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PERCEIVED ENVIRONMENTAL AND HEALTH IMPACTS OF GAS FLARING ON RESIDENTS IN KWALE COMMUNITIES, SOUTHERN NIGERIA

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ABSTRACT

This study was designed to examine the perceived environmental effects of gas flaring and its associated health impact on residents in Kwale communities, Southern Nigeria. Three research objectives guided the study. Descriptive survey design and purposive sampling technique was adopted for the study. 750 household respondents from five different communities in Kwale axis were used for the study and an 18 item self-structured questionnaire was used to elicit information from the respondents. The instrument for data collection was administered to the respondents in the communities. The study revealed that gas flaring impact on the social, economic and environmental quality of the communities as 79.6% of the respondents positively affirmed the finding. A reasonable percentage (89.6%) of the sampled household respondents consent that gas flaring impact on the environmental activities as well as health of residents in the study area. Furthermore, 68% of the respondents confirm that gas flaring has a devastating effects on the vegetation and agricultural activities of the residents as some of them reported cases of stunted growth of crops, withered crop leaves, defoliation of plant and wrinkling of plant leaves. A higher percentage of respondents confirmed cases of critical gas flaring health related sick suffered by either themselves or family members and some of the respondents as well complained of excessive heat radiation and increase in temperature. Based on the findings, sustainable strategy for natural gas utilization was recommended in order to curtail the negative impacts and convert the excessive gas for economic and environmental benefits.

Contribution/Originality: This study contributes to the existing literature by examining the perceived environmental effects of gas flaring and its associated health impact on residents in Kwale communities, Southern Nigeria.

1. INTRODUCTION

The Niger Delta area is a region endowed with mineral deposits, natural gases and petroleum. These deposits have been a blessing in disguise in some circumstance, and in others it is nothing but a continuous source of sorrow especially in communities where they are located. These natural resource deposits are a windfall to the Nigeria government whereas the communities where the reserves are located struggle to deal with the resultant negative impacts that come with its exploration and exploitation (Akpojwi and Akumagha, 2008). The Niger Delta area in Nigeria has experienced tremendous oil exploration and exploitations since the beginning of oil and gas production in 1958. This is largely due to the huge deposits of petroleum and gas within the region (Friends of the Earth

Nigeria, 2008). The production of natural gas, which was about 310 million cubic metres in 1961 in Nigeria, has steadily increased to about 27,039 million cubic metres as at 1998 (Department of Petroleum Resources, 1999). Several researchers have reported that Nigeria flares about 80% of natural gas produced during oil production (Oniero and Abroibo, 2000; Idris, 2010; Oseh *et al*., 2015).According to Uyigue and Agho (2007) there are over 123 flaring sites in the region and Nigeria has been recognized as the highest emitter of greenhouse gases in Africa. Gas flaring has being an issue of concern to Nigeria government since the discovery in commercial quantity oil and gas deposit and its resultant exploration. The reported impact of gas flaring is of local and global concern. Flaring of associated gas is one of the most challenging energy and environmental problems confronting the region locally and the world today at large. Akpojwi and Akumagha (2008) asserted that it is a multi-billion dollar waste, a local environmental catastrophe and a global energy and environmental challenge that has persisted for decades.

Flared gas has been reported to be a major contributor to global warming and climate change challenges (Oniero and Abroibo, 2000; Bassey, 2008; Idris, 2010). Flaring of natural gas has pumped out about 110 million metric tonnes of carbon dioxide to the atmosphere per year, which is about 0.5% of the World's carbon dioxide emissions. According to FOEN (2008) about 2.5 billion cubic feet of gas associated with crude oil are flared in Nigeria in this manner. This is equal to 40% of all Africa's natural gas consumption and represents 2.5 billion USD financial losses to Nigeria. This direct disaster caused by the multinational companies in Nigeria is a foremost source of greenhouse gases, volatile organic chemicals (VOCs), nitrogen oxides (NO_2), polycyclic aromatic hydrocarbon (PAH), sulphur dioxide (SO_2), black carbon, particulate matter (PM) and certain heavy metals thereby deteriorating the environment and affecting the quality of health and well being of the nearby communities (Ndinwa and Akpafun, 2012). Despite the fact that it has been reported by researchers in other part of the world that is it technically possible to capture and utilize the separated associated gas; in Nigeria the gas are generally combusted and flared in the open air (Ovadia, 2013). Over 100 continuous gas flaring sites are located within the Niger Delta. Statistical records available revealed that increases in the concentrations of air pollutants as a result of gas flaring in the region have significantly impacted on the health of the indigenes residing in the host communities, acidification of soil and rainwater, low crop yields, poor nutritional quality of crops harvested, corrosion of physical infrastructure and metal works in the region (Ogunfiditimi, 2005; Nkwocha and Pat-Mbano, 2010; Nriagu *et al*., 2016). These impacts have prompted numerous reports by other interested scholars around the world. However, despite the common flaring of gas by the oil industry in Delta State and Kwale communities at large; remarkably there exist no literature on studies of gas flaring affecting the environmental quality and associated health impact on the local people residing in Kwale communities in Ndokwa West Local Government Area of Delta State hence this study intend to fill the gap.

1.1. Objectives

The main objective of this paper is to evaluate the perceived environmental and health impacts of gas flaring on the local people residing in Kwale communities in Delta State. The study was guided by these specific objectives:

i. Assess the environmental impact of gas flaring on the agricultural activities and local economy of the study area.
ii. Assess the impact of gas flaring on the health and well being of the local people.
iii. Proffer workable integrated management plan and strategy for sustaining the environment of the communities and improving the health of the local people.

2. METHODS

2.1. Study Area

This study was carried out in Kwale, a community with sub-communities located in Ndokwa West Local Government Area of Delta State. It lies between latitude $6^{o}11^{1} - 52^{o}23^{1}$ N and longitude $6^{o}43^{1} - 42^{o}51^{48^{1}}$E see

Figure 1. Kwale is inhabited by three major native groups with the predominant being the Ukwuani, Aboh Ndoni speaking native; followed by the Urhobo-Isoko ethnic group (the second most dominated natives) and the Ijaws (Ukala, 2011). There are other non natives residing within the communities. Utagba ogbe is the main initial downtown area of the community. The community has an estimated population of over 176,060 people (National Bureau of Statistics, 2006) who are predominantly traders, artisans, fishermen, farmers, businessmen and civil servants. The community is a host to oil and gas companies, some of which have presence in different parts of the African cities. Some of the activities of the oil companies are situated in Ebedei nearby Umukwata, Ebendo, Umuseti and Umusadege with pipeline running from Aboh and river Ase creeks.

The annual mean rainfall of the area has been estimated to be between 1,450mm and 3,200 mm with a mean monthly temperature range of 24-25^{0} C during the wet season in August and 27-29^{0} C during tail end of dry season in March/April. Maximum temperature between the months of January and March has been reported to be 33^{0}C and minimum temperature of 21^{0} C has been recorded in the months of July and December (Kamalu and Wokocha, 2010). Temperature in the study area is seriously moderated by cloud cover and damp air. The area experiences a typical tropical, hot and humid climate with a long rainy season from April to November and a shorter dry season that lasts from December to March. The wind speed of the area ranges from 2-5 m/s during the dry season and up to 10 m/s in the wet season especially during heavy rainfall and thunderstorms. The major land use types in the area include forestry, agriculture, oil exploration and exploitation (Kamalu and Wokocha, 2010; Ukala, 2011).

