academicJournals

Vol. 8(6), pp. 150-156, June, 2015
DOI: 5897/JGRP2015.0495
Article Number: 915EC0C53587
ISSN 2070-1845

http://www.academicjournals.org/JGRP

Journal of Geography and Regional Planning

Review

Impact of silica mining on environment

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Received 16 April 2015: Accepted 27 May, 2015

From the beginning of human civilization, paradigm of man-nature relationship is changing continuously. After industrial revolution human interference in the natural ecosystem increased and technological development made us capable to explore and extract natural resources, while human greed enhanced the pace of their exploitation. With growing development, the man nature relationship became more imbalanced. Mineral resources were always in the centre of human interest due to their economic importance. Silica mineral is the major constituent of Lithosphere and its manifold industrial use makes it more valuable. But, its fast extraction damages the environmental quality of a region. In this paper the pros and cons of silica mining by the environmental perspective has been measured by taking Shankargarh region as a case. Out of 57 mining sites in the study area, one third of the mines are situated in three villages and these villages are at highest threat from environmental point of view. Although State Government has given Mining lease over only 206 acre land but during field survey the author noticed the illegal mining over area more than 2000 acres. Such large scale silica mining has changed the land cover and land use pattern of the region.

Key words: Environmental loss, land backfill programme, water filtration, undulating topography, mining Mafias.

INTRODUCTION

Mining activity exerts a long lasting impact on landscape, eco-system and socio-cultural-economic considerations. It is noteworthy to mention that the actual land mass available to mankind is just 30% of total global surface area. India's land area is about 2-3% of the global land area, where as it supports more than 16% of the global population. This important statistics reveals that the poor per capita land holding stands at 0.32 hectares, which calls for due attention to restoration/reclamation of land after mining in order to utilize the land for useful purpose.

Although the occurrence of minerals in Uttar Pradesh is rare yet the districts in the southern part viz. Lalitpur, Chandauli, Mirzapur, Sonbhadra, Allahabad hold important place in state`s overall mining of coal, diaspora, limestone, pyrophyllite, silica sand, sulphur etc.

Silica sand refers to sand having the composition and grain-size distribution required for industrial applications. Quartz or silicon dioxide (SiO_2) is one of the most common minerals found on the Earth's surface and is found in rocks like granite, gneiss, and sandstone. Industrial silica sand is a higher value product than sand and gravel used in the construction industry (Table 1).

Silica sands have a large number of other industrial

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Table 1. Mineral production in Uttar Pradesh (2010-11 to 2012-13).

Mineral	Unit	2010-11			2011-12			2012-13		
		No. of mines	Quantity	Value (`000 Rupees)	No. Of mines	Quantity	Value (`000 Rupees)	No. of mines	Quantity	Value (`000 Rupees)
All Minerals		26		36337639	25		42973146	23		43043967
Coal	`000t	5	12029	8747200	5	13968	15067800	5	15526	15122300
Diaspore	T		14462	15974		14527	18882		14910	18498
Limestone	`000`t	1	477	50105	1	2455	353545	1	2865	379183
Pyrophyllite	t	8	22634	5631	8	17215	3475	9	27555	5882
Silica sand	t	12	182067	23729	11	183367	34444	8	129639	23104
Sulphur	t		42915			36130			38856	
Minor Minerals				27495000			27495000		-	27495000

Source: Indian Bureau of Mines, 2014.

uses depending on their characteristics, that is,

1. Production of glass
2. Foundry sand
3. Ceramics
4. Sandblasting and other abrasives
5. Building products
6. Filler and extender
7. Production of silicon and silicon carbide
8. Pigments
9. Hydraulic fracturing and propping in the oil industry
10. Ultra high silica products in the electronic and fibre optic industries, fused silica, silicone products
11. Water filtration

Being a key raw material in the industrial development of the world especially in the glass, foundry and ceramics industries, it has continued to support human progress throughout history. Silica contributes to today's information technology revolution being used in the plastics of computer mouse and providing the raw material for silicon chips. Although glassmaking and foundry uses predominate, numerous minor uses are based on either the chemical purity or physical properties of the sand (such as grain-size distribution or grain shape). These include ceramics, water filtration, fluidized-bed furnaces and chemical manufacture.

