

# **EXTRACTION OF LIMESTONE AND ITS CONSEQUENCES ON ENVIRONMENT WITH SPECIAL FOCUS ON BENIGHAT RORANG RURAL MUNICIPALITY, DHADING, NEPAL**

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## **ABSTRACT**

Limestone extraction in one hand helps in infrastructural development, while in other, in Benighat Rorang has resulted in severe and frequently uncontrolled environmental degradation as well as socio-economic issues, notably affecting the most vulnerable communities living nearby and very few researches has been performed regarding the impact brought by the limestone extraction in the study area. So, this study was conducted with an aim to assess different socio, economic and environmental impact brought by the current limestone acquiring process. For this, primary data were collected through field observation, in-depth interview, focused group discussions and questionnaire survey whereas secondary data were collected through published and unpublished sources such as thesis, research article, database, annual reports and scientific manuscript. The data collected from 155 respondents using purposive sampling were later analyzed in xcel, using RII for likert scale questions. The results showed that the major problem with the limestone processing is the air pollution in mining areas. The Challenging geological and topographical conditions followed by exploitation of natural resources have degraded the soil stabilization and increased the risk of landslide. The perpetual limestone mining has created Problem in waste disposal and management followed by noise pollution due to continuous blasting and drilling. All these have put vulnerable population in risk. The social issues have arrived during land acquisition, further environmental degradation due to air, water, soil and noise pollution led migration and displacement of marginalized communities. Even the quality of limestone issues arises due to poor feasibility study and screening at the beginning. Apart from this, extraction has affected the biodiversity due to habitat destruction. To overcome these problems, solutions were put forwarded where application of modern extraction (controlled blasting) methods reduces the dust pollution around the environment. Similarly, monitoring and ensuring mining activities comply with environmental and social regulations set by local, national or international bodies helps in effective mining activities. Other important mitigation measures are provision of compensation for displaced communities or those affected by land degradation in mines. Practicing green cover, regular water spraying and use of dust collector around the mining areas also help to minimize noise pollution and avoiding night time operations minimize disruption of both wildlife and nearby communities.

**Keywords:** *limestone extraction, environmental degradation, controlled blasting, air pollution*

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## **1. INTRODUCTION**

Limestone is a type of rock made mostly of calcium carbonate, and humans have used it for thousands of years. In very old times, people made tools and grinding stones from limestone because it was easy to find and shape [13] As societies grew, limestone became important for building big structures. In ancient Egypt, Greece, and Rome, it was used to make temples, houses, and monuments. During the medieval period in Europe, many famous buildings like the Notre-Dame Cathedral in Paris were built using limestone because it is strong and lasts a long time. Besides construction, farmers also found that crushed limestone could be

spread on fields to reduce soil acidity and help crops grow better, a practice that became common many years ago [12].

The way limestone was taken from the earth changed greatly during the Industrial Revolution in the late 1700s and early 1800s. Before this, people used simple hand tools, but then machines powered by steam were introduced, which made mining much faster and easier [3]. In the 1900s, diesel and electric machines replaced steam equipment, making the process even more efficient. Today, limestone is one of the most mined materials in the world because it is the main ingredient in cement, which is needed for building roads, bridges, houses, and other infrastructure [5]. Nepal has a large amount of limestone, with estimates showing more than one billion tonnes of deposits, and much of it is good for making cement. Because of this, many cement factories have been opened in Nepal, and more are being built, especially in places like Dhading District.

In Dhading, one of the most active areas for limestone mining is Benighat Rorang Rural Municipality. This area has large deposits of limestone, including the Kandrang-Gadhi reserve, which has over 28 million tonnes of cement-quality limestone [2]. Mining here has brought some benefits to local people, such as jobs and better roads. For many families, working in quarries or related businesses is one of the few ways to earn money. The government also earns revenue from mining licenses, and the country saves money by producing cement locally instead of importing it. However, these economic gains have come with serious costs to the environment and to people's health, raising questions about whether the current way of mining is sustainable in the long run [4][11].

The process of limestone mining starts with removing the top layer of soil, plants, and rocks to reach the limestone underneath. This causes major damage to the land. Forests are cut down, fields are destroyed, and natural habitats for animals and plants disappear. In Benighat Rorang, local communities, including Indigenous Chepang and Tamang people, have reported that mining has led to more landslides, soil erosion, and loss of farmland. Once the vegetation is removed, the soil becomes loose and easily washes away during the monsoon, causing floods and damaging houses and roads downstream. The beautiful hills that once supported diverse life are now scarred with deep pits and piles of waste rock, changing the landscape forever [6].

Water is another major concern. Limestone mining uses a lot of water to control dust, cool machines, and wash the rocks. This reduces the amount of water available for farming and drinking in nearby village. Also, the runoff from mining sites carries mud, chemicals, and fine rock particles into streams and rivers, making the water dirty and unsafe [10]. Fish and other aquatic life die, and people who depend on these water sources face health risks. In some places, wells have dried up after mining started, forcing women and children to walk longer distances to fetch water. The change in water quality and quantity has created tension between mining companies and local communities, who feel their basic rights are being ignored [1].

Air pollution is perhaps the most visible and harmful effect of limestone mining. Drilling, blasting, crushing, and transporting limestone create huge clouds of dust that fill the air. This dust contains fine particles, including silica, which when breathed in over time can cause serious lung diseases like silicosis, asthma, and chronic bronchitis [9]. Workers in the quarries often do not wear masks or protective gear, and even people living nearby cannot escape the dust, as it settles on homes, food, and clothes. Studies in South Asia show that even when dust levels are below official limits, many miners still develop lung problems, suggesting that current safety standards may not be strict enough. In Benighat Rorang, residents complain of constant coughing, breathing difficulties, and eye irritation, especially during the dry season when dust is worst [8]. Noise from blasting and heavy vehicles also causes stress, disturbs sleep, and can damage hearing over time.

Even though there are international rules to make mining safer and more responsible, they are not well followed in Nepal. The International Council on Mining and Metals (ICMM) has set 10 Principles that ask mining companies to protect the environment, respect human rights, involve local people in decisions, and operate honestly [7]. But in practice, enforcement in Nepal is weak. There have been cases where companies continued mining even after being ordered to stop by government offices. For example, Annapurna Quarries

in Benighat Rorang was banned twice but kept operating, showing how rules are often ignored without consequences. Local communities say they are never properly consulted before mining starts, and their complaints are rarely heard. Without strong monitoring, fair laws, and real participation of affected people, mining continues to harm both nature and society.

limestone mining in Benighat Rorang Rural Municipality of Dhading District shows both the promises and the problems of resource extraction. On one hand, it brings jobs, income, and materials needed for national development. On the other hand, it causes severe damage to forests, water, air, and human health, especially for poor and Indigenous communities who depend most on natural resources. The current situation calls for urgent action: better enforcement of environmental laws, stricter dust and noise controls, fair compensation for affected families, and genuine involvement of local people in planning and monitoring mining activities. Future research and policy must focus on finding a balance where economic needs are met without destroying the environment that sustains life. Only through responsible and sustainable practices can limestone mining truly benefit Nepal and its people in the long term.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Benighat Rorang rural municipality is situated within the Dhading district of Bagmati province in Nepal. The rural municipality spans 29.17 square kilometers (11.26 sq mi) with a total population of 31,475 according to 2011 census. It is one of the prominent limestone-bearing regions of Nepal. The area is geographically characterized by mid-hills and river valleys, with rich deposits of limestone that have attracted quarrying and mining activities over the past decades.

