

Gas Flaring and its Socioeconomic Implications for Rural Communities in Kurdistan Region of Iraq (KRI): Reflections on the Impact of Gas Flaring in Tawke Community

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Abstract

The study critically examines the problem of gas flaring and its socioeconomic implications in the KRI with emphasis on Tawke community who are predominantly peasant rural farmers. For several decades, KRI allowed natural gas to be flared which poses severe challenges to health, agricultural productivity and the environment with huge socioeconomic dimension to the survival of the local population. Although Iraq has sizeable natural gas reserves, however, about 70% of natural gas produced are flared which is responsible for more than 20 million tons of CO₂ emissions annually that cost the domestic economy billions of dollars in lost revenue and other consequences including threat to public health and the environment. Thus, the study conducted simple narrative and in-depth qualitative in-person interview with some employees of DNO, public sector workers and members of the Tawke community on the impact and socioeconomic implications of gas flaring on their livelihood. The research findings resonate and lend credence to the widely held views on the state of the environment in KRI and revealed severe environmental consequences, health consequences, low yields in agriculture with socioeconomic and cultural implications on livelihood of the local people particularly Tawke community.

Keywords: Gas Flaring, Socioeconomic Implications, Associated Gas, Tawke Community, Environmental Consequences.

Introduction

Iraq is predominantly a mono-product economy heavily dependent on oil and gas which accounts for about 93% of government revenues and 45.6% of the country's Gross Domestic Product (GDP) in 2021 (Sosnowski 2019; World Bank 2023). Iraq is estimated to have natural gas reserves of about 3.74 trillion standard cubic meters (tscm), that is about 132 trillion standard cubic feet (tscf) and about 20 - 40 tscf in KRI mainly in the Sulaymaniyah Governorate (Al-Aboudi 2024). Majority of production in the main Iraq territory is associated gas from oil fields in Bastra, Akkas and Mansouriyah, while the KRI have numerous gas fields including Kor Mor with a capacity of 430 million standard cubic feet a day (mmscf/d) in addition to 1,000 barrels of liquefied petroleum gas (LPG) and 15,000 barrels of condensate (Al-Aboudi 2024). The majority of the associated gas produce in KRI other than Khurmala Dome are flared, but part of the production from Tawke and Peshkabir are reinjected into the field to maintain production in line with the Ministry of Natural Resources (MNR) mandate (Tabaqchali 2022).

Although Iraq has sizeable natural gas reserves, current limitation in domestic usage have been traced to poor regulatory framework, investment hurdles and insufficient natural gas infrastructure which have kept the amount of their natural gas production available for sale relatively flat since 2016 (EIA 2023). Thus, considerable amount of gas produced were flared with severe consequences on the environment and public health (Fisher and Wooster 2019), particularly local oil and gas producing communities who are predominantly peasant rural farmers like Tawke. In general, about 70% of natural gas produced in Iraq is flared, which is responsible for more than 20 million tons of CO₂ emissions annually that cost the domestic economy billions of dollars in lost revenue (Aqrabi-Whitcomb 2021). On a global scale, flaring not only results in revenue loss of around \$20 billion per year, but also contributes to up to 1.2 billion CO₂ equivalent tons of emissions per year, which is comparable to 260 million passenger cars off the road in emission terms (Charles et al 2020).

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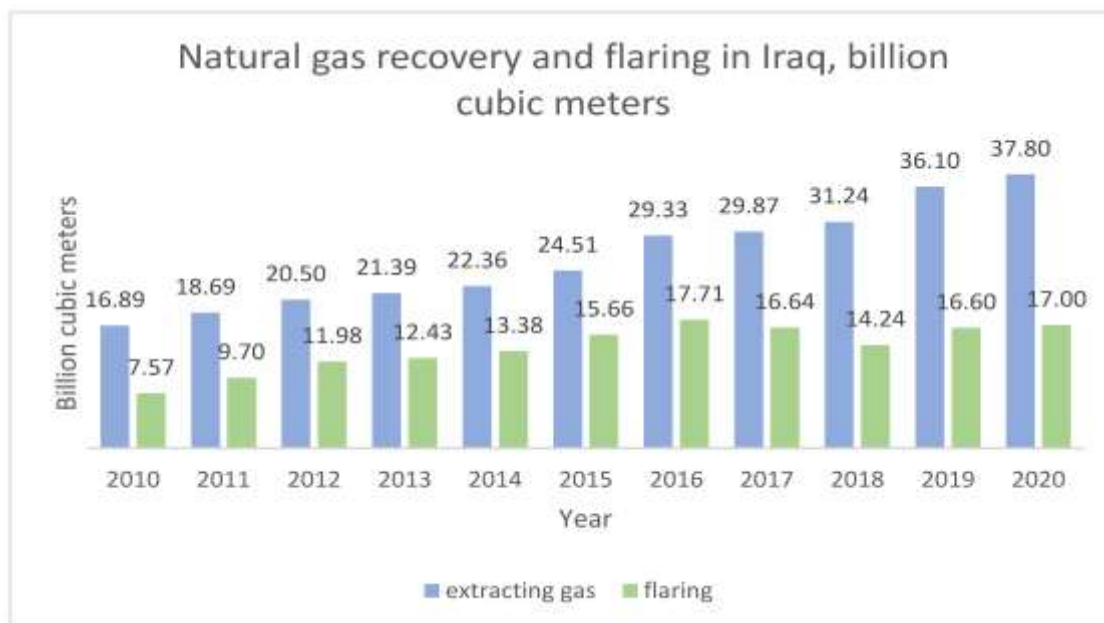
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According to the World bank (2022) data, Iraq and 3 other countries (Russia, US and Iran) accounted for about 45% of all global gas flaring for three years (2017 to 2019) and flared most of the gas produced globally (figure 5 below) only behind Russia Federation (Shuker 2022). Global gas flaring increased to levels not seen in more than a decade to 150 billion cubic meters (bcm), equivalent to the total annual gas consumption of Sub-Saharan Africa (World Bank 2022). But Shuker (2022) succinctly argued that Iraq alone flared approximately 16 bcm of gas per day equivalent of 0.5% of global production which is enough to power three million homes. As a result, thousands of gas flares at oil production sites around the globe burn approximately 140 bcm of natural gas annually, resulting in nearly 300 million tons of carbon dioxide (CO₂) emitted to the atmosphere (Elvidge et al 2018).

Similarly, the KRI is estimated to hold about 200 tcf (5.67 tcm) of natural gas reserves which constitute about 3% of the world's total reserves estimate (Tabaqchali 2022).. However, the proven reserves of KRI is estimate to be in the region of 25 tcf representing 20% of Iraq's gas reserves of 124.6 tcf at the end of 2021 with potential to generate additional 40 billion cubic meters of gas annually (Tabaqchali 2022). Consequently, Charles et al (2020) posited a number of critical perspectives essentially the challenges of gas flaring and its broader socioeconomic implications on Tawke and highlighted its complexity and intrigues. The paper provided a theoretical foundation for this study and delineated the socioeconomic dimension of gas flaring in Takwe.

