GEO ENVIRONMENTAL IMPACT ASSESSMENT OF COAL MINING IN LODNA AREA OF JHARIA COALFIELD

ABSTRACT

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Introduction

The most important event of current period is perhaps the people's concern about environment. Never before the people were so much alarmed about the deteriorating environment that is the storehouse of all living organisms.

Environmental awareness has reached at the doorsteps of common people by crossing conference halls and auditorium of five star hotels. Environment is the union of living and non-living components of our Nature. Environment is an external factor, which influences our activity upto a great extent. To maintain the ecological balance, it is necessary to conserve the environment. In ancient times our ancestors lived in the jungles. Due to progress of the civilisation several changes occurred in the human lifestyles. We invented new types of food to satisfy the hunger and new types of drinks to satisfy the thirst.. Huts and cottages turned into huge mansions and buildings. These activities are creating huge problems in front of us. Dimensions of pollution have been changing day by day. Last decade of this century is telling the facts of the coming decade of next century.

We are drifting away further and further from beautiful Nature with the development and induction of modern technologies in every field. We are horrified to be in a situation rather than satisfied. To break the umbilical chord with our Mother Nature is a heinous crime against her. Thank to our ancestors who lived with harmony among themselves and there was no question of conflict between man and nature.

Mining an important activity

Mining, the second only to agriculture, is world's oldest and most important industry. The dependence of the primitive societies upon mined products is illustrated by the nomenclature of these words "Stone Age, Bronze Age, Iron Age and now Atomic age", a sequence showing increasing complexity of social relationship with mining.

Mining is a devastating operation that not only destroys the natural ecosystem particularly if it is a surface mining but also produces tremendous distortions in social fabric. The associated problems of deforestation, waste disposal, air pollution, vibration, room blasting, land collapse and drop in water tables are of course marked perhaps to be expected in mining operation. But like information has been paid to the fact that most mining is done in remote tribal areas. Mining has its impact on health, hygiene, nutrition, sanitation, accidents, and increased intensity of work and market of an area.

History of mining in India is the history of civilisation. Khetri and Dariba in Rajsthan, various coal and iron ore mines in Bihar and Madhya Pradesh vividly display the mining activities of ancient times.

Coal mining had received its impetus in England in wake of the Industrial revolution from middle of the eighteenth century. According to the literature available in this subject, the first attempt of mining for coal in India dates back to 1774. About 92.9 tonnes of coal was brought to Calcutta by country boats in 1775 from Raniganj, which was not considered suitable for bunkers by the shipmasters. Acceleration in coal mining activity started only after introduction of Railways in India (1853). Indian coal first used by rail in 1855. Although the production of coal in the country had commenced as early as 1775, the output was small and remained at about 404 tonnes a year during the period 1815 to 1823. But by 1857, an annual production of 50,500 tonnes had been achieved.

Statement of the Problem

Coal mining plays a major role in our economy. On the other side it causes serious environmental problems. It affects the vegetation, forest area and soil also. Coal excavation mainly by surface mining causes serious impact on land. It affects the land twice, firstly by removing topsoil at the site and secondly at the place of dumping. After removal of surface soil from one place to other place, it decreases the soil fertility due to erosion and other fluvial activities.

Air pollution is one of the major problems that is associated with coal mining. Air quality near coal mining areas is very much affected. It not only increases Suspended Particulate Matter (SPM) of the area but also other gases (Sulphur Oxides, Nitrogen Oxides). Concentration of SPM is very high in coal washery unit where coal is washed for better calorific value. Mine fire is very common in Jharia coalfield. Mine fire results in the release of carbon monoxide, sulphur dioxide and nitrogen oxide.

Impact of coal mining on water quality has been also observed during the study. Surface coal mining decreases the water table of the area. Underground mining result in the accumulation of water under mine. Due to presence of sulphur in coal lumps, it forms sulphuric acid, which produces acidity in water systems. Nitrogen oxide after reaction with water forms nitric acid which also decreases the pH value of water present in the mine. Acidity of mine water discharge may affect the aquatic life in a receiving system. It destroys eggs of fishes present in the aquatic systems

Land degradation is mainly due to surface mining. Underground mining also plays a vital role in this activity. Over burden removal is the result of surface mining. It also degrades the land to a great extent. Major portion of land is occupied by over burden. It has been estimated that one tonne of coal excavation results in three tonnes of over burden.

Coal mining has brought changes in the landuse pattern of the area. Drastic change has been observed between 1925 to 1993. Coal dust causes negative impact on human health. Lung cancer or pneumoconiosis is caused due to settling of the dust particles in the lungs.

Location and Extent

The study area (Lodna area) is a part of Jharia Coalfield and this coalfield is the part of Dhanbad district (Bihar) which forms a part of the Chhotanagpur plateau. Lodna area comprises about 1450 hectares of land. Jharia Coalfield lies between latitude 23° 39' to 23° 48' North and longitude 86° 11' to 86° 27' East. The ground elevation of the area generally ranges between 240 m in the western part to 140 m in southeastern part above mean sea level having the general slope toward south and southeast. This coalfield measuring length of 40 Km. and width of about 12 Km., covering an area of 450 sq. Km. The Jharia Coalfield has been divided into many parts for the administrative control. Actual study area is Lodna that is named as area no. X , covering an area of 1447 Ha. It is a sickle shaped coalfield present in the form of basin and trenched with a major fault on the southern part.

Methodology and Research Design

To study the impact of coal mining, scientific and methodological information is necessary. Literature survey has been done in the libraries of different universities and institutions. Various information and data have been collected through field work and topographical maps. In present study special emphasis has been given on the analysis of the pollution level in the area. Base map have been prepared by using Survey of India topographical sheets on the scale 1: 50,000. Another map has been prepared with the help of maps provided by the controlling body of Bharat Coking Coal Ltd. a subsidiary of Coal India Ltd.

Data Source and Research Material

For the present study, Survey of India topographical sheets number 73 I/5 and I/6 have been used, which were surveyed in 1973 and published in 1976 on the scale 1:50,000. The extensive fieldwork has been carried out for collecting first hand data near pollution prone areas. Studies of the nature of soil and measurement of air quality have been done during research work. Water samples have been collected from different mines, river spot and handpumps located in and around the area during fieldwork. The measurement of stream length and mine area have been done in laboratory from toposheets by using rotameter. Similarly the area has been calculated with the help of curvimeter.

Chapter-II (Physical Settings)

The Jharia Coalfield, located in the Damodar valley, is the most important coalfield both in regard to its potentiality and development. It has about 380 collieries out of the total

900 in India. The exact date of discovery of Jharia Coalfield is uncertain Strangely enough, the lists of coal exposures from different Coalfields prepared by the Coal Committee of East India Company in 1837 and 1845 didn't contain any reference to this field which has since proved to be premiere coalfield of the country and veritable storehouse of the best quality coal.

Geology

The lower formattion of the Jharia coalfield lies unconformably on the Archaean and consists of rocks of the Talchir and Damuda Series. The Damuda Comprises the Barakar Measures, the Barren Measures and the Raniganj Measures. An area of about 54 sq. Km. is occupied by rocks of Raniganj Measures and about 218 sq. Km. by those of Barakar Measures. The rest of 181 sq. Km. comprise rocks of the Barren Measures and Talchir series..

Topography

The general altitude of the Coalfield varies from about 240 m in the northwest to about 98 m in southeast after the confluence of the Damodar and Barakar rivers. General slope is from northwest to southeast and east.

Climate

The climate of the area is generally dry. Rainfall generally occurs between July to October. Maximum temperature ranges between 24.5°C to 35.2°C. Sometimes it may be 40° C.

Soil Characteristics

Here soil is sandy and sandy loam. Some fertile soil is found on the other side of the river. Physical and chemical characteristics of different soil samples have been studied in detail.

Chapter-III (Nature and Methods of Coal Mining)

Both types of mining operations exist in the area, i.e., surface and underground mining. In early period underground mining was more pronounced. After 1989 more thrust has been given to surface mining. This is due to high production cost of coal by underground method. Coal seams used for coal excavation are very deep in the earth. Underground mining causes release of methane gas from the mines. Methane gas causes fire in mine, that is due to sparking of electric current. About 0.01 million tonne of methane was emitted during coal production in ten years span.

Chapter-IV

Landuse pattern is studied from toposheets, field survey and other maps of the area, showing changes in landuse pattern in the area. In 1973, there was about 195.58 hectares of land utilised for settlement purposes, but that became 242.21 hectares in 1993. Major change is found in mining sector. Only 3.99 hectares land was utilised for mining and quarrying (it is measured in context of surface mining) in 1973 while this became 119.65 hectares in 1993. Only 0.275 % land was used for mining purposes in 1973 while this became 8.268% in 1993. No major change has been observed in other activities.

Chapter-V (Environmental Degradation)

(A) Deforestation

In the study area there is no natural forest is found so, there is no question of deforestation. However, social forestry division of Bharat Coking Coal Ltd. has afforested 10.63 hectare land upto 1994-95.

(B) Water Pollution

For the study of water pollution, coal washery effluent and mine water of different colliery units and different water samples of Damodar river have been collected and analysed.

Coal Washery Effluent of Lodna Coal Washery

1. Huge amount of pine oil and grease is released into coal washery effluent. The oil and grease increases the level of pollutant in running water systems.
2. Biological Oxygen Demand value of coal washery effluent is very high while Dissolved Oxygen (DO) is zero. Sometimes BOD value goes upto 350 mg/l.
3. Chemical Oxygen Demand value is also very high in the effluent. It also represents the pollution level in the water systems.

Physico - Chemical characteristics of Damodar River water at different points

(1) BOD found within the permissible range.

(2) COD value is very high at all points

(3) Nitrogen as Nitrate found under permissible limit

(4) Total Suspended Matter (TSM) and Dissolved solids are also under limit.

(5) Fluoride as F is beyond the permissible limit at two points

(6) Copper, Iron and Magnesium are found within permissible limits

Mine Water Samples

Mine water of diffferent colliery unit has been analysed quarterly viz., Jan-March, Apr-June, Jul-Sep and Oct. - Dec. and so on.

<u>January – March</u>

1. pH in the range of 6.50 to 8.13
2. Hardness of mine water found in the range of 320 - 620 mg/l as calcium carbonate.
3. Calcium in the range of 40- 76 mg/l.
4. Magnesium as Mg found in the range of 68- 100 mg/l
5. Concentration of chloride in various water samples estimated between 30 - 72 mg/l .
6. Iron as Fe found in the range of 0.28 to 0.6 mg/l
7. Sulphate as $SO4^-$ ranges between 170- 240 mg/l
8. Conductivity of different water samples are in the range of 970 - 1480 micro mho/cm.
9. Total Dissolved Solids (TDS) are present in the range of 514 - 1250 mg/l in different water samples

April - June Period

(1) pH between 6.5 to 8.17

(2) Hardness found in the range 356- 626 mg/l as Calcium carbonate

(3) 42 -77 mg/l calcium estimated in water samples.

(4) Magnesium as Mg in the range 70 -105 mg/l

(5) Potassium in the range between 15 -27 mg/l

(6) Chloride concentration is 32 - 140 mg/l as Cl

(7) Sodium found in the range between 18 - 38 mg/l

(8) Sulphate as $SO4^-$ in the range between 190 - 244 mg/l

(9) Special conductivity observed between 900- 1500 micro mho/cm

(10)Total dissolved solids estimated 678 -1258 mg/l in mine water samples

July - September

(1) pH between 6.65 to 8.2

(2) Hardness found in the range 320- 558 mg/l as Calcium carbonate

(3) 40 -72 mg/l calcium as Ca estimated in water samples

(4) Magnesium as Mg in the range 66-102 mg/l

(5) Potassium in the range between 11 -26 mg/l

(6) Chloride 32 - 72 mg/l as Cl

(7) Sodium found in the range between 15 - 30 mg/l

(8) Sulphate as $SO4^-$ in the range between 180 - 220 mg/l

(9) Special conductivity observed between 990- 1640 micro mho/cm

(10)Total dissolved solids estimated 710 -1260 mg/l in mine water samples

(11)Iron found in the range 0.3 - 0.55 mg/l.

October -December

(1) pH between 6.85 to 7.50

(2) Hardness found in the range 330- 540 mg/l as Calcium carbonate

(3) 42 -72 mg/l calcium estimated in water samples.

(4) Magnesium as Mg in the range 66 -104 mg/l

(5) Potassium in the range between 12 -26 mg/l

(6) Chloride 32 - 76 mg/l as Cl

(7) Sodium found in the range between 18 - 32 mg/l

(8) Sulphate as SO_4^- in the range between 184 - 220 mg/l

(9) Special conductivity observed between 980- 1400 micro mho/cm

(10)Total dissolved solids estimated 514 -1254 mg/l in mine water samples

(11)Iron 0.28 - 0.50 mg/l as Fe

Land Degradation

In study area land has been degraded by following three activities:

(1) ***Mine fire activities*** - In Jharia it is not water but fire which causes the problem of land subsidence. Underground fire which first broke out in 1920s is still burning. It is now posing a major threat to Jharia Town itself. Fire hazard is associated with

underground excavation of coal. It occurs due to oxidation of sulphur minerals, which produces intense heat and release of large amount of toxic gases, fumes and smokes. Sometimes coal mine or water damp fire burns uncontrolled for years together. Area affected by mine fire is 313.12 hectares. Therefore, proper precautions to prevent the fires have to be taken throughout coal mining operations. Mine fire has been divided into three main areas:

(A) Lodna Bagdigi Fire – Here fire took place in the XV seam in 1935. Seams XV, XIVA, XIV, XIIIB and XIIIA are on fire.

(B) Jeenagora Joyrampur fire – Fire first started in 1944 and extended upto new Jeenagora in north and upto the boundary of south Jeenagora in the south. Joyrampur fire was first reported in XIIIA seam in 1965.

(C) South Tisra – North Tisra fire- Here fire started in the year 1964 from 9 seam of North Tisra Colliery. It reached the X seam of South Tisra Colliery in 1973

Impacts of Mine fire

(a) Release of noxious gases viz., Sulphur dioxide, and Nitrogen oxides into the environment. Concentrations of these gases are more than permissible limits. Concentration of sulphur dioxide in winter mornings and late evenings varies between 88.22 micro gm per cubic metre to 212.20 micro gm per cubic metre. Ambient air quality standard for this gas is 90 micro gm per cubic metre.

(b) Nitrogen oxide ranges between 22.77 to 45.00 micro gm per cubic metre in day hours. Carbon monoxide concentration found between 71.38 to 131.30 micro gm per cubic metre during early morning and late evening respectively. But air quality standard for this gas is 80 micro gm per cubic metre. Carbon monoxide concentration is very high near mine fire area.

(c) Branch Railway line feeding to Joyrampur is endangered.

(d) Dhanbad Balliapur road, which is passing through Jeenagora, suffers from severe threat to fire.

(e) Endangered surface structure of the 400 residential houses, office store and hospital of BCCL have to be rehabilitated.

(2) Subsidence - Subsidence is the striking or lowering of the land surface. It is a slow process. It takes place gradually, almost unperceptibile or it may occur quite suddenly. It affects the area from few square metres to as large as thousands of square kilometres. Sometimes it occurs due to natural phenomena, in other it is induced by withdrawal of fluids or by the mining or dissolution of solid materials. Coalmine subsidence is the local lowering of ground surface caused by underground extraction of coal. Total subsided area is 12.68 hectares

(3) ***Quarry and external overburden*** – As it is has been stated that coal is excavated both from surface and underground mining. surface mining degrades the land twice In excavation, the top fertile soil is removed from one place to other place. But overburden may be more or less depending on the depth of coal seam in the earth surface. Land degraded due to existing quarry in the area is 38.51 hectares Area which

will degrade in near future due to overburden dumping is 13.35 hectares. Area degraded due to abondoned quarry is 55.11 hectares.

Air Pollution

Air pollution is the excessive concentration of foreign matters in the air which adversely affects the well being of the individual or cause extensive damage of the environment as whole.

Jeenagora Open Cast Project

(1) Concentration of SPM (Suspended Particulate Matter) – It ranges between 243.33 to 608 micro gm per cubic metre . Highest in January – March period and lowest in July – September.

(2) Sulphur dioxide ranges between 8.66 to 19.32 micro gm per cubic metre . Highest in January – March period and lowest in July – September.

(3) Concentration of Nitrogen oxides varies between 8.16 to 26.74 micro gm per cubic metre .

North Tisra Area

(1) SPM ranges between 301.66 to 643.06 micro gm per cubic metre.

(2) Sulphur dioxide ranges between 14.78 – 24.21 micro gm per cubic metre. Highest in October – December period and lowest in July- September period.

(3) NOx ranges between 23.8 to 39.7 micro gm per cubic metre. Highest in October – December period and lowest in July- September period.

Lodna Area

(1) SPM ranges between 306.36 – 975.76 micro gm per cubic metre. Highest in January – March period and lowest in July – September.

(2) Sulphur dioxide ranges between 32.86 – 94.62 micro gm per cubic metre. Highest in January – March period and lowest in July – September.

(3) NOx ranges between 10.04 to 49.5 micro gm per cubic metre. Highest in October – December period and lowest in July- September period.

Dust Pollution

Jharia coalfield is the prime source of coking coal in the country. It causes negative impact on human health. In physical appearances about 70 percent of the population appeared either sick or in moderate state of health and by clinical examination 35 percent was found to be actually suffering from different ailments requiring treatment. A sample survey was conducted in the coal mining area to study diseases prevailing among persons associated with the coal mining activities, in which 10,000 persons were selected for the study. About 10.8 percent persons out of total were suffering from pneumoconiosis. Dust fall rate in Jharia coalfield was 30.5 tonnes per sq. km per month in 1983 which increased upto 40 tonnes per sq. km per month in 1995. Level of dust fall rate is maximum in summer season and lowest in monsoon period. Dust fall rate near Lodna colliery office was 58.67 tonnes per sq. km per month in April 1989. The lowest was found in Indian School of Mines (Administration Block) was 7.2 to 18.34 tonnes per sq. km per month. Dust fall rate near Lodna Colliery office was 65.0734 tonnes per sq. km per month for April 1996.

Ch. VI (Environmental Impact Assessment)

Climate

In mean maximum temperature no major change has been observed but slight deviation has been observed in mean minimum temperature after 1971, when nationalisation of coal industry begun and which ended in 1976. Except 1976 - 80 period declining trend of mean minimum temperature has been noticed. This may be due to coal mining and allied activities. An inverse trend against mean minimum temperature has been found. Upto 1970, relative humidity (RH) at 8.30 hours was under 70 % mark but after 1970 it followed an increasing trend. Relative humidity at 17.30 hours followed the increasing trend before 1951 - 1965. It has declined in 1966 - 70 period but after 1981 onwards it started increasing.

Hydrology

Evaporation or evapotranspiration, the combine loss from soil and vegetated surface, occurs when there is change of state of water from liquid to vapour. Water goes into the atmosphere through lower portion of the leaf. In many regions evaporation and transpiration are not measured separately and studied together as evapotranspiration. About 180 cm of water evaporated in a year near damsite (Dhanbad).

Hydrogeolgy

It can be defined as the study of groundwater with special emphasis given to chemistry. All the rivers either originate or flow through districts have an easterly or southeasterly course. Physico-chemical analysis of groundwater of Jharia coalfield and its adjacent part is given below:

1. Calcium is 40 mg/l in dug wells of Jharia. Calcium content in various tubewells of Dhanbad town varies between 30 – 78 mg/l. Calcium content in different well of Lodna area ranges between 104 – 108 mg/l.
2. Magnesium content in groundwater of Dhanbad town (outside of JCF) ranges between 8-33 mg/l in different tubewells of the area. Well water of Lodna area shows magnesium concentration in the range of 32 – 96 mg/l.
3. Potassium concentration in different tubewells of Dhanbad town are in between 1.7 – 8.0 mg/l. Potassium content estimated in different wells of Lodna area ranges between 6.5 – 24 mg/l in different seasons of the year.
4. Sodium content in dug wells of Central Ground Water Board in Jharia and Dhanbad are 40 and 54 mg/l respectively. Sodium content in different tubewells of Dhanbad town ranges between 22 – 50 mg/l while this is found between 16 – 70 mg/l in different tubewells of Lodna area.
5. Bicarbonate and carbonate content or alkalinity of groundwater ranges between 135 – 430 mg/l in different dug wells and tubewells of the area.
6. Sulphate concentration is fairly low in dug well of Central Ground Water Board. It is also low in different tubewells of Dhanbad town. 136 – 260 mg/l sulphate as SO_4 found in wells of Lodna area.
7. Chloride as Cl in different wells and tubewells of the study area and its adjacent part found between 14 – 170 mg/l.

8. Specific Electrical conductance of dug wells of Central Ground Water Board observed between 450 and 766 micro mho per cm respectively. Well water of Lodna area shown electrical conductance in the range between 530 – 2360 micro mho per cm while this parameter ranges between 352 – 760 micro mho per cm.
9. Physico-chemical characteristics (pH, total hardness, alkalinity, calcium, magnesium, iron etc.) of handpumps (Chapakal) water found under permissible limit except nitrate whose value was more than permissible limit. In some samples nitrate value found upto 64 mg/l. Nitrate value more than 45 mg/l is injurious to health.

Edaphic aspects:

Soil is an essential component of the terrestrial ecosystem, which lies at the interface between atmosphere and earth's crust. The soil is exposed to input of trace elements from many sources in a coal mining environment. Concentrations of trace elements in the soil of the study area are under permissible limit. Only iron has higher concentration in respect of other trace elements. It may be due to deposition of coal dust on the earth surface.

Terrain:

Coal mining particularly open cast process, is vulnerable for the earth surface of the area. Underground mining also affects the surface. It causes sinking of the surface which is termed as subsidence. Surface mining causes overburden generation, removal of overburden from the mine site and dumping at other places. This brings changes in the land surface topography of the area. The site of mining is deep and overburden site is high, sometimes difference between the two is 40 m.

Fauna (Animal species)

Human beings are the major component of the fauna of the area Persons residing near mining area have poor health. Persons working in the mines are also having poor health. It may be due to dust particles which are the out come of coal mining operations prevailing in that area. Noxious gases are emitted by coal mass burning inside the earth. Coal mining is one of the major factors responsible for this matter Respiratory and Gastro-enteritis disorders are more prevalent in the area. Gastro-enteritis is due to poor water quality used by local people. Water used in household activities is the mine water, which is generally hard in nature. Respiratory disorders occur due to settling of coal dust in the lungs. Transport velocity of coal dust is 25.3 metre per second in respiratory duct next to cement particles which is 25.5 metre per second

Flora (Plant species)

No rare plant species are found in the area. Mining does not causes extinction of such plant species. Plants generally found in the area are Bargad (Ficus bengalnesis), Mango (Magnifera indica) etc. Thick deposits of dust are found on the leaves of trees. It is evident from the dust fall rate which is quite high.

Conclusions

After analysing the information and data it can be concluded that coal mining has adverse impact on the environment by several ways. First it increases the air pollution which may produce adverse impact on the human health. High concentration of gases lead to death. During coal mining and transportation of coal dust releases into the surrounding atmosphere causes lung cancer to miners and inhabitants of the locality. Serious impact of coal mining on water bodies have been noticed. Mine water which is the result of the underground mining affects the water system of the area. In the study area mine water has been used for drinking with other allied works. This is causing gastrointestinal diseases in the locality. Underground mining has adverse impact on the water table of the area. Sharp decrease in ground water table has been noticed in the area due to coal mining. Huge amount of water (approximately 40-50 billion gallons annually) is pumped out from underground mines of Jharia Coalfield. Mine water has been used for coal washing to remove the impurities present in the coal. Washery effluent consists so many chemicals which is harmful to the aquatic organisms. Washery effluent has high value of BOD and COD but zero value of Dissolved Oxygen which is lethal to aquatic systems. Coal mining activity in the study area also causes land degradation by both opencast and underground mining. Here land is degraded by surface mining overburden removal, mine fire and subsidence. Due to mine fire hundreds of houses, railway lines, road and other cultural features fall in danger. Huge amount of dust is also generated by opencast mining and transportation of coal. Thick layer of dust can be seen on the leaves of the plants of the area. No major change in climatic conditions of the area is noticed due to coal mining. It has been seen that coal mining causes adverse impact on the water table. Terrain of the area has been badly affected by mining activities.

Recommendations:

From the analysis of the data of the study area it can be said that environment is severely affected by coal mining. Water produced by underground mining should be sprinkled on the road to minimise the dust pollution. Washery effluent which is the result of the coal washing should be treated before discharging into the river system. Gas masks should be provided to miners to minimise the incidence of lung cancer. Upper layer of the earth's crust should be preserved carefully so that it can be used at other place for afforestation and other agricultural activities. Suitable plant species have to be planted on the overburden sites. The excavated site of opencast mining should be used for recreational purposes. It can provide both employment opportunities and clean environment. Subsidence can be prevented by proper underground mining and strong support with subsequent backfilling of mine. More research work has been emphasised which can provide modern technology to overcome the problems caused by coal mining.

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Dedicated

to my

Late Grand Father

Shri R.L. Sharma

THE NORTH EASTERN HILL UNIVERSITY
JUNE 2000

I Shree Kant Sharma, hereby declare that the subject matter of the thesis is the record of work done by me that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute

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Shillong

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CHAPTER I

Introduction

Literary meaning of the environment is the union of living and non living components of our surroundings. Environment is an external factor which influences our activity. There is close relationship between man and environment. To maintain the ecological balance it is necessary to conserve the environment. Second name of the life is environment. According to old text life has been originating from five elements viz., Soil, Water, Fire, Air and Sky. These are all natural gifts to mankind. Gradually we have mooved towards industrialisation.

In ancient time people lived in jungles. Due to progress of the civilisation several changes have taken place in human lifestyles. We invented new type of food to satisfy our hunger and new type of drinks to satisfy the thirst. New types of clothes have been invented. Huts and cottages have turned into huge mansions and buildings. These activities are creating huge problems before the man of the modern world. These problems have been discussed in Rio Earth Summit, 1992. Due to fulfilling the requirement of growing human population we are cutting the forest day by day. Percentage of the forest area has declined from 1981 to 1991. Due to deforestation new type of problems are coming up. Pollution dimension has been changing day by day. Last decade of this century is telling the facts of the coming decade of next century.

Man is the product of the environment. Environmental conditions affect the human lifestyles. Every living organism depends on the balanced environment. Nature is the best open air school to mankind. Unfortunately, this school is facing bad times. The country's precious natural resources are being decimated and environment is degraded.

The survival and well being of a nation depends on sustainable development. It is a process of social and economic betterment. We are drifting away further and further from the beautiful nature due to use of modern technology which has been imported from western countries. We are horrified to be in a such situation rather than satisfied. To break the umbilical chord with our mother Nature is a heinous crime against Nature. Thanks to our ancestors who lived with harmony among themselves and there was no question or conflict between man and Nature. Industrial revolution lead to damage the environment and depletion of Natural resources. More and more resources are required for maintaining developmental process. This process results into environmental into degradation.

Environmental resources like atmosphere and water may be regarded as global public goods. Their preservation not only benefits the local population, but also the other countries. Nowadays we are living in polluted world. We are surrounded by poisonous substances which lessen our life span. Pure environment improves the quality of life. Day by day we are developing new techniques which cause environmental threat. Due to these disturbances many species of fauna and flora have extinguished and many species are in danger.

The most important event of the modern times is perhaps the people's concern about environment. Never before the people were so much alarmed about the deteriorating environment which is the store house of all living organisms. The alarming and dangerous sign of environmental crisis and degradation of our planet's biosphere is due to the impact of the mounting activity of human beings.

Defence of the environment is one of the most pressing problems of today. The welfare of the mankind linked is with viability and productivity of natural and agricultural ecosystems. Evidences accumulated even in the past several decades have clearly demonstrated that both the integrity and yield of these life support ecosystems can be adversely affected by air pollution.

Air pollution also is a product of the activities of man. As man started manufacturing chemicals and metals generating electrical powers, developing faster means of transportation and crowding in overpopulated cities, the problem of air pollution becomes inevitable. The air environment began to loose its earlier purity due to the concentration of smoke, dust and other pollutants.

When human being leant to stand on twin foot then he tried to develop his nature. By this quality he became separate from other animals of the society. It is the base on which he had created a separate empire over the society. Various processes are running in the environment, out of these even one process is disturbed then whole system is disturbed., Due to heavy exploitation of energy resources we are facing a unique type of problem called pollution. There is an ozone layer in the atmosphere which absorbs ultra violet radiation emitted from the sun. Due to release of chloro fluro carbons mainly used in air conditioning industry are responsible for ozone depletion. Ultra Violet rays cause skin cancer on human body.

Carbon dioxide accumulates in the environment by both natural and anthropogenic processes. In 1860 atmospheric carbon dioxide was 0.0285 percent which became 0.033 percent in 1977 and its percentage reached at 0.0334 in 1988 then goes to 0.0353 in 1990 (value in %). Percentage of atmospheric carbon dioxide has increased 10 times since 1880. In 1880 its concentration was 312 ppm which has gone up to 320 in 1969 which further increased up to 353 ppm in 1990.

Nowadays we are disturbing the nature in the name of development. Developed countries are giving out-dated technologies to the developing nations which results into environmental degradation. In 1960s development meaning economic progress at any cost, created a lot of problem to mankind. By this process developed countries became more richer and poor countries became more poorer. The citizens of third world countries are not getting basic amenities like food, cloth and residence. Environmental degradation is the result of modern civilisation. On the one hand we are talking to raise the standard of living whereas on other we are facing the shortage of natural resources. Ecological imbalance became the story of common man. So, it is necessary to make the people aware of the happenings of its surroundings. Special focus has been given on Rio Summit (1992).

Modern science and technology keeps dominance over Nature. Economic development produces many hindrances in daily routine work which is the result of scrupulous exploitation of natural resources. We must understand that man is also a part of Nature. When a part of Nature performing imbalanced actions then coming generations have to pay the price of this work. Environment and development are *complementary to each other.*

Today we are moving towards 21[st] century. The problems are originating by the rapid developmental activities. These developmental activities are producing numerous problems for the society. God has created human beings and for fulfilling the requirement of human beings created a beautiful earth. There is no myth that the earth is very beautiful in this universe. That almighty has created all animal and plant kingdom in such a way that they fulfil their requirement by adjustment. Almighty permits to consume the substances among the living organisms to a limit. When anyone crosses the limit the nature becomes aggressive which generates a lot of problems to the surroundings.

According to .report published by United Nations Environment and Development only 20 % of population of the developed countries consume 80 % natural resources. If we intend to give the basic amenities to all people of the globe we have to create many planets like earth. It has been experienced that can not provide solution to all problems.

Environmental awareness is as old as industrialisation. Pollution is the key source of industrialisation. It is well known fact that these accidents tended to think man in this concern. United Nations is the base which help the globe to think about the environment. A conference was organised in Swedish capital Stockholm from 5th June to 16th June 1972 which had been participated by the then prime minister Mrs. Indira Gandhi. Conclusions and recommendations of the conference stressed that if man wants to save the race he has to do the work in such a manner by which environment is not detoriated.

Simply you think about the environment. When environment is polluted and how it is polluted? What are the constituents by which water becomes polluted? What chemicals are present in stack gases cause sickness to human beings?

In otherwords one can say the man and other living organisms may be plant or animal in their surrounding including climate of the earth and other living organisms of the Universe are termed as environment. When air contains numerous soots and dusts are called polluted air. We are losing our natural resources. Environment is polluted day by day. The situation has become so complex that it attracts the attention of masses.

India is a developing country. Mineral consumption is a parameter of development. Development is mainly affected by minerals. Minerals are very precious to mankind. Minerals are not formed in a short period but it takes very long time.

Underground mining causes dewatering from earth crust which can produce water problems in future.

Industrialisation is the prime base of the origin of human race and its culture. This activity helps to increase the standard of living but in other side it is increasing new chemicals in the environment. It has been estimated that 10,000 new chemicals augmented every year in the environment.

In 1980 proved coal deposits in India was 20.70 billion tonnes which has gone upto 72.73 billion tonnes in 1997. Indicated Reserves of coal deposits in our country are only 32.0 billion tonnes but according to the estimates of 1997 it reached upto 89.84 billion tonnes. Estimated coal reserves found in the country are also increasing. It was 30.90 billion tonnes in 1980 and this has touched the figure of 42.08 billion tonnes in 1997. In other words, total coal deposits in India are 83.70 billion tonnes. Following the increasing trend it reached upto 204.65 billion tonnes in 1997 as per estimate done by Geological Survey of India.

Increasing demands of energy we will require a lot of energy in near future. The country's total installed capacity for power generation in 1996 was 83228 MW (Provisional). The electricity generation in 1995-96 was around 380 billion KWH. Out of 83228 MW, 60086.9 MW is generated by Thermal Power Plants. Only 2225 MW generated by Nuclear Sources. Demand by 2007 AD is estimated to be 142,000 MW which implies creation of capacity of nearly 10,000 - 12,000 MW per year.

Bihar is the largest producer of coal. 65205 million tonnes of proved deposits are reported in this state. Bihar has highest contribution in coal production (1995-96) is 27.3% of total coal produced in the country. Assam and North Eastern states have only 0.03 % of total coal production in the year 1995-96. Out of 70.44 billion tonnes of proved Reserves of coal in the country, 15.22 billion tonnes belongs to coking category and rest belong to non coking category. Similarly total reserves of coal is 201.95 billion tonnes in which 14.80 billion tonnes consist coking coal and rest 172.14 billion tonnes belong to non coking coal.

No statistical records of coal production are available prior to nationalisation (1973). In the year 1974-75 total coal production in India was 78.99 million tonnes. In 1980-81 it reached upto 100.86 million tonnes. In 1986-87 there was 144.74 million tonnes of coal production in our country. It was 204.14 million tonnes in 1991-92 which touched the mark of 237.25 million tonnes in 1995-96.

Power sector is the major consumer of coal followed by Steel industry. Thermal Power Plants consumed 130 million tonnes in 1989-90 and it has been projected that it will increase to 271 million tonnes in 1999-2000. Environment has been greatly effected with surface coal mines. A large amount of explosives were used in open cast mining. 3399 tonnes of explosives used in 1971 which touched the mark of 65372 tonnes in 1987. These explosives are only not producing noise pollution but also affect the other environmental structures, viz., building, ponds etc.

Increasing pollution, deforestation, biological diversity, discharge of hazardous chemicals which has influenced the food chain to a great extent have stressed the people to think about that. It is the cause by which environmental quality has been degraded gradually. A day will come when man will purchase oxygen for his survival.

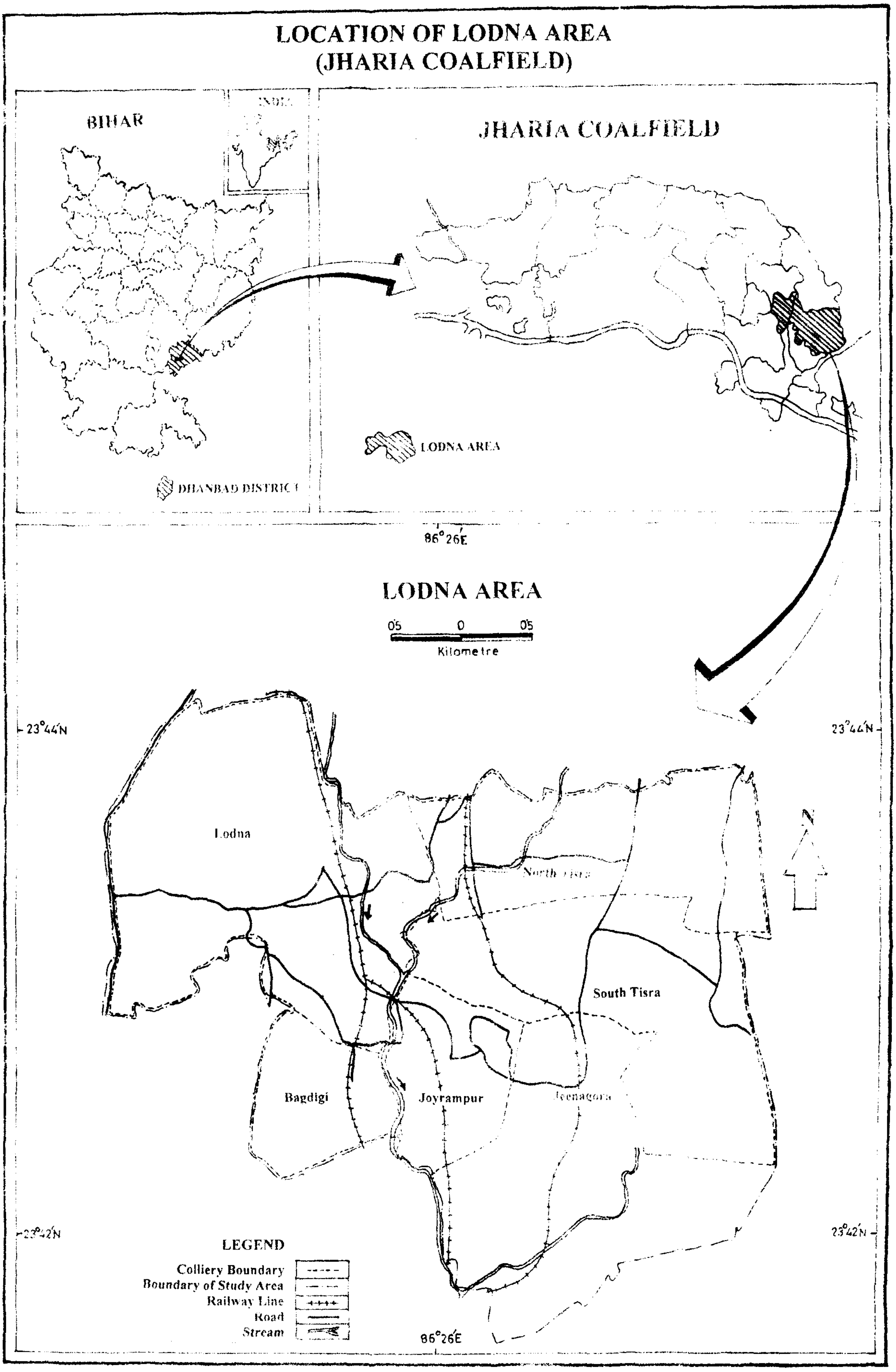
Coal mining is the modern activity of developing the process. It is a hazardous enterprise adversely affecting both man and nature. Extraction of coal denudes (degradation) the natural reserve nature. About the environmental devastation caused by the mining a recent analysis notes are -

Mining - is a devastating operation that not only destroys the natural ecosystem particularly if it is a surface mining, but also introduces tremendous distortions into the social fabric. The associated problems of deforestation, waste disposal, water pollution, air pollution, dereclination vibration room blasting, land collapse and drop in water tables are of coarse marked and perhaps to be expected in mining operations. But little attention has been paid to the fact that most mining activities are taking place in remote tribal areas and the impact on the health, hygiene nutrition, sanitation accidents, increased intensity of work, market and anti social activity is a necessary corollary of mining as it is being practised today.

Whether it is opencast or underground mining the environmental degradation its cause remains a relentless reality. Man is very close to the nature. Despite all sorts of progress and advancement in knowledge, science, arts, technology and strategy, is confronted with some problems emerging out of erroneous parts of his interactions/interrelationship with the biophysical environment. Mining, the second only to agriculture, is world's oldest and most important industry. The dependence of the primitive societies upon mined products is illustrated by the nomenclature of these epochs "Stone Age, Bronze Age, Iron Age and now Atomic Age" a sequence showing increasing complexity of society relationship with mining.

History of mining in India has the history of the civilisation, Zawar, Khetri, Dariba in Rajsthan, various coal and iron ore mines in Bihar and Madhya Pradesh, vividly display the mining activities of ancient times. Presence of heaps of slags of iron and non ferrous smeltings at several places in Bihar and Rajsthan States and elsewhere are mute testimony to vibrant mining and smelting industry operating in these areas.

Mineral exploitation during pre-independence era and to a great extent, a decade after, was limited and associated with haphazard way of working based on unscientific lines. The conceptualisation formulation and implementation of planned development on scientific lines started steadily from the year 1956 following Industrial Policy Revolution. After Industrial Revolution In India, Indian Mineral Industry has rapidly grown not only in size and output but also on scientific and modern technological application. Today mining is undoubtedly a vital sector for economy of our country. As on 01-01-1988, country had 9,809 mining leases covering an area of about 1.5 to 2.0 million hectares.


LOCATION OF LODNA AREA
(JHARIA COALFIELD)
BIHAR
JHARIA COALFIELD
LODNA AREA
DHANBAD DISTRICT
86°26'E
LODNA AREA
0.5 0 0.5
Kilometre
23°44'N
23°44'N
Lodna
North Tisra
South Tisra
Bagdigi
Joyrampur
Jeenagora
N
23°42'N
23°42'N
LEGEND
Colliery Boundary
Boundary of Study Area
Railway Line
Road
Stream
86°26'E

Location: The study area is a part of Jharia Coalfield. Jharia Coalfield is the only coalfield producing prime coking coal in the country.this coalfield is located in Dhanbad district of Bihar and lies between latitude 23^0 39' to 23^0 48' North and longitude 86^0 11'to $86^0$27' East. Dhanbad (main town) is situated at Grand Chord section of Indian Railways (Fig. 1.11). Grand Trunk Road passes near the main town. It is 275 kilometres west of Calcutta. Study divided into six units:

1. Lodna colliery - This is one kilometre away from Lodna railway station of The Eastern Railway. It is 11.40 kilometres from Dhanbad Railway station by bus route. There are six mouzas in this colliery region : (I) Madhuban (83 hectares), (II) Lodna (126 hectares), (III) Padhyadih (77 hectares), (IV) Bhaga (38 hectares), (V) Sharia (33 hectares) and (VI) Jealgora(22 hectares).
2. North Tisra Colliery- It is about 5 kilometres from Jharia, a small town of Dhanbad district. It is 2 Kilometres away from Lodna railway station. There is one village named Tilabani having an area of 5.21 hectares.
3. South Tisra Colliery- It is approximately 5 kilometres South west of Jharia Railway station. There are two mouzas named Tisra Mouza (130.43 hectare) and Surunga Mouza (131.37 hectare) located in this region.
4. Bagdigi Colliery - Railway station located within bagdigi colliery itself. Bus route passes through west junction of the colliery. There is one village Padhyadih(63.17 hectare) located in this colliery.
5. Jeenagora colliery- 15 km north from Dhanbad railway station and 7 km from Jharia railway station. There are three villages in the area: (1) Jeenagora (9236), (2) Sulanga (47) and (3) Parbad (44 hectare).

6. Joyrampur colliery- It is 7 km away from Jharia town and nearest railway station is Lodna (eastern Railway) is approximately 2 km. Joyrampur village located in the colliery having an area of 98.4 hectare.

Literature survey

Vast reserve of coal deposits are found in America, Russia, China etc. In these countries coal is excavated by sophisticated machines. Due to its nature, excavation of coal leads several types of problems. Several studies have been carried out in this field. These studies help us to ameiolerate the problems caused by this process. Coal is mainly excavated by two methods, one opencast method. In this method overland material of the coal deposits is removed and coal mining process comes into operation. This process is active where coal is not very deep from the earth surface, generally below 4 -10 metres of depth. Second process is called underground mining. In this type of excavation coal is excavated from very deep of the earth surface. It is mentioned that this activity leads to severe environmental problems.

Polluted atmosphere generally associated with domestic and anthropogenic activities. Nature has great role in pollution. Taken on a worldwide basis, the total mass of trace gases emitted by nature exceeds those emitted by several orders of magnitude. Carbon dioxide concentration is 320 ppm for clean air. Air becomes polluted if concentration of carbon dioxide become 400 ppm. Carbon dioxide concentration of 0.01 ppm seems to be clean. Polluted air having 40 - 70 ppm of carbon dioxide. Nitrogen Oxides concentration is 0.2 ppm in polluted air while clean air posses 0.001 ppm of Nitrogen Oxides. It is evident that the ratio of concentration of polluted air to clean air ranges from fractional to a 1000 fold. Sulphur dioxide emission from natural sources exceeds those from pollution sources.

However, radioactivity in coal is very low but carbonaceous shales contain greater amount of uranium. In America work is in progress in this field but no exact concentration of Uranium has been found in the coal but it has been estimated that coal is containing 1 ppm of Uranium. Combustion of fossil fuels releases large quantities of Uranium and Thorium. According to the USA Environmental Protection Agency (EPA) coal averages about 1.3×10^{-4} % uranium and about 3.2×10^{-4} % thorium. USA alone released 4.7 tonnes of uranium and 11.6 tonnes of thorium in the surrounding atmosphere in 1982.

The studies on impact of coal mining on ground water carried out in India are very few. Ground water recharge occurs due to rainfall. Work done in Illinois (USA) shows that water slopes from all the Overburden (OB). The acidity of water which has been collected 130 metre away from overburden dumps has higher value and well water of same area consist pH value 2.4. Concentration of sulphate, aluminium, iron, lead and zinc is also higher. Overburdens of the North East India consist large amount of pyrite. Rainfall in this area causes the formation of sulphuric acid. If there is no rainfall, vaporisation activity go up then grasses and other plants which have been planted to decrease the sediment load, turns to yellow.

Coal beds, water table and Geo hydrological regime may cause different type of conditions. For e.g. aquifer in an area may be up or below the seam or it may be a part of that. Water is locked in fractures of coal. Due to interval structure water flow is very low in the matrix.

Surface mining is the chief source of Suspended Particulate Matter (SPM) . It is dependent on blasting processes, geological structure of rocks etc. Unburned hydrocarbon which is due to vehicular emission also come into the atmosphere. In India work on dust pollution has been carried out between 1977and 1980 by Indian School of Mines. They studied about SPM in different areas of Jharia Coalfield and correlate with health aspect. In industrialised area value of SPM ranges between 73 and 1464 micro gram per cubic metre. In winter season highest concentration of SPM monitored in Nirsa Kumardhubi area which was 1464 micro gram per cubic metre. Central Mining Research Station which is now known as Central Mining Research Institute had been used as reference centre. Here SPM is found under permissible limit. All other places where air quality has been monitored was found not below 845 micro gm per cubic metre. Higher SPM value in rainy season is also reported in Nirsa-Kumardhubi area, 481 micro gm per cubic metre.

Air quality study has been done by Sharma (1990) in some areas of Raniganj Coalfield show that air is loaded with contaminants which adversely affect our surrounding environment. Fugitive emission of dust on haul roads (non metalled roads used by coal companies to transport the coal from mines to other place) has been studied by Sinha and Banerjee (1994). It is noticed that it contributes a greater role in dust pollution. Enormous amount of dust is released into the atmosphere by coal washery units. Level of air pollution is higher in winter season and lowest in rainy season.

Irrespective of the actual methods of coal mining being used, mining processes unavoidably bring about land surface disturbances. Continued improvement of coal mining methods in associated with the exploration of deeper coal seams (below 100 m in deep mining operation and a few hundred metres in surface or strip mining operations). Land disturbance due to coal mining can be classified into two categories: (a) land disturbed by surface mining (strip mining & open pit mining) and (b) land disturbed by underground (deep) mining. In German Democratic Republic (GDR) land reclamation was first officially endorsed in 1951 by establishing law. In 1957 Czekoslovakia enforced law to protect the natural resources. In Poland, planned reclamation had been started in 1961 when the economic committee of the council of the ministers made it mandatory. Such types of the law exist in Bulgaria, Hungary, Romania and Yugoslavia.

National Environmental Policy Act (NEPA) of United States of America was legislated in 1969 to cover a wide range of environmental problems. This act facilitates to consider all major federal actions that significantly affect he environment. Since 1977 reclamation of surface mined land for coal is monitored by office of Surface mining within U S Department of Interior.

In India no such law has been legislated to reclaim the area damaged by the surface mining. That's why a large area remains unused. This empty land can cause soil erosion in rainy season and air pollution during the period of summer season.

Objectives

Objectives of the research work are:

(i) To assess the nature and methods of coal mining

(ii) To assess the waste material generated by coal mining

(iii) Impact of coal mining on environmental degradation

- (a) Deforestation
- (b) Land Degradation
- (c) Water Pollution
- (d) Dust Pollution
- (e) Air Pollution

(iv) To assess the impact of coal mining and suggest correlative measures to maintain the ecological balance.

Data Source and Research Material

(1) Prefield work:- It consists literature survey and collection of secondary data from various sources. Some relevant information were also collected from various offices of Bharat Coking Coal limited who montors the coal mining activities in this coalfield. Basic information about study area was collected from State Pollution Control Board and Central Pollution Control Board. Geological map of the area was collected from Geological Survey of India. Toposheets 73 I/5 and I/6 on 1: 50,000 scale has been used for basic maps. Other relevant information includes population data and agricultural information had been obtained from census department and state agriculture department.

(2) Field work: - Extensive field work has been conducted in the study area. During field work coal production data and overburden material have been collected from General Manager's office of the study area. Data about air quality was collected during field work. Detail studies about mine fire have been conducted during field work. Detail information of noxious gases (carbon monoxide and nitrogen oxide) was also collected. Various water samples were collected from different handpumps for knowing the water quality of the area. Tubewell water samples had been also collected to know about hydrogeological characters of the area. Various water samples and mine water samples were collected to detail study of underground water and mine water respectively. During field study different water samples were collected from different stations of the Damodar river. Monthwise collection of washery effluent had been collected to estimate BOD, COD and other values of effluent discharge. Different soil samples were also collected to analyse the trace elements in the soils of the area. Data and information about health aspect has been collected during field work.

(3) Post field work:- After collecting all relevant information related to the topic has been processed and analysed. Data of coal production has been tabulated yearwise. Data of coal production of opencast and underground mining has been tabulated separately. Coal excavated by different collieries in different years in correct order. Data and information of overburden (OB) removed by opencast mining has been tabulated and stripping ratio has been done.

Amount of methane released into the atmosphere has been calculated with the help of coal production data and coefficient of methane. The data regarding water, soil and air has been analysed and presented in different chapters. The final maps have been prepared and interpreted.

Methodology and Research Design

To study the impact of coal mining, scientific and methodological information is necessary. Literature survey has been done in the libraries of different universities and institutions. Various information and data have been collected through field work and topographical maps. In present study special emphasis has been given on the analysis of the pollution level in the area. Base map have been prepared by using Survey of India topographical sheets on the scale 1: 50,000. Another map has been prepared with the help of maps provided by the controlling body of Bharat Coking Coal Ltd. a subsidiary of Coal India Ltd.

Plan of Work

The present study has been divided into six chapters.

Chapter first deals the introduction of the thesis work. This also includes statement of the problem and literature survey of the works related to coal mining in India and abroad. Methodology is also dealt in this chapter.

Chapter second elaborates the geology of the area and simultaneously topography of the area. Soil characteristics which include physical and chemical aspects of the soil found in that area. General climate and population has been also discussed in this section.

Chapter third related to nature and methods of the mining prevailing in that area. In this section amount of coal produced by opencast and underground mining has been also described. Overburden generation by opencast mining and stripping ratio has been mentioned in this chapter.

Chapter fourth emphasises about the change in landuse pattern in the area between 1973 and 1993. In this chapter change in landuse pattern especially by coal mining has been highlighted.

Chapter five deals the various aspects of environmental degradation. Impact of coal mining on different parameters has been elaborated in this section of thesis. Various parameters which includes deforestation, land degradation, water pollution, air pollution and dust pollution are mentioned here.

Final chapter is sixth which discusses the environmental impact of coal mining on climate, hydrological, hydrogeological, soil and morphology of the terrain of the study area. In this section impact of coal mining on fauna (especially human beings) and flora of the area has been elaborated.

In the last section of thesis summary of conclusions and bibliography has been arranged.

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CHAPTER II

Physical Setting:. of the Area

Geology

Introduction

Coal is a heterogenous aggregate of organic and inorganic materials. Organic material obtained from coal gives detail picture of its composition. It is made up of several floral groups. Systematic geological investigation for coal in India may be considered to have started in 1845 with the arrival of D.H. Williams of the British Geological Survey as the Geological Surveyor to East India Company as per recommendations of the Coal Committee of the Company in 1845. Therefore, the prerequisite of any geoenvironment appraisal is the study of geology of the area.

The oldest geological formations in the district are a group of Archaean (Dharwar) age which form the basement. Over these rocks were deposited slowly sinking faulted troughs (basins), the Lower Gondwana group of sedimentary strata including the coal bearing beds. Superficial deposits of alluvial sands of rivers and streams and residual soils derived from the weathering of bed rocks are Recent formation formed during the Quarternary period.

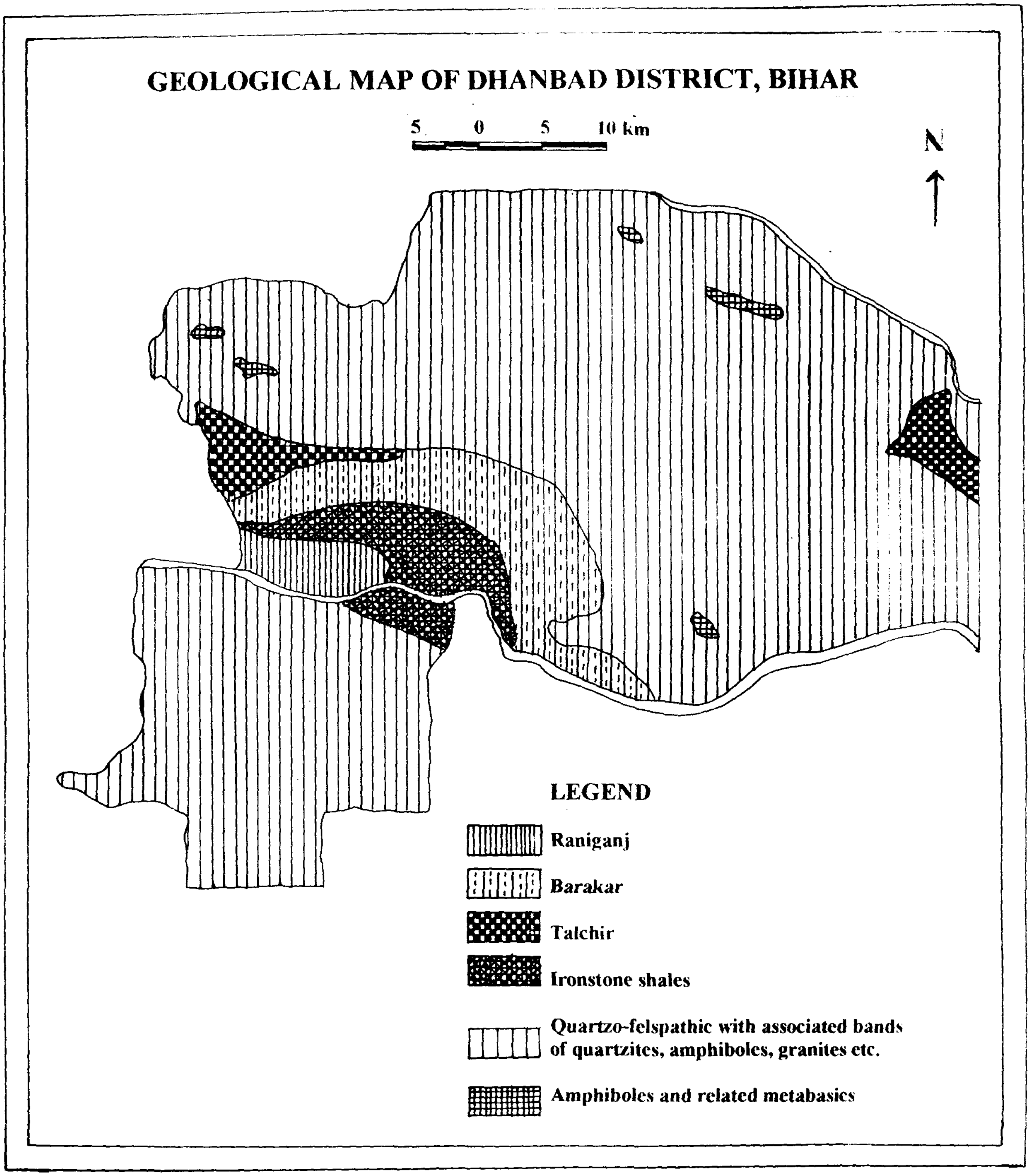
GEOLOGICAL MAP OF DHANBAD DISTRICT, BIHAR
5 0 5 10 km
N
LEGEND
Raniganj
Barakar
Talchir
Ironstone shales
Quartzo-felspathic with associated bands of quartzites, amphiboles, granites etc.
Amphiboles and related metabasics

Fig. 2.11

Table 2.11

Stratigraphic Succession of Dhanbad District

Quaternary		Soil/Alluvium
Triassic to Lower Carboniferous subgroup	Lower Gondwana Group	Raniganj sub-group or upper Coal Measures Ironstone shales group or Barren Measures Barakar sub-group or Lower coal Measures Talchirs
-------------------------------Unconformity -----------------------------		
Archaean	Crystalline	Metamorphites

Since the time of Ball (1881) considerable work has been done on the crystalline metamorphic rocks particularly by the Department of Applied Geology of the Indian School of Mines and Applied Geology, Dhanbad.

At the commencement of the Lower Gondwana period (about 300 million years ago) there was a glacial age in India evidenced by the glaciated Talchir boulder beds at the base of this group of rocks. The climate became warmer ushering in highly abundant growth of vegetation which supplied the materials for coal seams in the succeeding series of rocks in the Jharia Coalfield and in the Cis-Barakar portion of the Raniganj Coalfield in suitable environmental set ups. Geological map of a part of Dhanbad district has been shown in fig. 2.11.

Table 2.12

Geological Formations of Lower Gondwana in Jharia Coalfield

Superficial deposits	Recent	Soil and alluvium of rivers and streams.
Igneous Intrusives	Cnetaceo-Eocene Lower-Jurassic	Dykes of Basic Igneous rock,dolerites silts and dykes of ultrabasic igneous rocks, mica-peridotites and lamprophyres.
Lower Gondwana System	Upper permian Raniganj series (upper coal measures)	Brown medium grained sandstones, bands of sideritic sandstone weathering yellow; carbonaceous and mica- ceous shales; fire clays and coal seams.
Midle Permian	Barakar Measures	Laminated and massive sandstones, shales with nodules of ironstone (clayey siderite) or linonite at some places
Lower Permian	Barakar Series (Lower coal measures)	White coarse-grained micaceous sandstones; Carbonaceous and mica-cous shales, fire clay and coal seams
Upper carboniferous	Talchir Series	Boulder bed; green, fine grained sandstone; green shales showing nedular and needle shaped weatheri

-----------------Unconformity------------------------

Dharwar and Post Dharwar Crystalline rocks (basement)

The Archaean Crystallines are formed from rock types of both sedimentary and igneous origin. The sedimentary rocks originally deposited as sandy, clayey and calcareous impure sediments. These were consolidated and later subjected to regional metamorphosism and were converted into quartzites (granulitic and schistose varieties), micacous schists, crystalline limestones, Calc-silicate granulite and calc-gneissos and in some cases to amphibolites and hornblende schists. The quartzofeldspathic rocks are by far, the most prominent and the amphibolites/ metabasics occur interbeded with them as well as in the form of isolated bodies. The last two rock types may in part, be contemporaneous lava flows or sills subsequently metamorphised. All these happened in the Dharwar period about 900 million years ago.

