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Arab Journal for Security Studies

المجلة العربية للدراسات الأمنية

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AJSS

Environmental Challenges, National Security, and Strategic Responses of the Arab Gulf States



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التحديات البيئية والأمن القومي والاستجابات الإستراتيجية لدول الخليج العربي

تينغ وانغ

أكاديمية أنور قرقاش الدبلوماسية، الإمارات العربية المتحدة

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Received on 30 Dec. 2025, accepted on 11 Apr. 2026, available online on 10 Sep. 2026

Abstract

The Arab Gulf states are located in one of the richest resource regions in the world, boasting vast reserves of oil, natural gas, and minerals. However, this abundance is contrasted by a distinct environmental vulnerability, manifested in severe water scarcity, expanding desertification, and the degradation of marine ecosystems. In recent decades, rapid urbanization, growing population growth, and resource-intensive development patterns have deepened environmental pressures across the region.

For the Gulf states, the concept of national security is no longer limited to traditional military dimensions; rather, it increasingly intersects with environmental and climatic challenges. Accelerated global climate change intersects with regional environmental degradation, carrying direct implications for economic stability, social cohesion, and national security in these ecologically vulnerable countries.

The study addressed the environmental challenges facing the Arab Gulf states, including water scarcity, desertification, food security, and oil pollution. It analyzed the emerging impacts of population growth, climate change, and potential pollution resulting from development—such

المستخلص

تقع دول الخليج العربي في واحدة من أغنى مناطق العالم بالموارد؛ إذ تزر بحاياتيات كبيرة من النفط والغاز الطبيعي والمعادن. ومع ذلك، فإن هذه الوفرة تقابلها هشاشة بيئية واضحة، تتجلى في ندرة حادة في المياه، واتساع رقعة التصحر، وتدهور النظم البيئية البحرية. وخلال العقود الأخيرة، أسهم التوسع الحضري السريع، والنمو السكاني المتزايد، وأنماط التنمية كثيفة الاستهلاك للموارد في تعميق الضغوط البيئية في مختلف أنحاء المنطقة. وأما دول الخليج فلم يعد مفهوم الأمن القومي يقتصر على الأبعاد العسكرية التقليدية، بل بات يتداخل بشكل متزايد مع التحديات البيئية والمناخية. إذ يتقاطع التغير المناخي العالمي المتسارع مع التدهور البيئي الإقليمي، بما يحمله ذلك من تداعيات مباشرة على الاستقرار الاقتصادي، والتماسك الاجتماعي، والأمن الوطني في هذه الدول ذات البيئات الضعيفة.

وقد تناولت الدراسة التحديات البيئية التي تواجه دول الخليج العربي، بما في ذلك ندرة المياه، والتصحر، والأمن الغذائي، والتلوث النفطي. وتحليل التأثيرات الناشئة للنمو السكاني، وتغير المناخ، والتلوث المحتمل الناتج عن التنمية (نمط الحياة كثيف الاستهلاك

Keywords: security studies, Arab Gulf states, environmental challenges, national security

الكلمات المفتاحية: الدراسات الأمنية، دول الخليج العربي، التحديات البيئية، الأمن القومي



Production and hosting by NAUSS



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as energy-intensive lifestyles, new industrial programs, and military threats—on the environment and national security. Furthermore, it examined the measures taken by the Gulf states to address these challenges, including water desalination projects, renewable energy strategies, national visions, and other initiatives. Finally, the study evaluated measures that could foster a more sustainable and secure environment for local communities.

للطاقة، والبرامج الصناعية الجديدة، والتهديدات الحربية) على البيئة والأمن القومي. والإجراءات التي تتخذها دول الخليج لمواجهة هذه التحديات، بما في ذلك مشاريع تحلية المياه، وإستراتيجيات الطاقة المتجددة، والرؤى الوطنية، وغيرها. وأخيرًا، قِيَّمت الدراسة الإجراءات التي يمكن أن تعزز بيئة أكثر استدامة وأمنًا للمجتمعات المحلية.

1. Introduction

Environmental challenges in the Arab Gulf states have evolved from peripheral concerns into central components of national security. In a region defined by extreme climatic conditions and resource constraints, the interaction between water scarcity, energy dependence, and rapid socio-economic transformation has created a complex landscape of systemic risk. Rather than isolated environmental issues, these challenges reflect deeper structural tensions embedded within development models and governance systems.

Situated in one of the world's most resource-rich regions, the Arab Gulf states possess significant oil, natural gas, and mineral reserves. Collectively, the Gulf Cooperation Council (GCC) countries hold approximately 497 billion barrels of crude oil, accounting for 34% of the world's proven reserves (Al Suwailem & Aldayel, 2020). In addition to hydrocarbon wealth, this region is also endowed with abundant mineral resources, including copper, gold, silver, zinc, iron, aluminum, and so forth (Hijazi, 2024). In January 2024, Saudi Arabia released a new estimate of the value of its mineral resource reserves of approximately US\$2.5 trillion at the Future Minerals Forum (Kane, 2025). At the same time, mining in the Gulf states has emerged as a key sector for securing their economic development and for establishing their status as major players in the global market (Hijazi, 2024). However, despite

the fact that oil and other natural resources have enabled the GCC countries to achieve extraordinary and accelerated development in almost all aspects of life, the scale of massive production and consumption of natural resources has also led to profound environmental challenges in this region (Tababatabai, 2022).

Concurrently, the region is confronted with a number of vulnerable situations, including a scarcity of freshwater resources, the expansion of desert areas, and the deterioration of marine ecosystems. Over the past few decades, large-scale state-led development and urbanization, expanding immigration from around the world, and a rapidly growing population have led to a significant increase in environmental challenges for the Arab states in this region. The increasing challenges posed by global climate change and worsening regional conflicts and turbulence further threaten the national security of these states, which remain especially vulnerable due to their fragile ecological conditions. In general, the environmental challenges facing the Gulf States are closely intertwined with their geographic vulnerabilities, deep reliance on the petroleum industry, rapid urban development, and population growth. To address these challenges effectively, it is essential to adopt a collective approach that encompasses national strategies, regional cooperation, and global partnership. Given the Gulf region's geopolitical and economic significance worldwide, it cannot be overstated how



vital these urgent issues are, not only for the Gulf states themselves but also for global environmental stability and energy security. Behind these, what are the most pressing environmental issues encircling the Gulf states currently, and how do environmental challenges in the Gulf translate into national security risks? And to what extent have Gulf states' policy responses effectively mitigated these risks? These are the questions this paper intends to answer.

