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RESEARCH ARTICLE

ENVIRONMENTAL AND SOCIAL IMPACTS OF STONE QUARRYING-A CASE STUDY OF KOLHAPUR DISTRICT

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ABSTRACT

Rapid growth of construction activity, to meet the modern day requirements of increasing population and housing and infrastructure development needs of the society, has immensely boosted the demand for building materials in Kolhapur district. Stone quarrying continues to play major role in this process. However, the activity has caused serious environmental degradation and socio-economic conflicts in the study area. The major environmental and socio-economic problems related to quarrying revealed during this study include, landscape alteration, hill cutting affecting local biodiversity, generation of unproductive wastelands, dust pollution, noise pollution, illegal stone extraction, accidents and in some areas lowering of groundwater table.

INTRODUCTION

Quarries are open cast excavations from which fairly massive and deep deposits of hard or soft rocks are extracted, usually for the production of aggregates Coppin (1982). According to (Ukpong, 2012) quarrying is a form of land use method concerned with the extraction of non-fuel and non-metal minerals from rock. Quarrying is usually done by open-cast method using rock drills, explosion of dynamite and use of other methods. Quarrying negatively affects the environment in a variety of ways from exploration and blasting, transport and disposal of waste rocks. Major environmental effects are destruction of vegetation, disruption of animal habitats, diversion and blockage of natural drainage systems, soil erosion and river siltation, noise and vibration; and dust pollution (Maponga and Munyanduri, 1998). According to Stehouwer *et al*. (2006) quarrying activities exert tremendous pressure on limited soil and water resources, thus increasing the rate of erosion processes and subsequent damage of existing arable lands. Quarrying operations can intensely modify preexisting ecosystems and disturb hydro-geological and hydrological regimes. They can strongly modify the substratum, transform landscape patterns and integrity, destruct natural habitat and disrupt natural succession, as well as change genetic resources. In addition, mineral extraction can aggravate dust emission, noise pollution, and disturbance due to increased traffic. Also dumping of waste rock in open areas disrupts drainage and cause diversion of rivers and streams into farming areas and results into flooding of crop fields.

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Quarrying has land use policy implications- it is either agriculture vs quarrying or a coexistence of agriculture, often a source of conflict over traditional uses of land. Also the clearing of land to develop access roads and to open up mining sites destroys habitats for wild animals, reduces grazing areas for cattle, sheep and goats and reduces sources of plant life for human beings and animals (Chizoro *et al*., 1997). Besides affecting the locals, the noise from blasting and transport activities has caused migration from the surrounding areas, affecting ecological balance by disrupting the food chain (Munyandri, 1998). Environmental problems are further aggravated by lack of adequate mitigation measures by the respective quarry operators. This in turn affects the ecological sustainability which is a threat to the overall economic sustainability. With regards to the prevailing environmental legislation and its enforcement, there is total lack of efforts in monitoring, rehabilitation, restoration or post-mining programmes for minimization of adverse environmental impacts. Also Darwish *et al*. (2010) observed that in many of the developing countries, at the time of closure of quarrying activities, most quarries are left without any rehabilitation. Abandoned quarries can cause surface run-off and decrease natural recharge.

Mining activity often leaves long-term social, economic and environmental footprints (Lad and Samant, 2013). Social challenges related to the increase in quarrying activities in general include: threats to health and safety, displacement of communities, damage of cultural sites, and the formation of mining villages. One of the major problem is that, while the mining companies (and to a lesser extent, the government) pick

the biggest share of the benefits from quarrying; while local communities suffer from the negative impacts of these projects. This has led to persistent conflicts between the mine owners and the locals living near the quarry sites. Common conflicts revolve around self-determination and resource control, land use, socio-cultural survival, pollution and land degradation. Increasing cases regarding the negative environmental impacts of quarrying were being reported in the country. Supreme Court on February 2012 in the matter of Deepak Kumar v/s State of Haryana (I.A. no. 12-13 of 2011 in SLP (C) no. 19628-19629 of 2009) expressed serious concern on quarrying activity and ordered that the leases of quarrying including their renewal for an area less than 5 Ha be granted by States/Union territories only after getting EC from the MoEF. In order to ensure the above order of the Honourable Supreme Court, MoEF issued Office Memorandum (OM) on 18th May 2013 making all mining projects including mining of sand, clay and stone quarrying with lease area less than 5 Ha would be treated as category 'B' projects and will be considered by the respective State Environmental Impact Assessment Authority (SEIAA) after appraisal by the State Expert Appraisal Committee (SEAC). This important decision made mandatory for the State governments to include thousands of legal and illegal ongoing and proposed minor mineral mining activities for EIA before granting EC.

