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Research Article

An evaluation of the environmental effects of gypsum mining in Maharashtra's Nagaur District

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ABSTRACT

This article examines the environmental effect and sustainability index of gypsum mining activities in Rajasthan's Nagaur area. One of the key industries for a nation's economic development is mining. It also supplies essential minerals to meet basic human requirements. Although mining is seen as a harmful activity for the environment, it cannot be stopped since it is essential. As a result, a thorough analysis is needed to determine how mining affects the ecosystem. The rapid impact assessment matrix (RIAM) was used in this case study to evaluate the environmental effect of gypsum mining. The study's findings indicated both detrimental and beneficial impacts. Positive effects were evaluated on the economic operational component of the environment, whereas negative effects were noted on the physical, chemical, ecological, biological, social, and cultural components. When the sustainable index of the gypsum mining activity in the Nagaur area was evaluated, it was found to be -0.05, indicating that the current mining operations are not sustainable. The current research also made the suggestion that new regulations may be implemented in order to meet the objectives of sustainable development.

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Introduction

The mother of biotic factors like plants and animals as well as abiotic factors like minerals is Earth. Beneath the earth's surface lie minerals, a hidden treasure. This same surface also provides a foundation for plants to sprout and flourish, as well as a dwelling area for animals. The earth's surface divides minerals from living things, and the two are mostly unrelated to one another. Plantations are used to nurture plants on Earth, while mining is used to explore the planet for minerals. Mining and plantations are unrelated industries that engage in separate activities. However, it is noted that both mining and planting operations are carried out in some of the various locations; as a result, given their connected nature via the surface, they can have an effect on one another.

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Mining is unquestionably a productive and vital industry that has a negative influence on the environment and a good effect on the economy. Mining operations have a detrimental effect on the environment and contribute to contamination of the air, water, soil, and noise [1]. It's interesting to note that mining activity's financial gains are the sole reason ecology is being ignored [2].

One of the main objectives of emerging nations like India is sustainable development, given their limited resources and growing populations. Situated in the country's northwest, Rajasthan is the biggest state in terms of land in India. All categories of minerals, including metallic (copper, zinc, silver, etc.), non-metallic (China clay, gypsum sandstone, etc.), and fuel minerals (coal, fuel oil), are accessible in the state, which also leads the nation in mineral output. More than 95% of India's gypsum is produced in Rajasthan, which also exports gypsum all over the globe. Gypsum is a common building and construction material, and its chemical composition is CaSO4.2H2O. The need for gypsum is rising in both the agricultural and building sectors as a result of the expanding population. Gypsum mining is also expanded in the same amount to meet the need. Bikaner, Barmer, Nagaur, and Jaisalmer are now the main gypsum-producing districts in Rajasthan.

Numerous studies on diverse mining sites and environments have been conducted independently by geologists, environmentalists, ecologists, botanists, and zoologists. It is still necessary to concurrently research all elements of mining and the environment in combination. The influence of gypsum mining on the surrounding environment is evaluated in the current research using a set of factors to determine the outcome. The current research additionally determines the sustainability index in addition to the evaluation of the environmental effect of gypsum mining. The environmental effects of mining and quarrying may be lessened or even reversed with significant effort and appropriate government and private sector management [3]. The study's findings provide a framework for the effective future implementation of sustainable development objectives in the gypsum mining region. Numerous studies that demonstrate the important function gypsum plays in agriculture have been reported in the past. Still,

The gypsum dust is spread by wind and deposits itself on soil surfaces during the mining and processing of the gypsum. This research addresses the effects of gypsum dust passive circulation with a geographic emphasis on western Rajasthan, namely the gypsum mining region of Nagaur district. (a) Scenario of the environment. The research region is located in the middle western Rajasthani district of Nagaur, as seen in (Fig 1). The mining areas in the Nagaur district that have been chosen for this research are Bhadwasi in the Nagaur block and Goth Manglod in the Jayal block . In Nagaur block, the study area is situated between 27^ 17 ' 41" N and 27^ 21' 19¯N latitude, and between 73^ 38 ' 48.79¯E and 73^ 48' 11.50¯E longitude. In Jayal block, the study area is situated between 27^ 13 ' 22¯N and 27^ 14 ' 56 ' N latitude, and between 74^ 3' 24 ' E and 74^ 4' 11.8 ' E longitude. The whole region is located in an arid zone. The temperature in the region varies greatly over the course of a year. As shown in Figure 2, it experiences temperatures ranging from a high of 50˚C in the summer to a low of 12˚C in the winter. The research region does not contain any rivers. close to the gypsum mines.

