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THE ENVIRONMENTAL AND PUBLIC HEALTH IMPLICATIONS OF CONTINUED NORTH SEA OIL AND GAS EXTRACTION IN THE UNITED KINGDOM

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ABSTRACT
The United Kingdom continues to license new oil and gas projects in the North Sea while maintaining legally binding net-zero targets. This paper examines the environmental and public health consequences of that contradiction. The analysis focuses on three areas: marine ecosystem degradation, climate and pollution risks, and health impacts across direct, indirect, and socio-economic dimensions. Offshore operations release thousands of tonnes of oil annually through produced water, leave contaminated cuttings piles on the seabed, and contribute to methane leakage. Routine discharges and small-scale spills cumulatively degrade benthic biodiversity. Downstream combustion of extracted fuels adds over 200 $MtCO_2e$ per year, a figure excluded from territorial emissions accounting. For workers, exposure to benzene and other hydrocarbons persists despite safety improvements. For the wider population, indirect effects—heat-related mortality, flooding, air pollution, and food system disruption—are harder to trace but carry greater long-term significance. Socio-economic dependence on the sector also creates instability and unevenly distributed burdens. The paper concludes that continued extraction is not a neutral transition strategy but a policy inconsistency. Managing decline rather than expanding production would better align with climate and health priorities. Recommendations include phasing down new licensing, strengthening independent monitoring, integrating health impact assessments into energy policy, and supporting regional economic diversification.

Keywords:
Environment, North Sea, Public Health, Oil & Gas, Extraction

1. INTRODUCTION
The extraction of oil and gas from the North Sea presents a paradox that affects the energy and environmental sectors of the United Kingdom. On the one hand, the United Kingdom positions itself as a global leader in terms of climate governance due to the enactment of the Climate Change Act 2008 (Averchenkova et al., 2020). On the other hand, the country continues to license and support new oil and gas developments in the North Sea, thereby prolonging dependence on fossil fuels whose combustion is incompatible with long-term decarbonisation goals (*What Does More North Sea Oil and Gas Mean for UK Energy Supply and Net Zero? - Grantham Research Institute on Climate Change and the Environment*, 2024). This duality raises critical questions as to whether continued North Sea extraction represents a rational transitional strategy or a structural inconsistency in UK environmental policy. Much of the existing discourse on the extraction of oil and gas from the North Sea is justified on the grounds of economic necessity and energy security. It has been argued, however, that domestic production reduces reliance on imports, supports employment, and provides a stable energy supply during the transition to renewable sources (Marks, 2023). However, this argument fails to acknowledge the temporal and spatial framing of costs and benefits. It addresses short-term economic gains and national accounting over environmental and public health consequences that unfold over longer time horizons and across different geographic boundaries (Marks, 2023). In doing so, it risks obscuring the extent to which the apparent benefits of continued extraction are contingent upon the externalisation of environmental degradation and health issues.
From an environmental perspective, the impacts of North Sea oil and gas activities extend beyond the immediate risks of spills or mere localised pollution. They are embedded within a global carbon system in which the majority of emissions arise at the stage of combustion (Shaw et al., 2023). Yet, these downstream emissions are frequently excluded from national carbon accounting frameworks, which allows the UK to maintain a formal commitment to emissions reduction while facilitating the production of fuels that will be burned elsewhere. This gap raises important questions about the integrity of climate governance and whether current policy frameworks meaningfully capture the full environmental costs of oil extraction. The public health implications of continued extraction are grossly underexamined. While direct health risks associated with offshore operations and coastal pollution are relatively well recognised, the indirect effects mediated through climate change are more significant (Johnston et al., 2019). Rising temperatures, extreme weather events, and disruptions to food and water systems

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all have implications for human health, both within and beyond the UK. The continuation of oil extraction, therefore, contributes to a global health crisis, the costs of which are unevenly distributed across populations and generations. This paper argues that continued North Sea oil and gas extraction is best understood as a manifestation of political and institutional dynamics that prioritise short-term stability over long-term sustainability. The paper seeks to expose the tensions and contradictions that underpin the current UK energy strategy. In doing so, it challenges the prevailing narrative that continued extraction is compatible with public health.

2. OVERVIEW OF THE NORTH SEA OIL AND GAS ACTIVITIES

The trajectory of oil and gas extraction in the North Sea is often narrated as a story of technological achievement and economic transformation. However, a closer examination reveals a sector increasingly defined by decline, structural inertia, and contested policy relevance. Since production began in the late 1960s, the United Kingdom Continental Shelf (UKCS) has yielded approximately 47.7 billion barrels of oil equivalent, and this has positioned the UK as a major historical producer within Europe (UK GOV, 2024). However, this legacy of abundance now sharply contrasts with the reality of diminishing returns, rising costs, and intensifying environmental scrutiny, raising fundamental questions about the continued strategic importance of the sector. Research has shown that the UK oil and gas production peaked at approximately 2.9 million barrels of oil equivalent per day in 1999 but had declined to about 578-693, 000 barrels per day by 2024 (StatBase, 2025). Projections suggest further decline to around 0.7 million barrels per day by 2029, indicating that the basin has entered a mature phase characterised by depletion and reduced productivity (Hughes, 2013). This trajectory reflects the fact that remaining reserves are harder to access, more technically challenging, and increasingly expensive to exploit. Further, this illustrates the diminishing economic efficiency of extraction.

