INTRODUCTION

Minerals are essential raw materials in industrialization and economic development. Coal, being a primary source of energy plays a vital role in an energy-intensive economy such as India many developing countries, especially those dependent on oil imports to meet their energy requirements, lay great emphasis on the production and development of coal in order to fulfill their demand for energy. This has resulted in a considerable growth in coal mining in recent decades.

Mining results in severe damage to land air, water and vegetation. The impact of mining on the environment largely depends on method of mining adopted. The geo-mining-condition of the local and the size and duration of the mining operation. In contrast to underground mining, opencast mining results in extensive damage to the environment. Even though the method adopted for mining is often selected according to the characteristics of the coal seam and geo-mining conditions, of late political and social consideration have begun to exercise greater influence in the choice of mining method (K.V. Krishna Murthy 2004). Irrespective of the method of mining chosen, coal mining is bound to affect the environment in a number of ways. However, in view of the extensive damage caused by the coal mining, it is unrealistic to expect that coal mining can be minimized because the demand for coal in India is growing at an accelerated pace. The crucial issue is not one of reducing coal exploitation but rather one of minimizing its impact on the environment.

India is ranked eighth in the world in terms of total world coal resources and fourth in identified reserves, coal being the most abundant fossil fuel resources in the country. The challenge of increasing the coal production to meet the ever-growing needs of the country has been admirably met by the phenomenal increase in coal production from opencast mines; India ranks fourth in world coal producer and in the third largest producer of coal from open cast mines (chaulya 2003). There are 44 major coalfields located in peninsular India and 17 in the north-eastern region. The bulk of the coal reserves are confined to the southern-eastern quadrant of country in West Bengal, Jharkhand, Orrisa and Chattishgarh states. The geological reserves were estimated in
1996 to be 24123 Mt of cocking coal and 162914 Mt of non cocking coal up to a depth of 600m (Kumar 1996). Since the beginning of civilization, human beings have used various natural resources for their benefit. To make their life easier, they have produced facilities that use many of the Earth's energy resources. Energy is mainly produced by burning fuels such as coal, oil and natural gases on one side this kind of development makes our lives easier, but on the other hand it results into pollution by release of harmful substances into the environment. Burning of fossil fuels in industries and transport sector industrialization and urbanization have led to increase in concentrations of gaseous and particulate pollutants in the atmosphere leading to air pollution (Tripathi and Gautam 2007; Dwivedi and Tripathi 2007) Acid rain is one of the most serious environment problem emerged due to air pollution. Acid rain in a broad term that describes served ways through which acid falls out from the atmosphere.

Sources of air pollution in the coal mining areas generally includes drilling, blasting overburden loading and unloading, coal loading and unloading; road transport and losses from exposed over dumps, coal handling plants, exposed pit faces and workshops (CMRI-1998). These air pollutants reduce air quality and this ultimately affects people flora and fauna in and around mining areas (Chaudhari & Gazghate 2000). The major air pollutants produced by opencast mining are suspended particulate matter and respirable particulate matter (Sinha & Banerjee 1997).

The environmental impact of coal mining areas must be assessed by detailed studies of air quality (Jones 1993; canter 1996; CMPDI 1998; Chaulya et al 1998, 2000; Ferreiera et al 2000).

Mineral exploration and exploitation impinges on environment in a multiplicity of ways and it depends on various factors such as mining procedure, rocks types encountered climate, hydrology and topography of the area, size of operation and many more interrelated factors. Among various mining activities that contribute to environmental pollution, coal and coal related industries may conveniently be listed as the major pollutants.
COAL MINING AND ENVIRONMENT

Like any other mineral deposit, coal is also localized in its occurrence and needs to be mined, processed and transported before it is put to use. These processes affect the environment in a number of ways: e.g. mining leads to concentration of people in a particular locality; increase in the demand for public facilities; damage to property, crops and livestock; disturbance of existing landscape; dereliction of land, falling of trees; building up of mine waste and mill tailings; pollution of both ground water and surface water, air pollution; noise and vibration due to mine blasting and earth movers; and many more similar effects on the natural environment.

