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A PRELIMINARY ASSESSMENT OF ENVIRONMENTAL IMPACTS DUE TO BAUXITE AND LATERITE MINING IN KARINDALAM AND KINANUR, SOUTHERN INDIA

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Abstract

The present work deals with the assessment of possible environmental impacts due to the proposed bauxite mining and existing laterite mining in the Karindalam and Kinanur area of Kasaragod district of Kerala. A field survey was carried out in the laterite mining area of Karindalam and Kinanur area and data regarding ground water level and quality was collected. The local geology of the area was also documented. A comparison of the Google Earth images of 2003 and 2010 reveals that number of laterite mines have increased significantly during this period resulting in the land degradation. The water table of the area is moderately deeper (average depth 32 feet); hence there will not be much contamination due to percolation but care should be taken to avoid the contamination of surface water bodies by proper waste dumping and effluent treatment. Sustainable mining activities may benefit the local people due to provision of infrastructural facilities provided by local industry, as mining industry boost up the local market. Since the ore reserves of this area are economically viable, their utilization may improve the economic status of the people, provided the management should committed to environmental protection which leads to sustainable development of the region.

Keywords: *Bauxite; Karindalam; Kinanur; Environment; Kasaragod; Laterite*

Introduction

Kasaragod is the northern most district of Kerala state of south India, which is one of the backward districts. The district is blessed with different natural resources like bauxite, beach sands, laterite, granite etc. The inferred rich reserve of bauxite can bring prosperity, but at the same time, mining and related activities may lead to environmental degradation as happened in number of other localities all over the world. The area under investigation (Fig. 1) encompasses southern part of Kasaragod District of Kerala State. The area falls in the Survey of India Toposheet No. 48P/3 between longitude 75^{o}10'-75^{o}15'E and Latitude 12^{o}15'-12^{o}20'N. Kerala Clays and Ceramic Products Limited has already initiated mining in Thalayadukkam in the

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Karindalam area and large quantities of alumina-silica rich laterite are being transported to different Cement industries. The bauxite deposits are promising in Kinanur and Karindalam areas. The bauxite deposits are observed at an average depth of 7-8m. Karindalam is located at 12km East of Nileswaram town. The area falls within the realm of tropical climate. The summer monsoon is very active in this area compared to winter monsoon. The maximum rainfall occurs during June-August period [1]. The distribution of vegetation is thick at some areas whereas it is sparse at some laterite terrains. The main cultivation is cashew nut, rubber plantations and coconut. The area under the investigation is more or less a plateau with some isolated peaks. The area is covered by laterite with detached outcrops of charnockite and related gneisses. There are several small scale granite and laterite quarry present in the study area [2].

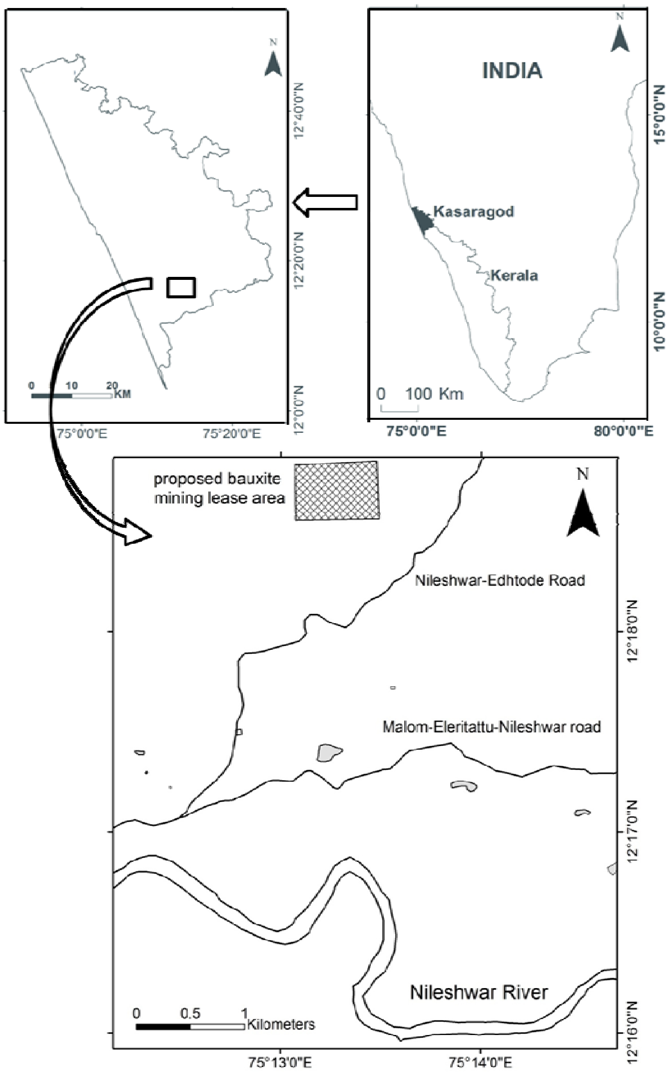

Fig. 1. Location map showing the proposed bauxite mining site and surrounding areas.