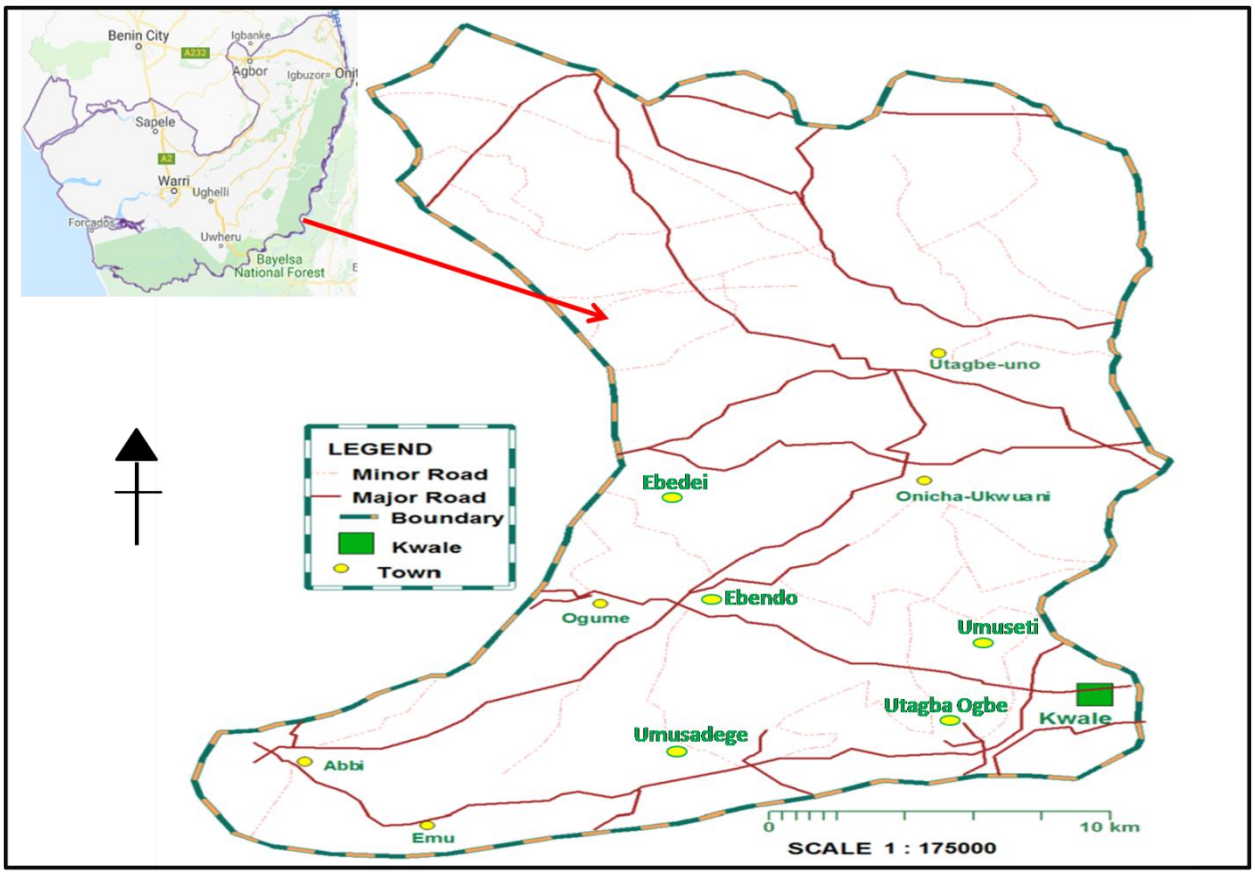

Figure-1. Map of Kwale showing the study location.

Source: Delta State Ministry of Land Urban Development and Housing (2016).

2.2. Research Design

Descriptive survey research design with two different approaches was adopted for the study. The design was chosen because it involves studying a group of items by collecting and analyzing data from only a few which is considered to be representative of the entire population. The targeted sample population for the study comprises of

five (5) communities in Kwale; that is; Ebedei, Utagba Ogbe, Ebendo, Umuseti and Umusadege. From the targeted population, a sample size of 750 respondents was purposively drawn from the communities that makeup Kwale. The sample was selected using purposive sampling technique. For a representative sample, in each community 150 respondents were selected. The researchers employed the used of purposive sampling technique in order not to be bias in selecting the samples. A sample size of 750 respondents were selected for the study; whereby every 4th, 8th, 12th, 16th and 20th buildings in each quarter were selected until the last building in the community was selected for the study. Data was sourced and collected from primary and secondary sources. Secondary data was sourced from books, articles and journals; whereas primary data was from questionnaires administered and on the spot field observation. 18 item set of questions in a well self-structured form of questionnaire was used to elicit information from the respondents. The questionnaire was sectionalized into A and B. Demographic information about the respondents constituting the sample was elicited from section A of the questionnaire. This includes age, level of education attainment, marital status, occupation and years of residents in the community. Section B elicited responses on the environmental and health effects of gas flaring in the communities. The researchers employed the use of the modified rating scale.

Copies of the instrument for data collection were administered by the researchers to the households sampled in assistance with one of the indigene of the community. The instrument was administered to one respondent each at a time representing that household and same time explain the purpose of the study as well as assuring the confidentiality of the information given. The researchers ensured that respondents completed and submitted the questionnaire immediately at the spot. The content in the questionnaire and options available as answers were read to the hearings of the respondents who were illiterates. The demographic aspect of the questionnaire was analyzed using simple statistics such as contingency table. The question specific aspects in the research instrument were analyzed using descriptive statistics such as graph, histogram, bar chart and pie chart.

3. RESULTS AND DISCUSSION

This section discusses the responses elicited from the respondents. Discussion of findings was presented in sections. Table 1 shows the frequency distribution of respondents based on their demographic and socio-economic characteristics from the five communities covered in this study. Gender composition of the community's household respondents sampled revealed that 56.8% were male whereas 43.2% were female. This therefore implies that there were more males residing in the study area than the female counterparts. On the spot observation at the field further revealed that male farmers were much more than the female. This finding disagrees with the report of Esu and Dominic (2013) but corroborated the findings of Akpafun *et al.* (2019) whom asserted that Delta State has a higher percentage of male population than their female counterparts. This report further disagreed with the findings of Facito and Spurling (1992) that women population are gradually taking over sub-Saharan Africa's population despite the risk and labour demand in agriculture. Analysis of data in Table 1 revealed that 66(8.8%) of the respondents were within the age range of 15 – 25 years, 114(15.2%) of them were 26 – 35 years of age, 309(41.2%) of the respondents were in the age group of 36 - 45years, 183(24.4%) of the sample were 46 - 55years of age and 78(10.4%) of the remaining respondents are in the age group of above 56 years. The distribution of the respondents based on age as shown in Table 1 revealed that above half (65.6%) of the household respondents sampled have their age range between 36 and 55 years whereas 24% of the respondents have their age range between 15 and 35 years. The result was in conformity with the report by Ogunfiditimi (2005); Udofia (2005); Olaniyi *et al.* (2008) and Ebiyeghagha (2010) that people of this age group (31-40 years) are smart, energetic, active and agile. It was also consistent with the findings of Akpafun *et al.* (2019) that a higher percentage of Delta State population is within the middle age range of 30-55 years.

Table-1. Frequency distribution of respondents based on demographic and socio-economic characteristics.

Variables	Frequency	Percentage (%)
Gender		
Male	426	56.8
Female	324	43.2
Total	750	100
Age		
15-25	66	8.8
26-35	114	15.2
36-45	309	41.2
46-55	13	24.4
Above 56	78	10.4
Total	750	100
Marital status		
Married	471	62.8
Single	228	30.4
Divorced/Widow	51	6.8
Total	750	100
Educational level		
Primary school	72	9.6
Secondary school	264	35.2
Graduate (HND/B.Sc)	366	48.8
Non-formal education	48	6.4
Total	750	100
Occupation		
Farming	129	17.2
Fishing	63	8.4
Livestock keeping	36	4.8
Trading	99	13.2
Artisan	57	7.6
Civil Servant	78	10.4
Private sector	72	9.6
Unemployed	111	14.8
Total	750	100

Information in Table 1 shows the marital status of the sampled household respondents in the study area. The result revealed 471(62.8%) to be married whereas the other 228(30.4%) were single and 51(6.8%) respondents were divorced. This shows that on average, over 60 percent of the respondents are married, whereas 30.4% and 6.8% were in the category of single and divorced/widow. This finding is not surprising considering the finding on age range in this study that over 65.6% of the household respondents are within 36 and 55 years. The finding corroborated the report of Esu and Dominic (2013) that respondents with male headed households were more than the female headed households in Ogbia Local Government Area, Bayelsa State. This finding was not in line with the report of Ndinwa *et al.* (2012) whom reported a higher percentage of single respondents in Abraka, southern Nigeria. With respect to education attainment of the household respondents, the analysis revealed 48(6.4%) of the sampled respondents had no formal education, 72(9.6%) of the respondents had primary six certificate, 264(35.2%) of them had the post-primary school certificate (secondary school certificate) and the remaining 366(48.8%) of the respondents had one form of qualification from a tertiary institution as their highest educational qualification. From the result analysed, it was established that over 80% of the respondents were educated. The implication of this finding is that, majority of the household respondents acquired one form of academic qualification. This result corroborated the submission by Olaniyi *et al.* (2008) but disagreed with the assertion by Akpafun *et al.* (2019) and Meinzan-Dick and Quniscunbing (2011) who substantiated the fact that, respondents in Sub-Saharan African countries have a very low level of education.

Opinion of respondents concerning their occupation shows that 129(17.2%) of the respondents were engaged in farming activity, 63(8.4%) choose fishing as their occupation, 36(4.8%) from the sample are into livestock keeping,

99(13.2%) of the sampled respondents are traders/business persons, 57(7.6%) of them are artisans, 78(10.4%) are civil servant workers, 72(9.6%) of the respondents are engaged in the private sector within the study area and the remaining 111(14.8%) of household respondents were unemployed. The finding revealed that 30.4% of the sampled household respondents are into one form of agricultural related activities such as livestock keeping, farming and fishing.

