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Environmental impacts of the Houthis' attacks against commercial shipping in the Red Sea

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As a result of the Houthis' attacks against commercial shipping in the Red Sea, shipping companies were compelled to reroute their ships via the Cape route instead of the regular Suez Route, which impacted the environment in addition to fuel prices and transit times. Among the environmental effects were the potential for oil spills from tankers that were attacked, the release of hazardous cargo from sunken cargo ships, and a 30–35% increase in carbon emissions resulting from the additional 3,000 nautical miles traveled. As an example of the first environmental impact, a bulk carrier carrying more than 41,000 tons of fertilizer when it was attacked and subsequently sank, resulting in spillage into the Red Sea, and an oil tanker carrying one million barrels of crude oil, which was later transferred to another tanker and towed to a safe port, can be cited. This study aims to highlight the environmental impacts and risks associated with the Houthis' attacks in the Red Sea, taking into account the maritime security and geopolitical perspectives through secondary research. The main finding of the study is that maritime security threats and risks can have detrimental effects on the environment, in addition to their financial impacts, and that strengthening organizational mechanisms is crucial.

KEYWORDS

Houthi attacks, Red Sea, maritime security, environmental impact, oil spills, carbon emission

1 Introduction

The Suez route accounts for approximately 12% of total global trade and 30% of global annual container transport volume (Peng et al., 2024). Due to these characteristics, it has become a focal point not only for states with similar security challenges but also for global actors facing challenges arising in the region. Therefore, the stability of the Red Sea region is crucial for ensuring that this trade flows uninterrupted (Rodríguez-Díaz et al., 2024). However, the Houthis' attacks have clearly and substantially curtailed trade through the Suez Canal, as shipping lines have chosen to reroute their vessels via the significantly longer voyage around the Cape of Good Hope. Moreover, the conflict has spread beyond the geographical boundaries of Israel and Gaza to the adjacent seas (the Red Sea) and neighbouring land (Lebanon, Yemen, and Syria) through reactive actions by regional players (Agarwala, 2025:143).

The US Energy Information Administration (EIA) claims that an average of 8.8 million barrels of oil passed through the Bab al-Mandab Strait each day (U.S. Energy Information Administration, 2023), representing 8.7% of the 101.7 million barrels per day worldwide demand in December 2023. After the Houthis' attacks, these numbers decreased to 4 million barrels per day through August 2024 (U.S. Energy Information Administration, 2024), accounting for approximately 3.9% of global demand (Arab News, 2025).

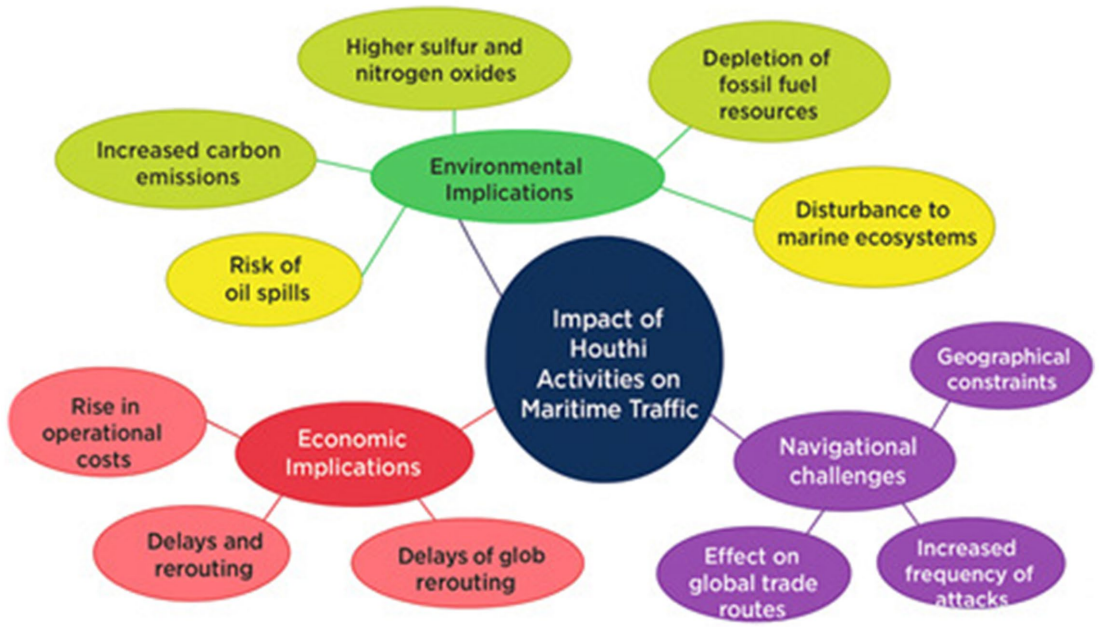

FIGURE 1
Houthi activities' effect on maritime traffic (Rodríguez-Díaz et al., 2024).

