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Environmental Impact Assessment of a Proposed Small-Scale Cement Mining Operations in Kigwo Boma, Kangapo 1 Payam, Kajokeji County, Central Equatoria State, Republic of South Sudan

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Abstract Population growth and urbanization in the developing countries where efforts are concentrated in the urban and rural development through provision of facilities such as roads, houses, etc has resulted in high demand for cement. Considering the impact of the cement project on the environment, it is mandatory to conduct an Environmental Impact Assessment (EIA) of the proposed cement project before commencements, which is the aim of this study. In South Sudan, EIAs are usually conducted to acquire certificate of no objection for a project in accordance with the Ministry of Environment and Forestry to predict the concentration of pollutants produce by a project/plant. All the assessments carried out aimed at analyzing and determining the concentrations of pollutants in the proposed site. The data were collected through primary and secondary data collection, onsite air quality monitoring and laboratory examination for the purpose of reporting the environmental impacts and to enhance the understanding of the stakeholders in decision making. The study revealed that the proposed project will elevate the noises of the site, cause loss of soil resource due to site clearance, spillage of chemicals and seepage from wastes. It will also cause chemical contamination of surface and ground water due to accidental spills during transportation and handling and seepage from wastes. Fragmentation of habitats and ecological processes are likely to occur due to positioning of project infrastructure and increased risk of accidents and injuries to communities from improved roads and additional traffic. However, the project will not have significant negative impact on environment if all the environment management plan, disaster management plan are strictly followed. More over this project will have a positive impact on the socio economy of this region as source of employment and income generation.

Keywords: *urbanization, environmental impact assessment, pollutants, ecological processes, mitigation*

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1. Introduction

The Republic of South Sudan, has land borders with Ethiopia in the east, Kenya and Uganda in the south, Central African Republic in the west and Sudan in the north. It was a part of the former Republic of the Sudan. The Republic of South Sudan declared its independence on July 9, 2011; it became the 54th country of the African continent and the world's youngest country. South Sudan is endowed with substantial resources particularly the limestone, which is abundant at about 140 kilometers from the capital city Juba. South Sudan is categorized among the least developed countries of the world. Growth in the economy in general and construction industry in particular have been recorded in the country in the last few years. The growth of the economy has resulted in a boom in the construction sector and in the subsequent demand growth for cement. This study is an Environmental and Social Impact Assessment (ESIA) of a proposed small scale cement mining project in Kigwo Boma, Kangapo 1 Payam, Kajokeji County, Central Equatoria State, Republic of South Sudan.

An environmental impact assessment (EIA) is an assessment of the possible positive or negative impacts that a proposed project may have on the environment; considering natural, social and economic aspects [1]. The aim of such an environmental impact assessment is to ensure that decision makers put all these factors into consideration to permit them determine the desirability or otherwise of the proposed project.

The International Association for Impact Assessment (IAIA) described an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of developmental project proposals prior to major decisions being taken and commitments made [1].

Environmental Impact Assessment (EIA) is a relatively new planning and decision making tool first enshrined in the United States in the National Environmental Policy Act of 1969 [2]. It is a formal study process used to predict the environmental consequences of any developmental project. Environmental Impact Assessment (EIA) thus guarantees that the potential problems are predicted and dealt with at an early stage in project planning and design [3].

Based on this analysis, an Environmental Management Plan that would ensure impact monitoring and mitigation planning can be drawn for proper planning of the new firm. In view of the fact that development is an ever growing process, its impact on the environment is also ever increasing, leading to rapid deterioration of environmental conditions. The impact assessment of a proposed cement factory is of immense important for the purpose of providing futuristic information about the likely environmental impacts that may result during the activities of the proposed project. Cement manufacturing can cause various environmental impacts at all stages of the project cycle. These include emissions of airborne pollution in the form of dust, gases, noise and vibration when operating machinery and during blasting in quarries, consumption of large quantities of fuel during manufacture, release of CO_2 from the raw materials during manufacture, and damage to the environment from quarrying [4].

