School of

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Investigating barriers to the effective management of untraceable oil spills: towards greater protection of the Musandam Peninsula coastline, Sultanate of Oman

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Abstract

This thesis examines the effects of small-scale ‘mystery’ marine oil spills from shipping on the environment and natural life, as well as the economy of the Musandam Peninsula in Oman. The study reveals that ‘mystery’ spills (i.e., spills from an unknown source), are more common than spills whose source can be identified. The perpetrators of these mystery spills go largely unpunished, yet they cause serious damage to coastal communities. This is a breach of environmental justice, which is the main theoretical concept informing this thesis. Musandam serves as a case study due to its strategic location in the Strait of Hormuz, a major oil transport route. Residents report that oil slicks and tar balls on Musandam's coast result from tanker and ship discharges in the Strait of Hormuz. The study highlights a weakness in the compensation system which requires information about which vessels are to blame for spills in order to operate the polluter pays principle. Such information is very difficult to obtain because many vessels pass through the Strait of Hormuz every day and oil spills can shift and disperse quite rapidly. This situation raises environmental justice concerns, particularly for local communities and fishers who face clean-up costs with little prospect of obtaining compensation to reimburse them. The stakeholders interviewed in the study proposed two solutions: establishing a regional compensation fund for mystery oil spills paid for by ship owners; and using technology to detect spillers more effectively. Additionally, stakeholders emphasise the need for greater community involvement in decision-making. This study pioneers the examination of mystery oil spills in Musandam, offering insights into dealing with opportunistic polluters. The framework developed has potential applicability to similar contexts elsewhere.

Author's Declaration

I hereby declare that this thesis represents my original work, and I am the sole author. This work has not been previously submitted for any academic award, neither at this university nor any other institution. All sources and references used in this thesis have been duly acknowledged.

Signed: 

Date: 06/11/2024

Dedication

This thesis is dedicated to my cherished family; to my dearest parents, although they didn’t hold formal degrees, they are the most profound professors in my life. Their lessons in love, integrity, and hard work have been my guiding principles. Thank you for being my basic greatest teachers.

I also dedicate this achievement to my beloved wife, the heart of my life, and my cherished children, along with my dear brothers and sisters. I am forever grateful for the immense beauty and joy you bring to my life. Your love, support, and unwavering presence have been my greatest blessings. It is to you that I dedicate this work. May our journey together continue to be filled with love, happiness, and boundless adventures.

Additionally, I dedicate this work to the land of the Sultanate of Oman and its promising future. I am filled with hope and optimism for the continued progress and prosperity of this great Oman.

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Glossary

Ashura	A government consultation committee.
Majlis	A traditional gathering or reception room within a house or communal space.
Sheikh	Tribal Heads.
Wali(s)	Ruler's representatives in regions.
Willayat(s)	Regions within governorates.
Oil Spill	The release of liquid petroleum hydrocarbon into the environment, typically as a result of human activity.
Mystery Spills	Untraceable oil spills where the responsible party or source remains unknown, and which pose challenges in identifying and holding accountable those responsible for the environmental damage.
Bunker Oil	Heavy fuel oil used in shipping which is typically derived from crude oil.
Ballast Water	Ballast water with its suspended matter is taken on board a ship to control the trim, draught, stability and stresses of the ship.
Double Hull	A ship hull design and construction method where the bottom and sides of the ship have two complete layers of watertight hull surface: one outer layer forming the normal hull of the ship, and a second inner hull which is a few feet inboard, and forms a redundant barrier to seawater in case the outer hull is damaged and leaks.
Sunnan Al-Bahar committees (Sea Code)	A platform for fishermen to come together and address any challenges they encounter in their fishing work.
Dhow	A traditional wooden sailing vessel that has been used for centuries in various parts of the Arabian Peninsula,

List of Acronyms

ACLN	Adversarial Corrector Learning Network
AIS	Automatic Identification System
BP	British Petroleum
BPP	Beneficiary Pays Principle
bbl.	Barrels
Barcelona Convention	The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean Sea against Pollution
Bunkering	The process of supplying ships or vessels with fuel, such as oil or liquefied natural gas (LNG), while they are docked in a port or at sea
CLC Convention	International Convention on Civil Liability for Oil Pollution Damage
CVOPCF	China Vessel-Source Oil Pollution Compensation Fund
COPE Fund	Compensation for Oil Pollution in European Waters Fund
EA	Environment Authority, Oman
EEZ	Exclusive Economic Zone
EJ	Environmental justice
EMSA	The European Maritime Safety Agency
ESI	Environmental Ship Index
EU	European Union
FGDs	Focus group discussions
FOPCF	Finnish Oil Pollution Compensation Fund (FOPCF)
GB	Governor of Buraimi
GCC	Gulf Cooperation Council
GM	Governor of Musandam
GT	Gross tonne for ships
IMO	International Maritime Organization
INTERPOL	International Criminal Police Organization
IOPC Fund	International Oil Pollution Compensation Fund
ITOPF	International Tanker Owners Pollution Federation Ltd
KI	Key informant

LRIT	Long Range Identification and Tracking
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978
MEMAC	Marine Emergency Mutual Aid Centre
MENELAS	Mediterranean Network of Law Enforcement Officials relating to MARPOL 73/78 within the framework of the Barcelona Convention
MEPC	Marine Environment Protection Committee
MHT	Ministry of Heritage and Tourism, Oman
MNZ	Maritime New Zealand
MOAFWR	Ministry of Agriculture & Fisheries Wealth and Water Resources, Oman
MSC	Maritime Security Centre, Oman
MTCIT	Ministry of Transport, Communications, and Information Technology, Oman
NOAA	National Oceanic and Atmospheric Administration, USA
NZOPF	New Zealand Oil Pollution Fund
OILPOL	Oil Pollution Convention of 1954
ONOSCP	Oman National Oil Spill Contingency Plan
OPA	Oil Pollution Act, Oman
OPRC	International Convention on Oil Pollution Preparedness, Response and Cooperation
OSLTF	Oil Spill Liability Trust Fund, USA
OSPAR	Convention for the Protection of the Marine Environment of the North Atlantic
OSRL	Oil Spill Response Limited
OSRO	Oil Spill Response Organization
OWWC	Oman Water and Wastewater Company
PDO	Petroleum Development of Oman
PESCO	Omani Company for Petroleum and Environmental Services
PPM	Parts per million
PPP	Polluter Pays Principle
P&I	Protection and Indemnity

RAF	Royal Air Force, Oman
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
RNO	Royal Navy of Oman
ROP	Royal Oman Police
ROPME	Regional Organization for the Protection of the Marine Environment
SAR	Synthetic Aperture Radar
SDR	Special Drawing Right
SOPF	Ship-source Oil Pollution Fund
SQU	Sultan Qaboos University
SS	Steam Ship
TEU	Twenty-foot Equivalent Unit
TOVALOP	Tanker Owners' Voluntary Agreement Concerning Liability for Oil Pollution
UAE	United Arab Emirates
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
US$	United States dollars
VMS	Vessel Monitoring System
VTS	Vessel Traffic Control System.
WHO	World Health Organization
5Ocean	Five Ocean Environmental Services

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CHAPTER 1. Introduction and Literature Review

1. Introduction

Oil pollution is a serious threat to the marine environment (Kostianoy, et al., 2020). The toxicity of petroleum hydrocarbons damages marine flora and fauna natural habitats and has direct impacts on fisheries, seawater desalination installations and coastal amenities such as tourist attractions, beaches, and harbours (Zhang, et al., 2019). Oil pollution therefore threatens livelihoods, homes, businesses, and communities' economic, social, and environmental well-being (Ahmad, et al., 2021), causing significant problems for coastal states across the world (Aldosari, 2019; Weitz, 2018). Annually, an estimated over 5.5 million tonnes of marine oil pollution is released from anthropogenic sources (Onyena & Sam, 2020). The causes of oil spills are many and varied but are usually associated with the transportation of oil by tankers, offshore oil exploration and extraction operations (Khan, 2008), though land-based sources also play a part, such as urban waste and industrial discharges which are released into rivers and eventually flow into the marine environment (Chen, et al., 2019).

Large-scale accidental marine oil spills attract huge media attention, but small-scale deliberate operational discharges from the oil industry, especially from tankers, often go unnoticed, despite the facts that they are the single largest anthropogenic source of marine oil pollution (Hassler, 2016) and they are in violation of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Even the slightest oil spill into the ocean causes a thin film to form on the water's surface which can quickly spread widely (Anyanova, 2012). (Zhao, et al., 2014), and collectively, they can cause a significant impact on the marine environment. They have a detrimental impact on the marine environment, causing widespread ecological damage, harming marine life, and disrupting ecosystems (Saadoun, 2015).

Research findings indicate an annual influx of approximately six million tonnes of oil into the environment, comprising various hydrocarbons, including those classified as light hydrocarbons and crude oil (Loyeh & Mohsenpour, 2020). In 2020, over 2 billion tonnes of crude oil were transported by sea (VSM, 2022). In European waters alone, 7,500 spills were detected in 2019 (Berti, 2020). Leaks are common on modern

cargo and container ships, which are powered by oil-based fuels and lubricants (ITOPF, 2022). When the heavy fuel oil that powers these ships is burned, it produces an oily sludge that leaks from machinery and drains down and accumulates in the bilge tanks (located at the lowest part of a ship) (Marinedefender, 2021). The contents of the bilge tanks are stored on board until they can be discharged. Between each trip, tankers are required to clean out their tanks, and thousands of gallons of sludgy waste are routinely evacuated from them (IMO, 2019; Walker, 2016).

Many tanker oil spills are oil sludge spillages (Dietl, 2013) that occur during regular tank-cleaning operations (Ahmad, et al., 2021). There are around 3,000 occurrences of such dumping in European waters per year (Paddison et al., 2022). Commercial vessels often discharge waste oil products into the sea to avoid the time (Gullo, 2011) and cost (Udechukwu & Jonah, 2020; Kontovas, et al., 2010) of legal disposal in ports (see Table 1.1). It is estimated that avoiding the oily water separator and disposal fees at port can save an owner 80,000- 220,000 US$ annually, depending on the ship's size, age, number of days at sea, and level of maintenance (Vollaard, 2017). This can equate to 5-12% of a ship's operating costs (Crist, 2003).

Table 1.1 Estimated costs (Euros) for legal disposal of two types of oily waste streams from vessels in UK ports. [source: Crist, 2003]

Vessel type	**Discharging of heavy fuel oil sludge into port waste reception facilities**		**Discharging of oily bilge water into port waste reception facilities**	
	Discharge cost following a 30-day voyage (Euros)	Notional daily cost (Euros)	Discharge cost following a 30-day voyage (Euros)	Notional daily cost (Euros)
Tanker	1,800	60	1,051	35
Bulker	1,375	46	843	28
Container	3,780	126	711	24
Dry Cargo	2,991	99	165	6

Some owners and tanker operators illegally install pipes in order to bypass the ship's oily water separator and pump oily water directly into the ocean (Marinedefender, 2021). This activity was outlawed by the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), which banned any discharge into the sea of oil or oily mixtures from ships (Kostianoy & Carpenter, 2018; Younos & Grady, 2014). The pursuit of financial gains frequently motivates ship owner/operators to violate the provisions outlined in the International Convention (Aladwani, 2019).

Such operational discharges are estimated to amount to 60 -175 million gallons each year (Anyanova, 2012). Illegalities associated with these violations include: falsification of records, tampering with monitoring systems, release of bilge as well as sludge, and the obstruction of investigations (Freestone, 2013). Water discharged offshore must contain only trace amounts of oil (15 ppm), which should not leave a sheen on the water surface, so any visible sheen in the water can be interpreted as evidence of a discharge of more than 15 ppm million (Crist, 2003). Subject to the provisions of regulation 4 of this annex and paragraphs 2, 3, and 6 of this regulation in the MARPOL 73/78 convention, any discharge into the sea of oil or oily mixtures from ships is prohibited except when all the following conditions are satisfied (REMPEC, 2022):

1. The ship is proceeding en route;
2. The oily mixture is processed through an oil filtering equipment meeting the requirements of regulation 14 of this Annex;
3. The oil content of the effluent without dilution does not exceed 15 parts per million; [Note this 15-ppm discharge is not applicable for the Special Sea Areas such as the Gulf and the Arabian Sea/Musandam.
4. The oily mixture does not originate from cargo pump-room bilges on oil tankers; and
5. The oily mixture, in the case of oil tankers, is not mixed with oil cargo residues.

As illustrated in Figure 1.1, the number of oil spills over 7 tonnes have reduced by more than 90% since 1970 (ITOPF, 2023). However, the reporting of small spills (less than 7 tonnes) is unreliable and data are often incomplete (Su, et al., 2019), so it is unclear whether the number of small spills is decreasing or increasing. It is estimated that over 80% of spills recorded since 1970 were small: between 1974 and 2015, there were an average per year of 1,815 illegal waste oil discharges of <7 tonnes; 175 spills were between 7 and 700 tonnes, and 30 spills of >700 tonnes were recorded globally from tankers (Su, et al., 2019).

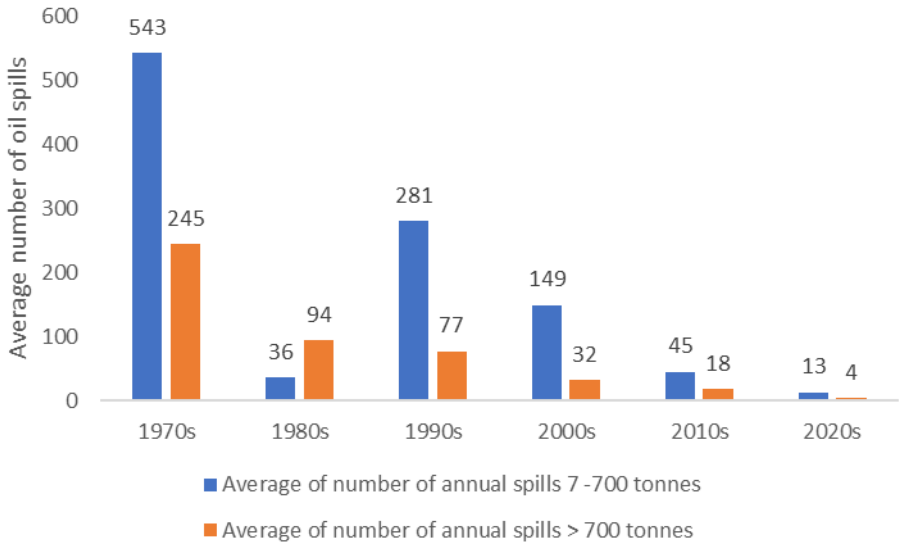

Figure 1.1 The average number of oil spills (7 -700 tonnes) and (>7 tonnes) from tankers [Source: (ITOPF, 2022)]

Oil spills have a variety of causes and circumstances, and understanding them can help manage risk. However, obtaining this information can be challenging because data can be inconsistent or lacking, especially for minor spills (ITOPF, 2022).

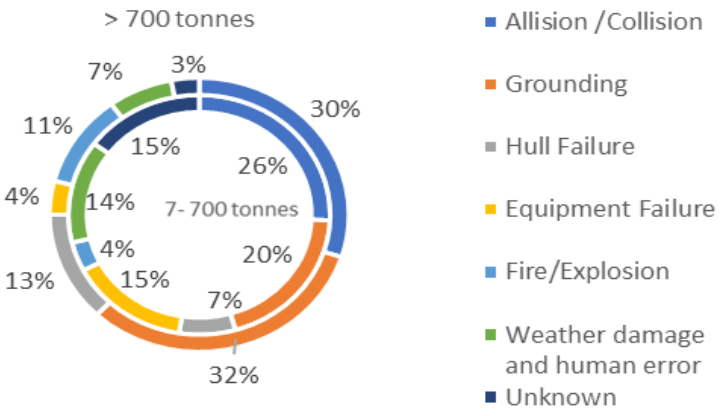

Figure 1.2. Causes of tanker spills between 7-700 tonnes and more than 700 tonnes, 1970-2022 [Source: ITOPF, 2022]

Figure 1.2 shows that the most frequent causes of oil spills > 7 tonnes from tankers are allisions / collisions and groundings. It presents statistics on the percentage of causes of oil spills for both those between 7 to 700 tonnes and those greater than 700 tonnes. Oil spills by unknown sources are more common for spills between 7 and 700 tonnes than for spills > 700 tonnes, but most common for spills < 7 tonnes (National Oceanic and Atmospheric Administration (NOAA, 2019). A study conducted by the

National Oceanic and Atmospheric Administration (NOAA) found that "smaller spills, less than 7 tonnes, accounted for 79% of total oil spill incidents". This is likely due to the fact that smaller spills can occur more frequently and in a wider range of locations, such as during transportation or at smaller facilities.

Li, et al., (2022) proposed innovative methods for accurately predicting oil spills. They introduced an adversarial learning approach that enhances the accuracy of forecasted wind fields in oil spill drift prediction by aligning them with reanalysis wind fields (Li, et al., 2022). This approach utilizes an Adversarial Corrector Learning Network (ACLN) framework, combining numerical and machine learning-based techniques (Li, et al., 2022). This advancement in accuracy enables more precise oil spill drift prediction, thereby enhancing the effectiveness of response and mitigation efforts. According to Al-Ruzouq, et al., (2020), the integration of remote sensing technologies and machine learning algorithms plays a pivotal role in oil spill detection and monitoring. This involves utilizing various data sources such as visible and infrared multispectral, hyperspectral, thermal, microwave, and laser fluorosensors for comprehensive data acquisition crucial in the detection and monitoring of oil spills. Remote sensing enables early detection, facilitating swift responses to minimize environmental impacts, and allows for large-scale monitoring of vast areas inaccessible through traditional methods.
Yekeen and Balogun, (2020) indicated that advancements in remote sensing technology have significantly improved the rapid detection and identification of oil spills in water bodies through various means, including the utilization of microwave sensors like Synthetic Aperture Radar (SAR) and Side-Looking Airborne Radar (SLAR), which possess all-weather and all-day capabilities and are particularly effective due to SAR's high spatial resolution for detecting oil spills on water surfaces by exploiting differences in emissivity between water and oil.

The mechanisms for impacted countries to claim compensation for damage caused by marine oil pollution from tankers are limited to spills that can be attributed to a specific vessel (Zhang, et al., 2021). This thesis focuses on oil spills that cannot be attributed to a specific tanker, synthesizing the data on the extent, causes and costs of marine oil pollution from these ‘mystery vessels’, an under-researched area. The problem is illustrated with data from the Hormuz Strait in the Persian Gulf, the busiest

oil tanker shipping lane in the world, and from the impacts of oil spills on the adjacent Musandam Peninsula in Oman.

The remainder of the chapter is set out as follows. Section 2 discusses mystery oil spills and actions taken to identify their sources. Section 3 describes the current mechanisms for compensation and their effectiveness in tackling the issue of obtaining redress for mystery oil spills. In section 4, the problem is illustrated in a case study of oil spills off the Musandam Peninsula which is situated adjacent to the busiest oil tanker shipping lane in the world, the Strait of Hormuz, in the Arabian Gulf. The marine environment and human communities of the Musandam Peninsula are particularly vulnerable to, and affected by, oil pollution from passing tankers. These impacts are described as well as the clean-up costs and the action taken by the Omani Government to deal with pollution from mystery vessels. Finally, section 5 summarises the findings of the chapter.

2. Mystery oil spills

Mystery spills pose an intractable problem for regulatory bodies (Beegle-Krause, 2018). Small-scale deliberate operational discharges from the oil industry, especially from tankers, often go unnoticed, despite the fact that they are now the single largest anthropogenic source of marine oil pollution (Hassler, 2016). Most small-scale spills are oil sludge spillages (Dietl, 2013) that occur during routine tank-cleaning operations (Bellefontaine & Johansson, 2016). When the heavy fuel oil that powers oil tankers, cargo and container ships is burned, it produces an oily sludge that leaks from machinery and drains down and accumulates in the bilge tanks (located at the lowest part of a ship) (ITOPF, 2022; Marinedefender, 2021). The contents of the bilge tanks are stored on board until they can be discharged. Between each trip, tankers are required to clean out their tanks, and thousands of gallons of sludgy waste are routinely evacuated from them while at sea (Walker, et al., 2019) . Some owners and tanker operators illegally install a pipe in order to bypass the ship's oily water separator and pump oily water directly into the ocean (Marinedefender, 2021). Additional illegalities associated with these violations include falsification of records, tampering with monitoring systems, and the obstruction of investigations (Mura, 2018). Such waste oil products are dumped into the sea to avoid the time and cost of

legal disposal in ports (Makoto, 2013). It is estimated that oily water separator and disposal fees at port can cost an owner 80,000-220,000 US$ annually, depending on the ship's size, age, number of days at sea, and level of maintenance. This can equate to 5-12% of a ship's operating costs (Vollaard, 2017).

The International Oil Pollution Compensation Fund (IOPC) fund provides financial compensation for victims of oil pollution, covers clean-up costs, supports claims, promotes preventive measures, and offers technical assistance to improve oil spill response and management (IOPC, 2020). It requires the identity of the polluting ship-owner to be known (Butt, 2013; IOPC Fund, 2020), if the complainant fails to prove that the damage occurred due to a specific tanker accident or discharge, the fund will not provide compensation as defined in the Conventions. This creates a serious challenge for countries because it is often extremely difficult to prove an oil spill came from a particular source. By the time oil from a spill reaches a beach, it may be chemically altered by dissolution and/or evaporation (Lemkau, et al., 2010), and this can happen within days of the spill. Polluting oil dispersal, low boiling components, evaporation and several environmental hazards will drastically alter the fingerprint of oil contaminants, compounding the difficulty of identifying the pollution source (Karakoç, et al., 2015; Lemkau et al., 2010).

Some forensic techniques are being developed in Turkey to improve the rate of identification of oil spillers (Ferraro, et al., 2007). The Turkish government is using chemical fingerprint technology to compare the fingerprint of mystery oil spills with the fingerprint of all recognized candidate source oils to track the source (Karakoç, et al., 2015), and this technology has been effective in some cases (Rodrigue, 2020). Elsewhere, in the absence of proof of the source, some national governments have paid out compensation for pollution from mystery vessels. For example, Canada has set up the Ship-source Oil Pollution Fund (SOPF) to ensure that claimants are compensated for damage arising from oil pollution by any vessel in Canadian waters, including mystery spills (ClearSea, 2019). This fund is generated by levies collected from oil cargoes. The SOPF fund has provided assistance for claims arising from mysterious spills in the fishing sector. It has compensated seven such spills from 1989 to 2016, disbursing a total of $134,542.25. Those spills involved discharge of oil from a ship or boat (Dumbrille & Dunn, 2020). Likewise, in the USA, the Oil Pollution Act

(OPA) of 1990 created a comprehensive regime that covers all types of marine oil pollution (Rodriguez, & Rodriguez, 2018; National Pollution Funds Center, 2009). OPA provides that any person or government may present a claim for compensation for removal costs or damages resulting from an oil pollution incident covered by the Act. Claims can be presented for: uncompensated removal costs, natural resource damages, damage to real or personal property, loss of profits and earning capacity, loss of subsistence use of natural resources, loss of government revenues, and increased cost of public services (U.S. Coast Guard, 2022). In the last three decades, the OPA has disbursed more than $1 billion to individuals filing claims related to OPA incidents. OPA has provided compensation for six cases of mystery spills between 2004 to 2008 at a total cost of US$ 16,189,470 (U.S. Coast Guard, 2023).

The China Vessel-Source Oil Pollution Compensation Fund (CVOPCF) was created in 2012, and funded by contributions levied on receivers of persistent oil products from oil producers (Li, et al., 2013). Article 6 of the Compensation Fund Law imposes a levy of approximately 0.045 US$ per tonne of oil transported, and it offers compensation for oil contamination in marine areas (Dong, et al., 2015), including that from mystery vessels (Zhu, et al., 2013). The Finnish Oil Pollution Compensation Fund pays compensation for oil spills and responds to oil spills on land and sea when the party that caused the accident is unknown or when the guilty party is unable to pay the costs (Ministry of Environment, 2020). The fund takes the view that it does not make sense to compel the party that owns the contaminated area to clean it if it is unable to do so.

Nevertheless, it is important to note that the number of incidents where national governments have compensated for oil spills from mystery sources is considerably lower than the number of uncompensated mystery oil spills. There is a lack of published research that quantifies the occurrence of and compensation for mystery spills. This is mainly because most mystery spills are small in scale; there are no records kept for oil spills below 7 tonnes; and often they go unnoticed, despite the fact that they are now the single largest anthropogenic source of marine oil pollution (Hassler, 2016).

3. Compensation for oil spills

Clean-up costs depend on a range of complex factors, including the volume of oil spill, the nature of the spilled oil product, the location, the time of the spillage, liability limitations, and regulations in place, as well as clean-up techniques (Carpenter, 2016). Oil type, location (Etkin, 2004), and the total amount spilled (Kontovas, et al., 2010) are regarded as the most important factors considered when establishing a per-unit account of the clean-up response (see Table 4). Montewka, et al., (2013) explained that costs of oil spill clean-ups are influenced by the following factors:

- Location: If an oil spill is not carried ashore by heavy winds it may naturally break up and little clean-up is required.
- Coastal population density: When spills occur in uninhabited areas, they usually go unnoticed, whereas demand for an immediate response is much higher in densely populated areas.
- Composition and properties: Light crude and refined oil spills sometimes evaporate naturally but where they persist, they form water-in-oil emulsions that can travel long distances and last for over two months in the marine environment (Hughes, et al., 2023). Crude oil from spills of persistent oils regularly forms tar balls that become stranded on beaches (Warnock, et al., 2015).

Egan, et al., (2021) stated that the costs associated with clean-up include mobilization of clean-up operations (by land vehicles and ships), where transportation costs can equate to $4 to $6 per tonne; disposal at landfill sites, which can be as low as $3 to $7 per tonne but may reach $100 per tonne in a controlled site with impermeable membranes and leachate monitoring stations; and/or incineration, which costs between $3 and $250 per tonne in a fully- enclosed plant with smoke emission control and other safety features (Kontovas, et al., 2010). There are likely to be additional costs such as administrative support costs in making decisions on preferred response techniques (White, 2002). Smaller spills are more expensive to clean than larger spills per unit due to clean-up response setting costs, the mobilization of equipment and personnel, and the cost of hiring experts to analyse damage caused by the oil spill (see Table 1.2) (Fingas, 2021).

In the realm of marine oil spill response, understanding the financial implications is crucial for effective resource allocation and decision-making. Grubesic, et al., (2017) present valuable insights into the estimated costs of cleanup efforts, which vary significantly depending on the spill size and the type of oil involved. Notably, for light crude oil spills, the cleanup cost is projected at $3,131.08 per tonne, whereas crude oil spills incur a higher expense of $14,520.66 per tonne. The financial commitment escalates further in the case of heavy crude oil spills, demanding a cleanup cost of $21,091.56 per tonne. This breakdown of costs by spill size and oil type offers a foundation for informed decision-making in environmental management and policy development.