Figure 1. Natural Gas Recovery and Flaring in Iraq (2010 – 2020)



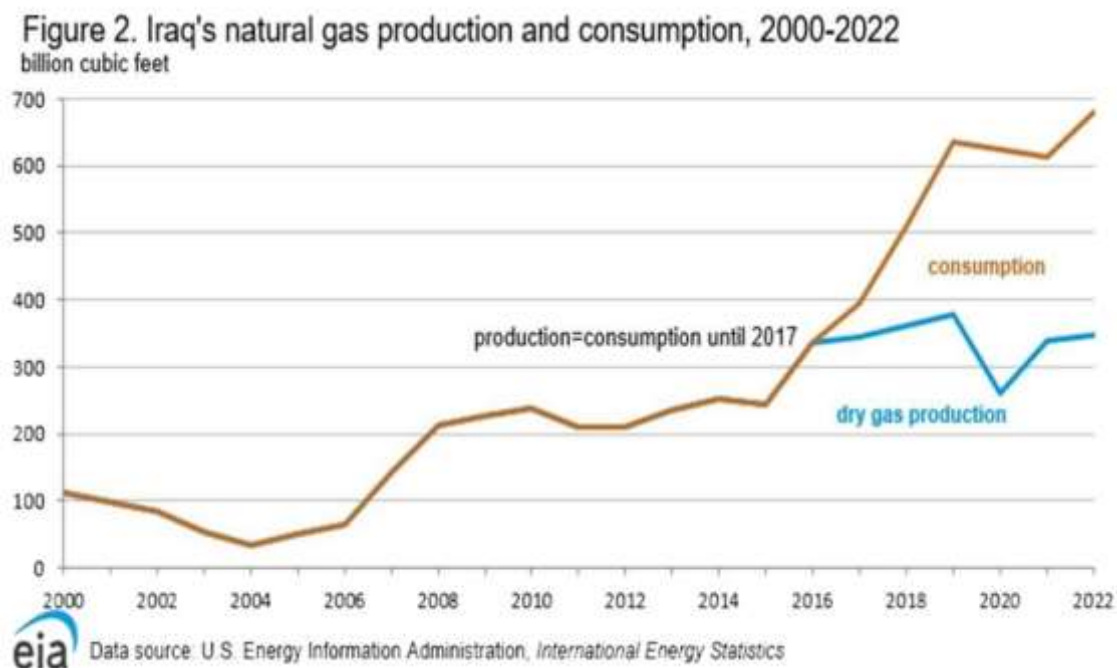
Sources: EIA (2022)

There are webs of literature (Fisher and Wooster 2019; Sarkari et al 2022; Shahab-Deljoo et al 2023) on gas flaring tailored broadly towards Nigeria, Russia and Iran. These studies dwelled on the environmental implications of gas flaring and its consequences in terms of health, agricultural productivity and air pollution on oil producing communities. There are moderately number of existing literature on gas flaring in KRI (Charles et al 2020; Zais et al 2021; Shuker 2022), nonetheless they have not clearly conceptualized its socioeconomic dimension and existential crisis on health, agricultural productivity, conflicts, migration, poverty, inequality and development particularly in rural peasant communities such as Tawke. Thus, the impact of gas flaring and its socioeconomic consequences particularly in rural communities of KRI need to be given serious attention and brought into the limelight in academic literature of environmental management. This is the one of the novelties which this paper aimed to critically contribute.

While the study contributes to the literature of gas flaring and its socioeconomic impact, however, the research question set out to examines how gas flaring affects the people and wellbeing of Tawke community? The study expands the current body of literature on gas flaring in KRI incrementally, widen the scope of qualitative research method and bring to limelight the issues of gas flaring in communities in KRI. The study conducted simple narrative and in-depth qualitative in-person interview with some employees of DNO, public sector workers and members of the Tawke community on gas flaring and its socioeconomic implications on their livelihood. In order to answer the research question and achieved the objective of the study setout above, the study was organized into four sections; section 1 dwelled on the introduction of gas flaring and chapter 2 reviewed the extant literature of gas flaring and its socioeconomic impact. The methodological framework was critically examined in chapter 3, section 4 discusses the findings of the paper, while conclusion and recommendations were drawn in chapter 5.

Gas Flaring in Kurdistan Region of Iraq (KRI)

According to the World Bank (2023) gas flaring is the burning of natural gas associated with oil extraction during production facilities which dates back to several decades. It represents the standard practice for disposing excess or needless gases burned off in flare stack during most of the downstream and upstream operations (Fisher and Wooster 2019). Gas flaring in the oil and gas industry is one of the most challenging and environmental issues for the world's future (Shahab-Deljoo et al 2023). Some of the flare gases have high heating values, and hence can be used as alternative fuels and as petrochemical feed after treatment or sold as commercial products (Shahab-Deljoo et al 2023). Incessant gas flaring is controversial issue in the oil and gas industry because it has many harmful environmental and health implications.

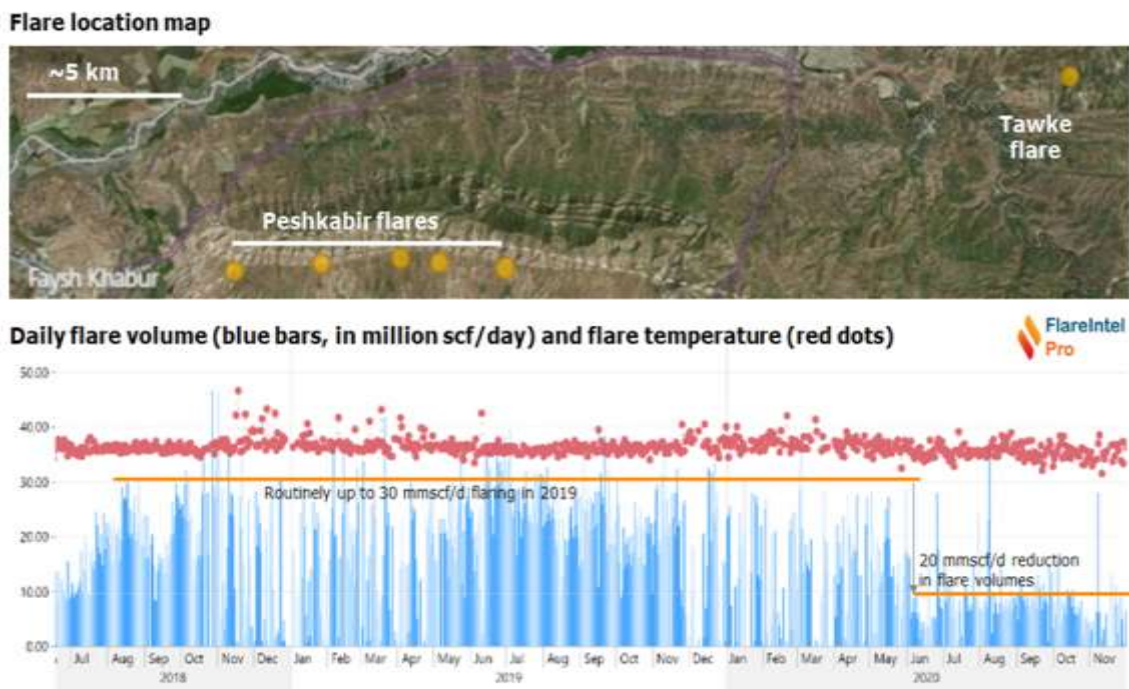


While natural gas production has increased substantially over the years particularly since 2017 as shown in figure 2 above, however, natural gas consumption has remained abysmally low. Overall, about 70% of gas produced in Iraq and KRI are flared as the country is notorious for gas flaring only behind Russia Federation with a 20 million tons of CO₂ emission annually at a huge cost to the domestic economy (Aqrabi-Whitcomb 2021). Overall, it is estimated that KRI flared about 145 mmscf/d, that is about 1.5 bcm annually with Khurmala alone accounting for about 2 bcm (Qamar Energy 2022). More evidently, routine gas flaring persisted over the years as a result of lack of inadequate gas gathering and utilization facilities in addition to the lack of infrastructure to harness and support export-oriented program. Regrettably, gas processing units in most stations are really marginal with each producing field on a standalone basis which reflect the state of gas development infrastructure in the region ((Tabaqchali 2022).