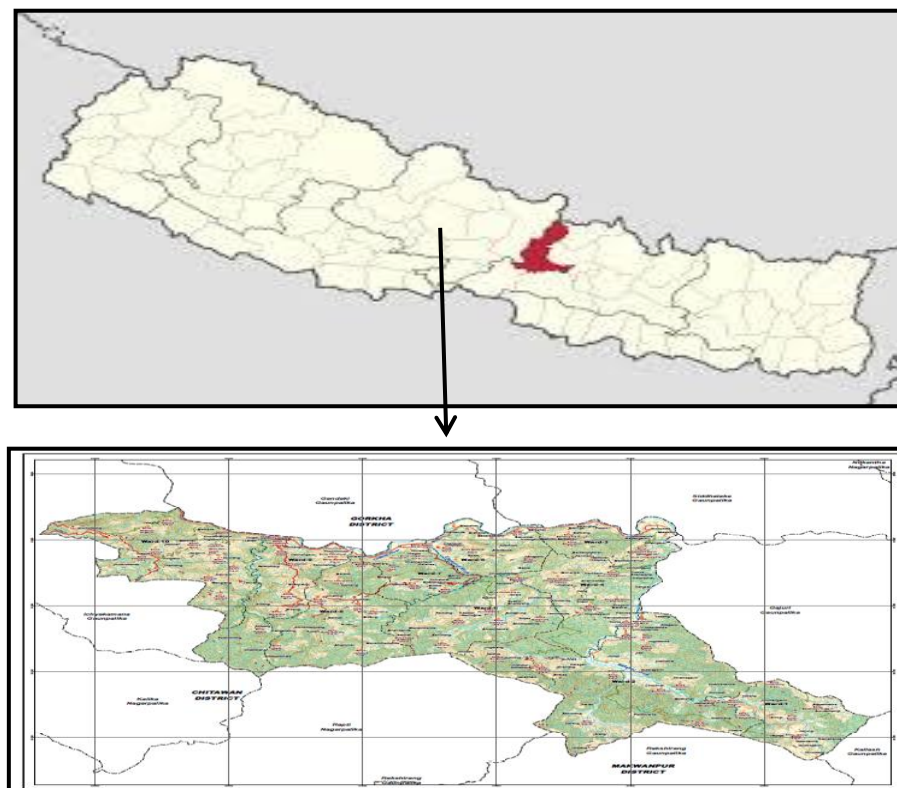


Fig. 2.1 Map of Benighat- Rorang rural municipality (Source: Google map)

## 2.2 Data Collection Methods

### 2.2.1 Field Observation

Field observation is a method in which the researcher will visit the site to collect required information related to the study. In this method, there is less chance of data mis-representation as the researcher itself is on field. In this study the collected data are for qualitative purposes. Field observation around the quarry sites, river banks, agricultural fields and settlement areas that are in close premise within the quarry sides was carried out. During field observation informal discussion were carried with the local residents, quarry workers and rural municipalities representatives, on site measurement of land degradation, dust emission was carried out where on-site measurement was performed through visual inspection. Photographs were taken as an evidence of field observation for the topic.

### 2.2.2 In-Depth Interview

Interviewing is one of the major methods of data collection in qualitative research. A two-way system of conversation between an interviewee and an interviewer that commence for obtaining information related to the specific study. Moreover, it is defined as a face to face verbal Interchange in which one person, the interviewer, attempts to draw out information or expression of opinion or belief from another person or persons. Researcher takes notes during the interview.

### 2.2.3 Focus Group Discussion (FGD)

It is also one of primary tools of data collections, where group of stakeholders are interviewed with the open-ended questions. In this survey, farmers living near limestone quarry sites, active youths, women's group representatives, political representatives, community leader were included.

### 2.2.4 Questionnaire Survey

Questionnaire survey is a set of questions that is used during a survey. Questionnaire survey-deals with data collecting method, which is used to gather, analyze and interpret the different views of a group of people from a particular population. Questionnaire survey helps to collect necessary information from the respondents through a set of questions necessary for the study of that particular area.

## 2.3 Sampling Technique, Sampling Size and Data Collection

Random sampling technique was used for collecting data. Questionnaire was prepared and the sample size was determined, and accordingly primary data were collected.

Slovin's developed the formulas for determining the sample size for categorical types of data. Sample size was fixed by using the formula:

$$\text{Sample size (n)} = N / (1 + Ne^2)$$

Where,

N= total no. of population and,

e= confidence error

now,

Total no. of population (N)= 31301

Confidence error (e) = 8%

Here,

$$\text{Sample size (n)} = N / (1 + Ne^2)$$

$$= 155$$

So, 155 respondents participated and presented their response.

Secondary data were collected through published journals, article, book, website, government statistical reports, newspaper reports, scientific paper etc.

## 2.4 Data Analysis

The RII was used to analyze the data collected from the respondents. In this research, Likert 5-point scale was used to determine relative importance index (RII) for the desirable cause and effects of limestone quarrying for cement production in Benighat Rorang rural municipality of Dhading district. The value of RII is given by the equation:

$$\text{Relative Importance Index (RII)} = (\sum W) / AN = (5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1) / 5N$$

Where, W = weight to each factor by the respondent ranging from 1 to 5

$n_1$  = number of respondents for least agree

$n_2$  = number of respondents for moderately agree

$n_3$  = number of respondents agree

$n_4$  = number of respondents for mostly agree

$n_5$  = number of respondents for strongly agree

A = highest weight i.e. 5 in this study

N = total number of respondents

The relative importance index (RII) ranges from 0 to 1.

## 3. RESULTS AND DISCUSSION

### 3.1 Relative Importance Index Analysis

The weightage was marked varied for one to five. For the RII analysis 155 respondents were involved. According to their view, they have marked for the options with the range of strongly disagree to strongly agree. The data were analyzed by taking average rank that is the weighted mean percentage and expressed in the Bar Graph value as shown below.

### 3.2 Major Problems Associated with Limestone Extraction

As represented in the Fig. 3.1, the major problems associated with limestone extraction are “Air pollution in mining areas” and “Challenging geological and topographical conditions” with highest RII value of 0.78, followed by “Exploitation of natural resources” with the RII value of 0.76. The least significant problems were “Habitat destruction”, “Misuse of social capital”, “Quality issues on the limestone source” and “Biodiversity loss” with RII range between 0.69 to 0.64 (Fig: 3.1).