Table 1.2. Marine oil spill cleanup cost by spill size for US spills (Source: Jonah and Agunwamba, 2020)

Oil type	**Clean-Up Cost of US Spills (US$ / Tonne)**	**Clean-Up Cost of US Spills (US$ / liter)**
No. 2 diesel fuel	$3,607.38/tonne	$3.24/liter
Light crude	$3,131.08/tonne	$2.86/liter
No. 4 fuel	--	---
No. 5 fuel	$8,693.58/tonne	$7.81/liter
Crude	$14,520.66/tonne	$13.05/liter

There are mechanisms in place to compensate impacted countries for these clean-up costs. For example, under the MARPOL 73/78 Convention, there are several procedures for providing compensation to victims of damage caused by oil spills from identified vessels. The most prominent is the International Oil Pollution Compensation (IOPC) fund scheme. Concern about oil spills and a series of problems over liability and compensation claims played a role in the establishment of the IOPC fund scheme in 1992, facilitated by the International Maritime Organization (IMO) as a regime to reimburse victims of oil pollution (Schmitt & Spaeter, 2005; IOPC Fund, 2020). The IOPC fund is an autonomous legal entity - an intergovernmental organization outside the United Nations – of which only states can be members. Two international conventions are the basis of the IOPC fund: the Convention on Civil Liability for Oil Pollution Damage (CLC) and the Convention on the Establishment of an International Fund for Oil Pollution Damage (Li, et al., 2013). These two conventions are associated with Annex I of the MARPOL 73/78 Convention 1973/1978, which forbids oil contamination at sea (Carpenter, et al., 2021). The IOPC

fund is financed by levies taken from the oil beneficiaries in Member States who receive over 150,000 tonnes of crude oil or heavy fuel oil at their ports or terminal facilities during the relevant calendar year after being transported by sea (IOPC, 2022). These levies are calculated from data contained in reports of oil receipts from contributors that are submitted to the IOPC Secretariat by the governments of Member States (IOPC, 2022). So, the funds for the International Convention on Civil Liability for Oil Pollution Damage (CLC) and the International Oil Pollution Compensation Funds (IOPC) are provided by the oil industry (Handl & Svendsen, 2019). These conventions ensure that victims of oil pollution caused by spills involving oil-carrying ships can receive adequate compensation (Juste-Ruíz, 2010).
The IOPC fund is managed by its Member States' governments, and the governing bodies meet twice a year to agree on compensation policies, legislation and finances (Kiran, 2010; IOPC Fund, 2020). The aim of the IOPC fund is to compensate parties who have fallen victim to oil pollution damage resulting from oil tankers in situations where the CLC has no liability. This can be because a CLC exemption applies to the ship-owner, or the ship-owner is unable to satisfy their CLC duties and their insurance is inadequate, or the loss surpasses the assets of the ship-owner (Billah, 2011). According to its Claims Manual, the IOPC fund will not pay compensation if the complainant is unable to prove that the damage suffered was the result of spillages involving one or more ships, as highlighted in the Conventions (Su, et al., 2019). The IOPC fund provides additional funding – from the Supplementary Fund – if the payable amount is insufficient to cover the damage (Soto-Oñate & Caballero, 2017). The entire sum of compensation accessible in the IOPC fund is US$ 1,047 million; made up of US$ 283.6 million in the Supplementary Fund; US$ 125.4 million in the 1992 fund; and US$ 6.3 million in the CLC (IOPC Fund, 2020).

International organisations are very effective in obtaining compensation for large attributable spills, but not very effective in obtaining compensation for small mystery spills (IMO, 2021; IOPC Fund, 2021; UNIP, 2014). IOPC system works quite well where specific (known) ships are damaged and oil leaks result (Yang, 2017). It works less well for mystery oil spills since whilst in principle the IOPCF may pay for compensation for spills from unidentified ships, there must be proof that the spill came from a ship transporting oil as cargo. It is true that in two exceptional circumstances, the IOPCF paid compensation for marine oil pollution from

unidentified sources, but the claimants were able to prove that the spills were caused by ships as defined by the Conventions: these are the "Incident in the United Kingdom" in 2002 (IOPC Fund, 2003) and the "Incident in Bahrain" in 2003 (IOPC Fund, 2004). However, these examples of compensation for oil spills from unidentified sources are very few compared to the unknown number of incidents of oil spills that are believed to be uncompensated because they cannot be attributed to a source. In the case of the two exceptional cases, the governments of Bahrain and the UK conducted investigations confirming the spilled oils as crude oils from tankers and ruling out other local sources, like coastal accidents or oil platforms or bunkering.

4. Local impacts of oil spills on the Musandam Peninsula in the Persian Gulf

To illustrate the impacts of oil pollution from mystery vessels, in this section we present data on the Musandam Peninsula on the southern edge of the Arabian Gulf, where oil spills (almost exclusively small spills) are a serious problem (Yaghmour, et al., 2022). The Persian Gulf is a semi-closed sea located in a subtropical area that is dominated by offshore exploitation and transport of oil and gas products (Alidoust, et al., 2021). Close to two million barrels of oil are leaked annually into the Gulf's marine environment because of the activities associated with oil traffic in the Gulf waters (Alqattan & Gray, 2021; Al-Saad & Salman, 2012). Although there are other dangers to the Gulf's marine ecosystem (Buskey et al., 2016; Carpenter & Nations, 1997), including overfishing, eutrophication, siltation, non-oil pollution, and global climate events (Mitra & Zaman, 2016), marine oil spills are the largest source of marine pollution in the Gulf water area (Chitrakar, et al., 2019)

Table 1.3 Comparison of volume of crude oil and petroleum products transported (million b/d) through the world's straits [Source: U.S. Energy Information Administration (EIA)]

Location	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Strait of Hormuz	17	16.8	16.6	16.9	17	18.5
Strait of Malacca	14.5	15.1	15.4	15.5	15.5	16
Suez Canal and SUMED Pipeline	3.8	4.5	4.6	5.2	5.4	5.5
Bab el-Mandab	3.3	3.6	3.8	4.3	4.7	4.8
Danish Straits	3	3.3	3.1	3	3.2	3.2
Turkish Straits	2.9	2.7	2.6	2.6	2.4	2.4
Panama Canal	0.8	0.8	0.8	0.9	1	0.9

4.1 The Strait of Hormuz and Oil Traffic

The Strait of Hormuz lies between Iran and Oman in the Persian Gulf (Figure 1.4). It is part of the world's busiest maritime region, with sea traffic growing steadily (Modarress, et al., 2012; Al-Maamary, et al., 2017). More goods, services, resources and technology are shipped through it than through any other strait in the world (Zohourian, 2019) (see Table 1.3). Crude Oil is the main cargo passing through the area.

The Persian Gulf, harboring 68% of the global oil reserves and over 40% of gas resources, stands as the most affluent marine environment worldwide in terms of hydrocarbon wealth. Consequently, the coastal areas and islands in northern Oman and southern Iran, situated within the Persian Gulf, face persistent exposure to oil pollution. Additionally, the Persian Gulf boasts extensive marine invertebrate diversity (Hassanshahian, et al., 2020).

Between 41,000 and 53,000 ships transit this strait per year, approximately one-third of which are oil tankers which made 220,000 regional port and terminal calls in 2019 (Al-Janahi, 2020). Figure 1.3 shows that over time, the number of port calls has increased, while the number of vessels passing through the Strait of Hormuz has only slightly increased due to the larger size of tankers and ships since 2010. In the past, ships had a container capacity of around 4,000 TEU (Twenty-foot Equivalent Unit), but now they have a capacity of over 24,000 TEU (Ge, et al., 2021; Garrido, et al., 2020). So each tanker can make multiple port calls in the region to collect crude oil. Hormuz Strait is a narrow, busy and strategically important transit route for much shipping (Searle, 2019; Jafari, 2012) and it is the only route through which oil is exported from the Gulf States and Iraq (Dietl, 2013).

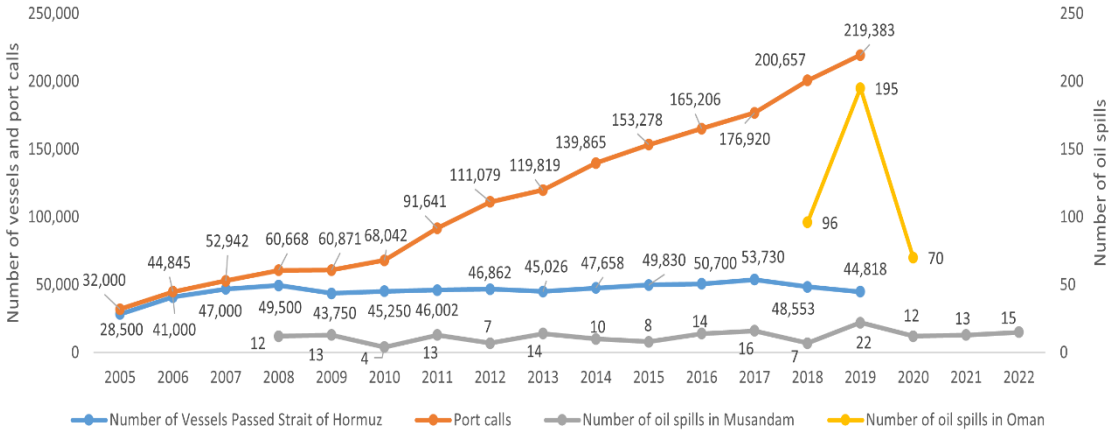

Figure 1.3. Number of vessels in the Strait of Hormuz 2005-2019 and number of oil spills in Oman 2018-2020 and Musandam 2008-2022 (Source: Al-Janahi, 2020; Muscat Daily, 2022; Environment Authority, 2020a)

Every day, 18.5 million barrels of oil transit the Strait (U.S. Energy Information Administration, 2019). In 2022, the average oil flow through the strait reached 21 million barrels per day, accounting for approximately 21% of the world's total consumption of petroleum liquids (U.S. Energy Information Administration, 2023).

Table 1.4 Annual Volume of crude oil, condensate, and petroleum products transported through the Strait of Hormuz (2018-2022) million barrels per day (source: U.S. Energy Information Administration, 2023)

The volume of crude oil	2018	2019	2020	2021	2022
Total oil flows through the Strait of Hormuz	21.3	19.9	18.3	18.8	20.8
World maritime oil trade	77.4	77.1	71.9	73.2	75.2
World total petroleum and other liquid consumption	100.1	100.9	91.6	97.1	99.6

Studies of the impact of oil pollution in the Persian Gulf indicate that spills here are mainly caused by the illegal discharge of ballast water (Ivanov, et al., 2023). Tankers often clean out their tanks in Omani waters before entering the Gulf to load oil cargo, and this involves discharging contaminated ballast water, dirty bilge, sludge and slop tank oil causing serious pollution of the coastline.

4.2 Oil Spills in the Musandam Peninsula

The Musandam Peninsula is located within the Northern territory of Oman and juts out into the Strait of Hormuz, at the Western end of the Persian Gulf (see Figure 1.4) (Wippel, 2013). It is a geographically and politically isolated region from the rest of Oman, separated by the northeast region of the United Arab Emirates (Al Abri, 2018). This physical separation from the main part of Oman and the capital Muscat where Government institutions are based, makes the Peninsula administratively and politically isolated (Berg, et al., 2014). The water of the Persian Gulf coupled with a long residence time of water, makes the flora and fauna particularly sensitive to pollution (Jafari, 2012). Given the high density of shipping traffic in the Strait of Hormuz, the Musandam Peninsula is particularly vulnerable to oil spills from passing tankers, but because of its isolation from the rest of Oman, action by Government to tackle the issues they raise in the Musandam Peninsula is often slower and given less priority compared to the rest of the country (Berg, et al., 2014). The impacts of oil spills from mystery vessels on the Musandam Peninsula have not been comprehensively studied, but a review of the limited academic studies and grey literature indicates wide-ranging environmental, societal and economic impacts. For example, the study conducted by Issa & Vempatti (2018) noted that 30,000 birds died due to oil spills along the GCC coastline, including the Musandam Peninsula. Yaghmour, et al., (2022) showed that 84.6% of sea snakes in the Gulf of Oman, including the Musandam Peninsula, were observed in 2021 with oil covering 75–100% of their bodies.

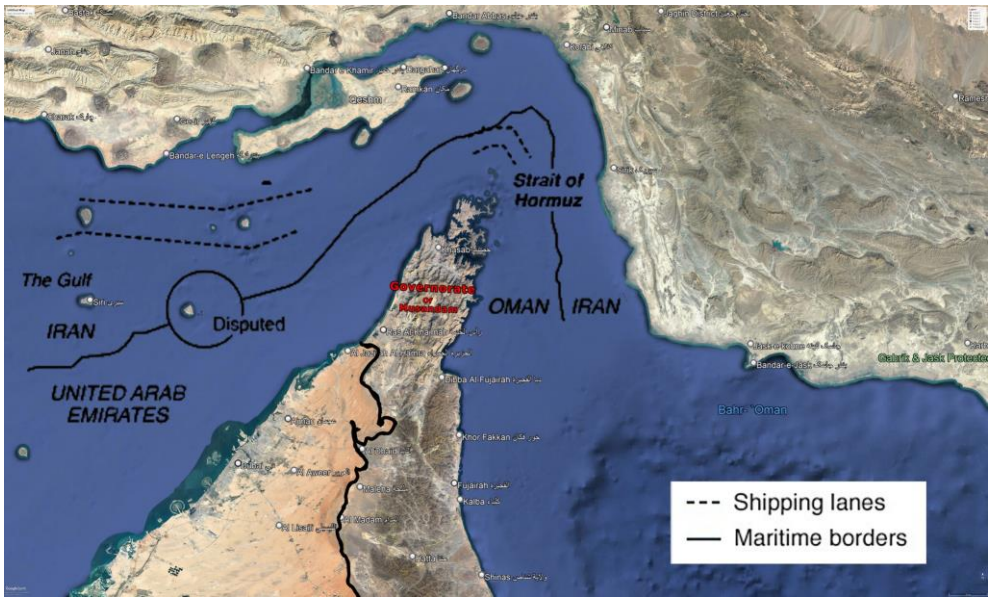

Figure 1.4. Passage of ships and tankers via Strait of Hormuz (Source: adapted by author from Google map), this map is for clarification purpose only.

4.3 Environmental and socio-economic impacts of oil spills on the Musandam Peninsula

The socio-economic impact of oil spills on Musandam is also striking. The prime source of protein for the human population is fish (Berg, et al., 2014). Fishing in the Musandam region is based solely on the traditional artisanal fishery which in 2018 had 2,126 fiberglass fishing boats and 93 Dhows in fishing villages in Dibba, Khasab and Bukha and over 3,549 fishermen (Ministry of Agriculture, Fisheries and Water Resource, 2022).

Oil pollution impacts fish because they ingest oil through their gills and this affects their growth, metabolic rates, and reproductive success by damaging their eggs and larvae (Grosell & Pasparakis, 2021; Karam, et al., 2019). The health of people eating oil contaminated fish can be adversely affected (Laffon, et al., 2016). Fishing gear is damaged by oil, clogging up engines and making nets unusable (Elenwo & Akankali, 2015; Krupp & Abuuzinade, 2008).

People in the Musandam Peninsula get much of their drinking water from the sea via desalination plants. Oil pollution spills adversely affect the equipment and function of desalination plants and subsequently the quality and taste of drinking water (Berg, et al., 2014). Washed-up marine oil pollution also destroys the landscape of the beaches, which makes the beaches unsuitable for recreational uses. On the Musandam Peninsula, it is regarded as a normal part of summer and beach life (UNIP, 1982) for children from local villages who play on the sandy beaches to come home with tar on

their feet and hands. According to local respondents (see chapter 3), oil spills in Musandam have also caused losses in tourism subsectors such as hotel accommodation, transportation, guides, and recreational fishing and diving Figure 1.5 illustrates the potential impact of oil spills on the marine ecosystem and human life in the Musandam Peninsula.

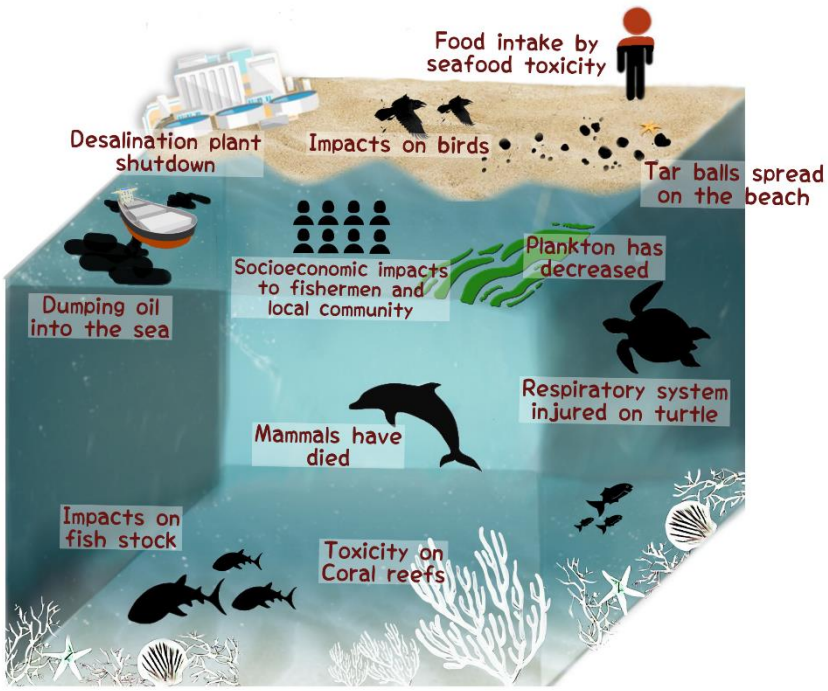

Figure 1.5 Oil spill impacts diagram on marine ecosystem and human life in Strait of Hurmuz Peninsula (Source: created by author using PICSART application)

The Musandam Peninsula, as it is a part of the Gulf and the Arabian Sea, has been designated by the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) IMO/MEPC 56/ Resolution 168 as a 'Special Sea Area' with effect from 1st of August 2008 (El-Habr & Hutchinson, 2008). Therefore, all discharges of oil/waste are prohibited except in very specific circumstances (Mason, 2003; IMO, 2020). Nevertheless, the Peninsula continues to experience many oil spills. Thousands of oil tankers pass close to the Musandam Peninsula every year, many of them illegally discharging oil or diluted mixtures containing oil into the marine environment adjacent to the Musandam Peninsula and surrounded areas (Environment Authority, 2020b). Figure 1.3 shows that the number of oil spills on the coast of Musandam has persisted or is rising as the density of shipping has grown in the Strait of Hormuz (Zohourian, 2019).

In Musandam, it is difficult to identify the vessels responsible for the oil spills because the slicks and tar balls which reach the Musandam coast discharged by tankers when passing through the Strait of Hormuz change their chemical features, which means their molecular fingerprint cannot be identified (Al-Saad & Salman, 2012). Muscat Daily (2022) reported that in 2021, the Chairman of the Environment Authority announced it received 361 complaints related to pollution in the last three years, with most filed in 2019 (see Figure 3). Approximately 140 oil spills were identified by the Environment Authority (2020a) as caused by unknown vessels between 2008 and 2019 in the Musandam Peninsula: on average, more than one mystery spill per month. However, anecdotal evidence suggests there are many more mystery oil spills on the Musandam coast than are officially recorded because fishermen and local people do not report them all to the authorities (Saleem, et al., 2021; Times of Oman, 2017; Issa, 2010). This is because oil spills are so frequent that people accept them as 'normal'; most of them are small; and there is a lack of awareness about reporting procedures. It is virtually impossible to identify the vessels responsible for these spills because the slicks and tar balls which reach the Musandam coast discharged by tankers when passing through the Strait of Hormuz change their chemical features, which means their molecular fingerprint cannot be identified (Stout & Payne, 2017; National Research Council U.S.b, 2003).

4.4 Efforts to address oil spills in Musandam

Some measures have been taken to deal with oil spills in Musandam (Environment Authority (2022). For example, the Governorate of Musandam's Department of Environment and Climate Affairs has launched a campaign to tackle the effects of oil pollution from unknown vessels through the Strait of Hormuz. According to Arab Today (2017), Alshehi (2019) and Ashok (2021), environmental experts collaborated with the Musandam Navy and the Khasab Municipality offering vessels to transport clean-up equipment to the affected area. Residents of the Dorsany area, as well as a handful of divers, took a central role in the process of cleaning their beach, with a slew of divers working alongside Nature Conservancy employees to remove oil pollution, consisting of suspended oily masses on the seafloor (Alshehi, 2019). Choudri, et al., (2016) reported that the Government of Oman represented by the Environment Authority the chief environmental authority of Oman, in coordination with the Oman Navy, was conducting marine investigations to find out the cases of oil

pollution on the beaches of the Musandam Governorate. Illegal behaviour and violations of oil tankers and sea ships regulations were observed, including the discharge of oily waste on the coasts of Musandam, especially in the eastern area of the Strait of Hormuz, such as Dibba city and its villages, but they did not find the guilty vessels (Yaghmour, et al., 2022). Moreover, the Omanian government has done little to obtain or provide compensation for residents affected by the spills.

5. Conclusions

This review has revealed several important gaps in the literature on the problem of unattributed oil spills. While previous studies describe incidences of major oil spills across the world, their causes, their effects, attempts to prevent them from occurring; and organizations established to provide compensation for the damage they inflict on vulnerable coastlines, there is little coverage of how compensation can be obtained for damage caused by marine oil spills from unidentified or mystery vessels. There is negligible discussion in the literature on the failure of international agreements to address the problem of liability for damages caused by unattributable oil spills, despite four states (Canada, USA, China and Finland) having established their own arrangements for dealing with mystery spills.

In short, small-scale mystery marine spills pose a very difficult problem for regulatory bodies (Samarasekara, et al., 2023). The nub of the problem is that mystery spillers avoid having to pay for clean-up costs and livelihood losses, a potential impact that is well theorized and likely in the context of Musandam. As a result, either national or international bodies or victims of oil spills have to bear these costs. Since few national or international bodies are willing to pay compensation for mystery spills, the burden generally falls upon victims. This is grossly unfair because it violates the polluter pays principle and is an environmental injustice. As we have seen in the case of Musandam, marginal groups are particularly at risk of such injustice. Further research is needed to explore possible ways of identifying mystery oil spillers and finding equitable ways of paying for clean-up of unattributed marine oil pollution. Neither individual states nor the international community seem greatly exercised about this injustice, and so a political solution appears unlikely. It may be that a technical solution is more promising – i.e., a way of identifying mystery spillers. Some forensic techniques are being developed in Turkey that might improve the rate of identification of mystery oil spillers. The Turkish government is using chemical fingerprint

technology to compare the fingerprint of mystery oil spills with the fingerprint of all recognized candidate source oils to track the source (Karakoç, et al., 2015), and this technology has been effective in some cases (Wise, et al., 2023). Implementing a similar technology in the Musandam area could greatly benefit the region. By adopting chemical fingerprint technology, local authorities could swiftly identify the sources of oil pollution, ensuring that responsible parties are held accountable and that necessary remediation actions are taken promptly. The Turkish model demonstrates the potential for such forensic techniques to make a tangible difference in environmental protection, and its application in Musandam could be a step forward in the region's environmental management efforts.

The application of generative artificial intelligence (AI) to this technology might help to reduce the number of small-scale mystery marine oil spills in Musandam and other coastal waters. By harnessing the capabilities of AI, particularly generative models, we can enhance our ability to detect, track, and mitigate these spills with unprecedented accuracy and efficiency. Generative AI algorithms can analyze vast amounts of data, including satellite imagery and oceanographic data, to identify patterns and anomalies indicative of oil spills. This advanced technology can facilitate early detection and rapid response, allowing for timely intervention to minimize environmental damage. Furthermore, AI-powered systems can continuously learn and adapt, improving their effectiveness over time, enabling proactive measures to prevent future incidents. Overall, the integration of generative AI into oil spill detection and response efforts holds great promise in combating this pervasive environmental threat.

This introductory chapter has unveiled critical voids in the existing literature concerning unattributed oil spills. It sheds light on the limited coverage addressing the methods of acquiring compensation for the detrimental effects caused by marine oil spills attributed to unidentified or mystery vessels. This chapter is foundational to the thesis, serving as a precursor to the subsequent practical research. It contributes to the overarching argument of the thesis by pinpointing significant gaps in the literature in understanding and highlighting the pressing need for further exploration. Moreover, it emphasizes the importance of establishing equitable measures for funding the clean-up of unattributed marine oil pollution. The next chapter provides the theoretical foundation of environmental justice which underlines the search for an equitable solution to the problem of mystery spills, and also describes the research methods used to investigate the problem and its potential solution.

CHAPTER 2. Theoretical Framework and Methods

1. Introduction

This chapter has two sections: (1) the theoretical framework that informs the thesis; and (2) the research methods used to obtain and interpret the data on which the thesis' findings are based. The theoretical framework is centered on the concept of environmental justice which requires the fair treatment of all people in the development, implementation, and the enforcement of environmental laws, regulations, and policies (Banzhaf, et al., 2019). It seeks to address the disproportionate burden of environmental harm inflicted on marginalized communities, particularly those that are low-income, indigenous, and communities of colour (Blue, et al., 2021). The research methods are largely qualitative, making extensive use of key informant interviews (n=67) and focus group discussions (n=10).

2. Theoretical framework

2.1 The concept of environmental justice

The concept of environmental justice emerged in response to the disproportionate burdens of environmental pollution and hazards experienced by marginalized and vulnerable communities (Hendricks & Van Zandt, 2021). According to Maantay, (2019), it encompasses the fair distribution of environmental benefits and risks, emphasizing the equitable treatment of all individuals, regardless of their socio-economic status, race, or ethnicity, in the development, implementation, and enforcement of environmental laws and policies.

The roots of environmental justice can be traced back to the 1980s when communities, particularly those consisting of people of color and low-income populations, started raising concerns about the unequal distribution of environmental burdens (Adeola, 2011).

This concept originated in the USA in the 1960s focusing on discrimination in the siting of hazardous waste facilities (Walker, 2012). Its proponents documented unequal exposures to hazardous waste facilities by race, ethnicity, and economic class and found that the poor and people of colour were heavily concentrated around such facilities (Mohai, et al., 2009). This disproportionate impact of hazardous waste on

marginalized communities is often rooted in historic injustices such as colonialism and systemic racism, and addressing these underlying inequalities is essential for achieving environmental justice. This can involve providing reparations for impacted communities and recognizing indigenous rights to their land and resources. Early campaigners for environmental justice aimed to ensure that all communities had equal access to environmental protection and that no community was disproportionately burdened with environmental hazards (Lee & Mohai, 2012). The environmental justice movement in the USA has since broadened to include human rights to clean air, water, land, food, and a safe and healthy work environment (Dunlap & Brulle, 2015). Schlosberg, (2013) explains that the discourse of environmental justice has expanded in scope to encompass inequities in the distribution of environmental risk. During the last 30 years, environmental justice has been a central concern for academics in a range of disciplines, including political science, sociology, geography, anthropology, and environmental studies (Schlosberg, 2013).