Open cast mining outsmarts those of underground mining not only in term of productivity but also from the safety point of view. There are about 157 open cast mines in the country, which produced 263 Mt of coal during 2001-02 with a productivity of 6.1 tonne per man shift (L.K. Bose, 2003) as against 365 underground miners that contributed only 64.8 mt coal with a productivity of 0.64 mt per manshift. However when we consider the magnitude of land disturbance and other ecological degradation arising out of open cast, under ground mining is preferred to the open cast method. Presently, the open cast method accounts for 80% of total coal in India and from a long term perspective, it in clear that better productivity achieved through open cast mining may not be commensurate with the price we would have to pay for environmental degradation.
TYPES OF ENVIRONMENTAL IMPACTS

Coal mining results in various environmental effects throughout coal fuel cycle as depicted in the Fig-1. The various impacts of coal mining on environment can be grouped as under:

**IMPACT OF COAL MINING ON LAND**

Irrespective of the type of mining used for extracting coal, mining invariably results in enormous land disturbance e.g., large scale excavation removing top soil, dumping of solid wastes, cutting of road, creation of derelict land etc. Surface mining has more potential impact on land than underground mining, more than 80,000 ha of land in
India are affected by various mining activities (Valdiya 1988). It is estimated that a total land of 539 sq. km in expected to be disturbed through opencast coal mining during the tenth plan period (L.B. Bose 2003), with improved technology, open cast coal mining is being used extensively because of the cost effectiveness and productivity; though its results in large scale land disturbance.

LAND DISTURBANCE

Land reclamation has emerged as an important tool of counter acting the negative after effect eyesore of coal mining since it helps in landscape redevelopment restoring land productivity it ecological integrity and economic and aesthetic value.

In India land reclamation has begun to be undertaken systematically only after coal mining was nationalized. By planting 1.65 crore plants, the NCL has emerged as the ideal company to have developed effective environmental management programme through afforestation to minimize the impact of mining various contaminants such as heavy metals, organic and inorganic substances etc. are released from different mining operation and minerals manufacturing. Mine pits and underground working, overburden and waste rock piles, are piles and tailing impoundments in the iron are mining industry are of particular significance (note), since these are the areas in which toxic contaminants are most commonly found. The most significant impact or lands mining and minerals industrial area is land degradation due to erosion and contamination. Erosion may be caused by land disturbance and removal of vegetation related to mining activities contamination of soil may occur from discharge run off leachate and seepage from tailing impoundments, pits and underground working as well as waste rocks piles, wind blown dusts from dry tailing impoundments may cause contamination of soil pollution, other sources of soil contamination include spills of funds, floatation reagents, cleaning solution as well as other chemicals used or stored at the site. Contaminated soils yield contaminated crops which give grasses having bio accumulated heavy metals. Mine fires also damage the land due to heat and additional subsidence. Mine water contains contaminants oil, grease, heavy metals, bacteria which should be treated before discharge on land. The overburden originates from the consolidated and unconsolidated materials
haphazardly mixed during mining activity. This is also called as mine spoils. There drastically, disturbed mine spoil ecosystem are usually, physically, chemically, biologically and nutritionally recalcitrant media for plant growth (Meyer, 1973). Mine spoils present undesirable condition for both plant and microbial growth because of low organic matter content, unfavorable pH, coarse texture, low water retention, poor water drainage and compact structure (Baker, 1990; Agrawal et al 1993).

IMPACT OF COAL MINING ON WATER

Coal mining requires large quantities of water for dust control, fire protection and coal washing. The average use of water in coal mining varies from 63 to 120 liters per metric tonne in underground mining and 17 liters per tonne for surface mining (E1-Hinnawai 1981). In addition to this, 33 liters of water per tonne is required for waste disposal both in surface and underground mining (UNESCO 1979). When this water drain through large area of the mine it carries with it any soluble minerals that may be present either in the coal or associated rocks, thus causing severe degradation of water quality. Coal-processing (washing and benefication) also causes serious water pollution.

Water pollution can be controlled in adequate care is taken to ensure that the fluids discharged from coal refuse disposal areas does not have a total acidity in excess of its total alkalinity contain more than 7.0 ppm total of iron and suspends solids in excess of 200 ppm and its pH value is not below 6.0 and above 9.0 (Charmubary 1979).

