MONITORING OF ENVIRONMENT, HEALTH AND SOCIO-ECONOMIC IMPACTS OF LIMESTONE QUARRYING NEAR CHAKWAL, PAKISTAN

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ABSTRACT: The limestone quarrying was occurring in the proposed study area. Environmental parameters, socio-economic and health impacts of quarrying were monitored. The noise level was comparatively high in the quarry area with the values ranging from 55 dB (A) to 89 dB (A).Similarly, surface water quality parameters, ground water quality parameters and ambient air quality was also monitored and compared with the NEQS values. PM_{10} was ranging from 139 to 187 µg/m^3, NO_2 values from 58 to 87 µg/m^3, TDS value was 3675 mg/l and TSS was high with the value 230 mg/l. The socio-economic status of the local residents was monitored and the health problems of the locals working and living near the site were also identified in which the main health issue is linked to dust. Dust problem and water shortage was the main problem of the area. Social issues and health problems were also linked to some of the parameters that were high.

Key words: Quarrying, Limestone, Noise, NEQS, PM_{10}, TDS, TSS

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INTRODUCTION

The term Quarrying derives from the Latin word ''quadraria '' which means a place from where the extraction of the material can be done. Quarrying is defined as the process by which resources like rocks can be extracted from the above and below of the land surface (Nartey *et al.*, 2012). Different factors determine the procedure for quarrying or mining operations as they are done according to the type of ore that is mined. (Dentoni and Massacci, 2013)

Various types of stones are used in the quarrying processes according to their properties and the uses and they are mined by using analytical techniques (Vaughn and Tripcevich, 2012). Limestone is used for various purposes specially in the cement manufacturing industries using the bond grind ability method. (Shahani *et al*., 2017) In the specified area, quarrying of limestone is occurring. It is mainly of marble. Marble trash produced by quarrying (marble quarry waste-MQW) and different processing plants (marble cutting waste-MCW) highly poses major social, economic, and environmental difficulties (Banez *et al*., 2010). Quarrying of the stone is depended on the quality of the stone which is going to be extracted; it's cheap transportation to the market, its tendency and distance downwards to the land surface (Omair *et al.,* 2014). Brittleness, drill ability, and strength parameters are mainly used by the workers for checking the rock response for excavation. (Iqbal and Abubakar, 2016)

Pakistan is rich in mineral reserves especially in marble and limestone (Mansoor and Syed, 2012). It incorporates vast assets of coal in Sindh region, some metals and the copper at the district Chagai Balochistan, Gilgit, granite and some of the marble in KPK, and also the gemstones of significance in KPK, AJK and Gilgit-Baltistan, resources of industrial minerals and rocks in Punjab (Khan, 2012). Pakistan has high potential in its mining and quarrying industries with the contribution of 14.47 % in the industrial sector overall. (Sulleman and Amin, 2015)

Several characters are considered for the drilling purposes (Bilim, 2011). Drilling and the splitting technique of dynamite are randomly used with the explosives creating major waste products. This kind of technique wasted about 50% of the quarry material. There are many mining industries in Pakistan as there are metallic and non- metallic deposits in Pakistan. (Dasanayaka and Sardana, 2015)

The study was carried out in Manihala village which is surrounded by mines of limestone. The surrounding sites of the study area are as follows.

East: Watli village
West: Ratucha
North: Manihala
South: Village tobar

Fig-1: Map of the study area

In 1985, Chakwal was considered as a district for the first time. Chakwal is in the south of Rawalpindi with almost 90 % population that is residing in the rural areas. The environment is sub humid and lies in semi-arid region (Ahmad *et al*., 2010). Different issues like disposal of wastes, water resources impacts and solid wastes are having their impact on fauna and flora of the particular area. (Yousaf and Sharif, 2013)

The proposed area is very rich in mineral resources. The mineral resources in Chakwal district are Bentonite, Coal, Argillaceous Clay, Dolomite Fireclay, Gypsum, Limestone, Rock Salt and Silica Sand (District Pre-Investment Study, 2012).