MATERIAL AND METHODS

Kolhapur district is situated in the southern most part of Maharashtra State between 15° 43' and 17° 17' north latitude and 73° 40' and 74° 42' east longitude. Total seven representative quarry sites namely Top, Chipri, Borpadale, Abdullat, Kasaba Thane, Sangawade and Borawade were selected to study the environmental and social impacts of stone quarrying (Fig. 1).

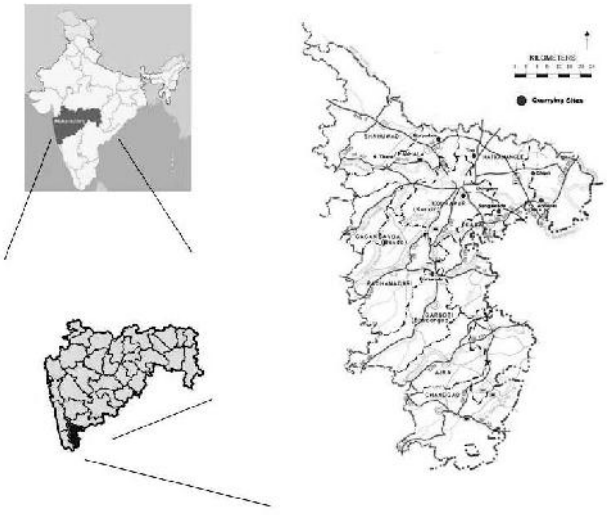

Fig. 1. Location map of study area showing quarrying sites

Methodology included field observations, photo documentation and mapping and quarry area measurement on Google Earth Satellite images, to assess the change and status of environmental impacts of quarrying. A structured questionnaire to know the local people perception about the impacts of quarrying was administered in the field during the study. Stratified random sampling technique was used on the basis of different parameters such as gender, in which 75 % males and 25% females were selected for the study. The stratification was also carried based on age groups which included youth below 25 years (25 %), adults between 25 to 50 years (50%) and seniors above 50 years (25%). On the basis of disproportionate sampling, the sample size for the questionnaire survey was 150 comprising of Top (25), Chipri(25), Borpadale(20), Abdullat(20), Kasaba Thane(20), Sangawade(20) and Borawade(20).

RESULTS AND DISCUSSION

The state of Maharashtra is mostly covered by basaltic rocks and is commonly known as Deccan trap. More than 70% of the area from part of Nagpur District in the east to Western Ghats in the west is fully covered by these rocks having enormous thickness. Stone in India is considered as a minor mineral and fall under the control of state government. Quarrying activity is in boom in the district. Rapid urbanization as result of industrialisation and socio-economic growth in the districts as tremendously increased demand for building materials, roads and infrastructure. The country side in most of the district is therefore dotted with abandoned or operating stone quarries and their number is ever increasing.

Field Observations

The selected quarries for the study were located at an elevation between 553m to 650 m above MSL. At sites Top and Borawade, large hillocks of elevation in the range of 605 to 640 were being cut for the removal of both murum and stone. Study sites namely Top, Chipri, Sangawade, Abdullat and Borawade and Borpadale had presence of old and abandoned quarries in addition to the ongoing quarries in the quarry clusters. While at Kasaba Thane site two small quarries were found for the construction of road. As per the year wise measurement of quarry area with Google earth satellite images, as compared to other sites, the quarry surface area expanse was more at sites such as Sangawade (87 ha), Top (86 ha), Chipri (57 ha) and Abdullat (55 ha) (Table 1).