IMPACT OF COAL MINING OF AIR

Air pollutants originate from various activities of mining such as drilling, crushing, screening, blasting, coal washing, dust from roads, mine-waste piles and stock piles, exhaust fumes from equipments, vehicular traffic and truck haulage. Transportation of coal from mines to plant is another major source of dust. In order to prevent such dust from becoming air borne, transport equipments such as truck dumpers and wagons should be leak proof and properly covered. To certain extent dust can be prevented by spraying suitable chemicals or water on top of these coal carrying vehicles.
Air pollution in coal mines is mainly due to fugitive emission of particulate matter which is gases including methane, carbon monoxide, sulphur oxide, and oxides of nitrogen. High levels of suspended particulate matter (SPM) increases respiratory diseases such as chronic bronchitis and asthma, while gaseous emissions contribute to global warming.

Air is the prime requirement for living beings; we cannot sustain on this earth without air. Enormous dust, suspended particulate matter (SPM) gases, noise, and vibration etc. are released from the environment from coal mining processes, handling, transportation etc. which degrade the air quality. Dust is released in the environment from coal mining processes, handling, transportation etc., Dust is also released from the overburden dumps, mine rock dumps, ore sub ore and haul roads, dry surfaces of tailing impoundments, as well as waste rock piles, if they are exposed to the environment Dhar, 1989.

**TYPES OF AIR POLLUTANTS**

Air pollutants are released by various man-made and natural sources can be divided into two broad categories.

**NON-GASEOUS POLLUTANTS**

These pollutants are known as particulate matter which includes all the solid residue of different elements, liquid droplets, aerosols, metallic contaminants, soil dust, fumes, carbon spray, oil grease. Mist, smoke heavy metal particles with more than 10µm in size, slowly settles onto the surfaces of land, water, buildings etc. and are called settleable particulates.

Particles with size less than 10µm in diameter are likely to remain suspended in the atmosphere for long time and are commonly called as suspended particulate matter (SPM), still fine particles less than 2.5 µm in size can easily cross the tracheal membrane and reach the respiratory system and are called as respirable suspended particulate matter (RSPM). Particulate matter enter into the atmosphere through condensation, dispersion.
combustion process including erosion, grinding, spraying industrial process, cement manufacturing coal and fuel combustion in power plant and vehicles.

DUST

Two form of dust are present into the atmosphere, natural dust and industrial dust. Natural dust contains seeds spore, pollen grains, algae, fungal material bacteria virus etc. (carinos et al., 2002). Particulate matters get dispersed into the environment by air current. Many chemical reactions which are taking place in the atmosphere are regulated on surface of particulates. Dust particles act as catalyst for atmospheric reaction.

FLY ASH

Much of the mineral matter in fossil fuels such as coal or lignite is converted during combustion to a fused glossy bottom ash commonly known as fly ash. Major components of fly ash are oxides of Al, ca, Fe & Si, other elements that occur in fly ash are Mg, S, Ti, P, K and Na. Element carbon (as soot, carbon black) is important fly ash constituents.

GASEOUS POLLUTANTS

Under normal condition these air pollutants are in the gaseous form. In this category in organic gases such as oxides of nitrogen (Nox), Sulphur (Sox) and carbon (Co, Co2), hydrides of Sulphur, F, N and Cl2, Br2, Hcl, Hcn and organic gases such Ch4, C3H8, C2H4, benzene, organic acids, isocyanates, acetone vapour, formed dehydrid etc. are common.

SO2

Oxides of sulphur are most important pollutant among all the inorganic pollutants. Sulphur oxide include both sulphur dioxide (So2) and trioxide (So3), of which So2 is more important as an air pollutants, although So3 is more toxic. So2 is probably the most dangerous of all gaseous pollutants on the basis of amount emitted. Sulphur dioxide emission results form the combustion of sulphur containing fossil fuels, such as coal and oil (Cullis and Hirschler; 1980; Brimblecombe et al, 1989).
NOX

In the atmosphere, oxides of N have six forms. These are nitrous oxide (N\textsubscript{2}O), nitric oxide (NO\textsubscript{2}), Nitrogen trioxide (N\textsubscript{2}O\textsubscript{3}), nitrogen tetraoxide (N\textsubscript{2}O\textsubscript{4}) and Nitrogen penta oxide (N\textsubscript{2}O\textsubscript{5}). Of all the oxides of N, NO\textsubscript{2} is the major toxicant because of its relatively high toxicity and its presence in ambient air.

