

Some Environmental Impacts of Natural Gas Flaring in Libya and Potential Solutions

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Publication Date: 2025/03/26

Abstract: Natural gas flaring in Libya has significant environmental and health consequences. Libya, as one of the top global contributors to gas flaring, emits large quantities of greenhouse gases, including carbon dioxide (CO₂), methane (CH₄), and nitrogen oxides (NO_x), which contribute to climate change and air pollution. The environmental impact extends to soil and water contamination, harming ecosystems and biodiversity. Additionally, exposure to pollutants from flaring has been linked to respiratory diseases, cancer, and other serious health conditions in local communities. In eastern Libyan towns, residents have reported increasing cases of eye inflammation, asthma, and cancer due to long-term exposure to toxic emissions. In response, the Libyan National Oil Company (LNOC) has pledged to reduce gas flaring by 83% by 2030 as part of global efforts to control emissions. This paper explores the environmental and health consequences of gas flaring in Libya and evaluates the possible mitigation strategies to reduce its effect. It highlights the urgent need for stricter regulations, cleaner technologies, and international cooperation to reduce emissions and protect public health.

Keywords: Natural Gas Flaring; Greenhouse Gases; Environmental Impact; Public Health

How to Cite: Saifaddeen Sallam; Ali Taher Abdollah (2025) Some Environmental Impacts of Natural Gas Flaring in Libya and Potential Solutions. *International Journal of Innovative Science and Research Technology*, 10(3), 1037-1042. <https://doi.org/10.38124/ijisrt/25mar961>

I. INTRODUCTION

Natural gas flaring is a major environmental and public health concern in oil-producing countries, and Libya is among the leading contributors to this issue. Gas flaring refers to the controlled burning of excess natural gas released during oil extraction when infrastructure for gas capture and utilization is inadequate. While it is often necessary for operational safety, excessive gas flaring results in the emission of greenhouse gases such as carbon dioxide (CO₂) and methane (CH₄), along with other harmful pollutants, including sulfur oxides (SO_x) and nitrogen oxides (NO_x), which contribute to climate change, air pollution, and ecosystem degradation [3]. These emissions accelerate global warming, deplete air quality, and pose severe health risks to populations living near oil extraction sites.

Libya's oil and gas sector is the backbone of its economy, accounting for over 90% of its export earnings [6]. However, due to outdated infrastructure, weak regulatory enforcement, and political instability, the country has struggled to implement sustainable gas utilization strategies. As a result, Libya remains one of the top ten gas-flaring countries globally, contributing significantly to environmental pollution and climate change [6]. According to the World Bank, Libya flared approximately 5.6 billion cubic meters of natural gas in 2021 alone, ranking it among the highest flaring nations in the Middle East and North Africa [15].

Beyond its environmental impact, gas flaring has direct health consequences for communities living near oil and gas extraction sites. Studies have shown that continued exposure to pollutants from gas flaring can lead to respiratory diseases such as asthma, chronic obstructive pulmonary disease (COPD), and lung cancer [9]. In eastern Libyan towns such as Jikharra, Awjila, and Jalu, residents have reported rising cases of respiratory illnesses, severe eye inflammation, and cancer, which they attribute to prolonged exposure to air pollution from nearby oil fields [21]. These findings mirror similar health crises observed in other oil-producing regions such as Nigeria's Niger Delta, where gas flaring has been linked to birth defects, pregnancy complications, and cardiovascular diseases [9].

Despite growing awareness of the issue, Libya's mitigation efforts have been slow due to economic challenges, lack of enforcement mechanisms, and ongoing political instability. However, in response to international pressure and the global push for carbon emissions reduction, the Libyan National Oil Company (LNOC) has committed to reducing gas flaring by 83% by 2030 [2]. This initiative includes investments in gas recovery and utilization projects aimed at capturing flared gas for domestic energy production. However, achieving this ambitious target will require strict regulatory enforcement, investment in gas processing infrastructure, and cooperation with international energy organizations.

This paper examines the environmental and health impacts of gas flaring in Libya, using case studies from affected regions such as Mellitah, Jikharra, Awjila, and Jalu. It also draws global comparisons, particularly with Nigeria’s Niger Delta, to highlight the long-term risks of unregulated gas flaring. Lastly, the paper discusses potential mitigation strategies, including policy recommendations and technological advancements, to address this urgent environmental and public health crisis.