This obviously indicate that the lack of gas pipelines and infrastructure has contributed immensely to the failure to develop Miran, Bina Bawi and Chemchemical, Khor Mor and many other gas projects in KRI hence KRG attempt to resolve this by engaging Russia's Rosneft in September 2017 to expand the region's gas infrastructure.

There are 190 sources of gas flaring site in KRI alone with over 19.5 bcm of high Sulphur content of gas flared gas between 2012 and 2019 (Aqrawi-Whitcomb 2021) with one flaring site alone capable of releasing over 100 tons of sulphur dioxide (SO₂) per day with socioeconomic and health impact. According to Charles et al (2020) gas flaring at the Peshkabir and Tawke fields (see figure 3 below) are the largest single contributor of greenhouse gas (GHG) emissions within their global portfolio, amounting to 639,200 tons of CO₂e in 2019. In financial terms, it represents more than \$2 billion in lost sales value when calculated at \$2.50 per million metric British thermal unit (mmbtu). The sulphur content of gas produced in KRI is particularly high, thus exposure to SO₂ is associated with respiratory illnesses, and when SO₂ is combined with water vapour in the atmosphere it forms acid rain that not only can be transported over large distances in many rural communities with significant damages to ecosystems, such as forests and freshwater habitats (Aqrawi-Whitcomb 2021).

Figure 3. Flaring At the Peshkabir and Tawke Fields (January 2018 to Late November 2020)

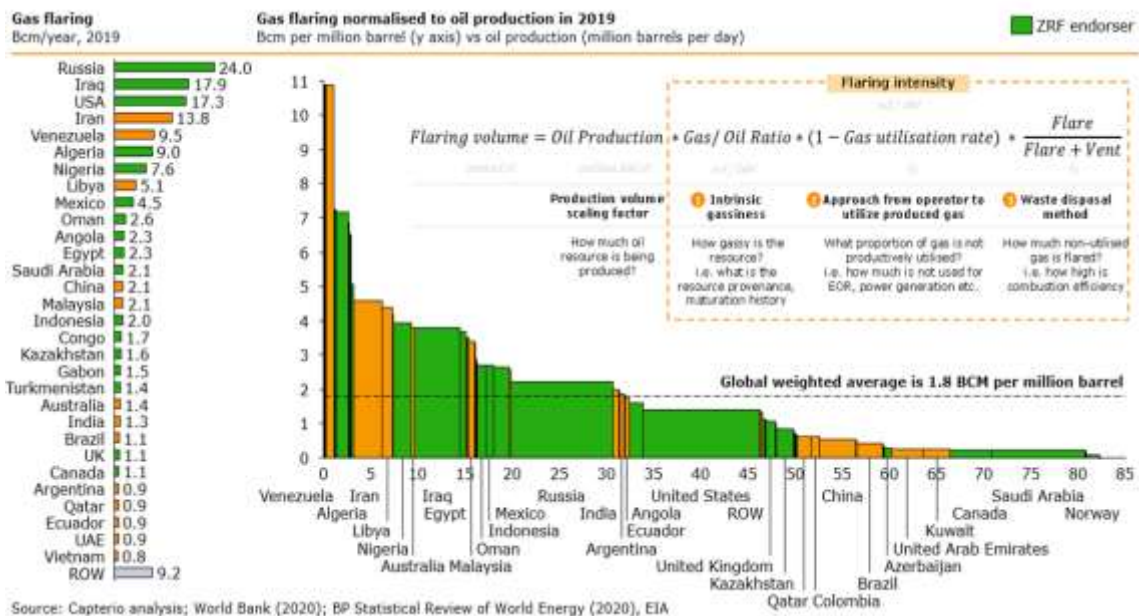


Sources: Charles et al (2020)

Above figure shows that real-time data of flaring at the Peshkabar and Tawke since 2 December 2020, gas flaring has increased to 15-30 mscf/d likened to operational problems. Significant volumes (20+ mscf/d) were flared from 2018 and in the first half of 2020 around 30 mscf/d were routinely flared until around June 4th, 2020 when flaring reduced to about 10 mscf/d (Charles 2020).

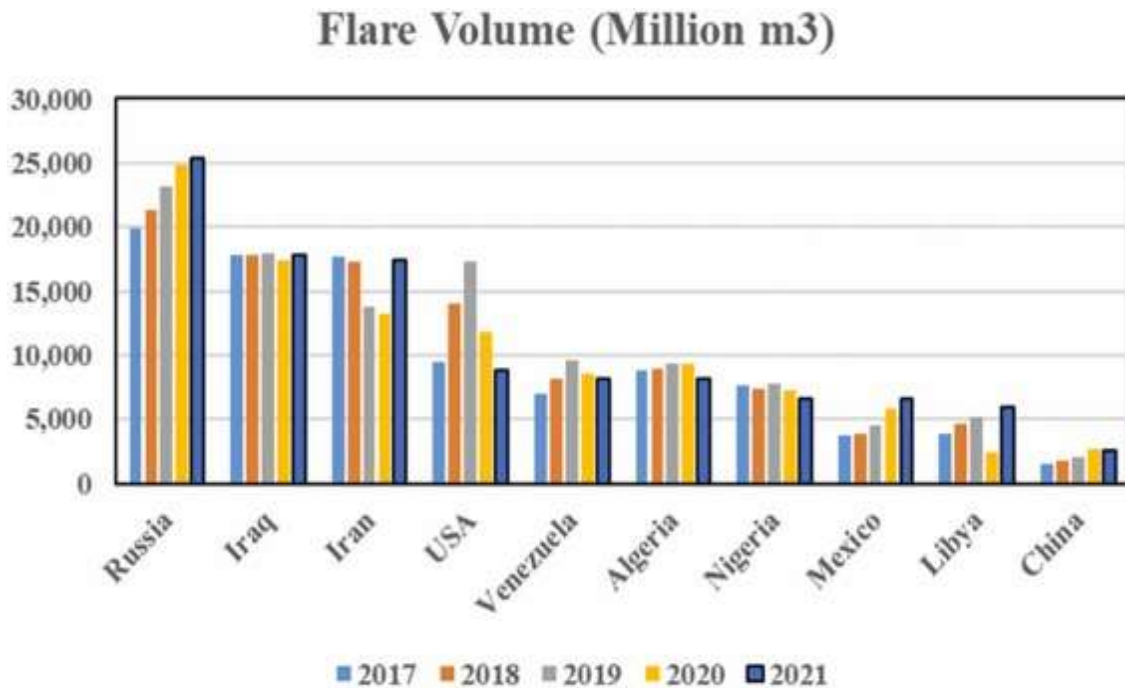
Natural gas could have been a huge game-changer to power the domestic electricity economy considering the untapped natural resource reserves of KRI, however, bulk of the gas produced in KRI is flared. Little wonder that Iraq is notorious for gas flaring just behind Russia Federation because gas pipeline infrastructure is generally basic as there is no linkage with major gas fields and power stations. Despite flaring substantial amount of gas, Iraq currently owes \$12 billion for gas and power supplies from Iran (Wahab and Ross 2023). Natural gas is usually flared during oil production, when barriers to the development of a healthy gas market and infrastructure prevent governments and companies to harness