COX

Oxides of carbon are mainly present in the two forms, CO and CO\textsubscript{2}. CO\textsubscript{2} is the fourth largest components of natural atmosphere. It is taken up by vegetation cover in the process of photosynthesis and photo respiration and where it replaces O\textsubscript{2}. CO is much dangerous than CO\textsubscript{2}. Most plants are insensitive to CO levels known to affect man, but at higher concentration 100 to 10,000ppm, it promotes leaf drop, leaf curling, reeducation in leaf size, premature ageing, etc. C inhibits cellular respiration in plants by reacting with cytochrome oxidize enzyme systems (Boelhaff et al, 2001). Much evidence is available indicating that the ambient concentrations of phototoxic pollutants are increasing due to anthropogenic sources, (Lefohn and Mohenen 1986; Pandey et al 1992; Batalha et al 1998; Mishra et al 2001). Plant growth, development and productivity were related to a number of physiological and biochemical parameters. Changes in the physical environment, affect the vegetation or biological system. Many evidences are available indicating that air pollutants are, at certain concentration negatively affect the plant cover; a level often called as phototoxic. Particles of nonbiological composition, which are considered as pollutants alter the composition of air and cause detrimental effects on plants and human health (Lewis and Brenman, 1978, Archr 1990, Patel and Tiwari, 1991a; 1992 b; Momen and helms, 1996; Schmerg, 1998 and Singh et al 2002; Momen et al 1997; 1999; 2002. Soni and senger (1993) investigated that power plant emissions in Korba, Madhya Pradesh region in responsible for pollution load in the area affecting the vegetation adversely Using Mangifera indica (Mango) as Holarrhina antidyentrice (Dhudhia) it was observed that the pH of leaf wash was close to neutral in upstream location and acidic in polluted zones. Leaf area was lower in polluted zone and higher or less polluted zones.
SO$_2$

SO$_2$ is an important air pollutant which damages plants (Malhotra & Khan 1984). SO$_2$ also affects on plant metabolism and biochemistry includes pigments destruction (Peiser and Yang; 1977; Schimazaki et al; 1980) decrease of lipids (Khan and malhotra, 1977). Sulphite also damage peroxidative plant cells constituents (Peiser and yang, 1985) Sarkar et al (1986) observed a close correlation between the distance of the plants from the roadside and acceleration is peroxidase and catalase activities on some dicotyledonous plants. Further, studies with plant – pollutant interaction have helped screening resistant plants with high pollution sink efficiency Held et al; 1991; Singh Pandey et al 2002 and Pandey & Pandey ; 1996; Pandey et al 2002 and sensitive species which could be used as phytomonitor of ambient air quality Pandey & Agarwal, 1991, 1994b; Pandey & Pandey, 1994.

Since concentrations of phototoxic air pollutants vary depending upon sources of emission, meteorological variables and topography of the area (Carinanos et al; 2000; Sanchez and Andrade, 2002), it is essential to study plant pollutant interaction under different climatic regimes using plant species with local and regional significant, such studies help not only establishing source receptor relationship but also develop area specific pollution control and management strategies.

The present study is mainly emphasized on the air pollution problem in the mining area and its impact on the vegetation and soil. Measurement of air pollution removal rate of vete of vegetation indicates that plants are very effective pollution sink. Therefore, air environment is one of the vital and critical component of environment on which plants depends. Primarily, the air pollution damage was studied through the measurement of acute visible injury symptom.

Mining activities result in the emission of various gaseous and particulate pollutants in the area. This is the dearth of information regarding the impact of air pollution on plants in and around opencast mining area. Studies have however, indicated deterioration of air quality due to mining (Bose et al 1983; Singh et al, 1990) variety of particulate are known to affect the vegetation adversely under field (Darly, 1966; Rao,
1971; Mc. Cune et al. 1965; Khannam. et al 1990; Nandi et al, 1987; Agrawal and Khanam, 1989) and laboratory conditions (Singh and rao, 1978; Borka; Singh 1991; Rao 1979), have shown *Dalbergia sissoo* a leguminous tree species growing around coal depot in Chandasi, Varanasi. The dust collecting effectiveness of plants is governed by morphological tracts of leaves such as epidermal and cuticular features, surface geometry, phylotaxy, orientation, size and area of leaf etc. Evergreen plants with horizontally oriented leaves were found to be good dust catcher as compared to deciduous vertically suspended leaves (Shetya and Chapekar 1980).