Table 1. Location and area of the study quarry sites

S.No	Name of Village	Location	Elevation in m above MSL	Area in Ha	Year
1	Top	16^0 47'11.47"N: 74^0 16'17.40E"	570 to 640	86	2013
2	Chipri	16^0 45'27.37"N: 74^0 32'08.98"E	567 to 580	57	2013
3	Sangawade	16^0 38'24.91"N: 74^0 19'28.95"E	565 to 600	87	2013
4	Abdullat	16^0 38'05.47"N: 74^0 30'33.46"E	563 to 575	55	2013
5	Borawade	16^0 25' 05.81": 74^0 30'33.46"	576 to 650	11	2010
6	Kasaba Thane	16°46'12.13"N :74° 5'13.44"E	553 to 569	1	2007
7	Borpadale	16^0 50'10.96"N: 74^0 08'00.83"E	624 to 644	9	2007

While at other sites namely Borawade (11 ha), Kasaba Thane (1 ha) and Borpadale (9 ha) the quarry area was found to be comparatively less. The depth of the quarries varied from one site to other. Quarries of massive depth above 15m were observed on sites namely Chipri, Sangawade and Top. The depth of one of the old abandoned quarries at Top was found to be in the range of 19 to 40m in height (Fig. 2).

Fig. 2. Massive depth quarries with accumulated water at Top

At Chipri an abandoned quarry in the range of 21m depth (of which roughly 0.5m murrum) was observed (Fig. 3). At Sangawade one quarry was about 23m deep. While at other quarry two benches of height 9.4m and 15.5m respectively, were observed. At the sites Abdullat and Borawade the depth of the quarries ranged above 7.5m. Quarry of 9m depth (of which approximately 3.3 m murrum) was found near Kasba Thane. While at site Borpadale the depth was about 9.7m in height. Importantly none of the quarry sites had mandatory protective walls or fencing around its periphery, display or warning sign boards around the quarries and they posed serious threat to life of humans and cattle alike.

Fig. 3. Huge depth quarry near Chipri

The quarries located near village Top are surrounded by agricultural lands on all sides. Massive old abandoned quarries, with accumulated water are located in the Top quarry cluster. The NH 4 highway passes very close i.e. at a distance of 25 m from the quarries. The large quarry cluster is located at the bottom of a slope of hillock, which has an elevation in the range of 628 to 691 m above MSL is which is also being used for quarrying activity. More than 30 stone crusher plants are located on the south-west side from the quarry cluster which are the major source of dust and noise pollution in the region.

The quarries at Chipri are in close proximity of agricultural field, fruit orchards as well as residential area. More than 15 stone crusher plants are located on the west side from Chipri quarry cluster. This is the major source of dust and noise pollution in the region. The quarries located at Borpadale border the agricultural lands and are also close to the village. Pits from where murrum deposits were removed can be seen on the site. The quarry cluster at Abdullat is also surrounded by agriculture landscape. There also is presence of a perennial canal close to the stone quarries. At Kasaba Thane two quarries which are close to river Kasari and KT weir on the river. Quarry 2 is located at a distance of 107 m while quarry 1 is at 9 m from the river Kasari on its west side. In the north of quarry 2 KT weirs is located at a distance of 0.15 km, while on east side there is a plantation at an elevation of 577 m to 618m above MSL. It was noticed that the blasting activities had led to sinking of pump set and electric motors of some of the farmers into the river. This had also developed cracks in the structure of the nearby K.T weir, which was about to collapse. However, in this case the quarrying company had compensated for the losses.

The Sangawade cluster there is a large number of abandoned as well as ongoing stone quarries and stone crushers, surrounded by agricultural lands. Continuous quarrying and stone crushing operation were found to be the main sources of dust and noise pollution in the area. The Borawade quarry cluster is also surrounded by agricultural land which shows presence of a canal near the quarries. A hillock of 650 m height above MSL is being cut down for the quarrying purpose. Of the 11 Ha area in the Borawade cluster, about 3 Ha area is a part of this hill which is being cut. The quarrying and stone crushing activity is affecting the local environment in the region. One of the major concerns about the quarrying activity is the safety of people around the quarries. Since most quarries are located in close proximity to houses and dwellings, the locals are more prone to the accidents caused by the stone quarrying activities. At Borpadale one woman had lost her life due to stone hit during blasting in the quarrying. In the past too similar accidents have taken place at Sangawade site. During field visits to Sangawade the stone debris generated during blasting could actually be seen and it was clear how one may suffer from such accidents. Abandoned quarries are another major but ignored problem as most of them lack protection of retaining walls or fences around the border of the steep sloped quarry.