(a) Evaluation of mining operations

Open cast mining is the process used to mine gypsum. Regular on-site surveys and observations of the mining region record primary data about gypsum mining and its effects on many parameters. Secondary data is gathered from various government publications (both central and state), RSMML data, the annual report of the Indian Mineral Department, and other sources. Examples of this kind of data include the area's mineral reserves, total mineral output, and other information.

(c) The Rapid Assessment of Environmental Impact (RIAM)

Since gypsum is deposited across a very wide region, it is extremely difficult to evaluate in a short amount of time how mining has affected each specific environmental component. Although there are many assessment tools and methods available for evaluating the impact of the environment, Pastakia and Jenson's [5] rapid impact assessment matrix (RIAM) is chosen for this case study because it is a decision-making tool for assessment in a larger site and is transparent, accurate, and easy to use. The elements of the elemental matrix are

simple to get and comprehend. Based on the evaluation criteria, two groups were identified: Group A and Group B. Group B symbolizes the situation's worth, whereas Group A serves as the standard for the condition's significance.

As shown in Table 1, Group B is categorized in HA1, HA2, and HA3, whereas Group A is further defined in HA1 and HA2. The following formula determines the study area's environmental score: Whereas the environmental score of the condition is defined by ES, the result of the multiplication of all group A scores is supplied by αt, and the result of the summing of all group B scores is defined by βt. The RIAM approach divides the environment's component parts into the following four groups. The criteria listed in Table 1 determine the value of each component. The components PC, BE, SC, and EO stand for physical/chemical, biological/ecological, sociological/cultural, and economic/operational, respectively. The values of the specified criteria are entered for each of the aforementioned components, and the matrix is then calculated to get the environmental score.

Table 1 Criteria and description of group A and Group B [4]

Criteria	Scale	Description
α1 Importance of condition	+4	Importance to national or international interests
	+3	Importance to regional or national interests
	+2	important to areas immediately outside the local condition
	+1	only local condition
	0	No importance
α2 Magnitude of effect	+3	Major positive benefit
	+2	significant improvement in status quo
	+1	Improvement in status quo
	0	No change
	-1	Negative change in status quo
	-2	Significant negative change
	-3	Major negative change
β1Permanence	+1	No change
	+2	Temporary
	+3	Permanent
β2Reversibility	+1	No change
	+2	Reversible
	+3	Irreversible
β3Cumulative	+1	No change
	+2	Non-cumulative
	+3	Cumulative

An environmental score in the +E range band, or between +72 and 108, is thought to have a significant beneficial influence. With range band +D, the range is significant positive between +36 and +71, and with range band +C, the range is moderately positive between +19 and +35. favorable and marginally favorable impacts are, respectively, +1 to +9 with range band +A and +10 to +18 with range band +B. No change is indicated by ES=0. With range band -A, ES between -1 and -9 is seen as having a little unfavorable influence. The range bands -B and -C, correspondingly, are regarded as having a negative influence (ES= -10 to -18) and a significantly unfavorable impact (ES= -19 to -35). Significant negative effect and large negative impact are defined as ES= -36 to -71 with range band -D and ES= -72 to -108 with range band -E, respectively.

(d) Calculating the indicator of sustainability

After generating the matrix, the environmental score may be determined using RIAM. The Sustainable Development Model [6] is used to determine the sustainability index for a chosen research region. Using the original numbers, the RIAM overall environmental score is negative. When the overall environmental score is negative, the sustainable development model produces an incorrect outcome. The relative environmental score is determined by multiplying the environmental score of each component by 108 in order to eliminate this mistake. Because each component has a capacity of 216, the relative environmental score ranges from 0 to 216. The formulae below are used to determine the environmental score (E) and human needs (Hn). The relative environmental scores for Physical/Chemical, Biological/Environmental, Sociological/Cultural, and Economical/Operational are represented by the letters PC, BE, SC, and EO, respectively. The maximum capacity of the Physical/Chemical component is represented by $PImax$, the Economic component by $\mathbf{D}Omax$, the Biological/Ecological component by $B\mathbf{D}max$, and the Sociological/Cultural component by $SCmax$.

END RESULTS AND TALK

The district of Nagaur plays a significant role in the nation's gypsum production. There are only two mining blocks in the world: Jayal and Nagaur. The government has approved 16 mining sites totaling 2660 hectares in size. Of the sixteen, two are run by RSMML, while the other fourteen are owned by private companies. Eight of the sixteen mining sites are located in the villages of Kherat and Manglod in the Jayal block, while the other eight are in the villages of Golsar, Makori, Jeevanbera, Bhadwasi, and Ganthilasr in the Nagaur block. Except for the Goth Manglod site, where it is discovered as a translucent crystal coupled with clays, gypsum is found in sedimentary deposits in other sites [6]. The government estimates the value of gypsum produced annually and at each mining location, recording the data for statistical purposes. Every element of the ecosystem is either directly or indirectly impacted by this economic activity. The goal of this research is to evaluate how these mining regions are affecting the ecosystem. This section discusses the study's findings.

