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Land Degradation and Health Impact Assessment of Limestone Mining: A Remote Sensing and GIS Approach

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ABSTRACT

Land degradation is caused due to multiple factors including human and natural. It not only causes unhealthy ecosystem but also impacts food production, biodiversity, and livelihoods. The human need and greed impact the whole community in terms of health dilapidation and living standard reduction. This paper focuses on two major aspects of mining including Health impact over the resident population and mine workers, and Land Degradation. The study area is situated south east of Kota district in Rajasthan which is undergoing massive mining activity of limestone popularly known as Kota Stone mining. Non reclaimed mining pits, ill health of the resident population and mining workers are the key concerns of this paper.

Land Degradation is assessed using the elevation data which is processed in 3D analyst tool of Arc GIS. The mining pits created by regular extraction are nearly 20-30 meters deep. The health impact is seen in terms of Particulate matter pollution and Noise Pollution. The questionnaire is designed according to the effects of suspended particulate matter, particulate matter pollution and noise pollution. A total of 80 resident population and 40 mine workers were studied in a primary health survey. A series of problems including Breathing difficulty, Cough, Asthma, Anxiety issues can be seen among the respondents.

KEYWORDS: Land Degradation, Mining, Noise Pollution, Particulate Matter, Health

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1. INTRODUCTION

Mining is a multidisciplinary industry, with its dependent industry branching into exploration, mining development, mine operation, decommissioning and land rehabilitation. Apart from creating impact over the face of earth, it does impact the people involved directly and indirectly. Noise and dust are ubiquitous in mining regions. Traumatic problems range from insignificant to fatal. Noise is generated during drilling, blasting, material handling, crushing. This induces hearing loss among the workers and sometimes the resident population. Whole body vibration is experienced while handling the machines which impact the spinal region and exaggerate pre spinal injuries. [1] Crystalline silica has been a serious hazard in mining operations. However, silicosis is mainly concentrated in developing regions and to Silicosis tuberculosis is most prevalent in Africa, where high prevalence of HIV among the miners increases the risk.[2] Ergonomic hazards are also common in the mining regions. Overhead work is common in mining regions which can cause or exaggerate shoulder injuries. Broken ground can cause knee or ankle injuries. Most mine operate 24hr a day, wherein the workers must work in shift which makes it at least 12hr of work per day. Fatigue remains common among the workers.[3] Unfortunately, fatal injuries are common in mining which impact the mental health of the workers. Such incidents develop post-traumatic stress disorder among the workers. Particulate matter exposure, which is specific to this region, over short term and long term include respiratory and cardiovascular morbidity such as aggravation of asthma, respiratory symptoms and increased hospital admissions, mortality from cardiovascular and respiratory diseases. Among 34 member states of WHO, almost 83% of the population of the cities for which PM data exist is exposed to, PM10 levels exceeding the Air quality guideline levels.[4]

Mining can affect the environment in numerous ways. Most conspicuous is disruption of land surface. The scars from the mining are long lasting and the resulting air and soil quality degradation can go beyond the limit of control.[5]

The study of Kota district shows NDVI (Normalized difference vegetation index) observation of non-agricultural land and the study area as whole reveals that there is a decline in health of vegetation. Land degradation is a usual phenomenon in the mining areas of Kota including Ramganjmandi due to extensive deforestation and improper mining practices which is leading to the deterioration in environmental quality.[1]

In the era wherein on a global level Amazon basin seeks help, micro regions too want possible attention. A problem often needs recognition before suggesting any solution to it. The present study must receive enough attention in the arena of commercialisation and human centred

earth. The greed to look good, live good and portray good, often leaves the natural environment in dilemma as if it is just for one species Homo sapiens? The green cover, the natural flowing water and even the blueness of the sky is in danger. The present research enlightens few areas encapsulating environment, health and most importantly study of these aspects at micro level, in this case a tehsil. Humans are both the polluters and sufferers of environmental damage. It is the relationship between human and environment, which when becomes imbalanced affect not only humans but also innumerable species existing in the concerned environment.[6]

Ramganjmandi is a tehsil of the district of Kota in the state of Rajasthan, in which lies the Ramganjmandi city. It is known as a stone city and coriander city. It is 73 kms away towards south of Kota on the Delhi-Mumbai broad gauze railway line. The latitudinal extension is 24° 08´00´´N to 24° 11´ 10´´N and the longitudinal extension is 75° 13´ 04´´ E to 76° 01´ 57´´ E.