The threshold value of tolerance limit of a plant species with regard to a particular type of particulate pollutant is not the same to all species, it is variable under different environmental condition and with the age of plant (Rao, 1980; and Das et al, 1981) Das and Patanayak (1978) has shown disturbance in gaseous exchange due to shading of cuticle and clogging of stomata by dust. Particulate also interfere with the pH and other physico chemical properties of the soil supporting the plant growth (Singh et al, 1995).

Sulphur has been recognized as a major gaseous air pollutant around coal burning operations (Agrawal & Agrawal, 1989, Singh et al, 1994; Rao and Dubey, 1990) Several reviews and books have been published on the effect of So2 on plants (Mudd 1975, Hallerger, 1978; unsworth and Ormond 1982; Bell 1984; Treshow, 1984, Treshow and Anderson, 1989) Plant have been described as efficient scavanger of atmosphere So2 (Post humous 1983) Sulphur dioxide enters the leaf interior through stomata and get oxidised to So3^2- or HSo3^- and finally to So4^2-. Sulphate is either consumed metabolically for organic S formation or stored. During oxidation of So2, free radicals are produced which are responsible for various adverse effect of So2 on different metabolic processes of plant (Heggested and Helk, 1971; Guderian, 1977; Lonzon, 1978; Heath, 1980; Black, 1982, Tomlinson, 1983; Treshow, 1984; Winner et al 1985; Darall, 1989; Several laboratory and yield experiments have observed reduction in stomatal size and density and increase in trichome size and number in plants. Growing in the polluted area. Furokawa et al (1980) correlated the degree of Necrosis or damage to the quantity of So2 absorbed further more, a number of studies have suggested that peak concentration and co-occurrence of pollutant pairs are more important in evaluating phytotoxic responses to
urban air pollution (Lefohn et al 1990, Pandey et al 1992; Pandey and Agrawal 1992, 1994a. A considerable reduction in the leaf area without any visible foliar injury symptoms has been reported by Rao et al (1990) in the plants growing near the coal fired, thermal power plants. Similarly, Stevling and Fengmeir (1997) observed a reduction in productivity and leaf area index of *Allium ursinum* plants treated with SO$_2$ pollutants without appearance of any visible injury symptom. Inhibition of plant photosynthesis due to SO$_2$ has been well established (Darrall 1989). Increased CO$_2$ concentration in the leaf, leads to the stomatal closure and thus inhibition of photosynthetic (Muller et al 1979; Siz and Swanson, 1974; Winner and Mooney, 1980; Winner et al; 1985; Taylor et al; 1986. Photosynthetic pigments are very sensitive to SO$_2$ (Hallurgen and Huss, 1975, De santo et al, 1979, Malhotra, 1977; Agrawal et al 1983; Khan and Malhotra 1977 reported alteration in lipid composition of pine needle chloroplast after SO$_2$ exposure. These structural changes can disrupt the enzymes system involved in CO$_2$ fixation. Biochemical loci are the primary site of alteration during SO$_2$ exposure leading to ultra structural and Cellular changes (Jagan and Klein 1977, Beg & Fareog 1988). SO$_2$ induced alteration in carbohydrate and nitrogen metabolism of plant have been reported (Kozoioi and Jordon 1978; Pahlson, 1989). The concentration of sugar starch and certain amino acids were found to increase while the protein concentration reduced (Malhotra & Sarkar, 1979, Koziol and Cooling; 1980; Grahage and Jagar 1982) Changes in the activity of various enzymes due to SO$_2$ pollution have been well documented (Peter et al 1989). Keller and Schwagler (1977) and Nandi et al. (1984), observed a positive correlation between the pollutant concentration and peroxidase activity. Malhotra and Kunest (1986) suggested that the increased amount of phenolic compounds stimulate peroxidase activity.

Inorganic sulphur has been reported as the main product in the plant cells resulting due to the absorption of SO$_2$ (Weight and Ziegler 1962; Jagan et al 1972). Thus sulphates quantification may be considered as an important parameters to characterize the effect of SO$_2$ in plant.

High concentration of nitrogen oxide may also occure in mining area depending upon the meteorological condition and density of road traffic nitrogen dioxide can affect the plant directly and cause visible plant injury. There are several reports of NO$_2$
fumigation promoting plant responses such as increase in chlorophyll and darker green leaves, leaf number, leaf area, and dry weight have been reported (Whitmore and Frees-Smith 1982; Singh 1980). Nitrogen oxides also play an important role in the complex phytochemistry of smog formation. NO$_2$ also contribute to acid precipitation during wet deposition which consequently damage aquatic life, forestry, and agriculture.

