

Peril of Uranium Mining-An Emerging Disaster: A case study of East Singhbhum, Jharkhand

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Abstract

India is a mineral rich country having a favourable geographical setup. Mining sector is one of the core economic drivers of the country. Uranium is a rare mineral which is used to generate nuclear energy and make weapons. Uranium ore is found in small quantities in soils and rocks which vary from place to place. East Singhbhum district of Jharkhand is a major uranium production centre having mine site, plant and dumping ground called tailing pond. The main deposits are located on the lands belonging to the tribal people. These people co-existed with the nature but due to lack of awareness and education they fell into the trap of country's developmental program. Mining for the national cause has turned out to be disastrous. The hazardous nature of radioactive ore and mill waste poses serious and unidentified health risks and environmental impacts.

Radon gas is continuously released in the atmosphere from the mining sites and tailing pond, having irreversible health effects. Wind carries the dust particles from tailing pond and mine site to long distances, that are inhaled by the tribal community residing in the vicinity, particles get deposited on the agricultural ground and also leach into the soil and aquifers. This leads to higher level of health hazards. The unaware communities are paying a huge cost. The objective of this paper is to understand the threats and risk associated with uranium mining in Jharkhand and to identify if there is any coping measure adopted by the tribal community who is directly impacted. This study is based on the semi structures interviews with respondents and non-participant observation and secondary literature including both primary as well as secondary source of data. The marginalized section of the society becomes more vulnerable as they reside in the land of mineral resources.

Keywords: Uranium, uranium mining, tailing pond, radiation, health risk and tribal.

Introduction

The nation celebrates its status of being a nuclear armed superpower. The country is proud of the shining missiles and possessing nuclear weapons but should take care of the community residing there.

Uranium mining process generates wide range of risk from everyday hazard to health risk by releasing harmful gases and dust that affects the health of tribal people. Not enough attention has been given to the communities residing nearby the mining site and tailing pond. Very few people are aware of the different aspects of nuclear energy, uranium mining and its impact. Nuclear energy is going to be the focus of Governments in the future. Uranium mining too is fast becoming a phenomenon all over. Hence, awareness on these issues is very important for Jharkhand in general and India in particular. Uranium waste is very dangerous for mankind. It takes around 100,000 years to dispose of uranium waste¹⁵.

Uranium mining is a subset of bigger environmental disaster and the most destructive industries. Mining strips billion tons of materials from earth, much of it is hazardous. It creates mountains of waste, environmental pollution, health hazards and leads to displacement and rehabilitation. Mining was taken up as a developmental work which has caused much damage to the indigenous people¹⁴. Uranium mines and tailing ponds have contaminated water with radiation and other heavy metals which are yet to be cleaned up⁴. Uranium mining is a slow onset disaster and its effect is seen after a long period of time.

Uranium mining though has not been yet visualized as a hazard, yet it has created huge risk to people residing in the vicinity of mine site and tailing pond. The impact can be seen in longer duration affecting entire ecosystem. The exposure by the contaminated ionizing radiation can be by three ways:

1. **External contamination:** When airborne radioactive materials such as dust and aerosols land on skin or clothes
2. **Internal exposure:** When a radionuclide is inhaled, ingested or otherwise enters into the bloodstream
3. **External irradiation:** When body is exposed to penetrating rays from an external source⁵.

This study on mining hazard and the accumulated risk has provided the opportunity to capture the issue in both general term and specifically as it affects the surrounding areas due to uranium mining.

Overview of the Study Location

Half of the world's uranium is found in Australia and Canada. Uranium mining is expanding everywhere. Uranium is mined for nuclear power and nuclear bomb but very little is known about its effect. Nuclear chain reaction produces nuclear waste and contaminates the environment².

It has a leading position with respect to mining and other industrial activities in Jharkhand State. Jharkhand is the producer of uranium ore which is used as fuel for nuclear power reactors. The State consists of four underground mines, one open cast mine and two processing plants and a by-product recovery plant located in East Singhbhum district⁷.

