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The Effect of Quarry Dust (Crusher) on the Quantitative Characteristics of Vegetation in Gaugas Area, Al-Khoms-Libya

Eissa M. Alakhdar[1], Suliman O. Alhuweemdi[2], Ali M. Alhadar[3], Anwer M. Alhadar[4]

Department of Earth and Environmental Sciences, Elemergib University, Al-khoms-Libya

Abstract: ***This study investigates the adverse effects of quarry (crusher) dust on the characteristics of quantitative vegetation in Gaugas region to the south of Al-Khoms. The study is conducted on the direction of prevailing winds in the region. The results illustrate the negative effects of quarry dust on the densities, abundances and frequencies of vegetation that increases the pressures on plant vegetation, living organisms and desertification expansion. Moreover, the results showed apparent negative effects on the Shannon biodiversity index. The results also demonstrate greater dominance of plants enduring difficult environmental conditions in locations near quarry.***

Keywords: Pollution, Dust, Vegetation, Crushing, Quarrying, Diversity, Gaugas, Libya

1. Introduction

Scientists and researchers have warned against dust resulting from various industrial sites, including quarrying and crushing, and its negative impact on plants because they receive dust through its lacunas, and affect the soil by blocking its pores and changing its chemical and physical properties[1, 2]**.** Thus, this dust has harmful effects on green and pastoral land spaces as it causes the degradation of plant diversity and animal diversity[2, 3]**.** However, the impact on rare and sensitive endangered plants is significant due to the dust is produced by cement, quarry, crushers and other industrial dust sources. Dust also causes low visibility to minimal levels and the blocking of sunlight, which affects the vital bioprocesses of plants, especially photosynthesis[1, 4]**.**

Studies have shown that quarry generate a major amount of fine, airborne dust particles that cause harmful effects on people and the environment including flora and fauna[5, 6]**.** The results showed in one of the studies that the activities of quarrying greatly affected the study area, as it led to the deterioration of the environment and distortion of the quality of water, air and soil [7, 8]**.**

These crushing and quarrying lead to the deterioration and erosion of the soil and natural vegetation cover [3, 7]**.** Moreover, the wildlife was greatly affected by the quarrying that were established in the pastoral areas and destroyed the natural plants and animal diversity [5, 9]**.** On the other hand, these activities could led to the occurrence of what resembles desertification so that agricultural areas in not existing except in small areas and far from crushing and quarrying [4]**.**

Some studies also showed that the crushing and quarrying caused a massive noise, this will led to migration of many different species such as birds and wild animals due to the lack of a suitable environment for living[2]**.**

Airborne dust from crushing and quarrying also play a major role in changing the chemical properties of the soil as it increases the base of the soil by increasing its calcium carbonate[4]**.** On the other hand, the liquid substances produced by the machines will decrease the soil acid ratio, which reflects negatively on soil fertility[5]**.** Furthermore, the solid crust of calcium carbonate formed on the surface of the soil in large quantities, up to about (4 mm) thick in some areas, prevents seeds from growing and makes it difficult for plants' roots to penetrate, which decreases vegetation density in these soils[10]**.**

A study was conducted on the impact of the accumulation of human activities on agricultural and pastoral lands in the Marj region in Libya and noted that crushing and quarrying are one of the human activities that pose a threat to the farming and pastoral environment because they lead to deterioration and erosion of soil and natural vegetation[11]

Another study was carried out on the impact of crushing and quarrying on plants growth. However, This study demonstrated that the flora had a significant decrease in total chlorophyll content[3]**.** In addition, had a major impact on seed balance and the content of all protein, fats and sugars of vegetation[9]**.** This paper aims to examine the negative effects of crushing and quarrying on the quantitative characteristics of vegetation diversity in the region of Gaugas south of Al-Khoms, northwest of Libya.

2. Materials and Methods

2.1. Study area

This study is conducted in Gaugas area surrounding crushing and quarrying activities, which located in south of Suq Alkhamis in Al-Khoms city, 120 km east of Tripoli city, as shown in Figure (1). The location is nearby the Mediterranean coast, specifically at longitude :13 :23.16 14east and latitude 32 :38 :1.01north. Many valleys and plateaus of low height spread in this region, which considered it one of the distinctive areas in terms of biodiversity, especially vegetations species.