Quarrying actions cause considerable impacts on the surroundings. The rocks when blasted with explosives for the extraction of required material increases the noise pollution and air pollution. It also causes destruction of habitat and biodiversity (Lameed and Ayodele, 2010). Satellite images mainly illustrate the mined and quarried areas which are increased exponentially in past few years (Darwish *et al.*, 2011) Rockfalls are mainly the biggest serious risk for the mine and quarry workers which is linked to the rock instability. (Peila *et al*., 2011)

Different respiratory problems are associated with the mining and quarying industries workers and the nearby population (Fugiel *et al*, 2017). Now-a- days, people giving their interest to the dust arising from this industry as finer particles when inhaled can cause problems. It is commonly renowned that dust likely 10 µm is inhaled overpass the larynx while the dust equivalent to 4 µm can be inhaled to the lungs. Airborne dust causes potential health impacts to human together with the effects on respiratory and cardiovascular systems (Molen *et al*., 2012). When dust is inhaled it can cause a state of ‘’pneumoconiosis’’ which refers to the disease of lungs (Nartey *et al.*, 2012).

The social development and the environment emissions in any society is significant as a social impact (Chang *et al*, 2011). Mining activities have many social impacts on the local communities involving dislocation of the communities, damage of cultural sites, and creation of the mining villages. A leading trouble is that the mining companies attain the profits from their companies, but on the other hand the locals are suffering from the impacts of the companies and their mining and quarrying activities. Many fights have occurred because of the issues that includes the socio-cultural survival, self-governance, land scarcity, territory practice, contamination, and resource regulation (Lad and Samant, 2014).

The mines act, 1923 is implemented in various industries where mining is performed and this law

emphasizes on the rights of the mine workers. The medical appliances and first aid rooms are necessary for mine workers (The mines act, 1923) Workers of mine live in the filthy conditions at the mine sites without access to basic services. There is also no means to offer compensation to ailing or injured mine workers, to the families of those killed on the job. (IUCN Report, 2010). Factories act 1934 usually provides with the safety measures of the workers and addresses the health issues (Raheem and Hinze, 2012) Factories act, 1934, Chapter three of health and safety deals with the guidelines to be followed by the factory workers and employer (The factories act, 1934). The International Labour Organization also focuses on the health and safety of the workers. Different researches in the respective field enhance the importance of worker's rights. (OSH, 2001).

MATERIALS AND METHODS

The information on the environmental monitoring, health and socio- economic impacts of the quarry is explored with the assistance of the interviews, published literature, questionnaires, surveys, observations and lab testing. (Nartey *et al*., 2012).

Environmental Monitoring was also supported by sampling, testing air and water quality factors. Ground water, Surface water, Air quality and Noise tests were done and results were compared with NEQS and the CORE standards.

Questionnaires and Interviews: Fifty (50) questionnaires were distributed among the site workers and the nearby residents**.** Ten (10) were given to the quarry operation workers and the other forty (40) to the local residents of the area. The questions were based on the social issues, health issues and fitness issues of the workers and locals. Both genders were considered for the questionnaires filling. The interviews and questionnaires both helped to identify the significant issues of the community.

The methodology was adopted for monitoring includes the study of journals, literature review and articles for the secondary data development. The questionnaires were formed for the social, health and economic based survey according to the site. These questionnaires were filled on the site visit and the interviews were also conducted. The monitoring of parameters was done that includes the noise monitoring, drinking water quality, wastewater quality and air monitoring.

Water Sampling: The method of sampling used was the grab sampling. The grab samples were taken at a specific site and at a specific short duration of time while the composite sampling mainly obtained when a number of grab samples obtained after the equal distance (Sharma and Tyagi, 2013). Different tests were performed concerning the water sampling by grab sampling method for both ground and surface water.

Materials and Instruments: The materials that were used in this study comprises of gloves, bottles, spatula, marker, hammer, plastic bag, and filter paper. While, the instruments that were used includes the HACH COD reactor, EUTECH PH 700, HACH digital titrator, HACH 2000, noise level meter, HAZ- scanner, turbidity meter, DO analyzer, desiccators, and weighing balance.

