3

LAND POLLUTION IN THE COAL AREAS OF WEST BENGAL
"Land" as a term means different things to different people. In some situations land may connote simply space or area. Whereas many people in past decades thought of land in terms of its suitability for agriculture, it is in fact utilized for many other purposes. Interestingly land, and some of its good agricultural land is being occupied by cities and smaller urban communities. Forested lands once attached by the pioneer to create a farm for himself, now intermingle with the farms or are spread over extensive areas where the land is largely unsuited for farming. To people who live in cities and work in an economy that provides time and money for recreation, land areas of a variety of dimensions became necessary for recreational purposes. Land is utilized for the building of highways, for
wildlife, for mining operations, for reservoirs, for airports and many other economic purposes. However, it is the agriculture that makes the largest demand upon the available land of the nation to meet the needs of the people for food and fibre. Land furnishes nourishment in the form of mineral elements for plants. It also provides a growth medium — a place for plant roots to take hold. Plants, however, are equally important to the land in that they contribute to soil formation. A good vegetative cover provides complete protection to the soil from the erosive forces of wind and water. Decaying plants produce organic matter to increase the soil's ability to absorb rainfall. The same organic matter increases the fertility of the land and further improves its ability to grow plants where plant roots increase the aeration of the soil.

In a somewhat different way the land provides a place for animals to "take root" when they use the land for their burrows. Animals, in turn, exert an influence on the land, witness the soil mining and aeration accomplished by earthworms and burrowing animals and the increase in organic matter and consequent fertility caused by the decay of animal bodies — from the tiniest insects to the largest mammals. The major contribution of the land to animals, however, is indirect. It is through the plants that grow on the land and furnish food and cover. Without plants, animals could not exist. But, conversely, many plants such as hickory trees would disappear were it
not for animals. The pollination by insects as with alfalfa and the seed distribution as with mulberry by many birds and mammals are examples of the virtually indispensable functions performed by animals. Then functions are being fostered when a living fence is planted between cropland and pasture, thus providing a habitat for bumblebees, solitary bees, and other insects useful in pollinating red clover, sweet clover, alfalfa and other legumes. It has been estimated by the environmentalists that to secure ecological stability, thirty per cent of the nation should be under adequate forest cover. But most of the countries in the world is unable to preserve so. Due to population explosion, widespread urbanisation, industrialisation, mining, building, highways, rail roads, water bodies etc. the sustainable development could not be maintained. It is evident from the record that only 21 per cent of the world's land surface is cultivable, of which only 7.6 per cent is actually under cultivation. The area of land now under cultivation is estimated to be 1500 million hectares, but how much this could be increased is uncertain as estimates of the potential arable land range from 0.9 billion hectares (BOERMA 1975) to 9.0 billion (PAWLEY 1971). But development to date has naturally been on the best and easiest land. That now remaining includes areas of dense forest, of desert, regions where development is unlikely until health hazards like malaria or trypanosomiasis have been cleared up, and areas presently unpopulated. Furthermore,
the development of new land would tend to be unevenly distributed, for there is little land available for new development in those countries with the worst problem of over population and underfeeding.

India's poverty is closely linked with its increasing deforestation and land degradation. As much as half of the 329 million hectares is considered degraded in one form or another. Satellite imagery between the Seventies and Eighties revealed that forests were losing tree cover at the staggering rate of 1.3 million hectares a year. Out of the 75 million hectares of forest under forest management, 40 million hectares are now without tree cover. Deforestation, especially in the watershed areas, has led to massive soil erosion. The Union Ministry of Agriculture estimated that the country lost 30 to 50 million tonnes of food grain on account of top soil loss. Dams built at enormous cost get silted much sooner than the annual siltation rates assumed. With such high incidence of soil erosion and siltation, the frequency and severity of floods too have increased, leading to enormous losses, human suffering and increased poverty and hunger. About a third of the country's land area is classified as drought prone. And in a bad drought year, as in 1987, over two-thirds of the country was severely affected. Loss of cultivable land due to desertification is largely man-made resulting from over cultivation, grazing, and cutting of tree cover, bad irrigation
practices etc. Desertification spreads from a small area until eventually lays waste large areas. The country has paid heavily for its neglect of the uncultivated half of India — forest, grazing and community land. The interests of the poor can be safeguarded only if development takes into account the dependence of the poor on common resources for their survival. The increasing degradation of land resources over the last 40 years has led to greater poverty and increased impoverishment. Although every Five Year Plan has focussed on poverty alleviation, they have not succeeded because the link between poverty and degraded land resources has not been sufficiently understood. If poverty in the country is to be tackled seriously, then the land use planning, issues such as deforestation, soil erosion and desertification, watershed management should receive the highest political attention. All forms of environmental degradation adversely affects agriculture and food production in one way or another. The 'State of the World' report (1990)\(^1\) mentions that soil erosion has slowly undermined the productivity of about one-third of the world's croplands. In irrigated areas in the 'Green Revolution' fields, soil has lost its nutrients, and where drainage is bad the land has become saline. Water logging

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\(^1\) Dr Kamala Choudhury, former Chairperson of the National Wasteland Development Board analyses the changing scenario in forest and Wasteland Management in 'Government Policies: Structural Changes for Better' The Hindu, Survey of the Environment, 1992.
and salinity have affected at least a fourth of the world's irrigated cropland. In India, where drainage is particularly neglected, at least half of the irrigated area is likely to become saline and abandoned as wastelands. There is no further possibility of expanding land for agriculture. A great deal of forest land was diverted for agriculture in the early years for food security. Any increase in food production must now come from higher yields, especially in the rainfed areas. In India, cultivable land per capita declined from 0.48 hectares in 1951 to 0.26 hectares in 1981. By 2000 A.D. it is likely to be 0.14 hectares per capita. This means not only greater land shortage, rural unemployment, indebtedness, but also massive migration to urban areas. The migration of 'environmental refugees' to urban areas has led to big slums, pollution and sanitation problems; epidemics such as malaria and cholera; and drugs, crime and violence. To accept such survival as millions do is to die a little every day.

Commercial coal mining in India as an article of trade started in 1774 at the instance of Warren Hastings for the benefit of the East India Company for the manufacture of arms and ammunition. This was in the Raniganj coal field area — along the western banks of the river Damodar over a tract of land from Dishergarh to the Raniganj town, and coal mining commenced here in surface mines quarries or small open cast mines. Large scale deforestation took place for such a cause
and slowly the decrease in the greenish areas. During the world wars the demand for coal was largely increased and it was done without proper care. It was in these periods the land degradation took place extensively as the sand-filling was not done properly. In addition, it has been also ascertained the greenish view in those areas was no more. The wide-spread deforestation took place with the increase in commercial mining which had a devastating effect to the erosion of the soil. With the dawn of independence, the production is increased and subsequently in the context of conservation, safety and scientific development of coal reserves, systematic and proper mining of coking coal and increasing demand from Iron and Steel and other industries, the Government of India took over all the coking coal mines on 16th October 1971, and nationalised them on 1st May 1972.

The coal areas in West Bengal is spread over in 4 districts, Burdwan, Birbhum, Bankura and Purulia covering an area of fourteen hundred and sixty sq.kms. (Table - 1).

Table - 1

<table>
<thead>
<tr>
<th>Raniganj Coalfield is Spread Over in 4 Districts of West Bengal and Three Districts in Bihar,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burdwan</td>
</tr>
<tr>
<td>Birbhum</td>
</tr>
<tr>
<td>Bankura</td>
</tr>
<tr>
<td>Purulia</td>
</tr>
<tr>
<td>Dhanbad</td>
</tr>
<tr>
<td>Deoghar &amp; Godda</td>
</tr>
<tr>
<td>---------------------------------------------</td>
</tr>
<tr>
<td><strong>1530 Sq.km.</strong></td>
</tr>
</tbody>
</table>
The district of Burdwan covers nearly 75% of it and is the largest producer of coal in our province. The Raniganj coalfield in West Bengal is the eastern most unit of Damodar Valley Coalfield and the coal deposits occur within the upper paleozoic rocks popularly known as 'Gondwanas' and it has been depicted in Table No.2.

Table - 2

1. Land degradation:
   
   (a) Land affected by mining till today has been estimated to be 78.23 Sq.Km.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Particulars</th>
<th>Total Quality(Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Subsidence</td>
<td>5112</td>
</tr>
<tr>
<td>2.</td>
<td>Open Cast</td>
<td>1200</td>
</tr>
<tr>
<td>3.</td>
<td>Overburden Heaps</td>
<td>470</td>
</tr>
<tr>
<td>4.</td>
<td>Fire Area</td>
<td>641</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7823</td>
</tr>
</tbody>
</table>

(b) Land reclaimed till today

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Total Quality(Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsided area</td>
<td>1352</td>
</tr>
<tr>
<td>Open cast</td>
<td>590</td>
</tr>
<tr>
<td>Fire Area</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>2095</td>
</tr>
</tbody>
</table>

(c) Biological Reclamation done till today

1. Overburden dumps 169
2. Subsided area and others 1800

| Total                | 1969              |
The present environmental scenario of Raniganj coalfield is very much shocking as a result of 200 years of mining activity along with large scale deforestation since the beginning of 19th century. Today the land effected by mining is very alarming to us as it penetrates not only the natural but also the human environment. It has been estimated that slightly more than 50% of the land was reclaimed through technological and biological process. To meet the requirement of production and need of the people many new projects have been undertaken by the Central Government under E.C.L. Those major projects are shown in Table No.3.

**Table - 3 (Fig. in Ha.)**

A. Tentative Scenario of land requirement for few major projects

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Project Opencast</th>
<th>Total land requirement</th>
<th>Quarry/Cavint</th>
<th>OB Dump</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Jambad</td>
<td>341</td>
<td>170</td>
<td>118</td>
<td>53</td>
</tr>
<tr>
<td>2.</td>
<td>Rajmahal</td>
<td>1403</td>
<td>930</td>
<td>310</td>
<td>83</td>
</tr>
<tr>
<td>3.</td>
<td>Sonepur Block</td>
<td>1866</td>
<td>1510</td>
<td>66</td>
<td>290</td>
</tr>
<tr>
<td>4.</td>
<td>Sahar juri Block</td>
<td>516</td>
<td>169</td>
<td>168</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>4126</strong></td>
<td><strong>2779</strong></td>
<td><strong>742</strong></td>
<td><strong>605</strong></td>
</tr>
</tbody>
</table>

B. Project Underground

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Project Opencast</th>
<th>Total land requirement</th>
<th>Quarry/Cavint</th>
<th>OB Dump</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Khottadigh</td>
<td>268</td>
<td>200</td>
<td>-</td>
<td>68</td>
</tr>
<tr>
<td>2.</td>
<td>Jhanjrah</td>
<td>1323</td>
<td>803</td>
<td>-</td>
<td>520</td>
</tr>
<tr>
<td>3.</td>
<td>Satgram</td>
<td>548</td>
<td>460</td>
<td>-</td>
<td>88</td>
</tr>
<tr>
<td>4.</td>
<td>Tilabani</td>
<td>341</td>
<td>183</td>
<td>-</td>
<td>158</td>
</tr>
<tr>
<td>5.</td>
<td>Nakrakonda</td>
<td>400</td>
<td>228</td>
<td>-</td>
<td>172</td>
</tr>
<tr>
<td>6.</td>
<td>Bankulia</td>
<td>900</td>
<td>869</td>
<td>-</td>
<td>31</td>
</tr>
<tr>
<td>7.</td>
<td>Ardhagram</td>
<td>498</td>
<td>440</td>
<td>-</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-total</strong></td>
<td><strong>4278</strong></td>
<td><strong>3183</strong></td>
<td>-</td>
<td><strong>1095</strong></td>
</tr>
</tbody>
</table>

**Grand Total** | **8404** | **5962** | **742** | **1700** |
It is alarming to us that 50 new projects have been taken into account for mining. It is estimated that by 2000 A.D., 1800 Hectares of land will be further degraded due to subsidence and caving. A major area will remain void and is likely to increase in further years.

Presently in the Raniganj coalfield areas more than 400 sq.kms. are blocked by surface structures including the plants and factories which may be seen in Table No.4.

<table>
<thead>
<tr>
<th>Table - 4</th>
<th>Area in Sq.Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Township &amp; Villages</td>
<td>139.89</td>
</tr>
<tr>
<td>2. Road</td>
<td>25.03</td>
</tr>
<tr>
<td>3. Railways</td>
<td>21.83</td>
</tr>
<tr>
<td>4. Oil Pipe Line</td>
<td>4.38</td>
</tr>
<tr>
<td>5. J.K. Ropeways</td>
<td>2.18</td>
</tr>
<tr>
<td>6. River Nullah</td>
<td>58.63</td>
</tr>
<tr>
<td>7. Industries</td>
<td>150.00</td>
</tr>
<tr>
<td>Total</td>
<td>401.94</td>
</tr>
</tbody>
</table>

With increase in production the appropriate authorities pay no heed to the concept of ecological balance which is severely injured. The land pollution may be created by many pollutants in the coal areas. Even the wind or water may not spare it to do so.

3.1 Soil Pollution:

The determination of the soil's potential for useful utilisation by man is a serious problem. The agriculturist has over the centuries, developed techniques whereby the productive capacity of virgin soil has been increased beyond all
measure, and this high productivity is now a sine qua non for man's survival. In increasing soil productivity and by bringing into cultivation more and more land, an artificial situation has arisen whereby the high level of soil fertility is maintained by a complicated series of treatments and managements which are incalculable opposition to natural tendencies. Any errors in the treatment or the management of the soil can therefore quickly lead to a destruction of fertility, which unless quickly recognised and countered can give rise to much human distress.

Soil deterioration falls under two broad headings which can conveniently be discussed separately although they are not infrequently complementary to each other. The first involves loss of fertility in the general accepted sense, whilst the latter involves the actual loss of fertile soil and is more familiarly known as soil erosion.