II. NATURAL GAS PRODUCTION, CONSUMPTION AND FLARING IN LIBYA

- According to EIA [11], in 2022, Libya's dry natural gas production was approximately 423 billion cubic feet (Bcf). However, production declined to 394 Bcf in 2023. On the other hand, in 2023, Libya's natural gas consumption was about 305 Bcf, accounting for more than 70% of domestic production. The electric power sector was the primary consumer, representing about 85% of the country's natural gas use in 2022.
- Libya ranked as the seventh-highest natural gas flaring country in 2023, venting or flaring approximately 240 Bcf, up from 191 Bcf in 2022 [11]. According to Statista, in 2022, Libya flared nearly 102 Bcf of natural gas, an increase compared to 2021 [10].
- Gas flaring increased by 49 Bcf (25%) in 2023, while oil production rose by 16%, leading to an 8% increase in flaring intensity (from 494 ft³ per barrel in 2022 to 540 ft³ per barrel in 2023) [16].

III. IMPACT OF NATURAL GAS FLARING ON ENVIRONMENT IN LIBYA

Natural gas flaring in Libya has significant environmental consequences, impacting air quality, climate change, and ecosystem health. Here are some key environmental effects:

A. Greenhouse Gas Emissions

Gas flaring releases large amounts of carbon dioxide (CO₂) and methane (CH₄) into the atmosphere. Methane, in particular, is over 25 times more potent than CO₂ in trapping heat over a 100-year period, contributing to global warming and climate change [18].

B. Air Pollution and Human Health Risks

Flaring emits toxic pollutants such as sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulate matter, leading to acid rain and respiratory issues in nearby communities. Prolonged exposure to these pollutants increases the risk of lung diseases, heart conditions, and cancer [11].

C. Soil and Water Contamination

Unburned hydrocarbons and heavy metals from flaring can settle on land and water sources, contaminating soil and groundwater. This can reduce agricultural productivity and affect marine life [13].

D. Biodiversity Loss

The heat and light from flaring can disturb wildlife habitats, particularly in desert and coastal regions. Birds and insects are often attracted to flaring sites, leading to high mortality rates due to intense heat exposure [20].

E. Wasted Energy Resources

Instead of being flared, natural gas could be captured for electricity generation or industrial use, reducing reliance on polluting energy sources. Libya’s National Oil Corporation (NOC) has announced plans to cut gas flaring by 83% by 2030 to mitigate these environmental damages [3].

Indeed, from the previous information, it can be seen that natural gas flaring has significant effects on the environment where Greenhouse Gas Emission has the highest impact as shown on Fig. 1.

