ABUAD Journal of Engineering Research and Development (AJERD)
ISSN: 2645-2685

Volume 3, Issue 1, 1-7

Risk Management Assessment of Production in Granite Stone: A Case Study of Quarries in Ondo, Ogun and Oyo States, Nigeria

Mbuyi Mata MELODI[1], Abiodun ADEYEMO[1], Victor Iyanu OLUWAFEMI[2]

[1]*Department of Mining Engineering, Federal University of Technology, Akure, Nigeria*
arletmelodi@yahoo.com/abbeypaull3@gmal.com

[2]*Department of Mining Engineering, Federal University of Technology, Akure, Nigeria*
victoriad53.vi@gmail.com

Corresponding Author: victoriad53.vi@gmail.com

Date Submitted: 08/04/2019
Date Accepted: 13/03/2020
Date Published: 30/06/2020

Abstract: *This study was on the risk management analysis of labour and equipment for effective production output in quarries, in Ondo, Oyo and Ogun States of Nigeria with aim of identifying the work hazards encountered by quarry workers, assessing the level of risk faced by quarry worker's, examining the likelihood of occurrence of hazards at quarry workplace and precautionary measures put in place. Sixty quarry workers were randomly selected across both skilled and unskilled division, and were administered with structured questionnaire to know the various hazards and hazard managements during their operations in quarry. Data collected was analysed using descriptive statistics, frequency tables and charts. Potential Hazards faced by respondents according to the analysis are electric shocks (69.23%), noise pollution (86.15%), dusts impact (86.15%), fly rocks during blasting (52.31%), excessive workload (73.85%), long hours of work (80.00%), slips and trips (93.85%) and wet floors/road (50.77%). Victims include the community people (64.62%), operators (69.23%), visitors (56.92%) and new workers (63.08%). Risk control measure mostly used was first aid facilities and this was adequate. Workers are also likely to experience fly rocks (26.2%), long hours of work (49.2%), wet floors/road (33.8%), hydrocarbon fuel spillage (52.3%), runoff from sites (33.8%) and soil erosion to farmlands (32.3%), dust impact on visuals (55.4%). Quarry workers (64.6%) attest they do not attend safety seminars because they are not given by the management. A proportion of 24.6% of the quarry workers have not been involved as causalities of any hazard despite regular (always) breakdown of workers (40.0%) at work place. The results of the water analysis revealed the level of heavy metals like Lead (Pb), Cadmium (Cd), Magnesium (Mg) and Chromium (Cr) are higher than the permissible limit recommended by WHO; hence the water sources pose a great threat to the health of the people and workers.*

Keywords: *Hazard, Analysis, Risk, Water, Quarry.*

1. INTRODUCTION

All around the world, the quarrying industry is known to be one of the most vibrant industries that provide a huge source of revenue for every country, Nigeria inclusive. Technological advancement all over the world has led to an immense improvement in the way quarrying activities are carried out. A quarry is a surface mining operated area, which produces enormous quantities of gravel, limestone, and other materials for industrial and construction purpose [1]. It is the same as an open-pit mine from which minerals are extracted [2]. While quarry operations are not only extraction of material (rock) but also crushing and screening, making the rock suitable for use as construction and industrial materials, agricultural materials etc. More often than not, where quarrying takes place, the land's vegetation is removed, the landscape is changed and the ecosystem totally disturbed [3-4]. Surface hydrology and groundwater levels and flow paths are also altered [5].

Quarries normally operate for about 30 years and during that time a variety of quarry equipment will be used for production. The design and general running operation of a quarry depends on the type of rock being extracted, the general environment surrounding the quarry, the size of the quarry and the geography and geology of the area of study [6-7]. So many quarries exist in this nation and thus, generating substantial income and revenue to the economy and reducing poverty but its environmental impact are been neglected by the authorities responsible for the establishment of this quarries and also by quarry owners and operators.

Increase in incidences of hazard encountered during quarry operation has led to the delivery of poor services by quarrying industries which in turn has been caused by poor and bad choice of labour [8]. In most Africans nations, quarrying is not well managed for environmental sustainability and safety [9]. The methods used are very poor and there is no solid plan for

source exploitation. Most of the quarries do collapse and there are no measures taken to rehabilitate such quarries since most of them are left open.

