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Discovering Thoughts, Inventing Future

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The Environmental Significance of Bioindicators in Sewage Treatment

By Dr. Judit Németh - Katona
University Rejtő Sándor Faculty of Light Industry, Hungary

Abstract - The presentation is about the significance of the bioindicators concerning environmental protection within the process of cleaning sewage. The existence of one or multi-celled organisms indicates the presence, condition or absence of certain parts of the water cleaning process. This way the optimal operation of the purifying appliances can be checked continuously and controlled in an environment friendly way.

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The Environmental Significance of Bioindicators in Sewage Treatment

Dr. Judit Németh - Katona

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I. Introduction

Life is dependent on water: an indispensable compound for all living organisms. It provides the medium, the dissolvent substance, and reaction agent for intracellular biochemical processes. It is one of the vital temperature controllers of the biosphere.

The total water supply of the Earth is approximately 1340 million cubic km but less than 3% of that (36.8 million cubic km) is fresh water, and the ratio of surface waters, lakes, streams, rivers, and groundwater is even less, only .64%, or 8.3 million cubic km.

The population of the Earth is presently 6.1 billion (US), (or 6.1 milliard GB). Based on current tendencies, this number is growing by 70 - 90 million per year. One of the most pressing global environmental challenges, due to the intensive population growth, is the lack of sufficient fresh water. Overpopulation, however, is not merely a consumption issue (5500 cubic km annually). The amount of wastewater or sewage water produced by the population is also increasing in direct proportion to population growth. Consequently, the pollution of water supplies, previously assumed to be of infinite capacity, has been significantly increased in the last three decades, thus sewage treatment has become a most pressing and immediate issue presently.

There are two options for the final disposal of sewage water. It can either be entered in natural waters, or in the ground, thus returning to the natural cycle. The self-purification capacities of the natural waters and the ground, however, are no longer able to handle the constantly increasing amounts of organic matter, and they have absolutely no resistance to toxins.

Following the example of self-purification in natural waters, biotechnological procedures have been used in sewage treatment more and more extensively, both in water clarification procedures, and in the related issue of water quality qualification.

Basically, there are two approaches to examine and determine water quality, and in a broader sense, environmental quality.

One approach makes the qualifications based on the indicators of end use (e.g. the parameters of drinking, industrial, irrigation, and sewage water), and interprets the data according to the appropriate standards. This approach is not quite operative because of its oversimplification. Obviously, any entity in the environment has a "quality" not only if it is used for some purpose. This is to confuse quality with the concepts of practicability, adequacy or utility.

The other approach determines environmental quality as the totality of attributes. This means that environmental quality is not determined based on a single characteristic, and it does not single out one variable, e.g. the temperature, the light conditions, the phosphorus content, etc.

Water as an environmental element can be defined as the sum of hydrological, physical, chemical, and biological characteristics. Some factors to be considered are: the properties of currents, the temperature and translucency of water, its free oxygen content, its ionic composition, its richness in different organic matter and living organisms, and various other factors.

If one wants to determine the actual quality of an environmental element, one cannot be limited to the examination of the relevant properties of the components separately. The qualitative "junctions" of any material system are not only, and moreover not primarily, characterized by the number of and the values of the components, but rather by their specific structure, i.e. the particular system of interconnections of the components within the domains of the given system. To analyze and interpret the complexity of the specific particularities created by the interactions of the individual constituents is significantly more complicated and more intricate than to study the idiosyncrasies of the individual components.

The accumulation of organic matter in natural waters, i.e. a positive change in the trophic state, is called eutrophication. The trophic state is defined by the organic matter content of a particular body of water. This state is induced by specific attributes as variables, e.g. the available amounts of phosphorus and/or nitrogen,

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the chlorophyll content, the algae biomass. It would be erroneous to reduce the cause of eutrophication to a single attribute or property. The interactions of various factors are required to produce the state of increased organic matter content, such as an energy source, several micro and macro elements, living organisms.

In the waters of Hungary, the trophic state is limited and determined primarily by the phosphorus content, sometimes by nitrogen, but it can also be the level of light available. Consequently, the subsequent phases of sewage treatment (i.e. the aerobic, the anoxic, and the anaerobic) must accomplish the decomposition of organic matter, the transformation of ammonia, nitrite, and nitrate, and must remove the excess amounts of phosphorus in order to produce water that is suitable to be absorbed by natural waters without triggering eutrophication, and can be returned to the natural cycle.

The purity level of water, the current relevant properties of water quality can be determined in a fast, efficient, and cost effective way using bioindicators.

An increased number of several different bacteria, the presence of Cyanophyta, Zooflagellata, and Ciliata, is an indication of water overloaded with organic matter, i.e. an indication of polysaprobic processes and oxygen deficiency. Our observations can determine if the nutrient content of the sewage water was insufficient, or toxic substances entered the system. Water like that has a high concentration of organic matter, the nutrient to microorganism load ratio is between 0.4 and 1.5. The load per volume is excessive, thus aeration is inefficient with very little oxygen present. The sludge forming time is between 0.5 and 2 days, resulting in poor sewage treatment efficiency. As a consequence of the overload, only small clusters of sludge are forming, and they are settling slowly, with lots of bacteria floating freely in the water (10 entities per ml).

Microorganism indicators are considered excellent water qualifiers because although they all call attention to a system overload, they indicate the cause and gravity of the situation in their own specific way.

The presence of nematode bacterium Thiotrix nivea *(See Fig. 1)* is an indication of the final stage, the ultimate putrefaction of water: hydrogen sulphide indicator. In this case it is necessary to empty and clean the aeration tank. This stage can be avoided if the other indicators are paid attention to in a timely manner.

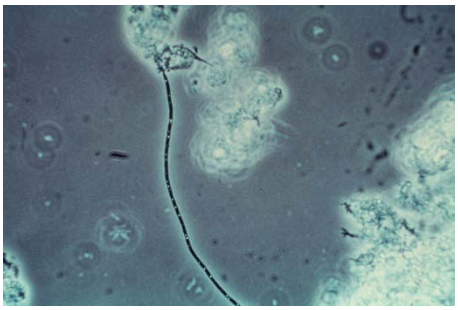

Figure 1 : Thiotrix nivea (magnified 400 times)

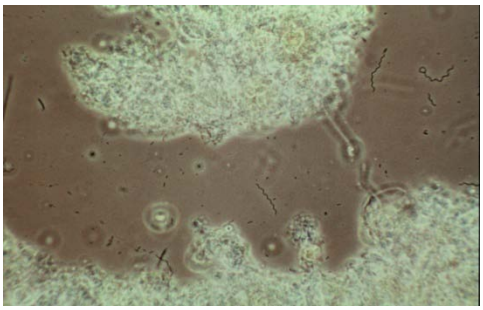

Figure 2 : Spirochaeta (magnified 250 times)

The presence of Spirillum and Spirochaeta species *(See Fig. 2)* signals the first stage of oxygen deficiency and an increase in the load. The Sarcina and Streptococcus phyla indicate a shift toward overload, alert of anaerobic processes, and the creation of stagnant "dead zones."

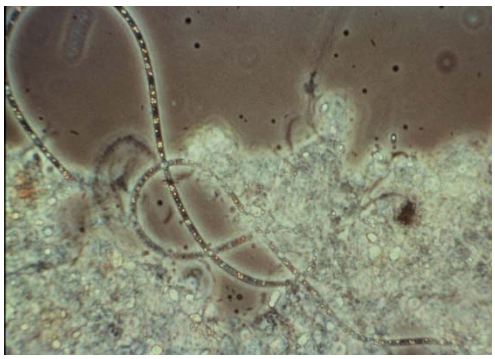

Figure 3 : Beggiatoa thread (magnified 400 times)

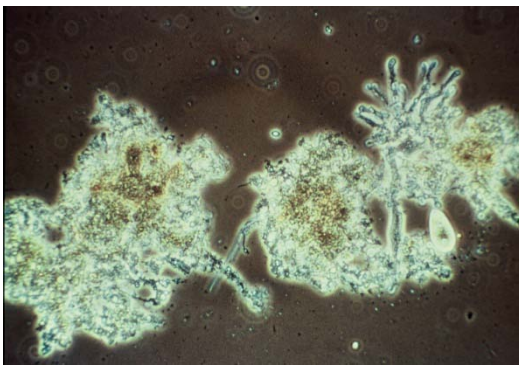

Figure 4 : Zooglea (magnified 400 times)

Sulphur bacteria, Thiocystis, Chromatium, and Beggiatoa species *(See Fig. 3)* point to insufficient clarification level, the formation of hydrogen sulphide, and the stage of putrefaction due to oxygen deficiency. A significant increase in the number of these bacteria results in a white, "furlike" coating.

The swelling and movement of the sludge, usually caused by the decomposition of nitrogen compounds, are indicated by the presence of Nocardia, Zooglea *(See Fig. 4).*

The flagellate protozoa *(See Fig. 5)* indicator organisms (Oikomonas, Trigonomonas, Trepomonas, and Bodo species, found in heavily loaded water rich in organic matter, show characteristics of both fauna and flora.

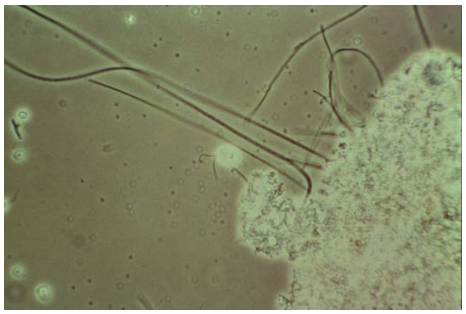

Figure 5 : Zooflagellata (magnified 250 times)

Figure 6 : Vorticella (magnified 400 times)

Besides bacteria and flagellate protozoa, the most significant indicator organisms are ciliate protozoa. The presence of these organisms indicates oxygen deficiency, system overload, and putrefaction. Ciliates most common in polysaprobic water are the Paramecium and Vorticella species *(See Fig. 6).*

In mezosaprobic sewage water the organic matter load is medium, the nutrient to microorganism ratio is 50% less than in polysaprobic water where the organic matter content is high. Sewage sludge is formed in 3.5 to 7 days, big clusters are formed that settle easily, and the freely floating bacteria are few. The free oxygen content is 4 to 6 mg per liter, which means sufficient aeration. Optimal conditions are indicated by the presence of certain ciliate protozoan: Chilodonella *(See Fig. 7)*, Litonotus, and Aspidisca species. They signal the process of nitrification, decreased ammonia level, and favorable aerobic (i.e. pertaining to the amount of oxygen) conditions).

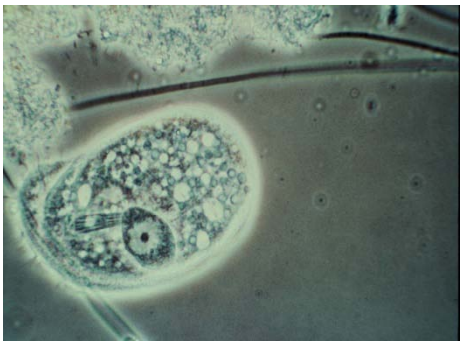

Figure 7 : Chilodonella (magnified 400 times)

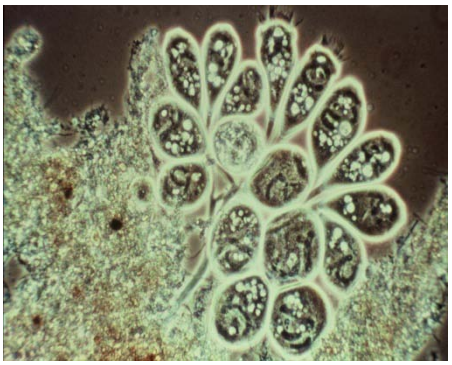

Figure 8 : Epistilis sp. (magnified 100 times)

Oligosaprobic water is poor in nutrition, and the decomposition of organic matter is at a low level. It may be characterized by excessive aeration, and the clusters floating in the water are small and loosely structured. This condition is indicated primarily by the thread bacterium Microthrix parvicella. This bacterium occurs frequently in the winter months, and can become a dominating organism. Epistilis ciliate protozoa *(See Fig. 8)* are present in large numbers when the efficiency of sewage treatment is above 65%.

Stabilized (aged) sewage sludge is indicated by the presence of metazoan organisms since they need more time to reproduce than the protozoic protocysts and bacteria. The most characteristic indicators are Tubifex tubifex of the nematodes *(See Fig. 9),* and the rotifer group (Rotatoria) *(See Fig. 10).* Due to their filtering feeding method they reduce the number of bacteria outside the clusters, they loosen the structure of the clusters thus the bacteria inside the clusters have access to more oxygen.

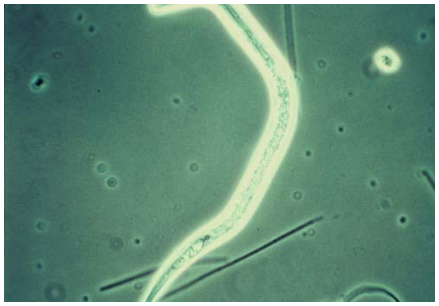

Figure 9 : Nematoda sp. (magnified 250 times)

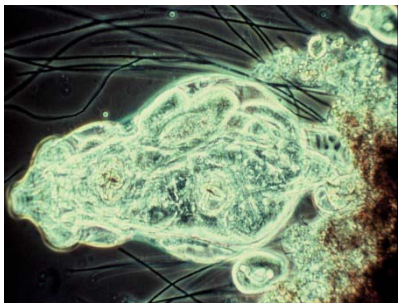

Figure 10 : Rotatoria (magnified 150 times)

II. Conclusions

Bioindicators indicate the presence and condition of the different stages of sewage treatment, also indicating the absence or excessive level of an entity. Observing the bioindicators, the quality of water, and the condition and operations of the treatment equipment can be continuously checked and controlled in a cost effective way. Thus the study of bioindicators is absolutely justifiable.

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Coal Mining, Environment and Contemporary Indian Society

By Dr. Sribas Goswami
University Serampore College, India

Abstract - Mining activity creates tremendous pressure on local flora and fauna particularly where diversion of forest land takes place for mining purposes. The effect of mining on ground water level, silting of surrounding water bodies and land are also great concern. Coal mining contributes largely towards economic development of the nation although it has a great impact upon the human health. It also has its impact on socio-cultural aspect of the workers and people residing in and around coal mining areas. Thus a holistic approach for taking up to mining activities, keeping in mind concerns for adjoining habitats and ecosystem, is the need of the hour. This requires identification of various sites where minerals exist and various factors ranging from appropriate angle of slope of overburden dumps, safe disposal drains, and safe techniques to various silt control structures etc. In India Coal companies are now working towards "clean coal" strategies, which aim to reduce environmental impacts. The reduced ash contents of the washed coal increase the thermal efficiency of combustion. Which in turn make a direct impact on reducing emission of pollutants. However the coal washing requires extra water and it can turn towards a pollution free society.

Keywords : *environment, pollution, coal mines, land degradation.*

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Dr. Sribas Goswami

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Keywords : environment, pollution, coal mines, land degradation.

I. Introduction

On the unstable earth, the un-resting man constantly uses the different resources for his daily life. Coal is recognized to be the main source for energy for many decades and contributes to nearly 27% of the world commercial energy requirement. Coal is mined by two main methods - Surface or opencast and underground mining method. Geological condition determines the method of mining. Coal mining is usually associated with degradation of natural resources and destruction of habitat. This causes invasive species to occupy the area, thus posing a threat to biodiversity. Huge quantities of waste material are produced by several mining activities in the coal mining region. If proper care is not taken for waste disposal, mining degrades the environment. The method of waste disposal affects land, water and air and in turns the quality of life of the people in the adjacent areas.

Mining activities are below the earth crust in hostile environment including darkness, hot and humid condition and slow moving air losing its oxygen content with the oxidation of coal. Release of inflammable methane; a natural product of the coal has tendency of layering along the roof due to its low density. Its concentration within 5 -15% form explosive atmosphere.

The explosion due to methane gas underground has been responsible for nearly 38% the total fatalities since 1901 in Indian coal mines. The inrush of water from the surface of subsurface water sources to the mine was responsible for nearly 24.9% of the total fatalities during the same period these environmental hazards often caused disaster, killing hundreds of miners in single occurrence and shaking their confidence for years.

The pneumoconiosis and dye to air borne coal and silica dust were identified as the main occupational hazards due to inhalation of contaminated air underground. The miners also suffered from a number of other skin, intestinal aid bronchial problems due to prolong exposure to the polluted water and air. They are grouped under occupational health hazards.

The movement of the strata including aquifuge or aquiclude disturbs the hydraulic regime. The disturbance of water level particularly that of the subsurface results in slow death of the plants, green carpet and biodiversity. The pollution of water due to leaching of salts from otherwise impervious strata and biological pollution due to rotting of biological mall underground causes scarcity of potable water though millions of gallon of water is pumped every day. The extensive caving causes surface subsidence and damage to surface features and land. The subsidence disturbs land from agricultural farms to forest, meadows to dwellings and thereby the total environment and ecology around the mining zone.

The domain of environmental damage due to the underground coal mining as such could be classed as follows:

a) Environmental Impact - Underground

Safety hazards

Explosion of gas and coal dust

Inundation with roof and side falls

Health hazards

b) Environmental Impact –Surface Domain

- Land disturbance
- Water regime disturbance
- Air pollution
- Biological disturbance
- Societal disturbance

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The impact of underground mining as such has been realized in the form of safety and health hazards for the miners because of the polluted environment, hostile ground behaviour and unhygienic working environment. Being away from the ray of sun with limited air availability, rising temperature due to thermal gradient of the strata and humidity due to the water charged formation around and every moment fear of accident of hazards have made the underground environment no better than death hole from the very late stage and realized much later by the common mass.

II. Objectives of the Study

1. To find out the impact of coal mining on environment in Raniganj and Jharia coalfield.
2. To find out the various components of the environment related with the coal mining projects.
3. To elucidate the coal mining practice in Raniganj and Jharia coalfield.
4. To discuss the various socio-economic infrastructure and environmental factors influencing the coal mining projects.
5. To discuss the causes and consequences of environmental degradation in the Raniganj and Jharia coalfield.

