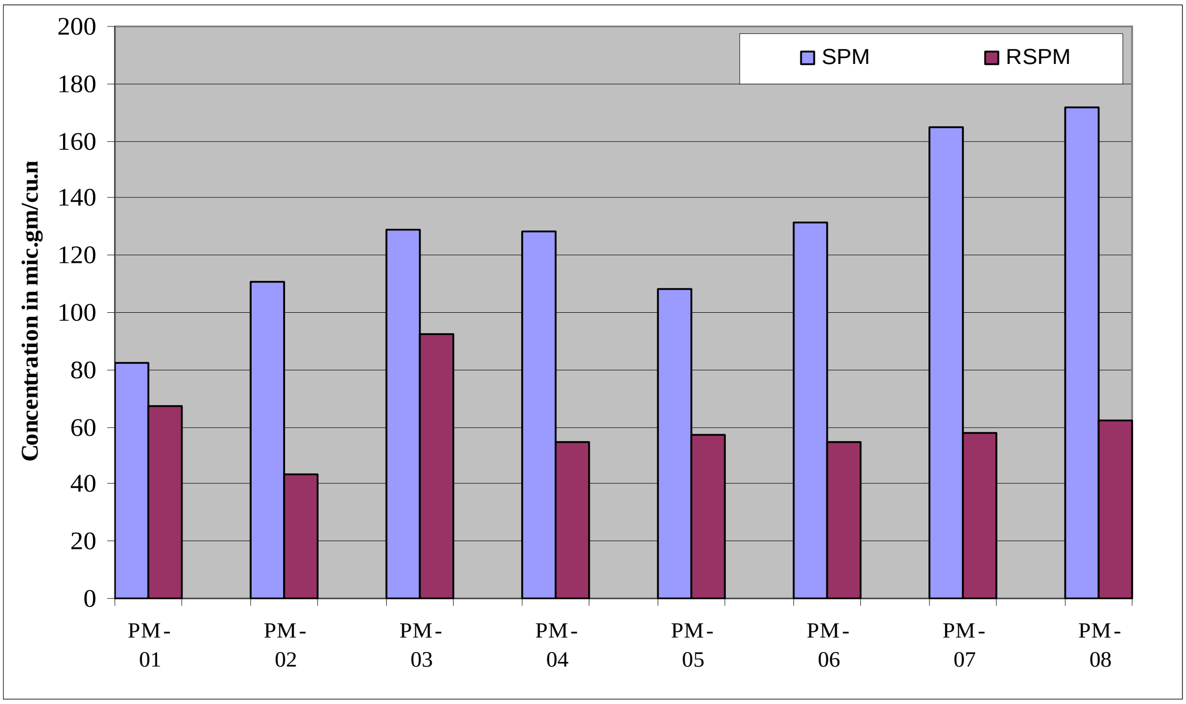


Fig. 3.9: Pollutant Concentration in Joga Village during Post-Monsoon

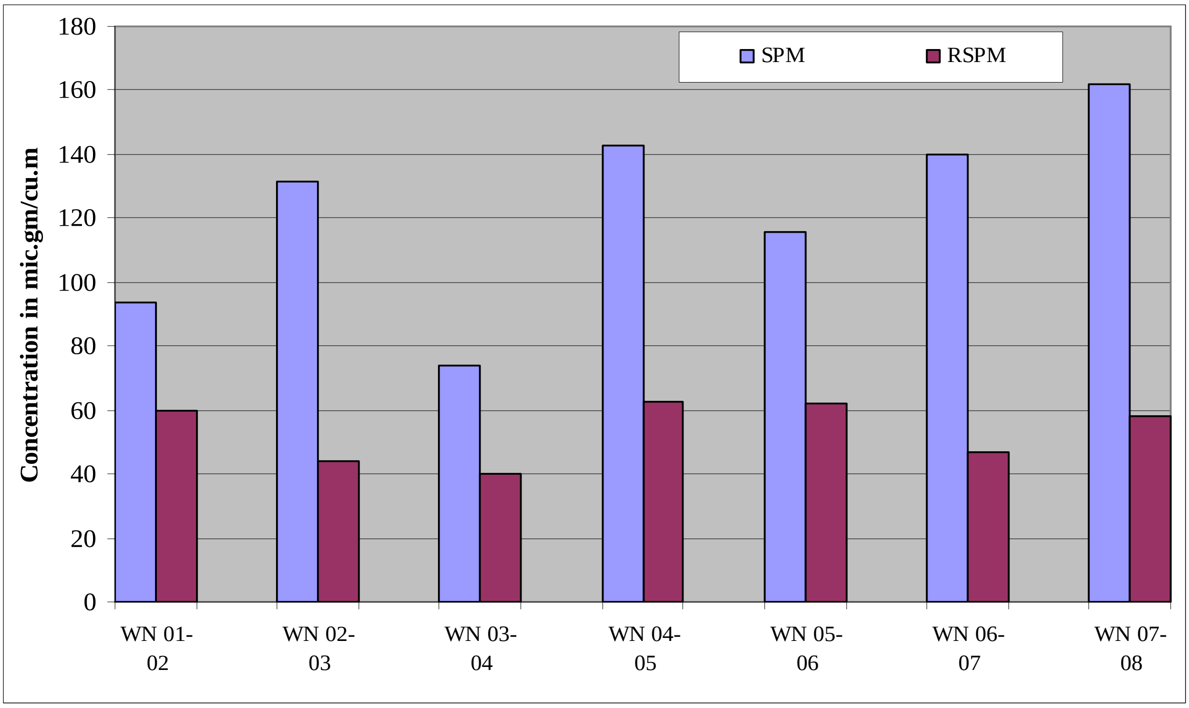


Fig. 3.10: Pollutant Concentration in Joga Village during Winter

3.2.3.2 Water Quality Status

There is a nallah at a distance of 1.5 KM from the village. The water quality was analyzed for all the seasons. The status of surface water quality is shown in the **Table 3.18** below

Table 3.18: Status of Surface Water Quality

Sr. No	Parameters	SW2
1.	pH	7.2 to 7.9
2.	Total Suspended Solids (mg/l)	8 to 36
3.	Oil & Grease (mg/l)	Nil
4.	Total Iron as Fe (mg/ l)	0.2 to 1.1
5.	Manganese as Mn (mg/l)	Nil
6.	Dissolved Phosphate as P (mg/l)	BDL

From the above table it can be observed that the surface water quality is meeting the standard with respect to all the analyzed parameters.

Similarly the ground water sample was collected from the bore well situated near the residential colony (Community water tank). The water quality parameters were analyzed for different parameters for all the season. The ground water status is shown in the following **Table 3.19.**

Table 3.19: Status of Ground Water Quality

Sr. No	Parameters	GW1	GW2	GW3	Limits IS:10500
1.	Colour (Hazen Units)	Colour less	Colourless	Colourless	5
2.	Ambient Temperature ^{o} C	25.8 to 27.0	25.6 to 28.2	25.9 to 28.4	--
3.	Total Dissolved Solids (mg/l)	620 to 650	710 to 720	390 to 430	500
4.	DO	2.9 to 3.8	2.3 to 3.8	2.8 to 3.5	-
5.	pH	7.4 to 7.5	7.3 to 7.5	7.3 to 7.8	6.5 to 8.5
6.	Turbidity (NTU)	4.7 to 10.6	5.3 to 16.1	0.4 to 2.6	5
7.	Total Suspended Solids (mg/l)	7 to 12	10 to29	7 to 16	-
8.	BOD for 3 days at 27 ^{o} C	<1	<1	<1 to 1.8	-
9.	COD (mg/l)	7.80 to 13.67	3.12 to 17.09	3.6 to 13.25	-
10.	Total Iron as Fe (mg/l)	0.1 to 0.27	0.11 to 0.32	0.12 to 0.17	0.3
11.	Dissolved Phosphate as P (mg/l)	0.028 to 0.042	0.024 to 0.054	0.0134 to0.038	-
12.	Sodium as Na, mg/l	50.2 to 60.4	64.1 to 87.1	23 to 38.4	-

Sr. No	Parameters	GW1	GW2	GW3	Limits IS:10500
13.	Potassium as K, mg/	1.2 to 1.9	0 to 2.7	0. 1to 1.3	-
14.	Calcium as Ca (mg/l)	65 to 74.54	46.49 to 65	36.87 to 50.5	75
15.	Magnesium as Mg (mg/l)	63.06 to 73.79	45 to 69.43	37.37 to 46.17	30
16.	Total Hardness as CaCO3 (mg/l)	422 to 490	350 to 402	280 to 310	300
17.	Chloride as Cl(mg/l)	74.48 to 124.65	116.26 to 117.04	64.13 to 78	25
18.	Fluride as F(mg/l)	0.4	0.4	1.2 to 1.6	1
19.	Sulphite as SO4 (mg/l)	23.5 to 42	31 to 40	20 to 27	2200
20.	Nitrate as NO3(mg/l)	3.2 to 4.9	1.4 to 4.25	0.7 to 2.4	45
21.	Alkalinity as CaCO3, mg/l	350 to 480	450 to 540	305 to 325	200
22.	Acidity as CaCO3, mg/l	0.28 to 0.56	0.14 to 0.49	0.91 to 0.98	--

3.2.3.3 Soil Quality Status

Soil quality assessed through collecting a set of soil samples which represents various land uses within the study area. The analysis of soil samples shows there is no considerable impact on quality of soil even though the mining and its allied activities are from 1950's including drastic increase in annual production from the year 2003-04 onwards. The following **Table 3.20** depict the soil quality of the Villages.

Table 3.20: Soil Quality Characteristics

Sl. No.	Particulars	S2	S3	S4	S4	S5
1.	pH (1:2 aqueous solution)	6.39	7.26	4 .36	5.4	5.45
2.	Electrical Conductivity (millimhos/cm)	1230	1000	1260	1290	1260
3.	Organic Carbon %	0.246	0.210	0.239	0.061	0.282
4.	Phosphorus as P_2O_5, Kg/Hec	89.60	14.34	50.18	39.42	93.18
5.	Potassium as K_2O, Kg/Hec	69.44	71.904	17.92	13.888	109.76
6.	Chloride as Cl, mg/100 gm	23.04	3.55	19.5	1.77	17.73
7.	Iron (Hcl Solubles), %	8.79	2.93	15.39	6.81	18.59
8.	Water Holding Capacity%	66.35	39.07	59.22	29.48	54.68

Sl. No.	Particulars	S2	S3	S4	S4	S5
9.	Sand %	99.64	96.28	99.319	99.48	98.95
10.	Silt, %	0.127	2.31	0.157	0.277	0.34
11.	Clay, %	0.233	1.41	0.524	0.243	0.71
12.	Texture	Sandy	Sandy	Sandy	Sandy	Sandy

S1 - Agricultural land, S2 - Forest land, S3 - Agricultural land
S4 - Forest land, S5 - Agricultural land

3.2.3.4 Noise Quality Status

Noise quality in the villages has been assessed through monitoring the noise level. Based on the noise level survey, the ambient noise at different villages has increased slightly due to movement of iron ore through tippers/trucks. The noise level carried out in the selected locations with in the village is shown in the following **Table 3.21.**

Table 3.21 Details of Noise Level

Sr. No.	Period	Average Noise Level in dB (A) Max.	Min.
1	2001	56	45
2	2002	60.2	40.8
3	2003	58.3	40.9
4	2004	59.6	40.03
5	2005	59.9	40.6
6	2006	60.02	39.2
7	2007	58.9	39.9
8	2008	60.3	39.4

3.2.4 Siddapura Village

Table: 3.22 General Socio- Demographic & Environmental Characteristics *(source: census & imd)*

Sr. No.	Parameters	Details in numbers	
1	Distance from the nearest city in Kms	15	
2	Total Geographical Area (Ha.)	451	
3	Total Cultivable Area (Ha.)	260	
4	No. of house holds	140	
5	Total Male Population	570	1118
6	Total Female Population	548	
7	Total SC Population	11	
8	Total ST Population	959	
9	Total Others Population	148	
10	No of Literates	181	
11	No of Literates - Up to Primary School	141	
12	No of Literates - Up to Higher Primary School	9	
13	No of Literates - Up to High School	31	
14	No of Literates - Up to Pre-University and above	Nil	
15	No of Schools	1	
ENVIRONMENTAL CHARACTERISTICS			
1.	Average Rain Fall in mm	528.28	
2	Temperature		
3	Minimum Temperature	24	
4	Maximum Temperature	39.2	
5	Relative Humidity		
6	Minimum Relative Humidity	18	
7	Maximum Relative Humidity	79.2	
8	Wind Speed in m/sec	4.8	
9	Predominant Wind Direction	East - West	
10	General Soil Texture	Clay	
11	Water Holding Capacity in %	55	
12	Iron Content as Fe in %	10.56	

There are 3 mines surrounded by this village. The name of the mines operating with in the 5 KM radius of the village along with the extent of mine lease area with aerial distance from the study village is shown below **Table 3.23.**

Table 3.23: Existing Operating Mines

Sr. No.	Name of the Mine	Extent of Mine Lease area in Ha	Aerial distance from the Village in KM
1	Mine -1	36.42	3.5
2	Mine -2	44.13	3.75
3	Mine-3	30.76	4.25

Table 3.24: Month wise Iron Ore Production of the Mine Since 2002- 2008

Year/Month	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Apr	45,687.00	10564	60510	64421	50548	146667
May	23,890.00	981	60137	64025	50237	145765
Jun	39,898.00	845	51201	54510	42772	124103
Jul	30,890.00	9017	51841	55192	43306	125655
Aug	20,891.00	9967	46546	49555	38883	112821
Sept	10,897.00	10563	59806	63672	49960	144961
Oct	10,524.00	10736	57542	61262	48070	139475
Nov	10,786.00	9639	57601	61324	48118	139616
Dec	9,834.00	9210	65746	69996	54923	159360
Jan	9,129.00	9456	61092	65041	51034	148078
Feb	10,761.00	8183	62284	66310	52031	150969
Mar	10,762.00	8918	63887	68017	53370	154854

3.2.4.1 Ambient Air Quality Status

The season-wise monitoring for Siddapur village was carried out for all the seasons as per the procedure and the assessment of the air quality is given in the following fig**.** This village located on Hospet-Sandur state highway. This road is being extensively by iron ore carrying trucks to reach railway siding facility located at Hospet. From the **Figures 3.11 to 3.13** we can see that, the pollutants concentration observed was significantly high compared to subsequent years even though there was a drastic increase in annual production in the region.