3.1.1 Deterioration of Fertility:

The most important factor in fertility deterioration involves the natural leaching of the soil and the consequent development of acidity. The lime losses of the soil become pronounced in regions of higher rainfall and in the vicinity of industrial smoke, and unless measures are taken to counteract the increasing acidity, low fertility will ensue. Under natural conditions the flora and fauna are able to adapt themselves to develop acidity
and an equilibrium is established leading to a stable natural economy. If husbandry practices are carried out on acid land, the deterioration may be enhanced by destruction of soil structure and the intimate humus mineral association will be disturbed. In addition, the potentiality of the soil for immobilising plant nutrients will be increased, leading to serious economic loss. A further form of deterioration concerns the natural water regime of the soil. This may be affected in two ways, i.e. by water becoming excessive or by the water supplies to the crop becoming restricted.

3.1.2 Soil Erosion:

The erosion of land surfaces, whereby loosely consolidated fragments of the earth's surface are moved by natural agencies and ultimately deposited on the sea-bed, is a phenomenon that has existed since the earth became a solid mass, and is ceaseless in its operation. It is a part of the natural order of things. Under normal conditions the rate of erosion is slow and its effects pass largely un-noticed, except that open drains become silted up and, especially noticeable after heavy rain, rivers and streams can be seen as turbid suspensions of eroded land surfaces.

There are occasions, however, when this erosion of the land becomes catastrophic in character and the living soil is removed too quickly for its usefulness as a growing medium.
to be exploited for the benefit of man. When this happens to husbanded land it becomes a very serious matter. Apart from cataclysmal events over which no control can be exercised it is possible for an acceleration of the erosion process to be brought about by ill-advised use of land and by introducing factors into the natural equilibrium which disturb it so as to emphasise the erosive element. In the past large areas have been disturbed in this way, as for example, by injudicious deforestation and removal of the protective cover afforded by trees without any attempts being made to substitute an alternative protection; in many regions, too, fertile areas of land have been intensively cultivated with the effect that the humus content of the soil has been subjected to loss by destructive oxidation and the structure has collapsed to render the soil much more susceptible to movement under the influence of erosion forces. Water and wind are the two main factors which lead to these soil losses.

The ability of rain to bring about surface erosion depends upon two things. First, the dispersal of the surface particles by the beating action of the raindrops; second, the power of the surface run-off water to transport the dispersed material. Of these two things the latter has the more positive effect in actually carrying away the surface soil. If there was no run-off there would be no erosion.
Wind erosion can be very devastating where it seriously occurs, and dust storms removing large volumes of soil can sometimes completely obscure daylight. The wind blown soil is often deposited on other land surfaces, leading to deposits of loess or dunes in littoral regions. Wind erosion most frequently affect soils with a particulate structure and fine sands are very susceptible. Certain organic soils with a moor type of humus which has partially oxidised and had its cohesive properties reduced, often become 'fluffy' and tend to blow. The soil is a natural object, differing in form and properties where it exists under different conditions, and capable of changing its form and properties should the conditions of its environment change. It is also capable of being modified artificially to increase its usefulness to mankind. It is the material on which grow the land plants of the earth needed to feed and nourish the varied population it supports.

3.1.2.1 Man's Ancient Struggle with Soil Erosion:

Man's struggle with soil erosion is as old as agriculture itself. It started when the earliest nomadic tribes, perhaps in the Zagros Mountains separating Persia and Mesopotamia, first upset Nature's delicate balance between plant cover and the erosive forces of wind and water. As man became civilised, his demands upon the land for additional food and clothing grew. He changed from nomadic herding to a fixed mode of agriculture and began cultivating the soil. This intensified use
of the land led to further destruction of the plant cover, and exposed more of the soil to the erosive forces.

Records of man's efforts through the ages to find a lasting adjustment to the land are written on the landscapes around the globe. The ruins of works along this amazing trail tell us that failures were far more numerous than successes. It behooves us to try to understand the causes of these failures and successes, lest we unknowingly contribute to the downfall of our own civilisation. An examination of the records of man's struggle with the forces causing soil erosion reveal that the efforts were mainly attempt to prevent the scouring effects of surface runoff. There is little evidence that he attempted to control wind erosion. Nowhere in the record of the ages is there anything to indicate that man knew the exact nature of the forces with which he was contending. In some cases he was aware of the fact that erosion was practically non-existent when the land surface was adequately protected by plant cover. Man learned however, that as soon as this cover was removed by cultivation of the land, or destroyed by over-grazing, erosion became active. It seemed uncontrollable when the land was deprived of the protection of plants. The protective influence of plant cover, even when it was employed, was thought to be that it retarded the flow of surface runoff and kept it spread uniformly over the surface as it moved downhill. Some attribute this protective effect to plant roots binding the soil and stabilising it against the erosive action of wind and water.
Less than a decade ago, it was discovered that the impact of raindrops on bare soil and the resulting splash was a major cause of soil erosion by water. Scouring by surface flow turned out to be only a partner. At the same time, it was shown that plant cover — so abundantly supplied by Nature nearly everywhere — is the counter measure provided to shield the soil from the beating raindrops. Discovery of the effects of raindrop's part in the erosion process also explained the failure of previous attempts to save the soil. Nowhere in the almost uninterrupted chain of land tragedies is there anything to indicate that anyone suspected that the presumably innocent raindrop had anything more to do with soil erosion than to supply water to create runoff.

3.1.2.2 Soil Erosion in the Old World:

So far as known, western civilization arose in the Near East. The cultures that developed through the ages moved eastward to China and westward through Europe, and across the Atlantic Ocean to the Americas. We are constantly reminded of our debt to the Sumerian peoples of Mesopotamia whenever we use a wheel, which they invented more than 6,000 years ago. We do homage to their mathematics each time we look at a clock or our own wrist watches to tell the time. Our calendar is a revision of the ancient Egyptians method of figuring the year.

Tillage of the soil had its beginning at least 7,000 years ago and developed in two great centres in Mesopotamia.
along the valleys of the Tigris and Euphrates rivers, and in the Nile Valley. On these alluvial plains, in an arid climate, tillers of the soil began to grow crops, with irrigation, in quantities greater than their own needs. For the first time, it was possible for some of the people to do other things than produce food. They had time to develop arts, science, statecraft, and means of expressing the aspirations of the human spirit. This gave rise to what we call civilisation. The history of Mesopotamia is one of a nation that grew up and lived constantly under the threat of raids and invasions by the peoples of the grasslands and the desert. Part of the story is of a precarious agriculture and of the failure of the irrigation canals due to silt deposition. It is the supposed place of the Garden of Eden and the Tower of Babel and the flat, flood watered lands along the Nile never had serious erosion problems. Today, after thousands of years of continued cultivation, the Nile River Valley is still an area where intensive cultivation is practiced. Moses' route from the fertile, flood-irrigated Nile River Valley led into mountainous lands, where forests and fields were watered by rain. Here, where sloping land was cleared for cultivation, falling raindrops and flowing water eroded the soil and carved gullies. Today, most of those slopes are sorry to behold. Sinai, where the Israelites wandered their herds for more than 40 years, is a picture of desolation. The brown soil mantle is eroded into enormous gullies. Between Sinai and Aquaba is a plateau that has been eroded through the years almost to a peneplain. This broad flat surface is covered with small stones
that have been fitted together through the ages to form a classic example of desert pavement. The peneplain surface dates back to Miocene times. There is evidence of accelerated cutting of the plain by torrential streams. But there is no indication that climate has changed since the Miocene era. Here, then is a cultural record dating from the Ice Age which proclaims that the climate has been remarkably stable.

Ezion Geber, which has been partly uncovered by archaeologists, was Solomon's seaport on the Gulf of Aquaba and the ancient Pittsburgh of the Red Sea—where copper was smelted—2,800 years ago. Petra, the capital of the Nabatean civilisation which flourished at the same time as the Golden Age of China—from 200 B.C. to 200 A.D.—is a desolate ruin. There are those who maintain that the climate is drier now than it was 2,000 years ago and therefore, this land cannot support as great a population that it did once. On the other hand, slopes of the surrounding valley are covered with the remains of terrace walls that have fallen into ruin, allowing the soils from large areas to be washed off to bare rock. Food is grown locally, but soil erosion has damaged the land beyond use for extensive cropping. The Jordan River is now a muddy stream, and the soils from more than half the upland area of the promised land have been washed off the slopes to bedrock and lodged in the valleys. There, they are still being cultivated and still being eroded by heavy rains that enlarge the great gullies in this alluvium. At Hebron, likewise, the soils have been washed off to bedrock and
only dregs of the land left behind in narrow valley floors to be cultivated for meager crops.

Soil erosion also has taken a heavy toll in the denuded highlands of Judea, as is illustrated in the drainage of Wadi Musrara. The records of abandonment of village sites in Wadi Musrara during the past 1500 years bear mute evidence of the decline of the land. The rate of abandonment is related to the progress of erosion. Students of the area have divided the drainage into three altitudinal zones: the plain, 0-325 feet; foothills 325-975 ft; and mountains, 975 feet and over. In the plain, 34 village sites are occupied and 4 abandoned; in the foothills, 31 occupied and 65 abandoned; and in the mountains, 37 occupied and 124 abandoned. Where soils have been held in place by stone terrace walls which have been maintained through the centuries to the present, they are still cultivated after several thousand years. They still are producing—not heavily, to be sure because of poor soil management. The glaring hills of Judea, not far from Jerusalem, are dotted with only a few of its former villages—places where terraces have been kept in repair for more than 2,000 years. Jerash, a settlement of 3,000 was once a center for some 250,000 people. The country about it is now sparsely settled with seminomad. When discovered, the ruins of this once powerful city of Greek and Roman culture were buried to a depth of 13 feet by erosional debris washed from the nearby slopes. In biblical times, this region
was famous for its oaks, wheat fields, and well-nourished herds. This area supplied grain to Rome and supported thriving communities. The reason for its decline is found in the loss of the soil—washed off to bedrock inspite of rock walled terraces.

The Phoenicians, however, were the first tillers of soil to encounter the severe soil erosion caused by rain on sloping cultivated land. Some 5,000 years ago, Phoenician tribes swept out of the desert, occupied the eastern shore of the Mediterranean, and established the harbour towns of Tyre and Sidon. In time, they began to clear the timber from the hillsides. As forests were cleaned, either for domestic use or for commerce, the slopes were cultivated and the soils of the slope eroded under heavy rains. The Phoenicians apparently recognised the problem of establishing a permanent agriculture on sloping lands, for they tried to control erosion by constructing walls across the slopes. Ruins of these walls may be found today. The measures failed, however and the soil mantle slipped downhill under the action of progressive erosion.

When the Romans were at the height of their power, the Lebanon forest was protected to grow timber for their fleet. Emperor Hadrian, determined to have it properly protected, had the boundaries designated by permanent markers. But only four small groves of this favour forest are left today.

The story of North China is much the same as that of the Lebanon forest. The line of cultivation in the Province
of Shansi was pushed up the slopes as the forests were cleared away. Soils that formerly were protected by forest litter were thus exposed to the beating rains, and soil erosion began a head-long process of land destruction and filling streams with soil waste and detritus. Runoff and erosion from cultivated land were many times as great as when the forest covered the land. Still visible are the remnants of terraces that were in use before Shansi Province was riddled by huge gullies. Temple forests in China, like the forest of Lebanon, demonstrate beyond a doubt that the present climate would support a generous growth of vegetation that is capable of preventing erosion on such a scale. Human occupation of the land has set in motion processes of soil wastage that are, in themselves, sufficient to account for the decadence and decline of this portion of China.

Over a large portion of the ancient granary of Rome, the soil has washed off to bedrock and the hills have been seriously gullied because heavy grazing removed the vegetative cover. The valley floors are still cultivated, but the runoff from the eroded slopes has cut great gullies there. At Djemila was found the ghost of Guicul, a city that once was great, populous, and rich. Except for about three feet of a single column, the city was completely covered by erosion debris washed from the surrounding hills. In 20 years, French archaeologists unearthed great temples, two great forums, splendid churches, and great warehouses for wheat and olive oil. The
surrounding slopes once had been covered with olive groves.

3.1.2.3 **Early American Experiences**:

No sooner had the early settlers of America begun to clear away the native plant cover and put the land in cultivation than they found themselves confronted with accelerated soil erosion. As long as land was plentiful, a farmer could clear new land as fast as the old was 'worn out'. Eventually, however, American farmers came to the time when they had to live with the land they had in cultivation, for there remained no new land to be cleared. Jared Eliot and Samuel Deane¹ were two of the earliest American colonists to become interested in soil erosion. Jared Eliot, a minister and doctor of Killingsworth, Connecticut, practiced farming in his spare time. When he called upon his parishioners and the sick in his community, he noticed their method and their problems. He noticed that water running from a vegetable hillside was clear, but that water running from a bare hillside was muddy. He believed that the mud in the water was fertile soil from above. Most of New England was hilly, and every time muddy water ran off one of the fields, that field got poorer. Like Eliot, Deans recognised the ill effects of erosion by water in New England and developed

ways to overcome it. He observed that with heavier rainfall in the hills "more of the fine mould would have been washed down into the hollows; and deeper channels would have been made in the soil by the running of water which are considerable inconveniences". Deane also observed that "certain crops do not impoverish the soil, but rather improve it. Such form a close shade over the ground, which kills weeds, and increase the putrefaction in the soil..."

To prevent the blowing and drifting of sand, Deane recommended hedge fences as well as plantations of locust trees. Speaking of the black locust he stated:

"This tree grows best in a sandy soil, and will propagate itself in the most barren places, where the soil is so light as to be blown away by winds. By sheltering such places and dropping its leaves on them, it causes a sward to grow over them, and grass to grow upon them... those who possess hills of barren sand... should not delay to make forests of these trees on such spots".