The use of equipment to reduce dust emissions during quarrying and manufacture of cement, and equipment to trap and separate exhaust gases are coming into increased use. Environmental protection also includes the re-integration of quarries into the countryside after they have been closed down by returning them to nature or re-cultivating them [5]. An independent research effort was conducted to identify critical issues for the cement industry and it was found that the most important environmental, health and safety performance issues facing the cement industry are atmospheric releases including greenhouse gas emissions, dioxin, NO_x, SO_2, and particulates, accidents and worker exposure to dust [6].

The carbondioxide (CO_2) associated with Portland cement manufacture falls into 3 categories: CO_2 derived from decarbonization of limestone, CO_2 from kiln fuel combustion and CO_2 produced by vehicles in cement plants and distribution. The first source is fairly constant: within the ranges of 0.47 – 0.54Kg CO_2 per Kg of cement, typically values around 0.50Kg world-wide. Second source varies with plant efficiency. For instance efficient precalciner plant will produce 0.24 Kg CO_2 per Kg cement, while low-efficiency wet process as high as 0.65Kg of CO_2 per Kg of cement (Environmental Health and Safety Performance Improvement, 2002). It has been reported that in typical modern practices (for example U.K.) averaging around 0.30Kg of CO_2 per Kg of cement produced. Third source is almost insignificant at 0.002 – 0.005. So the typical CO_2 is around 0.80 Kg CO_2 per Kg finished cement. This leaves aside the CO_2 associated with electric power consumption, since this varies according to the local generation type and efficiency. Typical electrical energy consumption is of the order of 90 – 150KWh per ton of cement, equivalent to 0.09 – 0.15Kg CO_2 per Kg of finished cement if the electricity is coal generated [5].

Overall, with nuclear or hydroelectric power and efficient manufacturing, CO_2 generation can be as little as 0.07 kg per kg cement, but can be as high as twice this amount for low efficient nuclear or hydroelectric plant. The thrust of innovation for the future is to reduce source 1 and 2 by modification of the chemistry of cement, by the use of wastes, and by adopting more efficient processes. Although cement manufacturing is clearly a very large CO_2 emitter, concrete (of which cement makes up to about 15%) compares quite favourbly with other building systems in this regard [5]. This current study is motivated by the fact that Portland cement is the most widely used building material in the world with about 1.56 billion tonnes (1.72 billion tons) produced each year. Annual global production of Portland cement concrete hovers around 3.8 million cubic meters (5 billion cubic yards) per year [7]. It is therefore crucial to conduct an Environmental Impact Assessment of a proposed cement factory considering the negative impacts of cement companies on the environment. This will serve as a means of controlling the activities of the proposed cement factory in terms of environmental pollution.

1.1. Evolving Policies and Institutions in the South Sudan Mining Sector

The long tradition (artisanal mining) in the mining sector has enabled South Sudan to establish an institutional framework and organizations to support the mining industry. The key institutions in the country include the Ministry of Mining, the Ministry of Environmental and Forestry, and many related Ministry and commissions. These institutions provide support to ensure optimal exploitation of the country's natural resources. The Mining Act, 2012 provides the overall legislative framework for mining in South Sudan [8]. The purpose of this Act is to provide for, encourage, promote and facilitate reconnaissance, exploration, development and production of Minerals and Mineral Products in South Sudan, consistent with the principles of sustainable development. The Draft Environment Protection Bill, 2012 stipulates the need to undertake a limited Environmental Impact and Social Assessment or Environment Impact Examination where and when the Lead Agency deems the project is likely to have a variety of impacts on the Environment [9]. The environmental policy of the government of South Sudan is directed towards maintaining ecosystems and ecological processes essential for the functioning of the bio-sphere; ensuring sound management of natural resources and the environment; adequately protecting human beings, animals and plants and their biological communities and habitats against harmful impacts and destructive practices, and preserve biological diversity. Environmental protection in South Sudan therefore is guided by the preventive approach, that is, with the recognition that socio-economic development must be undertaken in such a way as to avoid the creation of environmental problems. The policy seeks reconciliation between economic planning and environmental resources development with the view to achieving sustainable national development. Creation of awareness, among all sections of the community, of the environment and its relationship to socio-economic development, and of the necessity for rational resource use among all sectors of the country, is a vital part of the overall objective. The Act stipulates the rights of the citizens on land and the compensation modalities covering individuals, households and communities' ownership and/or use of land affected by public interventions. According to Sections 74, 75 and 77 of the Land Act, "expropriation of land for public interests should be based on a consultation process with the communities, negotiation and agreements endorsed by the impacted community and individuals evidenced by a written protocol between the individual or traditional authorities and their communities and signed by the local government and traditional authority".