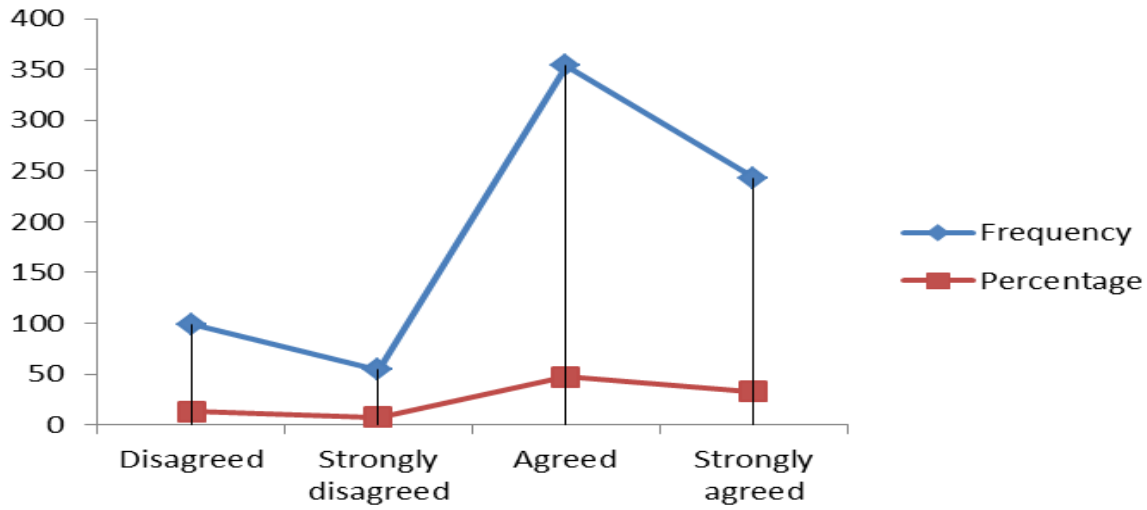

Figure-2. Response of respondents on if gas flaring affects the social, economic and environmental activities of the community?

Recent studies has revealed that gas flaring emit as many green house gases as 18 million metric tons, and release toxic substances in the areas were gases are flared, thus damaging both the environment and health of the people (Akankali and Oronsaye, 1997; Efe, 2003; Adati, 2012). However, investigation into if gas flaring affects the social, economic and environmental activities of the communities showed that 99(13.2%) of the respondents disagreed that gas flaring affects the above stated activities, 54(7.2%) of the sampled respondents strongly disagreed as well, that gas flaring affects the social, economic and environmental activities of their communities. This finding did not corroborate the study by Adewale and Mustapha (2015) that the reported impact of gas flaring in the Niger Delta is glaring on the host communities. It also did not correspond with the report by Akankali and Oronsaye (1997) that gas flaring has diverse social-economic effects on the environment, humans and other living creatures. Gas flaring causes serious social-economic, environmental damage and systemic poisoning of the ecosystem (Environmental Rights Action/Friends of the Earth Nigeria, 2008). Flaring of gas has been noted to be a concern for both the public and government of the day because of the environmental risk associated with the activity and its potential health concerns. Adewale and Mustapha (2015) asserted that smoke, odor and noise are some of the discomforting by-product from flaring activities which negatively affects nearby communities and their enjoyment to outdoors. This assertion was in conformity with the finding of this study were 354(47.2%) of the respondents affirmed that gas flaring do affect the social, economic and environmental potentials of their communities. The finding of Nwanya (2011) who noted that the deleterious impact of heat-trapping anthropogenic gases contribute to rise in global warming potential; is in line with this study were 243(32.4%) of the sampled household respondents strongly perceived that gas flaring impact negatively on the social, economic and environmental activities of the studied communities.

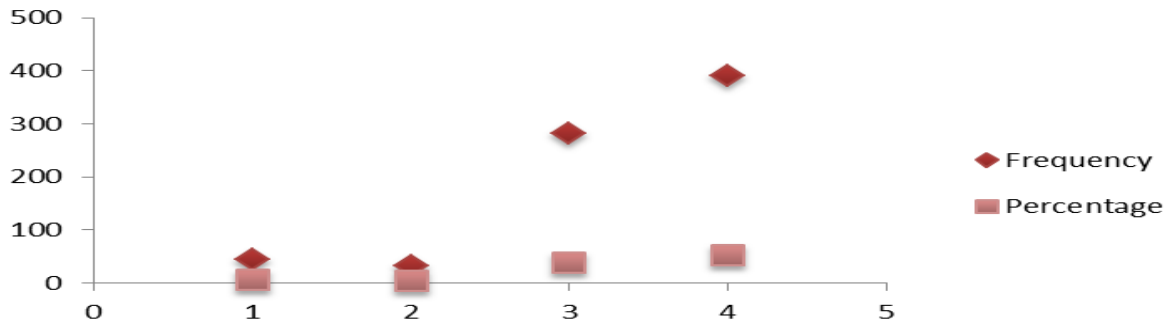

Figure-3. Response of respondents on if gas flaring has environmental and health effects on the indigenes of the communities?

The result as shown in Figure 3 revealed that respondents who disagreed with the said question in the questionnaire were 6%. Additional 33(4.4%) of the respondents acclaimed to strongly disagreed with the question. 282 (37.6%) of them consented to be in agreement that gas flaring has impacted negatively on the environment and health of the residents in the communities. This finding is in conformity with the submission by Nwanya (2011) that the deleterious impact of the by-products from flaring gas posses great risks to built-up environment, health and the social well being of the local communities residing close to flaring site. Also 390(52%) of the sampled household respondents whom strongly agreed with the question as stated in the questionnaire corroborated the studies by Efe (2003) and FOEN (2008) that gas flaring is a major contributor to the stock of greenhouse gases in the atmosphere thus adding to the climate change chaos and induce acid rains which pollute creeks and streams, damage vegetations and corrode roofs of buildings.

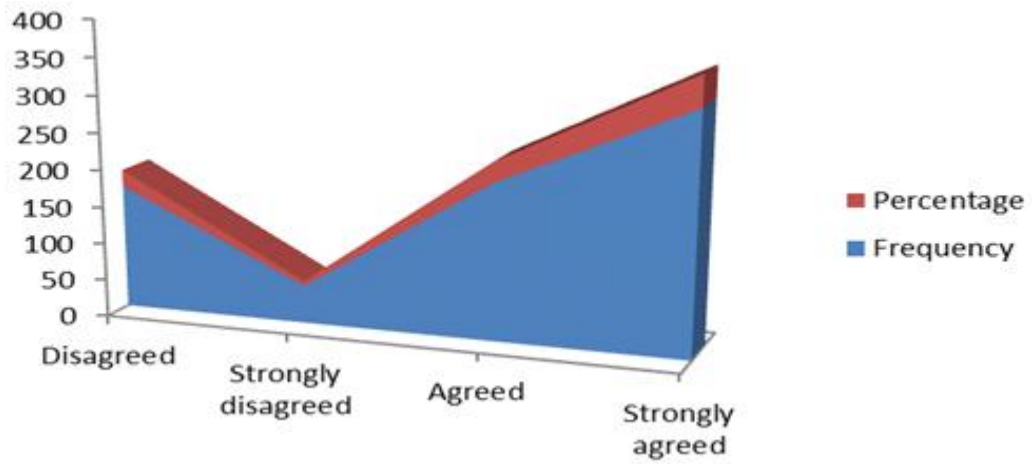

Figure-4. Response of respondents on if gas flaring affects the income of the people in the community?

Analysis as displayed in Figure 4 which sought to find out if gas flaring affects the income of the local people in flared communities revealed that 168(22.4%) of the respondents acclaimed to disagree that gas flaring affects the income of the people in the community, 51(6.8%) strongly disagreed with the question. However, this finding was not in consonance with the report by Dessel *et al.* (1996); Idris (2010) and Oseh *et al.* (2015). More so, 210(28%) of the respondents are in agreement with the item as stated in the questionnaire whereas 321(42.8%) of the remaining respondents acclaimed to strongly be in agreement that gas flaring impacts on the income of the residents of the community. The implication is that household respondents earned very low income especially respondents who solely depend on farming activities because of polluted farmlands by gas flaring. This finding is in line with the submission by AK-BASES (2005) that rural-based farmers in Akwa Ibom State earned very low income because of polluted farmlands.

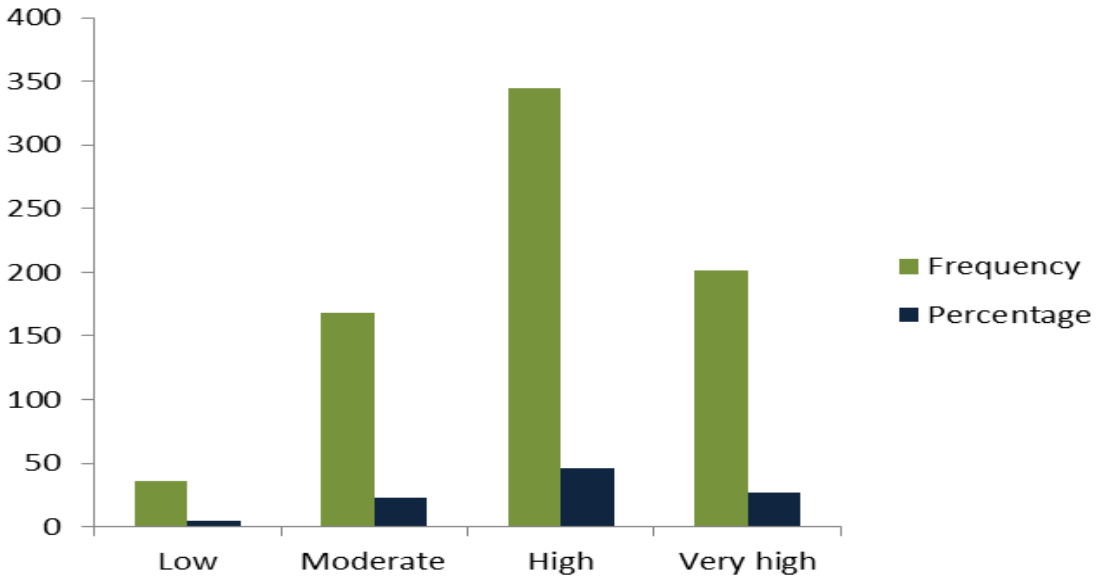

Figure-5. Response of respondents on how they perceive the level of temperature in their locality in terms of heat wave?