Houthi attacks in the Red Sea against shipping have sparked several maritime security risks and threats that have impacted international maritime activities. The Houthis have hit more than 130 vessels as of March 2025 (The Economist, 2025) in protest against Israel's blockade of Gaza since they started attacking ships in the Red Sea in November 2023. Neither the U.S.-led Operation Prosperity Guardian, launched in December 2023, nor the EU's Operation Aspides has prevented the Houthis entirely. However, following the signing of a truce in January 2025, the Houthis threatened to resume attacks after Israel cut off Gaza's electricity and stopped aid from entering the territory. Nearly two months after the United States launched "Operation Rough Rider," a military campaign against Houthi targets since March 15, 2025, Oman mediated another ceasefire agreement (Marine Insight, 2025a).

However, the ceasefire did not cover Israel, and the Houthis continued to launch missile and drone attacks, especially on Eliat and Ben Gurion airports. In contrast, Israel continued to launch attacks on Houthi-controlled ports in Yemen, such as Hodeidah and Salif, and on the Sana'a airfield (Lakhani, 2024). The most recent airstrikes were launched on 16 September 2025 by Israel targeting Yemen's Houthi-controlled Hodeidah port (Marine Insight, 2025b). Finally, the US-brokered Gaza ceasefire plan between Israel and Hamas came into effect at the beginning of October 2025, which led to the Houthi Chief of Staff's indication that their 'ban on Israel shipping' is on hold during the ceasefire (Ambrey, 2025a; Safety4sea, 2025a).

During the conflict[1] shipping companies that have diverted their ships around the Cape of Good Hope, adding around 10 days to voyages[2] (depending on the ship's speed, see Table 2 for further details), raising freight costs, and increasing insurance premiums are impacting the European countries that are heavily dependent on Suez traffic for energy, consumer goods, and raw materials, while Asian exporters are also facing higher shipping costs. Another regional financial effect is the decline in Egypt's revenues from the Suez Canal and the risks posed to the ports/logistics investments of the Gulf countries[3]. Therefore, these attacks can be considered a challenge to Western dominance over sea lines and disrupting global trade and supply chains. The graphical scheme of the different impacts of the Houthis' attacks on commercial shipping is illustrated in Figure 1.

It is suggested that another bubble should be added to this figure addressing "Social & Human Implications" (*impact on seafarers*)

Abbreviations: EIA, The US Energy Information Administration; IMO, International Maritime Organization; ITF, The International Transport Workers' Federation; GHG, Greenhouse gas; UNCTAD, The UN Trade and Development; EU ETS, EU Emission Trading System; EEA, European Economic Area; FSO, Floating Storage and Offloading; ICS, International Chamber of Shipping; MEPC, Marine Environment Protection Committee; MSC, Maritime Safety Committee; M/T, Motor Tanker; M/V, Motor Vessel; NM, Nautical Mile; NSR, Northern Sea Route; TEU, Twenty-Foot Equivalent Unit; UAV, Unmanned Aerial Vehicles; USV, Unmanned Surface Vessels; SLOC, Sea Lines of Communication.

1 As of the end of November 2025, Bab el-Mandeb transits have modestly increased. Two Greek companies have resumed transits, and other companies are openly transiting despite having previously withheld Automatic Identification System (AIS) transmissions (Ambrey, 2025a).

2 Africa's circumnavigation as a substitute for the Suez Canal increases the sailing trip between Singapore and Rotterdam by 3,467 nautical miles and 8 days, considering an average speed of 18 knots (https://sea-distances.org/, 2025, see Table 2 for further details).

3 The Suez Canal is an important source of foreign exchange earnings for Egypt, delivering $9.4 billion in the preceding fiscal year, or 2.3% of GDP in 2023. The Red Sea situation has reportedly resulted in a 40% decline in Suez Canal income. It was estimated that a deteriorating situation in Egypt could have a detrimental spillover effect on other nations in the area, including Ethiopia and Sudan (UNCTAD, 2024).

TABLE 1 Intersections between environment and geopolitics (derived by the author).

Intersected area	How they link	Selected academic sources
Environmental/Resource Geopolitics	Resource scarcity/abundance of environmental themes, such as oil, gas, minerals, and water, are used to shape geopolitical arguments (alliances, competition, and conflict).	O'Lear (2020), Dalby (2014), and Dalby (2020)
Environmental (Climate) Security	Environmental degradation and climate-related shocks act as threat multipliers, affecting stability. Natural resource scarcity is linked with violence, resulting in war or conflict.	Read (2024) and Demir (2022)
Environmental Geography	Environmental change (arctic melt, sea-level rise) reshapes strategic regions, access routes, and territorial disputes.	Lasserre and Cyr (2022)
Green Transition & Power Shifts	Shift to renewables and critical minerals alters energy dependence and geopolitical influence.	Scholten (2018)
Environmental Diplomacy/Agreements	Environmental treaties and climate negotiations become platforms for geopolitical bargaining.	Kalfagianni and Young (2022)
Maritime Geopolitics	Environmental and climate change impacts maritime chokepoints, naval power, and maritime security.	Brennan and Germond (2024), Germond and Mazaris (2019), and Smailis (2025)

considering factors such as psychological stress and anxiety (fear of attacks), reduced safety and security (risk of injury or death during attacks), and crew fatigue from longer voyages (due to rerouting and delays or unstable working conditions), which also indirectly effect maritime traffic resulting from the Houthis' attacks.