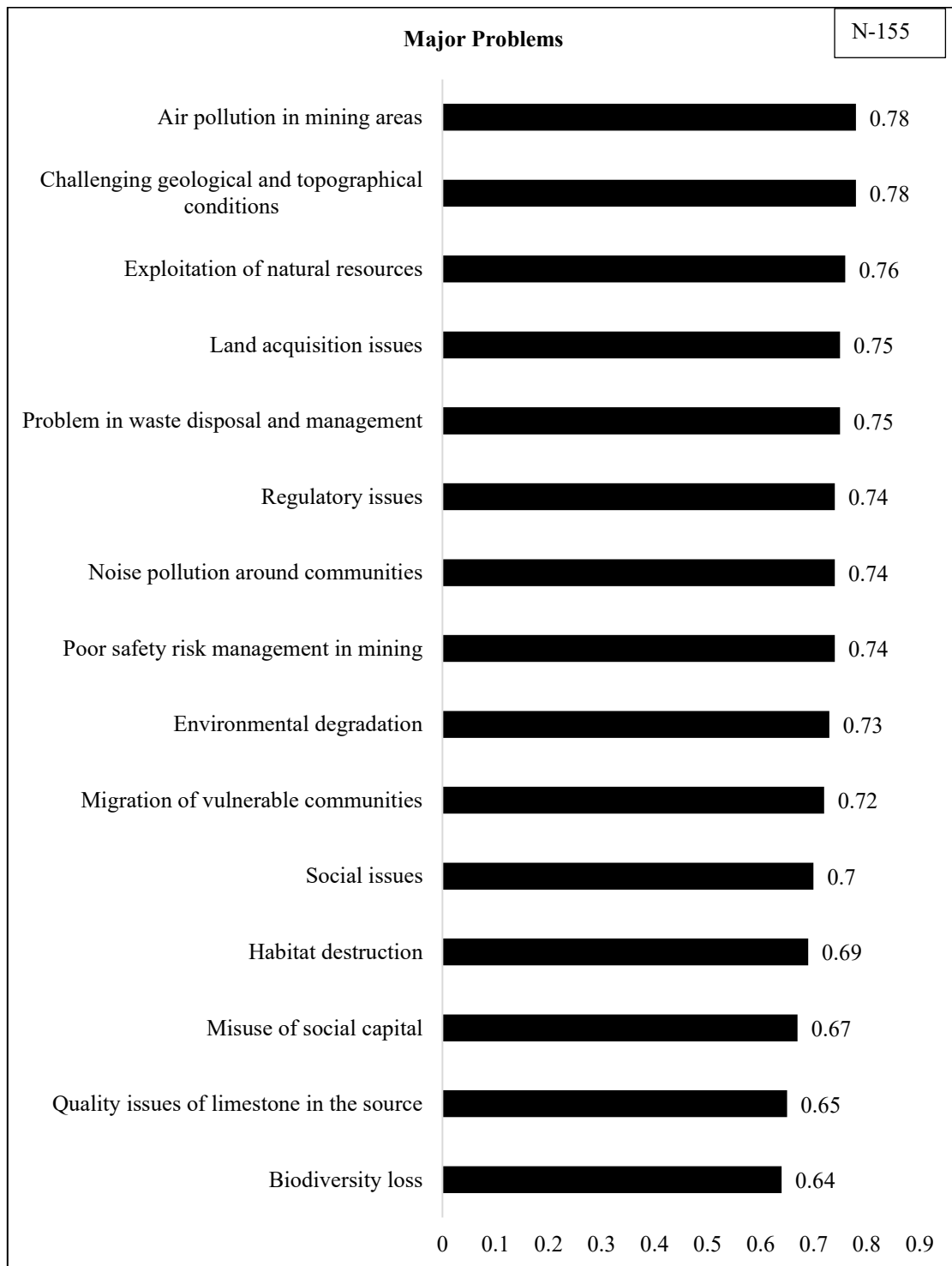


Fig. 3. 1 Major problems in limestone extraction

## 3.3 Causes and Effects of Problems

## 1. Air Pollution in Mining Areas

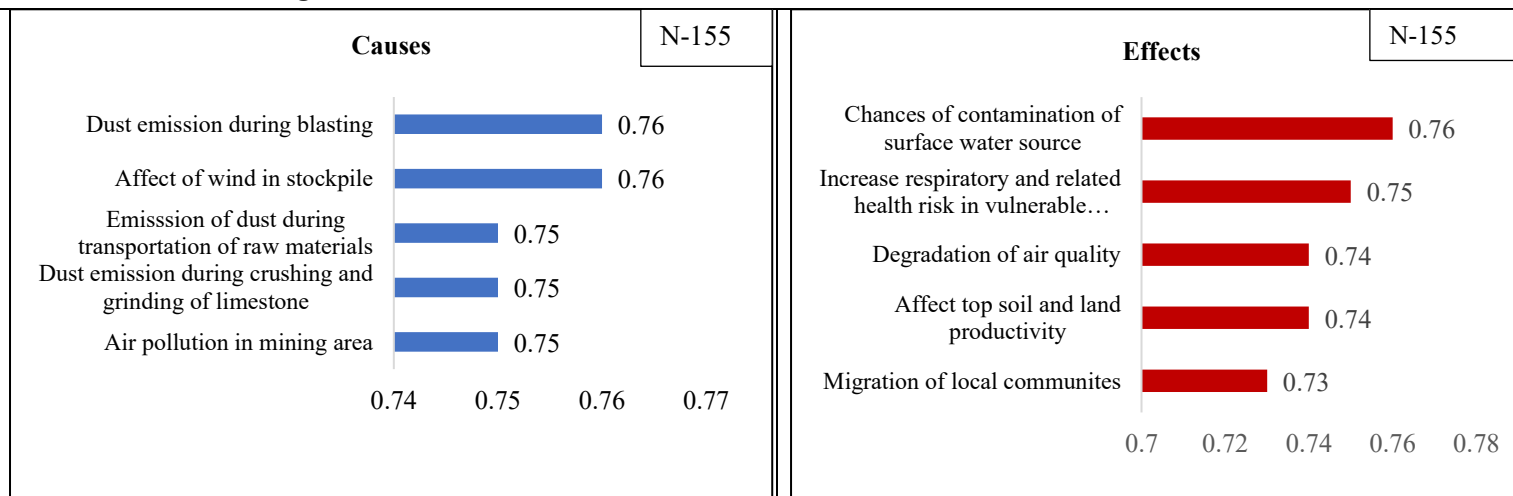


Fig. 3.2: Causes and effects of Air pollution in Mining Areas

## 2. Challenging Geological Conditions

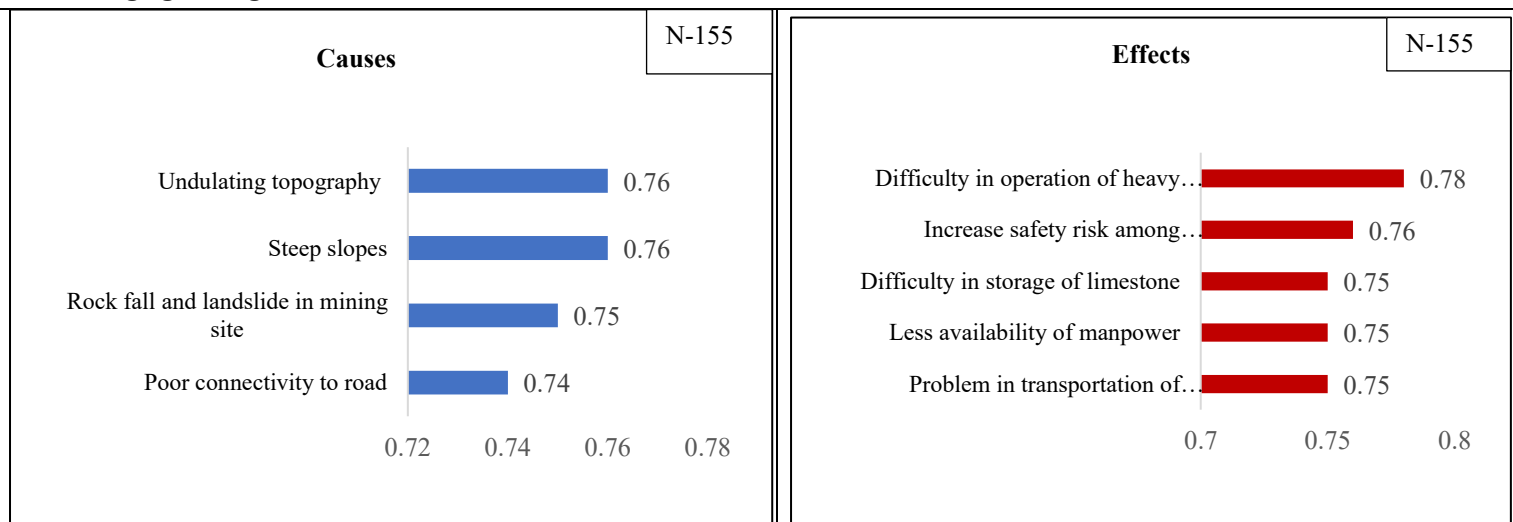


Fig. 3.3: Causes and effects of Challenging Geological conditions

## 3. Exploitation of Natural Resources

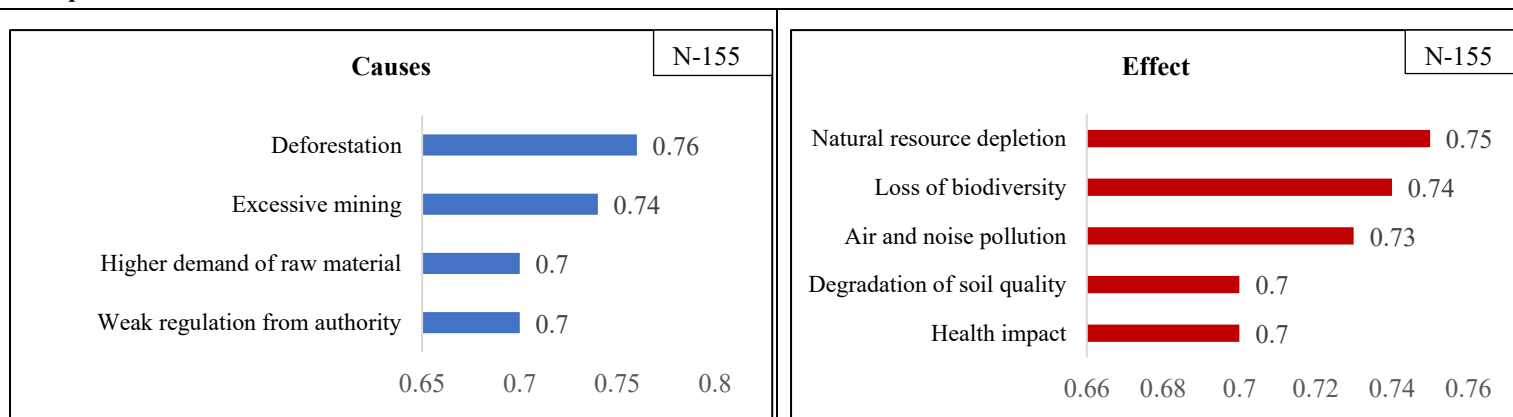


Fig. 3.4: Causes and effects of Exploitation of Natural Resources

#### 4. Land Acquisition Issues

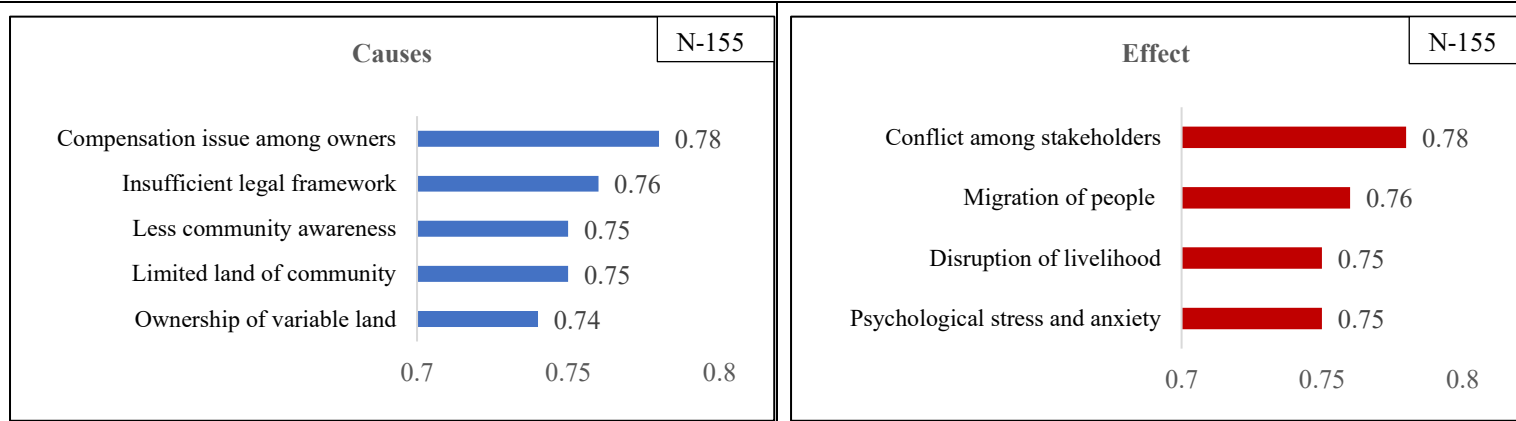


Fig. 3.5: Causes and effects of Land Acquisition issues

#### 5. Waste Disposal and Management

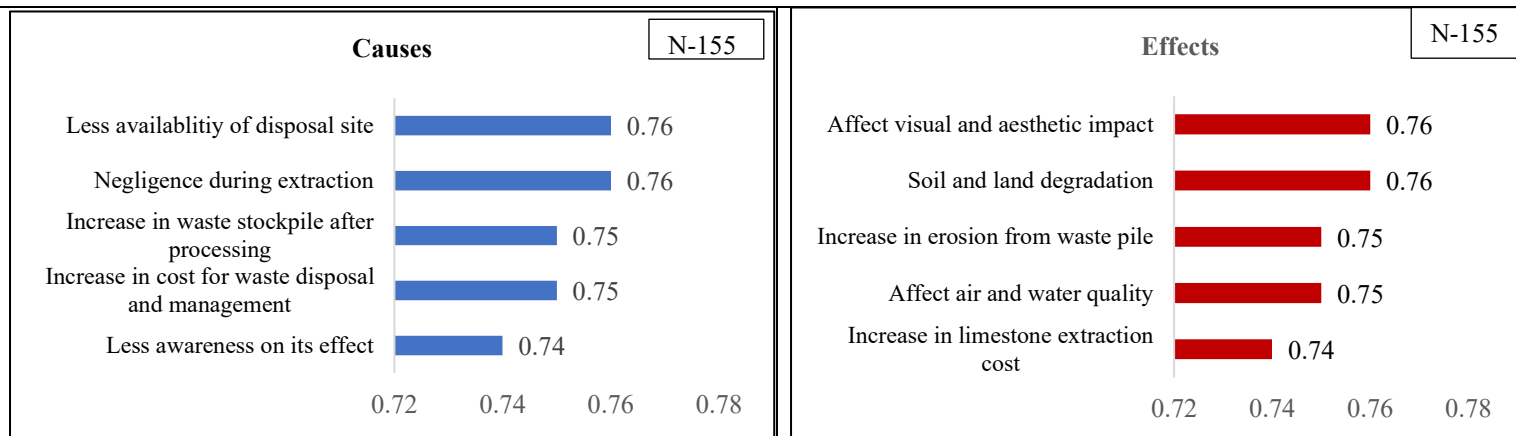


Fig. 3.6: Causes and effects of Waste disposal and Management

#### 6. Regulatory Issues

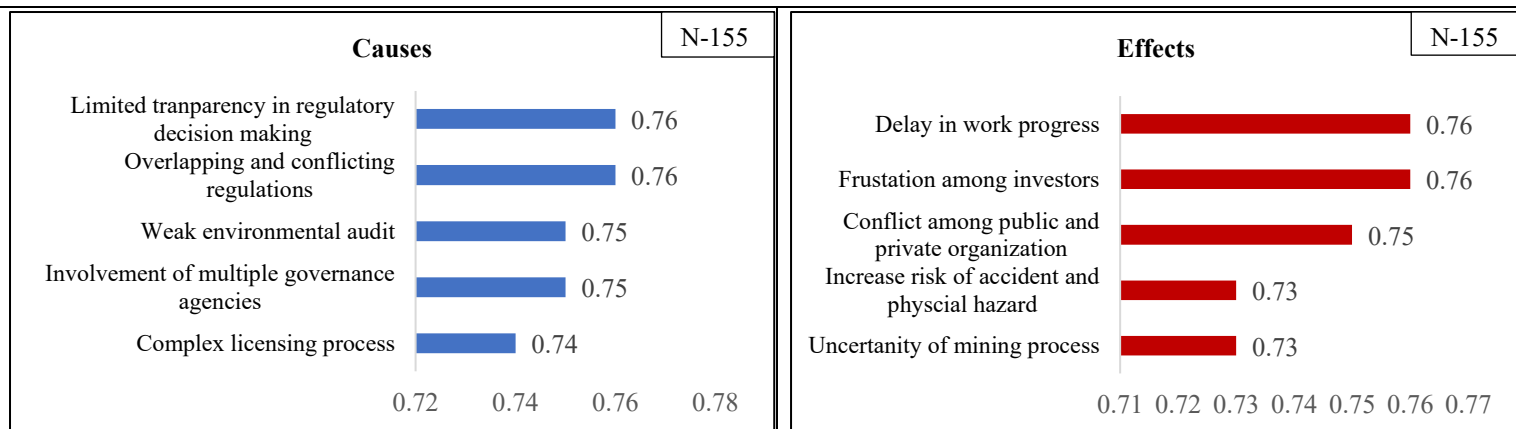