The Talchir measures is very well exposed near western, northern and eastern plank of the basin. Where fully exposed part comprises of about 245 m of greenish shales and fine grained sandstones containing about 15 m of boulder bed at the base.

The rocks of the Barakar stage consist of pebbly sandstone conglomerates, grits and fine to coarse grained sandstone siltstones fine clays (at the lower portion) shales, carbonaceous shales and coal seams. Thickness of Barakar Measures varies between 385 and 1200 metres. Barakar Measures is the main source of Indian coal. Metallurgical coal deposits also found in this Measure. It is made of conglomerate, sandstone, siltstone, shales, carbonaceous shale and monotonous sequence of different coal beds.

It is developed only to a limited extent in this coalfield. They form as oval shaped in the south western part of the coalfield and have a thickness of about 560 metres. They largely comprise micaceous sandstones, which are fine grained than those of Barakar. The conglomerates and the pebble beds are also not common. Shales and carboniferous shales containing thin coal seams have been extensively developed. Altogether nine seams of coal over 1-2 metres in thickness have been found.

The sedimentary rocks in the Raniganj and Jharia Coalfields are intruded by a series of dykes and sills of ultrabasic origin. These are mica-peridotites (commonly known as 'mica traps') commonly occurring as pseudomorphs, biotite as reddish brown flakes and apatite as needles are embedded in the highly altered matrix consisting of secondary minerals like serpentine, chlorite, Calcite, Kaolin, limonite, etc. The intrusions or lamprophyres occur commonly as silts and are called `pest' of the coalseams as they have often burnt these locally into `jhama'.

Alluvial sands and residual soils derived from the weathering of bed rocks from superficial deposits. Thick deposits of Recent alluvial sands occur adjacent to the banks of Damodar and Barakar rivers and the Jamunia, Khudia and Pusal streams. The Damodar sand is being used at places for stowing (filling the mining space) the goaf (space left after mining) areas in important coal mines in Jharia coalfield. Patches of older alluvium also occur on the banks of Damodar and Barakar rivers lying above present flood plains or in abandoned channels in shifting river courses.

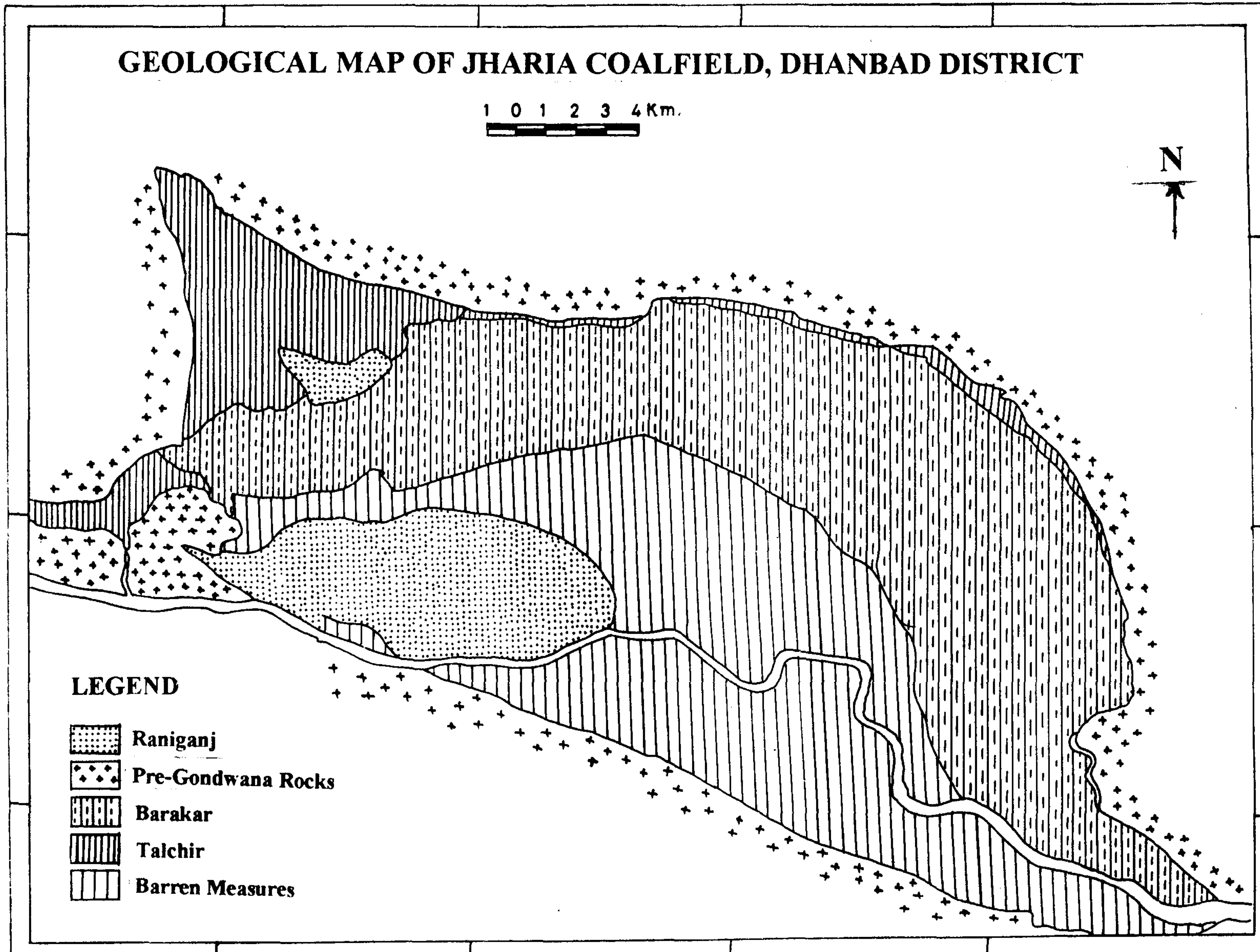
GEOLOGICAL MAP OF JHARIA COALFIELD, DHANBAD DISTRICT
1 0 1 2 3 4 Km.
N
LEGEND
Raniganj
Pre-Gondwana Rocks
Barakar
Talchir
Barren Measures

Fig. 2.12

Geology of Jharia coalfield is shown in Fig 2.12. Jharia coalfield (JCF) is situated in Damodar Valley and it is one of the longest coalfields in India. This coalfield is situated in Dhanbad district of Bihar and lies between latitude 23^0 39' to 23^0 48' N and longitude 86^0 11' to 86^0 27' E. The ground elevation of the field generally vary between 240 m in the western part to 140 m in the South Eastern part above mean sea level (MSL). Small sandstone ridges are found along the peripheral region of the coalfield.

The lower Gondwana formation of JCF lie unconformably on the Archean and consist of rocks of Talchir and Damuda series. The Damuda comprises the Baraker measures, the Barren measures and the Raniganj measures. An area of about 54 sq. km is occupied by rocks of the Ranigang measures and about 218 sq. km by those of the Barker measures. The rest of 181 sq. km. comprise rocks of the Barren measures and the Talchir series.

Table 2.13
Geological set up of Jharia coalfield

Recent		River alluvium
Jurassic	Rajmahal	or Dolerite dyke
Tertiary	Deccan trap	or Mica Lamprophyre
Upper Permeans	Raniganj series 560 m	Lapti & Kogre stage (with coal seam) TelmuchoStage
Middle Permean	Barren measures	Mohuda stage Harharpur stage Name stage Bheltand stage
Lower permean	Barakar series	Bhaga bandh stage Jealgora stage Narakarki stage Muraidih stage
Upper Carboniferous	Talchir series 245 m	Grem shales with nodular and needle shaped weathering fine khaki coloured sandstone.

-----------unaconformity ---------

Talchir measures

The Talchir measures is very well exposed near western, northern and eastern plank of the basin. Where fully exposed part comprises of about 245 m of greenish shales and fine grained sandstones containing about 15 m of boulder bed at the base.

Barakar measures

This formation consists of granular sandstone, shale, carbonaceous shale and several coal beds. Generally coal seams have average thickness but some seams are heavily thick. Coal of Lower Barakar formation is shale, carbonaceous shale and interbedded of unwanted materials. Ash content found in the range of 22 per cent to

37 per cent in different beds of this formation. Minerals found in these seams are homogenous and intergrown in nature.

Deposits of Upper and Lower Barakar formation found in the range of 95 metres to 370 metres and 130 metres to 380 metres respectively. Thickness of coal seams are also upto 24 metres. Prime coking coal lies in these deposits. Coal of these formations are easier for benefication rather than lower Barakar formation.

Barren Measures (Middle Measures)

Lithologically the rocks of the formation are very similar to those of the Barakar stage excepting for the comparative predominance of shale and the entire absence of coal seams of workable thickness. The line of division from a little above the topmost coal seam of the Barakar stage as demarcated by Fox.

Raniganj measures

Deposits found above Barakar formations consist no coal material. It is not well developed in Gondwana coalfields of Indian continent . This formation is made of greyish green or white green crossbedded sandstone, greyish shale and less developed to well developed coal seams. It is well developed in Jharia coalfield. Beneficial coal deposits are present in this formation. Its thickness in Jharia coalfield is 450 metres. There are 14 coal seams in this formation present in Jharia coalfield. It is the second thickest coal seam of the world. The highest thickness which is observed is 133 metres.

Large proportion of Indian coal has been contributed by this formation. This formation consists semi coking coal seams.

Recent Formation:

The nature of soil depends on the nature and chemical composition of the bed rock and on the climate and topography. Coarse gritty soil admixed with big fragments of rocks is formed from the weathering of pegmatites, quartz veins and conglomeratic sandstones. Sandy soils are characteristics of granitic rocks and sandstones. Basic igneous or metamorphic rocks and ferruginous sandstones give rise to the reddish brown ferruginous soils, sometimes lateritic. The crystalline limestones and calc-silicate granulites give calcareous soils and nodules of kankar (calcium carbonate) in the soil. The fine grained shales give loamy soil and carbonaceous shales and coal seams dark brown to black soil. Paddy field soils are, dark-brownish because of their content of 'humus'. While efflorescence `reh' (mixture of sodium sulphate, carbonate, etc) brought up from below by capillary action during dry season is also seen as thin encrustations on the surface.

COAL SEAMS

Coal Seams of the Barakar Measures

There are about 25 coal seams, 1.22 metres and above in thickness, associated with shales and carbonaceous shales. Eighteen coal seams (Table 2.14) have a regional extent and numbered I to XVIII from bottom to top. The other seams which are less persistent are numbered by suffixing the alphabet A, B etc. to the number of the coal seams immediately below them as (VIII A, XIII A, XIIIB, XIV A, XV A and XVIA). In addition a few seams of local nature are also met with.

The generalised sequence of the different seams from top to bottom is as follows:

Table 2.14
Coal Seams of Barakar Measures

Seam	Thickness(in metres)
XVIII	1.83 to 5.18
XVII	1.22 to 5.79
XVI	1.22 to 4.88
XV	2.74 to 11.89
XIV	1.62 to 10.69
XIII	2.13 to 9.14
XI/XII Combined	2.74 to 9.14
XII	1.52 to 5.48
XI	1.22 to 7.62
X (IX/X)	3.05 to 18.29
IX	1.22 to 11.58
VIII	2.13 to 8.83
V/VI/VII	11.89 to 22.55
IV	2.13 to 12.19
III	2.13 to 7.32
II	2.13 to 18.29
I	21.3 to 4.27

Coal seams of the Raniganj Measures

There are about nine coal seams 1.22 metres and above in thickness in this group and their sequence is given in table 2.15 :

Table 2.15
Coal Seams of Raniganj Measures

3 coal seams of Lohapiti area	- Each about 1.2 m. thick
2 coal seams of Kachara area	- 91 cm. to 1.3 m.
Bhurungiya	- 1.2 m.
Mohuda Top Seam	- 2.7 to 3.7 m.
Mohuda middle seam	- 1.2 m.
Mohuda bottom seam	- 1.8 to 2.4 m.

The study area is divided into six colliery units viz., Lodna, Bagdigi, Jeenagora, Joyrampur, North Tisra and South Tisra. Detail information about the seams present in the colliery units are given below:

(1) Jeenagora colliery- Here six coal seams are found. The uppermost seam is 13^{th} seam. Here it is divided into two parts namely 13A and 13. Thickness of the uppermost seam is 2.4 metres. Like Lodna colliery 11^{th} and 12^{th} seam also found in jointed form The most thickest seam is 10(X) seam. It 10 metres thick. The most thickest interburden lies on X seam. It is about 55.5 metres thick. This is also divided into two parts. The lowermost seam is 9(IX) which is about 1.8 metres thick. Detail knowledge about seam is given in table 2.16.

(2) Lodna colliery- Detail profile of this colliery is given in table 2.17.There are sixteen coal seams present in the area. The uppermost seam is 16(XVI). It is 3.0 metres thick. Below XVI seam 15A seam is present which is 1.7 metres thick. Approximate 65.5 metres thick interburden found on this seam (15A). Thickest seam is 14 seam which has 8.1 metres thickness. In this colliery XA is considered as special seam. There are five seams which have been divided in two or more than two parts in this colliery area. Here 13 seam found in three separate sections (13B, 13A and 13). Here 11^{th} and 12^{th} seams merged into one seam. There is a local seam in this part which is 0.61 metre thick.

(3) North Tisra Colliery - There are seven seams present in the area. The uppermost seam (XI/XII) is in jointed form. From table 2.18 it can be said that the most thickest is XI/XII (7.6 metres). After this seam huge interburden (approximate 61 metres thick) lies on 10 top(X) seam. It is merely 3.8 metres thick. Here 10th seam divided into 10 top (X) and 10 bottom (IX) seam. The lowermost seam divided into 7 top (VII) and 7 bottom (VI) seam. Betwenn 10 bottom and 7 top 9 (VIIIA) and 8 (VIII) seams are present.

(4) Joyrampur colliery - Detail profile about seam has been given in table 2.19. The most thickest seam is 10 top(X top).It is about 9.8 metres thick. There are nine coal seams present in the area. Here the uppermost seam divided into three parts viz., 13B, 13A and 13.The lowermost seam is 7(VII) seam measuring a thickness of 6.1 metres. Approximate 79.3 metres thick intterburden lies on 10 top seam. Here 11 and 12th seam also found in jointed form. IT lies below 13 (XIII) seam, measuring a thickness of 7.6 metres.

(5) Bagdigi colliery - Here the uppermost seam is 15A.There are eight seams present from which coal is excavated. All seams except 11/12 are divided into two parts. Here 13th coal seam divided into three sections (13B,13A and 13). The lowermost seam is a jointed seam which is formed by the submergence of 11 and 12 top seams. It is 2.1 metres thick. There are two seams named 15(XV) and 14 (XIV) having same thickness, 8.5 metres each (Table 2.191). The thickest interburden found on 15(XV) seam. The lowest interburden found on 13(XIII) seam.

(6) South Tisra colliery - In this colliery region only six coal seams are present. The uppermost seam is 10th . here it is found in 10 top (X) and 10 bottom(IX) seam. 10 bottom (IX) seam is an additional seam which is found in Jharia Coalfield.

Thickness of these seams are 5.0 and 5.2 metres respectively. The most thickest interburden (26 metres) present on 9 (VIIIA) seam in this area (Table 2.192). The lowermost seam is also divided into two. Between the uppermost and the lowermost 9 (VIIIA) and 8 (VIII) seams are present. The 9th seam is an special seam which is known as VIIIA.

Table 2.16

Partial Summary of Seam and InterburdenThickness of Jeenagora Colliery

Seam colliery	Name Geology	Approx. seam thickness (metres)	Approx. Inter burden thickness (metres)
13 A	XIII A	2.4	
			6.0
13	XIII	4.8	
			12.6
11/12	XI/XII	7.9	
			11.6
10 A	X A	1.8	
			55.5
10	X	10.0	
			24.0
9	IX	1.8	
			-

Table 2.17

Partial Summary and Interburden Thickness of Lodna Colliery

Seam Colliery	Name Geology	Approx. Seam Thickness (Metres)	Approx. Inter-burden Thick-ness (Metres)
16	XVI	3.0	
			65.5
15 A	XV A	1.7	
			36.9
15	XV	7.3	
			5.1
14 A	XIV A	2.2	
			18.8
14	XIV	8.1	
			13.5
13 B	XIII B	2.8	
			5.8
13 A	XIII A	3.5	
			8.7
13	XIII	3.3	
			18.4
11/12	XI/XII	7.3	
			15.8
Special	X A	1.37	
			-
9/10 Top	IX/X TOP	6.1	
			1.4
9/10 Bot	IX/X BOT	5.2	
			10.71
Local	Local	0.61	
			4.6
8 A	VIII A	2.6	
			6.7
8	VIII	2.7	
			3.1
7	VII	6.71	
			-

Table 2.18

Partial Summary and Interburden Thickness of North Tisra Colliery

Seam Colliery	Name Geology	Approx. Seam Thickness (metres)	Approx. Interbrden (metres)
11/12	XI/XII	7.6	
			61.0
10 Top	X	3.8	
			3.1
!0 Bot	IX	6.1	
			30.5
9	VIII A	3.7	
			5.7
8	VIII	2.6	
			-
7 Top	VII	5.6	
			4.0
7 Bot	VI	5.8	
			-

Table 2.19

Partial Summary of Seam and Interburden Thickness of Joyrampur Colliery

Seam Colliery	Name Geology	Approx. Seam Thickness (metres)	Approx. Inter-burden Thickness (metres)
13 B	XIII B	4.0	
			17.4
13 A	XIII A	2.4	
			7.0
13	XIII	3.6	
			21.6
11/12	XI/XII	7.6	
			79.3
10 TOP	X TOP	9.8	
			4.0
10 BOT	X BOT	3.0	
			28.0
9	IX	1.8	
			33.5
8	VIII	2.9	
			3.0
7	VII	6.1	
			11.6

Table 2.191

Partial Summary of Seam and Interburden Thickness of Bagdigi Colliery

Seam colliery	Name geology	Approx. seam thickness (metres)	Approx. Interburden Thickness(metres)
15 A	XVA	1.0	
			36.9
15	XV	8.5	
			5.5
14 A	XIVA	2.4	
			18.8
14	XIV	8.5	
			13.5
13 B	XIIB	2.3	
			10.5
13 A	XIIIA	2.5	
			5.6
13	XIII	3.6	
			16.8
11/12 TOP	XI/XII TOP	2.1	
			3.0

Table 2.192

Partial Summary of Seam and Interburden Thickness of South Tisra Colliery

Seam colliery	Name Geology	Approx. seam thickness (metres)	Approx. Interburden Thickness(metres)
10 TOP	X	5.0	
			1.0
10 BOT	IX	5.2	
			26.0
9	VIII A	2.8	
			06.8
8	VIII	2.5	
			4.5
7 TOP	VII	6.3	
			5.0
7 BOT	V/VI	6.3	
			-

Topography

The Jharia Coalfield is a part of Dhanbad district which form a part of the Chhotanagpur plateau but it is more of an upland in northern part. No large stretched in reported in this district which may be called plains. Chas and Chandankyari that is now under Bokaro district having low land area, which is suitable for agricultural purposes. The northern part of the district, north of Grand Trunk road is hilly. The Parasnath an important shrine of Jains is just outside of northeastern boundary of the district is a landmark with the altitude of 1366 metres is clearly visible from nearby road or railway station. This passes toward to hills of lesser altitudes, viz., Gormwa hill (496 Metres) NE of Topchanchi, Lachmanpur hill 606 metres near Rajbhita and Tundi Hill (744 metres, 582 metres) near Tundi. Isolated hillocks are also seen near Gomoh, South of Grand Trunk Road and east of the road from Gobindpur to Tundi. The Durgapur hill of Kenja Pahar (360 metres) located in Nirsa block and the Gisur hill (418 metres) in the Tundi block are also conspicuous in the otherwise plain surroundings.

The general altitude of the district varies from about 300 metres in the northwest to about 98 metres in the southwest at the confluence of the river Damodar and the Barakar rivers. General slope is thus from northwest to southeast and east. Three distinct characteristics of the landscape are perceptible. These are (a) the hill ranges branching out of the Parasnath hill in the remote northern and north western region (b) the coalfields of the southern and eastern part and (c) the series of the uplands and intervening low valleys with isolated bare ridges of varying elevation between them. In broad sense southern portion of the district consisting of the colliery area with industrial towns and northern portion occupied by hills and scattered villages. Big trees are almost absent except along the G.T Road and the fact that cultivation is

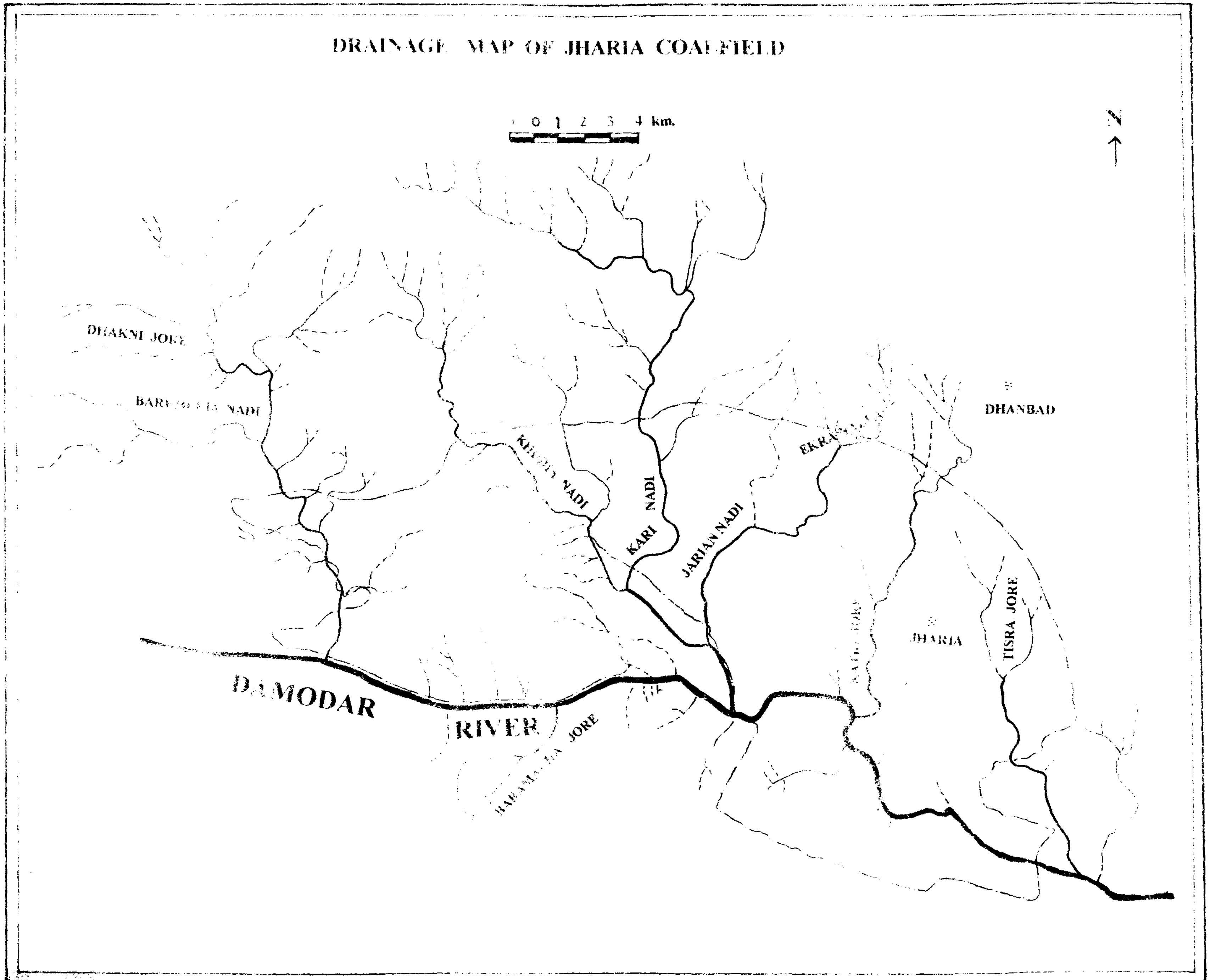
DRAINAGE MAP OF JHARIA COALFIELD
0 1 2 3 4 km.
N
DHAKNI JORE
KHUDIA NADI
KARI NADI
JARIAN NADI
DHANBAD
JHARIA
TISRA JORE
DAMODAR RIVER

Fig. 2.21

generally confined to the rice crops gives the general appearance of a barren waste to the district in dry seasons.

North Eastern part of the study area (Lodna) having higher elevation. Highest elevation found at North Tisra area where it is 208 metre high. In southern part of the study area has sloppy structure. Here slope is found in north to southward direction. Here land is situated at 178 metres above msl (Mean Sea Level). Only a small area of Lodna colliery is having upland part, otherwise surface of the study area is plain. Rivers flowing in the Jharia Coalfield shown in Fig. 2.21.

Climate

It is necessary to describe climate of an area when environmental pollution is focus of the study. Since the study area is in the part of Jharia Coalfield which lies in Dhanbad district of Bihar, the climatological data (1970-1990) collected at the observatory located in Dhanbad town (about 14 kilometres north east from the study area) have been utilised to present climate of the area.

Temperature is one of the important parameter of the climatic study. In 1970, the mean maximum temperature was 31.58 ^{0}C, and the mean minimum temperature was 18.9 ^{0}C Total rainfall recorded in 1970 was 1520.1 mm with mean value of 126.675 mm .Maximum and minimum relative humidity was 86 per cent and 23 per cent respectively. In 1971 value of mean maximum temperature declined to 29.92 ^{0}C while mean minimum temperature for the same period was 17.72 . High rainfall

(1929.4 mm) was recorded in this period. Highest humidity was 93 % and lowest humidity was 25 %.

Minor fluctuation have been observed in mean maximum temperature between 1972 and 1973 but no fluctuation has been observed for minimum temperature. There was low rainfall (1027 mm) in 1972 and high rainfall (2018 mm) in 1973 . There is no major variation in maximum and minimum relative humidity of the area in 1972 and 1973. Only 0.7 °C variation in mean maximum temperature has been found between 1974 and 1976 period. There is same pattern in minimum temperature. Major variation is found in rainfall between 1974 and 1976. Like other parameters there is no major change in relative humidity of the area. It ranges between 69 to 74.63 % in case of maximum relative humidity and 54.66 to 55.66 for minimum relative humidity. Mean maximum temperature ranges between 17.7 to 21.72 C. Increasing pattern in rainfall has been observed in 1977 and 1978 but it decreased upto 1157 mm in 1979. About 1748 mm rainfall recorded in 1977 and 2060 mm in 1978. Mean maximum relative humidity found between 66.83 and 77.16% and 55.83 to 60.25% for minimum relative humidity.

No major fluctuation has been observed between 1981 and 1983 period in temperature. It ranges between 31.05°C to 32.35 °C. Mean value of maximum temperature more or less same in 1981 and 1983 while it crosses the mark of 32 °C in 1982. In 1982 mean value of minimum temperature was 19.03 °C while in 1981 and 1983 it was in 18 °C mark. Rainfall in Dhanbad was normal in 1981 and 1983 but abnormal in 1982. More than 1500 mm rainfall recorded in 1981 and 1983 while this was under 1000 mm in 1982. Mean value of maximum relative humidity was 74.91% in 1981, 71.91% in 1982 and 72,25% in 1983. Mean minimum relative humidity was 60.33% in 1981, 53.66% in 1982 and 52.08% in 1983. Meteorological data is more or less same in the year 1984. For the years 1985 and 1986 no proper meteorological data is available for the study.

Between 1987 and 1990 period there was no major variation in mean maximum and minimum temperature. Same pattern is also observed in relative humidity. Average value of maximum relative humidity was about 70% while average value of relative humidity ranged between 61.27 and 69.9%. Highest temperature recorded between 1980 and 1990 was 40.81°C which was monitored in 1989. The year 1981 experiences lowest value of highest temperature (33.58 °C).

Table 2.31
Climatic Distribution of Dhanbad

Year	1	2	3	4	5
1970	31.58	18.9	1520.1	66.58	54.66
1971	29.92	17.72	1929.4	72.16	60.41
1972	32.19	18.16	1027.3	66.08	51.41
1973	31.45	18.21	2018	71.91	59.58
1974	32.13	16.83	1339.3	69	54.66
1975	31.85	17.62	1706.2	74.58	55.33
1976	32.67	17.75	866.9	71.16	55.66
1977	31.91	17.7	1748.5	77.16	56.91
1978	31.04	19.48	2060	74.33	60.25
1979	32.61	21.72	1157.7	66.83	55.83
1980	32.56	20.68	783.8	64.33	51.66
1981	31.05	18.8	1548.8	74.91	60.33
1982	32.35	19.03	883.2	71.91	53.66
1983	31.54	18.21	1665.1	72.25	52.08
1984	29.19	17.9	1966.1	73.4	56.3
1985	NA	14.37	1408.7	71.08	57.33
1986	31.2	15.3	NA	71.16	57.58
1987	32	16.98	1724	71.16	57.58
1988	31.42	16.53	1369.4	70.63	61.27
1989	32.53	15.71	1822	69.4	62.25
1990	29.35	15.47	1650	78	69.91

N.B. : NA – Not Available
1- Annual Mean Maximum Temperature in ^{0} C
2- Annual Mean Minimum Temperature in ^{0} C
3- Annual Rainfall in mm
4- Annual Mean Humidity at 8.30 hrs in %
5- Annual Mean Humidity at 17.30 hrs in %

Soil Characteristics

Physical Characteristics of Soil

Methodology

Before collecting soil samples from sites were selected for the study. Clean iron material was used to dig the site the site appropriate depth and soil of that site was well mixed. Soil collected at certain depth has been mixed and it is divided into four parts. One part of that soil collected in airtight polythene bags Weight of the soil samples should be not more than 500 grams. Triangular shape is useful to collect such type of soil samples. Separate mark has to be given to identify the correct soil samples.

High quality of sieves used for separation of sand , silt and clay material in the soil. Sieve have micro pores for separating the different materials. After each process weight of particular material (sand, silt and clay) was measured. After measurement of particular material percentage value was calculated. It can be calculated by:

$$\frac{\text{Weight of sieved material}}{\text{Total amount of soil sample taken for study}} \times 100 = \%\ \text{value particular material}$$

Result and Discussion

Soils of the area were analysed both physically and chemically. Soil examination was done in laboratory. Three samples have been collected at one place from different depths 0-15 cm, 15-30 cm and 30-60 cm. First site is Plantation area, which is situated on the other side of the river. Soil analysis of 0-15 cm depth show 57.2% sand, 33.18% silt and 9.6% clay material. The texture of this soil is sandy loam. Soil sample of 15-30 cm depth has 63.4% sand, 26.47% silt and 10.12 % clay material. Texture of this soil is also sandy loam. Soil sample contains 30-60% silt and 8.32 clay material.

Three samples in the range of 0-15 cm, 15-30 cm and 30-60 cm were collected and analysed. The uppermost soil cover (0-15 cm) consists 56.6% sand, 33.06% silt and 9.61% clay. This soil texture is classified as sandy loam. Second segment

(15-30cm) consists 57.3% sand, 25.03% silt and 17.75% clay. The texture of soil sample is silt loam. Soil below 30 cm a loamy sand because it consists 71.06 % sand 17.17 % siltand11.11 % clay material. Detail analysis of physical characteristics of soil samples has been given in table 2.41.

Soil at the bank of the Damoder river is also analysed in three ranges. Texture of the soil samples ranging between 0 and 15cm is sand. It consists 88.6% sand, 10.52 silt and 0.9% clay material. Percentage of sand increases with the depth. Sand percentage is 91.3% in 15-30 cm range while this is 93% in 30-60cm range. Percentage value of silt and clay material decreases with the increase of depth. It is 8.68% found between 15 and 30 cm while this is 6.35% in 30-60 cm range. Texture of other two samples are also sand in nature.

There are six colliery units present in the area. Out of six, two have underground mining process while other four units have open cast mines. Overburden is the result of opencast process. Soils samples of Jeenagora overburden was also analysed during study. On the basis of examination of different soil samples it can be said that texture of the soil sample are sand in nature. As the depth increases percentage value of sand also increases. Percentage value is 90.06% For the soil 0-15 cm range, 93.1% for the soil of 15-30 cm range and this is 94.1% for the soil collected between the depth of 30 cm and 60 cm. Percentage value of silt and clay material is decreasing with increase of depth. Silt is 9.45% in 0-15 cm range while it is 6.22% in soil sample of 15-30 cm depth. It is only 5.88 % silt found in soil sample collected at the depth between 30 cm and 60 cm. Clay material is 0.06% for the soil ranging 0-15 cm and this is 6.74% for the depth of 15-30 cm. No clay material found below 30 cm. Physical examination of the soil samples (North Tisra) of different depth ranges show that texture of these soil samples are also sand. Like other overburden with increasing depth. Percentage value of sand in uppermost soil sample (0-15 cm) is 89.97%. This is 93.09% in 15-30 cm depth while the value estimated for the depth of 30-60 cm is 94.1%. silt material decreases with the increase of depth. It is 9.49% in soil sample of 0-15% while this is 6.17% in 15-30% while this is 6.17%in 15-30cm. It is only 5.86% soil sample of the depth 30-60 cm. Clay material value is 0.06% in 0-15 cm and its value is 0.22 in15-30 cm depth. No clay material found in the soil sample of 30-60 cm depth.

Soil analysis of the various over burden is more or less same with other soil samples of the other overburden sites. Sand material increasing with depth. Silt material value goes down with the depth. No clay material found in 30-60 cm depth range.

Conclusion

On the basis of the analysis of twenty one soil samples it is clear that soil samples of the other side of the river is sandy loam. Plantation area has sandy loam. Upper portion (0-15cm) of agricultural land is also sandy loam while soil below that is silt loam. Soil found in the depth of 30-60 cm is loamy sand. Texture of the all soil samples collected from overburden area are sand because percentage value of sand is very high about (90 per cent). No clay material found in those soil samples.

Table 2.41

Physical Examination of Soil Samples of Lodna Area and its surroundings

Site	Depth in cm	Sand %	Silt %	Clay %	Texture
Plantation area (other side of river)	0 - 15	57.2	33.18	9.6	Sandy L
DO	15 - 30	63.4	26.47	10.12	Sandy L
DO	30 - 60	54.1	37.62	8.32	Sandy L
Agricultural land (other side of river)	0 - 15	56.6	33.06	9.61	Sandy L
DO	15 - 30	57.3	25.03	17.75	Silt L
DO	30 - 60	71.06	17.173	11.11	Loamy S
Bank of Damodar River	0 - 15	88.6	10.52	0.9	Sand
DO	15 - 30	91.3	8.68	0.01	Sand
DO	30 - 60	93	6.35	0.61	Sand
Over Burde Dump in Jeenagora area	0 - 15	90.06	9.45	0.06	Sand
DO	15 - 30	93.1	6.22	0.74	Sand
DO	30 - 60	94.1	5.88	0	Sand
Over Burden Dump in North Tisra area	0 - 15	89.97	9.49	0.06	Sand
DO	15 - 30	93.09	6.17	0.72	Sand
DO	30 - 60	94.1	5.86	0	Sand
Over Burden Dump in South Tisra area	0 - 15	90.04	9.46	0.05	Sand
DO	15 - 30	93.1	6.21	0.66	Sand
DO	30 - 60	94.09	5.89	0	Sand
Over Burden Dump in Joyrampur area	0 - 15	90.06	9.44	0.06	Sand
DO	15 - 30	93.09	6.22	0.75	Sand
DO	30 - 60	94.08	5.88	0	Sand
Sandy L	Sandy Loam				
Silt L	Silt Loam				
Loamy S	Loamy Sand				

Chemical Characteristics of Soil

Soil samples collected during field work were analylsed in the laboratory. To conduct chemical test first soil samples are diluted in demineralised water. If demineralised water (water has no mineral constituents) is not available tap water (pH 6.5-8.5) may be used to prepare the soil solution. The soil samples are poured into a small beaker to find out pH value of that solution, which indicates whether this soil is acidic, neutral or alkaline in nature. If pH value is found below 7 than it is said that particular soil sample is acidic and when its value is higher than 7 point scale it is said alkaline in nature.

Electrical conductivity (E c) is a parameter to study electrical current sensibility. If soil sample possess fewer amounts of impurities the electrical conductivity is more. The impurity present in soils produces resistance to electrical current. There is inverse relationship between impurity and electrical current in the solution.

Organic carbon

The most accurate procedure for the determination of organic matter in the soils is the dry combustion method for total carbon, in which the carbon dioxide is evolved on heating is trapped in the same absorbent, and a correction is made for any native (carbonate present). This is a reading method. Wet oxidation procedure using chromic acid will give result of a desired accuracy. As an approximate method, loss of weight of an over dry sample on egrution is a method after employed.

Nitrogen

Kjeldahl method is applied to determine the nitrogen content in the soil. In examination process 5 to 10 gm of soil sample has been mixed with 25 to 30 ml of sulphuric acid. Mercuric oxide and anhydrous sodium sulphate has been also added to estimate the nitrogen content in the soil.

Potassium

Near about 1 gm of soil has been taken and it is grinded together in a mortar with an equal weight of ammonium chloride. Further 4-5 gm of calcium carbonate (lime) has been added and mix thoroughly. After heating ammonia chloride evaporated. With the help of flame photometer content of potassium has been calculated.

Phosphrous

Soil sample first dissolved into water. Ammonium molybdate solution has been added in the solution. After that spectrophotometer has been utilised to estimate the phosphrous content in the soil.

Chemical Analysis of Soil samples of the area

Like physical characteristics all soil samples have been chemically analysed (see table 2.42). Soil sample (0-15 cm) of the plantation area is analysed first. Electrical conductivity of this soil sample is 0.05 micro mho/cm and pH value is 6.98. Organic carbon content in this soil sample is 1.49%. While available potassium content in this soil sample is 239.3 Kg/hectare and available nitrogen content is 0.014 per cent. As depth of the soil increases pH value decreases (6.62). Electrical conductivity is more in deeper soil sample (15-30 cm). Organic carbon is less than that of upper soil sample. It is 1.492 per cent in 0.15 cm soil sample while it is only 0.742% in 15-30 cm soil sample. Available phosphorus and potassium are 8.97 and 134.41 Kg/hectare respectively for the soil sample range of 15-30 cm. Available nitrogen is same. There is no change in pH value for the soil sample of 30-60 cm. Electrical conductivity is more.

This is due to low impurity in the soil. Here organic carbon is more (1.159 per cent). Available phosphorous, potassium and nitrogen have lower value than upper soil sample.

After plantation area agricultural soil samples have been analysed. Soil samples collected from three different depth ranges. First depth range is 0-15 cm, second is 15-30 cm and third is 30 -60 cm. The soil sample of the first range has 6.48 pH value. Electrical conductivity is 0.17 micro mho per cm. Organic carbon content in this soil sample is 1.33 per cent. It is lower than plantation area for the same depth. Available phosphorous and potassium content is 31.68 and 264.81 Kg per Hectare respectively. Available nitrogen is 0.018 per cent Soil sample in the range of 15-30 cm has higher pH value. Low electrical conductivity has been observed in this soil solution. Organic carbon content is also low (0.192 per cent). Other parameters viz., available phosphorous, potassium and nitrogen are also very low in comparison of upper soil samples. High pH value is found in that solution but electrical conductivity is low. There is an increase of organic carbon content in soil samples. Organic carbon content in this soil sample is 2.82 per cent. Lower availability of phosphorous has been reported in this soil sample. Available potassium is higher. It is 190.3 Kg per hectare. Available nitrogen in this soil sample is 0.0081 per cent.

Nature of the soil solution collected at the bank of the river Damodar is slightly acidic. Its pH value is 6.33. Electrical conductivity of the soil sample is 0.54 micro mho per cm. Organic carbon estimated in this soil sample is 2.06 per cent. Available phosphorous in the soil sample is 13.46 Kg per hectare. Available nitrogen n in this soil sample is fairly below. With the increase of the depth pH value increases. It is 6.53 for the depth of 15-30 cm. Electrical conductivity is low (0.18 micro mho per cm). Organic carbon is 1.13 per cent in the soil of 15 -30 cm depth. Available phosphorous and potassium are 15.64 and 78.4 Kg per hectare respectively. Available nitrogen is 0.011 per cent. Soil sample collected at the depth of 30 -60 cm has 6.59 value on pH scale. Higher electrical conductivity has been observed in that soil solution. Organic carbon content is fairly below (0.295 per cent). Available phosphorous and potassium are also low in comparison of upper surface of the earth. Available nitrogen is also low.

Overburden is being generated during opencast coal mining. Soil solution (Jeenagora) of the overburden (0-15 cm) has 6.63 pH value Its value increases with the depth. These are 6.64 and 7.12 for the depth of 15-30 cm and 30-60 cm depth respectively. Electrical conductivity is 0.12 micro mho per cm for the depth of 0-15 cm and it is 0.11 for the depth of 15 -30 cm. High value of electrical conductivity has been observed in the soil sample collected at the depth of 30-60 cm.

Chemical characteristics of overburden dumped in North Tisra colliery are more or less same with overburden of Jeenagora. Soil sample having pH value in the range of 6.62 to 7.1. Electrical conductivity decreases with the depth. Organic carbon content is 2.87per cent in upper soil sample. The lowest soil sample has 0.38 per cent carbon content. Pattern of available phosphorous, potassium and nitrogen content in the soil samples are more or less same with the chemical characteristics of Jeenagora area. Chemical characteristics of soil samples are given in table 2.42.

Table 2.42

Chemical Characteristics of Soil

Sampling Site	Depth (cm)	pH	EC in m mho/cm	Organic Carbon (%)	Available Phosphorous (kg/ha)	Available Potassium (kg/ha)	Available Nitrogen (%)
Plantation Area (other side of the river)	0-15	6.98	0.05	1.492	17.94	239.3	0.014
-Do-	15-30	6.62	0.06	0742	8.97	134.41	0.014
-Do-	30-60	6.62	0.12	1.459	8.08	89.6	0.0125
Agricultural land (other side of the river)	0-15	6.48	0.17	1.336	31.38	264.81	0.0182
-Do-	15-30	6.92	0.0099	0.192	8.98	112.1	0.0113
-Do-	30-60	7.08	0.09	2.824	6.72	190.3	0.0081
Bank of Damodar River	0-15	6.33	0.54	2.066	13.46	89.5	0.0126
-Do-	15-30	6.53	0.18	1.13	15.64	78.4	0.0112
-Do-	30-60	6.59	0.24	0.295	6.7	67.19	0.0084
Overburden Dump in Jeenagora Area	0-15	6.63	0.12	2.88	15.69	111.1	0.0112
-Do-	15-30	6.64	0.11	0.743	13.42	156.7	0.0154
-Do-	30-60	7.12	0.035	0.039	11.22	56.1	0.0126
Overburden Dump in North Tisra Area	0-15	6.62	0.12	2.87	15.68	112	0.0111
-Do-	15-30	6.63	0.11	0.741	13.43	156.8	0.0153
-Do-	30-60	7.1	0.036	0.038	11.21	56	0.0123
Overburden in South Tisra Area	0-15	6.61	0.12	2.86	15.66	112.08	0.0112
-Do-	15-30	6.62	0.11	0.742	13.45	155.95	0.0154
-Do-	30-60	7.09	0.04	0.036	11.19	55.9	0.0123
Overburden in Joyrampur Area	0-15	6.6	0.11	2.88	15.67	112	0.011
-Do-	15-30	6.63	0.11	0.738	13.42	156.7	0.0153
-Do-	30-60	7.13	0.038	0.039	11.20	56.11	0.0125

Population

Introduction

The staggering growth of population as evident in most of the socio-economically less developed countries of the world in the past has exerted a tremendous pressure upon their land and other resources. In recent years, the phenomenon may become so pervasive that the entire developmental processes get jeopardised. Generally, such a situation occurs when the resource mobilisation and developmental activities cannot keep pace with the rapidly increasing pressure of population in the area. In India, although the substantial progress has been made through planning in several sectors of the country's economy, the development of resources and infrastructural facilities has not been commensurate with the population growth rates and the risks of providing even the basic necessities- food, shelter and clothing- for future is becoming more and more difficult. Again, the population growth of India is becoming a problem of serious magnitude, as the country cannot productively employ the entire working age population.

Population of Dhanbad District

In 1981 total population of Dhanbad district was 21,15,010 which became 26,74,651 according to the census of 1991. Total rural population in 1981 was 10,44,310 which increased upto 13,03,699 in 1991. Total male population was 11,66,126 in 1981 which gone to 14,65,076 in 1991. Female population of this district was 9,48,884 in 1981 while this became 12,09,575 in 1991. There were 5,51,623 male population living in rural area. in 1981. Higher population found in urban area.

Dhanbad district is situated in Bihar state of Indian territory. Total area of this district is 26116.3 square kilometres comprising 452.32 square kilometres urban and rest 25,663.98 square kilometres is rural area. There are 4,83, 681 residential houses in Dhanbad district, according to 1991 census (table 2.51). Urban area has more residential houses than rural area besides having greater area. Urban area has 2,65,995 residential units while it is 2,17,686 in case of rural area. At present this district is divided into two parts. A seprate district Bokaro has been created in 1993 by Government of Bihar. Some parts of this district amalgamated in this district. Total male population was 7,71,879 in 1991 in the urban area while 6,93,197 male person residing in rural areas. Total female population in this district is 12,09,575 which consist 5,99,073 urban and 6,10,502 rural contribution. Total population (male) upto the age of 6 years is 2,53,232. Out of this 1,17,047 resides in urban area and rest living in rural area. Total population of male schedule cast was 2,27,718 in which 1,10,009 reside in urban centre while rest live in rural areas. Number of female schedule cast persons are 1,87,896.

Tribal population in this district is 2,25,282 in which1, 16,569 belong to male category and rest 1,08,713 render to female category. Total number of literates in Dhanbad was 12,07,380. Literacy rate is 45.14 per cent. Higher percentage of literates is male. Total number of workers in Dhanbad district is 7,00,083. Out of this 6,44,009 are male and rest 56,074 are female. Out of 34,163 workers 58.47 per cent are male. Male agricultural labourers having strength of 43,564 while female consists 12,555. Persons engaged in livestock, fishery etc. was 6349. Male has dominated this field. Persons associated with mining and quarrying are1, 74,281. Out of this 1,63,184 are male and rest 11,097 are female. There are 96,996 persons engaged in mining and quarrying are urban persons associated with mining and quarring living in rural area were 77285. Total population associated with manufacturing and industries is 11,507.

Population engaged in non household industries is 86,222. There are 66,651 persons engaged in non household activities residing in urban area. Total population engaged in construction work is 17,481. In Dhanbad district, 70,766 persons directly or indirectly associated with trade and commercial activities. Population employed in transport, communication and allied activities are 37,940. Marginal labourers and non marginal labourers were 39,037 and 19,35,531 respectively in this district.

Table 2.51

Population of Dhanbad District

Area	Urban		Rural		Total	
	M	F	M	F	M	F
Residential House	265995		217686		483681	
Household	272717		224102		496819	
Total population	1370952		1303699		2674651	
Total population	771879	599073	693197	610502	1465076	1209575
Upto 6 years	117047	110589	136185	134181	253232	244770
Schedule Caste	110009	85150	117709	102746	117718	187896
Schedule Tribe	26981	23595	89588	85118	116569	108713
Literate	510960	269411	330918	96091	841878	365502
Workers	333950	21970	310059	34104	640009	56074
Cultivators	8341	828	11636	13358	19977	14186
Agricultural Labourers	6320	1598	47244	10957	53564	12555
Livestock, Fishery	4576	72	1618	83	6194	155
Mining/Quarrying	91080	5916	72104	5181	163184	11097
Manufacturuing, Processing	4166	701	5244	1396	9410	2097
Non Household	65091	1560	18822	749	83913	2309
Construction	11560	649	4982	290	16542	939
Trade, Commerce	55007	1246	14181	332	69188	1578
Transport, Communication	27109	522	10194	115	37303	637
Other services	60700	8878	21034	1643	81734	10521
Marginal	1520	4705	4144	28668	5664	33373
Non Marginal	436409	572398	378994	547730	815403	1120128

Population of the Study Area

The study area is a part of Jharia Block. But for the census purpose it is considered as Census Town(CT) covering an area of 14.02 square kilometres. This area is surrounded by Jamadoba in west and Jharia (NA, Notified Area) in north of the study area. Jorapokhar, Bhagatdih, Bhowrah and Patherdih are its surrounding areas. All seven places cover an area of about 72.01 square kilometres.

Population of the study area is 55,677 in which 32,914 are male and 22,763 are female. There are 13,495 residential units in this area (table 2.52). Tisra has been considered as census town for census purpose. Children upto the age of 6 years having number of 9954. Population of the schedule cast people in the area is 18,774 in which 10,870 are male and 7904 are female. There are 1241 people belonging to schedule tribe living in the area according to 1991 census. Total number of literate in this area are 23,017 in which 17,031 are male and rest 5956 are female. Total number of workers are 15,838. Out of this 14,791 are male and 1047 are female. There are six cultivators in this area. Only 45 agricultural labourers live in the area. Persons engaged in fishing, hunting and allied activities are 81 in the area. Here 11,783 persons associated with mining and quarrying activities. Out of this 10,878 are male workers and rest 875 are female workers. Persons engaged in household activities having strength of 165. Non household industries employ 2389 persons in this area. There are 278 marginal workers and 39,561 non marginal workers live in the area. There are 18,047 male and 21,514 are female non marginal workers residing in the area.

Table 2.52

Population of the Study Area

Residential House	12796
Household	12796
Total Population	52605
Total Male Population	31107
Total Female population	21498
Population upto 6 years (M)	4664
Population upto 6 years (F)	4639
Male schedule cast	10147
Female schedule Cast	7369
Male Schedule Tribe	*685*
Female Schedule Tribe	513
Male Literate	16145
Female Literate	5641
Total Male worker	14031
Total Female worker	977
Male Cultivators	36
Female Cultivators	4
Male Agrilcultural Labourers	34
Female Agrilcultural Labourers	3
Male (Livestock)	76
female (Live stock)	3
Male Mining	10275
Female Mining	812
Male in Manufacturing, Processing etc.	131
Female in Manufacturing,Processing etc.	14
Male Non Household activities	367
Female Non Household activities	6
Male Construction	269
Female Construction	10
Male Trade, Commerce	1002
Female Trade, Commerce	21
Male Transport,Storage Communication	350
Female Transport,Storage Communication	7
Malê Other Services	1491
Female Other Services	97
Male Marginal	66
Female Marginal	702
Male Non Marginal	17010
Female Non Marginal	20319

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CHAPTER III

Nature and Methods of Coal mining

Introduction

Coal mining got its importance in the England after the industrial revolution. Coal mining in India was introduced in the middle of the 18th century. At that time little stress had been given on mining processes. First attempt had been made in this field in 1774 but coal was not excavated. In 1775 about 92.9 tonnes of coal was brought from Raniganj to Calcutta to operate the steamer services. Coal production got its impetus with the introduction of railways. First rail moved from Bombay to Thana in 1853. The Indian railways used Indian coal from 1855.

Although the production of coal commenced in early 1775 was very small in quantity. About 404 tonnes of coal was produced during period 1815 to 1823. But annual turn over reached to 50,500 tonnes in 1857. In the Kota area of the Singreni Coafield a small mine had also been working in 1857, but it was closed down soon afterwards.

With the expansion of the railways demand of coal tremendously increased. To meet the requirement of the coal other coalfields had been opened up. Production started between 1850 and 1900 in Raniganj area, Giridih in 1850 and Mohpani in Satpuras tract in 1862, Warora in Wardha valley in 1871, Umaria in 1882, Singreni in 1886 and Jharia in 1890. The most important Gondwana coalfields to be opened subsequently between 1900 and 1925 were Bokaro, Karapura, and Talchir in the country.

According to an estimate by Ministry of Coal, coal consumption in the country has been projected to increase from a level of 318 million tonnes in 1996-97 to 400 million tonnes in 2001-02 and further to 560 million tonnes in 2009-10.

However, as against a target growth rate of 6.3 per cent in coal demand during the Eighth five-year plan (1992-97), assuming an average annual compounded growth rate of 6.5 per cent in future. The overall demand for coal will reach a level of 445 million tonnes in 2001-02, 609 million tonnes in 2006-07 and 834 million tonnes in 2011-12. It would therefore, call for Herculean effort to meet the projected levels of coal production in future years. The percentage share of coal production has been declining over the years. During the early years following the nationalisation of coal mines, the share of underground process and opencast process (OCP) coal production was 75 per cent and 25 per cent respectively. Today however, the situation has just reversed. In Coal India Limited, while the production from opencast mines increased from 20.77 million tonnes in 1974-75 to 167.46 million tonnes in 1994-95 and it touched the figure 194 million tonnes in 1996-97. The total coal production in India in 1995-96 was 270.13 million tonnes. The underground coal mining employ 70 per cent of manpower, but their share in total output is less than 30 per cent.

In India coal has been prime source of energy (68%) followed by oil (one third which is imported). In the country substantial coal reserves (200 billion tonnes) have already been established in the coalfields and another 100 billion tonnes or so likely to be added with further exploration in the near future.

The method of working coal seams depends mainly on the seam as also on the nature of the over burden. During early days of excavation the methods were unscientific. Persons engaged in mining lacked proper skill. No proper safety for persons and property had been utilised in those days. Usually there were no adequate mine plans and no planning to tackle the problems.

During the latter part of the 19th century Geological Survey of India had given more thrust on safety and efficiency of the mines. Act no. VIII was passed in 1901 to ensure the proper mining methods. A separate department of mines came into existence.

The methods existed in those days were more or less similar to present day with the considerable modification. At that time " pillar and stall" system had been introduced for mining of coal. Nowadays longwall mining is widely used. The only difference is that the size of the pillars of the remote past ranged from 3.6 - 4.5 square metres with the galleries but nowadays the pillars vary from 24 - 30 square metres with the gallery of 4.5 metres width which is more suitable than that of mines. Here coal is excavated from the earth by two methods:

Underground Mining

More than half of proven coal reserves in India are available in Jharia, Raniganj, North and South Karnpura coalfields lying by and large, in state of Bihar, and adjacent areas. At the same time, almost entire steel grade coal and superior grade non-coking coal lie in the above region. Good quality coal is generally extractable only through underground coal mining methods. This coal finds applicability in production of steel, heat intensive industries and coke production. In last twenty-three years of nationalisation, major thrust has been for quantitative production of coal required for generation of the electricity. In absence of quality coal, consumers are looking towards coal imports to make up the needs. About 10 million tonnes of coal has been imported for steel sector in 1996-97. In due course, these figures are quite likely to rise. This can be checked by appropriate development of new underground coal mines indigenously for enhancing production of good quality coal. Opencast mining methods may not be suitable to mine coal from highly populous Jharia and Raniganj coalfields and other coalfields in the vicinity. Following types of underground mining are operated in our country and whole globe:

Fully Mechanised Longwall Mining

Fully mechanised Longwall faces have been tried and still being tried in India. A detail examination of the various longwall faces installed in different mines and their present status reveals that with one or two exceptions, the results so far have been rather disappointing. Fresh initiatives have, however, been undertaken to involve

Chinese expertise with the presumption that their roof and strata conditions alongwith other geomining factors are similar to Indian conditions.

Room and Pillar Methods

The most popular method used in India to produce coal by manual or semi - mechanised machinery is known as "Room"(or Board) and Pillar "mining". The Board and Pillar method is the basic method of mining, which is used throughout the world. In the U.S.A., which has the most competitive mining market in the world. The Board and Pillar method accounts for over 65 per cent of the underground production.

Manual or Basket Mining

The predominant means of extracting coal underground in India, uses the Room and Pillar method. The breaking of the coal and initial transport by hand is often referred to as "basket mining".

Semi-mechanised Mining

In this type of mining an electrically powered vehicle [Side Discharge Loader (SDL) or Load Haul Dump (LHD)] is used for carrying the coal from the mine. Though the production is similar to that of "basket mining" the manpower required is significantly less.

Continuous Miner Systems

In this system an electrically operated machine is designed to cut and load coal simultaneously. As may be gathered from its name, it is designed to cut coal continuously and is independently driven on tracks. The only limitation on its being able to cut and load continuously are the efficiency by which the cut coal can be transported away and the need for newly exposed roof to be systematically supported.

Opencast Mining

It is confined to the seams of 3 metres or more thickness. Previously this type of mining was economical. Over burden generated by this is considered to be 1: 1. But with the introduction of the modern techniques in this field this ratio becomes 1:3 which has been envisaged to be within economic limits.

Before 1989 surface mining was less prevalent in the Jharia Coalfield area. Surface mining can be mainly classified into working loose unconsolidated deposits, e.g., alluvial gravel, mineral sands and mining bedded deposits such as coal seam where mining operations travels laterally. The advantages of the opencast or surface mining are:

(a) Higher productivity

(b) Greater concentration of Operations

(c) Higher outputs

(d) Lower Capital and operating cost per tonne mined

(e) Greater geological certainty and easier exploration

(f) Better recovery of the mineral

(g) Greater safety

Strip mining of the coal uses the most spectacular machinery, although it does not make the deposits hole in the ground. This mining disfigures the area where it exists. Nowadays sophisticated techniques have been used. The first stage in opencast mining is to open up the ground to get at coal. The first slot is known as the box cut and is either side made in the shallowest part of pitching deposits to mine to the dip.

Coal mining in India by opencast (surface) mining in the last decade had made significant achievement both in terms of technological advancement as well as quantum jump in the coal production level. The post nationalisation period of the total coal mining operations in the country was simultaneous with the rapid demand for coal as a major fuel for industries and for energy generation.