This study situates environmental challenges in the Gulf within the broader framework of non-traditional security, where threats to national stability increasingly emerge from ecological, economic, and resource-based pressures rather than conventional military risks. Environmental security in this context refers to the capacity of states to ensure sustainable access to critical natural resources—particularly water, energy, and food—while maintaining social stability and economic resilience.

To conceptualize these interdependencies, this study adopts a resource nexus perspective, particularly the Water–Energy–Food (WEF) Nexus. This framework highlights the mutually reinforcing relationships among resource systems: water production in the Gulf depends heavily on energy-intensive desalination; energy production relies on hydrocarbon systems that contribute to climate change; and food security is constrained by both water scarcity and land degradation. These interconnections create systemic vulnerabilities, where stress in one domain can cascade into broader security risks.

Building on this, the study introduces the concept of interdependence security, which emphasizes that national security in the Gulf is shaped not only by resource scarcity but by the structural interdependence between environmental systems, economic models, and governance capacity. This

framework allows for a more integrated analysis of how environmental pressures translate into policy challenges, institutional constraints, and long-term stability risks.

This study adopts a qualitative, descriptive—analytical and comparative approach to examine the relationship between environmental challenges and national security in the Arab Gulf states. The research relies primarily on secondary data, including reports from international organizations (World Bank, WHO, GCC-Stat), academic literature, and policy documents. A comparative dimension is incorporated to highlight variation among Gulf states in terms of environmental vulnerability and policy responses. Rather than employing quantitative statistical modeling, the study focuses on analytical interpretation of data trends and policy frameworks.

2. Environmental Pressures and Structural Vulnerabilities in the Gulf

For a long period of time, the Gulf states have been confronted with a multitude of environmental challenges, many of which are traditional threats such as desertification, water scarcity, marine pollution, and so on. However, in the past few decades, a group of additional environmental problems has emerged, particularly those related to population growth, climate change, and rapid urbanization. These existing and emerging problems are intertwined, further complicating Gulf countries' efforts to address environmental issues.

2.1. Rapid Socio-Economic Transition and the Strain on Critical Resources

The Arab Gulf States have experienced significant population growth over the past few decades Figure 1.



This growth has been due to both natural increase and substantial immigration, particularly of expatriate workers. As shown in Table 1, the total population of the GCC countries was only 59.1 million (GCC-Stat, 2023). For example, the population of Saudi Arabia was over 33.7 million, with an annual growth rate of 4.7% from 32.2 million in 2022. Significantly, almost 57% of the Saudi population is made up of immigrants; in Qatar and the UAE, the figures are much higher (GCC-Stat, 2023). However, by the end of 2024, according to the latest data released by the Statistical Centre for the Cooperation Council for the Arab Countries of the Gulf, the population of GCC countries had reached 61.2 million, an increase of more than 2.1 million from 2023 figures (Emirates News Agency, 2025). Since 2021, the Gulf population has boomed by around 7.6 million people with a growth rate of 14.2 percent (Emirates News Agency, 2025). The World Health Organization (2024) predicted that the Saudi population will reach 47.7 million by 2050, with a projected increase of 43% from 2023 see Figure 2.

Furthermore, the Arab Gulf region has one of the youngest populations in the world, accompanied by high growth rates (Statista, 2024). According to

the General Authority for Statistics of Saudi Arabia, about 71% of the Saudi population is under 35, while the median age in 2024 was reported to be around 26.6 years (Saudi Gazette., 2024).

Rapid urbanization has led to high population densities in major cities. Until the 1960s, most of the population in Saudi Arabia was nomadic or semi-nomadic. But with rapid economic and urban growth, more than 95% of the population is now settled. 80% of Saudis live in ten major urban centers: Riyadh, Jeddah, Mecca, Medina, Hofuf, Taif, Buraydah, Khobar, Yanbu, Dhahran, and Dammam (House, 2012, p. 69).

The rapid population growth in the desert has posed serious challenges and exacerbated long-standing environmental problems, including water scarcity, food security, massive urbanization, and ecological degradation. Except for Oman, all other GCC countries are classified as severely water-scarce, and their water needs are primarily met through energy-intensive desalination. Despite water scarcity, water consumption in the GCC countries has surged incrementally, driven by economic growth, population growth,

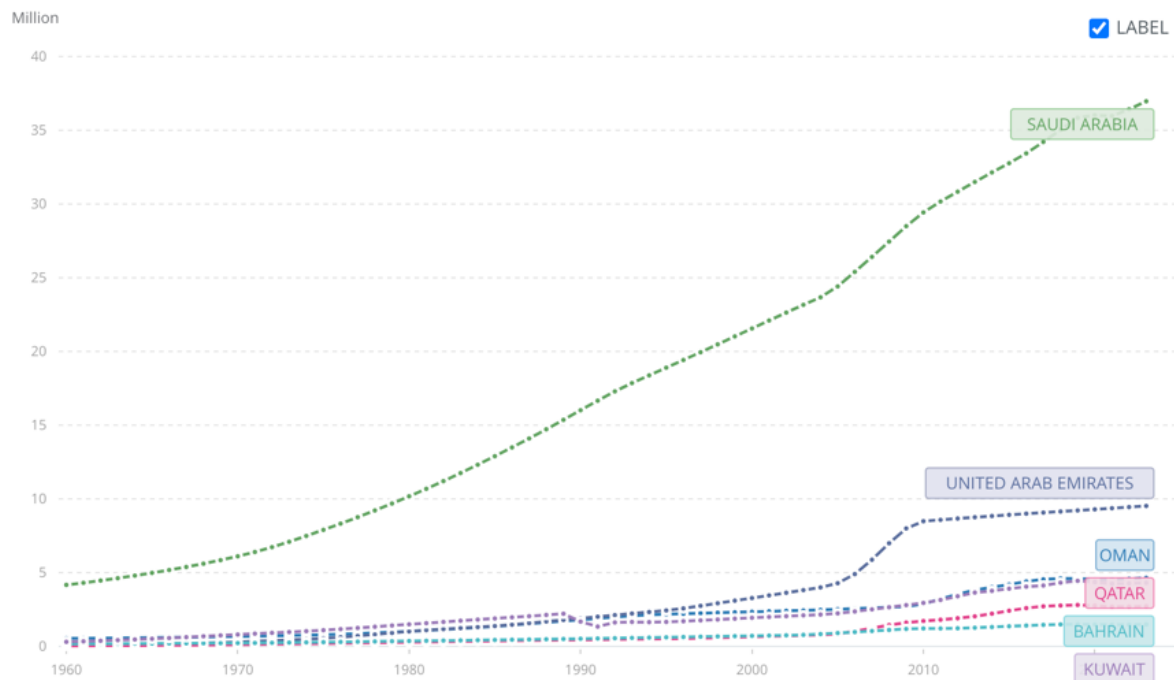
Table 1
Total Population of GCC Countries, 2022–2023 (Million People)