Early in the existence of this nation, many of the foresighted agricultural leaders and some of the farmers became frightened about the future. They advocated measures to prevent erosion from taking the bread out of their mouths. Since they were groping in the dark, however, they merely repeated the

errors of the past by adopting practices which appeared to be different but they were in reality were based on the same fundamental principles.

Deep plowing, contour tillage, hillside ditches and terracing were advocated more than 100 years ago. They were practiced by some farmers. Broadbase terraces with a slope for drainage and grassed outlets were described on a Virginia farm in 1838.

Sorsby¹, in presenting his essay before the North Carolina Agricultural Society in October 1857, stated:

"I was induced to write it from the interest I feel for the progress of the society and the advancement of the Agriculture of the State, and as the only and best way I am able to assist them. It may be considered as a new branch of agricultural science, founded upon correct and well established principles of the sciences of engineering and hydraulics; and essential to the welfare of the farmer, to the preservation of the soil, and to good husbandry. Forced, almost by necessity, and the strong sense of self-interest and foresight, a few intelligent minds have been brought to discover the urgent need of reforming the old destructive system of ploughing in straight rows up and down hills, and substituting the better mode of horizontal culture."

Sorsby realized that the up and downhill method of culture then in general use was leading to the destructing of the land. In discussing this, he said:

"The absurdity of the old method is really a subject of astonishment and mortification to those who practice the new methods. The arable lands of the South have been nearly exhausted by it and a careless and wasteful culture."

Horizontal culture was defined as cultivating land in parallel lines by a levelling instrument to direct and control rain water with the plow. Bonner, in making a study of the agricultural reform movements of the cotton belt, came crossing with the following:

"... the abundance of the land and the relative scarcity of labour had encouraged soil exhaustion and emigration. The effects of this brought citizens to a sober contemplation of a disintegrating social and economic system."

Erosion of a soil is caused by the wearing of the rain and snow waters which cannot penetrate into the soil fast enough to be carried away under drainage, and which, by reason of the slope and contour of the land, run off over the surface, carrying along particles of sand and clay. Washing of the land may be prevented by methods of cultivation and underdrainage. Side hill ditches were considered a part of cultivation.

Erosion is due directly to the runoff of water of which the ratio is dependent partly on slope, but chiefly on the

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nature of the soil and its produce; indeed, with any reasonable slope, a full cover of forest or grass with an abundant mulch, or close crop on deeply broken soil, or a friable furrow slice kept loose by suitable cultivation, with so fully absorb precipitation as to curtail the runoff or even to reduce it to slow seepage through the surface soil is the ideal condition, and the one toward which modern agriculture should be bent. The soil erosion movement is now passing into a new stage. There is no better way to illustrate the advance in the knowledge gained during the years than present the explanations of earlier and later scientists concerning the nature of the forces responsible for the erosion of our land.

3.1.2.4 How Water Erodes Land:

Water erosion manifested itself in two forms, sheet washing and gullying. The first tendency of intense rain is to pack the soil; but while the rain packs the soil, it pounds loose grains of soil that float away. The flow of excess water, carrying soil and humus with it, begins soon after the start of a rain. With water falling in all parts of the field at the same time, the thin sheet of water and soil increases in thickness as it moves from the top to the bottom of the slope. The removal of a rather uniform amount of soil from the surface with every hard rain is the process known as sheet erosion. Since surface runoff may occur without erosion but erosion never without
runoff, it is felt that the effect of the various factors on runoff was an indirect measure of their effect on erosion. It is apparently principally of the scouring action of surface runoff.

Physical measures for safeguarding lands may be combined into three groups, i.e. contour farming, bench terracing, and stream base level control for long-range control of the land. Water erosion as being the transportation of soil by rain water, included melted snow, running rapidly over exposed land surfaces. Water erosion are of three types, sheet erosion, rill erosion and gully erosion.

Sheet erosion is considered as sheet washing which was the more or less even removal of soil in thin layers over an entire segment on sloping land by flowing water. But the impact of the falling raindrop had a place in the erosion process, and it is associated principally with the scaling of the surface soil which in turn meant increased runoff and more scouring. Rill erosion is usually defined as small washes and gullies when the channels are so large and well established that they cannot be crossed by farming. Knowing these things, man knows that vegetative cover, which has long been known as a means for controlling wind erosion, also is the best measure for control of water erosion.

A new field of soil erosion science was discovered. For the first time, it was known why bare cultivated fields eroded severely during hard rains while, at the same time, portions of the same or adjoining fields which had a good plant
cover experienced little or no damage. Foliage and litter of
the plants intercepted the falling raindrops, absorbed their
Kinetic energy, and eased the broken drops to the ground as
clear water. Since the falling raindrop was prevented from
making direct contact with the ground surface before being
de-energized, the physical properties of the soil were not
disturbed. The clear water could enter the soil freely. It is
noticed that without raindrop splash there would be little
erosion outside the rills and gullies.

Water causes erosion by detaching soil particles
from the surface soil mass and transporting them, usually down-
hill. It may do this on any area where there is natural precip-
itation or where water is applied artificially to land sur-
faces. Water's erosive action is greatest and most destructive
where the protective cover of vegetation has been removed,
exposing bare land surfaces to the direct action of rainstorms.
The movement of soil by water is a complex process. It is influ-
enced by the amount, intensity and duration of rainfall, amount
and velocity of surface flow, nature of the soil, ground cover,
slope of the land surface, and many other factors. In each case,
the erosive power of water is determined by the interaction or
balance of several factors, some favouring soil movement and
others opposing it. Soil material must first be dislodged (de-
tached) from its position on the surface of the land before it
can be transported. It may then be splashed, rolled, slid, or
carried in suspension along the surface. These processes are
largely the result of raindrop splash, turbulence of moving water caused by raindrop splash and flowing water. Differences in soil erodibility suggest that both inherent soil properties and those brought about by land use especially by cultivation and other disturbances, play a major part in the water-erosion process.

Erosion, in its physical aspects is singly the accomplishment of a certain amount of work in tearing apart and transporting soil material. The water-erosion process begins when raindrops strike the surface of the soil and break down the clods and aggregates or when snow melts. It consists of three steps. In the first step, the soil particles are torn loose from their moorings in the soil mass; in the second step detached soil material is transported; and in the third step, soil material is deposited. The products of the first two processes cannot be expressed in a single quantitative result, because they cannot be expressed in like units. Detachment is expressed in terms of weight or volume per unit area, such as tons per acre. Transportation, on the other hand, is expressed in terms of weight or volume moved through distance, such as tonne-miles per acre. The two principal erosive agents that become active on land during rainstorms are falling raindrops and flowing water. The energy of falling raindrops is applied from above, and their principal function is to detach soil particles from the soil mass. The energy of flowing water is usually applied parallel with the surface and, outside of rills and gullies, its principal function is to transport soil material. Both raindrops
and flowing water are complete erosive agents in themselves, but in one phase of the erosion process they work together. That is when there is a shallow surface flow, in pre-channel stages, which lacks rotational energy to keep soil in suspension; then the falling raindrops, by keeping the water turbid, increase the ability of surface flow to transport soil particles.

Falling raindrops and surface flow produce widely different effects on the soil. The force of falling raindrops is applied uniformly over the whole surface on which the rain falls. Erosion caused by raindrops is more of a smoothing or levelling agent. Flowing water tends to collect in channel first, in small rills and then, as these small channels converge, in streams. The result of erosion caused by the flowing streams is to roughen the surface by cutting channels or gullies. It has been observed about 2 inches of soil were removed from the plowed field mainly as a result of raindrop splash.

3.1.2.5 How Wind Erodes Soil:

The wind has been active as an erosive agent throughout geologic times. It takes up soil from one place and deposits it in another. Outstanding examples are the extensive loess deposits in China and along the Missouri and Mississippi rivers in the United States. Although wind erosion has been active in some degree since prehistoric times, it has become much more active and more destructive because of the activity of man. This 'accelerated' erosion has been due to wrong methods of handling
the land or to use of land purposes to which it is not adopted. Wind erosion is perhaps most active in arid and semiarid regions where the land surface is often dry and vegetation is sparse or absent. The wind also may move large quantities of soil material in humid regions; and agriculturally considered, wind activity in such regions may be more important because of the greater value of much of the land affected.

The movement of soil by wind is a complex process influenced by conditions of wind and soil (including the nature of the eroding surface and amount of water in the soil) and many other factors. The cutting and transporting power of wind is determined by the interaction of several factors - some favouring soil movements, others opposing it. The activity in each individual case depends upon the net effect of these factors acting together. Soil material, in order to be transported by wind, must first be loosened from its position on the surface of the land. It may then be lifted, slid or bounced along on the surface of the ground. These processes are largely the result of wind turbulence, mainly eddies and irregularities of wind movement.

Differences in soil erodibility suggest that properties inherent in the soil and those brought about by land use - specially cultivation and other man-made disturbances - play an important part in the wind erosion process.

Only dry soils are moved. Wet or damp soils are not appreciably affected. The structure of the soil in an air-dry
state is, therefore, a much more reliable index of erodibility than the structure in a wet state. The amount of soil which is erodible by wind at a given velocity depends upon the critical height (is the height that slows wind velocity to 9 miles per hour or lower) of and distance between the non-erodible fractions that are exposed at the surface. The ratio of height of projections to distance between projections which will barely prevent the movement of erodible fractions is designated as the critical surface roughness coefficient. Under a given wind velocity the critical roughness constant remains the same for the whole range of size and proportion of the non-erodible clouds. The critical surface-roughness constant required to assure soil stability, however, varies with other factors, such as the wind velocity and the size and apparent specific gravity of the erodible fractions. These factors, in the aggregate, add considerably to the complexity of the wind-erosion process.

3.1.2.5.1 Types of Soil Movement:

There are three types of soil movement in the process of wind erosion: (a) saltation, (b) suspension and (c) surface creep. These usually operate simultaneously. The movement of soil by wind is dependent not so much on forces at the surface as on the velocity of the various strata of air through which the grains raise in saltation (moves in series of short bounces). This height is definitely limited. Wind erosion is mainly a surface phenomenon and it is directly dependent on the condition of the wind depth through which it rises.
3.1.2.5.1.1 Movement of Soil by Saltation

Most of the soil carried by wind is moved in saltation. Saltation is caused by the direct pressure of the wind on the soil particles and their collision with other particles. After being pushed along the ground surface by the wind, the particles suddenly leap almost vertically in the first stage of the saltation movement. Some grains rise only a short distance, others leap one foot or higher, depending directly on the velocity of rise from the ground. They also gain considerable forward movement from the pressure of the wind upon them, and acceleration of the horizontal velocity continues from the time the grains begin to rise until they strike the ground again. In spite of this acceleration, the grains descend in almost a straight line with an average angle of descent of between 6 to 12 degrees from the horizontal. On striking the ground, they either rebound and continue their movement by saltation or lose most of their energy by striking other grains - causing these to rise - and sink into the ground to form part of the movement in surface creep. Whether the movement is initiated by impact of descending particles or by impact of rolling grains, the initial rise of a grain in saltation is generally in a critical direction.

3.1.2.5.1.2 Movement of Dust in Suspension

In the mechanism of soil transportation by wind, very fine dust particles less than 0.1 mm in diameter are carried
in true suspension. Such particles make up a substantial proportion of the total soil carried. They have a lower falling velocity than the upper velocity of the turbulent wind and are carried more or less parallel with the general wind direction. Their transportation has been termed "suspension movement". Small particles transported by suspension enter the air-stream when the soil is bombarded by the saltation movement.

Once entrained in the air-stream they are suspended by the turbulence of the wind. The presence of fine dust in suspension, even in large quantities, does not affect the general character of the movement in saltation or surface creep, but its presence in the soil greatly influences both threshold wind velocity and the intensity of erosion for a given wind. The mechanism by which the fine dust is lifted from the ground may be entirely different from that of saltation. Soils composed of fine dust in an air current is mainly the result of saltation. Thus, without saltation movement, dust clouds would not arise except on a relatively limited scale as a result of disturbances by objects moving over the surface of the ground, or at the windward edge of an eroding area.

In contrast to the movement of grains in saltation, the movement of fine dust in suspension (after being lifted from the soil surface) is completely governed by the character of the wind movement. This fine dust is carried to great heights and long distances from its original location and thus may be considered a loss to the eroding area. On the other hand, the
soil moved in saltation and surface creep usually remains within the eroding area or its immediate vicinity—especially when wind blow from varying directions. The proportion of soil moved by the three modes of movement varies widely for different soils. Coarsely granulated soils erode by saltation and surface creep; finely pulverised soils, by saltation and suspension.

3.1.2.5.1.3 Movement of Soil in Surface Creep:

Quartz grains of about 0.5 to 1.0 mm in diameter are too heavy to be moved by saltation but are pushed along the surface by the impact of particles in saltation to form "surface creep". Unlike grains in saltation, which receive most of their impact energy from the direct pressure of the wind, the grains moving in surface creep derive their kinetic energy from the impact of grains moving in saltation.

3.1.2.5.2 Forms of Wind Erosion:

The wind-erosion phenomenon may be more easily understood by recognising the close-interdependence of the five main ways in which soil particles are loosened and transported. These five ways may be considered as different phases of the same phenomenon.

Detrusion — Detrusion is the dislodgement of coarse soil grains from peaks or surface projections by wind pressure or by the bombardment of highly erosive grains coming from the windward side.
**Effluxion** : Effluxion is the removal of soil grains ranging from 0.05 to 0.5 mm. in diameter, and is initiated and maintained by the direct pressure of the wind. The removal is almost entirely by saltation, but a minor portion of the soil may be removed in surface creep, and some fine particles may be picked up directly by the wind and carry away in true suspension.