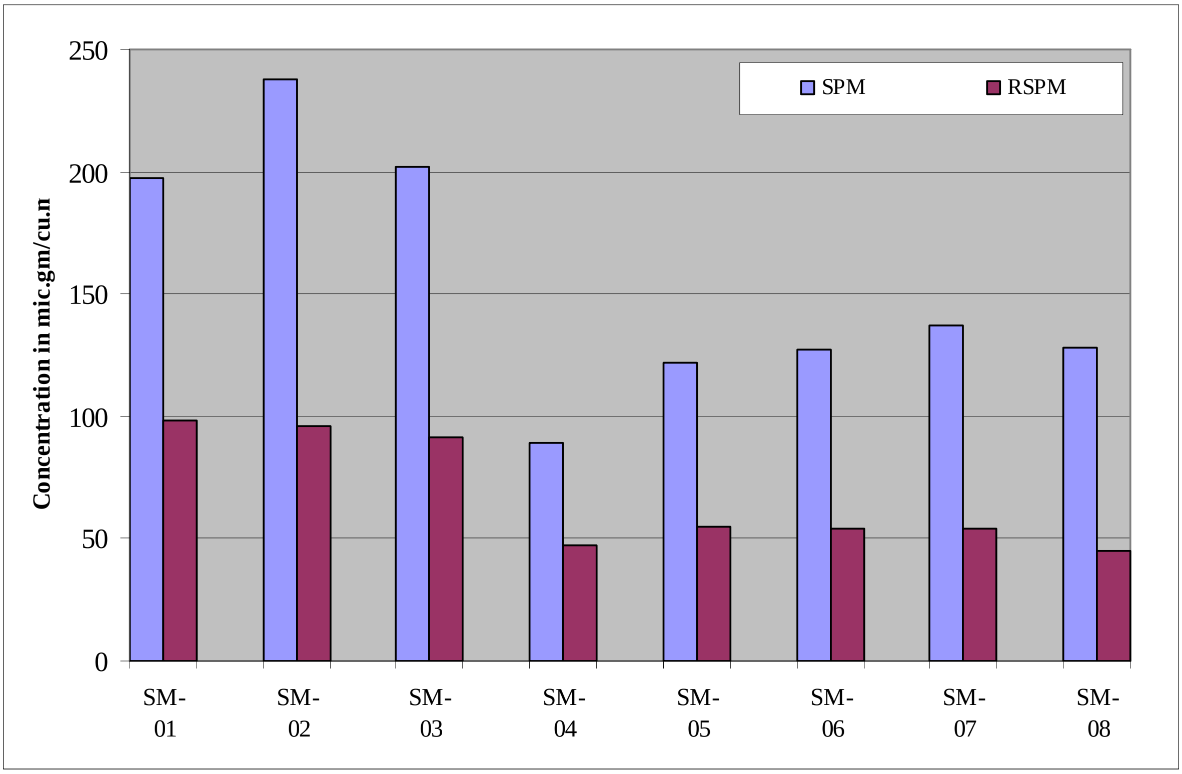


Fig. 3.11: Pollutant Concentration in Siddapur Village during Summer

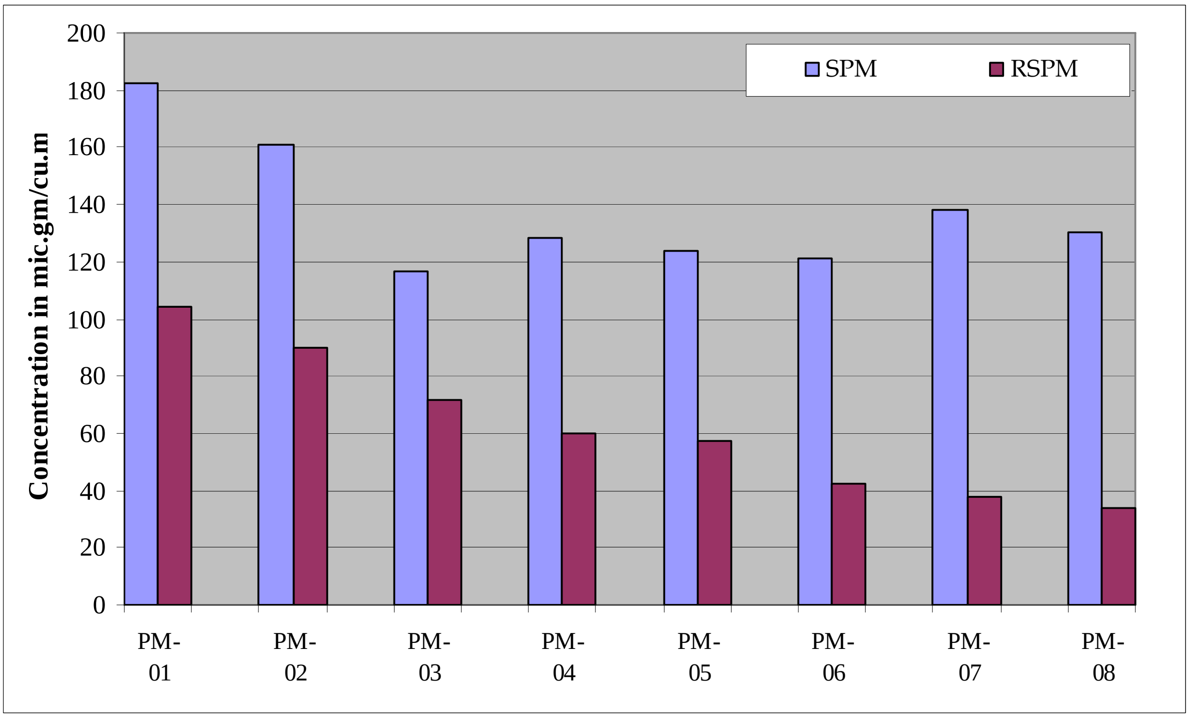


Fig. 3.12: Pollutant Concentration in Siddapur Village during Post-Monsoon

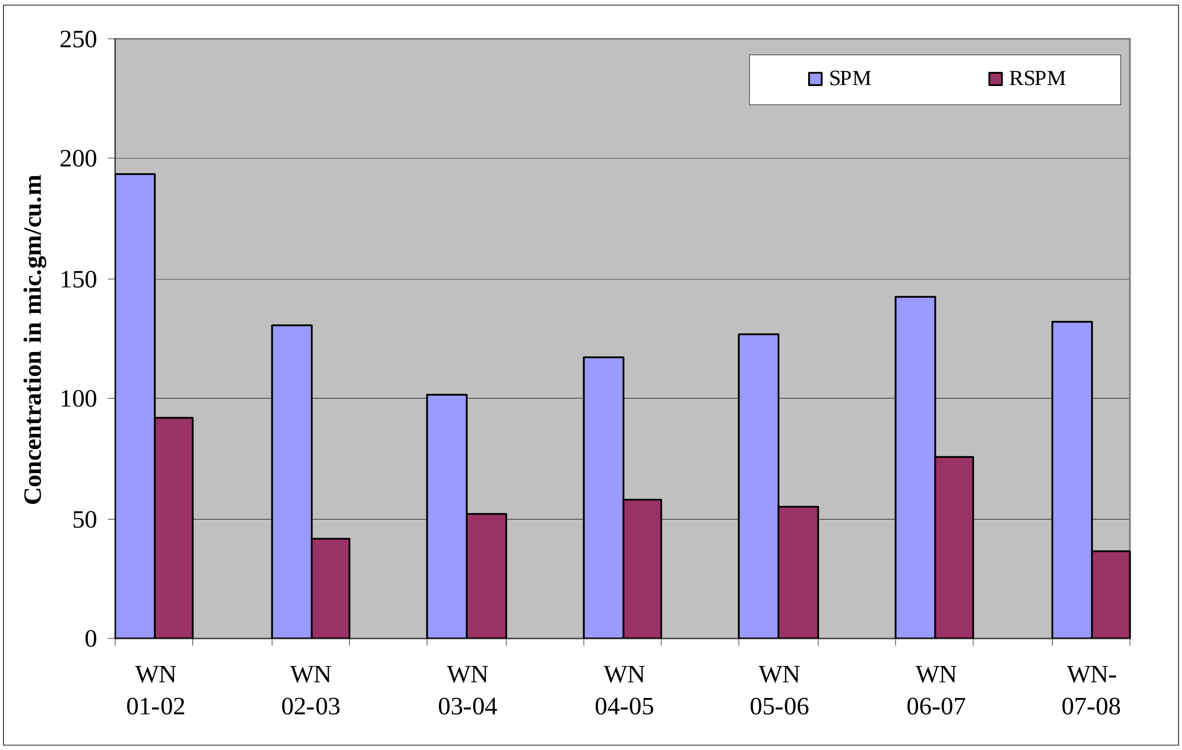


Fig. 3.13: Pollutant Concentration in Siddapur Village during Winter

3.2.4.2 Water Quality Status

Water quality assessment was carried out by drawing set of ground water and surface water samples and analyzed for various physical & chemical properties. Ground water samples were analyzed for various parameters as per IS: 10500 and surface water samples were analyzed for different parameters as per Indian Bureau of Mines (IBM), draft circular 2003.

The sample analysis report during the year 2001 and 2006 is shown in the below T**able 3.25.**

Table No. 3.25: Status of Surface Water Quality

Sr. No	Parameters	SW1
1.	pH	7.2 to 7.4
2.	Total Suspended Solids (mg/l)	60 to 65
3.	Oil & Grease (mg/l)	Nil
4.	Total Iron as Fe (mg/ l)	0.5 to 1.0
5.	Manganese as Mn (mg/l)	Nil
6.	Dissolved Phosphate as P (mg/l)	BDL

Similarly the ground water sample was collected from the bore well situated within the village near the school (Community water tank). The water quality parameters were analyzed for different parameters for all the season. The ground water status is shown in the following **Table 3.26.**

Table 3.26: Status of Ground Water Quality

Sr. No.	Parameters	GW1	GW2	GW3	Limits IS:10500
1.	Colour (Hazen units)	Colourless	Colourless	Colourless	5
2.	Ambient Temperature ^{0}C	26.6 to 32.4	25.8 to 30.1	24.7 to 31.4	--
3.	Total Dissolved Solids (mg/1)	980 to1250	630 to 780	430 to 520	500
4.	DO	2.6 to 3.1	2.4 to 3.8	2.3 to 2.9	-
5.	pH	7.0 to 7.5	7.2 to 7.6	7.4 to 7.8	6.5 to 8.5
6.	Turbidity (NTU)	1.8 to 23.1	2.8 to 10.5	0.9 t5o 5.2	5
7.	Total Suspended Solids (mg/1)	5 to 12	4 to 10	6 to 15	-
8.	BOD for 3 days at 27°C (mg/l)	<1	<1	<1 to 1.5	-
9.	COD (mg/l)	3.59 to 25.20	1.79 to 9.26	1.57 to 7.4	-
10.	Total Iron as Fe. (mg/1)	0.23 to 0.78	0.32 to 0.97	0.12 to 0.67	0.3
11.	Dissolved Phosphate as P (mg/1)	0.003 to 0.11	0.03 to 0.18	0.02 to 0.15	-
12	Sodium as Na, (mg/l)	62.3 to 87.2	64.7 to 75.9	55.2 to 76.4	-
13.	Potassium as K, (mg/l)	1.6 to 16.4	0.6 to 6.2	0.1 to 5.4	-
14.	Calcium as Ca (mg/1)	202.80 to 272.54	96.18 to 126.65	32.68 to 40.08	75
15.	Magnesium as Mg (mg/1)	36.95 to 103.73	20.24 to 60.82	38.22 to 52	30
16.	Total Hardness as $CaCO_3$ (mg/1)	825 to 1085	390to 524	270 to 352	300
17.	Chloride as Cl (mg/1)	264.28 to 319.67	99.75 to 118.59	27.46 to 51.44	25
18.	Flouride as F.(mg/1)	0.2 to 0.8	0.2 to 0.8	0.40	1
19.	Sulphate as SO_4 (mg/1)	21.5 to 47.5	12.5 to 24.5	5 to 14.5	2200
20.	Nitrate as NO3 (mg/l)	5.0 to 12.45	3.3 to 5.40	0.35 to 3.6	45
21.	Alkalinity as CaCO3, (mg/l)	382 to 509.51	430 to 550	318 to 380	200
22.	Acidity as CaCO3, (mg/l)	0.55 to 1.25	0.27 to 1.19	Nil to 0.96	--

3.2.3.3 Soil Quality Status

Soil quality assessed through collecting a set of soil samples which represents various land uses within the study area. The analysis of soil samples shows there is no considerable impact on quality of soil even though the mining and its allied activities are from 1950's including drastic increase in annual production from the year 2003-04 onwards. The following **Table 3.27** depicts the quality during different years.

Table 3.27 Soil Quality Characteristics

Sl. No.	Particulars	Results				
		S1	S2	S3	S4	S5
1.	pH (1:2 aqueous solution)	8.06	7.12	7.1	7.11	8.36
2.	Electrical Conductivity (millimhos/cm)	272	420	385	535	363
3.	Nitrogen as N, kg/ Hec	360	225	390	450	430
4.	Phosphorous as P2O5, kg/Hec	48	30	40	90	32.9
5.	Potassium as K2O2, meq/Hec	24.4	170	365	335	181.27
6.	Chloride as Cl (%)	19.5	11.5	9	14	3.2
7.	Iron as HCL Soluble, %	6.86	14.22	11.12	10.86	7.84
8.	Organic matter (%)	0.80	0.61	0.85	0.72	1.37
9.	Sand, %	86	35	15	20	94
10.	Silt , %	12	30	40	35	5
11.	Clay, %	0.8	35	45	45	0.1
12.	Texture	Clay	Clay	Clay	Clay	Clay
13.	Water holding capacity, %	55	50	50	50	40

S1 - Agricultural land, S2 - Forest land, S3 - Agricultural land,
S4 - Forest land, S5 - Agricultural land

3.2.4.4 Noise Quality Status

Noise quality in the villages has been assessed through monitoring the noise level. Based on the noise level survey, the ambient noise at different villages has increased slightly due to movement of iron ore through tippers/trucks. The following **Table 3.28** gives the average noise level monitored with at the selected villages in the village.

Table 3.28: Details of Noise Level

Sr. No.	Period	Average Noise Level in dB (A)	
		Max.	Min.
1	2001	59.4	48.2
2	2002	60.5	48.1
3	2003	61.2	50.1
4	2004	64.8	49.9
5	2005	65.1	50.1
6	2006	67.9	52.2
7	2007	71.2	52.8
8	2008	68.9	55.1

3.2.5 Vaddarahalli Village

This village located on Bellary-Hospet-Honnavar Highway no 63. There are no mines in the vicinity of this village. However, lot of iron ore carrying trucks ply on this road apart from public transport. Hence this activity contributes for the air quality in the village. Season-wise monitoring for various environmental parameters were carried out from Summer, Post-monsoon & Winter The **Table 3.29** gives general characteristics of socio-demographic of Vaddarahalli village.

Table 3.29: General Socio-demographic & Environmental Characteristics *(source: census & imd)*

Sr. No.	Parameters	Details in numbers	
1	Distance from the nearest city in Kms	9	
2	Total Geographical Area (Ha.)	412	
3	Total Cultivable Area (Ha.)	381	
SOCIO-DEMOGRAPHIC DETAILS			
1.	No. of house holds	217	
2	Total Male Population	687	1330
3	Total Female Population	643	
4	Total SC Population	238	
5	Total ST Population	391	
6	Total Others Population	701	
7	No of Literates	609	
8	No of Literates - Up to Primary School	339	
9	No of Literates - Up to Higher Primary School	137	
10	No of Literates - Up to High School	107	
11	No of Literates - Up to Pre-University and above	26	
12	No of Schools	1	
ENVIRONMENTAL CHARACTERISTICS			
1.	Average Rain Fall in mm	522	
2	Temperature		
3	Minimum Temperature	21.8	
4	Maximum Temperature	40.1	
5	Relative Humidity		
6	Minimum Relative Humidity	27	
7	Maximum Relative Humidity	96	
8	Wind Speed in m/sec	6.57	
9	Predominant Wind Direction	West - East	
10	General Soil Texture	Clayey	
11	Water Holding Capacity in %	50	
12	Iron Content as Fe in %	7.45	

3.2.5.1 Air Quality Status

The season-wise monitoring for Vaddarahalli village was carried out for all the seasons as per the procedure and the assessment of the air quality is given in the following fig**.** This road is being extensively by iron ore carrying trucks to reach railway siding facility located at Hospet. From the **Figure 3.14 to 3.16** we can see that, the pollutants concentration observed was significantly high compared to subsequent years even though there was a drastic increase in annual production in the region.

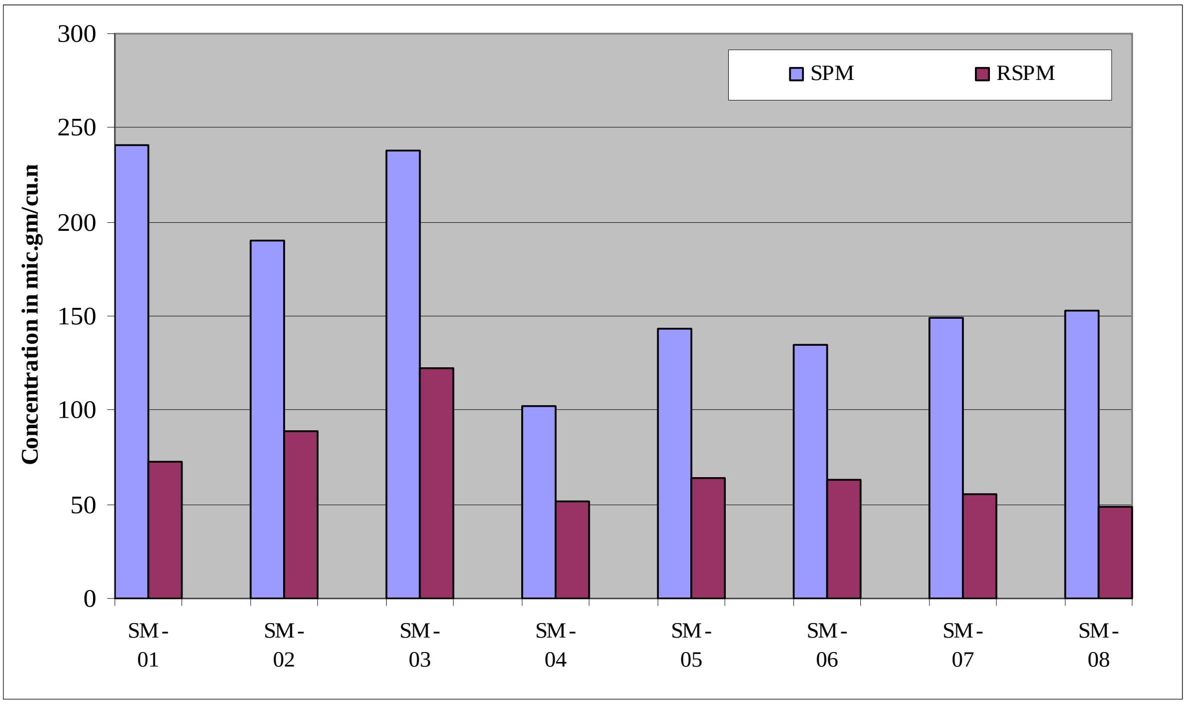


Fig. 3.14: Pollutant Concentration in Vaddarahalli Village during Summer

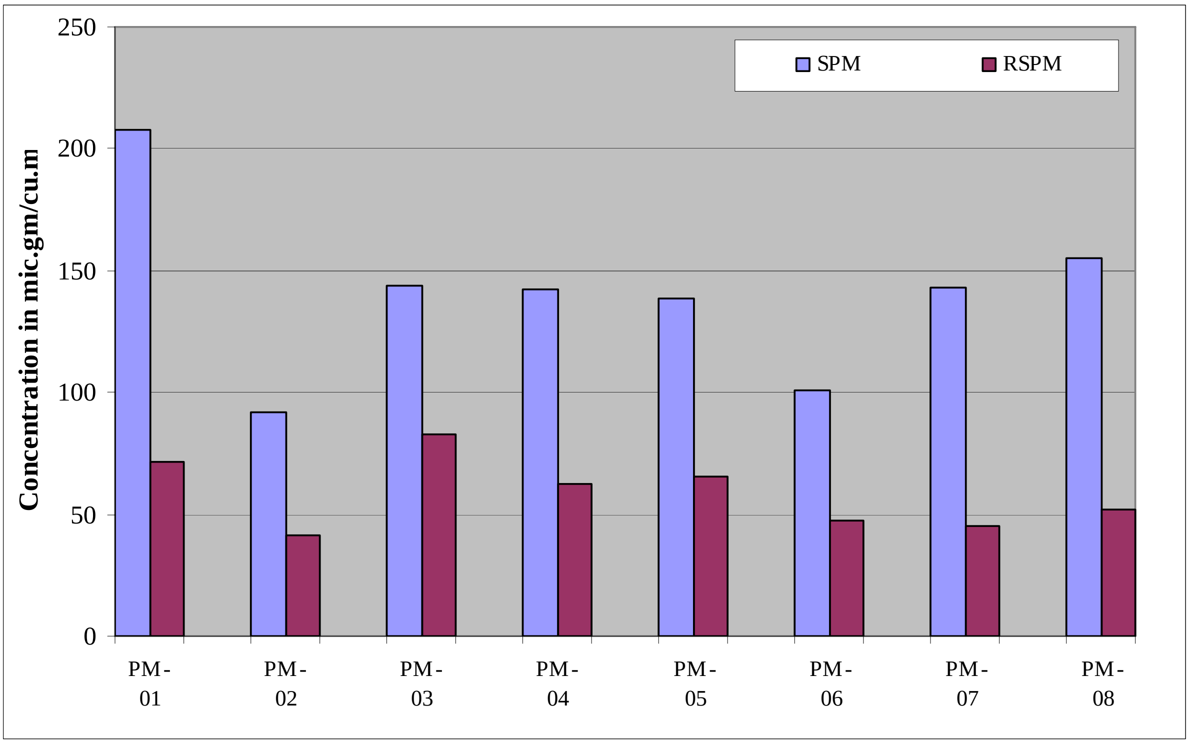


Fig. 3.15: Pollutant Concentration in Vaddarahalli Village during Post-Monsoon

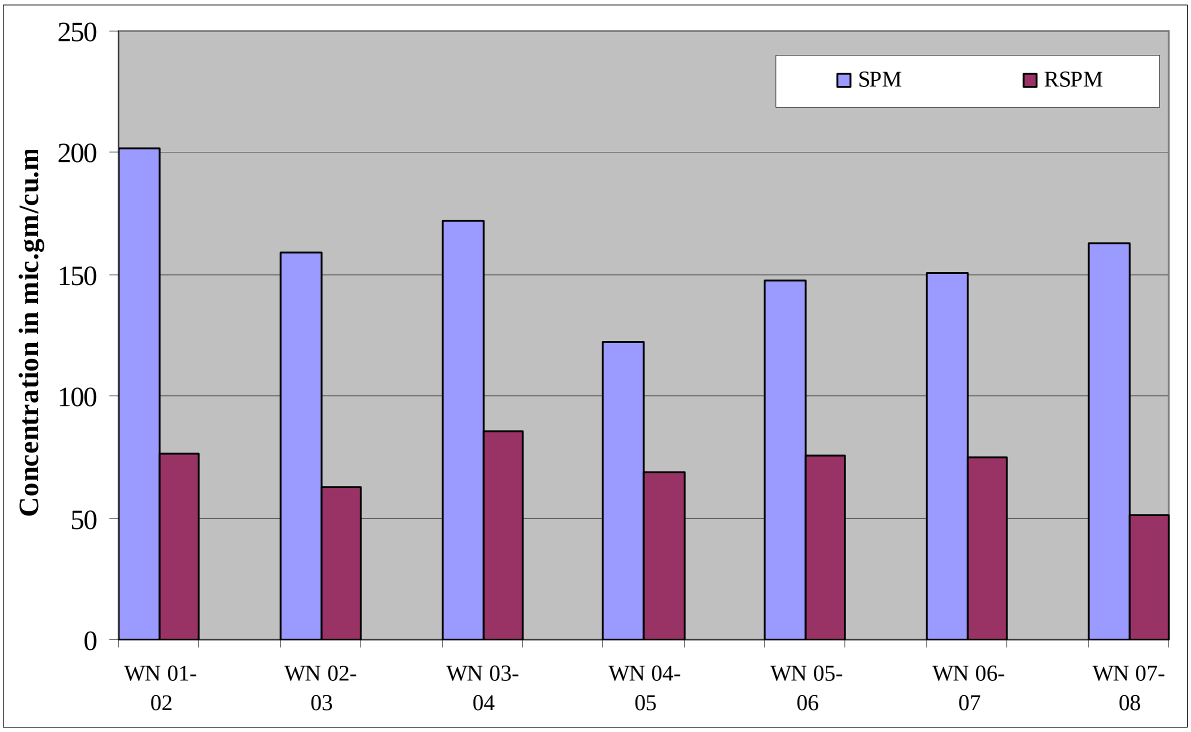


Fig 3.16: Pollutant Concentration in Vaddarahalli Village during Winter

3.2.5.2 Water Quality Status

There are no surface water sources around the village. However the ground water quality was analyzed taking the bore well water sample situated within the village. The ground water quality status is represented in the following **Table 3.30.**

Table 3.30: Status of Ground Water Quality

Sr. No.	Parameters	GW1	GW2	GW3	Limits IS:10500
1.	Colour (Hazen units)	Colourless	Colourless	Colourless	5
2.	Ambient Temperature ^{0}C	23.3 to 27.3	22.3 to 27.2	25.8 to 26.9	--
3.	Total Dissolved Solids (mg/1)	970 to 1120	650 to 75	420 to 490	500
4.	DO	2.4 to 2.8	2.1 to 2.6	2.7 to 2.8	-
5.	pH	7.3 to 7.5	7.4 to 7.7	7.6 to 7.8	6.5 to 8.5
6.	Turbidity (NTU)	4.8 to 7.5	8.3 to 12.5	2.4 to 3.1	5
7.	Total Suspended Solids (mg/1)	12 to 17	8 to 35	6 to 28	-
8.	BOD for 3 days at 27°C (mg/l)	<1	<1	<1	-
9.	COD (mg/l)	4 to 11.76	6 to 7.84	4 to 5.88	-
10.	Total Iron as Fe. (mg/1)	0.43 to 0.73	0.44 to b0.53	0.22 to 0.24	0.3
11.	Dissolved Phosphate as P (mg/1)	0.03 to 0.06	0.03 to 0.06	0.06	-
12	Sodium as Na, (mg/l)	72.2 to 86.9	69 to 79.3	69.1 to 74.5	-
13.	Potassium as K, (mg/l)	4.7 to 10.3	0.7 to 1.3	0.5 to 0.9	-
14.	Calcium as Ca (mg/1)	265.06 to 280.6	110 to 165.07	36.47 to 47.62	75
15.	Magnesium as Mg (mg/1)	40.83 to 45.98	8.11 to 63	41.12 to 43.84	30
16.	Total Hardness as $CaCO_3$ (mg/1)	830 to 890	446 to 534	260 to 299	300
17.	Chloride as Cl (mg/1)	248.34 to 268.33	103.55 to 111.71	29.26 to 33.6	25
18.	Flouride as F.(mg/1)	0.4 to 0.6	0.2 to 0.8	0.4	1
19.	Sulphate as SO_4 (mg/1)	37 to 68	18.5 to 21	7	2200
20.	Nitrate as NO3 (mg/l)	5.15 to 13.05	4.45 to 7.2	1.75 to 2.05	45
21.	Alkalinity as CaCO3, (mg/l)	400 to 505	440 to 555	350	200
22.	Acidity as CaCO3, (mg/l)	0.49 to 1.44	0.25 to 0.96	Nil to 0.48	--

3.2.5.3 Soil Quality Status

Soil quality assessed through collecting a set of soil samples which represents various land uses within the study area. The analysis of soil samples shows there is no considerable impact on quality of soil even though the mining and its allied activities are from 1950’s including drastic increase in annual production from the year 2003-04 onwards. The following **Table 3.31** depicts the soil quality during different years.