Schlosberg (2013) distinguishes between environmental justice, which applies to humans, and ecological justice, which applies to non-humans. He argues that while environmental justice movements focus on human rights and social inequalities, ecological justice movements consider the rights and needs of non-human nature, and he claims that the two concepts can be integrated to create a more comprehensive understanding of justice that includes both human and non-human nature. In this thesis, the theoretical framework is based on environmental rather than ecological justice. However, there are some elements of ecological justice that impinge on environmental justice: for example, oil spills harm seabirds, marine mammals, and marine flora. In this thesis, such harm is treated as part of the damage inflicted on human beings rather than as a breach of animal or plant rights.

It is important to note, however, that, as Pedersen (2013) says, there are challenges to implementing environmental justice in practice, including the following:

- The lack of a clear definition of what constitutes an environmental injustice.
- The difficulty of measuring and quantifying environmental inequalities.
- The potential for conflicts between groups seeking to promote their own environmental interests.
- The need for more effective legal mechanisms to address environmental injustices.

In what follows, an attempt will be made to deal with these challenges in the case of mystery spills in Musandam.

2.2 Seven principles of environmental justice

The concept of environmental justice has spawned many principles or conceptualisations or guidelines that inform decision-making about environmental issues (Reese & Jacob, 2015). According to Mohai, 2018 and Timmons Roberts et al., 2018), the role of these environmental principles is to apply or promote environmental justice. There are 17 principles of environmental justice adopted by the participants of the First National People of Color Environmental Leadership Summit, held on October 24-27, 1991 (see Table 2.1).

Table 2.1 Principles of environmental justice (Source: Annu. Rev. Environ. Resour. 2009.34:405-430. Downloaded from www.annualreviews.org Access provided by University of Newcastle upon Tyne on 04/24/23. For personal use only)

PRINCIPLES OF ENVIRONMENTAL JUSTICE
Participants of the First National People of Color Environmental Leadership Summit, held October 24–27, 1991, adopted the following principles:
1. Environmental Justice affirms the sacredness of Mother Earth, ecological unity and the interdependence of all species, and the right to be free from ecological destruction.
2. Environmental Justice demands that public policy be based on mutual respect and justice for all peoples, free from any form of discrimination or bias.
3. Environmental Justice mandates the right to ethical, balanced and responsible uses of land and renewable resources in the interest of a sustainable planet for humans and other living things.
4. Environmental Justice calls for universal protection from nuclear testing, extraction, production and disposal of toxic/hazardous wastes and poisons and nuclear testing that threaten the fundamental right to clean air, land, water, and food.
5. Environmental Justice affirms the fundamental right to political, economic, cultural and environmental self-determination of all peoples.
6. Environmental Justice demands the cessation of the production of all toxins, hazardous wastes, and radioactive materials, and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production.
7. Environmental Justice demands the right to participate as equal partners at every level of decision-making, including needs assessment, planning, implementation, enforcement and evaluation.
8. Environmental Justice affirms the right of all workers to a safe and healthy work environment without being forced to choose between an unsafe livelihood and unemployment. It also affirms the right of those who work at home to be free from environmental hazards.
9. Environmental Justice protects the right of victims of environmental injustice to receive full compensation and reparations for damages as well as quality health care.
10. Environmental Justice considers governmental acts of environmental injustice a violation of international law, the Universal Declaration on Human Rights, and the United Nations Convention on Genocide.
11. Environmental Justice must recognize a special legal and natural relationship of Native Peoples to the U.S. government through treaties, agreements, compacts, and covenants affirming sovereignty and self-determination.
12. Environmental Justice affirms the need for urban and rural ecological policies to clean up and rebuild our cities and rural areas in balance with nature, honoring the cultural integrity of all our

communities, and provided fair access for all to the full range of resources.

13. Environmental Justice calls for the strict enforcement of principles of informed consent, and a halt to the testing of experimental reproductive and medical procedures and vaccinations on people of color.
14. Environmental Justice opposes the destructive operations of multi-national corporations.
15. Environmental Justice opposes military occupation, repression and exploitation of lands, peoples and cultures, and other life forms.
16. Environmental Justice calls for the education of present and future generations, which emphasizes social and environmental issues, based on our experience and an appreciation of our diverse cultural perspectives.
17. Environmental Justice requires that we, as individuals, make personal and consumer choices to consume as little of Mother Earth's resources and to produce as little waste as possible; and make the conscious decision to challenge and reprioritize our lifestyles to insure the health of the natural world for present and future generations.

For the purpose of the present thesis, seven of those principles have been selected because of their relevance to the issue of oil spills. Three of these principles are backward-looking; and four are forward-looking (see Figure 2.1).

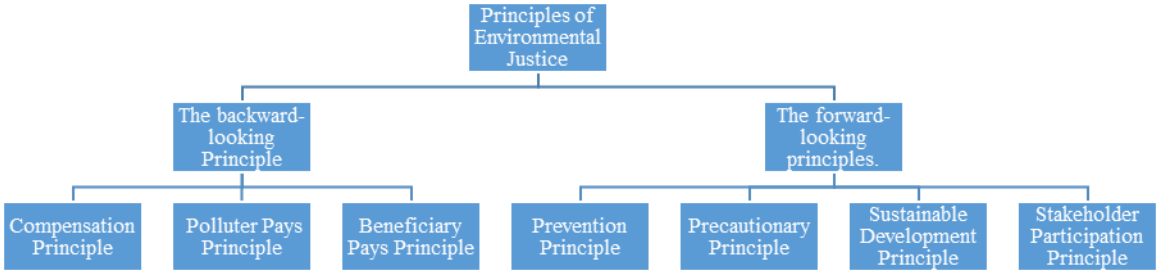

Figure 2.1 A simple representation of the theoretical framework of environmental justice

2.2.1 THE COMPENSATION PRINCIPLE (backward-looking)

Perhaps the most basic environmental justice principle as far as oil spills are concerned is the compensation principle (Schlosberg & Collins, 2014). This is the ninth of the 17 principles of environmental justice adopted in the 1991 Summit (see Table 2.1), and it affirms the right of victims of environmental injustice to receive full compensation and reparation for damages including harm to their health (Kaiman, 2015). This principle is backward-looking in that it focuses on compensating for past environmental injustices that have caused harm to marginalized communities. The idea behind this principle is to hold polluters and other parties responsible for the harm they have caused and to require them to provide just compensation to those who have been impacted by them (Baatz, 2013).

An example of the compensation principle in action is the case of the Flint water crisis (Mohai, 2018). In 2014, the city of Flint, Michigan switched its water source to the Flint River, which was contaminated with lead and other toxic substances. This decision caused harm to the predominantly black and low-income community, who were not informed about the risks and were not provided with safe drinking water. In response, lawsuits were filed against the city and state officials, and compensation was provided to the affected residents. Plater (2011) draws attention to another example - the Exxon Valdez oil spill in 1989, which caused significant harm to the indigenous communities in Alaska. The compensation principle was applied in this case, and Exxon was required to pay billions of dollars in compensation to the affected communities.

However, the compensation principle may be difficult to apply in practice. One difficulty is to identify the perpetrators of the environmental injustice, which is hard to do in the case of mystery oil spills (Mayer, et al., 2015). Another difficulty is to determine who is eligible for compensation from oil spillers, on what grounds, and to what extent? Some claims for compensation may seem straightforward, such as damage to fishers' nets and engines and loss of income from fishing during clean-up time (Opaluch, 2020). But other claims may be harder to justify or calibrate, such as hoteliers' loss of tourist guests; holidaymakers' loss of recreational activities such as scuba diving; and residents' contaminated clothes (English, et al., 2018).

2.2.2 THE POLLUTER PAYS PRINCIPLE (backward-looking)

2.2.2.1 Meaning of the PPP

The polluter pays principle is a comprehensive and diverse notion with distinct meanings and implications that depend on particular contexts (Walker, 2012). Its aim is to protect human beings, plants and their biocenosis against hazardous or noxious substances by holding to account the people who are responsible for releasing these substances (Knoepfel, et al., 2007). The polluter pays principle is a central feature of the way that many governments have sought to deal with environmental externalities, including marine oil spills. It has been an effective rule for dealing with attributed incidents though less effective in dealing with unattributable incidents where polluters cannot be traced.

The polluter pays principle is an economic justice notion which states that firms, or consumers are obligated to pay for the negative externalities they create (Bacq & Aguilera, 2022). It implies that entities responsible for pollution are financially, legally, and morally accountable for the detrimental outcomes of their actions (Khan, 2015), typically the environmental, economic and social costs (Tacconi, 2012). It is a model for abating damage done to the environment, demanding that the accountable individual, nation, or firm should bear the pollution cost (Khan, 2015). The cost to the environment primarily relates to the harm done to public goods such as clean water and fresh air, which are commonly unaccounted for in many market transactions.

The principle is based on the ethical idea that those who cause pollution should bear the costs of managing it to minimise damage to human health or the environment. The principle has been adopted in environmental policies around the world (De Sadeleer, 2020). For example, the European Union has incorporated it into its environmental policy framework: the EU's environmental regulation in 1984 adopted the "PPP EC Directive 84/631" on management and control (Jans, 2017). There is another EU framework directive in the field of waste - Directive 2008/98/EC – where it has been incorporated (Malinauskaite, et al., 2017). It is also reflected in international agreements such as the Rio Declaration on Environment and Development.

2.2.2.2 Applications of the PPP

The polluter pays principle has been applied to a wide range of environmental issues beyond oil spills (Larsson, 2023). For example, air pollution companies have been held responsible for the costs of reducing air pollution such as emissions from factories or power plants (Feng & Liao, 2016); water pollution (such as contamination of rivers or lakes from industrial or agricultural activities (Kanu & Achi, 2011); hazardous waste (such as toxic chemicals or electronic waste (Boudier & Bensebaa, 2011); and biodiversity loss (such as destruction of habitats or introduction of invasive species (Bai, 2014). In each case, the polluter pays principle is used to ensure that those responsible for environmental damage are held accountable for the costs associated with avoiding and mitigating that damage. This liability incentivizes companies and individuals to take steps to reduce their environmental impact.

The polluter pays principle is often implemented through the use of pollution taxes or fees (Rahman & Edwards, 2004). Companies that generate pollution are required to pay a fee or tax based on the amount of pollution they produce. Harris & Roach, (2022) says it usually takes the form of a government-collected tax that is levied for every unit of pollution emitted into the air or water. The revenue obtained from these fees is used to fund environmental programs or to compensate those affected by pollution (Levinson, 2010). Another way the polluter pays principle has been implemented is through liability laws that hold companies legally responsible for the costs associated with environmental damage (Larsson, 2023).

The polluter pays principle works well in dealing with pollution whose source is known. There are innumerable kinds of traceable externalities from pollution, including air pollution, water pollution, land pollution, noise pollution, and light pollution (Carrascal Incera, et al., 2017; Rodrigue, 2020), and many studies show attempts to deal with these traceable externalities by applying the polluter pays principle. For example, the US Clean Air Act requires polluters to obtain permits and pay fees based on their emissions (Gailhofer, et al., 2023). Also in the United States, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) holds companies liable for cleaning up hazardous waste sites and compensating those affected by contamination (Anon, 2023).

Water effluent charges have been imposed in the Netherlands to fund the installation of water treatment facilities in accordance with the water quality provision of the Surface Water Pollution Act (Krozer, et al., 2010). In Japan, the Japan Environmental Corporation (JEC) has been developed and capitalized to become a major government financial instrument to promote the abatement of pollution by imposing fines on known polluters (Chuang, et al., 2019). Also in Japan, the Basic Environment Law has established a system for assessing environmental damage and requiring polluters to pay corresponding recompense (Nejat, et al., 2015).

Environmental taxes or fees are levied for air quality control in Canada, Portugal, France, and the United States (He, et al., 2019). In the United States, pollution emission charges are imposed to fund air quality services (Thompson, et al., 2014). Aircraft noise charges are earmarked to compensate residents in France and Germany,

and waste disposal taxes are set aside for treatment and recycling costs in a variety of countries (Malina, et al., 2012; Lu, 2014).

Adaman, et al. (2011) stated that the Pollution Control Fund in Turkey was set up to collect taxes and levies relating to the environment, including taxes on motor vehicles and transportation (for example, inspection fees for motor vehicles and sales taxes for vehicles), as well as fees for pollution permits.

In sectors such as fly-tipping, CO2 emissions, and NOX emissions, many peer-reviewed papers show the polluter pays principle at work (see Muller & Mendelsohn, 2012; Bristow, 2016; Kim & Park, 2018). In Sweden, a carbon tax has been in place since 1991 that charges companies for their greenhouse gas emissions, and the revenue obtained from this tax is used to fund renewable energy projects and other environmental initiatives (Bachus & Vanswijgenhoven, 2018). A study by Khan (2015) claims that Sweden has the most robust and advanced application and integration of the polluter pays principle in the world.

The policy instruments of the 'extended producer responsibility' there include taxes such as advanced recycling fees and 'take-back policies': Holland was the first country in Europe which adopted and fully implemented the take-back policy (Gutowski, et al., 2005). The Dutch approach is based on the national system of collection points which have units for dismantling equipment at their end of life (Gálvez-Martos, et al., 2018).

On global warming, during the last 20 years, the polluter pays principle has been reflected in numerous national laws and international instruments to deal with the problem, generally by carbon emission regulations and carbon pricing mechanisms (Zahar, 2018; Heine, et al., 2020). For example, the Climate Change Tax (CCL) was introduced in the UK in April 2001, imposed on energy use in industry, commerce and the public sector, whose original goals were to enhance energy efficiency and reduce carbon emissions in these sectors (Dickie & Harper-Simmonds, 2017). This tax led to a reduction in emissions, indicating that the principle is an effective environmental protection principle in reducing greenhouse gas emissions. In British Columbia, Canada, a carbon tax was introduced in 2008 that charges companies for their greenhouse gas emissions, the revenue from which is used to fund clean energy

projects and to provide energy bill rebates to low-income households (Bubna-Litic & Stoianoff, 2014).

On the application of the polluter pays principle to the oil spills problem, there is an extensive literature, from which the following papers/books are of particular relevance (Bellefontaine & Johansson, 2016; Carpenter & Johansson, 2018; Gunasekara & Sathyadith, 2021). There is also much peer-reviewed literature on obtaining compensation for oil spills whose source is known (Touza, 2010; Kim, et al., 2017; Wait, et al., 2020; Egan, et al., 2021). Berti, (2020) showed how widespread the problem of oil spills is in Europe: 7,500 spills were identified during 2019 in EU waters; and how a growing number of agencies in the European arena are being formed to deal with them, including EMSA [European Maritime Safety Agency], REMPEC [Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea], and MENELAS [Mediterranean Network of Law Enforcement officials] (Carpenter & Kostianoy, 2019). The proposed Blue Fund being established by REMPEC and MENELAS to use fines from polluted vessels to pay for increased surveillance is particularly striking, providing a possible template for regional collaboration in the Gulf arena.

2.2.2.3 Challenges in implementing the PPP

However, there are several difficulties in implementing the polluter pays principle. First, on cross-border pollution, it is very hard to assess what damage is inflicted by one country's carbon emissions on neighboring countries. Callahan & Mankin, (2022) showed that the magnitude of economic losses from warming attributable to individual emitters is not known, undermining calculations for climate liability claims. Researchers found that the top five emitters (the United States, China, Russia, Brazil, and India) have collectively caused US$6 trillion in income losses from global warming since 1990. But how to measure the extent to which these emissions have caused damage to other countries is a major problem. Second, domestically, it is sometimes difficult to measure the extent of the harm done by a polluter. Quantifying whose emissions have caused damage to whom, and by how much, is problematical (Callahan & Mankin, 2022). For example, high levels of air pollution can cause an exacerbation of lung disease, such as an asthma attack or a COPD flare-up. But we don't know exactly how many early deaths are linked to air pollution. The effects of

air pollution are complex – they impact people differently depending on their health (Reddy, et al., 2021). It is also hard to estimate which source of air pollution is responsible for which early deaths.

Third, it is often difficult to estimate the cost of clean-up that is needed to restore the environment/economy/society/individual to its original condition of health because each case has unique clean-up costs (Mohammadiun, et al., 2021; Montewka et al., 2013). The costs associated with cleaning up an oil spill are strongly influenced by the circumstances surrounding the spill including: the type of product spilled; the location and timing of the spill; sensitive areas affected or threatened; liability limits in place; local and national laws; and clean-up strategies (Osofsky, et al., 2011). Determining the appropriate level of compensation for environmental damage can, therefore, be complex and contentious (Maler, 2013). Estimating a universal per-unit clean-up cost is essentially meaningless.

Fourth, it is often hard to trace the culprit. For example, it may be difficult to identify the specific polluter responsible for a particular instance of pollution (Franckx, 2021), especially where multiple polluters are involved or where environmental damage is difficult to quantify (Xepapadeas, 2011). The polluter pays principle does not work in dealing with pollution whose source is unknown. In the case of unattributed oil spills, since the polluter is unknown, by definition the principle cannot be applied. There is a well-established infrastructure for dealing with traceable oil spills, and although it may be an imperfect system, at least there is a structure. In the case of mystery spills, however, there is no such structure, only some isolated and fragmented ways in which some mystery spills are dealt with. This is a serious problem because the number of mystery marine oil spills is high compared to the number of traceable oil spills.

Fifth, a further challenge is balancing economic development with environmental protection. Some critics argue that strict application of the polluter pays principle could lead to excessive costs for businesses and hinder economic growth (Rao & Yan, 2020). On the other hand, its advocates argue that failing to enforce the principle could lead to long-term environmental damage and negative impacts on public health which themselves undermine economic growth.

2.2.3 THE BENEFICIARY PAYS PRINCIPLE (backward-looking)

The beneficiary pays principle is a backward-looking principle of environmental justice that holds those who have benefited from environmental harm are accountable for the costs of remediation and restoration. This principle is based on the idea that those who have enjoyed the economic benefits of environmental pollution should also bear the costs of cleaning up the mess (Ceballos, 2016; Page, 2012; Beder, 2013). The rationale for this principle is that it is the consumer of a product rather than its producer (as in the polluter pays principle) who stands to gain most from it and should therefore pay for any externalities that it is responsible for (Jensen, 2010). The beneficiary pays principle is a fundamental principle of environmental justice that has been recognized by various international conventions, including the Rio Declaration on Environment and Development (Page, 2012). It is particularly relevant in cases where wealthy corporations or individuals have benefited from the product of polluting activities, while the costs of pollution and environmental degradation are borne by local communities and the environment (Carroll & Shabana, 2010). The beneficiary pays principle seeks to redress this imbalance by requiring those who have benefited from the activities to pay for the costs of remediation and restoration.

Implementing the beneficiary pays principle involves five steps. First, the pollution must be identified, and the costs of remediation and restoration must be established. Second, beneficiaries must be identified – i.e., the communities or groups that have benefited from the activities that have caused the pollution (Charles, et al., 2010). This requires an investigation into the whole supply chain of a product to determine which actors profited from it. Third, the extent of the benefits accrued by these actors must be assessed (Agol, et al., 2014). Fourth, a policy framework must be developed for allocating levies in proportion to those benefits (Page, 2012). Fifth, the framework needs to be implemented and monitored to ensure it achieves a fair outcome (Costanza, 2020). However, such steps are not easy to take. For example, it may be very difficult to determine whether a particular person has benefited from an activity that caused pollution, and to what extent, compared to the benefit enjoyed by another person.

Nevertheless, the beneficiary pays principle is gaining traction in dealing with environmental pollution (UNEP, 2010). Indeed, it has been enshrined in several international environmental treaties and agreement. The Low Sulphur Charge is an example of the beneficiary pays principle in action. Shipping companies that operate vessels in the European Union area and benefit from the use of EU ports and waterways are required to pay a surcharge based on the amount of fuel consumed by their vessels during their voyage (Christodoulou & Woxenius, 2019). This surcharge is intended to compensate for the additional costs associated with using low-sulphur fuel or investing in equipment to reduce sulphur emissions, and to encourage shipping companies to reduce their environmental impact. Another example is port levies where shipping companies that use port facilities and services benefit from the infrastructure and resources provided by the port, and port levies are a way of ensuring that they pay for those benefits (Tongzon, 2009). These levies can be used to fund a variety of activities related to port operations, such as maintenance and upgrades to facilities, dredging of harbor channels, improvements to navigation aids and cleaning up operations. An illustration of a port levy that is used to fund environmental initiatives is the Environmental Ship Index (ESI) program in the Netherlands. Under this program, ships that meet certain environmental performance criteria are eligible for discounts on port dues at participating Dutch ports (Alamoush, et al., 2022). The discounts are funded through a surcharge on the port dues paid by ships that do not meet the performance criteria. The Aden Gulf Surcharge is another example of the beneficiary pays principle. The Gulf of Aden, located in the Republic of Yemen, is a critical shipping route that connects the Red Sea with the Indian Ocean (Jawad, 2021). However, the area is also known for its high incidence of piracy, which creates significant risks and costs for shipping companies that operate in the region (Kraska & Wilson, 2009). To compensate for these costs, many shipping companies that use the Gulf of Aden apply a surcharge to their customers. This surcharge is intended to cover the additional expenses associated with increased security measures, such as armed guards and security equipment, as well as the higher insurance premiums that are necessary to operate in the region.

The beneficiary pays principle is an important tool for environmental justice, as it helps to ensure that those who have benefited from environmental harm are held accountable for the costs of remediation and restoration. It is also an important

principle for promoting sustainable development, as it encourages customers (including companies and individuals) to consider the long-term costs and benefits of their actions. However, application of the beneficiary pays principle creates problems. For example, it may be very difficult to determine whether a particular person has benefited from an activity that caused pollution, and to what extent compared to the benefit enjoyed by another person.

2.2.4 THE PREVENTION PRINCIPLE (forward-looking)

The prevention principle is designed to stop environmental hazards that could harm marginal groups from happening in the first place, instead of waiting until damage has been caused and then cleaning-up after it (De Sadeleer, 2020). Once environmental damage has occurred, it can be difficult and expensive to undo, so prevention is seen as the most effective way to protect the environment and the health and wellbeing of vulnerable people and other living beings. As the world becomes increasingly aware of the impact of environmental degradation, the prevention principle has become a crucial tool in reducing the effects of pollution and other environmental hazards (Beder, 2013).

Preventing environmental hazards involves a range of different measures. These can include regulatory measures, such as laws and regulations that limit the amount of pollution that can be emitted by factories and other sources. It entails measures such as banning toxic emissions, imposing high standards of vessel maintenance, and close monitoring of transport activity (Pedersen, 2013). It can also involve technical measures, such as using cleaner technologies or implementing energy efficiency measures. Another preventive measure is education and awareness-raising. By educating people about the impact of environmental damage and the importance of prevention, we can help to create a culture of environmental responsibility. This can lead to changes in behavior and attitudes that can help to prevent environmental hazards from occurring (Sutton, et al., 2021).

The prevention principle has gained increased attention in recent years due to the growing concerns around climate change, pollution, and environmental degradation (Schlosberg & Collins, 2014). Many governments, organizations, and individuals are now recognizing the importance of taking a preventive approach towards protecting the environment. One example is the ongoing water crisis in Flint, Michigan, where

residents have been exposed to high levels of lead in their water supply, leading to health problems (Butler, et al., 2016). The situation in Flint has highlighted the need for preventive measures to be taken to ensure that lead is removed from the water so similar incidents do not occur in the future. Another example is the wildfires that have ravaged parts of Australia and the United States (Wiegleb, et al., 2013; Lindenmayer et al., 2016). While some of these fires were caused by natural events, others were a result of human activities, such as the use of fireworks or campfires in areas prone to wildfires. Preventive legislation has been passed to prohibit such activities during summer months (Troitzsch, 2016).

In the case of oil spills, Zhang, et al., (2021) preventive measures have been enforced to enhance the safety of oil tankers. One significant initiative is the mandatory construction of double hulls in oil tanker design to prevent oil pollution (Jafaryeganeh, et al., 2020). This requirement substantially diminishes the risk of oil leakages in case of collision or grounding, providing an additional safeguard for marine environments. Measures have also been taken to separate ballast water from oil cargo, ensuring that when released into the sea, the ballast water is free from any oil mixture. This helps to mitigate the potential impact of ballast water discharge on marine ecosystems (Bradie, et al., 2023).

However, the prevention principle has its shortcomings. For one thing, it is hard to draw the line between reasonable and unreasonable preventive measures. For example, one way to prevent marine oil spills from ever occurring is to ban all oil tankers, but this is obviously completely unacceptable. Is it reasonable, however, to insist on preventive measures such as double hulls, when the expense involved could make some oil tanker businesses bankrupt?.

2.2.5 THE PRECAUTIONARY PRINCIPLE (forward-looking)

The precautionary principle serves to safeguard vulnerable populations by mandating decision-makers to take action, despite scientific uncertainty, to prevent harm to them (Pedersen, 2010). For example, a government might refuse planning permission to build houses on brownfield sites even in the absence of complete information about contamination of the land, because there is a risk of harm to residents (Walker, 2018). The principle operates under the assumption that in situations where scientific

evidence is incomplete, it is better to err on the side of caution and take immediate measures to avoid potential future harm. The precautionary principle is founded on the belief that the burden of proof should be on those who propose an activity that may pose a threat to the environment and public health, rather than on those who oppose it (Harremoes, et al., 2013; Goldstein, 2001). It is particularly relevant in cases where scientific evidence is contested.

There are innumerable current examples of the precautionary principle in action. For instance, Harremoes (2013) stated that the European Union has adopted the principle as a guiding principle for its chemicals policy, under the REACH regulation. This has led to the restriction or banning of several chemicals that were suspected of being harmful to human health or the environment, even in the absence of conclusive scientific evidence. Another example is the long-running controversy surrounding the use of genetically modified organisms (GMOs) in agriculture (Myhr, 2010). While proponents of GMOs argue that they are safe and beneficial, opponents argue that their long-term impacts on the environment and public health are unknown (Kangmennaang, et al., 2016). The precautionary principle justifies their non-approval (for example in the EU) until the potential risks are better understood. In the epidemiological health sector, this principle is used to stop the spread of diseases that may have devastating effects on vulnerable individuals (Bozzini, 2017). The principle is also used to guide clinical decision-making and the approval of drugs and medical devices, by requiring healthcare providers and regulatory agencies to take into consideration the potential risks and benefits of a treatment or product before approving it (Eichler, et al., 2013).

The precautionary principle has been adopted by most countries as a sensible constraint on environmentally risky activity, but its application has often attracted criticism as an over-reaction to hypothetical or theoretical risk (Steel, 2014). At what point does an activity pose a risk that is sufficiently high to trigger a precautionary decision to ban it? Is it not a principle that is subjective rather than objective, in that decision makers who are low risktakers will apply it much more frequently than will decision makers who are high risktakers? There is an adage that if someone took the precautionary principle too seriously, they would never get up in the morning.