Jharkhand is located in the eastern region of Indian peninsular plateau. It is the 28th state of the Indian Union that came into existence on 15th November 2000 by the Bihar Reorganization Act. The word 'Jharkhand' means the 'land of forest' or 'bushland', it has forest and hilly tract. Jharkhand is enclosed by Bihar towards north, Chhattisgarh and Uttar Pradesh towards west, Odisha towards south and West Bengal towards east. Jharkhand covers a geographical area of 79.70 lakh hectare and lies on the Chhotanagpur Plateau, a north-eastern portion of the Peninsular Plateau of India. This plateau is sub-divided into the Ranchi and Hazaribagh plateau. The uneven region consists of succession of plateaus, hills and valleys drained by many rivers. Jharkhand is one of the richest areas in the entire country, rich in minerals deposit and forest. The State is a larger producer of fuel minerals; it is the 'red carpet' for industrial investments.

East Singhbhum district is situated at the extreme corner of Jharkhand. It has a leading position from the industrial growth and mining quarrying. Singhbhum means 'land of lions'. It is located between 22° 12' to 23° 01' North latitude and 86° 04' to 86° 54' East longitude. Entire district is rich in minerals such as iron ore, copper ore, uranium, gold and kyanite⁶.

The power that gets generated using nuclear energy has its genesis in Jharkhand. The largest deposits of uranium ore are found at Jaduguda. Since 1960s, the nuclear lobby of the country rushed to exploit the ore²². Uranium mining in Jharkhand State is leading to mass poisoning and slow deaths for tribal people. It is the slow onset, manmade disaster³. Uranium Corporation of India Limited (UCIL) was found in the year 1967 with its headquarter at Jaduguda, East Singhbhum district of Jharkhand where the first underground uranium mine is situated. It is a Public-Sector Undertaking (PSU) under the Department of Atomic Energy (DAE) for mining and processing of uranium^{20,21}.

Growing demand of uranium ore led to reopening of old mines and developing new mines in East Singhbhum region. Hill at Banduhurang village in Jharkhand is converted into open cast mine to extract uranium ore¹⁸. Turamdih mine and mill, Banduhurang open cast mine and Mohuldih mine are the latest formed mines adding to Jaduguda, Narwapahar and Bhatin mines³.

Material and Methods

The objective of this study is to understand the threats and risk associated with uranium mining in Jharkhand and to

identify if there is any coping measure adopted by the tribal community which is directly impacted. This study is based on the semi structured interviews with respondents and non-participant observation and secondary literature including both primary as well as secondary source of data. The data used includes the responses from the villagers residing near the mines, plant and tailing pond. Apart from this, various articles, case studies, documentary, print and electronic media were considered.

Minerals and Mining in Jharkhand: India is a mineral rich country and has favorable geographical setup similar to Canada, Australia, Brazil, South Africa, Chile and Mexico. The geographical environment is yet to be fully explored, assessed and exploited. Mining is one of the core sectors of Indian economy. It provides the raw materials to many industries. India is blessed with rich mineral resources and Jharkhand has large deposits of minerals which act as a solid launching pad for mining and mineral based industries. It has a major portion of nation's mineral reserve.

Mining is a major economic activity and industry is the backbone of the manufacturing and infrastructure sector of economy. The raw material that goes into industries includes thermal, iron and steel, petroleum and natural gas. India's mining sector is the third largest producer of coal (554.13 million tonnes in FY17) and third largest producer of steel (97.38 and 83.1 million tonnes of crude and finished steel in FY17), fourth largest producer of iron-ore (192 million tonnes in FY17, has 8 per cent of world's deposits of iron-ore), fifth largest in coal reserve in the world (308.802 billion tonnes FY16) and seventh largest bauxite reserve (2,908.85 million tonnes in FY17)¹. India produces 95 minerals, four fuels related minerals, 10 metallic minerals, 23 non-metallic minerals, three atomic minerals and 55 minor minerals¹⁰.

Jharkhand is blessed with natural gift of immense mineral potential and natural resources. Mines and minerals industry are the main drives of Jharkhand's economy. Jharkhand ranks third in terms of mineral production in the country and holds about 40 per cent of mineral wealth of India^{8,11}. Jharkhand has a wealthy treasure of iron ore (26 per cent of India's reserve), coal (27.3 per cent of India's reserve), copper ores (18.5 per cent of India's reserve), cobalt (20 per cent), apatite (17 per cent), steel, mica, uranium, bauxite, granite, limestone, silver, graphite, magnetite and dolomite and is trying to exploit plenty of mineral resources^{9,11}.