Being less capital intensive as compared to other mineral exploitation, quarrying of sand, gravel and building stones quarrying is wide spread in Nigeria [10]. Attaining the goal of quarrying measurements demands not only knowledge on accurate estimates for quarrying factors but also the knowledge of various hazards and risk factors that are associated with quarrying activities across a nation and how they have evolved. Quarry operations is acknowledged to be a conglomerate of various activities which include removal of over burden, drilling, blasting and crushing of rock materials; each of which is trailed with is peculiar chances of occurrence of hazards. Hence, a need for a regular risk assessment is needed. Apart from land degradation, other hazards of quarrying include swamp creation, deterioration of ground water, erosion of soil, noise and percussions from rock blasting, generation of dust, smoke and fumes; noxious gases and ground vibration [10]. Suspended particulate matter is prominent among all pollutants emanating from quarrying operations [11]. A risk assessment involves a detailed and systematic examination of any activity, location or operational system to identify hazards. According to [12], the assessment will consider the relationship between the likelihood and potential consequence of the risk of hazards occurring, and to review the current or planned approaches to controlling the hazards. New or improved hazards controls are added where required.

The study was therefore needed to develop a tool for improving stone quarry production activities through minimizing chances of occurrence of hazards to workers who regularly carry out these activities using various equipment and machineries. This study is aimed at analysing risk management analysis of labour and equipment for effective production output in quarries. The specific objectives are to: identify the work hazards encountered by quarry workers in the study areas; assess the level of risk faced by quarry workers in the study areas; examine the likelihood of occurrence of hazards at quarry workplace, and examine the precautionary measures put in plac**e** by quarry owners/managers to guard against quarry hazards.

There is limited information on the level of knowledge on and practice of the risk management standards in quarry firms in Nigeria. In most cases, quarrying is done without considering the exposures of the operational personnel (workers) to hazards, even though, there is little done to ensure that there are no avoidable accidents in quarries across Nigeria. Safety systems in manufacturing plant need to be optimized by changing the thinking of the managers and engineers to constantly strive to ensure that the system of operation is safe both to the labour and equipment operated. Precautionary practice such as OSH (Occupational Safety and Health) and other safety-related programs should be properly implemented and practiced.

A lot could be done in managing stone quarrying in these areas without posing danger to the surrounding community and lives of stone miners. It could also reveal the risks from the identified hazards from low to high; thereby providing better understanding of how hazards have high risk and thus examine if existing controls used are appropriate or need to be reviewed. This research then is required to reveal the implication of not carrying out effective risk management in quarries, as well as the effect of effective risk management structures as it would ensure a proper health and good working environment in the organization.

2. RESEARCH METHODOLOGY

2.1 Sample Size

This study was carried out on 60 quarry workers who are employed in small and medium scale quarry industries in selected South Western States in Nigeria which are Ondo, Oyo and Ogun States. The workers interviewed for this study comprise men and women between the age l6 and 60 years, who were engaged in various mine works and operations.

2.2 Sampling Technique

The respondents who participated were chosen using simple random sampling technique. Questionnaires were administered to all respondents in the quarry. Observation schedule was also used by the researcher to retrieve the necessary information for the research from the respondents.

2.3 Data Collection

Primary data was used for this study. The primary data was obtained through the use of structured questionnaire which was administered by trained enumerators to quarry workers. Data was collected on input variables, labour, explosives, quarry bench-size and socio-economic variables, injury and hazard occurrences, prices of output and problems encountered in production.

2.4 Water Analysis

For the water analysis, three water samples were randomly collected from a nearby stream in each of the three selected quarries namely; Kopek quarry in Oyo state, Digital quarry in Ogun state and Stone quarry in Ondo state.

Laboratory determination of heavy metals in water samples around the selected quarries were carried out at Multidisciplinary Central Research Laboratory, University of Ibadan, Nigeria. These assessments were carried out by using spectroscopic technique known as atomic absorption spectroscopy (AAS). Atomic absorption spectrometry is an analytical technique that measures the concentrations of elements qualitatively and quantitatively. If light of just the right one impinges on a free, ground state atom, the atom absorbs the light as it enters an excited state in a process known as atomic absorption. Atomic

Absorption Spectrometry (AAS) is a very common and reliable technique for detecting metals and metalloids in environmental samples [13]. The pH of the water samples was determined by pH meter.