Despite this decline, the North Sea continues to play a notable role in the UK's energy system. Current production still meets close to half of the country's oil and gas demand, suggesting that the sector retains short-term relevance for domestic supply (*The Future of Scotland's Oil and Gas Industry*, 2024). However, this contribution must be interpreted within the context of global energy markets. Oil and gas produced in the North Sea are not reserved exclusively for domestic consumption but are traded internationally, often exported and replaced with imports of different grades or forms (Linde et al., 2022). This undermines the narrative that domestic extraction directly translates into energy independence. Instead, it reveals the UK's continued integration into a globalised fossil fuel system in which price formation and supply dynamics are largely external to national control. The persistence of North Sea activities is also closely tied to the physical and institutional infrastructure that has developed over decades. Offshore platforms, subsea pipelines, and processing facilities represent significant sunk investments that create strong incentives for continued utilisation. This infrastructural embeddedness contributes to what is often described as "carbon lock-in," wherein past capital investments constrain present policy choices and make rapid transition more difficult (Lazarus et al., 2015). The existence of these assets influences regulatory and political decision-making, as governments seek to maximise returns on existing infrastructure rather than prematurely decommission it.

Estimates from the North Sea Transition Authority indicate that approximately 2.9 billion barrels of oil equivalent remain in proven and probable reserves, with an additional 6.2 billion barrels classified as contingent resources (North Sea Transition Authority, 2024). While these figures suggest that extraction could continue for several decades under favourable conditions, they also the fact that only a fraction of these resources may ultimately be economically viable or environmentally permissible to exploit. The distinction between technically recoverable and economically recoverable reserves becomes increasingly significant in areas where climate policy, carbon pricing, and investor pressures are reshaping the viability of fossil fuel projects. Furthermore, the UK's position within the North Sea region reveals important contrasts that challenge assumptions about the inevitability of continued extraction. While Norway has maintained relatively high production levels through sustained state investment and strategic management, the UK sector has experienced a steeper and more consistent decline (Beller et al., 1999). This divergence reflects differences in governance models and long-term policy planning. It suggests that the trajectory of North Sea extraction is not purely determined by geology but shaped by political and institutional choices, including fiscal regimes, regulatory frameworks, and approaches to energy transition. In this sense, continued investment in new fields and extended production cycles appears paradoxical. On one hand, new developments such as marginal field tie-backs and enhanced recovery techniques aim to extract additional value from remaining reserves. On the other hand, the incremental gains from such projects are relatively small in comparison to historical output and may have limited impact on national energy supply. Critics argue that new

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licensing rounds and field developments yield only marginal contributions to domestic demand, raising questions about whether such policies are driven by substantive energy needs or by the desire to sustain industry activity in the short term (*A Review of the 2020/2021 Marginal Fields Bid Licensing Round in Nigeria*, 2023).

3. ENVIRONMENTAL IMPLICATIONS OF CONTINUED NORTH SEA OIL EXTRACTION

The continued extraction of natural mineral resources from the North Sea has profound environmental implications for residents of the United Kingdom and even beyond. These implications include marine degradation, climate change and green house emission, pollution and environmental risks. This section will examine these environmental impacts in detail.

3.1. Marine Ecosystem Degradation

The degradation of marine ecosystems associated with continued North Sea oil and gas extraction is often framed as spatially limited and technically manageable. However, empirical evidence increasingly challenges this assumption, demonstrating that ecological impacts are both intensely localised and cumulatively systemic, with consequences that extend beyond immediate extraction zones (Asif et al., 2022). Rather than representing isolated disturbances, offshore activities contribute to long-term transformations in seabed ecology, biodiversity structure, and trophic dynamics, raising fundamental questions about the sustainability of continued extraction under existing regulatory frameworks (Liv Stranddorf et al., 2025). One of the most significant pathways of ecological degradation is the discharge of produced water, drilling cuttings, and associated contaminants into the marine environment. Produced water, a by-product of oil extraction, contains hydrocarbons, heavy metals, and naturally occurring radioactive materials (Bakke et al., 2013). While regulatory regimes permit controlled discharges, the cumulative scale of these releases is substantial. Studies based on long-term seabed monitoring reveal that sediment contamination near oil platforms can reach levels thousands of times higher than in surrounding areas, with hydrocarbons such as n-alkanes recorded at increases exceeding 10,000 percent within a 500-metre radius of installations (Ionescu, 2024). These findings undermine the notion that environmental impacts are effectively diluted or dispersed in offshore environments, instead indicating the formation of concentrated pollution hotspots around infrastructure.