Jharkhand State occupies first position in coal reserve, second position in iron ore reserve, third position in copper ore reserve, seventh position in bauxite reserve and is the sole producer of prime coking coal, limestone, dolomite, manganese, mica, china clay, graphite, soap stone, fire clay, coal bed methane, uranium, phosphorite, apatite, quartz, feldspar, gold and pyroxenite⁸. Jharkhand is one of the richest mineral zones in the world and boasts 40 and 29 per cent of India's mineral and coal reserve. Due to the presence of large mineral reserve, mining and mineral extraction are

the major industries in the State. The strategic location of the Jharkhand state provides an advantage to the industries as it is located close to market and ports of eastern India⁹.

Background and History of Uranium Mining: The exploration and mining of radioactive ores in Jharkhand began in the year 1967 under the UCIL. Uranium was considered as a rare, radioactive and unstable element found naturally in low concentrations in soil, rock, surface water and ground water. Uranium is the heaviest element which exists in the form of uranium ore in the earth's crust.

Uranium mining is a process of extraction of uranium ore from the earth surface through the conventional open pit or opencast mining and underground mining. The deposits are often located in the areas where the indigenous or tribal community resides. After the extraction of uranium ore from the ground, it is sent to the processing plant where extraction of uranium from the ore takes place. Concentrated uranium oxide (U_3O_8) having 74 per cent purity is produced which is also known as 'Yellow cake' along with mine tailings and contaminated wastewater.

Underground mining is done by digging a tunnel and using shafts to access and remove the ore. This proves to be very dangerous for the mine workers due to the highest level of exposure to the radon gas. The ore is mined as it is identified with the help of shaft that is sunk in the vicinity of the ore veins and crosscuts drive horizontally to the veins at various levels. Various tunnels also known as drifts are driven along the veins. The tunnels are driven upwards also known as raises and downward also known as winzes through the deposit. Raises are used to develop the stopes from where the ore is mined from the veins and extracted.

Stoping has two methods first is the 'cut and fill' or open stoping method where the extracted space is filled with waste rocks and cement while the second is 'shrinkage' method from which sufficient amount of ore is removed through chutes and a hole is left. Open cast or open pit mining is done where the overburden is drilled and removed and the exposed ore are blasted and excavated using loaders and trucks.

The ore is processed in the mill which is mined and brought from the Jaduguda, Bhatin, Narwapahar, Bandhuhurang and Bagjata mines. The ore of different size is crushed and undergoes a two-stage wet grinding process. The ground ore in slurry form is thickened and leached in leaching pouches under controlled pH and temperature condition. The leached liquor is filtered and undergoes an ion-exchange process where the uranyl ions get absorbed in the resin. The liquor is then washed and treated with magnesia to get the yellow cake (magnesium di-uranate). Yellow cake is thickened, washed, filtered, dried and packed in drums and the final product is sent to Nuclear Fuel Complex, Hyderabad to process it as nuclear grade fuel. The processing is done in

such a way that the effluent discharge is minimum with high recovery of product.

Threat due to Uranium Mining: The indigenous people have occupied the areas rich in mineral resources¹⁴. They have always been the victims of all mineral extraction losing their lands and livelihoods, suffering from unknown diseases, violation of human rights and facing the threat due to the adverse impact of anthropogenic environmental degradation. Among all the mining activities, uranium mining is the most dangerous. The opencast uranium mine emits radiation the most as compared to the underground mining. Uranium being a toxic metal, produces the radioactive materials (alpha, beta and gamma rays) during the decay process.

Uranium milling produces huge amounts of sludge, dust and radiating stones kept in special ponds or piles known as tailings which are usually abandoned. This tailing contains about 85 per cent of radioactive materials present in the ore and heavy metals such as arsenic, polonium, radium and chemical reagents. The tailing pond emits dangerous radon gas which is carcinogenic in nature. These components spread into environment by wind, erosion, seepage and leakage; it also contaminates the groundwater supplies and pollutes the air. The fine dust particles spread radiation in a large radius because it travels longer distance and then seeps into agricultural products like grass, vegetables and the livestock which are consumed by the local community.

The toxic material causes severe health disorder like urogenital disorders, leukemia or cancer and other deformities. The effect can be seen after 15 to 40 years of exposure to the fine dust or gas. The diagnosis of the cause of lung cancer, tumors, skin diseases is difficult.