Chemical and physical

The physiochemical characteristics of the surrounding environment are impacted by gypsum mining in both direct and indirect ways. The pace of mining and the distance from the mining site affect how much of an effect there is. The dispersal of gypsum particles around mining sites alters the characteristics of the surrounding soil. After gypsum is applied to land, the qualities of the soil are altered not only temporarily but also permanently. The soil's pH is altered, and exchangeable calcium and sulfur are increased while exchangeable magnesium and aluminum are decreased [7].

During the gypsum mining process, gypsum powder and particles end up in open water sources and storage. It modifies the chemical makeup of water. Pipelines have little effect on nearby water resources or the water supply system. Since rainfall is one of the primary sources of water for agriculture, it is believed that gypsum will inevitably mix with it and find its way onto agricultural land. garbage dumps in mining locations are expected to increase, however compared to other mineral mining sites, there are much less garbage dumps in gypsum mining areas. The surrounding environment of the mining area is seeing a significant emission of gypsum particles. The surrounding air quality was altered and air pollution increased as a result of the gypsum dust generated by the mining region. In addition, transport trucks and gypsum crushing equipment discharge pollutants into the air, causing air quality problems [8].

Heavy equipment usage in mining operations raises noise levels and causes noise pollution, as does an increase in traffic activity associated to mining and ore transportation. Gypsum mining is an open-pit mine; however, the mining process altered the land's characteristics and caused it to lose its natural value, as illustrated in Fig. 2b. The land could not be used for any other purpose during the mining process, but the post-mining area of gypsum can be used very effectively if the guidelines for reclaiming the land are strictly followed.

Ecological and biological

Although mining is thought to be bad for the environment and plants, gypsum really promotes the development of plants. Gypsum stops oxygen from penetrating the soil's surface and seals it, therefore conserving water. In this case study, gypsum mining benefits nearby plants but negatively impacts nearby animal life. Gypsum mining has a detrimental overall impact on the biodiversity in the area. It completely ruined the animal habitat. More land mammals, birds, and reptiles than aquatic ones may be found in this region. mostly animals that migrate from surrounding regions as a result of heavy human disturbance and population loss from mining activities. In these regions, human immigration is the only thing evident in terms of livelihood and employment. Regional environment and biodiversity are impacted, either directly or indirectly, by the departure of native species from the food chain and food web [9].

Cultural and sociological

Social health suffers greatly in gypsum mining communities and adjacent regions as well. The temperature and air quality were altered by gypsum dust and other particles created during gypsum mining, as seen in (Fig 2a). For those doing this labor, the gypsum particle and poor air quality immediately cause respiratory issues. Skin problems are caused by gypsum dust, and stomach ailments are also experienced by those who consume water from open water sources. Living circumstances close to mining operations are not very conducive to survival. People and laborers confront several obstacles in their everyday lives. These locations include the use of large equipment and cars to move workers and supplies, yet there is a high danger of accidents.

Mining sites often include dust particles and wastes, and since there is no suitable protocol or work plan for cleaning, these items might sometimes have an impact on the drainage system. Immigration of other communities from other regions of the nation may cause conflicts or muddle community structures, which affect local social structures. It can also make it extremely difficult to adhere to regional customs, traditions, and cultures because of these issues as well as a lack of a common platform. Better facilities and education are provided by the government and businesses to local youngsters in order to raise their educational attainment and prepare them for key.

Financial and functional

The primary goals of mining are economic expansion and the satisfaction of human needs. Employment is produced by this activity on a variety of levels. Some workers immigrate from other parts of the nation for specific labor, while others receive positions directly in the mining industry at various postings. Locals are impacted by this, either directly or indirectly, in order to find work and opportunities to launch new businesses. The regional level's per capita income grew together with the employment ratio [11].

Gypsum is a valuable mineral that has worldwide importance. It is produced to a high standard in Nagaur and Bikaner and exported to many countries. Gypsum is also used as a construction ingredient and fertilizer. There are only two established modes of transportation in this landlocked location, indicating the importance of transportation methods. Water transportation is not an option. The principal stations on the train line are those at Bhadwasi and Nagaur. The Bhadwasi station was built specifically to transport gypsum. Gypsum is mostly transported by road via national roads and other vehicles such as tractors and trucks. Goth Manglod Temple is indirectly, if very little, harmed, as are many other temples and tourist destinations [12].