the benefits of using it. Like many developing countries, Iraq flare gas reduction and recovery are still relatively primitive marred with insufficient high expense recovery infrastructures, technical difficulties, lack of appropriate policies and regulatory frameworks (Farina 2010; Shahab-Deljoo et al 2023). Furthermore, gas flaring is a common phenomenon in KRI primarily due to inefficient natural gas infrastructure, inappropriate economic management policy and absence of effective clear gas pricing framework in addition to high sulphate content of natural gas produced in the region. Whereas, the expansion of the domestic market, development of the regional market through the deliberate gas supplies to Turkey and expansion of the international gas supplies through LNG and other opportunities will steer the low carbon/CO₂ direction and significantly halt and pollution of environment and its socioeconomic impact on the peasant rural communities.



Historically, gas flaring and venting has been practiced in industrial scale worldwide with about 170 bcm flared globally which account for 17% of global natural gas production in 2021, equivalent of 300 – 400 million tons of CO₂ emissions yearly. Besides considerable economic loss, gas flaring represents a threat to the environment and contribute significantly to greenhouse gas effects with severe environmental impact such as methane, carbon dioxide, water vapor and nitrogen oxide which are responsible for global warming and catastrophic climate change (Shahab-Deljoo et al 2023). Globally, Iraq is reputed to flare about 18 billion cubic meters of gas a year (equivalent of \$2 billion in lost sales value at \$2.50/mmbtu), the largest amount of gas just behind Russia Federation in a country suffering from chronic electricity shortages. The quantity of gas flared annual is capable of providing 15 million households with electricity (World Bank 2023). Nine countries continue to top gas flaring in the world (Russia, Iraq, Iran, Algeria, Venezuela, US, Mexico, Libya and Nigeria), and they account for nearly three quarters of flare volumes which is almost half of global oil production (World Bank 2022). If fully harnessed, the gas flared in 2022 alone could provide many countries with much needed energy security and could generate as much electricity as Sub-Saharan Africa currently produces in a year.

Figure 5. Volume of Gas Flaring by Countries

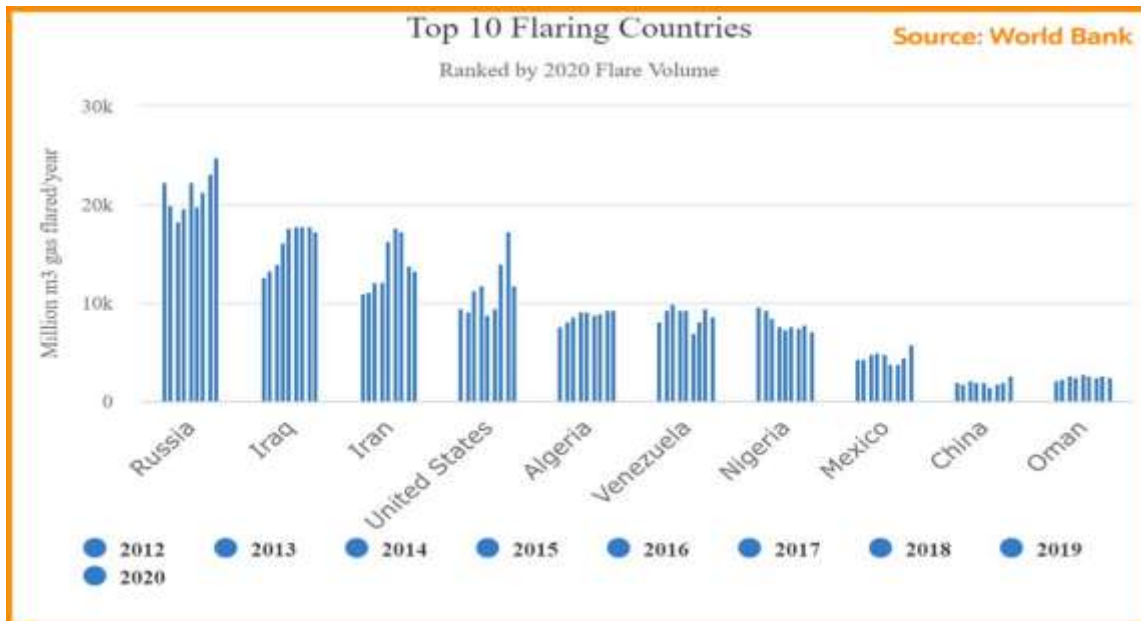


Sources: World Bank (2022)

Similarly, in 2021 Russia flared gases equivalent of 25.4 bcm, Iraq flared 17.8 and Iran flared 17.40 bcm respectively of annual flared gasses they ranked third among the top most gas flaring countries in 2021, but data from the world bank estimate that in 2021 alone global gas flaring was estimate to be about 144 bcm of gases, equivalent of about 400 million tons of CO₂ emissions (World Bank, 2022) of which 361 million tons were in the form of CO₂ and 39 million tons were in the form of methane (World Bank 2022). The 10 top major flaring countries (see figure 5 above) accounted for 75% of all gas flared in the world and 50% of global oil production and the first 7 countries in the emission of flare gases have continued to flare most gases for 10 years in a row (Shahab-Deljoo et al 2023). Interestingly, Iraq flared approximately 17.8 bcm in 2022 compared to 17.7 bcm in 2021 which indicate a rise of 0.3% (world Bank 2023). In financial terms, global gas flared in 2019 is estimated in the region of \$30.6 billion, equivalent of 30% of the EU gas consumption (Krane 2018). CO₂ emissions in Iraq increased from 27.1 million tons in 1972 to 177.8 million tons in 2021 growing at an average annual rate of 4.85%, arising from emissions of carbon dioxide from the burning of fossil fuels (World Bank 2023).

Gas flaring constitute a serious waste of valuable energy resource, lost opportunity to monetized gas resources for economic development and lost opportunity to utilize gas for electricity generation to support the much-needed economic growth. More fundamentally, gas flaring is a major hazard to the local population, harm the environment and livelihoods with severe economic effects. It poses challenges to national, regional and global ecosystem with significantly hazardous and irreparable damage including harm to soil, humans, animals as well as flora, fauna and soil. Local areas are also subjected to thermal impact with heat radiation impact from flare stacks, which significantly affect the existing ecosystems particularly in KRI that are mainly rural peasant communities. Health and agricultural impacts for local population are significantly high (Sarkari et al 2022). Overall, flare gases released have several harmful substances and have huge implications for the environment, including volatile organic compounds (VOCs) such as aromatic and aliphatic hydrocarbons (Hadjizadeh Zaker, 2022), sulfur-containing compounds (SO_x) and H₂S, nitrogen oxides (NO_x), carbon dioxide (Heidari et al 2016), carbon monoxide, and mercury-containing (Shahab-Deljoo et al 2023). Furthermore, flare stacks also produce considerable number of SO_x and NO_x with

humidity that causes acid rain effects particularly for areas such as offshore facilities. More fundamentally, Sarkari et al (2022) succinctly argued that the release of VOC during gas flaring is responsible for severe health issues for the surrounding environment, situation that is largely endemic in KRI.