As far as geology is concerned, Kota is a part of series of lower Vindhyan Group. Kota stone Deposits are spread over an area of 150 km^2. It is a minor mineral covered under the Rajasthan state minor mineral concession rules. It is a cheap flooring material. The minable reserves in the region could be found at Chechat, Suket, Julmi, Kumbhkot, Satalkheri, Laxmipura, Atraliya, Pipakheri.[6]

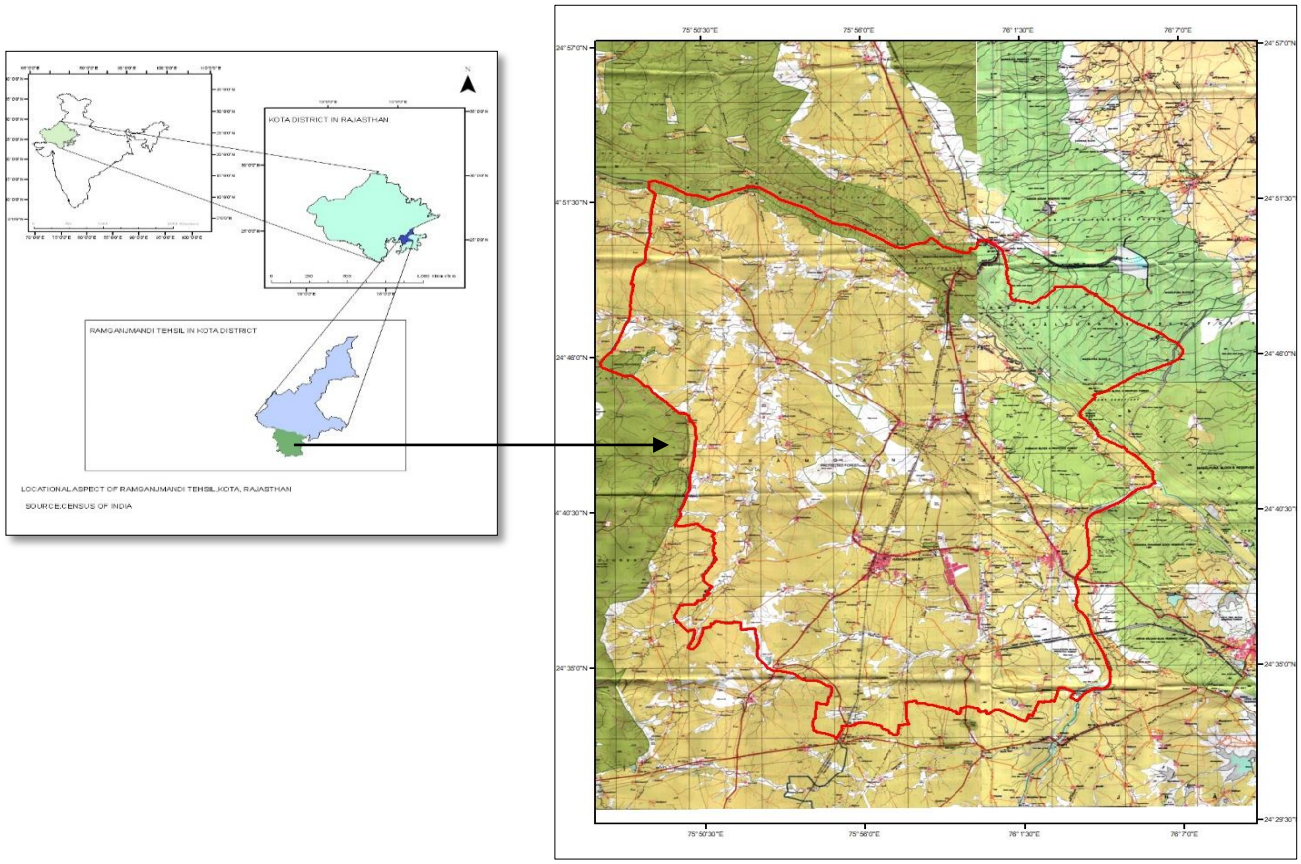

Fig 1: Locational Aspect of Ramganjmandi.

Ramganjmandi once famous for coriander cultivation is now famous for mines, extraction, mine mafias, poor air quality, water unfit for drinking, loss of agricultural land, deforestation, massive solid waste disposal. The present study focusses on few major headings-air, water, soil quality, solid waste disposal, deforestation, health impact, land use and land cover changes. Micro regional study often portrays the relationship between man and natural environment which is supposed to be in continuous harmony. The concept of 'Pays' as advocated by Vidal De la Blache signifies the importance region-based study. The strenuous task of detailed descriptive study should begin at the micro level. Either hills are covered with Kota stone scrap or mounds of scraps have been created. This not only diminishes the aesthetic value of the place but also create environmental degradation.[6]

2. EXPERIMENTAL SECTION

Land Degradation-