III. Sources of Data & Methodology

The methodology of the study includes collection of research materials by field study and observation methods. The present study is based on both Primary and Secondary data.

a) Study Area

One of the important coalfield in India as well as of West Bengal, namely Raniganj coalfield has been selected for research purpose. The Raniganj coal field is bounded by latitudes 23° 35° N to 23° 55° N and longitudes 86° 45° E to 87° 20° E is the most important coalfield of West Bengal (Burdwan District) lies in the Damodar valley region is surrounded by Durgapur – Asansol Industrial belt. For empirical study, another study area of Jharkhand namely, Jharia coalfield has been selected for research purpose. The Jharia coalfield is located in the Dhanbad district of Jharkhand state at a distance of 260 km from Kolkata towards Delhi. It is bounded by latitudes 23° 38° N to 23° 52° N and longitudes 86° 08° E to 86° 29° E.

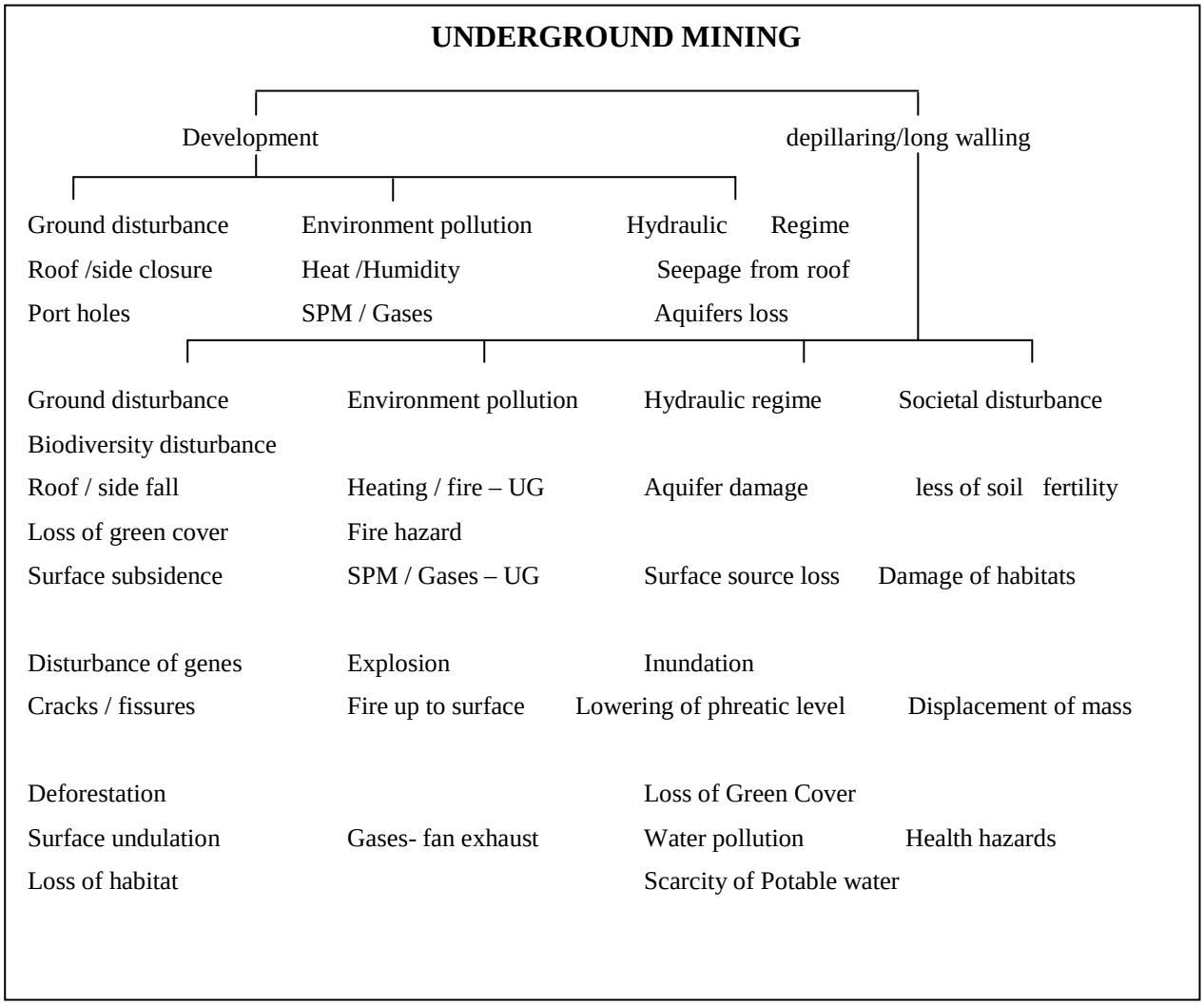
IV. Various Aspects of Coal Mines on Environment

a) Underground Environmental Hazards

Mining of coal underground starts in the form of narrow gallery development with pillars around and depillaring by way of drilling and blasting or mechanized cutting of coal by continues miners or shearing in case of long wall mining, the drilling, cutting shearing, loading and transport of the coal adds dust and fumes to the atmosphere. Coal dust and methane in the presence of a source of ignition creates the worst environmental hazard underground in form of explosion. The opening of the seams or fragmentation of the coal follows operation of the drills, movement of the machines and blasting of the explosive causes noise menace to the working environment.

The working philosophy in the form of inter connected narrow gallery and stable size pillars was developed for the safety against a) the roof fall, b)collapse of the burden cover, c) inflammable gas and coal dust explosion, d) water inrush and inundation and e) unhealthy working atmosphere due to heat, humidity and reparable dust. The long wall mining or depillaring operation aggravated the situation in restrict of a) surface subsidence, b) occurrence of roof and side fall, d) spontaneous heating and fire, and e) danger to the surface dwelling, biodiversity and forest cover. With the surface subsidence or occurrence of fire, the impact of underground mining reaches to the surface and affects environment and ecology. The following chart presents a view about underground mining hazards.

Figure 1 : Dimension of disturbed domain due to underground mining



V. Atmospheric Pollution

Environment of underground mine working has been extremely dangerous because of the constricted geometry, darkness around, suffocating mine atmosphere, heat and humidity. Working under poor light in the past caused miners mustangs, is practically unknown now because of the improved lighting. Heat humidity and thermal stress often extreme under deep mines have been responsible for poor efficiency of the miners.

Air conditioning of the atmosphere in some of the deep underground mines has been realized in the interest of efficiency. In the safety risks, ill health and likely injuries and accidents could be minimized. In this exercise, optimization of the man, machines, and environment system- physical environment in terms of heat, humidity, air movement, illumination noise, vibration, toxic agent, dust and fumes are to be looked into.

The environment of underground mines has been a subject of serious concern to the mine operators because of the liberation of methane with coal cutting, heat and humidity and generation of fumes with the blasting of coal. The opening of the seams with interconnecting galleries, coursing for intake and return air, creation of air draught and deployment of auxiliary or forcing fans were some of the conventional means adopted to improve the environment of underground. The suppression of dust or suspended participate matter was trued by water spraying from the loading or transfer points. In the subsequent years water infusion in the seams and water jet mounting on the cutting edges was tried to minimize dust menace during cutting of the coal.

The auto oxidation of the coal; a slow process is aggravated when large surface area of the fine coal particles come in come in contact of air. The oxidation of pyrite adds a new dimension to the problem and being

an exothermic process causes spontaneous heating and fire underground under favorable conditions. The heating process generates SO2, CO, CO2 and higher hydrocarbons. These gases reaching to the atmosphere through cracks and fissures make the underground atmosphere unsuitable for the miners and also pollute the surface atmosphere around the up cast channels. Similarly the blasting underground generates NOx and other gases in addition to fine particulate matter. The atmosphere underground was affected by a number of mining activities like cutting, blasting, loading and transport and preparation to beneficiation on the surface. The factors responsible for generating and adding different pollutants in the atmosphere underground are shown in the following chart. The most damaging constituent among them were the suspended particulate, impurity attributed to be due to handling, transport and preparation of coal and the methane released from the coal seams.

Some of the pollutant were the natural product of the coal formation while a number of them were produced during the mining operation, preparation and handling. The underground mining technology has been developed in different parts of the world to improve the mine environment and to minimize hazards associated with different activities.

VI. Noise Pollution Due to Mining Activities

The most mote generating equipment underground are the haulage, ventilators - main, auxiliary and forcing fans, conveyor transfer points, cutting and drilling machines. The ambient noise level due to different operations in underground mines varies within 80-1040 dB (A).In a mine of Raniganj and Jharia coal field, the noise level near fan house, conveyor system shearer and road headers was reported to be within 92 -93 dB (A). The values increased in many Indian mines because of poor maintenance of the machines and exceeded the permissible limit of 90 dB (A) for 8 hours per day exposure. The transfer points of the coal underground were the main point of the noise menace. The result of a noise survey for a coal mine conducted by DGMS is summarized in the following table, which indicates noise over 90 dB by the drills, breaking and crushing units and transport system underground.

VII. Impact of Underground Mining on Surface Domain

Most of the leases acquired for the mining purpose were interior barren land, agricultural farms, or government controlled fallow and forest cover. The development of the underground mining establishments, residential complex and civic amenities required nearly 10% of the total lease area which has to be restored at the cost of forest, farms, or fallow land. This land was used for the common facility development with the marginal disturbance to the soil cover and green carpet. However the naturalized biological genes of the mining area were driven out or disturbed with the human settlement, noise nuisance created by heavy vehicles and construction of jungle of concrete. With the clearing of the exotic plants, the natural plant succession of the area was hindered and the loss of the green cover followed soil erosion.

The concentrated mining of coal underground in and around Jharia, Raniganj and Katras towns has transferred the underground pollutants to surface atmosphere. The mine exhaust through main ventilators and the return airways added the gaseous and particulate pollutants to the surface atmosphere. The waste rock -shale or sandstone intrusion sorted out of the coal mass for quality improvement was stocked near the pits or the railway siding. Weathering of the coal and rock mass leaches from the dumps and noise menace from blast wave and movement of surface handling plants polluted the surface environment to variable degrees.

The non mining activities like burning of coal in open stock, active fires and road transport of the coal have added a new dimension to the atmospheric pollution of the region. The sources of pollution associated with underground mining are summarized as follows:

- Change in land use pattern and land depredation.
- Ground Vibration with blasting.
- Suspended particulate in the atmosphere.
- Noise and vibration menace due to mining and vehicular movement.
- Societal problems due to cultural, economic invasion and displacement.

VIII. Change in Land use Pattern

The underground mining has caused land degradation because of surface subsidence, solid waste and coal dumping, fire underground and silting of the surface. The disturbance of the aquifers and subsurface water table followed loss of green cover and vegetable mass. The subsidence and disturbance of hydraulic regime has been dealt separately because of their importance. The bunker age in Indian coalfields have been very poor when the coal produce has to be stocked open along the railway siding in the off seasons. The pit head stock varied up to the production level of 15 days to a month covering a large area. The green cover over the patch was lost and the dust polluted the area under the influence of underground mining and fire, affecting even the local non mining population. The waste rocks picked and scattered around created severe eye shore. The surface condition of Jharia coalfield is self revealing.

As the size, shape and magnitude of the dumps varied with demand, the land degradation under its influence was variable. Nevertheless, an area once under coal heap remained permanent eye shore unless reclaimed by systematic plantation. .

The other factors responsible for the degradation of land in coalfields of Raniganj and Jharia, primarily worked underground were the subsidence and fire. The subsidence in normal cases caused undulation of the surface, damage to the structures and drainage pattern. In case the slope exceeded 15 degrees, erosion of the soil occurred, when the top soil was removed with torrential rains. This converted the farms to wasteland of low fertility and caused siltation of the dams, streams and ponds. According to one estimate, over 5.5 million hectares of land is already converted to waste land in Damodar valley alone.

IX. Land Disturbance

Leaseholds for the underground mines were procured from the land lords who granted them the right for underground coal. The land for houses, dwellings and the associated activities were purchased piecemeal from different sources while large portion of the surface right remained under the control of farmers and landlords. Underground mining in these areas was conducted with full responsibility of the surface protection by the operators who normally maintained pillars as the natural support to the surface features. The condition was very damaging under the condition of Jharia coalfield where thick seams were worked under shallow cover. There are some pockets in the coalfield which have subsided by over 10m due to repeat depillaring activities. In geologically disturbed areas, deep pot holes were formed through which valuable fertile soil drained underground and many a time surface structures were damaged distorted or spoiled.

The exposure of the roof rock mass during development followed stabilization and attainment of equilibrium by way of sagging and progressive fall. Surface deformation in the form of pot hole occurred due to roof fall at shallow depth cover when the formation up to the surface and the features within the influence zone subsided without warning. Sinking of a family sleeping on the bed near Kenduadih colliery in September 1995 is a typical example of the same. The type of phenomena was not singular in Jharia coalfield because of the unscientific mining of thick coal seams under shallow cover. Over 40 pot holes were reported at Mahabir colliery since 1922 while a dozen such pot holes occurred at Handidua colliery during last 3 decades. These pots have been responsible for the destruction of the houses, damage to the railway line, roads, paddy fields and surface water sources.

The degradation of land in Jharia coalfield with the underground mining started in early 20th century with the thick seam mining under shallow cover. Nearly 6294ha. of land was estimated to be damaged before the nationalized of the mines of this field. The cause wise land damage of Jharia coalfield is summarized as follows:

- Surface subsidence 3487 He.
- Underground fire 1732 He.
- Abandoned pits 434 He.

The land of Jharia coalfield is under regular threat because of mining operation; failure of pillars and stocks, pillar crushing and advancing fire in adjacent pockets.

The story of Raniganj coalfield was in no way different where nearly 4000 He. of land subsided up to the year 1988 and the average will be disturbed by subsidence alone by the year 2000AD. The impact of underground coal mining in terms of loss of agricultural land was estimated to be nearly 1000 He in Jamuria, Asansol and Kulti blocks of Raniganj coalfield by now.

X. Surface Atmospheric Pollution

Mining below the surface destabilizes the ground, while the process of mining particularly blasting under shallow cover causes vibration of the surface structures and noise menace. The transfer of the raw coal, its beneficiation and handling generates coal dust while open burning of coal for steam or other usage releases gaseous discharge to the surface atmosphere. The movement of coal from the pit head to the loading or consumption points in open leaky trucks or open wagons also adds coal dust to the environment all along the route. The leaches from the waste rocks, discharge of effluents from the machines, pumping out of the hard and polluted water to the surface water sources make the water source unfit for mass consumption. The surface subsidence due to caving or fire damages the surface structures and endangers the surface dwellers. The underground mines were ventilated by large size fans discharging up to 12,000 m 3 /min. through fan evasive of 3m to 5m diameter at over 200 mm pressure. The air absorbing moisture from the underground workings often reduces the suspended particulate matter but the fumes of explosives, methane, SO 2, and Oxides of Carbon were added to the general body of air. The concentration of these hostile gases often creates a little impact over the surface and the population nearby. With the latest realization about the impact of these green house gases over the Ozone layer has drawn the attention of the global community and efforts were on to drain methane and put it to use as a fuel. The biodiversity and the local populace are also disturbed by the mining activities though they were mostly underground.

XI. Dust Concentration In Mining Areas

The dust concentration in the coal mining area is one of the worst menace affecting the common residents and miners alike. The miners from the organized sector get health support and other medical facilities while the common citizens suffer without any such insurance. Major portion of the menace is indirect; associated with open stock burning of coal, dumping, of the waste rock and road transport of coal and sand. The suspended particulate matter in mining atmosphere of Katras coalfield is revealing in this respect .The predominant air emission source in most of the coalfields is road generated dust and vehicular exhaust. In some of the areas road transport is the only mode of coal movement where open, leaky, inefficient trucks and dumpers carry coal on ill maintained roads and pollute the region. In Jharia coalfield, the vehicular movement contributed nearly 47% of total SPM load, while the direct contribution of the underground mining was estimated to be 6% only.

The ambient air quality of the mining area often polluted by the associated activities was of the non mining origin but of public concern and required remedial steps. The vehicular discharge engaged for the transport and handling of the coal within the coalfield was responsible to a large extent in adding suspended particulate pollutants in the general atmosphere. The concentration of suspended particulate matter in ambient air of the coalfield on an average was high and the extreme was up to 1464 mg/1 at Nirsa. The trace elements were also reported as pollutant in ambient air of Jharia coalfield, including lead, manganese, arsenic chromium and cadmium.

XII. Trace Element Pollutants In Air

The toxicity of trace elements and complexities of biological and chemical interaction and its impact on the health makes the study of trace element in the environment very relevant to the healthy living of the population. Most of these elements were present in soil or rock mass but their concentration increased in the mining areas because of large scale lithosphere disturbance. The metals released with different mining and associated activities get suspended in atmosphere and get easy access to human body. A survey of the ambient atmosphere of Jharia coalfield shows significant concentration of iron, lead, zinc and copper.

XIII. Water Pollution

The hydraulic cycle starting from ocean to sky and ultimately precipitation to the earth is no exception for the coalfield where the rain, natural moisture and surface to subsurface water sustain biodiversity of the region. The infiltrated water is charged to the coal measure aquifers and is retained by the aquiclude or aquifuge. Depending upon the thickness, porosity, permeability and storage coefficient of the rock mass, the capacity of the aquifers varied extensively over Damodar valley to Pench Kanhan coalfields. The coal seams known to be impervious, restricted the cross infiltration when different layers charged along the exposure served as the confined aquifers. The extraction of the coal followed disturbance of the aquifers and lowering of the water table. In this process mineral leaching occurs, affecting the water quality underground. The water pollution problems in mining may be broadly classified into the following four major heads.

- Acid mine drainage due to sulfur content
- Deoxygenating and Eutrophication of coal
- Hardness of water due to leaches
- Heavy metal pollution oil, tan and grease mixing in water

The mine effluents have high level of dissolved chlorides, nitrates, phosphates or sulfates of sodium, calcium magnesium and iron. At low levels, nitrates, and phosphates act as nutrients, causing rapid growth of algae and subsequent deoxygenating while at higher level, the character of the water is altered with deleterious effect over the fishes. The bicarbonates, sulfates, chlorides and calcium and magnesium cause hardness of the water and make it unsuitable for industrial and human consumption.

