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Limestone quarrying and its effects on environment - A multiagency approach study

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ABSTRACT

Concerns about the impact of quarrying are hardly new. Complaints about quarrying activities were voiced before 1890s. The issues of concern have not changed over time – visual intrusion, damage to landscapes, traffic, smoke, noise, dust, pollution and loss of land. Quarrying is very much part of the local heritage, but most of the peoples well aware of the negative impact of quarrying. The aim of the present study is to determine sensitive and specific areas that urgently need planning for sustainable resource and environmental management. In this context, a combination of Remote Sensing (RS) and Geographic Information System (GIS) tecchnical tools were employed. Based on the GIS studies, the Shahabad Basin was selected as the model sensitive region and was studied by using latest Landsat satellite imagery. These results indicate that amongst all the industrial areas lying on KAGINA RIVER basin, the Shahabad area is largest & most populated in this region. Shahabad area was further examined to determine the expansion of urban areas over a time period of 16 years using Landsat images. Finally, interpretations were done on the prevailing environmental situation. Our study not only delineated the importance of applying environmental policies but also demonstrate the effective pollution management.

KEYWORDS

Multiagency system (MAS);
Remote sensing (RS);
Geographic information system (GIS);
Quarry, pollution and sustainable development.

INTRODUCTION

Quarrying is necessary to provide much of the materials used in traditional hard flooring, such as granite, limestone, marble, sandstone, slate and even just clay to make ceramic tiles. However, like many other man-made activities, quarrying causes a significant impact on the environment[1]. This activity is the basic chunk of the revenue of this Hyderabad Karnataka region. In particular, it is often necessary to blast rocks with explosives in order to extract material for processing but this method of extraction gives rise to including noise pollution, air pollution, damage to biodiversity and habitat destruction.

The term 'quarry' popularly implies shallow or surface workings. The governments commonly use the term 'quarries' to imply licensed ASM (Artisinal Small Mines/ Quarries) operations. The terms 'small mines and quar-

ries' as well as 'ASM' to mean all licensed small, medium and some large mechanized enterprises, unlicensed and unregulated and small operations, scavenging operations, and finally non-legal (beyond the legal domain) practices of small scale mining[2]. A range of minerals is mined in India, but expecting the gemstones industry and some scattered gold and diamond in India, the largest segment of the minerals are low value, building/construction materials and coal; there are one or two exceptions such as some export-oriented marble and mica in India.

The term ASM and 'small mines and quarries' are interchange. Although in India with its long tradition of mining the term 'artisanal' mining takes a different connotation[3]. Artisanal mining, however, has no legal acceptance and the more popular term is 'small-scale mining' or SSM.

'Informal' implies the large range of activities and practices in mining and quarrying: digging, cutting, panning, processing, breaking, amalgamating, carrying, transporting, and marketing of a wide range of minerals or products from the earth's surface or the interior.

An older study by Carmen and Berger (1990) puts the figure in India at around 0.5 million people as employed in the small-scale mines. Since then, mining has increased in pace and the fact of informalisation of mining has become a reality.

The natural resource profile of Karnataka state

The natural resources of a region include the air, water, land, biodiversity and ecosystems, *etc*. The state of Karnataka is well endowed with many of these resources. Besides, the state has rich deposits of mineral wealth, distributed more or less evenly over its territory. These deposits contain Asbestos, Bauxite, Chromite, Dolomite, Gold, Iron Ore, Kaolin, Limestone, Manganese, Ochre, Quartz, Silica Sand, *etc*. The total available reserves of different minerals of the State are shown in TABLE 1.

Natural Resources are indispensable not only for sustaining life but also as an important input for economic growth. The global economy is expanding amidst global depletion in the natural resources. Due to poor availability of information on various aspects of natural resources and problem of quantification of natural resources, it is not possible to fully assess the damage being done to natural resources[4]. It is therefore necessary to develop a system of accounting of natural resources, which is likely to provide ample support to design the economic system, in such way that it is possible to attain economic growth without destroying natural resources[3]. The concept of Sustainable Development and natural resource accounting started almost three decades back and the procedures for accounting evolved gradually after identifying the gaps in the System of National Accounts. A necessity of combined technical approach was felt to initiate specific case studies with reference to selected items of natural resources and also in the context of specific regions.

TABLE 1 : Mineral resources of Karnataka

S.No.	Mineral	Total recoverable reserves (in Lakh Tonnes)
1.	Bauxite	273.32
2.	Copper	56.69
3.	Calcite	164.07
4.	China Clay	128.57
5.	Dolomite	3461.52
6.	Feldspar	1876.40
7.	Corundum	152.94
8.	Gold Ore	128634.34
9.	Granite	2029.86 Crores CUM
10.	Graphite	2625.00
11.	Lime Stone	174395.16
12.	Manganese	410.54
13.	Quartz	380.43
14.	Silver Ore	53776.24
15.	Iron Ore (Hematite)	10720.00
16.	Iron Ore (Magnetite)	27840.00
17.	Vanadium	88420.00
18.	Vermiculite	418.39

Source: Geological survey of India report.