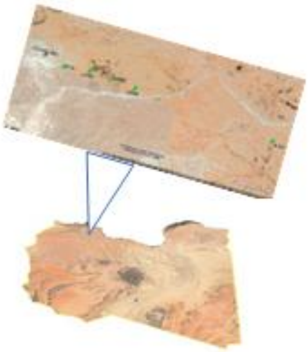

Figure 1: A satellite image shows the two sites of study and sample collection

Libya has a hot tropical climate that predominates most of the northern part of the African continent, excluding the narrow coastal strip and the north mountain regions (Green Mountain and Tripoli Mountains). These exceptional regions have Mediterranean and desert climates.

According to Al-khoms Meteorological Station, prevailing winds direction in winter season from the west, while in the summer season the prevailing winds direction from the north and east. Figure (2) illustrates the proportion of prevailing wind from different directions throughout the year in the study area according to the data given by Al-Khoms Meteorological Station. However, the predominant direction of wind in most seasons of the year is the west and northwest.

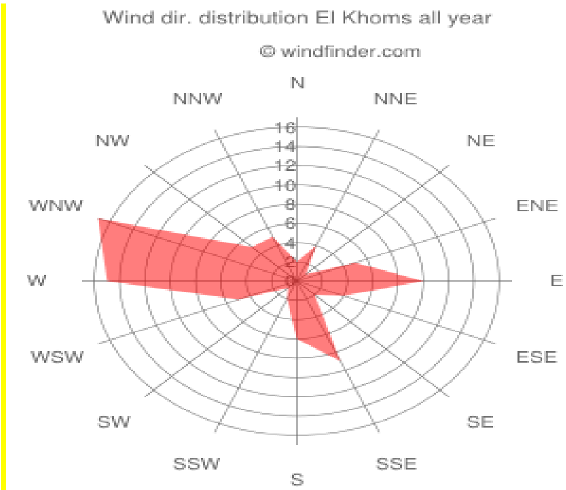

Figure 2: percentage of winds blowing from different directions throughout the year in the study area according to the data from Al-Khoms Meteorological Station

2.2. Methodology

The plant community is studied by using the square method to collect samples. Five sites are selected for the study, starting from the site of the quarry and moving northwest in the direction of the prevailing winds. Each site distance is 500m, 1000m, 1500m, 2000m, and 5000m respectively. A distance of 5000 meters is used as a control point regarding the impact of quarry on near and far areas. Each of the five sites is divided into four squares, and the size of each square is 5m×5m (25m^2) to represent the area of study seeking accurate results. Thus, the five sites are divided into twenty squares. As soon as the square borders are set, the number of plant species in each square is determined, then a sample of each type of plant is collected and taken to the Botany Department in the Faculty of Science at Elmergib University for identification and classification. The total number of species within each square has been counted and compiled. In addition, all data collected for the vegetation community have also been placed in a single table to facilitate their comparison and compilation**.**

2.2.1. Equations for calculating the quantitative aspects of the plant community

Density: It is the total number of individuals of a plant species per unit area.

$$\text{density} = \frac{(\text{total number of individuals of the species})}{(\text{unit area})}$$

The density of one plant species is considered a partial density because it is part of the total vegetation cover, so it is called partial or specific density. To find out the density of all plants, we calculate the total density.

$$\text{total density} = \frac{(\text{total number of individuals of each species})}{(\text{unit area})}$$

Relative abundance: determine relative abundance by knowing the density of plants, which is the total number of individuals of each type of plant in a unit area. Abundance has a general assessment scale developed by Braun Blanquette consisting of six degrees starting from + and then from 1 to 5.

5: Number of plant individuals covers more than 75% of the area and is called dominant.
4: Individuals spread abundantly, covering from 50% to 75% of the area, and it is called prolific.
3: Individuals cover from 25% to 50% of the area and are called dispersed.
2: The individuals are few, as they cover 5% of the area, and are called accidental.
1: There are many individuals, but they barely cover the area, and are called rare.
+: A very small number of individuals and they are called very rare.

$$\text{Abundance} = \frac{(\text{The total number of individuals of the same species within the area square})}{(\text{The total number of all species})}$$

Frequency: It is the degree of probability of the presence of the plant species in any square of the studied community, and it is expressed by the ratio of the number of squares in which the species is found to the number of squares studied (R%).