The historical underinvestment and insufficient infrastructure, coupled with strained relations between the Iraqi Federal Government and the KRG have contributed immensely to the pace of gas flaring in KRI (Al-Aboudi 2024). In addition, poor planning and the oil and gas industry governance structure have had an increasingly damaging impact on environmental security, critically impacting the health and wellbeing of its population, especially those living close to oil and gas fields, producing its own set of social, economic and political challenges. This is consistent to the views expressed by Mills (2016) which succinctly argued that KRI lacks significant gas infrastructure as there are no linkages between various gas fields, processing plants and power generation facilities to harness and process the gas for export.

In KRI about 85% of the electricity is generated from fossil fuels (Aqrabi-Whitcomb) and lack of natural gas infrastructure directly hinges on electricity supplies capacity as several turbines are idle due mainly to non-available of natural gas for its operations. Accordingly, lack of electricity hinders business operations and the use of generators in response to power outages causes noise and air pollution and inimical to public health of the local population (Charles et al 2020). Although electricity supplies have increased significantly in the last decade from 500 MW in 2007 to almost 3,000 MW in 2020, however, the KRG still needs to increase the output to more than 5,000 MW in order to provide 24/7 power to its residents (Aqrabi-Whitcomb). Even though about 85% of the electricity is generated from fossil fuels in KRI, however a staggering 90% of residential places in the entire Iraq supplement their electricity needs with generators, with a generation capacity of estimated at about 3 TWh due to the failures of the country's public energy provision and generation notwithstanding the abundance of natural gas (Aqrabi-Whitcomb).

Figure 7. Kurdistan Region Oil and Gas Infrastructure



Source: Tabaqchali (2022)

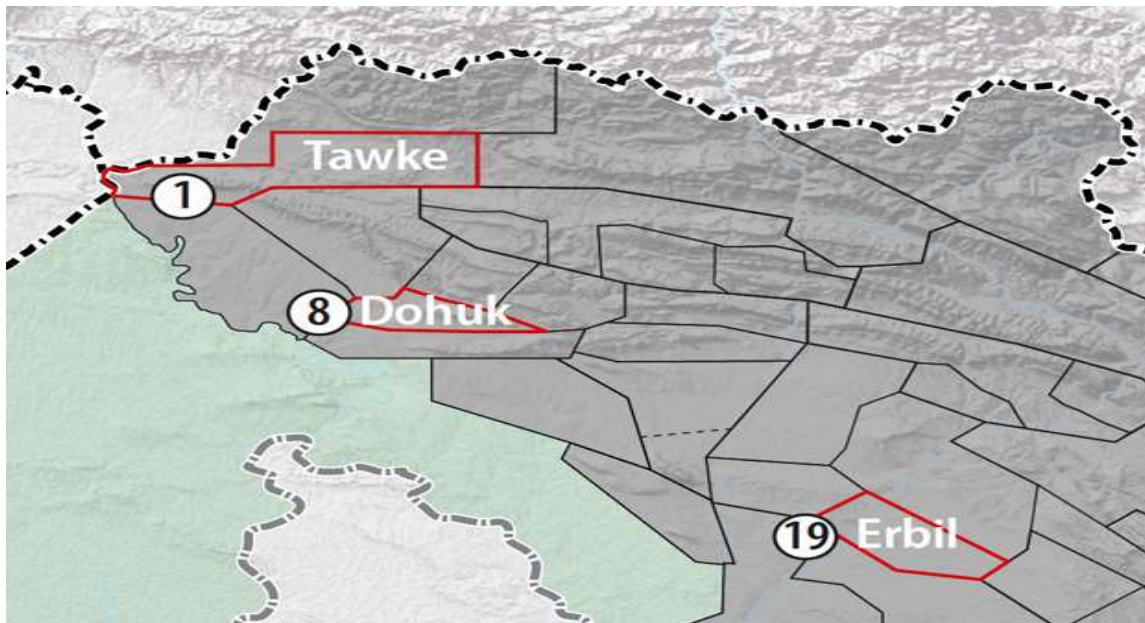
Iraq natural resource situation is hopelessly unique, the country is stupendously rich in crude oil and possesses vast amount of natural gas resources, but flares significant amounts and therefore remains dependent on neighboring countries like Iran for energy to meet its own needs (Wahab and Ross 2023). The oil and gas industry in KRI have remained largely an enclave economy with little or no serious linkages to the rest of KRG economy, whereas natural gas development is critical to its sustainable development needs (Zais et al 2021). As a result, the rural oil and gas producing communities in KRI for several decades bore the severe pains and discomfort of the supposedly natural endowment being flared at their own detriment and survival of the local population (Agbonifo 2015).

Study Area

The Tawke oil field is located onshore and lie within the prolific Zagros Fold-belt near Zakho in the North of Kurdistan, near the Turkish border. It covers an area of approximately 25 km by 3 km as defined by 3-D seismic and contains oil of very low gas oil ratio with API gravities between 25 and 27 degrees. It is one of the highest oil production fields in Kurdistan and largest foreign operated oil field of huge strategic importance to both the KRG and DNO.

The Tawke zone is a beautiful area with hills and farmlands of about thirty families of closely-knit community. Agriculture and livestock/cattle rearing are the main stay and sources of income for the local people. Most of their primary income source is from raising cattle and crops like wheat, barley, and fruit, which also helps to define their heritage and way of living.

Figure 8. Map of Tawke Indicating the Research Study Area



Source: Qamar Energy (2022)

Since the commencement of oil and gas production in Tawke, gas flaring has become a threat to the survival of the people with grave socioeconomic consequences. It also has impact on cattle rearing, agricultural productivity, health, environment and well-being of the people. The situation has been made worse by lack of sufficient healthcare and educational infrastructure, thus leaving the local population to deal with the aftermath of gas flaring. The Tawke ecosystem is severely jeopardized by oil and gas operations, the environment is contaminated by soot and fume emanating from flaring and the lives of its people are at great risk with hugely questionable future (Charles et al 2020).

The air quality is filled with toxic gases and smoke puffs from the neighboring oil fields, endangering not only the health and welfare of the locals but also the yield from their farms. Consequently, Elvidge et al (2018) succinctly argued that thousands of gas flares at oil production sites around the globe including KRI burn approximately 140 bcm of natural gas annually which result in nearly 300 million tons of carbon dioxide (CO₂) emitted to the atmosphere. The issue of gas flaring in communities is further complicated by lack of provision of modern infrastructure to address its adverse socioeconomic impacts (Shahab-Deljoo et al 2023).

Methodology

This section addresses the methodology framework of the study that was deeply rooted in a simple narrative but in-depth thematic qualitative method of data collection. Saunders (2007) argued that narrative is account of an experience that is told in a sequenced way which indicate a flow of related events that, taken together, are significant for the narrator and convey meaning to the researcher. The methodology involves the gathering of data through simple but comprehensive in-person interview with some employees of DNO operating in Tawke, public sector workers and some selected members of Tawke community on the impact of gas flaring in the community. It illustrates how the activities of DNO operations and the problem of gas flaring affects their livelihoods. Thus, adopting a collective case study with simple narrative allows for a “thick holistic description,” thereby leading to an “achievement of a level of understanding and interpretation” (Shkedi 2005, p.21). Furthermore, the collective case with simple narrative provided the opportunity to address the research questions and draw conclusion for this study.