INEXHAUSTIBLE RESOURCES

Dimensional stone resources are widespread in India. The calcareous stones are largely spread over the Northwest and the siliceous stones in the Deccan peninsula in South. With immense resources of Flaggy Limestone and Quartzite, Gulbarga district is a treasure trove of dimensional stones in the world & is regarded as Cement Kasi.

A significant portion of the global limestone industry is shared by limestone India. Among various dimensional stones, limestone figures as one of the most extracted and commercially viable stones. Limestone is sourced from different regions of India. Indigenous resources of machinery and tools have lifted the processing and finishing standards. The Indian market is shared by big limestone suppliers as well as small regional players.

The well known South Indian limestone, also known as Shahabad slabs is most popular in its blue- grey and buff color shades. Shahabad limestone stone is known to be tough, non- water absorbent, stratified, bedded. This slab stone is processed and finished in different sizes and thicknesses by limestone suppliers.

The Shahabad limestone is available in a wide range of colors blue & buff. This can be honed, polished, brushed & tumbled. These are located in the well known famous sedimentary Bhima basin.

Flaggy limestone: Deposits are widespread in Rajasthan, Karnataka and Andhra Pradesh Important varieties are Greenish Blue, Pale Brown and Black.

Figure 1 : Panaromic view of Shahabad limestone.

WORLD LEADER IN PRODUCTION

India is the largest producer of stones in the world accounting for over 30% of the world stone production. The Indian stone industry has been growing steadily at an annual rate of around 10% per year for the past few years. However, it leapt by a phenomenal rate of 30% in the last year (FY 1999-2000). TABLE 2 depicts the production data of stone from India.

TABLE 2 : Indian stone production (In thousand tons)

	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2001-05	2006-08
Marble	1966	2244	2086	2627	3186	3712	3622	3761	4754	4891	5284
Granite	989	3073	3618	4460	4555	4550	4950	5000	5300	5690	5840
Sandstone	4411	4435	3978	3304	4562	5501	5461	6310	9297	10512	10580
Flaggy Limestone	620	996	823	1407	1760	1710	2118	1428	1619	1940	2289
Slate	3	5	4	9	7	11	10	7	12	14	19
Total	7989	10753	10509	11807	14070	15484	16161	16506	20982	23317	24012

APPLICATIONS OF LIMESTONE

A generation of art sensitive middle class has emerged in India .The use of limestone India has also increased subsequently in flooring, cladding, roofing etc. New technologies have brought high expertise and perfection in its decorative uses. The limestone suppliers are working in close contact of the designers to build a vibrant limestone industry in India.

The rich rugged of limestone is thought to be the reason behind its popularity in cement production and interior & exterior decorations. Limestone can be used anywhere in home - sinks, statues, wall panels, floors etc. It is a versatile stone in the true sense.

Architects and designers have great scope to unleash their creativity working with limestone. It is a wonder that a stone so elegant does not need too much maintenance. Compared with granite and marble, limestone can be kept free from scratches more easily. The scratches are more visible on granite and marble than on limestone. Because of its slightly coarse texture and natural looks the use of limestone adds style to any room.

Environmental damages caused by quarries

Identification of the environmental risks associated

with quarry requires the characterization and quantification of their different types but also an assessment of the vulnerability of the specific environments contingent upon the geological and hydrogeological conditions and peripheral targets[5].

1. Characterization and quantification of the different types of waste. This study is based on quarry-by-quarry inventory, within the District, of sites associated with the management of mining & quarrying. It represents the first overview of the current situation in Shahabad as regards mining waste.
2. The survey involved two approaches:

i. a questionnaire related to the quantities of existing waste, associated with the typology of the mined substance(s), waste deposit(s) and mining systems and processing method(s),

ii. an estimation, on the basis of the different processes employed throughout the production chain in mining operations and their management at each level, of the main types of waste generated over the last five or ten years.

Comparison between the estimated data with the data obtained from the questionnaires reveals differences in the results that are due mainly to different regulatory approaches to fill in the questionnaire. Furthermore, legal definitions concerning the types of mining waste, from both the exploitation and processing standpoints may differ in spite of a common definition.

Assessment of risks linked to mining waste: The notion of environmental impact of mining activities is only fully meaningful if it includes a change in the initial environmental parameters, due to such activities[6]. These parameters, which govern the "quality of the environment", may have several components: chemical composition of the surface and ground waters, soils, biological diversity; visual aesthetic qualities, etc.

3. Improvement of management of waste

Mines are governed by a set of laws, generally combined in a Mining Code. The numerous regulatory texts, laws and standards, reveal that mines are a matter of concern to the national administrations. Mining/Quarry waste is governed by general waste laws and texts. The extent, to which environmental concerns are addressed in these national laws, varies from mineral to mineral.