1.2. Environmental Impacts of Mining Activities in South Sudan

Despite all these policies and institutions, environmental degradation in most of mining communities in South Sudan is still of a major threat and concern. The extent of environmental devastation caused by mineral mining in South Sudan is well observed but not yet documented due to no study being carried on the mining activities in South Sudan. Nevertheless, the magnitude of damage caused largely depends on the mining method being used [10]. This has become increasingly alarming, raising serious concerns among key stakeholders. Lack of coordination among regulatory bodies; inadequate research; ineffective community participation; cumbersome and lengthy processes in registering small-scale mines; and lack of environmental education and awareness creation have been recognized as a contributory factors to the persistent environmental devastation caused by mining in South Sudan.

The results of this study will therefore raise concern of the environmental impacts of a proposed project and inform policy makers in putting mitigation and Environmental Management Plan for the proposed project.

2. Research Methodology

Population growth and urbanization in the developing countries like South Sudan which recently gained its independence and where efforts are concentrated in the urban and rural development through provision of facilities such as roads, houses, etc, results in high demand for cement. However, the newest country hasn't established its cement factory hence the need for a large percentage of imports to meet the local demand, the consequence of which is the high price of cement. The situation is now forcing the South Sudanese government and private companies to invest in cement production for the purpose of replacing the imported cement with locally produced cement. The proposal was motivated by the availability of basic materials for the production of cement in the country. Efforts in this direction have led to the proposed location of Cement in Kigwo village, Kangepo 1 payam, Kajokeji County, Central Equatoria State. Considering the impact of the cement project on the surrounding environment, there is the need to conduct an EIA of the proposed cement project before operation begins, which is the purpose of this study. All the assessment works carried out in this study are aimed at analyzing and determining the concentrations of pollutants in the proposed site.

Kigwo village, Kangepo 1 payam, Kajokeji County, Central Equatoria State lies between latitudes 3.5° and 4.5° north of the Equator and between 31° East and 31.7° East, in the sub-tropical region of Africa. The altitude is between 500 and 1,000 above sea level (Easting 0424255, Northing 0362643). The Kajokei County has an area of 2,636 Km² and a population of 196,000, with a density of 74.45 according to 5th Sudan Housing Census of 2008. Kajokeji is about 112 Km from Juba City. The site has a relatively undulating terrain, with small hill all over, originally bearing thick Savannah vegetation type and some rocky area around. The housing colony is situated about two kilometers away from the site on a land originally belonging to Kigwo Boma community. Kajokeji has a humid climate experiencing a high annual rainfall of between 1,000-1,500 mm for a period of six to nine months per year.

The study site has four main land regions: The Eastern Mountain Range marks the eastern boundary of the county. The range runs from Kaya-Nile confluence along the Nile River Southwards to Nimule where the Nile bends towards Laropi and ends at the South Sudan-Uganda border. The South –Western Ranges-running in a curve from Sera Jale and Westwards along the Ugandan border and northwards into South Sudan at Mangalotore ending up at Gire Mount (the highest peak of the range). The Equatorial Woodland Belt (part of the greater Green Belt) a tongue of equatorial forest runs from central Kajokeji westwards through Böri to the Ugandan border at Mijale. The Central lowland is the area covered by alluvial laterite soils forming most of the arable land and is the largest of the four regions in the area.

Figure 1. View of the proposed cement project site and outcrop of limestone

The well known mountain peaks of Kajokeji County are Sera, Jale, Kimu, Nyiri, Gire, and Kendiri (ranging between 200 m and 600 m above sea level). These peaks encircle Kajokeji town making it a trough. The Eastern Range, stands at 1,000 m above sea level, and cuts off the River Nile from Kajokeji. The County/Kajokeji happens to perch on the western end of the Eastern African Rift valley and on the fault between two African tectonic plates: The Nubian Plate and the Somalian Plate. The geology of Kajokeji is dominated mainly by metamorphic rock punctuated with extrusive igneous rock of various ages. The Permian period of the Paleozoic era, covering from the time from 250 - 290 million years ago. This is a period of intense volcanic activity followed by a series of earthquakes. In the historical past, the Kajokeji escarpment seems to have tilted westwards throwing unattached rocks to hurtle eastwards.

