# Air pollution due to gas flaring in the Niger Delta: A review of current state of knowledge.

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# Contents

## Executive summary

Today, about 8 billion cubic meters of gas is flared every year at different oil production sites in Nigeria. It is well established that gas flaring produces air pollutants such as particulate matter (PM), ozone ($O_3$), nitrogen oxides (NOx), volatile organic compounds (VOC), sulphur dioxide ($SO_2$) and certain metals. Available evidence suggests that increases in the concentrations of air pollutants as a result of gas flaring in the Niger Delta have contributed to significant impacts on the health of local people, on crop production and the nutritional quality of crops harvested, and on other environmental aspects and physical infrastructure of this region. Although there are limits to the extent of research conducted so far in the Niger Delta, available evidence from the various studies reviewed in this report already indicates that gas flaring and associated air pollution can lead to increased prevalence of respiratory diseases and other related health problems. Furthermore, air pollution from gas flares can significantly affect natural vegetation and hence biodiversity. In addition, the deposition of acid precipitation and acidic particles on different ecosystems has impacted on aquatic life and soils micro-organism communities. The emissions of $CO_2$, $CH_4$ and of ozone precursor gases such as NOx and VOC from gas flares have also contributed to human-induced climate change. The localised and inhomogeneous spatial distribution of air pollutants from gas flares can exert significant impact on climatic conditions at a local scale. There is an urgent need for research on all these aspects to be expanded within the region, and for actions to be taken to reduce emissions and associated impacts.

## 2. Introduction

Approximately 8 billion cubic meters of gas is flared every year at different oil production sites in Nigeria (NOAA/GGFR satellite data). The flaring of natural gas from different oil production sites produces air pollutants such as particulate matter (PM), ozone ($O_3$), nitrogen oxides (NOx), volatile organic compounds (VOC), sulphur dioxide ($SO_2$) and metals (Anejionu et al., 2015). These pollutants have been shown to have negative impacts on human health. For example, exposure to high doses of air pollutants has been linked to respiratory problems, cerebrovascular disease, ischaemic heart disease, lung cancer and chronic obstructive pulmonary disease (Pope et al., 1995; Pope et al., 2002; Burnett et al., 2014; Ghude et al., 2016).

Furthermore, it is well established that higher concentration of air pollutants could have detrimental effects on crops (e.g., Heck et al., 1983; Dung et al., 2008; De Bock et al., 2011). For instance, Dung et al. (2008) found that air pollutants stemming from gas flaring affect crop productivity as well as nutritional quality in the Niger Delta. In addition, air pollution also affects natural vegetation, which may reduce biodiversity (Lovett et al., 2009; Ugochukwu and Ertel 2008).

As a result of the inhomogeneous spatial distributions of air pollutants, changes in their emissions and concentration levels can have significant local climate impacts (Chen et al., 2007; Shindell et al., 2012). Further to this, gas flaring contributes to climate change by releasing millions of tons of $CO_2$ and Black Carbon (BC) in to the atmosphere (World Bank, 2017; Okeagu et al. 2006). Also, gas flaring releases metals and other pollutants into the environment that have been shown to cause a variety of environmental problems. Other associated environmental problems apart from those mentioned above include wet and dry deposition of acid and acidic particles that lead to corrosion of metal roofs, harm to aquatic species and soil micro-organisms (see Anejionu et al., 2015).

In this brief review, we summarise the available evidence from the peer-reviewed scientific literature that gas flaring and associated air pollution poses elevated health and environmental risks to the inhabitants of the Niger Delta. The report is structured as follows: Sections 2, 3, 4

and 5 describe the adverse effect of air pollution on health, plants, climate and other associated environmental impacts. Concluding remarks are presented in Section 6.

## 3. Adverse effects of air pollutants on health

The emissions of air pollutants as by-products of gas flaring in the Niger Delta are of great concern as it has been demonstrated from exposure-response studies in different parts of the world that exposure to elevated air pollutants concentrations can have detrimental impact on human health (e.g., Pope et al., 1995; Pope et al., 2002). Research has shown that high concentrations of fine particulates ($PM_{2.5}$) causes respiratory problems, cerebrovascular disease, ischaemic heart disease and lung cancer (Burnett et al., 2014). Also, chronic obstructive pulmonary disease has been linked to exposure to elevated concentrations of ozone (Ghude et al., 2016).