**Extrusion** - Extrusion is the forward thrust of soil particles which are too coarse to be removed by direct wind pressure. If a field composed of these particular has on its windward side an area containing particles removable by effluxion, many of these coarse fractions may be removed as a result of bombardment by the smaller grains. Extrusion is carried out chiefly by surface creep.

**Efflation** : Efflation is the removal of soil in suspension, resulting mainly from movement of coarse grains in saltation. It is serious because it constitutes a removal of fine soil constituents, leaving the less mobile and inert sand and gravel behind.

**Abrasions** : Abrasion is the chipping off of particles of dust and coarse fractions from soil clods and other hard materials as a result of impacts from grains moving in saltation.

Some or all of these forms of erosion may be operating at the same time. However, none of these can exist without effluxion. In other words, effluxion is a pre-requisite to and cause of the other forms of wind erosion. Therefore a programme
of wind-erosion prevention and control should be based on either reducing the amount of particles ranging from 0.05 to 0.5 mm in diameter in a soil to an allowable minimum, or slowing down the movement of wind at the ground surface.

3.2 Classification of Land:

Land is allocated into eight classes, of which the first four are suitable for cultivation and the remaining four unsuitable. According to J.H. Stallings, the following classes of soils with their suitability of use are as under:

Class I - Soils in Class I have no, or only slight, permanent limitation or risks of damage. They are very good. They can be cultivated safely with ordinary good farming methods. The soils are deep, productive, easily worked and nearly level. They are subject to fertility and puddle erosion. Class I soils used for crops need practices to maintain soil fertility and soil structure. These practices involved use of fertilisers and lime, cover and green manure crops, crop residue, and crop rotations.

Class II - Class II consists of soils subject to moderate limitations in use. They are subject to moderate risk of damage. They are good soils. They can be cultivated with easily applied practices. Soils in Class

II differ from soils in Class I in a number of ways. They differ mainly because they have gentle slopes, are subject to moderate erosion, are of moderate depth, are subject to occasional overflows, and are in need of drainage. Each of these factors require special attention. These soils may require special practices such as soil conserving rotations, water-control devices, or special tillage methods. They frequently need a combination of practices.

Class III - Soils in Class III are subject to severe limitations in use for cropland. They are subject to severe risks or damage. They are moderately good soils. They can be used regularly for crops, provided they are planted to good rotations and given the proper treatment. Soils in this class have moderately steep slopes, are subject to more severe erosion, and are inherently low in fertility. Class III soil is more limited or subject to greater risks than Class II. These limitations often restrict the choice of crops or the timing of planting and tillage operations. These soils require cropping systems that produce adequate plant cover. The cover is needed to protect the soil from erosion. It also helps preserve soil structure. Hay or other sod crops should be grown instead of
cultivated row crops. A combination of practices is needed to farm the land safely.

Class IV - Class IV is composed of soils that have very severe permanent limitations or hazards if used for crop-land. The soils are fairly good. They may be cultivated occasionally if handled with great care. For the most part, they should be kept in permanent hay or sod. Soils in Class IV have unfavourable characteristics. They are frequently on steep slopes and subject to severe erosion. They are restricted in their suitability for crop use. They should usually be kept in hay or pasture, although a grain crop may be grown once in five or six years. In other cases, the soils may be shallow or only moderately deep, low in fertility, and on moderate slopes. These soils should be in hay or sod crops for long periods. Only occasionally should they be planted to row crops.

Class V - Soils in Class V should be kept in permanent vegetation. They should be used for pasture or forestry. They have few or no permanent limitations and not more than slight hazards. Cultivation is not feasible, however, because of wetness, stoniness or other limitations. The land is nearly level. It is subject to only slight erosion by wind or water if properly managed. Grazing should be regulated to keep from
destroying the plant cover.

Class VI - Class VI soils should be used for grazing and forestry, and may have moderate hazards when in this use. They are subject to moderate permanent limitations, and are unsuited for cultivation. They are steep or shallow. Grazing should not be permitted to destroy the plant cover. Class VI land is capable of producing forage or woodland products when properly managed. If the plant cover has been destroyed, the soils use should be restricted until cover is re-established. As a rule Class VI land is either steeper or more subject to wind erosion than Class IV.

Class VII - Soils in Class VII are subject to severe permanent limitations or hazards when used for grazing or forestry. They are steep, eroded, rough, shallow, droughty or swampy. They are fair to poor for grazing or forestry, and must be handled with care. Where rainfall is ample, class VII land should be used for woodland. In other areas, it should be used for grazing. In the latter case, strict management should be applied.

Class VIII - Soils in Class VIII are rough even for woodland or grazing. They should be used for wildlife, recreation or watershed uses.
3.3 Types of Soil in the Coal Belt Areas of West Bengal:

The whole coal belt areas of West Bengal is composed mostly of Class V, VI, VII types of soil and Class IV in very limited land areas. In this region soils have severe permanent limitation and hazards. It is irony and lignite. They may be cultivated occasionally if handled with great care. These soils should be in hay or sod crops and only occasionally should they be planted to row crops. These soils should be used for pasture or forestry. Cultivation is not possible and feasible, however, because of stoniness and other limitations. It is also subject to erosion by wind or water if improperly managed. Grazing should be regulated to keep from destroying the plant cover.

3.3.1 Gradation of Coal in the Region:

The entire coal region is spread over a number of different areas in which different types of coal may be found. The coal belt areas have been categorised through empirical survey to show the gradation of coal, its characteristics and the different seams. The Raniganj coal-field popularly now known as the Eastern Coal Field Limited consists of fifteen coal areas out of which the S.P. Mines and Rajmahal areas are in Bihar. It has been observed that the coal found in West Bengal are mostly second grade Bituminous coal and the gradation of it has been described as:

A - Good Quality of Second Grade Coal
B - Satisfactory
The whole coal areas in the Raniganj belt have been systematically classified which covers a wide range, and are described in different Tables (Tables No. 5 to 19) on the basis of different regions. In all the Tables¹ (5 to 19) number of terms have been used to clarify sub-gradation of coal with the following meanings:

- STM - Steam
- ROM - Mixed
- SLK - Slack
- MIC - Inclined Mining
- SC - Sector
- OCP - Open Cast Process

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Table - 5
Pandaveswar Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STM</td>
<td>ROM</td>
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<tr>
<td>Dalurband</td>
<td>Dobana</td>
<td>C</td>
<td>C</td>
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<tr>
<td></td>
<td>Jotejanki</td>
<td>C</td>
<td>C</td>
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<tr>
<td>Pandaveswar</td>
<td>Samla</td>
<td>B</td>
<td>B</td>
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<tr>
<td></td>
<td>Dobrana</td>
<td>C</td>
<td>C</td>
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<tr>
<td></td>
<td>Jotejanki</td>
<td>B</td>
<td>B</td>
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<tr>
<td>Kendra</td>
<td>Samla</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Ramanagar</td>
<td>Purusottampur</td>
<td>B</td>
<td>B</td>
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<tr>
<td>Kottadih</td>
<td>Samla</td>
<td>B</td>
<td>B</td>
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<tr>
<td></td>
<td>Kenda</td>
<td>B</td>
<td>B</td>
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<td></td>
<td>Bombahal</td>
<td>B</td>
<td>B</td>
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<tr>
<td>Nutandanga</td>
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<tr>
<td>(a) Pansuli</td>
<td>Samla</td>
<td>B</td>
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<tr>
<td>(b) Pure Samla</td>
<td>Samla</td>
<td>B</td>
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<td>Manjerbani</td>
<td>Samla/</td>
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<td>Samla</td>
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<tr>
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<td>C</td>
<td>C</td>
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<td>Karta</td>
<td>C</td>
<td>C</td>
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<tr>
<td>Parsundi OCP</td>
<td>Karta</td>
<td>C</td>
<td>C</td>
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<tr>
<td>Jorekura/Palarthali</td>
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<tr>
<td>Gangaramchak</td>
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<td>C</td>
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<tr>
<td>Kottadih (CHP)</td>
<td>Samla/Kenda</td>
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<tr>
<td></td>
<td>Bombahal, Dobrana</td>
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<tr>
<td></td>
<td>Jotejanki, Purusottampur combined</td>
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</table>

There are many collieries in this area and consists of different mining methods. The coal found in the collieries are not of the highest grade and contains ash in it. It is said that the entire coal used mostly by Railways and ancillary factories and a portion by power plants and for domestic purpose.
<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of coal</th>
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<td>Bankola</td>
<td>Jambad</td>
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<td>B</td>
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<td>Bankola</td>
<td>Bankola</td>
<td>C</td>
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<td>Bonbahal</td>
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<tr>
<td>Centenary in-cline</td>
<td>Bankola</td>
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<td>Bonbahal</td>
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<td>Kumardhihi</td>
<td>Bombahal</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>3 + 4 pit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North incline</td>
<td>Bombahal</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Kumardighi B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) 5 + 6 pits</td>
<td>Jambad Top</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>(b) Goenka</td>
<td>Bonbahal</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>PITS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilaooni</td>
<td>Bonbahal</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Moira</td>
<td>Kajora</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Jambad</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Khardra</td>
<td>Kajora</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Jambad</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Shankarpur</td>
<td>Jambad</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Shankarpur OCP</td>
<td>Jambad</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

The different gradation of coal is found in this area possessing the power of issuing long flames. The different mining method is also observed and is used mostly for surface transportation. Some portion of it is used also by Calcutta Electric Supply Company and basic industries.
The lowest grade of coal is found in this area and contains much ash and volatile matters though it produces some long flames. It is used mostly for domestic purpose, ancillary industries and some portion of it is used by Railways.
In this area the total coal comes from open pits which produces long flames. The coal found in this area does not vary immensely and is used mostly by steel industries and household purpose.
This area consists of many collieries consisting of different seams and has both types of mining methods. The coal is producing long flames and is mostly used by big industries. The coal is also used by chemical industries and household purposes.
In this area, different types of mining may be observed and is of many seams. The coal is widely used by big and small industries and for domestic purpose. It has been observed that the coal in this area contain less volatile matters than from Sripur and Bankola areas.

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naba Kajora</td>
<td>Jambad</td>
<td>B B B</td>
<td>Long Flame</td>
</tr>
<tr>
<td></td>
<td>Kajora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td></td>
<td>Sonachora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot; &quot;</td>
</tr>
<tr>
<td></td>
<td>Lower Kajora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Madhabpur</td>
<td>Sonachora</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Lower Kajora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Dhandadih OCP</td>
<td>Lower Kajora</td>
<td>B B C</td>
<td>&quot;</td>
</tr>
<tr>
<td>Lachipur</td>
<td>Sonachora</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Upper Kajora</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td>Ghanashyam</td>
<td>Sonachora</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Lower Kajora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Jambad sp.</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Khas Kajora</td>
<td>Chora</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Sonachora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Lower Kajora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Jambad</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Upper Kajora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Madhujore</td>
<td>Kajora</td>
<td>A A A</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Jambad</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Moira</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Madhusudanpur</td>
<td>Kajora</td>
<td>A A A</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Jambad</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td>Parascole</td>
<td>Kajora</td>
<td>A A A</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Jambad</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Jambad SP</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Parascole OCP</td>
<td>Kajora</td>
<td>B B C</td>
<td>&quot;</td>
</tr>
<tr>
<td>Jambad</td>
<td>Jambad</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Kenda</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Jambad OCP</td>
<td>Jambad</td>
<td>B B C</td>
<td>&quot;</td>
</tr>
<tr>
<td>Central Kajora</td>
<td>Kajora</td>
<td>A A A</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Lower Kajora</td>
<td>B B B</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>Sonachora</td>
<td>&quot; &quot; &quot;</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

The table above shows the seams and grade of coal at different collieries in the Kajora area. The characteristics of coal are also indicated, such as Long Flame. The coal is widely used by big and small industries and for domestic purposes.
### Table - 11

**Kunustoria Area**

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STM</td>
<td>ROM</td>
</tr>
<tr>
<td>Amritnagar</td>
<td>Nega</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Narainkuri</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Mahabir</td>
<td>Narainkuri</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>North Searsole</td>
<td>Kenda</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Singaran</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Kunstoria</td>
<td>Kenda</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Bansra</td>
<td>Kenda</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Purandip</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Bansra OCP</td>
<td>Jambad TOP</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Toposi</td>
<td>Topsyi/Kenda</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Singaran</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Parasea</td>
<td>Jambad</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>6 &amp; 7 incline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parasea OCP</td>
<td>Jambad</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Belbaid</td>
<td>Topsyi/Kenda</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Dobrana</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Amrasota</td>
<td>Kunustoria</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>(inclined A&amp;B)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name of CHP</td>
<td>Nega/Narainkuri</td>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>(coal handling plant)</td>
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</tr>
<tr>
<td>Amritnagar CHP</td>
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<tr>
<td>Kunustoria</td>
<td>Kena Seam of Kunustoria/Kenda</td>
<td>A</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Seam of Bansra</td>
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</tr>
<tr>
<td></td>
<td>combined</td>
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</tr>
</tbody>
</table>

Different process of mining can be found in this area and has many collieries. The coal produces long flames and is used mainly by big industries, power plants and household purposes. The Kunustoria colliery produces better types of coal and is sent to basic industries.
The production in this area is much more than Kenda, Kajora and Bankola area. The coal produces long flames and is widely used by small and medium sized industries, steam engines and household purposes.
Table - 13