Coal Production in study area

Coal production figure has been obtained from office of the General Manager, Lodna Area of Bharat Coking Coal Limited(BCCL) has been shown in table 3.11. Here coal is excavated by both underground and opencast (OCP). Coal production data is available for the period 1985-86 to 1995-96 (upto January). Whole study area

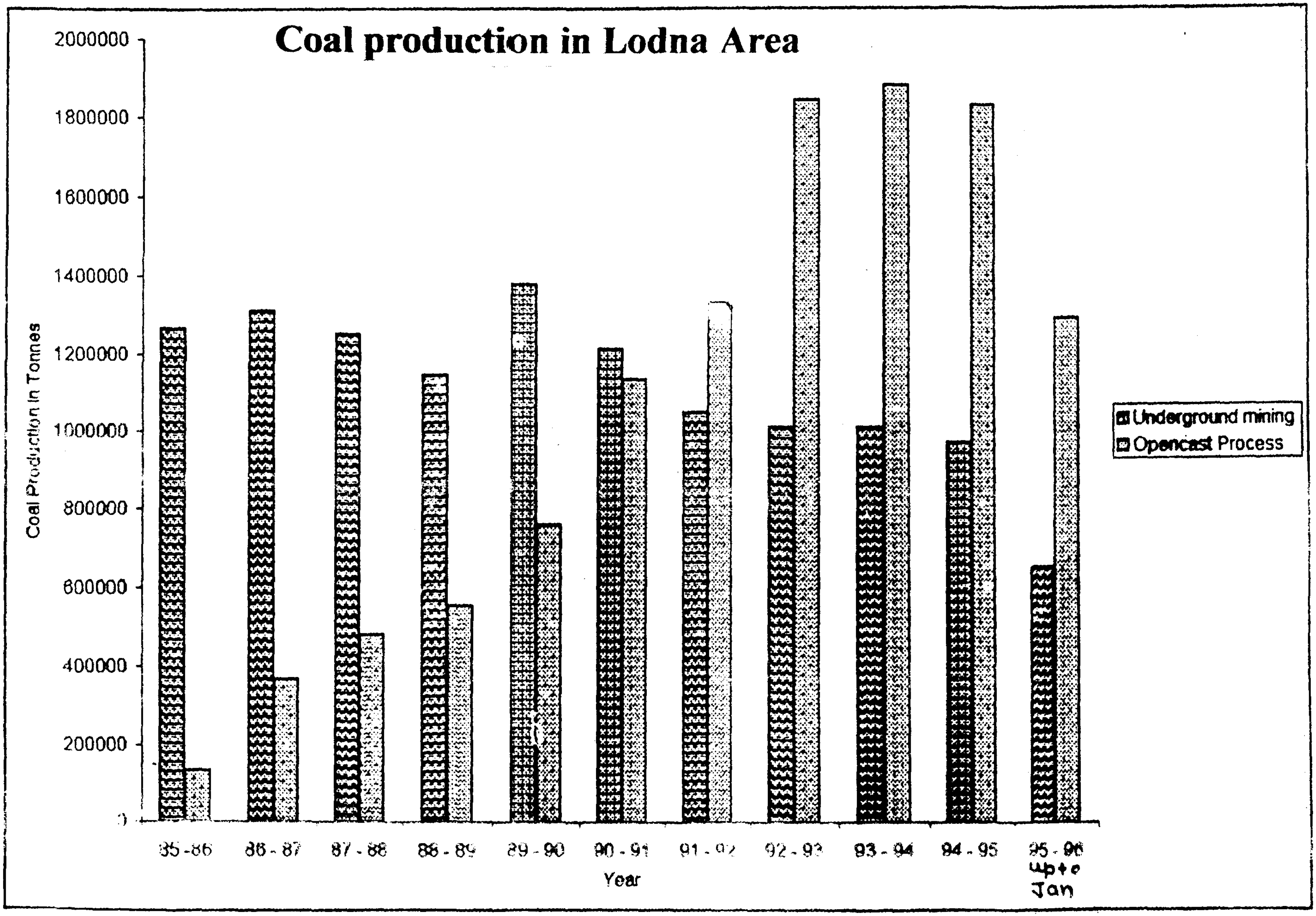
Coal production in Lodna Area
2000000
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
Coal Production in Tonnes
85-86
86-87
87-88
88-89
89-90
90-91
91-92
92-93
93-94
94-95
95-96 upto Jan
Year
Underground mining
Opencast Process

Fig. 3.11

is divided into six colliery units. Underground mining prevailed in the period (1985-86) and about 1266559 metric tonnes of coal was produced in Lodna area. Share of Lodna colliery in coal production is maximum in six collieries. About 33.05 per cent of total coal produced by Lodna colliery. Coal production by this colliery unit was 418600 metric tonnes. It was followed by Bagdigi colliery, 213722 metric tonnes. North Tisra colliery got third position in production in underground coal production. Fourth, fifth and sixth positions had been occupied by Jeenagora, South Tisra and Joyrampur colliery respectively.

In 1986-87 an increase in coal production have been observed in the study area. Total coal produced by underground mining in this year was 1310967 metric tonnes. This trend continued till 1987-88. Then a declining trend in coal production by coal mining had been observed. In 1989-90 coal production was more than previous year. It was 1144073 metric tonnes in 1988-89 which became 1375174 metric tonnes in 1989-90. From 1990-91 onwards declining trend in coal production by underground mining has been observed. In 1995-96 there was no production of coal by underground mining in South Tisra area. Declining coal production by underground process is mainly due to low output (Fig –3.11).

Coal production by opencast process

There was no production of coal by opencast process in Joyrampur colliery in 1985-86 (table 3.11). In 1985-86 South Tisra colliery was the only colliery producing coal by opencast process(OCP) In forthcoming year North Tisra were also among the

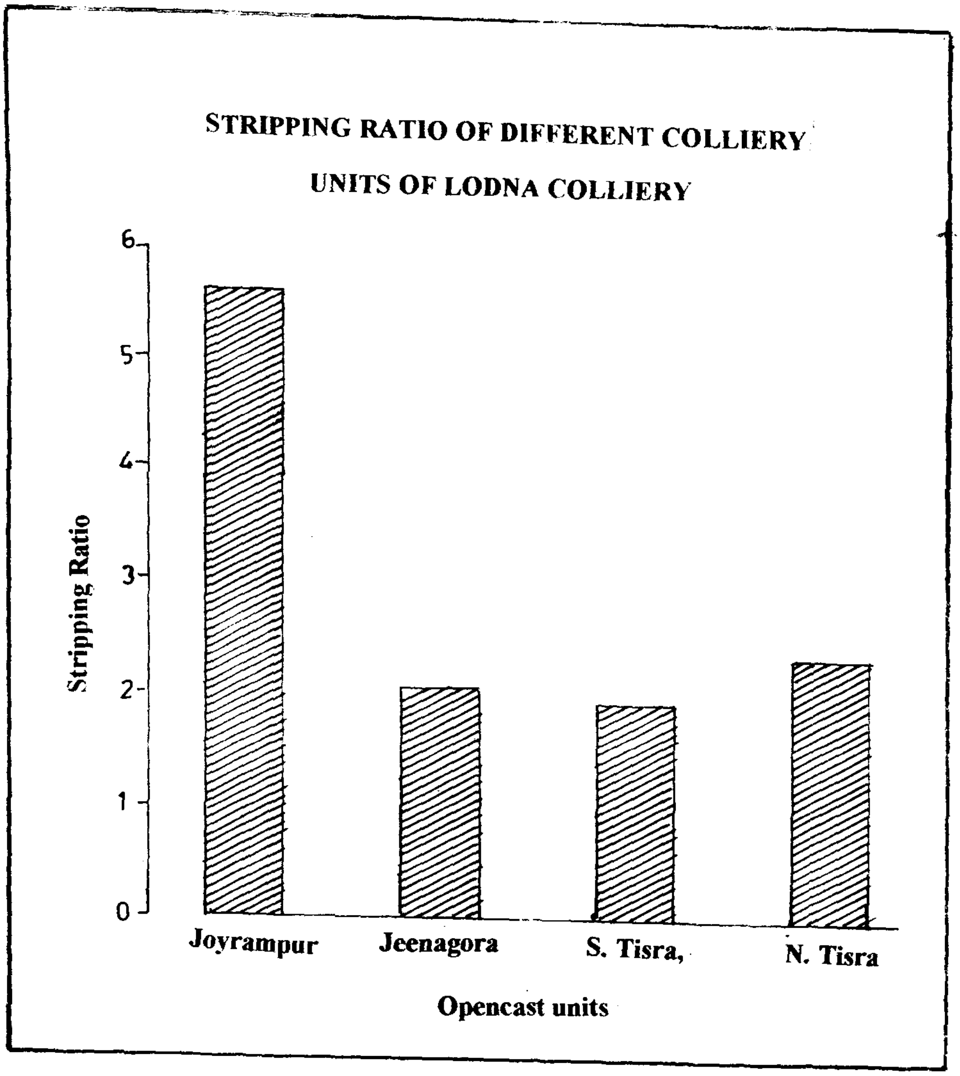
STRIPPING RATIO OF DIFFERENT COLLIERY
UNITS OF LODNA COLLIERY
6
5
4
3
2
1
0
Stripping Ratio
Joyrampur
Jeenagora
S. Tisra,
N. Tisra
Opencast units

Fig. 3.12

collieries producing coal by OCP. This trend continued till 1988-89. In 1989-90 Jeenagora also joined in this category. In 1985-86 there was 133775 metric tonnes of coal produced by OCP. This trend continued till 1993-94 after that declining trend has been observed. Highest increase of 69.69 per cent in coal production has been observed between 1991-92 and 1992-93. Second highest increase was 49.66 per cent between 1989-90 and 1990-91 period. There was total 11586145 metric tonnes of coal produced by OCP between 1985-86 and 1995-96 period. Since 1995-96 South Tisra colliery producing coal by only OCP. No opencast mining in other two collieries i.e., Lodna and Bagdigi. Here coal seams are found at considerable depth below the earth surface. Share of Underground mining was more until 1990-91 period. Thereafter share of underground mining was declined. It is mainly due to high production coal.

Opencast process (OCP) causing overburden generation. Stripping ratio is defined an amount of overburden generated by the production of one tonne of coal. Data regarding overburden is available for the period 1991-92 to 1994-95 (table 3.13). Out of six collieries only four of them producing coal by OCP (fig – 3.11) i.e., Joyrampur, Jeenagora, South Tisra and North Tisra. Highest stripping ratio estimated in Joyrampur (4.87) and lowest in South Tisra(1.92) colliery in 1991-92 period. Stripping ratio in Joyrampur colliery was 5.94 in 1992-93 which increased to 5.98 in 1993-94 (fig. 3.12). It was 5.67 in 1994-95. Stripping ratio was 2.34 in 1992-93 which went down 1.94 in 1993-94 and 1.73 in 1994-95. Low stripping ratio is estimated in South Tisra colliery area. It was 1.92 in 1991-92 which went down to 1.8 in 1992-93. It further increased to 1.89 in 1993-94 and 2.22 mark in 1994-95. Average value of

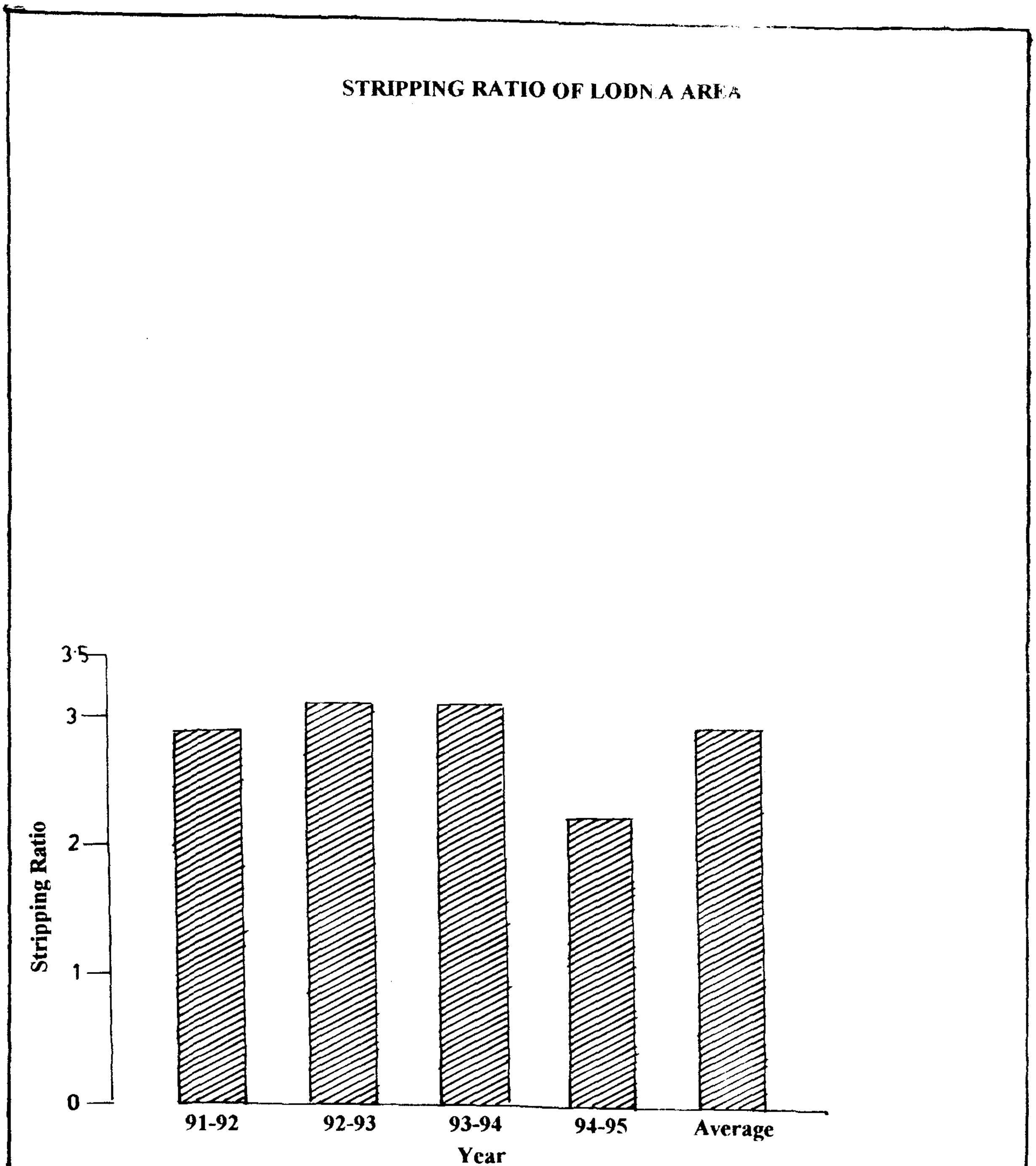
STRIPPING RATIO OF LODNA AREA
Stripping Ratio
3.5
3
2
1
0
91-92
92-93
93-94
94-95
Average
Year

Fig. 3.13

stripping ratio for Joyrampur colliery is 5.61 for the period 1991-92 to 1994-95. It is 2.07 for Jeenagora, 1.95 for South Tisra and 2.38 for North Tisra area. Average value of stripping ratio for 1991-92 period is 2.91 and 3.14 for 1992-93 and 1993-94 period. Stripping ratio of the study area is 2.75 for 1994-95. It can be said on the basis of the information available is that about three tonnes of overburden is generated by the production of one tonne coal in four period between 1991-92 to 1994-95 (fig- 3.13).

Over Burden Removal (OBR) in Lodna Area has been given in table – 3.12. As per statistics available from the office of the General Manager's office of Lodna Area An amount of 476291 tonnes over burden removed in Joyrampur Colliery of Lodna Area in 1991 - 92. This was 957200 tonnes in 1992 - 93. Over burden removal (OBR) in 1993 - 94, 1994 - 95, and 1995 - 96 (upto December) were 1065510 ,1014240 and 663830 tonnes respectively from Joyrampur colliery of Lodna area .

In five years period 1991-92 to 1995-96) more than twenty two million tonnes of overburden was removed due to surface mining in the area. Largest proportion (6.52 million tonnes) of overburden in 1992-93 period followed by the year 1993-94. The lowest amount of overburden removed in 1991-92 period.

Coal Production by Underground Mining

In Lodna area of Jharia coalfield large proportion of coal produced by underground mining (table – 3.11). In 1985-86 only 133775 metric tonnes of coal produced by open cast process. In the same year South Tisra colliery is the only colliery which produced coal by the opencast process. In South Tisra 168589 tonnes of coal produced by the underground mining. Lodna colliery was the major producer of coal by underground mining in the year 1985 - 86. Coal produced by underground mining was 418600 tonnes. This is followed by Bagdigi Colliery which produced 213722 tonnes by underground mining. Joyrampur, Jeenagora and North Tisra colliery produced 122609 , 170547 and 172492 metric tonnes respectively by underground mining. This is due to coal seam found very below in the earth crust.

In 1986-87 total coal produced from Lodna area was 1678605 tonnes. Total 1310967 tonnes of coal produced by Lodna area in the year 1986 -87 by underground mining. Lodna colliery with a production of 429686 tonnes leads at topmost position in this year also. Bagdigi area occupied second position. Third, fourth, fifth and sixth position occupied by North Tisra, Jeenagora, South Tisra and Joyrampur colliery respectively.

In 1987 -88 underground mine production was 1248927. In the year 1988 - 89 Lodna colliery was the largest producer of coal in Lodna area. Coal production from Bagdigi colliery declined. About 216,00 tonnes of coal produced in 1988 -89. Joyrampur, Jeenagora, South Tisra and North Tisra colliery produced more than that of previous year.

Total amount of coal produced by underground mining was 1375174 tonnes in 1988 - 89. South Tisra colliery produced 371482 tonnes by this process. So, it is evident that South Tisra and North Tisra colliery producing coal both by underground and open cast mining.

In 1989 -90 slight increase in coal production was observed in Lodna Colliery of the study area. Highest increase in coal production was observed in Joyrampur colliery. This year production was 157357 tonnes while this was 140840 tonnes in previous year. Slight increase in coal production also reported in Bagdigi Colliery. Total coal produced by underground mining was 1375174 tonnes in 1988 - 89. This year Jeenagora started production of coal by Open cast process. Coal produced by Jeenagora colliery was 64500 tonnes. South Tisra was the largest producer of coal by open cast process in study area followed by North Tisra Colliery.

In the year 1990 -91 coal production by underground mining had declined. This is due high production cost. All collieries except Bagdigi colliery produced coal lower than that previous year. This year opencast mining came into operation. North Tisra colliery was the largest producer of coal in study area , was 510459 tonnes followed by South Tisra colliery. In this year total 2343340 tonnes of coal produced in Lodna area of Jharia Coalfield.

Declining trends of coal production was reported in the year 1991 - 92. Production from Lodna colliery came down at the mark of 315786 tonnes while this was 383882 tonnes in 1990 - 91. In all collieries of the study area showing declined trend where underground mining is in progress. Share of opencast mining increased in respect of previous year. In this year highest production was achieved by North Tisra Colliery followed by South Tisra colliery . Joyrampur and Jeenagora colliery also contributes important share in OCP. Total 2372749 tonnes of coal produced in Lodna area in 1991-92

Only Bagdigi colliery showing increasing trend of production of coal by underground mining. Underground mining in other collieries showing lower production of coal 1992 -93. Coal excavated by underground mining was 1009876 tonnes. As it is earlier stated that lower production of coal by underground mining is mainly due to increasing cost of production by this method. As we go deeper depth from the earth surface production cost may further increase. Sophisticated equipments will be needed to excavate the coal by this method which require more investment. Besides this huge amount of electricity consumed by these equipments. In 1992 - 93 South Tisra colliery occupied topmost position in production of coal by open cast process which is followed by North Tisra colliery (642295 tonnes). Jeenagora and Joyrampur occupied third and fourth position in coal production by open cast process.

In 1993 -94 production from Lodna colliery was higher than previous year (344733 tonnes). Joyrampur colliery of the study area also produced large amount of coal in respect of 1992 -93. All other collieries of the study area showing lower production of coal by underground mining. Sharp declining was observed in South Tisra colliery. Total coal production by underground mining is just short of 831 tonnes than previous year.

South Tisra colliery got topmost position in this year with production of 834778 tonnes of coal by open cast process. Second place occupied by North Tisra colliery occupied second position. 178150, 229065 tonnes of coal produced by Joyrampur and Jeenagora colliery respectively. 100904.5 tonnes of coal produced by the underground mining and 1878113 tonnes coal produced by open cast mining.

Amount of coal produced by different pits of Lodna colliery showing positive trend. In 1994 –95, 363171 tonnes of coal produced by Lodna colliery. All other collieries where underground mining is active show negative trend in coal production. Sharp decrease observed in South Tisra. In 1993 94, 77408 tonnes of coal was produced in that year. But in 1994 – 95, 9964 tonnes of coal produced by underground mining. Total coal production in 1994 - 95 was 970929 tonnes. Significant increase in production of coal by open cast process observed in 1994 -95. Total 1828291 tonnes of coal produced by this process. Opencast mining is much more economical than underground one.

Methane is thermogenic and its generation begins at a high rank of high volatile bituminous. Major amounts of methane are generated from coal during coalification (process of coal formation). It varies from about 100 to 300 cubic cm per gm depending on the elemental values used and the assumption made about the products.

Methane is a highly explosive gas and its presence in coalbeds is considered a very serious hazard in coal mining. Flameproof electric equipment is used in underground mines. In other words, the methane gas is simply wasted during coal mining operations for the sake of the safety.

The Central Mining Research Institute Dhanbad, a Premier coal mining research institute of India has carried out detail investigation about methane gases which is emitted by the process of coal mining. Bore holes made during the mining process, emission of methane has been measured by Banerjee et al (1974). Some results of this work have been enumerated below. -

Amlabad mine in Jharia Coalfield is 400 m deep in 1971, an investigation in XIV seam shared that:

(a) Methane Quantity in return was 12.7 to 17.3 cubic metre / minute
(b) Gas emission from borehole was 1.8 to 2.5 cubic metre of gas per 100 sq. metre of the surface.
(c) Average gas pressure in boreholes was 52080.69 Kg /square metre and
(d) Gas composition was - Carbon dioxide 1.74 %, Oxygen 0.06%, Nitrogen 3.80 % and Methane 94.4 %.

After the nationalisation, Bharat Coking Coal Limited (BCCL) a subsidiary of Coal India Ltd. with the help of French experts carried out the study of XIII, XIV and XV seams. The gas emitted during boreholes in XIII seam was 0.68 to 1.45 cubic metre per minute and the gas mixture contained, 95 Under coal mines act(Sub regulation (5) of regulation 116 of coal mines regulation, 1957 it is mandatory to carry out gas emission measurement in mines.

American scientists got success in the field of Coal Bed Methane during last decade attracted the attention of coal producing countries including India. In India, 1991, Central Mine Planning & Design Institute (CMPDI), Ranchi made a tremendous effort in this field. This institute carried out detail study of coal from Parbatpur Block in Jharia Coalfield , Bihar . Here coal is excavted from deep mines. The methane content in coal samples is higher than 8 cubic metre per tonne. Its value increases with the depth at the rate of 1.3 cubic metre per tonne per 100 metre depth. The highest recorded value of methane content was 14.93 cubic metre per tonne at a depth of 800 metres. On the bank of Damodar river at a place 5-6 Km south of Bernpur gas is oozing out for about 3-4 years and caught fire.

Our knowledge about the permeability of Indian Coal is very poor. According to Central Mine Planning and Design Institute Limited (CMPDIL) and Central Mining Research Institute (CMRI) its level is around 10 to 120 millidorcies (a unit to measure the gas content). But these tests are not conducted as per Coal Bed Methane (CBM) industry standards. Emission of gas into mine working factors which influence the Gas emission are:

(1) Gas content of the coal

(2) Permeability of the coal

(3) Presence of joint system

(4) Depth of working

(5) Presence of other coal seams in the vicinity of the seam worked

(6) Thickness of the seam worked

(7) Methods of mining

(8) Methods of ventilation

Control of Methane Emission in Mining

(1) Dilution by ventilation - The most common method of dealing methane gas hazard. The ventilation system must be flexible, allowing sufficient good quality of air to be coursed (movement) into any working place where methane has been encountered. This method is appreciable where emission of gas is very low.

(2) Sealing - Cementation of small fissures is possible. This is only a temporary solution and can be affected, however only when gas pressures are very low.

(3) Methane Drainage - Drainage of the gas is the only positive reliable methods of controlling high gas emissions in the mine. It is almost accepted that when the gas content of seam exceed 8 cubic metre per tonne the pre drainage of gas is essential for intensive and efficient mining techniques to be effective.

Methane is emitted both from underground and surface mining. Generally one tonne coal production releases one cubic metre of methane during mining process and 0.09 cubic metre per tonne after mining. More gas content is present in deeper seams.

It has been estimated that about 1.09 cubic metre gas is being emitted in production of one tonne coal.

Production of coal emits methane into the atmosphere. About 1.09 cubic metre methane released into the atmosphere by the production of one metric tonne of coal. If production of coal is more methane is generated. In ten years span (1985-86 to 1995-96) about 26 million cubic metre of methane gas (table 3.14) emitted in the surrounding atmosphere. More methane locked in deeper seams of the coal. As depth increases methane content in the coal seams also increases. So, volume of methane may be more in deeper seams. Here volume of methane calculated with the help of coal production. About 1.4 million tonnes of coal produced in 1985-86 results the release of 1.52 million cubic metre of methane gas in surrounding atmosphere. In 1986-87 1.82 million cubic metre methane released on the production of 1.67 million tonnes of coal. Volume of methane released into the atmosphere was 1.84 million cubic metre in 1988-89 which became 3.10 million cubic metre in 1992-93. About 3.14 million cubic metre released into the atmosphere in 1993-94. Only 3.05 million cubic metre methane released into the atmosphere in 1994-95. It is due to low production of coal in that area in same year.

Conclusion

On the basis of information and data it can be said that process of coal mining has been changed from underground to surface. Sophisticated equipments are used for this process. In mid eighties underground mining was more dominant but from 90s

Table 3.11

Coal Production in Lodna Area (1986-86 to 1995-96 (upto Jan))

(in Metric Tonnes)

UG mining	1985 -86	1986 - 87	1987 - 88	1988 - 89	1989 - 90	1990 - 91	1991 - 92	1992 - 93	1993 - 94	1994 - 95	1995 - 96 upto Jan
Lodna	418600	429686	415625	416118	416588	383882	315786	318810	344733	363171	240545
Bagdigi	213722	221000	233245	21600	217486	218100	198558	200003	177620	162140	94273
Joyrampur	122609	137249	139048	140840	157357	150502	131600	154100	186350	176800	139815
Jeenagora	170547	171158	161895	165106	173263	129770	120875	112898	120139	97957	37572
S. Tisra	168589	160020	107072	192528	192707	171600	153700	119420	77408	9964	0
N. Tisra	172492	191854	192042	207881	217773	156568	127833	104645	102795	160897	136813
Total	1266559	1310967	1248927	1144073	1375174	1210422	1048352	1009876	1009045	970929	649018
Open cast											
Joyrampur	0	0	0	0	0	30773	97700	161100	178150	178740	126630
Jeenagora	0	0	0	0	64500	124256	130357	179769	229065	272061	168303
S. Tisra	133775	332330	356676	371482	397316	467400	538560	860016	834778	606960	496345
N. Tisra	0	17540	120503	179120	295120	510459	557780	642295	636120	770530	499118
L.F.P.	0	17768	2750	0	0	0	0	0	0	0	0
Total	133775	367638	479929	550602	756936	1132888	1324397	1843180	1878113	1828291	1290396
Grand total	1400334	1678605	1728856	1694675	2132110	2343310	2372749	2853056	2887158	2799220	1939414

Source: Bharat Coking Coal Limited, Dhanbad

opencast mining took the place of underground mining. Underground mining requires huge investment but output is low in respect of opencast process. Low production cost of coal by opencast process is performing main role in this activity. Huge amount of overburden generated by surface mining. It also affects the fertility of soil. Overburden causing siltation on the bottom of the site. During Summer Suspended Particulate Matter (SPM) go high due to loose soil particles.

Table – 3.12

Overburden removal in Lodna Area (in metric tonnes)

	Joyrampur	Jeenagora	South Tisra	North Tisra	Total Area
1991-92	476276	613792	1036210	1443984	3570262
1992-93	2692400	771058	1458440	1607956	6529854
1993-94	975410	695365	1579380	1949210	5199365
1994-95	1014600	769628	1362620	1150870	4297718
1995-96	663830	414150	1071100	1042672	3191752
Total	5822516	3263993	6507750	7194692	22788951

Source: Bharat Coking Coal Limited, Dhanbad

Table 3.13

Stripping Ratio in Lodna Area (1991-95)

Area	1991-92	1992-93	1993-94	1994-95	Average
Joyrampur	4.87	5.94	5.98	5.67	5.61
Jeenagora	2.27	2.34	1.94	1.73	2.07
South Tisra	1.92	1.8	1.89	2.22	1.95
North Tisra	2.58	2.5	3.06	1.41	2.38
Average	2.91	3.14	3.14	2.75	3.00

Table 3.14

Coal Production and Methane Emission (1985-1996)

Year	Coal Production (tonnes)	Methane emitted (cubic metre)	Methane emitted by underground mining (cubic metres)
1985-86	1400334	1526364.1	1380549
1986-87	1678605	1829679.5	1428954
1987-88	1728856	1884453.0	1361330
1988-89	1694675	1847195.8	1247040
1989-90	2132110	2323999.9	1498940
1990-91	2343310	2554207.9	1319360
1991-92	2372749	2586296.4	1142704
1992-93	2853056	3109831.0	1100764.84
1993-94	2887158	3147002.2	1099859
1994-95	2799220	3051149.8	1058313
1995-96 (upto January)	1939414	2113961.3	707429.6
Total	23829487	25974141	13345243.4

Factor: 1.09 x production of coal

Source: Bharat Coking Coal Limited, Dhanbad

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CHAPTER IV

Landuse Pattern

Introduction

Landuse of an area is a reflection of physiographic conditions, socio-cultural characteristics and politico historical background. Landuse characteristics are the result of landuse practices which are directly influenced by these attributes of land. The available land resources and their utilisation which shows an interaction between man and nature. According to various classical as well as neo classical theories of landuse, the processes of land operations and landuse intensification in the macro regional frame are always accelerated by the physical factors of the land, namely the relief features, geological structure, soil chareacteristics and climatic conditions. Though at macro-areal scale the landuse practices are influenced by the socio-economic factors viz., traditional customs of the land holders, tenancy status etc. Landuse has been studied to know about the activities that are active in the particular area. It represents the activities that are active on a piece of land in a year. It is dependent on economic, socio-political and physical attributes of the area.

Landuse map was first printed by National Atlas Organisation on 1: 5,000,000 scale in 1957. The Diagnostic survey of the Damodar Valley region has been conducted in 1958 on 1: 5,000,000 scale. At that time landuse surveys were conducted *under guidance of Prof. S. P. Chatterjee and mapping is based on the scheme earlier* followed by him in Howrah Land Utilisation Survey. According to National Atlas Organisation Calcutta land utilisation has been done on the basis of dense and open forest, scrub, Arable land, Arable land with trees, Plantation, Pasture, Rockey waste and sandy waste, Alpine grass and glacial region.

This classification was too broad to give a precise account of different uses of land. Further the classification and their precise standard definitions were necessary for the convenience of collection, agricultural development and planning with this end in view the committee for common co-ordination and agricultural statistics was constituted in 1950. Another committee later on revised the classification and improved the definition of various classes. The detail classification is as follow:

(1) Forest

(2) Land not available for cultivation

- (a) Land put to non agricultural uses
- (b) Barren and uncultivable land

(3) Other uncultivated land excluding fallow land

- (a) Permanent land of the grazing grasses
- (b) Land under miscellaneous trees, crops and grooves

(4) Fallow land

(5) Cultivated land

- (a) Net area sown
- (b) Net sown more than once

LANDUSE PATTERN OF LODNA COLLIERY (1973)

Fig. 4.11

In India the first attempt to evaluate the pattern of landuse was conducted during the British period (1913 –140 and was mapped on a scale of 1: 16 mile. Since then recently a fresh land survey has been done in the area under study. The analysis of landuse resources is very much significant from the point of view a rural development planning.

Landuse pattern of Lodna Area

Lodna area is a part of Jharia Coalfield. Its mining activities has been monitored by Bharat Coking Coal Limited which is a subsidiary of Coal India Limited (CIL). CIL is a public undertaking under Ministry of Coal. This area comprises six colliery units viz., Lodna Colliery, North Tisra Colliery, South Tisra Colliery, Joyrampur Colliery and Jeenagora Colliery. Data and information utilised to study the landuse pattern between 1973 and 1993 (tables 4.11 and 4.12). The nationalisation of coal industry started in 1973 and ended in 1976.

Landuse pattern of Lodna Colliery (1973)

In 1973, only 44.87 hectare of land occupied by settlements which is about more than 10 per cent of the area. Only a small fraction of land (3.28 hectare) was used for mining at that time. Here mining refers to opencast or surface mining. Underground mining has been not taken into account. About 8.33 hectare of land was under water bodies. About 403.52 hectare or 86 per cent land was barren or fallow land (fig 4.11)

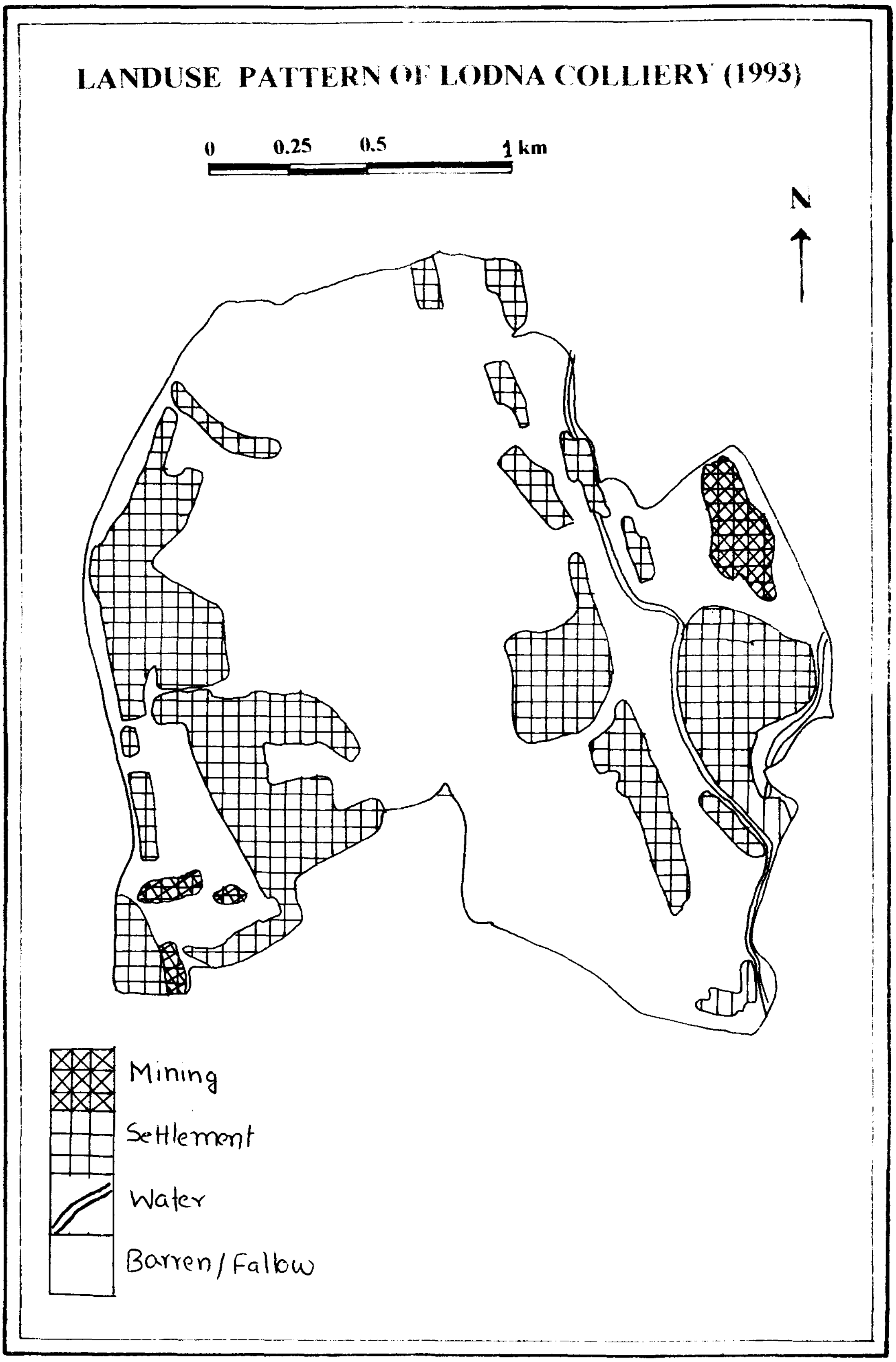
LANDUSE PATTERN OF LODNA COLLIERY (1993)
0
0.25
0.5
1 km
N
Mining
Settlement
Water
Barren/Fallow

Fig. 4.12

LANDUSE PATTERN OF BAGDIGI COLLIERY (1973)

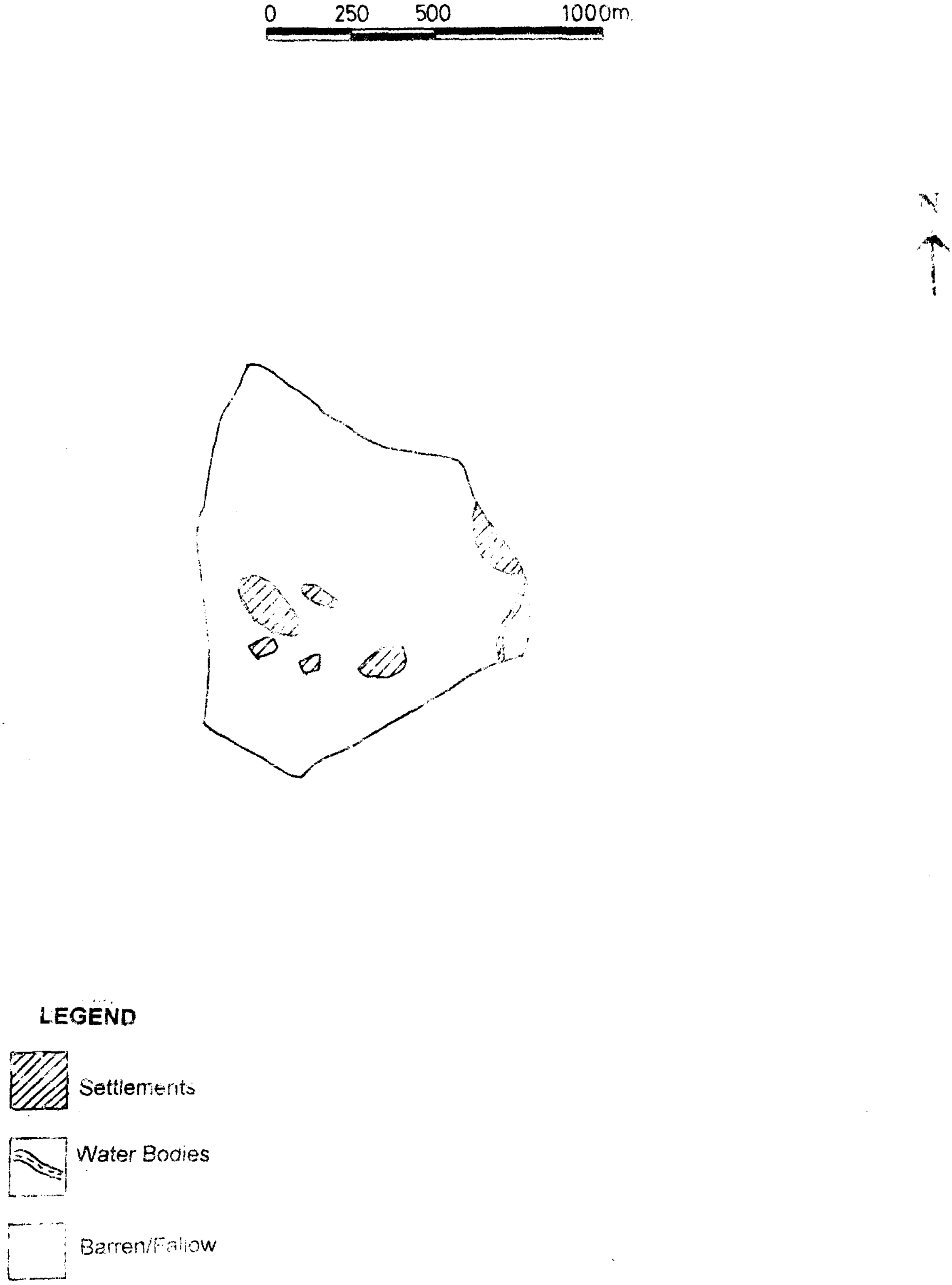

Fig. 4.13

LANDUSE PATTERN OF BAGDIGI COLLIERY (1993)

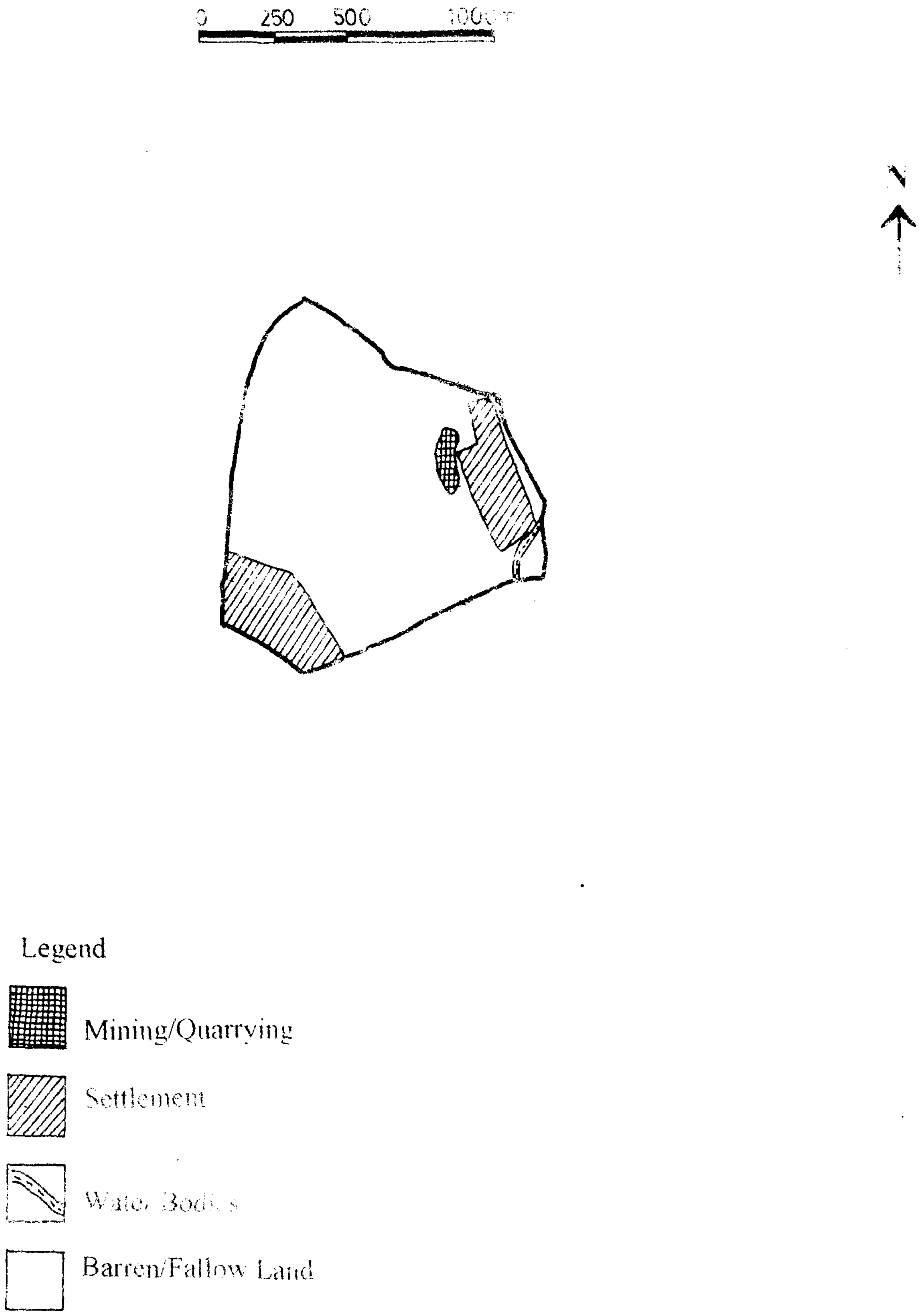

Fig. 4.14

Landuse pattern of Lodna Colliery (1993)

In 1993, major change has been noticed in settlements in the area. Land used for settlements in 1993 was about 75 hectare. About 9.19 hectare of land used for mining in that period which is about three times more than previous one. There is no change in area water bodies. Barren / fallow land which accounts 80 per cent of the colliery area. There is no agricultural activities found in the area due to unfavourable chemical composition of soil (fig. 4.12).

Landuse pattern of Bagdigi Colliery (1973)

In chapter three it has been mentioned that Bagdigi Colliery only produced the coal by underground mining. So, no mining spots were found in this colliery region in that period. About half per cent of land used for settlement purposes in 1973 (fig. 4.13). Only a small fraction of land was under water bodies. A large portion of land was barren/fallow land (65.77 hectare).

Landuse pattern of Bagdigi Colliery (1993)

Due to increase in population the area used for settlement has increased. In 1993 about 12.67 hectare land was used for settlement. About one hectare land was used for mining purpose. About 0.5 hectare land was under water bodies. There is an additional increase of 0.25 hectare of land by water bodies in 1993. Nearly 80 per cent of land of the colliery area was barren/fallow land in 1993 (fig. 4.14).

LANDUSE PATTERN OF JOYRAMPUR COLLIERY (1973)

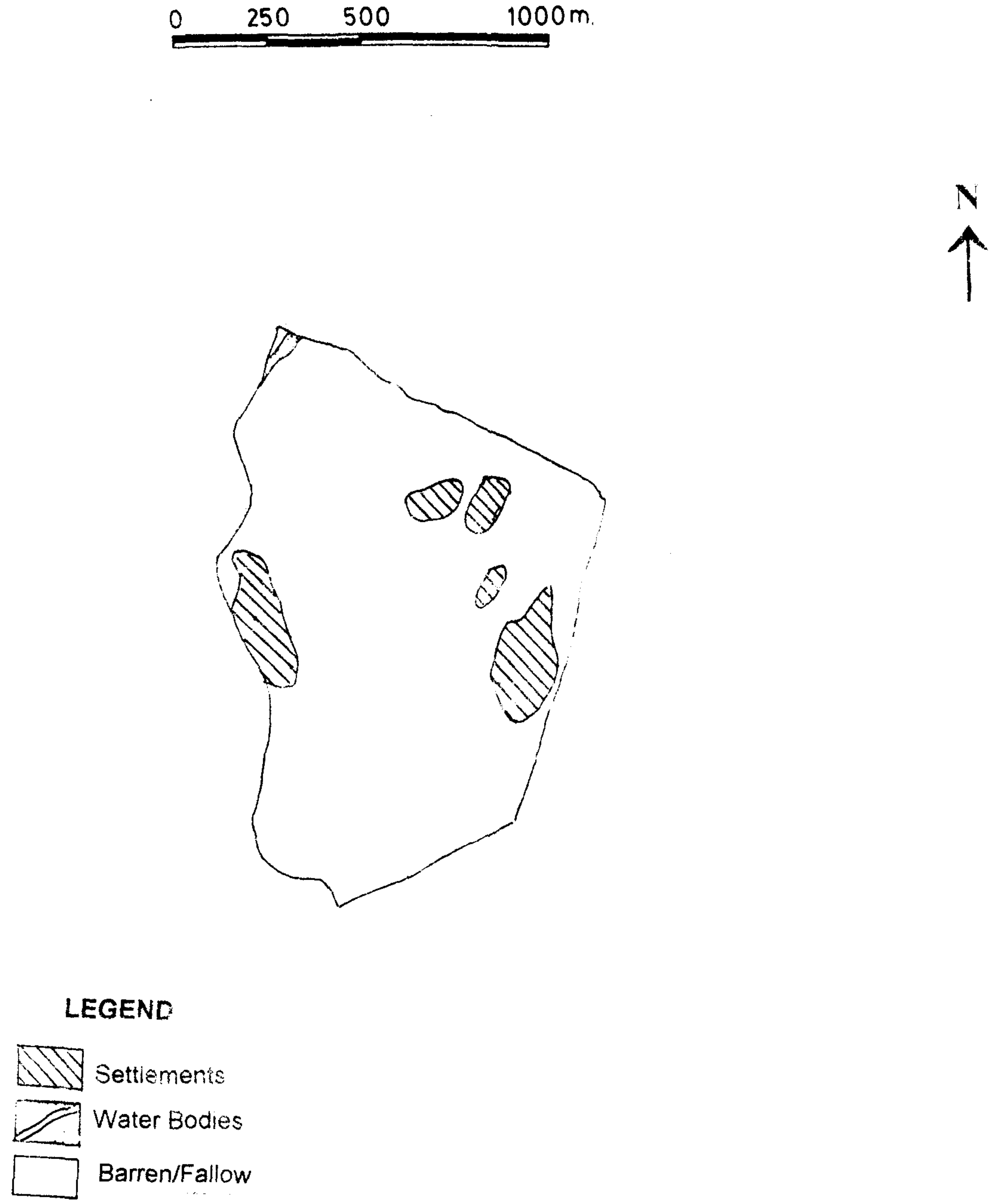

Fig 4.15

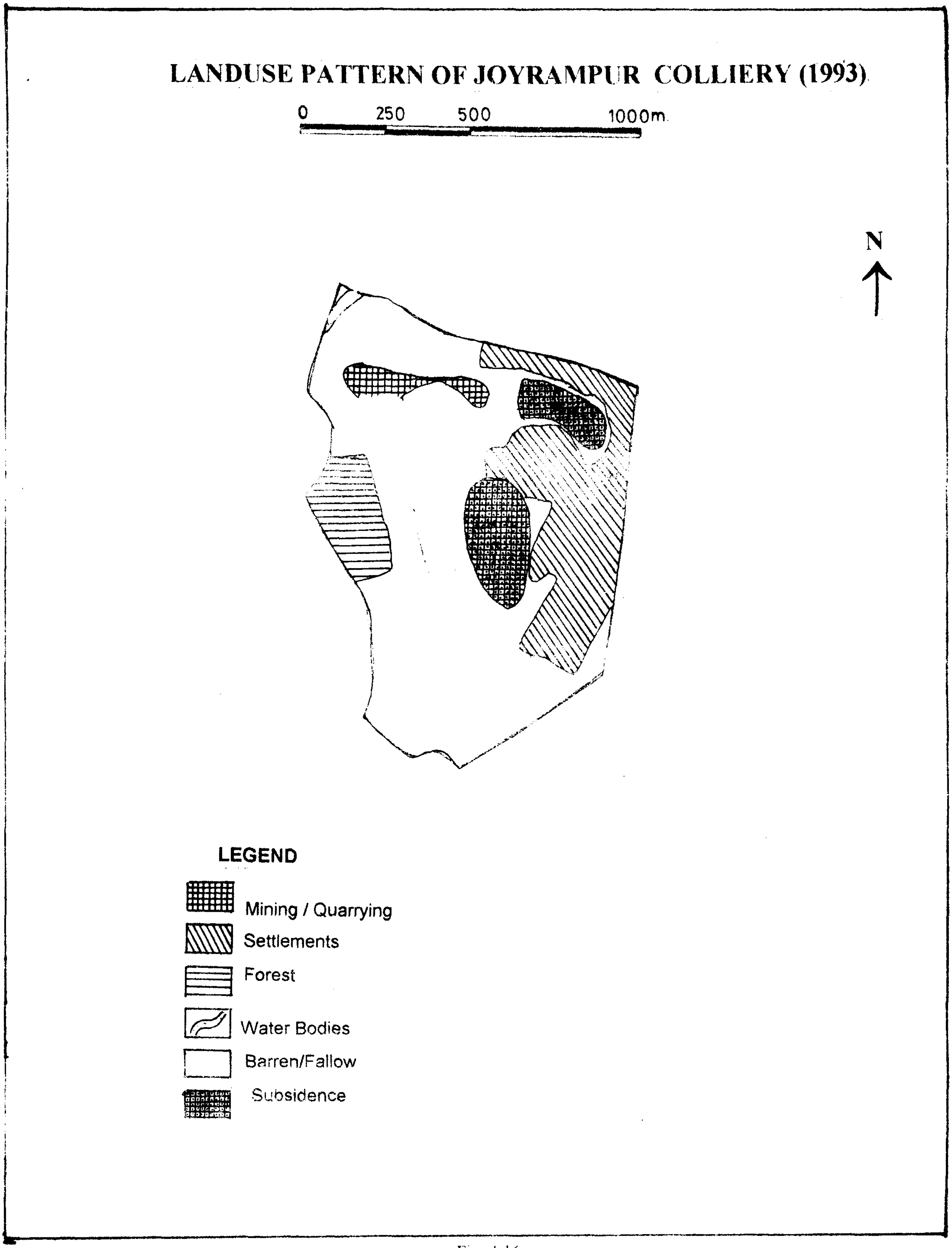
LANDUSE PATTERN OF JOYRAMPUR COLLIERY (1993)
0
250
500
1000m.
N
LEGEND
Mining / Quarrying
Settlements
Forest
Water Bodies
Barren/Fallow
Subsidence

Fig. 4.16

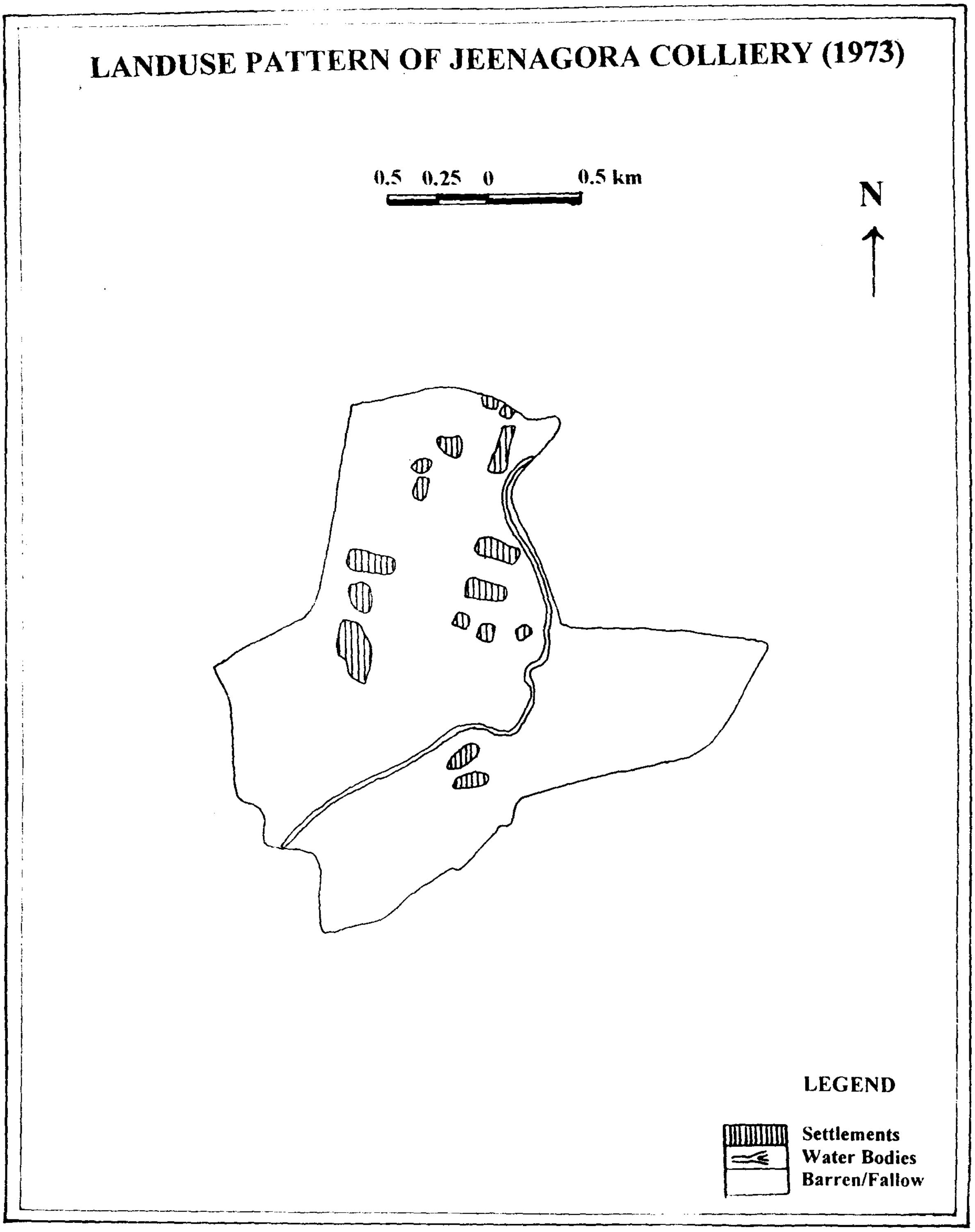
LANDUSE PATTERN OF JEENAGORA COLLIERY (1973)
0.5 0.25 0 0.5 km
N
LEGEND
Settlements
Water Bodies
Barren/Fallow

Fig. 4.17

Landuse pattern of Joyrampur Colliery (1973)

In 1973, there was no opencast mining in the area. A small portion of land was used for settlements. Minor jore (water stream) covering an area of 0,20 hectare. About 90 per cent land (90.66 hectare) in this colliery was barren land (fig. 4.15).

Landuse pattern of Joyrampur Colliery (1993)

There was an increase in settlement area between 1973 and 1993. It was 7.54 in 1973 that increased to 16.1 hectare in 1993. About 2.79 hectare of land used for coal mining. There is no change in area of water bodies. In 1993, subsidence (sinking of land) has been observed in this colliery area. The subsided land measures an area of about 12.68 hectare. Under reclamation of degraded land by coal mining afforestation has been done by Bharat Coking Coal Limited, controlling body of coal mining in the area is about 10.63 hectare. Rest area about 56 hectare is barren land (fig. 4.16).

Landuse pattern of Jeenagora Colliery (1973)

Total area of this colliery is 321 hectare. In 1973, 17.2 hectare land was used for settlements. No opencast mining existed at that time in this colliery. Water bodies covered an area of about 4.01 hectare in 1973. There was 299.79 hectare of land as barren or fallow (fig. 4.17).

