Land is one of the very precious natural resource capable of supporting a number of living organism including human, animals and plants. Living organism use it to sustain their life and in due course make certain changes to it. Under normal circumstances these changes are generally recyclable and thus land is able to support the life since generations. However, since last century human has tried to master the nature and tried to identify a technological solution to each and every land related problem. However, in reality this proved successful only to certain extent and thus land associated problems started accumulating. Over the year this decreased the original potentiality of the land and thus the land degrades. Land also degrades on account of natural causes but the degradation as result of ruthless exploitation of nature by man is more serious and difficult to reclaim.

There are varieties of anthropogenic activities which may culminate into widespread land degradation if its pace not checked. Among others coal mining is also regarded as a major land polluting activity. Within the earth coal seams are of complex nature, many impurities and dirt are associated with it as unwanted material and of course the way it is extracted and used, all may leads to widespread land degradation. Usually two types of mining are in vague, but it is the open cast coal mining operations which has higher land degradation potentiality in contrast to underground mining operations. It is not only the digging for coal and depositing such dig out materials which causes land degradation, but spread of dirt into other areas, by water or air or directly by humans through handling of such materials may spread the ill effect of coal mining into other areas also.

The Jharia Coalfield in India is one of most important coal mining area famous for its quality coking coal. The mining history of the area is very old which further get intensified decade after decade in accordance with the increasing energy requirement. Unfortunately little attention has been paid to environmental concerns especially during early periods and thus ill effects of coal mining get accumulated year after year. To intensify the mining operations in the area more and more hands were employed and to cater them all further more hands were required. All these have increased the population pressure on the resource base of the area. As a result of all these features a marked changes in the land-use pattern of the coalfield took place. These changes in land-use pattern have also influenced some natural constituents of the soils of the coalfield. All these changes took place on the peculiar physiography of the area.

The Jharia Coalfield geologically forms part of Gondwana basin and includes the sedimentary succession of Archaean Gneiss, Tilchir, Barakar, Barren Measures and Raniganj formations from bottom to top. Out of these, only the Barakar Formation and to some extent
the Raniganj Formation is known to have extractable coal seams. The ash content of these seams are moderate, sulfur content are low but they have the high presence of sandstone and shale as unwanted material. Thus coal mining in the area, especially open cast coal mining operations are bound to produce large amount of dust, rock fragments etc. Also with the depth the quality of coal deteriorates and thus with increasing depth more undesirable material will be generated in the area.

Topographically the Jharia Coalfield is a part of the Chotanagpur plateau characterized by old and uneven surface. The coalfield has few important streams which are usually guided by topographic faults to flow west-northwest to east-southeast direction. These streams are rain-fed, their volume of water drastically reduced during dry seasons and most of them even non-perennial in nature. Since general relief of the area is low, number of streams, their stream length and their capacity are low and also since they are flowing through relatively hard geological structures so they do not have a high potential to cause and redistribute ill effect of land degradation.

Climatically the Jharia Coalfield is tropical monsoonal which witness high rainfall during four monsoon months whereas in other months rainfall is significantly low. However, the average rainfall is not very high and since most of them are distributed over four monsoon months so their intensity are also not high. Similarly annual temperature distribution, wind pattern and velocity etc. though vary somewhat season to season but do not show any climatic extremes to cause its widespread ill effect on land. But here it must be noticeable that in any year wind activities are of some concern during pre-monsoon hot months when winds are relatively more active, soils are relatively bare, loose and dry. Similarly rain related phenomena are relatively more active during four monsoon months than any other season during any year. Overall neither geomorphologically nor climatically the area has any evidence to show that widespread land degradation may occur on account of natural phenomena.