XIV. Coal Mining and Damage of Flora and Fauna

The underground mines have been using huge amount of timber as a support, leading to large scale deforestation. Nearly 95% of the supports underground were timber chocks and props in the year 2002 and on an average the timber consumption was around 10 m3 / 1000 tons of coal produced during development and 50 -100 m3 /1000 tons of coal produced from the depillaring operations. The impact though indirect caused colossal loss to the forest wealth. The colonization of the area also required a large amount of timber for building work which resulted gradual denudation of the forest cover.

The environmental awareness brought life to most of the areas and concerted effort for reclamation of the subsided land or land under fire c hanged a number of barren patches under green cover. Over 1 million trees of different species have been planted in Jharia coalfield alone during last 15 years. As a result, the apparent mining lease has dropped from 17.7% in 1984 to 12.5% in 1999. The progress in Raniganj coalfield has not been to satisfaction because of the poor land holdings under government control.

XV. Biological Disturbance

The depillaring or long wall mining over critical area caused surface subsidence, cracks and fissure and lowering of water table. Soil cover the most valuable constituent of the earth crust sustaining biological domain was marginally disturbed along the fracture planes. Soil erosion is prominent in case of thick seam working under shallow cover due to steep slope. T he balance of soil is however least disturbed and is possible to be reclaimed for the useful purpose. The biotic survival of a region is influenced by three gifts of the nature-water, soil and air. All the three were affected for a limited period and to some extent with the underground mining and so the biological system of the area.

The lowering of water table and loss of surface water sources starved the trees -Sal, Mahua, Palas, Bija, Kendu and Bhelwa a portion of which was cut for common use. The surface cover slowly reduced to shrubs and bushes growing profusely in the rainy seasons and drying in winters. Bantulsi became the most common bush of the coalfields capable to sustain the particulate pollution because of the nature of the leaf. Forest as a result slowly disappeared from Jharia and Raniganj coalfields even though very little under the influence of direct mining.

These belts; rich in flora and fauna before the advent of mining suffered heavy loss even though the mining activities were mainly underground. The loss and the damage to the biodiversity may be attributed to the following reasons.

- Hunting by the mine officers
- Killing by the explorer and miners for their own safety
- Disturbance in living environment of the beasts and the birds
- Depletion of forest cover
- Noise menace due to movement of machines and blasting waves
- Urbanization on forests and inaccessible lands.
- With the depletion of the forest cover, increase in population and mining activities, the region rich in biodiversity slowly became barren.

The rare species - leopards, wild dogs, hyena, jackals, bears, bison, sambar, spotted deer and bores were butchered by the early miners as a fun or trophy and or for their safety. The frequent visit of bears in Katras mine area, leopard in west Bokaro and Satgram mining area were the past records. Chirping of the rare species of the birds is uncommon in most of the coalfields and their place taken by cawing of crows.

XVI. Land Degradation and its Effect on Agriculture

> "Oh my earth, we have belonged to each other for decades. I have been totally identified with your land and soil and thus have become a party in your continuous movement around the solar system amidst the endless sky."

The above four lines from the Nobel Laureate poet Rab indranath Tagore describes vividly and beautifully, the inseparable bond between man the land. But the meaning of the four lines may be conveyed as follows:

The fundamental link between man and land described by the poet is however rudely disturbed in an area when mining is started. The history of land loss and land degradation in coalfield areas of Raniganj and its adjoining areas are an eloquent testimony of disturbing this fundamental link between man and land.

The land is non-renewable asset and its degradation therefore has far reaching implications affecting the life of thousands of inhabitants living in the degraded land. Land loss and land degradation due to mining may be due to underground or opencast mining. In underground mining subsidence causes the major loss of land and in Raniganj and Jharia coalfield, extensive area may be considered to be degraded due to instability created by wrong mining procedure. In the surface mining, the excavation and spoil heaps is the major cause of land degradation. There are other causes of land degradation which are associated with mining. Land may become less productive and therefore degraded due to deposits of coal dust and other suspended particulate matter. The extension of urbanization associated with mining also contributes to land loss in many ways.

XVII. Land Degradation Due to Opencast Mining

In the Indian Coal industry the dependence on opencast mining has increased rapidly during the last two decades due to mechanization and modernization. The large opencast mines have advantage of low gestation period and higher recovery of coal and are more amenable to heavy mechanization and modern technologies than underground mines, thus ensuring speed and economy in implementation.

The total production of coal in the whole country from opencast in the year 1972 - 73 just prior to nationalization was around 18 mt. which amounted to approximately 20 percent of total production but in the year 2003 -2004 the opencast production contributed to 70 percent of total production of 238 mt.

The total requirement of land for opencast projects up to the year 2008 AD as per the master plan of Raniganj coalfield would be 80 km 2 (8000 ha) to

which must be added the land of 20 km2 (2000 ha) already damaged by opencast mining, which means that the opencast mining would damage 100 km 2 (10,000 ha) of land up to 2008 AD.

XVIII. Land Degradation Due to Underground Mining

Traditionally, coal production in Raniganj and Jharia coa lfield was mostly from underground mines though the scenario has changed significantly in favour of opencast mining after nationalization as has been stated earlier. A number of prestigious underground projects have been undertaken in Raniganj coalfield after nationalization, including one at Jhanjra which is already under implementation with Russian collaboration. Jhanjra underground project has been planned to be one of the biggest underground mining project in India. The work on an Indo - French project at Khottadih has been started recently.

The land loss and land degradation due to underground mining is of lower magnitude compared to opencast mining. But due to sustained underground mining activities carried over so long large area of coal bearing area has been degraded and lost due to subsidence. An estimate indicates that about 4600 hectare of land has undergone subsidence up to the year 1988 and the overage surface lowering is about 0.6 m. It may be anticipated that another 1000 hectare of land would b e affected by subsidence up to the year 2008 AD. The above estimate however do not take into consideration 47 areas where subsidence may be triggered anytime due to inadequacy of supporting coal pillars left underground.

It will, however be profitable to make an effort to portray a comprehensive and total picture of land degradation without going into project specific details.

XIX. Effect on Agricultural Activities

The estimate presented in the fore - going paragraphs indicates that approximately 15 to 17 percent of the total land in the coalfields in Raniganj and Jharia would be degraded due to mining and related causes. It is very difficult to assess the quantum of agricultural land involved in the total land degradation. The sample survey presented earlier shows that agricultural land has generally been 18 -55 percent of land degraded in a project. The quantum of agricultural land involved increases with mining entering into a relatively new area, whereas when the project is on an area where mining activities are already in full swing, the quantum of agricultural land involved may be smaller. A reasonable estimate may be that 35 -40 percent of the total land involved may be agricultural land, which means around 10,000 ha. of agricultural land might be involved in the Raniganj coalfield during the process of mining up to 2008 AD. The total land use pattern in the coalfield has never been verified in Raniganj coalfield though some aerial survey data is available for Jharia coalfield. The following table would, however, give an impression of the problem of dwindling agricultural land in the coalfields of West Bengal and Jharkhand.

XX. Migration of Workers from Agriculture

It is a difficult task to estimate the number of farmers and agricultural workers displaced or affected due to land loss and land degradation. From the relevant data it is revealed that in Satgram area alone the number of cultivators decreased from 4103 in The year 1971 to 1753 in 2004, which means a decrease in cultivators of 2350 in a span of 33 years. It may be noted that whereas in Asansol, Salanpur and Katras development blocks (all located in coalmining area) there has been a decrease in number of persons employed in agriculture by approximately 3300, 3500 and 2600 respectively over a period of ten years (1994-2004) there has been increase in agricultural employment in non mining areas.

In actual terms, it is not that a particular group of agricultural labors become completely redundant, but the partial loss of occupation pervades in the agricultural labour class. The effect of such partial loss of occupation becomes more intense because in the Raniganj and Jharia coal belt the people subsisting on agriculture have no means of augmenting their income by keeping cattle or by fish culture as these occupation have now become rare in the coal belt.

The tendency of indigenous population to shift from agricultural activities is being accentuated due to the presence of migrant labors employed in coal mines and having steady income. The unemployed men flock of these families tends to take up the job of “share cropping” replacing the traditional share cropper or agricultural worker in the process. If this trend continues and become dominant the profile of agricultural community in the coalfield will undergo a sea change.

XXI. Less Productivity in Agriculture

The issue of land loss and land degradation shall have to be considered along with the declining productivity in agriculture contributed by the side effects of mining. During the process of research, the paddy plants were collected from different polluted control sites in the mining areas where there have been considerable accumulation of suspended particulate matter and coal dust. There was considerable reduction in the grain size if paddy plants in all polluted sites and there was reduction of number of grains per spike. The weight size

and volume of grain produced at all paddy plants were also reduced. The summary of all the studies pointed out that polluted sites the production were reduced greatly. The water retention capacity of soil in the coalfield is also affected due to mining and this, in turn, addicts the field productivity.

XXII. Land Degradation and Society's Reaction

Land degradation and consequent land loss is the unique type of environmental effect associated with mining and is generally not encountered in this scale in any other industrial activity. Opencast mining in scale and in intensity creates most severe form of land degradation and therefore, coalfield communities all over the world hold strong views against open casting as mining operations.

In India the coalfield community's resistance towards land acquisition for an opencast project has delayed the starting of many projects. Such resistance has been most intense in the state of west Bengal. A number of opencast projects in West Bengal including "Sonepur Bazari" opencast project was considerably delayed because of the local citizens" resistance to the land acquisition. The reason of such resistance from coalfield community being most intense in west Bengal may be understood from a perusal of the history of Indian coal mining itself. Coal mining in India was first started in the Raniganj coalfield of the then Bengal more than 200 years back. During the intervening years the coalfield areas have become highly built up with many industries including two steel plants being set up in the area. There has been faced large scale migration from other states.

In future years as other coalfields also became highly built up such resistance from local citizens would be encountered there also. The industry and the government should keep this possibility in mind and should devise schemes to fulfill local aspirations. The reclamation of land should also get adequate priority from the industry.

XXIII. Subsidence and its Impact on Environment and Ecology

The extraction of coal from deep down the earth's crust creates a void and disturbs the initial equilibrium. With the increase in size of the void, the strata overlying the extracted coal seam collapse and tend to fill up the void. The process of settlement continues from roof of the coal seam upwards and ultimately the land surface overlying the extracted area subsides or sinks down.

The settlement process may be divided into two phases - primary settlement and secondary settlement. The primary settlement gets initiated within months of extraction of coal provided a critical area has been extracted, but the secondary settlement is a long drawn process and may continue for together. The amount of land subsidence depends mainly on the thickness of the seam extracted and also on the method of packing used for filling up the void created by coal extraction. In case sand is stowed in the void, the amount of subsidence would be very less and the damage to the surface would be minimum. With sand-stowing being used an extraction of 4.5 m (15 feet).

The depth at which mining is conducted has also got a bearing on land subsidence and surface damage. At shallow depth, the disturbance is more prominent. At greater depth, the area affected for a particular size of extracted area is more but the nature of damage is relatively gentle compared to that at shallow depth.

The subsidence of land over which some important structures like houses and dwellings are situated may however be prevented by restricting the percentage of extraction of coal and leaving blocks of coal pillars to ensure safety of surface structures. The mining legislation as it stands now has provisions for determining the size of such pillars, but during the first few decades of coal mining in Raniganj coalfield when mining legislations were either non-existent or were very sketchy, extraction of coal was done from many areas of Raniganj coalfield without bothering for surface stability. The pillars left were too small and no plan of such extraction was kept. This has given rise to a problem in many areas of Ranigan j and Jharia coalfield where sudden subsidence may occur any time causing damage to life and property.

XXIV. Conclusion

Mining has a significant impact on the economic, social and environmental fabric of adjoining areas. Although mining activities bring about economic development in the area at the same time the land degradation it causes creates ecological and socio-economic problems.

Mining adversely affects the eco-system as a whole. It is important to conduct suitable assessment studies to learn the potential adverse impact of mining or flora and fauna. The adverse impact should be identified at the planning stage itself so that corrective measures may be taken in advance.

The adverse effects of subsidence fissures have made most of the subsided areas barren and unstable. The indirect effect of subsidence has contributed to drying up of many tanks and dug wells in the vicinity. Much of these subsided land may however be put back to productive use with joint effort from coal companies and local bodies, but no concerted and coherent effort has however been taken in this direction. Not much study has been done towards reclamation of subsided

land in Indian coalfields. In a few areas of Raniganj coalfield, plantation on subsided land has been tried. The scientists are of the opinion that before starting reclamation of subsided land, the purpose of reclamation in terms of "land-use" should be decided in consultation with the local people. The most important thing is to plug the cracks and it may not be necessary to bring the subsided land to original profile even for use for agriculture, plantation and housing. Some researchers are, however, badly needed for improving water retaining capacity of subsoil in the subsided land. There is no specific legislation in India concerning subsidence, but as per common law, the coal company is to acquire the surface right of the property in which subsidence may occur due to underground mining. In some countries, there are specific legislation guiding the coal industry in matters of subsidence and perhaps such enactment may be the necessity of the day in our country also. In the foregoing discussions an attempt has been made to clarify the coal mining activities and its residual impact on environment and human health. It is also clear that mining is a site specific activity and is done at the sites where mineral exist. Also, mining is considered as an environmentally unfriendly activity.

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Leptochloa Fusca Cultivation for Utilization of Salt-Affected Soil and Water Resources in the Cholistan Desert

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Abstract - In the Cholistan Desert, 0.44 million ha are salt-affected low lying and clayey in nature locally known as *'dhars',* where rainwater as well as saline groundwater could be utilized for growing salt grasses like *Leptochloa fusca* as forage during summer. *L. fusca* is a promising candidate grass for economic utilization and better management of sodic, high pH, saline soil and water resources of the Cholistan Desert. *L. fusca* is known to be a versatile, halophytic, primary colonizer, easily propagatable, perennial, nutritive and palatable forage plant species. The grass has the good biomass producing potential and can grow equally well both under upland and submerged saline soil environment.

Keywords : *Cholistan, Leptochloa fusca, saline irrigation, salt-affected, soil reclamation.*

GJHSS-B Classification : *FOR Code: 090509, 961499*

Strictly as per the compliance and regulations of:

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I. Introduction

The Cholistan Desert (Figure 1) lies within the southeast quadrant of Punjab province between 27° 42' and 29° 45' North latitude and 69° 52' and 73° 05' East longitude (FAO/ADB, 1993; Arshad et al., 1995; Jowkar et al., 1996; Ahmad, 1998; 1999a; 1999b; 1999c; 2003; Ahmad et al., 2004; Ahmad, 2005a; 2005b; Ahmad et al., 2005; Ahmad, 2007a; 2007b; Ahmad and Farooq, 2007; Ahmad, 2010; 2011; 2012a; 2012b; 2013) and covers an area of 2,580,000 ha (Ahmad, 2002; 2010), out of which 1.13 million ha comprising stable as well as non-stable sand dunes, 0.95 and 0.06 million ha consist of sandy and loamy soils respectively, while 0.44 million ha are clayey in nature, locally known as *'dhars'*. About 17% of the Cholistan Desert consist of such *'dhars'* (Table 1) having flat and hard surface with salt incrustation and surrounded by sand dunes. *Dhars* are shallow to moderately deep, poorly drained with low vegetation, calcareous and having saline sodic fine to medium textured clayey soils. Except *Haloxylon recurvum*, other plant species can't survive due to salinity, compaction of soil and complete inundation during rainy season. The ponded rainwater in *'dhars'* stagnates for a period until the water evaporates (Khan et al., 1990; Ahmad, 2010).

It is judicious to utilize the land using ground saline and surface rainwater resources for growing palatable grasses. Biological approach for economic utilization of salt-affected soil is feasible and is the only viable method when the soil is sodic and sweet water is not available for irrigation (Abdullah, 1985; Ahmad, 2010).

Leptochloa fusca is high tolerant to saline and sodic conditions even irrigated by saline groundwater or ponded rainwater. After the successful cultivation of *L. fusca* in the Cholistan Desert, other palatable grasses like para grass (*Brichiaria mutica*), Rhodes grass (*Chloris gayana*), Bermuda grass (*Cynodon dactylon*) and *Sporobolus* grass species can be tested (Abdullah et al., 1990; Ahmad, 2010). The cultivation of salt tolerant grasses would not only provide much needed palatable forage for livestock but also improve the physical properties of the soil due to biological activity of grass roots.

II. Research Design and Methods

The purpose of this paper is to assess the available evidence and published arguments and to provide a constructive working synthesis of evidence about *Leptochloa fusca* in the literature. *L. fusca* is a promising grass for economic utilization and better management of sodic, high pH, saline soil and saline water resources of the Cholistan Desert. The plants respond to salinity stress in part by modulating gene expression, which ultimately leads to the restoration of cellular homeostasis, detoxification of toxins and recovery of growth (Ashraf and Harris, 2004). Salinity in soil or water is one of the major stresses and, especially in arid and semi-arid regions, can severely limit crop production (Shannon, 1997; Mansour, 2000; Ashraf and Harris, 2004; Ashraf and Foolad, 2005; Ashraf and Foolad, 2007). Several physiological responses to salinity that differ qualitatively or quantitatively between salt tolerant and sensitive species (Ashraf and Harris, 2004), and that are candidate indicators, it has not yet proved possible to find any sensitive criterion that could reliably be used by breeders to improve salt tolerance of plants (Kumar et al., 1994; Ashraf and Harris, 2004; Hamdia and Shaddad, 2010). Although the groundwater is saline but it can be used for saline agriculture to grow salt tolerant trees, vegetables, crops and fodder grasses in non-saline-non-sodic coarse textured soils with minimum adverse effects due to rapid leaching of salts

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beyond the root zone and flushing of salts from root zone by rains (Abdullah et al., 1990; Ahmad, 2010).