RESULTS AND DISCUSSION

The environmental quality was tested of the Manihala site. Ground water and waste water samples were collected along with ambient air monitoring and noise on the site. Water samples were analyzed for different parameters including pH, arsenic, turbidity, chloride, fluoride, boron, barium, sulphide, sodium, potassium, TDS, copper, lead, nitrate, nitrite, total coliforms and Escherichia-coli. While, ambient air monitoring was done for carbon monoxide (CO), nitrogen dioxide ($NO_{2),}$ sulphur dioxide ($SO_{2),}$ carbon dioxide (CO_2) and particulate matter ($PM1^0$). The particulate matter (PM^{10}) was high in quantity which is dangerous for the local residents as well as for the workers with the 139 to 187 $\mu g/m^3$. Nitrogen dioxide (NO_2), total dissolved solids (TDS) and total suspended solids (TSS) were also high with the value of TDS observed 3675 mg/l and TSS was 230 mg/l. The nitrogen dioxide (NO_2) was ranging from 58 to 87 $\mu g/m^3$. The dust problem because of PM^{10} was very widely spread. It was the reason that the local population was suffering from the asthma and lung problems. Water was very scarce at the proposed area and the community was suffering from the water shortage. Main facilities for living were not provided to the local residents and the workers. The maternity hospital was at a very long distance from the proposed location. Crime rates increased because of the less jobs and facilities. Major health issues that were identified include the asthma, heart problem, coughing, diarrhea, and lung problems because of the dust problems and water shortage in the study area. Education was not given preference in the proposed area as the schools and colleges were located at a distance.

Mines create a topmost public-health problem in Pakistan. Direct concerns include both the physical and emotional damages from the impact, flying debris by the blasting operation which is considered a dangerous activity (Armaghani *et al.*, 2015), and structural breakdown associated with their explosion. Indirect concerns rises in the occurrence of waterborne diseases, diarrhea, starvation, infectious diseases, and blowout of the human immunodeficiency virus linked with the augmented circulation of blood by physical work. Psychiatric illnesses, such as post-traumatic stress

disorder, arise in those that are not directly injured as well as in those which are physically suffered by the explosion (Ejaz *et al.,* 2011) All of the factors which are important according to the environment can be addressed in the EIA report and the proper SOP's and EMMP plan should be implemented at every site (Phillips, 2012).

TDS is mainly not considered as a main pollutant. It is used to describe the aesthetic features of drinking water and as a cumulative indicator of the presence of chemical contaminants which can be avoided by taking measures to stop mixing of contaminants with the water table (Mohsin *et al.,* 2013) while the total suspended solids are important factor to check the water clarity. If more solid particles are present in water the more suspended particles are present in wastewater (Tambekar *et al.,* 2012).

Water sources (groundwater, lakes, streams and rivers) can be polluted by heavy metals leaching from industrial and consumer waste; acid rain can exacerbate this process by releasing heavy metals trapped in soils (Mebrahtu and Zerabruk, 2011). Symptoms of exposure to high levels of arsenic may contain stomach pain, vomiting, diarrhea, impaired nerve function, change the pattern of the skin etc so the contamination should be avoided by taking measures to minimize the linkage of water aquifer with the waste (World Health Organization, 2011). Noise in the air is caused by anthropogenic activities. The noise level when exceeds the PEQS limit, it can affect the hearing activity of a human body. Psychological stress can be a disadvantage of high levels of noise so the proper ear muffs and PPE's should be used by the workers at the site (Gunlake Quarry Project, 2015).

The amount of oxygen in the body can be decreased because of the increased ratio of carbon monoxide in the blood (Public Health England, 2016). Contact with the Nitrogen dioxide for about 24 hours can cause cold bronchitis, asthma, airway inflammation, coughing, vomiting and long term contact can cause lung problems and the more severe attacks in the human (Committee on the Medical Effects of Air Pollutants, 2014). Life expectancy is decreased by long-term exposure to PM so the shift rotation is an important measure in this case. The reduction in life expectancy is primarily due to increase cardio-pulmonary and lung cancer mortality (World Health Organization, 2013).