2.5 Data Analysis

Questionnaire data analysis in the study was done by using descriptive statistics, time series analysis, non-parametric tests and an operational research simulation. For processing of data, the preliminary revilement involved coding, entering and displaying them for checking and cleaning errors. The next step was quantitative data processing and data quality control. The first step mainly used SPSS spreadsheet (data view and variable views). It was then possible to label the questions and statements on the variable view spreadsheet, giving them some meaningful values (or codes). This particularly was cumbersome because of the number or open-ended questions and statements provided stone quarries and key informants.

The following step was data entry and data display. Data entry involve entering the response of each respondent according to each variable. Some of the errors which were detected were related to wrong record of questionnaires responses to incorrect typing, to an inversion and to the recording of deliberate errors from respondents. Errors were cleared after checking variables and values row after rows and case by case. Then conformity of duplicate data was done in removable disk and cleaned copies were finally saved. This was to allow the qualitative data to be processed and to control the data quality. Quantitative data pre-processing involves the selection of a descending numeric measuring scale for each type of variables. Data pre-processing will pass a quality control before any quantitative and qualitative analysis.

3. RESULTS AND DISCUSSION

3.1 Potential Hazards

Table 1: Potential Hazards Associated with Quarry Work Activities

Multiple selection	Percentage (%)	Frequency (f)
Potential Hazards at Quarry Work Activities		
Electric shocks	69.23	45
Noise pollution	86.15	56
Dusts impact	86.15	56
Fly rocks during blasting	52.31	34
Excessive workload	73.85	48
Long hours of work	80.00	52
Slips and trips	93.85	61
Wet floors/road	50.77	33
Runoff from sites	35.38	23
Hydrocarbon (fuel) spills	16.92	11
Soil erosion of farmlands nearby	21.54	14
Usual victims of the Risk		
Community people	64.62	42
Equipment operators	69.23	45
Non – equipment operators	35.38	23
Visitors	56.92	37
New and young workers	63.08	41
Risk control measures at workplace		
Regular workers training	35.38	23
Improving work place spacing	33.85	22
Personal protective equipment	26.15	17
Employment of safety officer	10.77	7
Educating people at risk of control	32.31	21
Provision of first aid facilities	63.08	41
Adequacy of control measure		
Adequate	35.38	23
Still needs more to be done	64.62	42

Potential Hazards faced by respondents of this study are Electric shocks (69.23%), Noise pollution (86.15%), Dusts impact (86.15%), Fly rocks during blasting (52.31%), Excessive workload (73.85%), Long hours of work (80.00%), Slips and trips (93.85%) and Wet floors/road (50.77%). Usual victims include the community people (64.62%), equipment operators (69.23%), visitors (56.92%) and new workers (63.08%). Risk control measure more commonly used was the provision of first aid facilities and this was considered to be adequate.

3.2 Level of Risk

This helps to know which risks are most serious and should be dealt with first, it further helps to know if all workers are exposed to hazard or a few number.

Table 2 Level of Risk Exposure by Quarry Workers

	Risk level Frequency (Percent)		
	High	**Medium**	**Low**
Potential Hazards at Workplace			
Electric shocks on workers	05 (7.69)	25 (38.46)	35 (53.85)
Noise pollution on workers	32 (49.23)	27 (41.54)	09 (13.85)
Dusts impact on visual	23 (35.38)	36 (55.38)	01 (1.54)
Fly rocks	33 (50.77)	24 (36.92)	08 (12.31)
Excessive workload	45 (69.23)	19 (29.23)	02 (3.08)
Long hours of work	45 (69.23)	22 (33.85)	05 (7.69)
Slips and trips	24 (36.92)	22 (33.85)	20 (30.77)
Wet floors/road	20 (30.77)	13 (20.00)	32 (49.23)
Run-off from sites	28 (43.08)	11 (16.92)	26 (40.00)
Hydrocarbon (fuel) spills	09 (13.85)	07 (10.77)	49 (75.38)
Soil erosion of farmlands nearby	23 (35.38)	32 (49.23)	10 (15.38)
Hydraulic failures	24 (36.92)	22 (33.85)	20 (30.77)

This study revealed that more quarry workers are exposed to noise pollution (49.23%), fly rocks (50.77%), excessive workload (69.23%), long hours of work (69.23%) and slips and trips (36.92%). They were less exposed to dust impacts on visual (55.38%) and soil erosion of farmlands nearby (49.23%).