The land degradation is analysed with the help of elevation data using Satellite data from google earth with which a point file was created which was interpolated using Inverse Distance weightage method to create a Digital elevation model. With the help of this raster contours were generated. The DEM is further analysed in 3D analyst tool to create the elevation profile of the mining belt into three sections. The Elevation profile gives a picture of the mining pits created.

Health Impact Assessment-

A questionnaire is prepared centring around effects of Particulate matter pollution and Noise pollution. The Noise analysis is done by primary survey using SL-1352 Professional sound level meter. The device is used to measure dBA, A weighted Decibels, which is general noise level. Slow mode is used. The meter is kept 1 to 1.5 meter away from the sound source. The Microphone is kept at Ear level. The reading is then noted along with the GPS location at the source. Particulate matter 10 data is extracted from the secondary data sources of environmental clearance reports collected from Rajasthan Pollution Control Board.

RESULTS AND DISCUSSION

A. *Land Degradation*- With the elevation data from google earth a point file was created which was interpolated using Inverse Distance weightage method to create a Digital elevation model. With the help of this raster contours were generated. One can see the elevation values reduces to 315 meters at the mining pits. Similarly, the TIN values also give such description. With the help of Digital elevation model of the mine an elevation profile is created. One can see a dip of 25 meters and somewhere 30 meters due to the mining pits created. Land Degradation becomes an important cause of concern if not reclaimed properly.