Table-1.Summary of ambient air quality analysis of proposed project site of Manihala (District Chakwal).

Sr. No.	Sources	CO	CO_2	SO_2	NO_2	PM_{10}
	Units	**ppm**		**µg/m^3**	**µg/m^3**	**µg/m^3**
	NEQS	**9**	**--**	**120**	**80**	**150**
1	Near Quarry Site	BDL	433	BDL	85	172
2	Near Main Road	BDL	477	BDL	64	141
3	Near Crushing Area	BDL	404	5.2	87	187
4	Near Transportation Site	BDL	430	BDL	58	139

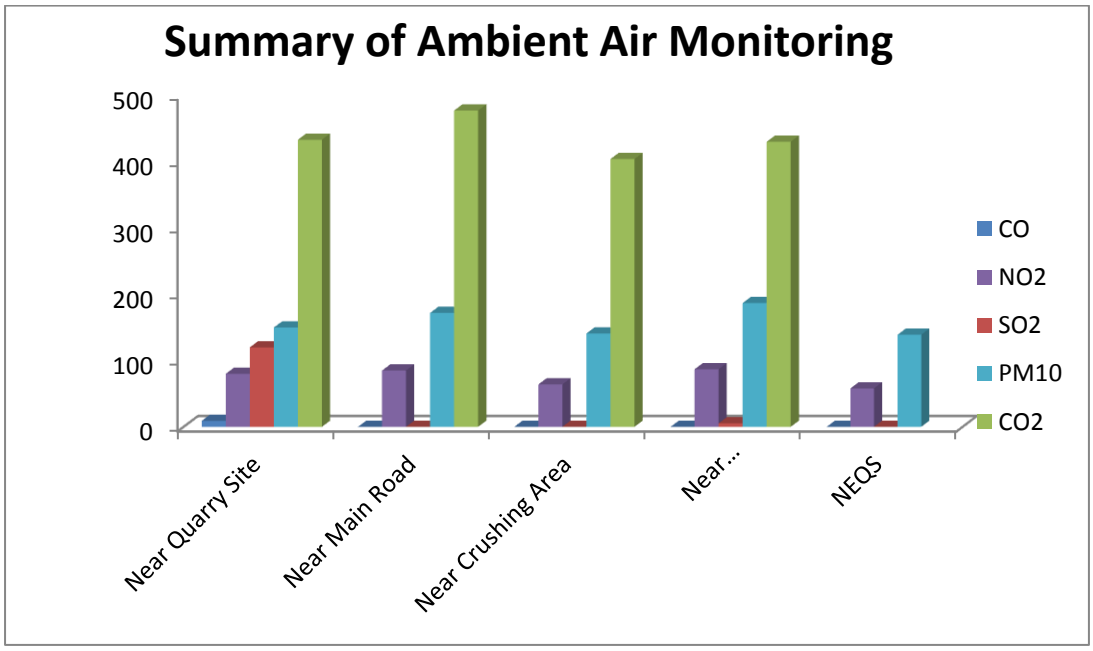

Fig-2: Result analysis of Ambient Air Monitoring

Table-2.Summary of noise level analysis of quarry site Manihala-District Chakwal

Sources	Noise Level dB (A)	NEQS dB (A)
Near Quarry Site	68	75
Near Main Road	55	
Near Crushing Area	78	
Near Transportation Site	76	
Near Explosion Site	89	