Globally, flaring of gas is a major environmental concern due to its high emissions of methane, CO_2 and benzene, which are known ozone-depleting substances and contribute to global climate change phenomenon (World Bank, 2008). Respondents' opinion concerning how they perceive the level of temperature experienced in their localities in terms of heat wave revealed that 36(4.8%) of the respondents consented that heat wave generated from the flare sites are low; 168(22.4%) of the sampled respondents claimed that the temperature is moderate. However, 345(46%) of the respondents attested that heat wave experienced in their various communities are high whereas another 201(26.8%) consented that they experience very high heat wave in their communities as a result of the flaring sites. This finding corresponded with the study by Bassey (2008); Orimoogunje *et al.* (2010) and Ajugwo (2013) whom in their different studies affirmed that gas flaring raised the temperature of the study area and rendered large area of land inhabitable and uncultivable by farm households. It further confirmed the submission by Efe (2003) that due to increased temperature in gas flaring communities, climate variability, proliferation of pests and widespread disease have seriously affected the quality of lives and well-being of farm household. Reports from several scholars have established that heat radiation from gas flaring site contributes to the increment in the soil temperature, which in turn destroy plants since plants absorb CO_2 from the atmosphere (Tolulope, 2004; Opafunso, 2005; Tzimas *et al.*, 2007).

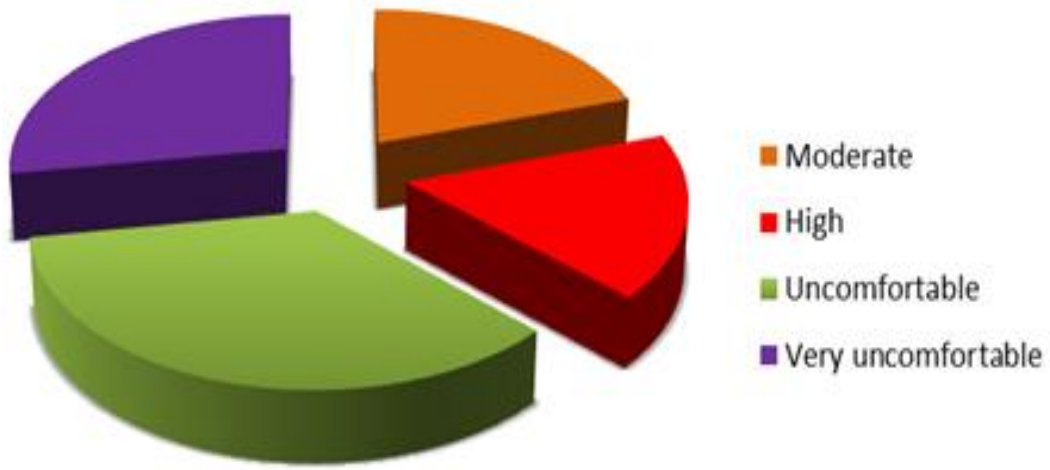

Figure-6. Response of respondents on how they rate the level of noise generated from the flaring site?

Noise is an audible acoustic energy that adversely impact on the psychological and physiological well being of the individuals. It is part of the by-products from gas flaring stations and produces many adverse effects on man and animals (Ugonna, 2014). Analysed response of respondents as displayed in Figure 6 revealed that 150(20%) of the respondents rated the level of noise generated from flare sites as moderate, 129(17.2%) of the respondents rated the noise level as high; 264(35.2%) of the sampled respondents rated the level of noise from flare sites as uncomfortable whereas the other 207(27.6%) accepted that noise level generated from the flare sites in their locality were very uncomfortable. This finding disagrees with reports by Abdulkareem and Odigure (2006) and corroborated the findings by Ilori (1999); Luginaah *et al.* (2000) and Oseh *et al.* (2015). Nriagu *et al.* (2016) reported that flares in many areas of the Niger Delta communities are continuous for 24 hours a day thus subjecting the residents to continuous noise pollution and permanent light. The observation in this study confirms the submission by Ovadia (2013) that constant noise from flare sites sends wild animals fleeing, and the local people must shout to be heard over the roaring flames. Also Akuirene *et al.* (2019) reported that emotional distress was prevalent among study participants residing close to flare sites with only <5% of the respondents has no adverse feelings about the continuous flaring of gas in their area. Ugonna (2014) also reported that noise has a detrimental effect on wild animals, increasing the risk of death by changing the delicate balance in predator or prey detection.

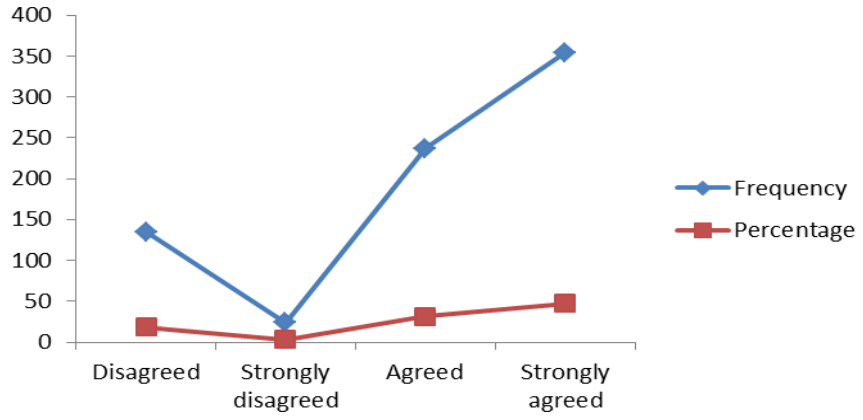

Figure-7. Response of respondents on if gas flaring pollutes the air and water in their communities?

Report by scholars in other parts of the world have suggested that living near a flare and production sites is an environmental stressor that can have adverse effects on health, well-being, and quality of life (Bhopal *et al.*, 1988; Luginaah *et al.*, 2000; Luginaah *et al.*, 2002; Cutchin *et al.*, 2008; Kponee *et al.*, 2015; Shultz *et al.*, 2015) Analysis as illustrated above shows that 354(47.2%) of the respondents were strongly in agreement by confirming that gas flaring do pollute the air and water within their surrounding environment; 237(31.6%) of the sample also agreed to the option in the questionnaire whereas 24(3.2%) of them strongly disagreed and 135(18%) of the other respondents disagreed that gas flaring does not pollute water nor air in the communities. This observation is clearly supported by the findings by Oghenejobh (2005); Oghenejoboh *et al.* (2007); Obia *et al.* (2011) and Oseh *et al.* (2015).

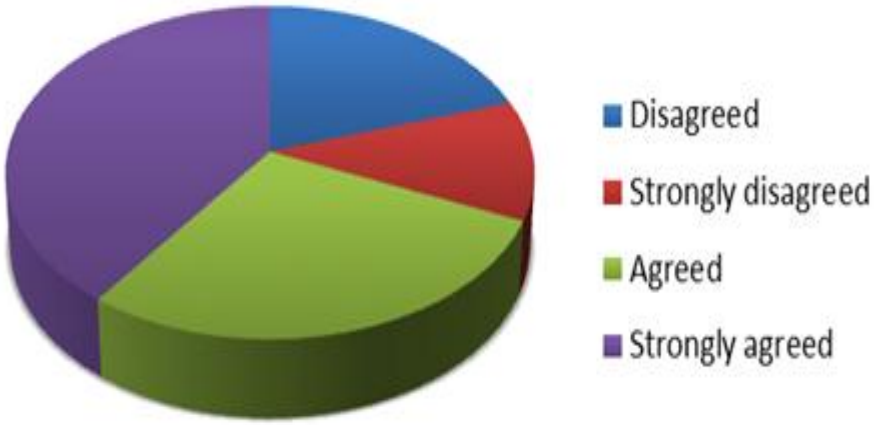

Figure-8. Response of respondents on if gas flaring affect buildings in their communities.