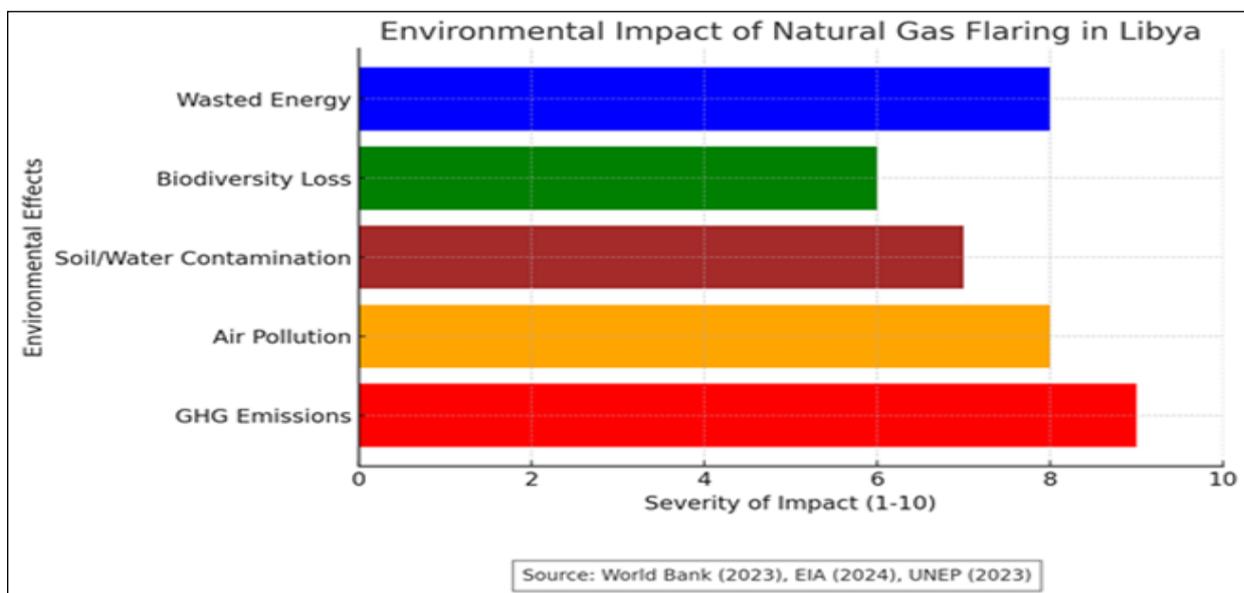


Fig. 1: Environmental Impact of Natural Gas Flaring in Libya

IV. IMPACT OF NATURAL GAS FLARING ON HUMAN HEALTH IN LIBYA

Natural gas flaring in Libya releases harmful pollutants that pose serious health risks to local populations. Some of the key health effects include:

A. Respiratory Diseases

According to [World Health Organization [19], Natural gas flaring emits particulate matter (PM2.5 and PM10), sulfur dioxide (SO₂), and nitrogen oxides (NO_x) which could lead to:

- Chronic bronchitis
- Asthma attacks
- Reduced lung function
- Increased hospital admissions for respiratory infections.

B. Cardiovascular Problems

Exposure to pollutants like carbon monoxide (CO) and fine particulates, according to [(United States Environmental Protection Agency [14], is linked to:

- High blood pressure
- Heart attacks
- Stroke risk increase
- Irregular heartbeats

C. Cancer Risk

According to International Agency for Research on Cancer [4], long-term exposure to benzene, toluene, and

formaldehyde, which are released during flaring, increases the risk of:

- Lung cancer
- Leukemia
- Other cancers due to DNA damage

D. Pregnancy Complications

According to United Nations Environment Program [13], pregnant women exposed to flaring pollutants face higher risks of:

- Premature births
- Low birth weight
- Birth defects
- Increased infant mortality

E. Neurological and Mental Health Effects

According to National Institutes of Health [7], Toxic chemicals from flaring can impact the nervous system, causing:

- Headaches and dizziness
- Cognitive impairments
- Increased anxiety and depression
- Developmental issues in children exposed to flared gases in their early life

These health effects can have severe consequences on the human’s health where the highest risk could happen because of respiratory diseases as shown on Fig. 2.

