IMPACT OF GAS FLARING ON BIODIVERSITY IN NIGER DELTA, NIGERIA

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Environmental pollution arising from gas flaring has impacted the biodiversity of Niger Delta. The main stresses relative to oil and gas operations arise from gas flaring, leakages of crude oil, and the escape of other chemicals used in production processes. This paper review highlighted the impacts of gas flaring on the biodiversity and the Niger delta environment. The negative effects of flaring on the flora and fauna of ecosystems have also been documented. The extinction of biodiversity, destruction and contamination of soil, and atmospheric pollution associated with gas flaring have not only deteriorated the environment, but also brought social impacts to the inhabitants of such area. Gas flaring has impoverished the communities where it is practiced, with attendant environmental, economic and health challenges. These difficulties faced by local communities and loss/threat to biodiversity from gas flares are sufficient justification for ending gas flaring practice. Fines by defaulting oil companies should be high enough to deter them while the gas can be processed and produced into cooking/domestic gas.

Key words: Niger Delta, gas flaring, biodiversity, energy, global climate change.

INTRODUCTION

Gas flaring is one of the most challenging energy and global environmental problems facing the world today (Ismail and Umukoro, 2012). The flaring involves the controlled burning of natural gas that is associated with crude oil in the course of routine oil and gas production operations from gas fields (Kahforoshan *et al.*, 2008).

The process is a multi-billion dollar waste, a local environmental catastrophe and a global energy and environmental problem which has persisted for decades particularly in the Niger-Delta region of Nigeria (Ismail and Umukoro, 2012). Gas flaring has negative effects on the immediate environment, particularly on the diversity of plants and wildlife fauna.

Biological diversity (biodiversity) is a measure of variation of life forms. It includes diversity within species (genetic diversity), between species (species diversity) and of ecosystems (Figure 1).

Biodiversity plays an important role in

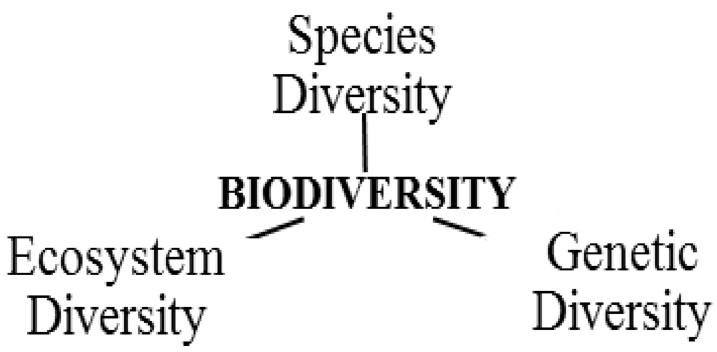

Figure 1. Three universally recognize concept of biodiversity.

maintaining ecosystem productivity, stability, sustainability and other ecosystem services that are essential for human existence (Pereira *et al.,* 2012; Vittoz *et al.,* 2013). Specifically, biodiversity is beneficial for air/water purification, cultural conservation, and reduction of the harmful natural effects in such an environment. Reduction or loss of biodiversity has become a serious environmental issue in many countries including Nigeria. Many factors ranging from habit fragmentation, loss/degradation due to oil exploration, air and water pollution, over-exploitation and unsustainable use of natural resources (gas flaring) has contribute to the loss of biodiversity (Vittoz *et al.,* 2013).

Gas flaring together with over exploitation of natural resources has been incriminated in biodiversity loss and environmental pollutions in the Niger Delta. Studies and reports implicating different oil and gas exploration and production activities in the Niger Delta to overall biodiversity depletion abound (Ohimain, 2003; Ohimain, 2004; Agbagwa, 2008; Emoyan *et al*., 2008; Agbagwa and Akpokodje, 2010; Agbagwa and Ekeke, 2011; Oseh *et al.,* 2015).

However, global climate change as a result of oil and gas exploration is often considered as one of the major factors causing biodiversity loss (Dawson *et al.,* 2011). Gas flaring is wastage of valuable resources much needed for domestic and industrial use which in-turn help in economic development (Malumfashi, 2007). Empirical investigations into gas flaring activities in Niger Delta vis-à-vis their impacts on this ecologically and biologically diverse but fragile region are lacking.

The Nigeria experience

Nigeria flares 17.2 billion m^3 of natural gas per year in conjunction with the exploration of crude oil in the Niger Delta equal to approximately one quarter of the current power consumption of the African continent (Ajugwo, 2013). The Niger Delta region known for hydrocarbon exploration and production covering an approximate area of 50,000 km^2 is located between Latitudes 4°0'0"N and 8°0'0"N, and Longitudes 5°0'0"E and 7°0'0"E of the equator (ERML, 1997).