Sripur Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STM</td>
<td>ROM</td>
</tr>
<tr>
<td>Bhanora</td>
<td>Koithi</td>
<td>SC I</td>
<td>SC I</td>
</tr>
<tr>
<td>Bhanora OCP</td>
<td></td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Bhanora West</td>
<td>Rana</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>Block Mine</td>
<td>Sripur</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>GIRIMINT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) ADJAI - II</td>
<td>Rana</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>(b) Kusa Danga</td>
<td>Kusadanga</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>incline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sripur</td>
<td>Koithi</td>
<td>SC I</td>
<td>SC I</td>
</tr>
<tr>
<td>Taltore</td>
<td>Jamuria</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Jamuria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A &amp; B PIT</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>NINGHA</td>
<td>PONIATI</td>
<td>SC I</td>
<td>SC I</td>
</tr>
<tr>
<td></td>
<td>Dishergarh</td>
<td>A*</td>
<td>A*</td>
</tr>
<tr>
<td>S.S. Incline</td>
<td>Sripur</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>(Shyamsundarpur)</td>
<td>Rana</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>GHUDSICK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) New Ghusick</td>
<td>Ghasick</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>(b) Muslia</td>
<td>Ghasick &quot;A&quot;</td>
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<td>A</td>
</tr>
<tr>
<td>Kalipahari</td>
<td>Kusadanga</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Damra</td>
<td>Upper Dhadka</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

* Price will be ₹3.89 extra per tonne due to additional heat value

In this area, the coal is much better than found in other collieries. Due to additional heat value, an amount of nearly ₹4/- is charged extra per tonne. The coal is mostly used by basic and chemical industries.
This area also consists a wide variety of coal in grade and is used for different purposes. It is mainly used for small industries and domestic purposes. It contains more volatile matters than Sripur Area and produces mostly long flames.
Table - 15

Sodepore Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of coal</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>STM</td>
<td>ROM</td>
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<tr>
<td>Chinakuri 1 &amp; 2 Pit</td>
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<td>SC I</td>
<td>SC I</td>
</tr>
<tr>
<td></td>
<td>Bharatchak</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Chinakuri 3 Pit</td>
<td>Borachak</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Ranipur</td>
<td>Sanctoria</td>
<td>SC I</td>
<td>SC I</td>
</tr>
<tr>
<td>Parbelia</td>
<td>Sanctoria</td>
<td>SC I</td>
<td>SC I</td>
</tr>
<tr>
<td></td>
<td>Hijuli</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Hijuli</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
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<td>Bhamuria</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Soddepur</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Mouthdih</td>
<td>SC I</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Poidih</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

Some coal are high grade and can be found mostly in Chinakuri pits. The coal from these pits are used for basic industries and power plants. But the coal from other collieries are not to the grade of Chinakuri.
### Table - 16

**Salanpur Area**

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of coal</th>
<th>Characteristics of coal</th>
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<td>C</td>
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<td></td>
<td>Salanpur 'B'</td>
<td></td>
<td></td>
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<tr>
<td>Dalmia OCP</td>
<td>Salanpur 'A'</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Salanpur 'B'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mohanpur OCP</td>
<td>Salanpur 'A'</td>
<td>C</td>
<td>C</td>
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<tr>
<td></td>
<td>Salanpur 'B'</td>
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<td>(b) Dabor OCP</td>
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<td>Special Seam in-</td>
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<td>cline of Darco-</td>
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<td>D</td>
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<td>(b) Samdih</td>
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<td>(c) P.B. incline</td>
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<td>C</td>
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<tr>
<td></td>
<td>(a) Gourangdih</td>
<td>D</td>
<td>E</td>
</tr>
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<td></td>
<td>(Debu)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Gourangdih</td>
<td>B</td>
<td>C</td>
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<td>Segunia</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(c) Khoirabad in-</td>
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</tr>
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<td></td>
<td>Dishergarh</td>
<td>SC I</td>
<td>SC I</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kusadanga</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
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<td>Monoharbahal</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>Lower Dhadka</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

N.B. Barmondia & Chalkballavpur collieries are in Raniganj measures. For administrative convenience collieries have been kept in Salanpur Area.
Most of the coal comes from open pits and is not of the quality as Chinakuri pits. The mediocre types of coal is found in this area and is used mostly by small industries, domestic purposes, by Railways and also for other less important uses. More than three-fourths of the coal produced in this area issues non-long flames.

Table - 17

Mugma Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>STM</td>
<td>ROM</td>
</tr>
<tr>
<td>Chapapur-I OCP</td>
<td>Badjna</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Chapapur-II Quarry</td>
<td>Brindaabanpur</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Chapapur-II (U/G)</td>
<td>Kalimati</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Badjna (Khusri Quarry)</td>
<td>Badjna</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Badjna (U/G)</td>
<td>Kalimati</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Badjna (Quarry)</td>
<td>Kalimati</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>Brindaabanpur</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>Badjna (U/G)</td>
<td>Brindaabanpur</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Hariazam (U/G)</td>
<td>Gopinathpur</td>
<td>W-IV</td>
<td>(Prov)</td>
</tr>
<tr>
<td>Hariazam (Quarry)</td>
<td>Singhpur</td>
<td>W-III</td>
<td>(Prov)</td>
</tr>
<tr>
<td>Hariazam (Quarry)</td>
<td>Kalimati Brindaabanpur</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>Gopinathpur (U/G)</td>
<td>Gopinathpur</td>
<td>W-IV</td>
<td>(Prov)</td>
</tr>
<tr>
<td>Gopinathpur IA Incline</td>
<td>Gopinathpur</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Gopinathpur OCP</td>
<td>Gopinathpur</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Shampur 'A'</td>
<td>Zero</td>
<td>W-III</td>
<td>W-III</td>
</tr>
<tr>
<td>Shampur (U/G)</td>
<td>Bhaljuri</td>
<td>W-III</td>
<td>W-III</td>
</tr>
<tr>
<td>Shampur (Khas Shampur)</td>
<td>Shampur-3</td>
<td>W-II</td>
<td>W-II</td>
</tr>
<tr>
<td>Shampur-4 (Prov)</td>
<td>Shampur-4 (Prov)</td>
<td>W-II</td>
<td>W-II</td>
</tr>
</tbody>
</table>

* W - Stands for washery Grade

Table 17 contd.. at p.91
Mugma Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STM</td>
<td>ROM</td>
</tr>
<tr>
<td>Mandman OCP</td>
<td>Kalimati</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>Shampur 'B' (U/G)</td>
<td>Gopinathpur</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

Rajpura

Satyanarayan Section
& West Barakar Section
(Quarry)

| Kalimati                  | C   | E   | E   |                     |

Khas Kalimati Section
(Quarry)

| Kalimati                  | C   | E   | E   |                     |

Nirsha (Quarry)

| Brindabanpur              | D   | E   | E   |                     |
| Kalimati                  | D   | D   | D   |                     |

Khoodia (U/G)

| Kalimati                  | C   | C   | C   |                     |
| Brindabanpur              | D   | D   | D   |                     |

Khoodia OCP

| Kalimati                  | C   | E   | E   |                     |
| Brindabanpur              | D   | E   | E   |                     |

Table contd...
Mugma Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of Coal</th>
<th>Characteristics of coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumardhubi (U/G)</td>
<td>Kalimati (Brindabanpur)</td>
<td>C C C</td>
<td>Non-long Flame</td>
</tr>
<tr>
<td></td>
<td>Chirkunda</td>
<td>C C C</td>
<td></td>
</tr>
<tr>
<td>Kumardhubi (Quarry)</td>
<td>Merah Section</td>
<td>Kalimati</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C E E E</td>
<td></td>
</tr>
<tr>
<td>Barmuri Project</td>
<td>Kalimati</td>
<td>C E E E</td>
<td></td>
</tr>
<tr>
<td>Lakhimata (Quarry)</td>
<td>Brindabanpur</td>
<td>C E E E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kalimati</td>
<td>C E E E</td>
<td></td>
</tr>
<tr>
<td>Lakhimata (U/G)</td>
<td>Brindabanpur</td>
<td>C C C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kalimati</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lakhimata (New M.S. Incl.)</td>
<td>Mugma Special (Prov)(Prov)(Prov)</td>
<td>C C C</td>
<td></td>
</tr>
<tr>
<td>Kapasara (U/G)</td>
<td>Kalimati</td>
<td>C C C</td>
<td></td>
</tr>
<tr>
<td>Kapasara (Quarry)</td>
<td>Kalimati</td>
<td>C E E E</td>
<td></td>
</tr>
<tr>
<td>Mandman Incline</td>
<td>Kalimati</td>
<td>C C C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brindabanpur</td>
<td>D D D</td>
<td></td>
</tr>
</tbody>
</table>

In this area different types of collieries having different processes can be found. The characteristics of coal found is also different. Nearly fifty per cent of the coal excavated is required for coking in different ovens and for washeries in big plants. The remaining portion is used for ancillary industries.
The total amount of coal is excavated from open pits and is not of a very high quality. The coal is used in areas of limited jurisdiction and has the characteristics of long flames.
Table - 19

Rajmahal Area

<table>
<thead>
<tr>
<th>Colliery</th>
<th>Seam</th>
<th>Grade of coal</th>
<th>Characteristics of Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STM</td>
<td>ROM</td>
</tr>
<tr>
<td>Rajmahal OCP</td>
<td>Lalmatia - II (TOP &amp; Bottom)</td>
<td>D</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Lalmatia - III Bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simlong</td>
<td>Simlong Seam No.1</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Simlong Seam No.2</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

* Only non-cooking long flame coal of Grade A, B, C, & D are entitled for long flame prices.

The production of the coal is very much limited as compared to Satgram, Sodepur or Bankola areas. The coal is used for domestic and in small industries and has the characteristics of Long or Non-long Flame.
Illustratively, in one of the underground mining in Khandra Colliery under Bankola area, there occurs different types of soils in different layers in different seams. This has been identified to show here as a test case through litho.

**Litholog of Borehole Section**

**Khandra Colliery**

The Khandra Colliery has three different seams - Kajora, Jambad and Bonbahal combined. Naturally their gradation of coal and characteristics of coal are in the seams. But the seams are to be found in different layers of the soil. The litholog of Borehole section depicts the lowest level which is at nearly 224 metres from ground level consists mostly of shalley sand stone. The shalley coal is also to be found in different layers. Though of minimum jurisdiction the shales are also visible. The section of strata through a pit reveals different types of sand stones in upper layers. As much of the layers contain sand stones the coal found here is not of a very high quality. The very hard stones and shales can be observed in the Litholog. It must be mentioned here that the costs incurred for the excavation of coal is much more in relation to the quality of coal. So productivity becomes the prime factor, and in doing so the decrease in the purity of environment is inevitable.
3.4 Land Pollution in Underground Mining:

Raniganj coalfield in West Bengal is the easternmost unit of the Damodar Valley Coalfield and the coal deposits occur within the upper Paleozoic rocks popularly known as Gondwanas. In general, Barakar formations contain 14 coal seams and Raniganj formations contain 10 coal seams. Coal reserve is estimated considering seam thickness of 0.9 metres and above to a depth of 1200 metres. This coal is of two types – coking and non-coking and has been estimated around 21,800 million tonnes. Table 20 as given below is self-explanatory about the types of coal in the region:

**Table - 20**

<table>
<thead>
<tr>
<th>Type</th>
<th>GSI Estimate (1.1.93) (Million Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-coking</td>
<td>20538.23</td>
</tr>
<tr>
<td>Medium Coking</td>
<td>403.21</td>
</tr>
<tr>
<td>Semi Coking</td>
<td>822.74</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21764.18</strong></td>
</tr>
</tbody>
</table>

The coal left on pillars in various mine workings have been tentatively assessed to be nearly 1000 million tonnes and the total quarri ble reserve in the belt has been estimated to be around 2122 million tonnes. The present environmental scenario of Raniganj
coalfield is the result of 200 years of mining activity along with large scale deforestation since the beginning of the 19th century. The underground mining requires large amount of sand for filling the coal excavated areas. Not only filling the vacuum spaces but also it must be done properly and effectively. The sand filling is done through large pipes by mixing with water to fill up the gaps. But it is a matter of concern that the sand filling is not done effectively and as a result soil pollution takes effect. It is to be noted that due to non-application of modern technological approach the soil pollution occurs in the underground mining by the improper sand filling and it is a great cause also for soil deterioration as the total particles of soil contains dusts of coal and ash. Not only this if the stowing is not done properly the upper areas remain unsafe. Due to spurt of demand of coal in our country the coal mining activities increased. It has been experienced that the implementation of safety rules are lax. The objective is only to maximise coal production from underground mines even in densely populated areas. Sand stowing though necessary was not done effectively in some areas which remain unsafe.

It may be mentioned at this point that during the Second World War, coal mining activities in Raniganj coal field was greatly increased. The coal production was done without maintaining the rules and regulations and sand stowing was not done properly. As a result the town of Raniganj, Barakar, Kulti and
Bahula are unsafe and 45 locations have been identified as unsafe due to past mining operations. It may be noted that the areas will remain unsafe as it requires crores of rupees to make them safe.

Operation of packing of the void left after coal extraction with stowing by hydraulic or any other means is a unique solution to many mining problems, e.g. extraction of coal from highly gassy seams, seams liable to spontaneous combustion, working liable to bumps, or premature collapse and multiple seams. Seams lying below water and water strata, built up areas, or seams on fire can be safely worked with the application of stowing. Stowing has been the only method by which thick seams in this area have been worked with high percentage of coal extraction. Invariably, sand is used as stowing material. Requirement of sand stowing is more than the total coal extracted and with the increased of production the sand stowing also increased. The Damodar and Barakar rivers have been the prime source of sand required for coal mines in West Bengal. Ajay river also meets requirement of sand for part of Raniganj coalfield. Naturally, extraction of sand from the rivers and water courses is a vital matter for the filling of voids in mining operations and this is done from the rivers mentioned. But this extraction of sand from bed of water courses and rivers have of late assumed importance from environmental considerations on account of possible effects on morphology of rivers and safety of structures on the adjoining banks in Kulti, Bahula, Andal and Pandaveswar Areas.
In each colliery nearly two thousand workers used to work continuously and it is a matter of grave concern that in the underground mining neither there is any toilet nor latrine which is very much essential for human beings. The employees working in the underground mining use the underground mining land for the use of toilets and latrines and as a whole it may be said that in most areas it is a common scene for the employees using the underground land extensively for the mentioned causes. Thus the land pollution is caused extensively from the improper disposal of human excreta and urine. This addition in the polluted land has a tremendous effect on the human beings in the underground mining. It gives birth to many harmful bacteria which produce stomach and throat ailments. It may be said that the continuous ailments of the employees which affect the stomach specially in the summer times is a pointer for the deterioration of land in underground mining. These pollutants are badly affecting the mines and damaging the ecosystems underground. It is also be noted that the filth created mixes with groundwater and goes outside as solid particles thus creating land pollution in the surface area and some are taken to the nearby ponds. Land pollution is also caused by the ashes, dusts of wood, rubbish, empty bottles and waste water. It is evident from the fact that the land becomes seriously polluted with the occurrence of these pollutants underground and an effect is also noted in this respect where it injures the quality of life of the employees. The throat congestion created to most of the underground miners is a symbol
of the land pollution created in its area. It may be stated here that the land pollution created underground may be avoided to a large extent through managerial functions but they are only prone to the increase of production.