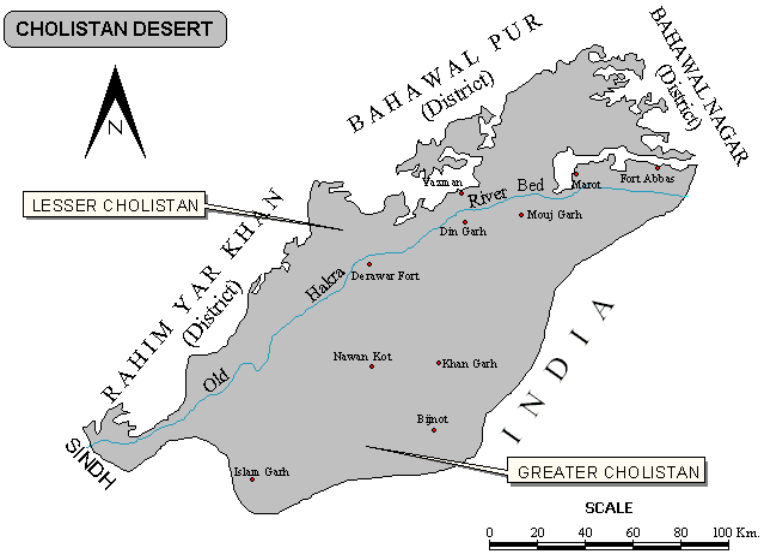

Figure 1 : Location map of the Cholistan Desert

Table 1 : Soil Types

Soil Types	Extent (Ha)	Percentage
Sand dunes	1,133,900	44.0
Sandy soils	945,500	37.0
Loamy soils	58,700	2.0
Saline sodic clayey soils (*Dhars*)	441,900	17.0
Total	2,580,000	100.0

Source: PADMU - Pakistan Desertification Monitoring Unit (1986).

III. Growth Characteristics of Leptochloa Fusca

Leptochloa fusca is also known as *Diplachne fusca,* widely spread in salt affected regions of Pakistan. This forage plant is locally known as *"Kallar grass"* (salt grass). Being a grass of sub-tropical climate, the plant follows the photosynthetic CO_2 fixation process of C_4 - NAD-malice enzyme metabolism (Gate, 1972; Zafar and Malik, 1984; Ahmad, 2010). It is native of saline soil which gives clear indication of its halophytic character; the plant is perennial or biennial in nature (Rao and Arshad, 1991; Arshad and Rao, 1993). It has been regarded as good quality forage especially in salt-affected and waterlogged areas where other superior forage species may not grow successfully.

Leptochloa fusca can be easily propagated and established through seed, stem cutting, root stumps or rhizomes. The grass can grow to a height of 1 to 1.5 meter with a high leaf production rate and can be grazed directly or cut for stall-feeding. This fodder appears highly palatable to sheep, goats, buffaloes and cattle alike and no toxic effects of this grass during long-term consumption have been diagnosed. Moreover, it is similar to other conventional fodder regarding its nutritional status and 3-4 cutting within 3 months may be easily harvested, producing 20-40 tons of green fodder per ha per year or 5-10 tons per ha per cutting in salt-affected soils (Sandhu et al., 1981; Qureshi et al., 1982; Sandhu, 1993; Ahmad, 2010). The grass grows well during the hot season from March to September with peak yields during rainy season *i.e.* July and August in Pakistan, indicating a strongly thermophilic character. The development of extensive and dense fibrous root system has been observed even in highly sodic soils (Joshi et al., 1981; Ahmad, 2010). The penetration of roots in such soils can enhance hydraulic conductivity, microbial activity, organic matter and ultimately leaching of salts. Joshi (1981) noted a decline of *L. fusca* growth due to decrease of soil sodicity, while Haq and Khan (1971) observed that *L. fusca* has a general tendency to decrease EC_e (electrolyte conductivity), SAR (sodium adsorption ratio), pH (soluble ions) and even ESP (exchangeable sodium percentage) of artificially salinized soils. Malik (1986) confirmed the utility of *L. fusca* not only as a primary colonizer of salt-affected

lands but also as ameliorative plant for the soil (Ahmad, 2010).

IV. Nutritional Requirements

It has been observed that 3-4 cuttings of this grass could be easily taken without the addition of nitrogen (N) fertilizer in salt-affected and less fertile soils. Malik (1980) demonstrated a high activity of nitrogen, which indicates strong associative symbiotic relationship of N_2- fixing bacterium (Bacillus gram negative) in the rhizosphere of *L. fusca*. Moreover, the nitrogen fixation through the growth of blue green algae and *Azolla* under flooded conditions may partly contribute to the nitrogen supply and economy of the specie. It was also observed that *L. fusca* contribute more stable organic matter fraction due to its slow decomposition as compared to succulent plant species like *Sesbania aculeata*. Kumar (1980) reported an abrupt increase in the yield of *L. fusca* from 24-26 tons per ha per year without N application to 41-46 tons per ha per year, when only 40 kg N per ha was applied in a sodic soil. Abdullah (1985) showed a definite ameliorative effect of phosphorus (P) on the growth of *L. fusca* under saline environment (Hanson and Scott, 1980; Agboma et al., 1997a; Agboma et al., 1997b; Díaz-Zorita et al., 2001). The application of P at the rate of 50 kg per ha gave significantly higher fresh and dry matter yield at EC_e 10 dS m^{-1} than all other treatments, which was followed by 75 and 25 kg P per ha at EC_e 20 dS m^{-1}. The synergistic P x salinity effect was obvious at the highest P level of 75 kg per ha. Thus, the specie is responded favourably to P application at all salinity levels studied *i.e.* EC_e 3.5 to 30 dS m^{-1}, indicating higher P requirements. In general, the specie is capable to accumulate trace elements (Zn, Cu, Fe, Mn) in a sufficient amount to meet the dietary requirements of the livestock under saline soil conditions (Abdullah et al., 1990; Ahmad, 2010).

V. Role in Soil Reclamation

Leptochloa fusca behaved as a typical crypno-eu-halophyte having both accumulating and excreting properties (Abdullah, 1986; Abdullah et al., 1990; Ahmad, 2010). The efficient salt excretion from the shoot makes it a useful plant to deplete excessive salt from the root-zone and to provide the better root-environment for the growth of other plants. The extensive and fibrous roots of grass can open soil, increase air exchange, organic matter and hydraulic conductivity, decrease rhizosphere pH, stimulate biological activities, dissolve native $CaCO_3$, enhance leaching of salts, lower the water table of waterlogged soils, release plant nutrients and the shoot foliage can increase organic matter, humus and soil mulching, decrease surface evaporation and improve physical properties of soil with the passage of time (Haq and Khan, 1971; Joshi et al., 1981; Abdullah et al., 1986; Malik et al., 1986; Akhtar et al., 1988; Ahmad, 2010).

VI. Use of Ground Saline Water for Irrigation

Dense saline-sodic soils of the Cholistan Desert (Baig et al., 1975) can be used for growing such palatable grasses, which is salt tolerant and capable of surviving in soils having poor properties (Baig et al., 1980). The sandy and loamy soil that is about 1 million ha can be brought under agriculture using underground saline water and harvested rainwater. Experiments showed that under certain conditions plant could not only survive but also even vast area of land could be irrigated with water of such high concentration. Moderately saline irrigation water stimulates vegetation, assists the benevolent bacteria of the soil and improves yield and quality (Akram et al., 1995). Further, use of brackish water reduces soil evaporation, transpiration of plants and increases resistance to drought (Abdullah et al., 1990; Ahmad et al., 1992; Ahmad, 2010). The solution of the adverse effect is suggested (CHIDS, 1991):

- Identification and selection of species and varieties tolerant of high salinity,
- The use of brackish water of such a degree of salinity only as is compatible with help of such species and with the nature of the soil,
- The selection of irrigation with such water in areas in which soils permeable, well drained and rich in calcium and the hydrates of iron and aluminium.

Pakistan Council of Research in Water Resources (PCRWR) has planted *Eucalyptus, Acacia, Parkinsona, Zizyphus* (Beri), *Tamarix, Prosopis, Asparagus,* Date palm, Pomegranate, Jojoba and Iple Iple (*Leucaena leucocephala*). The saline water of concentration TSS (total soluble salts) 2800 ppm (part per million) and SAR (sodium adsorption ratio) 14 was being used for irrigation (Dalton et al., 1997) along with harvested rainwater (Figure 2, 3, 4 and 5) to flush the salts at certain interval (Abdullah et al., 1990; Ahmad, 2010). The calcium sulphate fertilizer was also used to neutral the adverse effects of sodium salts. The growth of some of them is given in table 2, 3 and 4.

Table 2 : Biomass of Fodder Grasses/Ha Grown at Dingarh, Cholistan Desert Using Saline Water

Fodder grass	Biomass Fresh (kg)	Biomass Dry (kg)	Carrying capacity per year			
			Camel	Goat	Sheep	Cattle
Cenchrus ciliaris	16811	15012	2	14	16	3
Panicum antidotale	22191	12407	1	11	14	3
Lasirus sindicus	25217	18247	2	17	20	4
Napier Bajra	43710	38780	4	35	42	9
Leptochloa fusca	13449	11445	1	10	13	3

Forage requirement (Dry matter per day):
1 sheep = 2.5 kg 1 goat = 3.0 kg 1 camel = 25.0 kg 1 cattle = 12.5 kg
Source: PADMU – Pakistan Desertification Monitoring Unit (1986).

Table 3 : Biomass Potential of Some Salt Tolerant Forages

Species	Green matter (kg/plant)	Dry matter (kg/plant)	Green matter yield (tons/ha)	Dry matter yield (tons/ha)	Plants/ha
Atriplex amnicola 949	4.31	1.99	2.7	1.24	625
Atriplex amnicola 971	5.37	2.39	3.4	1.49	625
Atriplex amnicola 573	6.73	3.43	4.2	2.14	625
Atriplex amnicola × *Atriplex nummularia*	5.13	2.15	3.2	1.34	625
Atriplex buburyana 1205 (Carnarvan)	3.11	1.6	7.8	4.0	2500
Atriplex buburyana 1200 (Leonora)	2.0	1.2	5.0	3.0	2500
Atriplex cinerea 524	5.0	2.35	3.1	1.46	625
Atriplex lentoformis	5.45	3.19	3.4	2.0	625
Maireana aphylla 1062	2.53	1.2	6.3	3.0	2500

Source: PADMU – Pakistan Desertification Monitoring Unit (1986).

Table 4 : Survival Percentage and Canopy Cover of Some Plants Grown in the Cholistan Desert

Name of Tree / Shrub / Bush	Age (months)	Survival (%)	Height (cm)			Canopy Cover (cm)		
			Min.	Mean	Max.	Min.	Mean	Max.
Eucalyptus *(Camddulensis)*	24	76	90	156	223	66	113	161
Tamarix	24	48	59	106	154	52	112	173
Acacia	24	67	66	125	193	55	126	197
Beri *(Zizyphus)*	24	43	55	118	181	38	82	126
Jojoba *(Simmondsia chinensis)*	18	76	20	60	110	08	48	89
Atriplex halimus (Local)	11	65	--	77	---	--	45	---
Atriplex amnicola 573	11	40	--	48	---	--	08	---
Atriplex amnicola 197	11	80	--	74	---	--	15	---
Atriplex amnicola 223	11	25	--	47	---	--	09	---
Atriplex bunburyana 1041	11	60	--	51	---	--	07	---
Atriplex bunburyana 1036	11	70	--	66	---	--	13	---
Atriplex cincerea	11	40	--	28	---	--	02	---
Atriplex lintiformis	11	60	--	76	---	--	26	---
Atriplex commercial	11	25	--	44	---	--	13	---
Maireana aphylea	11	85	--	35	---	--	30	---

Source: PADMU - Pakistan Desertification Monitoring Unit (1986).

Figure 2 : Wild oats grown by highly saline irrigation at PCRWR research station at the Cholistan Desert (Pakistan). Ahmad, Farooq 2008

Figure 4 : Frost trees grown by highly saline irrigation at PCRWR research station at the Cholistan Desert (Pakistan). Ahmad, Farooq 2008

Figure 3 : Innovative approach for mustard crop cultivation with saline irrigation on sandy desert at the Cholistan (Pakistan). Ahmad, Farooq 2008

Figure 5 : Innovative approach for development of grassland with saline irrigation on sandy desert at the Cholistan (Pakistan). Ahmad, Farooq 2008

Table 5 : Salt Tolerant Plants Cultivated in the Cholistan Desert Using Saline Water

Forage Crop/Grass/Bush	Tolerance ($EC_e \times 10^6$) 4000 – 18000
Alkali grass *(Puccinellia airoides)*	High
Bermuda grass *(Cymodon dactylon)*	High
Kallar grass *(Leptochloa fusca)*	High
Salt grass *(Distichlis stricta)*	High
Desert wheat grass *(Agropyron cristatum)*	High
Barley *(Hordium vulgare)*	High
Rape *(Brassica napus)*	Medium
Clover *(Melilotus)*	Medium
Alfalfa *(California common)*	Medium
Oats *(Hay)*	Medium
Atriplex spp.	High

Source : PADMU – Pakistan Desertification Monitoring Unit (1986).

The germination capacity of different varieties of tomato, ladyfinger (*bhindi*), spinach (*palak*), cowpea and zucchini (*tori*) at different levels EC_e 3 to 18 mmho/cm was studied in sand culture (Akbar et al., 1996; Akbar, 2002; PADMU, 1986; Ahmad, 2010). The germination was delayed and decreased with the increase in salinity. Significant vegetables were found to fall in the order of salt tolerance: Spinach > Zucchini > Cowpea > Tomato > Ladyfinger (Abdullah et al., 1988; Abdullah et al., 1990; Abdullah et al., 1991; Ahmad, 2010). List of some salt tolerant grasses and forages cultivated in the Cholistan Desert using saline water is given in table 5.

VII. Conclusions

The growth factors such as easy propagation, high spreading rate, colonizing ability, vigorous growth, yield, palatability, nutritional value, long term survival and high adaptability to environmental stress make *L. fusca* an excellent and versatile specie that can be cultivated using brackish water and salt-affected land of the Cholistan Desert for economic exploitation. *L. fusca* develop succulence, which dilute the level of salt in the plant and stores water for use during dry period. The specie has great promise for the economic utilization of sodic, high pH, waterlogged and saline soils. Similarly, high saline-sodic water can be used for successful cultivation of *L. fusca*.

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Dynamics of Coal Mining Caused Environmental Crisis Versus Displaced People's Question of Survival: A Case of Talcher Coal Belt, Odisha (India)

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I. Introduction

Coal undoubtedly, works like a black diamond among all minerals at global economy. However, coal cannot be clean like other vital resources of nature- land, water and air to which it pollutes profusely. Further, it's extracting and mining projects add environmental costs that negatively affect the age-old human-environmental relationship in coal mining belt worldwide. It is an undeniable fact that the large scale coal mines cannot operate without disrupting the vibrant rhythm of ecology and wildlife habitats everywhere. In this process, the people consequently, those who live in and around mining areas cannot help, but bound to develop anti-environment attitude supporting the mining projects in long run. It is apparent that in order to happen so, the concerned government and mining authorities make deliberate strategies in the name of development in the mining belt. Such strategic environmental crisis and existential dualism are highly visible in the coal belts of Odisha. In this respect, Talcher coalfield, the coal capital of Odisha is increasingly getting into such catastrophic situation.

Talcher coalfield is highly pronounced as one of the most revenue generating regions of Odisha, and of India as well, but has become one of the worst three zones of major 10 environmentally threatened zones in Odisha (Odisha, State Pollution Control Board, 2006). The pollution effects not simply disrupt the local peasants' access to agro-economy and their common property resources (CPRs) i.e. village forests, fresh air, clean water sources etc, but also detach them from their earlier ethics of green thinking and environment-based beliefs and rituals. After land acquisition and environmental disruptions these peasants were involuntarily dispersed into different destinations for their resettlement. After over decades of their detachment from earlier ecosystems and village atmosphere they have undergone substantial changes in their life styles. Consequently, their requirement and questions of dependency on environment have also been changed. Some of the first generation senior oustees, who had seen the environment of old villages, and had experienced the early pangs and trauma of displacement, though highly critical of ongoing coal mining activities, but still hope of regenerating their relation with the environments in the peripheries (Garada, 2013 & 2012). The second/third generation oustees who have not seen earlier green village atmosphere, and have not experienced the early tragedy of displacement, not only have detached themselves from their ecosystems and environments, but also appear to be supporting the coal mining projects directly or indirectly in the process of land acquisition and deforestation in and around the Talcher coalfield. It is not simply the issue of environmental displacement, but also of the displacees' indifference to the environmental impact and crisis at present. So far, many studies/institutions have exposed the tragedy of mining induced human displacement, and environmental pollution worldwide, but unfortunately, hardly any

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research institution publicly draws world attention to the consequent crisis of human- environmental relationship, which is the worst form of displacements the world has ever seen in the past civilizations. Unfortunately, many studies conducted in India over the years on coal mining caused-displacement problems have hardly touched upon such issues seriously going beyond human displacement and their rehabilitations (Garada, 2013 &1995; Meher, 2003; Dhagamwar, De and Verma, 2003, Pandey, 1998).

In this backdrop, we have tried to analyze, in this paper, how the mining caused environmental crisis not only reduces/disrupts displaced people's access to common property resources (CPRs), but also results the crisis of human-environmental relationship at Talcher coal belt. This paper has consisted of six main parts such as Part-I consists of introduction, theoretical overviews on development versus environment, and of overviews on coal mining impact on local environment, Part-II consists of background of Talcher coalfield, study area, sample frame, research objectives, methods of data collection and socio-demographic profile, Part-III consists of finding on sample households' access to common property resources and their energy consumption pattern during pre and post-displaced periods, Part-IV consists of finding on the dynamics of coal mining caused environmental crisis and displaced peoples' response with sub-headings such as menacing of excruciating heat of summer time and displaced people's response, water pollution and displaced people's response and land degradation and displaced people's response, Part-V consists of finding on the issue of deforestation/ reforestation and Part-VI consists of a brief conclusion.

a) Development Versus Environment: Theoretical Overviews

In the context of increasing global population, urbanization and technological innovation extraction of coal from the earth and its extracting industries' growth cannot be compromised at any cost. Coal not only meets the major portion of energy needs of mankind in the modern world, but also equally contributes to the gross national product (GNP) of any coal resource rich country in the world. However, it adversely affects the physical environment of coal resource rich regions in irreparable condition. Notwithstanding this, the coal rich nation-states, at global level have been striving hard to speed up their GNP growth through opencast mining projects for last several decades. It is also true that any unsustainable economic growth and its consequent fast modern establishments bound to come under the threat of nature's revenge at present. It is now scientifically established fact that the GNP led growth, oriented to a culture of intensive use of energy for increasing production of goods and services, is extremely accountable for significant environmental change such as for example, global climate change, unpredictable rain, tough summertime and the like worldwide (see Garada, 2009; Meher, 2003). According to Wolgang Sachs the uncontrolled growth of GNP was once assumed to have turned many people- local or global into the cheerful enemies of the nature in 1980s (Sachs, 1997:38). It is alleged that at the cost of environment human materialistic forms of luxurious living have got lifted by the system of modern development (see Garada, 2009; Shiva, 1997; Baviskar, 1997; Sachs, 1997). In 1987, realizing this, Brundtland report announced prominently for "the marriage between the craving for development and concern for the environment" but unfortunately, this was never realized in true spirit (Sachs, 1997).