Silica sand resources are distributed in Andhra Pradesh, Bihar, Gujarat Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh States of India. Major mines of silica sand are in Allahabad District of Uttar Pradesh State of India. The Shankargarh area - of Allahabad District is famous for its Silica mines and for the quality of the silica deposits. These mines are situated in the Vindhyan Hills of the Allahabad District and extensive open cast silica mining is being performed since over three decades which is causing great damage to the forests and biodiversity.

DATA SOURCE AND METHODOLOGY

The study is empirical and based mainly on survey. The data regarding allocation of mining leases in the region was obtained from Department of Mines and Geology, Allahabad. To verify the ground reality a detailed survey of the study area was conducted. During the study the author did a schedule survey among the labourers working on mining sites to understand the availability of basic amenities like water, health and sanitation to them, and nature, process and volume of silica mining in the area. He visited more than 50 mining sites to document the impact of large scale surface mining on agricultural and forest land. Water is most important element in processing and refining silica sand and, therefore, to study the nature and amount of water use/reuse, and volume of vehicular movement involved in transportation of the refined sand, many processing plant installed near these mines were visited.

The study area

Shankargarh region is located between 25°10'N to 25°20'N latitude and 81°37'E to 81°45'E longitude

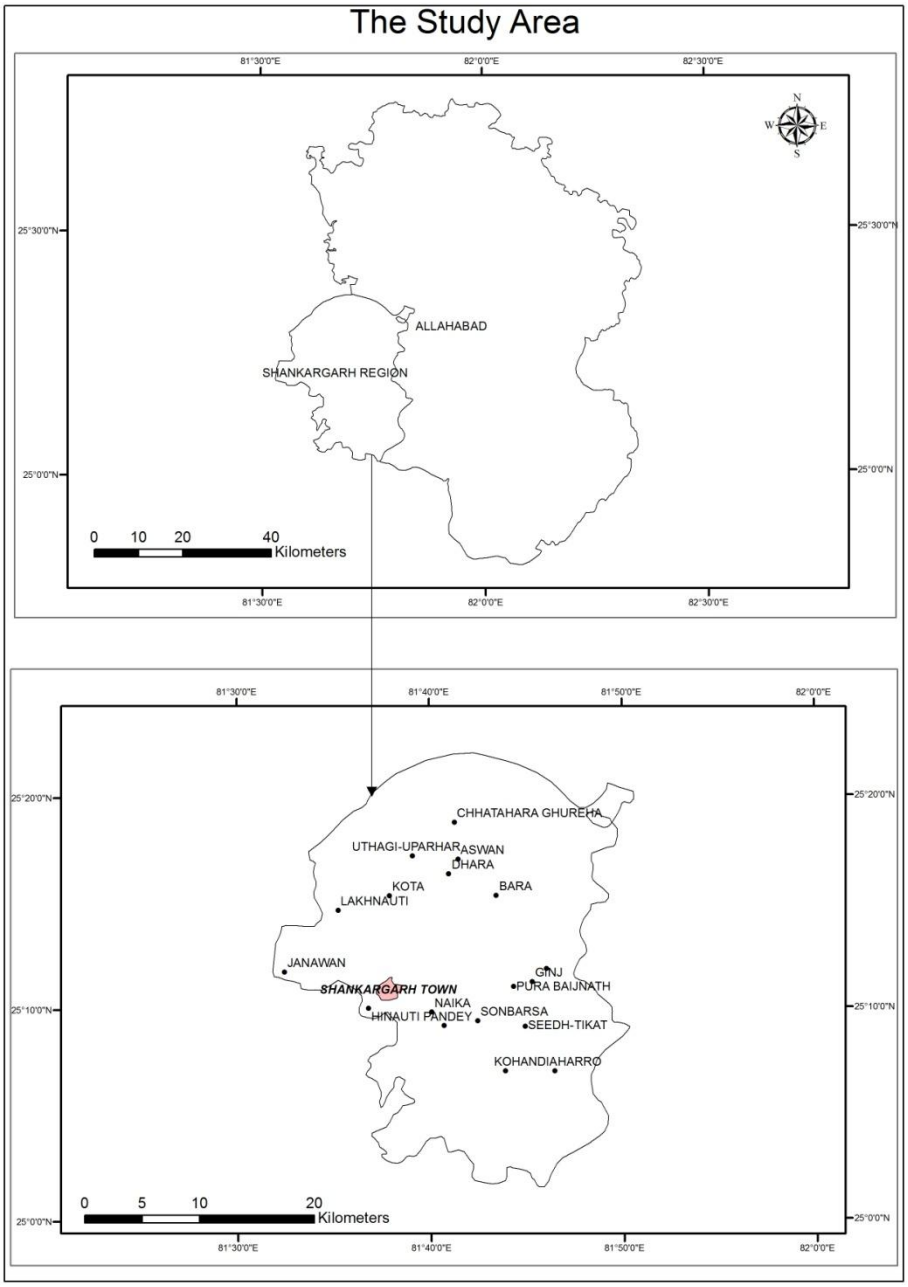

Figure 1. Location of Shankargarh Region in Allahabad District.

(Figure 1). The area forms a gentle undulating topography. This semi-arid area has no major physiographic features such as major rivers, hills and forest areas and the drainage pattern is dendritic. The region is rich in sand stone deposits and structurally the deposits are horizontally layered.

The most of the local people are tribals known as Kole. Literacy level is very poor and almost all females are illiterate who work as mining labourers in silica mines. Economic strata of people lie in one class only, as all are under very poor group (Mishra, 2015). The community land and surrounding area is rocky. Thus, there is a little possibility of agriculture.