Table 3.31: Soil Quality Characteristics

Sl. No.	Particulars	Results				
		S1	S2	S3	S4	S5
1.	pH (1:2 aqueous solution)	6.85	6.86	7.1	7.26	7.95
2.	Electrical Conductivity (millimhos/cm)	610	435	385	515	725
3.	Nitrogen as N, kg/ Hec	375	210	390	475	445
4.	Phosphorous as P2O5, kg/Hec	48	35	40	95	65
5.	Potassium as K2O2, meq/Hec	195	185	365	385	525
6.	Chloride as Cl (%)	11	9	9	13	12.5
7.	Iron as HCL Soluble, %	7.56	13.86	11.12	12.85	8.45
8.	Organic matter (%)	0.66	0.65	0.85	0.78	0.86
9.	Sand, %	23	33	15	18	35
10.	Silt , %	35	30	40	38	30
11.	Clay, %	42	37	45	44	35
12.	Texture	Clay	Clay	Clay	Clay	Clay
13.	Water holding capacity, %	50	50	50	52	45

3.2.5.4 Noise Quality Status

Noise quality in the villages has been assessed through monitoring the noise level. Based on the noise level survey, the ambient noise at different villages has increased slightly due to movement of iron ore through tippers/trucks. **Table 3.32.** Noise quality at the selected locations within the vicinity of the village

Table 3.32: Details of Noise Level

Sl. No	Period	**Average Noise Level in** dB (A)	
		Max.	**Min.**
1	2001	59.2	52.2
2	2002	60.1	50.2
3	2003	60.9	59.2
4	2004	63.4	52.4
5	2005	64.1	51.8
6	2006	67.3	52.8
7	2007	64	50.4
8	2008	66.1	54.2

3.3 DESCRIPTION OF FLORA - FAUNA IN THE STUDY AREA

3.3.1. Vegetation type (Flora) of the Study Area

The study area is an intermixed landscape of Reserve Forest (Ramgad RF, Hospet RF, Billakallu RF, Joga RF) which is in the range of Sandur Reserve Forest. The vegetation pattern is described as Southern dry Deciduous Forest. The area which comes under Eastern Karnataka is a dry area with low rainfall associated with high temperatures and consequently the soils are generally poor (Singh, 1988). However, the area supports for diverse form of plants. The diversity of vegetation is composed of dry deciduous tree species and scrub species. There is also a significant composition of Agro-system which is associated with the human settlement. The cultivation fields, cropping system, agro-trees, village community plantation on roadside, etc. are also the component of flora in the region. Nevertheless the weeds associated in the agriculture crops, roadside shrubs and under-shrubs which are dispersed by moving vehicles, etc. are also the component of vegetation of the area. The major crops grown in the study region is shown in the **Table 3.33.**

Table 3.33: Major Crops in the Study Area

Botanical Name	Common Name	Season
Allium cepa	Eerulli	Minor Rabi crop
Eleusine coracana	Ragi	Major Rabi crop
Gossypium arboretum	Cotton	Minor cash crop
Helianthus annus	Sunflower	Major Rabi crop
Oryza sativa	Rice	Minor double crop
Phaseolus vulgaris, Vigna sinensis, Pisum sativum,	Pulse	Major Kharif crop
Saccharum officinarum	Sugarcane	Minor cash crop
Sorghum bicolor	Jowar	Major Rabi crop
Zea mays	Maize	Major Rabi crop

The following **Table 3.34** shows the weeds, shrubs, under-shrubs, climbers and hedge plants which are generally seen in the study area.

Table 3.34: The Weeds, Shrubs, Under-shrubs, Climbers and Hedge Plants

Common name	Botanical name	Family	distribution
Rakshasabale	Agave sp	Agavaceae	Hedge
Lakki	Vitex negundo L.	Verbenaceae	Hedge
Kaadu seege	Acacia pennata (L.) Willd.	Mimosaceae	Climber in foot hills, hedge
Seegekai	Acacia sinuata (Lour.)	Mimosaceae	Thorny climber
Guruganji	Abrus precatorus	Fabaceae	Common climber
Hanne soppu	Celosia argentea L.	Amaranthaceae	Widespread weeds in agriculture field
Datturi-gida	Argemone mexicana L.	Papaveraceae	Common
Avara-gida/ tangedi	Cassia auriculata L.	Caesalpiniaceae	Roadside weed
Bilihindee soppu	Aerva lanata (L.)	Amaranthaceae	Common
Kodugalli/ bontekalli	Euphorbia tirucalli L.	Euphorbiaceae	Hedge plant, also near drain and canal
Utranigida	Achyranthes aspera L.	Amaranthaceae	Common
Dodda haralu	Jatropha curcas L.	Euphorbiaceae	Hedge
Lambaani gida, puchuli	Lantana camara L.	Verbenaceae	Spreading weeds
Ekka	Calotropis gigantea (L)R.Br	Asclepiadaceae	Common
Elegalli	Synadenium grantii Hk.F.	Euphorbiaceae	Hedge
Maralumathi	Xanthium strumarium L.	Asteraceae	Common
Garike	Cynodon dactylon (L.)	Poaceae	Common
Datturi	Datura metel L.	Solanaceae	Common
Thunge hullu	Cyperus sps	Cyperaceae	Agriculture weed
Ooralada gida	Ageratum conyzoides L	Asteraceae	Wet area
Avara-gida/ tangedi	Cassia auriculata L.	Caesalpiniaceae	Road side
Congress gida	Parthemium hysterophorus L.	Asteraceae	Widespread
Bandare, Bandarike	Dodonaea viscose (L.)	Sapindaceae	Rocky area, scrubs
Hittagani	Commelina benghalensis	Commelinaceae	Wet area
Ganga thulasi	Hyptis suaveolens Poit.	Lamiaceae	Common
Hedge ipomoea	Ipomoea carnea Jacq	Convolvulaceae	Common
Balli	Ipomoea staphylina R.Br.	Convolvulaceae	Fence, wall, ground
Kesavegadde	Colocasia esculenta (L.) Schott	Araceae	Drain, canal
Kattetumbesoppu	Trichodesma indicum R.Br.	Boraginaceae	common

The human settlements consist of village Agro-system and Homestead garden. General profile of the agricultural field indicates the demarcation of the land among different land owners by plantation of large number of tree are in the cultivation field by farmers, wherein it provides shade, timber, firewood and foliage for livestock. The collection of tree component in the agricultural activity is generally known as 'agro-forestry. The study area although consists of few agro-forest species there is large number of species planted on the roadside (avenue plantation), beside household of villagers (Homestead garden). The following **Table 3.35** gives the details of plant species generally found in the study area;

Table 3.35: List of Trees Growing in the Village Agro-system in the Study Area

Local names	Botanical names	Family	Distribution
Al mara	Ficus bengalensis L.	Moraceae	Community areas, bus stop, roadside
Sitaphala	Annona squamosa L.	Annonaceae	Home garden
Arali	Ficus religiosa L.	Moraceae	Roadside avenue
Bagge mara	Albizia lebbeck (L.) Benth.	Mimosaceae	Natural and roadside
Bellari jail	Prosopis juliflora (Sw.) DC.	Mimosaceae	Natural open areas and bunds, fence
Bilejali, Nayibela	Acacia leucophloea (L.) Benth.	Mimosaceae	Natural in open areas
Boppayi-hannu	Carica papaya L.	Caricaceae	Home garden
Eechala mara	Phoenix sylvestris Roxb.	Arecaceae	Canals & water course, Agro-forest
Gulmohor	Delonix regia (L.)	Caesalpiniaceae	Roadside
Honge	Pongamia pinnata (L.) Pierre	Fabaceae	Agro-forest and wasteland, common
Kaggli, Kempu jaali	Acacia chundra (Roxb.ex Rottler) Willd.	Mimosaceae	Natural in open area, foot hills forest
Kakke	Cassia fistula L.	Caesalpiniaceae	Naturally distributed
Kanthri kadama	Polyalthia longifolia Benth. & Hook. F.	Annonaceae	Home-garden, roadside
Kari jaali/ Barbura	Acacia nilotica (L.) Willd. ex. Del.	Mimosaceae	Natural in open area and inhabited areas
Maavina mara	Mangifera indica L.	Anacardiaceae	Agro-forest and Home-gardens
Muthuga	Butea monosperma (Lam.) Taub.	Fabaceae	Natural open areas
Neem	Azadirachta indica A.Juss.	Meliaceae	Agro-forest, roadside
Nelli, dadi	Emblica officinalis Gaertn.	Euphorbiaceae	Home-garden
Rain tree	Pithecellobium saman (Jacq.) Benth.	Fabaceae	Roadside avenue trees
Sima tangedu, Siamea	Cassia siamea Lamk.	Caesalpiniaceae	Planted in roadside and wasteland
Taayinkai	Cocos nucifera L.	Arecaceae	Home-garden, Agro-forest
Thaathininggu	Borassus flabellifer L.	Arecaceae	Agro-forest

Local names	Botanical names	Family	Distribution
Unse hannu	Tamarindus indica L.	Caesalpiniaceae	Agro-forest and avenue tree
Nugge	Moringa oleifera Lam.	Moringaceae	Agro-forest and Home-gardens
Eucalyptus	Eucalyptus sp	Myrtaceae	Bunds, wasteland
Neralle	Syzygium cumini (L.) Skeels	Myrtaceae	Agro-forest, Home-garden and Avenue tree
Bilvapatra	Aegle marmelos (L.) Correa ex.Schultz	Rutaceae	Found near temple
Karibevu	Murraya koenigii (L.) Spr.	Rutaceae	Home-gardens
Dodabevu	Ailanthus excelsa Roxb.	Simaroubaceae	Agro-forest
Jadi, Jaththi, Tega	Tectona grandis L.F.	Verbenaceae	Agro-forest
Basurimara	Ficus amplissima Smith.	Moraceae	Roadside
Baage sujjulu	Albizia chinensis (Osbeck) Merr.	Mimosaceae	Roadside

The main Agro-forest trees are Azadirachta indica, Ailanthus excelsa, Tamarindus indica, etc. The growths of the woody species are large in number when compared with the forest trees. This may be due to the frequent nourishment of manure and water by the farmer for the crops thereby the trees get benefited. The specie Neem is also abundantly planted in the roadside and home garden. The plant is well known species which can adapt in hot regions and wastelands. These species have thick foliage which can adsorb the fine dust particles which is air borne due to mining activity in the surrounding area.

Further the thorn species are also found in the open scrub and rocky area. There is sparse distribution of open scrubs, and a preliminary survey was undertaken to compile the check list of plants prevailing in the landscape. The following **Table 3.36** gives the plants that are generally found in the open hers in the study area.

Table 3.36: Plants in Open Scrub Found in the Study Area.

Local names	Botanical names	Family	Growth form
Bilejali, Nayibela	Acacia leucophloea (L.) Benth.	Mimosaceae	Tree
Kaggli, Kempu jaali	Acacia chundra (Roxb.ex Rottler) Willd.	Mimosaceae	Tree
Bellari jail	Prosopis juliflora (Sw.) DC.	Mimosaceae	Shrubby
Haladi pavate, maddi	Morinda pubescens SM.	Rubiaceae	Small tree
Balai, tupra	Diospyros melanoxylon A.Juss.	Ebenaceae	Small tree
Kari jaali/ Barbura	Acacia nilotica (L.) Willd. ex. Del.	Mimosaceae	Tree

Local names	Botanical names	Family	Growth form
Achu mullu, Therane	Canthium parviflorum	Rubiaceae	Shrubby
Kakke	Cassis fistula L.	Caesalpiniaceae	Tree
Bejjal, Dindiga	Anogeissus latifolia Wall.ex.Guill. & Perr.	Combretaceae	Tree
Butti-aaragale, garakele	Grewia villosa Willd.	Tiliaceae	Shrubby
Aralukadumandara, banne	Bauhinia racemosa Lam.	Caesalpiniaceae	Small tree
Avara-gida/ tangedi	Cassia auriculata L.	Caesalpiniaceae	shrub
Lambaani gida, puchuli	Lantana camara L.	Verbenaceae	shrub
Barige, Karisurimullu	Zizyphus oenoplia Mill.	Rhamnaceae	Spiny straggler
Nuguvempali	Indigofera sp	Fabaceae	Under shrub
Chikka Kaavali	Carissa spinarum L.	Apocynaceae	Shrub
Bandare, Bandarike	Dodonaea viscose (L.)	Sapindaceae	Shrub
Kodugalli/ Bottugalli	Euphorbia tirucalli L.	Euphorbiaceae	Succulent
Aadumuttada gida	Tylophora indica (Burm.F.) Merrill	Asclepiadaceae	Climber
Nela bedi soppu	Croton bonplandianum Baill.	Euphorbiaceae	Under shrub
Dodda haralu	Jatropha curcas L.	Euphorbiaceae	shrub
Dagadiballi, Sugadigida	Cocculus hirsutus (L.) Diels	Menispermaceae	Climber
Namadaberu, Sogade beru	Hemidesmus indicus (L.) Schult	Asclepiadaceae	Climber
Malkaamguni, Tandrasi	Maytenus emarginata (Willd.) Ding	Celastraceae	Shrub
Dundukalli elegalli, Yellikalli	Euphorbia nivulia Buch.-Ham.	Euphorbiaceae	succulent

The forests in the study region are especially composed of dry deciduous plant is the Reserve Forest of Sandur Range, which extended to Joga Forest and the Ramgad RF. The diversity of the area is unique when compared to other dry deciduous forest in Northern India, where the main composition is the thorn species.

Further, some of the species occurring in the open scrub also occurs in the Reserve forest such as Acacia chundra, A. nilotica, A. pennata, Bauhinia racemosa, Holoptelia integrefolia, etc (fringes and foot hill). The overall species occurrence in all Reserve forest has a homogenous pattern consisting of around 30 dry deciduous tree species. The distribution pattern is different among geographical landscape, whereas certain species are common to all areas such as Terminalia alata, Chloroxylon swietenia, Anogeissus latifolia, Maytenus emarginata, etc. the following **Table 3.37** gives the plant species that are generally found in the reserve forest of the study area.

Table 3.37: Checklist of Plant Species Found in the Reserve Forests

Common names	Botanical name	Family
Commonly distributed in all forest and its landscapes		
Dindiga, Bejjal	Anogeissus latifolia Wall.	Combretaceae
Gojji, Goje	Bridelia retusa Spr.	Euphorbiaceae
Katmangari, Mangase	Catunaregam spinosa (Thunb.) Tirveng.	Rubiaceae
Kakke, Kakke-kayi	Cassia fistula L.	Caesalpiniaceae
Huragalu, Hurihuli	Chloroxylon swietenia D.C.	Meliaceae
Nelli, dadi	Emblica officinalis Gaertn.	Euphorbiaceae
Kallbasali, Kondrage	Ficus arnottiana (Miq.) Miq.	Moraceae
Bilitale	Givotia rottleriformis Griffith	Euphorbiaceae
Buttle, Thadasalu	Grewia tiliifolia Vahl	Tiliaceae
Aval, Tapsi	Holoptelea integrifolia (Roxb.) Planch.	Ulmaceae
Haladipavette	Morinda pubescens SM.	Rubiaceae
Honne, Bengai	Pterocarpus marsupium Roxb.	Fabaceae
Geru, Goddugeru	Semecarpus anacardium L.f.	Anacardiaceae
Some, Sombi	Soymida febriguga (Roxb.)A.Juss.	Meliaceae
Paadari, Kariguddadu	Stereospermum suaveolens DC.	Bignonaceae
Jadi, Jaththi, Tega	Tectona grandis L.f.	Verbenaceae
Karee matthi, Unapu mara	Terminalia alata B.Heyne ex Roth	Combretaceae
Common in edge/ fringes and lower elevation		
Kaggli, Kempu jaali	Acacia chundra (Roxb.ex Rottler) Willd.	Mimosaceae
Acha, Karmara	Hardwcikia binata Roxb.	Caesalpiniaceae
Neelagiri	Eucalyptus sp	Myrtaceae
Tupra, Balai	Diospyros melanoxylon Roxb.	Ebenaceae
Rare distribution		
Beppale, Kadnili	Wrightia tinctoria R.BR.	Apocynaceae
Maddi mara, Vishesha dhoopa	Boswellia serrata Roxb.	Burseraceae
Murkali, Nurchilla	Buchanania lanzan Spr.	Anacardiaceae
Kaval, Kavulu mara	Careya arborea Roxb.	Lecythidaceae
Bilibeete, Pachari	Dalbergia paniculata Roxb.	Fabaceae
Bide	Dalbergia latifolia Roxb.	Fabaceae
Beladamara, Belathumara	Feronia elephantum Corr.	Rutaceae
Goravi, Kaanu	Ixora arborea Roxb.ex Sm.	Rubiaceae
Shrub, herbs and climbers		
Rakshasabale	Agave sp	Agavaceae
Ekka, Ekkamale	Calotropis gigantea (L.) R.Br.	Asclepiadaceae
Kathiramullu, Nibate	Capparis sepiaria L.	Capparaceae
Kondage	Cissus sp	Vitaceae
Bandare, Bandarike	Dodonaea viscose (L.) Jacq.	Sapindaceae
Malkaamguni, Tandrasi	Maytenus emarginata (Willd.) Ding	Celastraceae

Kallaarthi, Soudanga gida	Solanum erianthum D.Don	Solanaceae
Koranekelar	Tecoma stans Juss.	Bignoniaceae
Barige, Karisurimullu	Zizyphus oenoplia Mill.	Rhamnaceae

3.4 DESCRIPTION OF FAUNA (ANIMAL SPECIES) IN THE STUDY AREA

3.4.1 Fauna of the Study Area

The Reserve forest and the adjoining ecological landscape are renowned places for harbouring various wild animals. It includes the slot beer, Wild boar, porcupine, fox, jackal and even panther. The following **Table 3.38** gives the general wild life found in the forest area of the study area.