Country	2022 (million)	2023 (million)	Change (%)
Bahrain	1.5	1.6	▲ 3.4%
Qatar	2.9	3.1	▲ 4.5%
Kuwait	4.8	4.9	▲ 2.5%
Oman	4.9	5.2	▲ 4.7%
United Arab Emirates	10.3	10.7	▲ 3.8%
Saudi Arabia	32.2	33.7	▲ 4.7%
GCC Total	56.6	59.1	▲ 4.3%

Note: Data are from Population in the GCC 2023, by GCC-Stat, 2023, https://gccstat.org/images/gccstat/docman/publications/Populatin_in_GCC_2023_1.pdf



Figure 1
Arab Gulf States Population (1960-2023)



Note. Data from Total population – Oman, Saudi Arabia, United Arab Emirates, Qatar, Bahrain, Kuwait (World Bank, 2024). <https://data.worldbank.org/indicator/SP.POP.TOTL?end=2023&locations=OM-SA-AE-QA-BH-KW&start=1960&view=chart>

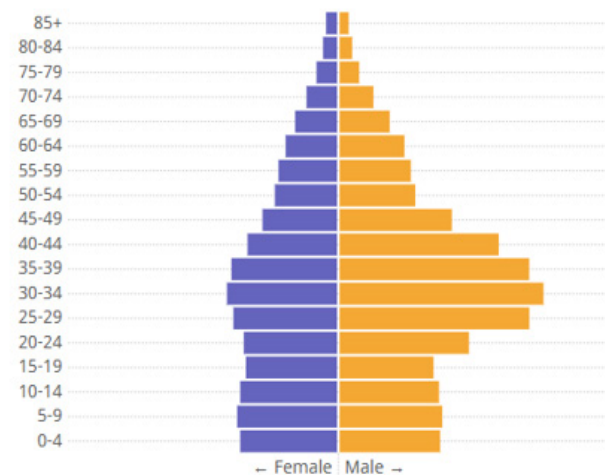
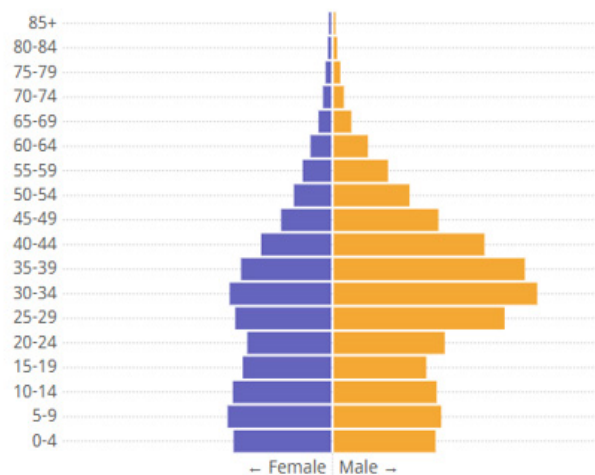
Figure 2
2023 Saudi Arabia Population

2023

Population by age and sex. Saudi Arabia

2050

Projected population by age and sex. Saudi Arabia



Note. Data from Saudi Arabia: Overall population over time (World Health Organization, 2024). <https://data.who.int/countries/682>



and urbanization. According to the World Bank (2024), per capita daily water consumption in these countries typically exceeds 500 liters, far surpassing that of countries with similar income levels, such as Germany, where it is approximately 120 liters. From a security perspective, this level of consumption reflects structural unsustainability in resource use, increasing dependence on energy-intensive desalination systems. At the policy level, it indicates a gap between state-led supply expansion and demand-side management. In the long term, such imbalances may heighten fiscal pressure, infrastructure vulnerability, and societal exposure to supply disruptions.

The excessive water use is rapidly depleting the GCC's already limited water resources. Currently, Gulf states have been the most desalination-dependent nations in the world, accounting for more than 60% of global desalinated water, and this is expected to double by 2030 due to the increasing demand of an expanding population (Qureshi, 2020).

2.2. Climate Change and Emerging Challenges in the Gulf

Another prominent aspect of these new environmental problems facing the region is climate change. According to the definition of the United Nations (UN, n.d.):

"Climate change refers to long-term shifts in temperature and weather patterns...since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil, and gas."

It is essential to recognize the interconnectivity between traditional environmental challenges and emerging threats. For instance, climate change will

exacerbate desertification and water scarcity, while rapid population growth and desertification can also contribute to climate change, water scarcity, and a range of other ecological challenges. The Gulf region is facing significant environmental challenges from both traditional threats and climate change; the latter is exacerbating existing vulnerabilities, including rising temperatures, desertification, and water scarcity (Fanack Water, 2024). These issues have caused serious threats to human health, economic stability, and the overall sustainability of the region.

One of the most disastrous results of climate change is rising temperatures. Unsurprisingly, the Gulf region is experiencing "unprecedented" heat waves, with temperatures rising almost twice the global average, making it among the fastest-warming regions in the world (Associated Press, 2022). These frequent heat waves, with temperatures exceeding 50°C (122°F), will compromise water and food security and threaten the human health and productivity of the region's millions of people (Associated Press, 2022).

Accompanied by accelerated population growth over the past decade, these countries have also experienced the highest extensive energy consumption in the world, which is almost 2.5 times that of the European Union (Asif, 2016). Based on current research, there is a direct connection between economic growth and energy consumption, as well as energy consumption and CO₂ emissions in the Gulf states (Salahuddin & Gow, 2014). As noted by Lahn and Stevens (2011) in *Burning Oil to keep cool*, all GCC countries are among the largest per capita CO₂ emitters in the world. Collectively, they account for 3.08% of global CO₂ emissions, with Saudi Arabia (1.8%) leading in 2020 (Hereher, 2022).