The major risks linked to mining/quarrying for the environment are twofold:

Risks associated with not only potential pollutant source but also the specific environmental context and the presence of targets in the event of liberation. The possible risks from the potential pollutant source in waste is dependent not only on the mineral characterization of the solid but also on the quality of the potential slabs, the direct environment (soil, groundwater, surface water, air) and the potential targets (human, fauna and flora)[7].

The operating and non operating quarries have a long term damage to the environment and are discussed below:

Air pollution

Dust from quarry/mine sites is a major source of air pollution, although the severity will depend on factors like the local micro climate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry[8]. The limestone quarries produce highly alkaline (and reactive) dust causing silicosis. Monitoring ambient air quality in and around Gulbarga District became a challenge to the local authorities.

The air pollution is not only a nuisance (in terms of deposition on surfaces) and possible effects on health, in particular for those with respiratory problems but dust can also have physical effects on the surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, as well as chemical effects which may affect long-term survival.

Noise pollution

Unfortunately, quarrying involves several activities that generate significant amounts of noise. It starts with the preparatory activities, such as establishing road or rail access, compound and even mineral processing facilities. Next is the process of exposing the mineral to be extracted and this is usually done by removing the top soil and other soft layers using a scraper, or hydraulic excavators and dump trucks. The excavation of the mineral stone itself will involve considerable noise, particularly is blasting methods are used. Following this, the use of powered machinery to transport the materials as well as possibly processing plants to crush and grade the minerals into cankers and other required size, all contribute even more noise to the environment.

MATERIAL AND METHODS

The present study aims at developing a methodology for natural resource accounting in the Gulbarga dist. state of Karnataka with a focus on selected natural resources. The aim of the study is to determine sensitive river basins and specific areas of quarries that urgently need planning activities for sustainable resource and environmental management. In this context, a combination of Remote Sensing (RS) and Geographic Information Systems (GIS) were employed. For this purpose, a comprehensive overview of the current situation of KAGINA river basin in terms of existing spatial data was provided and all tabular data gathered from the regional authorities on regional basis was assessed in combination with the Geometric Data of Kagina river basins in a GIS environment. Considering the GIS studies that covered entire basin, the Shahabad Basin was selected as the model sensitive region and was studied in more detail by using latest Landsat satellite image.

The realization of a Remote Sensing (RS) and Geographic Information System (GIS) specific to mining waste quantities and their pollution potential in different environmental contexts would thus constitute a tool in the assessment of risks linked of such materials[9]. At the moment, such systems are used for the information management on land use/cover planning. The risk management with a RS- GIS system in mining requires a considerable collection of specific data and additional series of external analyses. Then, results can be visualized successfully in the GIS system.

Mining-selected waste or tailings can be defined as a part of materials that result from the exploration, mining and concentration of substances governed by legislation on mines and quarries.

Environmental statistics

The increasing threat of pollution has persuaded both the state and central governments to assign one of the highest priorities to pollution control. The database prepared for this study will address the environmental statistical requirements arising from the need for environmental decisions on the following, among others:

1. Population pressure on biodiversity
2. Air quality – outdoor and indoor
3. Noise
4. Waste
5. Water
6. EA & Planning
7. Strategic Environmental Assessment
8. Conservation
9. Energy Efficiency and Conservation
10. Environmental monitoring

RESULTS AND DISCUSSION

Results of this comprehensive study indicated that all the industrial areas of the Bhima basin are largely most populated and urbanized. Shahabad area was further examined to determine the expansion of Industrial area over a time period of 16 years using Landsat images. Finally, interpretations were done by combining the demographic and statistical data on Land use and land cover, effect of dust on plants to present the prevailing situation of the environment[10]. Our study not only delineated the importance of applying environmental policies correctly for the efficient installation and operation of Cement industries in Gulbarga District., but also demonstrated that effective pollution management.

According to the returned questionnaires, a distinction can be made between the following three types of mine/quarry and related generated waste:

- Abandoned/old mines,
- Operating mines based substantially on old operating methods,
- Operating mines based on new design.

Figure 2 : Typical abandoned quarry photograph

CONCLUSION

For abandoned mines, it is important:

- to undertake site monitoring (including land form(s), geology, soil type(s), hydrogeology, flora and fauna, land use, heritage, overburden and waste characterization, etc.) to obtain a clear picture of the situation;
- to establish treatment objectives according to required future land use (for example, pollutant level in soil after treatment to be fixed depending on the proposed land use).

For operating quarries,

- For operating mines based substantially on old operating methods, it is essential to evaluate the control routine as regards pollution risks and the stability of the tailings and to take all necessary measures to limit risks. Substantial changes in the operation and monitoring phases are likely to be necessary to ensure a sufficient level of environmental protection.
- For operating mines based on new design, it should be evaluated whether these installations as well as their control routine are sufficient to prevent risks of pollution or accident. Additional measures could be considered if necessary.

The performance of old and new installations in terms of emissions and discharges have to be evaluated in order to see if differences in methods have an impact.

All management of mining waste disposal facilities must take into consideration long term environmental issues. Closure and after care operations are therefore of paramount importance to lower, as far as possible, the long term environmental risks.

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