Shankargarh is the biggest supplier of silica sand to the glass industry of the country. The area where these silica mines are situated is a backward despite the rich mineral resources that it has. Its extensive quarrying and open cast mining has resulted into long barren, unproductive and irregular sloppy lands therefore unfit for cultivation. As per government records (DMG, 2014), 57 mines are

Table 2. Silica Sand Mining Leases in Bara Tehsil of Allahabad District.

S/No.	Village	Area in acre	No. of leases
1	Chatehara-Ghurehtha	23.8	5
2	Sonbarsa	27.5	10
3	Janawa	6.5	3
4	Dhara	6.5	2
5	Seedh-Tikat	8	4
6	Kota	10.25	3
7	Lakhnauti	13.27	1
8	Geenj	16	5
9	Hinauti Pandey	18.68	4
10	Naika	3	1
11	Kohandia	19.75	7
12	Uthgi-Uparhar	19	3
13	Poore Baijnath	9.75	3
14	Bara	5	1
15	Aswan	5	1
16	Harro	14	4
	Total	206	57

Source: DMG Allahabad, 2014.

Figure 2. A silica sand processing plant.

being operated in the region on 206 acre land (Table 2). These mines are distributed in 21 villages. Sonbarsa occupies the largest area under mine followed by Chatehara-Ghurehtha, Kohandia, Uthgi-Uparhar, Hinauti Pandey and Geenj.Some silica sand mines in the region process the sand on-site however processing is done mainly off-site. Processing begins by washing the sand to remove fine particles (Figure 2).

Washing is done by spraying the sand with water as it is carried over a vibrating screen. The fine particles are washed off the sand and the coarse particles are carried along the screen by the vibration. An alternative method uses an upflow clarifier, where water and sand flow into a tank. Fine particles overflow the tank while the washed

Figure 3. A mined silica sand site.

Figure 4. The ravenous topography resulted from large scale open cast mining.

sand falls by gravity to the bottom. After washing, the sand is then sent to a surge pile where water adhering to the sand particles infiltrates back into the ground. From the surge pile the sand is sent to the dryer and screening operation where the sand is dried in a drum with hot air blasted into it. Then the sand is cooled and often further sorted to separate sand that is suitable for fracking from sand that is not suitable. Some non-metallic mining processors use 4500 to 6000 gallons of water per minute. Local aquifers cannot provide this much water, so reuse of water is necessary.

The land resources of the study area is severely degraded due to open cast silica mining and unfilled explored mines have become a potential shock to the land environment of the region (Figure 3).

These abandoned mines have changed the region`s topography. The continuous process of opencast mining has scarred the landscape, disrupted ecosystems and destroyed microbial communities of the area (Figure 4).