Currently, Arab Gulf states are producing higher greenhouse gas emissions than other regions. A study showed a significant increase in CO₂ gas concentration across the entire region, from 375 ppm in 2003 to 402 ppm in 2016, particularly in Kuwait, KSA, Bahrain, Qatar, and the UAE (Hereher, 2022). This generally reflects these countries' high dependence upon crude oil for their energy, industry, and transportation.

According to different research and scenarios, if the global average temperature rises by 4°C above pre-industrial levels, extreme temperatures could reach 56°C across this region, while summer temperatures may be 8°C warmer by the end of this century (Ezzeldin et al., 2023, p. 7). Climate change and extreme weather in the Gulf have already become catastrophic for children in this region, who are most likely to suffer from air pollution, extreme heat, and health problems (Wood, 2023). During summer in the Gulf, the unbearable heat increases the risk of heat-related illnesses and reduces outdoor economic activity. Some outdoor workers or delivery men may face life-threatening conditions under scorching temperatures above 50°C. In contrast, the room temperature can sometimes be below 20°C. "Burning oil, keeping cool" will create an enormous energy demand for air conditioning, potentially leading to an energy shortage and further climate deterioration.

Moreover, climate change may significantly affect coastal populations and cities, which constitute 90% of residents in most Gulf countries. These seaside areas are particularly vulnerable to climate hazards and extreme weather, and wildlife and natural habitats risk being wiped out due to improper exploitation and climate change (Husein, 2022). By 2100, if sea levels have risen globally by 1 meter on average, all coastal

cities around the Arab Peninsula will be deeply affected, and without comprehensive adaptation strategies, millions of people living in coastal zones could be displaced in the coming decades. As Wood (2023) notes:

"Nearly 350 square miles of Saudi coastal land along the Red Sea shore and nearly 240 square miles along the Gulf shore would be permanently underwater", and "the UAE would lose more than 100 square miles of coastal land, while Qatar would lose more than 50 square miles".

In contrast to rising sea levels and flooded coastal cities, desertification in the central parts of Arab Peninsula is another critical issue caused by climate change. Reduced rainfall, urban expansion, and unsustainable agricultural activities accelerate land degradation. This also leads to declining local farm productivity and increased reliance on imported food, which may have implications for long-term food security. More importantly, desertification will threaten biodiversity and cause habitat loss for native species, further destabilizing ecosystems.

2.3. From Water Scarcity to Water Security

Compared with other parts of the world, the Arab Gulf states are among the most water-stressed regions. Due to an arid climate, rapid population growth, and increasing water demand, these countries are facing not only acute water scarcity but also more serious water security issues.

Undoubtedly, water is the most crucial resource for life in the desert, and water scarcity is a long-standing challenge in the Gulf. Now, climate change is exacerbating this situation. In the past decades, reduced rainfall and increased evaporation have depleted already scarce water resources in this



Table 2
Rainfall in the GCC Countries (2024)

Country	Area (km ²)	Population (millions)	Variation in Annual Average Rainfall (mm)
Bahrain	652	1.7	80
Kuwait	17,818	4.3	110
Oman	212,460	5.1	50–300
Qatar	11,610	2.9	75
Saudi Arabia	2,149,690	34.8	70–500
UAE	83,600	9.9	90

Note. Adapted from “The Impact of Land Use on Water Resources in the Gulf Cooperation Council Region,” by B. Helal, M. Abdelrahman, & M. Al-Hajri, 2024, *Water*, 13(7), Article 925 (<https://www.mdpi.com/2073-4441/13/7/925>).

region. In comparison, Abdelraouf (2024) stressed that the GCC countries have minimal and irregular rainfall, typically less than 100 mm-year and as low as 50 mm-year in the northern and central parts of the desert peninsula see Table 2.

Comparatively, Qureshi (2020) noted that annual per capita water consumption in the GCC countries has been reported at 560 L/capita/day, more than 3 times the world average of 180 L/capita/day. Four of the six most water-scarce countries in the world are in the Gulf; however, their water consumption is much higher than that of other water-rich states. Albannay et al. (2021) found that the desert environment with limited renewable water resources and high per capita water consumption that characterizes the Gulf region, intensifies the challenge of sustainable water supply. For example, despite its arid climate, Saudi Arabia is the third-highest per capita water consumer globally, exceeded only by water-abundant the US and Canada (Hakimdavar, 2024).

As mentioned before, Abdelraouf (2024) highlighted that Oman is an exception to the water scarcity in the GCC, with approximately 583 cubic meters per capita per year. Tariq et al. (2022) explained that almost 61% of Kuwait’s freshwater

is primarily obtained through desalination. With no other options, other GCC nations have to rely on desalination. Although desalination provides valuable water resources, its environmental influences and concerns are non-negligible, including substantial brine discharge, marine pollution, and greenhouse gas emissions. Reuters (2024) reported that Saudi Arabia alone accounts for 22% of global brine production.

The water scarcity above poses significant challenges to sustainable development, public health, and national security. In parallel with these challenges, over-reliance on desalination to satisfy increasing water demands has also raised many environmental concerns, including brine pollution of marine ecosystems. According to scholars of NYU Abu Dhabi in 2023, the freshwater production in the Gulf has already exceeded 20 million cubic meters per day and will double by 2030 (Smart Water Magazine, 2023) see Table 3. In this way, desalination is not just a matter of domestic water supply, but has become a matter of national security in the Gulf. Because it is the only option for many GCC countries to obtain a freshwater supply. Water scarcity increases reliance on energy-