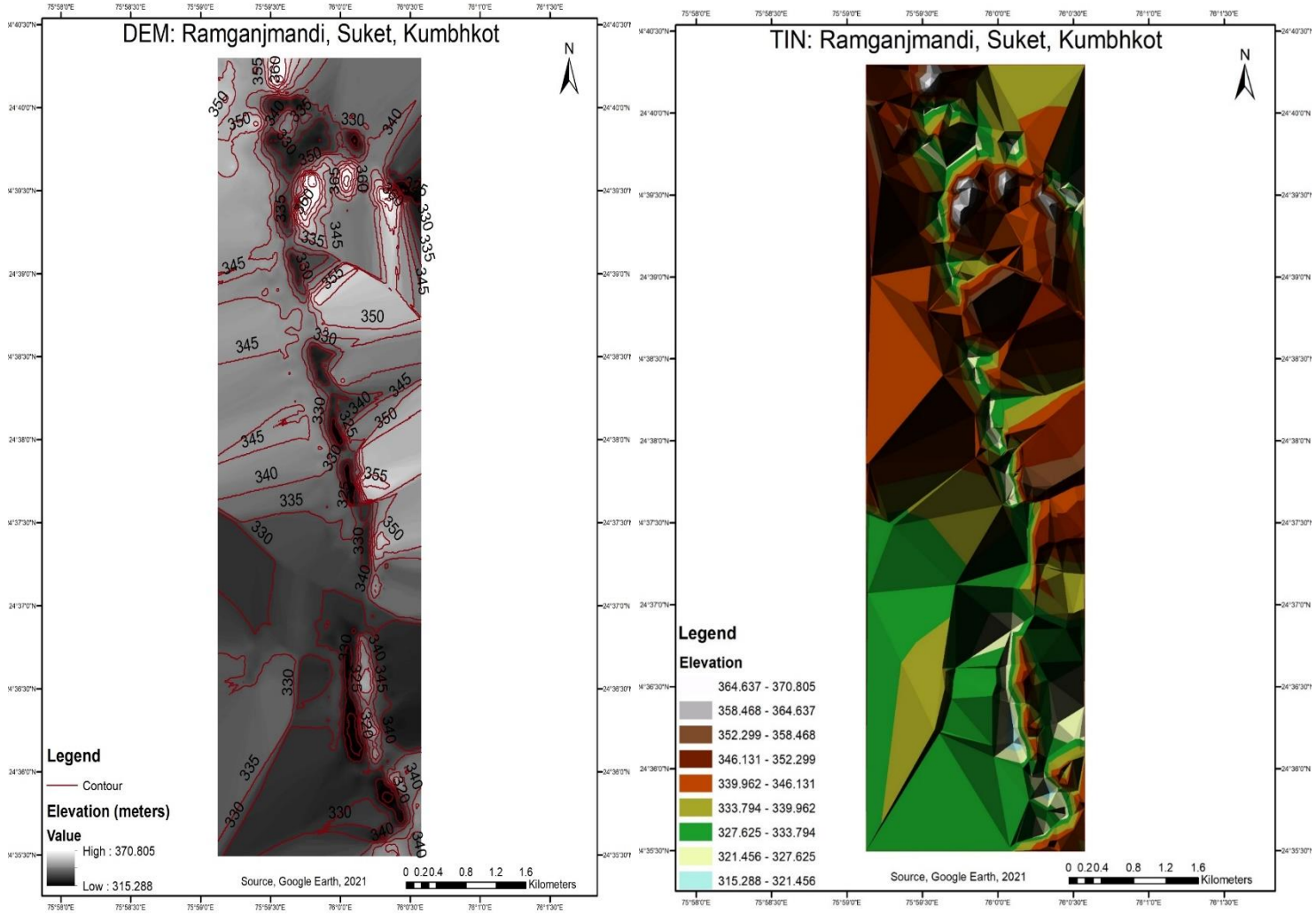

Fig 2: Digital Elevation model, Triangulated Irregular Network, Suket belt Ramganjmandi.