Empirical analyses drawing on more than three decades of benthic survey data demonstrate a consistent decline in species richness of approximately 28–30% in areas adjacent to oil and gas platforms (Chen et al., 2024). This loss of biodiversity reflects a deeper restructuring of ecological communities. Specialist species and higher trophic-level organisms, including predators and filter feeders, are disproportionately affected, while opportunistic generalist species become dominant. In one documented case, the abundance of the opportunistic worm *Capitella capitata* increased by up to 28 times in polluted zones, while predatory species experienced declines of around 70% (Tsutsumi, 1990). Such shifts indicate a transition toward simplified ecosystems characterised by reduced functional diversity and diminished ecological resilience. This simplification of marine food webs is particularly significant from an analytical point of view. Healthy ecosystems are typically defined by complex trophic interactions and high levels of biodiversity, which confer stability and adaptability in the face of environmental stress (Nehul, 2025). In contrast, ecosystems surrounding North Sea oil platforms exhibit shorter, less complex food chains, with fewer trophic linkages and reduced energy transfer efficiency (Nehul, 2025). This structural degradation suggests a reduced capacity for recovery, as simplified systems are more vulnerable to additional stressors such as climate change and overfishing. The implication is that the environmental impact of extraction is not temporary but may lead to long-term or even irreversible ecological transformation.

Beyond direct contamination, the physical presence of offshore infrastructure also contributes to ecosystem alteration. Oil platforms, pipelines, and associated installations modify seabed habitats, sometimes creating artificial reef-like structures that attract certain species (Ronen Galaiduk et al., 2024). While this is occasionally cited as evidence of ecological benefit, it is analytically misleading. The apparent increase in biomass around structures does not equate to ecological health but often reflects species redistribution rather than genuine biodiversity enhancement (Oliveira et al., 2024). Moreover, these artificial habitats are embedded within polluted environments, limiting their capacity to support diverse and stable communities. The net effect is therefore not ecological enrichment but structural distortion of natural habitats. Another critical aspect of marine degradation is the persistence of legacy pollution. Although regulatory changes in the early 2000s restricted the discharge of oil-based drilling cuttings, vast quantities of contaminated material remain on the seabed (Loss et al., 2026). These deposits continue to leach pollutants over time, creating long-term sources of contamination that are difficult to remediate without causing further disturbance. The decision to leave such materials *in situ* reflects a pattern in

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environmental governance, where the risks of active intervention are weighed against the costs of inaction, often resulting in the normalisation of ongoing ecological harm**.**

3.2. Climate Change and Greenhouse Gas Emission

Offshore oil and gas production on the UK Continental Shelf is responsible for approximately 14–16 million tonnes of carbon dioxide equivalent ($MtCO_2e$) annually from operational activities such as extraction, processing, and transportation (North Sea Transition Authority, 2022; Stuart et al., as cited in Riddick et al., 2019). These emissions represent a relatively small share of the UK's territorial greenhouse gas inventory, which stood at around 384 $MtCO_2e$ in 2023 (Department for Energy Security and Net Zero, 2024). However, this comparison is misleading because it excludes the larger emissions associated with the end use of the extracted fuels. When oil and gas produced in the North Sea are burned, they generate emissions that are several times greater than those produced during extraction. Estimates suggest that the lifecycle emissions of UK oil and gas production exceed 200 $MtCO_2e$ per year when downstream combustion is included (Ritchie, 2020), placing them among the most significant contributors to global emissions linked to UK-based activities.

This discrepancy highlights the central role of "Scope 3" emissions in understanding the climate impact of fossil fuel extraction. Under current international accounting frameworks, including those established by the United Nations Framework Convention on Climate Change (UNFCCC), countries are required to report emissions produced within their territorial boundaries but are not held directly accountable for emissions resulting from the consumption of exported fuels (UNFCCC, n.d.; Peters & Hertwich, 2008). This creates a structural gap in climate governance, whereby the UK can continue to license and produce fossil fuels while formally reducing its domestic emissions. The effect is not merely technical but political, as it allows governments to present an image of climate progress that is decoupled from the full carbon consequences of their energy policies (Hilson, 2025). The implications of this accounting gap are particularly significant in light of the UK's legally binding net-zero target under the Climate Change Act 2008 (UK Parliament, 2008). Achieving net-zero emissions by 2050 requires not only reductions in domestic emissions but also a broader alignment of energy production with global decarbonisation pathways (Climate Change Committee, 2023). Yet, continued investment in North Sea extraction risks locking in future emissions that are incompatible with these trajectories. According to the International Energy Agency (IEA, 2021), scenarios consistent with limiting global warming to 1.5°C do not require the development of new oil and gas fields beyond those already approved. This suggests that ongoing licensing in the North Sea is not aligned with internationally recognised pathways to climate stabilisation (IEA, 2021), raising questions about the coherence of UK energy policy.