Fig. 3.7: Causes and effects of Regulatory Issues

### 7. Noise Pollution and Communities

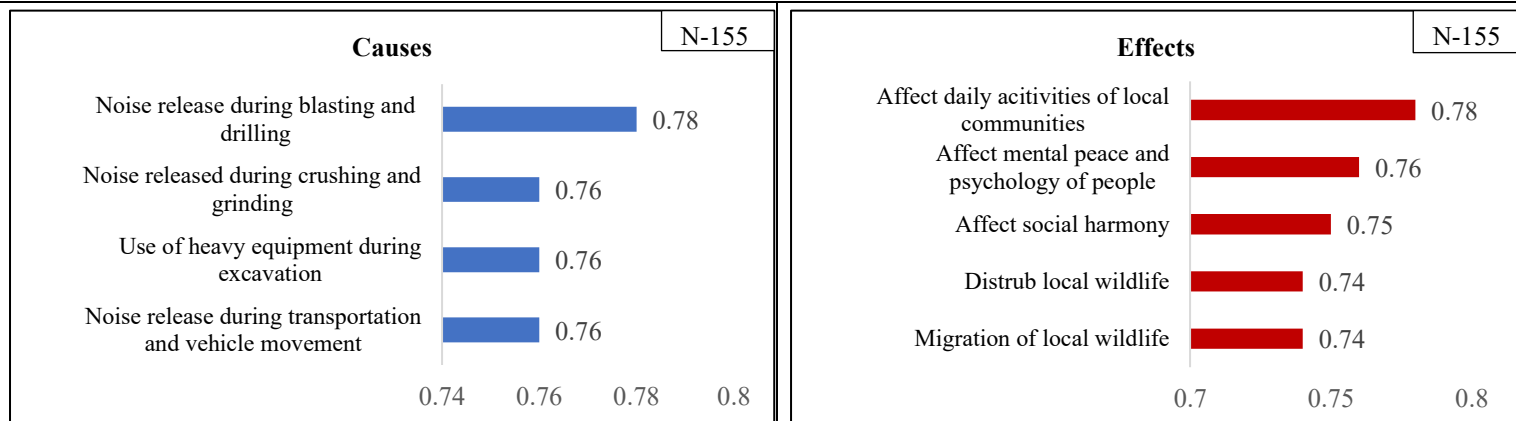


Fig. 3.8: Causes and effects of Noise pollution and Communities

### 8. Poor Safety Risk Management in Mining

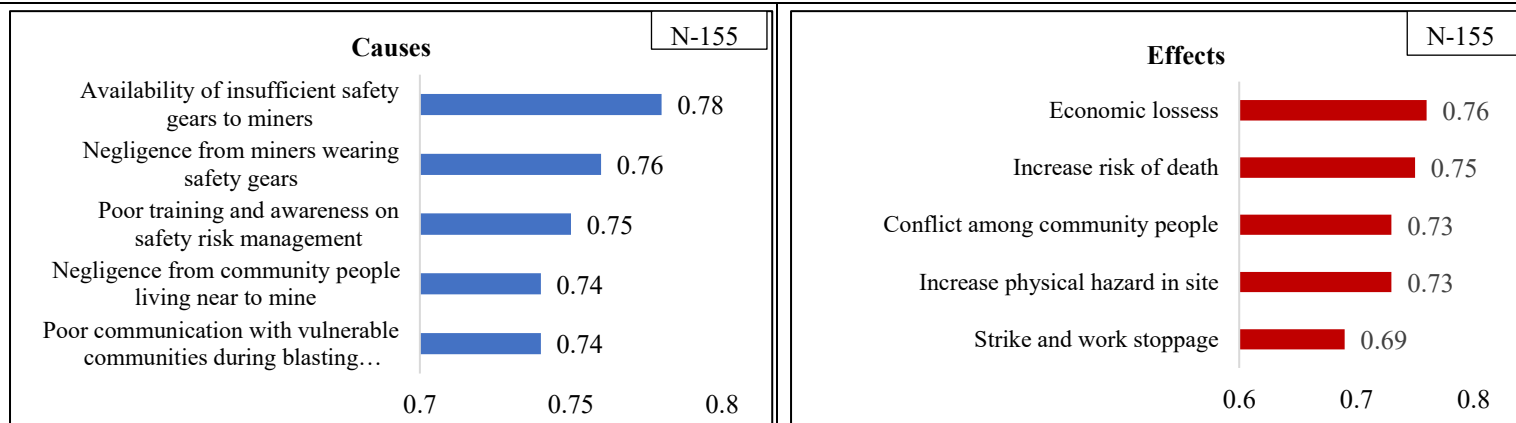


Fig. 3.9: Causes and effects of Poor Safety Risk Management in Mining

### 9. Environmental Degradation

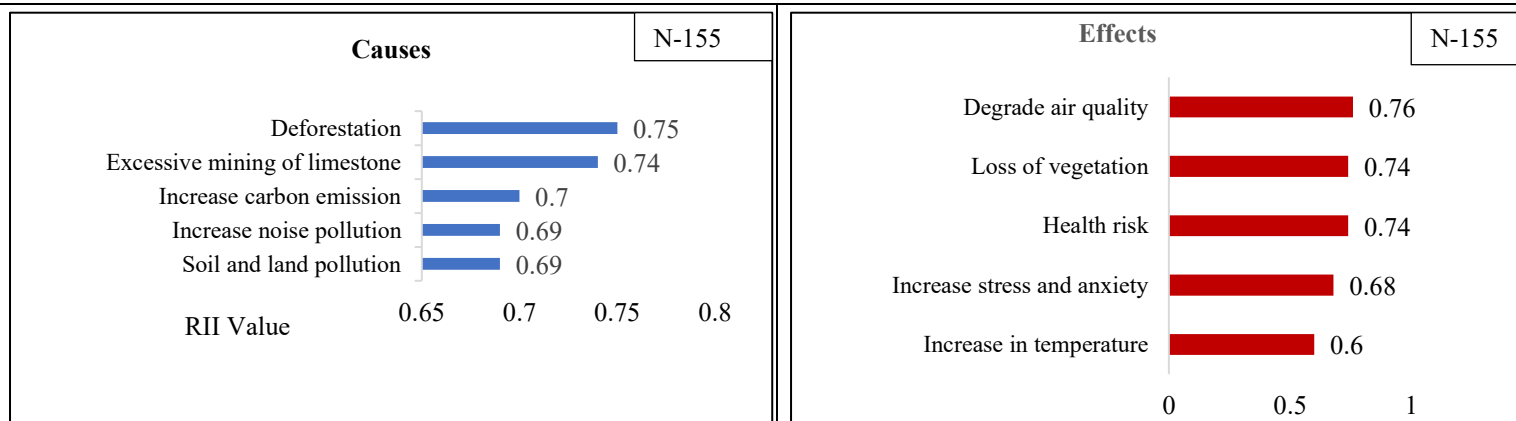


Fig. 3.10: Causes and effects of Environmental Degradation

### 10. Migration of Vulnerable Communities

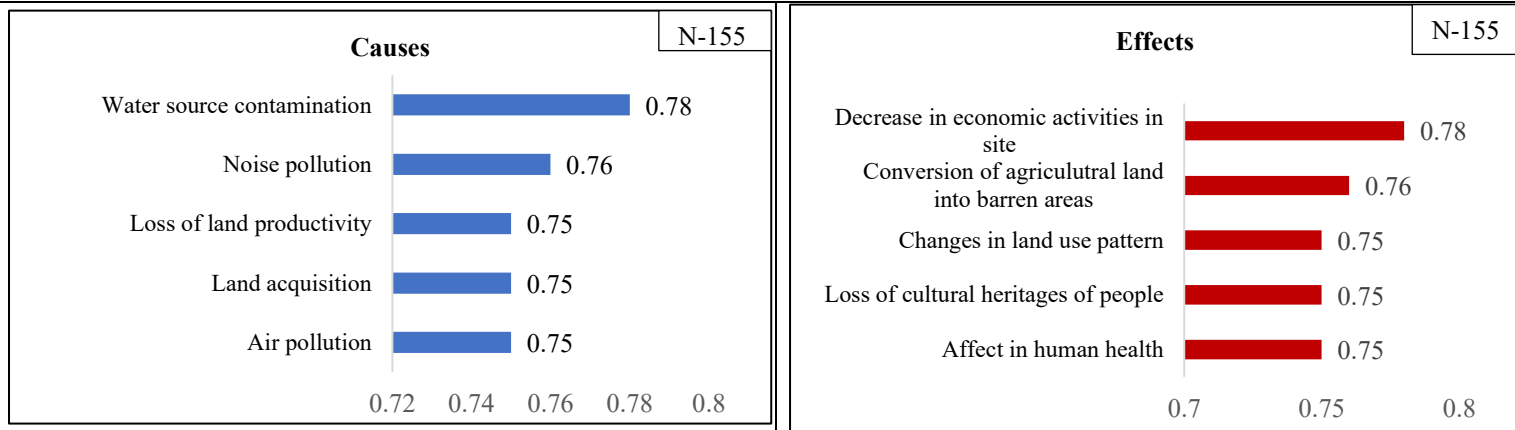


Fig. 3.11: Causes and effects of Migration of Vulnerable Communities

### 11. Social Issues

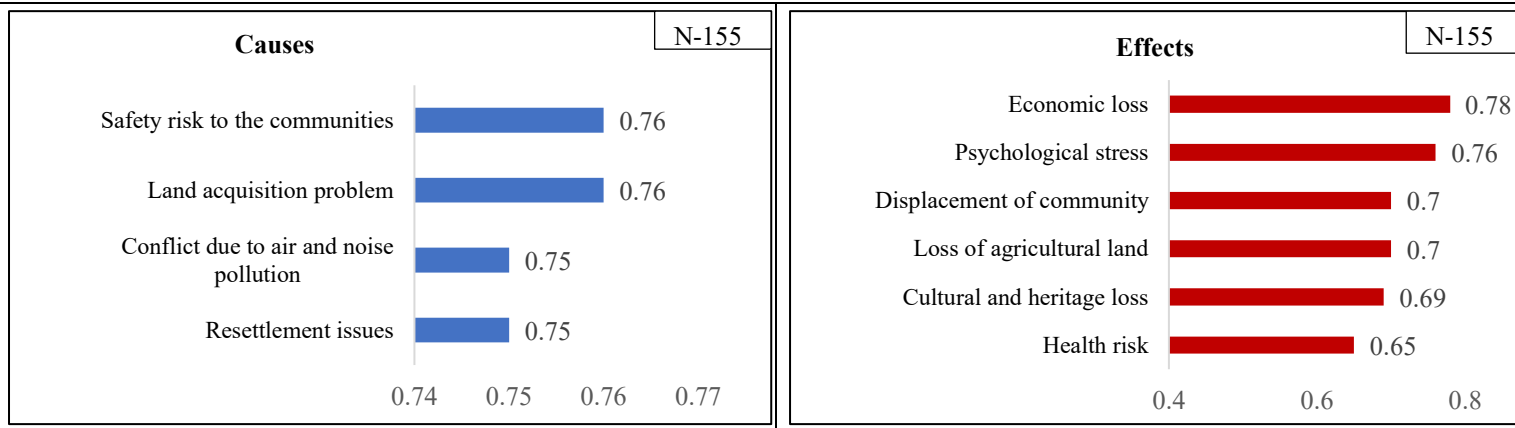


Fig. 3.12: Causes and effects of Social Issues

### 12. Habitat Destruction

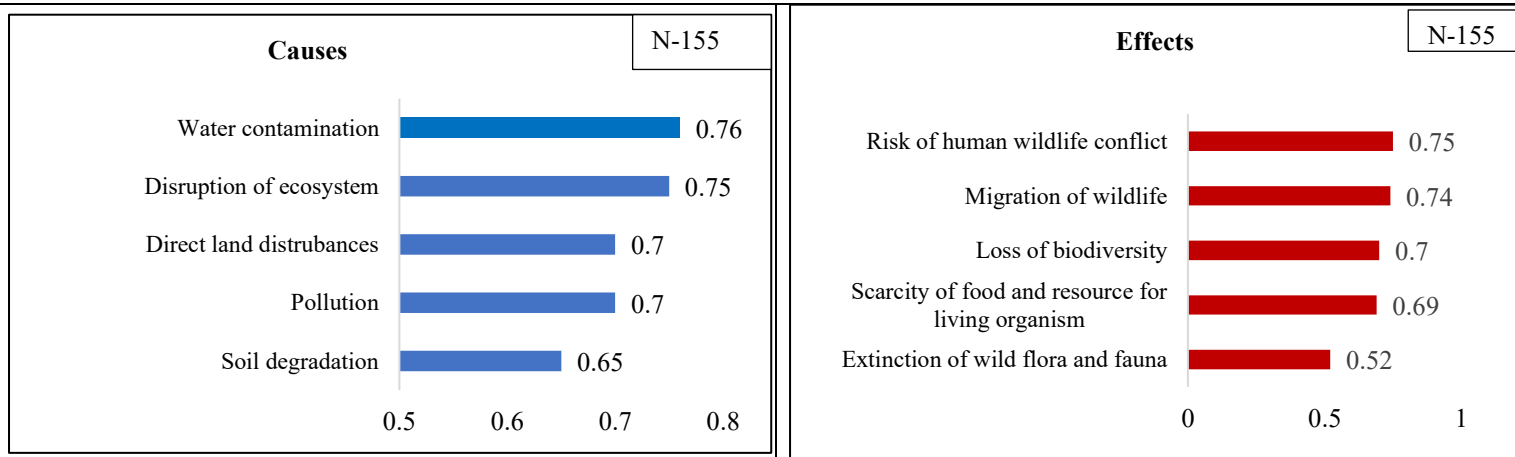