Of course, how and when development would go hand in hand with environment were not yet promoted. Unfortunately, when the questions of whether environmental disaster be tolerated for economic development or human development be adjusted with environmental protection were not resolved, the development specialists argued in 1970s that environmentalism was inimical to the alleviation of poverty and economic growth in the world. On the contrary, they also argue that it is the economic growth which reduces poverty but not environment. Hence, the economic growth is unrelated to environmental degradation. The growth reduces poverty, so as the poverty induces environmental degradation was another consequent argument. But, today human being wants both- reduction of poverty and protection of environment (ibid: 39).The activists and environmentalists argue that poverty has never been the enemy of nature. Rather, in the process of contemporary massive mining operation and huge industrialization, the poor of the resource rich regions will be aspiring urban life style and would be the future agents of environmental destruction (see Garada, 2013 &1995; Dhagamwar, De and Verma, 2003; Shiva, 1997).

But why do humans destroy the ecosystem, of which they are active parts, is an ecological query. That engages debate and deliberation involving more significantly the human exemptionalism paradigm (HEP) on onside, and the new ecological paradigm (NEP) on the other, worldwide (see Kaltenborn, Bjerke and Strumse, 1998; Dunlap and Van Liere, 1978, www.environment.gen.tr › Environment Writings). While the former paradigm views that human-environmental relationships are sociologically not important because humans are 'exempt' from environmental forces via cultural change, the latter paradigm views that humans are still ecologically interdependent with other species. But knowingly the latter's view the people in general are more conditioned by the modern cultural changes than by the corresponding changes of nature. This also gives rise to another controversy. While one group of intellectuals blame modern capitalism as the culprit for

all the environment problems, and for the crisis of ecosystem people, another group argues that we should take the benefits of modernization and industrialization keeping ecology in mind (reflexive modernization) (see Baviskar,1997; Beck, Giddens and Lash 1994; musicdoc.org.uk/cspt/documents/issue2-1.pdf). Thus, the dialectic of modernity versus reflexive modernity is looming large in the contemporary society. However, nothing could obstruct the forces of disruption to environment/ecology worldwide. For instance, the argument of "ecological modernization" developed in 1980s could not guarantee the check of environmental degradation worldwide (see Foster, 2002; Fisher and Freudenburg 2001; Baviskar, 1997). Even, the Marxism versus neo-Marxism controversy is not left behind in this regard. While the former views that the crisis of ecology and ecosystem people is due to labour, capital and state conflicts over production the latter views it is due to capital, state, labour and environmental conflicts. Thus, all these paradigmatic dialectics as if, celebrate their epistemological discourses, but in dilemma, dualism, so on and so forth without coming to a green peace resolution. Actually, what's required is an ecological approach to human development or more importantly "social ecology" or "human ecology". In fact, the environment is the surrounding that influences growth and development of living and non living organism inclusively. The Indian conception of nature is '*Prakriti'* which permeates every stone, tree, fruit and animal and sustains them combined with the human World (Shiva, 1989).

Vandana Shiva argues that since *Prakriti* grants the blessing of nature as gifts must be honoured and worshiped. Thus, gradually the social ecology is the emerging need of the hour. Unfortunately, all this existential dualism may be contextualized in virtually any mining belt where in fact, the interlocking human-environmental relationship has been highly damaged, disrupted and ruined or in the verse of destruction by the mining projects.

b) Coal Mining Impact on Local Environment: Overviews

In above backgrounds, according to environmentalists, coal mines especially, opencast coal mines have been disrupting human-environment relationship causing wide range of environmental problems such as, for example, air pollution, water pollution, noise pollution, land degradation, desertification of lands, deforestation and soil erosion and above all increasing miseries to displaced/affected people in the long run (Garada, 2012; Dhagamwar, De and Verma, 2003; Victor Munnik, 2010; Khatua and Stanley, 2006; Ezeigbo and Ezeanyim,1993). Our review of literatures demonstrates that the environment and ecosystems in and around the coal mining industries have now been irreparably impacted (see, Maiti and Maiti, 2007; Sarma, 2005; Dhagamwar, De and Verma, 2003:194-204; Keating, 2001; Fernandes and Paranjpye, 1997; http://moef.nic.in/downloads/public-information/EIA-Summaries.pdf). In fact, both opencast and underground mining projects adversely affect the people, society and environment. But unfortunately, the sustainability of environment is not prioritized over the prospect of former in the logic that coal has many significant uses worldwide. In the process of mining operation the human-environmental relationship gets disrupted not only in the industrial center, but also in the periphery where displaced ecosystem people live in. In macro global economy, local people are compelled to participate in environmental destruction imposed by mining and industrial houses beyond their control, because they are reduced to move as resource suppliers in periphery for the urban centers (Meher, 2003; Garada, 1995; Shiva, 1997: 276-292; Sachs, 1997). The people's local stability and ecological harmony are undermined as the forced relocation throws them out of their familiar common social and geographical resources such as ponds, wells, grazing lands, forests, community centers, panchayat/village meeting spaces, temples, etc. Further, the loss of familiar social and geographical surrounding put the PAPs into despair and detached them from their universe of meaning that was attached to their rural settings in the past (Garada, 2009, Kibreab, 2000: 293-331, Dhagamwar, De and Verma, 2003: 189-212, Shiva, 1997).

II. Background of Talcher Coalfield

Talcher coal belt is one of the fastest growing industrial complexes of India. Talcher coalfield (1860 sq.km area) is located in Brahmani valley to the north of Mahanadi River in the Talcher block of Angul district, about 120 km away from Bhubaneswar, the capital city of Odisha (MCL, Archives, 2007:16.5, 19.2). As per the 2001 census, there is a total of 143603 population, of which 16 per cent belongs to scheduled caste and 7 per cent belongs to scheduled tribe in Talcher block (District Statistical Hand Book, Angul, 2009). Brahmani river and its tributaries namely Singhra, Tikiria and Nandira are the main water sources flowing at Talcher locality. Talcher coalfield comes under Mahanadi coalfield limited (MCL), a public sector coal subsidiary of Coal India limited (CIL). It was established on 3rd April, 1992 with its headquarters at Sambalpur. It has acquired Mini Ratna Category-I status on 15.3.2007 for its better performance in term of coal production and profit generation (MCL, Archives, 2007: 5.6). A huge non-coking coal deposits suitable for thermal power plant attract the prospect of coalmining projects at Talcher-Angul belt. Talcher coalfield has eight opencast and three underground coal mines in its five coal areas namely Jagannath area, Bharatpur area, Lingaraj area,

Hingula area and Talcher area. From these coal areas a total of 14266.207 acres of land have been acquired by coal mines through Coal Bearing Act (CBA) (A & D) 1957, and LA Act 1894 from 1960 to 1999 at Talcher coalfield (till 31st May, 2007) (Land Acquisition Office, Angul,2007). After land acquisition total 6246 persons were sponsored by the coal mining projects for employment (ibid). Out of those total sponsored persons about 28 per cent was not yet employed till 2007. According to MCL Archives eight coal mining opencast projects namely Jagannath OCMP, Ananta OCMP, Bharatpur OCMP, Balaram OCMP, Hingula OCMP, Lingaraj OCMP, Bhubaneswari OCMP and Kaniha OCMP had created 4598 PAFs (project affected families) for resettlement till 2007(MCL Archives 2007:19:4). But till our field study 2007-08 only 54 per cent of them were resettled (23 % at the resettlement sites and 77 % at self settled clusters) (ibid). Besides coal mines other projects namely Rengali Multipurpose Project (RMP), Samal Barrage, National Aluminium Company Limited (NALCO), Captive Power Plant (CPP), National Thermal Power Corporation (NTPC), Talcher Thermal Power Station (TTPS) and many other polluting industries are operating at the vicinity of Talcher coalfield at present. A total of 1822.086 hac of forest land including reserve forest was there in the Talcher-Angul coal belt till 2006. According to latest statistical hand book, Angul, 2008-09 total geographical area of Talcher block is 21814 hect including 4169 hect forest area, and 5043 hect net area sown. The Satakosia gorge sanctuary of Talcher-Angul belt is quite famous in the state. The animals like elephant, tiger, leopard, barking deer etc, snakes like python, cobra, etc and avifauna like parakeet, peafowl, quails, emerald doves, owls, pigeon, bulbul, bees eater, dove, king fisher, etc are some of the wild creatures are found in the forest.

a) Study Area

We have studied the impact of two opencast coal mining projects namely Jagannath OCMP and Bharatpur OCMP at Talcher coalfield in the Angul district of Odisha. These two projects are located within a distance of 20 km from Talcher railway station. In the former project area average rain fall is 1410.66 mm per year, and in later project area, it is 1483.66 mm per year. In summer, comparison to other regions of the state temperature is saturated in these areas. As it is about 49 to 50 degree celcious temperature usually recorded during summer days in these areas (MCL Archives, 2007). A total of 1330.710 acres of lands in Bharatpur coal area during 1979 and 1984, and a total of 3648.587 acres of lands in Jagannath coal area during 1960, 1984 and 1990 were acquired by coal mines (Land Acquisition Office, Angul, 2007). Under these two projects total 2173 persons were sponsored for employment till 2007. But about 23 per cent and 33 per cent of them were not given jobs in Jagannath area and Bharatpur area respectively till 2007 (ibid).

b) Research Objectives

Our main objective is to analyze how the coal mining caused environmental crisis has become the crisis of displaced people at present. To understand the issues related to coal mining induced loss of access to common property resources(CPRs), to assess displaced people's energy consumption pattern in the context of environmental crisis, to analyze the people's response to, and their existential dualism/ dilemma on, the issue of pollutions, land degradation and deforestation during post-displacement situation and to view the emerging trends of weak human-environmental relationship in the coal mining belt are included as other objectives

c) Methods of Data Collection

Both primary and secondary data has been used in this study. Interview schedule, focus group discussion and observation methods have been used for the collection of primary data, and books, journal, reports, archive, internets, news papers, etc have been referred for our secondary data in this study. The descriptive research design, random sampling design and simple statistical method have been used in this paper.

d) Sample Households

We had surveyed 109 sample households covering seven villages affected by two opencast coal mining projects at Talcher coalfield during 2007-08. Out of these seven villages four villages namely Balanda-411, Purunia-7, Nakhetrapur-80 and Chandpur-64 were fully affected by Jagannath OCMP, and three villages namely Anantabereni-250, Baideswar-50 and Lachhmanpur-49 were affected by Bharatpur OCMP (Land Acquisition Office, Angul, 2007; MCL Archives, 2007). After displacement the project affected families were dispersed by the coal mining projects into different locations in and around Talcher coalfield. So far, only 50 per cent of the total 911 households affected by these two projects have been resettled at MCL made resettlement sites (MCL Archives, 2007:19:4). Due to non-availability of all 911 project affected families (PAFs) at one place, only 12 per cent of them were selected as sample households by utilizing simple random sampling method in this study.

Table 1 : Sample Households

SL.No.	Opencast Coal Mining Projects	No. of Sample Villages	Total Households (as on 1.04.2007)	Sample Households (12 %)
1	Jagannath OCMP	4	562	67
2	Bharatpur OCMP	3	349	42
Total		7	911	109

Source : Land Acquisition Office, Angul, Odisha

e) Socio-Demographic Profile

All of the sample households belong to Hindu religion. Majority of them are backward caste category people (60.55%) belonging to Chasa, Gauda, Guria, Teli, etc followed by scheduled castes (36.70%) mostly belonging to Dhaba, Pana, Khajuria, etc and general caste category (2.75%) mostly belonging to Brahmin and Karana castes till our field study 2007-08. All of them are highly affected families as they have lost their agricultural lands, dwelling structures, village environments, village ecosystems, etc due to coal mining activities for last several decades.

Table 2 : Social Composition of Surveyed Households

Sl. No.	Caste	Surveyed Households
1	OBC	66(60.55)
2	SC	40(36.70)
3	General	3(2.75)
Total		109(100.00)

NB: Figures in Parenthesis denote percentage.
Source : Household Survey 2007-08.

Except some fortunate employed people who are living in MCL quarter with all civic amenities all other non-employed land oustees (displaced people) are now feeling deprived and powerless surviving in project made resettlement sites (Handidhua resettlement colony, Central temporary colony and Kuiojungle resettlement colony) and self-settled clusters (Pabitrapur cluster and Rodhasar cluster). The displcees prior to their displacement, used to practice their sustainable agro-economy, allied activities and hereditary occupations for their livelihood in their old villages. Now their sustainable sources of livelihoods have been destroyed by the coal mining operations. However, they have improved their annual incomes, and have changed their life style over the years (Garada, 2013). Our study reveals that the post-displaced socio-economic status of sample households has changed their demographic profile at present. The marital status, number of widow/ widower, number of old age people above 60 years and literacy rate of sample households have been increased at present as compared to that of their pre-displaced periods (seeTable-3). But the number of un-married oustees and of young population (0-18) and average family size of sample households now have been decreased as compared to that of their pre-displaced periods.

Table 3 : Demographic Profile

SL.No.	Demographic Particulars	Pre	Post
1	Population		
1.1	Male	606(51.31)	499(50.56)
1.2	Female	575(48.69)	488(49.44)
Total		1181(100.00)	987(100.00)
2	Age structure		
2.1	Young (0-18)	423 (35.82)	254(25.73)
2.2	Adult (18-60)	623(52.75)	532(53.90)
2.3	Old Age (60+)	135(11.43)	201(20.36)
Total		1181(100.00)	987(100.00)
3	Marital Status	Pre	Post
3.1	Married	637(53.94)	565(57.24)

3.2	Un-Married	502(42.51)	371(37.59)
3.3	Widow/ Widower	42(3.55)	51(5.17)
Total		1181(100.00)	987(100.00)
4	Literacy		
4.1	Illiterate	258 (25.47)	140 (15.70)
4.2	Literate	755(74.53)	752(84.30)
Total		1013(100.0)	892(100.00)
5	Average Family size	10.83	9.05
6	Sex ratio	948.84	977.95

NB: Figures in Parenthesis denote percentage.
Source : Household Survey 2007-08.

Our study reveals that increased money income, cash based compensation, marital status as eligibility criteria for rehabilitation and resettlement package, etc are some of the important factors responsible for changing the marital status of sample households from 53.94 per cent in pre-displaced period to 57.24 per cent in post-displaced period. In our focus group discussion however, some senior oustees acknowledge the impact of mining caused urbanization, and of establishment of numerous schools in and around Talcher coal belt for their increased literacy rate at present. But most of them explain that this is not a new thing. As they argued that Talcher coal belt was among the high literacy regions of Odisha even before their displacement period. This change explains the reason for a marginal improvement found in the sex ratio of the sample households in post-displaced periods (seeTable3). It is also be true that as a result of dowry demand, many unmarried daughters are residing in their parental households at present.

III. Finding on Loss of Access to Common Property Resources

a) Status of Access to Common Property Resources

Our study reveals that almost all sample oustee families used to access all type of common amenities and common property resources as mentioned in the Table 4 before their displacement. Now, very less numbers of them ranging from 10 to 28 per cent access the resources that include village trees, community forest, government forest, grazing grounds, threshing grounds, village sitting spaces, play grounds, rivers, springs, water streams, ponds, tube wells, and cremation grounds.

Table 4 : Status of Access to Common Property Resources

Sl.No.	Common Property Resources	Yes (Pre)	Yes(Post)
1	Village trees/ Community forest	109(100.00)	10(9.17)
2	Government Forest	109(100.00)	25(22.94)
3	Grazing ground	109(100.00)	29(26.61)
4	Threshing grounds	109(100.00)	15(13.76)
5	Defecation grounds	109(100.00)	70(64.22)
6	Village sitting space	109(100.00)	25(22.94)
7	Play grounds	90(82.57)	20(18.35)
8	River	109(100.00)	12(11.01)
9	Springs/ Water Stream	109(100.00)	25(22.94)
10	Common Well	60(55.05)	80(73.39)
11	Pond	109(100.00)	10(9.17)
12	Tube Well	000(0.00)	30(27.52)
13	Festive Locations	109(100.00)	70(64.22)
14	Cremation ground	109(100.00)	20(18.35)
15	Community centers	109(100.00)	80(73.39)
16	Temple/deity space/ holy grooves	109(100.00)	109(100.00)

NB: Figures in Parenthesis denote percentage.
Source : Household Survey, 2007-08.

On the other hand, though many of the sample households ranging from 64 per cent to 73 per cent or more access the community resources i.e. defecation grounds, common wells, community centers, festive locations, temple/deity structures and sacred spaces at present, they have almost lost the earlier strategy/service of their collective stake and management over such CPRs. Our study also reveals that comparison to their old villages the project affected sample households did not have more community amenities at present locations. The PAFs desperately miss their earlier large size, and more number of cremation grounds, ponds and festive locations at their present resettlement sites. It seems that their dependency on common property resources is declining fast over the years. It is further, found that increasing deforestation and money incomes have changed the PAFs' fuel consumption pattern at present.

b) Energy Consumption Pattern of Displaced Households

In pre-displaced year 76 per cent and 21 per cent of the households used woods and coal respectively. as their main cooking fuels in their houses. But, at present, it is 12 per cent and 39 per cent respectively. Use of coal as cooking energy has been increased. Most importantly, use of Liquefied petroleum gas (LPG) for cooking purpose is about 30 per cent at present.