In addition to the abovementioned negative effects, there is another effect that is mostly ignored compared to its other effects, especially the economic ones, which are the "environmental" consequences. In essence, the environment and geopolitics are inseparable in today's interconnected world, encompassing everything from resource competition to climate-induced or environmental security, and from strategic chokepoints to the geopolitics of the green transition (Table 1). Environmental dynamics increasingly dictate the strategies and power positions of states. Recognizing this interdependence is essential for developing effective policies that ensure both environmental sustainability and global stability. The relationship between Houthi attacks and the increase in marine congestion highlights the fragile balance between regional geopolitical dynamics and the seamless operation of global trade routes. On the other hand, ensuring the security and functionality of the Red Sea and Suez Canal represents a crucial global problem that combines two increasingly intertwined domains: geopolitics and maritime security (Rodríguez-Díaz et al., 2024), which will be detailed in the following sections.

In the following section of the study, the literature will be reviewed, and the environmental impacts of the Houthis' attacks will be examined. This will be followed by the materials and methods, results, discussion, and conclusion sections.

2 Literature review and environmental effects of the attacks

When searching through the databases for similar studies, it was found that there are studies examining the impacts of Houthis' attacks on maritime traffic (Rodríguez-Díaz et al., 2024), studies focusing on their effects on maritime trade, markets and supply chains (Nandini et al., 2024; Notteboom et al., 2024; Yudaruddin et al., 2025), studies examining the attacks from the perspective of their impacts on disrupted navigation in the Red Sea (ITF, 2024), and studies focusing on oil spills (Agarwala, 2025; Lee, 2024), carbon emissions (Otu-Larbi et al., 2024; Peng et al., 2024) and the general environmental perspective (Anadi, 2024). Therefore, this paper aims to explore the attacks' environmental impacts from a geopolitics perspective, examining the environment-geopolitics-maritime security relationship, which is thought to be underrepresented in the literature (Rodríguez-Díaz et al., 2024; Agarwala, 2025:146), thereby helping to bridge the gap in this area. Literature review results are shown in Table 2.

2.1 Increased carbon emissions because of rerouting

The Paris Climate Agreement, which entered into force in 2016, aims to achieve zero carbon dioxide emissions by 2050. Accordingly, the International Maritime Organization (IMO) established ambitious new goals to cut to reduce greenhouse gas (GHG) emissions, which represents a key milestone for the shipping industry (Laffineur et al., 2023). The revised strategy aims to transition to alternative or virtually zero-GHG fuels by 2030, with a new objective of achieving net-zero GHG emissions from international shipping by around 2050. Considering that shipping-related carbon dioxide (CO_2) emissions are responsible for approximately 3% of total annual anthropogenic CO_2 emissions and are expected to rise significantly without any mitigating actions (Deng and Mi, 2023), it is crucial to implement the IMO's net-zero emissions objectives.

After the beginning of the crisis, container ship companies Evergreen, A.P. Moller-Maersk (Maersk), Hapag-Lloyd, HMM, and CMA CGM[4] issued notices of route changes as of December 2023 and ships that were diverted from the Suez Canal around the Cape of Good Hope released 42% more for an individual vessel (Notteboom et al., 2024) (see Table 3 for how 42% increase is calculated). This represents a significant increase in the carbon

4 The French navy escorted CMA CGM, the sole large container carrier remaining operating in the Red Sea, until they switched to the Cape route in early February 2024 (Notteboom et al., 2024).

TABLE 2 Literature review results (derived by the author).

Author/year	Aim	Conclusion(s)/recommendation(s)
Nandini et al. (2024)	Evaluate the ongoing Red Sea crisis's effects on international shipping trade and security to present a thorough summary.	Recent Houthi attacks on commercial Israeli ships have put the Red Sea's strategic significance as a crucial trade corridor linking the Middle East to Asia and Europe in grave danger.
Rodríguez-Díaz et al. (2024)	To shed light on the geographical and geopolitical difficulties that one of the most important commercial routes in the world faces.	Security concerns about Houthi attacks led to a sharp decline in maritime traffic in the Gulf of Aden and Suez Canal, which had an impact on the economy as well. To protect these vital shipping lanes, they support more robust maritime security protocols and global collaboration.
(2024)	The study aims to investigate the dual effects of the attacks by examining both the Houthis' immediate threat and the attacks' environmental impact.	The Houthis' attacks on commercial ships traversing the Red Sea are motivated by geopolitical objectives and are extremely worrisome for both the region's geopolitics and the planet's overall environmental sustainability.
Notteboom et al. (2024)	To examine the immediate and long-term effects of the Red Sea crisis on international supply chains, freight prices, maritime networks, and vessel operations.	If the security situation in the Red Sea does not improve sufficiently, inflationary pressures may rise, depending on the duration of the interruption and whether further disruptions occur.
Yudaruddin et al. (2025)	To investigate how different markets, geographical areas, and financial sector companies are responding to the US-Houthi conflict.	Compared to developing or frontier markets, developed markets are more negatively affected by the conflict.
ITF (2024)	To examine the short-term impacts of disrupted navigation and the costs associated with Red Sea navigation disruptions.	International cooperation among relevant authorities should be increased. The cost of maritime shipping should be questioned.
Agarwala (2025)	To examine the environmental impacts of the attacks by the Houthis in the Red Sea.	There is an urgent need for specific initiatives, such as regional cooperation and ongoing environmental monitoring.
Lee (2024)	To compare the environmental effects of the Iran-Iraq war with the Hamas-Israel war, and to draw some lessons for the use of the latter.	To ensure the safe passage of business while avoiding unintended escalation, Washington and London must strike a fine balance between offensive and defensive actions.
Peng et al. (2024)	To conduct an empirical study of the current Red Sea problem and how it affects global container logistics' excessive GHG gas emissions.	The efficacy of the EU's nascent maritime carbon pricing is jeopardized by the current regulatory structure under the EU Emissions Trading System, which raises the risk of carbon leakage, especially for medium and small-sized container ships.
Otu-Larbi et al. (2024)	To provide an analysis for a more comprehensive picture of the effects of the military's long war on the climate.	To provide a more thorough picture of the conflict's carbon emissions.