Bauxite is the product of weathering processes under tropical and sub-tropical climate [3, 4]. The minerals that are unstable under weathering condition undergo physical destruction and chemical decay. By chemical weathering some of the mineral, which are soluble get in to the solution and removed while the insoluble residues are left behind and form residual bauxite deposits. Agents of decomposition are surface water, acid, alkalies, vegetables and organisms. Depth of weathering is controlled by topography, climate and lithology. Rocks rich in alumina (containing feldspars and feldspathoids) are broken down during weathering. Silica and iron oxides released in such process are leached out with the consequent enrichment of alumina in-situ. If the leaching is not effective, the process may result in the formation of laterite and low-grade ferruginous bauxite deposits [5]. Sub surface and surface drainage must be operative to promote complete leaching. To form sizeable deposits in nature, the weathering process must be active for considerable amount of time. Where there is a sufficient concentration of the aluminium hydroxides, economic deposits of bauxite originate. The bauxite is gibbsitic with minor amounts of diaspore, limonite, goethite and kaolin [6]. The horizon of bauxite and/or laterite grades downwards in to lithomargic clay before passing in to bed rock. The general geological sequence is bauxite/Laterite (6.00-8.00m), lithomargic clay (1.00-30.00m) and bedrock (charnockite, gneiss etc) [7].

The alumina rich laterite of Karindalam area (Figs. 2 and 3) is being used as raw materials for the Cement Industries.

Fig. 2. The photograph showing alumina rich laterite terrain in the Kinanur-Karinthalam transect. The laterite mining area can be seen in the distance.

Fig. 3. The photograph showing dumping site of mined lateritic bodies.

Presently laterite mining is undergoing at Karindalam laterite mine by Kerala Clays and Ceramic Ltd., Kerala Government undertaking. The total area is 50 acres, at which in 10 acres, mining is going on. The proposed mining period is from 2004 to 2024. The laterites contain nearly 38-40% of alumina and 7 to 8% silica. Numerous laterite profiles are seen exposed in the area along road sides. Humus zone Laterite is porous pitted, clay like rock with red yellow, brown-grey and mottled colours depending on some measures on the composition. It has a hard protective limonitic crust on the exposed surface which is generally irregular and rough when the fresh soft rock is exposed to air it is quickly dehydrated and becomes quite hard.

Methodology

A Preliminary geological investigation in and around Karindalam laterite mine and Kinanur area was carried out. The secondary information regarding different aspects of mining operations, dumping of overburden and reclamation measures were collected. The ground water levels in the area were measured and first order assessment of water quality was done. The effect of mining on biodiversity in the area was also documented. Analysis of Google Earth satellite images of the year 2003 and 2010 was carried out to document the temporal changes in the topography and the possible land degradation due to laterite mining. Also an interaction and discussion on proposed mining activities was carried out with the local people.

Results and discussions

Geological investigations

The geological investigations in the area reveal the presence of crystalline outcrops of charnockite and gneisses. The exact relation of charnockite and gneisses is not clear. The crystalline are weathered in to thick lateritic profiles. Laterite in the area is porous, pitted, with red yellow, brown-gray and mottled colours. It has a hard protective limonitic crust on the exposed surface which is generally irregular and rough when the fresh soft rock is exposed to air and becomes quite hard. The Laterite exposed in the area is in-situ, laterite formed by the residual weathering of the crystalline rocks.

Effect on environment

Mining can impact biological diversity of the area. The different trees and plantation corps seen in the area are coconut, cashew nuts, areca nut, rubber etc. The main environmental problems of mining are deforestation, land damage, visual intrusion and disturbance of hydrological systems, air and water pollution. The proposed mining is an open caste mining which, involves creation of external overburden dumps, which destroys further lands and causes visual intrusion. Presently the area is environmentally sound, the water bodies are fresh, free from pollution and soil is fertile. Hence, vigilant management and sustainable eco-friendly activities (forestation, reclamation) from the authorities should be adopted when mining starts. Although the proposed mining site is in non-forest wasteland [8], the surrounding areas of it are thickly vegetated. Hence, there will not be any direct impact on flora or fauna. However, the mining related activities may impact the surrounding vegetation and environment in a number of ways [9].

The mining activities can also lead to deforestation, as the literature mentions [10, 11]. Valuable ore bodies located in thick forest or adjacent to them and if mined by open pit method, would inevitably require removal of trees and vegetation. The laterite mining is situated in a laterite hill without much vegetation; whereas proposed Kinanur bauxite mining area is in thickly vegetated area. Deforestation to a lesser extent is also caused by infrastructure facilities and spreading of over burden. This is in many cases drastically changes the micro-climatic conditions which ultimately lead to degradation of flora and fauna. Deforestation will be followed by massive soil erosion. Thus, there would be loss of most vital resources required for agriculture. At the same time, the silting of river system may cause widespread floods. Mining operations being site specific also give rise to the problems of land degradation. The overburden dumps; mined out quarries and such sided areas all result in change of land uses thereby affecting the land or house owners who are displaced. Dumping of waste material also affects vegetation. Some materials present in wastes affects the growth of vegetation. During rainfall these materials transported for long distances and affects flora and fauna along its path.