Proponents of continued extraction often argue that domestically produced oil and gas have a lower carbon intensity than imported alternatives, thereby reducing overall emissions (Porter, 2026). While it is true that UK offshore operations have achieved reductions in operational emissions—reportedly decreasing by around 20 percent between 2018 and 2023 (North Sea Transition Authority, 2025)—this argument rests on a selective interpretation of carbon intensity. It focuses on emissions per unit of production rather than total lifecycle emissions, which are dominated by combustion (Evans, 2025). From a global carbon budget perspective, the origin of the fuel is largely irrelevant; what matters is the total volume of fossil fuels extracted and burned. Consequently, the claim that domestic production is environmentally preferable risks functioning as a justificatory narrative that diverts attention from the need to reduce overall fossil fuel supply.

Moreover, the continued extraction of North Sea resources contributes to what can be described as a "supply-side lock-in" effect. By extending the lifespan of fossil fuel infrastructure and maintaining production capacity, it reinforces expectations of continued availability and consumption, thereby delaying the transition to low-carbon energy systems (Seto et al., 2016). Empirical analyses indicate that investments in new oil and gas projects can extend production timelines by decades, effectively committing future generations to higher cumulative emissions (Erickson et al., 2015). This dynamic is particularly problematic in a context where the remaining global carbon budget for limiting warming to 1.5°C is rapidly shrinking. The Intergovernmental Panel on Climate Change (IPCC) estimates that the world has a limited carbon budget of approximately 400–500 gigatonnes of CO_2 from 2020 onwards to maintain a reasonable chance of meeting this target (IPCC, 2022). Continued expansion of fossil fuel extraction, therefore represents a direct challenge to these limits (Ritchie, 2020).

In addition to its contribution to global emissions, North Sea extraction also has regional climate implications through the release of methane, a greenhouse gas with a global warming potential significantly higher than carbon dioxide over a 20-year period. Methane emissions from offshore operations, including leaks and venting, have been estimated to account for a non-negligible share of total greenhouse gas emissions from the sector. Although

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efforts have been made to reduce methane leakage, monitoring remains incomplete, and actual emissions may be higher than reported due to measurement uncertainties (Riddick et al., 2019). This further complicates the assessment of the sector's climate impact and suggests that official figures may understate the true scale of emissions (Green Alliance, 2024).

3.3. Pollution and Environmental Risks

The environmental risk profile of offshore extraction is therefore best understood as a combination of chronic pollution, legacy contamination, and residual accident risk, all of which interact within a governance framework that tends to manage rather than eliminate harm (OSPAR Commission, 2022). This raises a central question: whether current regulatory practices genuinely mitigate environmental risk or instead normalise a steady baseline of ecological degradation.

A substantial share of pollution in the North Sea arises from continuous operational discharges, particularly produced water. In the UK sector, annual discharges of produced water typically exceed 300 million tonnes, containing dispersed oil, production chemicals, and trace metals (OSPAR Commission, 2022). Even at regulated concentrations—often capped around 30 milligrams of oil per litre—this volume translates into thousands of tonnes of oil released into the marine environment each year (OSPAR Commission.). Data compiled by the OSPAR Commission indicate that oil discharges via produced water across the wider North-East Atlantic have remained in the range of 4,000–5,000 tonnes annually in recent years, with the UK continental shelf accounting for a significant proportion (OSPAR Commission, 2022). The regulatory logic underpinning these discharges is dilution: contaminants are deemed acceptable if sufficiently dispersed (Bom, 2023). However, empirical studies show that dilution does not eliminate ecological impact; instead, it redistributes pollutants across wider areas, creating diffuse but persistent exposure pathways for marine organisms (Meier et al., 2010).

The chemical composition of these discharges further complicates their environmental impact. Produced water contains polycyclic aromatic hydrocarbons (PAHs), alkylphenols, and heavy metals such as mercury and cadmium, many of which are bioaccumulative and toxic at low concentrations (Meier et al., 2010). Monitoring programmes have detected elevated concentrations of these substances in sediments and biota near offshore installations, with measurable biological effects including impaired reproduction and endocrine disruption in fish populations. Experimental and field-based studies have shown that exposure to alkylphenols can interfere with hormone systems in species such as cod and haddock, while PAHs are associated with carcinogenic and mutagenic effects (Meier et al., 2010; Tollefsen et al., 2011). These findings challenge the assumption that compliance with discharge limits equates to environmental safety, suggesting instead that regulatory thresholds may not fully account for sub-lethal and long-term ecological impacts.