Over the period of time large scale land-use change took place in the Jharia Coalfield. It is basically coal mining and related activities which directly or indirectly played significant role in guiding different land-use pattern of the coalfield. Over the period considered widespread land-use interchanges took place which shows there is stiff competition among different land-use to grow at the cost of other. In terms of area occupied, it is vegetation, agricultural land, barren land and settlements which are important whereas area put to direct mining use are small. Over the period dense vegetation and sparse vegetation both have decreased but decrease was high in the case of dense vegetation. In contrast to it area under
barren land and settlement has increased considerably. Though area under agricultural use and mining use show little changes but land use interchanges are higher in case of agricultural land than mining related use or mining use of land are relatively more static. Over the period considered wasteland area has increased slightly but not in any single year considered in this study the wastelands were dominated by mining activities. The contributions of sparse vegetation or barren land are much higher in contrast to land put directly to mining and related use. Thus the direct effect of mining and related activities in causing land degradation is highly localised. Thus land degradation in the vicinity of mining areas were basically on account of mining and related activities but land degradation in other areas were due to increased human population and thereby increased pressure on land. There is a general tendency with certain exceptions that agricultural use and settlements have occupied those lands which were earlier under vegetation cover. Therefore, in addition to mining and related activities other land-use activities are also need to be considered in order to understand widespread land degradation in the coalfield and along with supervision of mining related activities, the other land-use also need proper management strategy.

Due to different land-use in the Jharia Coalfield some peculiarity in general soil quality and its distribution cannot be ruled out. The most important coal related activity in the study area is open cast mining operation and associated dumps. The soil of the Jharia Coalfield along open cast mining operations are in general have higher concentration of sand in contrast to silt and clay while latter are more common away from open cast projects towards the Damodar. In fact the entire area has higher presence of sand fraction in soil but their proportion further increases near open cast mining operations. Also within different grades of sand these areas have higher presence of bigger size sand whereas finer size sand tends to accumulate away from them. The coarse fraction of soil in the coalfield have also shown nearly similar trend as that of sand. Since finer grades of sand are also present in sufficient proportion therefore soil texture is not a big problem but it is high soil coarseness which are of more concern for normal agricultural practices and this problem further aggravates around open cast coal mining operations. Chemically soils of the Jharia Coalfield are acid biased but there is no clear cut association of spatial distribution of soil reaction, its intensity and different land-use as noticeable in the area. The general high acidity in soil may be attributed mostly to its coarse texture and four months concentrated monsoon rainfall along with fossil fuel burning and associated acid rain. The electrical conductance and soil salinity as measured from dissolved salt in water show no any peculiar spatial distribution trend and in general these values are low and thus not problematic for normal vegetation
growth and development. Like the case of soil reaction here coarse soil texture seems to have played some role by facilitating easy leaching of salt with monsoon rain. Among concentration and spatial distribution of some heavy metals few have shown some association with the prevailing land-use of the area. First of all only iron as measured from Fe/Mn ratio, Cr and V has shown their very high concentration in the soils of the Jharia Coalfield. Except Zn most of the others have shown generally some area crossing lower critical concentration and no area closer to or above upper critical soil concentration. In the case of Zn, it has considerable area crossing lower critical soil concentration but no part of the study area has crossed upper critical soil concentration or even near to it. Now spatial distribution of soil concentration of Zn, Ni, Cu and to some extent high concentration area of Pb and Cr has shown some association with open cast mining uses and in other cases no clear or very weak association appears. Further the degree of weathering as reflected from CIA has shown a general high weathering rate and thereby relatively faster rate of soil formation in most part of the area. But there do not exist any clear relation with prevailing land-use and spatial distribution of CIA value. Finally the degradation in soil quality as reflected from SDI value have shown that in most part of the study area overall soil quality is somewhat poorer in contrast to the reference soil. There are some pockets in the open cast mining areas of the coalfield which have shown poorest soil quality and also there are some very small patches of land where soil quality is marginally better than the reference soil. Only a very small portion of the area has shown some better soil quality than the reference soil property. Except very poor soil quality in some pockets of open cast mining operation or near to it, no area has shown clear cut association of soil quality and prevailing land-use of the area.