2.2.6 THE SUSTAINABLE DEVELOPMENT PRINCIPLE (forward-looking)

The sustainable development principle originated at the Rio Earth Summit in 1992 as a means of ensuring that environmental protection is in balance with economic and social development (Scheiber, 2019; Mensah & Casadevall, 2019; Pedersen 2013). It has since become a standard criterion for progress, requiring that each generation has an obligation not to exploit the natural world at the expense of the well-being of the next generation (Schlosberg & Collins, 2014). It is based on the idea of intergenerational justice - that because each generation has benefitted from the efforts made by previous generations, it has a duty to bequeath benefits to the next generation (Pellegrino & Di Paola, 2023). It is a moral injunction that development should meet the needs of the present without compromising the ability of future generations to meet their own needs: we must not sacrifice the future for the present (Thompson, 2015).

There are endless examples of the application of the principle of sustainable development. One of the most prominent examples is the circular economy (Sauvé, et al., 2016). This is a model of economic development that is based on the principles of reduce, reuse, and recycle. In a circular economy, waste is minimized, and resources are used in a way that maximizes their value. Another example is sustainable tourism (Amerta, et al., 2018) which is designed to minimize the negative impact on the environment and local communities while providing economic benefits. It involves activities such as eco-tourism, cultural tourism, and community-based tourism (Singh, et al., 2021). Another example is green buildings (Hwang & Tan, 2012), which are designed to be energy-efficient, constructed of materials that are sustainable and renewable, and have a minimal impact on the environment (Nanda & Pring, 2012).

In short, sustainable development is a forward-looking principle that is all about creating a world that is fair to both the present and future generations (Kwiatkowska, et al., 2023). However, it is not above criticism. One criticism is conceptual - that it is a contradiction in terms, because development cannot be sustained indefinitely. Another criticism is practical: that it is too vague to be applied because the word ‘sustainable’ is ambiguous. For example, an activity may be economically viable but socially or environmentally damaging: is it therefore sustainable or unsustainable?.

2.2.7 THE STAKEHOLDER PARTICIPATION PRINCIPLE (forward-looking)

The stakeholder participation principle requires that people who are affected by environmental decisions have an entitlement to participate in those decisions so that their concerns will be taken into account (Pólvora, et al., 2020). It is a principle of environmental justice in that it lays down a basic right of people to be consulted on issues that affect them (Jensen, 2010). Stakeholder participation can take many forms, including public participation in decision-making processes, and ensuring that information about hazards is communicated clearly and transparently to affected communities. The importance of the stakeholder participation principle cannot be overemphasized. It is a principle that promotes transparency, accountability, and inclusivity in environmental decision-making (Lockwood, et al., 2010). By allowing people who will be affected by environmental decisions to participate in the decision-making process, the stakeholders are given a sense of ownership and responsibility for the decisions made. This is because they are able to contribute to the decision-making process and hold decision-makers accountable for their decisions. The stakeholder participation principle is forward-looking in that, its advocates claim, its implementation will improve the quality of environmental decision-making for the benefit of future generations (Pólvora, et al., 2020).

There are many examples of the stakeholder participation principle in environmental decision-making. One is the movement to clean up contaminated sites in low-income and minority communities (O'Connor, et al., 2019). In the past, these communities were often overlooked in environmental decision-making processes, which led to disproportionate exposure to environmental hazards. The stakeholder participation principle has helped to bring these communities to the table and ensure that their voices are heard. This has led to more comprehensive and effective clean-up efforts, as well as increased awareness of environmental justice issues (Sam & Zabbey, 2018). Another example is the movement to transition to renewable energy sources (Hage, et al., 2010). This transition is essential for mitigating climate change and reducing the harmful impacts of fossil fuels on the environment. Only by embracing the stakeholder participation principle, say its proponents, can we create a more just and sustainable future for all. For this transition to be successful, it must be done in a way that is equitable and this requires bringing together diverse groups to discuss and shape energy policies such as the siting of inland windfarms.

2.2.8 Interconnections between the seven principles

These seven principles of environmental justice are each independent or stand-alone conceptualisations of fairness in environmental policy. In some cases, they complement or reinforce each other (Figure 2.1). For example, the precautionary principle can be combined with several other principles, including the prevention principle and the sustainable development principle. The compensation principle is entailed in several other principles, including the polluter pays principle and the beneficiary pays principle. Also, the stakeholder participation principle is closely associated with the sustainable development principle (Kiss & Shelton, 2007). But in other respects, the principles offer alternative standalone approaches. For example, the polluter pays principle and the beneficiary pays principle require different cohorts to pay for the cost of clean-up and compensation. As we shall see, all seven principles can be applied to the case of oil spills in Musandam, though the most relevant principles are the compensation principle and the polluter pays principle.

2.3 Application of the seven environmental justice principles to Musandam oil spills

Oil spills cause extensive damage to aquatic and terrestrial ecosystems, as well as human health and livelihoods (Ejiba, et al., 2016). Environmental justice is particularly relevant in the context of oil spills, as these events can have a disproportionate impact on marginalized communities such as those that rely on fishing or other natural resources for their livelihoods, and those that are already exposed to environmental hazards such as air pollution or toxic waste (Osofsky, et al., 2012). For example, a community with a large population of low-income or minority residents are more likely to be located near an oil refinery or pipeline or near an important sea-lane of oil tanker movement, and therefore more likely to be affected by an oil spill (Teixeira & Krings, 2015). These communities are also less likely to have access to information about the health and environmental risks associated with the spill, or to have the resources to take legal action to hold the responsible parties accountable (Denedo, et al., 2017).

Several researchers have examined the connection between environmental justice and oil spills. For example, a study by Peres, et al. (2016) and Lauwo, et al., (2023) found that indigenous and low-income communities in Canada and the United States are

more likely than affluent communities to experience the negative impacts of oil spills, including health effects and economic losses (Tong, et al., 2023). Similarly, a study by Zia and Mehmood, (2018) found that the impacts of oil spills in Pakistan are often felt most acutely by marginalized communities, particularly those living near oil and gas fields. Musandam residents could be described as working-class victims of environmental injustice at the hands of wealthy oil tanker owners and other ships who dump oil on their shores and usually escape detection and compensation claims for clean-up and loss of income (external environmental injustice) (Ashok, 2021; Environment Authority, 2023). Moreover, an oil spill in Musandam could be deemed a violation of environmental justice in that it resulted in an inequitable distribution of environmental harm among different communities within Oman (domestic or internal environmental injustice).

The principle of compensation can be applied to victims of oil spills in Musandam in that it confers upon them the right to receive full compensation and reparation for any damage incurred (Payne, 2016). To ensure this, however, there must be clear and effective mechanisms in place to identify the responsible parties and hold them accountable for the damages caused by the oil spill. These mechanisms should be accessible and affordable to all affected parties, including marginalized and vulnerable communities (Telesetsky, et al., 2017).

The polluter pays principle can be applied to small-scale oil spills and their victims in Musandam by holding the responsible party or parties liable for the costs of clean-up and compensation for damages, including costs of containing and removing the spilled oil, as well as compensation for any harm caused to wildlife, ecosystems, or human health. However, implementing the polluter pays principle can be complex and contentious (Head, 2022).

First, it may be difficult to determine who is responsible for a particular spill, particularly in cases where multiple parties are involved. There are many cases where there have been problems of identifying the vessels responsible for oil spills (Soto-Oñate & Caballero, 2017). Finding out which oil spills are caused by which vessels discharging oily bilges of the engine room, releasing ballast water, or spilling oil and cleaning chemicals into the sea has often been near impossible (Lindgren, et al., 2016). This is a serious issue in Musandam because mystery spills often occur in its low-income or marginalized communities thereby exacerbating existing environmental injustices (Sze, 2020). In such cases, where the responsible party

cannot be identified or does not have sufficient resources to pay for damages, the government or a designated authority may be held responsible for bearing the costs of clean-up and compensation (Larsson, 2023). Some countries have established funds to compensate victims of pollution when it is difficult to identify a specific polluter (Hemminger, 2021). For example, in the United States, the Oil Spill Liability Trust Fund provides funding for oil spill clean-up and compensation in cases where the responsible party cannot be identified or does not have sufficient resources to pay for damages. In the case of Musandam, a fund could be established that is financed by fees paid by companies that transport oil through Musandam. The revenue generated from this fund could be used to compensate those affected by pollution from mystery spills. Second, determining the appropriate level of compensation can be challenging, particularly when it comes to non-economic damages such as harm to ecosystems or cultural resources.

With regard to applying the beneficiary pays principle to Musandam, it is possible to envisage taxing recipients of oil from vessels that transport it via the Strait of Hormuz (Testa, 2019). This would involve imposing taxes or fees on clients of shipping companies based on the amount of cargo they receive from transport through the Strait. The revenue obtained from these taxes could be used to fund clean-up efforts and compensate affected communities in the event of any pollution incidents (Hall, 2016). Implementing a taxation system for ships that transport via the Strait of Hormuz would involve four steps - developing a tax policy that outlines the objectives of the tax, the basis for calculating the tax, and the rates to be applied; establishing a tax collection mechanism; enforcing compliance through legal mechanisms such as fines or seizure of assets; and monitoring outcomes to ensure the system is achieving its intended objectives.

However, implementing such a taxation system would require careful consideration of the potential impact on shipping companies and their customers, as well as the administrative costs associated with collecting and enforcing these taxes. It would also require international cooperation among countries in the region to ensure that such a system is implemented across national boundaries (Zarif, 2022).

Applying the prevention principle to Musandam, it may be necessary to establish regulations that require companies and individuals that operate tankers and ships in the area to take steps to prevent spills and minimize their impact. This could include requirements for companies and individuals to have spill prevention plans in place,

vessels that have been built to high structural standards (e.g., with double hulls) and safer navigation routes.

Applying the precautionary principle to Musandam would require the government to put in place two forward-planning systems. First, it should establish an adequate satellite surveillance system to provide advance warning to Musandam of potential oil spills in the Straits. Second, it should create a store of oil dispersal equipment on the Peninsula rather than on the mainland, to speed up response times for oil clean-up.
Applying the stakeholder participation principle to Musandam would entail involving impacted communities in decision-making processes. Those Musandam communities that are most likely to be impacted by oil spills should be closely involved in the development of spill response plans for their areas. These communities usually have little political power and few financial resources to advocate for their own interests, making it difficult to hold responsible parties accountable and ensure that adequate clean-up and compensation measures are taken. Steps could be taken by the government to provide communities with access to information about the risks associated with oil spills and the measures being taken to prevent them. It could also include mechanisms for holding the government to account in obtaining adequate compensation.

Applying the sustainable development principle to Musandam means government should provide aid for communities that are heavily reliant on natural resources that may be impacted by oil spills, to provide new sources of income and reduce their vulnerability to environmental disasters in the future.

In conclusion, the concept of environmental justice is central to the issue of marine oil spills because oil spillers inflict grievous harm on innocent people. How the concept is implemented in practice, is however, far from straightforward, since there are at least seven principles of environmental justice that could be applied to the marine oil spills problem. In what follows, the theoretical framework of environmental justice will inform the empirical or fieldwork analysis of the oil spills problem in Musandam, and all seven principles of environmental justice will find a place in this analysis.

3. Methodology

A qualitative methodology was employed to address the research questions. The study employed a mixed method approach, drawing on a variety of tools including extensive scrutiny of peer-reviewed publications, government and non-governmental organization reports, and policy documents; participatory appraisal techniques like community mapping and transect walks with community members; semi-structured interviews with 67 key informants (KIs), and 10 focus group discussions (FGDs). The interviews were conducted either face-to-face or remotely, depending on the availability and geographic location of the participants.

3.1 Study area and participants

This research examines the issues of oil spill pollution through the lens of the community in Musandam, the most northerly coastal area in the Sultanate of Oman (Figure 1). Musandam was chosen as a case study because it has suffered from repeated small-scale oil spills and has been unable to obtain compensation for oil spills caused by unknown vessels, which are the vast majority of small-scale spillers. In cooperation with the Environment Authority staff, Musandam Governorate, and some Sheikhs of Musandam (De Oliveira Estevo, et al., 2021), 15 villages were chosen for investigation, all of which are highly dependent on small-scale fisheries for their livelihoods and are located along the Strait of Hormuz (Figure 1).

Of the 67 key informants (KIs), 60 were male and 7 were female. In addition to the individual interviews, ten focus group discussions (FGDs) were conducted to foster an open and dynamic exchange of ideas. These discussions involved a total of 29 participants, with each focus group comprising two or three discussants. The settings for these discussions were diverse, ranging from Majlis gatherings to coastal environments to on board traditional Dhows. These settings were chosen to create a comfortable and familiar atmosphere for the participants, allowing them to express their thoughts and experiences freely.

The KIs were selected in six sectoral categories: Oman government 33% (22); private sector 12% (8); regional countries 16.5% (11); international organisations 16.5% (11); fishermen and divers 13% (9); and local communities 9% (6). The 10 FGD focus groups were conducted along the Musandam coastline. The participants from

organisations in this study are listed in Table 1. Nineteen fishermen and members of local communities living along the coast of Musandam, from different villages, took part in this study. The participants' respective villages are listed in Fig. 1. The participants were selected based on information derived from a transect walk and community-mapping exercise in areas most impacted by oil spills.

A semi-structured format was used for both the KI interviews and the FGD topics, with a list of open-ended questions designed to encourage the participants to share their experiences and perspectives on oil spills. The questions were developed based on existing literature on oil spills and their impacts, as well as input from experts in the field (Nevalainen, et al., 2018). The questions for each group of respondents were tailored to their roles and experiences of oil spills. All interviews were recorded with the permission of the participants, and detailed notes were taken to ensure accurate and complete information.

Data collected from the interviews were analysed using a thematic analysis approach, in which common themes and patterns were identified across the different groups of participant. Initially, I manually selected 12 overarching themes to serve as codes, which were then inputted into Nvivo software for organization and analysis. Within each code, I established three subcodes to address the research questions on a local, regional, and international scale, ensuring comprehensive coverage of the data. Subsequently, all interview transcripts were uploaded into Nvivo, where participant responses were systematically highlighted within each group for ease of analysis and interpretation.

The results provided a deep understanding of the impacts of oil spills on Musandam and the wider region and helped to identify future strategies for prevention and mitigation of these impacts.

Figure 2.2 The location of the study and fishermen village's locations (Source: adapted by author from Google Earth)

3.2 Case study method

This research examines the issues of oil spill pollution through the lens of the community in Musandam, the most northerly coastal area in the Sultanate of Oman. Musandam was chosen as a case study for the investigation into the problem of obtaining compensation for oil spills caused by unknown vessels for two reasons. First, Musandam is sufficiently similar to other cases to make it worth studying as an example of a global problem. In other words, a study of Musandam's experience of oil spills is likely to yield some generalizations that are applicable to other cases. Marine oil pollution in the Musandam Peninsula area is like oil spillages elsewhere in that major spills are relatively infrequent but small spills are common and can cause considerable damage (Denny & Jacob, 2022); small spills are usually unattributable to particular vessels; and they cause governments immense difficulties in obtaining compensation for clean-up operations costs. Second, despite these similarities, there are some features of the Musandam case that make it distinctive and worth studying in its own right. For example, it has rare strategic significance because it is situated in the Strait of Hormuz which is the busiest waterway for oil tankers in the world, and this high traffic density means a greater chance of collisions and accidental oil spills

as well as affording opportunities for polluters to secretly release oily bilge water in littoral coastlines such as Musandam.

Since the 'case' in a case study can take many forms, such as an individual, an organization, a community, or an event, it is important to clearly define the unit of analysis (Schoch, 2020). This research adopts a single, embedded case study design that includes multiple units of analysis (Ebneyamini & Sadeghi Moghadam, 2018). These ‘units’ include government officials, private sector participants, supervisors and managers of oil pollution-related organizations, fishers and divers, and community residents (Bryman, 2016). Participants from international sectors, notably the ROPME (Regional Organization for the Protection of the Marine Environment), and International Maritime Organizations (IMO) were added as an additional unit of analysis. Yin, (2013) notes that the flexible design of the case study allows the researcher not only to accommodate additional units of analysis but also to determine which unit of analysis will be reconsidered when new discoveries are made during data collection.

3.3 Methods of obtaining data

3.3.1 Desk research

The first phase of obtaining data was desk research, and during this initial phase, the researcher engaged with the literature in the study area, including published academic research, and grey literature such as NGO and government reports, and statistical sources in the public domain. Although emphasis was placed on using academic and peer-reviewed journals, most publications of work undertaken on Oman coastal oil spills are from non-academic sources such as local newspapers, which are difficult to verify. The literature review was presented in Chapter 1.

3.3.2 Fieldwork

The second phase was fieldwork. This began with a small-scale pilot test. By using the proposed study instruments on a small sample group of the target population, pilot testing helps to strengthen the reliability and credibility of the instruments (Dikko, 2016; Cohen, et al., 2017). De Vaus, (2013) advises researchers to trial their instruments before starting investigations to eliminate the use of irrelevant variables. The pilot’s goal is to get respondent input on the meaning and clarity of the language

used in the proposed questions as well as comments on the priority and arrangement of the questions (Bryman, 2016; Silverman, 2019). Four respondents took part in a pilot survey of various oil pollution issues, and the findings were gathered in Oman. Some adjustments were made to the questions in light of the participants' remarks. For example, before the questionnaire took on its final shape, there was a process of eliminating certain sentences or statements that were thought improper or unnecessary, revamping some unclear elements, and introducing others to indicate some crucial characteristics. The pilot test also identified material that should be excluded because of repetition, obscurity, or prolixity. The excessive number of the questions was a particular problem in the early stages of development (Chenail, 2011), and as a result of the pilot, the questionnaire for all categories was condensed. Procedures for pre-study interviews were also used to test questions and develop expertise (Chenail, 2011; Bryman, 2016; Silverman, 2019). The researcher discovered how to ask focused, non-leading questions and to avoid veering off course to pursue side issues. Additionally, piloting allowed for the testing of the recording device's effectiveness and an evaluation of audio recording clarity (Malmqvist, et al., 2019).

An initial site visit to the study site of Musandam was made to meet with a wide spectrum of people in the community, especially those who had chosen to migrate to other areas, perhaps in response to the oil spills. So, the opportunity was taken to establish direct contacts with victims of the oil spill who no longer live in the community for various reasons but were interested in taking part in the research. For such persons the dates, times, and venue for interviews and focus group discussions were agreed. This preliminary visit served several purposes, including cementing contacts with key persons, recruiting field assistants, selecting villages within the Oman Community in which to conduct the research, and identifying potential focus group participants. The visit was also used to hold preparatory meetings with representatives of the Environment Authority, and representatives of the local communities in Oman. These meetings gave the researcher the opportunity to discuss the objectives of the research with the various groups, to work together on the research design and implementation, and to agree dates, times and venues for field work interviewing.

3.3.3 Key Informant interviews.

Interviews of key informants (KIs) are a commonly used method for data collection. The main KIs for this study were people with expertise in the issues raised by marine oil pollution. Firstly, these participants encompassed Omani government officials, scientific experts, and policy makers. Secondly, they included individuals from the private sector involved in direct dealings with oil spills. Thirdly, personnel and members from regional organizations, neighboring countries, and international organizations were selected who are involved in addressing oil spills and the oil sector. Fourthly, participants comprised individuals with firsthand experience of oil pollution in the inshore waters of the Musandam Peninsula area in Oman. Finally, the participants included coastal residents, tourists, hoteliers, and individuals who had firsthand experience with oil pollution along the beach areas of the Musandam Peninsula coastline.

The questions asked sought to elicit respondents' views on the causes, effects, clean-up, and compensation for marine oil spills. KIs' answers to these questions helped the researcher to understand the motivation, behaviour and perspectives of stakeholders. KIs also threw light on the successes and shortcomings of governmental policy, as well as helping formulate recommendations that could improve its performance (Lavoie, et al., 2019). Also, the questions aimed to extract perceptions of first-hand experience of marine pollution in Musandam coastal areas; knowledge of clean-up operations; views about the long-term harm done to the coastal environment; perceptions about the economic impact of the oil spills; descriptions of any compensation received; and thoughts on how to prevent such pollution happening in the future. Other questions asked were designed to elicit their personal experience of marine oil pollution in Musandam's coastal waters; their perceptions of the effectiveness of clean-up operations; their evaluation of the harm done to the marine ecosystem; their calculation of the negative impact of the oil spills on their businesses; their description of any compensation received; and their thoughts on how to prevent such pollution happening in the future. Data from third parties who monitor and measure oil pollution in this region were also obtained.

The interview questions were aligned with the projects' research goals and objectives (see Appendices A, B, C, & D). Most questions were open-ended to generate greater

interaction with interviewees. The researcher asked follow-up questions to encourage respondents to expand on their initial answers. Interview questions were initially devised in English and translated into Arabic for non-English speakers and their responses were translated after transcription. The translated transcripts were then independently checked by an English teacher who specialises in linguistics and translation studies.

3.3.4 Interview questions

The questions were divided into five sets. The first set of interview questions were concerned with how the respondents understand the nature and extent of marine oil pollution in Oman in general and Musandam in particular. It is important to examine stakeholders' perceptions of marine oil spills in order to estimate how serious a threat such spills are to the well-being of local communities. For example, Question 1 asked respondents about their experiences of oil deposits on the beaches of Musandam, and their socio-economic impacts on their lives. The second set of questions was about the steps taken to clean up this pollution. By answering these questions, respondents expressed their perceptions about the speed of clean-up; the identity of those carrying out the cleaning; the cost of clean-up; its effectiveness; and its impact on marine life and coastal livelihoods. For example, Question 2 was on "Reports on measures taken by the government of Oman to clean up the tar on the Musandam beaches". The third set of questions targeted the difficulties of determining which vessels are responsible for the pollution. Questions on this issue were put to all interviewees and focus group discussants, but it is likely that fishers and residents would have little knowledge or experience to contribute, so the study would rely on the expertise of other KIs. Questions 3 and 4 focused on this issue. The fourth set of questions explored the attempts made by the Government of Oman to obtain compensation from the owners of the polluting vessels. The answers to this set of questions would show whether the Omani government has managed to obtain compensation funds from either private companies which transport oil across of Strait of Hormuz or international regimes such as the IOPC fund or the P&I Club which are responsible for providing such compensation. Question 5 focused on this issue. The fifth set of questions explored the effectiveness of international organizations established to provide compensation for marine oil spills. These questions included the challenging issue of obtaining compensation for unattributed or 'mystery' oil spills. If respondents judged the

international organizations to be ineffective in providing compensation, they were asked to suggest alternative ways of obtaining compensation. For example, Question 6 dealt with this issue. Probing was used to elaborate specific proposals but in a sensitive manner to avoid interrupting the flow of answers.

3.3.5 Selection of KI interviewees

The quality of interviews is highly dependent on the selection of participants. On the selection of interviewees, according to Mason, (2010), a PhD project requires at least 35 interviews to acquire a reliable and valid amount of qualitative data. Graebner, (2009) emphasize the importance of limiting bias when conducting interviews by interviewing informants who have diverse perspectives on the phenomena.

To select interviewees from my transect walk and community-mapping exercise, I first collaborated with the Environment Authority in Musandam to understand the scope of the problem. Together, we developed a roadmap for field trips to visit various locations across the Musandam peninsula. Once the itinerary was established, I selected dates for visiting these areas and engaged with fishermen who were actively fishing during those days to gather their insights. Additionally, I identified interviewees from both government and private sectors based on their experience and involvement in oil spill management, whether in Oman or in regional and international contexts. Some interviewees were recommended by others within their respective sectors, adding depth to our selection process. For local communities, I chose individuals with expertise in oil spill impacts and those residing near the coast, as they are directly affected by such incidents. Accessing the desired respondents depends on the interviewee's availability and willingness to participate, and on the researcher's ability to visit the location agreed by the interviewee (Rowley, 2012). This logistical problem was solved by the researcher through Zoom calls. A purposive sampling method was applied in the respondents' recruitment for KI interviews (n=67) and focus group discussions (n=10) comprising 29 respondents. The participants were selected based on information derived from a transect walk and community-mapping exercise on areas most impacted by oil spills. The broad criteria for inclusion were (i) that all participants must be aged eighteen and above, (ii) that participants must have lived (past or present) in any of the Oman governorates within the time of oil spill incidences or up till the period of collecting these data; (iii) that participants included women; (iv) that members of the most vulnerable oil-spill

affected communities were included; (v) that people who played an important role in the marine environment sector were represented; and (vi) that unintended biases were kept to a minimum.

Before commencing the interview process, I made sure to contact the Environment Authority to obtain a letter of support to legitimize my approach to the interviewees as a formal study (Appendix F). This was an important step to ensure that the participants were aware of the nature and purpose of the interviews, as well as to establish a level of trust and transparency. By obtaining the letter, I was able to assure the interviewees that their participation was voluntary and that their personal information would be kept confidential. It was crucial to take these steps to ensure that the interview process was conducted ethically and in a professional manner.

Target interviewees were:

a. General managers and senior managers in the public sector in Oman.
b. Military personnel from the Maritime Security Centre, the Royal Navy of Oman, the Royal Air Force of Oman and the Royal Oman Police & Customs.
c. Regional and international organization employees who were responsible for dealing with oil pollution.
d. Academic experts and researchers with experience of oil spills and the marine environment.
e. Heads of department, consultants, and staff in the relevant government ministries both in Oman and neighbouring states.
f. Leading figures in the private sector.
g. Fishermen, divers, and local community representatives.

The interviewee categories were as follows (see Table 2.2):

Table 2.2 The organisations whose members took part in the study.

Unit studied		**Themes and concepts explored**
	Directors General and Directors n= 12	Perception of the nature and extent of marine oil pollution in Oman in general and Musandam in particular

Oman government		Perception of the cost of clean-up. Perception of the attempts made by the Government of Oman to obtain compensation from the owners of the polluting vessels
	Consultants n= 2	Perception of the impact of oil spills on marine life and coastal livelihoods
	Specialists n= 2	Perceptions of marine oil spills in order to estimate how serious a threat such spills are to the well-being of local communities. Perceptions about the speed of clean-up
	Military authorities n= 4	Perceptions of the difficulties of determining which vessels are responsible for the pollution
	Associate/ assistant professors- Academic sectors n= 2	Perceptions of the impact of oil spills on marine life and coastal livelihoods
Private sector participants	Petroleum Development Oman PDO and Oman Oil n=1	Perceptions of their experiences of oil deposits on the beaches of Musandam, and the socio-economic impacts on their lives
	Hotels / diving centres n= 7	
Regional cooperation and Neighboring countries	Marine Emergency Mutual aid Centre MEMAC	Perceptions of the effectiveness of international organizations established to provide compensation for marine oil spills. Perceptions of obtaining compensation for unattributed or 'mystery' oil spills. Perceptions about establishing a new policy to solve the issue of unattributed oil spills. Perceptions of marine oil spills in their territorial waters
	GCC Emergency Management Centre in Kuwait	
	Oil spill response officers in Gulf Countries, Iraq, and Iran n= 9	
International organizations	The International Oil Pollution Compensation Funds IOPC	
	International Maritime Organization IMO	
	Ship-Source Oil pollution Fund (SOPF)	
	The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)	
	Oil spill response organization (OSRO)	
	UK and Ireland Spill Association	
	The International Tanker Owners Pollution Federation Limited (ITOPF)	
	The European Maritime Safety Agency (EMSA)	
	The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC)	
	Coast Guard- USA	
	The UAE's Permanent Representative	
Local community and fishermen	First-hand experience of marine pollution in Musandam coastal areas n= 15	Perceptions of the problem of oil pollution on the Musandam coastline including its socio-economic impact; steps taken by the Oman government to clean-up the oil

Note that seven women were included in the category of government officials and international organisations, including those from the Ministry of Heritage and Tourism in Oman and representatives from international organizations such as the International Oil Pollution Compensation Funds (IOPC), the International Maritime Organization (IMO), the Ship-Source Oil Pollution Fund (SOPF), and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR).