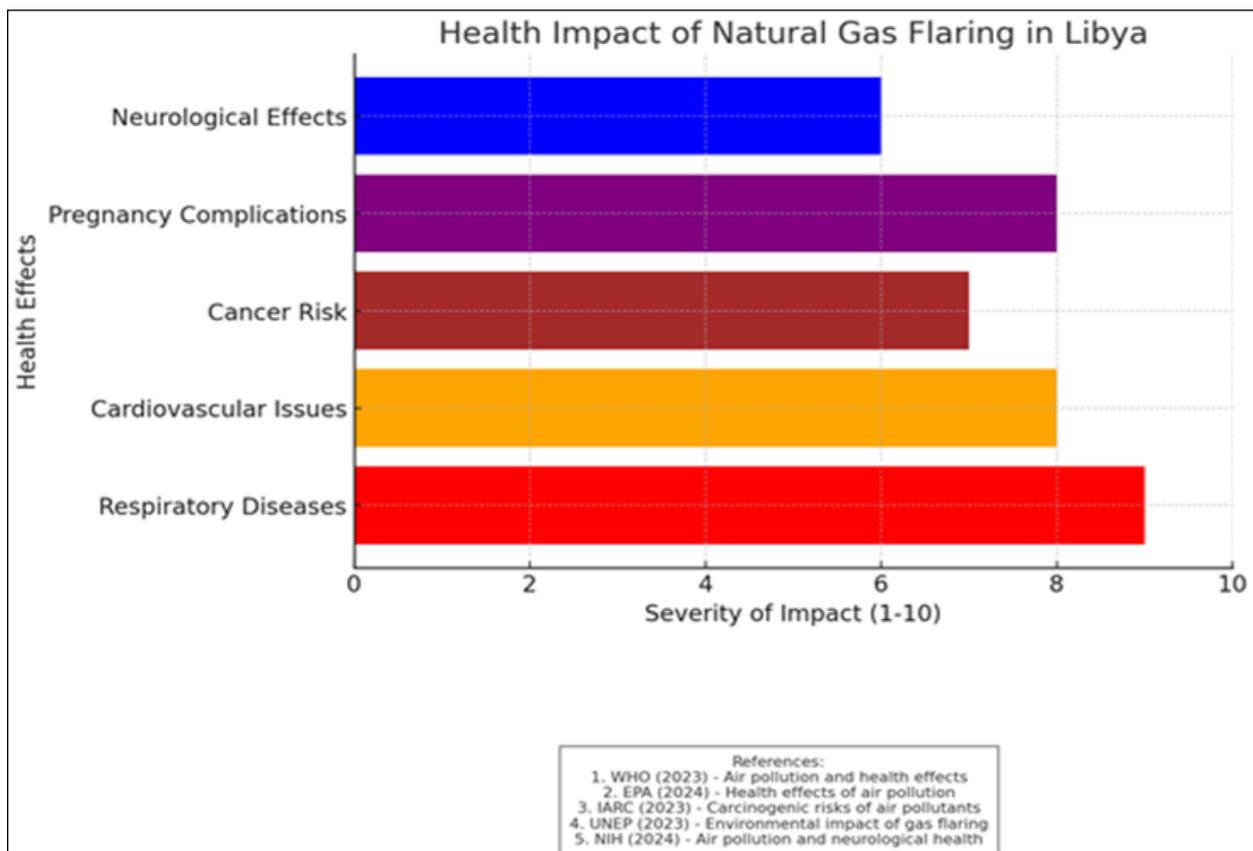


Fig. 2: Impact of Natural Gas Flaring on Health in Libya

V. CHALLENGES OF NATURAL GAS FLARING IN LIBYA

Libya faces multiple challenges in addressing natural gas flaring, which affects economic development, environmental sustainability, and public health. The key challenges include:

A. Lack of Infrastructure and Investment

Libya’s outdated gas infrastructure limits the ability to capture and utilize flared gas. The country needs gas processing plants, pipelines, and reinjection facilities to reduce flaring, but political instability and lack of investment deter progress [17].

B. Political Instability and Security Issues

Ongoing conflicts and political fragmentation make it difficult to enforce policies and implement projects to reduce natural gas flaring. The instability disrupts energy projects and deters foreign investment in gas recovery technologies [5].

C. Weak Regulatory Framework and Enforcement

Libya lacks strict laws and enforcement mechanisms to control gas flaring. Environmental regulations exist, but weak enforcement due to governance challenges leads to continued high flaring rates [13].

D. Economic Constraints and Revenue Loss

Flaring represents wasted economic potential instead of being used for electricity generation or export, the gas is burned off. This results in financial losses and increases reliance on imported energy sources [1].

E. Environmental and Climate Commitments

Libya has pledged to reduce greenhouse gas emissions but struggles to implement meaningful reductions in flaring. The country’s reliance on oil exports often takes priority over environmental policies [22].

F. Limited Public Awareness and Technological Expertise

There is low public awareness about the environmental and health impacts of flaring. Additionally, Libya lacks the technical expertise required for large-scale gas capture and utilization projects [8].

As it can be seen on Fig. (3), the political instability and fragile security system in Libya form the main severity challenges which lead to the uncontrolled flare of natural gas in the country.