Table 3
Mega Desalination Plants in the Gulf

Country	Total capacity (m ³ /day) ^a	Example of large-scale desalination plants per country		
		Large-scale plants	Total approximate capacity (m ³ /day)	Main beneficiary cities
Bahrain	856,800	Al Hidd 1	270,000	Several urban centers in Bahrain
Kuwait	2,835,850	Zour South, North	950,000	Several cities
		Doha East, West	970,000	Kuwait city
Oman	1,491,639	Al Ghubrah	300,000	Muscat, Oman
		Barka 1, 2	300,000	Muscat, Oman
Qatar	2,066,954	Ras Abu Fontas A, A1, A2, A3, B, B2	1,065,000	Doha and other cities
		Um Al Houl	620,500	Doha and other cities
		Ras Laffan A, B, C	740,000	Doha and industrial cities
Saudi Arabia	7,653,000	Jubail 1, 2	1,150,000	Riyadh
		Shoaiba 1, 2	650,000	Mekkah, Taif & Jeddah
		Ras Alkhair	1,000,000	Ma'aden Co., Riyadh, Sudair, Al-Washim
		Yanbu 1, 2, RO	380,000	Medina
		Jeddah 3, 4	300,000	Jeddah, Mekkah
UAE	7,477,781	Jabal Ali	2,000,000	Dubai
		Fujairah, F2	1,000,000	Fujairah, Sharjah and Abu Dhabi
		Umm AlQuwain	682,900	Ras Al Khaimah
		Taweelah	910,000	Abu Dhabi

Note. Data adapted from "The perils of building big: Desalination sustainability and brine regulation in the Arab Gulf countries," by M. Al-Saidi, A.-K. Ellermann, M. F. Fittkow, T. R. Perillieux, I. Saadaoui, & R. Ben-Hamadou, 2024, *Water Resources and Industry*, 32, Article 100259. <https://doi.org/10.1016/j.wri.2023.100259>

intensive desalination, making infrastructure and energy supplies more vulnerable to attacks or disruptions. Moreover, many GCC cities depend entirely on one or a few large-scale desalination plants. If one or more mega-plants are attacked or disabled, these cities or states would face an urgent national security problem.

The region's heavy reliance on desalination not only raises water security issues but also

raises concerns about its energy costs and environmental impacts. Most of these desalination facilities in the Gulf totally depend on fossil fuels, which will eventually contribute to greenhouse gas emissions, air pollution, and coastal ecosystem deterioration. With an increasing population and warming temperatures in the future, the high costs of desalination and water infrastructure will further strain their national budgets, and intensified



competition for water resources can lead to conflicts and social tensions in this area.

Even if it is impossible to secure water availability in the Gulf without desalination, it is still more essential to apply cleaner technologies, brine management innovations, and integrated coastal protection strategies to ensure long-term sustainability of the Gulf states.

3. Environmental Challenges as Structural Risks to National Security in the Gulf

Environmental pressures in the Arab Gulf states are no longer peripheral concerns but have become structurally embedded within national security dynamics. However, it is not easy to define environment and national security. Many people equate environmental issues solely with climate change, whereas environmental issues encompass a much broader range of concerns. As the White House (2015) National Security Strategy mentioned, related to climate change and national security:

“Climate change is an urgent and growing threat to our national security, contributing to increased natural disasters, refugee flows, and conflicts over basic resources like food and water. The present day effects of climate change are being felt from the Arctic to the Midwest. Increased sea levels and storm surges threaten coastal regions, infrastructure, and property. In turn, the global economy suffers, compounding the growing costs of preparing and restoring infrastructure.”

However, environmental issues such as climate change, water scarcity, desertification, and pollution are intertwined. According to Levy

(1995), “environment” refers to issues involving biological or physical systems characterized either by significant ecological feedback or by their importance to the sustenance of human life. In his opinion, environmental degradation constitutes a direct physical threat to national security interests when environmental damage results directly in the significant loss of life or welfare of citizens, or otherwise impairs our most important national values” (Levy, 1995, p. 46). At a conceptual level, environmental degradation constitutes a security threat when it undermines the material foundations of state stability or generates conditions conducive to political and social disruption. Many countries, such as Somalia and Sudan, are experiencing conflicts due to drought, water, or food insecurity, all of which are closely linked to environmental change.

Amid the growing severity of environmental problems, these collective and interconnected challenges not only threaten sustainable development but also simultaneously reshape economic development, social cohesion, and geopolitical relations. This requires comprehensive responses to mitigate their security implications. Kelley et al. (2015) found that the world population was expected to reach 9.7 billion by 2050; it was estimated that the global population facing severe water scarcity would increase from 40% to 60% by 2025. As for the GCC states, they continuously struggle with water security, driven by a combination of factors: natural resource scarcity, rapid population growth, high consumption patterns, the intensifying effects of climate change, and regional conflicts.

3.1. The Energy–Water–Security Nexus

In general, as Albannay and Takizawa (2022) showed that Arab Gulf states produce over 60% of the



world's desalinated water, with Saudi Arabia and the UAE representing the most significant contributors. Qureshi (2020) stressed that the GCC countries' vast investment in the desalination sector was estimated at USD 16-20 billion over the past two decades, with projections indicating a potential reach of USD 60 billion by 2050. However, the burden is intensified by the inefficiency of agricultural practices. Even though arable land in GCC countries constitutes less than 5% of total area, average agricultural use continues to absorb 70-80% of the region's renewable water resources (Abdelraouf, 2024).

The energy-water-security nexus in the Gulf creates additional vulnerabilities and risks. The dependence of desalination plants on fossil fuels makes water systems susceptible to disruptions in energy supplies caused by geopolitical tensions or infrastructure attacks. Furthermore, the vulnerability of coastal desalination plants to intensified regional conflicts indicates that geopolitical tensions have notable implications for water scarcity. During the Israel-Iran war in June of 2025, people worried about the strike on Iranian nuclear facilities. Alsayed and Calabrese (2025) mentioned that there once was a warning from Qatar's Prime Minister, "No water, no food, no life", referring to a potential nuclear catastrophe and the Gulf's heavy reliance on desalinated seawater. Moreover, the region's reliance on desalination makes it vulnerable to risks from military conflicts, cyberattacks, or non-state actors, thereby exacerbating existing security concerns.

3.2. Intensifying Climate Challenge and National Instability

At the same time, climate change is also intensifying environmental vulnerability and national security in this region. Extreme weather

(such as frequent heat waves, unusual floods, and rising temperatures) is disrupting daily life and productivity. Critical energy, urban infrastructure, water supply, and arable land are at risk from extreme weather, which could lead to internal tensions and regional instability. In April 2024, the UAE suffered unprecedented rainfall, triggering severe flooding and massive disruption across the country. According to a recent study by Francis et al. (2025), high-resolution satellite data revealed a clear link between urbanization, population density, and the severity of flood impacts in major cities.