Fig. 3.13: Causes and effects of Habitat Destruction

### 13. Misuse of Social Capital

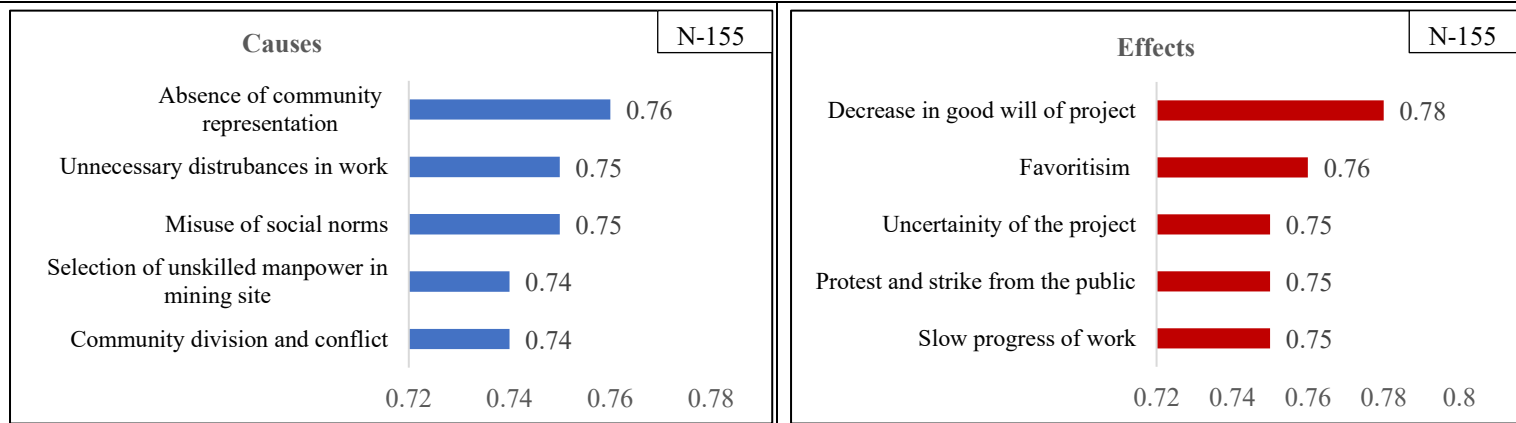


Fig. 3.14: Causes and effects of Misuse of social Capital

### 14. Quality Issues of Limestone in the Source

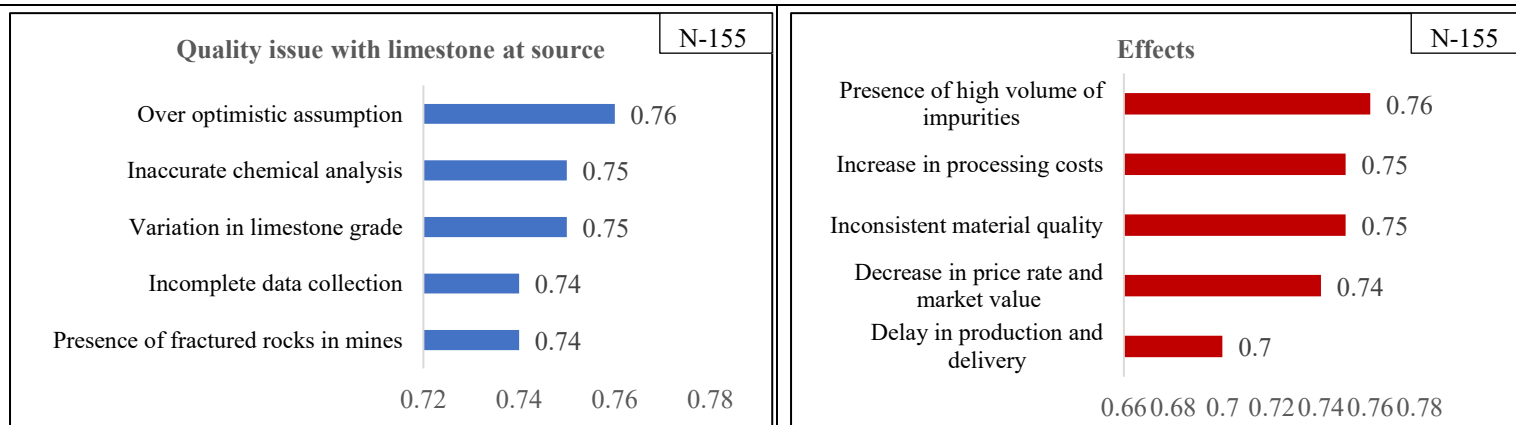


Fig. 3.15: Causes and effects of Quality Issues of limestone in the source

### 15. Biodiversity Loss

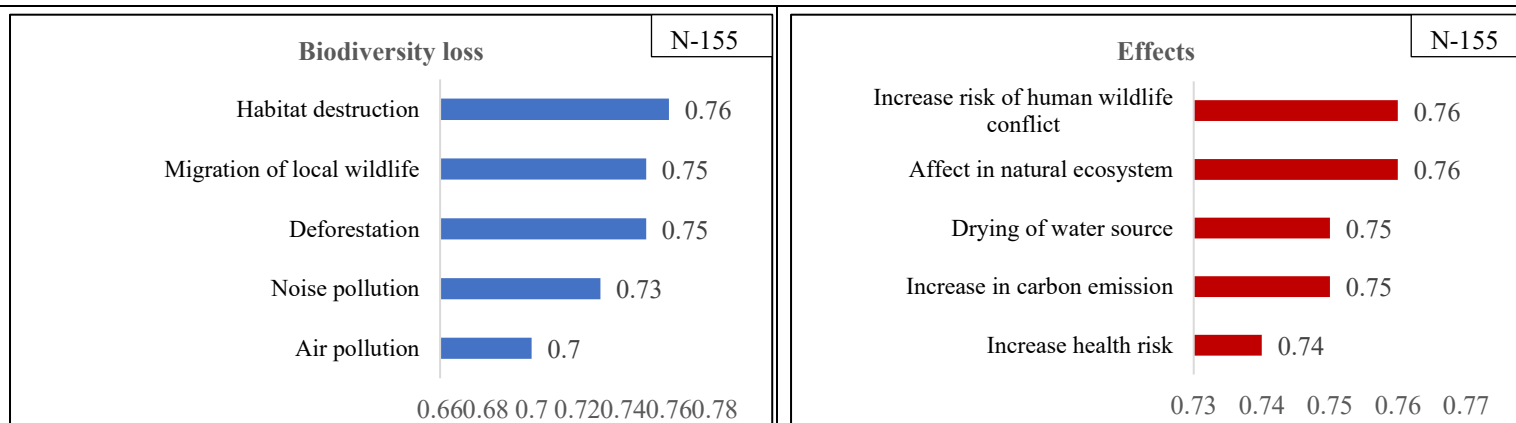


Fig. 3.16: Causes and effects of Biodiversity Loss

### 3.4 Mitigation Measures with Limestone Extraction

As shown in the Fig. 4.36 below, the mitigation measures drawn to overcome the problem of limestone extraction issues with the highest RII value of 0.78 is “Application of modern extraction (controlled blasting) methods that reduce the dust pollution around the environment” followed by “Monitor and ensure mining activities comply with environmental and social regulations set by