In communities were gases are flared, the corrosion of buildings and monuments are exacerbated and accelerated (Obia *et al.*, 2011). The phenomenon of acid rain due to the dissolution of acid gases in atmospheric water in the sky so that it becomes acidic with pH below 5.0 through atmospheric precipitations was reported by Oghenejobh (2005). The resultant impact was felt by its corrosion of rooftops, premature rusting of metallic object, damage to plant productive parts and discoloration of paints on building. From the above figure, 20% of respondents disagreed that gas flaring do impact on building infrastructure in their locality. Additional number of 11.6% of the respondents strongly disagreed with the opinion whereas 28.4% and 40% of the sample were in agreement with the question as stipulated in the questionnaire. The observation of respondents' perceived response on the impact of gas flaring on buildings in this study is in line with the findings by other researchers (Ekpoh and Obia, 2010; Nkwocha and Pat-Mbano, 2010; Obia *et al.*, 2011). Orimoogunje *et al.* (2010) asserted that in the oil producing areas of Nigeria, gas flaring has led to increased levels of acid precursors like SO_2 and NOx occasioning acidic atmospheric moisture and corrosion of galvanized iron roofing sheets. Ajugwo (2013) also asserted that corrugated roofs in the Niger Delta region have been corroded by the composition of rain that falls as a result of gas flaring. More so, in a study (Ekpoh and Obia, 2010) demonstrated that acid rain causes rapid corrosion of zinc roofs in three experimental sites that were located near pollution sources such as gas flare station or sea aerosols in the Niger Delta area relative to the controlled site that was located far away from pollution sources. Choi and Fisher (2003) whose study report indicated that in the Niger Delta, corrugated roofs are corroded by acid rains as a result of gas flaring revealed that roofing sheets that has 20 years life span last for only five (5) years.

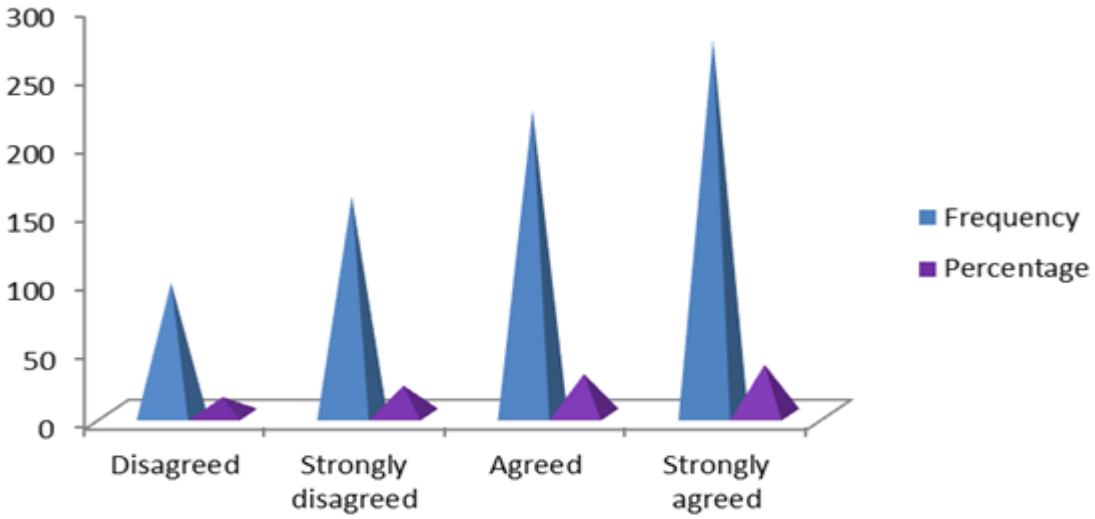

Figure-9. Response of respondents on if the increase in temperature resulting from gas flaring impact negatively on infrastructure in their communities.

Opinion of respondents concerning their view on if increase in temperature resulting from gas flaring impact negatively on infrastructure revealed that 96(12.8%) were in disagreement while additional 159(21.2%) from the sample strongly disagreed with the question as shown in Figure 9. Further findings revealed that a number of 222 respondents representing 29.6% attested that increase in temperature as a result of continuous flaring of gas in their locality impact negatively on infrastructure. Finally, it was strongly agreed by 273(36.4%) of the respondents that increase in temperature resulting from gas flaring impact negatively on their infrastructure. Overall, a considerable percentage of 66% of the sampled household respondents confirmed that high temperature resulting from gas flaring impact negatively on the infrastructures in the communities. This finding was in uniformity with the report by Oniero and Abroibo (2000); Efe (2003); Odigure *et al.* (2003) and Oseh *et al.* (2015). Nkwocha and Pat-Mbano (2010) and Obia *et al.* (2011) in separate studies established that building degradation has been attributed to major pollutants from flared gases that may have caused the observed impacts such as coloration of walls, corrosion of roof tops and leakage of roof tops.

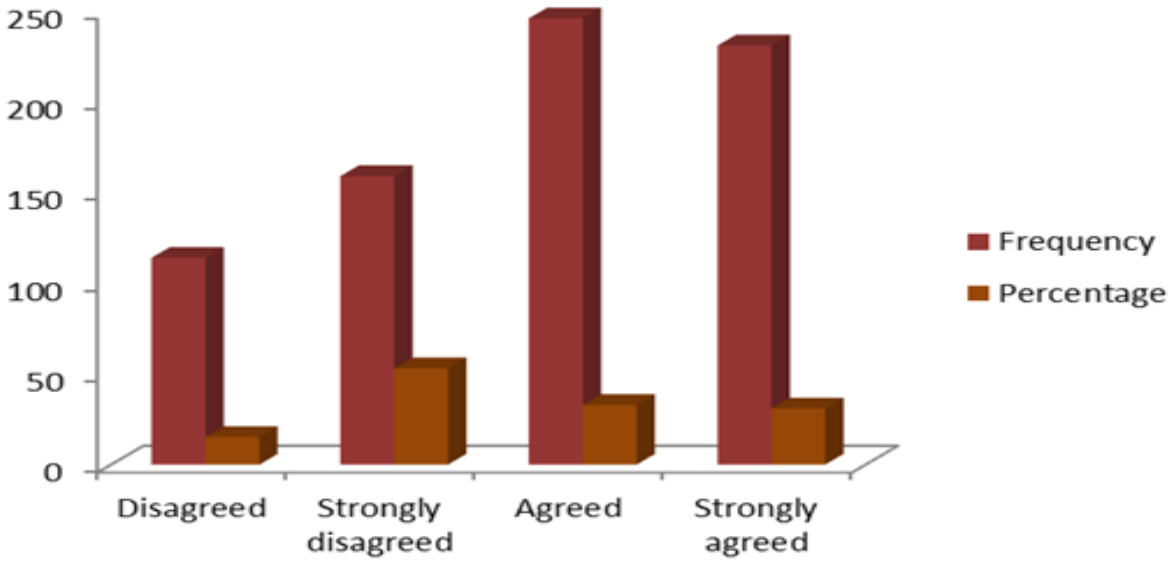

Figure-10. Response of respondents on if any member of their family has suffered any health disease resulting from flaring gas?

Gas flaring has been reported to contribute to numerous health diseases among residents in the Niger Delta area. To further established this fact, field analysis as revealed above showed that 114(15.2%) of the respondents disagreed that none of their family members have suffered any ill health related to gas flaring; 159(21.2%) strongly disagreed that their family members have suffered gas flaring health related illness. Moreover, 246(32.8%) of the sample respondents confirmed that one or two of their family members have been ill resulting from the flared gases in their locality. Furthermore, 231(30.8%) of the respondents strongly affirmed that their family members have suffered from gas flaring related illness. The respondents observed response further corroborated the assertion by Ukala (2011); Ndinwa and Akpafun (2012) in their separate studies that life expectancy resulting from gas flaring and other environmental issues in the Niger Delta is markedly lower in comparison to other parts of Nigeria and the average age of death in the region stands at about 40 years.

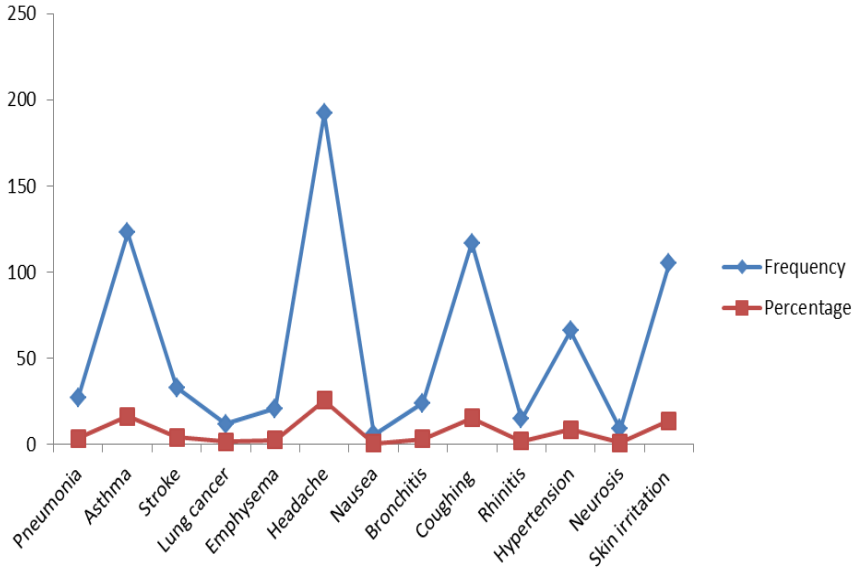

Figure-11. Response of respondents on what type of disease their family member has suffered.