The region is a citadel of gas flaring with little attention on the lethal effects of flaring on its biodiversity and ecosystem. However, Niger Delta is globally recognized as the fourth richest/largest biodiversity hot-spot in the world and extends over four ecological zones namely; coastal barrier islands, brackish/saline water mangrove swamps, freshwater swamp forests (permanent and seasonal), and dry upper plain lowland rain forests (World Bank, 1995).

The hydrological boundaries between these ecological zones are imperceptible; so also are some of the forest zones particularly the fringing of the mangrove forest and freshwater swamp forest. It is also the largest wetland in Africa with rich biological diversity (Mmom and Arokoyu, 2010). Its mangrove forest is the largest in Africa (11,134 km^2) and the fourth largest in the world (Spalding *et al.,* 1997). Across the different ecological zones, the Niger Delta is home to diverse assemblages of not evaluated, data deficient, least concern, near threatened, vulnerable, endangered and critically endangered wildlife species.

Agbagwa and Ndukwu (2014) have noted that some of the threatened species mostly by oil and gas exploration, which have been previously reported in International Union for Conservation of Nature (IUCN) red list are the pygmy hippopotamus (*Choeropsis liberiensis*), manatees (*Trichechus senegalensis*), maritime hippopotamus (*Hippopotamus amphibious*), Nile crocodile (*Crocodylus niloticus*), slender nosed crocodile (*Crocodylus cataphractus*) and dwarf crocodile (*Osteolaemus tetraspis*) ((World Bank, 1995).

Ohimain (2003) also reported that such wildlife species as the Cape clawless otter (*Aonyx capensis*), African palm nut vulture (*Gypohierax angolensis*), fire-footed squirrel (*Funisciurus pyrropus*), Hammerkop (*Scopus umbretta*), African fish eagle (*Haliaeetus vocifer*), Sclater's guenon (*Cercopithecus sclateri*), sitatunga (*Tragelaphus spekei*), white throated monkey (*Cercopithecus erythrogaster*), which occurred in the area required conservation. With continuous gas flaring activities, these fauna diversities which abound in this region will be extinct.

Table 1 indicates a 15 years gas flaring volumes and percentages in Nigeria. It shows

Table 1. 15 year's gas flaring volumes for Nigeria (million cubic metres).

Year	Gas produced	Gas flared	% of gas flared
1996	35450.00	26590.00	75.01
1997	37150.00	24234.00	65.23
1998	37039.00	23632.00	63.80
1999	43636.00	22362.00	51.25
2000	42732.00	24255.00	56.76
2001	52453.00	26759.00	51.02
2002	48192.45	24835.58	51.53
2003	51766.03	23943.03	46.25
2004	58963.61	25090.91	42.55
2005	59284.97	23002.71	38.80
2006	82036.86	28584.39	34.84
2007	84707.34	27307.13	32.24
2008	80603.61	21811.00	27.06
2009	64882.86	17987.59	27.72
2010	67757.65	16468.18	24.30

Source: Adole (2011).

that more gases were flared in the mid- and late-90s compared to recent past. Given the chart in Figure 2, Nigeria ranked second after Russia, followed by Iran among other countries with worst gas flaring.