Weinstein and Birk (1989) have suggested that potential ecological impact of air pollution is determined by the contaminants, environmental partitioning, exposure pattern, toxicity, and species sensitivity. Antioxidants such as catalase (Sarkar et al, 1986), superoxide dismutase (Agrawal et al, 1987) peroxidase Nanda et al; 1986 sarkar et al 1986; polyamine (Pierre and querioz 1981) and glutathione (Chament et al, 1986; Alscher et al, 1987) have been suggested to activate defense mechanism in plant against oxidative damage caused by pollutants. Since independence, India has made tremendous technological advancement and ranks among first ten industrialized nations. Evidently, such major industrial information has caused air pollution as one of the major environmental problem in the country. It is therefore, important to establish monitoring network over large area around coal mines, beside chemical measurements, biological monitoring of the situation also serve as an index of environment stress. The use of exotic and native plants or plantation developed at different sites has been in common practice for biological monitoring of pollution status along a concentration gradient around sources of pollution (Rao 1972, Agrawal & Agrawal, 1989, Agrawal et al 1991, Legg & Bongia 1986, Yadav 1998. Some higher plants appears to passes relatively huge sensitivity to air pollutants and sometime fairly specific symptom accompanying the effect of pollutants can be easily distinguishable and measurable such plants may be used as indication for detection of air pollutant and also for monitoring air pollution level. Some plants record the accumulation toxic effect of pollution through change in their morphological, anatomical, biochemical, biochemical and chemical characteristics (Saxe 1991, Soarse et al 1995, Agrawal et al, 1991).
EFFECT OF ACID RAIN ON FOREST TREES

The effect of acid deposition on higher plants arises in two ways – either through foliage or through out roots (Tomlinson 1983) crosslay et al (2001), conducted field experiment to determine the effect of acidic mist containing S and N on stem wood growth of silka spruce. The acidic mist provided 48 kg N and 50 kg S ha\(^{-1}\) for 3 years. Leaf in the most sensitive organ to pollutant damage and has been the target of many studies. It was found that acid rain caused anatomical alternation in the leaves of tropical species seedling and sapling of *spondian dulcis* Frost. *F. Mimosa artemisana* Herings and Paula and *Gallesia interifolia* (Sant Annasantos et al 2006).

The problem of coal smoke pollution appeared as early as in the beginning of thirteen century in London (Brimblecombe, 1975) Despite numerous complain on vegetation damage due to air pollution in Europe, the scientific investigations of this problem were not started until Sockhardt (1871) published a classic paper on ‘The effects of smoke or spruce (*Picea*) and fir (*Abies*) trees in Germany”. Studies on the effect of London fog’ on chlorophylls (Oliver 1894), and influence of sulphur dioxide on photosynthesis (Cohen and Ruston 1925) were amongst the pioneer work of physiological aspects of air pollution impact. The first report on biochemical basis of air pollution damage was due to Wislicenus (1914), Later, Stoklassa (1923), Katz (1949) and Thomas et al (1950) have investigated various physiological and bio chemical processes of plants responsible for the visible injury. Utilization of coal in power generation is emerging as the biggest environmental problem through fly-ash and gaseous emission in the environment and fly – ash dumping on the land (Singh et al 1991) have summarized the environmental impact analysis around coal mine and thermal power plant in Singrauli regions of Indian, in relation land degradation, air and water quality detoriation. Considerable information in available on the impact of SO\(_2\) or the plant community structure (Rosenberg et al; 1979, Materna, 1984; Rao et al 1990). Changes in the composition of lichens have been frequently used for mapping air pollution load in an area Hawkesworth (1971). After emission SO\(_2\) disperse in the atmosphere and is transported to the distant places along with the wind. The residence time of SO\(_2\) in air may vary from an hour to several days, depending upon the level of moisture, and
reaction potential of atmosphere Georgin (1978). In India S\textsubscript{2}O\textsubscript{3} has been recognized as a major gaseous air pollutant around thermal power plants (Pandey 1983; Agrawal and Agrawal 1989; Rao and Dubey 1990) Growth performance, Biomass accumulation and not primary productivity (NPP) of five exotic plant species planted to Stabilize and improve the coal mine spoils in India were assessed plant species showed a considerable variation in growth characteristics with response to their ages on coal mine spoils. The shoot height was found to be maximum in *Eucalyptus hybrid* and minimum in *cassia siamea* during whole course of study on the basis of biomass and primary productivity *E. hydrid* and *Accassia auriculiformis* were found suitable for plantation on coal mine spoil land (Dutta & Agrawal 2003). The establishment of vegetative cover on coal mine spoil is a challenging task due to problems such as compaction, poor water holding capacity, infertility, high acidity, or salinity of soil and extreme temperature (Moffat and Mc Neill, 1994; Richards et al. 1996). During opencast coal mining the removal of earth surface produces overburden material and its pilling on the unmined land creates overburden dumps. These dumps are physically, nutritionally and biologically poor in nature. The natural succession on these lands also taken longer duration (Wali, 1987, Jha & Singh 1992) The ability of different plant species to modify mine spoil characteristics has been found to differ considerably (Alexender, 9, b) A successful afforest ration on the mine area of Amarkantaka showed *Gravellia pteridofolia Eucalyplus Camaldenlensis, Pinus roxburgii* and *Pongamia pinnata* to be the most suitable species on the basis of growth performance Chaturvedi (1983). Fast-growing exotic species are reported to show fast growth native species on degraded land during initial couple of years of establishment (Parrota, 1999). The rate of litter fall and their decomposition have been suggested to be important factors for the establishment and future growth of vegetation through regulating the microbial activity of the soil (Dutta & Agrawal 2001). The mine spoil is formed due to heaping. The parent material is carbonaceous in nature Dutta & Agrawal (2002) reported the variation in different physico-chemical characteristic of mine spoil of Jayant coal mine area.