The mine waste of uranium is associated with the contamination of the surrounding environment which poisons air and water and proves to be dangerous to humans, animals and vegetations. The primary risk of uranium mining is due to radiation, which is exposed to the fauna through inhalation and ingestion of the radioactive particles in various forms. This radionuclide is known to be carcinogenic and causes different kinds of cancer.

The mine waste is being dumped on the fields and grazing grounds³. The unaware native residents of Jharkhand never knew the repercussion of these activities²². Tribal trusted the government and were trapped in the name of employment. They were used for their physical labor to dig and load the ore for transportation to the surface, as uranium mining is labor intensive. The people were subjected to radiation for prolonged period of time; they worked with no protective clothing which spread the contamination even to their families²¹.

The life expectancy of uranium workers and their families is getting reduced and children are born with incurable genetic

disorders²². Tailing pond, where the sludge is deposited, is also highly radioactive, which seeps through the ground, overflows during monsoon and blows as dust during summer and enters the ecosystem through food chain, air and water. Unknowingly, the local tribal have invited the evil through this mining project.

Jaduguda has suffered from various health impacts due to the existing uranium mines. The mining operations have adversely affected the ground water table, the effluent discharge from the mine site has seriously polluted the underground water resource and streams of these regions. The water pollution has adversely affected the fishes and aquatic life. The radioactive waste from the uranium mill and tailing ponds at Jaduguda flow into Subarnarekha River and its tributaries compelling millions of people living along the river to drink the radioactive and chemically contaminated water¹⁷.

These cases show how peoples' lives are being affected due to the uranium mining. They are paying the cost of their life for the Nation's development. National nuclear program is built upon the life of the people, as it deteriorates the living conditions of the tribal community residing near the uranium mining areas. Though, the lives of the people have become traumatic, scattered and painful, yet the national nuclear program is not going to stop. India wants to be a super power by 2020 by destroying its own resources.

Mining and its Aftermath Effects: Generally, a community does not get exposed to high dose of radionuclide that may cause acute effects. Rather it is the exposure of low doses which may result in increased risk of long-term effects. Though radionuclide may directly affect the community, it also contaminates the vegetation and water. Processing of uranium requires huge amount of water resources which leads to long term impact on environment. Uranium mining affects the air quality due to the exposure of radon gas, uranium dust and also contaminates the surface and ground water. Uranium mining can cause ecological disasters, as mining and milling produce lots of dust and radon gases. The radon gas is released after mining which is radioactive and the waste is produced after milling the ore which is then collected as tailings.

The effect of uranium mining is disastrous. Most of the uranium producing countries have no adequate environmental health and safety legislation and adhere to the International Atomic Energy Agency's safety guide¹⁹. Radiation from the uranium mines has harmful effect from generation to generation. Many countries like Brazil, Colorado, Texas, Australia Namibia and other countries have documented the terrible health hazards, water contamination and other pollution problems. The tailing contains uranium, thorium, radium and polonium and emits radon-222. In less developed countries, there is no set limit of emission from the dumps and it's monitoring¹⁹.

Through the literatures it has been found that health hazard and uranium mining go hand-in-hand. Uranium mines are located in different places in India, Jaduguda, Jharkhand is the first place where uranium mining was started.

Results and Discussion

Radiation does a great harm to the living cells and disrupts the cell's genetic instructions¹⁴. Nuclear radiation has caused dramatic increase in cancer among the indigenous peoples over the past 53 years. The waste product after the uranium extraction is dumped in the huge pond. The radioactive gases released from the processing and dumping site have directly affected the workers, fishes and wildlife.

Uranium mining poses radiation hazard to the public. There are mainly three types of exposure of the radiation from the surrounding of uranium tailing ponds, plant and mine site.

1. Uranium mining and milling operations produce gas having radioactive elements and dust particles that are being inhaled
2. The water discharged from the mines contains radioactive elements. It exposes radiation when consumed by humans
3. Gamma rays are exposed through the tailing ponds or mine tailings¹².

Exposure to uranium radiation on a regular basis for a prolong period of time increases the risk of acute radiation syndrome (ARS). Every day, the local community is exposed to natural radiation that comes from many direct and indirect sources such as soil, water, air and food. These elements contain radionuclides in nature which is inhaled and ingested by people. Radiation generated from the radionuclide damages the tissues or organs. The damage depends on the dose rate that is exposed to the sensitive tissues and organs. When the threshold level of exposure exceeds, it results in acute effects on tissues or organs such as skin redness, hair loss, radiation burns or ARS.