2.1. EIA Activities

In the process of executing the EIA, a preliminary assessment involving literature review, desk studies as well as consultations were carried out. A multidisciplinary field sampling was conducted to obtain baseline information. Laboratory analyses were also conducted. These together formed the basis for the EIA report.

2.2. Laboratory Analysis

The methods of analysis used are those specified in International Analytical Standard such as APHA for water quality. Soil samples were processed prior to analysis. The processing involved air drying and sieving through a 2-mm sieve to remove any debris then subjected to physical and chemical analysis following standard methods described by [11]. Soil pH was measured in a soil water solution ratio of 1:2.5; Organic matter by potassium dichromate wet acid oxidation method; total N determined by Kjeldhal digestion; Extractable P by Bray P1 method; exchangeable bases from an ammonium acetate extract by flame photometry (K+, Na+) and atomic absorption spectrophotometer (Ca2+, Mg2+); and particle size distribution (texture) by using the Bouyoucos (hydrometer) method. Heavy metals and trace elements by AAS from an EDTA extract

2.2.1. Water Samples

Water samples were taken at four locations, namely, spring water from Kigwo mountain (i.e. junction of Kigwo and Kayo stream), kayo stream water, borehole water in kigwo Boma (PHC clinic), and fourthly from Kigwo stream. Measurements for pH, temperature, Electric conductivity (EC), total suspended solid (TDS), dissolved oxygen (DO) and resistivity were done on site. The rest of the parameters for the samples were analysed in the department of Civil and Environmental Engineering, Public Health and Environmental Engineering Laboratory, Makerere University.

2.2.2. Soils Samples

Soil samples were collected from three distinct location, namely; from Moijo area, in the proposed project site in Kigwo Boma and along the Kigwo streams. Soil studies were undertaken to obtain information with regards to the physical and chemical properties, trace elements and Heavy Metals which are relevant to the determination of soil nutrient availability as well as Soil texture/classification.

2.3. Public Consultations

In an ESIA study, it is absolutely important that primary and secondary stakeholders be consulted in order to share and solicit information about a proposed project. The consultations aim to ensure that all stakeholders' interest are identified and taken into consideration during the project cycle. It is also a requirement of South Sudan Draft Environment Protection Bill (2012) and in line with international guidelines during any project undertaking that stakeholders' consultations be done. For the assessed Project, the other category of primary stakeholders was identified as neighbors such as the community. Secondary Stakeholders were identified government and County/payam/boma administration in charge of diverse sectors, and people who will be impacted by the project.

Table 1. Consultation meetings with authorities and local communities during the EIA study

Type of meeting	Stakeholder Group	Approx Number of Attendees
Authority Consultation	Director General in the Ministry of Mining	6
Authority Consultation	Commissioner of Kajokeji County	6
Authority Consultation	Former Commissioner of Kajokeji County	4
Authority Consultation	Director in the National Ministry of Agriculture & Rtd. Lt Col and Rev.	4
Community meeting	Moijo Village	20
Focus Group meeting: Community, Youth, Women and Children	Kigwo Boma/Village	110
Community and Youth meeting	Mere – County administration area	8
Community meeting	Wudu Market – Kajokeji town	22
Community meeting	Kansuk & Mogiri	17
Authority Consultation	Director for Mining economic and promotion	2

2.3.1. Stakeholders Consulted

Among the stakeholders of the Public Consultations includes:

Residents of villages around the project site and other payam/boma, Government functionaries of the project area, Government officials at the Ministry of Mining, Community leaders, Tribal heads of the area and Community Members. Residents of the following 14 villages/areas located in and surrounding the concession area, were also involved in the PCs: Kigwo, Moijo, Sokare Ketiwa, Kajokeji, Mere, Sera, Wudu, Deribe, Leikor, Kamlak, Weleta, Kiri, Luni and Saregoro

As part of the ESIA, the researcher identified additional villages and stakeholder groups whose views and information are important to include in the ESIA.

These are: Mondikolo Village, KansukVillage and Mogiri Village.