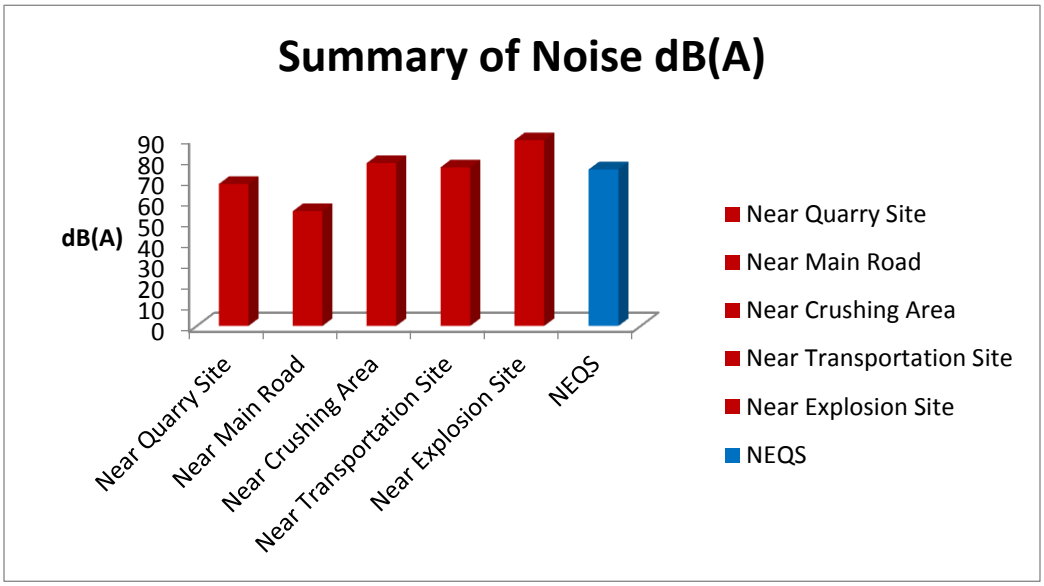

Fig-3: Result analysis of Noise Monitoring

Table-3.Summary of parameters for surface water quality.

Sr. No	Parameters	Units	NEQS	SW
1.	pH Value	....	6-9	7.14
2.	TDS	mg/l	3500.0	3675.0
3.	TSS	mg/l	200.0	230.0
4.	BOD_5	mg/l	80.0	8
5.	COD	mg/l	150.0	21.0
6.	Chloride	mg/l	1000.0	24.0
7.	Grease and Oil	mg/l	10.0	0.0
8.	Phenolic Compound	mg/l	0.1	BDL
9.	Sulphate	mg/l	600.0	24.0
10.	Cyanide	mg/l	1.0	0.005
11.	An-ionic Detergents	mg/I	20.0	BDL
12.	Sulphide	mg/l	1.0	0.012
13.	Fluoride	mg//	10.0	0.34
14.	Ammonia	mg/l	40.0	0.2
15.	Cadmium	mg/l	0.1	BDL
16.	Chromium Total	mg/l	1.0	0.004
17.	Copper	mg/l	1.0	0.008
18.	Lead	mg/l	0.5	BDL
19.	Nickel	mg/l	1.0	BDL
20.	Silver	mg/l	1.0	BDL

21.	Selenium	mg/I	0.5	BDL
22.	Mercury	mg/I	0.001	BDL
23.	Total Toxic Metal	mg/I	2.0	0.012
24.	Zinc	mg/l	5.0	0.34
25.	Arsenic	mg/l	1.0	0.02
26.	Barium	mg/l	1.5	BDL
27.	Iron Total	mg/l	8.0	0.14
28.	Manganese	mg/I	1.5	0.005
29.	Boron	mg/l	6.0	0.8
30.	Chlorine Total	mg/I	1.0	0.04