local, national or international bodies”. Similarly, other important mitigation measures put forwarded are “Provision of compensation for displaced communities or those affected by land degradation in mines”.

Additionally, Conducting IEE and SIA activities before conducting mining activities in potential mines areas”, “Regular monitoring air quality so as to ensure that emission do not exceed safe levels”, “Practice green cover, regular water spraying and use of dust collector around the mining areas”, “Avoid night time operations to minimize disruption of both wildlife and nearby communities”, “Implementing health monitoring programs for workers and communities exposed to potential hazards”, “Practice of vertical mining instead of expanding horizontally minimizes surface disturbances”, where RII values ranges between with RII values ranges between 0.76-0.75. The other important solutions drawn were “Use of sound proofing equipment or locating limestone operations far from sensitive areas like residential zones or wildlife habitat”, “Providing proper protective equipment for miners to ensure safe working conditions”, “Involving local communities on decision making process by providing information on mining process, potential impact and , “Engaging local communities to ensure that their social and cultural needs are met and respected throughout mining process, “Establishing conflict resolving mechanism between communities companies and government companies” and “Install proper drainage system water filtration system and treating waste water can help reduce water pollution” all with the same RII value of 0.74. The least significant is the “Practice restoration and land reclamation of mining site through planting vegetation” with the RII value of 0.74 (Fig3.17).