Landuse pattern of Jeenagora Colliery (1993)

Due to increasing demand and low production cost of coal, opencast mining became prevalent in late 80s. This method of mining has affected the landuse pattern of

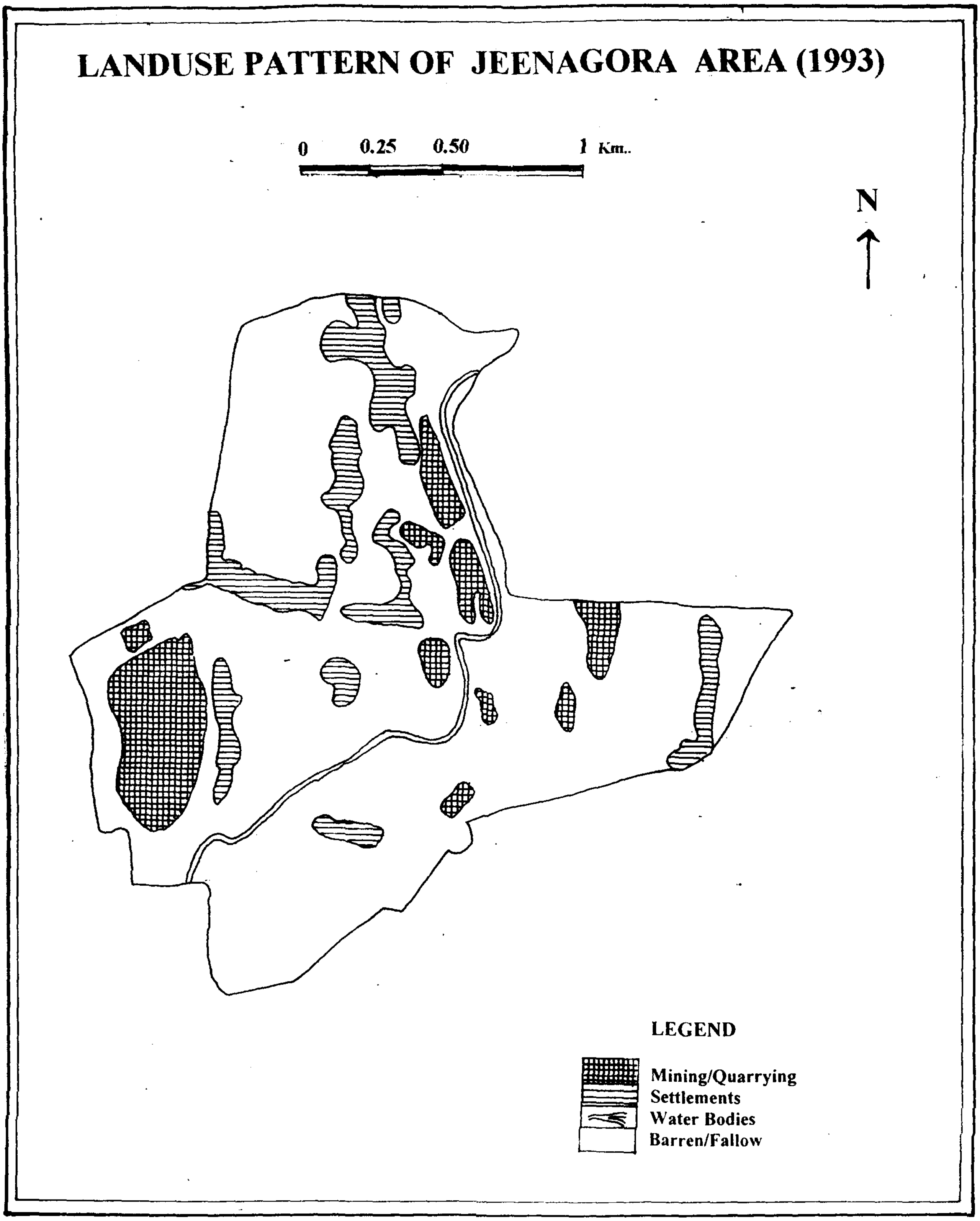
LANDUSE PATTERN OF JEENAGORA AREA (1993)
0 0.25 0.50 1 Km..
N
LEGEND
Mining/Quarrying
Settlements
Water Bodies
Barren/Fallow

Fig. 4.18

LANDUSE PATTERN OF SOUTH TISRA COLLIERY (1973)

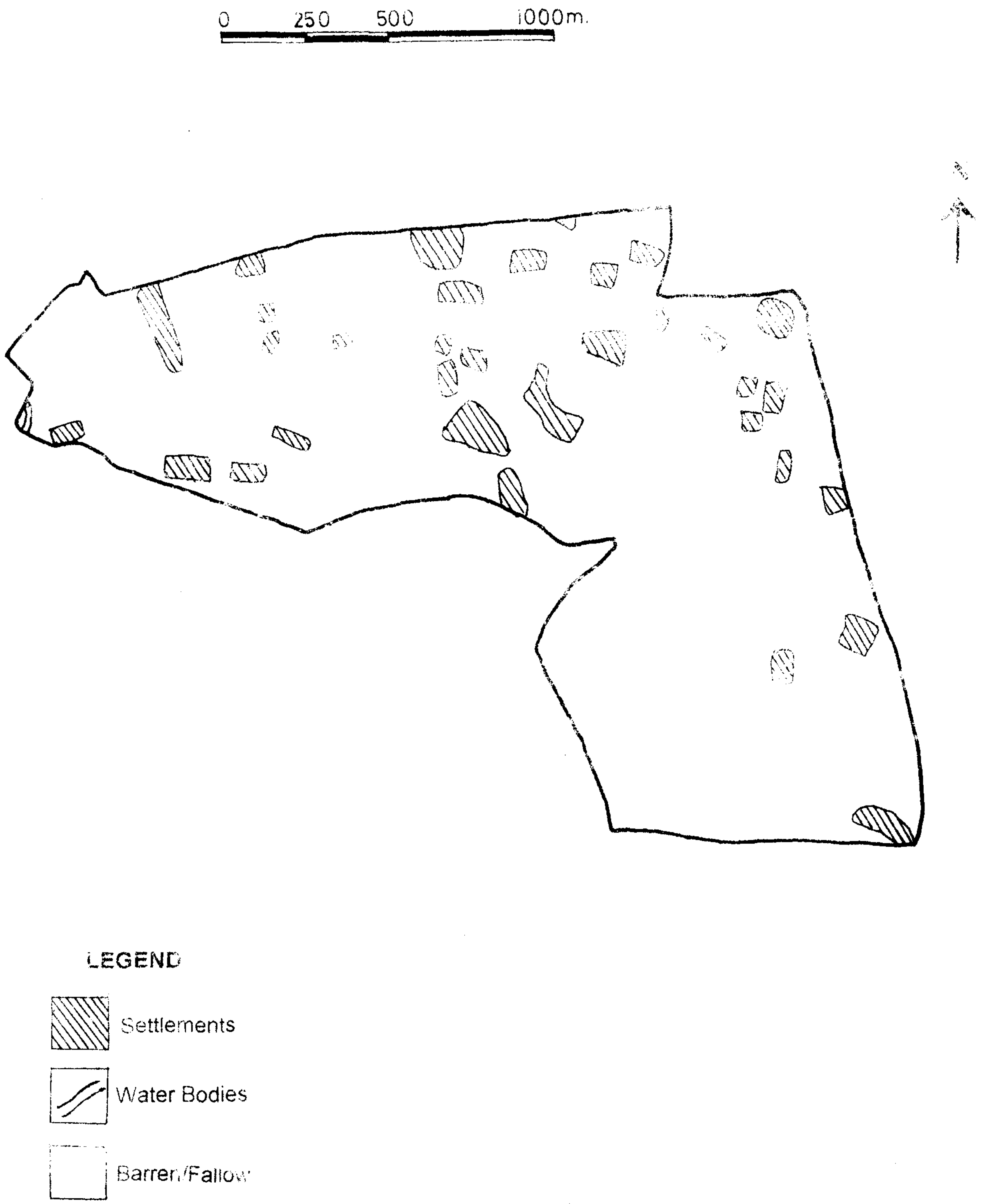

Fig. 4.19

LANDUSE PATTERN OF SOUTH TISRA COLLIERY (1993)

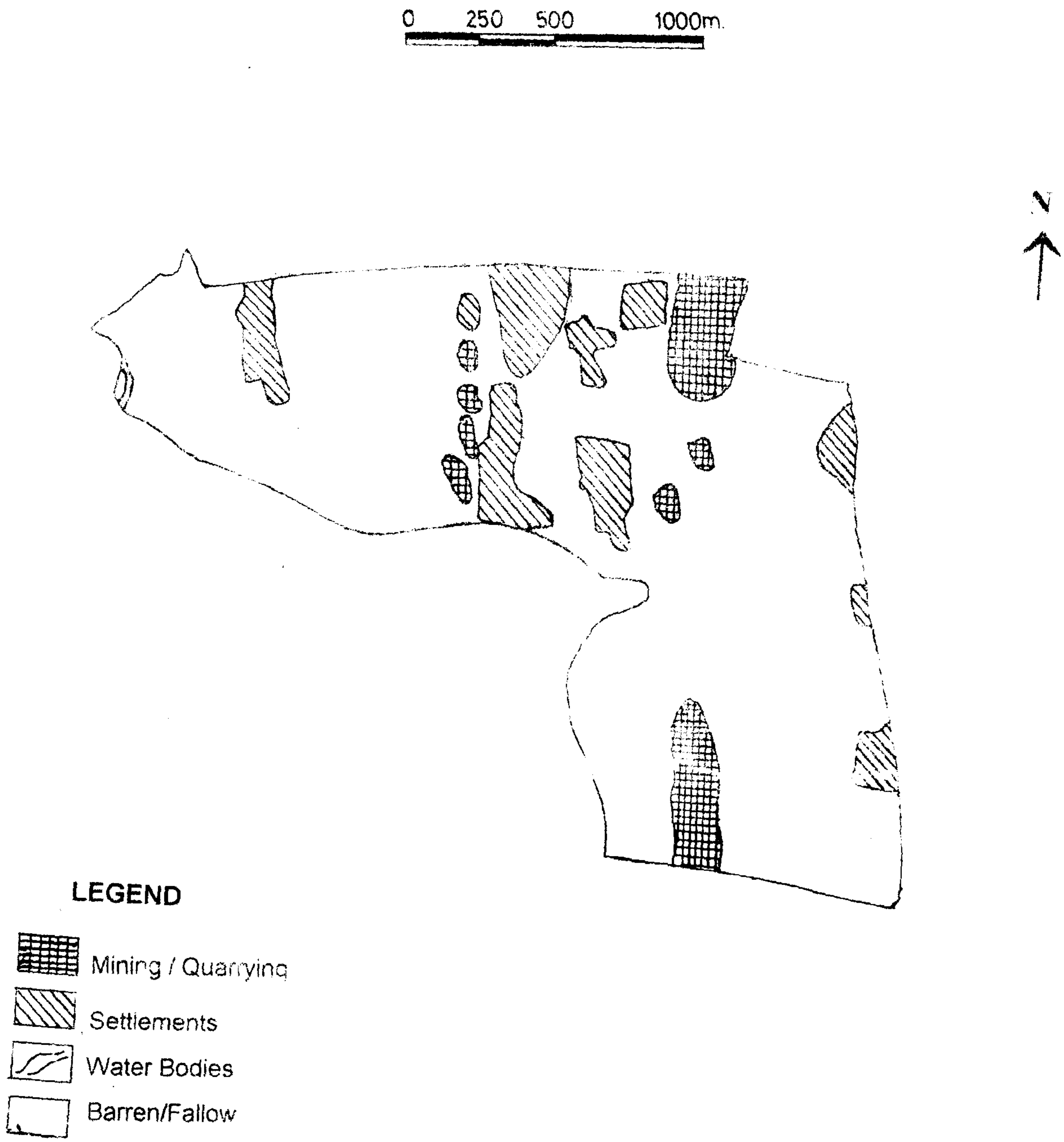

Fig. 4.191

the area upto a great extent. There was no surface or opencast mining in 1973 in the colliery area. About 30.97 hectare area used for surface mining in 1993. It is 9.6 per cent of the colliery area. Area of the settlements increased from 17.2 hectare to 23 hectare between 1973 and 1993. About 263 hectare (82 per cent) was barren land in 1993 (fig. 4.18).

Landuse pattern of South Tisra Colliery (1973)

In 1973, in South Tisra Colliery about 20.96 hectare of land was used for settlement purposes. Water body (Sulunga jore) passing though north west colliery area which covers an area of about 0.25 hectare. No surface mining was prevalent in the colliery in 1973. Barren land in the area accounts 241 hectare (fig. 4.19).

Landuse pattern of South Tisra Colliery (1993)

Like Jeenagora colliery, here coal production by opencast mining started in late 80s. In 1993, about 20.36 hectare land was used for surface mining in Jeenagora Colliery. It accounts 7.7 per cent on the colliery area. Slight increase in settlement sector has been also observed due to population load in the area. It was 20.96 hectare in 1973 which became 21.29 in 1993. About 84 per cent land was barren in 1993 (fig. 4.191).

Landuse pattern of North Tisra Colliery (1973)

Total area of this colliery is 257.69 hectare. About 18.11 hectare land was used for settlement in 1973. Like other collieries opencast mining was not in practice in

LANDUSE PATTERN OF NORTH TISRA COLLIERY (1973)

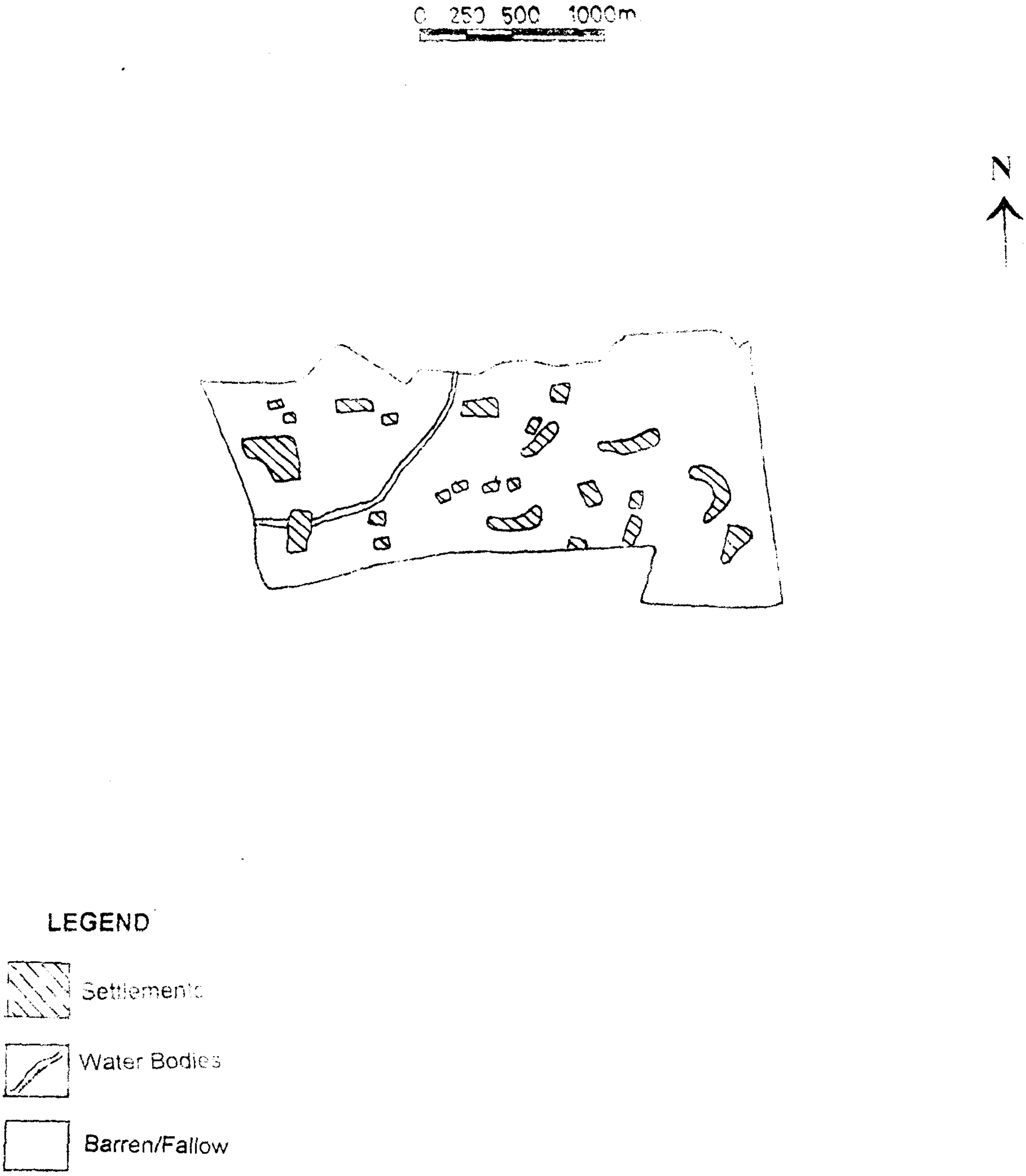

Fig. 4.192

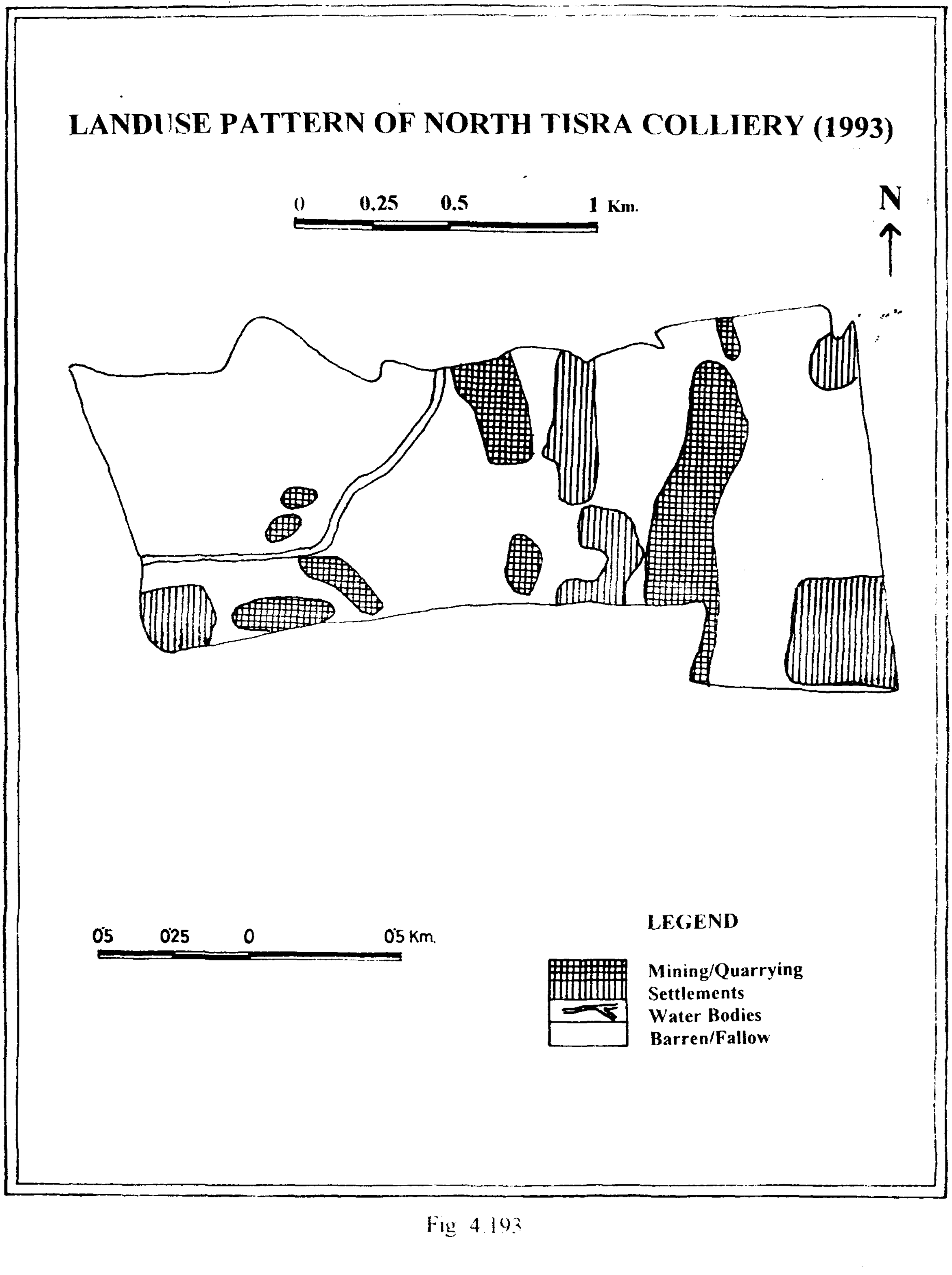
LANDUSE PATTERN OF NORTH TISRA COLLIERY (1993)
0 0.25 0.5 1 Km.
N
0.5 0.25 0 0.5 Km.
LEGEND
Mining/Quarrying
Settlements
Water Bodies
Barren/Fallow

Fig 4.193

1973. Water body (Sulunga jore) enters in the colliery through western part and goes out by northern side of the colliery area. Total area of water bodies was 2.8 hectare. Rest land (about 258 hectare) was barren in 1973 (fig. 4.192).

Landuse pattern of North Tisra Colliery (1993)

Sharp change has been found in mining acivities between 1973 and 1993. There was no opencast mining in 1973 while it occupied 28 hectare in 1993 (10.6 per cent of the colliery). About 9.5 per cent land was used for settlements in 1993. About 204 hectare of land (78 per cent) was barren in 1993 too (fig. 4.193).

Conclusion

According to the data and information it can be said that mining has changed the landuse pattern to a great extent between 1973 and 1993. The are under mining has sharply increased from mere 3.28 hectare to 91.95 hectare between 1973 and 1993. Mining is highly pronounced in Jeenagora Colliery. Joyrampur is the only area where subsidence has been observed in 1990s. It is the only area where afforestation has been done by Bharat Coking Coal Limited in 10.63 hectare in the study area.

Table 4.11
Landuse Pattern of Lodna Area (1973)
(in hectares)

	Lodna	Bagdigi	Joyrampur	Jeenagora	North Tisra	South Tisra
Settlements	44.87	3.53	7.54	17.2	20.96	18.11
Mining/Quarrying	3.28					
Water bodies	8.33	0.5	0.2	4.01	0.25	2.8
Barren/ Fallow	403.52	65.97	90.66	299.79	240.59	236.79

Table 4.12

Landuse Pattern of Lodna Area (1993)

(in hectares)

	Lodna	Bagdigi	Joyrampur	Jeenagora	North Tisra	South Tisra
Settlements	75.01	12.67	21.1	23	21.29	24.92
Mining/Quarrying	9.19	0.84	2.79	30.97	20.36	27.8
Water bodies	8.33	0.5	0.2	4.01	0.25	2.8
Barren/ Fallow	367.47	55.09	51	263	219.9	202.17
Subsidence			12.68			
Forest area			10.63			

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CHAPTER V

Environmental Degradation

Introduction

Utilisation of natural resources is interaction between two systems- the natural and human. In course of the utilisation sometimes the very resource base is eroded leading to devaluation or some sort of disturbance is triggered in the ecosystem functioning and structure causing ecological imbalance. In plain words are qualitative and quantitative decline/disimprovement/degenerationtion in the ecosystem potentiality productivity affecting habitat of man, plant and animal.

Both Natural and anthropogenic activities are responsible for it. Sometime impacts of anthropogenic activities are severe and irreversible. Anthropogenic activities include construction works of communication, multipurpose river projects, establishment of industries, urban centres, mining activities and so on. Though these are invariably planned by man but mostly leave adverse impacts on the environment which leads to degradation. Unplanned works are more harmful for the environment.

Environmental degradation has now become a more common and pervasive problem. Rapid deforestation, land degradation, soil erosion, air pollution, water contamination, urban congestion etc. are common to developed and developing countries alike. The problems in all together manifestations, dimensions and implication differ depending upon history, geography and level of economic development of a particular country.

The Earth Summit organised by the United Nations Commission on Environment and Development on 3 -14 June 1992, in Rio-de-Janerio, Brazil was the ecstatic culmination of the growing awareness of environmental degradation. The summit stressed that the right to development must be fulfilled so as to equally meet developmental and environmental needs of the present and future generations. In the path of economic development, all nations must cooperate in the essential task of eradicating poverty as an indispensable requirement of sustainable development. Henceforth to attain sustainable development, environmental protection should constitute an integral part in the development process and the former cannot be considered in isolation from the later.

Deforestation

Introduction

The forestry plays vital role in our economic, social and environmental activities. It plays key role in our country which has a predominantly agriculture-based rural economy. India is vast country has rich biodiversity. This country posses complex relationship between environment and society. Forests have an important role in sustaining the country's environmental stability and its economy, particularly in the rural sector where an estimated 50-60 million people, mostly tribal, depend on them for a living. India is one of the twelve mega biodivsrsity countries of the world. It is due to presence of numerous species of plant animals in the forests. Its ten biogeographic zones represent a broad range of ecosystems.

Total recorded forest area of approximately 77,000 sq. km is only one half of the area under agriculture. Although the recorded forest area was 23.4 per cent of the geographical area. But according to latest estimate of Forest Survey of India (FSI), a unit of Ministry of Environment and Forest, Government of India, through satellite imagery of 1987-89, is only of the order of 64.070 sq. km or 19.4percent.

According to the National Forest Policy (1988), 33 percent of the total land area of the country should be under forest cover. Out of a total of 413 district of the country for which forest cover has been assessed by the FSI in 1991. Out of them 105 districts have more than 33 percent of forest cover, 52 districts have forest cover between 19 percent and 33 percent, 217 districts up to 19 percent and 39 districts do not have any discernible forest cover at all.

A large part of India's forest is degraded and productivity is poor. Only about one-half of the forests have a crown density of over 40 percent. According to 1993 assessment, an area about 385575 sq. km has dense forest which possess crown density 40 percent and above. The annual production of wood per hectare is 0.7 cubic metre which compares poorly with the world range of 2.1 cubic metre (FSI, 1987). The total estimated growing stock of wood in 1987 was 4196 million cubic metres and net annual increment 52 million cubic metre or 1.24 percent of growing stock. According to latest FAO (Food and Agriculture Organisation) estimates, the total biomass of Indian forests is about 4806 million tonnes.

India has 15 percent of the world's livestock, but only 2 percent of the geographical area, 1 percent of the forest area, and 0.5 percent of pasture lands. Per capita availability of forest land dipped to 0.08 hectare which is a tenth part of the world average of 0.8 hectare.

It is not necessary that all anthropological activity degrade forest ecosystems a some believe. The state of Vermont, USA which was at least 75 percent cleared by 1850 is now approximately 80 percent in forest. The latest FAO (Food and Agriculture

Organisation) statistics for tropical forest indicate that there was a loss during the period 1981 - 90 of 0.8 percent per year, some 154,00,000 hectare annually

The forest cover increased in some part of the developed region of the world. However, in developing countries their trend is towards deforestation particularly in tropical forest. Shifting cultivation is also a major cause of deforestation. This cultivation is practised by landless indigenous people who clear all tress to grow subsistence crops. This is common in Africa, Asia and tropical America. After some years of the cultivation, the productivity of the soil is decreased which compels to search new space for the cultivation. The abandoned patches, called forest fallow, are being created at the rate of more than 5 million hectare per year. About 500 million people (nearly 10 % of the world population) and 240 million hectare of closed forests are involved in shifting cultivation, which is increasing at an average annual rate of 1.25percent.

Though each of the actions will have different biological, erosional, hydrlogical and socio-economic effects and though each is initiated by substantially differing socio-economic and cultural forces, they have all been labelled with one ambiguous word. It would be much more meaningful to use impact words such as “loss”, “conversion”, “alteration” and “degradation” to give a clear picture of how forests have fared at the hands of humans.

Deforestation in Jharia Coalfield

Study about forest in Jharia Coalfield was first carried out in the year 1925 when first time survey of that area has been done. According to this survey an area about 4.9 percent of the entire coalfield was under forest cover. On that time 4.7 percent area under mining activities. As mining process increases forest cover of the area decreases. In 1974 more depletion of forests took place. Only 0.7 percent forest covers while 17.4 percent of the area by mining activities. Mining area has increased from 4.7 percent to 19.42 percent between 1925 to 1993. The largest increase of 12.7 per cent in the mining area was recorded in 1974. This was due to the nationalisation of the mines. Increasing mining activity badly affects cultivable area. Surprisingly there was decrease in mining area between 1974 to 1987. This was mainly due to recession in the coal industry. However the rise in mining area between 1987 to 1993 is attributed to installation of a number of thermal power plants based on coal a fuel. On the other side the higher generation of electricity helped in increasing the mining of the coal.

There is no natural forest observed in the area. However, plantation has been done in the area after EPA 1986. So, no deforestation has been observed in the area.

Air Pollution

Introduction

The air in the study area is highly polluted due to coal mining. But before discussing in detail, it would be worth while to learn about the air pollution in general, which is a burning issue nowadays. In the introduction of "Waste Management and Control", a report by the Committee on Pollution, (National Academy of Sciences, 1966) pollution is defined as an undesirable change in the physical, chemical and biological characteristics of land and water that may or will harmfully affect human life or that of desirable species, our industrial processes, living conditions, and cultural raw material resource. Pollutants are residues of the things we make, use and throw away. According to Holdgate (1976) the introduction by man into the environment of substances of energy liable to cause hazard to human health, harm to living resources and ecological systems, damage to structure of amenity, or interference with legitimate use of the environment".

Martin (1976) defined it as "The presence in the environment significant amounts of unnatural substances or abnormally high concentrations of natural constituents at a level that causes undesirable effects such as bronchial irritation corrosion or ecological change". According to the Engineer's Joint Council in "*Air Pollution and its control* "Air pollution means the presence in the outdoor atmosphere

Pollution and its control "Air pollution means the presence in the outdoor atmosphere of one or more contaminants, such as dust , fumes gases, mist, odour, smoke or vapour in quantities of characteristics and of duration, such as to be injurious to human plant or animal life or to the property or which unreasonably interferes with the comfortable enjoyment of life and property".

According to Indian Standard Institution IS –4164 (1966) "Air pollution is the presence in ambient atmosphere of substance, generally resulting from the activity of man in sufficient concentration present for a sufficient time and under certain circumstances which interfere significantly with the comfort health or welfare of persons or with the full use or enjoyment of property".

The World Health Organisation(WHO) and United Nations (UN) defines air pollution and pollutants in the following way :Air is polluted when on or several pollutants are entered in the atmosphere at such a concentration and so, far a long time that they are harmful to man , animal, plants and material.

Concept of air pollution is changing with the time. Many years ago air pollution meant induction of smoke soot and odours into the atmosphere . But in previous two decades concept has changed. Now air pollution is any atmospheric condition in which substances are present in high concentration beyond the permissible limit which may produce lethal effect on man, animals vegetation or materials.

Nowadays ozone depletion and green house gases (GHG) are also included in air pollution. because of their potential to alter the climate of the global ecosystem.

Air pollution is not a new problem for us. Centuries ago noted scientist John Evelyn described about it. Air pollution can be hazardous to health. The first death occurred in the Measure valley in Belgium in 1930, because the meteorological condition produced a weak long air stagnation, leading to extremely high concentrations of the pollutants in the air. In 1948 similar meteorological conditions in Donora, Pennsylvania, resulted in nearly 7000 illness and 200 deaths. In 1952 about 400 deaths were attributed to a four-day " Killer Fog" in London.

Coal production in India was 101 million tonnes in 1978 and projected production by 2000 AD need to be expand 400 million tonnes to maintain the present economic growth and the rate of the development. Among 53 coalfields in India, two at Jharia and Raniganj are the oldest and most important producing bulk of coking and non-coking coals respectively.

Coal production of Jharia Coalfields was 14.5 million tonnes in 1972-73 17.9 million tonnes in 1974-75 and 20.70 million tonnes in 1979-80. By 2000 A. D. the production will be expanded to 60 million tonnes along with the capacity of washeries.

Although there had been regular studies on air pollution and its adverse impact on health regularly monitored in western countries and Japan. Emphasis has been laid in India not more than two decades back. In past no serious attention was paid on deleterious effects of air pollution on health, vegetation and materials of the surroundings. Epidemiological studies were very few in numbers. During latter part of 50's some attempts were made to study the respiratory troubles in the people of Calcutta.

Air Quality Studies in India

The first record of air pollution was found in the records prepared by Chakraborty and Rao of All India Institute of Hygiene and Public Health, Calcutta, who studied the air quality of Calcutta between 1955-59. In January 1958, the Department of Applied Chemistry of Calcutta made some studies regarding smoke, dust and gaseous concentration in the city Calcutta.

Bhabha Atomic Research Centre (BARC) carried out detail study in Chembur and Trombay industrial areas. Findings of that work proved the existence of sulphur dioxide and oxidants in ambient air quality in many places. In 1968-69 short-term air quality study were undertaken in India in four major cities namely Calcutta, Bombay, Kanpur and Delhi. The study highlighted the pollution level in these cities. On the basis of above-mentioned study National Environmental Engineering Research Institute, Nagpur had prepared a long-term plan to study the air quality in other places viz., Calcutta, Bombay and Delhi since 1973-74. Central Mining Research Station, Dhanbad, which came into existence in late 50's, has been engaged in research on health and air pollution in mines, industries and industrial area since 1960 or so, has embarked upon the problem since 1975-76.

Pollutants may therefore enter into the environment both by material or anthropogenic sources. It may occur as solid particles, liquid droplets, and gases or in various admixtures of these forms. The Standards of air quality have been presented in table 5.21.

Measurement of Air Quality

Measurements of pollutants are usually done in sets of units. One unit is parts per million (ppm) the number of molecules of the pollutant gas per million molecules of air or alternatively the volume of the pollutant gas per million volume of air. the other unit is mass per unit volume, usually micrograms or milligrams(mg) per cubic metre . Particulate matter is usually given in three units and sometimes in gases, one can convert between units by using the ideal gas law. If we assume a temperature of 25 degree centigrade and a pressure of 760-mm Hg., the conversion becomes :

1 ppm = molecular weight X 10,00,000/24,470 micro gram per cubic metre

1 micro gram per cubic metre = 24,470/ molecular wt. ppm

Conversion Factor (ppm)

Sulphur dioxide	=	micro gram per cubic metre x 0.000382
Carbon Monoxide	=	mill gram Co per cubic metre x 0.873
Ozone	=	micro gram per cubic metre x 0.00051
Methane	=	Methane mill gram per cubic metre x1.53
Nitrous oxide	=	micro grams Nitrous oxide per cubic metre x 0.000532

Source: Federal Register, 35: 8186-8201 (1971)

Combustion of sulphur compounds like coal contributed large amount of sulphur dioxide and some more sulphur trioxide in the surrounding environment.

Results and Discussion

Jeenagora Area

Suspended Particulate Matter (SPM), Sulphur dioxide, Carbon monoxide and hydrocarbon concentrations are increasing day by day. Transportation of coal by trucks, lorries and railway wagons also increase the level of air pollution. Air pollution also occurs by plying of buses and similar vehicles. According to the statististics available, 20 thousand heavy and 30 thousand light vehicles ply in Dhanbad District. Emission of noxious gases from the fire, covering an area of 20 square kilometres (Jharia Coalfield), also contribute to pollution in this belt. This fire wastes not only reserves of coal but also emits a great deal of smoke and fumes into the atmosphere. A study report of Central Mining Research Station (1978) has already pointed out that

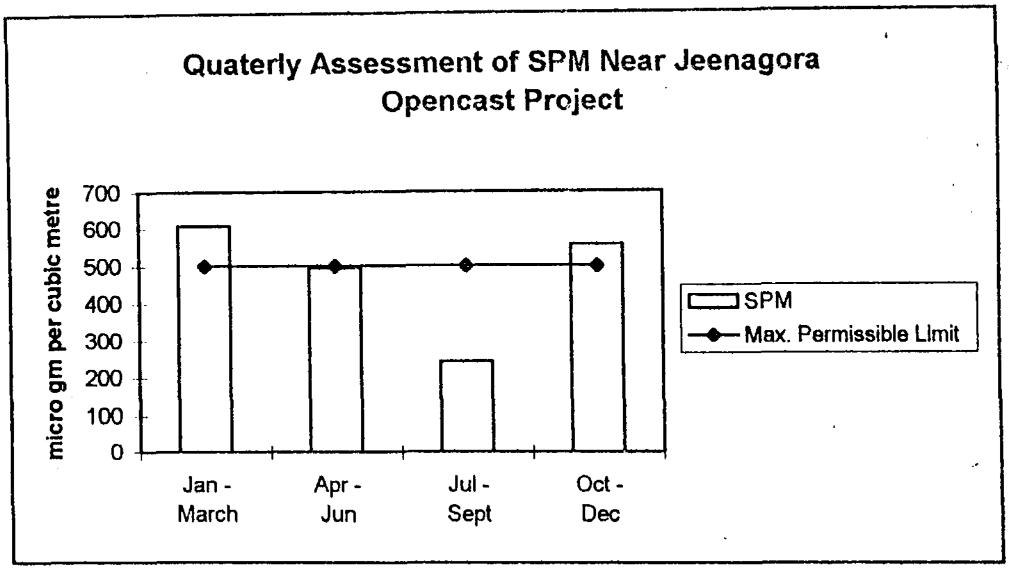


Fig. 5·21.

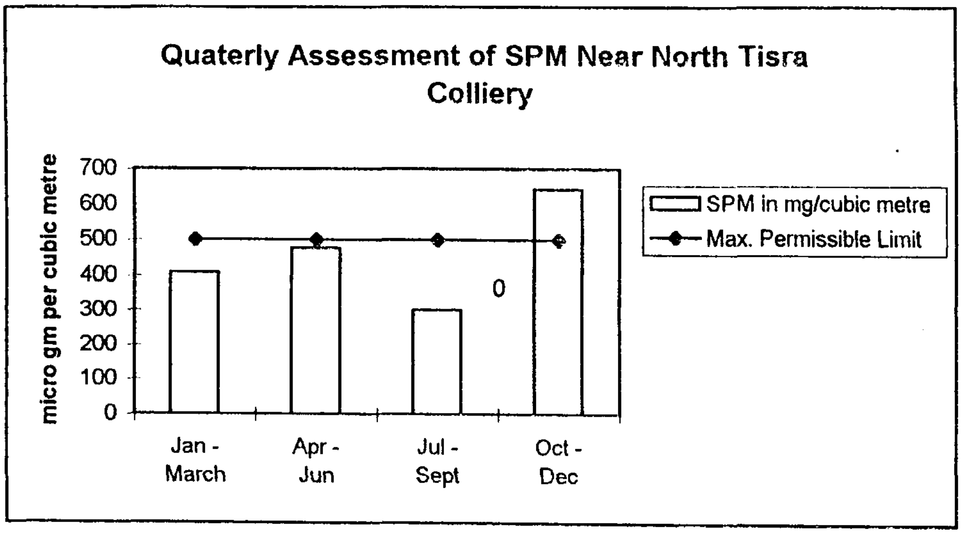


Fig. 5·22

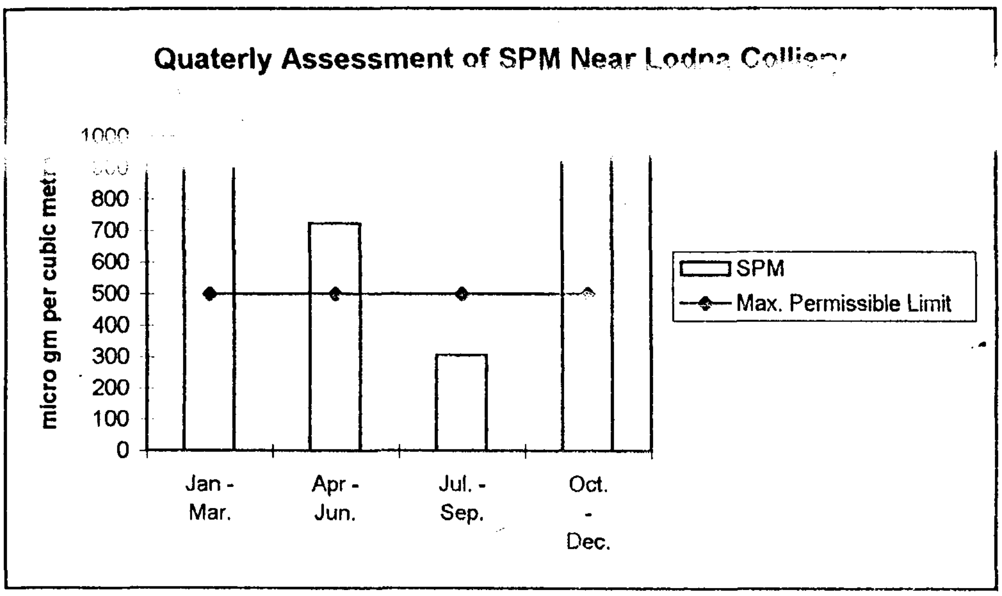


Fig. 5·23

more than 900 Kg of lead in the form of fume and dust and 850 cubic metres of Sulphur dioxide gas are daily discharged into the open atmosphere through Chimneys from the lead smelter at Tundoo near Katras (Dhanbad District).

Suspended particulate Matter (SPM) in Jeenagora area is 608 micro gm per cubic metre during January to March. Twenty four hours average value for SPM is 500 micro gm per cubic metre, considered as permissible limit for this parameter. This area consists residential quarters. It can cause adverse impact on the health. Details have been mentioned in later part of the thesis. Twenty four hourly SPM value is 495 micro gm per cubic metre micro gm/m^3 between April and June period. This is short of 5 micro gm per cubic metre from ambient air quality for industrial area. Value of suspended particulate matter sharply declined in rainy season (July - September), has been recorded 243.33 micro gm per cubic metre. This is due to pouring of the rain which suppress the dust particles. National Ambient Air Quality Standard is given in table – 5.21. High value of SPM has been observed in October to December period. It is 556.66 micro gm per cubic metre. It is above than permissible limit (Fig. 5.21).

Concentration of Sulphur dioxide in the surrounding atmosphere of Jeenagora area is 19.32 micro gm per cubic metre from January to March, for 24 hourly average (Plate 8). Maximum permissible limit for sulphur dioxide is 120 micro gm per cubic metre. Here concentration of sulphur dioxide is 15 micro gm per cubic metre in April to June. About 8.66 micro gm per cubic metre monitored in monsoon period. After monsoon its concentration increases. This is 15.18 micro gm per cubic metre in the same period. This is due to temperature inversion.

NO_x is termed as the combination of Nitrogen dioxide and nitrous oxide. Concentration of NOx is found 26.74 micro gm per cubic metre in winter season (January to March) of the year. This value goes down during summer season (April - June). This may be due to high velocity of the wind in that area. Lowest value has been recorded in monsoon season i.e., July to September. The 24 hourly average value of NOx is 8.16 micro gm permetre in this area, influenced by the rainfall. Some gases may dissolve in the water. Overall concentration of NO_x is under prescribed limit as mentioned in table 5.22.

North Tisra

Table 5.23 reveals that concentration of the suspended Particulate Matter (SPM) in winter season (January - March) is 408.33 micro gm per cubic metre which is below the permissible limit prescribed. In this area SPM increases in spring season (April - June) which accounts for 475 micro gm per cubic metre . This may be due to open cast mining in both North Tisra and South Tisra colliery of Lodna area of Jharia coalfield. This is further augmented by higher wind speed prevailing in that area. Lower value of SPM observed in monsoon period. This is 301.66 micro gm per cubic metre for 24 hourly average. But this increases in post monsoon period (October - December) i.e., 643.66 micro gm per cubic metre. This is influenced by the temperature inversion in this period. It usually occurs at night, when the earth loses heat by radiation and cools the air in contact with it. During this time air is moist and its temperature is below dew point, hence fog will form. The cool air stratum is covered by warmer air and the vertical movement is stopped until sun warms the lower air the next morning(Fig. 5.22).

Concentration of sulphur dioxide is higher in post monsoon period (October - December) and in winter season (January - March), accounting as 24.21 and 19.75 micro gm per cubic metre respectively, this is favoured by lower temperature. In summer season (April to June) SO_2 is also higher . This may be due to mine fire that produces huge amount of sulphur dioxide. In monsoon period concentration of SO_2 is low (14.78 micro gm per cubic metre) due to rainfall. Maximum permissible limit of this gas for industrial area is 120 micro gm per cubic metre and 80 micro gm per cubic metre for residential areas.

NOx is also under permissible limit in this area. Highest concentration of NOx is monitored in post monsoon period (39.71 micro gm per cubic metre) followed by winter season (January to March) which is 32.51 micro gm per cubic metre. NOx concentration found in summer season is 34.04 micro gm per cubic metre in 24 hourly time weighted average. Like other gases, concentration of NOx is also having low value of gases in monsoon season (July - September). Maximum prescribed limit for industrialised and residential area is same as SO_2.

Lodna Area

SPM concentration in the atmosphere is the highest in winter season (January - March) i.e., 975.76 micro gm per cubic metre. In post monsoon period this is having higher concentration. Some settlements are there from where this has been monitored. In summer season this is also higher. It is 722.7 micro gm per cubic metre (table 5.24). High concentration is due to colliery, watery unit, coke plant, tar plant, loading and unloading of the coal, boiler and surface blanketing operation. In watery units no sophisticated equipments has been installed to control the pollution. Electrostatic precipitator has to be installed to curb the air pollution by washery unit. Lower concentration of SPM is observed in monsoon season i.e., July to September. This is 306.36 micro gm per cubic metre. Only in monsoon season SPM is below the permissible limit(Fig 5.23).

Concentration of SO_2 in this area is 94.62 micro gm per cubic metre in January - March period followed by 81.5 micro gm per cubic metre in October - December. Maximum permissible limit of SO_2 is 12 micro gm per cubic metre for the industrial area while maximum permissible limit for residential area is 80 micro gm/m^3. Taking this fact into account it can be said that the area is affected by high concentration of sulphur dioxide. In the rest seasons i.e., summer and monsoon period SO2 concentration is under permissible limit.

Concentration of NO_2 is highest in post monsoon period (49.57 micro gm per cubic metre). In winter season (January to March) this is 46.18 micro gm per cubic metre .The lowest concentrate of NO_2 is found in monsoon period (10.04 micro gm per cubic metre).

Conclusion

As perinformation and data available regarding air quality it can be said that Suspended Particulate Matter (SPM) concentration is high in whole part of the year except monnsoon season when it is low due to rainfall in the area. Concentration of other gases (Sulphur Dioxide and Nitrogen Dioxide) are under permissible limit.

Table 5.21

National Ambient Air Quality Standards

(value in microgram per cubic metre)

Pollutants	Time weighted average	Industrialised Area	Residential Area	Sensitive Area	Methods of Measurement
Suspended Particulate Matter (SPM)	Annual Average	360	140	70	High Velocity Sampling Average Flow Rate not less than 1.1 cubic metre /minute
	24 hourly Average	500	200	100	
Sulphur Dioxide	Annual Average	80	60	15	Imported Waste and Gaeke Method UV Flurance
	24 hourly Average	120	80	30	
Nitrogen Oxides	Annual Average	80	60	15	1. Jacob & Hacchesen Sodium Arsenite Modified Method
	24 hourly Average	120	80	30	2. Gas phase Chemiluminous
Respirable Particulate Matter (RPM)	Annual Average	120	60	50	Respirable Particulate Sampler
	24 hourly Average	150	100	75	
Lead	Annual Average	1.0	0.75	0.50	AAS After Sample EPM 2000 or of equivalent filter paper
	24 hourly Average	1.5	1.0	0.75	
Carbon Monoxide (CO)	8 hour	5000	2000	1000	Non Dispersive filtered Spectroscopy
	1 hour	10000	4000	2000	

* Annual Arithmetic means of minimum 104 measurement in a year taken twice a week 24 hourly a uniform level
* 24 hourly / 8 hourly value should be met 98 per cent . However 2 per cent of the time it may exceed out not on two consecutive days.

Table 5.22

Air Quality near Jeenagora Opencast Project (1996-97)

(micro gram per cubic metre)

	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
Suspended Particulate Matter (SPM)	608	495	243.33	556.66
Sulphur Dioxide	19.32	15	8.66	15.18
Nitrogen Dioxide	26.74	22.04	8.16	23.21

Table- 5.23

Air Quality near North Tisra Colliery (1996-97)

(micro gram per cubic metre)

	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
Suspended Particulate Matter (SPM)	408	475	301.66	643.06
Sulphur Dioxide	19.75	19.99	14.78	24.21
Nitrogen Dioxide	32.51	34.04	23.8	39.71

Table – 5.24

Air Quality near Lodna Colliery (1996-97)

(micro gram per cubic metre)

	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
Suspended Particulate Matter (SPM)	975.76	722.6	306.36	692.6
Sulphur Dioxide	94.62	66.32	32.86	81.5
Nitrogen Dioxide	46.18	99.82	10.04	49.51

Water Pollution

Introduction

Water is merely a compound formed by the combination of two molecules of hydrogen and one molecule of oxygen. Sanitary engineers see water from different angle. They are interested particularly in the liquid form of water. From the viewpoint of public, water is an absolutely essential commodity. Our body consists 70 per cent of water by weight. It must be replies constantly as it evaporates from the lungs and skins and passes out of body in the form of water. Water is relatively more prone to pollution than air because it is more viscous, having lesser moment of inertia and possessing closer molecular distance than air. Air being available in the atmosphere in much larger proportion as compared to water. The pollutants in the air are quickly diluted and dispersed away along the down wind direction. The unequal distribution of water on the surface of the earth and the fast declining availability of fresh usable water per capita, per year due to increasing population. Water pollution problem is more delicate and severe than that of air.

Water has unique solvent quality. Even the highest quality distilled water is having dissolved gases and trace amounts of solids. The term 'water pollution' is referred to a condition of an excess material (or heat) that is harmful to humans, animals and aquatic life. The National Water Commission stated (1973) that " Water gets polluted if it has been not of sufficiently high quality to be suitable for the highest use people wish to make of it at present or in the future". With the introduction of contaminants in the water it is divided into two extremes: (1) a highly enriched, over procedure biotic community, such as a river or lake with nutrients from sewage or fertiliser or (2) a body of water poisoned by toxic chemical which eliminate living organism or even exclude all forms of life.

The concept of water pollution perhaps dawned earlier than air pollution and this led to adopt strategy to contain this menace quite early in times. It is rather unfortunate that the philosophy of air resources management is based on water resources management but there exists hardly any analogy. We do not have our resource in the way we posses our rivers or well. Air is everybody's environment and we live in it.

In strict sense pollution means any departure from the purity. When this theme has been discussed in environmental perspective it is considered the departure from the normal value of a parameter. This process is true to water also. Water is widely distributed substance and a good solvent that is has been never found naturally in a completely pure state. In the most polluted geographical areas water is loaded with heavy carbon dioxide, oxygen and nitrogenous substances and it also carry in suspension dust or other particulates picked up from the atmosphere. Dissolved compounds like dissolved compounds of metal viz., sodium calcium and iron found in surface and well water. The term hard water denotes the presence of salts of calcium and magnesium particularly bicarbonates, carbonates, sulphate and chloride of these elements. Even drinking water is impure in strict sense. Suspended materials dissolved in this have been removed and harmful bacteria destroyed but still many substances found in the solution. Indeed, absolutely pure water would not be present to drink because it has been the impurities that impart the characteristic taste by which it can be recognised.

The term "'water pollution" seems to be clear to all. Felfody (1972) gave precise definition as "Water pollution is every impact which changes the quality of our surface and subsoil waters to such a degree that its suitability either for human consumption or the support of man's natural life processes will decrease or cease".

According to USPHS, Water pollution is the presence of any foreign substance (organic, inorganic, radiological or biological) in water which tends to degrade the quality so as to constitute a hazard or impair the usefulness of water.

Water pollution include "discharge wastes including radioactive and other substances actually or practically harmful to such uses and alteration of properties of water in such a way as to be harmful, including temperature, tastes turbidity or odour.

Classification of Water Pollutants

(1) **Floating Materials**

Typical materials floated in the discharge particularly oil and greases. It makes water unsightly which retard the growth of zooplanktons and phytoplanktons. It interfere the growth natural vegetation which are toxic to fish and other aquatic life. Floating materials may also affect the Biochemical Oxygen Demand (BOD).

(2) **Suspended Matters**

A common example of suspended matter has been mineral tailings. These mineral tailing ruin fish spawning and breeding grounds. If the suspended matters has been organic, it would decompose using the dissolved oxygen and would produce noxious gases and odours.

(3) **Dissolved Impurities**

Typical dissolved substances like acids alkalis, heavy metals and insecticides for human consumption and destroy aquatic life. For e.g. phenol even in low concentration (0.001 mg/L) provide a very objectionable taste and odour. It also affects the food chain.

According to another classification water pollutants can be divided into following categories:

(a) ***Inorganic chemicals and mineral substance***

This category of water pollutants includes inorganic salts, mineral acids, finely divided metals or metal compounds (Plate 6). These substance came into the natural water due to various activities like smelting, metallurgical and chemical industries, mine drainage due to various natural resources. It will produce three general effects; (1) The acidity (2) Salinity (3) Toxicity of water.

Inorganic chemicals are many types enter onto the water by various sources like municipal and chemical waste water runoff. These pollutants have potential to injure the aquatic fauna viz. fish and other animal beings. It produces toxicity in the water which become unsuitable for human consumption. a prominent example of this type of pollutant is mercury. Mercury enters into the water by various chemical industries without proper treatment of the effluent. It is now well established that anaerobic bacteria in bottom mud can convert inorganic mercury into methyl mercury, which can be concentrated in living things and lead to mercury poisoning.

Another very important problem is acid mine drainage. Exposed coal mine surface consist sulphur most notably iron pyrite come into contact with air and water forming sulphuric acid which is carried into streams by water draining for mines. It is a common feature for operating mines as well as abandoned mines is most pronounced in bituminous coal mines.

Acid mine drainage (AMD) primarily cause acidity in water body. This will have bad impact on streams and has been one of the most significant Causes of water quality degradation in coal producing areas. This pollutant contains sulphuric acid and soluble compound of iron. This is due to active reaction between air and water and pyrite present in coal streams. It has been influenced by certain micro organisms but heir exact role has been not completely understood.

Due to mining process in deep mines the strata between the coal seam and the surface has been adversely affected by this process. Fissure caused by this activity become the source of draining the water into the mine. This water consist harmful pollutant will go bad with natural water sources. coal washeries of Indian coalfields produces 35 - 40 lakhs tonnes of coal dust annually. This causes increasing load of water pollutants (Plate 7).

Coal and various metal ores are enclosed in geological formation of reduced nature. Pyrite is locked with coal. When coal is exposed by the mining process it came into contact with it results autooxidation which is later influenced by microbial action causes the formation of large pollutants of acids. The iron rich acidic mine drainage kill aquatic life and renders the contaminated steam unsuitable for drinking purposes or for recreational use.

Some acid mine drainage also originates from sub surface mining. This is due to water flowing through the mine itself. This runoff from mounds of mine tailing or "gob piles" (rock and low grade coal separated from the high grade coal before shipment). This problem is curable after applying easy process. in sub surface mining, after coal extraction empty space is either filled with tailings or is allowed to collapse. Therefore, at any one time only a limited amount of rock is exposed for autooxidation process. In context open cast process removes the burden and leaves it with the tailing as porous ruffle, exposed to oxygen and percolation water. Oxidation of Iron and sulphur in presence of water molecule's pH value go down. It will produce serious impact on vegetation and soil cover of the area. The strip mining continues to give rise to acid mine drainage until most of the sulphide is oxidised and leached out. The recovery of the land may take a span of 50 to 150 years.

Mechanism of the Process

The mechanism of pyrite oxidation is not simple. With the introduction of atmospheric oxygen pH of the water go down due to oxidation. pH value come from neutral to 4.5 which is influenced by iron bacterium mettallogernium. In this medium contain Thiobacillus bacteria pH go down to 3.5 pH value. Micro organisms play important role in oxidation of pyrite.

Both Thiobacllus thiooxidans and autooxidation will produce from pyrite is enumerated below :

(1) $2\ Fe\ S_2\ + 7\ 0_2\ + 2H_20\ =\ 2\ Fe_2 + 4\ So_4\ + 4\ H^+$

The stabilised ferrous ion is oxidised by Thiobacillus ferroxidans to ferric ions.

(2) $2\ Fe_2\ + 1/2\ O_2 + 2H^+ = 2\ Fe_3^+\ + H_2O$

Mechanism (2) have some limitations. The ferric produced is able to oxidise the remaining sulphide to sulphate in non biological reaction

(3) $8\,Fe_3^{+} + S_2^{+} + 4H_2O = 8\,Fe_2^{+} + SO_4\,2^{-} + 8\,H^{+}$

In the above process the ferric ion is reduced back to ferrous ion which is available again for oxidation process.

(4) $2\,Fe^{3+} + 6\,H2O = 2\,Fe\,(OH)_3 + 6H^{+}$

The overall reaction for the oxidation process of can be summarised below

$2\,FeS_2\,7\,½\,O_2 + 7\,H_2O = 2\,Fe\,(OH)_3 + 4\,H_2\,So_4$

High amount of sulphuric acid produces acidity, the precipitated ferric hydroxide for deep brown colour of the effluent.

(b) ***Oil***

Oil is used as lubricant in almost all industries. Due to lack of proper care a large proportion of oil goes into the aquatic system affecting its inhabitants. It mainly affects the respiratory system of the fishes. It also prevents proper growth of aquatic floras. Coal washery which makes coal clean discharges a lot amount of oil into the water.

(c) ***Oxygen Demanding Wastes***

Dissolved oxygen is an important indicator of water pollution. Survival of plant and animal is dependent upon the ability of the water to maintain the minimal concentrations of this vital substance.

Fish needs large amount of oxygen while the bacteria and other lower vertebrates take least. Game fish requires dissolved oxygen is least, 5 mg/ litre (5 ppm). A body of water has been classified as polluted when the Dissolve Oxygen (DO) concentration drops below the level necessary for sustaining a normal biota for that water. The cause of deoxygenation has been called oxygen demanding wastes. These substances are decomposed by microbial actions. These substances are primarily organic materials which are decomposed by micro organisms into carbon dioxide and water. This activity activates the classifying of oxygen.

A common measurement of this type of pollution involves the amount of molecular oxygen needed to decompose the material through biochemical action. 5 day BOD is standard test to determine the dissolved oxygen in water. When the amount of sewage discharge has been relatively minor, a river will not become badly polluted as biological degradation will soon remove most of the wastes. The Biochmical Oxygen Demand (BOD) value of pure water is three ppm and of doubtful purity when it is 5 ppm.

The disappearance of plant and animal life is the rootcause of heavy discharge which result of the oxygen depletion in water. This is favoured by a direct killing effect or because of migration to other areas. Oxygen level become very low by this aerobic micro - organisms are distroyed or driven away and anaerobic one take place.

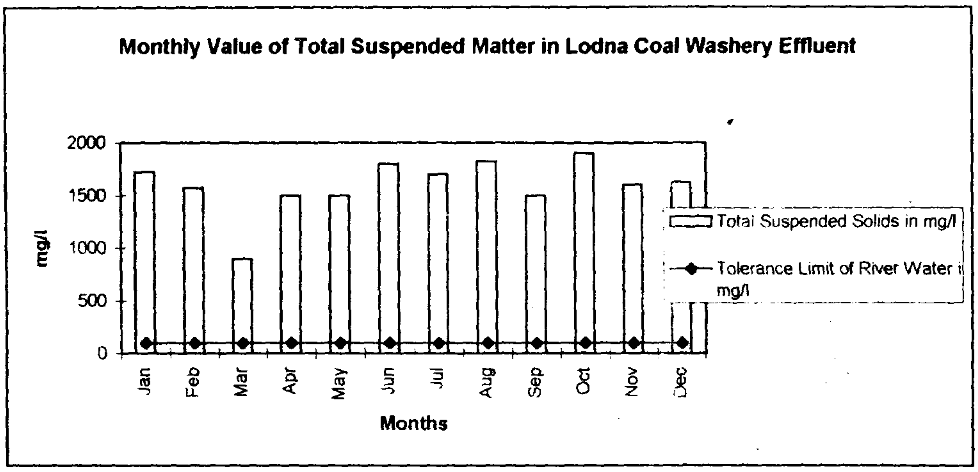


Fig. 5.31

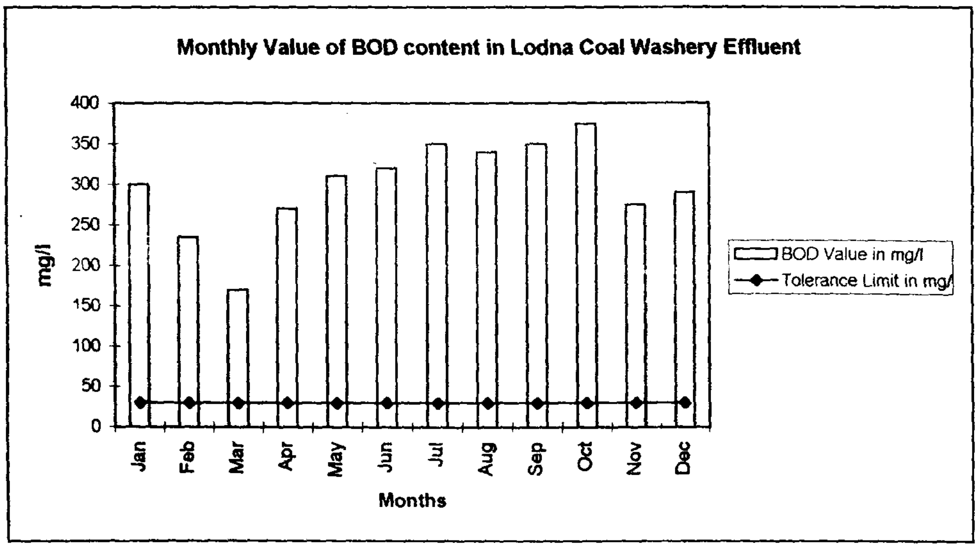


Fig. 5.32

Result and Discussion of Coal washery effluent

Chemical analysis of Indian coals shows high ash content. Coal is washed to remove the impurities associated with that. Raw coal feed to the washery plant After washing we get washery coal, middling, Reject and slurry. Percentage of material results after washing is 50, 25, 15 and 10 % respectively. Cleaning capacity of this washery is 120 tonnes per hour. Here two motor pumps with 1500 rpm and 1200 rpm are used to carry out the process. In the beginning huge coal lumps have been broken down into 5 cm and 10 cm diameter size particles and sent to the washing machine with the help of running belt. Mine water is generally used for washing the coal Physico- chemical analysis of coal washery effluent has been given in the table 5.31.