3.3.6 Selection of FGD participants

Also, ten focus group discussions (FGDs) comprising 29 respondents (all of them male) in total were conducted. Focus groups are a data gathering technique often used in qualitative research to discuss topics which depend on group interaction, and where it is important not only to take account of diverse views and perspectives, but also to determine whether consensus exists on central issues (Morgan, 2012). Another feature of a focus group is how it encourages group interactions and allows the researcher to observe interviewees' responses to contradictory opinions (Phillippi & Lauderdale, 2018). The central topics selected for focus group discussion were stakeholders' perceptions of the problem of oil pollution on the Musandam coastline including its socio-economic impact; steps taken by the Oman government to clean-up the oil and mitigate its effects on coastal communities; and attempts that have been made in the past and might be made in the future, to find financial solutions to the problem. Each focus group consisted of 2-3 fishermen and took place in either Khasab or Bukha. An audio-record, with the group's permission, was taken of the discussions to obtain a more complete, accurate, and permanent record than is possible by note-taking (Coast, 2017). Interestingly, focus group discussants generally spoke with a single voice, complementing rather than competing with each other. Instead of opposing the ideas put forward by the previous fisherman, everyone in the FGD contributed to and built upon them. As a result, I considered each FGD as a collective discussion with a shared perspective (Harrell & Bradley, 2009). The reason why no women were included in the FGDs was due to social restrictions in the Gulf region and the fact that women are not typically employed in the fishing sector.

3.3.7 Observation

Part of the fieldwork was carried out to investigate the feasibility of proposals to solve the problem of how to obtain compensation for marine oil pollution from unknown

sources. This entailed conducting online meetings with regulatory personnel responsible for administering compensation schemes addressing marine oil pollution from known sources. The aim was to gather feedback on potential recommendations for compensation schemes addressing damage caused by unknown sources (Thiele & Gerber, 2017). Such regimes and sites included the Regional Organization for the Protection of the Marine Environment in Kuwait; the Marine Emergency Mutual Aid Centre in Bahrain; and the International Oil Pollution Compensation Funds office in the UK, involving about 10 participants.

3.4 Method of analysing data

The audio recordings from the interviews and the focus groups were transcribed. Initially, I attempted to use the "happy scribe" website, which offers speech-recognition software that converts voice or audio recordings into written text in real-time. However, because virtually all of the transcribed data were in Arabic, this website was of little use because it required listening to the respondents' Arabic phrases and translating them into English. As a result, I decided to analyse the transcripts manually along with the outcomes of the software. Having transcribed the interview data, I translated it from Arabic to English, which provided the extra benefit of re-familiarizing myself with the data. The transcripts were then reviewed by an English teacher to make linguistic adjustments. The translated document with the audio was sent to the interviewees to verify the transcription and translation process. Fellow Arabic-speaking Ph.D candidates at Newcastle University were asked to listen to three randomly chosen audio recordings (names and related information were removed) and then read and provide feedback on the translated and transcribed hard copies to validate the translation and transcription process.

In order to authenticate the correctness of translation of the fishermen's dialect in their narratives, I enlisted the help of Environment Authority personnel (Abdul-Wahid Al-Kumzari - the Head of Oman’s Environmental Control Department) to listen to an audio recording and follow the transcript because he understands the dialect of Musandam fishermen. Although some fishermen in Musandam speak Arabic, they do so very fast and some of their words are not comprehensible. Others, like Kumzar fishermen, speak a very different language, unique to people who live in Kumzar’s semi-island. The language spoken by Kumzar fishermen and in the surrounding areas

combines linguistic elements from Middle Eastern languages with a mixture of other languages. I was careful about using idiomatic phrases, slang, or jargon when interviewing respondents. If an interviewee looked puzzled or confused by something I said, I asked if they understood, and if necessary, I rephrased or explained my comments. Four interviewees preferred to answer the questions on paper and send back the completed questionnaire by email because of the lack of time and/or for security reasons in their countries. Those interviewees were from the OSPAR Convention, Qatar, Iraq and Iran.

3.4.1 Thematic Analysis

Data from interviews were manually analysed by identifying matching keywords, themes, and phrases commonly used by participants (reflecting common views, attitudes, behaviors, ideas, and beliefs). Computer-based data analysis software such as Nvivo was initially considered because of efficiency and systematic data management (Cabrera, 2018) as well as for accuracy and speed of data analysis. However, because the data were collected in Arabic and Nvivo does not support right-to-left languages, it was not considered practical for this study. Although there are advantages in terms of speed of analysis, learning how to take full advantage of such programs can take considerable time, especially for new researchers (Panuwatwanich & Peansupap, 2013). Additionally, some writers argue that using software to analyse data can distance researchers from the data (Kaisler et al., 2013).

Data were analysed using thematic analysis, a method defined by Braun (2013) as organizing and describing datasets. Often, however, analysis goes beyond description to interpret different aspects of a research topic. The goal of thematic analysis is to identify the smallest unit of analysis that represents an interesting aspect of the data. The code for this unit is used to build broader patterns of topics that address the research or say something about the problem (Cabrera, 2018). It does more than simply summarize the data: a good thematic analysis identifies and interprets the key features of the data and is guided by, but not limited to, the research questions. Themes can be derived inductively from the data and/or by using the researcher's previous theoretical understanding of the phenomenon under study. The analysis of this study included elements of both methods. Braun (2013) distinguished two levels of analysis: semantic and implicit. A semantic approach focuses on the explicit

meaning of the data and identifies themes based on the face-value meaning of the data. An implicit approach attempts to look beyond the explicit meaning of the data to explore underlying assumptions and ideas. This study took the latter approach in examining the reasons for participants' language. The analysis presented is therefore a theorized interpretive analysis, not just an explanation of what the participants said.

Thematic analysis followed the six-step guidelines of Braun and Clarke (2006): (1) Familiarize yourself with the data before starting the qualitative analysis. I conducted all the interviews and focus groups myself, so I had initial knowledge of what the data were about. I also transcribed the data myself and later translated and worked on it several times. Immersion in the data through the collection and transcription process, including re-reading transcripts, exposed me repeatedly to all aspects of the qualitative data. During this early stage, general notes and impressions were formulated and recorded (Braun & Clarke, 2006). (2) Generate your first code. After some familiarization, I divided my data into meaningful groups or codes. Reading and re-reading the transcript revealed a list of codes representing interesting and/or unexpected aspects of the Musandam oil spills, including respondents' perceptions of the impact of international, regional and local policies on dealing with oil spills and tar deposits and their perceptions of the socio-economic damage caused by tar (Froggatt, 2001; Ezzy, 2013). The coding process was systematically run across the dataset, highlighting patterns and making notes in the transcribed text to identify codes. Coded excerpts from individual transcripts were then copied and collected in separate files to give an overall idea of the data patterns and the relationships between them. Searching for topics in this phase grouped the code into higher-level topics (Harrell & Bradley, 2009; Jackson & Bazeley, 2019). A visual representation helped identify the relationships between various codes and themes. At the end of this phase, I had a large set of candidate topics and subtopics, including representative data digests at each level.

3.4.2 Demographics

An example of this process of thematic analysis is the profile of respondents in terms of gender; age; education; and work preferences. On gender, data show individuals in the study, who are female or male: 100% of the fishermen and local resident participants are classified as male. This indicates discrimination against female

participation, which could be a result of the exclusive involvement of male community staff in the fishing industry or of traditional conventions that restrict women's interaction with others from outside communities. Whatever the reason, the data revealed a pattern of dominant masculinity or patriarchal powers in the Musandam community age, the data display the ages of the respondents involved in the study. The age indication was divided into the following four age ranges: 18 to 25, 26 to 45, 46 to 60, and over 60. The age range of 26 to 45 encompassed the largest proportion of respondents: 54.55% for Oman government; 39.47% for commercial and recreational fishermen; and 25% for private sector. The second greatest number of respondents are individuals aged 46 to 60, who constitute 75%; and 50%; 45.45% for private sector, coastal residents, and Oman government respectively. The third largest group were the 60 and above year olds who made up 33%; 28.95 %; and 4.17% for the same categories of the residents. Last were the 18 to 25-year-olds who comprised 10.53% of commercial and recreational fishermen (See Table 2.3).

Table 2.3 Age Distribution of Study Participants

Age	**18 to 25**		**26 to 45**		**46 to 60**		**60 and above**	
Omani Government	0	0	12	54.55%	10	45.45%	2	4.17%
Private sectors	0	0	2	25%	6	75%	0	0
Commercial and recreational fishermen	4	10.53%	15	39.47%	8	21.05%	11	28.95%
Coastal residents, tourists, & hoteliers	0	0	1	17%	3	50%	2	33%
Total	4	--	30	--	27	--	15	--

On educational characteristics, data showed the highest educational achievement attained by the participants in the study. None of the fisherman who took part in this research possessed a university degree: 42.1% of the total 38 fisherman participants had no education at all; and the percentage of respondents classed as secondary, and primary was the same - 28.95%. By contrast, half of the 10 local resident participants had university qualifications; 30% had secondary education; 20% had attended "primary school"; and no local residents had no education at all. 100% of the participants from other countries had university education qualifications (Table 2.4).

Table 2.4 Education Characteristics of the Participants

Education	No school		Primary school		Secondary school		University	
Regional country	0	0	0	0	0	0	12	100%
Commercial and recreational fishermen	16	42.1%	11	28.95%	11	28.95%	0	0
Coastal residents, tourists, & hoteliers	0	0	2	20%	3	30%	5	50%

On work characteristics, data showed 100% of the fishermen and divers who participated in the study were self-employed. Of the local residents who took part in the study, 20% were employees, 20% were senior managers, 40% were in the middle management position, and 20% were either unemployed or retired. Of the Omani government representatives, 27% were in middle management, while 64% were in senior management. Of private sector representatives, 12.5% of were in middle management, 25% were in the chief management positions, while 62.5% were in the chief management positions

(Table 2.5).

Table 2.5 The Work Characteristics of Study Participants

Work	Employee		Middle management		Senior management		Chief	
Omani government	2	9 %	6	27%	14	64%	0	0
Private sectors			1	12.5%	2	25%	5	62.5%
Commercial and recreational fishermen	--	--	--	--	--	--	--	--
Coastal residents, tourists, & hoteliers	2	20%	4	40%	2	20%	2	20%

3.4.3 Nvivo software

The data from both the KI interviews and FGD transcripts were analysed using Nvivo software, coding open-ended answers to prepare the data into manageable themes. The interview data underwent thematic analysis to identify common patterns. Twelve themes were manually selected as codes and inputted into Nvivo. Each code had three subcodes addressing local, regional, and international aspects. Interview transcripts were uploaded to Nvivo, where responses were systematically highlighted for

analysis. These themes included perceptions of the problem of oil pollution on the Musandam coastline including its socio-economic impacts; steps taken by the Oman government to clean-up the oil and mitigate its effects on coastal communities; attempts that have been made, and might be made in the future, to find solutions to the problem by creating scalable and effective policies to protect the Oman coastline from untraceable oil pollution; and perceptions about compensation. Since this research is qualitative, the study relied on the pattern-matching technique to determine the agreement of the data with the research questions.

3.5 Method of validating data

Important criteria for assessing study design are validity and dependability or reliability. Validity is tied to data quality, whereas dependability is related to technical quality, according to Denscombe, (2009). However, Bryman (2016) says they are inextricably linked since "validity requires dependability." There is a consensus that the researcher must check that the study design fulfils the requirements of both validity and dependability, whether seen as two different or linked scales (De Vaus, et al., 2013). Rigorous criteria of validity and reliability are essential in research, particularly for the independent researcher, whose methods and findings must be checked for bias (Noble & Smith, 2015; Ishtiaq, 2019).

There are several methods for determining a measure's validity and dependability. Cohen, et al., (2017) specifies four key aspects that must be examined to identify and evaluate research quality: 1) external validity, 2) internal validity, 3) construct validity, and 4) replicability. These are all important considerations, and before deployment, the data-gathering techniques used in this study were submitted to several types of validity and dependability tests. For example, applying the external validity to the research by fellow Arabic-speaking Ph.D. candidates at Newcastle University were requested to listen to two randomly picked audio recordings (with names and references removed) and then read and provide feedback on the translated and transcribed hard copies to validate the procedure. Ensuring internal validity in research involves applying rigorous measures within a case study design to control variables, maintain data accuracy, and establish clear causal relationships between studied factors. This research has also been validated through construct validity, which emphasizes the importance of clear and precise definitions of the theoretical

constructs or concepts under study. The questionnaires, scales, and tests employed to collect data have accurately captured the intended constructs without introducing bias or error.

The extent to which the data represents the issue it is designed to assess, as determined by the researcher and specialists in the field, is referred to as content validity (Noble & Smith, 2015; Kumar, 2018). The survey material was evaluated for content validity to establish whether it related to the study questions. For example, before designing the survey, a thorough literature analysis was undertaken to assess its validity. Once the questionnaire was created, experts were asked to appraise the questionnaire's look in terms of practicality, readability, consistency of style and structure, clarity of language utilized (DeVon, et al., 2007; Bryman, 2016). Supervisors were requested to examine the clarity of the phrasing, the probability that the target participants would be capable of answering the questions, and the questionnaire's design, to determine the appropriateness of the questionnaire. Then, depending on their comments, changes were made to ensure that the vocabulary was straightforward and plain to eliminate response mistakes. A copy of the questionnaire was sent to the Environment Authority in Oman to acquire formal clearance from the necessary authorities in the Sultanate and abroad for its execution. As a result, more changes were suggested and adopted. After that, consent from the Environment authority was obtained, and the survey questionnaire was completed.

The research utilized a triangulation of approaches – documentary analysis, semi-structured interviews, and focus groups – to study the phenomena from several viewpoints and to increase the precision of the information gathered (Khan, 2014; Choy, 2014). Using numerous sources of data assists in determining the dependability, improves the legitimacy of case study evidence, and 'confirms' the phenomena by generating 'interconnected avenues of inquiry' (Moon, 2019).

3.6 Ethical considerations

Particular care was taken with ethical considerations and risk reduction procedures prior to and during the research. The procedure followed was approved by Newcastle University's Ethics Panel (see Appendix 3). Four points are particularly important. First, the process of acquiring consent from research participants needed to be adapted to local conditions. Following Newcastle University procedures, participation information documents were produced setting out the nature of the research, the

involvement of research participants and their right to withdraw at any point, the anonymity of participants, and how the data would be stored and used (see Appendices). Having identified the potential participants, invitation letters were handed to them which contained details of the research. Before the commencement of each session, the participants were requested to complete consent forms (Appendix E). This meant all participants were invited to read through the invitation letter and consent form before deployment of the research tools. An oral form of consent acquisition was used for non-literate participants. Advice was taken from local research assistants and facilitators regarding the consent process, as in some contexts the use of forms of this kind can provoke unnecessary anxieties. For example, such forms may be associated with various forms of institutional malfeasance and thus must be treated with care, so misunderstanding is minimised.

Second, the question of research participant expectations was something that had to be addressed. During the time of sampling, most of the fisher participants could be classified as people from low socio-economic background recruited mainly because of the impact the oil spill hazard had on their livelihood. Care was taken through the informed consent process to ensure participants understood the limits of the research in terms of the immediate benefits that it could bring to them, so as not to raise their expectations. Additionally, steps were taken not to overestimate the political understanding of the people in the community. It should be noted that I am from this part of Oman, so I am familiar with the social, economic and political perspectives surrounding the oil spill issues. However, steps were taken to maintain a neutral and balanced position prior to and during the field work. For example, the researcher did not engage in personal conversation with the research participants and always maintained a neutral position when issues unrelated to the studies were raised.

Third, the devastating nature of oil spills has meant that many participants have unpleasant memories and trauma resulting from their impact. It was therefore anticipated that discussions of past experiences might resurrect these past traumas and open up old wounds for people. Advice and information on where research participants could seek further assistance was provided to all participants should they feel emotionally disturbed. The vulnerabilities of research participants in this regard were mitigated through the involvement of the research assistants who acted as

facilitators for community access, particularly in liaising with key figures such as sheikhs and elders of the villages in Musandam. Their involvement was instrumental in fostering a collaborative and respectful relationship with the local communities, ensuring smooth access and participation. Furthermore, our team also collaborated closely with department managers of the Environment Authority and the Ministry of Agriculture and Fisheries in Muscat and Musandam. This collaboration reassured the participants, while at the same time assisted in maintaining a close relationship between the researcher and the community leaders. Other measures to reduce risks and harm included arrangements for conducting interviews and focus group discussions in safe spaces (e.g., in a participants' home, or in the community town hall). The risk of researcher harm was minimized through use of mobile phones for personal security in an emergency, and by close contact being maintained with a reliable person in the nearby city who was kept abreast of all daily activities as the case study research was rolled out.

Fourth, Covid-19 raised several additional ethical considerations. Due to Covid-19, most interviews were conducted via video/audio conferencing, avoiding face-to-face meetings and physical contact as much as possible. Face masks or visors were worn by me at all times while traveling and during interviews. My hands were sanitized before and after in-person interviews. At least a 2-metre distance was maintained between the researcher and others, even when interviewing outdoors. Physical greetings were not made; touching eyes, nose, or mouth were avoided without washing hands; and washing hands with soap and water for 30 seconds or using alcohol-based hand rub was done frequently during the fieldwork. I took the necessary materials with me for the meetings and interviews, including face masks, wipes to clean the surface and hand sanitizers. I took extra face coverings with me to give to the interviewees if they did not have them.

3.7 Research questions

The main research questions are as follows:

1. What is the extent of the problem of oil pollution in the Musandam Sea?

   This question raises the issue of whether the coastal areas and waters of the Musandam Peninsula have been seriously impacted by (mainly small-scale) oil pollution, which has gradually increased over the last ten years.

In answering this question, the study examined the impacts of oil pollution on the marine environment of the Musandam Peninsula, and the evidence of discharge of oil pollutants by tankers in the Musandam Sea, making use of peer-reviewed literature and testimonies from fishers.

2. What steps have the Oman government taken to resolve this problem?

   In answering this question, the researcher searched government documentation and the grey literature for reports on measures taken by the Oman government to clean up the tar on the Musandam beaches, and on whether the government has managed to obtain compensation funds from either private companies which transport oil across the Musandam Sea, or international regimes which are responsible for providing such compensation. Interviewees were also asked for their perceptions of governmental action.

3. What are the rules imposed by international law which regulate oil pollution of coastal environments?

   In answering this question, the study conducted a literature search for data on the international law governing the discharge of oil substances by vessels at sea, including monitoring of such discharges and liability of oil transporting companies for clean-up charges. The research also examined the literature for information about international regimes which pay out compensation for any form of environmental pollution where the perpetrators cannot be detected.

4. What is the current situation of international organizations providing compensation for oil pollution by known sources?

   In answering this question, the study researched organizations such as IMO, IOPC and ROPME, and asked residents and fishers if they have received compensation.

5. What kind of new international agreement is needed to provide solution for protecting oil pollution caused by unknown sources?

   In answering this question, the study investigated the feasibility of establishing a new regional organisation or building on an existing organisation to obtain funds by a compulsory tax on private companies which transport oil through the Straits of Hormuz in order to pay for clean-up operations from oil discharges from their vessels.

4. Conclusion

This chapter has had two focuses: theoretical framework and methodology. The theoretical framework informing this thesis revolves around the concept of environmental justice, which calls for the equitable treatment of all individuals in the formulation, execution, and enforcement of environmental laws, regulations, and policies. By adopting this theoretical framework, the thesis aims to underscore the significance of fair treatment in addressing the issue of compensation for damages incurred due to marine oil spills from unidentified or mystery vessels. This lens of environmental justice serves as a guiding principle, emphasising the imperative for fairness and equality of resolving the complexities surrounding oil spills and their aftermath.

The research methods then employed in this thesis were predominantly qualitative, employing an extensive range of key informant interviews and focus group discussions. This fieldwork comprehensively explored the multifaceted issue of obtaining compensation for damage caused by unidentified oil spills; investigating potential ways of identifying the perpetrators behind mystery oil spills, and examining the complex relationship between various types of oil spills, including illegal spills, deliberate spills, mystery spills, and small-scale spills.

This thesis is built on the foundations of environmental justice theory and qualitative research methods. This twin basis enabled an investigation into damage compensation for mystery oil spills and facilitated the exploration of strategies to identify mystery spillers. In the next chapter, the full extent of the problem of small-scale mystery spills is explained.

CHAPTER 3. The Extent of the Problem of Marine Oil Spills

1. Introduction

The problem of oil spills at sea has shifted during the last 50 years. There are now fewer large-scale marine oil spills than in the past, but more small-scale spills (i.e., less than seven tonnes) (Keramea, et al., 2021). There are many reasons for the decrease in large-scale spills including improved large-scale vessel construction (such as double hulls); increased surveillance; higher insurance costs for convicted oil spillers; and steeper fines for illegal oil spillage (Yip et al., 2011). These reasons indicate a determined effort on the part of international, regional, and national bodies to get to grips with the problem of large-scale oil spills at sea (Moroni, et al., 2019). However, on the issue of small-scale oil spills, these bodies show no such determination to get to grips with it. Governments and ship owners show more commitment to International Conventions and Protocols than ever before. However, the international organizations tend to ignore small oil spills, despite the fact that small spills can cause significant harm to the environment, fishing, tourism, and the economy of the affected countries. Therefore, it is crucial to recognize and address the potential impact of small-scale oil spills as well as large spills (Farrington, 2013).

The present research has conducted a case study of Musandam in Oman to investigate these issues. As we shall see, the Musandam Peninsula is a particularly good case study because its residents have experienced repeated small-scale oil spills from oil tankers and cargo vessels passing through the adjacent Strait of Hormuz on their way to ports in the UAE, Qatar, Iraq, Kuwait, Bahrain, Saudi Arabia, Iraq and Iran (Al-Janahi, 2008; Mohammadi, 2005).

In this chapter, I use data collected in interviews with Oman and other GCC countries, including Iraq and Iran, to explore the relationship between illegal spills, deliberate spills, mystery spills, and small-scale spills. The distinction between illegal and legal spills depends on their respective adherence to applicable laws and regulations. Illegal spills are those that occur in violation of established laws, regulations, permits, or environmental standards. These spills involve actions or activities that are expressly prohibited by governing authorities. They are typically associated with non-compliance, negligence, or intentional misconduct, and they can result in legal

consequences, penalties, fines, and liabilities for the responsible parties. By contrast, legal spills are spills that occur within the framework of applicable laws, regulations, permits, and environmental requirements. While legal spills may still have environmental and economic impacts, they are not subject to legal penalties or liabilities if they conform to the prescribed guidelines and procedures.

The remainder of the chapter is divided into five sections. Section 2 clarifies the meaning of the terms used to describe oil spills. Section 3 explains the situation regarding large-scale spills. Section 4 focuses on the problem of small-scale spills. Section 5 examines the challenging issue of mystery spills. Section 6 concludes the chapter with a summary of its findings and some recommendations.

2. Definitions

An oil spill refers to the accidental or deliberate release of liquid petroleum hydrocarbon into the environment. It occurs when crude oil or refined oil products are released into water bodies, such as oceans, seas, rivers, or lakes, or onto land surfaces (Zhang et al., 2019). Ship-source marine pollution, as highlighted by Rong, (2018), can be categorized into three distinct types: operational discharges, deliberate dumping, and accidental spills. The first two categories involve voluntary actions carried out by ships, while the third category is involuntary (Figure 3.1).

ITOPF and the MARPOL 73/78 convention classify spills into three distinct size categories: <7, 7–700 and >700 tonnes (Murphy, et al., 2016). Large-scale spills involve the release of a substantial amount of oil into the environment resulting in extensive contamination of water bodies, coastlines, and surrounding ecosystems. These spills typically exceed a threshold of 700 tonnes (Miller et al., 2015). Medium spills fall within the range of 7 to 700 tonnes, i.e., where a significant volume of oil is released into the environment (Liu, et al., 2021). Small-scale spills typically involve relatively minor quantities of oil – seven tonnes or less – and are often localized and can happen during transportation, storage, or routine operations (Liu, et al., 2021).

Deliberate spills are intentionally caused by individuals or entities, regardless of whether they are legal or illegal. Deliberate spills include actions such as intentionally releasing oil into the environment for economic gain or sabotage. Such spills are

criminal offences, and ship owners are prosecuted and fined when caught red-handed and when sufficient proof has been brought to court (McGenity, et al., 2010). Mystery spills refer to spills where the source or responsible party is unknown or difficult to identify. These may occur due to accidental releases, unknown incidents, or deliberate acts conducted with the intention of hiding the identity of the responsible party (Escobar, 2019).

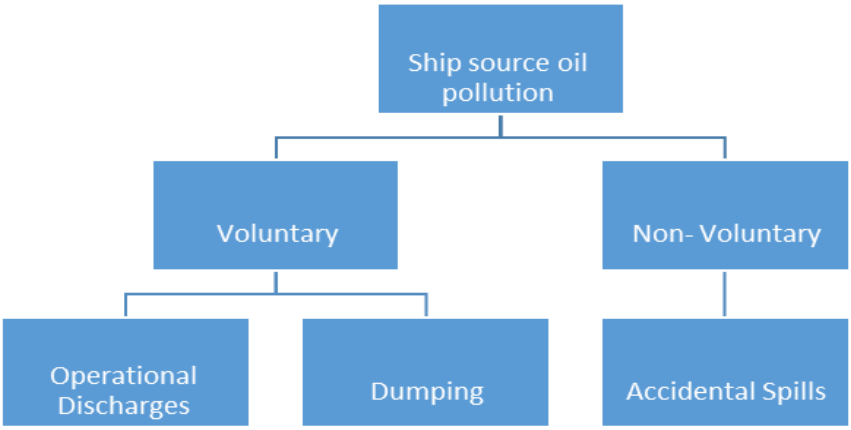

Figure 3.1 Different classifications for ship-source oil pollution (Source: the author)

The size or scale of a spill can vary significantly, regardless of whether or not it is categorized as a mystery spill. However, most mystery spills are small-scale spills. The term 'mystery spill' focuses on the challenge of identifying the source or responsible party. It underscores the difficulty in determining the cause and origin of the spill, which may require extensive investigative efforts and scientific analysis to unravel the mystery.