It is very much natural that working for more than eight hours require food for the employees. They used to carry their meals and food in their carriers. But there are many who bring the food in plastic wrappers or in small plastic bags and after having their food sometimes they through it to the underground land. It must be noted here that plastic has become a major land pollutant. Plastic bags, plastic paper, plastic wrappers remain undecayed for a long time on the earth and have nuisance value and pose health hazard. This is also very much problematic in the underground mining. It is to be added here that no dust bins or garbage cans can be found in the underground mining so that the added pollutant can be arrested. This pollution also has a tremendous effect to the health of the employees. The hazards created by the land pollution becomes permanent when it is mixed with other pollutants in underground mining. Not only it affect health but it has also a psychological effect and refrain from loving the institution. The land pollution is also created by the solid wastes that are to be found in underground mining. These wastes are also a great hazard to human health and occupation. It is evident from the fact that machineries are required for underground mining and to keep them in workable condition oil and grease is also required. Some of it pours on the land creating
tremendous land pollution in those specific areas. It is seen that these pollutants often mix with the dusts of wood and coal creating land pollution to a large extent. It must be mentioned here that sometimes the compounds are created which harms the land and also the different layers of the soil which is very much alarming and is a symbol of the degradation of soil layers extensively.

3.5 Land Pollution in Open-Pit Mining:

The open-cast mining operations are done in limited areas but in these pits land pollution occurs most. Most of the pits are burning and on both sides of the roads through the pits much ash and dolomites are seen. This leads to severe land pollution. This pollution is very much harmful and injures the miners to a large extent. The water is used for bringing down the temperature of the coal and to stop ignition. It is observed from the fact that when the pollutants mix with water the secondary pollutant is formed. The secondary pollutant thus formed injures the soil and it spreads bacteria to distant lands. It is evident from the fact that these bacteria are taken away by rain water to the nearby ponds, streams and rivers. When these pollutants pour into other water system it harm the aquatic life of that water system. The pollutants have a large effect of misuse of land. This effect is not temporary but is permanent in character as the destruction of the soil, creation of dust bowls and the deterioration of the environment take place. In addition to it, it is seen
that hundreds of surface transporters used to ply within the premises of open pits which injure the roads to a large extent. As the roads are not metallic it is evident that it has an alarming effect to human health. It not only disturbs the human beings biologically but also psychologically for the adverse effects and is permanent in character. Many of the people are suffering from acute skin diseases and it is said that the pollutants harm the skin enormously.

Large quantity of water is poured into the coal to stop fire and when water is poured into coal many compounds are formed which has a tremendous influence for injuring land. It is said that the erosion thus formed by the chemicals has a devastating effect on the state of affairs of the people. It is not only a health hazard but also has an effect on the state of mind. This pollution is widespread in the total pit areas and affect the land extensively. It gives birth to many harmful bacteria and from which produce asthma, liver diseases and throat congestions. It is said that the effect is not only confined to the particular region but these are taken away by rain to nearby water courses and injures the natural water system. It may be a point of importance that the soil pollution caused has an alarming effect as this may be the cause for the spread of diseases like cholera in May, 1993. More than fifty persons died (including children) and the worst sufferer are the children below the age of twelve. It is said not a house was left in which one may find the ineffectiveness of the pollution in Shankarpur area. It is noted that
many had left their premises at that time and went to stay at their's relative homes. The children were so shocked that many of them did not return back but stayed with their relatives. The soil pollution is occured with the secondary pollutants that take place. It is much more injurious than the primary pollutants as it has the capacity to erode the soil. The land pollution though lacks knowledge to a large extent but it should be the part of the authority to arrest soil pollution and make the people aware of it.

It is known to us that some mechanical process is involved for the extraction of coal from open pits and naturally oil and grease is necessary for their mobility. It is seen in most of the open-pits that land pollution is also created from the added pollutants like oil and grease. It hampers not only the upper layer of the soil but also creeps in. The water used paves the way for the soil deterioration to a large extent and many layers were effected. It is noted here that the reclamation of land after the coal extraction will become meaningless until this type of pollution is not arrested. This type of pollution occurs tremendously when the trucks discharge the rotten oil from it and thus creating health hazard. The land pollution has injured the soil ecosystem and has a great pressure on the minds of the people. One can easily understand the quality of soil when this pollutant mixes with other pollutants. The pollution thus occurred is no safe for the people at large and to mention the effect the labourers whose age was less than twenty-five years are all affected with hookworm. It has been seen that people who are below the age of
thirty irrespective of sex are the worst sufferers in relation to health hazard in open pits. Land pollution in the open pits is also created with the occurrence of parts of tyres, solid wastes, debris, cans and waste water. It is seen that the land pollution injures the soil alarmingly and has a harmful effect to human beings. It is likely to be said that people at this junction are not aware to the gruesome effect of land pollution and it becomes imperative on all concerned to make them conscious about it.

3.6 Soil Pollution in the Open Space

Other than the Mining Operations:

It is a known fact that the vast space of the coal areas were covered with thickly forests. The mining is done in this region for a period of more than two hundred years and the greenery could not be seen now. Land is used for the building of highways, for mining operations, for reservoirs, for industrial units and many other economic purposes. It is also the agriculture that makes the largest demand upon the available land and afforestation is not of great importance. Naturally much of the land in the upper surface of the mining is no hindrance to be used as dumping grounds. This includes mining wastes, solid wastes, trash, automobiles tires, cans, bottles and many more. This has rendered land pollution to a large extent. The effect at this stage is not only confined to miners but the people at large in this area. The misuse of land caused in the coal areas has an alarming effect on the land which eventually leads to the destruction of soil, soil erosion, creation of dust bowl and naturally deterioration of the environment. It has been also evident
that it harms the different layers of the soil which is a great headache for the people in the coal areas. Thus, the land pollution caused in the coal areas has a great effect on the mind and body of the people by causing skin and liver diseases.

Besides these, the land pollution is also caused by the improper disposal of human excreta, urins. But the most devastating elements of land pollution is created by oil and grease. It is seen that most of the surface transporters are old and often leakage is found in them which discharges oil in the surface area. The petrol and the diesel pumps are also by the side of the road; the spillage of oil also destroys the soil orders. It must be mentioned here that the land pollution also occurs with the grease that is being used to a large extent. It is noticed that most of the roads are not metallic and when the heavy vehicles ply in these areas both sides of the road do not remain good and are destructed. This destruction slowly leads to the creation of the dust bowls and the aggravation of the soil pollution. It is also being noticed that in rainy season all those pollutants are washed away creating pollution in the water recourses of the nearby region. Therefore it is said that the rivers Damodar, Ajay and Barakar become more polluted with this addition of pollution from coal mines which injures the aquatic life of the rivers. The pollution has a large effect on the lives of all the organisms in this season as it also damages the crop land and the domestic atmosphere. It is
seen that in summer and in rainy season the breakout of many diseases which is not only a health hazard but also has a psychological effect on the people as a whole.

The major source of land pollution is the massive amount of solid wastes disposed by our consumer society. There are thousands of domestic houses from which is disposed the rubbish, waste water and household refuse. It is a matter of concern that the human wastes remain for a pretty long time which is a cause of land pollution. For meeting the demands of the people in this area, thousands of consumer shops are also developed. The waste water from the commercial shops are discharged extensively which hurts the soil orders. These also produce large quantities of solid wastes which is seen particularly in thickly populated areas. This has a tremendous effect on land and deterioration of the soil occurs. This refuse gives birth to many harmful bacteria which eventually leads to human ailments. People in this region are affected with liver diseases and asthmas. They are also prone to many skin diseases. Solid wastes which are created from the mines are the worst polluter of land in the coal region. Notably these wastes are dumped on the ground for a pretty long time and this erodes soil enormously. The degradation which takes place from this effect is permanent in character and is injurious to the living organisms. This has also a tremendous effect to the spreading of diseases like cholera and some people used to
say that it had a tremendous influence to the tragedy occurred in 1993. It is in the coal region that as the people are mostly illiterate they suffer most from this type of pollution. They are prone to silicosis.

There are a large number of small and medium size industries which use coal as a primary fuel or ancillary to it. It is quite common that different types of waste materials are created and there should be some places to dispose of the solid wastes. The whole area is used as the dumping ground for the solid wastes and remain there for a long time. It may be mentioned at this point that the municipal sewage system is not efficient and effective enough to cope up with the problem. Naturally land degradation takes place covering a large area. It will be evident from the fact that the usable land for dumping purposes are all transferred into waste lands and not a single tree could be found in those areas. The solid wastes include different metallic pollutants like iron, cobalt, steel rods, cadmium, dyes and many more. It must be mentioned here that some small factories and the garages use the land for disposing of warm water. This excesses to the land will definitely teach a memorable lesson within a short period to the people of Ukhra, Raniganj, Khottadih and Pandaveswar areas. The land pollution also takes place with the occurrence of a large amount of waste water which is discharged from the small industries. This water carries all the effluents from the industries to the land and
has a serious effect on the quality of land. Much of the vast region of the coal areas are used for the dumping ground of waste water and has a tremendous effect on the quality of life to the people at large. It is to be said that the people in the coal areas in West Bengal is living in a very low environment; the illiterates are the worst sufferer.

It is in this environment that one may find hundreds of slums or pockets of poor houses, poor people and poor environment, either in the middle or at the periphery of the urban areas. It is a point to note here that the dirt, filth and stink fill the whole terrain. The domestic animals and pigs can be seen in this environment. The same room is used for cooking, co-habitation and breeding. What to say about the latrines and urinals in these areas. It is really a shame to us that the women from these slums has to use the land quite often as latrines and urinals. These areas are highly conducive to the spread of many diseases. Not only the dwellers are affected but the slums are also the cause for the spreading of livers, skin and many other diseases to a large extent. It is mostly in these areas one may find the use of plastics and other paper wrappers extensively. The plastic is a major land pollutant. The paper bags and the wrappers when disposed on the land enormously, land pollution takes place. It often hampers the soil orders to a large extent and thus the natural ecosystem is damaged. The
negative pollution created in this region will not only destroy the natural eco-system but will injure the health alarmingly causing incurable diseases and will also create mental tension. It is said that the acute skin disease which occur in this region is the result of these pollutants. Large scales of ringworms and eczema diseases occur to these slum dwellers and poor people and this effect does not leave the people so easily. Environment pollution in the coal areas is at the bottom: a question of pollution of affluence and influence on the one hand and pollution of poverty on the other.

Modern agriculture, with its potential to wrest the country out of 'food trap' and famines, usher in an area of self-sufficiency in foodgrains production, has also brought along a plethora of environmental problems. Most of these stem from the abuse of pesticides and the use of persistent plant protection chemicals that have been banned in the developed nations. Large areas in the coal-region is brought under cultivation but the soil is not so fertile as in other rural district areas. To produce more, indiscriminate use of pesticides and insecticides are used leading to the pollution of land and emergence of more virulent pests. Monoculture and the use of hybrid varieties invite a host of new pests and pathogens besides eroding the negative genetic variability. Use of synthetic fertilizers lead to nitrate
pollution of water recourses. The expansion of irrigated fields fed by larger dams without providing adequate drainage has resulted in rise in water table and salinity in hundreds of hectares in the coal areas. The release of methane from paddy fields is also another form of agricultural pollution according to recent findings.

The pesticide problem is the most serious one and needs to be tackled on a war footing. The per hectare consumption of pesticides in this region is far low than that in some of the developed regions. But as the people are illiterate to a large extent in this region the number of persistant chemicals that are sold in the markets and the indiscriminate use of plant protection chemicals are matters of grave concern to the people in this region.

The pesticide pollution in different parts of the areas has been well documented, and even the pesticide residue in food chain - in vegetables, eggs, fish, meat, milk and milk products, edible oil and in breast milk - have been detected in different parts of the region. The district of Burdwan, one of the most productive and aquaculture regions in the country have been showing severe pesticides pollution. The indiscriminate use of pesticides has also led to the emergence of more virulent pests that have developed a built-in-resistance in some of the frequently used chemicals. The sub-standard use of chemicals had resulted in the development of
new race of Helicoverpa armigera, which ravaged the crop. They were resistant to the chemicals but were more aggressive. The larvac of the virulent type raised their hood like an angry cobra when disturbed. It has critically been observed that they gobbled up all the greenary. There are several cases of insects developing resistance to insecticides and farmers resorting to excessive use of the chemicals in vein. Besides these, there are instances of pesticides poisoning, killing human beings and the livestock. More than one hundred people died in 1991-92 because of pesticide poisoning, and hundred of cases of crippling resulting from pesticides have been experienced in the coal areas. The pollution created by this agricultural pollutant has an alarming effect in the coal areas and it created havoc during the last five years. As literacy has not intervened thoroughly, environmental pollution has not only injected primary infection but also spread the secondary infection to an alarming extent.