Apart from these unsightly impacts, the degraded

Figure 5. A post mining site.

environment created in the aftermath of opencast mining is unable to support biomass development in the region (Figure 5).

Illegal and uncontrolled mining in the region is a big issue of concern. In an inspection of Directorate of Mines Safety, Varanasi, in August, 2014 in silica sand mines of some villages of this region, glaring violations of mining rules were noticed. Unqualified persons without any duly qualified blaster were given the task of blasting, thus endangering the life and safety of persons employed in the mines. During field survey author noticed that the sides of the opencast workings in all these mines were not kept benched or sloped, and stood near vertical over a height of 6m-10m. Loose boulders were allowed to remain within 3 mt. of the top edges of opencast workings. Undercuts and overhangs were also observed on sides of opencast workings and at none of these mines was the top of the opencast working kept fenced. Out-of-use pits had also not been backfilled. Furthermore, proper facilities of drinking water, first aid, ambulance and rest shelters were not provided anywhere.

Pointing out glaring violation of rules, the Mining Directorate, Varanasi states that, quarterly and annual returns of the mines are not being submitted to the Safety Directorate. Due to Mining Mafias, the situation has become uglier and in lack of sufficient regulatory mechanism, large scale illegal mining is posing threat to regional eco-sustainability. Increase in production and opening of new mines is generating pressure on environmental attributes.

The key environmental problems arising out of mining activities in the study area are;

Land Deterioration: Land degradation is one of the significant impacts of mining activity which is mainly in the form of alteration of land structure due to excavation, interference with natural drainage, ground water depletion, stacking of mine waste, loss of fertile top soil, degradation of forest land, adverse effect on aquatic biodiversity and public health. Due to unaccounted large scale open cast mining, the land is losing its productivity due to removal of top soil. Fast vegetation cover loss has promoted erosion in the area.

Loss of Biodiversity: Natural vegetation play a key role in balancing the local ecosystem and fast green cover loss has disturbed the eco-balance of the region.

Pollution: The SPM (Suspended Particulate Matter) generated by silica mining and from the rubble heaped on the side of mines, is posing threat to the local environment. These particles get accumulated on leaves and thus they disturb the photosynthesis and respiration process. Further they pose health hazard to the

surrounding population residing in the nearby villages. The rain water ponded in unfilled mines percolates downward thereby contaminating the ground water. Surface run-off of muddy water changes the nature of external water bodies and causes water borne diseases.

Deterioration of Ground Water and Natural Drainage System: In the refining process of silica sand, water is used in large amount for washing. Due to large extraction of ground water, the water table in the area is getting lowered rapidly. Due to surface run-off, accumulation of mud, silt and sand in the natural channels, the natural drainage system is getting disturbed.

Conclusion

The present study shows that at various stages of the mining, the government`s involvement is little. No health facilities are being provided to the workers and no proper clean water availability is made at the mining site. These hard labourers are under paid (Rs. 100) even less than the wage set under MNREGA. Total dependence on labour force at every stage of mining increases the chance of resource wastage. No Land Backfill process is carried out at excavated sites. No, forestation and afforestation programme has been implemented in the mining areas. Unregulated and rapidly expanding mining activities have completely changed the region`s topography and it has turned into a wasteland. Vegetation loss has promoted erosion, land degradation and loss in biodiversity. Green cover functions as lungs which purifies the air and reestablishes the eco-balance. But increasing human greed is continuously engaged in its removal. Increasing truck haulage, blasting at the sites and high increase in the SPM is reducing the air quality of the region.

In view of the illegal and unjudicious mining in the region government must play a decisive role at each level from allotment of mining license to fair selling of the valuable Silica sand and in turn providing fair and genuine wages to the hard working labourers, better health amenities and education to the working force. Control measures for air and water quality management should be formulated. Land Backfill Programme should be carried out through Reclamation and Restoration Programme. Forestation and afforestation should be carried out in region to increases the green cover. This highland area should be converted into Solar Power Generation Plant through Solar Panel installation to meet the local energy demand. Fencing of the mining area is must to avoid illegal mining and to diminish the environmental loss.

Conflict of Interests

The author have not declared any conflict of interests.

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