Table 3.38: Wild life Generally Found in the Forest Area.

Local name	Common name	Scientific name	Conservation status
Karadi	Sloth Bear	Melursus ursinus	Threatened
Maan-ga	Bonnet monkeys	Macaca radiate	Common
Mola	Indian Hare	Lepus nigricollis	Common
	Grey Mongoose	Herpestes edwardsii	Common
	Small Mongoose	Herpetes auropunctatus	Common
Karu handi	Wild Boar	Sus scrofa	Common
Chirathe	Panther	Panthera pardus	Threatened
Tola	Wolf	Canis lupis	Endangered
	Jackal	Canis aureus	Schedule
	Fruit Bat	Rousettus leschenaulti	Common
	Three striped palm squirrel	Funambulus palmarum	Common
	Porcupine	Hystrix indica	Schedule
Karu Bekku	Jungle cat	Felis chaus	Schedule
Punugu Bekku	Common civet, Civet Cat	Pardoxurus hermaphroditus	threatened
Chippu Handi	Pangolin	Manis crassicaudata	Rare

Nonetheless, it is important to spread knowledge on rare and threat animals in the area so as to create awareness on the important species. The mining activity should be undertaken without extensive disturbance to these animal species. The mining executives and worker should be given awareness on the conservation value of the rare and threat animals of the area.

3.4.2 Avi-Fauna

A large number of birds are distributed in the 10 km of the study area, which consist of common birds of Karnataka, Birds associated with human habitat, Birds habituated near water body. The below **Table 3.39** give the general bird species that are generally found in the study area.

Table 3.39: Bird Species Generally Found in the Study Area.

Birds in the terrestrial landscape	
Asian Koel	Eudynamus scolopaceae
Barbet	Megalaima sps
Black Drongo	Dicrurus macrocercus
Black kite	Milvus migrans
Black-winged Stilt	Himantopus himantopus
Brahminy kite	Accipter badius
Cattle Egret	Bubulcus ibis
Common Cuckoo	Cuculus canorus
Common Myna	Acidotheres tristis
Common or Small blue Kingfisher	Alcedo atthis
Common Sand Piper	Actitis hypoleucos
Common Swallow	Hirundo daurica
Eurasian Hoopoe	Upupa epops
Eurasian-collared Dove	Streptopelia decaocto
House Crow	Corvus splendens
House Sparrow	Passer domesticus
Indian Robin	Saxicoloides fulicata
Indian Roller	Coracias benghalensis
Lesser Coucal	Centropus bengalensis
Oriental Magpie Robin	Copsychus saularis
Oriental White-eye	Zosterops palpebrosus
Paddyfield Pipit	Anthus rufulus
Red-Vented Bulbul	Pycnonotus cafer
Red-wattled Lapwing	Vanellus indicus
Rock Pigeon	Columba livia
Rose-Ringed Parakeet	Psittacula cyanocephala
Scaly-breasted Munia	Lonchura punctulata
Tailor Bird	Orthotomus sutorius
White Breasted Kingfisher	Halcyon smyrnensis
Water or nearby water habitat	
Black-winged Stilt	Himantopus himantopus
Common Sandpiper	Tringa hypoleucos
Common Snipe	Gallinago gallinago
Great Thick-knee	Burhinus recurvirostris
Indian Moorhen	Gallinula chloropus
Indian River Tern	Sterna aurantia

Lesser Whistling Teal	Dendrocygna javanica
Little Cormorant	Phalacrocorax niger
Little Cormornant	Phalacrocorax niger
Little Grebe	Tachybaptus ruficollis
Little stint	Calidris minuta
Median Egret	Mesophoyx intermedia
Pintail	Anas acuta
Pond Heron	Ardeola grayii
White-breasted Kingfisher	Halcyon smyrnensis
White-breasted Kingfisher	Halcyon smyrnensis
White-breasted Waterhen	Amaurornis phoenicurus
Wood sandpiper	Tringa glareola

The prediction of ecological impact due to any developmental activity is now an integral part of decision making of any developmental projects. Similar to any other developmental activity, mining activity is also degrades the quality of the environment, thereby threatening the flora- fauna of the region. In the study area, the process of EIA of mining has evaluated different impacts both qualitatively & quantitatively on water, air and land including flora & fauna of the surrounding area. Hence it is necessary to plan & implement feasible scientific mitigative measures to prevent the loss of Forest cover and to encourage rehabilitation; mitigative measures for displacement of birds and animal; conservation plan, etc. Numerous plantation and reclamation works are incorporated in the mining activity as a part of the corporate social responsibility, the species found in the study area are generally exotic or foreign to the area such as Eucalyptus, Cassia siamea, Acacia auriculiformis, Grevillea robusta, etc. In addition Pongamia pinnata, Dalbergia sps, Bauhinia varigaeta, etc are also incorporated.

Hence it is necessary to recommend the mining authorities to incorporate the reclamation work, which mainly consist of plantation of local species. The idea is to bring back the same ecological landscape similar to the condition before mining. This shall further bring back the fauna components which are displaced during due to the mechanized activity involving machine and man.

CHAPTER 4

RESULTS & DISCUSSIONS

4.0 GENERAL

Mining is the major economic activity in many developing countries irrespective of mode of operation and mechanization. Mining has number of common stages/ activities, each of which has potentially-adverse impacts on the environment & ecology, societal and cultural heritage, the health of the communities living in the close proximity to mine lease areas.

At all levels, the mining industry is becoming more attuned to the importance of maintaining a mine's social – as distinct from its' legal – licence to operate. It is generally accepted that, if a mining operation is in conflict with significant sections of the local community, this will create difficulties with regulators, generate negative publicity and make it more difficult for carrying out mining operations.

To promote strong relationships with, and to enhance the capacities with the communities on issues which may affect them, it is necessary to have regular interaction with the local community, support them with infrastructural facilities, help them to uplift their social status. Support for community projects will reflect the priorities of local people, sustainability and cost effectiveness, which will increasingly seek to assess the contribution from the mining operations to local social and economic developmental activity.

Mining of iron ore contains trace elements that are released in to the environment during operations and end up in the atmosphere, in regional surface waters and on the soil. Continual loading of pollutants to the environment is of special concern for either metal and/or persist in the environment, because of their chemical structure. These pollutants remain in the open atmosphere for longer period. Exposure to these environmental pollutants occurs through direct inhalation or indirect exposure. Direct inhalation of the air toxicants can cause asthma attacks, respiratory infections, or changes in lung function.

The health risks from the exposure to environmental pollution depends on the duration of exposure, type of pollutant, concentration of pollutants and the sensitivity of the person to the particular pollutant. Both short-term and long-term exposures are important in assessing the potential risks, caused due to induced environmental changes. Studies have attempted to quantify the potential health risks caused due to exposure to toxic emissions are limited due to insufficient data and to account for multiple and cumulative exposure to many pollutants at the same time. The following paras will analyse the impact of excessive iron ore mining in the study villages vis-à-vis the measurement of economic cost imposed by the change in environmental quality of the surrounding villages.

4.1 VARIATION OF AIR POLLUTANTS WITH THE IRON ORE PRODUCTION

The ambient air quality was monitored by following the standard procedure for five villages namely Jaisinghpur Papinayakanahalli, Joga, Siddapur, and Vaddarahalli villages with in the study area of 10 KM. One village has been considered in the first quadrant, one village in the third quadrant and three villages in the fourth quadrant. Moreover Papinayakanahalli, Joga and Siddapur villages are located approximately at 120^0 to each other from the center of the study area of 10 kms. The reason for selecting three villages in the fourth quadrant was that many mining leases were operating in this quadrant compared to others. Further, this quadrant is having maximum movement of iron ore trucks.

The ambient air quality (AAQ) was monitored using pre-calibrated Respirable Dust Samplers (RDS) for all seasons except monsoon. The frequency of sampling followed was: - 24 hourly samples twice a week for four weeks in a month for all months except monsoon for Suspended Particulate Matter (SPM) and Respirable Particulate Matter (RPM), and - 8 hourly samples twice a week for four weeks in a month for all the months except during monsoon for SO_2 and NOx.

The methodology adopted for sample collection and its analysis is given in **Table 4.1.**

Table 4.1: Methodology Adopted for Sample Collection and its Analysis *(source: cpcb)*

Sr. No.	Parameter(s)	Sampling		Analysis	
		Guidelines	Method	Guidelines	Method
1.	Sulphur Dioxide (SO_2)	Bureau of Indian Standard	IS:5182 (Part V) 1975	Bureau of Indian Standard	IS:5182 (Part II) 1969
2.	Oxides of Nitrogen (NOx)	Bureau of Indian Standard	IS:5182 (Part V) 1975	Central Pollution Control Board	NAAQ/25/2003-04
2.	Suspended Particulate Matter (SPM)	Bureau of Indian Standard	IS:5182 (Part IV) 1999	Bureau of Indian Standard	IS:5182 (Part IV) 1999
3.	Respirable Particulate Matter (RSPM)	Central Pollution Control Board	NAAQ/25/2003-04	Central Pollution Control Board	NAAQ/25/2003-04

The following graphs show the variation of air pollutants (SPM & RSPM) in the study villages and the reference village.

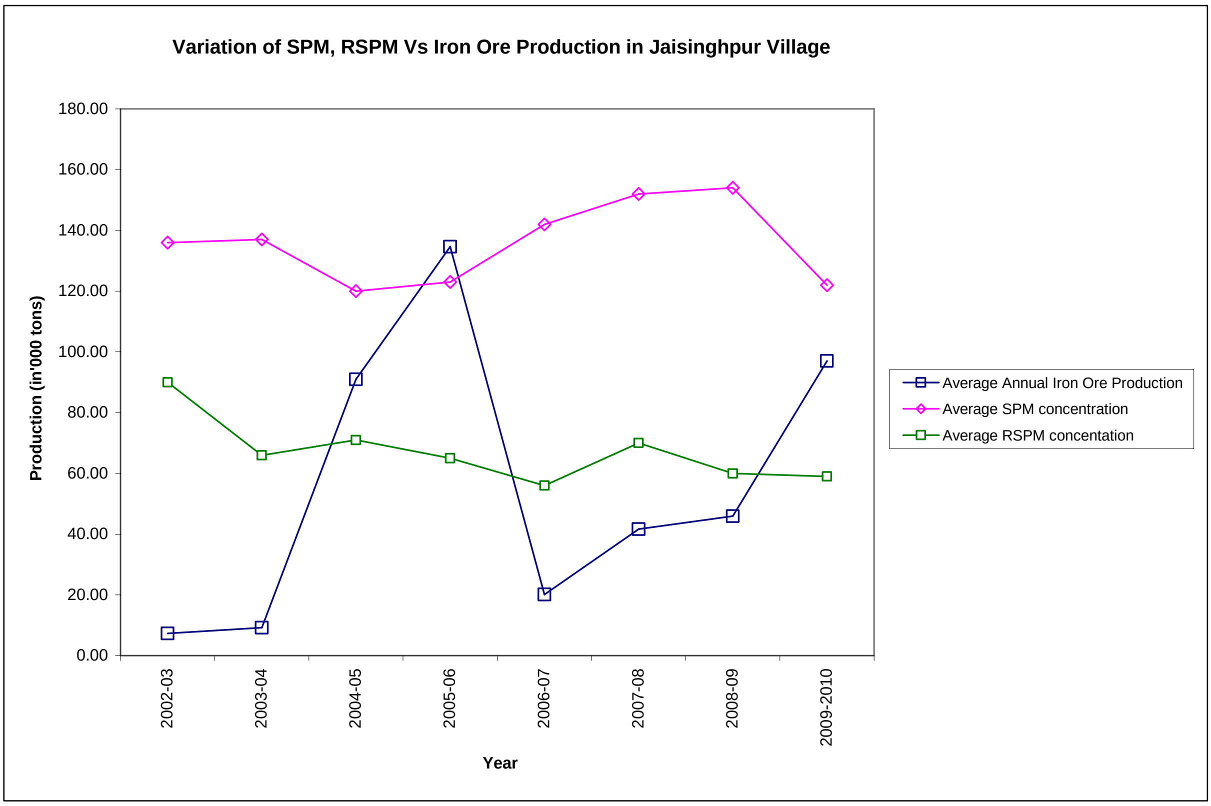


Fig 4.1: Variation of Air Pollutants with respect to Iron Ore Production

The above table indicates that when ever the production of iron ore is high, the ambient air quality has also increased. Similar trend can be observed in all the study villages. The variation of the air pollutants in other study villages are shown in the following **Figures 4.2, 4.3 & 4.4** below.

The meteorological parameters like wind speed, wind direction and temperature will significantly contribute for the concentration of air pollutant at the particular location. The air quality data was monitored for all the seasons, the above graph shows the average values of the air pollutant concentration.

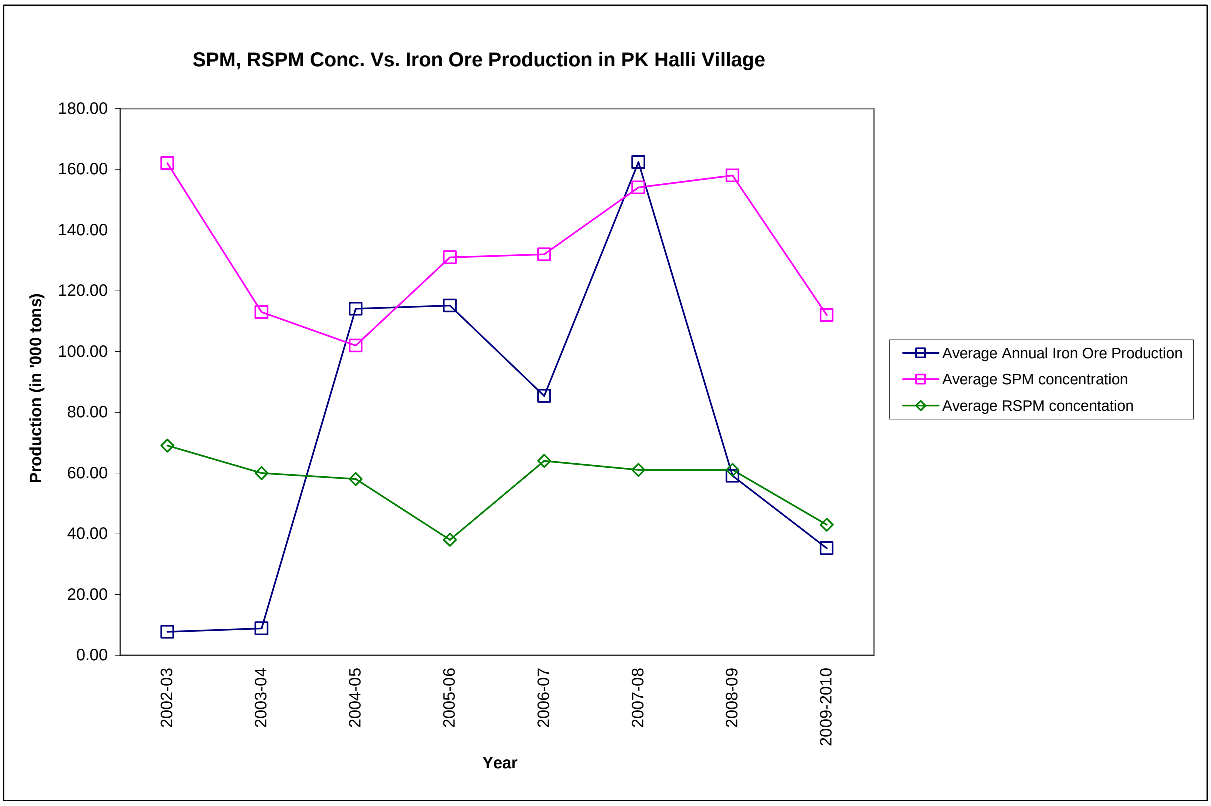


Fig 4.2: Variation of Air Pollutants with respect to Iron Ore production

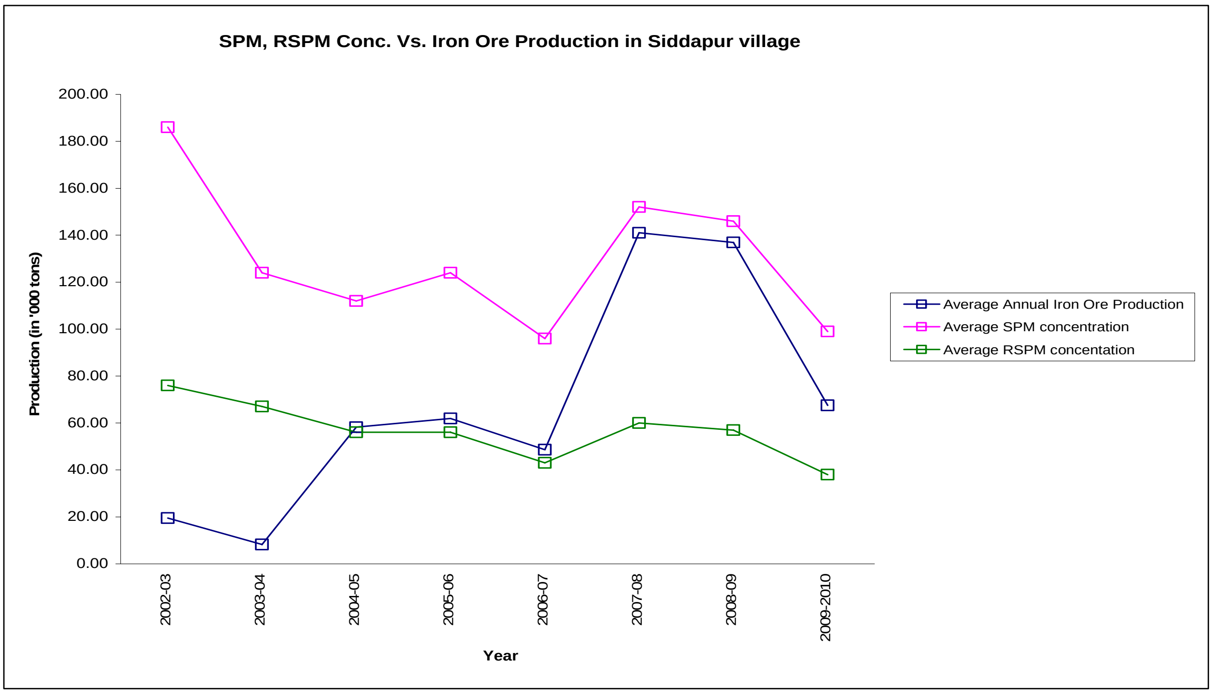


Fig 4.3: Variation of Air Pollutants with respect to Iron Ore production

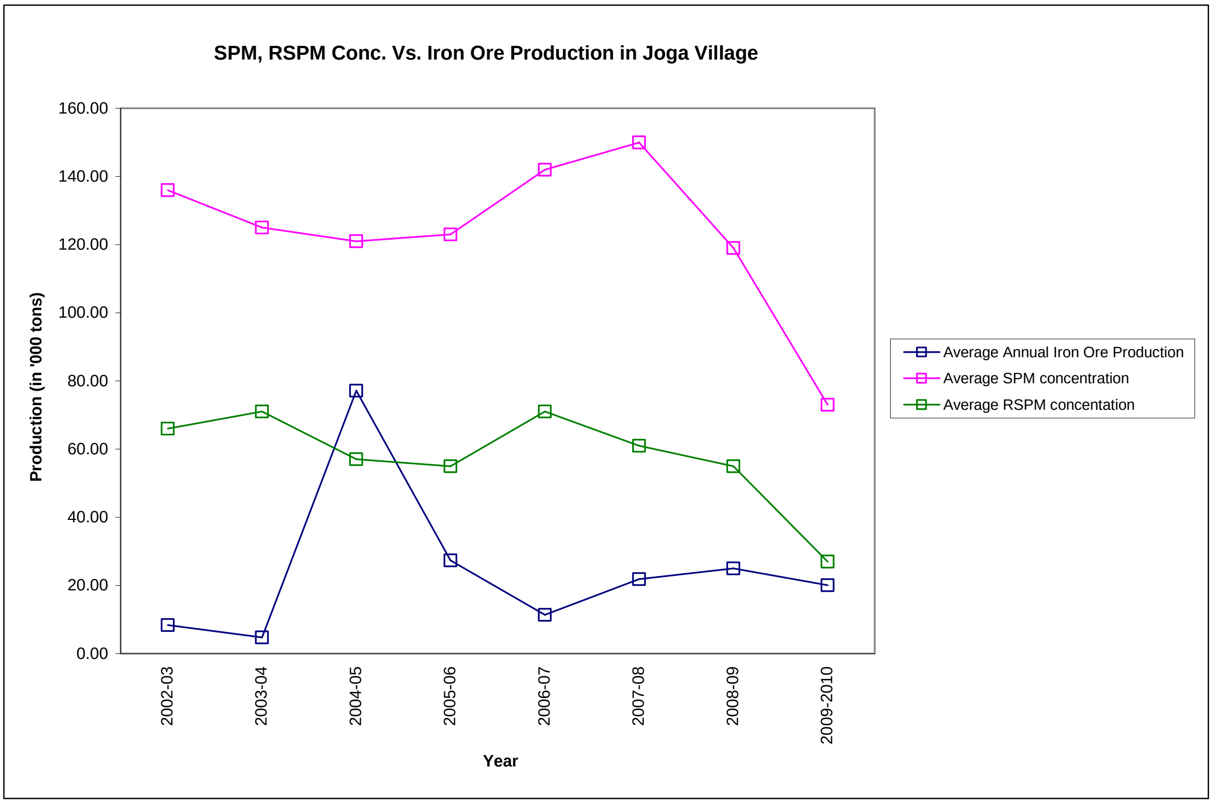


Fig 4.4: Variation of Air Pollutants with respect to Iron Ore production

There are no mines in the vicinity of Vaddarahalli (Reference Village)

4.2 SOCIO-DEMOGRAPHIC PROFILE OF THE HOUSEHOLD

This section mainly deals with the socio-demographic profile of the study area along with the analysis of different environmental parameters. The increase in iron ore production, subsequent impact on the socio economic conditions of the villagers situated around the study area was also discussed. The prevalence of environmentally induced illness, based on the epidemiological studies conducted in the other countries and within our country, where excessive mining has caused significant damage in terms of health due to induced diseases. The same was clearly explained in the earlier Chapter. The prevalence of environmentally induced illness for the past one year is examined within the respondents.