TABLE 3 Comparison of the Suez Canal route and cape of good hope route between Singapore and Rotterdam (derived by the author).

Item	Suez Canal route (baseline)	Cape of good hope route (reroute)	Difference between Suez and cape routes
One-way distance (nautical miles)	8,288 nm	11,755 nm.	+3,467 nm
Round-trip distance	16,576 nm	23,510 nm	+6,934 nm
Estimated round-trip days (at 18 kts)	38.4 days	54.4 days	+16.0 days
Assumed fuel burn (average)	6,139 tons of fuel (38.4 days×160 tons/day)	8,707 tons of fuel (54.4 days × 160 tons/day)	+2,568 tons of fuel
CO_2 emitted (using 3.114 t CO_2/t fuel)	**19,118 t CO_2**	**27,115 t CO_2**	**+7,997 t CO_2**
% change in voyage CO_2	—	—	**+41.8% (CO_2 increase)**

Calculations are for a typical large container ship (20K TEU) transit with 18 kts speed, assuming 160 tons of fuel per day, and for a standard combustion factor for residual fuel oil/heavy bunker fuel. Bold values represent the total CO_2 emissions per ton for a container ship with a capacity of 20K TEU traveling from Singapore to Rotterdam or vice versa through the Suez and Cape of Good Hope routes, along with their difference and percentage comparison.

footprints of companies reliant on shipping, which undermines their ability to meet "Net Zero commitments" (Safety4sea, 2025b; IMO, n.d.).

Vessel sailing speeds are increasing as a result of the Red Sea and Suez Canal disruption, which has forced ships to take longer routes (UNCTAD, 2024:13). This enables ship operators to manage fleet capacity and preserve

TABLE 4 Estimated CO_2 emissions associated with military-related activities during the Hamas-Israel conflict for the first 60 days (Lakhani, 2024).

Category	Sub-category	Emissions (tonnes CO_2-eq)
Flights (total: 254,650)	US supply flights	133,650
Flights (total: 254,650)	Israeli aircraft missions	121,000
Munitions (total: 21,002)	Israeli artillery	13,600
Munitions (total: 21,002)	Israeli bombs	6,689
Munitions (total: 21,002)	Hamas rockets	713
Land transport (total: 5,663)	Israeli tanks and armoured vehicles	5,663
Total	—	281,315 tonnes of CO_2 equivalent

schedule integrity. However, the ship's fuel consumption increases along with its speed and distance. For a large container ship, a 1% increase in speed typically results in a 2.2% increase in fuel consumption (Wright, 2022). These trends could weaken the environmental benefits of slow steaming. Moreover, if the option to increase speed is not used, additional ships will be required to maintain uninterrupted cargo movement, further increasing carbon emissions even more (Notteboom et al., 2024; Peng et al., 2024).

Moreover, continued insecurity in the Red Sea has forced many vessels to reroute via the Cape of Good Hope, sharply increasing emissions and exposure to European Union Emission Trading System[5] (EUETS) compliance costs. Under normal Suez operations, most Asia-Europe services sail directly into EU ports with limited incentive to adjust transshipment patterns. However, once ships are compelled to take much longer routes, their ETS-eligible emissions—and therefore their carbon costs—rise substantially. Recent evidence shows that under these crisis-induced conditions, operators are more likely to relocate transshipment to ports outside ETS jurisdiction to limit compliance obligations, a form of carbon leakage[6] intensified by the rerouting (Peng et al., 2024). Thus, the Red Sea crisis does not merely coincide with ETS avoidance behavior; it increases the economic rationale for it, linking maritime insecurity directly to environmental policy effectiveness.

2.2 Conflict-related emissions

The climatic cost of Israel's military response (CO_2 from aircraft missions, tanks and fuel from other vehicles, as well as emissions generated by manufacturing and exploding the bombs, artillery, and rockets) in the first 60 days of the conflict was equivalent to burning at least 150,000 tons of coal, according to a study that is based on only a few carbon-intensive activities and is therefore probably an underestimate (Table 4). This amount is greater than the yearly carbon footprint of more than 20 of the most climate-vulnerable nations in the world (Otu-Larbi et al., 2024; Lakhani, 2024). In addition to the direct effects of conflict-related emissions, rebuilding Gaza's 100,000 damaged homes with modern building techniques will require at least 30 million metric tons of GHG gas emissions, according to the study (Otu-Larbi et al., 2024), considering that most of the buildings have been destroyed or damaged in Gaza.