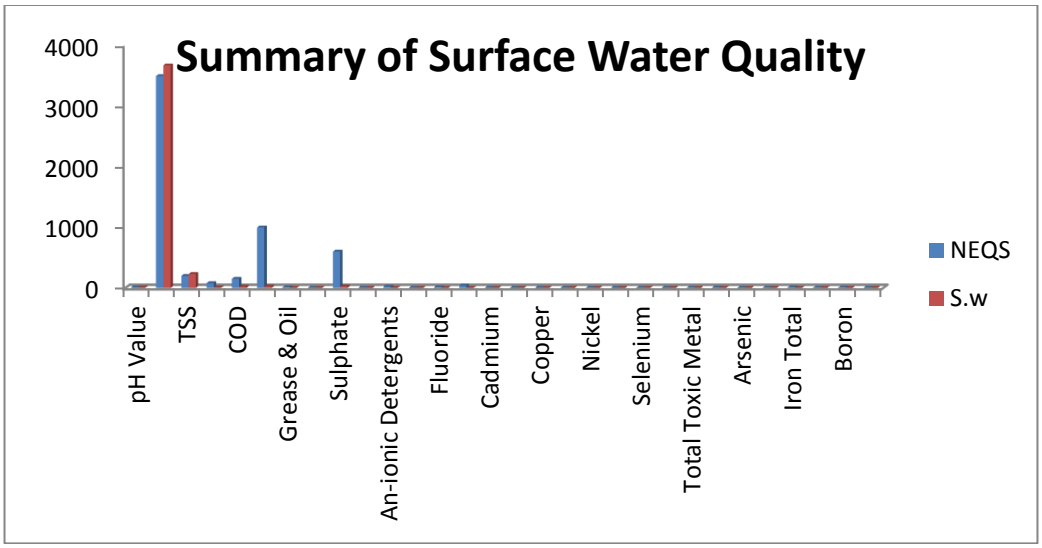

Fig-4: Result analysis of Surface Water Quality

Table-4.Summary of parameters for ground water quality.

Sr. No		Parameters	Units	NEQS	GW-1
1.	1	pH Value	....	6.5-8.5	7.28
2.	2	Arsenic	mg/l	≤0.05	BDL
3.	3	Turbidity	NTU	<5	BDL
4.	4	Chloride	mg/l	<250	64.0
5.	5	Fluoride	mg/l	≤1.5	0.24
6.	6	Boron	mg/l	0.3	0.2
7.	7	Barium	mg/l	0.7	BDL
8.	8	Sulphide	mg/l	---	BDL
9.	9	Sodium	mg/l	---	6.1
10.	0	Potassium	mg/l	---	2.7
11.	1	TDS	mg/l	<1000	570.0
12.	2	Copper	mg/l	2.0	0.070
13.	3	Lead	mg/l	≤ 0.05	BDL
14.	4	Nitrate	mg/l	≤ 50	7.6
15.	5	Nitrite	mg/l	≤3	0.005
16.	6	Total Coliforms	Cfu/100ml	0	Nil
17.	17	*E.coli*	Cfu/100ml	0	Nil

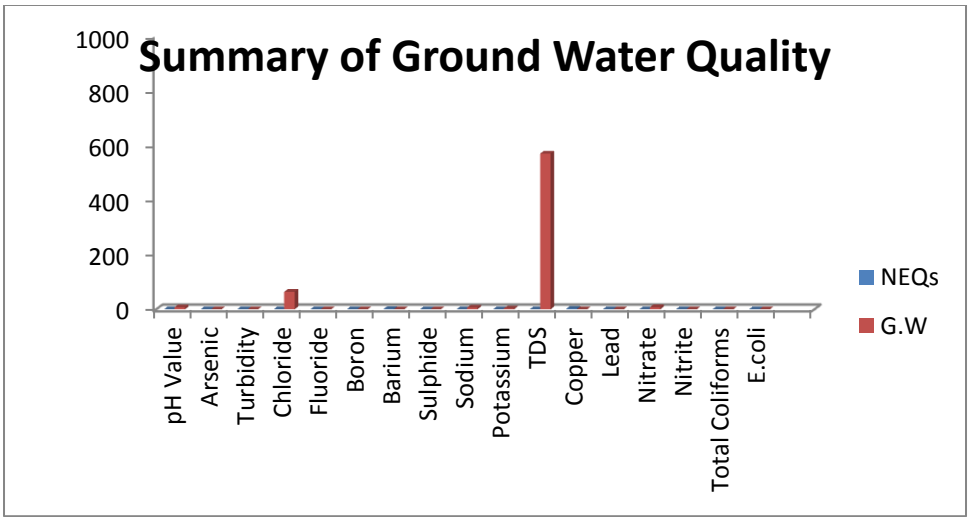

Fig-5: Result analysis of Ground Water Quality

Conclusion: The high level of PM_{10}, NO_2, TSS and TDS, along with the health impacts including asthma, heart problem, coughing and diarrhea were observed. Social issues were the increased crime rate because of low income, no maternity facility services near the quarry site.

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