The measurement of biomass helps to evaluate the nutrient cycling, organic matter and energy transfer and to predict the stability of plantation stands (Taylor and Zishang, 1987). The above ground biomass value of *C. equisetifolia* (23.3 th\textsuperscript{1}) and *G.
pteridofolia (25 th⁻¹) are also comparable to the 6 year old Albizzia procera (29.5 th⁻¹) plantation on the same coal mine spoil (Singh 1999). This reflects that total biomass accumulation was remarkably high in the plantation of E. hybrid water – holding capacity, soil moisture; available nitrogen (NH₄ – N and No₃ – N) and phosphorus content in minespoil soil were highest in E. hybrid plots. Dutta and Agrawal 2002), which clearly indicates that these planting have maximum favourable impact on soil and there by enhancing its own productively. The role of exotic species in restoration has often been looked with concern due to their negative impact on soil fertility and biodiversity (Lugo, 1997, Dutta and Agrawal 2003). The tree performance on restored open cast coal mine spoils can lead to beneficial changes in reclamation practice and renewed the prospect of commercial forestry on there restored land.

The overall results of open cost coal mining in relation to biological life from are not favourable. It destroys the forest as well as ground vegetation in one hand while in another it alters the physico-chemical and biological properties of the soil. (Dutta and Agrawal 2001). The spoils have low organic matter content, unfavourable pH, and drought arising from coarse texture or oxygen deficiency due to compaction (Agrawal et al 1993). The other factors checking the revegetation of mine soils may be salinity, acidity, poor water holding capacity, inadequate supply of plant nutrients and accelerated rate of erosion (Jha & Singh, 1992). Role of different plant species is stabilizing and improving the coal mine spoils have been studied by evaluating the changes in diameter of breast height, biomass accumulation and net primary productivity of five exotic tree species (Dutta & Agrawal 2003). The result showed an improved soil status under different plantation stands compared to bare overburden. G. pteridofolia have lowest bulk density. The selection of plant species also varied with the nature of the mine spoil as the plants exhibit variability in developing toxic tolerance. The impact of different plant species to the modification of mine spoil characteristics has been found considerable different (Alexander 1989 a,b) Litter falls, litter decomposition and nutrient release in five exotic plant species planted on coal mine spoil studied by (Dutta & Agrawal 2001). The litter decomposition process plays a critical role in maintaining the organic matter level through nutrient cycling and improving the soil fertility. Nutrient cycling is achieved through the activity of soil biota (Coundell, 1977.)
IMPACT OF COAL MINING ON WILD LIFE ECOLOGY

More often than not, many of the coal deposited (e.g. Gondwana and Tertiary coal fields of India) are located in thick forests or good vegetation cover that serves as abode for wildlife. Human intrusions into such forests either eliminate or drastically reduce the wild life habitat and forest resources. The damages is mainly caused by the human intrusion as well as machines, odor and noise, destruction of vegetation and other terrestrial habitats; and changes in water flow and the quality of water and air may contain toxic solution and oil scum’s which an great hazard to wild life.