Gas flaring associated with oil production

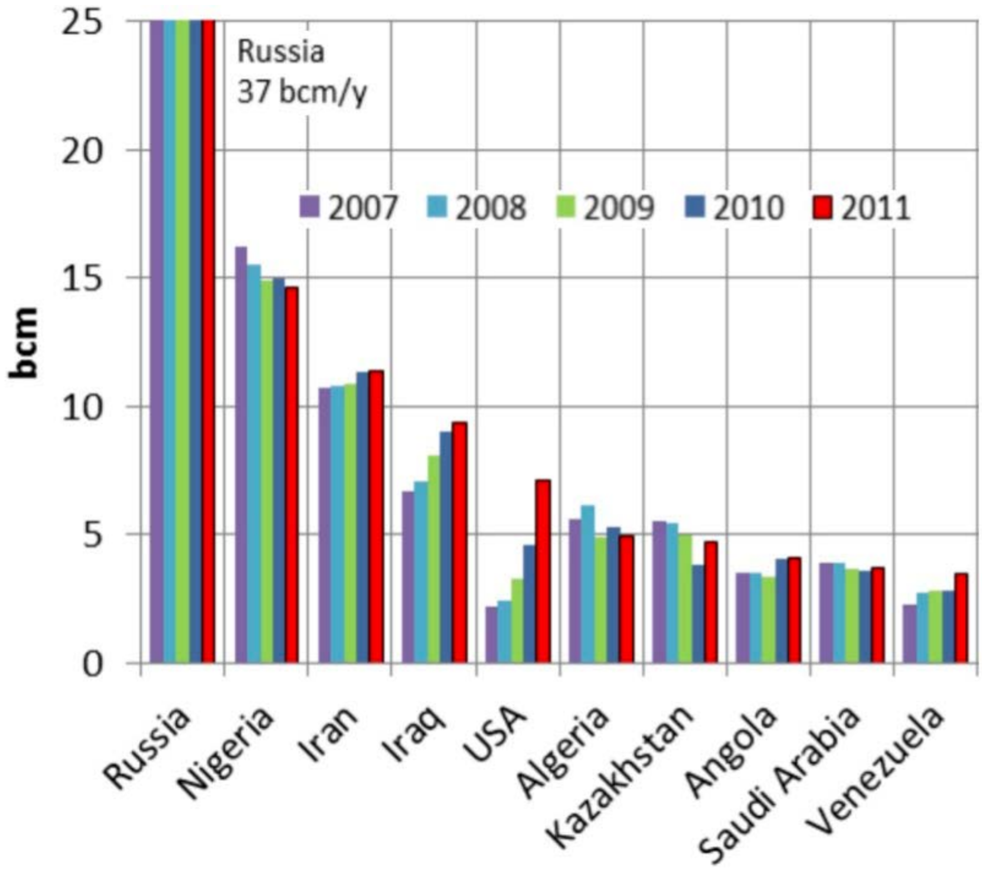

Figure 2. The world worst gas flaring countries in bcm per year.

in the Niger Delta is very unfriendly to natural ecosystems and biodiversity. Gas flares typically contain more than 250 toxins. Perhaps more important is the finding in a study of the impact of gas flaring on the environment, which revealed that there was almost 100% loss in yield of all crops cultivated about 200 metres away from the Izombe station, 45% loss of those about 600 metres away, and around 10% loss in yield for crops one kilometre away from the flare (Okezie and Okeke, 1987).

In 2004, the Nigerian Liquefied Natural Gas (NLNG) pipeline traversing the Kala-Akama and Okrika mangrove swamps (in the Niger Delta) leaked and caught fire, and burned uncontrollably for several days causing death of local plants and animals inhabiting the affected area (Zabbey, 2004). It must be stressed that incidents such as this one can result in the elimination of whole populations of endangered species which have restricted distribution.

Zabbey (2004) observed footprints of hippopotami during the construction of the NLNG gas plant in Bonny. These giant animals which once inhabit the Finima area where the NLNG plant complex now occupies, have vanished completely since the beginning of oil production. Whether the rare Finima hippo population all died out or embarked on forced migration to some relatively 'safe' and undisturbed area remains unclear. In any case, it is well-known that wildlife caused to migrate by anthropogenic disturbances are prone to suffering ecological catastrophes.

Impact of gas flaring on biodiversity

Gas flaring is a menace which has contributes negatively to climate change with serious environmental implications for both Nigeria, and the rest of the world in term of its biodiversity.

Impact on climate change

Gas flaring contributes to climate change by emission of CO_2, the main greenhouse gas contributing 9 to 26% (~ 400 ppm) unlike CH_4 which contributes 4 to 9% (~ 1.8 ppm) (Ajugwo, 2013). Global climate change is occurring at an unprecedented rate today mainly due to an increased emission of greenhouse gases such as atmospheric CO_2 (IPCC, 2007).

Since climate is the fundamental factor that determines organism life-stages such as plant germination and flowering, it can severely alter habitats and food sources for animals, and ultimately, could have significant impacts on biodiversity of species and ecosystems around the world. Global climate change affects our physical and biological environments, thus, it influences biodiversity both directly and indirectly through its interaction with other environmental factors (Ogawa-Onishiand and Berry, 2013).

Living organisms and ecosystems need to adapt to climate change through shifting habitats, changing life cycles, or developing new physical traits (Bellard *et al.,* 2012; Mantyka-Pringle *et al.,* 2012). Documented effects of climate change on biodiversity and ecosystems mainly include:

Species extinction and biodiversity loss: Climate change has led to a sharp increase in the rate of species extinction (Ogawa-Onishi and Berry, 2013; Kannan and James, 2009). The Millennium Ecosystem Assessment (2005) highlighted a substantial loss of biodiversity on earth, with some 10 to 30% of mammal, bird and amphibian species threatened with extinction.

Phenology changes: Changes in phenology (that is, time of natural events such as reproduction in certain species or the length of growing season) have been documented in many species including both plants and animals (Mantyka-Pringle *et al.,* 2012). For example, higher temperatures have led to earlier flowering in certain plant species (Sherry *et al.,* 2007), and an increase in the number of eggs laid by the spruce budworm (Ito and Ighere, 2017).