The justification for the choice of qualitative method is to connect with the people whose livelihood are being disrupted and to explore their insights and experience regarding the impact of gas flaring and the behavior of oil companies in Tawke community. Using simple narrative analysis techniques from the in-person interview yielded significant insights on the environmental consequences, socioeconomic and cultural implications of gas flaring. The identification of significant themes and patterns was made easier by thematic analysis, which improved knowledge of the complexity of gas flaring on Tawke community. However, some limitations emerged during the course of data collection including access to specific data from DNO and trust from members of the community for fear of divulging sensitive information to the public and the relatively small sample size.

In relations to ethical issues, there were considerable discussion on the rights to privacy, confidentiality and deception, as well as protection of participants from harm during and after data collection process. Thus, there was some assurance and reassurance of confidentiality to those who made themselves available for the interviews regarding gas flaring in Tawke community. Consequently, adequate care was taken to ensure that actual names of participants were not revealed in line with trust of confidentiality, instead abbreviations such as AA, BB, CC, DD and EE were used in place of interviewee's names. This aligns with the views expressed by Adetoun (2005, p.49) that it is imperative for researchers to “protect the identity of their participants in order not to expose them to any kind of recrimination, victimization and prosecution from any groups and organizations, the researcher must not precipitate a further crisis”.

Findings and Discussions

The synopsis of findings from qualitative data collection on gas flaring and its socioeconomic implications on Tawke community are organized and laid bare in the subsequent paragraphs of this section. It revealed the scale and impact of gas flaring on the environment, agricultural productivity, health, socioeconomic and cultural implications on the peasant rural community of Tawke and indeed the rest of KRI economy.

Effects of Gas Flaring on Agricultural Productivity

Routine gas flaring impact on the Tawke community include deteriorating soil quality due to several year of flaring and contamination of water used for agricultural operations. This poses a serious threat to agricultural productivity by lowering crops yields with disastrous effects on the delicately balanced ecosystem. Primary data revealed *serious commitment to the environment through processing and reinjecting natural gas into an underground reservoir to boost oil and gas production and limit gas flaring to the community (AA)*. Subsequently, the cleaned gas is reinjected into the reservoir for the purpose of reducing flaring that would otherwise be harmful to the environment and induce the flow of crude oil and gas production. Furthermore, primary data further showed *that oil companies are dedicated to guaranteeing sustainable energy practices while making local environmental preservation their top priority by continuously reducing the flaring level from the Takwe field (BB)*. The findings are consistent with literature (Tabaqchali 2022) that oil companies operating the Tawke and Peshkibir oil fields are using reinjecting technology to boost production in line with the directive of the MNR and more importantly to ensure commitment to environmental sustainability.

Conversely, the Iraqi Ministry of Health approximate that there are 2,000 cancer cases in Iraq and increasing annually due to the effect of gas flaring in Iraq, and the Al-Zubair District in Basra among the world's 100 brightest spots due to continuous gas flaring (Shuker 2022). *But findings revealed that the KRG and the international oil companies (IOCs) have taken a number of steps to eliminate gas flaring including use of gas for electricity generation (CC)*. However, the rural communities are more susceptible because of highly domesticated activities around farming and cattle rearing. The finding is consistent with literature (Charles et al 2020), which further shows that the people of Takwe community have been facing health challenge arising from gas flaring. Similarly, Smith (2018) argued that hazardous pollutants like sulphur dioxide, nitrogen oxides, and uncertain organic substances found in flare gas emissions lower crop productivity and degrade soil fertility, which has a significant negative influence on the area's agricultural output. Moreover, *findings from primary data showed that crops growth and total agricultural productivity are adversely affected (DD)* which corroborated the views expressed by Jones (2019) that water sources necessary for irrigation are

contaminated. Quite remarkably, Brown (2020) contended that exposing castles to harmful emissions lowers their output in terms of milk and meat, consequently stability of the economy.

Effect of Gas Flaring on Health

Prolonged contact with hazardous soot, fumes and toxin from gas flaring have the capacity to exacerbate public health, endanger the health of local population and reduce life expectancy with severe consequences on local population. Findings showed *chronic frequent health conditions such as acid rain associated with rainfall, respiratory illness, heart disease and increase risk of hospitalization that places huge burden on the ill-equipped local medical facilities (EE)*. This position is corroborated by Murray (2016) that there is a linear relationship between gas flaring and high rate of cancer in rural communities with little or no healthcare facilities to manage it. Further to these findings, in 2021 the KRG in collaboration with Germany and Finland government accesses the poor air quality in KRI and concluded that it contains toxic chemicals with potential of devastating health impacts and inhalable airborne particulate matter called PM10 (Aqrawi-Whitcomb 2021). Indeed, there is deteriorating air quality in KRI and many parts of Iraq (Shahab-Deljoo2023), but there are others attendant impact associated with SO₂ from gas flaring such as respiratory illnesses, acid rain with significant damages to ecosystems such as forests and freshwater habitats (Whitcomb 2021). In addition, primary data revealed the effect of gas flaring and its attendance socioeconomic impact on Tawke community but the operating oil company are supporting them through corporate social responsibility (CSR). *Our CSR programs enable farmers and the community to adjust to the altering environmental landscape by focusing on the adoption of sustainable agricultural practices and support the stability, long term survival of the local economy and employment opportunities for the community (FF)*. These practices and findings are consistent with the KRG oil and gas law which encourage oil companies to give employment preference to the local population in communities in which they operate (Oil and Gas Law 2008).

Socioeconomic Implications of Gas Flaring in Tawke

To a large extent, every aspect of the oil and gas operations has a significant impact on the environment with socioeconomic implications such as poverty, urban-rural migration, low income, conflict, insecurity, inequality and loss of means of livelihood for the local population. Again, primary data revealed a *significant socioeconomic and environmental disequilibrium which has seriously undermined the survival of the people of Tawke community (GG)*. *Socioeconomic and environmental dynamics of the local population are intertwined hence the impact of flaring is greatly felt by people in Tawke community (HH)*.

Consequently, Adams (2018) summed up the socioeconomic argument of gas flaring and maintained that it is detrimental to healthcare and agriculture with propensity to aggravate poverty, social inequalities and jeopardies the capacity of the local people to meet its sustainable development needs. In addition, rivalry and struggle for limited resources orchestrated by gas flaring has heightened tensions, conflicts and disputes amongst members of the communities which often snowball into conflict and insecurity of huge dimension (Williams 2019). *Primary data also showed that routine gas flaring in Tawke community have adverse socioeconomic impact on the local people with prevalent poverty, conflict, resilient and injustice (GGG)*. The findings are consistent with data from the Ministry of Planning and corroborated by the Federal Ministry of Planning in Baghdad that Duhok governorate is the poorest area of Kurdistan region, the position it has held for over 16 years (Aziz 2023; Al-Awsat 2023) with a poverty rate of 8.6% due largely to displaced people mainly refugees in various camps, unfairness in the allocation of projects and lack of cottage industries (KRG Statistics Board 2022). In general, the KRI is doing much better than the rest of Federal Iraq economically but also faces rising poverty levels due to budget cut, lack of job opportunities and limited perspectives for its young population likened to gas flaring (Aqrawi-Whitcomb 2021).