When the dose rate is low for a long period of time, it can greatly damage the cells which in long run leads to be carcinogenic and can cause cell mutation. This proves to be a greater risk for workers since they are more sensitive to radiation. The exposure of radioactive elements can cause lung cancer, skin cancer, bone cancer, leukemia, kidney damage and birth defects. The local inhabitants experience high rate of lung, stomach and skin cancer, leukemia, blood disease, kidney disorders and respiratory illness due to the radioactive gas released from uranium wastes.

Moreover, uranium ore emits radon gas which is a potential threat to health due to its radioactivity. Inhaling high concentration of this gas is carcinogenic to humans. Therefore, radon leads to lungs cancer risk¹⁶. The radioactive dust and contaminated groundwater lead to suspicious deaths. Radioactive material when kept exposed to the environment as nuclear waste may lead to slow onset of

radiation. The communities residing in close vicinity to the Nuclear Processing Plant (NPP), mines or tailing ponds are eternally exposed to radionuclides. These particles come in contact when they are deposited on clothes or skins and can affect the internal organs when inhaled, ingested or absorbed through open wounds.

The water bodies which are the major lifeline of the tribal community have been affected by uranium mining. The Runkini river dried up due to the dumping of the waste leading to scarcity of water. This in turn is forcing the community to consume contaminated water¹⁷. The effects of long-term ingestion of contaminated ground water affects the kidney function; the intake of elevated levels of uranium in water may lead to progressive or irreversible renal injury and even affects bones.

In Jaduguda, the lands were taken by UCIL that once belonged to the tribal community which were very fertile once. In these lands, the tailing ponds have been constructed which is one of the sources leading to radiation exposure. Chatikocha, Dungridih and Turamdih villages are situated very close to the tailing pond about 40, 60 and 20 meters respectively away from the pond. There are possibilities that the wind can easily blow the waste dust and radon gas across the villages and the vast area of agricultural land of Subaranarekha valley. During the monsoon, the tailing pond overflows into the fields and river.

In the year 2006, there was a pipe burst which led to leakage of waste, the toxic sludge killed many fishes, frogs and riparian life. This leak reached to Subaranarekha River and severely contaminated the water resources. In 1986, the tailing pond burst open and the waters flowed towards the villages. The study of radioactive contamination around Jaduguda uranium mines by Hiroaki Koide of Kyoto University, Japan confirms that the amount of air-gamma dose exceeds 1 mili Sievert (1mSv) per year in Jaduguda and reaches 10 mSV/years around tailing ponds. The strength of pollution in the tailing ponds is 10-100 times higher than the place without contamination and radon emanated from tailing ponds spreads contamination¹².

When the extracted ore is transported to the processing plant in trucks, the transportation safety measures are not appropriate and are not followed according to the standards. These raw ores of uranium are being taken by trucks/dumpers. The ores are being taken openly or partially covered by tarpaulins which is a non - protective coverage, thus it falls down along sides of the road which comes in direct contact with human, livestock as well as environment and make people and animals vulnerable to health hazards. This also contaminates the soil that affects the vegetations. Uranium concentrates are left carelessly at Rakha Mine railway station. According to the Vice-Chairman and member, Board of Directors of the IPPNW, the uranium waste is disposed openly near the villages which is exposing them to the radiation¹³.

According to a geologist and environmentalist, the radioactive waste will get mixed with the soil and in the long run it will create health related problems to both humans and animals. Villagers of Tilaitand have stopped using water from the wells and ponds, they have also said that the waste from tailing pond had destroyed their crops. One of the villagers said that by using the contaminated water they have become sick and have witnessed it on the plants and animals too. According to the NGO, Paryavaran Chetna Kendra, the fruits are becoming seedless, in the case of kendu locally known as Tiril/Tend/Kend (*Diospyros melanoxylon*) the seeds are getting deformed and the leaves are turning white in colour instead of green. The impact is seen on trees growing in the vicinity of UCIL and tailing ponds.