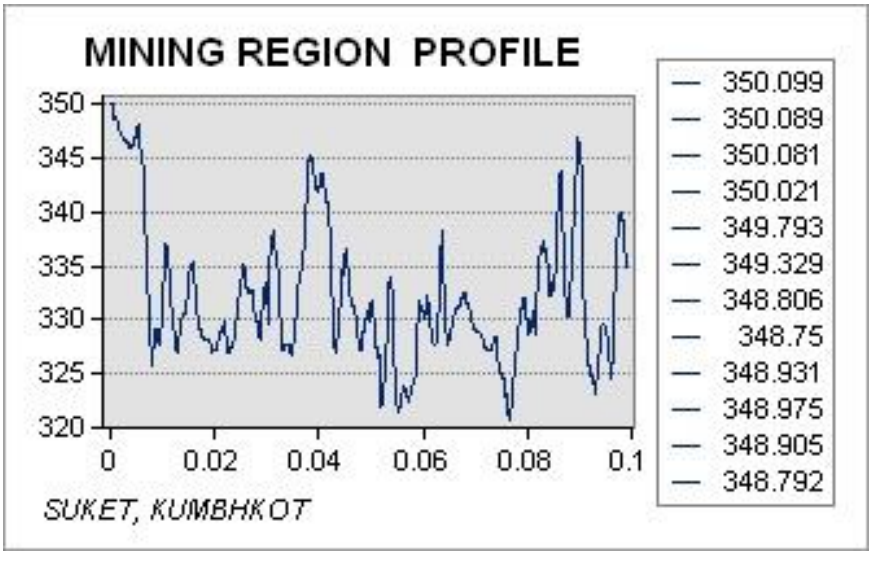

Fig 3: Elevation Profile, Suket Belt, Ramganjmandi.

B. Health Impact

As far as the noise levels in the tehsil is concerned, Day time monitoring is executed for the region. Maximum noise level is 120.4 dB and minimum value is 50. The mean value is 85.93 dB. The standard deviation for the noise level is 20.01 depicting a good variability. The median value is 80.6. The low noise level is found around the Mukundara national park in the north of tehsil. The mining region shows high sound level as high as 120.4 in Kumbhkot region. The scatter plot can also be virtually divided into three sections Residential region near mines, Mining Belt, Sensitive Zone (Fig 4).

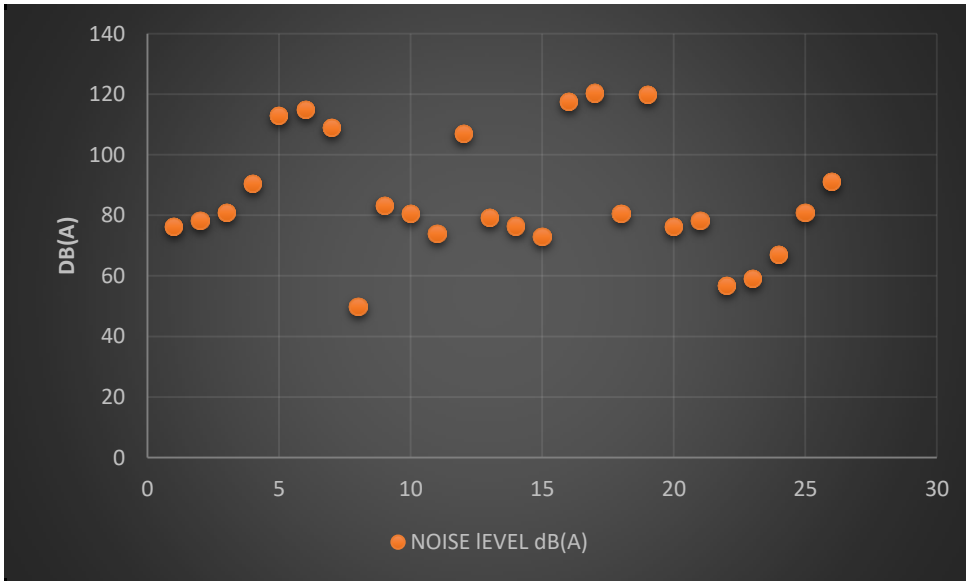

Fig 4: Noise Levels, Ramganjmandi

The sampled sites are compared to all the standards as given above. As per WHO guidelines, 96% sampled sites are unfit. As per the MOEF, 2000 guidelines80.76% are unfit. As per WHO and ILO guidelines according to area categories92.85% are unfit. As per OSHA/ILO guidelines 61.53% are unfit.

As far as the secondary data air pollution survey is concerned, suspended particulate matter in the region is averagely found as 262.24 µg/m3. The minimum is found at Atraliya mine at the core zone. The maximum is found at Dhingsi village (Fig 5).