Further the respondents where the incidences of suffering from the pollution induced set of health disorders for definite duration and where there is a cost involved for the treatment of particular diseases was only considered due to technical reason in the study. Respondents who are suffering from the set of diseases like cough, asthma, dust allergy, respiratory disorders etc, but have not approached doctor for the treatment, but have taken medicine directly from the shop and suffered for very short period were excluded from study.

The prevalence of illness and the frequency of illness were mainly enquired among the respondents, both in the study and reference villages. The following paras explain the socio-demographic characteristics of the respondents including the health impact caused due to the increase in iron ore production.

4.3 CHARACTERISTICS OF THE RESPONDENTS

The respondents in the study and the control villages were earning members of the household and in their absence, immediate head of the households was considered. (The rationale for considering the earning member as the respondent was that, the study requires income and expenditure of the household and the earning member was the best person to answer this question). It was also assumed that the respondents have sufficient knowledge about impact of increase in mining activity in the vicinity and its health impact and can understand the situation to answer the questionnaire. The respondents are either directly experienced the affect or have aware of the problem through different medias on the activities that are going on in their surrounding area.

4.3.1 Socio-Demographic Profile

The **Table 4.2** shows the distribution of the respondents in the study and reference village household in terms of gender, marital status, age group, family size, number of household members,

Table 4.2: Village wise Characteristics (in percentage)

Parameters	Characteristics	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
Gender (%)	Male	90	77	77	93	93
	Female	10	23	23	7	7
Age Group (%)	20-30 Years	20	13	27	17	30
	30-40	20	33	37	27	43
	40-50	33	30	23	33	10
	above 50 years	27	24	13	23	17
Size	Ave. Family size	5	4	4	3	5

Parameters	Characteristics	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
Number of House Hold Members	Male	27	23	23	28	28
	Female	3	7	7	2	2
	Children	86	45	48	44	41
Marital Status (%)	Married	97	80	77	100	97
	Un Married	3	20	23	0	3

From the above table, it can be observed that, the 77- 93 percent of the respondents are male population. The age group of the respondents also ranges from 13 – 30 who falls between the age group of 20- 30 years. 20-43 percent of the respondents fall within the age group of 30-40 years. About 10 – 33 percent of the respondents fall between the ranges of 40- 50 years. It can also be observed that the average family size ranges from 3 – 5 in study and reference villages. Most of the respondents are married people (77- 100% of the respondents).

4.3.2 Educational Status

Data on the educational status was obtained as a part of social survey. This also helps to know the capacity of the respondents in understanding the scenario and also to measure the contribution of increase in ore production to the upliftment of the villages. The following **Table 4.3** shows the educational status of the respondents in the study & the reference area.

Table 4.3: Educational Status of the Study Area in Percentage (N= 30 in each Village) (in percentage)

Sr. No.	Parameters	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
1	Illiterate	57	50	57	47	40
2	Up to Primary School	23	27	27	30	33
3	Up to High School	13	20	7	13	17
4	PUC/Diploma	4	3	3	7	3
5	Graduation	3	0	6	3	7
	Total	**100**	**100**	**100**	**100**	**100**

From the above table, it can be concluded that illiterate respondents are high in all the villages (it ranges from 40 – 57 %). The respondents who have completed graduation are very less (ranges from 3 – 7 %) and even there are no graduate respondents in PK Halli. Another significant number of respondents have left the schooling after the completion of the primary schooling (ranges from 23- 33 %). The same is also represented in the form of **Figure 4.4** mentioned below.

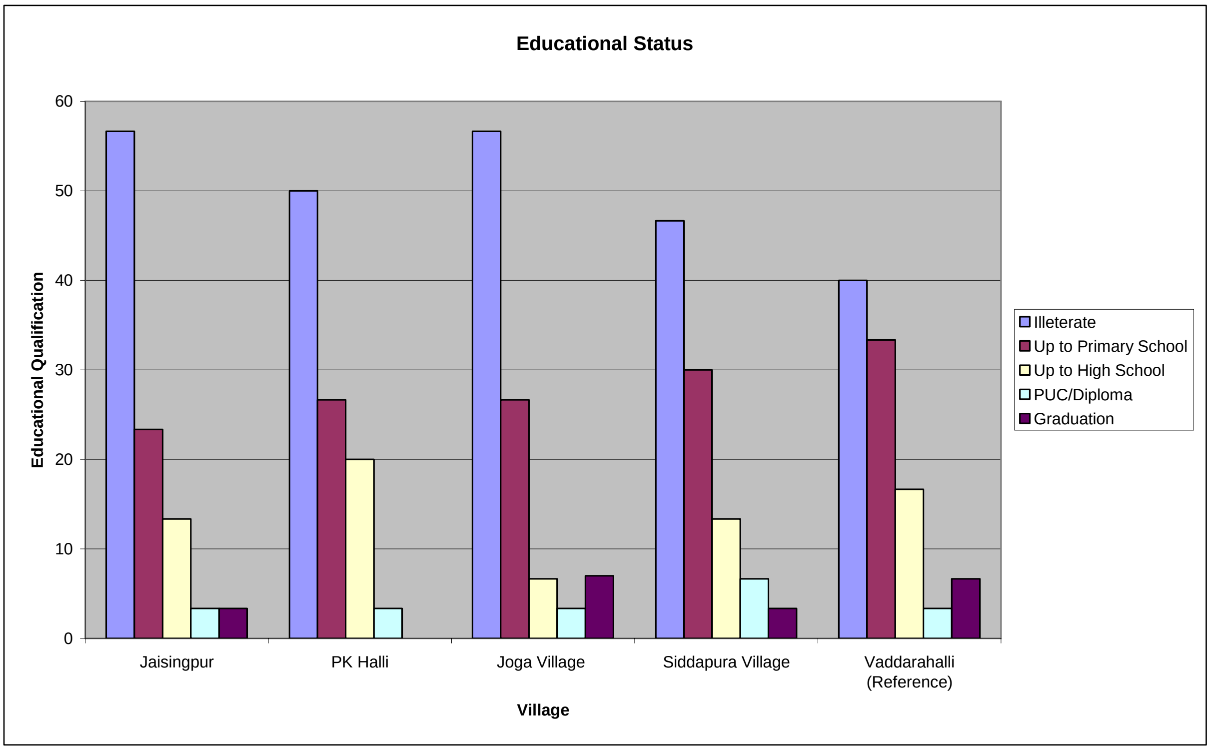


Fig. 4.4: Educational Status of the study and the reference village

4.3.3 Occupational Status

The below **Table 4.4** gives the occupational profile of the respondents in the study & the reference area. The table clearly indicated that about 37 to 63 % of the respondents from the study area are working in the mines lease area surrounded by their villages. Even thou there are no mines in the reference villages, about 27 of the respondents work in the mine lease area of the study area, as these villages are nearby to each others.

Table 4.4: Occupational Profile of the Study Area in Percentage (N= 30 in each Village) (in percentage)

Sr. No.	Parameters	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
1	Farmer/Cultivators	27	17	27	47	37
2	Working in mine	40	63	37	37	27
3	Skilled/ Semi Skilled labour	20	3	7	10	10

Sr. No.	Parameters	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
4	Business man	3	4	10	3	12
5	Driver	7	3	12	3	7
6	Others	3	10	7	0	7
	Total	**100**	**100**	**100**	**100**	**100**

The same is also represented in the form of figure below (Fig 4.5)

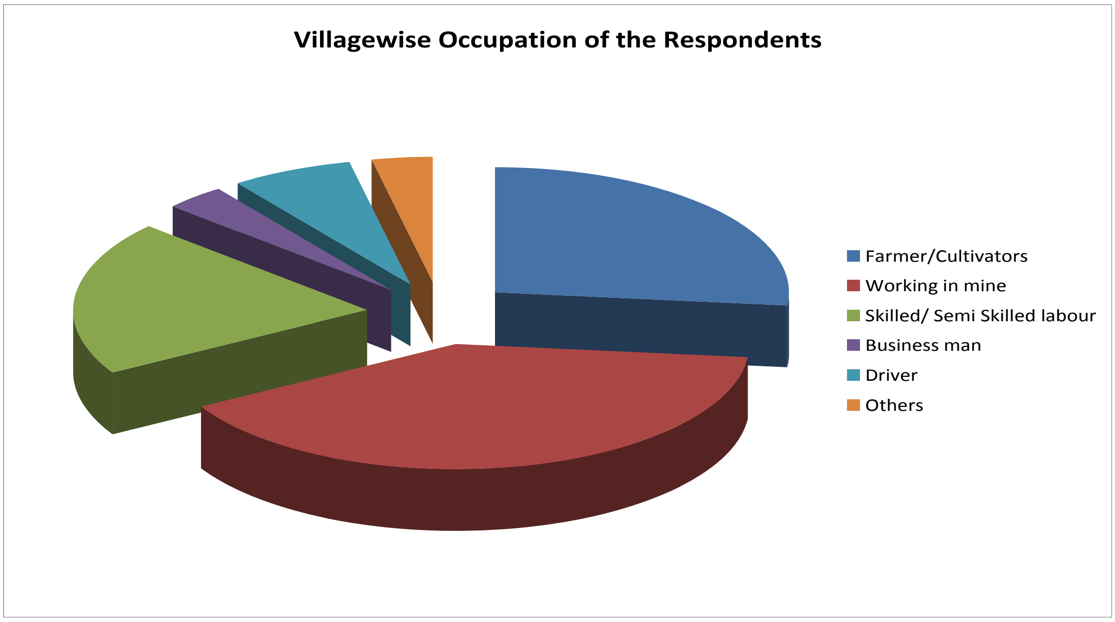


Fig. 4.5: Occupational Profile of the respondents in the study & the reference villages

4.3.4 Monthly Income Distribution

The following **Fig 4.6** depicts the monthly income distribution among the respondents in the study are the reference area. The main source of income is from the agricultural activity apart from the labour employed in the mining lease area.

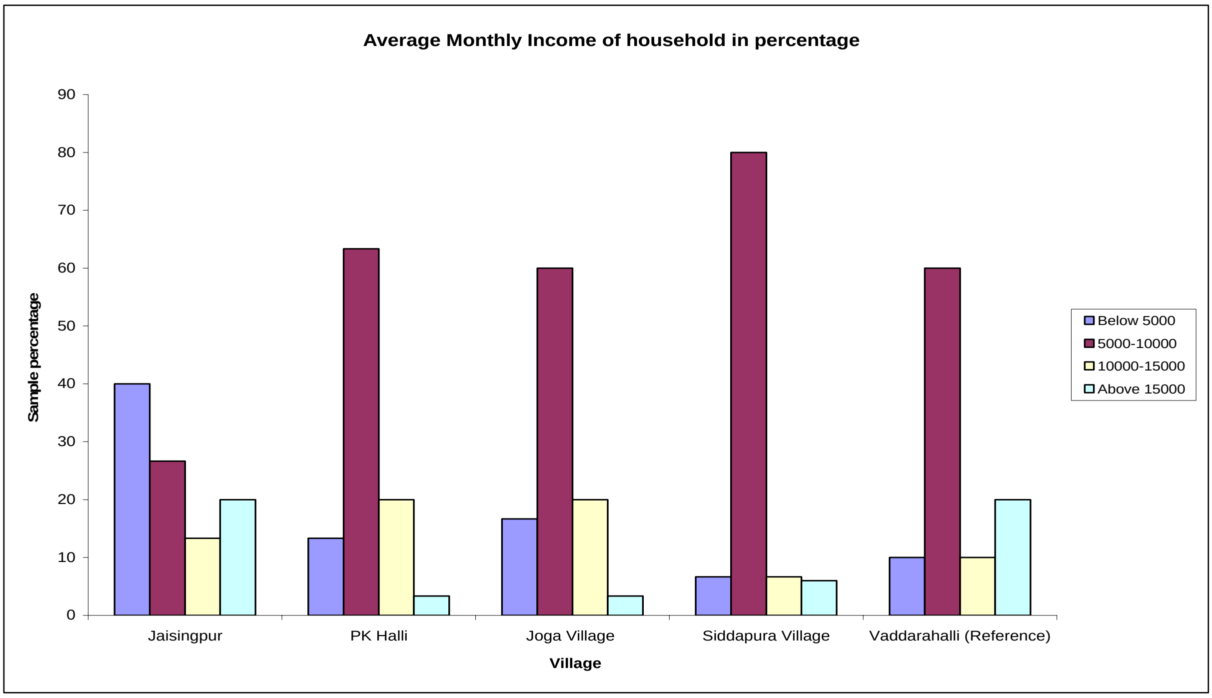


Fig 4.6: Average Monthly income of the respondents in Percentage

From the above figure, it can be observed that, large percentage of respondents fall in the range of Rs 5000 to Rs 10,000 in all the villages (ranges from 27 – 80 %).

Respondents with income below Rs 5000 range from 7-40 in the study as in the reference village. A small percentage of respondents fall in the monthly income range of Rs above 15000 (3 – 7%).

Table 4.5: Average Household Expenditure in the Study Area (in Rs)

Household Expenditure	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
Domestic	2527	1983	1882	1400	1750
Education	1012	756	678	1010	680
Medical	1650	1218	1125	1450	658
Others	1210	1012	780	650	717
Health Cost Incurred by the individual due to Deterioration of environmental quality	1975	1609	1485	2119	791

4.3.5 Monthly Expenditure

The table gives the average house hold expenditure in the study & the reference area. From the above table it can be observed that respondents from the study and villages will spend more money towards domestic consumption and on education of their children. It can also be that respondents who are residing in study villages where there are mines around these villages and are working in the mines as workers of have incurred an out of pocket expenditure towards the health cost due to deterioration of environmental quality of their village due to increase in Iron Ore Mining. The respondents in Jaisingpur and Siddapura villages have incurred an additional such expenditure. The same can be internalized to the cost of mine if the same can be reimbursed to the affected workers. The table also helps to conclude that more mining in the area will helps to earn more income which can be spent to uplift the a economic status of the respondents .

The analysis of the above table indirectly indicates that the social status of the study village where there are more number of mine lease area vis a vis more labourers working in these mines. The average expenditure for different parameters like domestic, education is high in Jaisinghpur village and the health cost incurred towards environmentally induced illness, due to deterioration in the air / water quality in the surrounding area.

The average house hold expenditure is depicted in the **Figure 4.7.** From the table it can be concluded that, expenditure on house hold and additional health cost is almost the same amount. However, the cost incurred in the non mining area is less compared to mining belt. This is indirectly the local community is exposing to environmental degradation due to mining and related activity.

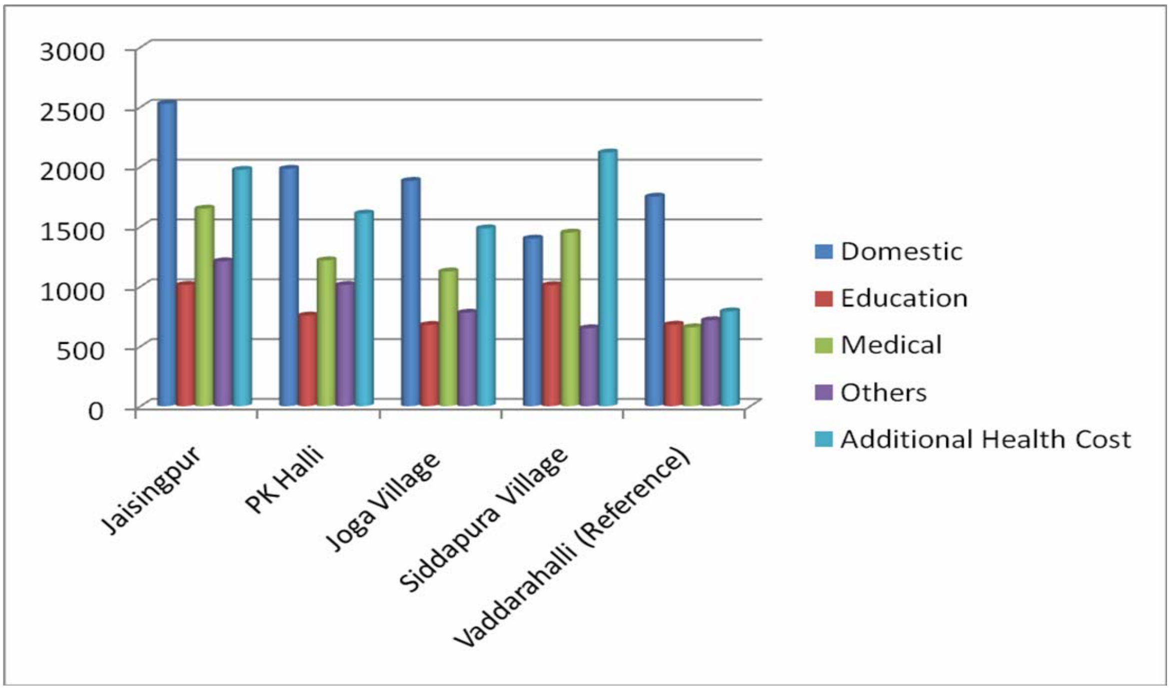


Fig. 4.6: Average household expenditure in the Study Area

4.3.6 Source of Income

The **Table 4.6** depicts the source of income for the household in the study & the reference area.

The above table indicated that the incomes from the wages for working in the mine at different study are ranges from 27 % to 54%. This table also indicates about 60 % of the respondents in the reference area has agricultural income as there are no mines in the surrounding area. The source of income from 'others' includes petty shops, provision store, workshops and small hotels/dhabas.

