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BASELINE ASSESSMENT OF HYDROCARBON CONTENT IN LEAVES OF *ELAEIS GUINEENSIS* AROUND A FLOW STATION IN OBAGI COMMUNITY, RIVERS STATE, NIGERIA

[1*]Simbi-Wellington, W.S.; [2]Aleru, K.K. and [3]Amadi G.O.

[1,2,3]Department of Forestry and Environment,
Rivers State University, Nkpolu-Oroworukwo Port Harcourt, Nigeria.

*Corresponding Author

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ABSTRACT

Gas flaring remains a significant environmental issue in the Niger Delta region of Nigeria, contributing to hydrocarbon pollution that affects air quality, soil health, vegetation, and human wellbeing. This study investigates the concentration of total hydrocarbon content (THC) in the leaves of *Elaeis guineensis* (oil palm) around a gas flare station in Obagi, Ogba-Egbema-Ndoni LGA, Rivers State. Sampling was conducted across four directions (North, South, East, West) from the flare site and at a control location 1,200 meters away. Leaf samples were analyzed using a DR/890 colorimeter. In addition, a structured questionnaire was administered to assess community perceptions of gas flaring on crop productivity. Mean THC concentrations observed were: Control location (3.0600 kg/mg), South location (7.7367 kg/mg), West location (8.3967 kg/mg), North location (10.7767 kg/mg), and East location (8.3100 kg/mg). The mean THC concentration around the flow station was significantly higher than at the control location ($p<0.05$). The concentration at the North location (10.7767 kg/mg) was significantly higher than at the other study locations, indicating an increase in hydrocarbon concentration along the prevailing wind direction. No significant differences were observed among the South, West, and East locations. This finding aligns with meteorological dispersion patterns and community responses. The result suggest that gas flares are a major contributor to hydrocarbon deposition in *Elaeis guineensis* leaves in the study area. Consequently, agricultural activities should be discouraged near flow stations in Obagi Community.

Keywords: Gas flaring, *Elaeis guineensis*, hydrocarbon pollution, Niger Delta, environmental monitoring, crop productivity.

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INTRODUCTION

The Niger Delta hosts vast oil and gas reserves, but the environmental consequences of oil extraction have been profound. Gas flaring which is the combustion of associated gas during oil extraction is a major source of air pollution in the region (Evoh, 2002; Hassan and Konhy, 2013). Gas flaring, the burning of waste gases in an open flame, has been a consistent practice in Obagi Community for over three decades, occurring 24 hours daily (Evoh, 2002; National Point Orji,2018; Newspapers, 2019;). This practice, common in oil-producing regions like the Niger Delta, is a significant environmental factor, affecting agriculture, human health, and the ecosystem. The thermal pollution from flaring creates distinct micro-climates around operations (Alakpodia, 1989), potentially hindering crop growth which thrives best below 30°C (Emekwuru, 2024). Gas flaring devastates agricultural soils, fresh water, and aquatic life, leading to stunted crop growth and reduced yields (Alakpodia, 1989). Pollutants released during flaring include hydrocarbons, sulfur dioxide, nitrogen oxides, and particulate matter. These pollutants settle on vegetation, impairing growth and reducing crop yield (Dosunmu and Amadi, 1996).

Elaeis guineensis, an economically significant crop in the region, is particularly vulnerable due to its wide surface area and local consumption. It is a monocotyledonous plant, typically growing up to 15 meters in height with an unbranched trunk bearing a crown of 25-40 large fronds. As a monoecious plant, it produces both male and female inflorescences (flowers) in alternating cycles. The female inflorescence develops into the palm bunch, bearing drupe fruits with a leathery exocarp, fleshy mesocarp from which palm oil is extracted, and a stony endocarp enclosing the kernel. Its fruit features are distinctive (USDA, 2006).

Elaeis guineensis is a versatile plant, utilized for palm sugar, fermented beverages, palm wine production, and as a source of red palm oil for cooking. It is also used in making sugar palm vinegar and as roofing material for huts. Its leaves provide material for palm fiber brooms, wrappers, broom sticks, fiber ropes, fishing strings from the midrib, webbing, and whips (Okolo *et al.,* 2019).