The conflict involves billions of dollars' worth of guns, tanks, support trucks, and fighter jets, all of which consume massive amounts of fuel and produce considerable GHG gas emissions that are difficult to estimate and rarely discussed or are often exempted from disclosing their GHG emissions publicly under the pretense of national security.

2.3 Oil spills

Oil spills and slicks are among the most prevalent pollutants emitted by ships when at sea or during accidents/attacks and have severe environmental, social, and economic implications. For ships targeted and attacked by the Houthis in the Red Sea, oil slicks figure prominently as a pollutant of concern, raising concerns about the environmental impact on the delicate ecosystem. Oil slicks can contaminate gill tissues, causing suffocation or disease, accumulate in food chains, affecting commercially important fish, and impact benthic organisms when oil settles on the seabed.

There were ships among the attacked ones that caused more than 124 miles of oil spills (Fitt, 2024), as listed in Table 5. Among these, bunker fuel (as found on M/V Rubymar and M/T Chios Lion) is very viscous, highly toxic, and slow to degrade, while crude oil cargoes (from M/T Sounion and M/T Chios Lion) are more volatile, but still toxic to marine life. In addition to impacts on marine life[7], oil slicks also have other negative effects, such as their effects on tourism, on which some riparian countries (Egypt, Sudan, Saudi Arabia, and Eritrea) rely for diving and coastal activities. Oil slicks are visually damaging and ecologically destructive, potentially reducing tourist revenue. Additionally, oil slicks can interfere with navigation, fouling hulls and port facilities, and increasing maintenance costs.

5 As of January 2024, the EU ETS, which is a market mechanism that puts a price on climate change-inducing CO_2 emissions, was extended to cover maritime transport, beginning with CO_2 emissions from large ships exceeding 5,000 GT, which include 50% of emissions on voyages between EU ports and non-EU ports and 100% of emissions on voyages within the EU.

6 By moving transshipment activities from within the ETS-compliant regions to nearby areas not under ETS jurisdiction, companies can obscure the actual maritime emissions. If this transshipment strategy is employed to circumvent carbon pricing, it is termed 'carbon leakage' (Peng et al., 2024).

7 Hundreds of aquatic life types and ecosystems thrive in the Red Sea's warm surface water temperature and high salinity. Among the richest marine ecosystems in the world and the most resilient to climate change are the coral reefs in the area, which are home to more than 1,200 fish species and more than 350 types of coral (Mazzucco, 2025).

TABLE 5 Heavily damaged-sunken ships or ships with fatalities after Houthis' attacks [derived and updated from Agarwala (2025)].

Ship name	Incident date	Status after attack	Oil spill – spill distance
M/V galaxy leader	19 Nov 23	Hijacked (Nov 2023), held by Houthis	N/A
M/V Rubymar	18 Feb 24	Sank after a missile attack. She was carrying 21,000 metric tons of fertilizer as cargo and had approximately 200 tons of heavy fuel oil and 80 tons of marine diesel.	18 miles of oil slick on the sinking
M/V true confidence	6 Mar 24	Damaged with casualties (March 2024) but remained afloat	Not recorded a significant oil slick.
M/V tutor	12 Jun 24	Sank following a drone/missile strike with one crew missing (she was carrying 80,000 metric tons of coal)	12 miles of oil slick
M/V verbena	13 Jun 24	Attacked and abandoned, yet towed to safety	Not recorded a significant oil slick.
M/T Chios lion	15 Jul 24	Attacked by an unmanned surface vessel while carrying 100,000 mt. crude oil	125 miles of oil slick
M/T Sounion	21 Aug 24	Abandoned, heavily damaged by multiple fires, but salvaged and towed to safety. She was carrying 1 million barrels of crude oil	2 miles of oil slick
M/V magic seas	6 Jul 25	Sank (July 2025) with four confirmed dead (carrying fertilizer and steel billets)	Around 40 miles long oil slick
M/V eternity C	7 Jul 25	The vessel was assaulted with sea drones and rocket-propelled grenades and was seriously damaged. 9 crew presumed dead. The vessel was abandoned and sank shortly after the attacks.	Around 50 miles long oil spill

Another example is the weaponization of the Floating Storage and Offloading (FSO) Safer oil tanker, in which the Houthis utilized the threat of environmental calamities as a negotiating tool to achieve their strategic goals. The FSO Safer, moored outside Yemen's Ras Isah port city, is a super tanker that the Yemeni government formerly used as an FSO facility. The FSO Safer fell into the hands of the Houthis when they seized power in the Hodeidah Governorate. Its payload of around 1.4 million barrels of crude oil became an environmental time bomb due to prolonged lack of maintenance, which greatly increased the risk of corrosion-induced spills. The Houthis repeatedly violated agreements throughout the many rounds of negotiations they had with the UN to plan a salvage effort. In August 2023, the United Nations successfully oversaw a $144 million ship-to-ship oil transfer operation after years of intermittent negotiations (Mazzucco, 2025). The IMO provided technical support and played a key supporting role in the initiative (IMO, 2024). An oil spill in the region would have been a massive humanitarian and environmental calamity. A major leak was expected to have had a considerable impact on Yemen's northwestern shoreline, including the Yemeni Islands in the Red Sea, particularly Kamaran Island. Oil may also have drifted and impacted neighbouring countries such as Djibouti, Eritrea, and Saudi Arabia, and the clean-up alone would have cost $20 billion (United Nations, 2023).