Table 4.6: Source of Income of Household in Different Villages of the study Area (in percentage)

Sr. No.	Source of Income	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
1	Agriculture	26.67	16.67	46.67	20	60
2	Livestock	6.67	3.33	3.33	6.67	13.33
3	Mining	40	53.33	26.67	53.33	20
4	Forest produce	6.67	0	13.33	6.67	0
5	Others	20	26.67	10	13.33	6.67

An attempt was also made to know the indoor air quality through analyzing the source of energy in the kitchen / bathroom. The following **Table 4.7** gives the status of the household, energy for cooking and the bath.

Table 4.7: The Status of the Household, Energy for Cooking and the Bath (in Percentage)

Sr. No.	Parameters		Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
1	Status of House	Kutcha House	6.67	33.33	26.67	36.67	36.67
		Semipucca House	63.33	20	46.67	30	26.67
		Pucca House	30	46.67	26.67	33.33	36.67
2	Energy for Cooking	Cow dung	16.67	6.67	20	13.33	6.67
		Fire Wood	66.67	70	66.67	73.33	83.33
		LPG	16.67	23.33	13.33	13.33	10
3	Energy for Bathing	Fire Wood	76.67	93.33	76.67	76.67	83.33
		Cow dung	23.33	6.67	23.33	23.33	10

About 20 - 64 % of the respondents in the study and reference area are residing in semipucca house, about 65 – 84 % of the respondents in the study and the reference area are using fire wood as the source of energy in the kitchen and 77 – 94 % of the responds uses fire wood in the bath room for heating purposes.

4.4 ENVIRONMENTAL IMPACT STUDIES THROUGH EVALUATION TECHNIQUE

For the purpose of evaluation of change in the quality of the environment due to increase in mining activity in the study area, Environmental Impact matrix was developed based on the baseline data collected on different environmental attributes like water, air, noise, soil characteristics and the details of flora-fauna in the study area. This methodology is evolved to quantity the environmental impact in the study area due to increased mining operations. The method involves a method of evaluation, through a weighing scaling checklist. The checklist consists of various parameters identified from different environmental attributes like ecology, air, water etc for this purpose. All these parameters have been assigned importance weight through quantitative analysis for increasing mining activity. The resultant importance weight points are presented in the **Table 4.8** below.

4.5 HEALTH STOCK MEASURES AMONG THE RESPONDENTS

It is evident that the increase in iron ore production increases the dust emission in the surrounding environment and accidental discharge/ runoff during the rainy season causes accumulation of the fines / soil in the nearby surface water body. Exposure to high concentration of the dust in the air and continuous inhalation and consumption of polluted water, causes health impact in the exposed population. The following table gives the health stock in the respondents of the villages both in the study and the reference area.

Table shows the number of respondents suffering from specific diseases in both the area along with time of exposure and the distance of travel, as it is evident that as the time of exposure and duration of exposure increases, the inhalation of polluted air increases and hence the probability of suffering from respiratory disease will also increases.

Table 4.8: Health Status of the Respondents in the Study Area (in Percentage)

Sr. No.	Disease	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
I	**Air Pollution Induced illness**					
1	Asthma	10	13	3	7	0
2	Dust Allergy	33	43	27	37	20
3	Respiratory infection	3	0	20	17	10
4	Skin Allergy	27	17	23	13	13
II	**Water Pollution Induced illness**					
1	Malaria	10	7	13	0	3
2	Jaundice	3	10	7	3	0
3	Gastro Intestinal disorders	13	7	0	7	0
4	Dehydration	0	3	3	3	0
III	**Noise Pollution Induced illness**					
1	Loss of hearing	0	0	3	7	0
	No Problem	0	0	0	0	53

The Relationship between Health Status & the time spent by the respondents in the mining area is given below table. The mining companies predominantly operate in the day light hours between 06 hrs to 18 hrs in this study area.

Table 4.9: The Relationship between Health Status & the Time Spent

Sr. No.	Disease	Jaisingpur	PK Halli	Joga Village	Siddapura Village
1	Asthma	6	8	8	7
2	Dust Allergy	8	6	5	7
3	Respiratory infection	6	4	7	5
4	Gastro Intestinal disorders	4	7	5	5
5	Water Borne Disease	4	4	5	6
6	Loss of hearing	0	4	5	5

An attempt was made to collect the data on the frequency of doctor's visit by the respondents who are suffering from the set of environmentally induced illness. The following **table 4.10** gives the frequency of doctor's visit in the study and the controlled villages.

Table: 4.10: Doctor's Visit by the Respondents Since Last One Year in Percentage

Sr. No.	Number of Doctor's Visit	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
1	0-3	73.33	60.00	80.00	70.00	56.67
2	4-6	20.00	26.67	10.00	16.67	33.33
3	above 6	6.67	13.33	10.00	13.33	10.00

From the above table it can be observed that large number of respondents suffering from the set of induced illness in all the study villages have visited the doctor for 0 – 3 times for taking treatment. It ranges from 60 – 80 % in the study villages where there are operating mines and it is 57% where there are no mines and health victims are also less. As the frequency of doctor's visits increases, the number of respondents reduces indicating that the respondents are suffering from chronic diseases and not the acute one.

It was also observed from the field survey that all the mining labour are being provided with safety shoes, mask and ear plugs as preventive/ mitigating measures. These will reduce the environmental burden induced due to the exposure to different pollutants/ occupational risk with in the mine lease area.

Further baseline data on the health care facilities provided by the government/ the private medical practitioner with in the study area and the reference area was also collected to know availability of treatment facilities to the respondents. The following **Table 4.11** gives the status of health care facilities in the study and the control villages.

Table: 4.11: Number of Health Care Facilities Available in the Study Area

Sr. No.	Type of Hospital	Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
1	Government	1	1	0	0	0
2	Private Clinic	2	3	1	2	2

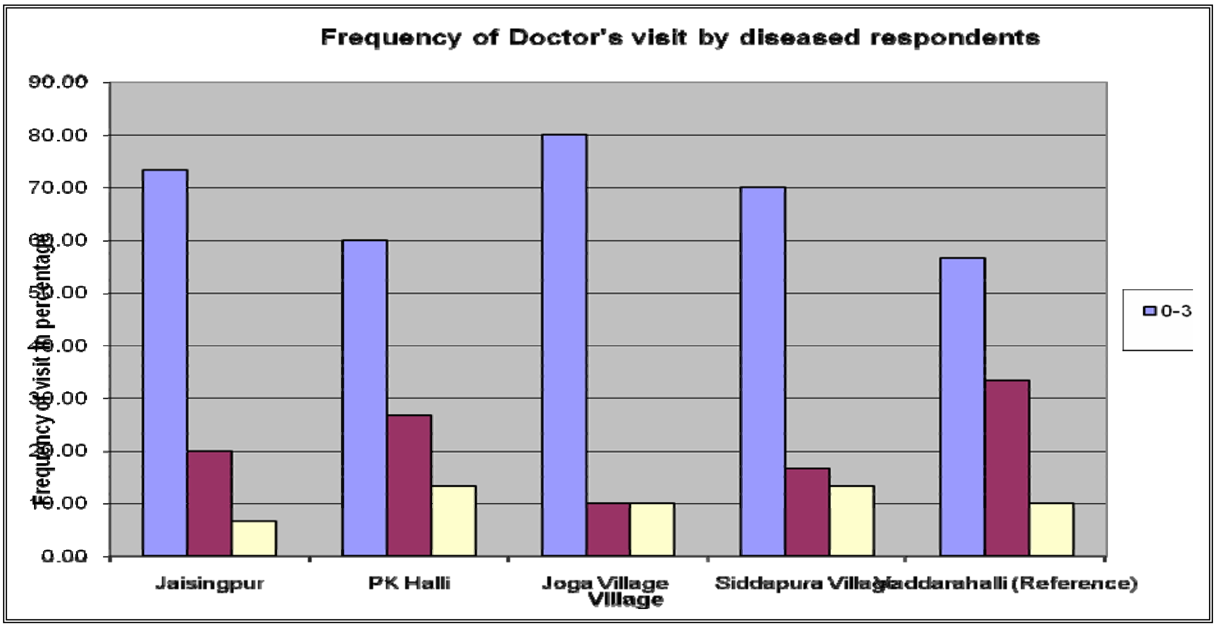


Fig. 4.9: Frequency of Doctor's Visit by Diseased Respondents

The above table indicates that there are few government hospitals in the study villages (only Jaisinghpur and PK Halli has one primary health unit/centre, where as there are no government hospitals in other villages). All the villages have private medical practitioners operating the clinic. The villagers have to depend on these clinics for any unforeseen emergency. At two places, the private doctors were residing in the same village, hence an easy access to the villagers in case of emergency.

This has also contributed for higher expenditure on the health cost, as the doctor's fee ranges from Rs.50- Rs.100 in the study and in the control villages as compared with the consultation with the government hospital. The government has provided free medical checkup for low income group (people from below poverty line (BPL) and there is only registration fee of Rs 20 for the respondents who are above poverty line (APL). There are no hospitals in the mine leases spread across the study area.

4.6 MEASUREMENT OF THE HEALTH COST

An attempt is made to measure the health cost imposed by increase in the mining activity, which has contributed for deterioration of air quality, water quality in the study villages. The following **Table 4.12** to **Table 4.16** gives the health cost incurred by the respondents in different study villages individually.

Table: 4.12: Treatment Cost Incurred by the Respondents in Jaisingpur

Sr. No.	Disease	Number of patients in Jaisingpur	Average Doctor's fee paid in Rs.	Average Cost of medicine Spent /person/ Visit in Rs.	Total Cost of Medicine/ Visit in Rs.	Loss of Income due to sick/y in Rs.	Total Cost Incurred towards medicine/ time in Rs.
	Air Pollution induces Diseases						
1	Asthma	4	100	480	1920	3000	5020
2	Dust Allergy	13	100	382	4966	750	5816
3	Skin Allergy	5	100	235	1175	1000	2275
	Water Pollution induces Diseases						
1	Malaria	2	100	125	250	500	850
2	Jaundice	3	100	785	2355	750	3205
3	Gastro Intestinal disorders	2	100	345	690	1000	1790
4	Dehydration	1	100	150	1	250	351
						Total	**19307**

Table 4.13: Treatment Cost Incurred by the Respondents in PK Halli Village

Sr. No.	Disease	Number of patients in P.K Halli	Average Doctor's fee paid in Rs	Average Cost of medicine Spent /person/ Visit in Rs	Total Cost of Medicine/Visit in Rs	Loss of Income due to sick/yr in Rs	Total Cost Incurred towards medicine/ time in Rs
	Air Pollution induces Diseases						
1	Asthma	3	100	280	840	3750	4690
2	Dust Allergy	10	100	180	1800	500	2400
3	Respiratory infection	1	100	380	380	500	980
4	Skin Allergy	8	100	565	4520	250	4870

Sr. No.	Disease	Number of patients in P.K Halli	Average Doctor's fee paid in Rs	Average Cost of medicine Spent /person/ Visit in Rs	Total Cost of Medicine/Visit in Rs	Loss of Income due to sick/yr in Rs	Total Cost Incurred towards medicine/ time in Rs
	Water Pollution induces Diseases						
1	Malaria	3	100	384	1152	500	1752
2	Jaundice	1	100	1385	1385	2500	3985
3	Gastro Intestinal disorders	4	100	980	3920	1000	5020
						Total	**23697**

Table 4.14: Treatment Cost Incurred by the Respondents in Joga Village

Sr. No.	Disease	Number of patients in Joga Village	Average Doctor's fee paid in Rs	Average Cost of medicine Spent /person/ Visit in Rs	Total Cost of Medicine/Visit in Rs	Loss of Income due to sick/yr in Rs	Total Cost Incurred towards medicine/ time in Rs
	Air Pollution induces Diseases						
1	Asthma	1	50	315	315	1500	1865
2	Dust Allergy	8	50	265	2120	750	2920
3	Respiratory infection	6	50	342	2052	750	2852
4	Skin Allergy	7	50	512	3584	1250	4884
	Water Pollution induces Diseases						
1	Malaria	4	50	205	820	750	1620
2	Jaundice	2	50	1160	2320	500	2870
3	Dehydration	1	50	260	260	500	810
						Total	**17821**

Table 4.15: Treatment Cost Incurred by the Respondents in Siddapura Village

Sr. No.	Disease	Number of patients in Siddapura Village	Average Doctor's fee paid in Rs	Average Cost of medicine Spent /person/ Visit in Rs	Total Cost of Medicine/Visit in Rs	Loss of Income due to sick/yr in Rs	Total Cost Incurred towards medicine/ time in Rs
	Air Pollution induces Diseases						
1	Asthma	2	80	296	592	3250	3922
2	Dust Allergy	11	80	318	3498	2000	5578
3	Respiratory infection	5	80	300	1500	2250	3830
4	Skin Allergy	4	80	285	1140	3750	4970
	Water Pollution induces Diseases						
1	Jaundice	1	80	658	658	3000	3738
2	Gastro Intestinal disorders	2	80	426	852	1750	2682
3	Dehydration	1	80	125	125	500	705
						Total	**25425**

Table 4.16: Treatment Cost Incurred by the Respondents in Vaddarahalli Village

Sr. No.	Disease	Number of patients in Vaddarahalli	Average Doctor's fee paid in Rs	Average Cost of medicine Spent /person/ Visit in Rs	Total Cost of Medicine/Visit in Rs	Loss of Income due to sick/y in Rs	Total Cost Incurred towards medicine/ time in Rs
	Air Pollution induces Diseases						
1	Dust Allergy	6	80	210	1260	1000	2340
2	Respiratory infection	3	80	268	804	1250	2134
3	Skin Allergy	4	80	432	1728	1750	3558
	Water Pollution induces Diseases						
1	Malaria	1	80	135	135	1250	1465
						Total	**9497**

The following **Table 4.17** gives the consolidated total additional Economic cost incurred by the respondents in the study and the reference village due to Pollution/ Annum is in rupees.

Table 4.17: Total Additional Economic Cost Incurred by the Respondents

Sr. No.	Name of the Village	Total additional Economic cost incurred due to Pollution/ Annum in Rs
1	Jaisingpur	1975
2	PK Halli	1609
3	Joga Village	1485
4	Siddapura Village	2119
5	Vaddarahalli (Reference)	791

The above Table clearly indicates that the respondents who are residing in those villages where there are more number of mines and the transportation of ore laden vehicles.

Even though the statutory authorities like Ministry of Environment & Forest (MoEF) and the State Pollution Control Boards (SPCB) stipulated the condition that the ore laden vehicles shall have to be covered completely with the tarpaulins and the ore has to be transported with wet condition, generally the mine owners will transport the ore in the open loaded vehicles with out any cover and in the dry state. This ultimately makes the fine ore to get air borne and lots of spillages will also takes place on the road sides of the villages exposing the people who are residing on the road side to higher concentration of the dust.

Further there was also a condition that the haulage roads with in the mine lease area has to be wetted with water sprinkling arrangement on regular basis and the mines dumps also has to be provided with water sprinkling arrangement. However due to practical difficulties, generally the haulages roads were not wetted. This has also contributed for higher concentration of air pollutants in the vicinity.

4.7 IMPACTS OF MINING ON VEGETATION

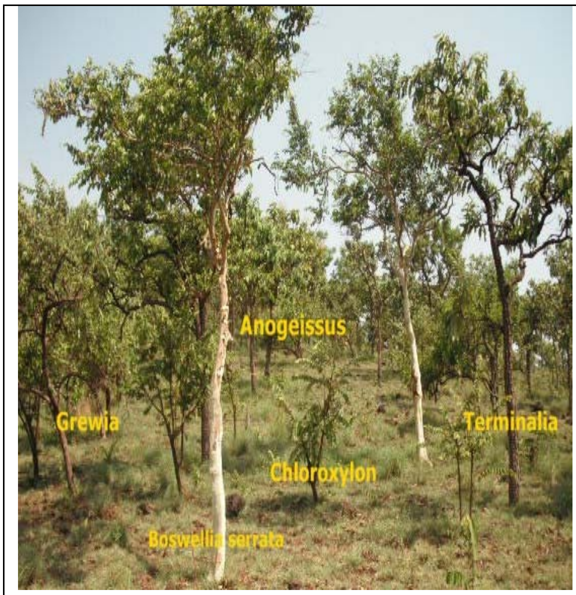
The distribution of human settlement and density of population is drastically changed since the past few decades owing to its geological component that is rich in Ores. The activities of agriculture create less pressure on the natural forest in the surrounding area, whereas mining activities have imparted a change in the local landscape. The nature of impacts of mining on natural vegetation is different from different activities. The nature of impacts of the increase in the mining activity on the surrounding environment is discussed in following paras;

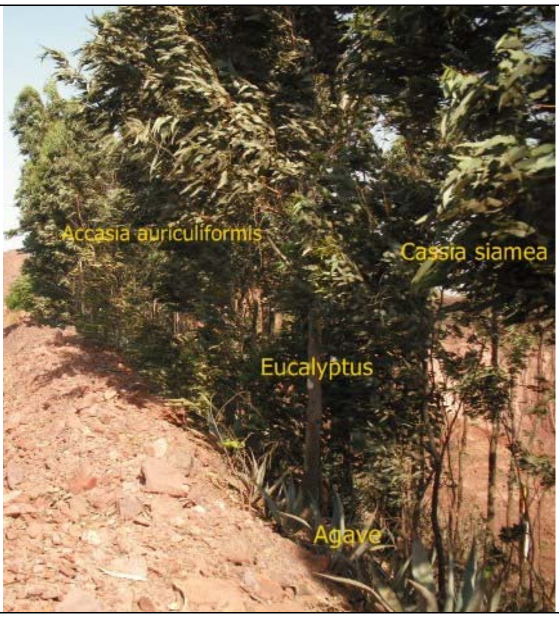
4.7.1 Denudation of Natural Vegetation

There is removal of green cover and top soil in mining activity. The top soils are conserved accordingly as proposed in the mine scheme whereas the vegetation cover is removed once for all. The Mine Lease in the study area mostly falls under the Reserve forest. The ores deposits are stored inside the mountain folds, thereby it is also feasible for extraction from the top of hillocks. Site clearance for starting mining activity involves removal of plants & trees in the surrounding vicinity. Further, an approach road is also required for the incoming and outgoing ferrying vehicles. A general presentation of the mines showing the extend of removal of vegetation cover can be view from aerial images

Denudation of vegetation cover (lateral view and aerial view of google image)

4.7. 2 Replacement of Natural Vegetation





The localized natural plants are replaced by un-sustainable Exotic species

The program on reclamation and afforestation in the mine area is undertaken with fast growing species. The fast growing species are mostly Eucalyptus, Acacia auriculiformis, Cassia siamea, Grevelia robusta, Casuarina equisetifolia, etc. These fast growing species extract nutrient and water extensively from the substratum thereby leaving behind the soil not fit for any plant growth. Moreover, whether the local birds and animals can shelter the fast growing grooves is a big question.

4.7.3 Solid Waste and Waste Water such as Dust and Mine Wash-out

Another problem with mining activity is the transportation and vehicular movements. The dust dispersed from the local village road contaminate in the surrounding structure, biotic component, household utensils, etc.

Dust on vegetation and Mine wash-out contaminating Cultivation field

The generation of the fine dust due to air borne particulates contaminates the surrounding air environment. The mine wash-out which will follow the surface run off due to rains will get accumulated in the cultivation field has become a serious issue since from the beginning of the mining activity. The loss of crops cannot be estimated practically, but crop losses are reported due to dust accumulation on foliar surface of the plants; and reduction in production due to poor soil condition. The contamination of mine wash-out is common in the nearby cultivation fields, if not checked by providing proper technical reclamation/conservation measures such as check dams, gully plugs and toe retention wall. Creation of scientifically designed storm water drainage at critical locations such as around the rejection dump area, shoulders of the haulage road and all round the active mine pit to carry rain water, which will prevent of lose muck and dust particles joining the adjacent agricultural field and or siltation natural drainage system.

4.7.4 Effect of Dust on the Plants Growth;

The Dust is one of the main nuisances produced during the mining operations. The removal of top soil, clearing the site for mining, and excavation of the ore through operation of heavy earth moving machineries, movement of vehicles including drilling & blasting operations creates lot of dust in the surrounding area. With the monitoring and measurements of statutory authorities, the dispersal of dust from the mining activities are restricted with the implementation of various pollution control measures like regular water sprinkling on the haulage road, mining pit, avenue plantation, covering the ore with tarpaulin which transportation, transporting the ore in wet condition etc, the problems of dust dispersion from mining activities is still a long debate.