The foundation of every area's growth is its industrial and infrastructure sectors. In the vicinity of mining sites, the government and businesses built roads, transportation infrastructure, water supplies, buildings, power supplies, schools, hospitals, and other amenities. This area has seen the establishment of several gypsum factories that produce POP (paris sheet plaster) and fertilizer. property value decreases when the government purchases property for mining purposes and the remaining land cannot be used for residential purposes for safety concerns.

Following the values listed in (Table 1), when all the data in (Table 2) have been completed. The relative environment value and capacity for each component added together yields the following result.

Table 2 Data matrix for relative environment score by RIAM

S. No.	Environmental components Physical/Chemical	Criteria for group A		Criteria for group B			ES	RV	Relative environment score
		$\alpha 1$	$\alpha 2$	$\beta 1$	$\beta 2$	$\beta 3$			
1	Soil quality	1	2	2	2	3	14	+B	122
2	Water quality (open sources)	2	-3	3	3	3	-54	-D	54
3	Water quality (close sources)	2	0	1	1	1	6	+A	114
4	Climate	2	-1	2	3	3	-16	-B	92
5	Air quality	2	-3	2	3	3	-48	-D	60
6	Waste dumps	2	-2	2	2	3	-28	-C	80
7	Land characteristics	3	-2	2	2	2	-36	-D	72
8	Land use	1	-3	2	2	2	-18	-B	90
9	Noise level	3	-2	2	2	3	-42	-D	66
10	Aesthetic	3	-3	3	3	1	-54	-D	54
	Biological / ecological								ΣPC=764
1	Plant life	1	1	2	3	2	7	+A	115
2	Animal life	2	-3	2	2	2	-36	-D	72
3	Biodiversity	2	-3	3	3	3	-54	-D	54
4	Crop productivity	3	-1	1	1	1	-9	-A	99
5	Habitation	1	-3	2	2	2	-18	-B	90
6	Migration	2	-3	3	3	2	-48	-D	60
7	Environmental risks	2	-3	2	3	3	-48	-D	60
8	Ecosystem Scenario	1	-3	2	2	2	-18	-B	90
	Sociological / cultural								ΣBE= 640
1	Living condition	1	-2	3	3	3	-18	-B	90
2	Social health	2	-2	3	3	3	-36	-D	72
3	Accidents	2	-1	1	1	2	-8	-A	100
4	Sanitation	2	-2	2	2	2	-24	-C	84
5	Social welfare	2	2	3	1	1	20	+C	128
6	Social awareness	3	2	1	1	1	18	+B	126
7	Social security	2	-1	1	1	1	-6	-A	102
8	Traditions and customs	3	-1	1	1	1	-9	-A	99
9	Education	3	1	3	3	3	27	+C	135
	Economic / operational								ΣSC= 936
1	Investment	3	3	2	2	2	54	+D	162
2	Employment	3	3	2	2	2	54	+D	162
3	Income per capita	3	3	2	2	2	54	+D	162
4	Mineral value	4	3	3	2	2	84	+E	192
5	Land value	3	-2	3	3	2	-48	-D	60
6	Transportation	3	2	2	2	2	36	+D	144
7	Industry development	3	3	2	2	2	54	+D	162
8	Infrastructure development	2	3	3	3	2	48	+D	156
									ΣEO = 1200

This unfavorable sustainability rating demonstrates that human demands transcend environmental concerns. Additionally, the Nagaur district's gypsum mining area is not sustainable, as shown by the value of SI = -0.05.

FINAL VERDICT

The goal of this research is to evaluate the environmental effects of the gypsum mining region in the western Rajasthani district of Nagaur. The Nagaur district is a global supplier of high-quality gypsum. Understanding the effects of gypsum mining on several elements necessitates doing an environmental impact study. The environmental score for each component is determined using RIAM, and the outcome shows that the gypsum mining industry is not sustainable, as shown by the sustainable development index of -0.05. Before opening gypsum mining sites, the government prepares rules. However, this research found that the mining and other associated operations are not carried out properly or in accordance with the recommendations. It has been seen that just the financial gains are taking precedence over the physical/chemical, social/cultural, and biological/ecological factors. Environmentally sustainable and well-managed mining operations are required. A framework is still required to concentrate on other realities, such as labor training, reducing needless

transportation usage, fostering social cohesion within the community, and other postmining activities for improved land use. In order to achieve the sustainable development objectives and a healthy environment, a high sustainability index necessitates striking a balance between human demands and the environment.

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