While numerous studies have addressed the impact of gas flaring on air quality, soil quality, thermal pollution, and the physical environment, a notable gap exists regarding the hydrocarbon content in plants exposed to gas flares. This study aims to bridge this gap by providing crucial information on the effect of gas flaring on the hydrocarbon content in the leaves of *Elaeis guineensis*, a major agricultural tree crop in the region.

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MATERIALS AND METHODS

Study Area

The study was conducted in Obagi, a community within the Ogba/Egbema Ndoni Local Government Area (ONELGA) of Rivers State, Nigeria. Obagi is situated at latitude 5°15′4.1″N (5.2511°N) and longitude 6°36′46.7″E (6.613°E), with an elevation of 19 meters (62 feet). The inhabitants are predominantly subsistence farmers, with some traders. *Elaeis guineensis* is a major agricultural gift, often cultivated alongside other crops such as *Manihot esculenta*, *Telfairia occidentalis*, and *Musa* species.

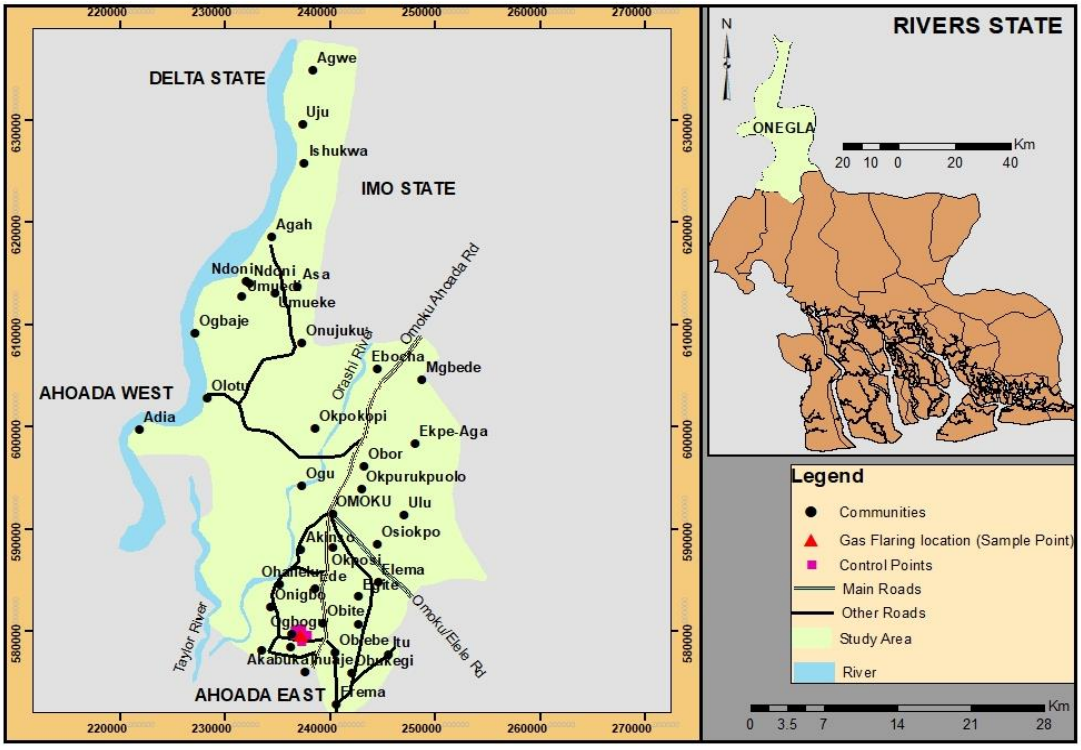

Fig. 1: Map of Rivers State showing Obagi and flare station locations

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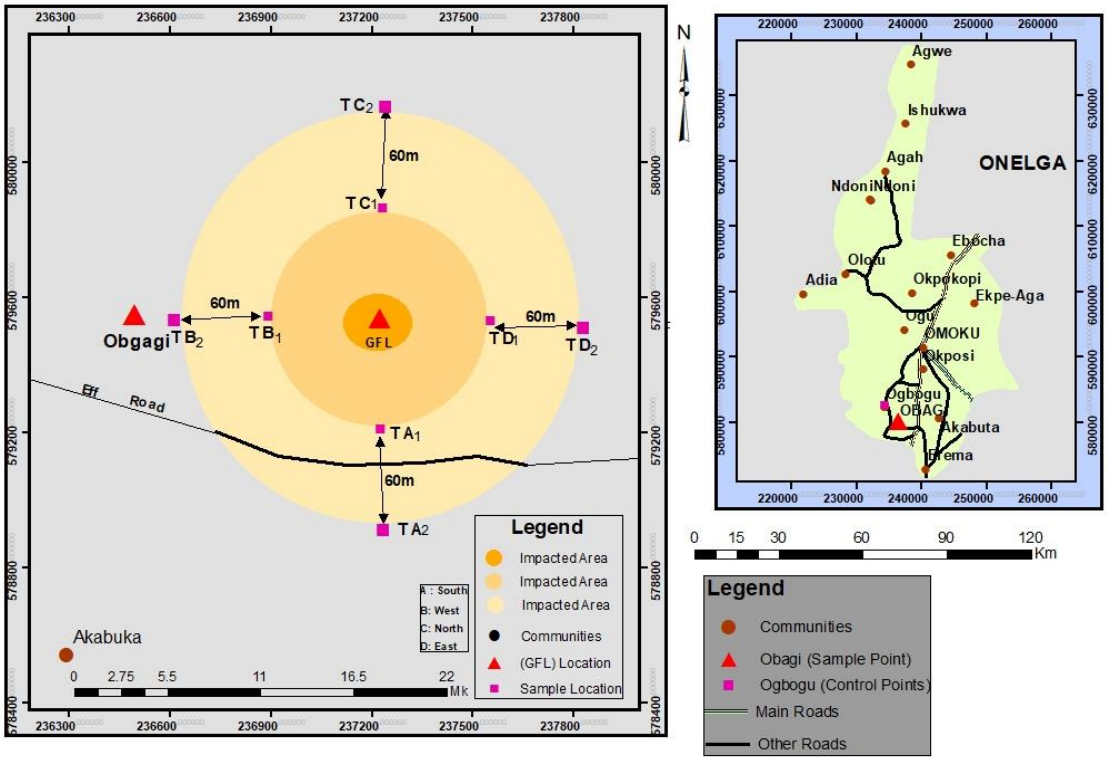

Fig. 2: ONELGA map showing sampling points and wind direction

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Figure 3: Photograph of gas flaring at the study site

Sample Collection

The systematic sampling method was employed in the study. The study area was divided into four transects, North (NT), South (ST), East (ET), and West (WT) locations, each measuring 60m long and 15m wide, around the cardinal points of the flare station. Leaf samples