In addition to routine discharges, the North Sea is subject to frequent small-scale spills and accidental releases that cumulatively contribute to pollution levels. Official statistics from the UK offshore industry report hundreds of hydrocarbon release incidents annually, the majority classified as minor. For example, data from the Health and Safety Executive and the North Sea Transition Authority indicate that between 300 and 400 reportable releases occur each year, with total volumes often exceeding 100 tonnes of oil equivalent (Oceana, 2024). While individual incidents may be small, their frequency suggests a systemic issue in operational integrity. Moreover, reliance on self-reporting raises concerns about underestimation, particularly for minor leaks that may go undetected or unreported. Research has shown that the true volume of chronic oiling events may be underestimated by 43% or more due to opaque and incomplete reporting standards (Oceana, 2024). The analytical significance lies not in any single event but in the aggregate effect of repeated releases, which contribute to chronic environmental exposure.

The risk of major oil spills, although statistically less frequent, remains a defining feature of offshore extraction. Historical events such as the Piper Alpha disaster underscore the potential scale of catastrophic failure. The Piper Alpha release is estimated to have spilled 670 tonnes of oil, causing lasting damage to marine life (Graham, 2024). More recent incidents, including the 2011 Gannet Alpha spill in the UK North Sea, released an estimated 200 tonnes of oil, demonstrating that large spills remain a credible risk even in a mature regulatory environment (Reuters, 2015). Risk assessments conducted by industry and government bodies typically assign low probabilities to such events, yet their potential impact is extremely high, affecting wide areas of marine habitat and requiring prolonged recovery periods. This creates a classic "low-probability, high-consequence" risk profile that is difficult to fully mitigate through regulation alone.

Legacy pollution from historical practices adds a further layer of environmental risk. Prior to stricter regulations introduced in the early 2000s, oil-based drilling cuttings were routinely discharged onto the seabed, forming

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cuttings piles that remain contaminated with hydrocarbons and heavy metals (Schaanning et al., 2020). Surveys estimate that hundreds of such piles exist across the UK continental shelf, with some containing oil concentrations exceeding 100,000 milligrams per kilogram of sediment (Schaanning et al., 2020). These deposits act as long-term sources of contamination, slowly releasing pollutants into surrounding environments and affecting benthic communities (Schaanning et al., 2020). The decision to leave most cuttings piles in place reflects a regulatory trade-off: removal could cause further disturbance, while in situ management accepts ongoing pollution. This illustrates a broader pattern in environmental governance, where historical contamination is effectively absorbed into the baseline condition of the ecosystem rather than fully remediated.

Another aspect of environmental risk is associated with infrastructure ageing and decommissioning. Many North Sea installations are now operating beyond their original design life, increasing the likelihood of equipment failure and leaks. The UK faces the challenge of decommissioning more than 1,500 wells and hundreds of platforms and pipelines over the coming decades, with estimated costs exceeding £40 billion (Oil & Gas UK, 2019). Decommissioning itself carries environmental risks, including disturbance of contaminated sediments and potential release of trapped hydrocarbons (Fowler et al., 2014). Furthermore, not all infrastructure is removed; some pipelines and subsea structures are left in place, raising questions about long-term monitoring and liability (Fowler et al., 2020). The scale and complexity of decommissioning highlight that environmental risks do not end with production but extend far into the post-operational phase.

4. IMPLICATIONS ON PUBLIC HEALTH

The public health implications of continued North Sea oil and gas extraction extend beyond immediate occupational hazards to encompass broader environmental and socio-economic effects. These impacts are often diffuse and unevenly distributed, raising critical concerns about regulatory adequacy, long-term health risks, and the extent to which such burdens are externalised within current energy policy frameworks. These impacts will be addressed hereunder.

4.1. Direct Health Impacts

Direct health impacts linked to North Sea oil and gas extraction tend to receive less public attention than environmental damage, yet the evidence points to a set of risks that are persistent, measurable, and unevenly regulated. These impacts are most visible among offshore workers, but they also extend to coastal populations through air and water pathways. The issue is not simply the existence of hazards, but how routinely they are treated as acceptable within operational norms.

Offshore workers operate in conditions where exposure to hazardous substances is built into the job. Hydrocarbon vapours, volatile organic compounds such as benzene, and combustion by-products from flaring and power generation are part of the working environment (Wilde et al., 2025; Steinsvåg et al., 2007). Benzene exposure, even at low concentrations over long periods, is associated with blood disorders and increased cancer risk (Burrup, 2025). Studies from offshore installations in the North Sea and comparable regions have shown that workers in certain roles, particularly those involved in maintenance and processing, experience higher cumulative exposure than safety guidelines assume (Ridderseth, 2023; Steinsvåg et al., 2007). While monitoring systems exist, they often rely on periodic sampling rather than continuous measurement, which can miss short-term peaks that carry significant health implications (Ridderseth, 2023).