Fishes and frogs have developed unknown diseases and started dying due to the contaminated water; there are many cases of deformities of animals as well as their deaths. Small animals like rabbit, mice and monkeys are disappearing. Buffaloes and cows are being born with deformities. People have noticed the deformities in cows born without tail. Fishes were discovered with unknown skin diseases. Now, the radioactive materials have entered the food chain of humans too.

A local plant known as Thethar/Amori is affected by radiation which contains radium, radon and polonium in it. The nearby locations are also affected by the radiation which is not openly declared by the Government because it will create chaos among the residents.

According to the villagers, the water bodies have been contaminated but the actual reason is unknown. These days the awareness has been provided by the NGO's working in the area, this enabled the people to know the source of contamination. They add further that the water bodies are so much contaminated that while taking bath or washing clothes in the water bodies, it does not produce foam. The aquatic ecosystem is affected severely. Even though, the local communities are forced to use the contaminated water bodies for taking bath, washing clothes and irrigating fields because they do not have any other alternative source. The utilization of the water from the well is prohibited by the company (UCIL), since it contains 40 per cent of uranium in it; still the people are using the water for other domestic purposes except cooking and drinking. One of the villagers said that there is abnormal size of vegetable (radish and turnip) growth which is restricted to consume. The vegetable growth is so pathetic that even the cattles are not consuming it.

The people residing along the side of tailing pond of Turamdih mention that the water colour turns into yellow. In Jaduguda people reported that if water is kept in container for longer period, then the container becomes oily and greasy and turns yellow in colour. The cattle also suffer from unknown diseases, they are born with deformities. There are three tailing ponds at Jaduguda and one in Turamdih where

tons of radioactive wastes are dumped from all over India. These tailing ponds are uncovered and are exposed to the human beings, animals and the entire ecosystem in direct as well as indirect manner.

Tailing ponds are earthen in nature and the embankments are made of pervious clay which leads to seepage and overflows during rainy season, contaminating the ground water table and water bodies. During summer days, the tailings becomes dry, look as silver ground and wind blows the fine dust particles towards the villages. It does not even have proper fence, sometimes animals while grazing enter the pond.

Summary and Conclusion

Uranium mining was initiated for the development of the country but has turned into a disaster for the tribal community. Mining activities destruct the forest, disrupting the lives and livelihoods of people. The tribals pay the biggest price for the development. The rapid destruction of resources, impact upon socio-economic and cultural heritage of the indigenous people and environmental destruction have greatly affected the entire stretch.

The communities residing near the mines, plant and the tailing pond belong to the scheduled tribes and are unaware of the negative impact of the uranium mining. The indigenous community bears the burden of mining and people are victims of the contaminated environment. They are directly affected by the contaminated water, soil and air. The processed waste disposal site is surrounded by the villages, located at less than five km distance. These people have additional risks as they cannot afford to bear the cost of the diseases they face. Most of the workers are in contractual jobs and thus they do not have access to the company's medical support. Many suffer from these unknown diseases which are difficult to be diagnosed by the local doctors. Many get perished due to lack of awareness of the cause of sickness and inappropriate medication. These vulnerable groups of the society become more vulnerable as they reside in the land of mineral resources.

The impact of nuclear and radiological hazards can potentially be very high and the response and coping mechanism can be lengthy and differ from other hazards in several ways. People do oppose the project but they do not have voices. Being a marginalized section of the society, they also do not have any coping mechanism of their own to avoid the risks generated by the uranium mining. There is no specialized monitoring equipment placed in the villages near the mine site and tailing pond to measure the radiation level.

Thus, the routine risks of radiation have a huge threat upon the tribal community affecting their physical health as well as the surrounding in which they live. The grave environmental and health impact of uranium mining and radioactive waste disposal make the tribal community more vulnerable. Therefore, the company and the government

should have a risk reduction approach to minimize the risk and vulnerability of the tribal community.

Recommendation

Few recommendations are as follows:

1. Radiation measuring instruments must be installed in the vicinity of mine site and tailing pond.
2. Regular monitoring must be done to identify which particles (alpha, beta, gamma rays) are emitted.
3. A radiation specific hospital must be constructed solely for radiation affected patients, facilities and instruments for immediate decontamination, diagnosis, treatment and specialized doctors must be available.
4. The community awareness must be generated and resettlement provisions must be provided.
5. The treatment cost must be subsidized or even made free for the tribal community as they have been and still are the forced victims of the human induced technological hazard.

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