Health diseases such as asthma, bronchitis, cancer and skin diseases among patients residing close to flaring site have been reported to directly correlate to gas flaring by Ogunfiditimi (2005). Studies from other parts of the world have as well linked health issues such as skin disorder, heat irritation, sunstroke and heat exhaustion to gas flaring (Luginaah *et al.*, 2002; Cutchin *et al.*, 2008). Information displayed in Figure 11 concerning respondents' opinion on the kind of health disease, them or any member of their family have suffered resulting from flaring of gas in the communities revealed that 27(3.6%) of the respondents affirmed that either themselves or family member have suffered pneumonia, 123(16.4%) of the respondents claimed to have suffered asthma, 33(4.4%) of the sampled respondents affirmed to have suffered stroke, 12(1.6%) attested that their family member have suffered lung cancer resulting from exposure to gas flaring sites, 21(2.8%) of the respondents claimed that members of their family has suffered emphysema, 192(25.6%) attested that their family members have been a victim of headache, 6(0.8%) confirmed to be victim of nausea, 24(3.2%) acclaimed that their family members have suffered bronchitis, 117(15.6%) of the respondents opted for cough as the illness suffered by their family members, 15(2%) attested that there have been reported cases of rhinitis among their family members, 66(8.8%) of the respondents identified hypertension as the illness their family members have suffered, 9(1.2) of the sample households claimed neurosis as the illness reportedly suffered by their family members resulting from the exposure to gas flaring in the communities whereas 105(14%) confirmed that there has been reported cases of skin irritation among family members. This implies that none of the sampled household respondents opted out from any of the health diseases; they all affirmed to have either suffered or have family member who have suffered from one health disease or the other. This finding affirms the reported finding of Akuirene *et al.* (2019) that there is a potential linear relationship between acid rain from gas faring communities with diabetes and cardiorespiratory diseases. It also corroborated the report by Opafunso (2005) who established 87% and 78% of observed health related environmental impact of gas flaring in Delta and Rivers States respectively. The official report of FOE (Friends of the Earth) (2004) indicated that gases flared into the environment of the oil producing communities in Nigeria contain widely-recognized toxins which pollute the air and induces serious respiratory ailment such as asthma, inflammation and bronchitis.

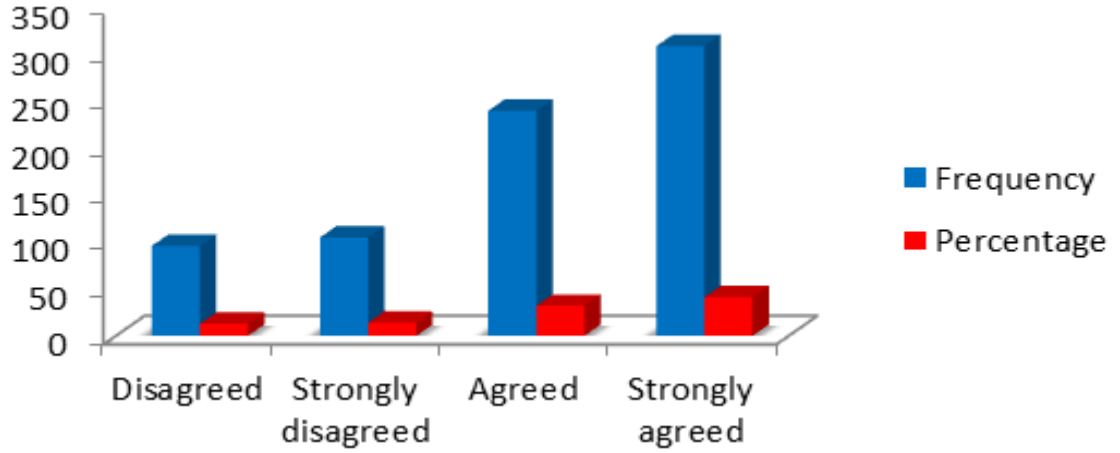

Figure-12. Response of respondents on if gas flaring affects the vegetation and agricultural activities in the communities?.

The natural environment of the Niger Delta area is mainly used for agriculture which sustains the local populace by means of farming and fishing. The harvests are sold both at the local and national marketplaces. It is documented and widely agreed upon that flaring of natural gas releases toxins and chemicals into the atmosphere, which by means of acid rains percolate into the soil and eventually absorbed to the rooted fruits and vegetables (Ukegbu and Okeke, 1987). A critical review of the analysed questionnaire indicated that 96(12.8%) of the respondents do not belief, flaring of natural gas has a direct impact on the vegetation and agricultural activities of the indigenes in the communities, 105(14%) were strongly in disagreement with the option in the questionnaire that gas flaring does impact negatively on vegetation and farm land. Contrary to some of the response of the respondents; a higher percentage of 240(32%) and 309(41.2%) of the household respondents were in various degree of affirmation confirming that gas flaring has a devastating effect on vegetation and agricultural activities in the study area. It can be deduced from the finding that a higher percentage of household respondents affirmed that gas flaring has negative impact on the vegetation and agricultural land of the communities. Opafunso (2005) in his study reported that gas flaring on agriculture is more pronounced in Delta and Rivers States with 78% of the respondents in each state confirming high incident of disturbance.

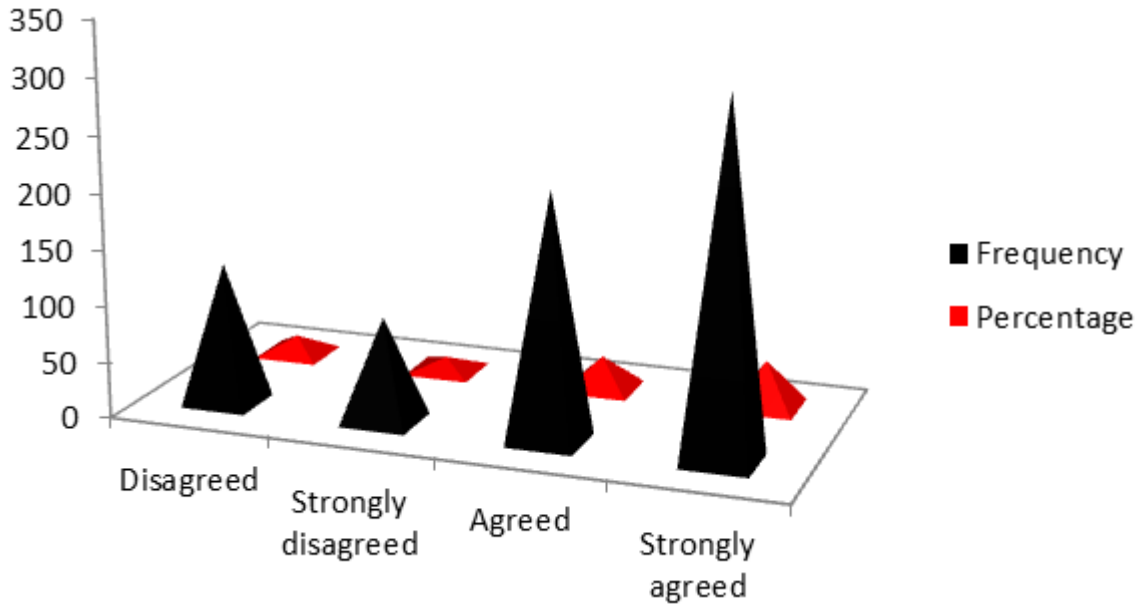

Figure-13. Response of respondents on if gas flaring plays a role in reducing the quality of farm produce in their farms.

Abdulkareem (2006) revealed in his research that flaring has adversely affected crops and agricultural farmlands in most oil producing communities in Niger Delta. Acid rain caused by gas flaring has been implicated in altering the vegetation of the area by replacing the local vegetation with stubborn elephant grasses (*Penisetum purpureum*), a grass plant that thrives in very harsh environment. Result derived from the analysis as shown in Figure 13 revealed that 126(16.8%) of the sampled respondents disagreed that gas flaring plays a major role in the quality of reported farm produces in their communities; 93(12.4%) of the respondents strongly disagreed with the option in the questionnaire whereas over 70.8% (29.2% for agreed and 41.6% for strongly agreed) of the household respondents affirmed that flared gases contribute to the reduction in quality of farm produce in the communities. The finding is in uniformity with the report by Akpojwi and Akumagha (2008) that cassava tubers have been observed to decrease in length and in weight with increasing proximity to flare sites. It also affirm the study by Opafunso (2005) that fruit trees around flare sites grew well but did not flower and therefore did not produce fruits. Ukegbu and Okeke (1987) reported that gas flaring destroys seeds, rooted vegetables and fruits in oil producing communities.