3. Large-scale and medium-scale oil spills

The views expressed by the international participants in the current study show that during the last 50 years there has been a sharp decline in the occurrence of large-scale oil spills (Figure 3.2). For example, according to KI-39 (an international organisation official): *"Oil spill has decreased, I mean the larger pollution cases anyway, because of there is more attention to the regulations like the MARPOL 73/78 convention, so there is more attention in the coastal states as well to what's going on around their waters*". Another international organisation official – (KI-42) - said "*The data we*

collect from tankers, since the 1970s, indicates that spills are decreasing, both in volume and frequency of occurrence as well". He stated that *"the International Tanker Owners Pollution Federation Limited* (ITOPF) *reported that the number of oil spills from tankers has decreased significantly over the past few decades, with the number of spills greater than seven tonnes in 2020 being the lowest in 50 years*". This participant provided Table 3.1 which shows a decrease in the average number of oil spills categorized by their volume, either 7 - 700 tonnes or >700 tonnes, originating from tankers for the last decades. Similarly, KI-45 (a third international organisation official) stated "*the International Maritime Organization* (IMO) *has reported a decrease in oil spills from ships, which they attribute to improved regulations and industry practices. The IMO notes that the number of oil spills from ships greater than 7 tonnes has decreased from an average of 24 per year in the 1970s to just two per year in the last decade*". The IMO reported that the volume of oil spilled from tankers has decreased, with 2020 being the lowest year on record (ITOPF, 2022). KI-47 (USA participant official) stated that "*as I have heard the major oil pollutions are decreasing and the small oil spills are increasing".*

Table 3.1 The average number of oil spills (7 -700 tonnes) and (>700 tonnes) from tankers [source: ITOPF (2022)]

Years	**Average of number of annual spills 7 -700 tonnes**	**Average of number of annual spills > 700 tonnes**
1970s	543	245
1980s	36	94
1990s	281	77
2000s	149	32
2010s	45	18

These participants say major oil spills are decreasing because of improved safety regulations and technologies that are preventing spills from occurring in the first place. It appears that international organizations have given heightened attention towards oil spills, particularly in the light of significant incidents that have occurred in the ocean in the last decade. These incidents have served as wake-up calls, prompting the establishment of regulations and frameworks aimed at protecting the marine environment from large-scale oil pollution (Khalil, et al., 2020).

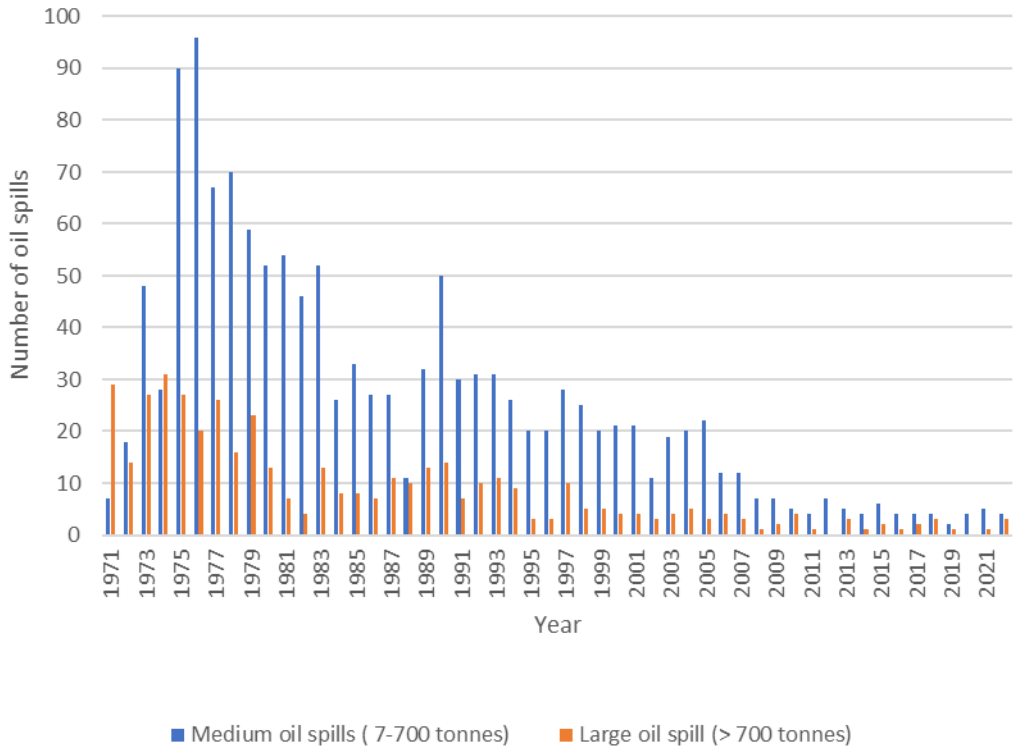

Figure 3.2 Global number of oil spills from Tankers, 1970-2022 (Source: International Tanker Owners Pollution Federation (ITOPF) (ITOPF, 2022)

According to Marzooq et al., (2019), oil pollution incidents are classified into three tiers: Tier 1: Operational spills at an operator's facilities who is expected to respond with their resources. Tier 2: Spills that have the potential to extend outside the Tier 1 response area and may be larger in size, underlining the need for additional resources and the gravity of the situation. Tier 3: Oil spills cause a significant impact due to their scale and likelihood and demand for substantial resources from national and international sources.

The process of defining these tiers of capability and their boundaries calls for a risk management study to ensure appropriate risk mitigation strategies (IPIECA 2008).

It is essential to recognize that while the extent and size of the spill is relevant to the tier classification, other factors such as environmental resources at risk, seasonal accessibility and geographical remoteness also play a part. For this reason, the tiers should not be defined quantitatively, as there are too many variables in a spill (e.g., oil type, location, environmental setting, weather, local governance, etc.) to calculate the amount and quantity of resources required by a given volume of oil spilt.

The number of large-scale oil spills has decreased in the Gulf countries' waters, according to KI-29 (a regional participant): "*The Kingdom of Bahrain, for example, experienced its last Tier Two oil accident in 2003, which significantly impacted the environment and resulted in environmental and property lo*sses". Similarly, interviewee KI-28 (another regional participant) said, *"one large-scale oil spill incident occurred in 1982 in Ras Al-Hadd by CME tanker spilled the amount of 52,428 tonnes, but in general large-scale oil spills have decreased".*

Likewise, in Oman, there have been few large-scale oil spills during the last ten years. Those incidents have been successfully dealt with, particularly when the source of the spills is identified by either the IOPC Fund or the P&I Club. According to the Omani government participant, KI-17 (a government participant),

> *"there were two large to medium scale oil spills incidents involving in Oman water by known sources. The first one was the Nessa R3 incident in 2013, which was resolved through cooperation with the International Oil Pollution Compensation Funds (IOPC). The second incident occurred in 2019 and involved a collision between the tanker Viviana and the bulk ship Ji mei shunhao in Fujairah. Their spills reached the coastline of Oman and resolved through direct contact with the P&I Club".*

Generally, large-scale oil spills in GCC countries resulting from tankers and ships have been infrequent, with occurrences happening approximately once every five years or even less frequently, despite the geographical proximity of Gulf countries to the Strait of Hormuz and the high volume of ship and marine traffic passing through the strait for the transportation of crude oil and cargo. The remarkably low number of large-scale ship incidents in the region over the past few decades can be attributed to the improvements in the region's infrastructure and the implementation of stringent safety measures to prevent maritime accidents.

The participants in this study, including individuals from international, regional, and Oman government, collectively highlight the seriousness of large-scale oil spills when they do occur. For example, KI-39, (an international participant) said "*The impact of the spill can extend to the surrounding environment and can also impede economic activities in the regio*n". According to KI-29, (a regional Participant)

"oil spills have a profound impact on the environment, economy, society, and public health, which is a cause for concern. As many countries in the region rely heavily on the sea for food and water supply through desalination plants, any Tier Two or Three oil spills could significantly affect fishing activities, water desalination operations, and the movement of ships, leading to adverse economic consequences. Moreover, such incidents can have long-term detrimental effects on the environment, posing a risk to public health".

The worst oil spill in the Gulf in living memory occurred during and after the 1991 Gulf War, when an estimated 10.8 million barrels of oil leaked into the waters of the Persian Gulf (Naser, 2013). High levels of heavy metals were reported after this major oil spill (Jupp, et al., 2017). KI-28 (a regional participant) said that *"Since the Gulf War in 1991, when large-scale oil spills impacted the coastlines of Saudi Arabia and Kuwait, traces of oil have persisted in the beach sediment. Even now, when digging just one foot or 18 inches into the sand, remnants of oil can still be found"*. According to KI-1, (an Omani government official), *"the impacts of the large-scale oil incident Nesa R3, which occurred in 2013, continue to persist on the affected beach, particularly on the sand and mountains. It has been observed that these effects have endured for a period exceeding eight years".*

4. Small-scale spills

International organizations have devoted considerable attention to marine oil spills in the wake of large-scale incidents that occurred during the last 50 years (Zhang, et al., 2021). However, these international organizations have given limited attention to addressing small-scale oil spills. While large-scale oil spills often receive extensive media coverage and prompt governments to immediate response efforts, small spills have received much less media interest and governmental response (Little, et al., 2021). Yet small-scale oil spills, although individually less significant in terms of volume, can have cumulative and long-term impacts on marine ecosystems and local communities. As indicated by Varsami and Tromiadis (2018), the data compiled thus far reveals that the vast majority, approximately 81%, of nearly 10,000 incidents fall within the first category. There is evidence from international participants that small-scale oil spills are increasing: KI-47 (an international participant) stated that *"as I*

have heard the major oil pollutions are decreasing and the small oil spills have been increasing… there are still numerous small-scale spills happening globally. Moreover, there could be underreporting of spills, which makes it challenging to have completely accurate statistics". It does seem there has been an increase in minor oil spills in the Musandam area, particularly in the western part of the Strait of Hormuz, where vessels are known to discharge their oil wastes before passing through the Strait (Ivanov, et al., 2023).

The limited focus on small spills by international organizations is attributable to five factors. The first factor is the major logistical challenge of detecting and monitoring smaller spills, as they often go unnoticed or are not promptly reported. Second, the response and clean-up efforts for small spills are less prioritized due to resource constraints and the perception that they pose lesser immediate threats compared to large-scale incidents. Third, small spills (i.e., under seven tonnes) are under-reported by those affected compared to large spills so data are often incomplete (De Oliveira Estevo, et al., 2021). KI-45 (an international participant) said *"the smaller releases of oil spills are difficult to quantify because there are no international statistics nor reporting requirements at the international level to be able to track that, I think that there are still quite a lot of smaller operational side spills that aren't quantified but still may cause significant damage to the environment over time".* The Environment Authority in Oman lacks accurate small- scale oil spills statistics due to a shortage of staff and a lack of reporting from local residents who often view such incidents as commonplace occurrences throughout the year. KI-2 (Oman government participant) explained that *"obtaining accurate statistics regarding oil spills in Oman is challenging, as there is no precise data available"*. Fourth, small spills are more likely than large spills to come from unknown sources (Su, et al., 2019), and are therefore more difficult to obtain compensation for clean-up (Li, et al., 2016). Fifth, there is less publicity about small spills because they cause less damage individually than do large-scale spills. These five reasons may be summed up as 'out of sight, out of mind', in that governments seem content to leave small spills to the weather and to coastal communities' efforts to clean-up.

5. The frequency of small-scale and mystery oil spills across the globe

Major oil spills from sinking tankers are thankfully very rare these days. However, smaller oil spills from shipping are unfortunately still common. Smaller oil spills happen every day due to incidents of leaking illegal discharges or dumping of sludges. These waste materials can be washed back to the shore, littering beaches with hazardous debris (Europe Commission, 2014). Although the majority (81%) of reported oil tanker incidents involve small-scale spills (< 7 t), ITOPF emphasized the insufficient data on these smaller spills (ITOPF, 2015). This lack of information has led to their exclusion from current assessments (Neves, et al., 2015). Sankaran, (2019) mentioned that these activities are characterised by their covert nature, making them difficult to detect and quantify accurately. Identifying the exact sources of these small-scale oil spills can be challenging due to their nature and the difficulty in tracing them back to specific incidents or vessels.

A literature review on small-scale spills across the world reveals that most incidents involving known sources are linked to ship accidents, collisions, sinking, and accidental releases during oil transfers (Cakir, et al., 2021). Small-scale oil spills can occur in the sea without immediate or identifiable sources (Michel, & Fingas, 2016). These spills are often referred to as "mystery spills" because their source is unknown or difficult to determine (Owens, et al., 2016). Examples of such mystery spills include the following:

1. Tar balls on beaches: Tar balls, small clumps of weathered oil, sometimes wash up on beaches without a clear source (Bhatkar, et al., 2019). They can result from natural seepage of oil from the seafloor, illegal discharge from ships, or residual oil from past spills that resurface due to ocean currents and wave action.
2. Oil sheens: Oil sheens are thin layers of oil on the water's surface that can occur without an apparent source (Jacketti, et al., 2020). They often result from oil leaks or spills that are not immediately visible or have dissipated, making it challenging to identify the exact source.
3. Unknown ship discharges: In some cases, small-scale oil spills can occur as a result of illegal discharges from ships that go undetected or unreported (Hassler, 2016). Ships may release small quantities of oil or oily waste into the

sea, intentionally or unintentionally, without leaving a clear trail or being caught in the act.

An online search was conducted to find small-scale and mystery oil spills across the world. Two papers were particularly helpful in providing a global perspective. Moroni et al. (2019) highlighted the environmental impacts of small-scale oil spills from several marine environments, including the Eastern Mediterranean Sea, the North Sea, the Venice Lagoon, and the Gulf of Finland. These spills cause physical disturbances to local marine habitats, affecting the organisms living there and damaging sensitive species and ecosystems due to toxic inputs from the oil. The study notes that small and medium-sized spills account for 95% of all recorded oil spill incidents, making them a significant source of pollution with a cumulative impact on marine environments. Asif et al. (2022) discuss the main environmental impacts of small-scale oil spills on shorelines, particularly in locations such as the Gulf of Mexico, Norilsk in Russia, the Northeastern USA, and the Mediterranean Sea. These impacts include habitat damage, where oil spills significantly harm both shoreline and intertidal zone habitats, leading to long-term ecological changes and biodiversity loss. The study also notes that oil components can bioaccumulate in marine organisms' tissues, leading to biomagnification in predators at higher trophic levels, which disrupts food webs and ecosystem health.

To find particular hotspots I conducted searches on Google Scholar, Newcastle University Library, Science Direct, and Google using keywords such as "recent small oil spills" and "mysterious spills." I believe that the data I have collected is comprehensive and definitive, but it provides only a fraction of the true picture. This search revealed the following list of small-scale and mystery oil spills across the world:

- “Mysterious Oil Sheens in the Gulf of Mexico” (2012): In 2012, multiple reports of oil sheens were observed in the Gulf of Mexico (Morandin & O’Hara, 2016). Thousands of small oil spills were destroying the Gulf of Mexico (Huang, et al., 2019). These sheens appeared without any apparent source or identifiable responsible party. The U.S. Coast Guard conducted investigations, but the origin of the sheens remained unknown (CNN, 2012; Futurism, 2016).

- “Gulf of Mexico Tar Balls”: After the Deepwater Horizon oil spill in 2010, tar balls, small clumps of weathered oil, continued to wash up on Gulf Coast beaches for years. These tar balls were often attributed to residual oil from the spill and natural seepage, but it was challenging to determine their exact sources (Kennicutt, 2017). Minor oil spills are often more numerous than reported through the examination of satellite images, oceanographers have discovered that small oil spills in the extensively drilled northern Gulf of Mexico are frequently more extensive than what is officially reported. The findings were presented at the Gulf of Mexico Oil Spill and Ecosystem Science Conference in New Orleans, Louisiana (Schrope, M, 2013).
- According to Hyder et al., (2017), aerial surveys conducted in the North Sea reveal an annual observation of 500 to 1,200 oil spills. These surveys also suggest that 73–88% of the spills are smaller than 1 m^3 in size.
- “Mystery Oil Spills in Nigeria's Niger Delta”: The Niger Delta region in Nigeria has experienced numerous oil spills, including smaller-scale incidents with unknown sources. Due to illegal oil bunkering, sabotage, and inadequate maintenance of oil infrastructure, small oil spills can occur without immediate identification of the responsible party (Onyena & Sam, 2020).
- “Red Sea, Israel” (2021): In February 2021, an oil spill was reported in the Red Sea off the coast of Israel. Investigations suggested that the spill originated from a ship passing through the area, leading to concerns about marine life and coastal ecosystems (Cohen, 2021)
- “Mystery Oil Spill off Australia's Coast” (2009): In 2009, a mystery oil spill occurred off the coast of Queensland, Australia. It resulted in oil slicks washing up on beaches in the area. Despite investigations, the exact source of the spill was never determined, leaving it classified as a mystery spill (The Guardian, 2009).
- “Unexplained Oil Sheens in the Mediterranean Sea” (2016): In 2016, several incidents of unexplained oil sheens were reported in the Mediterranean Sea. These sheens were observed on the water's surface but could not be linked to any specific oil spill or source. Authorities conducted investigations, but the exact cause of the sheens remained unclear (EMSA, 2023).
- The illegal discharge of oily waste from ships is an important source of oil

spill pollution in the Bohai Sea in China (Liu, et al., 2021).

- “Unattributed Tar Balls in the Caribbean”: Tar balls have occasionally been found on beaches in the Caribbean without a clear source or origin. These tar balls may result from various factors, including natural seepage, historical spills, or illegal discharges from ships passing through the region (Warnock, 2015).
- “Mystery Spills in California”: Along the California coastline, small oil spills or sheens have been reported without clear sources. These incidents have often been attributed to various factors, such as natural seepage, illegal discharges from ships, or residual oil from historical spills. Identifying the specific origin of these spills has proven difficult (Svejkovsky, et al., 2016).
- “Mystery spills in UAE”: An oil slick has been observed along a 3km stretch of coastline on Kalba beach from unknown sources (Haza, 2020). The occurrence of oil spills is commonly associated with vessel activities, particularly during tank cleaning procedures where residual substances are flushed into international waters. The resultant black sludge inevitably reaches the shoreline, inflicting harm upon marine life and ecosystems. (Yaghmour et al., 2022; Haza, 2020).
- " Mystery spills in Oman": An oil spill has been documented, indicating the presence of oil along Musandam beaches by unknown sources. The incident'sdetails and characteristics, such as the extent of the spill, the type of oil involved, and potential environmental impacts (Saleem, et al., 2021; Times of Oman, 2017).
- “Unknown Oil spills in Iran”: The predominant source of oil pollution in the northern and southern regions of the Persian Gulf has been attributed to shipping activities. Notably, chronic oil spills arising from ballast water washing and oil platform operations persistently contribute to environmental contamination (Mokhtari et al., 2015; Ebrahimi-Sirizi & Riyahi-Bakhtiyari, 2013).

From this list, it can be inferred that small-scale oil spills occur frequently both globally and in the Gulf region but only a few of these spills are reported, and they are primarily left to natural processes for clean-up, such as evaporation or dispersion. Participants KI-11 (representing Daba Mansupality), KI-30 (representing the UAE),

and KI-34 (representing Iran) jointly asserted that *"small-scale oil spills are primarily concentrated in the eastern sector of the Strait of Hormuz, including regions such as Musandam in Oman, the eastern territories of the UAE, and the southeastern areas of Iran"*. In contrast, there is a relatively lower occurrence of small-scale oil spills in other Gulf countries, specifically in the western waters of the Strait of Hormuz as KI-6 (from the Musandam Coast Guard) noted *"a relatively lower occurrence of small-scale oil spills in the western waters of the Strait of Hormuz"*. This disparity in small-scale oil spill occurrences within the Gulf region is attributable to three reasons. First, the eastern section of the Strait of Hormuz witnesses a higher volume of maritime traffic, with numerous oil tankers and cargo ships navigating through this area, increasing the risk of accidents leading to oil spills according to KI-30 (a UAE responder) said *"The Port of Fujairah facilitates the import and export of substantial shipments of fuel oil and crude oil, making it a preferred choice for numerous vessels. Due to the high demand as most ships prefer to dock at Fujairah Port rather than other ports, the anchorage area becomes congested, leading to ships being compelled to wait outside this designated zone"*. Second, in the western waters of the Strait of Hormuz states uphold stricter regulations and enforce more robust measures for maritime safety and environmental protection, resulting in fewer instances of oil spills, as KI-8 (a Navy participant) states " *The* [western] *waters of the Arabian Gulf [Persian Gulf] are characterized by their shallow depths and house naval bases equipped with satellite radars. As a result, the majority of ships and vessels refrain from disposing of debris into the* [western] *Arabian Gulf [Persian Gulf]*". Third, in the western waters, enhanced satellite monitoring discourages illegal discharges by ships before passing through the Strait of Hormuz, further reducing the likelihood of spills (Nezhad, et al., 2018).

6. The seriousness of the small oil spills in Musandam

The international organizations and governments in the Gulf have shown limited concern for small-scale marine oil spills. This is primarily due to the perception that these spills often evaporate or disperse in the middle of the ocean without reaching the coastline. However, the situation is different for areas like Musandam in Oman, the eastern part of the UAE, and the southeast of Iran. These regions are situated along

international waters, within 12 nautical miles from the coastline. As a result, most oil spills in these areas do reach their respective beaches, particularly in Musandam, which is densely populated and located close to the Hormuz Strait. These frequent small spills have had a major impact on the local community residing in the affected areas. For example, on the Musandam Peninsula, it is regarded as a normal part of summer and beach life (UNIP, 1982) for children from local villages who play on the sandy beaches to come home with tar on their feet and hands which contains toxic substances. FGD-4 said:

> *"The issue at hand is that our houses in Kumzar village are situated in closeproximity to the beach. As a result, the entire community, including both adults and children, is significantly impacted by oil spills. The pervasive smell of the oil spills permeates our houses, adversely affecting our respiratory systems. The inhalation of these noxious fumes poses a health risk and can lead to respiratory complications"*.

Small-scale spills also damage the fishing sector in Musandam. Many fisher respondents in Musandam gave first-hand accounts of the harm that small scale oil spills have inflicted on them. For example, KI-51 (a Khasab fisher) said about the negative impact of small-scale oil spills that *"the most damage is that we couldn't catch fish because the fishing gears was damaged by oil"*. KI-58 (a fish trader) said *"fishermen had some diseases like skin allergies by oil spill"*. According to KI-53 (a diver) *"we cancelled many trips when oil spills had occurred or changed to other places where no oil spill, we threw out the contaminated diving equipment by oil spills which can't be cleaned".* The fishing communities have limited chances to participate in alternative livelihood activities, and they seldom have any additional sources of income. Oil spills in Musandam have also caused losses in tourism subsectors such as accommodation, transportation, guides, and recreational fisheries (Badri & Sedaghat, 2017). KI-66 (a hotel manager) said *"oil spills have affected the tourism sector directly as we have had many tourists cancelled their reservations when they have been informed about the oil spill".*

Decision makers and governments generally perceive that the majority of oil spills fall within the category of small-scale pollution, which is measured internationally under 7 tonne according to the MARPOL 73/78 Convention. However, the under 7 tonne is quite arbitrary as it is difficult to accurately measure the quantity of oil spilled in the ocean because oil can quickly spread out and be carried away by ocean currents. However, the 7 tonne is set by the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC) and the International Maritime Organization (IMO).

The impacts of small-scale oil spills do not fundamentally differ from those of large-scale spills, in that, despite their smaller size, small-scale spills can still have detrimental effects on the environment, wildlife, and local communities, as the above respondents in Musandam testify - all of them were referring exclusively to small or medium size oil spills. The release of even a relatively small amount of oil can contaminate water bodies, disrupt ecosystems, and harm marine life and human livelihoods (Mokhtari, et al., 2015). The effects can be long-lasting and may require extensive clean-up and remediation efforts. Therefore, it is essential to address and mitigate small as well as large oil spills to protect the environment and minimize socio-economic harm.

7. Mystery spills

Mystery oil spills refer to instances of oil contamination in the marine environment where the exact source and cause of the spill are unknown or difficult to determine. These spills often occur unexpectedly, without clear identification of the responsible party or the circumstances leading to the release of oil (Owens, et al., 2016). The occurrence of mystery oil spills introduces challenges to response and remediation efforts, given that the absence of information about the source can impede the implementation of effective mitigation measures. This hindrance arises from the difficulty in obtaining compensation and financial support in the absence of clear attribution (Mafiana, et al., 2021). In cases where the source of the spill is not known, identifying the type of oil that has been spilled, the amount of oil released, and the potential effects on the environment and wildlife can be difficult. Additionally, the

uncertainties surrounding these spills cause problems in attributing responsibility and seeking compensation for the damages caused (Krestenitis, et al., 2019).

Although the source of mystery spills, by definition, is hard to track, the fact of mystery spills is easier to authenticate. For example, Bernhard, et al. (2022) stated that by using publicly accessible satellite imagery, vessel-tracking data, and machine learning, experts successfully pinpointed over 1,500 possible instances of illicit dumping on a global scale between July 2020 and December 2021. Likewise, Paddison, et al. (2022) reported that ships are regularly discharging bilge water secretly in an illegal manner, and they concluded that the number of cases of commercial ships dumping oil into European waters could be as high as 3,000 per year. Approximately 140 oil spills were identified by Oman's Environment Authority as caused by unknown vessels between 2008 and 2019 in the Musandam Peninsula: on average, this means more than one mystery spill per month. However, FGD perceptions suggest there are many more mystery oil spills on the Musandam coast than are officially recorded because fishermen and local people do not report them all to the authorities for example, according to FGD-7, *"the frequency of oil spills in the area has become so commonplace that local residents perceive them as 'normal.' The majority of these incidents are characterized by their small scale, and there is a notable deficiency in awareness regarding reporting procedures".*

In the current study, several international participants commented on the issue of mystery spills. For example, KI-42 (an international participant) said "*data from mystery spills is very hard to compile*". According to KI-28 (a regional participant) *"the Gulf region has experienced a total of 17 mystery oil spills between 2010 and 2019 by unknown sources. These spills were caused by various incidents including collisions, explosions, sinking, military action, intentional discharges, and leakage. Notably, the main cause of these oil spills has been identified as tankers"*. However, based on the observations and estimations of the local community in Musandam, the actual number is likely to be considerably higher. The local community has stated that a high proportion of mystery spills remain unreported to the environmental authorities in the region. KI-50 (A Kumzar fisherman) *said "mystery oil spills have occurred in the area sometimes two or three times a month"*. KI-30 (from the UAE) stated:

"I will be talking about pollution in the eastern coast of the UAE or in the Emirate of Fujairah. The main concern is the unknown source of oil pollution or untraceable oil spills or pollutions that eventually end up into our shores. Operational oil spills or known source of oil spills are not a big concern, because we can handle them and we have certain techniques to deal with them, but the main concern is those unknown oil spills".