The social dimension and the conservation of the Tawke community distinct cultural legacy have been severely altered and weakened by gas flaring activities which put the community in jeopardy (Evans 2020). The disruption and strangulation of the people's traditional means of livelihood particularly farming and cattle rearing and their inability to grow local crops and produce enough of their own local foods have adverse effect on their culture and survival. *Finding showed that gas flaring impact on farm yields, a situation that limit the local farmers ability to grow enough food locally which seriously undermine the local population culture and way of life*

(III). Economically, agriculture is the mainstay of Tawke community and gas flaring has greatly shifted the market dynamics dramatically, thus impossible to meet market supplies of essential crops on a consistent basis (Harris 2017).

Conclusion, Recommendations and Policy Implications

This study analyses and examines the impact of gas flaring on Tawke community, undoubtedly gas flaring remains one of the most challenging environmental problems in KRI. The study illustrates the linkages between various environmental factors, vis-à-vis natural resources management, infrastructural development, environmental management, socioeconomic development and the survival of the people of Tawke community. It underscores its impact on health, agriculture and environment of the inhabitants. Moreover, the socioeconomic component of study highlighted a delicate disequilibrium between environmental management and socioeconomic stability with ripple effects on the peasant rural community and the survival of the local means of livelihood mainly peasant farming population. While natural gas continues to experience rapid economic development globally due to a shift in global energy consumption mix to a more environmentally friendly energy over the last decades, however, gas flaring continues to persist in KRI with negative environmental, socioeconomic and cultural consequences. Gas flaring as the most significantly impacted environmental problem in KRI has been further exacerbated by poor infrastructural and institutional incapacity. The gaps in infrastructural and regulatory framework permeate so resolutely in most rural communities in KRI that require a concerted and comprehensive approach to curtail incessant gas flaring.

Recommendation and Policy Implications

The study provides an overview of the causes and consequences of gas flaring in Tawke. Based on the findings, discussions and analysis of the problems associated with gas flaring, this subsection makes some policy recommendations to address the issues in the paper.

In the face of the seemingly poor management of natural gas endowment in major communities in KRI and indeed Tawke, it is recommended that concerted effort should be made through a more ambitious approach to a long-term strategy, planning and coordination to monetize the abundance natural gas resources in KRI. Gas development is the most ambition step to address the impact of gas flaring in KRI and there must be a deliberate effort toward the realization of this goal.

There should be collaboration between industry, government, civil society and the local community to adopt a more environmentally friendly options that put environmental management, natural resources management, community development and well-being of the people at the front burner. The Tawke area may progress in the direction of a more resilient and environmentally friendly future, protecting its cultural assets and enhancing the well-being of its citizens. Promote mutually beneficial relationships and strong channels of energy coordination amongst the government, local communities, and energy companies, particularly the peasant rural community of Takwe.

More fundamentally, there is also a need to enforce more stringent, oversight and institutional framework of gas flaring operations that guarantee strict adherence to environmental regulations and the adoption of ecologically sound practices that guarantee sustainable development of local communities in KRI. In relation to sustainable development, there is a need to lessen the social and economic burden brought upon the community due to the effects of gas flaring, empower the Tauki community by encouraging sustainable livelihoods, expanding economic opportunities, infrastructural and socioeconomic development for the rural population. It is important to encourage community efforts and to participate in the process of decision making that put the local well-being first and to strengthen their resilience and dedication to sustainable environmental practices.

There is also a need to increase investment in natural gas development and alternative sources of clean energy to reduce dependence on fossil fuel and environmental impact of gas flaring on rural communities in general and in particular Tawke community. Institutional reform is imperative and central to KRI to provide the much-needed synergy to stimulate investment in the oil and gas industry and indeed the gas sector, shifting significant dependence on fossil fuel and ultimately pushing Iraq into sustainable natural gas development pathway limiting gas flaring and ultimately it impacts on the local peasant community to sustainable development. There should be rapid development and increase in the pace of gas utilization for electricity generation that could help to reduce gas flaring and a deliberate policy to encourage energy companies to invest in gas development and gas reinjection technologies.

References

- Abdulrahman, S. A. (2020). Environmental Law of the Kurdistan Region, and Its Compatibility with International Principles of Environmental Policies. *Technium Soc. Sci. J.*, 9, 217.
- Abu, R., Patchigolla, K., Simms, N., & Anthony, E. J. (2023). Natural Gas Flaring Management System: A Novel Tool for Sustainable Gas Flaring Reduction in Nigeria. *Applied Sciences*, 13(3), 1866.
- Adetoun, B.A. (2005): "The role and function of research in a divided society: A case study of the Niger-Delta region of Nigeria" in Porter et al (Ed), *Researching in Conflict in Africa: insights and experiences*. Tokoyo: United Nations University Press.
- Adeyanju, G.C., Osobajo, O.A., Otitoju, A. et al. Exploring the potentials, barriers and option for support in the Nigeria renewable energy industry. *Discov Sustain* 1, 7 (2020). <https://doi.org/10.1007/s43621-020-00008->
- Adumene, S., Khan, F., Adedigba, S., Mamudu, A., & Rosli, M. I. (2023). Offshore oil and gas development in remote harsh environments: engineering challenges and research opportunities. *Safety in extreme environments*, 5(1), 17-33.
- Agbonifo, P. E. (2015): Opportunities, Challenges and Obstacles to Economic Growth and Sustainable Development Through Natural Gas in Nigeria. *Journal of Sustainable Development in Africa*, Vol. 17, No. 5.
- Agbonifo, P. E. (2016): Natural Gas Distribution Infrastructure and the Quest for Environmental Sustainability in the Niger Delta: The Prospect of Natural Gas Utilization in Nigeria. *International journal of Energy economics and Policy*, Vol. 6, Issue 3, pg 442 to 448.
- Al-Aboudi, M. A. M. (2024): Taking Advantage of a Window of Opportunity in the KRG-Baghdad Gas Standoff, Policy Analysis
- Al-Awsat, A (2023): A Quarter of Iraq's Population Lives Below the Poverty Line. Available online at: <https://english.aawsat.com/hoe/article/4092091/quarter-iraqs-population-lives-below-poverty-line> (access on 24/3/23).
- Aqrabi-Whitcomb, P. (2021): Ending Gas Flaring and Powering a Sustainable Economy of the Kurdistan Region of Iraq. The Payne Institute for Public Policy, Colorado School of Mines, USA.
- Aziz, P. A. (2023): Duhok struggles with highest poverty levels in Kurdistan Region. Available online at: <https://perefraf.com/en/investigation/5783> (accessed on 27/3/24)
- Charles, J. H., Hepp, B and Davis M. (2020): Celebrating successful flare capture projects with independent data-driven evidence, Capterio. Available online at: <https://flareintel.com/wp-content/uploads/2021/04/20210415-Capterio-article-celebrating-successful-flare-capture-projects-final.pdf> (accessed on 8/5/24)
- Choi, P. M., O'Brien, J. W., Tscharke, B. J., Mueller, J. F., Thomas, K. V., & Samanipour, S. (2020). Population socioeconomics predicted using wastewater. *Environmental Science & Technology Letters*, 7(8), 567-572.
- Elvidge, C.D., Bazilian, M.D., Zhizhin, M., Ghosh, T., Baugh, K., Hsu, F.-C. (2018): The potential role of natural gas flaring in meeting greenhouse gas mitigation targets. *Energy Strateg. Rev.* 20, 156-162. <https://doi.org/10.1016/j.esr.2017.12.012>.
- Farina, M. F. (2010): Flare Gas Reduction: Recent global trends and policy considerations GE Energy Global Strategy and Planning
- Fisher, D. and Wooster, M. J. (2019): Multi-decade global gas flaring change inventoried using the ATSR-1, ATSR-2, AATSR and SLSTR data records. *Remote Sensing of Environment*, pg. 1 – 16
- Flanagan, B. E., Hallisey, E. J., Adams, E., & Lavery, A. (2018). Measuring community vulnerability to natural and anthropogenic hazards: the Centers for Disease Control and Prevention's Social Vulnerability Index. *Journal of environmental health*, 80(10), 34.
- Gysels, M., Evans, N., Meñaca, A. E. A., Toscani, F., Finetti, S., Pisman, H. R and Pool, R. (2020): Culture and end of life care: a scoping exercise in seven European countries. *The Ethical Challenges of Emerging Medical Technologies*, 335-350.
- Henry, L. A., Harries, D., Kingston, P., & Roberts, J. M. (2017): Historic scale and persistence of drill cuttings impacts on North Sea benthos. *Marine environmental research*, 129, 219-228.
- Jokar, S. M., Wood, D. A., Sinebaghizadeh, S., Parvasi, P. and Javanmardi, J. (2021): Transformation of associated natural gas into valuable products to avoid gas wastage in the form of flaring. *Journal of Natural Gas Science and Engineering*, Vol. 94
- KRG Statistics Board (2022): Kurdistan Region Statistics Office, Ministry of Planning, Kurdistan Regional Government.
- Lee, J. Y., Watt, R. G., Williams, D. M., & Giannobile, W. V. (2017). A new definition for oral health: implications for clinical practice, policy, and research. *Journal of Dental Research*, 96(2), 125-127.
- Mills, R. (2016): *Under the Mountains*, Oxford Institute for Energy Studies