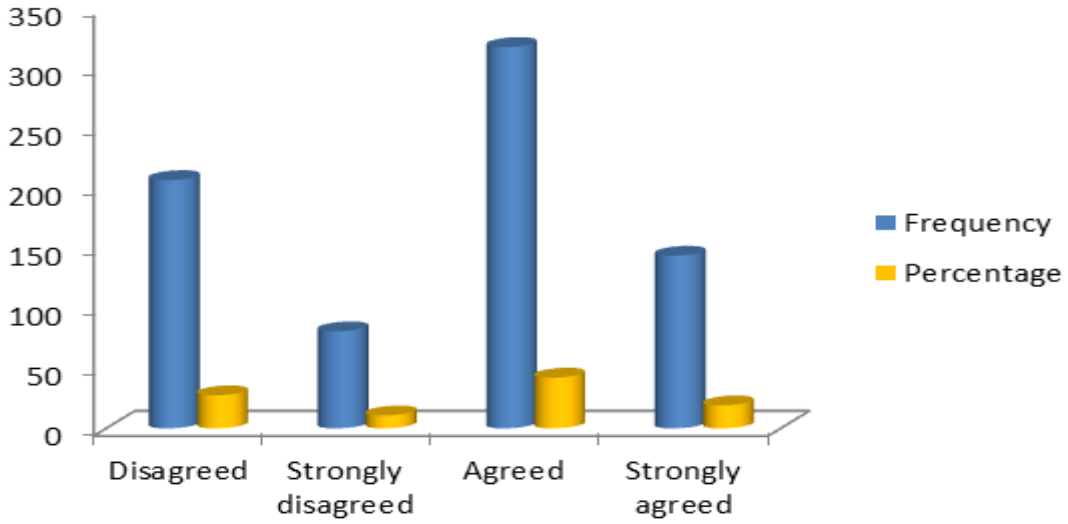

Figure-14. Response of respondents on if gas flaring could cause farm household food insecurity.

One of the recent terrifying menace endangering human existence, driven from gas flaring is the potentiality of a rapid warming of the planet earth impelled by the agglomeration of heat retaining gases on the atmosphere which has led to a phenomenon in recent time called green house effects. This phenomenon has contributed in altering the climatic condition of the atmosphere which in turn has impact negatively on vegetations and farmlands (Ndinwa and Akpafun, 2012). Typical flare sites in the oil fields are located at ground level and surrounded by thick vegetation, farmlands and huts which are 15-35 metres away from the flare (Ilori, 1999; Oghenejobh, 2005). The radiation from the exothermic combustion process is a function of the flame temperature and the geometrical design of the flare stack. In some cases the surrounding soil is scorched, vegetation and farmlands are parched and villagers often complain of internal heat due to the cumulative effects of long exposure to radiant heat (Ilori, 1999; Oghenejobh, 2005). Indicated in Figure 14 above, is respondents' perceived impact of gas flaring on household food insecurity. It was revealed that 207(27.6%) of the respondents disagreed that gas flaring could cause farm household food insecurity in the communities. Also, another 81(10.8%) of the sampled respondents were of strong disagreement with the questionnaire whereas 318(42.4%) of them attested that gas flaring could cause food insecurity to farm households. More so, 144(19.2%) of the respondents strongly agreed to gas flaring been a cause of food insecurity in their various communities. This finding corroborated and maintained the findings in the reports by Ogunfiditimi (2005); Ajugwo (2013); Oseh *et al.* (2015).

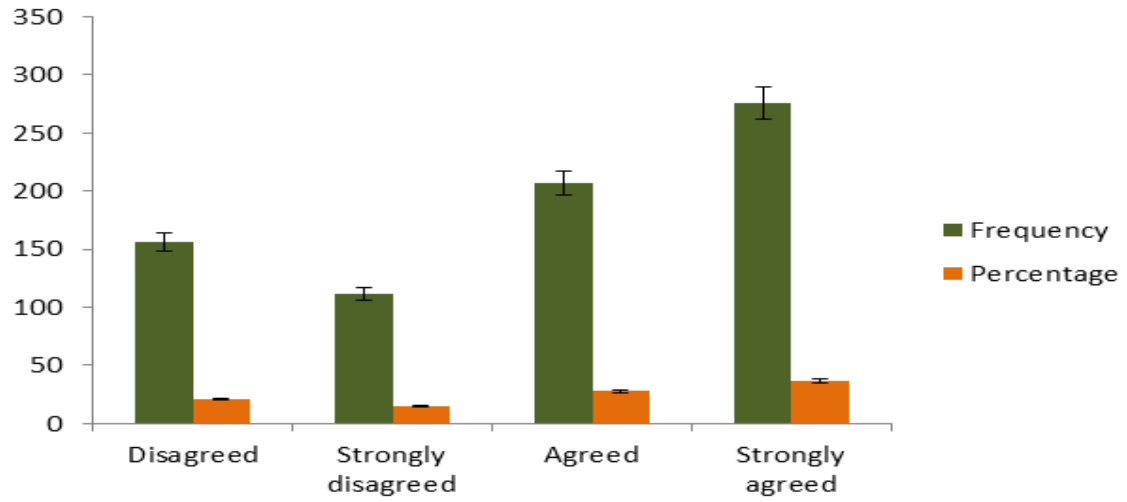

Figure-15. Response of respondents on if the impact of gas flaring discourages expansion of farm size in the community.

Graphical presentation of the response of respondents pertaining gas flaring and expansion of farm size revealed that 156(20.8%) from the sampled respondents acclaimed to be in disagreement with the question as stated in the questionnaire that gas flaring discourages expansion of farm size in the community; 111(14.8%) of the respondents strongly disagreed with the question whereas 207(27.6%) of the sample concurred by agreeing with the questionnaire that indeed the impact of gas flaring do discourage farmer in expanding their farm sizes. Also, additional 276(36.8%) of the respondents were strongly in agreement with the question as stated in the questionnaire. Looking at the response of the sampled household respondents, it was confirmed that 64.4% from the overall sample wholeheartedly affirmed that the impact of gas flaring discourages the expansion of farm size. This critical revelation is not surprising as 70.8% of the respondents have already established earlier that gas flaring reduces the quality of farm produce in the communities.

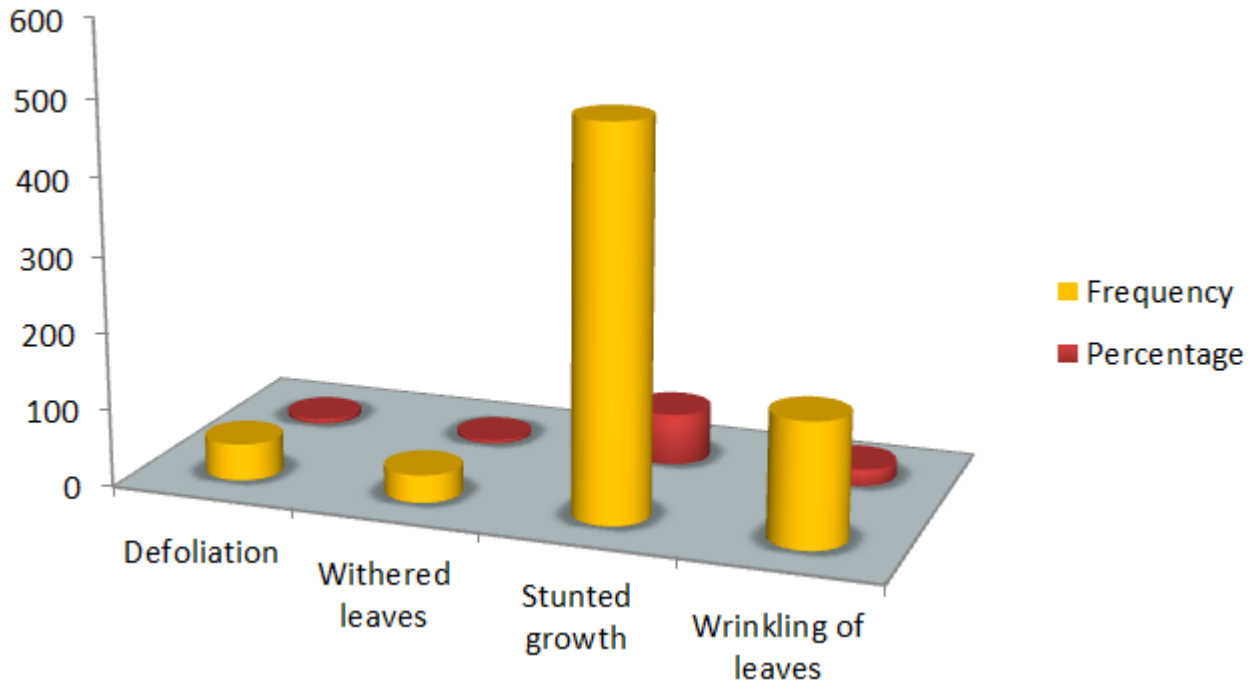

Figure-16. Response of respondents on how they perceived the effects of gas flaring on their farms.