Air quality on offshore platforms is shaped by confined spaces, diesel-powered equipment, and routine flaring. Nitrogen oxides and fine particulate matter are common by-products (Petroleum Safety Authority Norway, 2020). These pollutants are linked to respiratory conditions, including reduced lung function and chronic irritation (Petroleum Safety Authority Norway, 2020). Workers frequently report symptoms such as headaches, fatigue, and throat irritation (Petroleum Safety Authority Norway, 2020; Parkes, 2012). These are often treated as minor or temporary effects, yet their persistence raises questions about whether current exposure limits reflect real working conditions. The framing of such symptoms as manageable side effects tends to obscure the cumulative burden over time.

The physical environment adds another layer of strain. Offshore work involves long shifts, high noise levels, and exposure to vibration. Noise-induced hearing loss remains one of the most documented occupational issues in the sector (Lai, 2001). Hearing protection is standard, but compliance and effectiveness vary, particularly in high-intensity operational zones (Lai, 2001). Fatigue is another concern. Rotational work patterns, often involving extended periods offshore, disrupt sleep cycles and increase the risk of accidents (Parkes, 2012). Fatigue also interacts with chemical exposure, compounding its effects on concentration and overall health.

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Chemical exposure is not limited to hydrocarbons. Workers may come into contact with drilling fluids, corrosion inhibitors, and cleaning agents. Some of these substances contain compounds that can irritate the skin, eyes, and respiratory system (Ormerod et al., 1989; Alfonso et al., 2019). In certain cases, prolonged exposure has been linked to dermatitis and other chronic conditions (Ormerod et al., 1989; Alfonso et al., 2019). The regulatory approach typically assesses each substance in isolation, yet real-world exposure involves mixtures. The combined effects of multiple chemicals remain less well understood and are rarely captured in standard risk assessments (Rider & Simmons, 2018).

For coastal communities, direct exposure is less intense but still relevant. Emissions from offshore activities can reach shorelines, particularly under certain weather conditions. Studies have detected elevated levels of pollutants in areas close to major offshore hubs (Wilde et al., 2025). While concentrations are generally lower than those found on platforms, long-term exposure remains a concern. Fishing communities may also face risks through contact with contaminated water or seafood, although this pathway is less consistently monitored.

Emergency incidents present another dimension of direct health impact. Fires, explosions, and major leaks are rare but not negligible. When they occur, the consequences are immediate and severe. The history of offshore extraction includes incidents that have led to loss of life and long-term health consequences for survivors (Cullen, 1988). Safety standards have improved, but the underlying risks have not disappeared. Ageing infrastructure and extended operational lifespans introduce new uncertainties (Offshore Petroleum Regulator, 2012). Equipment that was not designed for decades of continuous use may be more prone to failure, increasing the likelihood of exposure during accidents.

4.2. Indirect Health Implications

The indirect health effects of continued North Sea oil and gas extraction are harder to pin down than immediate occupational risks, but they are wider in scope and often more damaging over time (Mulcahy, 2024; UK Health Alliance on Climate Change, 2025). These impacts sit within the broader relationship between fossil fuel use and climate change (Muttitt et al., 2025). Extraction feeds a system that drives rising temperatures, unstable weather patterns, and environmental shifts that shape health outcomes in ways that are uneven and often delayed (Mitchell et al., 2024).

One of the clearest pathways runs through climate change itself. Oil and gas taken from the North Sea do not stay offshore. Once burned, they contribute to greenhouse gas accumulation, which alters temperature and weather systems (Muttitt et al., 2025). The United Kingdom has already seen an increase in heatwaves over the past two decades, with higher average summer temperatures and more frequent extreme heat events (Mulcahy, 2024). Between June and August 2022, over 3,000 excess deaths were recorded in England and Wales during five heat periods (Mulcahy, 2024). Heat exposure is not a marginal issue. It raises the risk of dehydration, cardiovascular strain, and respiratory problems, especially among older adults and people with pre-existing conditions (Thompson et al., 2024; Mitchell et al., 2024). Mortality rates tend to rise during prolonged heat periods, even in countries with developed health systems (Mulcahy, 2024).