Dispersal and deposition of the air borne dust on the nearby human settlements and cultivation field attract serious concern among the general public. The settling of dust on household material, biotic component and livestock has disturbed the well-being of a society. Meanwhile the deposition on natural plants and vegetation has not raised alarm on legal ground. But as far as crops are concerned various issues are raised on the issues of loss of crop yield. The loss is also emanated from the contamination of sediments from the wash-out during rain.

Regarding studies on impact of dust on plants, various studies are available in the regional context of India. The general impacts highlighted are reduction in chlorophyll content, protein and other metabolite. This may be due to fly ash pollution (Prasad, 1990), cement dust (Tiwary and Patel, 1993) as well quarry dust pollution (Pandit et al., 1996, Somashekar et al., 1999). Also effect on leaf epidermis (stomatal index, length, width of guard cell) is highlighted in plant growing near stone crushers (Shammushauel, 1995; Paramesha et al., 2007).

Further studies on the impact on crops are also available relating to various physiological effects such as reduction in growth and biomass yield on Brassica oleraceae and B. campestris by Zagar et al. (1999) and Shukla et al. (1990). The reduction in chlorophyll content, protein, starch, yield and phytomass in Groundnut was reported by Prasad and

Inamdar, 1990. Overall, particulate dust falling on leaves may cause foliar injuries, reduction in yield, change in photosynthesis and transpiration, etc. (Raina et al., 2008).

4.8 ENVIRONMENTAL MANAGEMENT MODEL

An environmental management system is a tool used to identify measure and manage the effects of its human activities on the environment. An EMS sets out the goals for environmental performance and a plan for achieving those goals. Ideally, the company will set goals in areas such as compliance with environmental laws, minimization of risks to human health and the environment, use of natural resources, and prevention and reduction of pollution.

Environmental Management System is most effective when they are part of normal business activities rather than treated as separate programs or initiatives. The EMS provides a systematic way to integrate those efforts and direct them toward established goals. The significant range and variations of EMSs can be attributed to the differences among organizations in size, activities, impacts, regulatory requirements, corporate culture and policy commitments. This is applicable to organizations of all types and sizes, is based on five components:

1. An environmental policy that commits the organization to "prevention of pollution," "continual improvement" and compliance with "relevant environmental legislation and regulations."
2. Planning to implement the environmental policy, this entails identifying all of an organization interaction (activities, products or services) with the environment (its “environmental aspects”) and designating the “significant” aspects and setting quantifiable objectives and targets for addressing those significant aspects.
3. Implementation and operation, which requires an organization to ensure the availability of resources, define roles and responsibilities, develop documented procedures, emergency preparedness plans and ensure employee competency, training and awareness.
4. Checking and corrective action to measure and track the performance of the system against its own goals and to evaluate compliance with the relevant laws and regulations. The organization must also identify, investigate and correct any non-conformity. The organization must ensure that internal audits are conducted.

5. Review of the EMS by top management "to ensure its continuing suitability, adequacy, and effectiveness. The following Environmental index has been evolved based on the primary analysis of the data collected on different environmental attributes.

ENVIRONMENTAL IMPACT

Attributes	Measurable Parameters	Villages				
		Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
Environmental pollution	SPM in μg/NM^3	8	5	8	5	2
	RSPM in μg/NM^3	5	5	8	5	2
	Hardness in mg/l	8	5	5	2	5
	Suspended Solids in mg/l	5	2	2	5	2
	T.D.S. in mg/l	5	2	5	5	5
	Turbidity in mg/l	8	5	2	2	5
	Total Iron as Fe in mg/l	2	2	8	5	2
	Community noise dB(A)	2	2	5	2	2
	Occupation noise dB(A)	5	5	2	2	2

$$\text{Exceedence Factor (EF) for Environmental Attributes} = \frac{\text{Measured Parameter} - \text{Standard Parameter}}{\text{Measured Parameter}}$$

EF	Severity Index (SI)
0 to 0.25	2
0.25 to 0.50	5
0.50 to 0.75	8
0.75 to 1.0	10

Qualitative Impact Index (QII) of Ecological Parameters

	Measurable Parameters	Villages				
		Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
Ecological Parameters	Vegetation/Agriculture	M	M	M	M	L
	Crops	M	M	L	M	L
	Soil Characteristics	M	M	M	M	M
	Ground water	L	L	L	L	L
	Soil erosion	S	S	M	S	M

Impact Index- Severe= S, Moderate=M, Low=L

Qualitative Impact Index (QII) of Social & Economic parameters.

Attributes	Measurable Parameters		Villages				
			Jaisingpur	PK Halli	Joga Village	Siddapura Village	Vaddarahalli (Reference)
Social	Age (yrs)	<30	x	x	x	x	x
		>30	x	x	x	x	x
	Sex	Male	x	x	x	x	x
		Female	x	x	x	x	x
	House hold members	<3 members	x	x	x	x	x
		>3 members	x	x	x	x	x
	Education	Literates	+	+	+	+	+
		Illiterates	_	_	_	_	_
	Infrastructure		+	+	+	+	+
Economical	Economy output		+	+	+	+	+
	Employment		+	+	+	+	+
	Drinking water supply		+	+	+	+	+
	Community health		+	+	+	+	+
	Occupational health		_	_	_	_	_

Impact Index- Positive= + Negative = - Not Significant = x

The above Tables clearly indicates that there is an positive impact on the economic out put, employment as there is an increase in the employment opportunities and hence there is a economic output for the people. Further, the basic facilities of the villages like drinking water supply, community health and infrastructure will improve because of contribution from the owners of surrounding mining companies with the intension that they can operate the mining operations with the complete cooperation from the surrounding community. This also is a part of social responsibility of the entrepreneur under "**Corporate Social Responsibility**" for environmental protection.

There is an always a positive impact on the community health the affordability of people for health care facilities and also from the mine owners.

There is no impact on social aspects like age, sex, house hold members etc due to increase in iron ore mining in the surrounding area as these parameters are demographic features of any location and or not location specific/area specific. However, there is a positive impact on the literacy rates of the people due to the facilities provided by wither government through collection of high revenues in terms of tax from the mining companies or directly from mining companies themselves as a part of social obligations.

The qualitative impact index of ecological parameters are also reveals that in all the villages of rhe study area, there is a moderate impact on vegetation, agriculture, crops and soil characteristics due to increase in mining activity by the surrounding mines. However, there is least impact on the ground water aquifer in all the study villages and there is severe impact on soil erosion in three out of five villages of the study area, but there is a moderate impact in two villages on the issue of soil erosion. The overall analysis of qualitative impact index reveals that the impact will be from low to moderate as compared to the severe.

The overall analysis of the environmental management model envisages the efficient management system for preventing/controlling the impact of increase in the iron ore mining on different environmental attributes including flora and fauna.

CHAPTER 5

CONCLUSIONS & SCOPE FOR FUTURE WORK

The iron ore mining brings wealth to the society, a country as a whole foreign exchange. Lot of industrial, infrastructural and developmental activities requires iron as a raw material which contributes for economic growth of the country. However, mining causes negative externality through degradation of land, surface and ground water and air quality of the surrounding environment and ecology.

Proper identification and measurement of these impacts on different component of the environment is necessary for internalizing the environmental degradation to the development so as to achieve "Sustainable Development" as per Kyoto Protocol. Hence the present study has made an attempt to measure the impact of excessive iron ore mining in Bellary-Hospet Sector on the surrounding villagers including the local environment & ecology.

Detailed data on socio-demographic status of the villages which are situated around the mine lease areas at four villages were collected and a reference village was also considered for comparison. Detailed analysis of field data collected on various social and environmental attributes reveals that the villages have lacuna in terms of having basic facilities like hospitals, schools, community centers, training centers etc which contributes for upliftment of living standards of the people.

In all the study villages, illiterates were high when compared with the respondents with educational qualification of primary and high school. There were very few respondents who have completed the graduation in all the villages.

The analysis of occupational profile have supported the hypothesis that more respondents were working in the mines, situated near the study area and there were few respondents who are residing in the reference village, are working in the mines of other villages. Apart from the mines, agricultural activity has contributed significantly for the income of the house holds. There was small percentage of respondents who are earning through business, drivers.

The analysis of average monthly income of the household reveals that the study village Siddapura was more number of mine leases is situated, has high rate of average monthly income when compared with the other study villages.

The respondents have spent significantly more amount towards domestic, medical and education in the study villages where there are mine leases. It has also revealed that the respondents have incurred high “out of pocket” expenditure towards treatment for the diseases which are induce due to exposure for environmental pollutants either in the working mine leases or during transportation. This health cost is high in the study area of Siddapura and Jaisinghpur due to more number of leases vis-à-vis increase in workers working in these mines.

The analysis of source of income for different household in study area reveals that source from agriculture activity is significant apart from mining. Livestock and forest produce have also contributed to a small extent among the respondents.

An attempt to measure the in door air quality in the study area through collecting a data on status of house, source of energy in the kitchen/bath room have revealed that higher percentage of respondents are residing in semi Pucca house and are using fire hood as energy source in their houses. Cowdung is also being used by the respondents to a significant extent.

The health data collected from the respondents have revealed, significantly more number of respondents is suffering from dust allergy, skin allergy in the study area where there are mines and are working as workers in those mines.

The data collected on the ambient air quality in the selected stations of study area reveals that increase in iron ore production has significantly contributed for deterioration of air quality combing with the transportation of ore without dust containment measures. The analysis has revealed that SPM concentration has reached as high as 310 $\mu g/nm^3$ whereas RSPM has 160 $\mu g/nm^3$ which is five times higher than the AAQM standards. Continuous exposure to this higher concentration for longer duration will significantly contribute for health impact and health cost among the respondents.

The increase in iron ore production has not significantly contributed for deterioration of surface water quality in the surrounding villages. The analysis of surface water quality of nallah/tank water has revealed that few parameters are near to the standards but well within the limits. Hence there is a need to have preventive measures like construction of toe retention wall, check dams, gully plugs and contour trenches to prevent accidental/ unforeseen run-off due sudden down pour/cloud burst.

The analysis of ground water has indicated that, there is no significant change in the water quality as most of the area has clayee structure where there are less pores which can carry surface water to the ground water aquifer/ground water table.

Finally the analysis of health impacts due to deterioration of environmental attributes among the respondents in the study area has indicated that, the respondents who are residing in the villages near to the mine and working as workers in the mine lease area are suffering from set of air pollution induced respiratory related illness. The study villages viz. Siddapura and Jaisingpur villages where more mine are operating has shown high incidences of illness among the respondents contributing for higher health cost incurred through treatment. As the mine's owners have not provided clinics/health care establishment within the lease area, the expenditure incurred towards the treatment has resulted in "out of pocket" expenditure which makes house hold to become indebtness.

The analysis of environmental management model suggests that the mining companies to implement effectively the principles of systematic & scientific method of mining adopting technical and biological reclamation techniques such as engineering measures vis-à-vis construction of scientifically designed soil erosion control measures.

CHAPTER 6

REFERENCES

1. Abubacker, (1994), “Socio Economic Impact of Air Pollution: A Study of Cement Factories in Tiruchanapalli, Tamil Nadu, PhD Thesis, Bharathidarshan University.

2. Alberini, Anna, et al., (1997), “Valuing health effects of air pollution in developing Countries: the Case of Taiwan”, Journal of Environmental Economics and Management (34), pp: 107-126.

3. Bismarckkwakuasar, Darkoh M.B.K. (2001), “Socio-economic and Environmental Impacts of Mining in Botswana: A case study of the Selebi-Phikwe Copper Nickel Mine”, Eastern Africa Social Science Research Review, Vlol. XVII, No.2, pp 1-42.

4. Barbieri JC. (2004), Gestao ambiental e mpresarial. Sao Paulo: Saraiva

5. Charbel Jose Chiappetta Jabbour, Fernando Cesar Almada Santos (2008), “Relationships between human resource dimensions and environmental management in companies: proposal of a model”, Elsevier, ScienceDirect, volume-16, page number 51-58.

6. Daily BF, Huang S. (2001) “Achieving sustainability through attention to human resource factors in environmental management. International man resource factors in environmental management. International journal of Operations and Production Management”; 21(12): 1539-52.

7. “Environmental and social impacts of mining”.- www.Rainforestinfo.org.au/ wrr 2003.

8. Edward Lim (2007), “ Benefits & Issues of open-cut coal mining on the socio-economic environment-The Iban Community in Mukah, Sarawak, Malaysia” World academy of Sciences, Engineering and Technology 25.

9. Emmanuel K. Boon, Frederick Ababio (2009), “Corporate Social Responsibility in Ghana: Lessons from the mining sector”, 29th Annual conference proceedings of the international association for impact assessment, Accra international conference centre.

10. Frank Montavon, Robert Sroufe, Ramnarasimhan, 2006, “An examination of corporate reporting, environmental management practices and performance”, ScienceDirect-Journal of Operations Management 35, pp-998-1014.

11. Grossman, Michael (1972), “On the Concept of Health Capital and the Demand for Health”, Journal of Political Economy, Vol 80, No: 2, pp: 223-255.

12. Gerking S. and Stanley L.R (1986), “ An Economic Analysis of Air Pollution and Health: The Case of St Luise” Review of Economics and Statistics, (68), pp:115-121.

13. Gaven Hilson, Barbara Murck, (2000), “Sustainable development in mining industry: Clarifying the corporate perspective, Resource policy 26, pp 227-238.

14. Gavin Hilson,(2002) “Environmental impact of small-scale gold mining in Ghana: identifying problems and possible solutions” Imperial College Centre for Environmental Technology, Royal School of Mines, Prince Consort Road, London SW7 2BP, Vol. 168. No. 1, March 2002, pp. 57-72.

15. Gavin Hilson, (2002), “Small scale mining and its Socio –Economic impacts in developing countries”, Natural Resource Forum, Vol.26, Issue 1, pp 3-13.

16. Hanley, Nick, Ryanand, Robert Wright (1999), “Estimating the Monetary Value of Health Care: Lessons from Environmental Economics”, Health Economics, Vol. 12, pp: 3-16.

17. Heledd Jenkens, Natalia Yakovleve, (2006), “Corporate Social Responsibility in the Mining industry: Exploring trends in social and environmental disclosure” , Journal of Cleaner production 14, pp-271-284.

18. Janewbold (2006), Chile’s Environmental momentum: ISO-14001 and the Large scale mining industry-Case studies from the state and the proviate sector”, Journal of Cleaner production 14, pp-248-261.

19. Kitula, A (2006), “The environmental and socio-economic impacts of mining on local livelihoods in Tanzania: A case study of Geita District”, Mendeley, vol-14, pages: 405-414.

20. Larson, Bruce et, al., (1999), “The Economics of Air Pollution, Health Risk in Russia: A Case Study of Volgograd”, World Development, (10), pp:1803-1819.

21. Pigou, A.C, (1920), “The Economics of Welfare”, Mac Million, London.

22. Prasad, R. (1990), “Impact of coal mining and other coal based industries on the pigment concentration and productivity of paddy”. In: R.K. Trivedy and M.P. Sinha (ed.) Impact of mining of Environment. Ashish Publishing House, New Delhi.

23. Prasad, M.S.V. and Inamdar, J.A. (1990), “Effect of cement kiln dust pollution on groundnut”. Indian Bot Cont., **7**(4): 159-162.

24. Pandit, B.R., Prasannakumar, P.G. and Pahurkar, A.J. (1996), ”Reduction in protein and chlorophyll contents in Calotropis gigantean (L) R.Br. growing near a stone crusher”. Poll. Res., **15**(4): 375-376.

25. Paramesha, N.D., Somashekar, R.K. and Ushamalini. (2007), “Impact of quarry dust pollution on foliar epidermics of five species growing near stone crushing industry”. Journal of Industrial Pollution Control, **23**(1): 93-95.

26. Seiffert MEB. ISO 14001, (2005): sistemas de gestao ambiental. Sao Paulo: Atlas;.

27. Tiwari, T.N. and Patel, M.K. (1993), “Effect of cement dust on some common plants: Correlation among foliar dust deposition, chlorophyll content and calcium content”. Indian J. Envt. Prot., **2**(13): 93-95.

28. Tungalag.A, Tsolmon.R, Bayartungalag. B (2008), “Land degradation analysis in the ongi river basin”, NUM-ITC-UNESCO, Ulaanbaatar, Mongolia, vol. XXXVII. Part B7.

29. Tungalag A, Tsolmon R, Bayartungalag B (2008), "Land degradation analysis in the Ongi River Basin", International Archives of the Photogrammetry, remote sensing and special information sciences. Volume XXXVII. Part B7.

30. The Socioeconomic impacts of small scale mining", -www.detectorprospector. com/gold-prospecting-public-sites/ec.

31. Singh, N.P. (1988), "Flora of Eastern Karnataka". Mittal Publications, Shree Hari Printers, Delhi.

32. Shukla, J., Pandey, V., Singh, S.N., Yunus, M., Singh, N. and Ahmad, K.J. (1990), "Effect of cement dust on growth and yield of Brassica campestris L". Envntal. Pol., **66**: 81-88.

33. Shammushauel, P (1995), "Effect of cement dust on stomatal structure". Ecology and Environmental Conservation, 1: 7-9.

34. Somashekar, R.K. and Ravi kumar, R. and Ramesh, A.M. (1999), "Impact of granite mining on some plant species around quarries and crushers of Bangalore district". Poll. Res., **18**(4): 445-451.

35. Raina, A.K., Rathore, V. and Sharma, A. (2008), "Effect of stone crusher dust on leaves Melia azadirach Linn. and Dalbergia sissoo Roxb. in Jammu (J and K)". Natural Envrion. Pollut. Technol., **7**: 279-282.

36. Vanessa Petkova, Stewart Lockie, John Rolfe and Galina Ivanova (2009), "Mining developments and social impacts on communities: Bowen basin case studies", Content Management pty Ltd Rural Society 19: 3 page no. 211-228.

37. Vanessa Petkova, Stewart Lockie, John Rolfe and Galina Ivonova (2009), "Mining development and social impact on communities: Bowen Basin Case Studies", Rural society, Vol 19:3 pp 211-228.

38. "Weber-Fahr. M.J.Strongman, R. Kunanayagam, G.McMahon, and C. Sheldon, (2001) "mining and poverty reduction", Natural Envrion. Pollut. Technol., 5: 263-272.

39. Zargar, A.H., Zargar, M.Y., Dar, G.H. and Ganai, B.A. (1999),."Impact of cement dust on growth and biomass yield of Haak (Brassica oleraceae"). Appl. Biological Res., **1**: 179-181.

40. Zobrist J, Sima M, Dogaru D, Senela M, Yang H, Popescu C, Roman C, Bela A, Frei L, Dold B, Balteanu D (2009), "Environmental and Social Economic Assessment of Imapcts by mining activities-A case study in the Certej River catchment, Western Carpathians, Romania, Environmental Science Pollution Research Institute. Aug:16 Suppl 1 S14-26.