Result from data analysis as shown in the above figure revealed that 48(6.4%) of the respondents confirmed that gas flaring lead to defoliation of crops in their farms; 36(4.8%) of the sample conveniently attested that the effect of gas flaring on their farms are felt through withered leaves of crops. 504(67.2%) acclaimed that gas flaring

causes stunted growth in crops in their farms; whereas another 162(21.6%) of the sampled respondents affirmed that their farm experiences wrinkling of crop leaves as a result of the impact of gas flaring sites. The implication of this finding is in line with that reported by Orimoogunje *et al.* (2010) whose research established that crop yield was reduced to the barest minimum as farmland could no longer sustain cultivation after several years of environmental damage from flares and fumes released affect plant growth thus, leading to low farm yield.

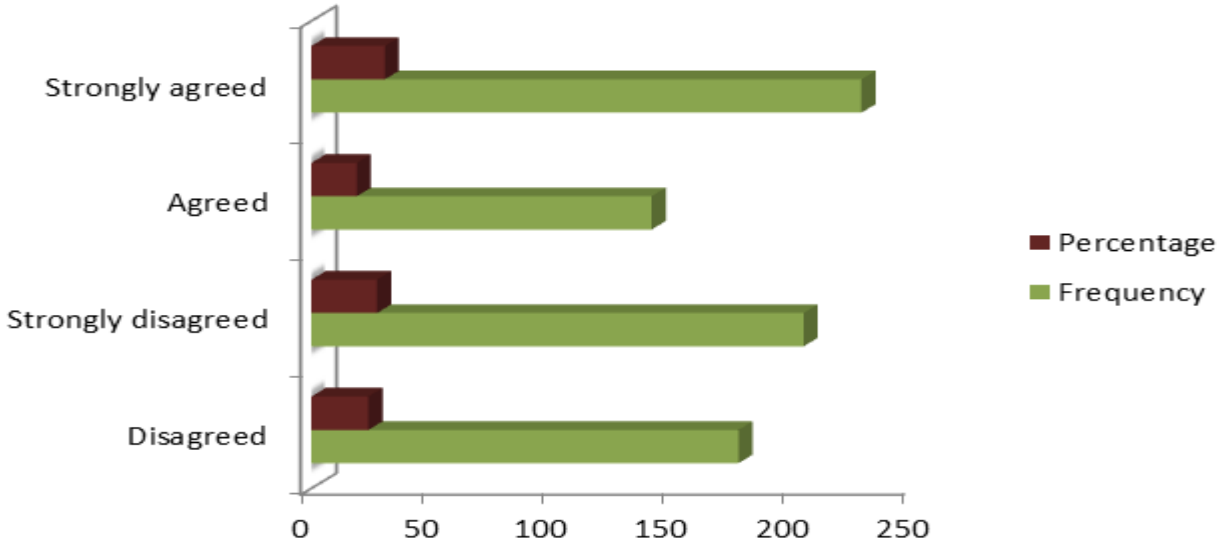

Figure-17. Response of respondents on if government and oil companies are making efforts to stop gas flaring in the community?

177 (23.6%) of the respondents to the questionnaire disagreed that the Nigerian government along with the petroleum organizations has a credible plan established to eliminate flaring of natural gas, 204(27.2%) were also strongly in disagreement to the question whereas 141(18.8%) of the respondents were in agreement that the Nigeria government are working towards eradicating gas flaring and the other 228(30.4%) of the sampled respondents were strongly in agreement with the opinion that government in conjunction with the petroleum companies have plans established to stop gas flaring. The finding affirmed the report by Ugonna (2014) who rightly asserted that the Nigerian government has not enforced environmental regulations effectively because of the overlapping and conflicting jurisdiction of separate governmental agencies governing petroleum and the environment. It also maintains the findings of Elenwo and Akankali (2014).

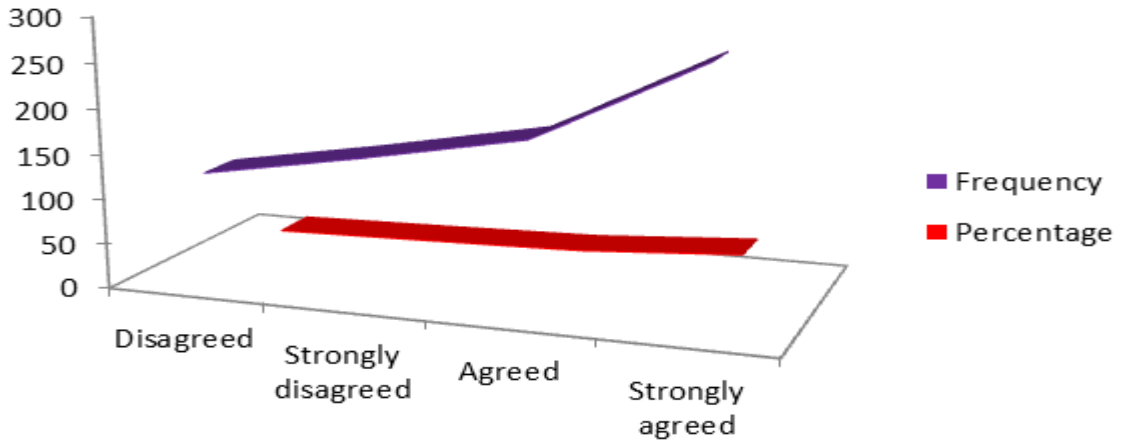

Figure-18. Response of respondents on if the laws regulating oil production in Nigeria should be reviewed?.

A part of the questionnaire which sought to ascertain the opinion of respondents towards reviewing laws regulating oil production in Nigeria indicated that 126(16.8%) of the respondents were in disagreement on the

review of the various laws regulating oil production in Nigeria; 156(20.8%) strongly disagreed with the option in the questionnaire. 189 (25.2%) of the sampled respondents agreed that established measures and unnecessary legislation be reviewed. Also, another 279(37.2%) of the respondents were strongly in agreement that the laws regulating oil exploration and exploitation in Nigeria be reviewed. The overall of 37.6% of the respondents who declined their consent in supporting the review of laws regulating oil production were observed to either be a staff of the oil companies or has a relation that works for the organization. This affirmation corroborated the finding of (Adewale and Mustapha, 2015).

4. SUSTAINABLE STRATEGY FOR THE UTILIZATION OF NATURAL GAS

The utilization of natural gas entails designing a workable strategy for harnessing the resources from the point of production to several other options that will encompass the economic and environmental benefits of mankind. The utilization of natural gas which is extracted during crude oil production involves converting the resources which are discriminately released into the Nigeria environment as waste into economic and environmental use. For a sustainable benefit and efficient natural gas utilization plan, this study grouped the options into three major strategies for consideration and implementation.

4.1. Sustainable and Flexible Management Plan

For Nigeria to witness rapid industrialization and economic development in utilizing the opportunity from gas production; there is need to restructure the management plan of gas infrastructure in the country. This can be achieved by incorporating a private- public- partnership plan that will allow for full divestment of the current gas pipeline operating companies. Private participation will give room for a healthy competition in this sector and decentralized the monopoly of the Nigerian government. The strategic management plan should incorporate some selected multinational companies as a joint venture to operate and manage the gas infrastructure. It should be modeled in line with the Nigerian Liquefied Natural Gas Company and exclude the Nigeria National Petroleum Corporation from the join consortium.

4.2. Transparent Governance and Sustainable Regulatory System

For a long term strategy that will enhance economic development of gas infrastructure, there is need to collapse the overlapping and conflicting agencies that are empowered to supervise petroleum production activities in the country. A single regulatory agency with a gas act be established with the right modalities for investors to participate in the sector.

4.3. Sustainable Financing Pattern

There is need to establish an Energy Bank in Nigeria with the sole responsibility to interface with other international finance organizations on long term low interest loans for gas infrastructure in Nigeria. This is necessary because gas infrastructure is capital intensive and requires huge investment.

With the effective implementation of the above itemized strategies for natural gas utilization, huge economic and social benefits will be derived by the local communities as well as better environment for agricultural activities in the form of fishing and farming will be achieved.

5. CONCLUSION

This study investigated the perceived environmental impact of gas flaring and the resulting health challenges on residents in the communities studied. The paper has objectively and critically analysed the data collected from the field. The decades of continuous gas flaring in the communities has resulted to countless numbers of environmental and health issues on the local people as revealed from the analysed response of the sampled

household respondents. It was revealed that the environmental conditions of the communities fell below expectation due to damages caused to the environment as a result of continuous activities of gas flaring. A major outcome revealed by the findings of this study is that gas flaring possesses danger to the environment and health of the local people of the communities if urgent measures are not taken to abruptly halt the activity. The study conclusively recommends sustainable strategy for the utilization of natural gas through a sustainable and flexible management plan, transparent governance, sustainable regulatory structure and financing structure with better incentives.

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