Moreover, it was reported that after the U.S. airstrikes on the Ras Isa oil port on April 17, 2025, petroleum derivatives leaked into the Red Sea and surrounding waters, thus creating the risk of an ecological disaster (Sameai and Fırat, 2025). Finally, although the least likely scenario, the Houthis' claimed attacks against the U.S. nuclear-powered carriers after the U.S. and U.K. strikes targeting Houthis' positions in Yemen in May 2024 (Newsweek, 2024), suggest that missile or drone attacks could have much more detrimental consequences in terms of nuclear spills in the Red Sea.

2.4 Sunken/damaged ships and impact on marine ecosystems and wildlife

The Houthis have used a wide range of munitions, including anti-ship ballistic missiles, cruise missiles, rockets, and RPGs. These were delivered to targets using Unmanned Aerial Vehicles (UAVs), Unmanned Surface Vessels (USVs), and land-based launchers, or the UAV-USVs were utilized as weapons themselves. The majority of these strikes missed their targets, but others resulted in severe/minor damage or fires on board the ships. However, some attacks resulted in the sinking of several ships. M/V Rubymar (general cargo ship), M/V Tutor, M/V Eternity C, and M/V Magic Seas (bulk carriers) are four examples that sank after attacks as of September 2025. Some ships were attacked and abandoned but did not sink; they were subsequently towed to safety, such as the M/V Verbena and the M/T Sounion. Among the attacks resulting in fatalities, M/V True Confidence, M/V Tutor, M/V Magic Seas, and M/V Eternity can be mentioned. A list of ships that have sunk, been severely damaged, or had fatalities is listed in Table 5.

Damaged or sunken ships carrying either hazardous cargo or crude oil, after being hit by Houthi attacks, represent another dimension of the environmental impact. The sinking of the Belize-registered M/V Rubymar, carrying approximately 21,000 metric tons of fertilizer —a dangerous cargo that posed a serious threat to marine life in the region—in March 2024 (Ghobari, 2024) was the first example. A few months later, a Greek-flagged oil tanker, Sounion, carrying 150,000 tons of Iraqi crude oil, was attacked by Houthi rebels (Kowalenko, n.d.) in August 2024. After evacuating the 25 crew members and extinguishing the fire, the vessel was towed to a safe anchorage, and its crude oil was transferred successfully to another tanker near Suez in December 2024 (Safety4sea, 2024). In September 2024, two more tankers carrying crude oil—the Panamanian-flagged M/V Blue Lagoon I and the Saudi Arabian-flagged M/V Amjad– were also hit by two ballistic missiles and a suicide drone. Expert analysis indicates that either the Sounion or Amjad oil spills could have led to a disaster "four times the size of the 1989 Exxon Valdez disaster" which led to the spillage of 11 million gallons of oil in Alaska's Prince William Sound, impacting 1,300 miles of coastline and causing significant repercussions

for aquatic life, wildlife habitats, and local industry and towns [Foundation for Defense of Democracies (FDD), 2024].

July 2025 witnessed two ship sinkings. The first one, M/V Magic Seas, was also carrying fertilizer and steel billets (or iron) when it was attacked and sunk by the Houthis on July 6, 2025 (The New Arab, 2025), and M/V Eternity C had completed a humanitarian cargo delivery for the UN's World Food Programme to Berbera, Somalia. At the time of the attack, it was sailing in ballast —meaning it was not carrying any cargo—and was en route to Jeddah, Saudi Arabia, to refuel. The most recent attack before this study was published was on the Israeli oil tanker "Scarlet Ray" in the northern Red Sea by a ballistic missile, which directly hit the ship. This represented the furthest north location since the Houthis began to attack ships in response to the Israel-Hamas conflict in 2025 (EOS Marine, 2025).

In the case of the two examples that sank with fertilizer (Rubymar and Magic Seas), the fertilizer dissolves easily in water and can cause soil acidity, water pollution, and harm to aquatic life. When dissolved in water, this chemical encourages the growth of algae and macrophytes, reducing dissolved oxygen levels, which is harmful to aquatic life. Because fertilizer can cause algal blooms, it can create low-oxygen dead zones, devastating local fishing and shellfish harvesting. Concerning the Tutor that sank with coal, coal in the marine environment influences fish eggs and larvae and reduces the diversity of marine animals (Agarwala, 2025).

Apart from the cargoes carried by the sunken ships, another dimension of the problem is the fuel that the sunken ships have on board. If not salvaged, this oil will flow into the ocean, generating an oil slick when the fuel tank's waterproof integrity is damaged by corrosion over time. Although these fuels are refined and their viscosity is significantly lower than that of crude oil, allowing them to disperse more naturally, they are still environmentally harmful substances. Therefore, it can be concluded that the Houthis' attacks have raised serious environmental concerns regarding marine ecosystems and wildlife, as the Red Sea supports coral ecosystems and rare aquatic species, including mangroves that protect the coastline.