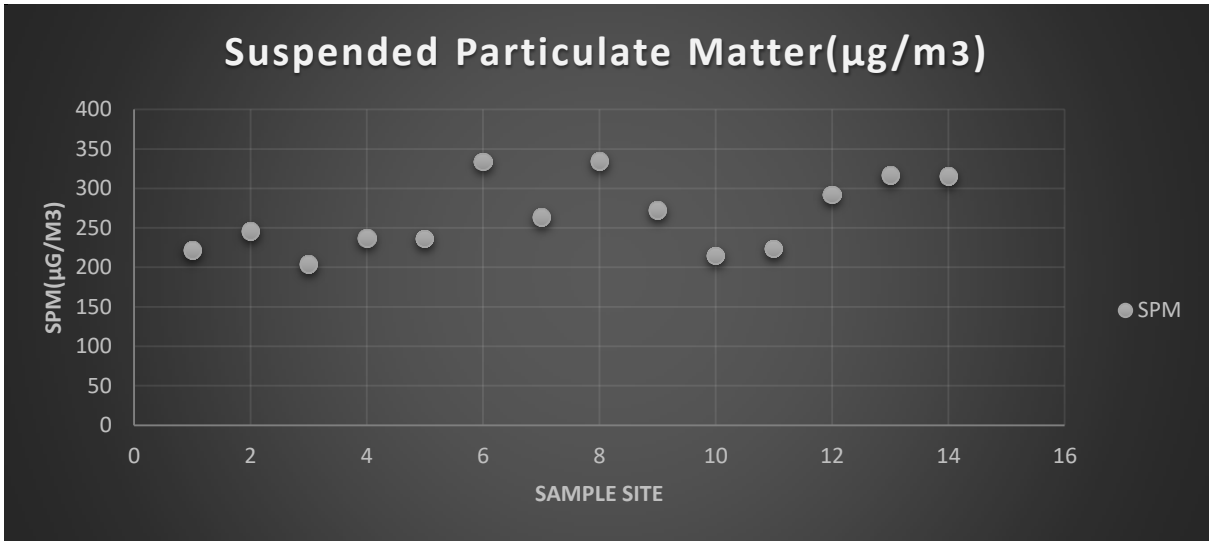

Fig 5: Suspended Particulate Matter, Ramganjmandi

The average of PM 10 is 84.87 µg/m3. The maximum value is 93.11 near Atraliya mine office. The minimum is found at Satalkheri Zone (Fig 6).