Flooding presents another route through which climate-linked changes affect health. Parts of the UK are already prone to coastal and river flooding, and rising sea levels increase that risk (Munro et al., 2024). Flood events do more than damage property. They disrupt access to clean water, increase the spread of waterborne diseases, and leave lasting psychological effects on affected communities (Munro et al., 2024). Anxiety, depression, and long-term stress are common after repeated exposure to flooding (Munro et al., 2024; UK Health Security Agency, 2024; Oxford University Press, 2024). People who experience flooding are at higher risk of depression, anxiety, and post-traumatic stress disorder (PTSD), with the risk of long-term mental health problems reported to be up to nine times more likely for flood victims compared to those who have never experienced flooding (Oxford University Press, 2024). These outcomes do not show up in short-term health statistics but place sustained pressure on individuals and public health systems (Munro et al., 2024).

Air quality adds another layer to the indirect impact. Fossil fuel extraction feeds into a wider system of combustion that releases pollutants such as nitrogen oxides and fine particulate matter (PM2.5) (Healthy Air Coalition, 2023). These pollutants are linked to asthma, chronic obstructive pulmonary disease, and cardiovascular illness (UK Health Alliance on Climate Change, 2024). Even when emissions occur far from population centres, they contribute to regional air quality patterns (Healthy Air Coalition, 2023). Research in the UK has consistently linked air pollution to thousands of premature deaths each year: in the UK, exposure to outdoor air pollution contributes to about 30,000 deaths every year (Mulcahy, 2024), and PM2.5 exposure alone is estimated to cause up to 43,000 premature deaths annually (Healthy Air Coalition, 2023). The connection between extraction and

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these outcomes is not always direct, but it is part of the same chain. Production enables consumption, and consumption shapes exposure.

Food systems are also affected in less obvious ways. Climate change influences crop yields, fish stocks, and supply stability (Pinnegar & Buckley, 2024). Warmer ocean temperatures and changing currents can alter fish distribution in the North Sea, affecting both ecosystems and the communities that depend on them (Pinnegar & Buckley, 2024). Disruptions in food supply can lead to price increases and reduced access to nutritious food, particularly for lower-income households (UK Health Alliance on Climate Change, 2025). Poor nutrition is tied to a range of health issues, including weakened immune systems and higher rates of chronic disease.

Mental health sits at the intersection of these pressures. Climate-related disruption, economic uncertainty, and environmental change create a background level of stress that is hard to quantify but widely reported (McCall, 2025). People living in areas affected by environmental decline often describe a sense of loss tied to changing landscapes and livelihoods. This is sometimes referred to as ecological grief (McCall, 2025). Direct impacts include anxiety, stress, and trauma from floods and droughts, and increased risks of suicide and symptoms of mental health disorders from heat and air pollution (McCall, 2025). "Eco-emotions" stem from prolonged exposure to climate change-related issues, including grief and guilt over environmental damage and anxiety about future climate-related hazards (McCall, 2025). It does not fit neatly into clinical categories, but it reflects a real psychological burden.

What makes these indirect effects difficult to address is the way they are distributed. The benefits of oil and gas extraction tend to be concentrated, while the health impacts are dispersed across populations and over time. Coastal communities, older populations, and those with fewer resources are often more exposed to the consequences (UK Health Alliance on Climate Change, 2025). The link between cause and effect is stretched across space and time, which allows responsibility to become blurred (Mitchell et al., 2024).

4.3. Socio-economic Health Impacts

The socio-economic effects of North Sea oil and gas extraction shape health outcomes in ways that are less visible than direct exposure but just as significant. These effects sit at the intersection of income, employment, regional inequality, and access to services (O'Neil & Ellis, 2018). Health in this context is not only about disease or injury. It reflects living conditions, job security, and the stability of local economies that depend on a single industry (Thombs & Willis, 2025).

For decades, the oil and gas sector has provided high-paying jobs, particularly in regions such as northeast Scotland (REHIS, 2017; Shapovalova et al., 2021). Cities like Aberdeen have benefited from this concentration of economic activity (Shapovalova et al., 2021). Higher wages can support better housing, improved diets, and access to private healthcare. These factors tend to produce positive health outcomes for those directly employed in the industry (REHIS, 2017). However, this benefit is uneven. It is tied to a specific skill set and a limited segment of the population. Those outside the sector often do not share the same advantages, even when they live in the same region (Shapovalova et al., 2021).

This uneven distribution creates a pattern of local inequality (Shapovalova et al., 2021). While some households experience financial stability, others face rising living costs linked to the presence of a high-income workforce. Housing prices in oil-dependent areas have historically been higher than national averages, placing pressure on lower-income residents (Shapovalova et al., 2021; Grampian Regional Council, 1970s, as cited in Shapovalova et al., 2021). Increased costs can reduce access to adequate housing and strain household budgets. These pressures have clear links to health, including stress, poor nutrition, and reduced ability to manage chronic conditions.