None of the quarries are reclaimed or even an attempt was made to do so, despite this being mandatory as per the existing mining regulations accepted by the mine owner. And as they are not reclaimed are potential health hazards, and prone to serious accidents. One person had lost his life in a quarry located at Chipri, while 2 children were injured in one of the abandoned quarry at Sangawade. Locals and cattle were insecure at all the non reclaimed/restored abandoned quarry sites after the incidences of accidents, It was a striking

observation during pilot survey as well as field studies that not a single quarry site was either restored or reclaimed as per the laid down procedures, even there was no sign of any such attempt to do so. This was also confirmed in interaction with the locals and mine workers. Strangely no information was available about the present status of stone quarry with the DMO i.e. total estimated material was to be removed, how miuch is exactly removed till date, up to what depth the excavation is permitted and done, what regulations are to be followed and in case of violation what actions are taken against the concerned parties. How many illegal quarries are there and what is their present status etc. what are the current standards about the permissible height, hill cutting angle, maximum depth of a quarry allowed etc. the DMO did not have any satisfactory information about any of them. Neither had he had satisfactory information about the location, number, status of all the quarries in the district. This became evident when the SEAC in 2013 asked to furnish the details to all the DMOs in the state. This reflects the scant concern to a major activity causing serious and permanent negative environmental impact on the ecology of the region.

Respondents' perception about the environmental impacts of Quarrying

In the Social Impact Assessment (SIA) survey of the impact of stone quarrying on local environment information was generated through interview technique. This revealed vital information from the respondents. On educational level it was found out that of the sampled population 20 % were illiterate. Among the literates 25% had reached up to primary education, 28 % secondary, 30% higher secondary 13% graduate, 3% Diploma and 1% post graduate. Though the graduate percentage was less in the sampled population the literacy level was higher with only 20% being illiterate.

Within the surveyed area the respondents were reported to be involved in diverse livelihood activities such as agriculture, service, mining and agriculture labour. Majority (51 %) of the respondents had agriculture as their main occupation. 16% of the respondents were involved in diverse services, 13% carried out household work, only few 6% worked as mine worker while 5% work as labours in agricultural fields. It was interesting to note that such a small population (6%) was involved in the stone quarrying activity despite it being the major changed landuse in the region. The major crops cultivated in the study areas were sugarcane, vegetables, rice and maize. Most respondents in the study area belonged to lower middle class with 40% had their monthly income ranged between Re. 5001 to 7000 and 27% had it between 3001-5000. About 13% had low income i.e. below Re.3000 while about 20% earned above Re. 7000 per month. It was revealed that majority of the respondents (70%) mentioned that they experienced negative effects of the dust pollution due to quarrying and stone crushing activity (Fig. 4). This finding was justified by using the test of significance for proportion ($Z_{Calculated}$ 4.89 > $Z_{Tabulated}$ 1.96). The response was stronger in descending order by locals from sites at Top (88%), Chipri (80%), Borawade (75%), and Abdullat (70%) Borpadale (60%), Kasaba Thane (60%), Sangawade(50%). The difference in the percentage at various sites was mainly due to fact that Top, Chipri, Borawade Abdullat and Borpadale have presence large number of stone crushers closely located to the residential area.

Fig. 4 Crusher emitting dust near village Top

The negative effects of dust pollution, due to quarrying and stone crushing, on the health of locals as quoted by the respondents were impact on fodder of cattle (51%), respiratory problems (44%) accumulation of dust on homes (40%) and irritation of eyes (50%) (Fig. 5).