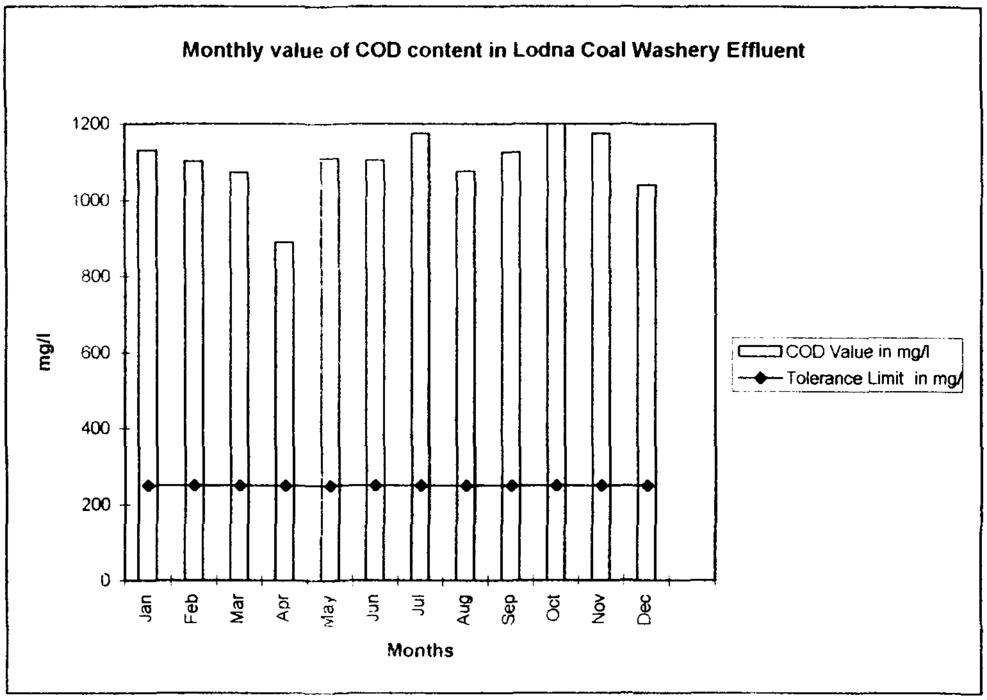
Temperature of the coal washery effluent found between 26.9 °C and 31°C . Washery effluent has pH value in the range of 7.56 to 8.47 and Dissolved Oxygen (DO) value between 2.8 and 4 mg/l (milligram per litre). Alkalinity of washery effluent under permissible limit. Washery effluent has hardness in the range of 320 - 440 mg/l. This hardness is due to using of mine water. Mine water is generally hard water. Hardness of effluent is found under tolerance limit of river water.

Suspended solids released by washery unit is very high. Tolerance limit is only 100 mg/l In whole year its amount never goes down below 895 mg/l. Lowest value observed in March is 895 mg/l and highest concentration of suspended solids is 1600 mg/l November Dissolved solids upto 2100 mg/l allowed to discharge in running water or river for such effluents. TDS observed in effluent under prescribed limit.

Highest value has been observed in the month of April (1620 mg/l) and lowest in February (100 mg/l). Please see Fig. 5.31.

Sulphate content in the washery effluent is very low, value found in the range of 9-25 mg/l. Coal washery effluent has calcium concentration in the range between 48 and 85 mg/l while tolerance limit of river water is 31.2 mg/l of calcium. Magnesium content in river water is only 1.6 mg/l while washery effluent having value in the range of 37- 52 mg/l. Iron content in washery effluent is under prescribed limit. Phenol concentration in washery effluent is in the range of 0.01 to 0.07 mg/l in various months of the year. It has been observed that even a small portion of phenol may affect the aquatic system particularly fish. Even 0.001mg/l phenol brought its smell in fish when we eat. Significant amount of oil and grease released into effluent of coal washery. Oil particularly pine oil is used to conserve the micro coal. It has been estimated that one tonne of pine oil is needed to wash 12,500 tonnes of coal. Grease is used as lubricant is also washed with the action of the water. Oil and grease content found in the range of 7.6 to 9.3 mg/l. This oil and grease content helping in the increase of rising of BOD and Chemical Oxygen Demand (COD) values.

Biological Oxygen Demand (BOD) is estimated lowest in the month of March (170 mg/l) and goes upto 350 mg/l in the month of July (Fig. 5.32). Tolerance limit for BOD value is only 30 mg/l. Thus we are augmenting greater load of water pollutant in our river system. Chemical Oxygen Demand (COD) value is also high in discharge of coal washery effluent. Tolerance limit is 250 mg/l but only in month of April its value



Monthly value of COD content in Lodna Coal Washery Effluent
1200
1000
800
600
400
200
0
mg/l
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months
COD Value in mg/l
Tolerance Limit in mg/l

Fig.5.33

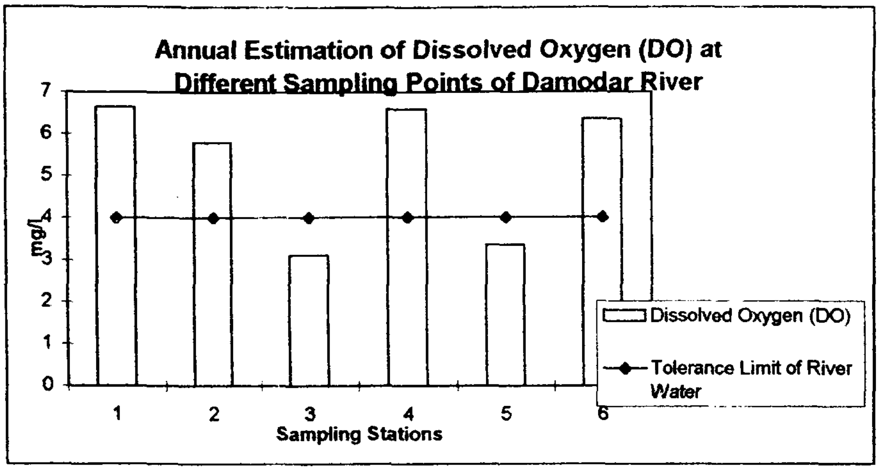


Fig. 5.34

1. Chandrapura Thermal Plant A
2. Chandrapura Therma Plant B
3. Near Telmucho Bridge
4. Confluece Point at Katri River
5. Near Mohalbani Bridge
6. Near Sudamdih Bridge

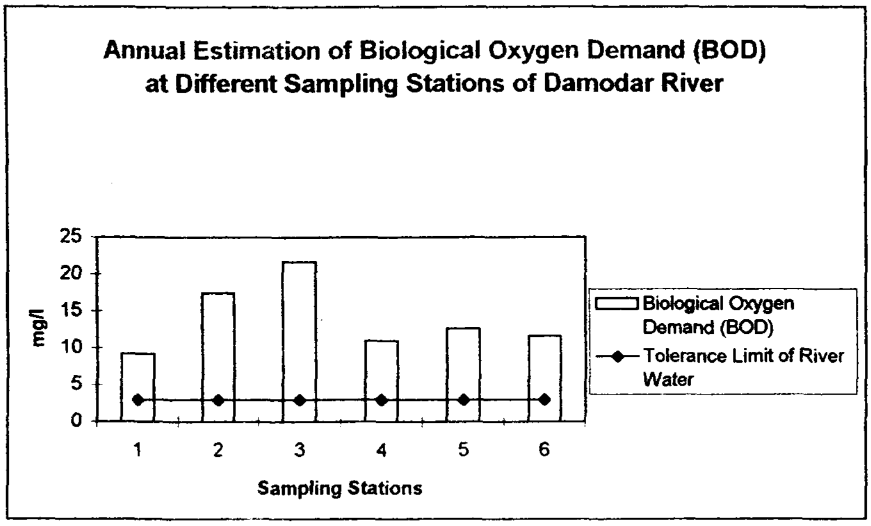


Fig. 5.35

estimated in three digits, otherwise its value in four digits in rest months of the year. COD value is found in the range of 890 mg/l to 1200 mg/l which is much higher than permissible limit (Fig 5.33).

Physico chemical Characteristics Of Damodar River falling under Jharia Coalfield

River water has been also undertaken to study the impact of coal mining on river systems. Various water samples have been collected to study the water characteristics of river water falling under Jharia Coalfield. Five water samples have been collected at various stations (Table 5.32).

River water at Chandrapura Thermal Plant A& B and upto Sudamdih Railway bridge, pH value is found under permissible limit. Temperature of river water is highest at Chandrapura Thermal Plant B is 33.8 °C. This is mainly due to discharge of hot water from the plant. Dissolved Oxygen (DO) found to be lowest at Mohalbani Bridge is 3.35 and highest at Karori and Damodar Confluence point. DO at Chandrapura Thermal Plant A&B is found 6.65 and 5.81 mg/l respectively (Fig. 5.34). Near Sudamdih Railway bridge DO is 6.35 mg/l. BOD value of river water found under permissible limit. Highest BOD found at Telmucho Bridge and lowest at Chandrapura Thermal Plant A is 21.7 mg/l and 9.25 mg/l respectively (Fig. 5.35). Tolerance limit for BOD in river system is 30 mg/l. As per recommendation made by Central Board for the Prevention and Control of Water pollution (1979), the water used as a source of raw water with conventional treatment for public water scheme should not have BOD

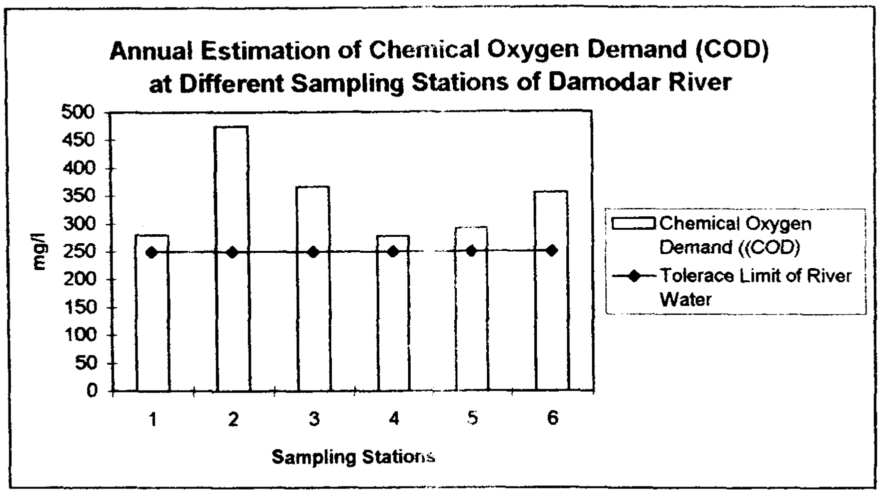


Fig. 5.36

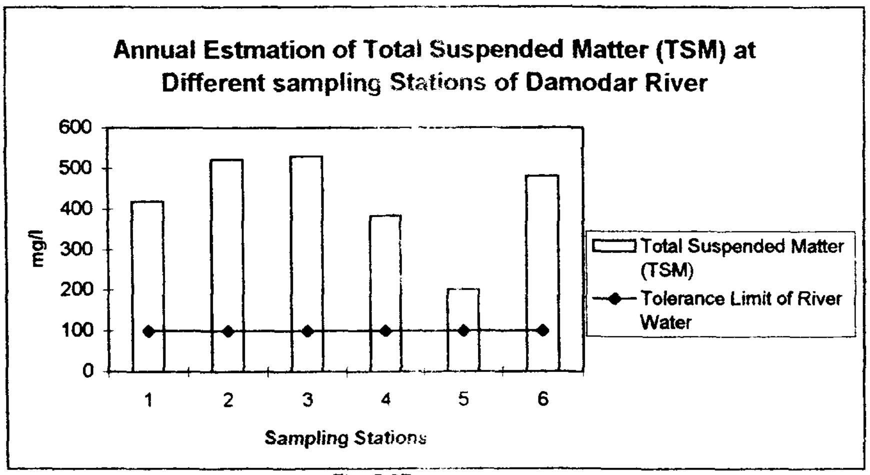


Fig. 5.37

1. Chandrapura Thermal Plant A
2. Chandrapura Therma Plant B
3. Near Telmucho Bridge
4. Confluece Point at Katri River
5. Near Mohalbani Bridge
6. Near Sudamdih Bridge

value more than 3 mg/l. Damodar water is used to supply for drinking purposes after treatment. Taking this view in account water of a Damodar river having higher BOD value. DO value is also higher. River water having DO value is 4 mg/l.

Chemical Oxygen Demand (COD) of Damodar river at different places also varies. Highest COD value is observed near Chandrapura Thermal Plant B (475 mg/l). Hot water discharged by the plant contains high amount of impurity. High value of COD indicates that water quality at that point is poor. COD value is high is observed at all places from where samples are collected for the study. Tolerance limit of water for the COD value is 250 mg/l. 280 mg/l COD estimated near Chandrapura Thermal plant A (Fig. 5.36). Near Telmucho bridge it goes upto the mark of 366 mg/l. 278 mg/l estimated at the confluence point of the River Damodar and Karori. Here COD value is low due to addition of non polluted water in the river system. COD value at Mohalbani bridge and Sudamdih railway bridge having 292 and 355 mg/l respectively. High value of COD at these points is due to discharge of washery effluents and domestic sewage of that area. It has been estimated that about 4 tonnes of good quality of coal daily discharged into the Damodar river.

Total suspended matter (TSM) in studied samples is found between 202.5 and 530 mg/l (Fig.5.37). Highest value of TSM found at Telmucho bridge followed by the water sample collected from Chandrapura Thermal Plant B (522 mg/l). High value of TSM at Chandrapura Thermal Plants is due to introduction of (settle down) fly ashes released by the plants through stack gases. 480 mg/l TSM found at Sudamdih railway bridge. Here high value is due to discharge of coal washery effluent in the river, which contains high amount of coal dust (Photo 3 and 4).

Dissolved solids in water of Damodar river is found under permissible limit. Collected water samples for the study shows that higher value of dissolved solids. It is found between 225 and 305 mg/l. Tolerance limit of Dissolved solids is 2100 mg/l for river water. Chloride concentration as chlorine is found very low. Maximum permissible limit is 100 mg/l. Chloride concentration found in the range of 10-19.2 mg/l. Ammonia nitrogen in river water found between 0.004 and 0.298 mg/l. Which is under prescribed limit.

Nitrate nitrogen in water samples of Damodar river for study the water quality found in the range 7.02 - 23.12 mg/l. Lowest value found at Chandrapura Thermal Plant A. Highest value found at the confluence of Katri and Damodar river is 23.12 mg/l which has been followed by in the water , collected near Sudamdih railway bridge (22.75). According to World Health Organisation (WHO) guidelines water having nitrate nitrogen more than 10 mg/l is injurious to health especially children. It causes disease called Methemoglobinemia.

Fluoride as Fluorine in water samples of Damodar river found between .316 - 1.34 mg/l. Highest concentration of fluoride estimated in the water sample collected from Telmucho bridge. Desirable limit of Fluoride (as Fluorine) in water is 0.6 - 1.2 mg/l. Low Fluoride level is linked with dental carries above 1.5 it may cause

Fluorrosis. Fluoride as F 0.314 and 0.348 mg/l found in the river water near Mohalbani bridge and Sudamdih railway bridge respectively. Damodar water near Mohalbani bridge is used for the drinking purposes after treatment. Supply of drinking water in mine, urban and semi urban area has been done by Mineral Area Development Authority (MADA).

Copper is an essential element of human body. Damodar river water contains low concentration of copper. Copper estimated in water sample varies between 0-0.030 mg/l. Tolerance limit of river water for copper is 2.80 ppm. Iron content in river water is found in between 3.24 mg/l to 12.51 mg/l. River water possessing 14.70 mg/l is understood uncontaminated.. If value of iron will go down below 5.0 mg/l indicates that water is the best quality. Lead content in river water is reported under prescribed limit. Zinc and Nickel are also found under permissible value.

Magnesium content in river water ranging between 8.21 and 16.4 mg/l.. Lowest concentration of magnesium in river water is estimates in water sample of Damodar and Katri confluence. It is understood that high value of magnesium is due to discharge of mine effluent from different colliery located at the vicinity of Damodar river. Tolerance limit of water for magnesium is 1.6 mg/l. High concentration of magnesium requires proper treatment before disposal. Most Probable Number (MPN) count varies between 2010/100 ml to 3000 /100 ml in studied samples. Maximum permissible limit for inland surface water, for MPN count is 5000 for 100 ml sample (IS 2296 - 1974).

Analysis of Mine Water samples of Lodna Area

Mine waters have been analysed four times in a year, viz., January- March, April- June, July-September and October- December (Tables 5.33 - 5.36). Detail analysis of mine water samples collected quarterly is given below:

(a) ***January -March***:

Before discussing the detail of mine water, it is better to mention that in this area underground mining performs important role in coal production. Due to increasing cost of underground production more thrust has been shifted towards open cast mining. Production by open cast process is more vulnerable than underground mining. The underground mining generate a lot amount of water present in fissure of the rocks.

Negative logarithm of Hydrogen ion concentration i.e., pH of the water sample indicates whether water is acidic, basic and neutral. It represents the negative value of Hydrogen ion concentration in water sample. All mined water samples having pH value in the range of 6.50 to 8.13. Mine water of Jeenagora Lodna colliery 1 pit, no. 4 colliery pit and South Tisra collieries having lower pH value . According to a study carried out in United States, consumption of such water may cause constipation. Visibility of water sample is clear. All water samples having total hardness more than 300 mg/l (WHO limit is 300 mg/litre). These mine water are very hard in nature. Mine water released by Joyrampur colliery is highest. Total hardness in this water sample is 620 mg/l flowed by mined water of Lodna colliery 7 pit X seam (600 mg/l). Hardness of Bagdigi water sample is 576 mg/l. This water is used for domestic purposes including drinking. Drinking water in collieries supplied by Mineral Area Development Authority (MADA). Such water is supplied for few hours in a week. Sometimes whole week water is not supplied for drinking purposes. So, in the absence of availability of alternate sources mine water is used for drinking purposes too.

Calcium in mined water ranges between 40-76 mg/litre. According to IS 10500-1983 Desirable limit of calcium drinking water is 75mg/l. So, calcium content in water samples is under prescribed limit. Magnesium content in mine water is higher than calcium hasn't magnesium content found in water samples of Lodna colliery pit. It is 68 mg/litre. Highest value of magnesium content is found in the sample of 7 pit x seam of Lodna colliery (106 mg/litre). Mine water of North Tisra has 100 mg/litre of magnesium . Desirable limit for this parameter is 30 mg/litre. In the absence of other sources, this can be extended upto 100 ml /litre (IS 10500-1983). Taking this matter into account some water consists higher value of magnesium. Magnesium content as Mg is 106 mg/litre present in mine water of 7 pit X seam of Lodna colliery followed by Joyrampur colliery. It causes encrustation in water supply sometimes and adversely affects on domestic one. Concentration of Potassium in mined water is under prescribed limit

Chloride concentration in mine water samples is found is under desirable limit. Desirable limit of this parameter is 200 mg/l (WHO Guidelines). Presence of sodium content in mine water is also under permissible limit. Presence of iron in water sample found in the range of 0.28 to 0.6-mg/l. Maximum concentration of iron in mine water sample should not exceed 0.1 mg/l (WHO). Iron as Fe in water sample should not exceed 0.3 mg/l (IS 10500 1983). Beyond this it may cause adverse effect on domestic uses and promotes iron bacteria.

Sulphate has important contribution in hardness of water. Mine water of Lodna Area having high concentration of sulphate radical. WHO limit is 200 mg/l. All water samples except three samples (Jeenagora, South Tisra and North Tisra) having high sulphate. Highest sulphate concentration is found in water of 1 pit of Lodna colliery. According to IS 10500- 1983 maximum limit for sulphate in drinking water can be increased upto 400 mg/l if magnesium (as Mg) does not exceed 30 mg/l. But all water samples have higher value of magnesium. Magnesium content in water samples has been already stated earlier.

Total dissolved solids (TDS) in mine water ranges between 514 - 1256 mg/l. Aesthetic value according to World Health Organisation guidelines maximum limit is 500 mg/l. Coal and its associated material get dissolved in water in main cause of high TDS value.

April - June period

Mine water pumped out having pH value in the range between 6.50 to 8.5 but according to IS 10500 - 1983 specification is ranges between 6.5 - 8.5 . Total hardness of mine water is high. Joyrampur colliery discharges hardest water (626 mg/l). This is followed by 7 pit of Lodna colliery, which has 604 mg/l as calcium carbonate in that water. Maximum hardness of water used in domestic purpose not exceed to 300 mg/l as Ca Co_3 while this has been extended upto 600 as per IS 10500 - 1983.

Calcium content in mine waters estimated ranges between 42-77 mg/l. Highest concentration found in mine water of North Tisra Colliery. High calcium content in mine water can damage the water supply structure due to encrustation in the supply system. This high content of calcium not causes any hazardous impact on health. Presence of magnesium in mine water ranges between 70 and 105 mg/l. No impact on health if magnesium is upto 150 mg/l provided the sulphate content is low in mine water. But in mine water sulphate value is high in all water samples. Sodium and Potassium concentration in mine water found under permissible limit. Chloride content is low in studied samples. Maximum value of Iron as Fe in water is o.65, in mine water sample of 7 pit of Lodna colliery. Some of mine water used for drinking and domestic purposes. A large amount of mine water discharged into jores (big drains) which ultimately met with the Damodar River.

July - September Period

Mine water having high pH value in this period. It may be due to influx of rain water which ultimatly go into the phreatic aquifers and pH value observed in the range between 6.65 and 8.25. Highest value of hardness is estimated in mine water collected from 7 pit of Lodna Colliery, is 600 mg/l. This is followed by North Tisra colliery (558 mg/l). All other water sample do not touch the mark of 500 mg/l. Calcium content and magnesium content estimated in mine water is found under limit. Only water sample of Joyrampur colliery crosses the mark of 100 mg/l. Magnesium as Mg is 102 mg/l in mine water of this colliery .

Potassium, chloride and sodium in mine water indicate that findings of these results are found under permissible range. Sulphate concentration in mine water found in the range between 180 -220 mg/l. This indicates that the hardness of water is due sulphate radicals. It means water possessing permanent hardness. TDS value is found in prescribed limit. If TDS value is found under 500 mg/l, it is best for human consumption.

October - December Period

The pH value of the mine water observed in this period is low against monsoon one. pH value found in the range of 6.81 - 7.50. Total hardness of mine water samples are under 600 mg/l value. Highest value of total hardness estimated in mine water of South Tisra Colliery (540 mg/l). Lowest value is estimated in water sample collected from 1 pit of Lodna colliery (330 mg/l). Calcium content found in the range between 40 and 74 mg/l. Magnesium and its salt has important role in hardness of water. In studied mine water it is found in the range between 72 and 106 mg/l. Mine water is used for drinking purpose due to unavailability of proper supply of water by the relevant authority.

Concentration of Potassium, sodium and chlorine in mine water is found under limit. Iron content is high but found under prescribed limit. As it is stated earlier that mine water is hard in nature. So, it must have high concentration of sulphate, bicarbonate or chloride of calcium and magnesium. TDS of these water samples are found in the range between 514 and 1254 mg/l. High value of TDS can cause disorders in the digestive system.

Handpumps have been installed by Public Health Engineering Department (Govt. of Bihar) and private persons having pH value in the range of 7.6 to 8.2. Physical appearance of water is clear. Hardness of these water samples estimated between 150 -580 mg/l as calcium carbonate. One sample of Loyabad village contains 580 mg/l calcium carbonate in water sample. Water having hardness more than 600 mg/l is not fit for u domestic use. Villages selected for the study the water quality falls under Jharia Coalfield (Table 5.37). Alkalinity of water samples varies between 180 and 640 mg/l. Water sample of Dhurkijori village lower alkalinity. Alkalinity value for the water sample of Loyabad village is 640 mg/l. Fluoride as fluorine is found under permissible limit. Chloride and other parameter which have been studied is found within the permissible limit.

Analysis of the Water samples Outside of the Jharia Coalfield

Chas block which is now under newly constructed Bokaro district is not under coalfield region has been taken for the study the water quality. The main aim of this study is to assess the water quality of water. Is there any difference between the water of coalfield region and outside region. Total hardness of studied water samples found in the range of 50 to 250 mg/l as calcium carbonate. These water samples contain no harmful constituent, considered fit for human consumption. All parameter which have been studied are found under permissible limit except fluoride (Table 5.38). Only a few samples having either high or low as per IS - 10500, 1983 .

Table 5.31

Physico - Chemical characteristics of Coal washery Effluents of Lodna Coal Washery (1996-97)

Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct	Nov.	Dec.
Temperature	27.1	28.1	26.9	28.1	29.2	30	31	31.5	29	29	28	27
pH	7.82	7.56	7.83	7.74	7.84	7.94	7.87	8.47	7.82	7.72	7.72	7.52
DO	0	0	0	0	0	0	0	0	0	0	0	0
Tot. Alk	88.2	73.8	72	70	80	98	75	83	74	110	82	84
Tot Had	316	356	304	340	340	440	360	362	360	335	330	320
TSS	1725	1570	895	1500	1500	1800	1700	1825	1500	1900	1600	1625
TDS	1125	100	950	1620	1210	1300	1075	1475	1075	1200	1200	1025
TVS	815	827	770	1050	920	1100	800	980	810	1100	1075	1100
Sulphate	24	11	9	20	27	30	20	25	25	24	24	24
Chloride	32	28	22	30	28	38	26	34	35	32	31	34
Fluoride	0.03	0.01	0.01	0.04	0.08	0.15	0.08	0.06	0.08	0.06	0.08	0.08
A. Nitrate	36	52	28	32	32	34	35	35	40	34	34	34
Cal.	72.6	56	48	72	72	80	82	84	75	82	85	85
Mag.	52	42	37	43	43	50	44	52	53	43	52	44
Iron	0.31	0.36	0.26	0.28	0.35	0.34	0.32	0.32	0.5	0.31	0.3	0.33
D. Iron	0.2	0.15	0.1	0.05	0.15	0.22	0.2	0.22	0.21	0.16	0.2	0.2
Chrom.	0.05	0.04	0.01	0.04	0.05	0.06	0.06	0.05	0.05	0.06	0.06	0.06
Phenol	0.04	0.02	0.01	0.05	0.04	0.08	0.06	0.06	0.07	0.08	0.06	0.07
O & G	9.2	8.1	7.6	9.2	9	8.5	8.5	9.3	8.75	9.25	9.3	9.3
BOD	300	235	170	270	310	320	350	340	350	375	275	290
COD	1130	1102	1072	890	1110	1105	1175	1075	1125	1200	1175	1040

All value in mg/l except pH , otherwise mentioned

DO- Dissolved Oxygen , Tot. Alk.- Total Alkalinity, Tot. Had.- Total Hardness, TSS – Total Suspended Solids, TDS – Total Dissolved Solids, TVS – Total Volatile Solids, A Nitrate – Ammonia Nitrate, Cal. – Calcium, Mag. – Magnesium, D. Iron – Dissolved Iron, Chrom. – Chromium, BOD – Biological Oxygen Demand,COD – Chemical Oxygen Demand, O& G – Oil and Grease, Temperature in ^{0}C

Table 5.32

Physico - Chemical Charecteristics of Damodar River water falling under Jharia Coalfield (1996-97)

Parameters	Chandrapura Plant A	Chandrapura Plant B	Telmucho Bridge	Confluence of Damodar and Katri River	Mohalbani bridge	Sudamdih Railway bridge
Temperature	31	33.8	33.2	27.9	28	28
pH	8.09	7.61	7.58	7.38	7.05	7.39
Dissolved Oxygen	6.65	5.81	3.1	6.58	3.35	6.35
Biological Oxygen Demand	9.25	17.5	21.7	11	12.6	11.6
Chemical Oxygen demand	280	475	36.6	278	292	355
Total suspended matter	418	522	530	383	202.5	480
Dissolved Solids	254	305	296	297	225	245
Nitrogen as Nitrate	7.023	11	18.5	23.12	13	16
Fluoride	0.516	1.05	1.34	0.316	0.316	0.348
Copper	0.16	0.026	0	0.016	0.022	0.014
Iron	5.6	12.51	6.86	6.6	3.24	4.58
Lead	0	0.03	0	0.01	0.012	0
Zinc	0	0.056	0.06	0.028	0.069	0.038
Nickel	0	0.013	0.03	0.01	0	0
Magnesium	8.21	11	12.86	16.4	8.16	8.35
MPN/100ml	2500	2350	2450	3000	2010	2400

MPN – It denotes Most Probable Number

All values are mg/l except pH, otherwise mentioned

Table 5.33

Physico - Chemical Charecteristics of Mine Water Samples

Period October - December (1996)

	1	2	3	4	5	6	7	8
pH	7.14	7.04	6.85	6.88	6.98	6.94	7.50	6.81
Colour	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Tot Had	480	372	410	330	340	488	540	340
Calcium	70	42	50	44	42	74	72	40
Magnesium	90	72	104	66	70	106	100	72
Potasium	12	18	14	14	15	26	22	16
Chlorine	60	32	52	40	34	45	76	44
Sodium	32	22	30	22	18	20	26	28
Iron	0.45	0.35	0.50	0.50	0.35	0.28	0.28	0.30
Sulphate	220	184	200	210	220	210	178	200
Cond micro mho/cm	1482	980	1400	1020	980	1290	1390	986
TDS	710	670	514	678	710	910	1254	712

All values except pH are in ppm (mg/L), otherwise mentioned

1. Bagdigi 12 Pit X seam
2. Jeenagora X seam
3. Lodna Colliery 7 pit X seam
4. Lodna Colliery 1 Pit seam
5. Lodna Colliery 4 Pit seam
6. Joyrampur Colliery (near Lodna Area Office)
7. North Tisra near English school
8. South Tisra Colliery

Table 5.34

Physico - Chemical Charecteristics of Mine Water Samples

Period July – September (1996)

	1	2	3	4	5	6	7	8
pH	8.2	6.65	8.25	6.98	7.00	6.92	7.51	6.82
Colour	Clear							
Tot Had	510	408	600	320	340	482	558	360
Calcium	68	42	48	40	40	72	72	42
Magnesium	84	66	100	64	70	102	100	72
Potassium	11	15	12	14	14	26	24	16
Chlorine	62	30	51	38	32	44	72	40
Sodium	30	20	23	22	15	20	24	26
Iron	0.55	0.4	0.5	0.5	0.4	0.3	0.28	0.3
Sulphate	218	180	220	208	210	212	180	202
Cond micro mho/cm	1476	1220	1640	1012	995	1298	1398	990
TDS	775	700	710	680	730	920	1260	720

Value in ppm (mg/l) except pH, otherwise mentioned

1. Bagdigi 12 Pit X seam
2. Jeenagora X seam
3. Lodna Colliery 7 pit X seam
4. Lodna Colliery 1 Pit seam
5. Lodna Colliery 4 Pit seam
6. Joyrampur Colliery (near Lodna Area Office)
7. North Tisra near English school
8. South Tisra Colliery

Table 5.35

Physico - Cheemical Characteristics of Mine Water Samples

Period April - June (1996)

	1	2	3	4	5	6	7	8
pH	8.07	6.50	8.25	6.92	7.01	8.17	7.61	6.82
Colour	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Tot Had	580	408	604	364	356	626	562	364
Calcium	74	46	54	42	42	72	77	42
Magnesium	90	70	105	69	72	102	104	72
Potassium	15	20	17	16	17	27	24	18
Chlorine	64	32	140	42	34	45	74	44
Sodium	38	20	30	23	18	20	28	28
Iron	0.50	0.45	0.65	0.50	0.40	0.45	0.30	0.30
Sulphate	232	190	224	244	232	220	172	204
Cond micro mho/cm	1500	900	1410	1015	980	1300	1398	990
TDS	718	678	520	684	720	914	1258	720

All values except pH are in ppm (mg/l), otherwise mentioned

1. Bagdigi 12 Pit X seam
2. Jeenagora X seam
3. Lodna Colliery 7 pit X seam
4. Lodna Colliery 1 Pit seam
5. Lodna Colliery 4 Pit seam
6. Joyrampur Colliery (near Lodna Area Office)
7. North Tisra near English school
8. South Tisra Colliery

Table- 5.36

Physico - Chemical Characteristics of Mine Water Samples

Period January – March (1997)

	1	2	3	4	5	6	7	8
pH	8.02	6.50	8.11	6.87	6.98	8.13	7.51	6.79
Colour	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Tot Had	576	400	600	360	350	620	560	360
Calcum	72	45	52	42	42	70	76	40
Magnesium	88	70	106	68	70	104	100	70
Potassium	12	18	14	14	15	26	22	16
Chlorine	60	30	50	40	32	45	72	42
Sodium	32	20	30	22	18	20	26	26
Iron	0.50	0.40	0.60	0.50	0.35	0.40	0.28	0.30
Sulphate	230	190	220	240	230	220	170	200
Cond micro mho/cm	1480	970	1410	1010	980	1290	1390	986
TDS	710	670	514	680	712	910	1256	710

All values except pH are in ppm (mg/l), otherwise mentioned

1. Bagdigi 12 Pit X seam
2. Jeenagora X seam
3. Lodna Cdliery 7 pit X seam
4. Lodna Colliery 1 Pit seam
5. Lodna Colliery 4 Pit seam
6. Joyrampur Colliery (near Lodna Area Office)
7. North Tisra near English school
8. South Tisra Colliery

Table 5.37

Physico - Chemical analysis of Potable water of Dhanbad Block (1996-97)

	1	2	3	4	5	6	7	8	9
pH	7.6	8.0	8.2	8.10	8.2	8.1	8.0	7.6	8.0
Colour	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Tot Had	150	580	400	250	260	150	200	220	236
Tot Alk	180	640	470	280	300	184	248	260	276
Fluoride	0.9	0.9	0.6	0.7	0.8	0.8	0.6	0.8	0.9
Chlorine	20	70	60	44	50	20	24	24	24
Iron	2.5	0.3	0.4	0.25	T	3.0	0.25	0.3	0.4
Sulphate	5	180	140	50	60	25	30	35	40
Cond micro mho/cm	660	880	1750	530	930	590	910	910	910
TDS	290	580	525	350	380	290	410	410	410
Turbidity	15	5	5	5	5	10	10	5	10

Values in ppm(mg/l) except pH, otherwise mentioned

(1) Village Dhurkijori
(2) -do- Loyabad
(3) -do- Loyabad
(4) - do- Putki
(5) -do- Siyalgudri
(6) -do- Algana
(7) -do- Dhobni
(8) -do- Siyalgudri
(9) -do- Parsia

Table - 5.38

Physico - chemical characteristics of Handpump water, out side coal mining area (1996-97)

	pH	Turbidity	Colour	Total Hardness	Total Alkalinity	Fluoride	Chloride	Iron	Sulphate	Conducivity micro mho/cm	TDS
Chas College	7.4	5	C	170	190	0.65	25	0.1	20	570	310
Santhaktih	7.1	6	C	250	300	0.72	22		25	588.6	370
Chnayar	7.01	5	C	140	170	06	28	0.2	18	307.5	200
Bhindagora	6.8	10	C	400	444	0.8	20	0.2	180	1052.4	690
Bedani	6.5	5	C	120	160	1.24	20	0.25	5	440.5	280
Sidhbani	7.06	4	C	90	124	0.2	18	T	2	88.6	50
Barmasiya	7.10	3	C	50	170	0.4	18	0.25	T	151.4	100
Sardaha	7.6	5	C	180	180	0.2	50	T	10	578.9	386
Uppertola	7.2	6	C	140	220	0.7	60	0.3	<0	752.9	480
Nawadih	7.1	7	C	240	254	1.13	64	0.3	30	752.4	350
Chandank-yari	6.5	8	C	180	220	0.4	60	0.5	20	555.6	700
Chandank-yari	7.2	5	C	160	180	0.5	56	0.25	5	1070.6	100
Ghaghri	7.3	6	C	80	100	0.6	44	T	5	152.4	110
Lanka	7.3	7	C	100	124	0.7	24	0.3	25	172.6	400
Chandank-yari	6.5	8	C	220	260	2.2	44	0.25	20	611.4	100
Sahistola	7.6	5	C	150	180	1.16	20	0.2	15	152.6	300
Block Campus	7.2	5	C	130	164	1.52	20	0.4	5	462.4	300

Values in ppm(mg/l) except pH, otherwise mentioned

C denotes Clear

Land Degradation

Introduction

Land degradation is a complex phenomenon because there is a multitude causes and effects, both opposite and offsite. All human use land for their livelihood. The state of the land and its impact is critically influenced by nature' wheel of fortune which brings great variations in rainfall, wind and temperature patterns. Much land degradation is taking place during periods of extreme climatic conditions such as prolonged droughts, severe flooding and so, forth.

Coal is either excavated by opencast process or by underground mining. During underground mining board and pillar method is most widely accepted. Pits were abondoned as the seam of high grade coal ran out. It means that the inferior quality coal seams are lost as the trapped coal become practically irrecoverable. Large amount of coal remained in pits in the form of pillars to support the surface.

Surface mining causes land disturbance where overburden is removed by extraction of soil sand or gravel. In both cases, fertile, top soil or soil fertility may be lost. Due to this activity surface hydrology of that area has changed. Mining wastes includes rocks or low grade ore.

Excavation of coal from underground seams had certain consequences for the surface. During the process whole amount of coal is excavated from the cavities. The cavity formed as a result of underground mining seldom stowed (filling of cavities or mining site by soil materials) by sand, cause the water from the surface to drain into these cavities. On this process moisture is retained by the topsoil. It decreases the fertility of the land surface. Agricultural yields are also influenced by mining activities. It has adverse impact on agricultural yields. Entire eastern coalbelt is mono crop region lacking any substantive source of irrigation.

In Jharia it is not water but fire which is causing the problem of land subsidence. Underground fire which first broke out in 1920s is still burning. It is now posing a major threat to Jharia Township itself. A number of other localities along the Katras road are also badly affected like Kendwadih, Karkend Bazar, Eka and Bansjora. According to a BCCL (Bharat Coking Coal Ltd. a subsidiary of Coal India Ltd.) estimate in 1972 about 80 million tonnes of prime coal was lost due to fire since opening of the coal mining in the JCF (Jharia Coalfield). According to a CMPDIL (Central Mine Planning and Design Institute Ltd. a subsidiary of Coal India Ltd.) report 33 million tonnes of coking coal have already been lost while another 50 million tonnes are trapped underneath the burning seams.

It is estimated that for every million tonne of coal extracted through open cast mining a surface area of about 11 hectare (ha) gets directly damaged. A similar area is also damaged due to creation of external over burden dumps. About 20.77 million tonnes of coal produced by opencast mining in the year 1974 - 75 having 26.29 per cent share of total coal production. Over burden removed due to this process in the same year was 16.70 million tonnes with stripping ratio 0.80. The coal produced in 1986- 87 causes over burden removal of 185.62 million tonnes. In 1995 - 96, 361.08 million tonnes over burden generated by the production of 182.43 million tonnes of coal with stripping ratio of 1.98. Share of opencast mining in this year was 76.895% of total coal produced in the country.

In open cast mining land affected twice. First top soil which may contain fertile quality has been dumped at other place without proper care. So, a lot of fertile soil is lost by this process. Formation of soil takes thousands of years. When production process begins in the area causing not only production of coal but also overburden. Explosives are used to initiate the process causing damage to environmental structures viz., buildings, dams etc. Land is degraded due to coal mining in the study area are:

(1) Mine fire activities

(2) Subsidence

(3) Quarry and external dumping

(1) Mine Fire

Introduction

Coal mine fires present a very serious hazard to both the safety and the environment (health) of mining operations. Although the mining industry has

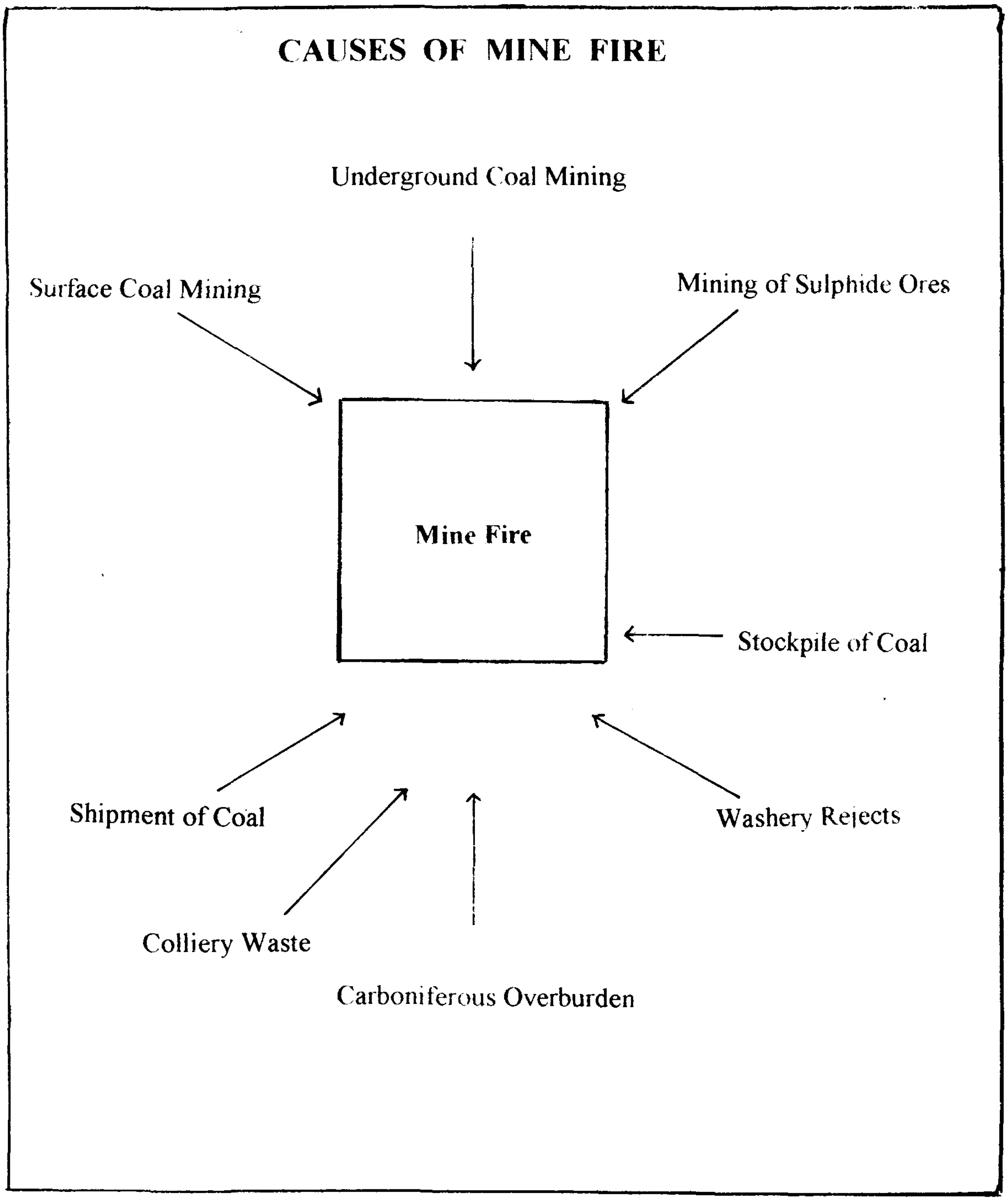

CAUSES OF MINE FIRE
Underground Coal Mining
Surface Coal Mining
Mining of Sulphide Ores
Mine Fire
Stockpile of Coal
Shipment of Coal
Washery Rejects
Colliery Waste
Carboniferous Overburden

Fig. 5.41

considerable knowledge and experience in combating mine fires, major losses and damage still frequently occur. Among the major loss as loss of life and closure of numerous mines are more common. Serious fire often results in the closure of the mine and sterilisation off large quantities of reserves (Plate 4).

Cause of fire

Fire hazard is associated with underground mining of coal. It occurs due to oxidation of the sulphur minerals which produces intense heat and release of large amount of toxic gases, fumes and smokes. Sometimes coal mine or water damp fire burns uncontrolled for years together. Therefore, proper precautions to prevent fires are taken throughout the coal mining operation (Fig. 5.41).

Coal like other carbonaceous material undergoes autooxidation when exposed to air. If the condition of confinement is such that the heat produced by autooxidation is not fully dissipated, the temperature rises and ultimately coal catches the fire .In coal mining even with best technology and efforts some amount of coal is left is goaved (space left after mining) out area. Unless the area is completely separated to cut off the supply of the oxygen the remaining coal may catch fire. Development of the subsidence cracks provides passage of the supply of the oxygen. A coal seam may also catch fire at its outcrop region, particularly at quarry edge if due to negligence, some hot material is dumped against the coal face. A fire once started in a coal seam, gradually starts spreading in all direction. All seams found in the area have been affected by mine fire.

The fire can be broadly divided into three areas as follows:

(a) ***Lodna Bagdigi Fire*** - In this area fire exist between XI/XII to XV seams.

(b) ***Jeenagora Joyrampur Fire*** - This fire exist in XI, XII, XIII & XIIIB seams.

(c) ***South Tisra*** - North Tisra fire - In this area VII, VIII, IX & X seams are affected by fire.

(a) ***Lodna Bagdigi Fire*** - Here fire took place in the XV seam in 1935. Water jets and water gas had been used to control the fire. This incident took lives of 19 persons. After then fire dvanced into upper seam and still advancing towards Dhanbad - Patherdih Railway Line. 8 Pit, 13 Pit, Tar plant i.e., XV, XIVA, XIV, XIII B & XIII A are on fire.

Beniagir Fire - This fire has occurred in XV seam in Beniagir in Bhalgora Area and also spread into upper seams viz., XIV A & XV . This fire is proceeding toward 2 pit Bhaga.

Bhaga Fire - This fire had been traced in 1946. It is the result of spontaneous heating of coal. XV, XIV A & XIV seams are affected by this fire.

New Standard Lodna Fire - This fire is from the erstwhile North Barakar Colliery. This has also occurred due to spontaneous heating, which is advancing from north side along XIV A and XIV seam towards Lodna. This fire is approaching towards Pit No. 1,2, & 4 of new Standard Lodna . XIII, XI & XI seams have also come in the contact of this fire.

Madhuban Fire - This fire is the result of heating of debris in XI /XII seams in the year 1978. It is now advancing through X, XII & XIII seam towards dip side and have reached upto Chatkori Jore endagering Chatkori Jore , Dhanbad Patherdih Railway Line, Lodna Washery, New Standard Pits and Lodna Bazar area.

Jeenagora - Joyrampur Fire

Introduction

Both Jeenagora and Joyrampur colliery having similar threats due to presence of fire. Some wise steps have been taken in past but the same could be useful to control the spread of the fire. X, XI/XII, XIII & XIII A seams of Jeenagora colliery under fire. In Joyrampur colliery fire exist in XI/XII , XIII, XIII A, & XIII B seams. On surface there are two fire in Joyrampur colliery which need immediate attention.

(a) Jeenagora colliery -

(1) Fire in X seam - this seam falls under Khas Jeenagora(K.J) Section (Central Jeenagora). This fire started in 1944 and extended upto new Jeenagora in the north and up to the boundary of South Jeenagora in the south. In 1972 it crossed the barrier of north, it reached upto Kalithan Jeenagora and South Tisra Colliery. To check the fire a trench had been dug in 1960.

(2) Fire in XIII/XIII A seam K.J. section- In March 1978 a dangerous magnitude of flame has been observed in the shale heap near railway siding. After removal of shale the fact become cleared that the fire has travelled in XIII seam of K.J. Section from Joyrampur by puncturing the barrier mentioned above. The sea of fire was located to the near boundary in XIII seam.

(3) It is apprehended that the XIII seam fire has travelled to XI/XII seam through goaf in Khas Jeenagora Section.

Joyrampur Colliery

(1) Fire in XIII B and XIII A seams

The first fire in XIII A seam was reported in 1965. This fire extended in the dip so,that between railway tract and jore have also travelled to XIII A seam working lying about 13 metres below. Joyrampur Barraree section adversely affected by this fire due to fire caught in XIII B seam in 1968. This being interconnected with XI/XII seam goaf in Lower Jorrampur section affected working of XI/XII seam.

(2) Fire in XIII seam

The fire was first detected in 1976 in XIII seam of Lower Joyrampur. Khas Joyrampur section came into the contact of fire in 1989 which is caved upto VII seam.

(3) Fire in XI/XII

This fire first was observed in 31st December 1989 Necessary steps have been taken to control the fire to check further extension towards XIII B section of Khas Joyrampur.

North Tisra Colliery

Here fire started in the year 1964 from 9 seam of LUJ in Quarry debris. These fires gradually spread upto 4 top and bottom seam. This fire has apparently travelled towards SG unit and at present spread to No. 8 seam and 7 seam top and bottom workings. During the year 1989 blazing fire was detected at the quarry edges of 8 seam where innumerable connection exist. During June 1991 a blazing fire was detected in 7 seam top section.

South Tisra Fire

Introduction

About 0.24 sq. Km of this area under fire and nearly 10 million tonnes of coal are locked inside the earth due to this activity in various seams of that area. X, IX, VIII and VII seam worst affected by fire and extended upto Diamond Tisra section, Bengal Jharia section and South Tisra Section.

The X seam quarry fire of North Tisra crossed over to IX/X seam quarry at Diamond Tisra section of South Colliery in the year 1973. Preventive measures had been taken to stop the fire activity. To check its advancement toward IX/X seam within a span of 2 years. In the meantime fire encroached IX/X seam quarry of AG Section in the year 1975. To check its further advancement it was decided to dig out a trench along IX/X seam but after sometime this has been suspended due to higher intensity of fire. In 1976 again fire broke out in underground working of IX, VIII and VII seams of D T section. After stowing some portion the opening of these seams were closed in 1977. To protect Jeenagora Goluckdih branch (E. Railway) siding lines from the aggression of fire, South Tisra project started in 1982. About 33 Hectares of affected surface area was blanketed with matti during the period upto 1983.

On 22. 04. 84 fire crossed through stopping No. in VII seam working in A G section. Seeing the thickness it was decided immediately to stop the fire activity the area stowed. It was further decided that other seams should be isolated to check the activity in VII and VIII seam. On 24.04. 1986 the fire crossed through the side of stopping of VII seam out by dissolution stopping. Stowing was done to prevent spread of fire. Besides these the fire will produce adverse impact on various environmental structures which are mentioned below:

(a) Branch Railway line feeding to Joyrampur is endangered.

(b) Hard coke batteries at Joyrampur are endangered.

(c) Dhanbad Balliapur Road, which is passing through Jeenagora, suffers from severe threat to fire.

(d) Chakkari jore is endangered in Joyrampur colliery as well as in Jeenagora colliery.

(e) Endangered surface structures of the area 400 houses, office store and hospital shall have been to rehabilitate (Plate 5).

(f) Madhuban bazar

(g) Lodna coke plant, Tar plant and entire Lodna colliery complex.

(h) Dhanbad Patherdih main Railway line from Bhulan Bararee colliery to 8 pit of Lodna colliery.

Detail profile about the fire, seam thickness and interburden thickness in different seams of Lodna area.

(1) Jeenagora colliery -There are six seams present in the area .Upper most seam is 13A (Table 5.42) and lower most seam is 9. Approximate thickness of 13 A seam is 2.4 metres. There is no fire in 13 A seam. The 13 seam is found below 13 A seam which is 4.8 metres thick. Interburden thickness (non coal material) on that seam is 6 metres . Seam number 11 and 12 is merged in one seam in this colliery area having 7.9 metres thickness . Interburden thickness on that seam is 12.6 metres . Most thickest seam is 10 seam which is having 10 metre thickness . Most thickest interbrurden is found on 10th seam in this colliery. Seams affected by fire are 13, 11/12 and 10 . Here mining is done by underground process.

(2) Lodna colliery - There are sixteen seams present in this colliery. The uppermost seam is 16th seam which is 3 metres thick. No fire is present in this seam (Table 5.43). This seam is near about 120 metres deep in the earth surface. That's why here

coal is excavated by underground process. Seam 15 A is just below the 16th seam, which is 1.7 metres thick Interburden thickness on this seam is the most thicken interburden in this colliery. This seam is affected by fire. Seam 14th is the most thickest seam found in this colliery, which is also suffering from fire. Seams facing the severest fire are 15A, 15, 14A. 14, 13B, 13A, 13 and 11/12. Seam 15th is divided into 15A and 15 th and 13 th seam divided into three seams i.e.,13B, 13A and 13th. Coal is excavated by underground mining except in seam 11/12 where it is done by open cast process. Two seams are separated from one another by non coal materials called inter burden. It varies between 1.4 metres and 65.5 metres. Special seam(XA) and the seam present below this seam are not facing fire threat . Seam 7th is the lowest seam found in this colliery . It is 6.71 metres thick having 3.1 metre thick interburden above it .

(3) North Tisra colliery- There are 7 seams present in this colliery . The uppermost seam is a combined seam of 11 and 12 . It is 7.6 metres thick facing no fire (Table 5.44). Below this a joint seam is present. It is 3.8 metres thick possesssing 61 metres thick interburden. Coal excavated from uppermost seam by open cast process. The process of Underground mining has been applied to excavate the coal from 10 top seam. No fire present in this seam. Seams below 10 top seams facing fire threat. Both surface and underground mining have been used to excavate the coal from this seams . The 9th seam (VIIIA) has 30.5 metres thick interburden . It is 3.7 metres thick.

(4) South Tisra colliery- There are six coal seams found in this colliery . The uppermost and lower most seams are divided into two parts. Uppermost seam is 10 top seam (X) followed by 10 bottom seam (IX) .The upper most seam is the most thickest seam (Table 5.45). Coal is excavated both from underground and surface mining. These seams experience fire. The 10 bottom seams is 5.2 metres thick and has only 1 metre thick interburden. The thickest interburden is present on 9th (VIIIA) seam. The lowermost seam is 7 bottom (V/VI). It is 6.3 metre thick and has 5 metres thick interburden. All seams located in this area have been facing severe threat of fire .

(5) Joyrampur colliery- The uppermost seam is 13B seam. It is 4 metres thick facing fire threat. Coal is excavated from this seam by both underground and surface mining (Table 5.46). Seam number 13A(XIIIA) is found below the 13B seam. It is 2.4 metres thick having 17.4 metres interburden on it. The 11 th and 12 th seams are found in jointed form. Fire problem in 13B, 13A, 13, and 11/12 seams posses fire. In rest of the seams viz.,10 top , 10 bottom, 9 ,8 and 7th seam coal excavated with underground process. No fire is present in these seams.

(6) Bagdigi colliery- There are 8 seams present in this colliery. The uppermost seam is still unmined and this seam possess no fire. Seam number 15th is just below the 15A seam (Table 5.47). It is 8.5 metres thick possessing 36.9 metres thick interburden. Here coal is excavated from underground process. Fire is present in this seam. The 11 and 12 th seams are in jointed form. This is the lower most seam found

in this colliery. No fire is present in this seam. Fire is active in 15A, 15, 14A and 14 seams. No fire is seen in 13B, 13A and 13th seams.

Subsidence

Introduction

Subsidence is the sinking or lowering of the land surface. It is a slow process. It takes place gradually, almost imperceptibility or it may occur quite suddenly. It affects the area from few square metres to as large as 1000s of square kilometres. Sometime it occurs due to natural phenomena, in other it is induced by withdrawal of fluids or by the mining or dissolution of solid materials.

Coal mine subsidence is the local lowering of the ground surface caused by underground extraction. Subsidence causes trough type depressions and occurrence of grown holes. Such type of phenomena can cause significantly environmental problem in mining areas. It includes surface instability damage to the structures modification to surface drainage and groundwater regime.

Special type of problem caused by room and pillar mining. Since the method off mining is applied mainly in relative shallow (usually less than 300 metres below the surface) conditions. Here subsidence can be observed during the life of the many and mine years after mining has caused. Where subsidence occurs at the surface and pillar mine. There are two main factors, however, which are characterised by

(i) A general saucer - shaped or elongated depression which can be over a relatively extensive area and

(ii) Sinkhole development which is localised and can form of a steep conical depression or a hole with vertical sides and occasionally of appreciable depth.

A common cause of subsidence in room and pillar mining is that of localised roof failure, especially over mine junctions. It results migration of rock from the pillar into the mine out openings. Sinkhole development is the most common form of surface subsidence associated with room and pillar working.

Mining subsidence induced sinkholes are hazardous are disruptive to the surface mining regarding present day and future uses of the surface. It can prove to be significant to surface movement and quality of sub surface water. It mainly occurs due to shallow underground mining using inappropriate techniques.

Where ground water movement is impeded, the level of water table is maintained despite ground subsidence resulting from mining because water can flow from the edge of the subsidence through rise in the original level. During the subsidence therefore, the groundwater table only appears to rise as its distance from the ground surface is reduced.. By contrast, ground water without inflow and influence and foliage or ground water system isolated in lower strata will go down with subsiding grounds.

Results and Discussion

It has been already mentioned that whole study area divided into six parts or colliery units. Detail information about subsidence in the area has been mentioned below:

(A) Lodna- For excavation purpose it is divided into nineteen parts. XV seam excavated at five points (Table 5.48). This seam is 6.70 metres thick and situated 126 metres below the earth surface. These zones are depillared before took over of the nationalisation of coal industry. These zones are filled by water. There are four zones in XV/XIVA and XIV seams. Thicknesses of XIVA and XIV seams are 2.13 and 8.3 metres respectively. XIVA seam is found 130 metres below from the earth surface. These zones depillared before took over of this industry. Nationalisation of coal industry started in 1973 and got completed in 1976. Details regarding subsidence is not available. These zones are affected by minefire. 10 to 12 zones also depillared before take over. Mining seams affected by fire. 13th seam has highest depillared zone. It is 46.5 hectare. The coal excavated from XI/XII to XIII B seams. This is 80-120 metres below the earth surface. Area depillared before took over of this industry. Data regarding subsidence is not available. Seam thickness varies between 1.7 and 14.02 metres in this colliery area. No subsidence is observed in this region.

(B) Bagdigi -This area classified in zone number 21 which consists 37.37 hectare depillared in this zone. XV and XIVA /XIV seam affected by coal mining in this area

(Table 5.48). These seams ranging between 24 and 72 metres. No subsidence observed in this area.