In general, mining activities are accompanied by varieties of environmental impacts, which can contribute towards degradation of environment as a whole. The rehabilitation and restoration of mined area may take several years. Effect of Bauxite mining on biodiversity in south western Australlia and rehabilitation of Jarrah forest is shed light on long term time requirement for the restoration [12]. The process of the environmental degradation which starts with the extraction of minerals, resulting in land degradation and addition of pollutants to air and water, continuous as the minerals are beneficiated and further processed. Mechanization of mining has invited a few environmental problems, which defy solution. Road dust problem in opencast mine is one such. Haul road dust is formal of a spectrum of sizes, from submicron particles to large pieces of a few centimetre diameters. Loaded dumpers moving at high speeds crush the larger pieces. The dust is a potential source of pollution.

Effect on ground water

In the open cast mining, excavation and filling works disturb the original topography of the area. Mining excavations may intercept ground water flow. While the effects are quite evident on the environment, the effects of the large distortions on the natural pattern of groundwater flow orientation and chemical quality, on the environment at large are often longer term. Measurable effects, and sometimes contamination may take some time to appear. Quarrying and open cast mining can cause conspicuous effects on groundwater level and quality. The most serious and widespread environment effects of mining however emanate from the disposal or storage of spoil. An assessment of the ground water conditions of the area was carried out (Table 1). The initial observation of ground water suggests that the quality is generally good. The water is colourless and odourless. The water depth is around 9.5m in the area during summer season. The water table of the area is moderately deeper; hence there will not be much contamination. But care should be taken to avoid the contamination of surface water bodies by proper waste dumping and treatment.

Satellite image interpretation

A comparison of Google Earth satellite images of the years 2003 and 2010 reveals that the number of laterite mines has increased significantly within a period of 7 years (Fig. 4a and b). The laterite mines were almost absent during the year 2003 (Fig. 4a). However, in 2010 several laterite mines have come up in the area resulting in the land degradation. These mines can be clearly identified by their reddish brown colour in the images (Fig. 4b). The presence of laterite mines was confirmed by the field observation.

a

b

Fig. 4. The satellite image of the study area:
a - taken in 2003, b - taken in 2010.

Table 1. Ground water survey (water level measurement and quality of water during summer season)

Sl. No	Name of the Place	Water level (meters below ground level)	Remarks
01	Manjalayamkad	9.50	Water is colorless, odor less. Water scarcity during summer season
02	Thalayadukkam	9.50	Water is colorless, odor less. Water Scarcity during summer season
03	Choyyamkod	9.90	Colorless, odor less. Water available during summer season
04	Nelliyadukkam	9.20	Water is colorless, odor less. Water level lowering and turbid water during summer season
05	Kamma	10.50	Water is colorless, odor less.
06	Kariolil	10.20	Water is colorless, odor less. Water Scarcity during summer monsoon
07	Kinanur	9.50	Water is colorless, odor less. No problem in water quality and scarcity
08	Kanpayil	9.00	Water is colorless, odor less. Water Scarcity during summer monsoon

Conclusion

Mining has both advantages and disadvantages to the society. The continued mining activities may benefit the local people with the development of infrastructural facilities provided by local industry. The mining industry may also enhance the local market. Since the ore reserves of this area are economically viable, their utilization may improve the socio-economic status of the people provided the management should be committed to environmental protection with a sustainable development of the region. Although the proposed mining site is in non-forest wasteland, the surrounding areas of it are thickly vegetated. This will not cause any direct impact on flora or fauna. However, the mining related activities may impact the surrounding vegetation and environment.

Transportation activities may pose some impacts to the ecosystem which can be minimized by reclamation and conservation plans. The Mining authorities should implement following environmental measures:

- The vegetation should be planted in mining areas and dumping sites which can act as natural pollution sinks. Later over this area, initial reclamation crops with mulches, soil stabilizers, grass species and leguminous plants can be planted as a first measure to improve the soil fertility and to bind the loose material.
- The slopes of contour benches of the static dumps can be planted at closer intervals with suitable fast growing shrubs, root bearing and hardy species like Acacia. The plant species to be grown in the areas should be dust tolerant and fast growing species so that a permanent green belt is created.
- Deciduous and semi-deciduous plants could be planted to improve the soil quality with humus and carbon content.
- The water table of the area is moderately deeper; hence there will not be much contamination. But care should be taken to avoid the contamination of surface water bodies by proper waste dumping and treatment.
- The number of laterite mines has increased significantly during the period 2003-2010 causing the degradation of land. The satellite images can be used to monitor the construction of illegal mines in the area.

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