Insecticides, most of which are neuro-toxins, followed by fungicides and herbicides are the wide variety used in this region. Among insecticides the BHC (HCH), is the most popular and farmers use this cheap and most toxic insecticide liberally in the fields without realising the consequences. Several toxic agro-chemicals that have been banned in the developed countries are still being used in the coal areas and which are popularly known as the 'dirty dozen'. It is evident of the pesticide use pattern in this region that
rice grown over 24 per cent of the cropped area uses about 18 per cent, vegetables raised over 3 per cent area uses about 14 per cent and plantation crops covering 2 per cent of the area uses 8 per cent. According to the investigations made by some voluntary organisations, though the country used just two per cent of the world's pesticides, half the world's pesticides, half the world's pesticide poisoning cases and almost three quarters of the deaths take place here. Poor handling of the poisons, inhalation of the poison in the form fine droplets and penetration through skin have led to several deaths. In the last two decades it is observed that besides a number of food items, the soil and water are highly polluted in the coal areas and in most samples the residue levels far exceeded the maximum limits prescribed by the FAO and WHO. The danger of misuse of pesticides is particularly greater among the small holders, who are ignorant of the toxic nature of the chemicals they handle. Most of the pesticides they buy do not have proper instructions or warnings. Judging the seriousness of the problem, it become very much obligatory for educating the farmers on the dangers of the chemicals and the right methods of handling them. It is also important that the traders know about the proper labelling, packaging and disposal of pesticides when not in use any more. The Government should also reevaluate the pesticides and permit the use of only selective and non-persistant chemical in the country so that to save our land from pollution. The other major cause of worry arising from intensive farming is the
fertilizer pollution. Though, these synthetic inorganic nutrients are not directly toxic to man and other life forms they have been found to upset the existing ecological balance. The nutrients escape from the field ends and are found in excessive quantities in rivers, lakes and coastal waters. Algae blooms occur when the nutrient load is high, and these smother other aquatic vegetation and also interfere with the oxygen regulation in the water bodies. This phenomenon may lead to loss of fish. In certain cases, the high nutrients may increase the fish production, but the dangers seem to outweigh the benefits in most cases. Among the major synthetic plant nutrients, nitrogenous fertilizers cause most harm. Contamination of the environment arises because not all the fertilizer applied is taken up by the crop and removed at harvest. In the tropics and sub-tropics maximum recovery in dryland crops is 50 to 60 per cent, but seldom more than 30 to 40 per cent for rice, because much of the nitrogen is lost as ammonia into the atmosphere. Even in highly controlled conditions and with the best agronomic practices, recoveries remain low. It is therefore clear that what is needed in the present context is a sustainable agricultural production strategy that would not eat into national assets. The eco-friendly agriculture of high degree of productivity have to be met successfully without which the people in this region will be in doldrum. It is then clear that the land pollution in the coal areas occur from innumerable pollution. In addition to it is evident from the fact that land pollution is also caused
extensively by the dumping on the ground huge amount of wastes from agricultural practices. It is very much clear that as these wastes are chemical wastes the land pollution occurs extensively. It hampers the soil orders and destruct the soil. The soil erosion that occurs inhibits the growth of plant root and leaves a concentrated deposit of chemical compounds. It is observed in some areas that the dumping is done enormously through heavy agricultural mechanisations which complete the process of degression into the lifeless layer of mud or dust. The dumping of solids resulting from agricultural practices completely reverse the soil eco-system and has a tremendous effect on the life of every organisms in the coal areas. It is said that this pollution has a direct effect on food and after the rain, it plunders the whole area and rivers. Naturally large areas are totally affected with the solid wastes from agricultural practices. It is said that the negative pollution created in these areas will be badly affecting and damaging the eco-system in this region. The bacteria which is very harmful may take birth from these pollutants will affect people causing asthma, various lives diseases and throat ailments. It is also to be noted that the soil pollution occurs from the secondary pollutants. Soil pollution is also caused in the coal belt areas through lime losses. The lime losses of the soil became pronounced in areas of higher rainfall and in the vicinity of industrial smoke. In Haripur, Raniganj, Kulti and Barakar areas the husbandry practices are carried out on acid land, the deterioration is enhanced by destruction of soil structure and the intimate humus
mineral association will be disturbed. In addition the potentiality of the soil for immobilising plant nutrients will be increased leading to serious economic loss. Under normal conditions the rate of erosion of land surfaces is slow and its effect pass largely unnoticed except that open drains become silted up and after heavy rain, rivers and streams can be seen as turbid suspensions of eroded land surfaces. The fertility of the soil is eroded for in most areas monoculture is introduced. The rotation of crop between two serial crop is not practiced here and naturally the technical approach is not implemented. It is an important method of maintaining soil fertility in cultivated areas.

Land pollution is also caused in the coal areas by wind erosion. Wind erosion make removal of soil when dust storms removing large volumes of soil leading to deposits of dunes. Wind erosion most frequently affect soil with a particulate structure and fine sands are very susceptible. Certain organic soils with a nor type of humus which is partially oxidised and had its cohesive properties reduced, often become 'fluffy' and tend to blow. Water also erodes land in the coal areas through sheet washing. The intense rain is to pack the soil, but while the rain packs the soil it pounds loose grains of soil that float away. The flow of excess water, carrying soil and humus with it, begins soon after the start of a rain. With water falling in all parts of the field at the same time, the
thin sheet of water and soil increases in thickness as it moves from the top to the bottom of the slope. It is to be noted that the land affected by mining is more than 50 sq.kms. but the land reclamation is not done more than 15 per cent of it. For more new projects it is estimated as an increase of 20 sq.kms. within 2000 A.D.

It has been seen that new projects have been taken for the increase in production of coal. Naturally further land degradation will take place due to subsidence, caving, overburden and by opencasting. This will completely wither away the soil eco-system which will have a devastating effect on the organisms living in the region. Before the commercial functioning of coal, the whole region was green. But with the introduction of mining the policy of deforestation takes effect. As more production has been and is the target of E.C.L., large scale and abrupt deforestation took place. This has resulted a terrible event for the erosion of soil. Not only the upper surface of the land is disturbed but also the large scale erosion of soil orders took place which has resulted in the enormous economic loss. If this was done keeping in mind the concept of sustainable development soil erosion could have been prevented to a large extent. The presence of trees did not have allowed the wind or water to carry with it a layer of soil. The wind or water would have no influence for the deterioration of the soil orders. It must be mentioned here that to prevent land pollution from
wastes, the recycling of the wastes and used materials even is not done properly. The sanitary fills up which is very much essential for the garbage is a far cry to the appropriate authorities. No one can think about it. But recently there is a growth of consciousness in some social institutions. Very few common people and some Government officials are aware about the areas relating to its condition of environment. They have also taken initiatives for social forestry in limited areas. It should have been the responsibility of the appropriate authority to make wide scale of afforestation and by converting waste lands into fresh lakes, reservoirs, orchards and other land use so that one may not think that it was ever a coal mine.

3.7 Land Pollution in the Industrial Units:

From the early 1960s, large scale of industrialisation took place around the coal areas of West Bengal and covers a vast area of land surface. Thousands of people are directly related to these industries and huge population are related indirectly. The industries harm the land surface, the different layers and aeration of the soil to meet their objectives and thus adversely affect large section of the people.

3.7.1 Durgapur Steel Plant:

This is a Central Government Undertaking having an integrated steel industry comprising of coal washing, coke
ovens, blast furnaces, steel melting shops, rolling mills etc. It requires raw materials like coal, iron ore, lime stone etc. It is quite natural that with the size of the industry, the effluents and the wastes are produced. This is one of the biggest steel industry in our country and it produces immense wastes which is very much harmful to land. Massive amount of solid wastes are disposed on the land which are the major source of soil pollution. After the coal is used in the coal washeries and other units, it is seen that tonnes of particles of coal remain unused and it remain on the ground for a number of months. This huge disposal is a serious cause for land pollution. This affect not only the upper soil of the soil orders but inject other layers also. It is said that in rainy season this pollutant goes to a long distance and it pollutes the other land areas. In heavy showers it disturbs the water courses in the nearby towns. The land pollution thus caused will not be localised but will have a harmful effect to the quality of aquatic life. The added pollutants are said to have a tremendous effect specially in the rainy and winter season. The secondary pollutant which is more dangerous than the primary pollutant harms the land to an enormous extent. The sulphuric acid which is created in the plant adds pollution on the land and makes it more complex in nature. The land pollution so created has a tendency not to be confined in its related spaces.
In addition to it, large scale of waste materials like iron, copper, aluminium etc. can be found in the steel areas which harm the soil orders to a large extent. These pollutants not only harm the upper layer of the soil but these also injure the soil chemically. In the atmosphere and also in rainy season all these chemicals are turned into compounds and thus the soil orders are infected with the secondary pollutants. It is said that large number of people are suffering from various chronic diseases, skin diseases and this type of pollution has a tendency to spread the diseases. It is also seen that a large quantity of construction debris, automobile tyres, cans, bottles etc. are dumped on the land of the steel area which remain very much responsible for land pollution. These sources of land pollution not only erodes the land surface but it also creates dust bowls and frustrates the environment. Land pollution from the steel plant is a major cause for the disturbance of the environment. The soil orders so harmed will not only disturb the local areas but it will affect the water system underground. This will create problem on the eco-system in this plant area. The excessive use of the land will have a tremendous effect to the people at large as it must be understood that lakhs of people are directly and indirectly related to this industry. And at the same time it is noted that the people in the plant areas are less conscious regarding the soil pollution that is occurring tremendously in the plant area.

Land pollution also occurs from the wastes like steel, sheet, wheel and axle, garbage and many more lying on the ground
for a long time. It may be seen that the pollutants are so heavy that it causes the destruction of the soil extensively. The soil orders are greatly damaged as it causes great harm to the upper soil enormously. This erodes the land to an alarming extent. In addition to it, a large amount of oil and grease is required for keeping the machineries fit. The land pollution is also caused from the spillage of these pollutants. This has a tremendous effect on the land system. It is said that the pollution in rainy season becomes very much dangerous as it creeps into the ground thus withering the soil ecosystems which harms the underground water. The water system thus gets disturbed from the injudicious use of land. It is also seen in some places that the underground pipes and storage wells etc. are required in this industry. The seepage of oil from the underground pipes pollutes the soil and underground water. Pollution of land ecosystem is also hampered by the seepage of rain through the polluted soil. The land pollution is largely responsible for spreading cholera and diarrhea and causing acute skin diseases. It is said that this pollution is also a great cause for producing asthma and throat ailments. It must be mentioned at this point that the land pollution is not arrested even by recycling the waste materials to a large extent. Perhaps the appropriate authorities are reluctant to it. Plastic has become a major pollution in relation to land. This can be found in some places of the plant areas. The plastics have a
tremendous effect on the quality of land. It has a nuisance value and pose a serious threat to health hazard. This pollution has an alarming effect to the quality of health at large. It is very much badly affecting thus withering the natural ecosystem in the environment. This negative pollution which vehemently attacks the human beings also penetrates the soil eco-orders. The excessive use of land has degraded the land and it also hurts the people mentally creating tensions.

Land pollution is also caused in the plant area by the dumping of third pollution - dumping of garbage, ashes, sludges, building materials and rubbish, empty bottles, cans, etc. which is very much devastating in the plant area. The enormous pollutants created in the plant affect the land to a large extent. It hurts the soil orders and give birth to many harmful bacteria when mixes with water and produce throat congestion, liver diseases and acute skin diseases. It is said that during heavy showers the pollutants are taken away by rain water to the water recourses and rivers nearby. The land pollution so created is much above the permissible limit. The discharge so made by this plant, specially garbage, rubbish, ash is not even dumped in a sanitary landfills to prevent soil pollution in the plant area. There are ponds near Waria Station of the D.S.P at which some of the effluents from its nearby units are discharged into these ponds the vital being the discharges from the captive power plant. Two of the ponds are completely filled with ash particles creating tremendous land pollution. This ash also
mixes with the particulate matters creating land pollution in those areas. It is seen that within a distance of 5 Sq. Kms. not even a household plant - only the herbs and the shrubs can be noticed. It is said by many villagers that the tragedy of 1992 occurred from the land pollution where more fifty persons have died and more than one thousand people were admitted to Durgapur Hospital because of the spread of cholera in the month of July. It is evident from the fact that the whole masses are totally unaware about the land pollution. Once upon a time the tubewells and wells were used in these nearby ponds are now of no use because of the bad quality of water. Land pollution is also caused in this plant from the hot water that is discharged into the land. Though it is in very few places, yet it disturbs a lot where it seeps. It is not only a threat to the soil orders but also a threat to the quality of life. This waste water when mixes with other elements give rise to pollution level and becomes poisonous in its effect to land. It is said that it may even produce incurable disease to human health.


This mill is situated on the left bank of Damodar River at Ballavpur near Raniganj. It is a known fact that it is an integrated paper mill consisting of Pulping Unit and Paper Making Unit and Caustic Recovery Section. Huge amount of water is required in this plant for the total process. The mill
manufactures paper by conventional sulphate process from raw material like bamboo and hard type of eucalyptus. It is evident that large quantities of bamboo and eucalyptus are required for this industry. This is kept straightly on the ground over a vast stretch of land and for an unlimited period. Though this is not a major cause for the erosion of soil orders but the upper layer of the soil is disturbed due to excessive use. While on the other the land pollution occurred with the presence of particles of raw materials. These particles has a tendency to mix with the soil orders and harm the soil ecosystem. It is very much conducive for these particles to pollute the land in the rainy season. It is said that after the heavy showers the land pollution caused by the particles of raw materials has a devastating effect as it is not confined with the definite area but slowly destroys the other areas also. In some places the drains are silted up largely by these pollutants and after the rain it largely mixes with the other water recourses nearby. Further the agricultural lands near the factory are disturbed by these wastes which have a harmful effect for the growing of seed. There are a large quantity of particulate matters in this plant and when the pollutants mix with those suspended particles it harm the people producing various skin diseases, liver diseases and other chronic ailments.