Thus land degradation is a serious ecological problem in the Jharia Coalfield. Over the years the area has witnessed widespread land-use changes nearly in entire area of the coalfield. But the area occupied by coal mining and related activities has not changed much. Also land-use interchanges either from coal mining and related activities to other land-use or from other land-use to this particular category is not much significant over the period considered. Thus direct role of coal mining in influencing changes in different land-use pattern in this coalfield is not much important. In fact it indirectly created such circumstances by which the human pressure on land has increased and this pressure on land has become main driving force to cause stiff competition among different land-use in this coalfield. In any single year the direct coal mining and related use never become dominant land-use and never witnessed much increase in area occupied by them. Thus in terms of area covered, other type of wastelands become more important than the mining areas. But if we look at the
degree of degradation then definitely open cast mining operations have witnessed more poor quality of soil in contrast to other areas. Here it must also be noted that in general the soil quality of nearly entire area are inferior in compare to reference soil quality. Thus it is not only the actual mining area but other areas also need equal attention in devising any successful land management plan. Also due attention must be given to other type of land-use prevailing in the Jharia Coalfield along with coal mining uses. In fact it is not only the understanding of land-use, changes in them and factors associated with them are important in totality but the land management planning and implementation part must also consider them in similar integrated manner.

Coal mining is world over known to cause widespread land degradation and therefore a complete land management plan must become part of mining plan before actual mining will take place. First of all the area need to be investigated not only in terms of geology but also in terms of geohydrology, geomorphology, climate, natural vegetation, prevailing land-use, population pressure and anticipated pace of changes in them. This will form the background standard for reclamation and help in devising proper land reclamation plan. The land-use and surrounding vegetation will give the information about final goal of land reclamation to reinstate the area. Knowledge of geomorphology of the area will help in identifying suitable dumping sites so that there will be least possibility to interfere with the natural drainage of the area. It will help in avoiding unnecessary contact of surface water with mining and mined out materials and thereby reducing chances of surface and ground water pollution. Further whatever wastes are generated these are deposited to dumping sites by means of heavy vehicle and again they are taken back at the time of refilling the quarry. So these dumping sites should be close enough to minimise unnecessary spread of dust materials and other mine wastes both at the time of their deposition and at the time of reclamation. Closeness of dumping sites will also minimise the energy used in such activities. The OBD slopes as witnessed in the field are steep and continuous. Keeping in mind the large scale of mining operations and large amount of overburden generated, if slope of OBD is reduced to lower its susceptibility to erosion it will require to be spreaded over large area. Thus it would be better to generate a stair type break in slope to reduce its susceptibility to erosion. Also at the time of planning for overburden sites, trees can be planted around it as a protection chain to minimise the spread of such unwanted materials to surrounding areas. Different layer of soil has different properties and usually it is topmost surface soil which is very valuable in reclamation. So such soil be preserved separately with due care and should be used as early as possible. Digging of pit creates local level depression which causes surrounding surface
water to accumulate into it. These waters are pumped out to further extract coal. Thus, at first surface water gets polluted, causes loss in surface drainage and secondly, it is again released to the surface using energy in polluted form. Better if some kind of concrete drain constructed around them keeping in mind general slope of the area so that most of such water could be diverted downslope without getting polluted. Before digging pit geo-physical properties of different layers of earth materials need to be investigated since at the time of back filling of quarry such properties need to be kept in mind so that as far as possible each layer should resemble original one. Since over the years, materials which is used to back fill the quarry loses its most of plant nutrients so artificially some nutrient can be added to help vegetate the area. In selecting the plant species used to regenerate the area the local plant diversity must be kept in mind. Now outside direct mining operations, concentration must be given to integrated location of different mining related industries so that waste of one unit may be used as input of other unit to minimise overall waste and also material transport burden. Similarly whenever new settlements are planned, if not necessary it may be vertically expanded instead of constructing structure more and more on new land. Demand for higher agricultural output has put stress on natural vegetation of the area and it may further pave the way to make such land barren. Better if agricultural output will be increased by increase in its intensity instead of creating pressure on natural vegetation. For this integrated use of surface and ground water resource and wherever required some lime should be added to soil to increase its pH along with normal agricultural practices. The area with degraded vegetation and barren land must be planted with suitable species and such areas along with dense vegetation area need to be protected by the concerned authority.

In the mining map of India Jharia is an important coalfield and the extent and quality of its reserve indicates that its importance will further increase with the rise in demand of fossil fuel and metallurgical coke. Thus in future the coal production from the coalfield is bound to increase which may put fresh danger to land degradation. But if proper land management plan were adopted and followed then it is possible to increase the coal output along with minimising its adverse impact on land.