The phenomenon of desertification, on the other hand, presents a significant risk to food security in the Gulf region. The degradation of cultivable land and water scarcity increases these countries' dependence on food imports and their susceptibility to regional conflicts and the global food market. Meanwhile, the substantial costs of combating desertification, including reforestation and irrigation projects using new technologies, are also an increasing financial burden on local governments. Food security or financial burden, either way, these will eventually have a significant impact on the national stability of local countries.

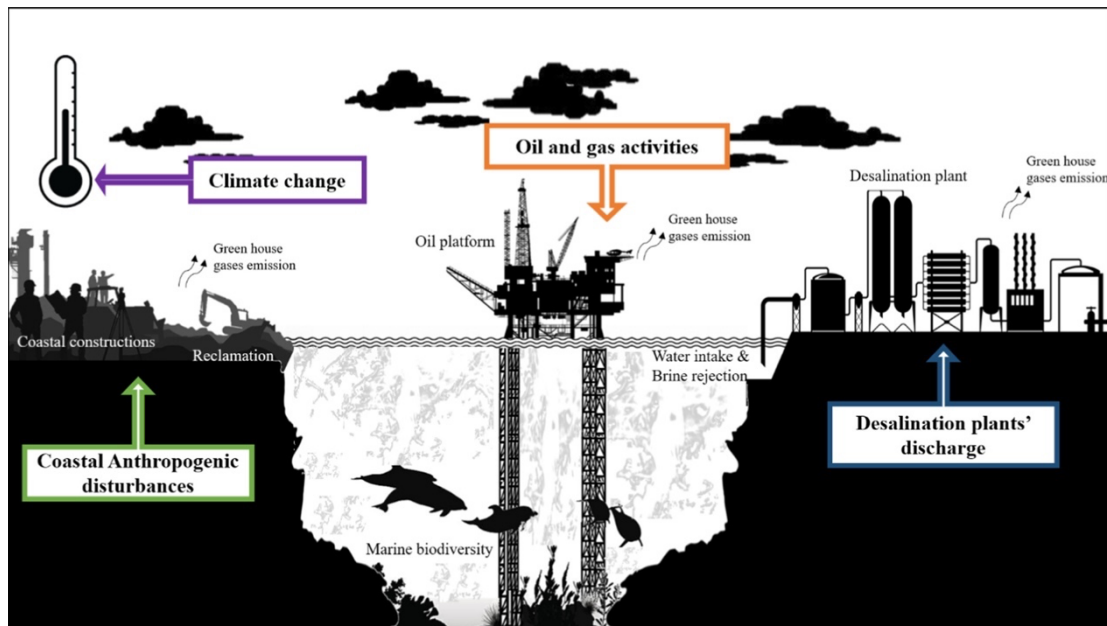
3.3 Dual-Dimensional Marine Pollution

Additionally, marine pollution from oil spills and industrial discharges presents a dual-dimensional threat to the environment and the economy. There are diverse drivers of pollution in the Arabian Gulf, but climate change, the oil and gas industry, coastal anthropogenic activities, and desalination plants are considered the most important sources of pollution see Figure 3. As mentioned before, coastal infrastructure for water, energy, nuclear reactors, and food supply is increasingly coupled with mega-



Figure 3

Drivers of pollution in the Arabian Gulf



Note. Reprinted from "Marine health of the Arabian Gulf: Drivers of pollution and assessment approaches focusing on desalination activities," by H. Hosseini, I. Saadaoui, N. Moheimani, M. Al-Saidi, F. Al Jamali, H. Al Jabri, & R. Ben-Hamadou, 2021, *Marine Pollution Bulletin*, 164, Article 112085 (<https://doi.org/10.1016/j.marpolbul.2021.112085>).

projects, which pose emerging environmental risks and potential threats to coastal cities and ecosystems.

Conversely, coastal degradation, particularly rising sea levels, has also endangered desalination and urban settlements. Cross-border pollution and industrial activities can also strain international relations and increase the complexity of the regional security landscape.

In general, Gulf states' security dynamics are inextricably linked to a set of environmental challenges in this region, including water scarcity, climate change, desertification, and the energy-water-security nexus. In response, GCC countries are exploring renewable energy or renewable-powered desalination projects to reduce their reliance on fossil fuels and mitigate potential risks. But there should be more prompt, solid, and

coordinated actions from the GCC states to mitigate these considerable challenges and enhance their long-term security and stability.

4. Strategic Responses of the Gulf States: Economic Transition and Environmental Protection

Upon further analysis, these emerging environmental challenges in the Gulf are closely linked to their socio-economic structures and development models. Currently, the Arab Gulf states are at a pivotal juncture, facing two divergent development paths. One path perpetuates a traditional energy economy that is heavily reliant on fossil fuels and on resource dependence. The alternative path involves a fundamental transition toward a sustainable economy grounded in new technologies, renewable energy, and environmental stewardship.



Since the modern era, the economies of the Arab Gulf states have been based on traditional natural resources, primarily oil and gas extraction. Even if this model has proven financially profitable for the Gulf oil states; it has also resulted in considerable environmental costs and long-term economic vulnerabilities. According to the resource curse theory, countries with abundant natural resources – especially oil and gas – often experience slower economic development, weaker governance, and greater corruption compared to countries with fewer natural resources. This means that resource wealth, rather than fostering prosperity, might undermine governance ability, economic development, and long-term social stability (O'Neil, 2004, p. 147). Since the 1980s, most developing countries have become wealthier, yet many oil states are not wealthier or more peaceful than they were three decades ago. Ross (2012) argued that “from 1980 to 2006, per capita incomes fell 6 percent in Venezuela, 45 percent in Gabon, and 85 percent in Iraq. Many oil producers—like Algeria, Angola, Colombia, Nigeria, Sudan, and again, Iraq—have been scarred by decades of civil war.”

Surprisingly, the Gulf states have enjoyed long-term economic prosperity since the 1970s, which seems to contradict this profound theory. However, recent research by Abdelkawy (2024) from King Faisal University of Saudi Arabia confirmed that the resource curse hypothesis exists in the Gulf as well, which showed that “while oil rents drive short-term growth, they constrain long-term economic expansion, especially as economies fail to develop non-oil sectors.” Thus, there is an urgent need for diversified investments in technology, finance, and tourism, which are less exposed to global oil price fluctuations.