Land pollution is also caused in this plant from the wastes in pulp unit. The wastes in this plant is not simple but complex in nature and have a tremendous effect on the land. In this plant large quantity of water are required for screening
the raw materials. The raw liquor discharged from the plant is very much ominous. The solid wastes from this plant is kept in a nearby ground area which pollutes rigorously. It not only hampers the soil orders but have a permanent effect to the whole area. The multi-stage old bleaching unit where white fibre is washed and thereby the solids discharged can be seen in many places. This disturbs the land system enormously and this pollutant is prone in producing acute skin diseases and hook worm. Therefore it has been seen that most of the workers in this plant are affected with hook worm. The pulp then mixed with alum, glue, talcom power, etc. and subsequently sent to the paper machine where paper is made. The paper units produce huge amount of paper particles which are heaped in a particular place. These can be seen extensively to many more places. The parts of paper particles dumped on the ground destroy the ground cover and remain undecayed for a long time on the earth and it has a tremendous nuisance value and cause a serious health hazard. It must be noted here that the effect on nose, throat and skin is caused from this pollutant. It is said that during rainy season it not only hurts the soil orders but float with the water in the nearby water recourses and harms the aquatic life of Damodar river.

Land pollution is also caused by particles of iron and copper which is seen in many places. The soil orders are seriously disturbed with the presence of these waste metals thus
affecting the environment to an alarming extent. As the industry is old there are also many added secondary pollutants which harm the upper surface of the land. Land pollution is also occurred from sludges, rubbish, cans etc. but the most harmful effect to the land is caused from oil and grease. The oil and grease is required more in this plant and more wastes can be seen where the pipes and machineries are too old to continue. This type of pollution destroys not only the upper surface of the soil but destroys the natural eco-system of the soil. It is said that after the heavy showers the pollution so occurred is not only confined within its boundary but it meets the water recourses and harms the aquatic life therein. Land pollution is also caused with the dusts of coal which is required for the power plant. Large quantities of coal dusts are dumped on the ground from the discharge of power plant and it harms the land extensively as large quantities of coal are required for this plant. The negative pollution thus created is no good for this area as it has a severe effect on the quality of life. It must be mentioned here the ignorancy of the appropriate authorities in this plant regarding the warm water. It is to be noted that a large scale of hot water is discharge on the upper layer of the ground causing serious land pollution. The land pollution so occurred by so many innumerable pollutants is a significant problem in the quality of life in this plant area.
3.7.3 **Durgapur Thermal Power Station (D.V.C)**

The power plant is situated near Waria Station at Burdwan district. Out of four units only one unit is in order which is producing nearly 350 megawatts per day. It is said that the modernisation will take place very soon and then the other units will be in order. It is noted that coal is the only source of energy and huge quantities of raw material is required in this plant. Similarly large quantity of water is required for cooling and other processes out of which more than 80 percent of the water is discharged. In this plant land pollution is caused extensively with the occurrence of large quantity of coal dusts on the land surface. The upper soil is totally injured by the dumping on land of large amount of coal. This is one of the major sources of land pollution which destructs the soil. This pollutant becomes more destructive particularly in the rainy season when not only the upper surface but it creeps in with water. Naturally the soil eco-system is hampered withering away the sustainable development. It is often said that after heavy shower it is not possible to make them confined, it even destructs the nearby water recourses having an alarming effect to the aquatic life. This addition of unwanted substances in an indefinite proportion pose a serious threat to health hazard. It is very badly affecting and damaging the total eco-system in the region. The negative pollution created in the plant area has now become a grave concern but the appropriate authority is in a fix about the gravity of the pollution.
Land pollution is also caused from the dumping of solids of industrial wastes. It is a matter of fact that large amount of industrial wastes can be seen in the plant area like iron, copper, etc. which has an alarming effect on soil pollution. As it has not yet introduced the modernisation process the metallic parts getting obsolete day by day and slowly the destruction of metallurgical instruments take place. The solid wastes are dumped on the ground causing serious land pollution. It does not only hamper the upper layer of the soil but also injures the soil eco-system at large. It is said that soil erosion and also the creation of dust bowls take place in this regard. Land pollution is also caused by the large scale dumping of construction debris, old papers, cans, bottles etc. which have a very harmful effect on the quality of soil. It is seen that this pollution injures the land structure and thereby badly affects the people in this area. People are affected from various diseases and specially in rainy season the pollution is not confined. It goes into water recourses with the shower and injures the aquatic life nearby. An added pollutant is oil and grease and is required in large proportion in this plant to keep the machineries fit. Naturally there are some wastes and it can be particularly seen near the running units. The pollution thus created has a gruesome effect on land and it is slowly becoming grave day by day. The oil that creeps in destructs the underground soil eco-system and the quality of the soil. It has a large influence for creating nuisance in the area and pose a serious health hazard.
The land pollution in the plant area is also caused by the dumping of garbage, trash, ashes, sludges and other materials. These pollutants had a large effect on land surface. It is very much badly affecting and has a great nuisance value. The excessive use of land has resulted a seious health hazard for which the people are not at all conscious. The land pollution becomes acute with the pollutants such as plastic bags and plastic wrappers in some places. These pollutants remain undecayed for a long time on the earth and injures the human health enormously. These pollutants give birth to many harmful bacteria which produce asthma, stomach and threat ailments when mixed with water. These bacteria are taken away by rain water to water resources and rivers like the Damodar river. It is seen that the fly ash arrested by the precipitators is being mixed with water and pumped into ash ponds about one Km away from the power station by the side of the river Damodar. This has a tremendous effect on the soil orders. A vast area will look like desert as the extensive area is full of thorn trees and shrubs. It is not possible to afforest over a wide range of land. It is said that the rain water carries the dust to distant places which erodes not only the soil orders but also the underground water. It contains huge amount of suspended solids which is much beyond the permissible level. The most damaging part is created by the discharge of warm water on the ground surface. Nearly 80 percent of hot water is discharged and much on the ground surface has a terrible effect on soil orders and living organisms.
3.7.4 The Indian Iron & Steel Company Ltd.

Burnpur:

This is an India Government Undertaking. It is an integrated steel mill comprising of blast furnaces, rolling mill, steel melting shop but no coal washery. Large scale of water and coal is required for running this industry. The major source of land pollution is the massive amount of waste coal that is found in the plant area. Extensive dumping of unwanted substances in an indefinite proportion cause serious land pollution. The destruction of upper soil, injuring the soil eco-order and the deterioration of the environment are the effects of misuse of land. Large scale of skin diseases and throat ailments are the effects to the people in the plant area. In addition to aforesaid it is seen that the huge scale of dumping of construction materials, garbage, tires, wooden particles, etc. have a large effect on the land system. It is evident from the fact that these pollutants not only injure the soil orders but also have a shocking effect to the people at large. This is very badly affecting and damaging the eco-systems in the plant area. It is a matter of fact that these pollutants give birth to many harmful bacteria which produce asthma and liver diseases. After heavy showers these bacteria are taken away by rain water to nearby streams and rivers. These pollutants after mixing with water recourses have adverse effect in the water system. It is thus amply clear that the effect of the land pollution does not remain confined within a definite area.
People generally used to say that the pollution created in the environment is much more grave than the pollutants discharged through water effluents. The filthy environment created by these pollutants is not a concern to the appropriate authority. The land pollution in the plant area is also caused by the dumping of waste materials and other solids. This third pollution is very much injurious to soil and human health. This pollution is also caused over an extensive area and really becoming day by day impossible to arrest the land pollution. It has an extensive nuisance value and pose an alarming health hazard. It is very badly damaging the environment as it becomes a threat to the quality of life. It has a devastating effect on the human health. Keeping these pollutants for a long time indicate the birth of many harmful bacteria which has a permanent effect on health. During the rainy season it becomes very filthy and thus injures the environment to an alarming extent. To mention here it must be said that the land pollution could be arrested by applying the minimum principles i.e. by sanitary landfills. But this is a far cry to the organisers of the plant. Perhaps no one has ever dreamt of such a noble cause to arrest the land pollution. It will become crystal clear when one will see the huge amount of metallic wastes like iron, copper, steel etc. lying over a large extent of area for a long time. It is a matter of grave concern for the massive amount of dumping of huge iron particles, steel etc. for an unlimited period. These pollutants have a gruesome effect which injure not only the health of the
people but it has also a psychological effect on the human beings. It is evident from the fact that these pollutants become more dangerous when mix profusely with water in the rainy season. Not only it had the effect of primary pollutants but also of secondary pollutants.

As it is an old plant and the modernisation is not in effect, the machineries need oil and grease for its smooth functioning. Naturally some oil and grease are poured on the ground and it slowly creeps in. It will be really folly on my part to explain the tragedy that occurs on the soil orders. It is said that the most dangerous pollution occurs during the rainy season when it mixes with other suspended solids and floats to nearby rivers or watercourses. One can easily understand the terrible pollution that is created by these pollutants. This pollution affects the other areas. The dumping caused by this plant is much beyond the permissible limit and it has a wide effect. In some areas land pollution is caused by dumping plastic materials. It is a known fact that plastic has become one of the major land pollutants. Land pollution is also caused from the ash and dolomites which are very much harmful to soil ecosystem. This injures the upper layer of the soil in such a manner that when it mixes with water or other pollutants it becomes easy to injure the next layer. One other pollutant must be added at last and that is hot water. The plant requires huge amount of water for cooling purpose and it is evident that many leakages can be found in the pipes through which it passes and
naturally hot water is poured on the ground and creeps in the soil orders causing soil pollution.

3.7.5 Reckitt & Colman of India Limited, Dhadka :

It is a well known fact that it is a private sector and is situated about 4 Kms away from the Asansol Railway Station and is located on the left bank of Nunia Nullah. The industry manufactures ultra-marine blue using china clay, sulphur, soda ash, silicon and reducing agent like pitch as raw materials. Coal is the only source of energy to this plant. It is evident from the fact that land pollution occurs primarily from the raw materials itself. The dumping of these raw materials on the ground continuously and over a long period erodes soil structure. It is a well known fact the degradation of land that takes place in the factory by the dumping of these raw materials is very badly damaging and affecting the ecosystems of the factory area. These pollutants become more dangerous during heavy shower when the land pollution is not confined to a definite area. It goes straight to the Damodar river through Nunia Nullah thus affecting the aquatic life of the water courses as it carries with it large scale of suspended solids. It also gives birth to many harmful bacteria which produce throat ailments and effect the eyes. As the area is thickly populated it injures more people to an alarming extent. Land pollution is also caused from the
wastes of coal which is injurious to human health at large. It must be mentioned here that this too increases the pollution level during the rainy season. It is evident that the appropriate authority is not very much aware about the soil pollution that occurs which is of immense importance in the area. The blue dusts can be seen in a wide area in this plant. But this is not soluble in water and cannot percolate to the underground strata. But exposure to a high concentration level the degradation takes place. These dusts mix with various other solids and liquids and is problematic in character. The land pollution is also caused with the secondary pollutants. When this becomes an acid it is clear to us that it will harm the soil structure. It has a very tendency to injure the aquatic life after mixed with water. Slowly it erodes the underground water also. The mixture of the aforementioned materials is calcined in a kiln and finally grounded. The grounded materials are washed with fresh water to remove sodium sulphate present in the mixture. The ultra-marine blue is a complex of aluminium, sodium containing sulphur. It is then very much clear that large scale of solid wastes are formed from the processing unit of this plant. The solid waste ash from the boiler plant and the pot kiln ash are the pollutants to mention. It is poured on the land of nearby villages which injures the land surface. It is to be noted here that the dumping of the ash is taking place for a long time and goes beyond the permissible limit. The
greenaries which have taken place earlier are destructed in this region. It is said that the poor villagers sometimes use this pollutant as domestic purposes. It is noteworthy that any disaster may take place easily to the poor villagers. The land pollution thus occurred injures the area extensively specially during the rainy season. Land pollution is also caused in this area by the dumping of third pollutants. Large scale dumping of broken pots, empty bottles, cans and refractory materials can be seen for a long period. These dumping wastes are badly affecting and damaging the ecosystems in the factory area. It not only injures the upper fertile layer of the soil orders, creates just bowls but destructs the ecological balance. It must be stated here that the pollutants in water give birth to several kinds of bacteria and virus grow which is very much conducive for the spread of diseases like cholera, diarrhea, gastroentris and liver diseases. Land pollution is also caused from various metallic solids like aluminium, lead, copper etc. which has a fatalic approach to human beings. These pollutants has a psychological effect also. It creates tension and reduce the efficiency of work. These metallic wastes give birth to many virus bacteria which give birth to cancer, neurological problems and lung diseases. The problem of pollution aggravates where it is seen that the land is disturbed by hot water carrying suspended particulate matters.

Land is frequently hailed as the basic contributing factor to the rapid and successful development of a
nation. The increase in population and modernisation of a developing nation has however reserved the process of development. The land in the coal areas of West Bengal may suffer a setback because of its avoidable devastations. Most of the areas had a good forest and vegetative cover before the advent of the British. This scenario is no more at the present moment due to large scale of increase of coal production for meeting the demands of the society which may lead to severe soil degradation. The process of scientific stowing is one of the significant criteria for a good soil management after extraction of the coal. The avoidance of such an implementation may create a havoc in relation to land pollution. The implication of coal mining over such an extensive area in West Bengal may reflect us the acuteness of the soil erosion. To disregard of environmental values, the people in the coal region may have a consequent effect of it. Taking the full advantage of the illiteracy of the people, the appropriate authorities may be in a position for the relentless exploitation of the natural resources which may destruct the of the soil.