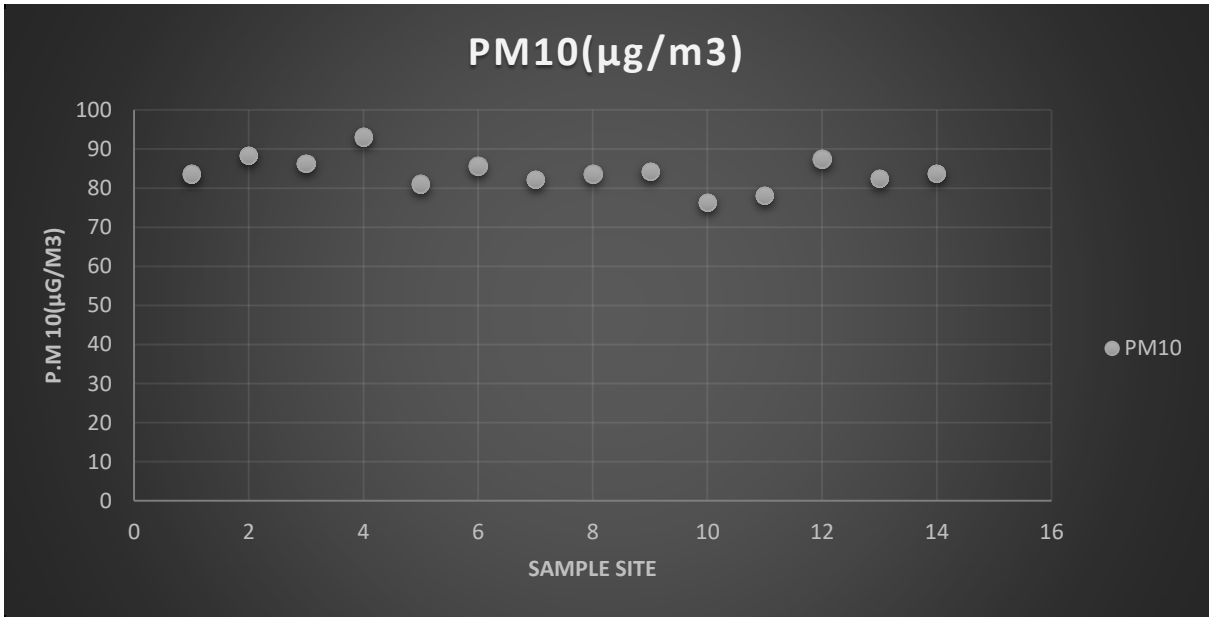

Fig 6: Particulate Matter 10 Concentration, Ramganjmandi

The average of Sulphur dioxide concentration is 14.72 µg/m3. The maximum is 18.2 µg/m3 found at satalkheri core zone. The minimum is 18.2 µg/m3 measured at Atraliya mine office.

The average of Nitrogen dioxide Concentration is 32.62 µg/m3. The maximum is measured as 40.11 µg/m3 near Haul road Atraliya Mine. The minimum concentration is 25.3 µg/m3, measured at laxmipura mining office.

In reference to the above data the questionnaire is so designed focusing on particulate matter impact assessment, silicosis assessment and the Psychological assessment which can be attributed towards regular exposure mining operation's noise levels.

C. Major health problems in mine workers and resident population

A total of 80 resident population and 40 mine workers were surveyed from the currently operated mining region of Kumbhkot, Chechat and Suket.

1. **Difficulty in Breathing-** Lime particles may cause irritation, but they are not classified as carcinogens.[7] The effects on the respiratory tract are respiratory tract irritation, breathing problem, airway narrowing and loss of cilia and mucus membranes.[8] In the study area 78.75% of the resident population faced difficulty in breathing, 15% did not faced such difficulty and rest 6.25% are not sure about their experience. Among the mine workers 40% of the workers experienced difficulty in breathing during drilling and blasting, 55% did not experience such difficulty, rest 5% of them are not sure about their experience.
2. **Cough and sneezing for more than 15 days-** Exposure of particulate matter poses symptoms like respiratory irritation causing coughing and sneezing. In the survey 67.5% faced regular coughing and sneezing during the times of blasting and the transportation of extracted material, 30% did not face such issue and rest 2.5% of them are not sure about their response. Since the mine workers have direct exposure to the dust throughout the mining operation from blasting, drilling, loading and transportation. 82.5% faced coughing and sneezing issues for more than a period of 15 days and rest 17.5% faced coughing for a lesser duration.
3. **Asthma-** it is often a consequence of inhalation of particulate matter. Exposure to various irritants can trigger asthma. Asthma triggers are different from person to person. It can be caused by pollen, dust mites, respiratory infections, cold, air pollutants, smoking habit and genetics. In the study area, among the resident population 12.75% respondents have asthma problem, 12.5% do not have such issue and rest 8.75% are not sure about it. Among the mine workers 92.5% of them do not have asthma problem but rest 7.5% developed the problem after working in the mine.
4. **Hypertension/ high blood pressure-** when the blood pressure increases to unhealthy levels it is termed as High B.P/Hypertension. Narrow arteries tend to increase the resistance in the blood flow. So narrower the arteries higher shall be the blood pressure. Abdelraziq.et.al in their study over correlational analysis over high blood pressure and noise level found a positive correlation of 0.55 in males and 0.440 in females. In this study area 56.25% of the respondents faced hypertension,37.5% did not face such issue rest 6.25% were not sure about it. Among the mine workers 67.5% faced high blood pressure issues, rest 32.5% did not face such problem. High

blood pressure often causes frequent headaches, Nosebleed, fatigue, confusion, chest pain, difficulty breathing.