Issa, (2010) revealed through statistical analysis that nearly half (48%) of the oil spilled offshore the UAE resulted from illegal discharge by moving vessels. Issa's study detected over 600 possible oil spills from satellite images covering around 800 kilometers of the West and East coasts of the United Arab Emirates. The analysis focused on slick detection, slick statistics, satellite imagery, slick types, and the significance of the study.

In Oman, interviewee KI-12 (an Oman Environment Authority official) stated, *"the number of reported mystery oil spills fluctuated between 2008 and 2019 in Musandam area according to the Environment Authority annual report, but in general, the actual number of small-scale oil spills is likely to be higher than reported"* (see Figure 3.3). He said, *"it is likely that the official numbers underestimate the frequency of spills because of shortage of staff, remoteness of villages in Musandam; and rough sea conditions".*

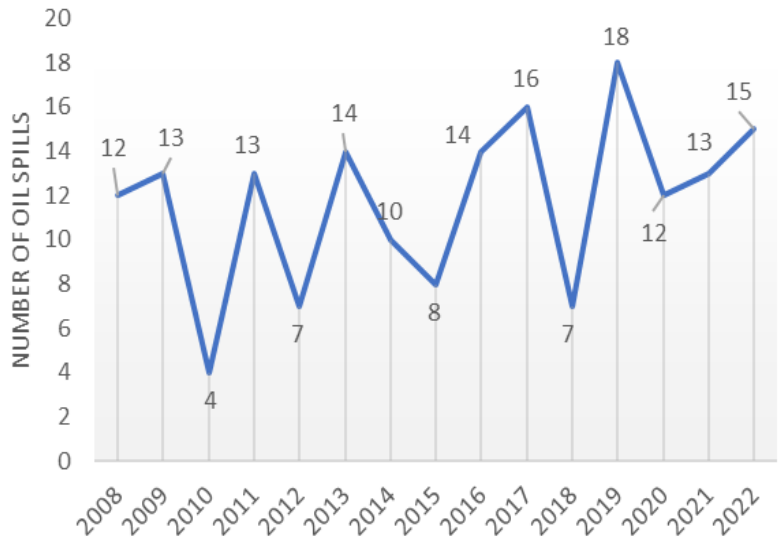

Figure 3.3 The extent of reported mystery oil pollution between 2008 and 2022 in the Musandam Sea Area using official data provided by a member of staff in the Environment Authority. .

One example of mystery oil pollution in Musandam is described by KI-12 (an Omani government respondent) as follows:

> *"In October 2019, fishermen informed Environment Authority (EA) via the hotline number of the Pollution Operation Monitoring Centre complaining about oil pollution in their village "Doursany Khawr" beach in the form of black oil spread across the sea in several locations. This beach is considered one of the most important fishing areas, with an abundance of fish. Cleaning the affected areas involved employing the Royal Air Force of Oman and the Royal Navy of Oman to monitor the quantities of pollution and to identify the source of these pollutants by using a CASA plane and Navy ships. Samples of pollution were taken for analysis in order to discover the type of oil and the carbon fingerprint. EA coordinated with Khasab Municipality and volunteers to provide equipment to clean the affected beach and coordinated with the Royal Oman Navy to transport equipment and individuals to the beach, as there is no road, but only sea access to that beach. A diving exercise was carried out by volunteer divers to extract bitumen from coral reefs and get rid of oil pollutants in the surrounding area. However, Oman did not find out which vessel was responsible for this oil pollution and therefore has been unable to obtain compensation for the costs of its clean-up operation. So, the cost of clean-up operations and environmental rehabilitation was paid by Oman government".*

According to KI-38 (a regional participant from UAE), *"mystery oil spills have shown a higher frequency during the summer season in comparison to the winter season".* This observation aligns with the experiences shared by fishermen in FGD-1, who reported that "*oil spills predominantly occurred during the summer months. In these instances, the spilled oil tends to dissolve in the sand on the beach, resulting in a longer-lasting impact that can persist for several months. On the other hand, during the winter season, oil spills were described as freezing and sinking into the water"*. The reasons for this seasonal pattern are not yet fully understood, and further research is needed to explore the underlying factors contributing to this phenomenon. The increased occurrence of mystery oil spills during the summer highlights the need for enhanced monitoring and surveillance measures during this period to promptly detect

and mitigate any potential environmental impacts, because of their impact on the tourism industry.

There is some evidence that the frequency of discharge oil waste and dumping in the waters of Strait of Hormuz has been on the rise (Akbarzadeh-Chomachaei, et al., 2023). According to the majority of fisher respondents in Musandam mystery oil spills are on the rise. For example, KI-49 (a Kumzar fisher) stated that *"I have experienced mystery oil spills many times in the area and the latest one was in Dorsani in 2019, Sabita, Kumzar and other neighbouring villages. These villages were polluted many times a year and become sometimes black in color… The oil spills are increasing year by year"*. Likewise, interviewee KI-52 (a Shaboos fisher) said *"oil spills by unknown sources are increasing year by year. In the past the oil spills were a little…*[because] *the cargo ship and oil tankers were not as many as now".*

On the other hand, some fishers said mystery spills were decreasing in frequency. For example, FGD-9 stated that "*mystery spills are decreasing nowadays, but in the past, we faced many about twice a week"*. These contrasting opinions among fishermen regarding the frequency of mystery spills in the Musandam area can be attributed to several factors: not all of them are full-time fishermen; they vary in the number of their fishing trips, the specific fishing methods used, and the areas where they fish. All these factors can vary their exposure to oil spills and the extent of the impact on their livelihoods.

8. Photographic evidence of oil spills on Musandam coasts

During my field visits to Musandam to conduct interviews with fishermen in various marine villages, I documented the environmental conditions firsthand. Among the sights captured through my camera lens were the distressing images of rocks and beaches marred by the accumulation of oil and tar balls. These photographs serve as poignant visual evidence of the ecological impact of pollution on coastal ecosystems (see Figure 3.4 Photos dated on 16 March 2022).

Figure 3.4 provides examples of oil spill leakage along the Musandam shoreline (Source: the author).

Further visual evidence of oil seepage along the Musandam shoreline, is depicted in the pictures below which were provided by the Environment Authority. These images vividly illustrate the potential environmental impact of such leakage which, washed up marine oil pollution destroys the landscape of the beaches (see Figure 3.5). However, on Musandam Peninsula, it is so common that it is regarded as a normal part of summer and beach life and children from local villages who playing on the sandy beaches come home with tar on their feet and hands (see Figure 3.6).

Figure 3.5 shows two examples of leakage from oil spills in the Musandam shoreline (Dorsany village) that threaten the environment and marine life [Source: Environment Authority, Sultanate of Oman].

Figure 3.6 Children play on the sandy beaches come home with tar on their feet and hands in Kumzar village. Picture taken by local community given to the Environment Authority on 24 May 2018

In addition, Numerous oil spills have been identified through satellite imagery captured by Sentinel-1A and MODIS Terra, which are provided by MEMAC, in the past years. These findings have been communicated to the Oman Environment Authority for further action. For instance, a recent observation on October 1, 2023 revealed oil pollution spreading across a significant area measuring 186 square kilometers, with a maximum length of 72 kilometers using Sentinel-1A and MODIS Terra (see Figure 3.7).

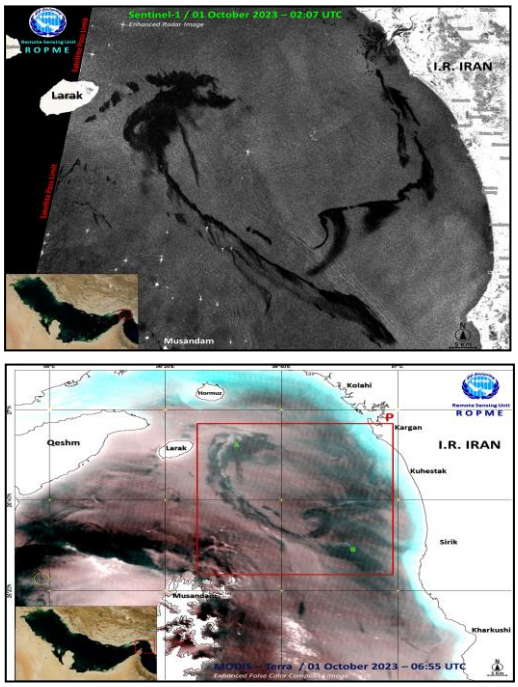

Figure 3.7 shows the oil pollution spread over a total surface area of 186 Sq Km, with a max length of 72 Km and a max width of 13.8 km. (Source: MEMAC)

Furthermore, the imagery detected crude oil present in three distinct patches of dark color, which were observed spreading east of the Haffah, Limah, and Khatmah coasts in Musandam area (see Figure 3.8). This oil spill, covering a total surface area of 8 square kilometers, occurred on September 14, 2023, and is likely the result of deliberate discharge from a navigating oil tanker or marine vessel during transit. Such detailed observations underscore the ongoing challenges posed by maritime activities.

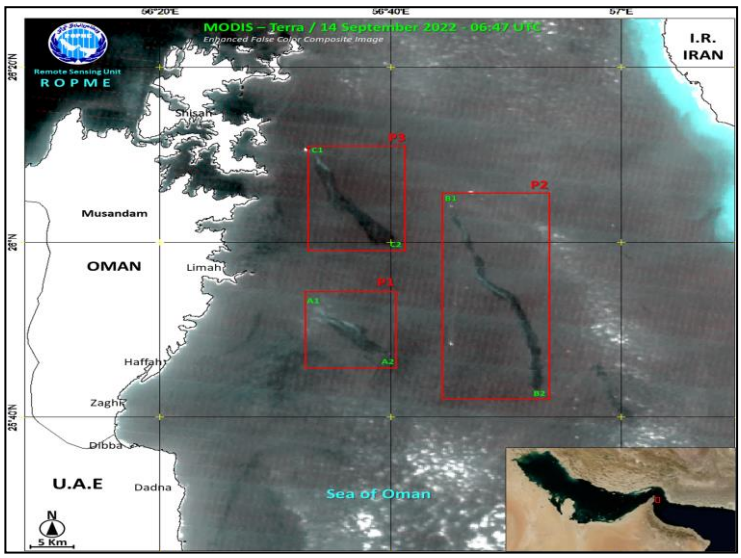

Figure 3.8 shows oil pollution in three disconnected patches of dark color spread east of Haffah, Limah, and Khatmah coasts over a total surface area of 8 KM (Source: MEMAC)

The fact of the matter is that mysterious oil spills continue to occur frequently along the coasts of Musandam, the eastern coast of the Emirates, and the southeastern coast of Iran. These spills are attributed to the proximity of these areas to the vital Strait of Hormuz, which serves as a major passage for ships and marine tankers. These vessels often engage in the illegal discharge of oily liquids into the seawater before entering the Persian Gulf region.

9. Discussion

The majority of respondents, including those from international, regional, and Omani government perspectives, perceive a decline in the occurrence of large-scale oil spills due to improved regulations, better safety measures, and greater awareness among the industry and the public (Li, et al., 2019). However, they also observe an increase in the frequency of small-scale spills as mystery spills. Fishermen and local communities in Musandam have not encountered any major oil spills originating from known

sources within the Musandam area in recent years, but they have experienced numerous mystery spills in the vicinity throughout the 21st century, varying in size from small to medium spills. There appear to be more mystery spills in the eastern part of the Strait of Hormuz than in the western part because ships and tankers release oil waste before entering the Strait. This practice may be driven by the fact that the area after passing the Strait is relatively enclosed and better monitored by radar systems deployed by surrounding countries (Yaghmour, et al., 2022).

Andrews, et al., (2021) stated that the primary concern for fishermen lies in addressing the challenges posed by small-scale mystery spills, while international and regional organizations tend to concentrate their efforts on tackling large-scale oil spills (Zhang, et al., 2021). This divergence of priorities can create tensions among the stakeholders involved in oil spill responses. Fishermen and local communities perceive a lack of representation in decision-making processes and feel their concerns are not being adequately addressed (Thoya, et al., 2022). There is a perception that international and regional organizations prioritize the interests of large corporations over the well-being of local communities (Kearney & Hilborn, 2022). This perception can strain relationships and hinder effective collaboration among the various stakeholders, which undermines the important role that fishermen and other local communities can play in reporting spills and helping responders identify areas that may be impacted by oil.

10. Conclusion and Recommendations

In conclusion, this chapter has provided an overview of the extent of the problem of oil spills and the shift of attention that has occurred in recent years from large-scale to small-scale spills. The research emphasises the crucial distinction between large-scale oil spills, which are decreasing in number; relatively easy to attribute to the spillers; and usually compensated by the polluters and international funds; and small-scale mystery spills, which are increasing in number; very hard to trace to polluters; and rarely compensated.

There are three main findings, First, the majority of participants are agreed that the occurrence of large-scale oil spills has decreased over the years on a global scale. This decline can be attributed to improved safety and prevention measures in the oil

industry, including enhanced regulations and enforcement, advances in technology and monitoring systems, increased awareness of environmental risks, and improved response capabilities (Chen, et al., 2019). Second, although some international and regional stakeholders have reported a decrease in small-scale spills, most local observers have highlighted an increase in them. For example, participants from Musandam, Eastern UAE, and Southeast Iran, which are situated along the East of the Strait of Hormuz, have pointed out that these regions have experienced a growing number of small-scale spills. This discrepancy in perceptions can be attributed to the fact that many small-scale spills do not reach the shore or evaporate before causing significant harm. The consequences of these spills are particularly concerning for the local fisheries and fishermen who rely on the coastal ecosystems for their livelihoods (Salem & Ghouniem, 2022; Gracia, et al., 2020). They also pose a threat to the marine environment and its resources, highlighting the need for effective prevention and mitigation measures (Zhang, et al., 2019). Third, based on first-hand accounts, it has been noted that all the spills that occurred in local areas were classified as mystery spills. These spills are characterized by the inability to attribute them to a specific source or vessel. Despite efforts to identify the responsible party, invariably no single source is definitively identified when these oil spills occur. It is important to highlight that these mystery spills vary in scale, ranging from small to medium spills (de Oliveira, et al., 2021). Even though they may not reach the magnitude of large-scale spills, they still pose a serious threat to the local fishing industry and the income derived from fishing activities (Ferreira, et al., 2022).

Based on the findings of this chapter, ten recommendations are suggested for improving the response to oil spills that apply not only to the Musandam area but also to many other countries that face same problem:

1. It is important for all stakeholders to acknowledge the persistent issue of small-scale oil spills and work collaboratively to address the root causes and develop comprehensive solutions.
2. The regulatory framework in Musandam requires strengthening by increasing penalties for violators and improving enforcement mechanisms to make the polluter-pays-principle work.

3. Greater efforts in surveillance, monitoring, and prevention are needed to minimize the occurrence of these mystery spills in Musandam.
4. Collaborative actions involving local communities, government agencies, and other relevant stakeholders can help raise awareness about the importance of responsible oil handling practices and facilitate the implementation of measures to mitigate the economic and environmental impacts of these spills.
5. Promotion of public awareness by campaigns to increase knowledge of the risks and impacts of oil spills and to encourage public participation in spill prevention and response efforts will help to alleviate the problem.
6. Raising awareness among vessel operators about responsible oil waste disposal practices is essential.
7. Enhanced cooperation among countries in the region to address the transboundary risks posed by oil spills is another necessity.
8. Conducting regular drills and exercises to test the effectiveness of spill response plans and ensure that response teams are well-prepared to handle spills will also help.
9. Continuing the region’s policy, which aligns with the International Maritime Organization's (IMO) Oil Pollution Preparedness, Response, and Co-operation (OPRC) guidelines, to mandate the reporting of oil spills of 50 barrels or more within the state.
10. Enhancing and strengthening the existing Port State Control Memorandum of Understanding (PSC MOU). Such tools are essential as they give the state the full legal right to inspect the ships and their logs and investigate all the ships’ safety certificates, crew certificates, oils and places of waste discharge.

By implementing these recommendations, Musandam can be better prepared to prevent, respond to, and mitigate the impacts of spills on its marine ecosystem.

This chapter detailing the extent of the problem of marine oil spills contributes to the overarching argument of the thesis, which focuses on obtaining compensation for damage caused by unidentified or mystery vessels' oil spills and on methods for oil spill remediation. By explaining the substantial environmental and economic repercussions of mystery spills in Musandam, Eastern UAE, and Southeast Iran, this chapter underscores the importance of mitigating these impacts.

In short, the chapter lays the groundwork for the thesis's central argument by highlighting the complexity of oil spill impacts, shedding light on the evolving nature of spills, particularly the rise in small-scale mystery spills in specific geographic regions. The next chapter continues the argument by investigating the complex issues raised by the problem of oil spill remediation.

CHAPTER 4. The issues of remediation

1. Introduction

The primary objective of Chapter 4 is to explore the methods available for oil spills remediation. Because of the substantial environmental and economic impacts that oil spills can cause, it is crucial to mitigate these impacts effectively (Ewim, et al., 2023). Mechanical techniques such as booms, skimmers, and sorbents have been widely utilized to treat large-scale spills, whereas natural forces including wave and wind action, evaporation, and biodegradation have been relied upon for dispersing small-scale spills (Hoang, et al., 2021). Both these strategies play valuable roles in reducing the environmental consequences and promoting the restoration of impacted areas. Section 2 of the chapter examines the effectiveness of different methods for oil spill remediation, critically evaluating both man-made techniques and natural dispersal in cleaning up oil spills. Section 3 investigates four categories of remediation problems – technical; logistical; financial; and political. Section 4 presents a case study of remediation issues in Oman in general and Musandam in particular. Section 5 concludes the chapter with a summary of the findings; a discussion of their policy implications; and a statement of 16 recommendations for improving the cost effectiveness, technical efficiency, and socio-economic sustainability of oil spill remediation practices.

2. Assessing the Effectiveness of Oil Spill Remediation Methods

This section evaluates the effectiveness of three methods of remediation employed to deal with marine oil spills – mechanical, chemical, and natural.

2.1 Mechanical Methods

Mechanical methods play a crucial role in the clean-up of oil spills as they are widely employed for the containment, recovery, and removal of spilled oil from the environment (Dhaka & Chattopadhyay, 2021). One method involves deploying physical barriers, such as booms, which are filled with air for buoyancy, to contain and prevent the spread of oils (Dhaka & Chattopadhyay, 2021). Skimmers are then employed to skim the oil from the water surface, sucking oil stains trapped by booms, and they are supported by tanks or containers for collecting oils (Ndimele, et al.,

2018; ITOPF, 2014b). Skimmers can be either vessels equipped with specialized equipment or floating devices that efficiently collect the oil (Hoang, et al., 2021). Containment and skimming can be effective in removing large quantities of oil, especially in calm waters with favorable weather conditions. Another mechanical method of remediation is sorbent materials that absorb oil: absorbent pads, booms, and specially designed polymers are deployed to soak up the oil (Board, 2022). These materials can be effective in removing oil from the water surface or shoreline. A third mechanical technique is in situ burning which involves igniting the oil on the water surface, allowing it to burn in a controlled manner (Fingas, 2018). This method can be effective for removing large quantities of oil quickly though it is only suitable for certain types of oil and specific spill scenarios because it can generate air pollution and produce residue that requires further cleanup.

The efficacy of mechanical methods in oil spill clean-up, aiming for a sustainable approach, is contingent upon four critical factors, as supported by various studies:
Timing: Early response emerges as a pivotal factor influencing the success of mechanical methods. Swift deployment of equipment and resources is essential to contain and recover oil promptly, preventing its spread and reducing the complexity of mitigation efforts. This aligns with findings from research on oil spill response strategies, emphasizing the significance of rapid intervention to minimize environmental impact (Mamozai, et al., 2024).

Spill Characteristics: The type of oil and its viscosity play a crucial role in determining the effectiveness of mechanical methods. Research by Azizian, & Khosravi, (2019) highlights the importance of tailoring clean-up techniques to the specific properties of the spilled oil. Different oils present varied challenges, requiring tailored approaches for efficient removal.

Environmental Conditions: Weather, currents, and waves exert considerable influence on the efficiency of mechanical methods. Adverse conditions, such as rough seas and strong winds, can impede containment and skimming efforts. In contrast, calm conditions are more favorable for successful clean-up operations. These findings are consistent with studies emphasizing the impact of environmental factors on oil spill response strategies (Li, et al., 2022).

Scale of the Spill: The magnitude and extent of the oil spill significantly influence the feasibility and efficiency of mechanical methods. Large-scale spills demand substantial resources, equipment, and manpower to achieve effective clean-up. Research by Li, et al., (2016) underscores the challenges posed by scale in oil spill response efforts, emphasizing the need for scalable and adaptable strategies.

According to KI-17 (an Oman Environment Authority official): *"the Environment Authority in Oman is equipped with various tools, capabilities, and equipment pollution such as booms, skimmers, dispersants, oil-absorbing materials, spraying devices for dispersed materials through ships and aircraft to combat oil pollution".*

By critically assessing these factors, drawing insights from diverse sources, and integrating findings from relevant studies, a more nuanced understanding of the complexities surrounding the effectiveness of mechanical methods in oil spill clean-up can be achieved.

2.2 Chemical Methods

Chemical methods, particularly the use of dispersants, are another approach to the artificial removal of oil spills. Dispersants are chemicals that are applied by aircraft or vessels to the oil slick to divide the oil into smaller droplets that can mix with the water and be subject to natural degradation processes by being exposed to microbial and chemical breakdown in the water column (Board, 2020; Farrington, 2013). Dispersants are most effective when applied early, during the initial stages of an oil spill, as they can prevent the formation of a thick surface slick and reduce the spread of oil (Hoang, et al., 2021). They are particularly useful for offshore spills where mechanical methods, such as skimming, are difficult because of distance or environmental conditions (ITOPF, 2014a). However, the use of dispersants also has limitations and may be less effective on certain types of oil, such as heavy or weathered oil, which may not readily disperse. The efficiency of dispersants can also be influenced by weather conditions, including wind, waves, and currents, which can affect the dispersant's contact time with the oil. Additionally, dispersants may have harmful environmental impacts, particularly on marine life and ecosystems (Osborne, et al., 2022; Ye, et al., 2021). The use of dispersants in oil spill response is subject to regulations and guidelines to ensure their safe and appropriate application. These

regulations often include provisions for monitoring and assessing the effectiveness and potential impacts of dispersants (Grote, et al., 2018).

Oman has not yet utilized chemical dispersants for oil spills in the sea, despite having them stored for long periods and having a specialized airplane available for applying these dispersants to the oil, with two key factors being the shortage of qualified personnel and stringent conditions associated with their use. The proper application of chemical dispersants requires a high level of expertise and training. The shortage of qualified personnel in Oman with specialized knowledge in handling and applying chemical dispersants may pose a significant challenge according to KI-02, (an Oman Environment Authority official): *"Oman possesses numerous dispersant tanks in storage. However, they have not been utilized to date due to stringent regulations governing their use in Omani waters, particularly in areas designated as sensitive and it's worth noting that there haven't been any oil spills to date".*

The use of chemical dispersants is subject to stringent regulations and conditions to prevent adverse environmental and ecological impacts. Oman's commitment to environmental protection and preservation may lead to a cautious approach in employing chemical dispersants. Stringent conditions may include factors such as specific environmental conditions, proximity to sensitive ecosystems, and adherence to international guidelines. The stringent regulatory framework ensures that the use of dispersants is carefully controlled and monitored. During oil spill drills, water is used instead by the plane to assess the efficiency of the equipment when simulating the process of pouring water over the sea. KI-16 (a Royal Air Force of Oman participant) stated that *"Oman has multiple planes dedicated to detecting and locating oil spills. This includes four CASA reconnaissance planes for monitoring and detecting oil spills, as well as four CASA aircrafts capable of transporting oil dispersants".*

2.3 Leaving Oil Spills to Nature

Leaving oil spills to nature, known as natural attenuation or natural recovery, is an approach where natural processes are relied upon to remove and degrade the spilled oil (Liu, et al., 2021). When oil is spilled into the environment, it undergoes physical and chemical processes that contribute to its breakdown. Wave action, wind, and sunlight exposure can cause the oil to disperse, spread, and evaporate. These natural

forces can break the oil slick into smaller patches, facilitating its natural breakdown over time. Additionally, exposure to sunlight and air can initiate chemical reactions that lead to the degradation of certain components of the oil (McGenity, et al., 2010). Also, microorganisms, particularly bacteria and fungi, can play an important role in the biodegradation of oil. Naturally occurring microbial populations can utilize the spilled oil as a source of energy and carbon, breaking it down into simpler compounds through metabolic processes. This natural biodegradation process can be influenced by factors such as temperature, nutrient availability, oxygen levels, and the type of oil spilled (Overton, et al., 2020).

International organizations generally tend to support natural remediation methods, favoring allowing spills to dissipate naturally. KI-45, (an International Maritime Organization participant), said "Any spill response will generate a significant volume of oiled waste, so obviously wherever *possible a natural process would be preferred because it's the least intrusive economically and environmentally."* In Musandam, natural remediation is the default approach because the local communities have limited awareness and understanding of mechanical and chemical remediation methods. Most residents are unfamiliar with the existence and usage of the equipment needed for these artificial methods, and so oil spills are typically left to natural processes unless they reach a large scale or directly impact local fishermen, prompting complaints to the government.

3. Four categories of problems of oil spill remediation identified by respondents

Following on from the above analysis, we can divide the issues of marine oil spill remediation discussed by KIs into four categories: technical; logistical; financial; and political.

3.1 Technical issues of remediation

This category addresses the complex technical issues involved in efficiently cleaning up an oil spill in Oman. One important technical issue is the shortage of trained personnel in oil spill remediation. The use of oil spill remediation techniques without proper training can have negative environmental consequences. As KI-41 (an UK and Ireland Spill Association interviewee) noted, "*Personnel expertise presents a*

significant challenge in oil spill remediation efforts" Experts are needed to ensure that remediation efforts do more good than harm. As KI-39 (an International IOPC Fund interviewee) said, "*Oil spill remediation efforts must always carefully consider the tradeoff between the benefits and the potential impact. For example, in situations where oil spills occur near sensitive areas like coral reefs, intervention with dispersants can sometimes lead to more harm than good, exacerbating the damage rather than mitigating it".*

Another important technical issue is monitoring and detecting oil spills. The establishment of a monitoring system in the Strait of Hormuz poses a technical challenge, given that it is an open sea area, making continuous surveillance a difficult task. KI-10 (Participant from Ministry of Agriculture & Fisheries Wealth and Water Resources) said:

> *"Constant monitoring of the seas is not feasible, and detection of oily waste discharge by ships can be accidental, either through Air Force planes or Royal Navy of Oman ships. At times, pollution may go undetected, leading to oil spills scattered along the shore. Monitoring throughout the day is a challenge, making it difficult to identify the source of pollution, and consequently, difficult to hold the violating ships accountable".*

KI-16 (Royal Air Force of Oman participant) said, *"Given the length of Oman's coastline, which stretches over 3,165 kilometers, it is not possible to maintain constant surveillance at all times".*

It is particularly difficult to identify the exact ship responsible for an oil spill. Collecting accurate and representative samples from the affected area can be challenging, especially in cases where the oil has dispersed or evaporated, while differentiating the specific source of the oil among numerous vessels passing through the area can be complex, as it requires extensive analysis and comparison of the collected samples with potential sources. KI-23 (a Sultan Qaboos University participant) explained that

> *"the dynamic nature of ocean currents and weather conditions can further complicate the identification process. The movement of oil spills over time and*

the potential mixing of oils from multiple sources can blur the individual fingerprint s, making it difficult to attribute the pollution to a specific vessel".