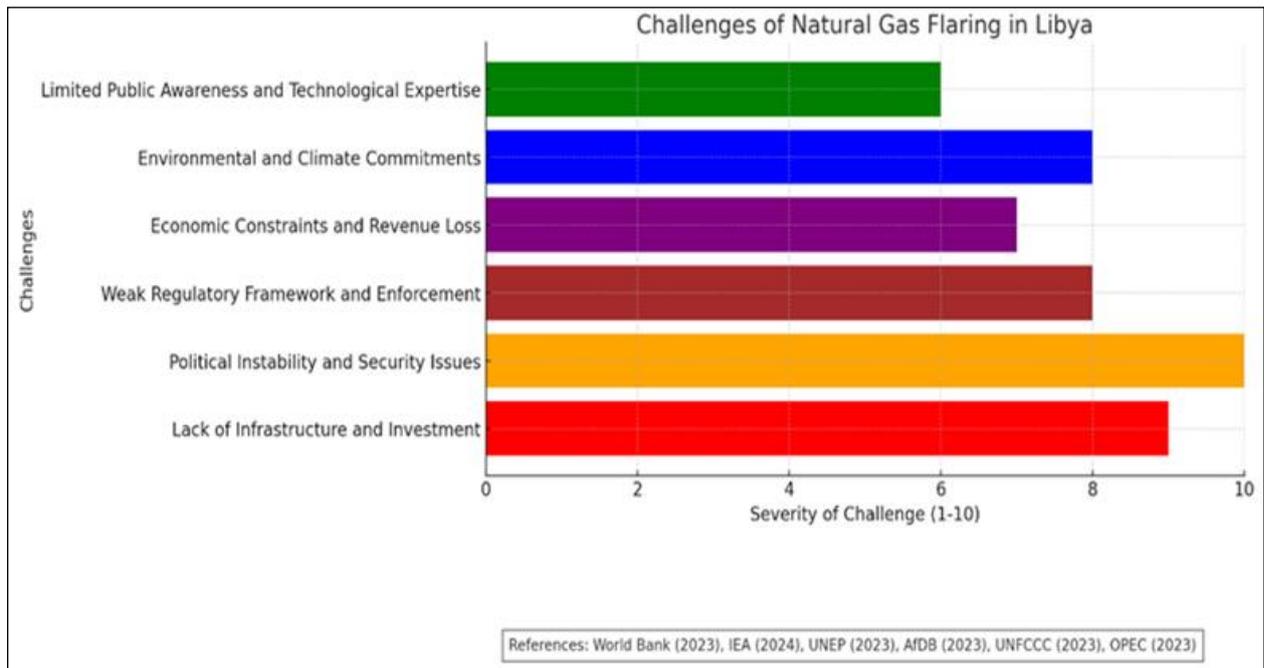


Fig. 3: Challenges of Natural Gas Flaring in Libya

VI. POSSIBLE SOLUTIONS TO GAS FLARING CHALLENGES IN LIBYA

To address the challenges of natural gas flaring in Libya, the following solutions can be implemented:

A. Infrastructure Development and Investment

- Upgrade and expand gas processing facilities to capture and utilize flared gas.

- Invest in gas-to-power projects to use flared gas for electricity generation.
- Encourage public-private partnerships to attract foreign investment in gas infrastructure [17].

B. Strengthening Political Stability and Security

- Enhance governance and regulatory frameworks to ensure energy sector stability.

- Improve security in oil-producing regions to encourage investment in gas projects.
- Establish transparent policies to create a more stable investment climate [5].

C. Implementing Strict Regulatory and Environmental Policies

- Introduce stronger environmental laws to penalize excessive flaring.
- Monitor and enforce compliance with flaring reduction commitments.
- Align national policies with global environmental agreements (e.g., Paris Agreement) [13].

D. Promoting Economic Incentives for Gas Utilization

- Provide tax incentives and subsidies for companies that invest in flare reduction.
- Encourage gas reinjection into reservoirs to enhance oil recovery and reduce emissions.
- Develop domestic gas markets to increase utilization of natural gas in industries and households [1].

E. Advancing Technological Solutions

- Adopt flare gas recovery systems to capture and repurpose excess gas.
- Invest in liquefied natural gas (LNG) technology to enable gas exports.
- Explore carbon capture and storage (CCS) to mitigate environmental impact [22].

F. Raising Public Awareness and Capacity Building

- Educate local communities on the environmental and health impacts of gas flaring.
- Train technical professionals in gas recovery and utilization technologies.
- Promote research collaborations with international organizations to develop sustainable solutions [8].

VII. CONCLUSION

Libya's natural gas industry presents both opportunities and challenges to the country. While the country possesses vast natural gas reserves, issues such as outdated infrastructure, political instability, weak regulatory enforcement, and environmental concerns hinder its full potential. Natural gas flaring remains a major problem, causing economic losses, environmental degradation, and public health risks. Reducing gas flaring in Libya is essential for mitigating climate change, protecting public health, and preserving biodiversity. Investing in gas recovery technologies and enforcing stricter environmental regulations can help address this issue.

To overcome these challenges, Libya needs stronger policies, better enforcement, and increased investment in gas utilization infrastructure. International cooperation and technological advancements could help the country reduce gas flaring, improve energy efficiency, boost economic growth, protect public health, and contribute to global climate commitments.

ACKNOWLEDGMENT

The authors declare that they have no conflicts of interest and have read and approved the final manuscript for publication.

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