The frequency will be measured according to the Raunkier method by dividing the whole study area into a regular, equal, large number (20-25) of squares. The squares vary in size according to the kind of society of the study, whether it is a grass society, a tree society or a shrub society.

$$Frequency\ R\% = \frac{(The\ sum\ of\ the\ squares\ in\ which\ the\ type\ appeared)}{(The\ total\ sum\ of\ the\ studied\ squares)} \times 100$$

Shannon index: Shannon and Wiener independently derived a function that became known as the Shannon index of diversity. The Shannon index assumes that individuals are randomly tested within a population where all species are assumed to be represented in the sample and calculated from the equation:

$$H^{`} = -\sum pi\ ln\ pi$$

(Pi) is the percentage of individuals of the species present in the sample, (ln) the natural logarithm, and the value of (pi) estimated by (N/ni).

3. Results and Discussion

3.1. The number of plants in each site

The results illustrated in figure (3) show that plant numbers increased significantly at a distance of 500 metres, with the highest value being 2216 plants. The more moving away from the quarry site towards the direction of the prevailing wind in the area, the lower number of vegetation was within 1000 and 1500 metres, respectively. The lowest recorded number of plants was 1022, possibly due to the high quarry position on the mountain and the concentration of dust on the plants and soil at these sites, This could be the dust accumulated on plants in the two sites indicated and formed a layer of solid inorganic casing on the surface of the leaves. as a result could led to reduces the access of light to the vegetations, which significantly affecting the growth and reproduction of plants.

The total number of plant species counted after 2, 000 metres has increased gradually by moving further to 5, 000 metres from the site of the quarry. The enhancing of plant diversity as a result of declining of dust ratio and accumulated contaminants on plants and soil.

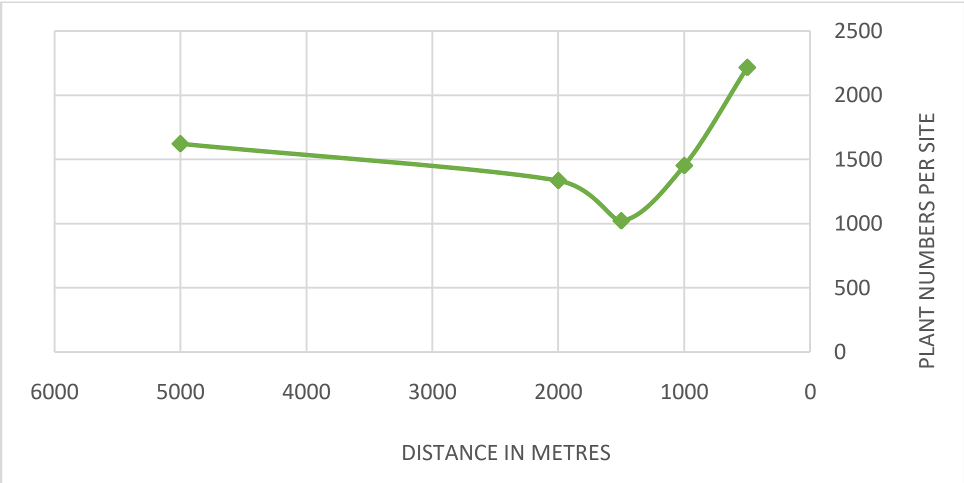

Figure 3: shows the relationship between the number of plant species and the distance in meters from the site of the quarry

3.2. The effect of quarrying and crushing on the quantitative characteristics of the plant community

Studying the quantitative characteristics of the plant community will illustrate and acknowledge the nature of the relationships between plants in the community, as well as the surrounding environment. Furthermore, it demonstrates the similarities and differences between the plant communities, as it indicates the economic importance of the plant community.