(C) Joyrampur - Depilllaring zone in this colliery covering an area of 14. 87 hectare (Table 5.48). Area depillared before take over. Here subsidence is observed which is due to crack. Here coal is excavated between 60 and 167.68 metres below the surface of the earth. Seam thickness found in the range of 1.8 to 9.4 metres. This area is divided in to six zones.

(D) Jeenagora - This area is divided into 17 zones , starting from 31 and ends up to 47. Depillaring area ranges between 0.6 and 26 hectares (Table 5.48) . Seam thickness varies between 1.8 and 10.06 metres . Various seams excavated from 26 metres and 125 metres depth from the surface . Minor subsidence has been observed in this area . Some seams depillared before take over , while some are started after nationalisation of coal industry . Subsidence observed in VIIIA and VIII seams in 1993 -94 period . seams like IX/X caught under fire has also subsided.

(E) South Tisra - Numbering of this area started from 51 and ends to 58 (Table 5.48). Total depillar area in this colliery region is 81.77 hectares. Seams from which coal has been extracted at present time are o seam, special, 6 seam, 7,8,9 and 10 seams in this area. Here coal is extracted from 21 metres to 120 metres of depth. Depillaring started here in and after nationalisation. Records are not available for the seams that depillared in 1988 and 1994. Space created by excavation of coal has been stowed by clay and sand It is due to presence of fire in VII, VIII, IX and X seams of the area.

(F) North Tisra - Total depillared in this colliery region are 43.14 hectares. Seams which are in operation are 10, 7,8 and 9 .other seams like 0 and 6 are also functional. Seam thickness varies between 3.2 metres and 13.7 metres (Table 5.48). Location of these seams varies between 25 and 60 metres in the earth surface. Some parts of 10, 7 and 8 seams depillared before take over of the coal industry. In 1973 0 seam had been depillared. Sixth seam depillared in 1982, 1983 and 1993.Detail information regarding to subsidence is not available. Some seams like VII, VIII and IX caught fire causes heavy loss of coal.

(3) **Quarry and external dumping**

In chapter three nature and methods of coal mining has been already discussed. Both types of mining are prevalent in the area. Underground mining causes subsidence which has been already discussed above. In the study area large portion of the land used for opencast mining. Generally coal is found 4-10 metres below the earth surface. In opencast mining firstly oerburden lying on the coal deposits has been removed and then this material dumped at another place. So, it has been found that here land degraded twice. Here land is also degraded by abondoned mines (mines producing no coal). The land degraded by surface mining and overburden dumping are shown in fig 5.42.

Land Degradation due to Coal Mining in Lodna Area

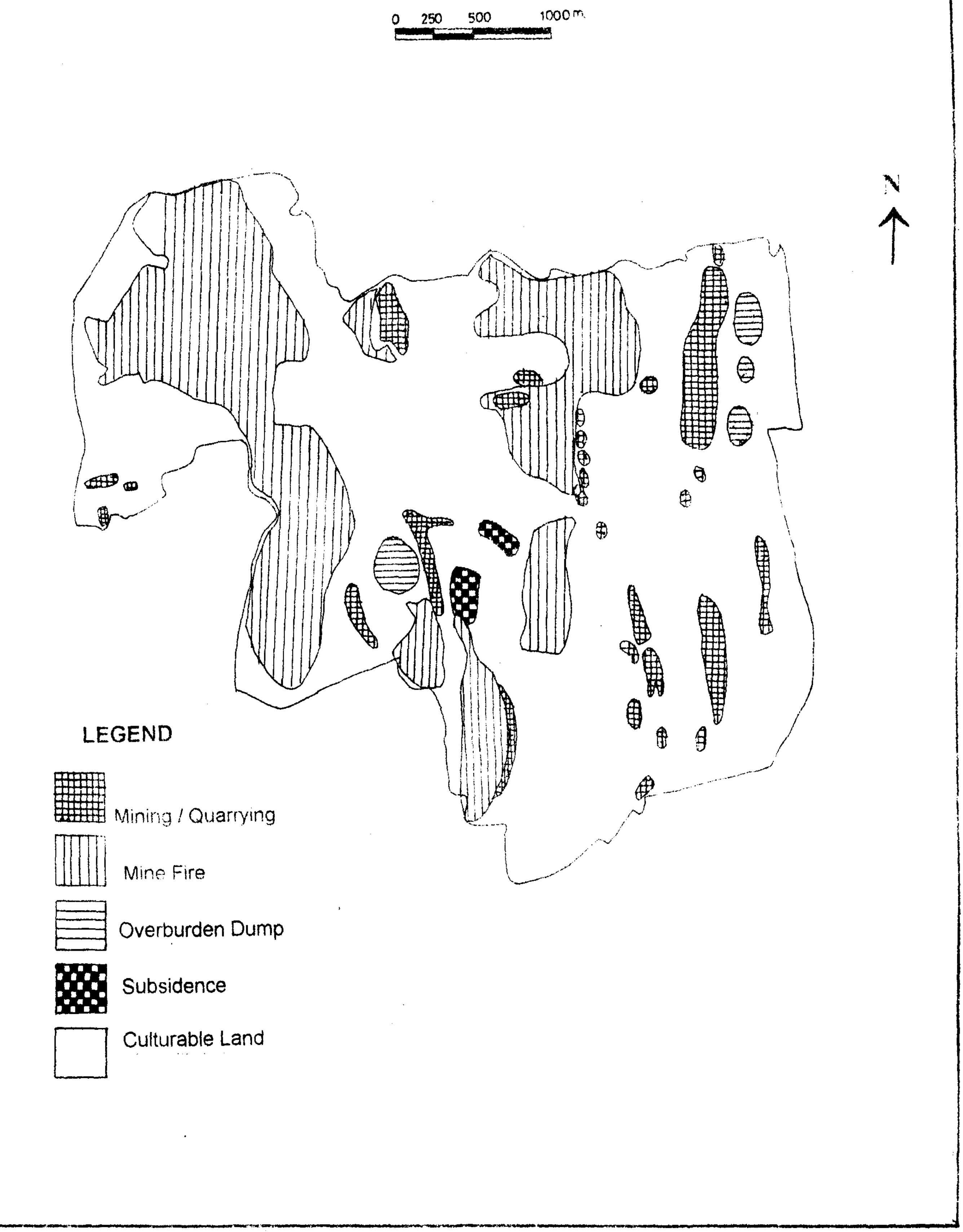


Fig. 5.42

Conclusion

On the basis of available information and data it can be said that coal mining has negative impact on land in the study area. Out of total leasehold area 1447.51 ha, 432.77 ha land degraded due to this activity (Fig. 5.42). Mine fire which is associated with underground mining plays a vital role in this activity. This fire not affected land only but also destroyed a large amount of coal in the area. About 313.12 ha land comprises approximately 21.63 per cent of total leasehold area is under fire threat. Opencast mining which become more prevalent in late 80s generated a large amount of overburden. Dumping of this overburden degrades the area about 13.35. Abaodoned quarries also degraded a large portion (55.11 per cent) of land in the area. About 38.51 ha land degraded due to active mining. Smaller portion of land has been degraded by subsidence. However, there are various spots has been detected where land may subside any time.

Table 5.41

Reserve of Seam on Fire

Seams	Reserves in Million Tonnes
XIV	0.96
XIV A	0.41
XIV	2.95
XIII A	0.22
XIII B	0.10
XIII	0.27
XI/XII	5.82

Table 5.42

Partial Summary of Seam Thickness and Interburden Thickness of Jeenagora Colliery

Seam thick-ness	**Name Geology**	Approx. seam thickness (metres)	Approx. Inter burden thickness (metres)	Mining Status	Fire Present
13 A	**XIII A**	2.4		Underground (old)	NONE
			6.0		
13	**XIII**	4.8		Underground & Surface (old)	YES
			12.6		
11/12	**XI/XII**	7.9		Underground & Surface (old)	YES
			11.6		
10 A	**X A**	1.8		Underground (old)	POSSIBLY
			55.5		
10	**X**	10.0		Underground (old)	YES
			24.0		
9	**IX**	1.8		Underground (old)	NONE
			-		

Table 5.43

Partial Summary and Interburden Thickness of Lodna Collery

Seam Colliery	**Name Geology**	Approx. Seam Thickness (Metres)	Approx. Inter-burden Thickness (Metres)	Mining Status	Fire Present
16	**XVI**	3.0		Underground (old)	NONE
			65.5		
15 A	**XV A**	1.7		Underground	YES
			36.9		
15	**XV**	7.3		Underground (old)	YES
			5.1		
14 A	**XIV A**	2.2		Underground (old)	YES
			18.8		
14	**XIV**	8.1		Underground (old)	YES
			13.5		
13 B	**XIII B**	2.8		Underground (old)	YES
			5.8		
13 A	**XIII A**	3.5		Underground (old)	YES
			8.7		
13	**XIII**	3.3		Underground (old)	YES
			18.4		
11/12	**XI/XII**	7.3		Underground & Surface	YES
			15.8		
Special	**X A**	1.37		Underground	NONE
			-		
9/10 Top	**IX/X TOP**	6.1		Underground	NONE
			1.4		
9/10 Bot	**IX/X BOT**	5.2		Underground	NONE
			10.71		
Local	**Local**	0.61		Underground	NONE
			4.6		
8 A	**VIII A**	2.6		Underground	NONE
			6.7		
8	**VIII**	2.7		Underground	NONE
			3.1		
7	**VII**	6.71		Underground	NONE
			-		

Table 5.44

Partial Summary of Seam and Interburden Thickness of North Tisra Colliery

Seam Colliery	**Name Geology**	Approx. Seam Thickness (metres)	Approx. Interburden thickness (metres)	Mining Status	Fire Present
11/12	**XI/XII**	7.6			
			61.0		
10 Top	**X**	3.8		Underground	NONE
			3.1		
!0 Bot	**IX**	6.1		Underground & Surface	YES
			30.5		
9	**VIII A**	3.7		Underground & Surface	YES
			5.7		
8	**VIII**	2.6		Underground & Surface	YES
			-		
7 **Top**	**VII**	5.6		Underground & Surface	YES
			4.0		
7 **Bot**	**VI**	5.8		Underground & Surface	YES
			-		

Table 5.45

Partial Summary of Seam and Interburden Thickness of Joyrampur Colliery

Seam Colliery	Name Geology	Approx. Seam Thickness (metres)	Approx. Inter-burden Thickness (metres)	Mining Status	Fire Present
13 B	XIII B	4.0		Underground & Surface (Active & old)	YES
			17.4		
13 A	XIII A	2.4		underground and Surface (Active & old)	YES
			7.0		
13	XIII	3.6		Underground & Surface (Active & Old)	YES
			21.6		
11/12	XI/XII	7.6		Underground & Surface (old)	YES
			79.3		
10 TOP	X TOP	9.8		Underground	NONE
			4.0		
10 BOT	X BOT	3.0		Underground	NONE
			28.0		
9	IX	1.8		Underground	NONE
			33.5		
8	VIII	2.9		Underground	NONE
			3.0		
7	VII	6.1		Underground	NONE
			11.6		

Table 5.46

Partial Summary of Seam and Interburden Thickness of South Tisra Colliery

Seam colliery	Name Geology	Approx. seam thickness (metres)	Approx. Interburden Thickness (metres)	Mining Status	Fire Present
10 TOP	X	5.0		Underground & Surface (old)	YES
			1.0		
10 BOT	IX	5.2		Underground & Surface (old)	YES
			26.0		
9	VIII A	2.8		Underground (old)	YES
			06.8		
8	VIII	2.5		Underground & surface (old)	YES
			4.5		
7 TOP	VII	6.3		Underground & Surface (old)	YES
			5.0		
7 BOT	V/VI	6.3		Underground (old)	YES
			-		

Table 5.47

Partial Summary of Seam and Interburden Thickness of Bagdigi Colliery

Seam colliery	**Name geology**	Approx. seam thickness (metres)	Approx. Interburden Thickness (metres)	Mining Status	Fire Present
15A	**XVA**	1.0		Unmined	None
			36.9		
15	**XV**	8.5		Underground (old)	Yes
			5.5		
14 A	**XIVA**	2.4		Underground (old)	Yes
			18.8		
14	**XIV**	8.5		Underground (old)	Yes
			13.5		
13 B	**XIIIB**	2.3		Underground (old)	None
			10.5		
13 A	**XIIIA**	2.5		Undrground(old)	None
			5.6		
13	**XIII**	3.6		Underground(old)	None
			16.8		
11/12 TOP	**XI/XII** TOP	2.1		Underground (active)	None
			3.0		

Table 5.48
Detail Profile of Subsidence in Lodna Area

Colliary Name	Zone	Dipillars (ha)	Dipillared seams	Seam Thickness (m)	Depth from Surface (m)	Dipillaring Year	Subsidence Observation	Remarks
Lodna	1	2.93	XV	6.7	12.6	Pre Take Over	Records are not available	Water Logged
	2	1.54	XV	6.7	12.6	Pre Take Over	Records are not available	Water Logged
	3	0.51	XV	6.7	12.6	Pre Take Over	Records are not available	Water Logged
	4	1.1	XV	6.7	12.6	Pre Take Over	Records are not available	Water Logged
	5	0.9	XV	6.7	12.6	Pre Take Over	Records are not available	Water Logged
	6	12.3	XV/XIV A/XIV	6.7/2.13/8.3	115/130/145	Pre Take Over	Records are not available	Suspected Fire
	7	1.5	XV/XIV A/XIV	6.7/2.13/8.3	115/130/145	Pre Take Over	Records are not available	Suspected Fire
	8	10.21	XV/XIV A/XIV	6.7/2.13/8.3	115/130/145	Pre Take Over	Records are not available	Suspected Fire
	9	10.5	XV/XIV A/XIV	6.7/2.13/8.3	1115/130/145	Pre Take Over	Records are not available	Suspected Fire
	10	3.3	XV to XIV A	6.7/2.13	69/79	Pre Take Over	Records are not available	Suspected Fire
	11	1.54	XV to XIV A	6.7/2.13	69/79	Pre Take Over	Records are not available	Suspected Fire
	12	9.1	XV to XIV A	6.7/2.13	69/79	Pre Take Over	Records are not available	Suspected Fire
	13	46.5	XV to XI/XII	6.7/8.3/2.13	20/30/50/74/	Pre Take Over	Records are not available	Fire not detected

Contd....

				3/7.2	79/89/120			
	14	24.54	XI/XII - XIII B	7.2/1.7	12 to 80	Pre Take Over	Records are not available	Fire not detected
	15	10.6	XI/XII/XIII	14.02	20 to 70	Pre Take Over	Records are not available	Fire not detected
	16	29.74	XV t to XI/XII	6.7/1.53/2.14	35/45/54/70/	Pre Take Over	Records are not available	Fire in XI/XII/X
				/2.7/2.48/7.2	75/80/104			
	17	4.2	XI/XII,XIII,XIIIA,XIIIB	7.2/3.6/2.7	70/45/38/30	Pre Take Over	Records are not available	Fire in XI/XII
				/12.48				
	18	5.6	XI/XII	7.2	75	Pre Take Over	Records are not available	Stowed
	19	6.7	XI/XII/XIII	14.02	30	Pre Take Over	Records are not available	Fire Active
Bagdigi	21	37.37	XV/XIVA/XI	6.7/2.13/8.3	24 - 72	Pre Take Over		Fire in XIV XIVA,XV
Joyrampur	22	14.87	11or 12	7.4	60	Pre Take Over		Fire
			10 seam	9.4 Top Bottom	88.72	Pre Take Over	Subsidence by crake	
			9	1.8	126.22	Pre Take Over	Subsidence by crake	
			8	2.9	161.56	Pre Take Over	Subsidence by crake	
			7	6.7	167.68	Pre Take Over	Subsidence by crake	
	23	13.01	11/12/XIII/XIIIA/XIIIB	7.4	60	Pre Take Over	Subsidence by crake	
	24	6.13	Same as zone 22	Same as zone 22	Same as zone 22	After take over		
			except 11/12	except 11/12	except 11/12			
	25	2.79	Do	Do	Do	After take over		
	26	2.79	Do	Do	Do	After take over		
	27	0.67	X & IX	9.4/1.8	88.72, 126.13	After take over		
Jeenagora	31	0.6	IX/X	2.7	80	1976 - 1977	0.006	Fire
	32	3.7	IX/X	8.4	100	Before take over	0.37	Fire
	33	2.4	IX/X	8.4	110	Before take over	0.24	Fire

Contd....

	34	7.8			40 to 70	Before take over	0.078	
	35	2.5			90	Before take over	0.085	Fire in XI,XII,XIII,XIIIA
	36	2.7			70	IX/X	0.027	Fire
						Before take over		
						and rest 1972-77		
	37	2.5	IX/X & VIIIA	10.06 to 1.8	60	IX/X Before take		
						over and VIII		
						Seam in 89-90		
	38	26	IX/X, VIIIA, VIII&VII	10.6,1.8,2.4&5.7	15 to 25	IX/X,VIIIA Before	0.26	Fire in X seam
						take over and rest		
						in 1972-77		
	39	0.6	VIII	2.4	35	Before take over	0.006	
	40	1.2	VII & V/VI	5.7, 6.1	40	Before take over	0.012	
	41	1	VII	5.7	40	Before take over	0.01	
	42	0.7	VII	5.7	40	Before take over	0.007	
	43	2.6	IV Bottom	6.1	30	1981	0.026	
	44	2	II	6.1	50	1981-82	0.02	
	45	1.2	III	13	26	Before take over	0.012	
	46	0.6	III	13	26	Before take over	0.012	
	47	1.4	VIIIA & VIII	1.8 & 24	40	1993-94	0.006	
							0.014	
South Tisra	51	8.1	0 seam spl/1	4.9,2.13	33,30,21	1978, 1990	Records are not available	
	52	3.4	6 seam	6.5	33.04	1981-84	Records are not available	
	53	31.9	10,7,8,9	12.18,2.43,1.98, 11	120,101,75,77	Before take over	Records are not available	

Contd....

	54		10	12.18	77.72	1988-94	Records are not available	Stowed(Fire in VII,VIII,IX &X)
	55		XI/XI	7.93	50	Before take over	Records are not available	
	56		XI/XI	7.93	70	Before take over	Records are not available	
	57		XI/XI	7.93	65	Before take over	Records are not available	
	58		XI/XI	7.93	65	Before take over	Records are not available	
North Tisra	61	6.9	10 seam	13.7	50	Before take over	Records are not available	Fire in VII. VIII, IX
	62	3.9	10 seam	13.7	50	Before take over	Records are not available	Fire in VII, VIII, IX
	63	3.3	10 seam	13.7	50	Before take over	Records are not available	Fire in VII, VIII, IX
	64	5.8	7,8,9 seam	15.3	40	Before take over	Records are not available	Fire in VII, VIII, IX
	65	8.9	7,8,9 seam		40	Before take over	Records are not available	Fire in VII, VIII, IX
	66	3	7,8,9 seam		40	Before take over	Records are not available	
	67	1.3	0 seam	3.2	20	Before take over	Records are not available	
	68	1.4	6 seam	6.39	20	Before take over	Records are not available	
	69	0.9	6 seam	6.39	25	Before take over	Records are not available	
	70	1.8	6 seam	6.39	60	Before take over	Records are not available	
	71	5.94	10 seam	13.7	50	Before take over	Records are not available	Fire in VII, VIII, IX

Dust Pollution

Introduction

Jharia Coalfield is the only source of the prime coking coal in the country. Air pollution nowadays high due to increasing trends in opencast mining activities, vehicular emissions, soft coke making as well as due to the emission from numerous fire areas in the coalfields. Several reports on the air pollution reveal the fact that of suspended Particulate Matter (SPM) is quite high. In physical appearances about 70 percent of the population appeared either sick or in moderate state of health and by clinical examination 35 percent was found actually suffering from different ailments requiring treatment. A sample survey conducted by Central Mining Research Station Dhanbad in 1986 revealed the fact that out 10000 workers of all category taken for study showed that about 10.8 percent of them suffered from pneumoconiosis.

Banerjee et al., (1990) extensively studied the dust fall rate and SPM near a large fire area inccluding Lodna also of Jharia Coalfield for 26 months and observed that dust fall rate has increased over the years to 31 - 40 tonnes per square Km per month and 705 – 791 micro gram per cubic metre for SPM.

Bose et al, (1983) measured the seasonal value of SPM and dust fall rate during Summer , Monsoon and Winter season were 380 - 401 in summer season and 161 - 254 and 321 - 436 micro gram per cubic metre respectively in monsoon and winter seasons. Level of dust fall was 23 - 30.5, 7 - 13 and 15.5 - 18 tonnes per square Km per month for summer, monsoon and winter seasons respectively.

Dust comes out from various sources. Factories especially like cement, coal etc. And vehicles on the road are some of them. Around 40 percent of air pollution in India is Dust Pollution. Many morphological features are identified in plants which are helpful in scavamging dust from the atmosphere.

One of the major impacts of large scale mechanised opencast operation in the formation of large amount of SPM. The uncontrolled SPM not only creates serious health hazard but also affects the productivity through poor visibility and mainly detoriates the ambient air quality in and around the mine sites. Vehicular movement on the haul road is the most important cause of fugitive dust emission. This is nearly 85 percent of the dust emitted from a surface coal mine.

According to a study Dust fall Rate in Administrative Block of Indian School of Mines, Dhanbad is found between 7.20 and 18.34 tonnes per square Km per Month and it is 58.67 tonnes per square Km per Month in Lodna Colliery office during April. In later part of the year the value decrease due to rainfall.

Dust Pollution by the Transportation

All forms of transport exhibit certain common environmental features. Coal is mainly transported by Railways and Trucks cause severe damage to environmental structures like buildings and highways. Thus transportation also contributes in air pollution.

The transport of coal in all its form necessarily involves fugitive dust even though the precautionary measures are being taken. It has been estimated that 0.02 percent of the coal lost as fugitive dust during loading and the same percentage lost during unloading (Plate 9). Until now actual loss occur during transportation. There is little information available regarding the fact that how much coal is lost en route. Air quality content in the vicinity of the reloading ways for coal transportation and storage may reach 100 mg per cubic metre and even higher if low wind velocity prevail. The dust in the environment greatly affects the crop, other vegetation and animals (Plates 10 and 11). Dust particles come into the atmosphere also affects the visibility and would prove a general disamenity.

Rail Transport

Coal is also transported by Rail. It is generally loaded at mine siding into the wagers will carry 55, 75 or 100 tonnes of coal. Fugitive emission is a common feature in railway transportation. Coal particles and other air pollutants released into the atmosphere in en route. It is now estimated that 25 percent of coal dust gone into the environment during loading and the same percentage lost during the time of unloading (Plate 7). Losses also occur due to spillage. Some study suggests that 0.2 Kg per tonne is lost during loading and the same amount is lost during unloading. In transit period 0.05 to 1.0 percent of coal dust released into the atmosphere. Szabo (1978) gave an illustration to study dust pollution that carries coal (Table 5.51).

Coal is carried by mainly trucks in road network (Plate 13). It has been mentioned that nearly 0.04 percent of coal lost as fugitive dust during the process of loading and unloading. Taking this fact into account the amount of coal dust lost as fugitive dust is shown in table 5.53.

Large proportions of coal transportation has been performed by rail network. Some study has been carried out in this respect reveals the fact 0.2 Kg per tonne coal is lost during loadiing and the same amount is lost by unloading and about 0.5 percent coal is lost as fugitive transmission during transit period.

Coal transported to various Thermal Power Station is beyond 985 Km. Coal supplied to such various Thermal Power Stations cause another loss of 0.5 Kg per tonne as fugitive transmission during transit is shown in table 5.55

Particular pollutants, which accounts for about 5 percent of the weight of all air pollutants make up a missellaneous category. The term particulate itself implies a single kind of gritty entity. However, particulate pollution has multiple components include sulphate salts dust from finely divided particulates of carbon or silica.

In the troposphere the residence time of particles ranges from 6 days to two weeks. But in lower stratosphere micron sized particles or smaller particles may remain for 1 to 3 years. This long residence in the stratosphere follows the photochemical process. Particles in the troposphere can produce changes in the earth surface, reflectivity, cloud reflectivity and cloud formation.

Coal washery not affects the aquatic system but also air. Coal washery where coal is washed for its utilisation in the blast furnace generates a lot of air pollutants. During the process huge coal hump (large size of coal boulder) has been broken into smaller particles (5 cm diameter). During the process huge amount of coal dust released into the atmosphere. On the basis of coal washing capacity it can be estimated that how much coal dust released into the environment. It has been estimated that 677 tonnes of particulate matter will go into the atmosphere in a year. Respiarble limit for particulate matter is 538 tonnes per year. This observation has made on the consumption of 8,46,000 tonnes of raw coal used by this washery for the year 1995 - 96. According to an estimate that 0.03 per cent material emitted as particulate matter into the surrounding atmosphere by the production of one tonne clean coal from a washery unit. Clean coal and middling production by this washery is shown in table 5.56. Coal has been used as raw material for clean production. About 151.5 thousand tonnes of clean coal produced in 1988-89 by Lodna Coal Washery which increased upto 170.2 thousand metric tonnes in 1989-90.After 1989-90 production of clean coal declined. It was 169.6 thousand tonnes in 1990-91. In next year there is an increase of 10.7 thousand tonnes has been observed in 1991-92. Increasing pattern in coal production has been observed up to 1993-94.Clean coal produced in 1994-95 was 195 thousand tonnes which further declined to 183 thousand tonnes in 1995-96. About 30.05 per cent decrease in coal production has been found between 1995-96 and 1996-

97. Clean coal Production has been reduced by 22.46 per cent in comparison of previous year.

On the basis of clean coal production from a washery unit, this can be calculated by above mentioned formulae (0.03 per cent material emitted as particulate matter into the surrounding atmosphere by the production of one tonne clean coal). Approximate emission of particulates in the environment was 459 tonnes in 1988-89. Respirable limit of particulate is 338 tonnes per year. So, emission of these particulates can cause adverse impact both on biotic and abiotic environment. Emission of particulates is very high in whole year period except 1997-98. This is due to low production of coal by washery. Highest value of particulates was estimated in 1993-94 (607 tonnes). Higher emission of particulates is due to poor management of washery. Electrostatic precipitator (ESP) has not been installed in the washery unit. It is helpful in controlling dust pollution inside washery.

After the process of coal washing we collect four materials. First clean coal followed by middling, after then slurry and finally rejects produced by washery unit. About 49.1 thousand tonnes of middlings produced in 1988-89. In next year it went down to 48.2 thousand tonnes which increased up to 49.3 thousand tonnes in 1989-90. Increasing pattern in middling production was continued till 1997-98. About 28 percent increase found in middling production between 1990-91 and 1991-92. About 6.38 per cent increase is lowest in whole year period as per data available. Middling production data has been given in table 5.56.

Coke plant is also present in the area. From every tonne of coal used for making soft or hard coke in beehive ovens (special type of oven used for preparation of coke), the pollutants released in the atmosphere is given in table 5.57 (Plate 12).

Hard Coke produced by beehive ovens (oven used for preparation of soft and hard coke) in the Lodna area has been given in table 5.58

About 0.1 per cent of coal lost as fugitive dust or particulates during coke formation. About 978.11 tonnes of particulates released into the atmosphere by the production of 97811 tonnes of coke during 1991-92. There is an increase in coke production causes more emission of particulates into the atmosphere in 1992-93. However low production of coke is observed in 1992-93. Coke production in study area during 1993-94 was 82140 tonnes which generated 821.4 tonnes of particulates in the environment.

Results and Discussion

Transportation of coal causes dust pollution. Coal is either transported by Rail or Road network. About 40/8 million tonnes of coal has been tranported by coal during the period 1991-92 to 1996-97 mainly by trucks from Jharia coalfield causing production of 2.49 million tonnes coal as fugitive dust in the environment during transit. From 1991-92 to 1996-97, 103.94 million tonnes of is carried by rail from different parts of Jharia coalfield producing 41.57 million Kg coal as fugitive dust the surrounding environment. Coal supplied to different thermal power stations during the period 1995-96 and 1996-97 is 57.2 and 75.6 lakh tonnes respectively. Fugitive transmission during transportation is 28.6 and 37.8 lakh Kg respectively dust in the form of Suspended Particulate Matter (SPM) and other noxious gases like Ammonia, Carbon monoxide,, Hydrocarbon are produced during preparation of Hard Coke from beehive ovens. Data of Hard Coke production by beehive ovens of Lodna area are available for the period 1991-92 to 1994-95. In Jeenagora and Bagdigi colliery there are no beehive ovens. Production of Hard Coke started in North Tisra Colliery from 199-95. Amount of Ammonia produced by preparation of Hard Coke is 1.0 Kg per tonne. Carbon monoxide, Hydrocarbon, SPM and Sulphur dioxide produced during Hard Coke preparation are 0.5 Kg per tonne, 4.0 Kg per tonne, 100 Kg per tonne and 1.9 Kg per tonne respectively (Table 5.57).

Conclusion

On the basis of information and data available regarding dust pollution it can be said that coal mining causing emission of large amount of dust in the environment. Concentration of particulates is above than respirable limit i.e., 338 tonnes per year. But here concentration of dust particles is much higher than permissible limit. Here dust emitted by coal mining, washery units and coke oven plants. Dust pollution causing severe impact on human health, it causes mainly lung cancer. Dust pollution can be minimised by sprinkling of water on the haul road and coal that is ready for transport.

Table 5.51

Atmospheric emission for a unit train transporting 11,430 tonnes of coal on a round trip of 985 Km (Szabo, 1978)

Emission	Kg per trip
Particulates	345
Sulphur dioxide	780
Nitrogen oxides	4855
hydrocarbon	2075
Carbon monoxide	935
Particulates during loading	2285
Particulates during Unloading	2285
Fugitive transmission in transit	5700
Total	19,260

Table - 5.5 2

Raw coal Offtake (Bharat Coking Coal Limited)

In Million Tonnes

Year	Total	Rail	Road	To power Houses *
1991 - 92	26.1	15.04	11.06	7.9
1992 - 93	27.63	17.00	9.87	9.9
1993 - 94	29.4	18.6	10.8	11.8
1994 - 95	29.1	18.7	10.4	11.3
1995 - 96	27.3	16.9	10.4	10.9
1996 - 97	27.5	17.7	9.8	12.4

Source: Bharat Coking Coal Limited, Dhanbad

- It is the part of transportation made by Railways. Name of the Power Houses to which coal supplied are Chandrapura Thermal Power Station, Bihar Thermal Power Station, Damodar Valley Corporation Thermal Power Station, Kota Thermal Power station, Panki, Tanda, Paricha, Harduaganj, Tamilnadu Electricity Board, Badarpur Thermal Power Station, Kolaghat, Barauni Thermal Power Station, Muzzaffarpur Thermal Power Station, Bokaro Steel Limited , Durgapur Steel Plant Thermal Power Station.

Table 5.53

Raw Coal Offtake by road (mainly trucks) and fugitive dust lost by this activity

Year	Offtake by Road (million tonnes)	Amount of coal lost as Fugitive dust (million tonnes)
1991 - 92	11.06	0.4424
1992 - 93	9.87	0.3948
1993 - 94	40.8	0.432
1994 - 95	10.4	0.416
1995 - 96	10.4	0.416
1996 - 97	9.8	0.392

Factor: Offtake of coal x 0.04 percent
Source: Bharat Coking Coal Limited, Dhanbad

Table – 6.54

Raw Coal Offtake by Rail and particulates lost during loading and unloading

Year	Amount of Coal transported by Rail (million tonne)	Amount of Particulate matter released into the environment (million Kg)
1991 - 92	15.04	6.016
1992 - 93	17	6.8
1993 - 94	18.6	7.44
1994 - 95	18.7	7.48
1995 - 96	16.9	6.76
1996 - 97	17.7	7.08
Total	103.94	41.576

Factor: Offtake of coal x 0.04 percent
Source: Bharat Coking Coal Limited, Dhanbad

Table 5.55
Loss of coal as Fugitive Transmission

Name of the Station	Transportation by rail 1995-96 in lakh tonnes	Transportation by rail (1996 - 97) in lakh tonnes	Fugitive transmission in 1995 - 96 in lakh Kg	Fugitive transmission in 1996 97 in lakh Kg
Kota	15.4	13.4	7.7	6.7
Ropar	18.6	21.4	9.3	10.7
Bhatinda	6.0	6.7	3.0	3.35
Badarpur (Delhi)	10.0	17.7	5.0	8.85
Tamilnadu Elec. Board	2.0	9.4	1.0	4.7
Harduaganj	5.2	7.0	2.6	3.5

Factor: Coal Transported x 0.5 Kg
Source: Bharat Coking Coal Limited, Dhanbad

Table 5.56
Clean Coal and middling production by Lodna Coal Washery Plant
(Figure in '000' Tonnes)

Year	Clean Coal Production	Middling Production	Approx. Emission of Particulates in Tonnes
1988-89	151.5	49.1	459
1989-90	170.2	48.2	516
1990-91	169.6	49.3	514
1991-92	177.3	64.1	538
1992-93	186.0	80.0	564
1993-94	200.0	67.0	607
1994-95	195.0	70.0	591
1995-96	183.0	94.0	555
1996-97	138.0	100.0	418
1997-98	107.0	107.0	324

Factor: Production of Coal x 0.03 percent
Source: Bharat Coking Coal Limited, Dhanbad.

Table 5.57

Pollutants released by coke oven plants by the production of soft or hard coke

Name of Pollutant	Quantity (Kg)
Carbon monoxide	0.5
Hydrocarbon	4.0
Ammonia	1.0
Sulphur dioxide	1.9
Suspended Particulate Matter (SPM)	100.0
Total	107.4

Table 5.58

Hard Coke Production by Beehive Ovens of Lodna Area

(Figure in tonnes)

	1991 - 92	1992 - 93	1993 - 94	1994 – 95
Lodna BP	57006	60152	43760	29458
BH	11522	11615	9861	3669
Joyrampur	13865	14307	13529	12707
South Tisra	15418	15122	14990	NA
Jeenagora	NA	NA	NA	NA
North Tisra	NA	NA	NA	15158
Total	97811	101196	82140	60992
Emission of particulates (Kg)	97811	10196	82140	60992

Source: Bharat Coking Coal Limited, Dhanbad

NA- Not Available

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CHAPTER VI

Environmental Impact Assessment

Introduction

Impact assessment is a concept that evolved in search for ways to render development and protection of the environment. It is the key matter of complex and interdependent world of today. It is becoming clear that air, water and soil must of necessity be treated precious natural resources requiring useful management The meaningful impactt assessment has to be taken up at the project at the inception stage i.e., use of the technology, sociological aspect and the physical structure of the area.

The environmental movement of the 1960s and early 1970s pioneered by the people such as Rachel Carson, Barbara Ward and Barry Commoner, resulted in environmental groups becoming physically active in many countries. As a partial response to these pressure groups governments accepted the principle that active organisations should have an opportunity to participate in the decision making process of those major developments which could have significant impacts.

In the early 1970 there was a greater environmental awareness, a realisation of limited natural resources, a requirement for greater public accountability by government and industry. The first comprehensive legislation in the United States, the National Environmental Policy Act (NEPA) came into force on January 1970. But in our country Environmental Protection came into force in 1986 when Parliament passed the law. Before this Air Pollution Act 1974 was passed by Indian Parliament and Water

Pollution Act 1982. But environmental awareness came into public after Environmental Protection Act (1986). Nowadays people aware about the environmental problems due to intervention of Judiciary. Due to order of Supreme Court all polluting industries have been closed and transferred from one place to other place.

In order to predict and assess the impacts associated with a proposed action it is necessary to describe the environmental setting in which the proposed action takes place. This gives the baseline information against which prediction and assessment can be made. Here author describing about the environment which has been degraded by coal mining. In early days environmental assessment was conducted to study about the impact of the proposed action of project. But nowadays it is widely used to study the impact which is still continuing in the particular area by particular activity.

Increasing demand for environmental quality and clean surrounding places a high priority on the quality of natural surroundings. Protection of scenery, clean air and water, minimisation of noise congestion and noxious city scapes and open space for active outdoor recreation have all taken on now importance. An impact can be defined as any change in physical, chemical, biological, cultural and socio-economic environmental system that can be attributed to human activities.

Because of great diversity of the biotic and abiotic elements and large number of possible states of relation between these elements, ecosystems are highly complex and can only be shown in the expert team. It is broadly divided into two parts:

(a) Abiotic factors - It includes climate, wind direction and speed, temperature, precipitation and morphology of terrain.

(b) Biotic factors - It mainly includes fauna (living animals) and Flora (plant kingdom).

Climate

The word climate has originated from Greek word Klima which means "an inclination or slope" e.g. of the Sun's rays; a latitude zone of the earth ; a clme. In the beginning climate has been understood to mean the atmospheric conditions that prevail in a given region or zone. In the older form "clime" was sometimes taken to include all aspects of the environment. The best modern definition of climate is " the total experience of weather and atmospheric behaviour over a number of years in a given region". Climate is an average of weather conditions prevailing over an area. It should include an average value of the climatic elements such as temperature, humidity, rainfall and wind that prevail at different times over an area. It must also include their extreme ranges, variability and frequency of various occurrences. Just as one year differs from another year by a smaller but sometimes significant amount. Therefore climate is time dependent and climate values or indices should not be quoted without specifying what years they refer to.

The epics like the Mahabharata and the Ramayna, poetic compositions of classical Sanskrit literature given in the more splendid pieces of information on climatology. The people of the epic age were aware with the chief characteristics of Indian climate and seasonal changes.

Atmosphere is the envelope comprising several colourless, odourless and tasteless gases over the earth. All living organisms can not survive without atmosphere. Atmospheric phenomena are a source of astonishment and awe to man from the childhood. We tend to call natural calamities as the act of God because we are not aware to its full process. The Aryans very early realised this fact that all the climatic phenomena develop and exist in the atmosphere which surrounds the earth surface.

Man has been dependent upon his natural environment, particularly upon the environmental process that we call as ' weather and Climate'. From early times man applying his knowledge to safeguard and improve the quality of life on this planet..

Traditionally, climate was considered to be a static parameter reflecting the mean state of the atmosphere and as such it was believed that though there may be variations in meteorological parameters in space and time. The debatable point nowadays is that climate change is no myth but it influences agriculture, hydrological resources and the quality of life in cities and rural areas.

Urban area is the major source of various types of emissions like carbondioxide, carbon monoxide, sulphur dioxide, nitrogen oxides and aerosols. Besides these mining and other industries also contributes a greater role in producing noxious gases. Their impact on climate reaches a beyond the limits of the urban area itself.

Ever since the birth of the planet earth, its atmosphere, land and ocean have interacted to produce its climate under the driving mechanism of solar radiation. Out of several reasons, one of the major reasons for change is the changing chemistry of the atmosphere. This clue has been drawn in United Nations Conference on Environment and Development (UNCED). It is now widely accepted that anthropogenic activities are producing disturbance in the equilibrium of atmospheric environment.

Unscrupulous use of natural resources causes global warming. Day by day we are augmenting noxious chemicals into the environment viz. nitrogen oxides, Carbon monoxide, carbon dioxide, sulphur dioxides and several other chemicals. If this trend is not stopped the temperature of the earth will be increased by 3.5 °C in the middle of the twenty first century. It produces deleterious effect on the environment.

Some other scientists explored the problem further, including the Stockholm conference on the Human Environment in 1972. Their warming led to a 1988 United Nations Intergovernmental Panel on Climate Change (UNIPCC) comprising some 2,500 scientists being established under the auspices of the World Meteorological Organisation and the UN Environmental programme.

Perhaps the largest ever congregation of Heads of Government took place in Rio de Janeiro in 1992 and nearly 170 signatory parties adopted the U N Framework convention on climatic change. The Summit officially called the 1992 UN conference an Environment and Development better known as **Earth Summit**.

Carbon dioxide is emitted by the burning of the coal, oil and natural gas. These fuels are an integral part of the modern economy and weaning the world from then has always been acknowledged as a difficult task. Mainstream climatologist say that such a doubling would raise the average surface temperature of the globe any where from a moderate 3 °F (Farenheiht) to potentially catastrophic 8 °F (a unit of temperature).

Temperature

Temperature is an important parameter of climate. Average surface air temperature varies between January and July. The value range from 35 degree centigrade in North America to below - 50 °C in Antarctica. The temperature is greatly influenced by altitude. The temperature is also affected by latitude, continentiality, ocean currents and prevailing winds.

Temperature is measure of the hotness of something. For a measure to be rational there must be an agreement upon a scale of numerical values defining hotness and upon devices for realising and displaying these values. The most commonly used practical scale is the International Temperature Scale (ITS) on which temperatures are designated as Celsius degree.

The impact of those factors in the long term of the planet can not be therefore, denied. Though studies in India indicate that there is a slight warming trend in the surface air temperature yet isolated cities and areas in the country show greater increasing trends in the temperature. Increasing in minimum temperature also confirming the hypothesis of heat islands.

Rupa Kumar and Hingane 1988 have analysed the temperature data of the major industrial towns. Results of their analysis reveal that these industrial cities (Calcutta, Banglore and Mumbai) have increasing trends of maximum and minimum temperature as compared to surrounding Delhi showed a cooling trend while Chennai and Pune did not show any significant trend.

Result and Discussion

Climatological data collected from Dhanbad observatory has been averaged to each 5 years except 1957 - 60 which is for 4 years period (Table 6.11). Dhanbad observatory was established in the year 1941. So, data collected from this observatory has been averaged in 1941 - 45, 1946 - 50 and so on. Climatological data for the year 1956 is not available so next average has been taken for 4 year period

As far data available it has been said that there is no major changes in temperature indices. Generally mean Maximum temperature found in the range between 31. 03 °C and 32.15 °C. Higher temperature has been observed in 1957 - 60, 1966 - 70 and 1976 - 80 periods which are 31.99, 31.78 and 32.15°C respectively. So, it can be said that coal mining has not adverse impact on temperature index in the area. Mean Minimum temperature of the area ranges between 15.99 °C and 21.19 °C. In 1941-45 period it was 20.05 °C which went down in 1946-50 period. Highest mean minimum temperature had been observed in 1957- 60 period which was 21.19 ^{0}C. This is due to average of the 4 years study. From 1976-80 onwards declining trend in minimum temperature had been observed. It was 19.47 °C in 1976-80 period. This was 17.66 ^{0}C in 1981-85 and 15.99 ^{0}C in 1986-90 period.

Mean value of relative humidity (RH) has been under 70 % mark up to 1966 - 70 period. Relative Humidity found in the range between 62.3 and 72.71 %. 62.3 % (RH) had been observed in 1951 -55 period. 70.79 % RH has been found in 1971 - 75 period. Relative humidity was 70.76%, 72.71% and 72.15% 1976 - 80, 1981 - 85 and 1986 - 90 period respectively. So, it can be stated that intense coal mining might have affected the relative humidity of the area after the beginning of the nationalisation. Before 1951 data had been recorded once in a day. From 1951 data had been recorded twice in a day. Relative humidity ranges between 46.8 and 62.88. In 1986 - 90 period only crossed the 60 % mark.

Rainfall

Like other meteorological indices data related to rainfall also averaged to the five year period (Table 6.12). The author takes monsoon period for the study of rainfall i.e., June to October. From November to May rainfall occur due to cyclonic efffect and reasons. So, these months have been not taken for the study of the rainfall.

1941 - 45 period - In this period 168.04 mm rainfall recorded in June month. Highest rainfall recorded in July month (401.42 mm). Lowest rainfall recorded in November month which is 5.82 mm rainfall recorded in August and September month are 357.08

and 109.9 mm respectively. Rainfall in next 5 year period has been averaged in the 1946 - 50. About 243.88 mm rainfall recorded in June month. Rainfall recorded in the month of July was 391.98 mm. Heavy showers witnessed in August month (692.78 mm).

1951 - 55 period

Highest rainfall recorded in August month which is 379.14 mm followed by July 371.16 mm Data of the year 1956 has been not available. So, next data averaged to four year period i.e., 1957 - 60. June month received 124.6 mm rainfall while highest rainfall recorded in the month of August which was 292.32 mm. 207.75 mm rainfall recorded in the month of September. Total rainfall recorded in this period is 1011.06 mm.

Rainfall recorded in **1961 - 65** period having lower quantity than previous four years period. June month of this period received lower amount of showers in comparison to previous period. All monsoon months except July having low rainfall (320.12 mm). In next five year period (1966 - 70) June month received high rainfall in comparison to previous five year period (200.2 mm). August month of this period received highest rainfall which was 401.7 mm while lowest rainfall recorded in October month which was 56.64 mm. In **1971 - 75** period average rainfall is higher than previous period . Highest rainfall recorded in the month of September and lowest in October. June month which is the beginning of monsoon period having slightly lower rainfall in comparison to previous period.

In 1976 - 80 period June month received highest rainfall since 1941 which is 299.36 mm. July month received high rainfall than previous one which is 366.9 mm. September month received 308 mm rainfall. Meteorological data from the month August to December is not available. So, average has been done on the basis of four years period for the month August to December. 283.28 mm rainfall recorded in the beginning of the monsoon season of the period 1981 - 85. July month receives highest rainfall (18.38 mm) in this period followed by August September and so, on. In last period of the studying the meteorological data June month received 229.84 mm rainfall. July month of this period having highest amount of rainfall since 1941 which is 556.3 mm which again followed by August, September and so, on. Meteorological data from the month of July to December for the year 1986 is not available. So, up to these periods it has been averaged in four years sequence for the above said period.

Conclusion

In mean maximum temperature there is no major change observed but slight deviation has been observed in mean minimum temperature after 1971 period. This is the period when nationalisation of coal industry began and ended upto 1976. Except 1976 - 80 period declining trend of mean minimum temperature has been noticed. This may be due to coal mining and allied activities. There is inverse trend against mean minimum temperature has been found. Upto 1970 Relative humidity (RH) at 8.30 hours is under 70 % mark but after 1970 it follows increasing trend. RH at 17.30 hours followed the increasing trend before 1951 - 1965. It has been declined in 1966 - 70 period but 1981 onwards it is increasing.

Table 6.11

Meteorological Data of Dhanbad Observatory for the period 1941-1990

	Mean Max. Temp	Mean Min Temp.	Max. Humidity	Min. Humidity
1941-45	31.03	20.05	68.4	NA
1946-50	30.91	19.57	67.99	NA
1951-55	31.84	20.52	62.3	46.8
1957-60	31.99	21.19	66.31	52.86
1961-65	31.41	20.32	64.43	54.51
1966-70	31.78	20.19	63.06	51.54
1971-75	31.5	17.7	70.79	58.73
1976-80	32.15	19.47	70.76	47.42
1981-85	31.03	17.66	72.71	55.93
1986-90	31.3	15.99	72.15	62.88

Data for 1980 (Aug.- Dec.) not available
Data for 1986 (Jul.- Dec.) not available

Table 6.12
Rainfall data of Jharia coalfield 1941 -1990 (in mm)

Month	1941 -45	1946 -50	1951 -55	1957 -60	1961 -65	1966 - 70	1971 - 75	1976 - 80	1981 - 85	1986 - 90
January	21.84	6.22	29.72	13.82	3.9	16.82	15.28	16.36	14.26	3.06
February	25.64	8.92	9.92	9.05	30.05	4.56	18.36	30.8	31.28	29.14
March	11.56	27.68	9.38	17.77	13.64	11.42	27.48	31.26	33.52	21.2
April	23.42	24.42	10.28	11.25	38.68					
May	39.34	70.76	35.28	23.92	57.68	96.38				
June	168.04	243.88	181.12	124.6	156.34	200.2	192.46	299.36	283.38	229.4
July	401.42	391.98	371.16	257.34	320.12	324.42	332.46	366.9	418.38	556.3
August	357.08	692.78	379.14	292.32	241.04	401.7	343.4	241.37	339.34	476.67
September	247.46	201.18	240.42	207.75	188.68	246.4	397.1	308	207.36	312.95
October	109.9	82.94	41.9	129.05	127.56	56.64	143	62.25	81.82	89
November	5.82	13.02	9.96							
December	1.4	1.56	1.76							

Hydrological cycle

Introduction

The term Hydrologic cycle has different meaning depending on the temporal and spatial scales. On the one hand it deals about the moisture fluxes over the entire globe in various forms. On the other hand it can refers to daily or monthly accounting of moisture inflows and outflows and storage of the basin Hydrological cycle has no beginning or no emd. Many processes are involved in it. After evaporation from ocean and land water becomes the part of the atmosphere. The evaporated moisture is lifted and carried into tthe atmosphere until it comes on the earth surface in the form of precipitation process. The precipitated water may be transpired by the plants or may flow over the ground surface. Remaining amount of water gets deposited into the big ditches for evaporation or latter runoff (the detention process). More portion of water intercepted into the atmosphere. The hydrologic cycle is not a simple process but it is complicated one consisting evaporation, precipitation, interception, transpiration infiltration, percolation, retention, detention, over land flow, through flow and runoff.

Numerous cycles like continental, regional and local are the components of hydrologic cycle. Although the total amount of water is constant but its distribution to various region may not be constant in the space and time. The distribution of the water has been influenced by various physiograaphic factors, including topographical features, geological formations and type of vegetation. These physsiographic factors in turn may modify distribution and frequency of rainfall; the occurrence of snow and ice and the effect of the wind, temperature, humidity and solar radiation on evapotranspiration (the loss of water from the soil by both evaporation and transpiration). Larrgest volume of water is stored in the ocean (97.5%). Glacier and ice caps store is only 2.4 %. Most scientists are aware of the great mobility of water in the hydrologic cycle- the unending flow of water in all of its various sites from the ocean to the atmosphere, to land, and back to the ocean again- such has not always been the case. The literature reveals a history of confusion and misunderstanding about he mobility of water and even the basic operation of the hydrologic cycle.

Hydrologic Cycle in Modern Perspective

Thornthwaite (1937) advocated the idea of the close relation between local evaporation and local precipitation, which is intimately related with environmental conditions. Cultivated soil would act like sponge and absorb rain rather than allowing it to flow off. The evaporation of this larger amount of absorbed rainfall would provide the moisture for increased precipitation year by year as cultivation spread.

Water Budget relation

$$P = R + E$$

P - Precipitation
R - Total Runoff
E - Evaporation

Precipitation

It represents an available water supply which must be distributed to fulfil various human demands (storage evapotranspiration, percolation, runoff).Precipitation occurs in various forms, viz., dizzle, rain, snow, sleet, haul etc. Precipitation is the result of large masses of air when cool down in the atmosphere. With the increasing height temperature would go down brings air current at the saturation point. Thus air with vapour pressure below saturation can be brought to saturation (100 per cent humidity) merely by efficient cooling.

The condensation process is quite different from the precipitation process. One process by which this can occur depends on the presence of both ice crystals and water droplets in the cloud. The saturation Vapour pressure with respect to ice is less that it is with respect to water at some below freezing temperature.

Evaporation

Evaporation or evapotranspiration, the combine loss from soil and vegetated surface, occurs when there is change of state of water from liquid to vapour. This is favoured by energy transfer as much as heat is required to effect evapotranspiration. Evaporation is the process by which molecule water at the surface of water or moist soil acquires enough energy by solar radiation by which it turns into gaseous state. Transpiration is the process by which plant losses water in the atmosphere. Water goes into the atmosphere through lower portion of the leaf. In many regions evaporation and transpiration are not measured separately and studied together as evapotranspiration. The amount of solar energy received at the earth surface may average more than 700 calories a square centimetre a day in hot and dry areas and less than 100 calories a square centimetre in polar regions.

The amount of energy required cubic centimetre of water is 597 calories. Therefore, if all the available energy were used directly by the evaporation, the maximum evaporation rates of almost 400 centimetres (157 inches) should be expected for water surfaces and maximum transpiration rates of 350 to 400 centimetres (138 to 157 inches) should be expected for the dense vegetation. But this is not reality because mostly long wave radiation lost in the way. In general 320 centimetres (126 inches) per year evaporation has been observed and only a few measurement of transpiration have averaged more than 220 centimetres (86 inches) per year.

Unless water table is within a few feet of the surface, ground water is not discharged by the evaporation. If the soil is thoroughly saturated, however, the rate of evaporation may approach that free water bodies.

Factors Influencing Evaporation

Evaporation is greatly influenced by Dalton's law, which is governed by environmental conditions. Meteoric and physiographic factor also influences the process of evaporation. Meteorological factors include temperature, humidity, wind barometric pressure and precipitation. Physiographical factors are water quality, depth of water body and composition and extent of water surface.

Change of water into water vapour requires heat energy which comes by solar radiation so solar radiation influence the evapotranspiration up to a great extent. It has been suggested that the term solar radiation is basically applicable to water losses from a free water surface. Solar radiation is dependent on time of day, the season, latitude and sky condition.

Interpretation of Worksheet

Evaporation of water has been calculated near water reservoir at Damsite in Dhanbad (Table 6.21). Average value of monthly temperature, heat index interim factor and sunshine correction factor are required for the study. More evaporation occurs when average value of temperature is high. High value of evaporation is found in the month of May and lowest in the month of December. Both temperature and heat index factors are high in May. Total amount of water evaporated in year is 70.95 inches (180.14 cm). In the month of May 28.52 cm of water evaporated in the atmosphere. In June 24.79 cm water goes into the atmosphere. In monsoon period it ranges between 16.99 cm and 24.79 cm Sharp decrease in evaporation has been found between October and November months of the year. It is 13.33 cm for October and 6.85 cm for November. Even a minute change in temperature affects the evaporation up to a great extent.

Runoff

A very important role of surface water in the hydrologic cycle is played by the runoff. Runoff (Streamflow) of the water discharged through streams consisting wholly or in part of water computed by overland flow (surface runoff) and group water flow or base flow .It is the flow collected largely within a drainage basin that subsequently appears at the outlet of the basin. The surface runoff is that part of the runoff travelling over the ground surface and through channels to reach the basin outlet. Overland flow is that portion of runoff, which flows over the land surface towards stream channels. After the flow enters into a stream, it joins with the other components of flow to form the total runoff or the streamflow in the stream channel.

Runoff depends on complex geological, meteorological, ecological, topographical and other conditions such as permeability and moisture content of the groundsurface and soil, intensity, duration and a real distribution of precipitation; humidity and temperature of the atmosphere; type and density of vegetation; slope of the land surface and depth of water table. Geological and topographical conditions and intensity of precipitation have pronounced opposite effects on the surface and groundwater runoff.

Seasonal and Annual Runoff

In some ground water investigation and many water balance studies estimation of monsoon or annual runoff is essential. A number of formula and tables are available for computation of runoff for different type of catchments in India (Dhir et al, 1955) An expression useful in this context is the runoff coefficient K that is expressed by

$K = R/P$

where R = Runoff in centimetre, P = Rainfall in centimetre

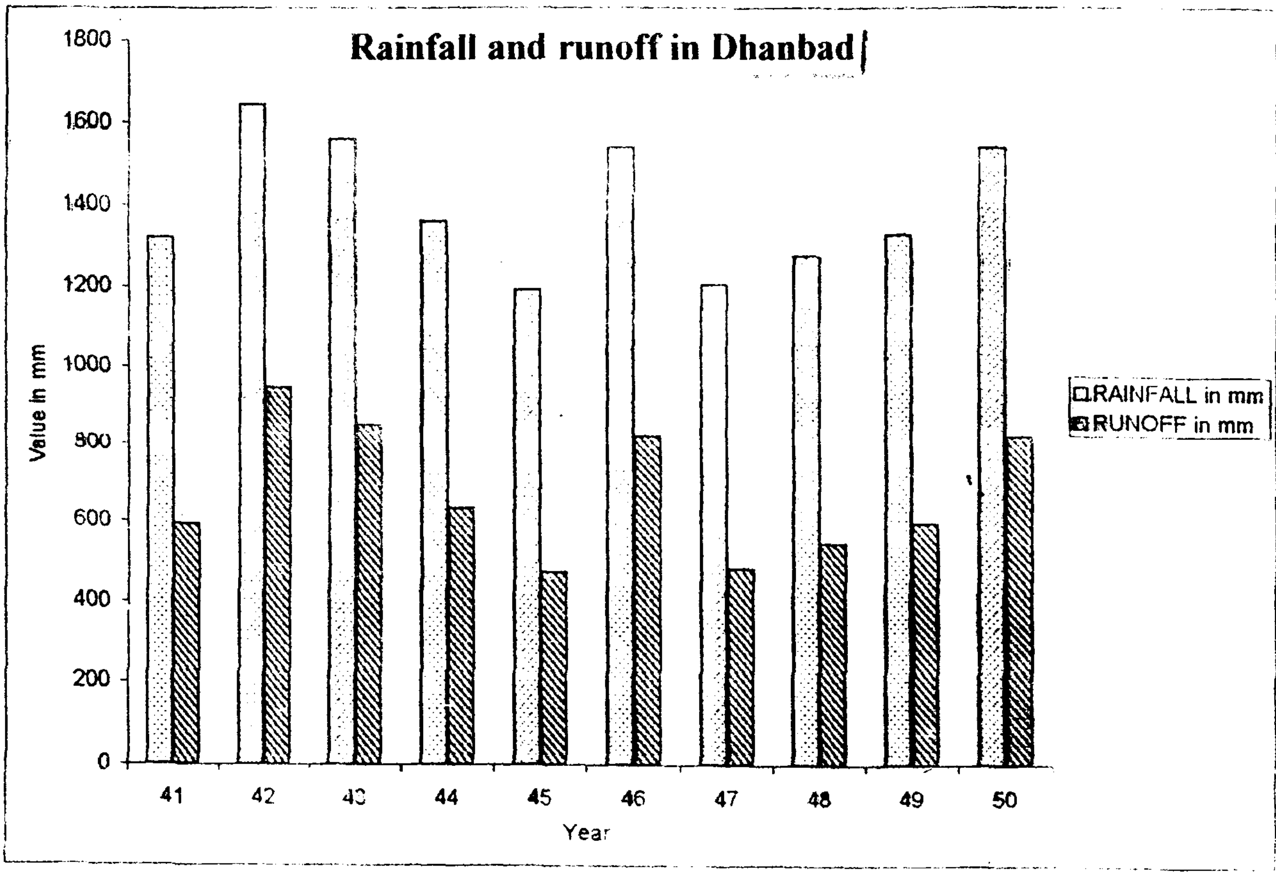
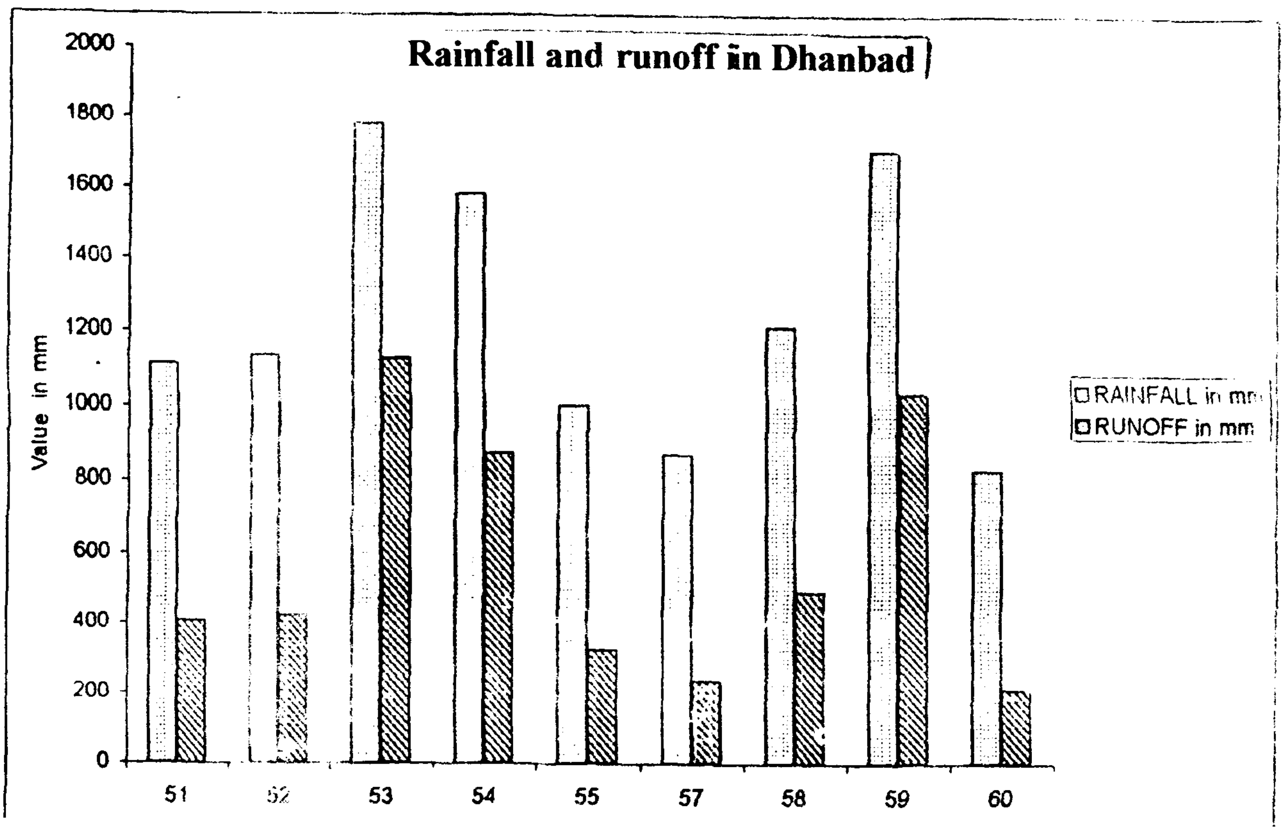

Rainfall and runoff in Dhanbad
Value in mm
RAINFALL in mm
RUNOFF in mm
Year
0
200
400
600
800
1000
1200
1400
1600
1800
41
42
43
44
45
46
47
48
49
50

Fig. 6.21


Rainfall and runoff in Dhanbad
Value in mm
RAINFALL in mm
RUNOFF in mm
0
200
400
600
800
1000
1200
1400
1600
1800
2000
51
52
53
54
55
57
58
59
60

Other formulae for estimation of catchment runoff from rainfall are Dhir et al, 1955 Ingress formula for ghat areas

$$R = 0.85 P - 30.5$$

Inglis formula for non ghat areas

$$R = \frac{(P - 17.8)}{254} \times P$$

Result and Discussion

For calculating runoff, data of rainfall has been used. Runoff is calculated in cm. This has been calculated by using Inglis formula for non ghat areas, which is mentioned above. Data of runoff has been analysed in five year interval. Rainfall data is available for 1941 to 1994 period. Runoff is totally dependent on the rainfall in the area. Value of runoff increases or decreases with rainfall. In 1941 total runoff in Dhanbad was 59.18 cm which went up to 94.42 in 1942. It was 84.82 cm in 1943. Runoff calculated for the year 1944 was 63.16 cm and low runoff was recorded in 1945. Its value increased in 1946 with increase of rainfall Difference between 1949 and 1950 was 35 cm The highest difference was observed between 1941 and 1942 and lowest between 1948 and 1949 (Table 6.22).