Economic dependence on oil and gas also introduces a level of instability that affects long-term health (Thombs & Willis, 2025). The sector is tied to global price fluctuations. When oil prices fall, job losses follow. The downturn in 2014 led to tens of thousands of job cuts across the UK offshore industry, with an estimated 120,000 jobs shed between 2014 and 2016 alone (O'Neil & Ellis, 2018). Redundancy on that scale has immediate financial consequences, but it also carries psychological effects. Unemployment is associated with higher rates of depression, anxiety, and substance misuse (O'Neil & Ellis, 2018). Communities built around a single industry are more exposed to these shocks because there are fewer alternative employment options (Thombs & Willis, 2025).

The structure of offshore work adds another layer to the socio-economic picture (Parkes, 2012; O'Neil & Ellis, 2018). Rotational schedules often involve long periods away from home. Workers may spend weeks offshore followed by shorter periods onshore. This pattern can strain family relationships and disrupt social support networks (Parkes, 2012; O'Neil & Ellis, 2018). Research on offshore workers has linked these schedules to higher levels of stress and difficulty maintaining stable family life (Parkes, 2012). The impact is not confined to the

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workers themselves. Partners and children also experience the effects of absence and irregular routines, which can influence mental health and overall wellbeing (O'Neil & Ellis, 2018).
Access to healthcare services can also vary across oil-dependent regions (Hanlon et al., 2010). While higher incomes may allow some individuals to seek private care, public health services in these areas can face uneven demand. Population changes driven by industry cycles can strain local infrastructure. During periods of growth, an influx of workers increases demand for housing, schools, and healthcare. When the sector contracts, funding and service provision may not adjust at the same pace. This mismatch can leave gaps in care, particularly for vulnerable groups.
There is also a broader issue of how the benefits and costs of extraction are distributed across society (Muttitt & McKenna, 2020). Revenues generated from North Sea oil have contributed to national income, but the long-term health costs linked to environmental damage and climate change are spread more widely (Muttitt & McKenna, 2020). Communities that do not benefit economically may still face the consequences of pollution or climate-related disruption. This imbalance raises questions about fairness. It highlights a disconnect between who gains from extraction and who bears its indirect health burdens (Muttitt & McKenna, 2020).

5. RECOMMENDATIONS

1) A first step is to address the mismatch between climate commitments and ongoing licensing. Continued approval of new oil and gas projects sits uneasily with long-term emissions targets. A gradual phase-down of new licensing, paired with clear timelines, would reduce uncertainty and signal a shift in direction. This approach allows existing operations to wind down while avoiding the expansion of future emissions. Without such clarity, policy risks remaining reactive and inconsistent.
2) Regulatory frameworks also require closer scrutiny. Current systems tend to focus on compliance with discharge limits rather than cumulative impact. Monitoring should shift toward long-term ecological and health outcomes, not just short-term thresholds. Continuous measurement of emissions, including methane leaks and flaring, would provide a more accurate picture of environmental performance. Independent verification of industry data would strengthen transparency and reduce reliance on self-reporting.
3) Public health needs to be more directly integrated into energy policy. Health impact assessments are often treated as secondary to economic considerations. This balance can be adjusted by requiring that major licensing decisions include a detailed evaluation of both direct and indirect health effects. These assessments should consider long-term exposure, not only immediate risks. Strengthening occupational health monitoring for offshore workers would also address gaps in current oversight, particularly in relation to cumulative chemical exposure.
4) Regions that depend on oil and gas require targeted support to diversify their economies. This includes funding for infrastructure, education, and local industry development. Without this support, the shift away from fossil fuels risks deepening regional inequalities. A well-managed transition can reduce these risks while maintaining economic resilience.
5) Environmental remediation should not be treated as a secondary concern. Decommissioning of offshore infrastructure presents an opportunity to address legacy pollution, but it also carries risks if handled poorly. Clear standards for decommissioning, including long-term monitoring of abandoned sites, would help prevent further contamination. Funding mechanisms should ensure that operators remain responsible for environmental costs rather than transferring them to the public.

6. CONCLUSION

Continued oil and gas extraction in the North Sea reflects a tension that runs through current UK energy policy. The sector still contributes to supply and employment, yet its environmental and public health costs are difficult to reconcile with long-term climate commitments. Evidence from marine ecosystems shows sustained degradation, while emissions linked to extracted fuels extend far beyond national accounting frameworks. These impacts are not isolated. They are embedded in the structure of the industry and the policies that sustain it. Public health effects, both direct and indirect, reinforce this concern. Occupational risks, air pollution, and climate-related pressures combine to create a burden that is unevenly distributed across populations and over time. Socio-economic dynamics add another layer, with benefits concentrated in certain regions while broader risks are shared more widely. The core issue is not the existence of oil and gas resources, but the continued reliance on them

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despite clear evidence of long-term harm. Managing decline rather than extending production offers a more consistent path with environmental and health priorities. A transition that is deliberate and supported can reduce disruption while addressing structural risks. Without such a shift, the gap between policy commitments and outcomes will remain unresolved.

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