- Murphy, K., Stone, K., Cameron, E. S., Strand, L., Combs, C., Khan, A., & Ungar, M. (2022). "Steeped in Oil": The Socio-Psychological Factors and Processes That Influence Community Members' Attitudes toward Economic Diversification in an Oil and Gas-Producing Community. *Society & Natural Resources*, 35(9), 936-954.
- Murray, C. E., Davis, J., Rudolph, L., Graves, K. N., Colbert, R., Fryer, M., ... & Thigpen, B. (2016). Domestic violence training experiences and needs among mental health professionals: Implications from a statewide survey. *Violence and victims*, 31(5), 901-920.
- Obi, C. I. (2010): Oil Extraction, Dispossession, Resistance, and Conflict in Nigeria's Oil-Rich Niger Delta. *Canadian Journal of Development Studies*, 30 (1-2), pp. 219 - 233.
- Porter, L. (2023): KRG misses deadline to end gas flaring, Iraq Oil Report. Available online at: <https://www.iraqoilreport.com/news/krg-misses-deadline-to-end-gas-flaring-45482/>
- Qamar Energy (2021): Opportunities to Strengthen the Natural Gas Section in the Iraq Kurdistan Region: A Step Towards a Cleaner and More Secure Energy Future. US Department of Energy, Office of International Affairs
- Salih, M. Q., Hamadamin, R. R., & Hama, J. R. (2023). Emission and exposure of hydrogen sulfide in the air from oil refinery: Spatiotemporal field monitoring. *International Journal of Environmental Science and Technology*, 20(5), 4727-473
- Salih, M. S. (2022). Environmental Provisions in Iraqi Kurdistan Region Production Sharing Contracts.
- Saunders, M., Lewis, P. and Thornhill, A. (2007): *Research Methods for Business Students*, Harlow, Pearson Education Ltd (4th Ed.).
- Sarkari, M., Jamshidi, B. Khoshoei, M. A. and Fazlollahi, F. (2022): Flare gas reduction: A case study of integrating regeneration gas in flash gas compression network. *The Science and Technology of Fuel and Energy*, Volume 318,
- Shahab-Deljou, M., Medi, B., Kazi, M. and Jafari, M. (2023): A techno-economic review of gas flaring in Iran and its human and environmental impacts. *Process Safety and Environmental Protection*, Volume 173, pg. 642 – 665.
- Shkedi, A. (2005): *Multiple Case Narrative – A Qualitative Approach to Studying Multiple Populations*. Amsterdam: John Benjamins Publishing Co.
- Shuker, Z. (2022): Gas flaring in Iraq: Structural Issues, Geopolitical Players and Policy Implications
- Smith, L. G., Jones, P. J., Kirk, G. J., Pearce, B. D., & Williams, A. G. (2018). Modelling the production impacts of a widespread conversion to organic agriculture in England and Wales. *Land Use Policy*, 76, 391-404.
- Sosnowski, P. (2019): Rentier economy of the Kurdish Region in Iraq as a source of barriers for the Regional security sector reform. *Security and defence Quarterly*, 23(1), War Studies University, Poland.
- Tabaqchali, A. (2022): The Kurdistan Region of Iraq's Gas-Export Potential: Déjà Vu All Over Again. Atlantic Council Middle East Programs
- The World Bank, 2011. Global Gas Flaring Reduction Partnership: Improving Energy Efficiency & Mitigating Impact on Climate Change [WWW Document]. World Bank. [http://siteresources.worldbank.org/INTGGFR/Resources/GGFR_NewBrochure %28Oct2011%29.pdf](http://siteresources.worldbank.org/INTGGFR/Resources/GGFR_NewBrochure%28Oct2011%29.pdf), Accessed date: 22 June 2018
- Tonmukayakul, U., Shih, S. T., Bourke-Taylor, H., Imms, C., Reddihough, D., Cox, L., & Carter, R. (2018). Systematic review of the economic impact of cerebral palsy. *Research in developmental disabilities*, 80, 93-101
- U.S. Energy Information Administration (2023): Short-Term Energy Outlook September 2023.
- Vilsaint, C. L., NeMoyer, A., Fillbrunn, M., Sadikova, E., Kessler, R. C., Sampson, N. A. and Alegría, M. (2019). Racial/ethnic differences in 12-month prevalence and persistence of mood, anxiety, and substance use disorders: Variation by nativity and socioeconomic status. *Comprehensive psychiatry*, 89, 52-60.
- Wahab, B. and Ross, D. (2023): Iraq's Power Problem (Part 2): Implications of the New Oil-for-Gas Deal with Iran. The Washington Institute for Near East Policy.
- World Bank (2022): Global Flaring and Methane Reduction Partnership (GFMR).
- World Bank (2022): Global Gas Flaring Tracker Report, International Bank for Reconstruction and Development, Washington DC
- World Bank (2023): Global Gas Flaring Tracker Report, International Bank for Reconstruction and Development, Washington DC
- Zais, M., Aziz, B. and Waller, R. (2021): Gas in Iraq Kurdistan: Market Realities, Geopolitical Opportunities, The Policy Forum.
- Zimmerer, K. S., de Haan, S., Jones, A. D., Creed-Kanashiro, H., Tello, M., Carrasco, M., Meza, K., Plasencia Amaya, F., Cruz-Garcia, G. S., Tubbeh, R., & Jiménez Olivencia, Y. (2019). The biodiversity of food and agriculture (Agrobiodiversity) in the anthropocene: Research advances and conceptual framework. *Anthropocene*, 25, Article 100192. <https://doi.org/10.1016/j.ancene.2019.100192>.