IMPACT OF SOLID WASTE

The major solid waste in a coal mine in the overburden segregation of the stones in the coal handling plants and coal breeze also contribute to the solid waste generation. The overburden to coal ratio in opencast coal mining in about 2m$^3$ ton of coal.

IMPACT OF NOISE AND VIBRATION IN COAL MINING

Coal mining involves a complex process of activities that can be categorized under three distinct phases. They are:

1. Removal of top soil and overburden in case open cast method is used driving shafts and audit for under ground mining.

2. Extraction of coal through drilling crushing, loading, hauling, handling and transporting of coal. And

3. Restoration of the disturbed land. A cumulative effect of there mines activities produce enormous noise and vibration in the mining area which constitute a source of disturbance. In order to avoid the adverse impact of noice and vibration, their potential should be evaluated with a view to providing appropriate sound reduction schemes.

Noise in best controlled at source by choosing machinery and equipment suitably by their proper installation and by providing noise insulting padding.
IMPACT OF TRANSPORT IN COAL MINING

From the initial exploration stages to the final stage of consumption, coal travels long distances through various modes. The principal environmental impact of surfaces transportation of coal the fugitive coal dust. It is the major pollutant arising from loading, unloading, transportation and storage. It is estimated that about 0.1 percent of coal is lost during transit and loading/unloading operation (OECD 1978). It has been estimated that 7 accidents occur per 106 vehicle – miles and there are 0.03 deaths and 0.5 injuries per accident (Morris et al 1979) during coal transportation by truck. This is equivalent to 2.4 deaths and 1/3 injuries for the generation of 1 G. w (e) yr\(^{-1}\) Chadwick 1987).

IMPACT OF VILLAGE SETTLEMENTS

Due to mining and allied activities population in the area would increase. So the new settlements would come up in the area to accommodate them. Further village falling in the mining area would be displaced. Rehabilitation of the land out scouts in terms of occupation as well as housing amenities etc. would be a major impact in the area. Operation of coal mining projects and allied activities have direct and indirect impact on the socio-economic condition of the existing inhabitants like the environmental impact, the social impact of mining often difficult to quantify. Incidentally, there is very little discussion of the negative impact of coal mining in relation to society. Mining is most likely to affect the five aspects of a society. Viz: (1) Population (2) quality of living (3) Social and Cultural system (4) Economy and (5) Technological system (Ghose, 1988) has pointed out that through coal mining in the Raniganj – Jharia region has brought industrial development to the regions, it has not benefited to the regions, it has not benefited the local people, as its natural resources were sucked on for use elsewhere.

Recent scientific efforts not only have generated a wide array of information on atmospheric pollutants but also have opened the ways of several classes’ of new research in this area. In the coal field area, air pollution, in particular received serious attention because the ambient air of many world cities have shown to contain pollutants at alarming concentration.
In view of the increasing dependence on coal as energy source during coming decades, and the environmental problem related to this developmental activity the present work started in January 2007 in Singrauli area around Jayant open cast coal mine situated in Sidhi district of Madhya Pradesh, India. The Singrauli region in the South–eastern part of Madhya Pradesh, is one of the most polluted industrial sites of Asia. It encompasses 11 open cast coal mines and six thermal power stations. The aim of the study was to demarcate highly pollute area and to discriminate them from areas relatively less affected by this source. Thus the present study will add not only to our existing knowledge of air pollution problem but also help develop measure to mitigate ambient air pollution load and to develop successful management strategies.

The present investigation was conducted with the following objectives:

1. To determine the fall out pattern and ambient concentration of air pollutants.

2. To determine the spatial and temporal variation in air pollutant concentration.

3. To determine the changes in physico chemical properties of the soil.

4. To determine the spatial variation in heavy metal accumulation pattern in soil.

5. To quantify the dust intercepting capacity of plants.

6. To evaluate incipient plant responses with references to select physiological, biochemical and growth characteristics.

7. To determine the heavy metal accumulation pattern in plant foliage.

8. To screen resistant plant species with high pollution sink efficiency useful for plantation programmes and sensitive plant species as phytomonitor.

9. To identifying bioindicator and bioaccumulator plant species.

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