3.2.1. Density of vegetation

Figure (4) represents the total density of vegetation cover in the studied sites, measurement unit (plant/m2). The highest vegetation density in the studied sites in the region was 88.64 plants per square meter. The vegetation cover gradually decreases by moving away from the site of the quarry. The lowest density observed as an average of an area of 100 square meters is 40.88 plants per square meter, and it was at a distance of 1500 meters from the site of the quarry. Then the density gradually increases at a distance of 2000 and 5000 meters respectively. This noticeable difference in the density of plants between the sites could be the decreasing of chlorophyll in leaves of plants which were affected by the generated dust from the quarry.

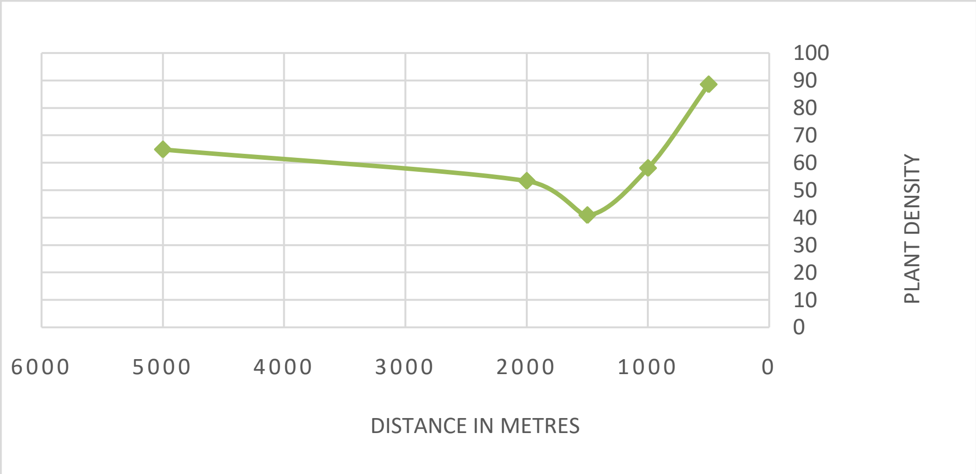

Figure 4: shows the relationship between the total density of vegetation and the distance in meters from the site of the quarry

3.2.2Study of relative abundance

Figure (5) represents the variation of abundant vegetation in the study sites. The abundance is an essential measure for the cover of vegetation, which basically corresponds to the density of vegetation cover in most of the sites studied in the region. The results demonstrate that the highest number of plants recorded in the squares placed in the area 500 meters away from the quarry site was 1.504 plants, while the lowest number of plants was 0.996 at a distance of 2000 meters from the quarry site, This indicates to an apparent effect of dust from quarry on vegetation. Moreover there was less effect of quarry dust on vegetation in site (500m) because of the high location of quarry from nearby area and the differences of wind strength which means less dust in this location (500m) compared with the rest of the sites.

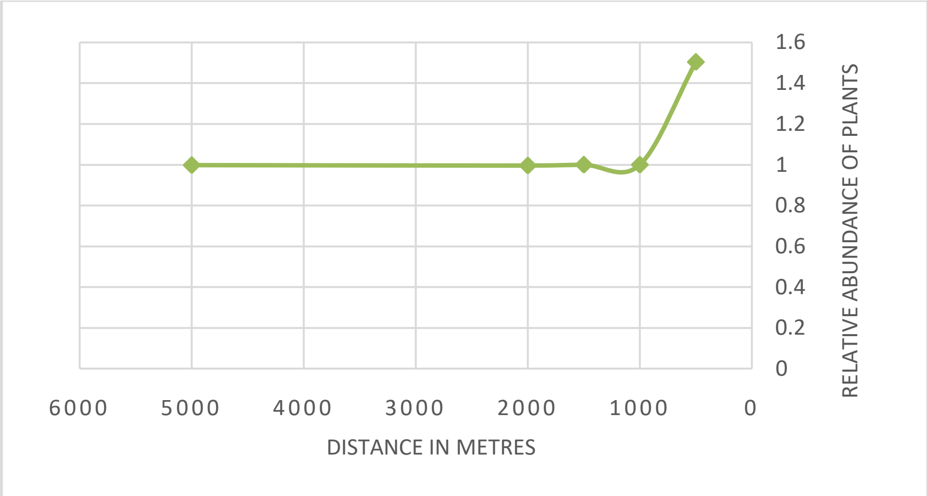

Figure 5: shows the relationship between the relative abundance of plants and the distance in meters from the site of the quarry

3.2.3Frequency study

The results from the frequency study, as illustrated in table (1), indicates that most species were not exist in all squares. That means their frequency is not equal to R = 100%, i. e., In other words the plants were heterogeneous and their individuals were found at distances from each other. In addition there were rare plant species In complex plant communities and was not explosion of that species over the all study area, which means that other plants species had occupied the rest of the area.