were carefully and randomly collected in three replicates at each study location and a control location (CT) 1,200 meters away from the study location. A total of 15 leaf samples were collected from mature oil palm trees belonging to two distinct age classes (4-year-old and 5-year-old palms), considering visual health, maturity, and uniformity in size to reduce biological variability.

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Table 1: Coordinates of Sampling Points (GPS)

Location	Code	Latitude	Longitude
South	ST	5.23466N	6.62734E
West	WT	5.23633N	6.62464E
North	NT	5.24091N	6.62331E
East	ET	5.24285N	6.62895E
Control	CT	5.22588N	6.64338E

Social Survey

Structured questionnaires and oral interviews were conducted to assess the perceived effect of gas flaring on the productivity of *Elaeis guineensis*. Two hundred questionnaires were distributed, and 150 were retrieved. The questionnaires gathered demographic information and data on the effect of flaring on crop productivity, targeting both male and female respondents, including students, civil servants, farmers, hunters, and traders.

Laboratory Analysis

Collected leaf samples were oven-dried at 90°C and pulverized to a uniform size using a laboratory mill. Two grams of each sample were weighed into a clean extraction container, to which 20 ml of hexane (extraction solvent) was added. The mixture was thoroughly mixed, allowed to settle, and then carefully filtered into solvent-rinsed extraction bottles using filter paper and Buchner funnels. The extracts were concentrated to 2 ml and then transferred for clean-up and separation. The total hydrocarbon content was determined using a DR/890 colorimeter.