There was sharp decrease in runoff calculated in 1951. Previously it was 82.05 cm in 1950 (Fig 6.21) steep increase both in rainfall and runoff in 1953 In 1960 low runoff calculated ((21.03 cm) but in 1961 increase in runoff due to high rainfall in the catchment area (Fig. 6.22). The highest value of runoff calculated in 1968 of the 1960-1970 period (Fig 6.23) In 1971 high rainfall recorded i.e., 1929.4 mm which

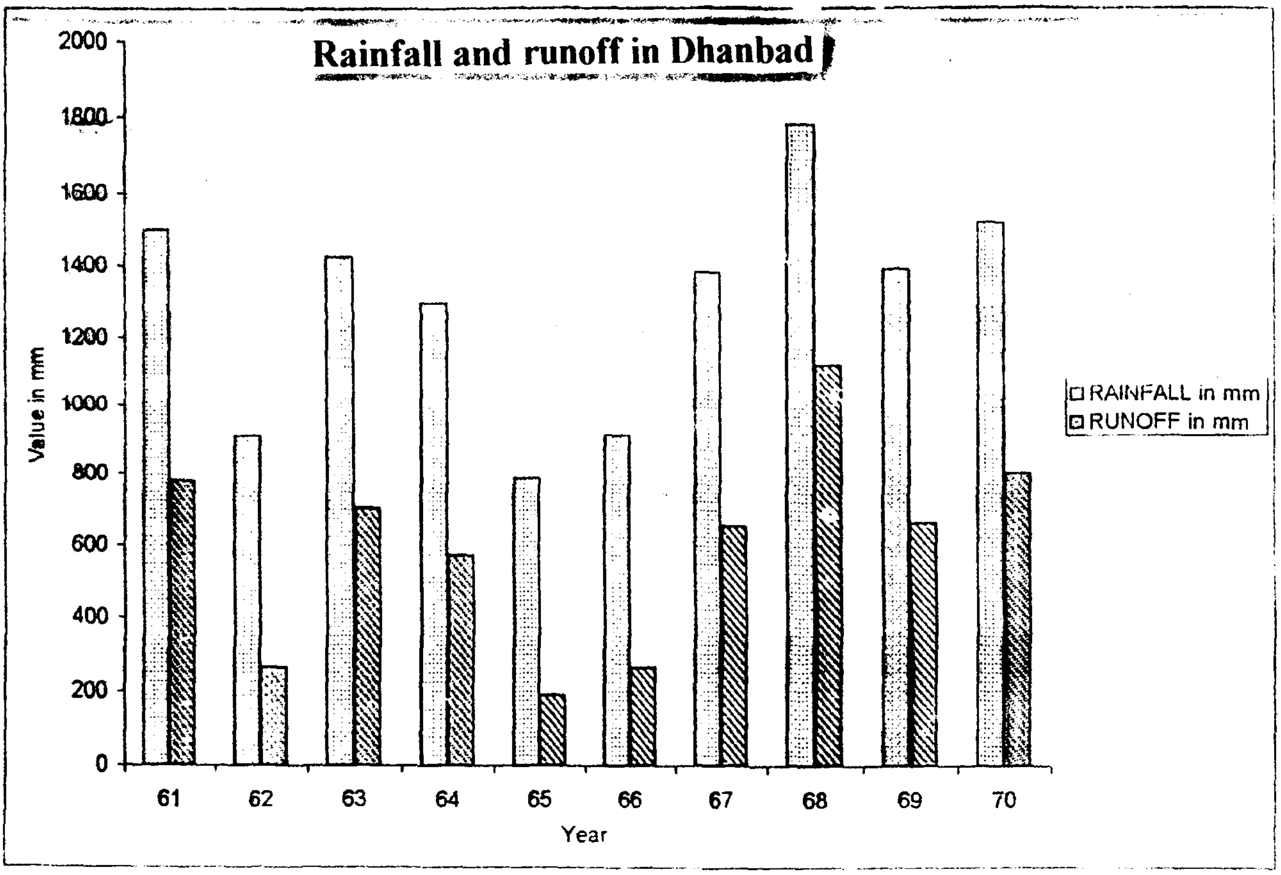


Fig. 6.23

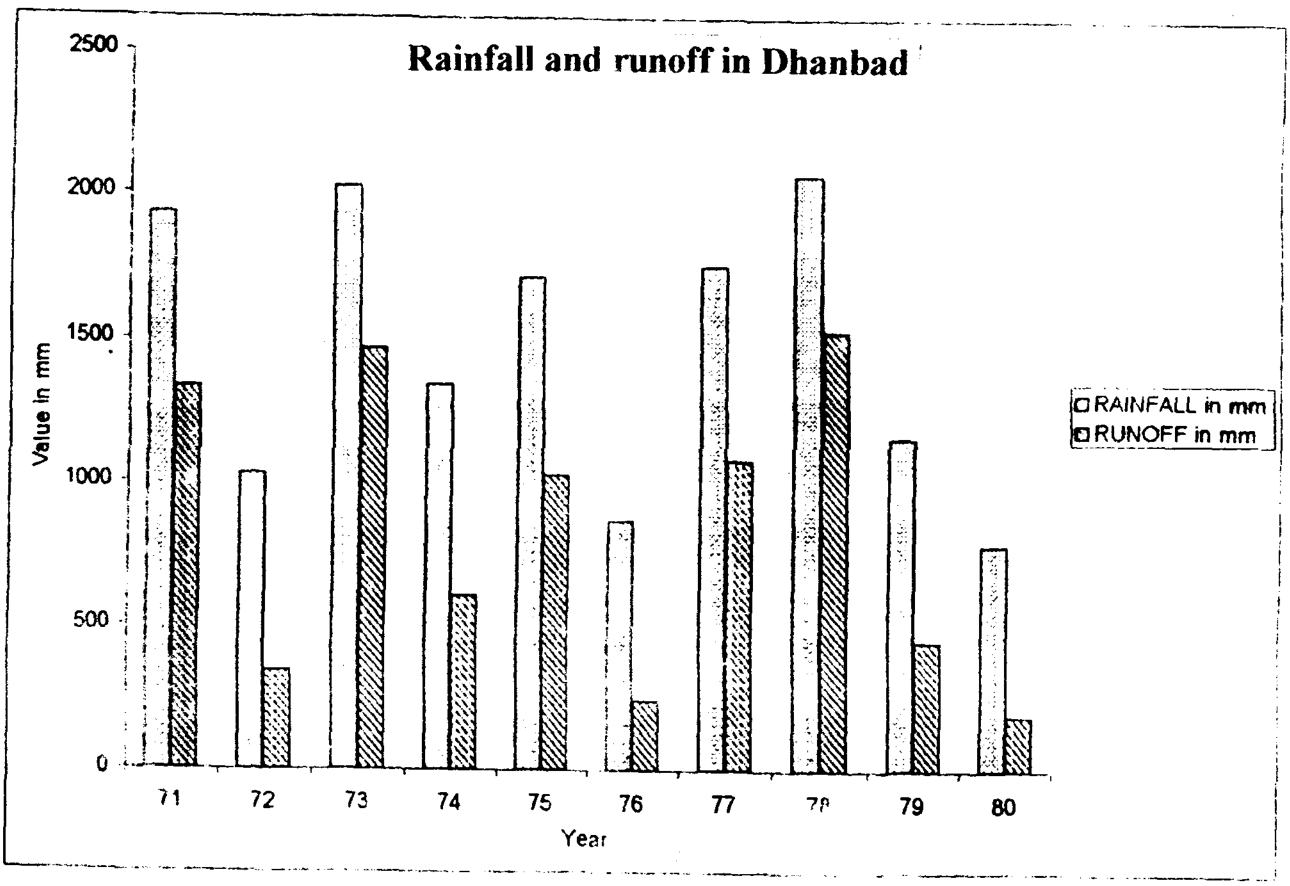
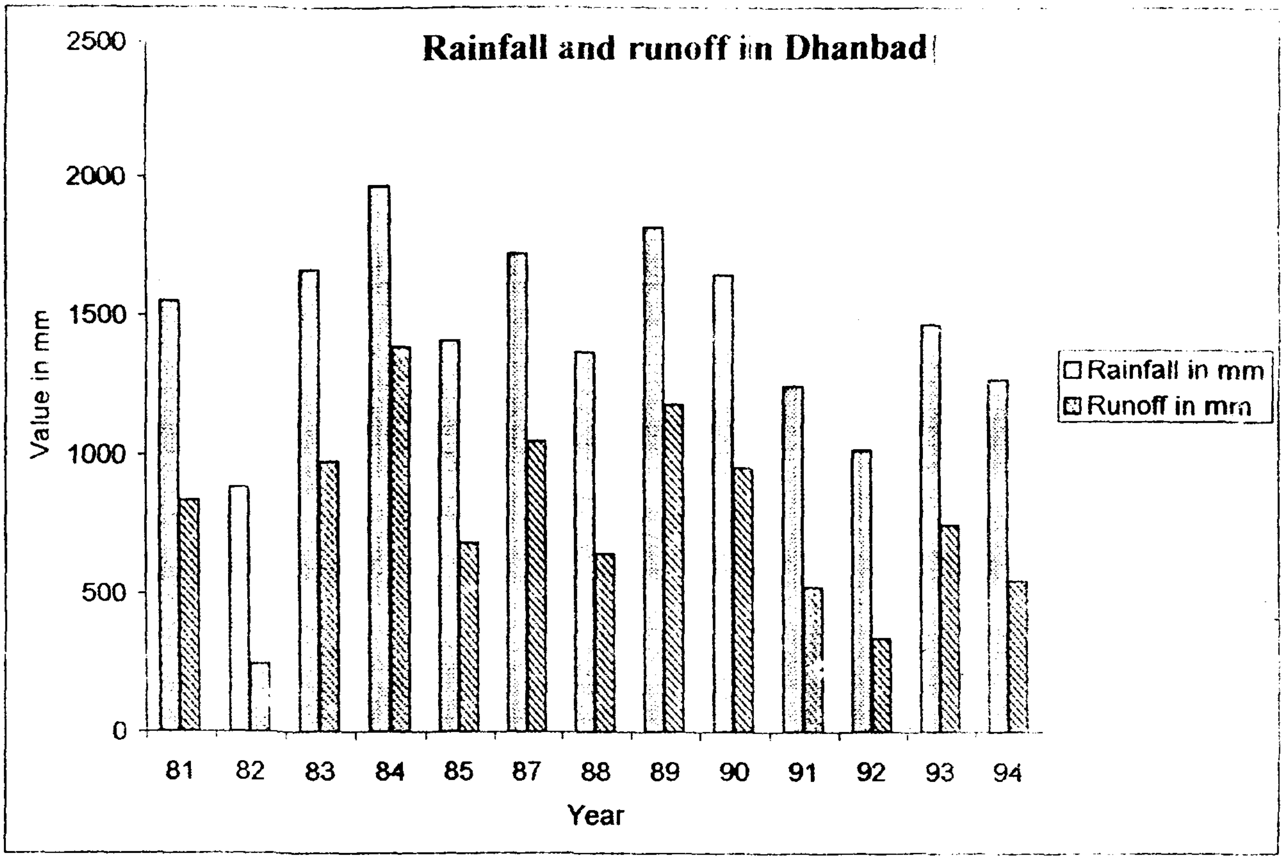


Fig. 6.24



Rainfall and runoff in Dhanbad
2500
2000
1500
1000
500
0
Value in mm
81
82
83
84
85
87
88
89
90
91
92
93
94
Year
Rainfall in mm
Runoff in mm

Fig. 6.25

produces 133.03-cm runoff in the area. The highest value of runoff calculated for the year 1978 (152.63) in 1970-90 period (Fig. 6.25). The lowest value of runoff calculated in 1980(18.69) shown in Fig 6.24. In 50 years period the highest value of runoff observed in 1978 and the lowest in 1980. Rainfall is more or less same in fifty years period so, no major variation found in same period. On the basis of data and information it can be said that coal mining has no negative impact on hydrological processes.

Table- 6.21

Evaporation Worksheet

Water Reservoir at dam site

Using Thornthwaite's method found in Dunnie and Leopold 1978 (P 136)

Month	Overall mean Air Temperature in °C	Heat Index Interim factor	Latitude sun-shine Correction Factor	Potential evaporation (inch)	Potential evaporation (cm)
January	19	7.4	0.9	1.47	3.73
February	21.3	8.8	0.95	23.2	5.89
March	26.4	12.1	1.0	5.2	13.2
April	31.1	15.5	1.06	9.81	24.91
May	31.9	16.1	1.11	11.23	28.52
June	30.5	15.1	1.13	9.76	24.79
July	28.8	13.8	1.12	7.91	20.09
August	28.3	13.5	1.09	7.24	18.38
September	28.2	13.4	1.02	6.69	19.99
October	26.7	12.3	0.97	5.52	13.33
November	22.5	9.5	0.91	2.7	6.85
December	18.7	7.2	0.89	1.38	3.5
Total Evapo-ration				70.95	180.18

Table 6.22

Annual Rainfall and Runoff in Dhanbad

Year	Rainfall in mm	Runoff in mm	Year	Rainfall in mm	Runoff in mm
1941	1318.13	591.8336575	1969	1790.4	663.6696693
1942	1640.5	944.5792323	1970	1520.1	803.1992953
1943	1559.5	848.2083661	1971	1929.4	1330.374472
1944	1358.8	631.6815118	1972	1027.3	343.4983819
1945	1187.5	471.961122	1973	2018	1461.858268
1946	1536.4	821.6715591	1974	1339.3	612.3342874
1947	1199.5	482.3973425	1975	1706.2	1026.541276
1948	1271.3	547.209563	1976	866.9	235.1210276
1949	1324.2	597.5582835	1977	1748.5	1081.109941
1950	1535.4	820.5322677	1978	2060	1526.346457
1951	1107.6	405.3641575	1979	1157.5	446.5349173
1952	1129.9	423.4455945	1980	783.8	186.9393858
1953	1781.3	1124.393028	1981	1548.8	835.864189
1954	1581.3	873.637122	1982	883.2	245.2097008
1955	1000.2	323.7655276	1983	1665.1	974.8701614
1957	869.3	236.5933425	1984	1966.1	1384.087957
1958	1210.7	492.2401142	1985	1408.7	682.5539724
1959	1708.7	1029.727201	1987	1724	1049.332283
1960	825.3	210.3215315	1988	1369.4	642.3240787
1961	1498.5	779.0430118	1989	1822	1179.27874
1962	910.9	262.8340984	1990	1650	956.2204724
1963	1426.8	701.4912756	1991	1244.9	522.9070118
1964	1296.3	570.729248	1992	1017.63	336.3908177
1965	787.4	188.914	1993	1468.95	746.5909459
1966	913.4	264.4544724	1994	1270.36	546.3348227
1967	1382.5	655.5			
1968	1781.4	1124.5			

Hydrogeology

Introduction

Hydrogeology can be defined as the study of groundwater with particular emphasis given to its chemistry, mode of movement and relation to the geologic environment. This term was first used in 1802 by the noted French naturalist Lamarck. Lucas in 1879 was probably first to use the term hydrogeology for the geologic study of ground water. Mead gave the widest currency to this meaning of term in his classic book on hydrology, first published in 1919. He narrated "hydrology" as the study of laws of the occurrence and movement of subterranean waters. Mead stressed the special character which dealt with the study of ground water as geological agent. Meinzer later subdivided the science of hydrology. According to him water which completing hydrologic cycle from the time it is precipitated on the land until it is discharged into the sea or returned to the atmosphere, into surface hydrology and subterranean hydrology or "geohydrology".

An individual of an urbanised urban area may use from one million to five million gallons of water during his lifetime. If we include the amount which has been utilised for industrial and agricultural purpose it will exceed ten million gallons. Vast quantities of water used for heat exchange.

Importance of ground water is little known however their approach in philosophy and mathematics was quite impressive. Greeks were impressed with the large size rivers than the observed runoff from heavy rains. Thales an Ionian philosopher of the School of Miletus has been called the first true scientist. He taught that water was driven into the rocks by wind and that it was forced to the surface by rock pressure where it emerged as springs. Plato (427-347 BC) gave little attention on underground cavern which is the source of all rive. Although Aristotle (384-322 BC) was a student of Plato, he gave modified version of Plato's concepts about the origin of ground water. According to Aristotle ground water occur in an intricate sponge like system of underground openings and water was disclosed from these openings into springs. Romans followed the path of Greek teachings. Bernad Pallisy (1509 - 1589) a French Philosopher was perhaps the first to have thoroughly modern views concerning the hydrologic cycle as reflected in the dialogue between Theory and Practice. According to Keppler German astronomer that sea water was digested and that fresh water from the springs are the end products of Renaissance which occur in AD 1600 little advancement was made in hydrgeology. Henry Darcy 1803 - 1858 was the first person to state clearly the mathematical law which governs the flow of ground water.

It is difficult to establish the relations between geology and groundwater. Russian geologist had studied the relationship of groundwater with frozen grounds while on other hand Dutch geologist and geophysicist have contributed to understanding of groundwater in coastal sand dunes. Japanese geologist and geophysicist have contributed to understand the hot springs. William Smith of England had corelate with the water supply. A Daurbree of France wrote one of the earliest general treatises on geological aspect of ground water. H.T. Sterns has established the relation between volcanic rocks and occurrences of ground water. The work of W.M. Davis and J.H.Bertz discussed about the formation of limestone cavern. Depite the greater number of geologist O.C. Meinzer contribution in this field is the most appreciable. He stressed on the importance of phreatophyte, the main contribution for the science of hydrogeology. He focused on different facets of the new branches of earth sciences beitween 1920 and 1940. At that time he was a member of United States Geological Survey.

Drainage

All the rivers which either originate or flow through the district have an easterly or south easterly course. Hill streams almost dry bed during the greater part of the year and sudden sparts of sophisticated torrential flow with each storm are observed in all of them. none of the rivers except Damodar is navigable. In most rivers water flow during only monsioon seasons.

Damodar is an important river originates from Palamu district with an easterly course for about 125 kilometres within the district. On the entry into the district it receives Jamunia river, a stream marks the boundary between Hazaribagh and Dhanbad districts and Katri further east. From the southern side Garga Nadi near the western boundary of the district and Gobai or Gowai Nadi meeting Damodar east of Bhojudih are its tributaries of some significance. Barakar river is the most important tributary of Damodar river and it confluence's at the eastern border of the district. It originates from the northern flank of Chhotanagpur plateau hills in Hazaribagh district. This river has south easterly flow in Dhanbad district until it abruptly veers to south beyond the Durgapur hills. It maintains its south easterly course till it debounches into Damodar river Dishergarh near Asansol in West Bengal. Its important tributary is Khudia which talke its rise in the extreme west of the district between the Parasnath and Tundi ranges and drains the whole country between that range and the high ridge which marks the northern limit of Jharia Coalfield.

Hydrgeological Conditions

Numerous small diameter wells 37- 63 mm diameter fitted with hand pumps and one or two large diameter tube wells have constructed by Coal Mine Labour Welfare Organisation (CMLWO) at Dhanbad. Some dug wells can bored wells also reported which has been dug by Bharat Coking Coal Limited (BCCL) drawing groundwater froim these deep-seated fracture zones used for drinking and domestic purposes.

Groundwater conditions in various lithounits are usually described under two broad heads:

(a) The porous formation and

(b) The fissured formation

(a) The Porous Formations

The main members of this formation are the Newar and older alluvium of the recent and subrecent ages are insignificant in Dhanbad district. Recent alluvium is found in very thin veneers in topographic depression along the Damodar river. Insignificant Occurrences may also be noticed along Barakar river and its some tributaries.

(b) The Fissured Formations

It is the only the fissured formation reported in this district. The Archean metasedimentaries the granites and intrusive metabasics and the Lower Gondwana sedimentaries which constitute the productive aquifer. The first three come under consolidated formation and the last one under semiconsolidated formation.

Consolidated Formation

Groundwater present in unconfined condition in all these consolidated formation. The saturated thickness found in the range of 0.8 -10.0 metres (average 3.0 metres) in the month of February - March in a year of normal rainfall. Weathered mantle is generally thicker in schistose, rocks than the granites and metabasics. Water level in open well in open well in all these rocks ranged from 1.5 - 11.5 metres below ground level (b.g.l) in the month of January March 1982. Spatial observation of depth to water levels for the same period shows that in general water level confirms to topography and the overall groundwater flow conforms to the general slope of land surface. Observation made between January and June 1982 show the declination of water level in the weathered residium of consolidated formation ranging from 0.07 to 3.38 metre.

Availability of groundwater in the interconnected joints and fractures in the consolidated formation at shallow depth (with 15 b.g.l) are under confined condition. They are connected with the overlying saturated weathered residium. In the deep seated fracture zones, groundwater occurs apparently under semi confined condition as the water levels in these differ from adjacent dug wells tapping saturated weathered. Chemical qualities of dug well and deep tubewell also differ from one another.

Semi consolidated Formation

Talchir shale containing pebble bed, the variegated Barren Measure and the Barakar an Raniganj sandstone of the lower Gondwana formation come under this formation. Sometimes quite hard and compact sandstone of Barakar measure come under the consolidated group.

Here groundwater present in unconfined condition in top weathered mantle of these rocks which comes under semi consolidated formation in the deeper fracture zones which have imparted secondary porosity and permeability in these rocks .

Weathered mantle and the shallow fracture zones connected to it in the different lithounits. Fracture zone in these rock recorded down to 39.6 m.(dug well zones whereas the upper surface of the zone of saturation (water table) is recorded at depths varying from 1.08- 13.23 m. in January - March 1982. Water level fluctuation recorded by National Hydrograph Network Stations of this area for the period of 1976- 1985 (10 years) vary from 1.15 to 5.95 m. An average 3.5 metre of seasonal water level fluctuation has been adopted for the semi confined area occupied by semi-consolidated rocks.

The Gondwana Sandstone in general, are known to constitute good aquifers at many places. However, the yield potential of the trees adjoining active mines in the coal belt is poor. With continued dewatering activity from mine pits, the neighbouring wells register gradually lower water levels long before the advent of summer and many of them ultimately dry up. Thus active mine often act as groundwater sinks. Conversely the water logged abandoned mines act as potential source of ground water. In nearby Raniganj Coalfield hydrogeological test show that water logged abandoned shaft yielded 900 - 1350 m^3/day for insignificant drawdons.

Depillaring in abandoned mines cause ground subsidence which in term causes formation of extensive fracture and fissured lying in the overlying rocks often bearing a fumbled mass of rubble at the surface.

Recharge - Discharge relationship

Rainfall is the main source of recharge of groundwater throughout the district. Tanks and bund's contribution to recharge phreatic aquifer is very insignificant. Both the Damodar and Barakar river and their principal tributaries are effluent in nature and therefor, they do not contribute to the groundwater body. This fact has been supported by the geological Survey of India in the Panache Reservoir area and has been corroborated by systematic hydrogeological surveys undertaken by the Central Ground Water Board in the district. Groundwater flow directions broadly conforms to surface water flows and the configuration of Topography.

Hydrochemistry

Water consist various type of chemical constituent in its own. Nearly 36 chemical constituents found in water. Out of these some which is directly related with health and hygiene of human beings. To study the extent of groundwater pollution detailed analysis of physico chemical and bacteriological properties carried out in the laboratory.

(a) Bacteriological Study

Bacteria and other micro-organisms are too small to visible for naked eye is present in groundwater. Some of bacteria are harmless while some causing harm termed as pathogenic bacteria. Coliform bacteria are present in the intestines of human beings and other warm blooded animals are transmitted through faecal matters. Although coliform bacteria is harmless to us but it indicates the presence of pathogenic bacteria.

Biochemical Oxygen Demand is an important parameter to study the bacteriological quality of ground water. biochemical Oxygen Demand (BOD) is termed as the oxygen consumed by the micro-organisms to degrade complete inorganic compound to simpler components viz., carbondioxide and water. When oxygen is complete and no oxygen is required therefore BOD value is zero.

(b) Physical Quality

Unlike surface water, groundwater is generally clean colourless and odourless with the presence of little or no suspended matter and relatively constant temperature. Due to properties of the ground water can directly used without treatment with few exceptions of ground water present in the source coming from caverns and other large openings which permits suspended matter and pollutants to enter into the aquifer.. Some of the physical qualities may be critical to restrict the usability of the water for specified purposes. It is therefore necessary to assess the physical quality of water in addition to the chemical quality.

Colour, Odour, Turbidity

Colour, Odour, turgidity and temperature are the important parameters to considered for water purposes should free of colour and objectionable odorous. Presence of iron or other organic matter may bring change in the colour of the water. The presence of hydrogen sulphide cause odour of rotten eggs.

Turbididity in groundwater is due to insoluble sediments, organisms and organic matter. Usability of ground water in certain industries and for artificial recharge purposes may be restricted by turbididty limits.

Temperature

Temperature of groundwater is largely dependent on atmospheric temperature, terrestrial heat, exothermic and endothermic reactions in the rocks. Infiltration of surface, insulation, thermal conductivity of rocks, rate of movement of groundwater regime.

Temperature of Shallow Groundwater

The temperature of shallow groundwater is controlled to a considerable extent by the atmospheric temperature. Generally temperature of ground water is the mean annual temperature of the air. This fact has been supported by the study which is carried by hydrogeologists of United States. Groundwater's temperature would exceed the mean annual temperature by about 1-2 ^{0}C Ground water temperature is generally higher than the atmospheric temperature during winter and lower during summer.

Maximum temperature fluctuations occur when water table occurs close to the ground surface. Within the shallow depth, groundwater temperatures may be also controlled by the degree of insulation in the zone of areation. Studies have indicated that the temperature of ground water was comparatively greater in areas where the zone of aeration is made up of porous materials, such as blown sand, than in consolidated rocks areas with little cover of porous rock.

Chemical Quality

Chemical quality of groundwater dependent on source, geology climate and use Water is an excellent solvent and it is important to know the geochemistry of the dissolved solids constituents.

Chemical constituents of Ground Water

It is mentioned above that ground water is dependent on various sources out of these Calcium, Magnesium, Sodium, Potassium (cations) and carbonate, bicarbonate, Sulphate Chloride, Nitrate (Anions) are important among them.

Total Dissolved Solids (TDS) - It includes all solids materials in the solution which show the ionisation process or not It does not include suspended sediment, colloids or dissolved gases.

Natural water range from less than 10 ppm of dissolved solids for rain or snow. Water for most domestic and industrial use should be less than 1000 ppm and water for most agricultural uses should be less than 3000 ppm.

Silica

Except for oxygen, silicon is the most abundant element in the earth's crust. In most natural water, only the fourth and fifth most abundant dissolved constituent. Low mobility is due to slow rate of solution of certain natural silicates. Residual quartz and various clay minerals also show very slow rates of solution Although silica is generally given as silicon oxide in reports of water analysis, but it is probably monomeric silicic acid $H_4 SiO_4$ in the natural temperature. Subsurface water saturated with amorphous silica at temperature normally encountered in temperate regions should contain from 90 to 110 ppm of silica. pH of ground water will normally have impact on the amount of silica which will go into the solution.

Calcium

Calcite aragonite, dolomite, anhydrite and gypsum is the key source of calcium in groundwater. Appreciable amounts of calcium present in most igneous metamorphic and sedimentary rocks. Due to weathering process in igneous rock and metamorphic rocks calcium come into the ground water. Main source of calcium is feldspar, amphibole and pyroxene group. Calcium carbonate is found as cementing material in sand stone, shales and other detritus deposits. The carbonates and sulphates of calcium, however are soluble in most natural waters. Because of its abundance in most rock types ants solubility, calcium is present almost everywhere in water.

Calcium carbonate is easily soluble in water provided that there is an abundant supply of Hydrogen ion. It can be express as follows:

$$\mathbf{Co_2 + H_2O = H_2Co_3 = H^{\cdot} + HCo^{3-}}$$
$$\mathbf{HCo_3 = H^{+} + Co^{3-}}$$
$$\mathbf{CaCo_3 + H^{+} = Ca + HCo^{3-}}$$

Calcium carbonate continues to dissolve as long as there is carbonic acid in water but precipitation of Calcium carbonate may occur once the acid is used up.

Pure water at 23 ^{0}C can dissolve only 13 ppm of calcium carbonate or about 5 ppm of calcium. In as much as some carbondioxide is almost always present. Sodium and Potassium salts enhance the solubility of calcium carbonate. Magnesium salts are more soluble than Calcium salts.

Concentration of calcium in normal potable groundwater generally ranges between 10 and 100 ppm (mg/l). Calcium in these concentrations has no known effect on the health of human and animals. In deed as much as 100 ppm of calcium may be harmless. Calcium concentration in dug well of Jharia is 40 mg/l while samples collected from tube well located in Indian School of Mines Dhanbad found in range between 66 and 78 (Table 6.31). Water samples of Jagjivannagar and Patliputra Medical College having 76 mg/l and 16 mg/l respectively. Calcium concentration in water collected from tube well of Refugee colony, Hirapur Town Hall and Officer colony are 30,38,56,52 mg/l respectively. There is two tube well in Officer's colony.

Concentration of calcium in the well located in Lodna and Coke oven siding near fire area is 104 mg/l in the month of September while the value reaches upto 108 mg/l in the month of January and May. The low value of calcium perhaps due to influx of rainwater during that period (Tables 6.32 - 6.35).

Magnesium

The chief constituents of magnesium in hydrosphere are dolomite in sedimentary rocks; olivine, biotite, hornblende and augite in igneous rocks and serpentile talc , diopside, and tremolite in metamorphic rock. In addition of calcium magnesium also present in the limestone. The geochemistry of magnesium is quite similar to that of calcium. The solubility of Magnesium carbonate is also controlled by the concentration of carbondioxide. In ordinary atmospheric conditions the solubility of magnesium carbonate in water, in the presence carbondioxide is nearly ten times that of calcium carbonate. Under a partial pressure of carbondioxide of 0.003 atmosphere only 20 ppm of Calcium will remain in the solution, as against 190 ppm of Magnesium.

Depite the higher solubilities of magnesium compounds, magnesium is generally found in lesser concentration in natural waters that is calcium. The difference between them is due to low solubility of dolomite in the solution. Common concentration of magnesium ranges from about 1-40 ppm. Water from rocks rich in magnesium may have as much as 100 ppm. Water having low concentration of calcium and magnesium is made soft by cation exchange.

Magnesium concentration in three tube wells of Indian School of Mines is 33, 25, and 24 mg/l respectively. Water samples collected from tube wells of Jagjivan Nagar, Patliputra Medical College. Refugee Colony, Hirapur Town Hall and two tube wells of Officer's colony showing the magnesium concentration are 13, 8, 20, 8, 11 and 13 mg/l (Table 6.31).

Value of magnesium in well water located near coke oven siding near fire area is 90 mg/l throughout the year. While the well situated near Lodna railway Station -2 having magnesium concentration 96 mg/l in the month of December and it become 64 mg/l in March, 88 mg/l in the month of September. Water sample collected from the well behind South Tisra Colliery Near N. Plant 3 having highest magnesium concentration 84 mg/l in the month of May and in rest period of the year it is nearly 80 mg/l. The well situated opposite South Tisra Sumandir has highest concentration of magnesium during the month of December (42 mg/l). It is 40 mg/l in May. Water sample collected from the well behind 8 pit of South Tisra Colliery having concentration of magnesium in the month of December which is 62 mg/l and 60 mg/l in March. In May and September the value of magnesium 60 and 57 respectively (Tables 6.32 – 6.35).

Potassium

Potassium comes in ground in ground water by weathering of orthoclase, biotite, leucite and nepheline in igneous and metamorphic rock. Water percolating through evaporite deposits may contain very large quantities from the dissolution of sylvinte and nitre in some sedimentary rock.

Although the abundance of sodium and potassium is equivalent in igneous and metamorphic rocks of the earth's crust, concentration of Potassium in ground water is one tenth or even one hundredth that of sodium. Two factors are responsible for low concentration of potassium in the ground water first to the fact that potassium enters into the structure of certain clay and clay like minerals during weathering and second in the resistance of potassium minerals to decomposition by weathering. Vegetation helps in accumulation of potassium. This however accounts for the removal of only a small amount of potassium for most of the organic material is decomposed in place and relatively little is removed by erosion. All natural water contains measurable amount of potassium. In most potable ground water its value in the range of 1 ppm or less to about 10 to 15 ppm (mg/l) and commonly ranges between 1.0 and 5.0 ppm. An interesting feature of potassium is that dilute waters containing only 20 ppm of dissolved solids may contain about 2 ppm of potassium.

Water samples collected from dug wells used for the study of National Network Observation set up by Central Ground water Board showing potassium concentration is 3.4 mg/l in Dhanbad and 1.7 mg/l for the well located in Jharia block. Water samples collected from the various tube wells situated in the premise of Indian School of Mines having potassium concentration in the range of 3.7 - 8.0 mg/l. Tube wells located in Jagjivan Nagar and Patliputra Medical College consists 4.5 and 2,25 mg/l respectively. Water samples collected from Refugee Colony, Hirapur Town Hall and the samples of Officer's colony are 3.25, .45, 1.3 and 1.75 mg/l respectively.

Potassium content is highest in water sample, collected from well of Lodna and Coke oven Plant siding near fire area is 24 mg/l in the month of December. This value becomes 20.0 in the month of March, 20.4 in the month of May and 22.0 mg/l in monsoon period. Potassium concentration is 28 mg/l in December, 17 mg/l in March, 19 mg/l in May and 17.0 mg/l in September of the water sample collected from the well situated at Lodna railway station-2 of Lodna area. 18.0 mg/l in December (winter season), 10 mg/l in spring season (March), 9 mg/l in summer season (May) and 10.0 mg/l of potassium found from the water sample collected from well behind South Tisra Colliery near N2 Plant 3 of Lodna are of Jharia Coalfield. Water sample of the well situated opposite south Tisra Sumandir having potassium concentration 9.0 mg/ in winter season, 6.5 mg/l in summer season and 22 mg/l in Monsoon season. Potassium Content in water sample situated behind 8 pit of South Tisra colliery is 12 mg/l in December, 11 mg/l in the month of March, 10 mg/l in the month of May and 8 mg/l September. Concentration of potassium in all water samples of the study area is under permissible limit. Detail analysis of well water has been given in tables 6.32 to 6.35.

Sodium

Sodium unlike calcium, magnesium and silica is not found as an essential constituent of many of the common rock forming minerals. Sodium bearing minerals like albite and other members of Plagioclase, feldspar, nepheline, Sodalite, glemocophane aegerine etc. Presence of sodium in natural water is due to release of soluble product. result of weathering of plagioclase. In area of evaporite deposits the solution of halite is also important. Large amounts of exchangeable sodium come into the natural water by clay minerals.

Most sodium salts are really soluble in water but no active participation in chemical reactions as do the salts of alkaline earth. Measurable concentration of sodium found in the natural waters. Rainwater contains 0.2 ppm of sodium. Area of igneous and metamorphic rocks that are also are the regions of moderate to high rainfall generally have waters with 1 - 20 ppm of sodium.

Water samples collected from the three tube wells of Indian School Of Mines estimated 22- 43 mg/l. 50 mg/l and 40 mg/l sodium found in water sample of the tube wells located in Jagjivan Nagar and Patliputra Medical College respectively. Sodium content in water samples collected from Refugee colony, Hirapur Town Hall and officer's Colony (2 tube wells) are 36, 23, 22, 22 mg/l

Amount of sodium present in water sample of various well are 66 mg/l, 72 mg/l, 60 mg/l, 18 mg/l and 22 mg/l for the serial no. 1,2,3,4 and 5 respectively in the month of December. Sodium concentration in water samples of serial number 1,2,3,4 and 5 in the month of May is 64,70,20,18 and 19 mg/l. Sodium concentration in different wells located in different part of Lodna Area is 40, 45, 24, 26, 20 mg/l for the serial no. 1,2,3,4 and 5 respectively in summer season (Table 6.34). In monsoon season this value is 31, 33, 16, 40 and 19 respectively for different water samples for the quality of well water in this area.

Bicarbonate and Carbonate

The amount of standard concentration of sulphuric acid which is needed to titrate a water sample to an end point of 4.5 is a measure of the alkalinity of water. Alkalinity is due to carbonate and bicarbonate ions. Hydroxide iron and silicate may have some influence on alkalinity throughout normal range of pH values. Most carbonate and bicarbonate ions in ground water are derive for the carbondioxide in th soil and solution of carbonate rocks.

Ground water generally contain more than 10 ppm but less than 800 ppm bicarbonate concentration 50 and 400 ppm are most common. Tube wells of Indian School of Mines having concentration in the ranges between 276 - 400 mg/l. Bicarbonate concentration is estimated in the water sample of Jagjivan Nagar tube well is 430 mg/l and 135 mg/l estimated from the water sample of the tube well present in the premise of Patliputra Medical College. Tube wells of Refugee colony, Hirapur Town Hall and ttube well of Officer's colony having 235, 173,142, and 154 mg/l bicarbonate content in these water samples.

Sulphate

Sulphur is a minor constituent of igneous rocks despite heavy concentration in water and sedimentary rock. Sedimentary rocks particularly organic shales may also yield large amount of sulphates. At normal condition its concentration is less than 2 ppm. Sulphate come into the natural water by gypsum, anhydrite and other igneous and metamorphic rock. Sulphate is also enriched by the sulphide ore bodies, pyrite bearing shales, lignite, coal and gypsiferous beds.

Most sulphate compounds are readily soluble in water. Lowest concentration of the sulphate is in rainwater. Ground water from igneous and metamorphic rock or from sediments derived from them, is generally less than 100 ppm. Reduction of the sulphate by bacteria is the main source of hydrogen sulphide gas emanating from ground water in association of lignite and coal.

Tube Wells situated in Dhanbad block has 20 mg/l of sulphate in its water while the well water of Jharia block has 30 mg/l of sulphate content. Sulphate content in different water samples of Dhanbad having low concentration of sulphate. Highest concentration of sulphate is 52 mg/l found in water sample of Officer's colony and lowest in water sample of Patliputra Medical College.

Different well water of Lodna Area having sulphate concentration in range of 138 to 256 mg/l in winter season. During spring season its value is found between 136 and 256 mg/l while this value go slightly up during summer season which is in the range of 144 to 260 mg/l. During Monsoon season (September) sulphate concentration ranged between 192 and 260 mg/l (Table 6.35). Maximum permissible limit of sulphate content is 400 mg/l according to IS 10500- 1983.

Chloride

Although the chloride content of sea waters an important entity in the hydrologic cycle is of the order of 13000 ppm. Chloride concentration in rainwater is generally below (10 ppm). Chloride is a minor constituent of our earth's crust but it is a major dissolved constituent of our natural water. Chloride is a major constituent present only in igneous and metamorphic rocks. Significant amount of chloride is also present in micas, hornblende and natural glass.

Most chloride in ground water comes from different sources. First, chloride from ancient sea water entrapped in sediments; second solution of halite and related minerals in evaporate deposits; third concentration by evaporation and fourth solution of dry fall out from the atmosphere. All chloride salts are highly soluble and chloride is also relatively free from effects of exchange.

Chloride concentration in the different wells of Lodna area having in ranges 15-170 mg/l. In the month of May this values in the range of 6-54 and 20-94 mg/l in monsoon period.

pH

It is the value by which we can say whether water or aquatic media is acidic, basic or neutral. It is the negative logarithm of hydrogen ion concentration in moles per litre. In natural water its value is 7. When the value of this parameter is below 7, called acidic and above 7 is called basic. In most water pH value is dependent on the carbondioxide, carbonate- bicarbonate equilibrium. Different water samples of the area having pH value in the range between 6.20 and 8.13 Most ground water samples have a pH range of 6 to 8.5.

Total Hardness

It denotes the concentration of calcium and magnesium in water and is usually expressed as the equivalents of calcium carbonate. It is an important criterion for determining the usability of water for domestic drinking and many industrial supplies.

Specific Electrical Conductance and Resistance

This term denote the characteristics of a medium to the passage of electricity. Ressitivity is the reciprocal of conductivity. In water quality determination conductivity defined as the conductance of a cube of one centimetre side of a substance reported in mhos/cm. Most natural water's conductivity is much less than unity. For convenience, conductivity is therefore, expressed in micro mho /cm. Which is equal to one million times the value given in mho/cm.

Well waters of Lodna area ranges between 530 and 2360. Specific conductance of different tube wells water samples found in the range of 352 - 760 micro mho/cm. Highest value of conductance observed in tube well water present in the premise of Indian School of Mines while lowest value is observed in water sample collected from the tube well of Hirapur Town Hall (Dhanbad).

Due to mining process ground water has been affected. Information available in this regard by Central Ground Water Board, Public Health Engineering Department and other people of the are and its surroundings water table is below 2-4 metre below ground level (mbgl) in 1981-82 and this level further go down 4-5 m.bgl in 1987 and in 1994 this was 5.5 -7 metre below ground level in this coalfield.

Principal source of ground water recharge is rainfall. Most of the part of year river and its tributaries not contributing significant amount of water resource. Some minor recharge may be take place in the shallow phreatic aquifer through the large tanks constructed by bunding perennial steams for the purpose of irrigation. Maithon and Panchet reservoir contributing recharge in South Eastern part of Balliapur Block. Depth of Water table in Dhanbad district of Bihar ranges from 3.00 metre to 9.00 metre below ground level within the metamorphics and 0.6 metre to 9.20 metre below ground level in the sediments.

Table 6.31

Study of physico- chemical quality of tubewell water located in Dhanbad town

Sl No.	Location	depth m.bgl	Sample collection	Total Iron	Calcium	Magne-sium	Sodium	Pota-ssium	Bicar-bonate	Sul-phate
	1	2	3	4	5	6	7	8	9	10
1	Indian School of Mines	91.2	July'96	0.9	80	33	22	7.6	400	20
2	-Do-	91.44	July'96	1.6	52	25	22	8	276	27
3	-Do-	83.81	July'96	3.35	68	24	43	3.7	315	27
4	Jagjivan Nagar	30.5	June'97	1.75	78	13	50	4.5	430	5
5	Patliputra Medical College	-	June'97	6.25	17	8	40	2.25	135	4
6	Refugee Colony	-	June'97	1.6	31	20	36	3.25	235	24
7	Hirapur Town Hall	-	June'97	0.5	40	8	23	0.45	173	12
8	Officer's Colony		July'96	5.35	58	11	22	1.3	142	52
9	-Do-		July'96	3.25	53	13	22	1.75	154	52

Contd...

Sl no.	Location	Chloride	Fluoride	Nitrate	Total Hardness	Sp. Cond.	pH
	1	11	12	13	14	15	16
1	Indian School of Mines	34	0.57	2	330	760	7.51
2	-Do-	34	0.56	2	230	576	7.82
3	-Do-	52	0.73	4	265	680	7.71
4	Jagjivan Nagar	15	0.98	2	245	701	7.92
5	Patliputra Medical College	8	0.85	2	67	248	7.63
6	Refugee Colony	27	1.1	6	153	495	8.01
7	Hirapur Town Hall	20	0.78	2	123	352	7.96
8	Officer's Colony	55	0.75	8	185	480	8.04
9	-Do-	45	0.61	6	180	502	8.13

All values in mg/l (ppm) except pH otherwise mentioned

Table 6.32
Physico - Chemical Analysis of Well Water Samples of Lodna Area
Period October December (1996-97)

Sl No.	pH	Colour	T. Hardness	Calcium	Magnesium	Potassium	Chloride as Cl	Iron as Fe	Sodium	Sulphate	Conductivity micro mho/ cm.	TDS	Copper	Zinc
1	7.18	Clear	680	108	90	24	106	Trace	66	256	1600	70	Trace	Trace
2	7.14	Clear	650	120	96	28	174	Trace	72	222	1630	95	Trace	Trace
3	6.5	Clear	500	56	80	18	20	Trace	60	200	918	60	Trace	Trace
4	6.2	Clear	272	38	42	9	15	Trace	18	138	533	62	Trace	Trace
5	6.79	Clear	260	34	62	12	24	Trace	22	210	540	60	Trace	Trace

All values are in mg/l (ppm) except pH otherwise mentioned
1) Well of Lodna and Coke oven siding near Fire Area
(2) Well near Lodna Railway Station -2
(3) Well behind South Tisra Colliery Near N2 Plant -3
(4) Well opposite South Tisra Sumandir
(5) Well behind 8 Pit of South Tisra Colliery

Table 6.33
Physico - Chemical Analysis of Well Water Samples of Lodna Area, Period January - March (1996-97)

Sample no.	pH	Colour	T.I Hardness	Calcium	Magnesium	Potassium	Chloride as Cl	Iron as Fe	Sodium	Sulphate	Conductivity micro mho/ cm.	TDS	Copper	Zinc
1	7.01	Clear	675	108	90	20	104	0.2	64	256	1660	66	Trace	Trace
2	7.14	Clear	644	96	64	17	170	0.28	70	220	1630	80	Trace	Trace
3	6.5	Clear	500	58	80	10	20	0.25	20	200	912	108	Trace	Trace
4	6.22	Clear	286	42	32	19	15	0.15	18	136	533	61	Trace	Trace
5	6.81	Clear	256	30	60	11	24	0.22	19	196	545	62	Trace	Trace

All values except pH are in ppm (mg/l), otherwise mentioned

1. Well of Lodna and Coke oven siding near Fire Area
2. Well near Lodna Railway Station -2
3. Well behind South Tisra Colliery Near N2 Plant -3
4. Well opposite South Tisra Sumandir
5. Well behind 8 Pit of South Tisra Colliery

Table 6.34
Physico - Chemical Analysis of Well Water Samples of Lodna Area
Period April - June (1996-97)

Sample no.	pH	Colour	T. Hardness	Calcium	Magnesium	Potassium	Chloride as Cl	Iron as Fe	Sodium	Sulphate	Conductivity micro mho/ cm.	TDS	Copper	Zinc
1	7.4	Clear	680	108	90	27.4	40	0.2	40	360	1954	66	Trace	Trace
2	6.95	Clear	652	116	88	19	54	0.25	45	230	1990	81	Trace	Trace
3	7.05	Clear	504	60	84	9	21	0.2	24	220	1230	108	Trace	Trace
4	7.08	Clear	282	44	40	6.5	6	0.2	26	144	900	63	Trace	Trace
5	6.85	Clear	254	32	60	10	22	0.3	20	200	540	60	Trace	Trace

All values except pH are in ppm (mg/l), otherwise mentioned

1. Well of Lodna and Coke oven siding near Fire Area
2. Well near Lodna Railway Station -2
3. Well behind South Tisra Colliery Near N2 Plant -3
4. Well opposite South Tisra Sumandir
5. Well behind 8 Pit of South Tisra Colliery

Table 6.35
Physico - Chemical Analysis of Well Water Samples of Lodna Area,
Period July -September (1996-97)

Sample no.	pH	Colour	T. Hardness	Calcium	Magnesium	Potassium	Chloride as Cl	Iron as Fe	Sodium	Sulphate	Conductivity micro mho/ cm.	TDS	Copper	Zinc
1	6.52	Clear	660	104	90	22	94	0.2	31	260	2360	66	Trace	Trace
2	7.14	Clear	640	80	66	17	90	0.25	33	220	2170	81	Trace	Trace
3	6.72	Clear	500	56	80	10	56	0.15	16	200	950	108	Trace	Trace
4	6.46	Clear	280	40	32	22	30	0.15	40	130	780	62	Trace	Trace
5	6.72	Clear	250	29	57	8	20	0.25	19	192	530	62	Trace	Trace

All values except pH are in ppm (mg/l), otherwise mentioned
1. Well of Lodna and Coke oven siding near Fire Area
2. Well near Lodna Railway Station -2
3. Well behind South Tisra Colliery Near N2 Plant -3
4. Well opposite South Tisra Sumandir
5. Well behind 8 Pit of South Tisra Colliery

Edaphic aspect

It is the uppermost part of the earth. The uppermost part consists essential nutrients, which is helpful to cultivation. Soil is an essential component of terrestrial ecosystem, lies at the interface between atmosphere and earth's crust. The soil is exposed to input of trace elements from many sources in a coal mining environment. Soil is the natural inhabitants of microorganisms and arthropods(jointed leg animals). Edaphic aspect is associated with the study of soils.

Study of trace element in terrestrial ecosystems have indicated that many areas around coal mines, urban complex and major road network contains trace elements beyond permissible limit.

Trace elements from atmospheric deposition

Atmosphere is an important medium of transport for elements from various source. soils are often contaminated upto a hundreds of kilometres away from the site of the mining operations through emissions. The elements usually present in the atmosphere with a size range of 5 micron metre to 20 micron metre but most of them are between 0.1 micron metre and 10 micron metre diameter and have average residence time of 10 to 30 days.

Natural and anthropogenic sources of trace elements in soils

Average albundance of trace elements in soils, the earth's crust, sediments and igneous rocks are given in appendix 3. Abundance of lead (Pb) is found rock (16 micro gm pergm). Accoirding to Nriagu 1978 mean Lead content is 1 - 9 micro gm/gm in gabbro and 8.3 micro gm per gm in amdestite. In sedimentary rock Lead content is 23 micro gm pe gm.

Soil is a siink for anthropogenic lead. Average concentration of copper is 80 mg per kg in lithosphere while values for the earth's crust range from 24 mg per kg to 55 mg per kg. soil:s from urban areas are 5 to 10 times high in extraceable Cu to those of adjacent rural areas due to the combustion of wood product, fossil fuels and waste incinerations.

Iron (Fe) iis also an important micronutrient but it is not classified in trace elements. The presence of Fe in soil is few percent. Hematite and Magnetite are the major constituentss mineral found in the soils. Large scale of iron presence due to anthropogenic process. Presence of zinc mainly dependent on the rock composition. Its mean value is 40 mg per kg in granites to 100 mg per kg in basaltic rocks. In sedimentary rocks its concentration varies between 80 mg per kg and 120 mg per kg in white sandstones. lLimestone carries 10 30 mg per kg of zinc in the soils.

The average concentration of chromium (Cr) in crustal rock is 100 mg per kg. Annual wastes comtain 20 mg per kg to 25 mg per kg chromium in the soil. Disposal of fly ash on land is the largest single input of chromium to soils.

The average concentration of Nickel (Ni) in thr world soil is 40 mg per kg. It varies from soil to soil. Domestic soap which is used for cleaning the clothes also contain nickel. In soap its value is 100 - 700 mg per kg and powdered detergents its value is 400 - 700 mg per kg. Powdered bleaching contain 800 mg per kg concentration of Nickel. Presence of nickel in coal and fly ash is given in following appendix 4.

All the rocks of the earth's crust contain Manganese (Mn) in high amounts. It ranges from 200 mg per kg to 1000 mg per gm in igneous rock and 400 - 600 mg per kg in limestone. Im sandstone its value ranges in 20 mg per kg to 500 mg per kg.

The Cobalt content of sedimentary rocks ranges from 10 mg per kg to 50 mg per kg while range in ultrabasic rocks is 100 - 200 mg per kg. in basic rocks it ranges from 30 - 45 mg per kg whereas in general rock its value is 5 - 10 mg per kg Main source of cobalt im the soil are (a) parent material from which it derives from (b) use of fertiliser as cobalt composition 0.1 mg per kg value ranges between 0.1 mg per kg to 11 mg per kg in sedimentary rocks. Anthrpogenic sources like incineration of batteries have the major contribution to earth crust of cadmium. The present attempt to provide to study the trace element in and around Lodna area of Jharia Coalfield. Critical concentration of trace elements in soils is given in table 6.41.

Conclusion

On the basis of the information and data available (Table 6.42) for the study of trace elements in the soil it can be said that concentration of these elements are under permissible limit. All trace elements having low presence in the soil sample. Cobalt Nickel and Cadmium are not found in the soil samples collected for the study. So, it can be said that the coal mining not contributing trace elements in the soil.

Table 6.41
Critical concentration of trace elements in Soils

Element	Normal range micro gm per gm	Critical soil Concentration micro gm per gm*
Lead	2 - 300	100 - 400
Copper	2 - 250	60 - 125
Zinc	1 - 900	70 - 400
Chromium	5 - 1500	75 - 100
Manganese	20 - 10,000	1500 - 3000
Cobalt	0.5 - 65	25 - 50
Nickel	2 750	100
Cadmium	0.01 - 2.0	3 - 8

* The critical soil concentration in the range of values above which toxicity is considered to the people.

Source: Brown H.J.M., 1979, *Environmental Chemistry of Elements*, London, Academic Press.

Table 6.42
Concentration of trace elements in soil samples of the study area and ISM campus

Element	Range of Concentration (micro gm per gm)	ISM Soil concentration (micro gm per gm)
Lead	3.5 - 100	1.95
Copper	3.95 - 25.05	2.43
Iron	39.05 - 90.25	10.49
Zinc	25.05 - 73.115	11.24
Chromium	10.03 - 36.75	0.20
Manganese	10.75 - 89.65	5.05
Cobalt	1.05 - 10.05	-
Nickel	1.32 - 18.25	-
Cadmium	0.02 - 0.24	-

Terrain

Morphology of the terrain is highly affected by coal mining. In past coal is excavated by underground mining. Underground mining causes sink of the ground level which is termed as subsidence. This occurs when large amount of coal has been excavated from the mines. In due course some activities beneath the earth surface, pillars get broken which causes subsidence. It makes the terrain uneven. Opencast mining is cheaper than underground one. So opencast mining is nowadays widely practised by the coal companies. The opencast mining causes formation of several goafs (space left after mining). The opencast mining affects the terrain twice. First at the sight from where coal has to be excavated and secondly at the place where it has to be dumped. The overburden removal by the process also affects the morphology of the terrain. Overburden generated by the coal mining in the Lodna area is given in table 3.12. Plates related to overburden located in the area are shown in plate number 12 and 13.

Impact of Mining on Human Health

Health is defined in keeping with current health promotion thinking which recognises the importance of the physical, social, emotional, economic, political environment in shaping the health of the population and individuals. Health means more than the absence of the disease - rather a state of complete physical, mental and social well being. Health is only possible where resources are available to human needs. Working environment is protected from health affecting pollutants, pathogens and physical hazards. According to the World Health Organisation (WHO) definition health includes, physical psychological and social aspects, as measured by reduction in mortality and morbidity from infectious diseases, reduction in psychological problems, improved child development and greater social being.

The current concept of health is distinct and broader from the traditional view which emerged from 19th and 20th century. In 19th century local governments believed that physical environment is responsible for bad health. Biomedical model of health has arose in 20th century. In recent times it is a public health focus. World Health Organisation (WHO) epitomises the current concept by defining 'Health as a state of complete physical, Social, Mental and spiritual well being - and merely the absence of disease of infirmity. It gives holistic approach on interrelated effects of the economic, social political and physical environment of well being.

Health for all emerged in the late 1970s, when member state of the WHO agreed on the obquoted declaration that: " the main social large of the government and WHO in the coming decades should be attainment by all citizens of the world by the year 2000 of a level of health that will permit to lead a socially and economically backward life". Moreover, the centrality of health to sustainable development is illustrated by thee accompanying Rio Declaration which states on its first principle that: " Human beings are at the centre of concerns of sustainable development. They are entitled to a heallthy and progressive life in harmony with nature".

A healthy environment is prerequisite for human health. It is dependent on social activities and the physical and biological environment. It includes maintaining a natural resource base that is not contaminated by pathogens and toxic substances. Unrestrained population growth in developing countries and over consumption in industrialised countries produces severe pressure on natural resource.

Unscrupulous use of available resources causes environmental degradation. High profile societies use natural resources many times more than general people. On average, each person in developed countries consume natural resources at least 10-20 times as high as corresponding average in the developing world.

Almost all forms of energy production have enough potential to produce environmental change which may directly or indirectly affects the human life. Majority of the global population exposed to air pollution. Near about 1000 million urban people suffering from this type of problem.

Fossil fuels are the largest source of the atmospheric pollution. Main sources of air pollution are caused by coal fired or oil fired power station, motor vehicles, autoexhaust. High concentration of sulphur dioxide in combination with smoke and particulates in urban air has been associated with increased mortality, particularly from cardiorespiratory disease.