Table 5 : Energy Consumption Pattern of Pre and Post-Displaced Households

Sl.No.	Type of Fuel used	Pre	Post
1	Gas	0(0.00)	33(30.28)
2	Coal	23(21.10)	42(38.53)
3	Kerosene	0 (0.00)	6 (5.50)
4	Wood	83(76.15)	13(11.93)
5	Cow-dung	1 (0.92)	0 (0.00)
6	Others	2 (1.83)	15(13.76)
Total		109(100.00)	109(100.00)

NB: Figures in Parenthesis denote percentage.
Source : Household Survey 2007-08.

Thus, the PAFs after passing through decades of their indifference to mining caused deforestation, did not like to depend on the forest for the consumption of fuel hoods at their kitchen. The PAFs also express that since their kitchen no more rely on forests and forest products they are moving toward urban market for all type of consumptions at present. Our study also reveals that resettled PAFs more often fall in conflict with the local people sharing the forest resources in and around the resettlement sites. In this respect, the PAFs have not only lost their earlier access to CPRs, but also have undergone the adverse effects of coal mining caused environmental crisis over the years. How can they come out from the ongoing environmental crisis is a serious question at present?

IV. Finding on Dynamics of Coal Mining Caused Environmental Crisis and the Displaced People's Response

The question of air pollution, water pollution, noise pollution, land degradation and deforestation has been established in Talcher coal belt as many studies, reports, and government institutions reveal this fact (Reza and Singh, 2010, Garada, 2009, Pandey 1998, http://angul.nic.in/index.htm). Because of the fact, the central pollution control board (CPCB) in 2010 declared Talcher Angul belt as one of the 23 most polluted industrial complexes of the country. Now, it is observable that the whole atmosphere of Talcher coal belt seems to be fed with toxic coal dust, toxic coal smoke and toxic coal waste every moment. Further, it seems that the environmental crisis is, as if, retreating and revenging the local people in unexpected ways.

a) Menacing of Excruciating Heat of Summer Times and Displaced Peoples' Response

Talcher is increasingly found to be one of the hottest spots in the entire country. Recently on 24th May 2013 12:23 PM Talcher coalfield was recorded highest temperature (47.2 degree celcious) in the state (The New Indian Express, 2013). During field study 2007-08 we observed extremely hot days in Talcher coalfield. The people of Talcher coal fields quite painfully apprehend the menace of excruciating heat of summer every year. The scorching sun and its heat wave just before midday (from 10.30 AM onward till 3.30 PM) to the end of afternoon are unbearable. It is very difficult for the local people spend their summer time as they daren't turn out to carry on their everyday business bareheaded under scorching sun nor do they take as usual rest at home due to humidity, sweating and frequent power cut. The entire Talcher town, government offices and public market remain inactive during summer days. Even, then there was no pollution watch board for the information and public scrutiny of everyday pollution in the locality. However, the MCL authority claims that they supply the

water sprinklers to cool the atmosphere on the roadside whereas the government people claim that they encourage for water depot and sunstroke treatment in an emergency basis. The district government authority also argues that the Talcher is not exception to the global climate change, and thus soaring temperature anywhere is a global phenomenon. The people argue that they are also not less responsible for this, since they have allowed industrial houses to pollute and destroy their environment and ecosystem. But about 90 per cent of the sample households do not complain against the concerned government authority for such problems. Many of them are quite indifferent to the increasing temperatures and instead, busy using electric fans as if, they do not have any role to play. It seems that though, they are helpless but simple accept what government will do for them at this moment.

b) Water Pollution and Displaced Peoples' Response

The coal dusts, waste waters from domestic sources, industrial workshops, coal stockpiles and mine flow, mine discharge water, etc pollute the water sources at Talcher coalfield. Suspended coal powder, fly of coal ash, solids of coal, clay and oil are the important pollutants. As a result, local river Brahmani with its tributaries-Tikira, Singrajhor and Nandira has been highly polluted. Now, it has become the most contaminated river of the state. In our focus group discussion senior displaced people argue that the people who use the polluted water from this river are suffering from skin diseases, tuberculosis, cancer, etc at present. Their domestic animals also suffer from different diseases, and even die after using polluted water. They are compelled to drink filter water or tank water, and no more feel safe to use water from open sources for their domestic needs. But, so far, surprisingly, no effective remedial pollution control measures have been taken up by the government authority to free the water sources from the industrial pollutants. The available few dug wells and tube wells are also polluted and remain dysfunctional throughout the year. Our study reveals that the displaced households hardly complain formally to the concerned authorities for making functional of their water points, thinking it is the government authority's work to look after. For instance, about 61 per cent of sample households express that they have never taken any steps to repair the dysfunctional wells, and hardly know how mining operations destroy the water level of the locality. Even, many of them do not want to know it except how they will they get tank water facility at present.

c) Land Degradation and Displaced People's Response

Mining caused land degradation and landlessness have reduced the peasants into the project affected families. The project affected families are also not very keen to revive their land–based living. At present situation the open cast mining project OCMP severely degrades the land with no hope of land reclamation (Garada, 2009). Loss of vegetation due to mining, siltation around the mining dumps pits/ excavation, waste dumps, soil erosion, etc are main causes of land degradation. But the MCL authority did not have any visible strategy for land reclamation and afforestation programme. For instance, out of total 1859.31 hec mine used lands only 44 per cent has been reclaimed, and 57 per cent has been backfilled. In my studied mine in Bharatpur OCMP, out of total 341.18 hec of mine used lands together, only 25 per cent has been reclaimed, and nearly about 13 per cent has been backfilled till 1/4/2006 (MCL Archives, 2007:17.18). In case of Jagannath OCMP out of total 363.16 hec of mine used lands only 51 per cent has been reclaimed, and 48 per cent has been backfilled (ibid). The PAFs argue that the reclaimed lands should have been utilized for development of agriculture, forestry, wildlife habitation and the activities of recreation in the locality. However, our study reveals the land oustees' dualism and dilemma on the question of reviving the agro-economy at present. As for instance, many oustees argue that they do not have lands for cultivation, other argue that they have lands but that cannot not be cultivable at present without adequate reclamation and irrigation, and still other argue, even if, agricultural land is available somewhere, they feel it will not generate good livelihood option for them at present. It is also fact that land degradation is very high in the mining areas, but not so in the peripheries where the land oustees have been resettled.

For instance, the resettlers in Pabitrapur self-settled cluster have barren/inferior lands but not degraded lands. In Handidhua resettlement colony and central colony the land oustees do not have any landed properties. The PAFs in Kuiojungle resettlement site do not want to develop their forest lands for agricultural purpose. In the Pabitrapur self settled cluster each land oustees, though do have lands and also have access to forest area they neither cultivate the land nor do depend on forest resources for their livelihoods. Our study reveals that hardly anybody is interested in agricultural activities, and almost everybody is attracted toward non-farm employments at present. Unfortunately, 87 per cent of sample households express that the first generation oustees though wish to continue agricultural activities, but cannot carry on it due to their old age. The second generation oustees cannot do it because agriculture does not fetch them good income or somehow or other they are engaged in industrial and non-farm employments at present. They also wish their present generation to aspire and achieve industrial and other non-farm employments in the future. Thus, the land based-living have been highly affected by the mining industries, and affected people want to pursue their

non-farm based living at present. Thus, it seems that PAFs are compelled or wish to good bye to their agricultural mode of production at this juncture.

d) Deforestation and Displaced People's Response

The ongoing deforestation in Talcher area poses great threat to the human-environmental relationship at present. The deforestation is not simply the decisive indicator, but also disastrous factor of environmental crisis everywhere. The truth of mining caused deforestation is open secret in Talcher area. Our review of literatures related to deforestation at Talcher coal belt reveals that as if, there is no forest areas left to be acquired for the future expansion of the mining activities (The Times of India, 2013; Choudhury, 2011-12). Acknowledging the facts of deforestation even the MCL authority has mentioned such information in its MCL Archives, 2007. According to MCL Archives total 8357.878 acres of forest land were applied, and total 2151.138 acres of forest land were physically possessed by coal mines for mining operation till 2007 in both Talcher and Ib valley areas of Odisha (MCL Archives, 2007:6.36). When we had our field study during 2007-08 we relied on the government report for our analysis. According to a "state of environment report, Orissa, 2006" provided by Orissa state pollution control board (OSPCB), out of total 1822.086 hac of forest land including reserve forest in the Talcher-Angul coal belt about 27per cent was lost, and 38 per cent was supposed to be lost due to mining activities. It is found from the Table-6 that as much as 106.16 hac of forest lands were completely lost till 2006 due to our studied Jagannath opencast mining project. Similarly, out of 198.171 hac of forest land available before displacement in Bharatpur study area about 33 per cent has already been lost and rest 67 per cent was likely to be lost in the area.

Table 6 : Loss of Forest Area (hac) due to Coal Mines at Talcher Coalfield

Sl. No.	Opencast Coal mines	Total forest land including reserve forest	Total forest land lost for mining activities	Total forest area to be lost for mining
1	Balanda	1045.75	245.0(23.42%)	315.0(30.12%)
2	Lingaraj	240.804	6.71(2.78%)	109.687(45.55%)
3	Bharatpur	198.171	65.01(32.80%)	133.161(67.19%)
4	Ananta	146	74.0(50.68%)	82.0(56.16%)
5	Jagannath	106.16	106.16(100%)	-
6	Kalinga	85.201	-	60.523(71.03%)
Total		1822.086	496.68(27.26%)	700.371(38.43%)

(Figures in brackets give percentage estimates of total forest land)

Source : State of Environment Report, Orissa, 2006 published by Orissa State Pollution Control Board, Govt. of Orissa.

The affected people are quite highly dialectical on the entire afforestation strategy of mining projects in Talcher coalfield. According to a MCL report till April 2006 only 1349561 plants were planted of which my studied projects had 39.18 per cent only (27.31 % in Jagannath area and 11.87 % in Bharatpur area) (MCL Archives, 2007:17.18). MCL authority claims that the total compensatory afforestation cost paid by the MCL in both Talcher and Ib valley area of Odisha was 98.42 lakh, of which some 16.77 lakh was only in my study area (Jagannath OCP) (ibid: 18.4). This is what the land oustees repeats an Oriya proverb saying "Sumdra ku Sankhe pani" (need is sea however, provided is merely a conch of water). This is what they feel that they can no more revive their earlier green belt in Talcher area. The PAPs also argued that the trees having food value, timber value and medicinal value should have been planted in and around the affected villages for a better regeneration of human relation with nature. However, the MCL and government authorities have deliberatively enforced the compensatory afforestation programme without seeking PAPs' wish and participation like giving compensation whereas there's no participatory rehabilitation. They complain that the government and MCL authorities have significantly failed to do any things in this regard. It is widely speculated in the area that the MCL authority deliberately showed a standing of healthy forestland over actually mining degraded forestland in the official record, so as to keep away from controversy. Further, due to massive deforestation in Talcher locality some wild animal like elephants come close to the village sites, and raid crops and disrupt human habitations and domestic animals there (http://angul.nic.in/forest.htm # district environment). Other wild animals like tiger, leopard, bison, sambar, barking deer, spotted deer, wild boar, sloth beer, pangolin, civet cat, porcupine, mongoose and snakes like python, cobra, etc are not seen nearby the villages thanks to huge deforestation in Talcher vicinity. The floras like piasal (pterocarpus trijuga), sisso (dalbergia),

gambhari (gmelina), kurum (Adina cordifolia) and specially aonla (phyllonthus emblica), mahua (bassia latifolia), kendu (diospvros) are reducing fast while sal (shorea robusta) and other shrubs are increasing in proportion (Garada, 2012, http:// angul.nic.in/ forest.htm # district environment). The affected people argue that their forest resources like timber, fodder, fuel-wood, bamboo, kendu leaf, medicinal herbs (ayurvedic) amla, char, etc have been destroyed by the mining operations, and other are on the verse of their destruction. And despite this, the resources that are not however, being destroyed are restricted by the forest department for people's access at present. As a result, the plight of leaf pluckers, seeds collectors and fruits gatherers has been aggravated at present.

V. Issue of Deforestation and Reforestation

While some senior land oustees remind themselves of the lost crunchy and green leaves they used to see in and around their villages, other oustees lament of some useable produces like leaves, seeds, fruits, nuts, oil, etc, that the lost trees were being endued with at their old villages. Still other argues, since they stay in the rural areas, it is hard to live without forest and its leafage that tidy their air and stabilize their ecosystem. But hard reality is that hardly anybody is serious about the reforestation of Talcher locality. It is clear from the Table7 that about 90.82 per cent of total sample households blame mining and industrial projects for deforestation, and 44.95 per cent and 45.87 per cent of them wishes government and mining/industrial authorities should take care of the activities of reforestation respectively. While only 9.17 per cent of the households blame themselves for deforestation, only 4.59 per cent of them feel that they are responsible for the reforestation.

Table 7 : Response on the Issues of Deforestation and Reforestation

Sl.No.	Who is responsible	Deforestation	Reforestation
1	Government	49 (44.95)	15(13.76)
2	Mining and Industry	50(45.87)	89(81.65)
3	People (themselves)	10(9.17)	5(4.59)
Total		109(100.00)	109(100.00)

NB: Figures in Parenthesis denote percentage.
Source : Household Survey 2007-08.

We also find that the people living in cluster, colonies and MCL quarters, and gender and age specific groups, have different opinions regarding the questions of who is responsible for deforestation and reforestation in Talcher coal belt. But hardly anybody strongly think that they are not less responsible for both deforestation and reforestation of Talcher coal belt at present.

Table 8 : Question of Depending on Forest

Sl. No.	Question of Depending on Forests	Livelihoods	Fodder/Fuel woods/timber	Minor Forest Produce	Not Depending on Forest	Total
1	Status of Dependency	1(0.92)	50(45.87)	10(9.17)	48(44.04)	109(100.00)
2	Younger Generation's future Dependency	0(0.00)	30(27.52)	0(0.00)	79(72.48)	109(100.00)

NB: Figures in Parenthesis denote percentage.
Source : Household Survey 2007-08.

Further, we can observe from the Table -8 that only 1 per cent of the sample households still depend on forest for their livelihood, and nobody want their younger generation to depend on the forest for the same. It is also observed that though 27.52 per cent of them wish their younger generation to depend on forest for fodder/fuel woods/timber, etc but as much as 72.48 per cent of them do not want their younger generation to depend on forest in future. In fact, it is quite observable that still land oustees exploit forests for their household need of fodder/fuel/woods/timber, and for their agricultural and allied activities. Now, PAFs are enmeshed into their existential dualism and dilemma since they neither able to sustain their environmental

ethics to protect their forests because they still bargain compensation on forest land acquisition on coal mining expansion nor do they ignore it because, still they need forest based-living at present.

VI. Conclusion

It is a naked truth that pollutions and pollution effects are now inevitable phenomenon since pollution sources have already been set in and around the Talcher coal belt over the years. The question of water pollution, air pollution, noise pollution, land degradation and deforestation have been redundant now, and instead of, it is increasingly facilitating toward a culture of pollution to which somehow or other affected people figure out how to fine-tune with it living in and around Talcher coal mining industries. But pollution impact has gone to such an extent that the very environment is as if, retreating and revenging the mining affected people in unexpected ways. Many of them now, quite painfully apprehend the menace of excruciating heat of summer every year. It is very difficult for the local people spend their summer time as they daren't turn out to do their everyday work under scorching sun nor do they take as usual rest at home due to humidity, sweating and frequent power cut. But dilemma is that many of them are indifferent to the increasing temperatures, and in lieu, busy using electric fans, as in such situation they think that they are helpless, and do not have any role to play. Now local mining affected/displaced people greatly miss earlier fresh water sources for the purpose of their drinking, bathing and domestic uses. But they hardly take any collective initiative to repair the dysfunctional water points, and do not want to know how mining operations destroy the water level of the locality. As a result, they suffer from malaria and different skin diseases after drinking polluted waters of open sources. Many of them also perceive that in addition to pollution impact, now the cause of their frequent illness perhaps not consuming pollution free green leaves, vegetables and different such food items which they used to obtain from their kitchen gardens and agricultural fields before displacement. Now, the mining caused land acquisition and land degradation have reduced the land oustees into the project affected families (PAFs). But unfortunately, they are also not very keen to revive their agricultural activities. Now many of them argue that they do not have lands for cultivation, other argue that they have lands but that cannot not be cultivable at present without adequate reclamation and irrigation, and still other argue, even if, agricultural land is available somewhere, they feel it will not generate good livelihood option for them at present. It is also fact that land degradation is very high in the mining areas, but not so in the peripheries where the land oustees have been resettled. However, some senior PAPs suggest that they should be given back the reclaimed mine used land and backfilled lands for their cultivation in the peripheries. But, it seems that the MCL authority did not have any visible strategy for such constructive progarammes. The entire deforestation and compensatory afforestation strategy of MCL and government are highly criticized by the local people. Every mining affected people argue that since they stay in the rural areas it is hard to live without forest, and its leafage that tidy their air and stabilize their ecosystem. All seniors land oustees feel that their loss of access to common property resources cannot be compensated by any means of rehabilitation and resettlement programme. But, hard reality is that nobody is damn serious about the reforestation activities in Talcher locality, and none of them strongly think that they are not less responsible than any mining project for the ongoing environmental crisis and their suffering at present context.

In order to reverse back the normalcy of ecosystem at Talcher coalfield some concerned stakeholders plead to cease the entire ongoing mining and industrial activities which is impossible now. It is also impossible to regain displaced people's access to their earlier common property resources. But, when coal resources will be exhausted and coal mining will be closed down, there will be no options for them but to regenerate the entire affected environment and ecology. At this juncture, the displaced people in particular and local people in general are not only dialectical on the queries of development versus environment, but also equally suffering from their crisis of existential dualism/dilemma. Our review of literature reveals that development and environment cannot go hand in hand. Unfortunately, thus, the question of whether environmental catastrophe be tolerated for economic development or human development be adjusted with environmental protection cannot be resolved. Therefore, the ecological question of why humans destroy the environment/ecosystem, of which they are active parts, is justified to some extent.