3. Results and Discussion

3.1. Soil Analysis Result

3.1.1. Chemical Characteristics of the Soil of the Project Area

The soils in the county are normal red iron-rich laterite derived from the red gabro rock. The Kuku of Kajokeji County are known historically for making their own hoes from the iron ore obtained from Katurungu's village where the iron ingots where bride price were made. The summaries of the characteristics of the soil in the project area are as shown in the Tables below.

Table 2. Routine analysis

Sample No.	pH	OM	N	Av.P	K	Na	Ca	Mg
		%age		ppm	Cmoles/kg			
S 1.1	4.9	1.22	0.12	10.6	0.52	0.11	4.8	2.12
S 1.2	5.9	1.96	0.10	52.2	0.65	0.12	6.5	4.25
S 1.3	5.8	2.38	0.15	61.9	0.44	0.12	4.9	1.66

Table 3. Trace Element and Heavy Metals

Sample No.	Cu	Zn	Fe	Mn	
	ppm (mg/kg)				
S 1.1	1.39	7.26	111.27	58.59	
S 1.2	1.96	2.38	114.68	54.29	
S 1.3	2.22	1.48	165.4	104.83	
Normal range	0.1-3.0	1-40	50-1000	5-500	
Sample No.	Cr	Co	Ni	Pb	Cd
	ppm (mg/kg)				
S 1.1	2.25	0.00	0.01	1.31	0.00
S 1.2	2.31	0.00	0.74	0.15	0.02
S 1.3	4.86	0.00	0.00	0.67	0.01
Normal range	0.1-20		0.05-5.0	0.2-2.0	0.03-0.3

Table 4. Soil texture/Classification

Sample No.	% Sand	% Clay	% Silt	Classification
S 1.1	60.0	26.0	14.0	Sandy Clay loam
S 1.2	54.0	28.0	18.0	Sandy Clay loam
S 1.3	42.0	30.0	28.0	Clay loam

Sample detail description

S 1.1	Soil samples from Moijo area
S 1.2	Soil samples from the proposed project site – Kigwo boma
S 1.3	Soil samples along the bank of Kigwo stream

N.B: Each soil sample is a composite sample (each one sample is a collection of five grab samples).

The texture of the soils in the area is generally sandy clay loam except along the bank of Kigwo streams where the texture is clay loam. The sand content is very high and above 50 % in most places sampled while the clay and silt contents are low. The pH of sample (S 1.1) indicates that the soil is acidic and at such low pH values interventions like liming may be required but the rest of the samples has normal pH. Soil pH of between 5 – 7.5 is associated with high fertility. Organic matter and Nitrogen levels are below the critical values. Available Phosphorus are in normal concentrations. The exchangeable bases are also in normal ranges. Neither the trace elements nor the heavy metals have above normal values to cause pollution; hence they are in safe ranges. The study reveals that emissions from the movement of vehicles during material transportation, cement evacuation, limestone as well as gypsum transportation will be direct/indirect and significant. Emissions from earth-moving and construction equipment and other vehicles passing the road are likely to increase the concentration of carbon monoxide, nitrogen oxide, lead, hydrocarbons and particulate matter along the project route. Exposure to carbon monoxide can interfere with the absorption of oxygen haemoglobin and an acute exposure to nitrogen oxide is a major cause of respiratory disease, while hydrocarbon concentrations can cause severe eye irritation, coughing and sneezing. Mitigating measures will be required to reduce the impact on the air quality. Increased environmental temperatures will have an effect on the surrounding environment.

3.2. Water Quality

3.2.1. Physio-chemical Characteristics of Surface Water

The summary of the Physio-chemical characteristics of sampled water collected in the study site is indicated in the Table 5. Sampling was conducted along the existing water bodies and the water bodies' exhibiting similar characteristics – temperatures ranged from 28.7°C to 32.2°C and pH values ranged from 6.48 to 8.24.