Confronting multiple challenges in a fragile geographical environment and a resource-cursed economy, Arab Gulf states are implementing a series of ambitious economic initiatives to diversify their economy and foster national development. The fundamental and decisive transition from a traditional, polluting economy to an eco-economy will undoubtedly have numerous consequences for the environment in the future. Traditional industrial activities and energy consumption have resulted in significant damage to ecosystems in the Arabian Gulf. For GCC states, the eco-economy model would ensure economic growth is environmentally sustainable and aligned with global climate commitments. So far, they have made significant investments in solar, wind, and green hydrogen, while simultaneously reducing their reliance on fossil fuels to meet domestic energy demands. The development of smart cities in the Gulf is a leading example, including energy-efficient, low-carbon Masdar City in the UAE and NEOM in Saudi Arabia. Meanwhile, their remarkable process of economic diversification also has a number of implications as follows:

To address these economic and environmental challenges, the GCC states are implementing a number of strategic responses. National strategies, such as Saudi Arabia's Vision 2030 and Oman's Vision 2040, prioritize sustainable development and the environment. These national initiatives are accompanied by strategic investments in advanced technologies, such as solar-powered projects and wastewater recycling, intended to reduce energy consumption and alleviate pressure on freshwater resources.

As shown above, facing these challenges, GCC states must implement comprehensive strategies



Table 4
Arab Gulf States' Oil and Non-Oil Sector Growth in 2023

Country	Oil Sector Growth (2023)	Non-Oil Sector Growth (2023)	Key Drivers
Saudi Arabia	-8.40%	4.30%	OPEC+ production cuts, diversification efforts
Kuwait	-3.80%	5.20%	Reduced oil demand, resilient fiscal policies
Oman	-	2.00%	Renewable energy, construction, tourism
Qatar	1.30%	3.60%	Tourism, major global events
UAE	0.70%	4.50%	Tourism, real estate, manufacturing
Bahrain	-	3.80%	Financial services, tourism, aluminum industry

Note. Data are adapted from "Economic Diversification Efforts Paying Off in GCC Region but More Reforms Needed," by World Bank, 2023, <https://www.worldbank.org/en/news/press-release/2023/11/22/economic-diversification-efforts-paying-off-in-gcc-region-but-more-reforms-needed>.

that incorporate technological innovation, regional cooperation, and sustainable policies. Despite these economies' historical reliance on oil and fossil fuels, a strategic transition towards green, more diverse economies might be the inevitable approach to mitigate environmental challenges while maintaining economic stability see Table 4.

The most pressing and complex strategy for the Gulf states is diversifying their economic structures, which requires them to reduce their reliance on hydrocarbons by investing in other sectors, including renewable energy, manufacturing, tourism, and technology. Saudi Arabia's Vision 2030 emphasizes the development of tourism and renewable energy as cornerstones of its diversification strategy. World Travel & Tourism Council (2024) stated that in 2023, the tourism sector grew by more than 32% and contributed a record-breaking 444.3 billion SAR, representing 11.5% of the entire Saudi economy and supporting more than 2.5 million jobs- almost one in five jobs in the country. As Minister of Tourism of Saudi Arabia, Ahmed Al-Khateeb said:

"Tourism is a key pillar of the Kingdom's Vision 2030 economic diversification plans

and we have made great strides promoting investment in the sector - with more than \$800 billion earmarked by 2030 - as well as creating new jobs and growing the contribution of tourism to GDP." (World Travel & Tourism Council, 2024)

Another crucial factor to address environmental challenges is technological innovation. Renewable projects and smart cities, such as Masdar City in the UAE. It integrates energy-efficient infrastructure, sustainable transportation, and advanced waste management, thereby establishing a standard for environmentally conscious urban planning in the Gulf.

Other essential strategies for tackling environmental challenges involve investing in nature-based solutions, such as the Saudi Green Initiative. It aims to plant billions of trees and combat desertification, improving ecological balance. There are also many projects in the Gulf focused on sustainable urban development, renewable energy, water recycling, marine ecosystem restoration, and more.

Despite shared structural challenges, Gulf states exhibit significant variation in their environmental responses. While the UAE has advanced rapidly



Table 5
Environmental Challenges and Strategies by GCC Country

Country	Challenges	Strategic Initiatives
Saudi Arabia	Water scarcity, Desertification, Oil dependency, Extreme heat, etc.	Vision 2030: Economic diversification and renewable energy (e.g., NEOM city).
		Saudi Green Initiative: Afforestation, carbon reduction, and ecosystem restoration.
United Arab Emirates	Coastal erosion, Marine pollution, Rising sea levels, etc.	Investments in desalination and water management.
		Masdar City: Sustainable urban project.
Qatar	Scarcity of arable land, Water dependency, Carbon emissions, etc.	Noor Abu Dhabi: Solar energy investments.
		Hosting COP28: Leadership in global climate efforts.
Kuwait	Oil spills, Waste management, Air pollution, etc.	Policies promoting renewable-powered desalination and water conservation.
		Sustainable infrastructure for FIFA World Cup (e.g., energy-efficient stadiums).
Bahrain	Coastal ecosystem loss, Rising sea levels, etc.	Advanced irrigation systems.
		Research on sustainable urban planning under Qatar National Vision 2030.
Oman	Cyclones, Desertification, Water resource stress, etc.	Investments in waste-to-energy projects and air quality monitoring.
		Economic diversification focusing on tourism and renewables.
		Environmental education campaigns to raise public awareness.
		Protection of marine ecosystems, including mangroves and coral reefs.
		Sustainability in urban planning under Bahrain Economic Vision 2030.
		Enhanced water recycling systems.
		Community-based reforestation projects.
		Expansion of renewable energy (wind farms and solar parks).
		National climate adaptation policies for extreme weather.

Note. Created by the author using publicly available data from Gulf national economic and sustainability strategies, including Saudi Vision 2030 (Environmental and Economic Transformation Initiatives), Masdar City (Sustainability and Renewable Energy Projects), Qatar National Vision 2030, Kuwait Vision 2035, Bahrain Economic Vision 2030, and Oman Vision 2040.