2.5 Impacts of the attacks from maritime security, geopolitics, and governance perspectives

A key component of the definition of marine security, which varies depending on geography and security threats, is geopolitics (Kismartini et al., 2024). The Hamas-Israel conflict has proven to us that emerging technologies are changing traditional maritime security risks and threats. The use of asymmetric threats such as unmanned air or sea drones is a new method for disrupting Sea Lines of Communication (SLOCs). Houthi attacks against merchant ships in the Red Sea using suicide drones are a good example of the changing nature of traditional maritime security threats. An armed non-state actor that has no navy has partially seized control of the Bab al-Mandeb Strait -which is one of the world's most important chokepoints- since December 2023 and has largely maintained it to date despite ongoing operations and air strikes. Although there are studies claiming that the international coalition's engagement in Yemen has strengthened the Houthis, heightened regional concerns, and enabled Iran's sectarian foreign strategy (Cafer and Şahīn, 2024:183), the preemptive attacks on the Houthis carried out by the international coalition reduced their capacity to disrupt maritime security, even if not stopped entirely (Karlsson, 2024). These response operations would require additional ships to be present, thereby potentially increasing operational costs, emissions, and the risk of pollution.

Another aspect of the issue is that the Houthis were better able to compete with other armed groups for financial support and assistance due to the massive global attention their campaign received, which increased their legitimacy as Yemen's primary political force (Lee, 2024:121). By targeting merchant and naval vessels, the Houthis have weaponized geography, showing that a relatively small non-state actor can disrupt global trade and energy flows. This elevates their status in regional geopolitics, giving them leverage against stronger states such as Saudi Arabia, the UAE, and even Western powers.

It can be inferred that, despite the ceasefire, the reliability of the Suez Canal route is still uncertain, and the use of the Cape of Good Hope will persist until permanent stability is established, albeit with its associated environmental burdens. This state of uncertainty may continue to lead to alternative trade routes apart from the Cape of Good Hope route, such as the Northern Sea Route (NSR) or the Middle Corridor—especially after the construction of the Zangezur Corridor that will connect the mainland of Azerbaijan with the Nakhichevan Autonomous Republic for the transportation of goods from Asia to Europe or vice versa. Nevertheless, the shift to NSR could encounter other risks, such as the risk of accidents that may cause oil spills, requiring cleanup operations in remote areas with harsh weather conditions, while the capacity of the Middle Corridor is very limited compared to sea routes.

The Mediterranean Basin's function as the "hub-of-hubs" linking four continents could be significantly impacted if the attacks continue despite the ceasefire. Because of this unique situation, carriers might be more inclined to use transshipment hubs close to the Strait of Gibraltar, which would split services on important Asia–Europe lines in the container market. Similar options might be provided by West African ports (Notteboom et al., 2024).

Another effect of the Houthis' attacks against the merchant shipping in the Red Sea, according to the Bloomsbury Intelligence & Security Institute, was the return of the Somalia piracy activity in the Gulf of Aden and Arabian Sea (Desurmont, 2024). Somali pirates have reappeared in the Gulf of Aden amid Houthi attacks on foreign-owned ships traversing the Red Sea. Since January 2024, Somali pirates have intensified their activities with more attacks in three months than in the entire year of 2023, according to the International Maritime Bureau (ICC International Maritime Bureau, 2025) and other open sources (Safety4sea, 2025c). The Africa Center for Strategic Studies highlights growing collaboration between the Houthis (in Yemen) and al-Shabaab (in Somalia), which is contributing to maritime insecurity in the Gulf of Aden and Red Sea. Therefore, the resurgence of Somali piracy, partially catalyzed by heightened Houthi attacks in the Red Sea, carries significant environmental implications for the wider Gulf of Aden and western Indian Ocean region.

Finally, when examining the emergency response mechanisms for attacked ships and different organizations' roles in the conflict from governance perspective, considering that the coastal states have limited rescue and salvage capacities, either naval assets within the EU Naval Mission Operation Aspides (as in the French frigate's assistance to M/T Sounion's incident to rescue the crew), or private salvage companies [as in M/T Sounion's (Ambrey, 2025b) and M/V Eternity

C's salvage operations (Meade, 2025)] assisted attacked ships to stabilize them and/or prevent further environmental hazards.

To protect ships from attacks and -indirectly protect the environment- different organizations took preventive measures, such as the Protection & Indemnity (P&I) clubs' call for tighter Red Sea precautions; by requiring shipowners to audit their links to Israel, the International Chamber of Shipping's (ICS) "call for the immediate cessation" of Houthi attacks and urge states with influence to help stop them. Last but not least, in May 2024, IMO's Maritime Safety Committee (MSC) adopted a resolution condemning the attacks as "illegal and unjustifiable," reaffirming the importance of freedom of navigation and the safety of seafarers, which is non-binding as a regulatory body under the UN umbrella, having no law enforcement mechanism. Therefore, as an organization whose effectiveness depends heavily on its member states, the IMO's statements remained largely rhetorical, despite environmental protection being a core part of its mandate through its Marine Environment Protection Committee (MEPC).