APPENDICES

APPENDIX-A

Questionnaire

“Socio-Economics and Environmental Impact Studies due to Mining at Bellary-Hospet Sector”

Date of Entry: _______________

Name of the Village: _____________________

Name of the Respondents: ______________________________

Address: ____

____

Section A: Socio- Economic Profile

1. Age :
2. Religion : 1- Hindu, 2-Muslim, 3-Christain 4-Others
3. Category : 1-General, 2-SC, 3-ST, 4-Others
4. Sex : 1- Male, 2 – Female
4. Marital Status :

Married	1
Un Married	2

5. Education Qualification :

1	2	3	4	5
Illiterate	Up to Secondary	Up to High School	Technical Diploma/(ITI)	Graduate

6. Occupation:

1	2	3	4
Farmer	Unskilled Labour	Skilled Labour	Others

7. Working Place:

1	2	3	4
Private (with in mines)	Business	Driver	Others

8. Total monthly Income:

1	2	3	4
<.5, 000	5,000 - 10,000	10,000 - 15,000	>15,000

9. Income from Other Sources:

1	2	3	4
Agriculture	Livestock	Forest Produce	Others

10. Household Expenditures:

1	2	3
Domestic	Education	Others

11. Number of Household Members:

Number of Male: Number of Female: Children:

12. Do you stay in own or rented house?

Own	1
Rented	2

13. Type of House:

1	2	3
Kacha	Semi Pucca	Pucca

14. House Hold Assets:

1	2	3	4
TV	Fridge & Washing Machine	Vehicle (2, 3 & 4)	Others

15. Indoor Air Quality:

1	2	3
Type of flue used in Kitchen	Type of flue used in Bathroom	Ventilation in House (Kitchen)

Section B: Air Quality Status

1. Ambient Air Quality: (to be filled by analyst)

1	2	3	4
Suspended Particulate Matter (PM10)	Suspended Particulate Matter (PM2.5)	Sulphur Di Oxide (SO2)	Oxides of Nitrogen (NOx)

2. Iron Ore Production:

1	2	3
Ton/Day	Ton/month	Ton/Annuam

Section C: Water Quality Status

1. Name of the Water Source:

1	2	3	4
Public Supply	Open Well	Bore Well	Other

2. Whether it's a Drinking Source:

3. Distance from the Habitat

4. whether it is supplied by the mine authorities:

5. Time & Duration of supply:

6. Ground Water Quality: (to be filled by analyst)

1	2	3	4	5	6	7	8	9	10
pH	TDS	Turbidity	Total Iron	Calcium as Ca	Magnesium	Total Hardness	Chlorides	Fluorides	Alkalinity

Section D: Noise Quality Status

1. Is there is any Mines nearby: 1-Yes 2-No

2. If Yes, how many mines are operating
3. whether they will carry out blasting 1-Yes 2-No
4. If Yes, duration and frequency of blasting:

5. Whether they experience the noise and vibration of blasting 1-Yes 2-No

6. If Yes, the rating they can give 1- Normal 2- Moderate 3- High

7. Noise level Measurement (to be filled by the analyst)

Section E: Health Impact Assessment

1. Are you aware that Environmental pollution causes illness?

Yes	1
No	2

2. Are suffering from any Diseases? 1-Yes, 2-No

1	2	3
Type of Diseases	Duration of Diseases	Have you Consulted any Doctor

3. Consultation of Doctor:

1	2	3
Government	Private	Other

4. Health Status:

1	2	3	4	5	6
Cost incurred to meet the Doctor	Doctors Fee	Cost of Medicine	No of days of medicine taken	No of leaves taken due to diseases	Loss of wages

5. Hospitalization if Any:

1	2	3	4	5	6	7	8
Name of the Disease	No of days Admitted	Cost of hospitalization	Cost of medicine	No of people occupancies	No of leaves taken	Loss of wages	Total exp Incurred

Section F: Awareness on the Environmental Pollution

1. Do you feel the mining activity has changed the environment of the area? 1-Yes, 2-No

2. If yes, the rating they can give 1- Normal 2- Moderate 3- High

3. Do you feel any change is required? 1-Yes, 2-No

4. Who should take action? 1-Government, 2-Mine Owner

5. Will you contribute for restoration of the Environment? 1-Yes, 2-No

6. If Yes, what is your contribution?

7. What Suggestions you make to restore earlier condition?

1	2	3	4
Restriction on Production	Restriction on Transportation	Intensive Afforestation	Restriction on Mine lease area

V. Contingent Valuation to Elicit Willingness to Pay to Reduce Pollution

1. Are you willing to pay as one time basis for reducing pollution? 1- Yes 2- No

2. If yes, how much are you willing to pay to reduce the pollution (Select from the following Table)?

1	2	3	4
Less than 100	between 100 to 250	between 250 to 500	More than 500

3. Have you have understood the scenario? 1- Yes, 2- No

4. Did you consider your budget while answering this question? 1- Yes, 2- No.

Thank You for spending your valuable time and filling up the questionnaire. The information given by you will be used only for study purposes.

APPENDIX –B

AIR QUALITY DATA OF DIFFERENT VILLAGES

JAISINGPUR VILLAGE

YEARLY AVERAGE VALUES

Sr. No	Date of Sample Collection	Pollutant Concentration TSPM in mg/NM3			Pollutant Concentration RSPM in mg/NM3		
		Minimum Value	Maximum Value	Average Value	Minimum Value	Maximum Value	Average Value
1	2001-2002	196	327	262	75	106	89
2	2002-2003	102	186	141	42	86	64
3	2003-2004	86	171	131	47	103	75
4	2004-2005	87	137	113	37	75	58
5	2005-2006	89	156	125	35	72	56
6	2006-2007	105	176	143	54	89	71

PAPINAYAKANAHALLI VILLAGE

YEARLY AVERAGE VALUES

Sr. No	Date of Sample Collection	Pollutant Concentration TSPM in mg/NM3			Pollutant Concentration RSPM in mg/NM^3		
		Minimum Value	Maximum Value	Average Value	Minimum Value	Maximum Value	Average Value
1	2001-2002	146	293	211	66	116	98
2	2002-2003	123	195	156	55	85	71
3	2003-2004	84	171	129	46	106	76
4	2004-2005	68	125	96	32	77	54
5	2005-2006	108	164	133	39	82	61
6	2006-2007	77	171	127	42	79	61

JOGA VILLAGE

YEARLY AVERAGE VALUES

Sr. No	Date of Sample Collection	Pollutant Concentration TSPM in mg/NM3			Pollutant Concentration RSPM in mg/NM^3		
		Minimum Value	Maximum Value	Average Value	Minimum Value	Maximum Value	Average Value
1	2001-2002	196	331	262	75	106	89
2	2002-2003	102	186	141	42	86	64
3	2003-2004	86	171	131	47	103	75
4	2004-2005	87	137	113	36	75	57
5	2005-2006	89	158	125	35	72	56
6	2006-2007	105	176	143	54	89	71

SIDDAPURA VILLAGE							
YEARLY AVERAGE VALUES							
Sr. No	**Date of Sample Collection**	**Pollutant Concentration TSPM in mg/NM3**			**Pollutant Concentration RSPM in mg/NM^3**		
		Minimum Value	**Maximum Value**	**Average Value**	**Minimum Value**	**Maximum Value**	**Average Value**
1	2001-2002	151	246	191	68	128	98
2	2002-2003	149	215	182	56	109	76
3	2003-2004	108	174	140	46	97	72
4	2004-2005	76	143	112	36	74	55
5	2005-2006	104	146	124	37	79	56
6	2006-2007	40	135	85	23	77	47

VADDARAHALLI VILLAGE							
YEARLY AVERAGE VALUES							
Sr. No	**Date of Sample Collection**	**Pollutant Concentration TSPM in mg/NM3**			**Pollutant Concentration RSPM in mg/NM^3**		
		Minimum Value	**Maximum Value**	**Average Value**	**Minimum Value**	**Maximum Value**	**Average Value**
1	2001-2002	159	272	217	53	87	72
2	2002-2003	105	192	147	42	88	64
3	2003-2004	144	226	185	65	130	97
4	2004-2005	80	161	122	35	79	61
5	2005-2006	109	173	143	54	84	68
6	2006-2007	75	172	129	37	82	62

APPENDIX –C

POLLUTANT CONCENTRATION IN DIFFERENT SEASONS

(Sample was given as there are about 65 Pages of data)

AMBIENT AIR QUALITY MONITORING DATA

Location: Research Study Area **Period:** Summer May 2001

Unit: µg/cum

	06-00 to 06-00 hrs						24 hours average	
Hours	**06- 00 to 14-00 hrs**		**14-00 to 22-00 hrs**		**22-00 to 06-00 hrs**		**06-00 to 06-00 hrs**	
Date	**SO_2**	**NO_x**	**SO_2**	**NO_x**	**SO_2**	**NO_x**	**SPM**	**RPM**
A I. Siddapur Village:								
03.5.2001	8	15	10	18	8	20	228	120
04.5.2001	10	18	12	16	7	19	180	106
10.5.2001	9	19	10	14	10	18	220	124
11.5.2001	7	16	5	17	16	20	201	89
17.5.2001	6	21	7	20	12	19	174	72
18.5.2001	10	18	4	19	15	16	168	66
24.5.2001	9	20	6	17	11	21	190	85
25.5.2001	6	21	18	10	17	20	258	119
A II. Papinayakana Halli Village:								
03.5.2001	10	14	9	12	8	19	420	105
04.5.2001	6	12	4	18	4	16	218	92
10.5.2001	7	13	6	17	5	18	190	120
11.5.2001	6	12	5	15	4	15	221	147
17.5.2001	5	10	4	16	5	17	255	139
18.5.2001	4	12	9	18	4	19	302	154
24.5.2001	6	14	7	15	9	21	380	168
25.5.2001	5	16	7	13	6	17	438	175
A III. Joga Village:								
03.5.2001	8	15	6	14	6	18	80	57
04.5.2001	5	12	5	10	4	11	78	54
10.5.2001	6	14	4	12	3	9	64	42
11.5.2001	5	11	8	14	4	15	97	53
17.5.2001	9	17	6	13	5	17	116	71
18.5.2001	6	12	5	14	8	19	87	54
24.5.2001	5	14	4	15	6	17	72	50
25.5.2001	9	15	5	18	8	19	102	68
A II. Vaddarahalli Village:								
07.05.2001	8	15	6	13	8	14	286	82
08.05.2001	5	14	4	12	7	13	247	80
14.05.2001	6	10	8	11	6	15	185	75
15.05.2001	4	12	7	15	5	14	198	68
21.05.2001	9	11	6	14	4	16	233	76
22.05.2001	5	10	5	13	6	15	276	78
28.05.2001	6	09	10	14	7	13	180	85
29.05.2001	7	12	11	12	9	12	191	81
A III. Jaisinghpur Village:								
09.05.2001	10	12	08	14	09	15	442	101
10.05.2001	11	12	09	10	10	14	465	093
16.05.2001	09	14	10	11	08	16	383	088
17.05.2001	08	15	08	15	07	12	371	085
23.05.2001	07	16	07	14	06	11	303	081
24.05.2001	06	13	09	16	07	15	418	079
30.05.2001	08	12	08	13	09	14	364	092
31.05.2001	09	14	10	13	11	13	399	088

AMBIENT AIR QUALITY MONITORING DATA

Location: Research Study Area **Period:** Winter 01-02
Season: Jan. 2002
Unit : µg/cum

	06-00 to 06-00 hrs						24 hours average	
Hours	**06-00 to 14-00 hrs**		**4-00 to 22-00 hrs**		**22-00 to 06-00 hrs**		**06-00 to 06-00 hrs**	
Date	**SO_2**	**NO_x**	**SO_2**	**NO_x**	**SO_2**	**NO_x**	**SPM**	**RPM**
A I. Siddapur Village:								
02-01-2002	8	15	9	18	7	16	190	96
03-01-2002	11	20	10	22	9	19	178	105
09-01-2002	7	16	12	15	6	13	224	90
10-01-2002	9	22	8	17	10	18	188	108
15-01-2002	12	18	6	13	8	22	178	98
16-01-2002	13	16	9	20	9	14	170	90
22-01-2002	8	19	5	14	7	17	202	89
23-01-2002	10	23	11	24	8	21	186	65
A II. Papinayakana Halli Village:								
02-01-2002	07	16	9	12	8	16	181	94
03-01-2002	5	12	6	15	6	13	224	98
09-01-2002	8	19	7	11	9	18	253	108
10-01-2002	7	21	10	17	10	15	181	95
15-01-2002	5	18	7	14	8	12	178	111
16-01-2002	10	24	8	19	7	18	183	87
22-01-2002	6	14	8	12	8	16	207	104
23-01-2002	10	16	6	13	8	14	164	94
A III. Joga Village:								
02-01-2002	7	14	10	12	7	11	86	42
03-01-2002	9	12	6	11	5	11	108	62
09-01-2002	5	11	8	12	8	18	112	54
10-01-2002	8	14	5	9	6	12	85	65
15-01-2002	9	16	7	15	7	14	114	84
16-01-2002	7	13	5	12	6	13	122	68
22-01-2002	10	15	7	13	8	14	88	54
23-01-2002	6	10	8	15	5	12	94	66
A II. Vaddarahalli Village								
03.01.2002	6	16	5	18	6	12	232	96
04.01.2002	8	14	10	14	4	9	151	69
10.01.2002	11	18	9	12	9	16	164	84
11.01.2002	12	17	11	15	7	15	194	56
17.01.2002	9	10	6	12	10	14	170	82
18.01.2002	7	14	9	17	11	16	182	102
24.01.2002	10	13	11	10	8	10	214	92
25.01.2002	5	19	7	16	5	15	248	76
A III. Jaisinghpur Village								
03.01.2002	5	10	5	9	8	14	224	121
04.01.2002	8	14	6	13	5	19	236	88
10.01.2002	10	16	10	15	9	12	204	90
11.01.2002	7	15	7	13	10	24	185	107
17.01.2002	6	17	6	16	7	11	186	94
18.01.2002	9	12	9	18	11	22	156	76
24.01.2002	11	15	5	14	8	13	189	93
25.01.2002	8	18	11	21	10	17	162	68

AMBIENT AIR QUALITY MONITORING DATA

Location: Research Study Area **Season:** Post-Monsoon 2003

Unit: µg/cum

	06-00 to 06-00 hrs						24 hours average	
Hours	06- 00 to 14-00 hrs		14-00 to 22-00 hrs		22-00 to 06-00 hrs		06-00 to 06-00 hrs	
Date	SO_2	NO_x	SO_2	NO_x	SO_2	NO_x	SPM	RPM
A I. Siddapur Village								
02.09.2003	3	1	9	4	7	10	153	92
10.09.2003	8	2	5	9	3	1	137	71
19.09.2003	5	9	1	10	6	11	175	124
30.09.2003	2	7	10	1	11	3	148	90
A II. Papinayakana Halli Village								
02.09.2003	10	7	2	8	5	3	117	85
10.09.2003	1	4	6	10	7	12	186	124
19.09.2003	5	8	1	15	3	11	145	116
30.09.2003	2	4	7	10	14	6	177	120
A III. Joga Village								
02.09.2003	5	12	3	9	4	12	110	82
10.09.2003	3	10	8	1	1	6	145	112
19.09.2003	6	2	14	9	10	3	136	98
30.09.2003	15	8	11	7	17	10	151	118
A II. Vaddarahalli Village								
04.09.2003	7	10	5	13	11	4	192	120
09.09.2003	3	12	9	7	1	8	183	117
17.09.2003	9	5	6	4	2	1	207	26
26.09.2003	4	2	8	6	9	3	165	108
A III. Jaisinghpur Village								
04.09.2003	11	7	1	6	10	3	96	48
09.09.2003	3	9	5	12	8	1	77	41
17.09.2003	9	20	12	3	2	2	47	26
26.09.2003	5	4	9	7	6	3	112	70

PUBLICATIONS

List of Publications based on Ph.D Research Work

Sr. No.	Title of the paper	Authors (in the same order as in the paper. Underline the Research Scholar's name)	Name of the Journal/ Conference/ Symposium, Vol., No., Pages	Month & Year of Publication	Category *
1	A Comprehensive Assessment of Increased Iron Ore Production on the Environment – A Case Study	Shanth A. Thimmaiah, Y. Venkateswara Rao and Ch.S.N. Murthy	International Journal of Earth Sciences and Engineering, ISSN 0974-5904, Vol.04, No. 02	April 2011	1
2.	Attributable Ill Health due to Urban air Pollution	Ravi D.R, Dr.C. Nanjundaiah, Shanth A. Thimmaiah	International Journal of Earth Sciences and Engineering, ISSN 0974-5904	Accepted for publication	1
3.	An Economic Analysis of Environmental Pollution & Health- A case study of Bellary-Hospet Sector.	Shanth A. Thimmaiah, D.R. Ravi, Y. Venkateswara Rao and Ch.S.N. Murthy	International Journal of Earth Sciences and Engineering, ISSN 0974-5904	Accepted for publication	1

*** Category:** 1: Journal paper, full paper reviewed
2: Journal paper, Abstract reviewed
3: Conference/Symposium paper, full paper reviewed
4: Conference/Symposium paper, abstract reviewed
5: others (including papers in Workshops, NITK Research Bulletins, Short notes etc.)

ABOUT THE AUTHOR

Name: **SHANTH AVERAHALLY THIMMAIAH**

Designation: **Director**

Address: **METAMORPHOSIS**
#143, II Floor, 39th Main, 4th Cross,
Behind Silk Board, BTM Layout II Stage,
Bangalore-560 068.

E-Mail: shanth@metamorphosis-india.com

Residential Address: E-516, Nirman Nydhile,
Gottigere, Bannerghatta Road
BENGALURU, KARNATAKA, INDIA
Pin Code: 560 083
Tel. No. +91 80 26781037, Cell: +91 98450 27475

1. Educational Qualification:

Period	Institution Name & Address	Qualification	Subjects	Grade
1991-1996	Karnataka Regional Engineering College, Surathkal, Karnataka	B.Tech.	Mining Engineering	Second Class
1996-1998	Karnataka Regional Engineering College, Surathkal, Karnataka	M.Tech.	Industrial Pollution Control, (Chemical Engg. Dept)	First Class

2. Registered /Recognized Training Courses Attended:

Sr. No.	Title of the Course	Conducted / Organized by (Name & Address)	Dates	
			From	To
1.	Training program on “Preparation of Mine Closure Plan”	Ministry of Coal & Mines, Indian Bureau of Mines, Govt. of India.	16/06/2004	18/06/2004
2.	A course on Executive Development Program “Environmental Management Capacity Building Technical Assistance Project, Mining Sub-component, Activity II-B: Training”	Indian School of Mines, Dhanbad	07/01/2002	15/02/2002
3.	Orientation Program on Environment Status for	Goa Mineral Ore Exporters Association,	20/12/2002	22/12/2002

	Mines.	Panaji, Goa.		
4.	Workshop on " Environmental Audit (EA) and Environmental Impact Assessment (EIA) As The Tool For Preventive Management	The Institution of Engineers (India), Goa Local Centre, Ponda, Goa.	02/03/2001	03/03/2001
5.	Workshop & Conference "Hazardous Waste Management"	Indian Environnemental Association (IEA), EnviroVISION 2001, Mumbai	31/05/2001	02/06/2001
6.	Training on "Public Health, Pollution Control & Process control areas"	Kudremukh Iron Ore Company Ltd., Kudremukh-577142, Chikmagalur Dist.	07/07/1997	27/08/1997

3. Membership of Professional Bodies:

Sr. No.	Professional Body (Name & Address)	Membership		Valid Till
		Grade	No.	
1.	Ministry of Coal & Mines, Government of India, Indian Bureau of Mines	Recognized Qualified Person	RQP/GOA/ 168/2004/A	23/08/2014
2.	Ministry of Environment & Forests, New Delhi. (Cosmo Conscious Research Laboratory, Bellary, KAR)	Analyst	-	Gazette Notification No. S.O. 773 (E).

4. Professional Experience

Period	Organization with address	Department	Designation	*Role/Duties/ Responsibilities
19/10/2006 to Till date	METAMORPHOSIS^{SM} HEAD OFFICE: #143, II Floor, 39th Main, 4th Cross, Behind Silk Board, BTM Layout II Stage, Bangalore-560 068, KARNATAKA.	Environment, Mining, Environmental & Industrial Research Laboratory	Director	Overall responsibilities of Environment, Mining & Laboratory duties
17/05/1999 to 16/09/2004	V. M. Salgaocar & Bro. Pvt. Ltd. Salgaocar House, Off. Francisco Luis Gomes Road, Post Box. No. 14, Vasco-da-Gama, GOA-403 802.	Geology & Mine Planning Dept.	Environmental Engineer	Environmental & ISO –QMS & EMS for the entire group.
22/09/2004 to 10/10/2006	Transit Surveys, 2nd Cross, Nehru Colony, Bellary- 583 101, KARNATAKA.	Environment & Laboratory	Sr. Manager	EIA –EMP Preparation

20/08/1998 to 10/05/1999	Transoft International Pvt. Ltd., J.P. Nagar, Bangalore-76	Environment	Environmental Engineer	Preparation of REIA & EMP of power plants