5. **Cancer patient in family-** Silica dust is harmful when inhaled. As per Cancer council exposure to silica causes lung cancer, silicosis, chronic obstructive pulmonary disease.[9] In the study area a family among the resident population had uterine cancer. But there were no cases related to lung cancer. Among the mine workers none of them reported cancer of any form.
6. **Fatigue/Weakness**- Among the resident population 50% reported regular fatigue and weakness. Among which most of them were females. 41.25% did not face any form of weakness and fatigue on a regular basis and rest 8.75% were unsure. Among the mine workers 57.5% faced regular fatigue and rest 42.5% did not. The mine workers reported fatigue after completion of their shift and they believed a regular resting period is necessary to ensure healthy input towards their work.
7. **Frequent fever**- Among the resident population 2.5% of the sample population reported regular fever which cannot be attributed to silicosis since the other symptoms were missing. 97.5% population did not report such issue. Among the workers, none of them reported regular or frequent fever.
8. **Bluish discoloration of lips**- Bluish discoloration of lips is common symptom of Silicosis.[10] This symptom was not found among the resident and mine worker sample population.
9. **Silicosis-Indications of silicosis** usually appear after many years of exposure. In early stages, symptoms are mild and include cough, sputum, and progressive shortness of breath. As the scarring continues to worsen, the first real signs of a problem may be an unusual chest X-ray and a gradually growing cough. As far as the study area is concerned none of the resident and mine worker population report silicosis. But they tend to report the other symptoms including frequent fever, breathing difficulty, fatigue and weakness.
10. **Trouble in sleeping**- Irregular sleeping, disturbed sleep is often a consequence of Noise pollution. Noise is a significant cause of sleep disturbances. Poor sleep causes endocrine and metabolic quantifiable agitations and is associated with several cardiometabolic, psychiatric and social negative outcomes both in adults and children.[11] Among the resident population 50% of the sample population experienced mild trouble in sleeping, 21.25% experienced moderate trouble in sleeping and rest 23% addressed severe trouble in sleeping. The days of blasting tend to induce troubled sleep as per the respondents.

Among the mine workers 57.5% respondents reported mild trouble in sleeping, 27.5% reported moderate trouble and rest 15% severe trouble in sleeping.

11. **Restlessness**- it is a common symptom of anxiety disorders. It is the feeling of 'on edge' or having an 'uncomfortable urge to move. In the concerning study area 41.25% of population faced mild restlessness, 48.75% faced moderate restlessness and rest 10% faced severe restlessness. Among the mine workers 67.5% reported mild restlessness, 20% reported moderate restlessness and nearly 12.5% reported severe restlessness.

12. **Panic attacks**- Loud noise can be overwhelming causing panic. Panic attack can happen when a person has high level of anxiety. During a panic attack, a person may experience tremendous gush of emotions, including helplessness and fear and the physical symptoms can include a rapid heartbeat, fast breathing, sweating, and shaking.[12] In the concerned study area 70% of the resident population were unaware of the health disorder. When explained deeply by the interviewer 21.25% reported that they have not felt such situation and rest 8.75% agreed that they had face such situation in past. Among the mine workers 57.5% were totally unaware of the situation, 40% never faced such situation and rest 2.5% agreed to the symptoms when explained comprehensively.

CONCLUSION

Ramganjmandi is growing centre of limestone mining. In the period of last 30 years the mining belt has continuously increased imposing a massive impact over the land and the health of the mining workers and resident population. Pits of more than 25 meters are created in the region which have not been reclaimed properly. The resident population and mining workers are facing serious health issues such as anxiety, restlessness, difficulty in breathing, cough and sneezing, sleeping problems, hypertension. Unsuitable work environment is the main cause of these health issues.

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