Source: Saudi Vision 2030 — <https://www.vision2030.gov.sa>; Masdar City — <https://masdar.ae>; Qatar National Vision 2030 — <https://www.npc.qa/en/QNV/pages/default.aspx>; Kuwait Vision 2035 — <https://www.mofa.gov.kw/en/pages/kuwait-vision-2035>; Bahrain Economic Vision 2030 — <https://www.mofne.gov.bh/en/project-initiatives/bahrain-economic-vision-2030>; Oman Vision 2040 — <https://www.oman2040.om/?lang=en>

in renewable energy and sustainability initiatives, other states, such as Kuwait, have experienced slower progress, reflecting differences in institutional capacity and policy implementation see Table 5.

Although Gulf states have undertaken many projects and initiatives to address environmental challenges and maintain national security in this resource-rich yet vulnerable region see Table 6, the



Table 6
Key Environmental Projects in the Gulf Region

Project	State	Focus Area	Key Impact
Masdar City	UAE	Sustainable Urban Development	Energy-efficient buildings, green transport, and renewable energy integration.
Saudi Green Initiative	Saudi Arabia	Reforestation	Planting 10 billion trees, restoring 200 million hectares of land.
Noor Abu Dhabi	UAE	Renewable Energy (Solar)	Produces 1.2 GW of clean energy, reducing 1 million tons of CO ₂ annually.
NEOM Green Hydrogen Plant	Saudi Arabia	Renewable Energy (Hydrogen)	Produces 600 tons of green hydrogen daily using 4 GW of renewable energy.

Note. Compiled by the author from publicly available project information from Masdar City, Saudi Vision 2030, Noor Abu Dhabi, Offshore Energy, and Smart Water Magazine

path ahead remains long and demanding. It might take several generations' hard work to complete the journey to sustainable resilience in the Gulf.

5. Policy Recommendations

Confronted with a collective array of severe environmental and security challenges, Gulf states also need to adopt a comprehensive, multi-level policy approach. The following section will provide recommendations for national, regional, and global actions.

5. 1. National Strategies

- It is most essential to complete and improve their existing national initiatives. While Gulf countries have developed comprehensive strategies to address environmental change, the ultimate success depends on whether these plans can be effectively implemented or not. It is recommended that Gulf states maintain current initiatives and adapt them to emerging challenges rather than launching new ones.
- Further promote civil education of sustainable development. Despite these strategies and technological applications, fostering a culture of sustainability is more important and

necessary, as it promotes public awareness and engagement. Involving the public in environmental protection is the most effective way to ensure long-term success. Only civil education among societies can eventually promote water conservation, energy efficiency, and environmental protection.

- Establish an eco-friendly society. The Gulf states are undergoing a remarkable transition from reliance on fossil fuels to renewable energy sources. Not only should governmental efforts in clean energies be encouraged, but the private sector should also be encouraged to develop green technologies.

5. 2. Regional Cooperation

- Set up a GCC data-sharing platform. The rapid development of AI and high-tech should be utilized to monitor resource consumption and environmental impacts in the Gulf region. Data-driven decision-making will be more efficient and accurate. GCC states should jointly establish a data-sharing platform to facilitate tracking of climate change, environmental challenges, and energy consumption.
- Regional Framework for Environmental Protection. Gulf states could set up a



framework for environmental protection, which encompasses several key areas: sharing scarce resources, preventing desertification, crisis management, routine discussion, and so on. Furthermore, they could set up an environmental foundation for joint technology transition, clean energy investment, ecological protection, crisis management, etc.

- **Environment-Security Nexus.** Arab Gulf states could also integrate environmental protection into their broader regional security strategy. This would enable them to respond more effectively and more comprehensively to environmental disasters, such as extreme weather, floods, and drought, and to prevent potential conflicts over natural resources.

5. 3. Global Partnership

- **Alignment with Global Frameworks and Partners.** The GCC countries should align their policies with global frameworks, such as the Paris Agreement. It is also imperative for GCC states to coordinate with the United Nations Framework Convention on Climate Change (UNFCCC) and other global initiatives to implement climate action plans. Non-governmental organizations (NGOs) and private companies are also potential partners to secure funding for specific projects and advanced technologies.
- **Technology Cooperation and Transition.** One of the GCC's primary objectives is to use advanced technology to address environmental challenges. It is crucial for Gulf states to participate in leading-edge technology projects with global partners, such as the US, the EU, China, Japan, South Korea,

etc. Technology collaborations and transfers in renewable energy, water management, and other advanced technologies will significantly reduce financial costs and environmental impacts, while boosting economic efficiency in the Gulf.

- **Environmental Diplomacy.** As Islam (2022) says, environmental issues are increasingly intertwined with other traditional areas of foreign relations, including trade and investment, development, human rights, and even military security. As middle powers in the world, GCC states could promote environmental diplomacy to engage with foreign governments and multilateral institutions to advance specific policies and cooperation. When great powers are in dispute, GCC states could take a leading role in advancing international environmental cooperation. For instance, GCC states could use COP conferences and climate/environmental forums to advocate for common interests, raise funds, and facilitate technology transfers for Global South states. In this way, GCC states could position themselves as leaders in climate solutions and environmental diplomacy.

6. Conclusion

Located in one of the world's most resource-rich and burning hot regions, "burning oil to keep cool" is a well-known way of living in the Gulf for decades. However, the Gulf states are confronting increasing environmental challenges closely interlinked with rapid population growth, climate change, and water security. Environmental issues are no longer merely matters of environmental protection or ecological change, but are intertwined with social stability, economic development, and national security.



This paper presents an overview of the most pressing environmental issues facing the Arab Gulf states, including the strain on critical resources due to rapid population growth, emerging challenges posed by climate change, and severe water security. It also examines Gulf states' strategic measures to encounter these challenges, including economic transition, environmental protection, national projects, renewable energy strategies, and others. Ultimately, environmental challenges in the Gulf are not merely ecological concerns but structural security issues embedded within resource-dependent economic models. Addressing them requires not only technological solutions but institutional transformation, policy coordination, and a reconfiguration of the relationship between development and sustainability. The future stability of the Gulf will depend on how effectively states manage this transition.

The study acknowledges several limitations. First, it primarily on secondary data and policy documents, which may not fully capture implementation dynamics at the local level. Second, the absence of quantitative modeling limits the ability to measure causal relationships statistically. Third, the regional focus on GCC countries may not fully capture broader Middle Eastern dynamics. Future research could incorporate field-based studies and comparative quantitative analysis to deepen empirical validation.

Funding

The author received no financial support for the research, authorship, and/or publication of this article.

Conflicts of Interest

The author declares no conflicts of interest.

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