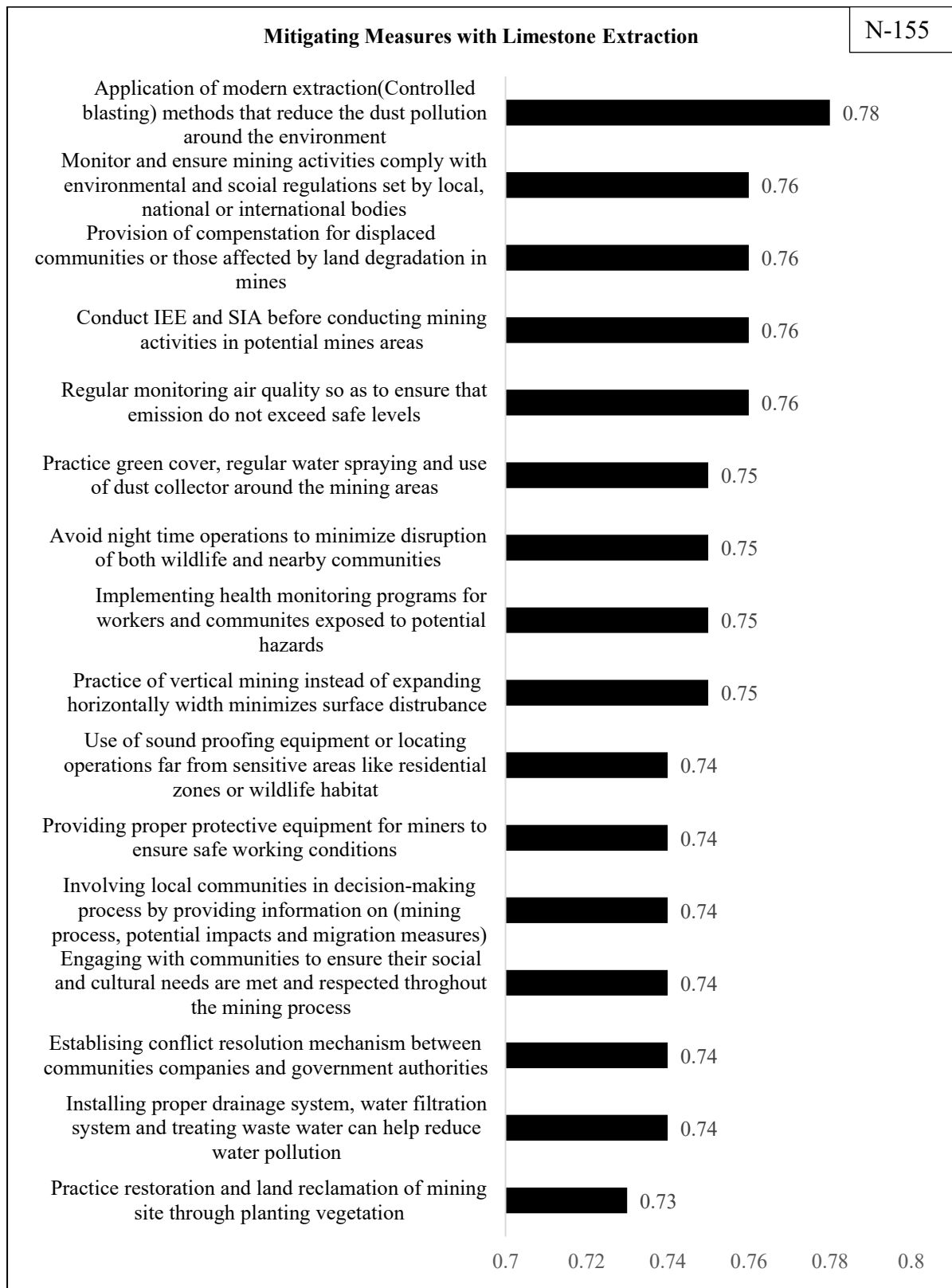


Fig. 3.17: Mitigation Measures with Limestone Extraction

### 3.5 Discussions

#### i.) Finding from Field Observation

During the field observation at Benighat Rorang Rural Municipality of Dhading district, several consequences were identified during the extraction of limestone. Due to extraction of limestone, environment was drastically exploited. Large-scale open-pit limestone extraction visible near hill slopes, where a prominent removal of topsoil and vegetation cover was seen. Thee slope seems unstable with signs of minor landslides and rockfalls. The quarry site was open pit extraction and the dust coating on leaves in minor air breeze that have affected crop production. There was loss of vegetation. There was unstable slope in the site. During informal communication and on observation, some households were even displaced from the quarry area and some of them are even o facing cracks in houses due to blasting vibrations. The communities living have mixed perceptions where some support extraction for economic reasons, while others express concern over long-term environmental damage. There environmental impact in the site was pronounced that includes dust, noise, water pollution, soil degradation, biodiversity loss etc. The socio -economic effects includes jobs created but with poor safety; displacement and cracks in houses etc. The community concerns include lack of regulation, weak compensation, inadequate CSR etc.

#### ii.) Finding from Focus Group Discussion

In the focus group discussion at Benighat Rorang Rural Municipality of Dhading district, participants were farmers, youth, women, elders, shopkeepers etc. There was excessive environmental loss, socio-economic loss, poor governance, and community views were discussed.

On discussion the farmers and women group stressed on the environmental problems such as dust pollution, water scarcity, noise, biodiversity loss etc. Local communities reported excessive dust affecting crops, livestock and human health. Even the farmers were unhappy and were found concerned with the declining soil fertility and reduced crop yields due to limestone dust deposition. Even the environmentalist highlighted on the biodiversity loss, soil erosion, and contamination of water sources feeding into the Trishuli River. Similarly, the socio-economic loss includes job created but unsafe work, local economy increased, displacement of the community etc. The municipal officers put forwarded the challenges in monitoring the limestone mining activities due to limited resources; noted pressure from private companies for lenient policies. Even the community leaders criticized lack of transparency in revenue sharing and weak enforcement of environmental regulations

#### ii) Finding from In-Depth Interview

In-depth interviews were conducted with the technical experts of Hauxin Narayani Cement Pvt. Ltd., environmental engineer, geologist and government officials to gain deeper insights into the challenges of limestone extraction.

The environmental impacts include dust, declining crop yield, biodiversity loss, polluted water etc. The socio-economic impacts includes jobs created but low wages, displacement with poor compensation etc. Poor governance system includes weak monitoring, low transparency, company pressure etc. The people perceptions includes youth see opportunities, elders stress, long-term risks etc.

### 4. CONCLUSIONS

The overall analysis of primary data collected through a mixed-method approach reveals that the major problems and consequences associated with limestone extraction are air pollution in mining areas and challenging geological and topographical conditions. Beyond these, the uncontrolled exploitation of natural resources has also created significant challenges for nearby communities. One of the most pressing concerns is the improper management of waste generated during limestone extraction and processing, which has led to the contamination of surface water sources and, in turn, generated social tensions among local residents. The study further observed migration of affected communities due to deteriorating air quality in mining zones. Additionally, noise generated from drilling, blasting, crushing, and the continuous movement of heavy vehicles during transportation has disturbed the mental peace of surrounding communities, contributing to widespread noise pollution. Poor regulatory enforcement and

lack of proper oversight have also resulted in inefficient extraction practices and compromised the quality of mined limestone. Moreover, the difficult geological conditions demand regular safety inspections; however, the implementation of safety risk management practices remains poor and inconsistent, disrupting the ecological balance of the area. To address these challenges, several practical solutions have been identified. The adoption of modern extraction techniques, such as controlled blasting methods, can significantly reduce dust pollution in mining environments. Regular monitoring and compliance checks should be conducted to ensure that all mining operations adhere to the environmental and social regulations established by local, national, and international authorities. Furthermore, carrying out Initial Environmental Examinations (IEE) and Social Impact Assessments (SIA) before commencing mining operations in potential areas is essential. Continuous air quality monitoring should also be prioritized to ensure that emissions remain within safe levels. Complementary measures such as maintaining green cover, performing regular water spraying, and installing dust collectors around mining zones can further help control air and water pollution. Lastly, avoiding nighttime operations can minimize disturbances to both wildlife and nearby communities, fostering a more sustainable and harmonious mining environment.

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