Experimental Design and Data Analysis

A Randomized Complete Block Design (RCBD) was used for data analysis. Means were separated using Duncan Multiple Range Test (DMRT) at a probability of 95% ($p \leq 0.05$). Descriptive statistics, including frequency tables, were used to analyze information on the perceived productivity of the plant around the study area from the questionnaire responses.

RESULTS

Total Hydrocarbon Contents in Leaves of *Elaeis guineensis*

The analysis revealed varying concentrations of total hydrocarbon in the leaves of *Elaeis guineensis.* The North location recorded the highest concentration (10.7767 kg/mg), compared to other locations (South: 7.7367 kg/mg, West: 8.3967 kg/mg, East: 8.3100 kg/mg). The control location exhibited a significantly lower concentration (3.0600 kg/mg) as shown in Table 2.

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The chemical analysis revealed significantly higher THC concentrations in leaf samples collected near the gas flare station compared to the control location. The concentration observed at the North Location (10.78 kg/mg), was more than three times the concentration at the control location (3.06 kg/mg). This finding confirms that *Elaeis guineensis* near flare sites accumulate hydrocarbons over time due to atmospheric deposition from gas combustion. This finding is consistent with Kindzierski (2000), who noted that gas flaring releases pollutants such as volatile organic compounds (VOCs), sulfur dioxide, and unburned hydrocarbons, which is deposited on vegetation impairing plant function. These compounds may also alter the photosynthetic capacity and biochemical balance of plant tissues as reported by Carter (2003).

Table 2: Mean Total Hydrocarbon Contents in Plant Leaves of *Elaeis guineensis*

Location	THC (kg/mg)
North	10.78 [a]
West	8.40 [b]
East	8.31 [b]
South	7.74 [b]
Control	3.06 [c]

Mean with different superscripts are significantly different at p≥ 0.05 using DMRT.

Figure 4: Image of sampled oil palm leaves

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Effect of Wind Direction on the Dispersal of Hydrocarbon

The results indicated that hydrocarbon concentrations in *Elaeis guineensis* leaves were higher along the prevailing wind direction (North-East). The North location, which is towards the wind direction, had a significantly higher concentration (10.7767 kg/mg) compared to the other study locations. Although no significant differences were observed among the South, East, and West locations, the East location (8.3100 kg/mg) had concentrations higher than the South (7.7367 kg/mg) and the control (3.0600 kg/mg) as shown in Figures 5 and 6.

Wind direction was recorded as North-East during the study period. The highest THC level was observed at the North location, suggesting that pollutants are carried along this axis and settle on surrounding vegetation. The West and East locations also recorded elevated THC levels, while the South was comparatively lower.

This spatial pattern aligns with the findings of Simbi-Wellington and Ideriah, (2020); Ugbebor and Yorkor (2018), who highlighted wind direction as a key factor in pollution dispersion from flare stacks. The data suggest that the directionality of hydrocarbon distribution is not uniform but significantly influenced by meteorological dynamics.