Table 1: shows the frequency percentage of each plant type in each location of the study area

S. N	Location Type	Species frequency at each site				
		1	**2**	**3**	**4**	**5**
1	Gymnocarpos decandrum	%20	**%20**	**%20**	**%20**	**%20**
2	Malva nicaeensis	%20	**%20**	**%20**	**%20**	**%15**
3	Anacyclus monanthos	%20	%0	%0	**%20**	**%20**
4	Retama raetam	%10	%5	%0	%10	**%10**
5	Sonchus oleraceus	%15	%0	%20	%0	%0
6	Plantago aldicans	%15	%5	%20	%5	%10
7	Launaea residifolia	%20	%10	%20	**%5**	**%20**
8	Atractylic serratuloides	%20	%10	**%0**	**%5**	%20
9	Pituranthos tortuosus	%20	%20	%0	**%20**	**%20**
10	Stipa capensis	%20	%20	%20	**%20**	**%20**
11	Cynodon dactylon	%10	%10	**%0**	**%5**	**%10**
12	Salpiglossis spinescens	%10	%10	**%5**	**%20**	%15
13	Salvia lanigera	%5	**%15**	**%15**	**%15**	%20
14	Androcymbium gramineeum	%10	%0	**%10**	**%5**	**%5**
15	Onopordum espinae	%0	**%15**	%0	%10	**%20**
16	Delonix regia	%0	**%20**	%20	**%15**	%20
17	Iris sisyrinchium	%0	**%15**	%20	**%10**	**%20**

3.2.4 Species Diversity Shannon Wiener Study

The Shannon Wiener (H') biodiversity index ranges from 0 to 5, where the number (0) indicates that the environment is under severe pressure and the number (5) represents a healthy environment. The biodiversity index is based on the following criteria: [12]

H' ≤ 1 = low biodiversity

H' ≤ 3 = medium biodiversity1<

H' ≥ 3 = high biodiversity

The Shannon index is characterized by the fact that a larger number of species will contribute to raising the value index, which is why it is widely used in protecting rare wildlife and assessing value in society[13]**.** stated that this indicator is often lower in areas exposed to human influence. The obtained results are consistent with what was mentioned by the quarrying and crushing of mountain which reduce the diversity of plants and the dominance of few species that can resist such disturbances in some sites and thus leads to a decrease in the value of the Shannon index of diversity in these communities[14]**.** Table (2) shows that the biodiversity in the study area generally ranges from average in most of the distances studied to low at 2000 meters from the quarry. It also shows that this indicator's values fluctuate by decreasing and increasing, then decreasing and increasing again to reach its maximum value at 5000 meters from the site of the quarry. According to the Shannon-Wiener Biodiversity Index, it is 1.9 and within the medium diversity range. It can be mainly due to the effect of wind direction and intensity on reducing dust concentrations in the studied sites. In addition to the nature and characteristics of the different sites from which samples were taken, which may help the growth of specific plant species in one site but not in another, and thus the indicator of value is affected.

Table 2: shows the value of the Shannon-Wiener index of plant diversity in each location of the study area

Shannon index	Distance from crushers (meters)
1.41	500
1.06	1000
1.57	1500
0.99	2000
1.90	5000

4. Conclusion

The dust emitted from quarrying and crushing has a negative effect on the plant leaves. in addition, it delaying their growth and decreasing productivity. Therefore, the results obtained in this study revealed an apparent effect of the quarry on the size and density of vegetation cover and its bio diversity in the area, which may lead to an increase in pressure on the plant cover, which cause destructive effect on other living organisms and increase rates of desertification in this area. Furthermore, the results also illustrated an evident change in the Shannon index of bio diversity, and this indicates the presence of an impact of dust emitted from the quarry on the diversity of the vegetation cover in the region. It also reveals greater dominance of plants enduring difficult environmental conditions in locations closer to quarrying and crushing in the direction of the prevailing winds.