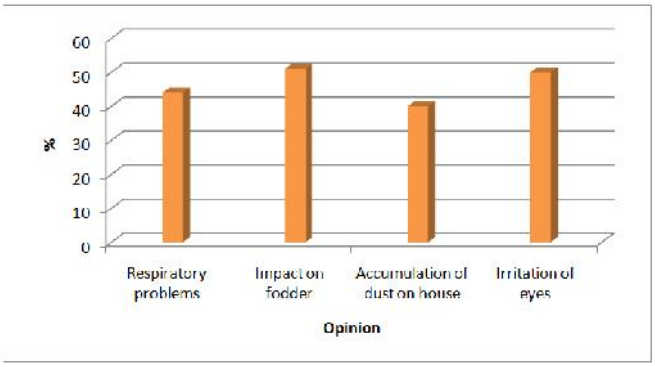

Fig. 5. Effects of dust pollution on local people

Whereas above 76% of the respondents complained about these negative effects of dust pollution on agriculture (Fig. 6). The two major negative impacts of dust pollution on agriculture, as per the respondents, were reduction in agriculture yield due to dust deposition on crops (75%) and reduction in availability of water and ground water (25%). The locals revealed that they were experiencing more than 50% reduction in the overall agricultural production in last few years. One of the common problems faced by the local farmers was that the agricultural labours were reluctant to work in the dusty atmosphere and it was getting difficult for the farmers to hire agriculture labours. Some of the locals from Chipri site have even filed a case in court against the concerned quarry operator. Similar situations increasingly added tension in the social fabric of the area. Also majority (70%) of the respondents agreed that the fruit trees in the surrounding area have also been affected on account of dust pollution, which has resulted into their stunted growth and decreased fruit yield as a consequence of dust accumulation on

these fruit trees. The available water sources in the study area varied from one site to other which included groundwater sources such as well water, hand pumps, tube wells and surface water sources such as stream, canal and tap water. When enquired about the availability of water source, some (34%) said that they experienced scarcity of water. However, the response about the scarcity of water was more evident from sites at Top (72%), Abdullat (65%) and Chipri (60%). The respondents from these sites were very sensitive about this problem and alleged that the stone quarrying activity has disturbed the aquifers, resulting in reduction in the groundwater level. This in turn had also affected the agriculture yield due to non availability of water source.

Fig. 6. Stone crushing activity close to agricultural land at near village Borawade

A vast majority (80%) of the respondents stated that they suffered severely from the noise pollution caused from the stone quarry related activities. The test of significance (Z test) of proportionality for the effect of noise pollution on locals was used to find out the local's perception about the impact of noise pollution. At 5 % level of significance the calculated Z value was found to be greater than the tabulated Z value ($Z_{Calculated}$ 7.34 > $Z_{Tabulated}$ 1.96). This justifies that there is a negative impact of noise pollution on locals. As per the respondents the major sources of noise pollution were use of dynamite in blasting operations in quarry (64%), followed by noise by stone crushers (36%) and transport of stone material by truck/dumper/tractor etc. (28%). The major effects of noise pollution on the health of people in the area around the stone quarries, as per the respondents, was in descending order, were fear due to loud noise and vibrations (66%), loss of peace (53%), increase in heart beat (45%), headache (28%). Some (19%) feared about development of cracks in their house and others (8%) about potential of accidents due to quarrying operations. The respondents from Top and Chipri were more responsive about the stone blasting activities as many of them had already suffered from damage to their property. About 65% of the respondents from all the study sites revealed that their area, before the initiation of stone quarrying operations, was stony outcrop or barren land, with little vegetation and grasses with average biodiversity. However, about 60% of the respondents from Chipri site opined that before stone quarrying the area was an agriculture land. In general about 47% of the respondents revealed that the stone quarrying activity also goes on during night time. When enquired about the employment generated locally by the quarrying activity, only 25% agreed that stone quarrying provided employment in the form of mine labour and transport. It was observed that the trucks, dumpers and tractors for stone and aggregate transports are either independently owned by the respective quarry owners or they belonged to local fleet contractors. A majority (75%) of the respondents revealed that most stone quarry labours have migrated from neighbouring other states and are hired on contract basis. About 50% of the respondents believed that the truck/tractor transport activity in and out of the quarry was not safe and that they were worried about it. A majority (75%) of the respondents confirmed that the stone quarrying is not a better and sustainable alternative to the traditional means of livelihood such as agriculture, business or service etc. They also agreed that future planning is not possible by the earnings from employment in stone quarrying activities as it is short time, seasonal and uncertain as it would continue only till the stone deposits last in the quarry.

Conclusion

Increasing demand for stone and aggregates has led to extensive uncontrolled stone quarrying operations in Kolhapur district causing increased environmental degradation and socio-economic conflicts. Among the benefits realized in the study area due to stone quarrying include employment generation, infrastructural development and valuable revenue in the form of royalty to the government through legal mining activity. But the employment potential of the stone quarrying for locals was observed to be limited as most workers employed were from outside the area and state like Karnataka state. It is to be noted that in spite of its remarkable direct and indirect contribution towards development, quarrying is also responsible for several negative environmental and socio-economic impacts, particularly when the quarrying activity is carried out haphazardly and not as per the prescribed norms and regulations.

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