3.3 Likelihood of Hazard Occurrence

Table 3: Likelihood of Occurrence of Hazards at Work place

	Likelihood of Occurrence within a Year					
	Almost certain	**Likely**	**Possible**	**Unlikely**	**Rarely**	**Extremely rare**
Potential Hazards at Workplace	Freq. (%)	Freq.	Freq.	Freq.	Freq.	Freq. (%)
Electric shocks on workers	20 (30.8)	(%)	(%)	(%)	(%)	5 (7.7)
Noise pollution on workers	27 (41.5)	10 (15.4)	15 (23.1)	3 (4.6)	12 (18.5)	0 (0.0)
Dusts impact on visual	5 (7.7)	13 (20.0)	5 (7.7)	6 (9.2)	9 (13.8)	3 (4.6)
Fly rocks on workers	13 (20.0)	9 (13.8)	36 (55.4)	5 (7.7)	2 (3.1)	6 (9.2)
Excessive workload	31 (47.7)	17 (26.2)	7 (10.8)	13 (20.0)	4 (6.2)	10 (15.4)
Long hours of work	6 (9.2)	8 (12.3)	1 (1.5)	10 (15.4)	5 (7.7)	8 (12.3)
Slips and trips	7 (10.8)	32 (49.2)	10 (15.4)	2 (3.1)	7 (10.8)	3 (4.6)
Wet floors/road	15 (23.1)	12 (18.5)	3 (5.0)	18 (27.7)	22 (33.8)	10 (15.4)
Runoff from sites	16 (24.6)	23 (35.4)	7 (10.8)	5 (7.7)	5 (7.7)	5 (7.7)
Hydrocarbon (fuel) spills	4 (6.2)	22 (33.8)	4 (6.2)	8 (12.3)	10 (15.4)	5 (7.7)
Soil erosion of farmlands nearby	17 (26.2)	34 (52.3)	8 (12.3)	4 (6.2)	10 (15.4)	5 (7.7)
Hydraulic failures	21 (32.3)	21 (32.3)	7 (10.8)	6 (9.2)	7 (10.8)	10 (15.4)
		17 (26.2)	2 (3.1)	4 (6.2)	9 (13.8)	

Note:

a) Almost = will certainly occur at least once
b) Likely = likely occur once
c) Possible = may occur (but not likely)
d) Unlikely = not expected
e) Rarely = most unlikely to happen
f) Extremely rarely = can happen in extreme and exceptional situation

The result shown in Table 4.3 above indicated that electric shocks (30.8%), noise pollution (41.5%), excessive workload (47.7%) and hydraulic failures (32.3%) are potential hazards at quarries workplaces surveyed for this study that workers were almost certain to face within a year. Workers are also likely to experience fly rocks (26.2%), long hours of work (49.2%), Wet floors/road (33.8%), hydrocarbon fuel spillage (52.3%), runoff from sites (33.8%) and soil erosion to farmlands (32.3%). They also may have some dust impact on visuals (55.4%).