3 Materials and methods

A desk-based, qualitative research design was used in this study, which was bolstered by selective quantitative data analysis. The first goal was to examine the relationships between the Houthis' attacks and their environmental effects. The second objective was to investigate the attacks from a broader perspective encompassing maritime security and geopolitical concepts. The dataset's core consisted of secondary sources. Search terms such as "environmental impact of the Red Sea crisis/Houthis' attacks in the Red Sea" and "maritime security, geopolitics, and environmental impacts of maritime security risks" were used to find peer-reviewed academic literature on Scopus, Web of Science, and Google Scholar. Reports from the European Commission, the IMO, UNCTAD, and the International Transport Workers' Federation (ITF) were also included to provide industrial and policy perspectives alongside the academic sources. Considering that news about the attacked ships in the region was published on the internet shortly after the incidents, a systematic selection and interpretation of reliable websites was conducted.

The qualitative data were examined using thematic content analysis. Sources were coded into three thematic clusters: (1) maritime security and geopolitical risks; (2) environmental implications of maritime disruptions; and (3) the role of alternative trade corridors. As the research is desk-based, it relies on the accuracy of published sources and databases. Direct fieldwork or stakeholder interviews were not undertaken, which limits the ability to capture first-hand perspectives. Nonetheless, triangulation across academic, policy, and industry reports was employed to mitigate bias and strengthen validity.

4 Results

According to the International Maritime Chamber of Commerce, 20% of container ships worldwide were taking a longer route around the southern edge of Africa rather than through the Red Sea (Nandini et al., 2024) before the ceasefire. However, although Bab el-Mandeb transits have slightly increased as of the end of November 2025, after the ceasefire, true Suez revival requires a verified, sustained security corridor.

During the conflict, increased fuel use also led to increased sulfur and nitrogen oxide emissions, which exacerbated the health risks associated with air pollution, particularly in coastal areas. Additionally, the increasing risk of maritime conflicts and navigational challenges increased the likelihood of oil spills, a major hazard to marine environments. Indirectly, ships are frequently rerouted to avoid conflict zones, which also increased maritime traffic in previously unexplored areas where they need to face Africa's inefficient and aging ports that's avoiding attacks by Houthi rebels through the Red Sea (Goko-Petzer, 2024).

Therefore, disruptions in the SLOC cause not only financial losses but also have negative environmental consequences, which may pave the way for increasing the traffic on other alternative routes, such as the NSR, in the future. Although the Red Sea crisis primarily affected cargo traveling between Asia and Europe or vice versa, it has had the potential to disrupt supply chains in other industries that rely on intermediate imports from Asia-Pacific countries. These kinds of disturbances could have an impact on energy supply and security, food security, and environmental sustainability as well (Peng et al., 2024). Moreover, oil spills, hazardous cargo leaks, and sunken ships in the region attacked by the Houthis damaged coral reefs and marine ecosystems.

Another result of the study is the urgent need to strengthen existing regulatory and operational mechanisms, enabling more effective preventive measures and rapid response to avert further environmental incidents, starting from the IMO's current framework. Enhancing IMO's frameworks would not only improve governance and compliance among Member States but also enable more proactive precautionary measures, timely interventions, and effective mitigation of environmental incidents. Such reforms are essential to prevent further ecological damage and to ensure that international shipping operates safely and sustainably in vulnerable maritime zones.

5 Discussion

The main finding of the study is that maritime security threats and risks can have detrimental effects on the environment, in addition to their financial impacts. The Houthis' attacks against merchant shipping in the Red Sea serve as a notable example of this. The study's findings align with the limited existing research on the subject (Agarwala, 2025; Anadi, 2024:110; Notteboom et al., 2024; Rodríguez-Díaz et al., 2024). However, it also diverges from some of them by prioritizing political solutions instead of enhanced maritime patrols or additional naval assets in the ongoing operations, while it also expands on those studies from different perspectives (conflict-related emissions), such as the climatic cost of military responses or the carbon cost of rebuilding Gaza's 100,000 damaged houses. As maritime security challenges are politically motivated, the solution also lies in policy and governance, considering that the Houthis have continued their attacks despite multiple operations and air strikes against their targets. However, the impacts of environmental degradation at sea continue to be poorly understood among policymakers, maritime security practitioners, and analysts alike (Bueger and Edmunds, 2024:209). Additionally, this study diverges from the aforementioned studies

by attempting to connect these environmental issues with the concepts of maritime security and geopolitics. Therefore, it may shed light on future research concerning the environmental effects of maritime security risks from a geopolitical perspective and related threats or further examine the connections between them.

6 Conclusion

The ongoing conflict and resulting instability in the region have had a profound impact on the environment, and its effects will persist, considering the potential emissions associated with rebuilding Gaza and that turning back to the Suez route may still need some time, despite the ceasefire. The study's conclusion highlights the importance of enhancing national, regional, or organizational collaboration to enhance the current maritime security and environmental protection frameworks' response mechanisms. Moreover, the situation underscores maritime security and environmental sustainability cannot be treated as separate agendas. Future studies can focus on how these mechanisms can be enhanced and which policy responses must be prioritized for environmental protection.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

FO: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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