Table 5. Physio-chemical characteristics sampled water

Parameters	Unit	Sample Identification				WHO Standards *
		1	2	3	4	
pH		7.2	7.4	7.2	7.2	5.5 – 9.5++
Temperature	°C	35.3	33.3	34.4	33.4	ns
EC	µS/cm	252	254	454	571	2500++
TDS	Mg/l	127	125	226	285	1500++
Resistivity	KΩ	4.7	4.7	4.8	2.10	ns
Salt content	ppt	0.02	0.02	0.16	0.22	ns
Apparent colour	PtCo	n.d	21	18	874	50++
Chlorides	Mg/l	n.d	n.d	n.d	n.d	250
Nitrates	Mg/l	13.2	8.8	4.4	35.2	50
Total Alkalinity (as CaCO3)	Mg/l	140	105	325	330	600++
Total Phosphorus	Mg/l	n.d	0.282	0.656	1.106	ns
Total Zinc	Mg/l	0.040	0.034	0.400	0.029	5++
Total Iron	Mg/l	0.033	0.066	0.119	1.068	0.30++
Total Cadmium	Mg/l	n.d	n.d	n.d	n.d	0.003
Total Calcium	Mg/l	3.6	4.2	6.0	15.0	100-300
Total Chromium	Mg/l	n.d	n.d	n.d	n.d	0.05
Copper	Mg/l	0.176	0.223	0.140	0.114	1.0++
Lead	Mg/l	0.356	0.658	0.323	1.646	0.01
Magnesium	Mg/l	2.677	3.433	4.356	3.671	<100-300
Manganese	Mg/l	0.054	0.036	0.099	0.033	ns
Nickel	Mg/l	n.d	n.d	n.d	n.d	0.07
Potassium	Mg/l	3.5	5.2	7.0	21.2	ns
Sodium	Mg/l	5.7	6.0	11.3	29.2	200++
Fluoride	Mg/l	2.9	0.5	1.0	1.4	1.5
Sulphate	Mg/l	11.0	0.9	0.8	16.4	400++

*World Health Organization drinking water standards, 2011 [12]; ++ East African Standards for natural portable water, EAC 2014; ns – not specified; n.d not detected; detection limit for total phosphorus is 0.004mg/l; detection limit for chromium and cadmium is 0.001mg/l.

Sources:

1. Spring water from Kigwo mountain (Junction of Kigwo and Kayo stream)
2. Kayo stream water
3. Borehole water in Kigwo boma (PHC clinic)
4. Kigwo stream water

The WHO drinking water standards and East African standards are used to assess the suitability of this sampled water sources for drinking. All the tested parameters of these water sources, except apparent colour, total iron, Lead, and Fluoride (cells with grey highlights) complied with the portable water standards. This compliance implies that no health risks or aesthetic problems are envisaged with this water with regards to these parameters when used for drinking. The sampled source 4 is with detectable apparent colour, which most likely is a result of suspended materials and/or iron.

Water source 4 exhibited high iron levels (>0.3mg/l) and that not only contribute to the colouration (brownish) of the water but also cause undesirable taste in beverages, staining of sanitary ware and laundry. All water sources (1, 2, and 4) had lead levels above the standard (>0.01mg/l), these are associated with adverse health effects in babies and children leading to physical and mental development while in adults, it can lead to high blood pressure and kidney problems. Whereas lead is reported to be rare in source water supplies, its existence in drinking water follows primarily from plumbing material. Finally, source 1 had fluoride levels above standard (>1.5mg/l). Fluoride in higher concentrations is commonly found in groundwater, particularly in volcanic or mountainous areas, and other rocks derived from highly evolved magmas. Excess levels of fluoride have potential of causing dental fluorosis (staining of teeth).

Site preparation, excavated soils and compaction of soil creates turbidity with high spatial extent, especially during the rainy season but these impacts will be of short duration. The overall negative impacts of these activities is however not significant. Effects of volatile and heavy metal compounds e.g. Na+,+, on water quality will be increasing with time. Acidic oxides e.g. CO_2, gradually increase the pH of the water. Pollution of ground water sources may arise as a result of inadequate disposal of refuse and other construction wastes. Runoff of sediments as a result of erosion and from dust and sand at construction site will lead to turbidity of surface water courses.