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Struggle for Hegemony and the Economics of Nuclear Proliferation in a Non-Proliferation Regime: The Case of Iran Nuclear Programme

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Abstract - This paper studies the nuclear proliferation in a non-proliferation regime using Iranian nuclear stand-off as case illustration. It seeks to find out the core reasons why nuclear proliferation has been possible under international prohibition. It seeks also to find out the reason why Iran has successfully defied international sanctions and isolation against its nuclear programme. With the aid of documentary method of data gathering and rational actors model as framework od=f analysis, this paper observed that struggle for hegemony among the super powers, pursuit of international trade in nuclear materials and technology, skewed provisions in the principles of NPT, nuclear states refusal to disarmament are the major factors responsible for nuclear proliferation under NPT regime. The paper also observed the same factors together with Iran's strategic location and natural resources endowments are responsible for Iran's successful defiance of international sanctions against its nuclear programme. It is therefore recommended that all nuclear states should unconditionally dismantle their nuclear weapons and facilities under unrestricted supervision of the five permanent members of UNSC. The principles of NPT should be reviewed and fundamentally restructured.

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I. Introduction

The origin of Nuclear Non-Proliferation [NPT] is traceable to August 1945 Hiroshima and Nagasaki nuclear bombs experiences in Japan, which the United States [US] detonated over those cities during World War 11. The bomb's manifest capability to engulfed its targets with unprecedented destructive power conferred on its possessor with military deterrent capability, claim to superiority and enhanced influence in the international system (see Mandelbaum,1981). Consequently, the US, in the Baruch Plan, proposed the internationalization of the control of nuclear fuel cycle used in manufacturing the bomb in 1946. It is my contention that this proposal was a US strategy to consolidate its military dominance and also to save mankind from this scourge death. Consequently, due to international struggle for hegemony and the economic benefits that are associated with nuclear technology, the then Soviet Union vetoed it out and assiduously pursued its own operational nuclear weaponry that was successfully tested in 1949 [Holloway, 1994]. This was followed by United Kingdom (1952), France (1960) and China (1964).

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This development led to the modernization of nuclear warheads and invention of more sophisticated weaponry by the two super powers that represent the rivalry communist and capitalist blocks. However, the superpowers developed common interest preserving only the existing five nuclear states and preventing new ones from emerging [Lavoy, 2004]. Consequently, a joint US-Soviet draft Non-Proliferation Treaty [NPT] was submitted to the United Nations in 1967, which was adopted as a legal and normative foundation for existing initiatives to promote non-proliferation with minor modifications. Since 1968 when the treaty was opened for signature, over 190 countries gave their accent to NPT while the International Atomic Energy Agency (IAEA) emerged as institutional monitoring agent to safeguard the treaty [Barnaby, 1969:34-36].

Nevertheless, Israel, North Korea, India and Pakistan defied the UNSC and the IAEA, and developed nuclear bombs while countries like South Africa, Japan, Syria, etc have potential nuclear technology. Iran is seriously pursuing its 'civil' nuclear programme. Multiple international pressures and sanctions have being mounted on Iran to abort its nuclear programme but in vein. The US and Israel have equally threatened to carry out pre-emptive strikes on Iranian nuclear sites but to no avail thereby making its nuclear programme a centre of cynosure in Middle East security [Jafarzadeh, 2007]. Iran argues that it has a right under international law to develop civil nuclear programme for peaceful generation of electricity. On the contrary, the United States, Israel, and the European countries view Iran's nuclear capabilities as a threat to world peace and strongly oppose Iran's nuclear-development program [Bahgat, 2006]. They have applied many options such as regime change, isolation, and imposition of international sanctions to deter Iran but to no avail.

It is noted that all the international outcry and sanctions against Iran have been dominated by Western countries' voices and actions and complemented by some Middle East western allies that fear Iran's regional monopoly and dominance. As sanctions and regime change have successfully played an increasing role as foreign policy instruments of the United States and the Western Capitalist block against perceived antagonistic third world regimes, why has Iran successfully defied these instruments? Secondly, did Iran really breach the

Non-Proliferation Treaty [NPT]? This paper seeks to provide answers to these and other ancillary questions. By exploring answers to these questions, this paper provides the framework for UNSC reconsideration of its policy and sanctions against Iran for its nuclear programme, and its approach to NPT. It provides viable alternatives for solving the problems hindering the implementation of NPT with a view to safeguard international security and peace.

Consequently, the paper covers the evolution and dynamics of international Nuclear Non-Proliferation Treaty [NPT], the evolution and dynamics of Iran's nuclear programme, international response to the programme and Iranian defence. Specifically, the periodic scope of this research is 1975 – 2013. This research investigates the particular principles of NPT violated by Iran, the connection between Middle East politics and its nuclear programme, Super Powers involvement in the programmes, their reasons thereof and the implications of their actions for the current recorded successes by Iran.

II. Materials and Methods

Considering the wealth of literature available as empirical studies, debates and criticism on NPT, Iran nuclear programme, US policy to the Arab World and Middle East, international security and struggle for hegemony, this paper adopts the secondary method of data collection. The method uses archival documents wherein published materials such as books, journals, conference/seminal and workshop papers, magazines and newspapers, government and NGO publications are preserved as sources of data. In addition, such works that are electronically available in the internet are used. The method here is to digest their contents and sift their findings as data.

Consequently, content analysis is adopted as method of analysis wherein sifted data are checked for consistency of the opinions of either the authors and/or the actors; and evaluated with other existing findings on the subject. These data shall equally be examined in the light of other thesis and findings on the subject matter. Through these methods, the paper forms opinions on the data generated during the research and their consequences for resolving the Iranian nuclear crisis and the problems confronting the implementation of NPT.

However, the conclusions reached paper are limited to findings, views and reports that are available in published works used because there is no other source of finding out what happened between 1975 and 2013 between many countries involved in NPT and Iran nuclear programme. It is also limited to the issues raised in the research questions contained in this research. Finally, the discussions and inferences reached in the paper is limited to the researcher's ability to secure and analyse information, particularly on such public issues like nuclear politics, non-proliferation, Western-Arab states relations and Middle East politics.

III. Gap in The Literature

a) Nuclear Proliferation

Discussing proliferation from the point of view of cross boarder transfer of nuclear materials and weapons, available literature reveals five categories of reasons why countries pursue nuclear programme as Security, Prestige, Domestic Politics, Technology, and Economics (Cirincione, 2007:49). See for instance security threats such as the presence (or absence) of a security threat and a security guarantee from a powerful alliance partner (Rublee, 2009; Kapur, 2001; Potter, 1982; Sagan, 2000); levels of economic development (Singh and Way, 2004, Jo and Gartzke, 2007); availability of sensitive nuclear assistance (Kroenig, 2009b; Fuhrmann, 2010); economic development strategies (Solingen, 2007); prevalence of proliferation regime (Montgomery 2005); national pride and "myth makers" (Lavoy, 1993); acquisition of latent capacity capability (Hymans, 2012; Meyer, 1984; Schroeer, 1984); Democracy/liberalizing governments, and status motivations where democratic governments may pursue nuclear programme in other to boost their popularity and retain power like in India and Pakistan (Chafetz, 1993; Perkovich. 1999; Mansfield and Snyder, 1995; Snyder, 2000); and the psychology of individual leaders (Hymans, 2006) among others.

Many other scholars identified factors that discourage countries from pursuing nuclear programme. These include an alliance with a powerful ally (Davis, 1993; Thayer; 1995); bipolarity where states cue up behind two well-structured alliance systems anchored by the two dominant powers (Bennett and Stam, 2000; Gibler and Sarkees, 2002; Frankel, 1993; Betts, 1993]; economic integration and interdependence (Paul, 2000). Contrary to the argument of some scholars that alliance deters nuclear proliferation, some other scholars argue that international alliance is needed to solve the problems of scarcity of all sorts of resources [money, political authority and consensus, laboratory quality reagents, access to imports, and so on] needed to establish a successful nuclear programme [Bailey,1991:50-81]. These allies not only add specific capabilities needed to manufacture end-products such as nuclear weapons and ballistic missiles; they also sustain and support the growth of the whole system. By so doing, the technology spreads beyond the acquiring state [Hughes, 1987; Bijker and Law, 1992]. On their part, Lavoy (1993), Elworthy (1986), and Sagan (2000) argue that the degree of autonomy exercised by domestic elite in taking policy decisions is a strong force that determine whether a state pursue nuclear arms or not.

Nevertheless, the literature identified six methods through which the international community has tried to prohibit the spread of nuclear technology. These are; deterrent strategies, which involve the use of sanctions, threats, coercion, etc (Hawkins,1984; Downs, Rocke, and Barsoom, 1996; Hufbauer, Schott, and Elliott, 1990); remunerative strategies, which include rewarding actors that are engaged in nuclear proliferation for withdrawing from the act or providing incentives aimed at behavioural changes towards abandoning it (Stranlund, 1995; Ayres and Braithwaite, 1992); preventive strategies, which include the use of "premonitory surveillance" to detect nuclear acts before they occur; generative strategies, which seeks to generate or create new opportunities from the choices available to potential proliferants to avoid proliferation (Connolly and List, 1996); cognitive strategies, which seek to provide potential proliferants with new, more complete, and more accurate information that can solve the proliferant's concerns, and enable a decision on causal relationship between behaviours and consequences; the costs and benefits of different behaviours; and the likely behaviour of other actors [Martin, 1992]; and the normative strategies that seek to change proliferant's behaviour by altering its deep-seated values (Wapner, 1995).

b) UNSC and Nuclear Non-Proliferation

The UNSC on an effort to forestall the spread of nuclear technology and materials drew the Nuclear Non-Proliferation Treaty [NPT], which is the most widely signed international treaties in history. The treaty recorded remarkable success. For instance, in 1993 South African deactivated its nuclear program and the six warheads it had produced [GlobalSecurity.org, 2005] due to international pressure and U.N.'s economic sanctions. Thus, sanction was a powerful international instrument that forced South Africa to disarm, while the IAEA was responsible for both the inspections and reporting the openness that the South Africans displayed in dismantling their nuclear program.

Similarly, Libya voluntarily aborted its pursuit of the production of nuclear and chemical weapons, as well as procuring the ballistic launchers from North Korea to deliver them (Salama, 2004). Some scholars argue that Iraq's dependent on external sources for nuclear experts and nuclear materials, international sanctions and aggressions such as the U.S. invasion of Iraq in March 2003; the October 2003 seizure of a German cargo ship loaded with loaded with uranium enrichment components by the U.S. Navy in the Mediterranean Sea were responsible for Oraq's unilateral decision to abandon the nuclear programme (Leverett, 2004).

Nevertheless, the UNSC greatest failure has been its inability to prevent North Korea's efforts to produce nuclear arms. Currently, North Korea is modifying its nuclear bombs with more sophistication and long range reach under the watching eyes of UNSC and its NPT regime [Sanger, 2009]. This is because World Powers i.e. the United States, France, Germany, Britain, Russia, and China who are forced to play the peacekeepers have different interests with regards to the nuclear stand-off (Norris and Kristensen, 2005; Fackler, 2009; International Crisis Group, 2009). On their part, North Korea has repeatedly claimed that it was developing nuclear arms for self defence and to defy U.S. sanctions and nuclear threats, and will also sell its nuclear weapons or nuclear material in exchange for much needed hard currency.

Similar experiences that explicitly revealed the role of hegemonic interest of the Super Powers in the failure of NPT was the nuclearization of India and Pakistan since the late 1974. Neither of the country signed the NPT, since India claimed it was discriminatory and Pakistan would not sign if India did not sign it first (Nuclear Threat Initiative, 2007). UNSC sanctions against both sides were light and were even lifted shortly after. India tested its first nuclear explosive in 1974, and detonated five series of nuclear test between May 11th 1998 to May 13th of the same year, while Pakistan began to develop its own nuclear program since the 1970s, had its first nuclear test in 1983 with up to six follow-up tests between May 28th and 30th, 1988 [Lodi,1999]. Each has continued to modify and increase their nuclear stockpile [Norris and Kristensen, 2009: 82-84]. The US is keeping mute because it's strategic alliance or partnership with Pakistan.

Iran's nuclear programme has a different experience and response from the UNSC. Chubin [1995] correctly argued that Iran nuclear programme is driven by its view of the world, its concept of its role in international politics, Iranian values and interest, and the lessons derived from recent history. Such include Iran's justified fear of specific security threats in the region and from the Western powers (Cordesman and Hashim, 1997). Iran's security threats can be found in its shared 1,448-kilometer border with the Shatt al-Arab, turbulent Iraq, US dominated and belligerent Afghanistan, Pakistan, India, and especially Israel's possession of nuclear weapons (Takeyh, 2006; Ehteshami, 2009). During the Iran's eight-year war with Iraq, Iraq used chemical weapon against Iranian military and civilians without UN condemnations (Cordesman, 1999:269; Chubin and Green, 1998; Chubin, 1994:70). It is therefore erroneous for scholars like Chubin (1995) to have argued that the nuclear programme is motivated more by political reasons.

Yaphe and Schake [2000]; Amirahmadi [ND:12]; Eisenstadt [1999]; and Cohen [2001] among others, correctly noted that the drivers of Iran's nuclear weapons programme self-reliance, quest for greater voice in the international scene; complementing the

deficiencies in conventional weapons; and to strengthen deterrence and or security threats.

Although scholars like Eisenstadt (2009), DeSutter (1997) have suggested ways of preventing Iran from acquiring nuclear weapons, others are convinced that UNSC and the US cannot stop Iran's nuclear weapon programme (Yaphe and Schake, 2000; Chubin and Green, 1998). Thus, they suggested ways of dealing with a nuclearized Ira. UNSC adopted the options of sanctions, threats and isolation in pursuit of de-nuclearizing Iran. However, the literature reveals contradictions and differences with regards to international response to Iran's nuclear programme. This is because of structure of international politics, emerging powers and prevalent medium power politics in the international arena (Shen, 2006; Kemp, 2006). Consequently, Iran adopted multi-faceted approach to its nuclear crisis that has successfully countered international pressure and actions. Leurs [2008:6] captured it in the following manner;

> The third challenge is that Iran has developed several tactics intended to undercut the current US strategy. It has improved relations with Russia, attempted to use its oil exports to win support from an energy-hungry China, and launched a diplomatic offensive aimed at its Persian Gulf neighbours. Iran has also sought to counter US pressure in the UN Security Council by agreeing to negotiate with the International Atomic Energy Agency (IAEA).

IV. Framework of Analysis

The rational action model/theory is adopted as framework of analysing data generated for this research. The framework enhances an understanding and modelling of rational state or individual socio-economic and political behaviour, domestically and internationally [Blume, 2008]. Rationality as used here simply refers to an individual acts, which appears to be balancing costs against benefits to arrive at action that maximizes personal advantage [Friedman, 1953:22]. In rational choice theory, these costs are only external to the state or individual rather than being internal.

The pioneering protagonists of this theory include a sociologist, George Homans [1961], Blau [1964], Coleman [1973, 1990], and Cook [1977]. Added to these scholars are Elster [1986], Roemer [1988], and Wright [1989], who did not only integrate the theory into the study and explanation of political choices and actions but also argued that it is the basis of a Marxist theory of class and exploitation.

The central principle of this theory is the appreciation of methodological individualism, which believes that complex social phenomena can be explained in terms of the elementary individual actions of which they are composed. This holds that:

> The elementary unit of social life is the individual human action. To explain social institutions and social change is to show how they arise as the result of the action and interaction of individuals (Elster 1989: 13).

Individuals are seen as motivated by the wants or goals that express their 'preferences'. They act within specific, given constraints and on the basis of the information that they have about the conditions under which they are acting. At its simplest, the relationship between preferences and constraints can be seen in the purely technical terms of the relationship of a means to an end. As it is not possible for individuals to achieve all of the various things that they want, they must also make choices in relation to both their goals and the means for attaining these goals.

The theory holds that individuals must anticipate the outcomes of alternative courses of action and calculate that which will be best for them. Thus, such actor rationally chooses the alternative that is likely to give them the greatest satisfaction [Heath, 1976: 3; Carling, 1992: 27; Coleman, 1973]. Therefore the basic assumption of the theory is that the patterns of behaviour in the societies [in this case, international arena] reflect the choices made by individuals or states as they try to maximize their benefits and minimize their costs. It entails choosing a "rational" action given one's preferences, the actions one could take, and expectations about the outcomes of those actions.

Furthering analysis on the assumptions or basic principles of the theory, its protagonists raised five subsidiary assumptions about individuals' preferences for actions and these are: a]. All alternative actions are ranked in an order of preference; b]. All the alternative actions must be compared with each other highlighting their requirements, costs and expected results; c]. The independence of irrelevant alternatives. For instance, if A is preferred to B out of the choice set {A,B}, then introducing a third alternative X, thus expanding the choice set to {A,B,X}, must not make B preferable to A. d]. An assumption that an actor has the full knowledge of the consequences of any choice being made; and e]. An individual has the cognitive ability and time to weigh every choice against every other choice.

Although, this theory like most theories in social sciences, humanities and arts suffers some weaknesses, we consider it appropriate for the study. We acknowledge such weaknesses or limitations of the theory like: the theory ignored the role of uncertainty, assumes complete knowledge of contending actors, their capacities and possible actions, which is not true. Actor's knowledge of environmental implications and different limitations affecting its rational capacities (time, assumptions, information, and resources) are limited.

The theory's empirical output has also been limited and that is why countries like Iraq were destroyed for possessing weapons of mass destruction and

nuclear technology when none existed. The US, IAEA, and UNSC were unable to accurately predict and stop North Korea, India, Pakistan and Israel's nuclear weapon programme earlier.

However, the relevance of the theory for this research lies in its ability to highlight the place of interests or factors such as security, power, nationalism and politics, and survival etc as drivers of states choice in their pursuit of nuclear programme. Equally, it enables this research to isolate each actor both local and international that is involved in Iran's nuclear stand-off in order to examine its interests and choices in the pursuit of any policy to that effect. Through its exhibition of rational balancing of costs and effects before choices are made, the theory enables the research to examine the rationale and strength of Iran's successful defiance of international pressure and sanctions to date.

Finally, considering the five basic assumptions of the theory, it enables the study to evaluate UNSC actions, resolutions and in-actions with a view to understand if the international community has a detailed knowledge why its sanctions have failed to deter Iran's pursuit of nuclear programme, and the possible consequences of pre-emptive strike either by UNSC, the US and Israel separately and collectively. There-from, viable recommendations shall be offered on how best to implement the NPT with success. Thus, the theory is applicable for this study.