5. Recommendations

1) Further similar studies on quarry sites and other sources of dust emissions in the region should be conducted to assess the quantities emitted and their

impact on the region's vegetation and bio diversity. Also, performing regular classification studies of vegetation in the area which can track, anticipate and avoid any potential degradation may decrease plant cover.

2) The activities of Quarrying and crushing must be regulated within the legal framework, and new permits should only be issued once environmental conditions are strictly conformed. In addition, all crushing and quarrying must install emission filters and screening devices and commit to improving ecological aesthetics by boosting tree planting in the range of two kilometers of quarry sites.

3) Should paving the work site and the roads which leading to it and installing a wind vane and water sprayers in order to decrease the dust emission in study area.

References

[1] RANI, H. B., and SWAMY, N. S. (2007) IMPACT OF CRUSHING AND QUARRYING ON VEGETATION IN TUMKUR DISTRICT, I Control Pollution23, 227-234.
[2] Lameed, G., and Ayodele, A. (2010) Effect of quarrying activity on biodiversity: Case study of Ogbere site, Ogun State Nigeria, African Journal of Environmental Science and Technology4, 740-750.
[3] Hassan, I. A. (2022) Impact of Quarrying Activities on the Surrounding Vegetation in Ogun State, Nigeria, Journal of Forest and Environmental Science38, 263-274.
[4] Manzoor, J., and Khan, M. (2020) Environmental perspective of stone crushing and quarrying: A case study from Poonch District of Jammu and Kashmir, India, Current World Environment15, 68.
[5] Akanwa, A., Onwuemesi, F., Chukwurah, G., and Officha, M. (2016) Effects of open cast quarrying technique on vegetation cover and the environment in south-eastern Nigeria, American Academic Scientific Research Journal for Engineering, Technology, and Sciences21, 227-240.
[6] Panda, S., Muduli, S., Mishra, B., and Dhal, N. (2018) Application of Crusher Dust as Mineral Fertilizer for Plant Growth. (Institute of Minerals and Materials Technology, Bhubaneswar, Odisha, India).
[7] Missanjo, E., Ndalama, E., Sikelo, D., and Kamanga-Thole, G. (2015) Quarry Dust Emission Effects on Tree Species Diversity in Chongoni Forest Reserve and Vegetation Characteristics in Adjacent Villages, Dedza Malawi, International Journal of Information and Review2, 511-515.
[8] Samba, G., Fokeng, R. M., Nfor, J. T., Ngwaimbi, R. C., and Youogo, C. M. K. (2022) Effects of Quarrying Activities on Environmental Sustainability in Makenene, Centre Region, Cameroon. Journal of Environment and Earth Science www. iiste. org ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol.12, No.1.
[9] Sharma, S. B., and Kumar, B. (2016) Effects of stone crusher dust pollution on growth performance and yield status of rice (Oryza sativa. L), International Journal of Current Microbiology and Applied Sciences5, 796-806.
[10] Zverev, V. E., Zvereva, E. L., and Kozlov, M. V. (2008) Slow growth of Empetrum nigrum in industrial barrens: Combined effect of pollution and age of extant plants, Environmental pollution156, 454-460.
[11] Pal, S., and Mandal, I. (2017) Impacts of stone mining and crushing on stream characters and vegetation health of dwarka river basin of Jharkhand and West Bengal, Eastern India, Journal of Environmental Geography10, 11-21.
[12] Prinster, A. J., Hoskins, J. L., and Strode, P. K. (2019) Pitfall Traps & Diversity Indices: Using Quantitative Reasoning to Test Edge Effect Theory, The American Biology Teacher81, 234-241.
[13] Heil, L., Fernández-Juricic, E., Renison, D., Cingolani, A. M., and Blumstein, D. T. (2007) Avian responses to tourism in the biogeographically isolated high Córdoba Mountains, Argentina, Vertebrate Conservation and Biodiversity, 183-200.
[14] Chittibabu, C., and Parthasarathy, N. (2000) Attenuated tree species diversity in human-impacted tropical evergreen forest sites at Kolli hills, Eastern Ghats, India, Biodiversity & Conservation9, 1493-1519.