It is important to note that most of the comprehensive studies conducted in different parts of the world have entailed monitoring air pollution levels and the health of inhabitants over considerable periods of time (usually several years). Similar large-scale comprehensive research on the impact of air pollution on health has not yet been conducted in the Niger Delta. Nonetheless, a number of shorter-term studies have been carried out in the Niger Delta (e.g. see Gobo et al., 2009; Olawoyin et al., 2012). For example, Gobo et al., 2009 investigated the relationship between air pollutants from gas flaring and associated human health problems. They found higher occurrence of respiratory diseases, eye/skin irritation in areas with long gas flaring history (Igwuruta/Umuechem) compared to areas with no gas flaring.

## 4. Impact of air pollution on plants

It is well established from field experiment that high levels of air pollutants can have negative effects on plants (Heck et al., 1983; Dung et al., 2008, De Bock et al., 2011). For example, the study of Dung et al., 2008 found that gas flaring and associated air pollutants in the Niger Delta resulted in crop development retardation for crops growing closer to the flaring point compared to those further away. Also, their results show that air pollutants from gas flaring can reduce the nutritional quality of crops harvested. In turn, these air pollution impact on crops mean that increasing food demand will be met by intensification on current land or expansion of arable land, resulting in land use changes and other related environmental problems (Chuwah et al., 2015). Furthermore, air pollutants from gas flaring can negatively affect natural vegetation,

thereby reducing biodiversity (Ugochukwu and Ertel, 2008) and contribute to global warming by reducing $CO_2$ uptake by plants (Sitch et al., 2007).

## 5. Impact of air pollution on local climate

Gas flaring contributes directly to global warming by acting as a source of $CO_2$ and $CH_4$ in to the atmosphere (Okeagu et al. 2006), which are two major greenhouse gases. Other air pollutants emitted from gas flares such as BC, or which are formed in the atmosphere from precursor gases such as NOx, CO, and VOC (ozone), also have a warming effect on the climate system. Studies in different parts of the world have shown that air pollution can have a significant impact on local climate. Due to the short residence time of air pollutants in the atmosphere, their spatial distributions are inhomogeneous, with higher concentrations mostly located near emission sources. This implies that changes in emissions of air pollutants can significantly affect local climate (Chen et al., 2007; Shindell et al., 2012) and in some cases regional climate through atmospheric teleconnections (Chuwah et al., 2016).

## 6. Other impact of air quality on the environment

The dry or wet deposition of nitrate and sulphate has been identified as a major problem to the inhabitants of the Niger Delta. Studies have shown that wet and dry deposition of acids and acidic particles in the Niger Delta has affected the ecosystem, impacting in particular on aquatic life and soil micro-organisms (see Ekpoh and Obia 2010 and other references therein). In addition, the deposition of acid has also been shown to be responsible for the rapid corrosion of metal sheeting (such as is used for roofs) and the deterioration of paint and stone. This has significantly reduced the durability of buildings, monuments and other physical infrastructure (Ekpoh and Obia, 2010). For example, Ekpoh and Obia, (2010) found direct links between gas flaring, associated acid deposition and zinc corrosion in some parts of the Niger Delta.

## 7. Conclusion

It is clear from the limited scientific literature available that air pollution emanating from gas flaring and its associated effects on health and environment is a cause for concern in the Niger Delta. In this short review, we present the current state of knowledge of the effects of gas flaring on air pollution and associated health and environmental impacts. The following conclusions can be drawn:

Results from the literature show that there are clear connections between gas flaring, air pollution and adverse effect on health, crop yield, biodiversity, soil etc. Different studies clearly

indicate that exposure to air pollutants (particulate matter, ozone, nitrogen oxides and sulphur dioxide) is a contributory factor for respiratory problems and other health problems.

Rising air pollution levels due to gas flaring have affected crop yield as well as nutritional quality of harvested crops. In addition, air pollutants from gas flaring can negatively affect natural vegetation thereby reducing biodiversity. Furthermore, wet and dry deposition of acids and acidic particles has affected the ecosystem, especially aquatic and soil systems, and damaged physical infrastructure.

The emission of $CO_2$ and $CH_4$ from gas flares contribute to global warming. The localised and inhomogeneous nature of air pollutants can exert significant impact on local climate and in some cases remote climate via atmospheric teleconnections.

So far, no large-scale comprehensive research studies have been carried out on the impact of air pollution coming from gas flaring on health in the Niger Delta. There is a need to increase research effort on understanding the association of gas flaring, air pollution and related health and environmental impacts in the Niger Delta.

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