V. Data Collection and Analysis

a) Nuclear Non-Proliferation Treaty [Npt]

United States test first test of nuclear device at Alamogordo, New Mexico in 1945, its subsequent use over Japan during World War 11 and the manifest destructive impact of the device laid the background for Nuclear Non-Proliferation Treaty. The US sponsored the Baruch Plan in 1946 that sought to outlaw nuclear weapons and internationalize the administration and use of nuclear energy. This plan was rebuffed by Soviet Union, who later tested its own nuclear device in 1949 followed by China, France, and the United Kingdom in the 1950s.

In 1961, Ireland sponsored a Resolution that was approved by the United Nations General Assembly that made it mandatory for all countries to enter into an agreement that would ban the further acquisition and transfer of nuclear weapons. In 1965, the United Nations disarmament conference began Geneva and considered a draft nuclear non-proliferation treaty. The conference completed its negotiations in 1968, and on July 1, 1968, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was opened for signature while its implementation began on March 5, 1970. By the early 1980s, 190 Parties including the five permanent members of the UNSC have signed the Treaty. Only three states, namely; India, Israel, and Pakistan refused to sign the Treaty, while only one state (North Korea) has announced its withdrawal from the NPT.

NPT fundamentally demands that nuclear states should not transfer nuclear weapons or other nuclear explosive devices to any recipient or in any way assist, encourage or induce any non-nuclear-weapon state in the manufacture or acquisition of a nuclear weapon. Secondly, non-nuclear-weapon states are prohibited from acquiring or exercising control over nuclear weapons or other nuclear explosive devices and not to seek or receive assistance in the manufacture of such devices. Thirdly, all Parties to the Treaty have a right to develop nuclear energy for peaceful purposes and to benefit from international cooperation in this area; in conformity with their non-proliferation obligations (see Article IV). Finally, the Treaty provided that all Parties should undertake to pursue good-faith negotiations on effective measures relating to cessation of the nuclear arms race, to nuclear disarmament, and to general and complete disarmament under strict and effective international control. However, Article X of the NPT sets forth the right of Parties to withdraw from the Treaty.

These principles are inherently weak, defeatist, and provoke sentimental schisms between the nuclear and non-nuclear states. For instance, the treaty fails to define what a nuclear weapon actually is and the main object of prohibition under the Treaty thereby leading to manifold problems for compliance determination. Secondly, the non-nuclear states conceive the Treaty as a political and legal instrument that symbolizes attempts at perpetual international hegemony by the five permanent members of the United Nations Security Council that need to be resisted (see Parsi, 2012:177). Thirdly, the treaty has greatly undermined itself as it seeks to limit the spread of nuclear weapons while facilitating the spread of nuclear power technology, including those dual-use capabilities that possess inherent relevance to the acquisition of nuclear weapons (see Ford, 2010:241–242). The Super Powers ate not committed to the Treaty. For instance, during the ratification process of NPT, Goldblat [2003] noted that the US Congress declared that,

> ...the US Government made a declaration of interpretation, according to which the Treaty would cease to be valid in time of war. In other words, from the start of hostilities, transfer of nuclear weapons or of control over them, as well as their acquisition by non-nuclear weapon states by other means, would cease to be prohibited.

These generated controversy that made many states to embark on nuclear acquisition programme even before the ratification of NPT. To worsen the situation, the US refused to ratify the Comprehensive Nuclear Test Ban Treaty (CTBT) of 1996. Secondly, Russia and the United States also unambiguously declared their intention to retain nuclear weapons for the indefinite future. Moreover, with the exception of the

United Kingdom and more recently France, the all the Nuclear Weapon States have significant modernization programs underway for their nuclear forces; and the US in particular has been attempting to update its nuclear weapon production complex with new nuclear weapon designs [Walsh, 2006]. Scholars like Dokos [2001] have even argued that US and Russia substantial and bilateral reduction of nuclear arsenals did not occur as a result of NPT commitments, but because of changed geopolitical circumstances and the practical need to retire aging parts of the nuclear arsenals.

Finally, the Treaty generated legitimate grievance of those within the treaty as the nuclear states are not disarming [ElBaradei, 2011:236]. This led to the current trends in massive nuclear technology and material proliferation in spite of the various frameworks established to deter their proliferations. Such frameworks include the establishment of the International Atomic Energy Agency's (IAEA) safeguards system, a network of bilateral and multilateral nuclear cooperation agreements, the system of multilateral export controls, and a series of UN Security Council Resolutions, including Resolution 1887 of 2009. States equally entered into cooperation and alliance system to safeguard the expansion of peaceful civilian nuclear energy.

b) Iran Nuclear Programme In NPT Regime

Scholars have argued differently, as highlighted above, on the actual factor[s] that led to Iran's pursuit of nuclear programme. This section is do not intend to join issues with these scholars but focuses primarily on the sources and development of Iran's nuclear programme, international actions against it, the objectivity or rationality of such actions, and the factors that orchestrated international failure to stop the programme.

US pursuit of hegemonic control of the Persian Gulf led to its Israel, Britain and other European states allied sponsorship of "Operation Ajax" that restored the Shah to power in Iran prior to the 1979 revolution. Thereafter, the US initiated a new era of cooperation with Iran, which involved technical and economic development, military cooperation and support, as well as the development of nuclear technologies for peaceful energy use, which actually began in 1957. The US wanted Iran to become the "Defender of the Gulf" in order to free up American power elsewhere [Cordesman, 1999: 358–365]. The Cooperation, which was initiated by President Eisenhower of America provided for the installation of U.S. equipment in Iran, the supply of technical training to Iranian scientists, and provisions for a supply of fuel to power a series of nuclear reactors. The deal offered Iran the opportunity to acquire a reprocessing facility, thereby providing the Shah with the ability to develop a complete nuclear fuel cycle and a means to produce fuel for nuclear weapons. This encouraged Iran to sign the Nuclear Non-proliferation Treaty in 1968.

Iran acquired its first nuclear reactor in1967 from the United States, which was later transformed to the Aimrabad Nuclear Research Centre in Tehran (now called the Amirabad Technical College) (Jablonski, 1984:56). In 1975, further acquisition of an additional eight nuclear reactors was made. European countries such as Germany and France joined the US and received billions of dollars from Iran for the sale of reactors, fuel, and the training of scientists. In addition, Iran purchased a 10 percent share of a uranium enrichment plant that was built in France as part of a joint French, Belgian, Spanish and Italian consortium [Cordesman, 2000:5].

Politically, this served the interests of the Shah because it enabled the regime to suppress and dominate the citizenry - a scenario that led to the 1979 revolution. Nationalism and a change in leadership edged the US out in the struggle with other world powers for the control of Iran's influence, politics, technology and economy in their pursuit of regional control of Middle East. Consequently, countries like Germany and the United States, whom had once promised to sell more nuclear reactors and establish power plants in Iran, cancelled their business contracts after the downfall of the Shah. On its own part, the new Iranian regime arrested many Iranian nuclear scientists; others were forced into exiled, or killed, leaving the program in shambles. However, the Iran-Iraq War prompted Ayatollah Khomeini to re-activate Iran's nuclear programme.

On its part the US exhibited great effort to slow-down and or completely prohibit the proliferation of nuclear weapons technology to Iran, which it started (Cordesman, 1999:239). For instance, the US frustrated Iran's efforts in 1991 to purchase a 10-megawatt research reactor from India, to purchase enriched fissile material from Khazakstan in 1992, to purchase two 300-megawatt reactors from China between 1992 and 1994; to purchase a $45 million nuclear power plant from Ukraine in 1998, and to purchase a uranium hexafluoride conversion plant from China (Cordesman, 1999:241-243; Eisenstadt, 1999:141). The US government has also continued to block Iran's requests for loans from the International Monetary Fund (IMF) and the World Bank [Yaphe and Schake, 2000:108; Sick, 1998:6]; it has also opposed consistently Iranian candidates for posts in international organizations (Chubin and Green, 1998:160). In addition, America incessantly has mobilized international organizations against Iran in different occasions. In this instance, several international sanctions like that of UNSC, NATO, and EU have being imposed on Iran, yet the results of these actions fall short of expectations. The UNSC passed three sanction resolutions on March 2006 that are pro-US interest in the crisis and three others to re-enforce them, yet Iran developed its uranium enrichment

capability by increasing its centrifuges from 164 to 3000. Walsh [2008:6] tacitly summarised it thus;

> ...in the race between centrifuges and sanctions the centrifuges are wining. The historical record here is sufficiently clear that scenario American and European officials have conceded the point.

Iran remains undaunted and has continued its nuclear programme with success.

Nevertheless, Iran intensified its diplomatic efforts at reaching bilateral agreements leading to external assistance in acquiring nuclear equipments and technical skill. This influenced Iran under President Akbar Hashemi Rafsanjani to approach China, France, Germany, Pakistan, Argentina, Spain, Czechoslovakia, and Russia etc for assistance [Giles, 2000:80] in the quest to nuclearize Iran. By 1984, Ayatollah Khomeini obtained assistance from France and Pakistan to establish a new nuclear research centre in Esfahan (Cordesman, 2000:7-8). The same year, Iranian requested that Germans should return to complete the Bushehr nuclear power plants that they had started building under the Shah but the Germans refused (Eisenstadt, 1999:141). Similarly, in 1987, Argentina agreed to train Iranian scientists in their Jose Balaseiro Nuclear Institute as well as sell Iran $5.5 million worth of uranium (Cordesman, 2000: 7- 8) but later declined due to American pressure [Eisenstadt, 1999:141].

In 1995 Russia signed an $800 million agreement with Iran to complete one of the two reactors in Bushehr and to provide technical training and low-enriched uranium fuel for a period of 10 years beginning in 2001 (Yaphe and Schake, 2000:40). In 1997, Iran equally "..obtained new nuclear technology from Russia" [Cordesman, 1999:241-242] and purchased four tactical nuclear weapons from Russian smugglers for $25 million while Argentinean scientists helped to activate these weapons [Cordesman, 1999:244].

It is pertinent and objectively arguable at this point that the international outcry, pressure and sanctions against Iran are misplaced and unjustifiable. The nuclear states that are under international prohibition by the NPT from transfer nuclear technology were the both the initiators, developers and sponsors of Iran's nuclear programme – its purpose not considered. They were blinded by the quest to secure and or maintain hegemonic control of the Persian Gulf on one hand, and improve/secure increased income from foreign trade. That is, the same powers that prohibited nuclear proliferation defied it because of their pursuit of hegemony and national income. In addition, these powers have equally defied the principle of nuclear disarmament, which is one of the major provisions of NPT; rather they have pursued the modernization of their nuclear weaponry. Why has the nuclear watch dog displayed serious indifference to these violations under the NPT regime and why must it be Iran that will pay for the crimes committed by all?

In all, Iran has insisted that its nuclear program is for peaceful purposes and represents its exercise of nuclear rights conferred by Article IV of the NPT. The Iranian leadership has long claimed that since they are signatory in good standing with the NPT, the sole reason for their pursuit of nuclear power is related to civil purposes [Eisenstadt, 1999:130]. The US and its European and Middle East allies disagree with this position, proceeded to sponsor and or impose international sanctions against Iran. In addition to IAEA argument that Iran has not provided a satisfactory explanation of either its past nuclear behaviour or the inconclusive but worrying pattern of its evidences (Hersh, 2001; Miller, 2007:551 – 559), the U.S. Energy Information Administration reports that Iran has over 93 billion barrels of proven oil reserves in addition to the suspected 191 billion barrels of proven and possible oil reserves located in the Caspian Sea, and an estimated 812 trillion cubic feet in proven natural gas reserves [Zunes, 1999:1; Cordesman, 1998: 4, 22]. These are evidences adduced by the US and IAEA to prove that Iran is pursuing nuclear weapon production.

The porous nature of these evidences is buttressed by the fact that Iran tactically and successfully classification of its nuclear programme and made it impossible for antagonists of its nuclear programme to tender objective evidence with which full international mobilization could be possible (Leurs, 2008; Ehteshami, 2009:32). When did the stockpiling of oil reserve become an international/objective yardstick for determining a country that is pursuing the production of nuclear weapon? It must be admitted that this paper is not concurring to Iranian or US position but fundamentally argues that the US and other nuclear states armed Iran but became enemies when their interests in Iran was defeated. They have equally circumvented NPT principles, and by virtue of their international behaviour particularly against emerging powers, pose nuclear threats to countries like Iran. This provoked the need for mutual nuclear deterrence and the contemporary pervasive proliferation of nuclear technology and materials.

Mutual alliance system evolved among emerging powers suffering from US antagonism and internationally led castigation and sanctions that are determined to assert their independence, sovereignty or autonomy in the pursuit of their national interests. The strategic economic and security potentials of such countries safeguarded their cooperation with other world powers likes Russia, China, and North Korea, who are US rivalries in the international scene. For instance, the stability of the Middle East as a major source of energy, which is needed for industrial development by some world power like China, and as a potential market for nuclear technology proliferation-prone zone have tend to

neutralize the effects of international sanctions against Iran. The bilateral energy ties between Iran and many regional or international powers have played serious neutralizing role against international sanctions and isolation. Similarly, Iran's global trade ties with many countries particularly in the energy industry made it difficult for the United States and its partners to isolate Iran from the international community (Government Accountability Office (GAO) 2008: 35). Oil and gas deposits are too significant in the world's international energy supplies and therefore cannot be sidelined without debilitating consequences for the economies of the leading industrial nations [Zunes, 1999:1].

Equally, Iran's funding of development and liberation struggles in many Less Developing Countries particularly in the Arab World renders international isolation of Iran weak and ineffective. For instance, Iran's Arab allies particularly the Hezbollah and Hamas appreciate the fact that the prospect of US-Iranian accommodation could end their primary source of funding and jeopardise their struggle or nationalism [Sadjadpour, 2009]. Therefore, such countries defy international sanctions against Iran.

In addition, Iran is physically sandwiched between both the oil rich areas of the Caspian Sea and Persian Gulf, while at the same time being located at the international crossroads of Central Asia and the Middle East. Iran's geographic location is therefore too strategic to be ignored by any country that participates in international production and distribution of goods and services. European Union, for instance, finds it difficult breaking off diplomatic ties with Iran for a long time because of this, while Belgium is the only Western European state that has severed diplomatic relations with Iran [Yaphe and Schake, 2000:109].

Russia and China view Iran's nuclear question as an opportunity to contest US hegemonic control of the Middle East - a geopolitical region with vast natural and economic resources. That is why Russia remains the main Iran's military supplier and its main nuclear partner followed by China [Ehteshami, 2009: 32]. Since the 1980s China has been responsible for helping the Islamic Republic build fuel fabrication, uranium purification, and zirconium tube production facilities, and even provided it with the equipment used in electromagnetic isotope separation enrichments of weapons grade uranium [Cordesman and Al-Rodhan, 2006]. For these reasons, the two countries have continued to oppose any form of military action by the United Nations against Iran. Iran's ability to continue with its nuclear programme can therefore be seen as a by-product of an interactive game between the world powers struggling for hegemony (Kemp, 2006: 2), the economics of the sale of nuclear material and technology, and the place of energy in modern development. The failed experience of US-led sanctions can therefore be interpreted on the basis of the above factors and the strategy deployed by Iran in the face of world powers balancing strategy in the Middle East.

VI. Conclusion

The Nuclear Non-Proliferation Treaty [NPT] regime emerged out of the need to avert a similar occurrence of the nuclear holocaust in Japan during World War 11. The major problems hindering this objective were the inevitable need and use of nuclear energy for power and industrial development, and the dual applicability of these materials for peaceful and military purposes. This led to the establishment of international management system in the movement and use of nuclear materials needed for peaceful purposes. In addition, acquiring nuclear capability/weapon raised military deterrence to the highest level thereby making it a national security priority for states seeking international recognition and role.

The paper observes that the skewed provisions over possession and transfer of nuclear technology and materials in the principles of the NPT provoked agitations among non-nuclear states that it is intended by nuclear states to dominate them. Furthering this, the nuclear states instead of disarming themselves are modernizing their nuclear weapons while they impose restrictions on others from acquiring same. As rewards, they have equally being transferring nuclear technology and materials to their regional allies in the Less developing Countries as a strategy of safeguarding their hegemony. Through this programme, the US initiated and began the process of nuclearizing Iran when they restored the Shah to power. Driving by nationalism against US overwhelming dominance and exploitation of Iranian economy and politics, Iran went through revolution in 1979 that edged the US out of Iran.

Subsequently, the US and its allies turned against Iran and its nuclear programme. However, Supper Power rivalry, the need for pivotal need for Iranian energy, interstate trading and consequent alliances among anti-US forces orchestrated a strong cooperation between Iran and other major world powers. These powers have continued to sponsor and support/assistance Iran's nuclear programmes to the detriment of international sanctions and isolations. These powers have equally blocked previous attempts to secure international military strikes against Iran nuclear sites and territory. Therefore, the struggle for hegemony among world powers, the irreplaceable need for oil and gas as sources of inevitable energy in the current development process, and the needed increase in national economy derived from the sale of nuclear materials have propagated nuclear proliferation and sustained Iran's nuclear technology in the midst of NPT regime.

This paper therefore recommends that:

1. All nuclear power states must unilaterally dismantle their nuclear weapons plant and disable their

nuclear weapons under the unrestricted supervision of all the members of UNSC. Successful implementation of NPT statutes depends on this otherwise emerging powers who feel threatened or who need nuclear deterrence for their emergence have no other option than to pursue it.

2. The nuclear facilities and weapons of Israel, Pakistan, and India must be disable under the unrestricted supervision of the five permanent members of UNSC to enable Iran abort its nuclear programme. This is because the security threat posed by these nuclear states is one of the major factors that led to Iranian programme.
3. Justice should be applied in UNSC actions against violators of NPT statute. If NPT prohibited the procurement, purchase and sale or transfer of nuclear facilities or materials being used for manufacturing nuclear weapons, all nations that were involved in the development of Iran's nuclear programme such as the US, China, Russia, France, Belgium, Spain, Germany, the US and Italy should be sanctioned. This should be a confidence building mechanism that will discourage others from participating in such international business and defiance of international obligations. Iran should not be a 'scape goat'.
4. The Principles of NPT should be reviewed and fundamentally restructured.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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