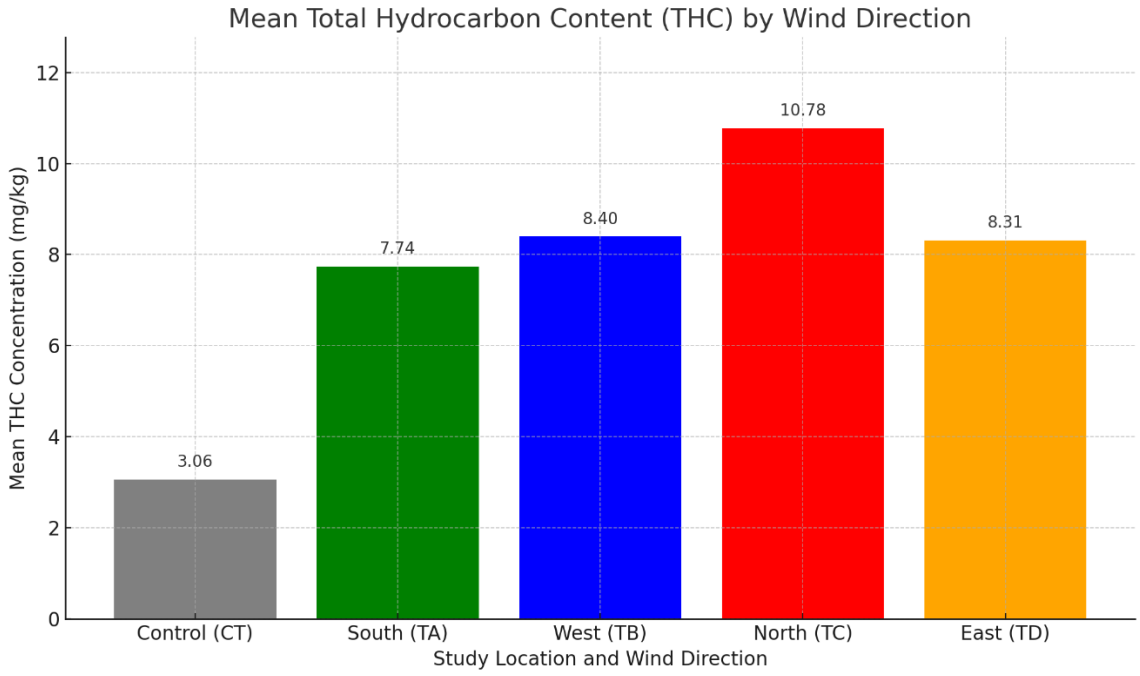

Figure 5: Effect of Wind Direction on Total Hydrocarbon Content

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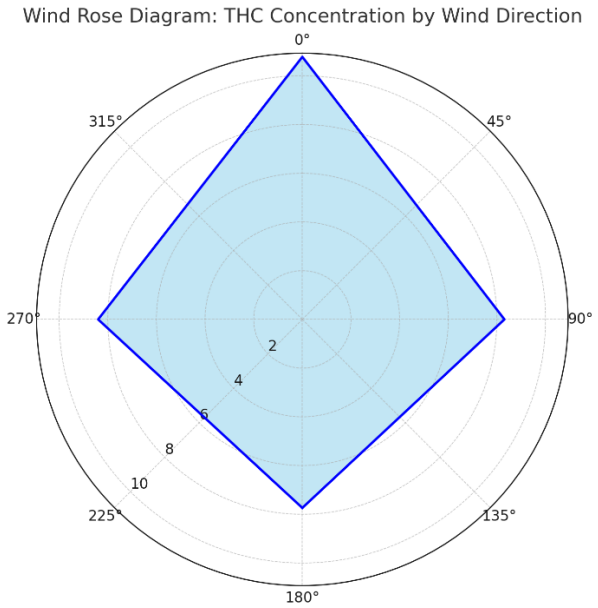

Figure 6: Wind Rose Diagram: THC Concentration by Wind Direction

Effect of gas flaring on the productivity of Elaeis guineensis around the study area.

Demographic Information of Respondents

A total of 150 respondents participated in the study, with demographic details summarized in table 3. Most respondents (40%) reported residing in the study area for 23 years and more, indicating a population with deep-rooted ties to the local environment and agricultural practices. This long-term residency is consistent with findings by Olagunju (2013), who noted that experienced rural dwellers are more likely to be engaged in perennial crop cultivation, such as oil palm farming.

Christianity was the dominant religion among respondents (60%), followed by traditional religion (35.3%) and Islam (4.7%). The sample was predominantly male (66.7%), reflecting the gender nature of agricultural labor in many West African communities, as reported by Onu et al., (2021) and Abassombe et al., (2023), who observed that men often constitute the majority of oil palm farmers.

Age distribution showed that most respondents were between 31–40 years (30%) and 51–60 years (26.7%), with a significant proportion, in their most economically productive years. This aligns with the observations of Ngaisset and Jia, (2020), Yeboah and Jayne, (2020) and Mulyasari, et al., (2023) who reported that oil palm farming is typically managed by adults in their prime working age.

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The marital status as observed was, 66.7% married, which is typical in rural agrarian settings and supports the role of family labor in smallholder agriculture (Idrisa *et al.,* 2012 and Adegboye, 2016). Educational attainment was generally low, with 43.3% having no formal education, a trend also highlighted by Mthethwa *et al.,* 2022 and Achukwu *et al.,* 2023 as a barrier to the adoption of improved agricultural practices.