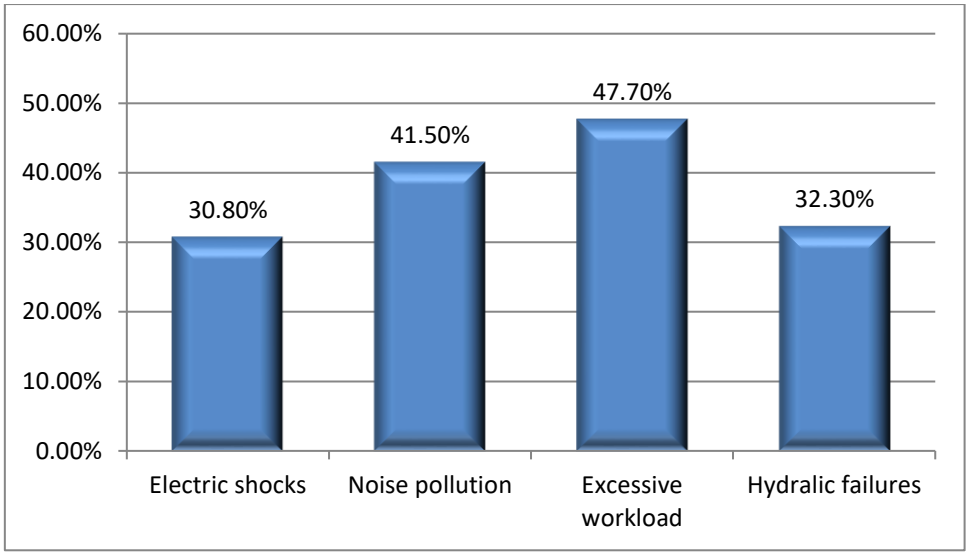

Fig. 1: Hazards, Almost Certain to Occur at Quarry Workplaces

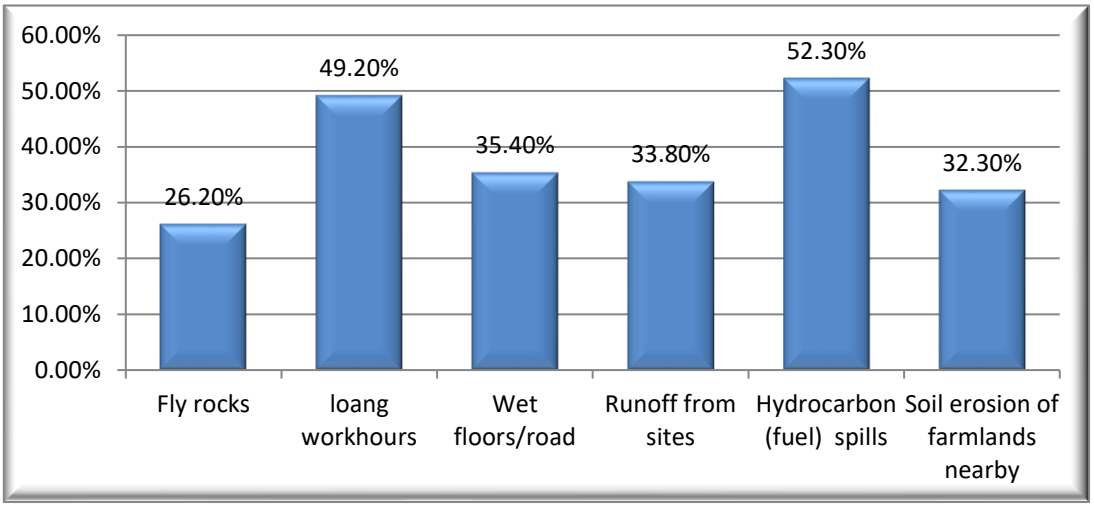

Fig. 2: Hazards, Likely to Occur at Quarry Workplaces

3.4 Laboratory Water Analysis

Table 4: Results of Water Analysis

Sample Locations	pH	Temperature (ºc)	Pb (mg/L)	Cd (mg/L)	Ni (mg/L)	Mg (mg/L)	Cr (mg/L)
Kopek Quarry	7.06	25.8	0.263	0.150	0.000	43.200	0.047
Digital Quarry	7.11	25.8	0.358	0.290	0.000	19.500	0.061
Stone Quarry	5.92	25.7	0.675	0.170	0.000	5.100	0.135

The results of the water analysis revealed that the pH values of water samples collected from stone quarry streams are within the standard value given by the World Health Organisation (WHO) for domestic use. The standard value according to WHO is 7.2-7.6 (slightly alkaline in nature). The level of Pb, Cd, Mg and Cr in all the three streams are far above the 0,01mg/L, 0.003mg/L, 0.00 mg/L and 0.05mg/L standard value recommended by WHO for the four elements respectively (Tshade, 2016). On this basis, the water is unsafe for domestic purposes (especially for drinking). This observation therefore calls for concern since these water bodies posed a great threat to the health and welfare of the workers and the people in the study areas.

3.5 Assessing precautionary measures at workplace

Table 5: Precautionary measures at workplace

	Freq. (n = 60)	%
Safety Precautionary Measures		
Provision of Medication and First aid	25	38.5
Regular Training of workers on safety	3	4.6
Provision of personal protective equipment	12	18.5
Following up reports on equipment status	10	15.4
Regular equipment repairs	15	23.1
Ever Participated in Safety Seminar		
Yes	18	27.7
No	42	64.6
Number of Casualty Experience since work started		
None	16	24.6
1 – 5	10	15.4
6 – 10	8	12.3
Above 10	8	12.3
Level of workers breakdown due to workplace hazards		
Rarely	2	3.1
Often	12	18.5
Always	26	40.0
Sometimes	16	24.6
Frequently	4	6.2
Nature of Hazard, Casualty and Risk		
Orthopedic Ailments	3	4.6
Exposure to Carbon dioxide	9	13.9
Tuberculosis	4	6.2
Collapse of Mine pits	9	13.9
Fall at mine opening	2	3.1
Constant Headache	5	7.7
Water Pollution	12	18.5
Injuries	6	9.2

Provision of medication and first aid (38.5%) was noted to be the most dominant and effective precautionary measure put in place to curtail workplace hazards while this was followed by regular repairs of equipment (23.1%). Most quarry workers (64.6%) attest that they do not attend safety seminars simply because they were not given by the managements of the workplace. A proportion of 24.6% of the quarry workers have not been involved as causalities of any hazard in spite of regular (always) breakdown of workers (40.0%) at work place. The most prominent hazards faced by the workers is water pollution (18.5%).