Shifts in geographic range: Climate change forces organisms to respond by adapting or migrating, and results in geographic range changes for species (Vittoz *et al.,* 2013). As an example, the northern boundaries moved further north for some plants and animals as temperature increased (Parmesan and Yohe, 2003).

Ecosystem functioning and service changes: Ecosystem production and stability are closely linked to biodiversity. Loss of biodiversity due to climate and land use change may lead to increased greenhouse gas emissions, further exacerbating climate change (Vittoz *et al.,* 2013). In contrast, increases in biodiversity could enhance ecosystem productivity and carbon sequestration, and may reduce the negative effects of climate change.

Impact on agriculture

The flares associated with gas flaring give rise to atmospheric contaminants. These include oxides of Nitrogen, Carbon and Sulphur (NO_2, CO_2, CO, SO_2), particulate matter, hydrocarbons and ash, photochemical oxidants, and hydrogen sulphide (H_2S) (Obioh, 1999). These contaminants acidify the soil, hence depleting soil nutrient. Previous studies have shown that the nutritional values of crops within such vicinity are reduced (Imevbore and Adeyemi, 1981). In most cases, there is no vegetation in the areas surrounding the flare due partly to the tremendous heat that is produced and acidic nature of soil pH (Ubani and Onyejekwe, 2013). The effects of the changes in temperature on crops included stunted growth, scotched plants and such other effects as withered young crops (Orimoogunje *et al.*, 2010). He concluded that the soils of the study area are fast losing their fertility and capacity for sustainable agriculture due to the acidification of the soils by the various pollutants associated with gas flaring in the area.

Impact on freshwater acidification/acid rain

Freshwater pH is predicted to decrease by 0·3 to 0·5 pH units by 2100, changes that are 100 times faster than those seen over the last 100 000 years (Haughan *et al.,* 2006). The reduction in carbonate ions is likely to make skeletal construction and maintenance more costly for organisms with calcareous exoskeletons (molluscs, corals and plankton, such as coccolithophores) with potential impacts on fish where calcifying organisms are major components of the diet. It is important to note that gas flaring in oil rigs and wells contribute significantly to greenhouse gases in our atmosphere which in-turn reduce the pH of freshwater bodies (Ayoola, 2011). While the predicted pH change is almost certain, the ecological and biodiversity effects are largely unknown and difficult to evaluate at the appropriate spatial scale (Haughan *et al.,* 2006). Gas flaring activities have been incriminated as the main cause of acid rains (Medilinkz, 2010). Primarily, acid rain is caused by emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO) combined with atmospheric moisture to form sulfuric acid and nitric acid respectively. Acid rain damages vegetation and acidifies lakes and streams thereby leading to high mortality of aquatic life. Prior to washing down by rain, SO_2 and NO_2 gases and their particulate matter derivatives, sulfates and nitrates, contribute to visibility degradation and harm public health.

Impact on human health

Adverse effects: Gas flaring adversely affect human health by the inhalation of hazardous air pollutants emitted during incomplete combustion of gases flared. Adversely, these pollutants impair human health by causing cancer, neurological, reproductive and developmental defects (Ajugwo, 2013). Deformities in children, lung damage and skin problems have also been reported (Ovuakporaye *et al.,* 2012).

Haematological effects: Incomplete combustion of hydrocarbons has also been identified to impair haematological parameters. These changes affect blood and blood-forming cells negatively (Ajugwo, 2013) leading to anaemia (aplastic), pancytopenia and leukemia (Kindzierski 2000).

Increased fire risks

One of the most serious potential consequences of gas flaring is increased fire risk during drought period in topical Africa. Increased frequency of fire may result in substantial changes in community composition and structure, as well as loss of biodiversity (Ausden, 2007). Novel means of predicting and managing fires are needed (Davies *et al*., 2006), together with a framework for assessing the long-term impacts of fire and fire management on wild species.

CONCLUSION

Gas flaring and its impacts globally on biodiversity have continued for decades ever since the exploration of crude oil and natural gas began. With the continuous increase in demand for energy from fossil fuels like hydrocarbons in the next few decades, different researchers need to come together harnessing research works of decades in the oil and gas industry, academia and governments to determine ways of reducing gas flaring drastically in order to also prevent biodiversity loss through flaring,

RECOMMENDATION/SUGGESTIONS

The difficulties faced by local communities from gas flares are sufficient justification for ending gas flaring practice. Government should as a matter of urgency, make stringent laws and take drastic legislative action against defaulting companies not just by payment of fines. Fines for defaulting companies should be so exorbitant so as to deter them. Furthermore, the gas can be processed and produced into cooking/domestic gas. Environmentalists and human right activists should continue in their quest to end this menace.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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