Occupationally, farming was the most common livelihood (33.3%), followed by civil service (23.3%) and trading (16.7%). The prominence of farming is consistent with national statistics indicating that agriculture remains the primary occupation in rural Nigeria (NBS, 2011, Agbelekale, 2020, FAO,2025).

Table 3: Demographic Information of Respondents

Variables	Frequency	Percentage (%)
Years of Residency		
3-6 years	10	6.7
7-12 years	20	13.3
13-17years	30	20
18-23year	25	16.7
23 & above	60	40
Religion		
Christianity	90	60
Islamic	7	4.7
Traditional	53	35.3
Sex		
Male	100	66.7
Female	50	33.3
Age		
Below 20	15	10
21-30	20	13.3
31-40	45	30
41-50	23	15.3
51-60	40	26.7
61-70	7	4.7
Marital Status		
Single	40	26.7
Married	100	66.7
Divorce/Separated	10	6.7
Educational level		

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Below secondary	15	10
Secondary school	40	26.7
Tertiary & above	30	20
None	65	43.3
Occupation		
Students	15	10
Civil servants	35	23.3
Hunter	10	6.7
Farmers	50	33.3
Traders	25	16.7
Employed	10	6.7
Unemployed	5	3.3

(Source: Field Survey, 2019)

Productivity of *Elaeis guineensis*

As shown in table 4, most respondents (60%) had 15 years or more of farming experience, suggesting a high level of expertise and traditional knowledge in oil palm cultivation. This finding is corroborated by Olagunju (2013), who emphasized the importance of experience in maintaining productivity in perennial crop systems.

When asked about factors responsible for the decline in *Elaeis guineensis* productivity, respondents most frequently cited gas flaring (46.7%), followed by poor soil nutrients (20%), soil type (16.7%), disease (10%), and insect infestation (6.7%). The impact of gas flaring on agricultural productivity has been well documented in the Niger Delta region, where it contributes to soil degradation and reduced crop yields (Anejionu *et al*., 2015). Similarly, nutrient depletion and poor soil conditions are recognized constraints in oil palm production (Corley and Tinker, 2016). The role of pests and diseases, though less frequently mentioned, is also supported by the literature as a significant threat to oil palm sustainability (Murphy *et al.,* 2021 and Egonyu *et al.,* 2022).

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Table 4: Productivity of *Elaeis guineensis*

Farming activity	Frequency	Percentage (%)
Year of experience as a farmer		
Below 5 years	20	13.3
5-15 years	40	26.7
15 years & above	900	60
Total	**150**	**100**
Factors responsible for crop decline		
Gas flaring	70	46.7
Lack of Nutrient	30	20
Insects	10	6.7
Disease	15	10
Soil type	25	16.7
Total	**150**	**100**

(Source: Field Survey, 2019)

CONCLUSION

This study offers compelling evidence that gas flaring poses a significant environmental threat in Obagi, Rivers State, with measurable impacts on both vegetation and agricultural productivity. The analysis revealed that the total hydrocarbon content (THC) in the leaves of *Elaeis guineensis* was markedly higher in areas closer to the gas flare site. Notably, the North transect recorded THC concentrations that were more than 250% greater than those observed at the control site, underscoring the direct influence of proximity to flaring activities on pollutant accumulation in plant tissues.

The study identified wind direction as a critical factor influencing the spatial distribution of airborne pollutants. The dominant North-East wind pattern facilitated the transport of hydrocarbons towards the North and East transects, which correspondingly exhibited elevated THC levels. This spatial pattern indicates that wind plays a pivotal role in determining the zones of highest environmental exposure.

Local farmers' perceptions of declining oil palm productivity were consistent with the quantitative findings. A majority attributed reduced yields to gas flaring a view corroborated by the elevated THC concentrations in foliage and supported by existing literature linking air pollution to reduced crop performance. The convergence of empirical data and community observations reinforces the conclusion that gas flaring is adversely affecting agricultural output in the area.

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In general, this study not only highlights the environmental degradation associated with gas flaring but also emphasizes the need for urgent regulatory and remediation measures. Effective policies aimed at curbing emissions, combined with local interventions such as soil and crop management, are critical to safeguarding both ecological health and rural livelihoods in flaring impacted regions like Obagi community.

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