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Majority of quarry workers (skilled and unskilled) work under various conditions with different hazards associated with it. Some of which include electric shocks on workers, noise pollution on workers, dusts impact on visual, fly rocks on workers, excessive workload, long hours of work, slips and trips, wet floors/road, runoff from sites, hydrocarbon (fuel) spills (most frequent), soil erosion of farmlands nearby and hydraulic failures. This study revealed a non – participation of quarry workers in the workplace safety seminars; which was a result of non - inclusion by management in the company programmes.

The results of the water analysis carried out in the study areas call for concern in view of the high level of heavy metals such as Lead (Pb), Cadmium (Cd), Magnesium (Mg) and Chromium (Cr).

4.2 Recommendations

Regular lectures and seminars need to be given to quarry workers on health, safety and environment. There is a need for regular review and assessment of current safe states of operational equipment and machineries used at workplace. Complaints made on poor state of trucks and other equipment should be reviewed from time to time to keep quarry safe.

REFERENCES

[1] Duan, W., Hai R., Fu, S., Wang, J., Yang, L. and Zhang, J. (2008). Natural Recovery of Different Areas of a Deserted Quarry in South China, Journal of Environmental Sciences, 20(4), 476-481.
[2] Risk Assessment Workbook for Mines (2009). Metalliferous, Extractive and Opal Mines, and Quarries, Mine Safety Operations Document of New South Wales Government, Industry and Investment, 56.
[3] Bradshaw, A.D. & Chadwick, M. J. (1980). The Restoration of Land: The Ecology and Reclamation of Derelict and Degraded Land. Blackwell, Scientific Publication. Oxford, England.
[4] Roberts, R.D., Marrs, R.H., Skeffington, R.A. and Brad Shaw, A.D. (1981). Ecosystem Development on Naturally Colonized China Clay Wastes. Vegetation Changes and Overall Accumulation of Organic Matter and Nutrients. Vol69, 153-161.
[5] Oyinloye, M.A. & Olofinyo, B.O. (2017). Environmental Impact of Quarry Activities on Resident of Akure Region, Nigeria, SCIREA Journal of Environment, 2(2), 34-36.
[6] Osterkamp, W.R. & Joseph, W.L. (2000). Climatic and Hydrologic Factors, Ed. Daniels, W.L, Chapter 8, 193-215.
[7] Nicolau, J.M. & Asensio, E. (2000). Rainfall Erosion on Opencast Coal Mine Lands: Ecological Perspective, Haigh, M.J. Ed., Reclaimed Land: Erosion Control, Soils and Ecology, 21.
[8] Isaac D.N., Betty, S.A., Daniel, A.G., Kwadwo T.A. & Alex A (2015). An Assessment of the Institutional Capacity for the Management of Quarry Industries in Ghana - The Case of Buoho Stone Quarries Building and Road Research Institute, UPO Box 40, KNUST, Kumasi-Ghana, Civil and Environmental Research Journal, Vol5, 15-18.
[9] Nyakeniga A.C. (2009). An Assessment of Environmental Impacts of Stone Quarrying Activities in Nyambera Location Kisii County. B. Tech. Thesis, Environmental Planning and Management at Kenyatta University, 40.
[10] Oguntoke, O., Aboaba, A. & Gbadebo, T.A. (2009). Impact of Granite Quarrying on the Health of Workers and Nearby Residents in Abeokuta, Ogun State, Nigeria. Ethiopian Journal of Environmental Studies and Management, 2(1), 8.
[11] USEPA (2008). Region 4: Laboratory and Field operations – PM 2.5: Objectives and History. Available: https://www.en.wikipedia.org/wiki/particulate.
[12] Risk Assessment Workbook for Mines; Metalliferous, Extractive and Opal Mines, and Quarries (2009). Mine Safety Operations Document of New South Wales Government, Industry and Investment, 56.
[13] Buffle, J. (1990). Complexation Reactions in Aquatic Systems, Englewood Cliffs: Prentige Hall, 45.