Particulate emission from coal combustion during coke production may be inhaled by human beings, and with stack as well as 200 metre deposition may occur within a circle of 500 km radius. Its diameter is very small and gets deposited in different regions of the respiratory system depending upon their effective aerodynamic particle size. Larger particle preferentially deposited in nasopharangeal and trachaeobranchial region and generally removed after a short time by cilial action and consequently swallowed. Smaller particles settle down in lungs.

Results and Discussion

There are no rare species of animals found in the study area. Animals found in the area are cow, buffalo, goats, pigs frog etc. Avi fauna mainly includes wild fowls, bee eater, Koel, Myna etc. Human beings are important among them. Health status of human beings has been taken in this account. There is no statically record is available for the employees who get regularly checked by the doctors of the organisation. Data used for the study the health status has been taken by Central Hospital of Bharat Coking Coal Lttd. located in Dhanbad town. Here patients admitted in latter stage. From the year 1997 authorities of BCCL putting the number of patients diseasewise.

In 1997 total number of patients admitted in male medical ward I is 1398 (Table -6.51). There is another male medical ward II and one female medical ward and there is similar number of patients admitted in these wards. So, taking the number of patients admitted in male medical ward and convert it into three wards, there is about 4200 patients admitted in 1997. Highest number of patients admitted in 1997 in male medical ward is 154 which is in September month. Number of heart disease patients get admitted is highest (16.23 %) followed by patients suffering from Acute Gastro Enteritis. Only one patient has been admitted suffering from lung cancer. Highest number of patients admitted in the hospital is 227 in the whole year followed by July month. Patients suffering from other disease mentioned in table 7.11 is 716. Acute Gastro Enteritis is highly prevalent in monsoon season (July - September).

A survey has been conducted in 1991 -92 to study the morbidity pattern (Table 6.52) suggest that patients suffering from GI disorder is 31.2 % in coal mine areas where it is 25.6 % in steel industry belts and 21.7% in rural areas. Patients suffering from respiratory trouble is also highest in coal mine area. Respiratory trouble is mainly caused by dust prevailing in particular area. Iron filling has 11 m/s transport velocity (Table – 6.53) in individuals. Coal dust has highest transport velocity which is the main cause of respiratory trouble. Table no 6.54 suggest that health status improving since

1971. Data collected from District Civil Surgeon Office Regarding water borne disease (Table 6.55) reveals the fact that dysentery patients are highest in the coal mining areas followed by skin diseases which ranges between 30-35 percent. Constipation disease is also prominent disease which occurs due to water in the area. It is understood that hard water used by persons residing in the area. About 5 to 8 percent patients suffering from leprosy disease.

Conclusion

On the basis of the data and information available it has been said that coal mining is not only a single factor which is responsible for poor health condition in the area. As it has been already mentioned that miners not having gas masks inside mines. Management inability is the root cause of unavailability of gas masks. Majority of workers interviewed during research work had been suffering from respiratory. It has been suggested that more studies have been required to find out the impact of coal mining on humans.

Impact of Coal Mining on Plants

No rare species of plant species found in the study area. So, there is no threat to plant species in the area due to coal mining. The plants found in the area are mentioned below. Thick deposits of dust are found on the leaves of the plant.

Flora (Plants) found in Lodna Area of Jharia Coalfield is:

Dominant species

(1) Babul (Acacia arabica)

(2) Subabul (Leucaeno leucopholia)

(3) Akashmoni (Acacia auriculiformis)

(4) Palas (Butea monosperma)

Other species

(1) Siris (Albizia lebek)

(2) Semul (Bombyx malberium)

(3) Neem (Azadirecta indica)

(4) Bargad (Ficus bengalnesis)

(5) Pipal (Ficus religiosa)

(6) Bel (Aegle marmelos)

(7) Gulmohar (delonix regia) etc. are common species found in the area

Table 6.51

Mnthwise breakup of admissions with the following diseases in male medcal ward I (ward comprises thity beds admissions alternate day in Central Hospital Dhanbad

Month	Total admission	CVA Cases	Respiratory Diseases COPD	IHD other Heart Diseases	Accute Gastro Interitis	Hepatitis	Cirosis Liver & Complication	Cancer Lungs	Other diseases*
Jan.	88	5 (5.6)	22(25)	12(13.6)	2(2.27)	3(3.4)	0(0)	1(1.1)	43(49.03)
Feb.	102	10 (9.8)	16(15.68)	14(13.7)	1(0.9)	7(6.8)	4(3.9)	0(0)	50(49.22)
Mar.	123	19 (15.4)	22(17.8)	18(14.6)	3(2.4)	7(5.6)	3(2.4)	0(0)	51(41.46)
Apr.	95	16 (16.8)	19(20)	11(11.5)	3(3.15)	3(3.15)	0(0)	0(0)	43 (45.26)
May	108	12(11.1)	11(10.18)	12911.1)	7(6.48)	2(1.8)	3(2.7)	2(1.85)	59)54.62)
Jun.	107	15(14)	13(12.14)	10(9.34)	1(0.9)	3(2.8)	0(0)	1(0.9)	64(59.81)
Jul.	134	5(3.9)	24(19.9)	11(8.2)	12(8.9)	1(0.71)	0(0)	5(3.9)	76(58.71)
Aug.	132	14(10.6)	19(14.31)	13(9.8)	15(11.36)	2(1.5)	2(1.5)	1(0.7)	66(50)
Sep.	154	9(5.8)	13(8.4)	22(14.28)	16(10.38)	2(1.2)	1(0.6)	1(0.6)	90(58.44)
Oct.	119	13(10.9)	21(17.60	9(7.5)	7(5.8)	0(0)	1(0.8)	0(0)	68(57.14)
Nov.	142	21(14.78)	32(22.5)	20(14)	7(4.9)	3(2.1)	1(0.7)	0(0)	58(40.84)
Dec.	94	9(9.5)	15(15.95)	13(13.8)	3(3.19)	0(0)	5(5.3)	1(1)	48(51.06)
Total	1398	148(10.58)	227(16.23)	165(11.8)	77(5.58)	33(2.36)	20(1.43)	12(0.8)	716(51.21)

Source Bharat Coking Coal Limited, Dhanbad.

* It includes the patients who are suffering from food poisoning, seizure disorders with neurocysticercosis brain, renal failure gastric bleeding and fever(malaria, filaria, meningitis and meningoentertitis)

Figure given in brackets represents percentage value

CVA-Cerebo Vascular Accident
IHD- Iscimic Heart Disease

N.B. Here is also medical ward II and one female medical ward comprising of thirty beds each occasionally patients to be accommodated in extra beds or floors. There is five hundreds beds in Central Hospital BCCL.

Table 6.52

Morbidity Pattern in the Coalfield Region (1991-92)

Location	Rural Area	Coalmine Area	Steel Industry
Particular of ailments			
GI disorder	21.7	31.2	25.6
Respiratory	14.3	19.9	10.1
Fever (malaria, filaria etc.)	15.6	12.7	7.9

Source: Bharat Coking Coal Limited, Dhanbad.

Table 6.53

Transport Velocity of Dust in Ducts

Material	Transort Velocity in individuals(metre per second)
Iron fillings	11
Lead fillings	25
Sand	17.2
Coal dust	25.3
Cement	25.5

Source: Bharat Coking Coal Limited, Dhanbad.

Table 6.54

Anemia and Helminthes among Coalmines Community

Period of Study	Number of cases studied	Anemia (percent)	Helminthiasis (percent)
1970-71	715	66.3	33.7
1981-82	487	40.5	42.3
1986-87	568	35.6	57.9
1990-91	389	33.7	40.2

Source: Central Mining Research Institute, Dhanbad

Table 6.55

Water born Diseases in Coalmine areas

Water born Diseases	Approx. percentage of patients
Dysentry	40-60
Diarrhoea	10-20
Constipation	25-35
Skin diseases	30-35
Jaundice	5-15
Tapeworm	20-35
Leprosy	5-8

Source: Central Mining Research Institute , Dhanbad

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SUMMARY AND CONCLUSIONS

Summary and conclusions

After analysing the information abd data it can be said that both types of mining operations exist in the area, i.e., surface and underground mining. In early period underground mining was more pronounced. After 1989 more thrust has been given on surface mining. This is due to high production cost of coal by underground method. Coal seams usedl for coal excavation are very deep in the earth. Underground mining causes release of methane gas from the mines. Methane gas causes fire in mine, that is due to sparking of electric current. 0.01 million tonne of methane is emitted during coal production in ten year span of the study area.

Landuse pattern studied from toposheets, other informations available and other maps of the area, show changes in landuse pattern in the area. In 1973, there was about 195.58 hectares of land utilised for settlement purposes, but that became 242.21 hectares in 1993. Major change is found in mining sector. Only 3.99 hectares land was utilised for minimg and quarrying (it is measured in context of surface mining) in 1973 while this became 119.65 hectares in 1993. Only 0.275 % land was used for mining purposes in 1973 while this became 8.268% in 1993. No major change has been observed in other activities.

Some vegetation found before the beginning of coal mining in the area. But today there is no natural forest found in the study area. On the basis of information and data available there is no natural forest found in the area. So, there is no deforestation in the area. Social forestry division of Bharat Coking Coal Ltd. has afforested 10.63 ha land up to 1994-95.

Air pollution iis the excessive concentration of foreign matters in the air which adversely affects the well being of the individual or cause damage to property.

Jeenagora Open Cast Project

(1) Concentration of SPM (Suspended Particulate Matter) – It ranges between 243..33 to 608 micro gm per cubic metre . Highest in January – March period and lowest in Jully – September.

(2) Sulphur dioxide ranges between 8.66 to 19.32 micro gm per cubic metre . Highest in January – March period and lowest in July – September.

(3) Concentrattion of Nitrogen oxides varies between 8.16 to 26.74 micro gm per cubic metre .

North Tisra Area

(1) SPM ranges between 301.66 to 643.06 micro gm per cubic metre.

(2) Sulphur dioxide ranges between 14.78 – 24.21 micro gm per cubic metre. Highest in October – December period and lowest in July- September period.

(3) NOx ranges between 23.8 to 39.7 micro gm per cubic metre. Highest in October – December period and lowest in July- September period.

Lodna Area

(1) SPM ranges between 306.36 – 975.76 micro gm per cubic metre. Highest in January – March period and lowest in July – September.

(2) Sulphur dioxide ranges between 32.86 – 94.62 micro gm per cubic metre. Highest in January – March period and lowest in July – September.

(3) NOx ranges between 10.04 to 49.5 micro gm per cubic metre. Highest in October – December period and lowest in July- September period.

For the study of **water pollution**, coal washery effluent and mine water of different colliery units and different water samples of Damodar River.

Coal Washery Effluent of Lodna Coal Washery

(1) Huge amount of pine oil and grease released into coal washery effluent. These oil and grease will increase the level of pollutant in running water systems.

(2) Biological Oxygen Demand (It is defined as the amount of oxygen consumed by the microorganisms to convert complex inorganic compound into simpler organic compounds) value of coal washery effluent is very high, sometimes it goes upto 350 mg/l.

(3) COD (Chemical Oxygen Demand) value is also very high in the effluent. It also represents the pollution level in the water systems.

Physico - Chemical chreceristics of Damodar River water at different stations

(1) BOD found in the permissible range.

(2) COD value is very high at all points

(3) Nitrogen as Nitrate found under permissible limit

(4) Total Suspended Matter (TSM) and Dissolved solids are also under limit.

(5) Fluoride as F is beyond the permissible limit at two stations

(6) Copper, Iron and Magnesium found in permissible limits.

Mine Water Samples

Mine water of different colliery unit has been analysed quarterly viz., Jan-March, Apr-June.

January - Marclh

(1) pH in the range of 6.50 to 8.13

(2) Hardness off mine water found in the range of 320 - 620 mg/l as calcium carbonate.

(3) Calcium in the range of 40- 76 mg/l.

(4) Magnesium as Mg found in the range of 68- 100 mg/l

(5) 30 - 72 mg/l chloride as Cl found in different water samples.

(6) Iron as Fe found in the range of 0.28 to 0.6 mg/l.

(7) Sulphate as SO4- ranges between 170- 240 mg/l.

(8) Conductivity of different water samples is in the range of 970 - 1480 micro mho/cm.

(9) Total Dissolved Solids (TDS) are present in the range of 514 - 1250 mg/l in different water samples

April - June Perriod

(1) pH between 6.5 to 8.17

(2) Hardness found in the range of 356- 626 mg/l as Calcium carbonate

(3) 42 -77 mg/l calcium estimated as Ca

(4) Magnesium as Mg in the range of 70 -105 mg/l

(5) Potassium in the range between 15 -27 mg/l

(6) Chloride 32 - 140 mg/l as Cl

(7) Sodium found in the range between 18 - 38 mg/l

(8) Sulphate as SO4- in the range between 190 - 244 mg/l

(9) Special conductivity observed between 900- 1500 micro mho/cm

(10)Total dissollved solids estimated 678 -1258 mg/l in mine water samples.

<u>July - September</u>

(1) pH betweem 6.65 to 8.2

(2) Hardness found in the range 320- 558 mg/l as Calcium carbonate

(3) 40 -72 mg/l calcium estimated as Ca

(4) Magnesium as Mg in the range 66-102 mg/l

(5) Potassium estimated in the range between 11 -26 mg/l

(6) Chloride found in the range of 32 - 72 mg/l as Cl

(7) Sodium found in the range between 15 - 30 mg/l

(8) Sulphate as SO4- in the range between 180 - 220 mg/l

(9) Special conductivity observed between 990- 1640 micro mho/cm

(10)Total dissolved solids estimated 710 -1260 mg/l in mine water samples

(11)Iron found iin the range of 0.3 - 0.55 mg/l

<u>October -December</u>

(1) pH between 6.85 to 7.50

(2) Hardness found in the range 330- 540 mg/l as Calcium carbonate

(3) 42 -72 mg/l calcium estimated as Ca

(4) Magnesium as Mg in the range 66 -104 mg/l

(5) Potassium in the range between 12 -26 mg/l

(6) Chloride 32 - 76 mg/l as Cl

(7) Sodium found in the range between 18 - 32 mg/l

(8) Sulphate as $SO4^{-}$ in the range between 184 - 220 mg/l

(9) Special conductivity observed between 980- 1400 micro mho/cm

(10)Total dissollved solids estimated 514 -1254 mg/l in mine water samples

(11)Iron 0.28 - 0.50 mg/l as Fe

Land Degradation is a complex phenomenon because there are multitude causes and effects, both opposite and offsite. All humans use land for their livelihood and its impact is critically influenced by 'nature', which brings great variation in rainfall, wind and temperature patterns. Much land degradation takes place during periods of extreme climatic conditions such as prolonged droughts, severe flooding and so forth.

Surface mining causes Land disturbance from where overburden is removed. Soil/ sand /gravel is excavated in the process of mining. In both cases fertile top soil or soil fertility may be lost. Excavation of coal from underground seams has certain consequences on the surface. During the process whole amount of coal is excavated from the cavities. The cavity formed as a result of underground mining seldom stowed (filling of goaf) by sand, hence the water from the surface drains into the cavities. During this process moisture is retained by the top soil. It decreases the fertility of the land surface. Agricultural yields are influenced by mining activities. In study area land has been degraded by following three activities:

Mine fire activities -- In Jharia it is not water but fire which causes the problem of land subsidence. Underground fire which first broke out in 1920s is still burning. It is now posing a major threat to Jharia Town itself. Fire hazard is associated with underground excavation of coal. It occurs due to oxidation of sulphur minerals, which produces intense heat and release of large amount of toxic gases, fumes and smokes. Sometimes coal mine or water damp fire burns uncontrolled for years together. Area affected by mine fire is 313.12 hectares. Therefore, proper precautions to prevent fires are taken throughout coal mining operation. Mine fire has been divided into three main areas:

(A) Lodna Bagdigi Fire – Here fire took place in the XV seam in 1935. XV, XIVA, XIV, XIIIB and XIIIA are on fire.

(B) Jeenagora Joyrampur fire – Fire first started in 1944 and extended upto new Jeenagora in north and upto the boundary of south Jeenagora in the south. In Joyrampur fire was first reported in XIIIA seam in 1965.

(C) South Tisra – *North Tisra fire- Here fire started in the year 1964 from* 9 seam of North Tisra Colliery. It reached at the X seam of South Tisra Collliery in 1973.

Impact of Mine fire

1. Release of noxious gases viz., Sulphur dioxide, and Nitrogen oxides into the environment. Concentrations of these gases are more than permissible limits. Concentration of sulphur dioxide in winter morning and late evening varies between 88.22 micro gm per cubic metre to 212.20 micro gm per cubic metre. Ambient air quality standard for this gas is 90 micro gm per cubic metre .
2. Nitrogen oxide ranges between 22.77 to 45.99 micro gm per cubic metre in day hours. Carbon monoxide concentration found between 71.38 to 131.30 micro gm per cubic metre during early morning and late evening respectively. But air quality standard for this gas is 80 micro gm per cubic metre. Carbon monoxide concentration is very high near mine fire area.
3. Branch Railway line feeding to Joyrampur is endangered.
4. Hard coke Batteries at Joyrampur are endangered.

5. Dhanbad Balliapur road, which is passing through Jeenagora, suffers from severe threat to fire.
6. Chatkari jore is endangered in Joyrampur colliery as well as Jeenagora colliery.
7. Endangered surface structure of the 400 residential houses, office store and hospital have been to rehabilitate.
8. Madhuban bazaar suffers from severe threat to fire
9. Lodna Coke Plant, Tar Plant and entire colliery complex are also facing threat to fire.
10. Dhanbad Patherdih main Railway line from Bhulan Bararee colliery to 8 pit of Lodna colliery.

(2) Subsidence – Subsidence is the striking or lowering of the land surface. It is a slow process. It takes place gradually, almost unperceptibile or it may occur quite suddenly. It affects the area from few square metres to as large as thousands of square kilometres. Sometimes it occurs due to natural phenomena, in other it is induced by withdrawal of fluids or by the mining or dissolution of solid materials. Coalmine subsidence is the local lowering of ground surface caused by underground extraction. Total subsided area is 12.68 hectares.

(3) Quarry and external overburden – As it is stated that coal is excavated both from surface and underground mining. Surface mining degrades the land twice. In excavation top fertile soil is displaced from one place to other place. It has been calculated that one tonne of coal excavation results in the production of three tonnes of overburden. But it may be more or less depending on the depth of coal

seam in the earth surface. Land degraded due to existing quarry in the area is 38.51 hectares. Area which will degrade in near future due to overburden dumping is 13.35 hectares. Area degraded due to abondoned quarry is 55.11 hectares.

Dust Pollution

Jharia coalfield is the prime source of coking coal in the country. It generates huge amount of in the atmosphere. Dust causes adverse impact on human health. In physical appearances about 70% of the population appeared either sick or in moderate state of health and by clinical examination 35% was found to be actually suffering from different ailments requiring treatment. A sample survey conducted in the coal mining area to study diseases in persons associated with the coal mining activities. 10,000 persons were sellected for the study. About 10.8% persons out of total were suffering from pneumoconiosis. Dust fall rate in Jharia coalfield was 30.5 tonnes per sq. km per month in 1983 which increased upto 40 tonnes per sq. km per month in 1995. Level of dust fall rate is maximum in summer season and lowest in monsoon period. Dust fall rate near Lodna colliery office was 58.67 tonnes per sq. km per month in April 1989. The lowest found in Indian School of Mines (Administration Block) was 7.2 to 18.34 tonnes per sq. km per month. Dust fall rate near Lodna Colliery office was 65.0734 tonnes per sq. km per month for April 1996.

Dust pollution by transportation of coal

All forms of transport exhibit certain common environment features. Coal is transported either by rail or road network. It has been estimated that 0.02% of the coal loaded is lost as fugitive dust and the same percentage lost during unloading. Until now actual loss of coal during transportation is not estimated. Air dust content in the vicinity of reloading for coal transportation and storage may reach 100 micro gm per cubic metre and even higher if low wind velocity prevail.

Hydrogeology

It can be defined as the study of groundwater with special emphasis given to chemistry. All the rivers either originate or flow through districts have an easterly or southeasterly course. Greater portion is covered with different lithounits of the Archean Group and less than 20 percent of geographical area is covered by sedimentary rock of the Lower Gondowana system, mainly occurring in or adjacent to the Damodar and Barakar river valleys in long and narrow faulted troughs. Physico-chemical analysis of groundwater of Jharia coalfield and its adjacent part is given below:

1. Calcium as Ca is 40 mg/l in dug well of Jharia. Calcium content in various tubewells of Dhanbad town varies between 30 – 78 mg/l. Calcium content in different well of Lodna area ranges between 104 – 108 mg/l.
2. Magnesium content in groundwater of Dhanbad town (outside of JCF) ranges between 8-33 mg/l in different tubewells of the area. Well water of Lodna area shown magnesium concentration in the range of 32 – 96 mg/l.
3. Potassium concentration in different tubewells of Dhanbad town are in between 1.7 – 8.0 mg/l. Potassium content estimated in different wells of Lodna area ranges between 6.5 – 24 mg/l in different seasons of the year.

4. Sodium content in dug wells of Central Ground Water Board in Jharia and Dhanbad are 40 and 54 mg/l respectively. Sodium content in different tubewell of Dhanbad town ranges between 22 – 50 mg/l while this is found between 16 – 70 mg/l in different tubewells of Lodna area.
5. Bicarbonate and carbonate content or alkalinity of groundwater ranges between 135 – 430 mg/l in different dug wells and tubewells of the area.
6. Sulphate concentration is fairly below in dug well of Central Ground Water Board. It is also low in different tubewells of Dhanbad town. 136 – 260 mg/l sulphate as SO_4 found in wells of Lodna area.
7. Chloride as Cl in different wells and tubewells of the study area and its adjacent part found between 14 – 170 mg/l.
8. Specific Electrical conductance of dug wells of Central Ground Water Board observed between 450 and 766 micro mho per cm respectively. Well water of Lodna area shown electrical conductance in the range between 530 – 2360 micro mho per cm while this parameter ranges between 352 – 760 micro mho per cm.
9. Physico-chemical characteristics (pH, total hardness, alkalinity, calcium, magnesium, iron etc.) of handpipe (Chapakal) water found under permissible limit except nitrate whose value was more than permissible limit. In some samples nitrate value found upto 64 mg/l. Nitrate value more than 45 mg/l is injurious to health.

Climate

In mean maximum temperature no major change has been observed but there is slight deviation has been observed in mean minimum temperature after 1971 period. This is the period when nationalisation of coal industry begun and ended in 1976. Except 1976 - 80 period declining trend of mean minimum temperature has been noticed. This may be due to coal mining and allied activities. There is an inverse trend against mean minimum temperature has been found. Upto 1970 Relative humidity (RH) at 8.30 hours was under 70 % mark but after 1970 it follows increasing trend. Relative humidity at 17.30 hours followed the increasing trend before 1951 - 1965. It has declined in 1966 - 70 period but after 1981 onwards it started increasing. The most important observation from this data is that Wind speed follows the declining trend both 8.30 hours and 17.30 hours from 1941 to 1990 period. It may be due to heavy load of dust particles and other pollutants present in the environment.

Hydrology

Evaporation or evapotranspiration, the combine loss from soil and vegetated surface, occurs when there is change of state of water from liquid to vapour. This is favoured by energy transfer became much as heat is required to evapotranspiration. Evaporation is the process by which molecule of water at the surface of water or moist soil acquires enough energy by solar radiation by which it turns into gaseous state. Transpiration is the process by which plant loss water in the atmosphere. Water goes into the atmosphere through lower portion of the leaf. In many regions evaporation and transpiration are not measured separately and studied together as evapotranspiration. The amount of solar energy received at the earth surface may average more tham 700 calories a square centimetre a day in hot and dry areas and less than 100 calories a square centimetre in Polar Regions.

Terrain

Coal minimg particularly open cast process, is vulnerable for the earth surface of the area. Underground mining also affects the surface. It causes sinking of land surface which is ttermed as subsidence. Surface mining causes overburden generation removal of overburden from the mine site and dumping at other place bring change in land surface of thie area. Site of mining is deep and overburden site is high. Sometimes differences between two are upto 40 m.

Edaphic aspects

Soil as am essential component of terrestrial ecosystem, lies at the interface between atmosphere and earth's crust. The soil is exposed to input of trace elements from many sourcces in a coal mining environment. Concentrations of trace elements in the soil of the study area are under permissible limit. Only iron has higher concentration in irespect of other trace elements. It may be due to deposition of coal dust on the earth surface.

Fauna (Animal speciesO

Human bieings are the major component of the fauna in the area. Persons residing near mining area have poor health. Persons working in the mines are also having poor health quality. It may be due to dust particles which are the out come of coal mining prevailing in that area. Noxious gases are emitted by coal mass burning inside the earth. Coal mining is one of the major factors responsible for this matter. Respiratory and Gastro-enteritis disorders are more prevalent in the area. Gastro-enteritis is due to poor water quality used by local people. Water used in household activities is mine water, which is generally hard in nature. Respiratory disorders occur due to settling of coal dust in the lungs. Transport velocity of coal dust is 25.3 metre per second next to cement particles which is 25.5 metre per second

Flora (Plant species)

No rare plant species found in the area. Mining does not causes extinction of such plant species. Plants generally found in the area are Bargad (Ficus bengalnesis), Mango (Magniferra indica)etc. Thick deposits of dust found on the leaves of trees. It is evident from the dust fall rate which is quite high.

Conclusions

From the data and information available from primary and secondary sources and analysis following conclusions are drawn:

(1) Coal mining causes dust pollution. Annual average concentration is more than permissible limit. Suspended Particulate Matter (SPM) is also high.

(2) Transportation of coal also causes dust pollution. Enormous amount of coal dust is released in the surrounding environment.

(3) Huge amount of coal lost as fugitive in the environment during loading and unloading of this material.

(4) Coal mining causes land degradation. About 432.77 hectares of land is degraded due to coal mining in the study area, which is nearly 29.9 % of the total study area (1447hectares).

(5) Coal mining has brought changes in landuse pattern of the area. About 4-hectares land was used for mining and quarrying in 1973, which accounts to 119-hectares in 1993. There is no major change observed where underground mining was active on those days. Nowadays open cast mining is more prevalent. This is due to low production cost of coal. According to an estimate made by BCCL that one tonne production of coal by underground mining costs Rs. 1300 while it costs only Rs. 800 in case of open cast process.

(6) Groundwater is also affected by coal mining. Water table was 2-4 metres below ground level (mbgl) in 1981-82, which further went down 4-5 mbgl in1987, and this was 5.5-7 mbgl in 1994.

(7) No major changes have been observed in climate of the area . Climatic data for the area is available from 1941 to 1991. Data for some years are not available.

(8) Coal dust released by coal mining, drilling, transportation and allied activities has negative impact on human health. Proper records about medical facilities are not available. No statistical record of miners regarding incidence of disease is availalble for the study area. In physical appearances about 70 percent of the population appeared either sick or in moderate state of health and by clinical

examination 35percent was found to be actually suffering from different ailments requiring treatment. In a sample survey conducted in the coal mining area to study diseases in persons associated with the coal mining activities. 10,000 persons were selected. Out of that 10.8percent persons were suffering from pneumoconiosis. So, it can not be said that coal dust is the only factor for poor health condition in the area. Thousands of vehicles are plying on the road causing poor environment.

(9) Fugitive transmission of dust during loading and unloading both by rail or road network is also causing poor visual quality.

(10) No rare plant species is found in the area. So, there is no chance for extinction of plant species in the area. However heavy deposit of dust has been observed on leaves on the plant found in the area.

(11) Mine fire is more prevalent in the area. It causes release of noxious gases in the environment. Average concentration of carbon monoxide, sulphur dioxide and Nitrogen oxides are more than permissible limit Mine fire results heavy destruction of coal in the area.

(12) Chemical analysis of Indian coal shows high ash content. During washing large amount of coal goes into the Damodar River. Concentration of suspended solids is very high in coal washery effluent sometimes upto 1600 mg/l. Hundred tonnes of pine oil is discharged into the water body. High value of Biological Oxygen Demand(BOD) and Chemical Oxygen Demand(COD) are found in coal washery effluent.

(13) High COD value found in water of Damodar River. It is not only due to discharge of coal washery effluent but also due to discharge made by thermal plants located at the vicinity of Damodar River.

(14) Miners, working inside mines , in transportation of coal and associated with coal washery units suffering from pneumoconiosis due to high concentration of Suspended Particulate Matter(SPM). SPM value near crusher point is 1300 micro gm per cubic metre.

(15) Underground mining causes release of water that has been accumulated in the mines. Flooding of the mines with water, absorbs oxygen that may cause mine fire.

(16) Large amounts of methane go into the atmosphere, which is generated, from coal mining. Methane is found between the crevices of coal lumps. It has been estimated that 0.1743 million tonnes of gas emitted in the atmosphere between 1985-86 and 1995-96 (upto January).

(17) Underground mining has severe impact on earth surface. Sinking of earth surface causes subsidence. There are 39 spots located in the study area, which may subside any time covering an area of 626.46 ha.

(18) Heavy amount of soil is eroded. Erosion of the dumped overburden causes siltation on the bottom of the deposit.

(19) Dust fall rate increased due to coal mining.

(20) Various developmental structure viz., Dhanbad Patherdih Railway line, 400 residential houses, Lodna Area Hospital facing serious problems due to this activity.

(21)Air quality has changed. Mine fire emits noxious gases into the atmosphere. Concentration of these gases(Carbon monoxide, Nitrogen oxides and Sulphur dioxide) are above than permissible limit.

(22)Mean maximum temperature of Dhanbad has not changed but there is slight deviation observed in mean minimum temperature after 1971. Nationalisation of coal industry boosted coal production in the area. This change is not due to coal mining only but also by other anthropogenic activities.

(23) On the basis of information available it can be said that coal mining will not affect the geology of that area in near future.

Recommendations

Implementation of following suggestions can help in improving the quality of the environment of study area:

1. Mine drainage can be controlled by using landscaping that controls the amount of water that flow into mines.
2. Sealing of coalmines prevent water to flow in or out. It can control mine drainage upto a great extent.
3. Full use of mine water can control mine drainage.
4. Disposing of waste rock from coalmines in layers, sandwiched between layers of earth is also a step, which can control mine drainage.
5. Seeding of various plant species should be established on that portion of the area which is closest to the source of the prevailing wind during the growing season to

minimise covering or damaging of youth plants by drifting tailings. It will help in conserving fertile material of the heap.

6. The use of companion crop, to produce surface winds and provide some shade is beneficial.
7. Nitrogen fertilisers should be applied several tonnes to grow the plant because soil lack proper nitrogen content.
8. Establishing initial plant communities using available species that are tolerant of drought, low soil pH, poor soil texture, the lack of organic materials and nutrients (it includes carbon , nitrogen , phosphorous, potassium etc.).
9. Modifying the localised micronutients to benefit plant establishment.
10. Re-establishing soil invertebrate (lower class animals viz., arthropods) and microbial communities to ensure natural organic decomposition essential to the rebuilding soils.
11. Re-establishment of nutrient cycle and conservation.
12. Following plant species are recommended:

ROAD SIDE

(i)	Delonix regia (Gulmohar)
(ii)	Ficus bengalnesis (Bargad)
(iii)	Ficus religiosa (Aswath)
(iv)	Polyalthia longifolia (Devdar)
(v)	Peloforum farganum
(vi)	Eucalyptus globulus

RESIDENTIAL AREA

(i)	Albizzia lebbeck (Siris)
(ii)	Acasial auriculiformis (Akashmoni)
(iii)	Dalbergia sisso (Shisham)
(iv))	Leucaena leuconcephalia (Subabul)
(v)	Casia fistula (Amaltas)
(vi))	Pongamia pinnata (Karanj)
(vii)	Emlica officinalis(Amla)
(viiii)	Acacia arabica (Babul)
(ix)	Acacia catechu (Khair)
(x)	Madhuke longifolia (Mohua)
(xi)	Casia siamea (Kasid)
(xii)	Bombax malbaricum (Semal)
(xiii)	Azadirachta indica (Neem)
(xiv)	Butea monosperma (Palas)
(xv)	Agave

FRUIT TREES

(i)	Magnifera indica (Mango)
(ii)	Suzygium cumuni(Jamun)
(iii))	Annona squamosa (Sitaphal)
(iv)	Aegle marmelos (Bel)
(v)	Zizziphus zuzuba (Ber)

13 The following tree species will prove relatively easier to establish and more useful for revegetatiion of mine spoil.

(a) Acacia auriculiformis – hardy, nitrogen fixer useful for dry and arid areas,

(b) Albizia lebek – Nitrogen fixer, soil binder, suitable for dry and alkaline soil,

(c) Azardichta indica – Wind breaker, good for arid and nutrient deficient soil,

(d) Casia siamea – Fast growing evergreen, nitrogen fixer, grown or saline and alkaline soil,

(e) Dalbergia sissoo – Nitrogen fixer for agroforestry timber,

(f) Derris indica – Dwarf deciduous tree, sandy crown leaves shade tree, leaf provides green manure,,

(g) Euclyptus sp – Dense underground root system used for land reclamation, timber pulp and paper, medicinal oil,

(h) Gamlena arobiea – Increased soil nitrogen, fodder , timber pulp,

(i) Melia azadarech – Medium size tree, deciduous, very fast growing,

(j) Leucaenea leucocephalia – Nitrogen fixer used as fodder, fast growing, restores watersheds and grasslands.

14 Sprinkling of water (mine water) on roads to bring down the dust fall rate near coal mining site.

15 Water should be sprinkled on coal loaded in wagons to curb dust. It brings down coal dust that is lost during transportation.

16 Goaf (space left after mining) should be developed as aquarium. So, it not gives only employment of local youth but also provides economy for the people.

17 Gas mask should be provided to each miner. It will decrease the incidence of pneumoconiosis.

18 As it is stated that one tonne of coal excavation results in release of one cubic metre water. Mine water is hard in nature. This mine water should be stored and it can be supplied for drinking purposes after treatment. This water can solve water problem of the locality.

19 Subsidence is very intimately connected with underground mining process. Therefore, actions should be necessarily taken well in advance and during mining operations to avoid subsidence.

20 Subsided land can be reclaimed by backfilling operation of topsoil of the area. Soil upto a depth of 50 cm can be scrapped to be preserved. If damaged land has been not brought to original condition such areas can be used for agriculture, development of township or other infrastructure facilities, fish farming or recreational purposes.

21 Trench of 2 metres x 2 metres should be excavated around old dumps. Mounds should be formed on the outer skirt of excavated soil. It will help in soil conservation.

22 Dense vegetation should be grown in this area. Dense vegetation prevents the incoming and outgoing radiation, dust pollution, screen air particles.

23 Plants like Spruce and Pine should be planted in mine area. The tree Spruce can collect 32 tonnes of dust from the atmosphere in a year. Pine and Beach can collect 36.4 and 63 tonnes of dust respectively in a year. Plantation of such type of trees which can collect dust of an affected area.

24 Afforestation brings not only fresh oxygen to the atmosphere but also conserving water resourc:es. A well stocked forest soil which shelters deep rooted trees has a moisture storage capacity varying 50,000 to 2,00,000 cubic metres of water per square kilometre. Dense vegetation also reduces extreme of soil temperature by its canopy action and interaction on the forest floor.

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Appendices

Appendix - I

Indian standards specifications for drinking water IS 10500 - 1983

Substance or Characteristics	Requirement desirable limit	Undesirable effects outside the desirable limit	Desirable Essential	Remarks
Colour Hazen units, Max	10	Above 10 consumer acceptance decreases	Essential	May be extended to 50 only if toxic substance are not suspected in absence of alternate sources
odour	Unobjectionable		Essential	a) Test cold when heated b) Test as several dilutions
Taste	Agreeable		Essential	Taste to be conducted only after safety has been established.
Turbidity NTU Max.	10	Above 10 consumer acceptance decreases	Essential	May be extended upto 25, in absence of alternate sources.
pH value	6.5 - 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	Essential	May be extended upto 9.2 in absence of alternate sources.
Total hardness as CaCo3 mg/l Max.	300	Encrustation in water supply structure and adverse to effects on domestic use	Essential	May be extended upto 600, in absence of alternate sources.
Calcium as Ca mg/l Max.	75	Encrustation in water supply structure and adverse to effects on domestic use	Desirable	May be extended upto 200, in absence of alternate sources.
Magnesium (as Mg)mg/l Max.	30	Encrustation in water supply structure and adverse to effects on domestic use	Desirable	May be extended upto 100, in absence of alternate sources.
Copper (as Cu) mg/l Max.	0.05	astringent taste discolouration and corrosion of pipes fittings and utensils will be caused beyond this	Desirable	May be extended upto 1.5
Iron (as Fe) mg/l Max.	0.3	Beyond this limit taste appearance are affected has adverse effect on domestic uses and water structures and promotes iron bacteria	Essential	May be extended upto 1.0 in absence of alternate sources

Manganese (as Mn) mg/l Max.	0.1	Beyond this limit taste appearance are affected has adverse effect on domestic uses and water structures	Desirable	May be extended upto 0.5 where alternate source is not available.
Chlorides (as Cl) mg/l Max.	250	Beyond this limit. taste corrosion and palatability are affected.	Essential	May be extended upto 1000 in absence of alternate sources.
Sulphate (as SO4) mg/l Max.	150	Beyond this causes gastro intestinal irrigation when magnesium and sodium are present	Desirable	May be extended upto 400 provided magnesium (as Mg) does not exceed 30.
Nitrate (as NO3) mg/l Max.	45	Beyond this methane moglobinemia takes place	Desirable	No relaxation
Fluoride (as F) mg/l Max.	0.6 to 1.2	Low fluoride levels are linked with dental carries above 1.5 it may cause flurosis	Desirable	If the limit is below 0.6 water source should be rejected but suitable public health measures should be taken. Maximum limit may be extended to 1.5 if no better alternate source is available.
Phenolic compounds (as C6H5HO) mg/l Max.	0.001	beyond this it may cause objectionable taste and odour	Desirable	may be relaxed upto 0.002
Mercury (as Hg) mg/l Max.	0.001	Beyond this the water becomes toxic.	Desirable	No relaxation of this limit is allowed to be tasted when pollution is suspected.
Cadmium (as Cd) mg/l Max.	0.01	Beyond this the water becomes toxic.	Desirable	No relaxation of this limit is allowed to be tasted when pollution is suspected.
Selenium (as Se) mg/l Max.	0.01	Beyond this the water becomes toxic.	Desirable	No relaxation of this limit is allowed to be tasted when pollution is suspected.
Arsenic (as As) mg/l Max.	0.05	Beyond this the water becomes toxic.	Desirable	No relaxation of this limit is allowed to be tasted when pollution is suspected.
Cyanide (as Cn) mg/l Max.	0.05	Beyond this the water becomes toxic.	Desirable	No relaxation of this limit is allowed to be tasted when pollution is suspected.
Lead (as Pb) mg/l Max.	0.1	Beyond this the water becomes toxic.	Desirable	No relaxation of this limit is allowed to be tasted when pollution/plumbosolvency is suspected.
Zinc (as Zn) mg/l Max.	5.0	*Beyond this it can cause astringent taste and an opalescence in water.*	*Desirable*	*May be relaxed to 10.0. To be tasted when pollution is suspected.*

Anionic detergents (as MBAS) mg/l Max.	0.2	Beyond this limit it can cause a light froth in water	Desirable	May be relaxed to 1.0. To be tasted when pollution is suspected.
Chromium (as $Cr6^{+}$) mg/l Max.	0.05	May be Carcinogenic above this limit	Desirable	May be relaxed to be tasted when pollution is suspected.
Polynuclear aromatic Hydrocarbon (as PAH) mg/l Max.	-	May be carcinogenic	Desirable	-
Mineral oil mg/l Max.	0.01	Beyond this limit undesirable taste and odour after chlorination takes place.	Desirable	May be relaxed to 0.03. To be tasted when pollution is suspected.

Appendix - II

Tolerance Limit of River water (mg/l)

Suspended solid	- 100
Dissolved solid	- 2100
COD	- 250
BOD	- 30
Chloride	- 1000
pH	- 6- 8.5
Iron	- 14.70
Manganese	- 2.80
Copper	- 1.50
Calcium	- 31.2
Magnesium	- 1.6
Sodium	- 30

Appendix - III

Average abundlance of trace elements in soils, the earth' crust, sediments and igneous rocks

Element	Soil (ppm)	Crust (ppm)	Sediments (ppm)	Igneous Rocks ppm
Manganese	850	975	760	1000
Barium	500	450	690	640
Zirconium	300	190	200	1700
Strontium	300	385	450	350
Chromium	200	150	130	117
Vanadium	100	145	130	90
Rubidium	80	165	270	2800
Zinc	50	125	80	80
Celenium	50	46	50	40
Nickel	40	95	95	100
gallium	20	15	30	20
Copper	20	75	57	70
Nb	15	20	20	20
Lead	10	15	20	16
Tin	10	40	16	32
Boron	10	10	56	13
Cobalt	10	35	22	18
Cadmium	0.5	0.2	0.5	0.13
Mercury	0.01	0.07	0.04	0.06
Selenium	0.5	0.007	0.6	0.01

Source - Andrew Jones , D.A., 1968, *Mineral Industry Bulletin* 11:1

Appendix - IV

Concentration of Chromium and Nickel in coal and fly ash mg/Kg

Description	Chromium	Nickel
Coal	15	15
Fly ash		
(a) Bituminous	172	11
(b) Sub - bituminous	50	18
(c) Lignite	43	13

Source: Adriano P.C. *et. al.*, 1980 , *Journal of Environmental Quality* a: 333 – 444

Appendix - V

Monthly percentage of daytime Hours of the 0 - 30 North of the Equator

	Jan	Feb	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
30	7.31	7.02	8.37	8.71	9.54	9.49	9.67	9.21	8.33	7.97	7.2	7.16
28	7.4	7.07	8.37	8.67	9.46	9.39	9.58	9.17	8.32	8.02	7.28	7.27
26	7.49	7.12	8.38	8.64	9.37	9.29	9.49	9.11	8.32	8.06	7.36	7.37
24	7.58	7.16	8.39	8.6	9.3	9.19	9.4	9.06	8.31	8.1	7.44	7.47
22	7.67	7.21	8.4	8.56	9.22	9.11	9.32	9.01	8.3	8.13	7.51	7.56
20	7.75	7.26	8.41	8.53	9.15	9.02	9.26	8.95	8.29	8.17	7.58	7.65
18	7.83	7.31	8.41	8.5	9.08	8.93	9.16	8.9	8.29	8.2	7.65	7.74
16	7.91	7.35	8.42	8.47	9.01	8.85	9.08	8.85	8.28	8.23	7.72	7.83
14	7.98	7.39	8.43	8.43	8.94	8.77	9	8.8	8.27	8.27	7.76	7.93
12	8.06	7.43	8.44	8.4	8.87	8.69	8.92	8.76	8.26	8.31	7.85	8.01
10	8.14	7.47	8.45	8.37	8.81	8.61	8.85	8.71	8.25	8.34	7.91	8.09
8	8.21	7.51	8.45	8.34	8.74	8.53	8.78	8.66	8.25	8.37	7.98	8.18
6	8.28	7.55	8.46	8.31	8.68	8.45	8.71	8.62	8.24	8.4	8.04	8.26
4	8.36	7.59	8.47	8.28	8.62	8.37	8.64	8.57	8.23	8.43	8.1	8.34
2	8.43	7.63	8.49	8.25	8.55	8.29	8.57	8.53	8.22	8.46	8.1	8.42
0	8.5	7.67	8.49	8.22	8.49	8.22	8.5	8.49	8.21	8.49	8.22	8.5

Source - Nokes, Sue e, Environmental Hydrology, Andy D. Ward and Willary J. Elliot (eds), Lewis Publishers, Boca Raton , 1995, pp. 91 -126

Bio-data

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Examination Passed	Board/University	Year	Division/Class/Grade	Subject (s)
Matric	BSEB, Patna	1981	I	Hindi, English, Math, Nat. Scs., Soc. Scs.
I.Sc.	BIEC, Patna	1983	II	Physics, Chemistry, Biology
B.Sc. (Hons.)	M.U. Bodhgaya	1988	I	Zoology
M.Sc.	M.U. Bodhgaya	1993	I	Environmental Sciences
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10. Work experience: As water analyst in PHED (Govt. of Bihar), 1992-93.

11 Paper Published - Several Papers published in various national and regional journals.

Shree Kant Sharma

Photographs of Jharia Coalfield

Plate 1 : Active Opencast Mining

Plate 2 : Abandoned Site after Opencast Mining

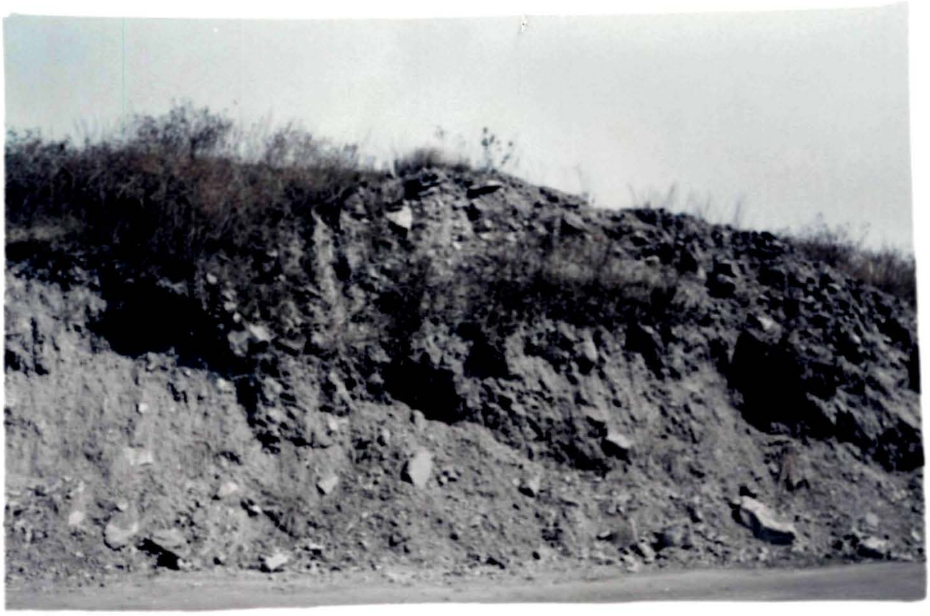

Plate 3 - Overburden Site

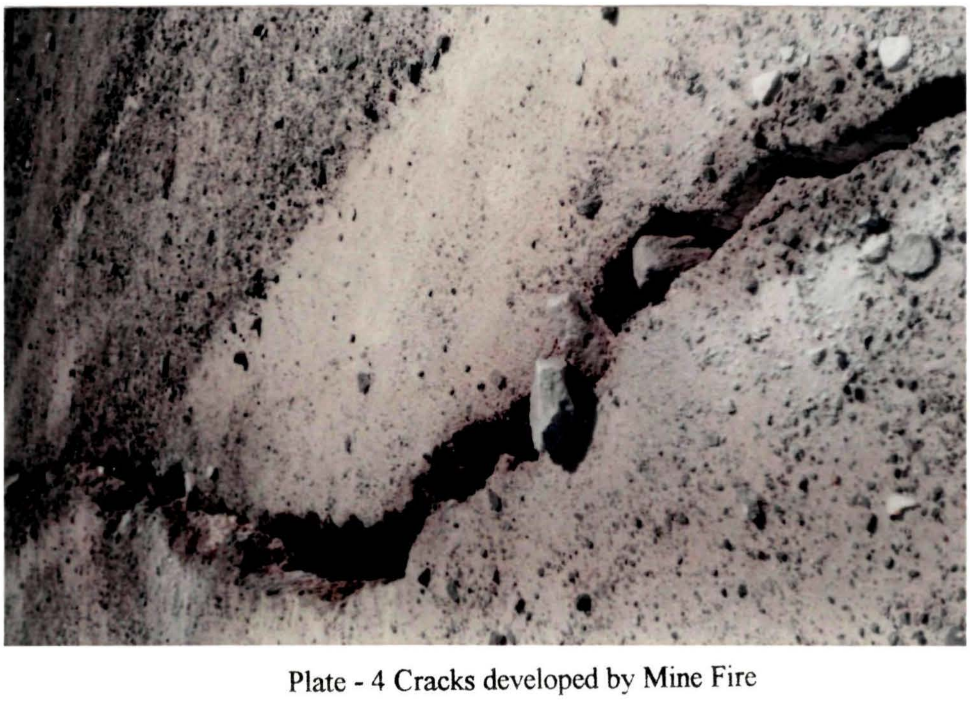

Plate - 4 Cracks developed by Mine Fire

Plate – 5
Smoke and Cracks
Produced by
Mine Fire

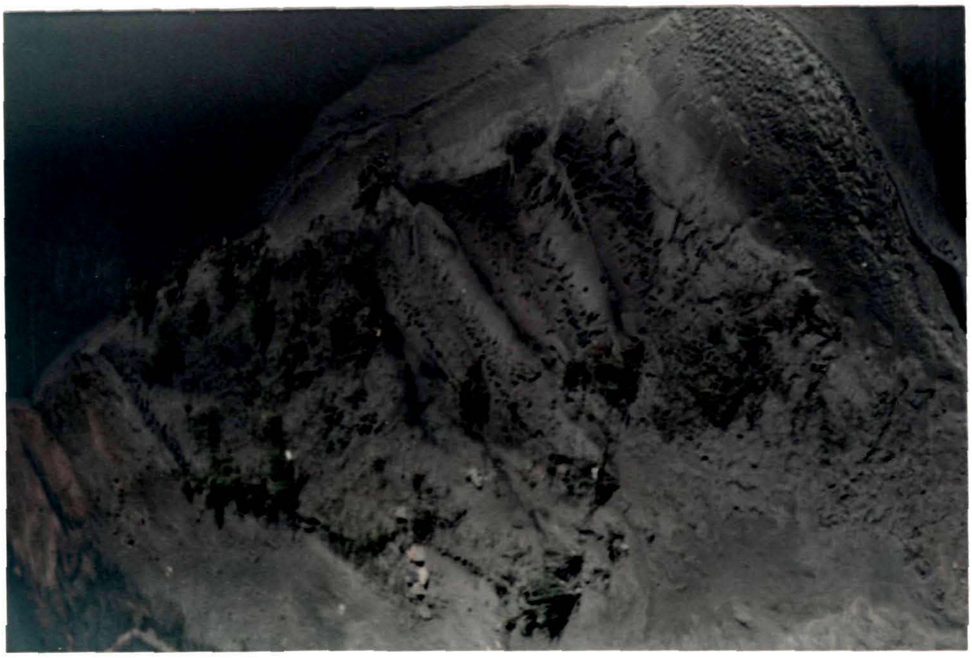

Plate - 6 Coal Dust in the River Bed

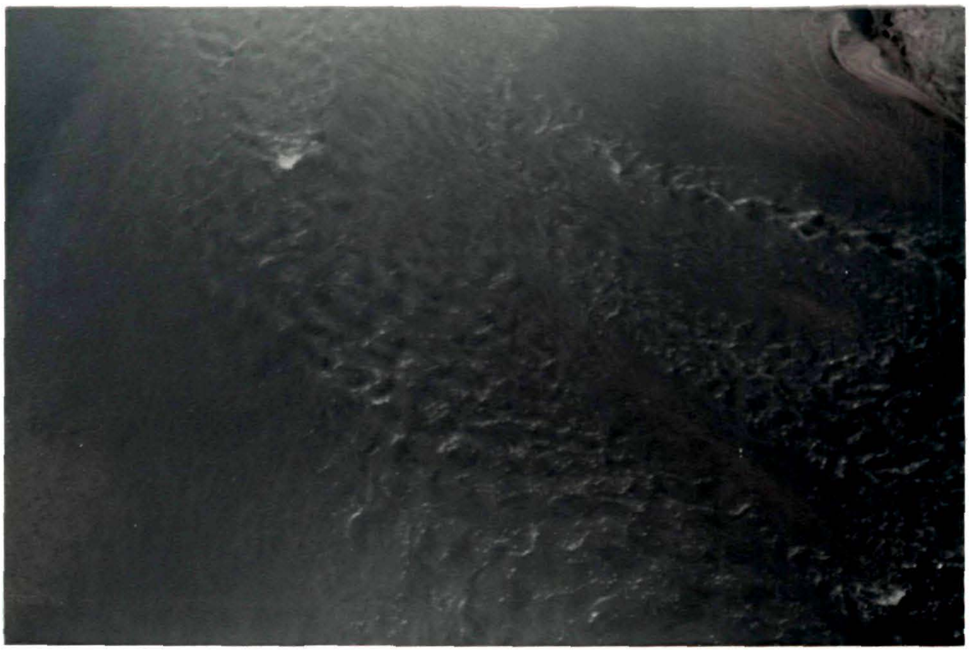

Plate - 7 Flow of Coal Dust in the River Bed

Plate - 8 Air Pollution due to Burning of Coal

Plate -9 Dust Generated during Loading of Coal

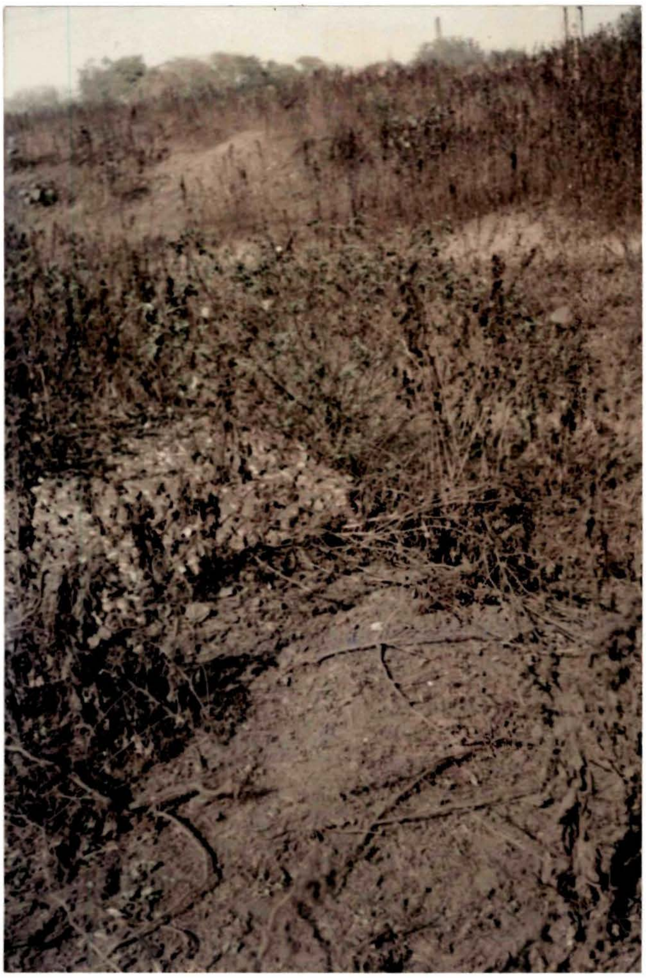

Plate - 10
Dust Deposition on
Plants - a sign of severe
Dust Pollution

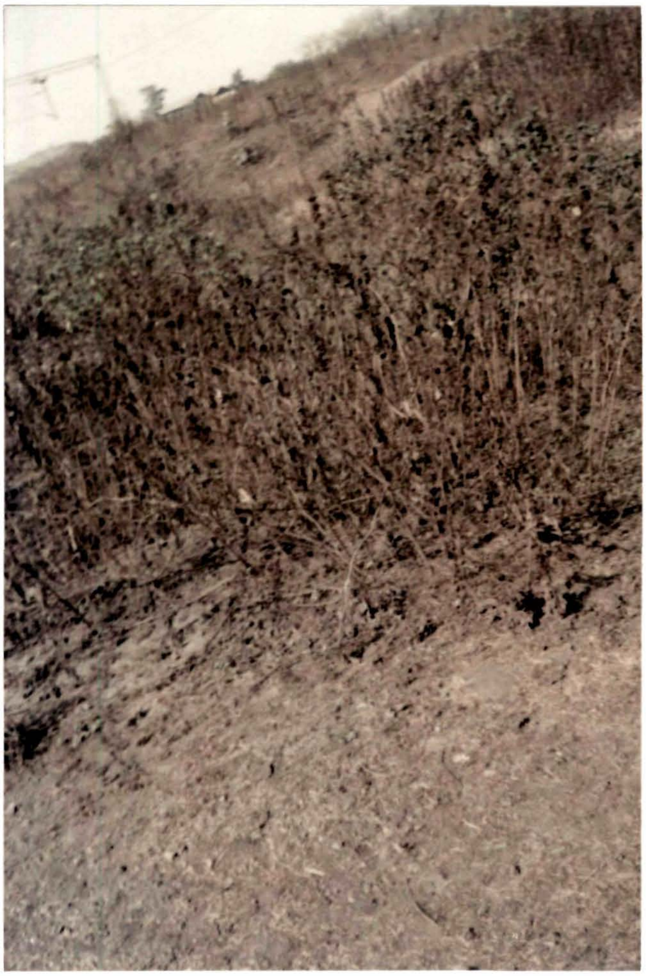

Plate - 11
Decaying of Plants

due to Dust Deposition

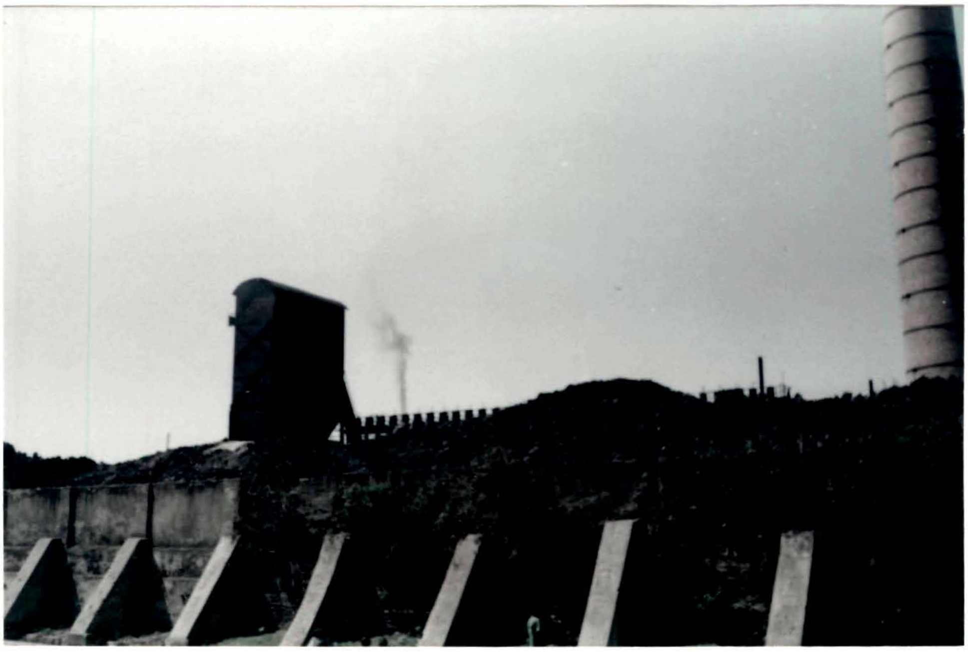

Plate - 12 Stack gases coming out of Coke Plant

Plate - 13 Dust Pollution Created by Trucks