3.3. Ambient Air Quality

Table 6. The average Ambient Air quality of the project area

Parameters	Unit	Level
CO2	ppm	420
CH4	ppm	00
NOx	ppm	00
SO2	ppm	00
PM2.5	µg/m3	13
PM10	µg/m3	27

The scenario of the existing ambient air quality in the study sites has been recorded during the study Period within the proposed project area. The existing Ambient Air Quality (AAQ) status has been monitored for PM, SO_2, NO_x, CH_4, H_2S & CO_2 at each located station of the proposed cement project study area. The following portable gas detector was employed: KP826 Portable multi-gas detector for CH_4, SO_2, NO_x, H_2S, and KP810 Portable gas detector for measurement of CO_2 in the atmosphere as well as Handheld Particulate matter tester CW-HAT200 for particulate matter. Accordingly, the average Ambient Air Quality (AAQ) in the proposed cement project site for the monitored gases are presented in Table 6.

Table 7. World Bank/IFC ambient emissions guidelines for cement and lime manufacturing [13,14]

Pollutant	Units	Guideline Value for Cement Manufacturing*	Guideline Value for Lime Manufacturing
PM (New Kiln)	mg/Nm^3	30[1]	-
PM (Existing Kiln)	mg/Nm^3	100	-
Dust	mg/Nm^3	50	50
SO_2	mg/Nm^3	400	400
NO_x	mg/Nm^3	600	500
HCl	mg/Nm^3	10[2]	10
Hydrogen Fluoride	mg/Nm^3	1[2]	-
Total Organic Carbon	mg/Nm^3	10	-
Dioxins and Furans	Mg TEQ/Nm^3	0.1[2]	-
Cadmium and Thallium (Cd+TI)	mg/Nm^3	0.05[2]	-
Mercury (Hg)	mg/Nm^3	0.05[2]	-
Total Metals[3]	mg/Nm^3	0.5	-

3.4. Noise Levels

Activities in the construction phase do not constitute a constant, continuous source of noise quantifiable in the same way as noise in the operational phase of the project. With changing levels of activity and shifting sources of noise, noise levels will vary considerably in magnitude and over time. Noise levels in the project area are presented in the Table 8.

Table 8. Noise Levels in the Study Area

Sample location	Noise level dBA
Kigwo boma/Village	41.3
Kigwo stream	47.5
Kayo stream	48.3
At the quarry/overburden stockpile	43.1
Moijo Village	40.6
Cement Plant Site	48.2
World Bank limits (Industrial; commercial)	70.0

It is expected that noise levels will be highest at areas closest to the heavy equipment such as crushers and also due to movement of heavy duty vehicles.

Potential sources of vibration include blasting in quarries, pilling in construction, road traffic and heavy machinery. Vibration transmitted from the site activities to the neighborhood may therefore cause anxiety as well as annoyance to the community.

Dusts will also be generated from point or diffuse sources which include sources such as exhaust stack. Nevertheless, cement dusts constitute, if not controlled, a nuisance within the plant and the surroundings, as it affects not only the health of the employees working in the plant but also the neighboring communities, especially those downstream. Adequate mitigation measures such as Electrostatic Precipitators (ESP) and Fabric Filters will be put in place to ensure almost zero fugitive SPM emission and limit exhaust PM emissions to less than 200 μg/s. Soil erosion is anticipated due to exposure of topsoil from bush clearing and excavation. The surface area to be exposed is a small fraction of the total land area in the project area. Hence, the impact is not significant, indirect, cumulative and is reversible. Loss of flora and fauna due to bush clearing and exposure of top soil is expected to have a significant impact on the ecology and biodiversity. The loss of vegetation canopy will have significant impact on the soil since the project is expected to be on dry land as well as hydrological regime of the area.

3.5. Expected Environmental Impacts of the proposed project

- Continuous noises resulting from daytime operations of the quarry, cement plant, haul road and associated infrastructure
- Placement of project infrastructure, resulting in a temporary loss of soil resource, and change in soil characteristics, land capability and land use
- Spillage of chemicals and seepage from waste resulting in permanent loss of soil resource, and change in soil characteristics, land capability and land use
- Site clearance resulting in a permanent loss of soil resource, and potential change in soil characteristics, land capability and land use as a result of increased erosion
- Chemical contamination of surface water resulting from accidental spills during transportation and handling, and seepage from wastes
- Contamination of groundwater resulting from seepage from sewage and other waste
- Loss of habitat due to site clearing and earthmoving activities
- Contaminated storm water runoff from cement plant, roads and other surfaces affecting surface and groundwater quality
- Loss or disturbance of species of special concern due to site clearing and construction activities
- Fragmentation of habitats and ecological processes due to positioning of project infrastructure
- Modification or degradation of aquatic habitats due to altered hydrological regimes and surface or groundwater quality
- Introduction of alien invasive plants due to site clearing and disturbance of vegetation
- Impeded photosynthesis and transpiration rate of plants due to dust generation
- Safety impacts to local communities and other road users due to increased road accident rates during construction
- Influx of potential job seekers into the area and associated risks
- Increased chances of the spread of communicable diseases such as HIV/AIDS and STDs linked to influx of predominantly male job-seekers and workers
- Increased risk of accidents and injuries to communities from improved roads and additional traffic
- Physical displacement of households residing at Kigwo Boma/Village
- Local and regional benefits resulting from increased Revenue to Government
- Generation of direct, indirect and induced employment and income
- Indirect damage to cemeteries through land transformation activities
- Reduced availability of natural resources and ecosystem services to local communities
- Sinkhole formation resulting from dewatering of subsurface cavities, resulting in safety and structural stability risks

3.6 Public Consultation

3.6.1. Summary of Stakeholder Comments Received during the EIA Consultation

The comments, issues and overall perceptions expressed by stakeholders consulted in this ESIA, are summarized below.

- Summarily, the people have positive perception about project installation.
- All the people in the project area are aware of the project.
- They are of the views that the project will help to provide them job opportunities, reduce poverty, promote education, improve infrastructure, bring general awareness, promote health facilities etc.
- There is an expectation that there will be qualitative and quantitative improvements in all walks of life. Their future generations will have the chance to live a better life in all respects.
- The people have clear perception that the installation of the plant in the area is beneficial for the community especially and country on the whole.
- Study findings depict that the people of the study area perceive overall positive impacts as a result of installation of the plant. Therefore, their attitude towards the project installation is quite positive.
- As far as the Social Impact Assessment (SIA) is concerned, positive social impacts are dominant over hardly conceived any negative social impacts observed during the study.
- The people have high expectations and hope from the plant activity and its management.
- They correlate their positive attitude towards the plant with many socio-economic opportunities and benefits.
- The people believe that installation of the plant in the area will open up employment opportunities which in turn follow a chain of indirect socio-economic benefits.
- They also perceive accelerated economic activity due to the business opportunities likely to emerge in the area.
- Directly or indirectly, hundreds of the local people will get employment and business from the installation of the plant.
- People foresee many socio-cultural and psychological positive impacts on their lives and the community.

- They feel that the plant and its related activities will provide a strong base for social change.

3.6.2. Potential Impacts Perceived by Stakeholders

According to the data gathered by the researcher, the impacts perceived by the inhabitants of the project area and the government officials can be divided into the categories below:

- Positive impacts are perceived by all the respondents as almost all the respondents are very enthusiastic about the installation of the plant because it will surely raise the living standard of the people of this area along with more jobs and business opportunities.
- The inhabitants of this area do not feel any threat to their cultural values as their society is homogenous in nature and they look forward to this project as an opportunity to rebuild their future as well as the future of their upcoming generations.
- Head of Kajokeji Territory which is the Governor expressed his views in terms of increase in the revenue of the territory, development of the county and payam, as a result of the installation of the proposed Cement Plant.
- The respondents also considered the installation of the Plant as a positive step towards industrialization.
- The respondents also expect Electricity to be available in their village.
- The only village that is going to be displaced is Kigwo Village. They were demanding house in return for the house and other basic needs.

4. Conclusions

Since an environmental impact assessment (EIA) is an assessment of the possible positive or negative impacts that a proposed project may have on the environment; mitigating and managing the inherent environmental problems requires sound environmental and socio-economic responsibility. The study revealed that the proposed project will elevate the noises of the site, cause loss of soil resource as a result of site clearance and spillage of chemicals and seepage from wastes. It will also cause chemical contamination of surface and ground water due to accidental spills during transportation and handling and seepage from wastes. Fragmentation of habitats and ecological processes will occur due to positioning of project infrastructure and increased risk of accidents and injuries to communities from improved roads and additional traffic. Physical displacement of households residing at Kigwo Boma/Village will occur. Mitigation measures and Environmental Management Plant aimed at reducing and possibly mitigating such impacts should be put in place.

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