3.2 Logistical issues of remediation

The main logistical issue of remediation was cited by respondents to be coordination. According to KI-45 (a member of an International Maritime Organization), *"one big issue during any spill is…lack of coordination against environmental recovery and appropriate intervention".* Coordination problems include the practical tasks of organizing and conducting oil spill clean-up operations, such as the timeliness of response, resource allocation, transportation of equipment and personnel, and cooperation between the various stakeholders involved in the clean-up process. KI-22 (Maritime Security Center participant) claims, *"the Maritime Security Center established in 2013…plays a crucial role in coordinating national efforts to combat oil pollution".* However, although Oman boasts many bodies dedicated to addressing oil pollution, including the Environment Authority, Royal Oman Police, Royal Air Force, Royal Navy of Oman, Maritime Security Centre, and various oil companies, their collective potential is hindered by a dearth of centralized leadership and coordinated contributions.

One complication is that some authorities in Oman, such as the Oman Air Force and Navy, have primary responsibilities and duties that do not directly involve dealing with oil pollution incidents. They can play a crucial role in supporting and assisting during such incidents through their expertise and resources, such as providing aerial surveillance or logistical support. But cooperation and coordination among such authorities is a major task to ensure effective response and management of oil pollution incidents in Oman's waters. According to KI-16 (Royal Air Force of Oman participant), *"time constraints present a significant challenge in dealing with oil pollution incidents. Although the pollution may be reported promptly, our resources may be occupied with other tasks, with national security taking precedence. In some cases, the delay in responding to the report may diminish our chances of identifying and apprehending the polluter".*

In the case of Musandam, many respondents alluded to the lack of coordination among stakeholders, including the Environment Authority, Municipality Office,

Ministry of Agriculture and Fisheries, Military Authorities and local communities. As a result, each organization operates independently, with limited interaction despite the presence of several committees tasked with promoting collaboration. Two notable committees, the Maritime Security Center (MSC) and the Oman National Oil Spill Contingency Plan, bring stakeholders together in the event of oil spills. However, these committees are only activated when the source of the spill is identified, the spill is of significant scale, or an oil drill operation has taken place. Moreover, according to KI-5 (Oman Marine and Fishery Center participant), "*Random works between official authorities cause delays in completing tasks and pose challenges to the clean-up operation and the lack of clear guidelines and the independent nature of government work further exacerbate the delays the clean-up operation".*

One specific deficiency identified by many respondents is poor logistical procedures involved in transporting oil spill clean-up equipment from Muscat to Khasab, a distance of 600 km. This slows down the speed of clean-up operations. Local fishermen and residents say the lack of clean-up processes and equipment deployment in the Musandam area is a serious concern. According to KI-15 (Khasab Municipality in the Governor of Musandam participant), *"the location of the Musandam Governorate is geographically difficult, such as the presence of bays and rocks, and its distance from the mother capital, Muscat, which is located in the far north and is separated by the United Arab Emirates, which makes it difficult to transport equipment and materials necessary for the operation"*.

3.3 Financial issues of remediation

Financial considerations play a vital role in the successful implementation of oil spill clean-up efforts. These include budget allocations, resource expenditure, cost-effectiveness of remedial approaches and funding for long-term monitoring and restoration efforts. According to KI-26 (a private sector participant), *"The primary cost component of oil spill remediation encompasses containment and clean-up operations, including equipment deployment, labor costs, vessel/aircraft operations, and disposal of oil, debris, contaminated materials and waste management"*. The costs of remediation vary depending on the size and location of the spill, the type of oil involved, and the extent of the environmental damage (Ndimele, et al., 2018). The immediate costs involve containing and cleaning up the spilled oil, assessing and

monitoring the environmental impacts, and restoring affected ecosystems (Udechukwu & Jonah, 2020; Kontovas, et al., 2010). There are also immediate administrative costs. Oil spill remediation involves legal and administrative processes that can incur heavy expenditure. This includes costs related to compliance with regulatory requirements, obtaining necessary permits, engaging legal counsel, and fulfilling reporting obligations. Legal expenses may incur liability claims, compensation to affected parties, and potential fines or penalties (Opaluch, 2020).

In addition, there are long-term costs for restoration and rehabilitation activities aimed at mitigating the future ecological impacts of the oil spill. These costs cover the implementation of measures to restore affected ecosystems, such as shoreline clean-up, habitat restoration, reseeding of oiled areas, and reintroduction of wildlife. Restoration and rehabilitation expenses may also include ongoing monitoring and research to assess the recovery progress and adjust restoration strategies as needed (Solo-Gabriele, et al., 2021). According to KI-10 (a government participant), *"financial support should also be provided to restore and rehabilitate the marine environment; However, I have not previously heard about any financial support being provided to restore and rehabilitate the marine environment"*. Also, there may be significant long-term economic and social impacts associated with oil spills. For example, local economies that depend on fishing or tourism may suffer protracted impacts that can be difficult to quantify in monetary terms.

These financial burdens become more challenging when oil spills cannot be traced back to their sources. In such cases, governments find it difficult to solely shoulder the costs associated with cleanup efforts, detection measures, environmental restoration, addressing economic repercussions, and managing public health concerns. When spills are untraceable, the responsibility for managing and mitigating their impacts often exceeds the capacity of governments to handle them independently, particularly in regions like Musandam where small-scale spills are relatively common and usually not traceable to the polluters. According to KI-2 (an Oman government official) the main problem is *"the financial support required to* [remediate]… *but in the case of unknown source, no financial support available".* Likewise, KI-14 (another Oman government official) said the problem is *"providing financial resources, as most of these oil spills are of unknown source".* This lack of financial

support can leave affected communities and ecosystems struggling for years to recover from the environmental and economic impacts of oil spills.

Three additional considerations are worth bearing in mind in relation to the cost of remediation. First, the extent of remediation measures that are chosen is a matter of policy. Remediation is on a continuum, and governments choose where they place themselves on that continuum. As KI-39 (An international participant) stated, '*The very concept of clean-up is contested, ranging from getting rid of every trace of oil to no action at all if oil does not reach land".* Second, the cost of remediation can be substantial. For example, remediation of oil spills in Musandam is expensive. According to KI-16 (an Oman government official),*"Oman has multiple planes dedicated to detecting and locating oil spills …* [But] *conducting surveys using these planes can be quite expensive, with costs ranging between £5,000 to £8,000 per hour, which includes operational costs, fuel, and maintenance".* Third, it is important to remember that the costs of not taking action to address an oil spill can be even higher than the costs of taking action (Watson et al., 2019).

3.4 Political issues of remediation

Political issues of remediation can be divided into domestic and international categories. Domestic political issues comprise the dynamics of decision-making in Oman that may have an important impact on oil spill remediation in Musandam. It includes factors such as public awareness, regulatory frameworks, political will, and engagement of various stakeholders including government agencies, environmental organizations, and affected communities. KI-13 (an Omani government participant) highlighted that "*the public, including fishermen, and social media channels play a pivotal role in raising awareness and expediting the oil remediation process*". The lack of public awareness about the sources and potential risks and impacts of oil spills was made clear by FGD-05 (Dorsany fishers), who said:

> *"… for the past 50 years of living in the area, they have consistently observed oil along the coasts and in the open sea. They noted that the sources of this oil remain unknown to them, aside from presuming it originates from passing ships disposing of waste …… and not receiving any warnings about the hazards posed by these oils or guidance on proper disposal methods".*

Inadequate understanding among the public about the importance of prompt reporting, proper disposal of hazardous materials, and adherence to preventive measures can contribute to the escalation of oil spill incidents (Chen, et al., 2019). Additionally, limited public engagement in oil spill response and decision-making processes can impede the implementation of comprehensive and community-centered remediation strategies (Dosemagen, & Gehrke, 2017). Educating the public about the risks and impacts of oil spills is essential for fostering a culture of environmental stewardship. Engaging local communities, fishermen, and stakeholders in oil spill response planning and involving them in monitoring and reporting incidents can contribute to early detection and rapid response (Walker, et. al., 2015).

International political issues comprise Oman's relations with other countries, principally Gulf countries, and with international organisations such as MEMAC and IOPC. The interconnected nature of the Gulf region poses a significant challenge to oil spill remediation and the seeking of compensation. When an oil spill occurs in the waters of one country, it has the potential to quickly spread and impact neighboring nations due to shared waters and currents. According to KI-36 (The UAE's Permanent Representative at the International Maritime Organisation participant), *"another problem is the Gulf countries are connected to each other, which allow for the rapid spread of oil spills between them".* This creates a complex situation where many countries may be affected by an oil spill, requiring coordinated efforts for effective containment, cleanup, and restoration. The process of seeking compensation for damages can also become complicated, since if the spill crosses international borders, it involves different legal jurisdictions and protocols. The primary issue here lies in the fact that each country tends to handle oil spill incidents independently, which can lead to fragmented efforts and limited sharing of resources and expertise. This lack of coordinated response hinders the effectiveness of oil spill remediation in the region. According to KI-34, a regional participant, *"each country in the Gulf tends to manage oil spill incidents independently, particularly in cases of small-scale and mystery spills. However, it was noted by Iran government that some countries face challenges due to limited resources and expertise in their efforts".*

The Gulf countries already have the Kuwait Regional Convention and its Protocol, aiming at the cooperation and coordination that is obliged to work under this

instrument. However, it seems Member States and the Convention Secretariat are not meeting their obligations towards this essential legally binding instrument.

Addressing oil spills that occur across borders, therefore, necessitates international cooperation and collaboration among many countries and stakeholders. According to KI-45 (a member of an international organisation), *"oil spill clean-up is a very expensive undertaking, which is why the international compensation regime is indispensable for countries faced with a significant oil spill"*. The open nature of the ocean allows oil spills to easily traverse national boundaries, highlighting the need for coordinated efforts to mitigate the environmental and economic consequences.

The expansive and interconnected nature of the open ocean creates a scenario where oil spills can effortlessly cross national boundaries (Solo-Gabriele, et al., 2021). This underscores the critical importance of coordinated efforts among countries to effectively mitigate the environmental and economic consequences associated with such incidents (Ivshina, et al., 2015). Given the fluidity of ocean currents and the extensive reach of marine ecosystems, a spill in one region can swiftly impact neighboring nations. Addressing the impacts of transboundary spills necessitates a collaborative and collective response. The nature of spills that cross national borders demands coordinated efforts from the affected countries and relevant international bodies. Recognizing the interconnectedness of environmental systems and the shared responsibility for safeguarding ecosystems, a joint approach becomes imperative. This collective response involves information-sharing, resource pooling, and cooperative strategies to mitigate and manage the consequences of transboundary spills. Through effective collaboration, nations can enhance their preparedness, response capabilities, and the overall resilience of affected regions, fostering a shared commitment to environmental protection and sustainable management (Chazot, & Rhodes, 2017).

This underscores the importance of international cooperation and liability frameworks to ensure efficient and comprehensive oil spill remediation. KI-47, an international participant, said *"dealing with oil spills, especially those that extend across borders, typically requires collaboration and coordination among multiple countries and stakeholders. Transboundary spills pose unique challenges, as they require international cooperation to effectively address the environmental and economic impacts"*.

There is another factor: the high cost of remediation makes it important for countries to share the financial burden. According to KI-45 (a member of an international

organisation), *"oil spill clean-up is a very expensive undertaking, which is why the international compensation regime is indispensable for countries faced with a significant oil spill".*

In the Gulf region, international collaboration on remediation is coordinated by MEMAC, which is the working arm of ROPME (MEMAC, 2014). According to KI-28 (a regional organisation official), *"the Marine Emergency Mutual Aid Center* (MEMAC) *which is the working arm for the ROPME (Regional Organization for the Protection of the Marine Environment), coordinates among the Member States and cooperate whenever any Member States requested any information or help or support them with the combating team or salvage within the Persian Gulf or Sea of Oman".* MEMAC and ROPME each have their own roles but they complement each other. KI-28 points out that MEMAC's role is not to prevent oil spills from happening but to mitigate their effects: "*But they never prevent the oil spill pollution in the area only manage it to reduce and limit negative impacts as far as possible".*

In addition to the regional collaboration between Gulf states, there are several global organizations that play a vital role in assisting countries across the world (including the Gulf) during oil spill incidents, facilitating efficient clean-up operations. These organizations collectively contribute to the global efforts in oil spill preparedness, response, and environmental protection (Chen, et al., 2019). They not only provide advice and technical expertise but also offer crucial resources and equipment for effective remediation efforts. Among the most prominent organizations in this field are the International Oil Pollution Compensation Funds (IOPC), and the International Tanker Owners Pollution Federation (ITOPF). KI-42 (an ITOPF participant) said *"The main purpose of ITOPF is to provide technical expertise, assistance, and training for oil spill preparedness, response, and damage assessment from tankers and other maritime sources".* KI-40 (an international interviewee) said "*the Oil Spill Response Organizations (OSRL) is a third-party company that has members in many countries".*

4. Case study of remediation of oil spills in Oman

During the last ten years, there have been six serious oil spills in Omani waters – in 2013, 2017, 2018, and 2019 (three incidents). The 2013 spill was dealt with in cooperation with IOPC (IOPC Fund, 2022). According to KI-2 (an Oman government official),

> *"An example of oil pollution in Oman was the 856 GT tanker Nesa R3,* [which] *sank approximately 1.4 nautical miles off the Port Sultan Qaboos, on 19 June 2013…. Because Oman is party to the 1992 CLC and the 1992 IOPC fund Convention, the Omani authorities informed them about the Nesa R3 incident. The Nesa R3 carried less than 2,000 tonnes of persistent oil as cargo. The 1992 IOPC fund Executive Committee made payments of compensation in respect of admissible losses arising out of the Nesa R3 incident toward clean-up operations and people who worked in during the incident. The claim was for a payment of a total of OMR 3,521,364 and BHD 8,419 (USD 9,169,333.24)".*

The 2017 oil spill was dealt with by the Omani government alone, fining the culprit. KI-2 said,

> *"This is the case of the tanker, Georgios in 2017, fishermen from Daba Wilayat reported to the Ministry that oil pollution on their fishing grounds. Immediately, the Royal Air Force of Oman was informed, and a CASA plane was sent to the reported place) and caught the Georgios which had deliberately released oil into the sea. Then, the Oman government issued the owner a fine of OMR 50,000 (US$129880)".*

The first 2019 spill was the Pink Rose incident which, again, was dealt with alone by the Omani government fining the owner: KI- 17 (an Oman official participant) said

> *"The vessel was found discharging oil waste into the water while parked in a designated waiting area at sea. As a result, the Omani government imposed a fine of OMR 10,000 (US$26,000) on the owner of the vessel as a punitive measure for the violation".*

The second 2019 spill was dealt with by contact with the P&I Club. According to KI-26 (a service provider participant),

> *"…in November 2019 an oil slick was observed as a result of collision between the tanker Viviana and the bulk ship Ji mei shunhao, at the Port of Fujairah anchorage, in the UAE. The quantity of 340 m3 of gross contamination and collection of oiled debris was removed from the beaches, some of which ended up a few kilometers away at Shinas (Abu Baqara - Shinas' shoreline) on the Omani coastline. The claim was for a payment of a total of OMR 120,012.868 (USD 311,748,55) and the Oman government issued the owner a fine of OMR 10,000 (US$26,000)".*

The third 2019 spill (which occurred in Musandam) was by an unknown source, and Oman did not receive compensation from any organisation. According to KI-12 (an Oman government official),

> *"In October 2019, fishermen informed Environment Authority (EA) via the hotline number of the Pollution Operation Monitoring Centre complaining about oil pollution in their village "Dorsany Khawr" beach in the form of black oil spread across the sea in several locations. This beach is considered one of the most important fishing areas, with an abundance of fish. Cleaning the affected areas involved employing the Royal Air Force of Oman and the Royal Navy of Oman to monitor the quantities of pollution and to identify the source of these pollutants by using a CASA plane and Navy ships. Unfortunately, the source of the spill was not found. Samples of pollution were taken for analysis in order to discover the type of oil and the carbon fingerprint . Then, EA coordinated with Khasab Municipality and volunteers to provide equipment to clean the affected beach and coordinated with the Royal Oman Navy to transport equipment and individuals to the beach, as there is no road, but only sea access to that beach. A diving exercise was carried out by volunteer divers to extract bitumen from coral reefs and get rid of oil pollutants in the surrounding area. However, Oman did not find out which vessel was responsible for this oil pollution and therefore has been unable to obtain compensation for the costs of its*

clean-up operation. So, the cost of clean-up operations and environmental rehabilitation was paid by Oman government".

In Musandam, the above response to the 2019 Dorsany spill was not typical, because in general oil spill remediation in the governorate appears to be ineffective. As per the consensus among the majority of interviewees, as emphasized by FGD-4, *"oil spills in Musandam have not been cleaned up quickly and effectively but left to nature and only addressed if they were large, not small, spills".* In such cases, fishermen would bring the issue to the attention of the government, which would then mobilise relevant authorities in Musandam with the available resources to clean up the spills. This is what happened in the case of the Dorsany spill.

Remediation efforts have been sporadic for three reasons. First, the authorities do not always have the necessary equipment and resources to effectively contain and clean up spills in time as this equipment is located in the capital, Muscat, which is 600 km from Musandam. Second, the Oman government focuses its attention on the few large-scale spills rather than the many small-scale spills, as KI-16 (an Oman government official) explains*: "all the major accidents* [were] *cleaned quickly and effectively, but the minor ones especially in Musandam haven't been cleaned as it required budgets to do it. Also, the repetition of spills in Musandam makes it difficult to clean up these spills".* Third, most of the oil spills in Musandam are mystery spills and therefore compensation for clean-up work is unlikely to be forthcoming. This inhibits efforts to mobilize resources for oil spill cleanup efforts and causes delays or incomplete cleanup efforts, KI-12 (Environment Authority Musandam participant) said, *"untraceable oil spills are left to natural forces to clean up unless they threaten the beaches, presumably because no compensation for clean-up can be expected"*. Where polluters cannot be identified, affected communities and ecosystems are left struggling to recover from the environmental and economic impacts of oil spills. When the government does take action, the Oman government and other Gulf countries prefer to deploy mechanical rather than chemical equipment to contain and clean up oil spills. According to KI-14 (an Oman government official) *"this method can be effective in containing and removing oil from the water and is better than leaving it to nature since Natural factors affect the environment badly because it transfers this pollution to the beaches and leads to distortion of the general landscape".*

5. Conclusion and recommendation

In summary, this chapter has examined oil spill remediation methods with a specific focus on Oman and Musandam. It has explored the problems associated with these methods and assessed the effectiveness of remediation techniques. The chapter has also investigated the coordinated efforts required and the financial implications associated with remediation. The findings of the study reveal the substantial local damage inflicted upon Musandam due to unidentified small-scale spills for which compensation has been unobtainable. This unfair situation highlights the absence of accountability of the polluter and the disproportionate burden placed on local inhabitants, including fishers and small diving center businesses, who bear most of the clean-up costs. Governments cannot always bear the full cost of clean-up efforts on their own, particularly in regions like Musandam where spills are relatively common. Under the pollution pays principle, the responsibility for funding clean-up and recovery efforts should fall on the polluters, but this rarely happens in Musandam. Fishermen and local communities in Musandam perceive they are subject to inequitable treatment, economic marginalization and cultural patronization.

Respondents in Musandam contend that resolution of this pattern of discrimination lies in collaborative efforts between the government, governorate authorities, and local communities who must work together to establish more effective mechanisms for funding and coordinating oil spill response and remediation efforts according to KI-04 (A participant of Ministry of Transport, Communications and Information Technology) said that *"there is a need for collaborative efforts involving the government, governorate authorities, and local communities. These entities must work together to establish more effective mechanisms for funding and coordinating oil spill response and remediation efforts".* This could include insurance policies or funds specifically designed to cover the costs of spills, as well as improved regulation and enforcement to ensure that oil transportation companies are held accountable for their actions (Billah, 2011). To address this challenge, it may be necessary to explore alternative funding sources for oil spill clean-up efforts, such as partnerships with international organizations or private sector corporations. Additionally, investing in improved technology for oil spill clean-up and increasing preparedness and response planning could reduce the overall cost and duration of clean-up efforts (Ishak, et al., 2020). Also, the storage of mechanical equipment within the Musandam area would

ensure preparedness for a speedy response to oil spill emergencies. The interviewees also suggested public awareness campaigns and education programs to inform local communities about the risks and impact of oil spills on the marine environment.

These findings provide 16 recommendations for policymakers in Oman:

1. Strive to minimize the adverse impact of oil spills on Musandam communities. While eliminating oil spills may be unattainable, it is possible to mitigate the risk of leakage by strengthening safety standards.
2. Establish a fair compensation mechanism that upholds equity between claimants.
3. Address the inter-generational implications of oil spills in the ocean. Acknowledge that the effects of oil spills may endure for hundreds of years, impacting not only the present generation but many future generations.
4. Ensure clear and transparent communication with local communities affected by oil spills regarding the distribution of compensation. This transparency is essential to empower local individuals in making informed decisions for themselves.
5. Establish storage facilities in Musandam for clean-up equipment near high-risk areas. This will ensure quick access to booms, skimmers, and dispersants, reducing response time in the event of an oil spill.
6. Provide training for oil spill responses, including conducting regular programs to educate and train individuals to effectively use mechanical and chemical equipment to contain and clean up oil spills efficiently and minimize environmental damage.
7. Create a dedicated fund to support the oil spill remediation process. This fund could be used to cover the costs of equipment, clean-up operations, environmental assessments, and compensation for affected parties. Having a dedicated fund ensures that financial resources are readily available for prompt and effective response to oil spill incidents.
8. Enhance coordination among stakeholders, including the Environment Authority, in the Musandam region. This is crucial for the proper implementation of the National Contingency Plan to ensure effective environmental management and response.

9. Encourage industry stakeholders to adopt best practices, invest in research and development of spill response technologies, and ensure proper maintenance and inspection of infrastructure to prevent spills.
10. Empower stakeholders in the sector with greater authority and access to technical information regarding the transboundary movement of oil. This is part of the proper implementation of the Oil Spill National Contingency Plan and the OPRC Convention, to which Oman is a party. Addressing these gaps will mitigate financial impacts and strengthen the overall effectiveness of oil spill response and management.
11. Regularly exercise of the Oil Spill National Contingency Plan through both field and tabletop exercises. These exercises will ensure that all elements of the National Contingency Plan—such as surveillance, information and data exchange methods, equipment deployments, documentation, and claims processes—are thoroughly covered and effectively implemented.
12. Strengthen international agreements and protocols and regional collaboration. Encouraging Oman to implement international agreements, such as the International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC) to which it is a party, will enhance cooperation and standardize response measures. Although the Gulf countries already have the Kuwait Regional Convention and its Protocol, aiming at the cooperation and coordination that states are obliged to work under, the Member States and the Convention Secretariat are not meeting their obligations towards this essential legally binding instrument. Regional response networks and frameworks can facilitate coordination among neighboring countries and improve preparedness and response capabilities.
13. Improve information sharing and capacity-building. Developing platforms for the timely exchange of information, best practices, and lessons learned can help bridge knowledge gaps and build response capacities among countries.
14. Encourage community engagement and support. Involving local communities in decision-making processes, providing information, and ensuring their voices are heard can help address their concerns,

facilitate equitable distribution of resources, and support socio-economic recovery.

15. Invest in advanced monitoring systems, early warning systems and the use of the drone. Implementing sophisticated monitoring systems that utilize satellite imagery, remote sensing, and other state-of-the-art technologies to detect and track oil spills in Omani waters will help identify the sources of oil spills and track the responsible vessels, enabling faster response and aiding in holding offenders accountable for their actions. They are reliable techniques and promise to provide good evidence for legal claims against spillers.
16. Promote research and innovation. Investing in research and development of advanced technologies and methods for oil spill detection, containment, and cleanup will minimize environmental impacts.

Implementing these 16 recommendations would greatly improve the fairness of treatment, long-term planning, meaningful public participation, and transparent communication in addressing the problem of oil spills in Musandam.

This chapter has contributed to the overall argument of the thesis by highlighting the issues of remediating the damage of oil spills. The next chapter follows on by focusing on the problem of obtaining compensation to pay the costs of remediation.

CHAPTER 5. The subject of compensation

1. Introduction – the context of compensation claims

This chapter focuses on the issues of liability and compensation for contemporary ship-source oil pollution. The case study is marine oil pollution in Musandam, a northern coastal area in Oman, and the main objective of the research is to critically examine the current arrangements for making marine polluters liable for the damage they do and processing claims for compensation against them. In many cases where the source of the spills is known, the financial resources earmarked for clean-up operations predominantly stem from international organisations such as the IOPC Fund and P&I clubs. These collaborative efforts are designed to ensure that the necessary funding is available to facilitate and support comprehensive remediation efforts following an oil spill incident, thereby restoring affected ecosystems, safeguarding livelihoods, and preserving environmental integrity (Yang, 2017).
However, the situation is entirely different where the source of a spill is not known. Obtaining compensation for untraceable oil spills is extremely difficult, if not impossible in most instances because pinpointing a specific source or responsible party is exceptionally challenging. This lack of attribution makes it difficult to establish legal liability, a fundamental requirement for pursuing compensation claims (Afenyo et al., 2023). This is the case in Musandam, where the sources of nearly all oil spills are untraceable. As a result of this deficiency in oil spill compensation, Musandam fishermen are paying from their own pockets to clean up oil spills on the beach in order to make it suitable for their fishing methods.

Section 2 of this chapter examines the role of international organisations in relation to liability and compensation for oil spills. Section 3 provides an overview of the regional framework for obtaining compensation for oil spills in the Gulf region. Section 4 investigates national arrangements for dealing with compensation for oil spills. Section 5 explains Oman's structure for pursuing compensation in response to environmental incidents. Finally, section 6 provides a summary of the chapter's findings, followed by a discussion of their policy implications, and the presentation of 10 key recommendations aimed at enhancing the effectiveness, efficiency, and sustainability of oil spill compensation procedures.

2. International Organisations

Many international organisations have dealt with the issues of liability and compensation for damage caused by marine pollution (Jacobsson, 2007). Sands & Peel (2012) claimed that the polluter pays principle established the obligation of the polluter to bear responsibility for causing pollution and for the cost of remediation, including cleaning the environment and restoring it to its original position – costs which are determined by the polluted country. How far this obligation has been honoured is more questionable, but it is true that international agreements have addressed civil liability and compensation claims for damage caused by marine pollution from ships (Molenaar, 2007; Billah, 2016). There are two kinds of international organisations that deal with compensation for oil spills – international conventions and private insurance corporations. Of the former, the International Maritime Organization (IMO) has led the moves to establish some of these agreements, including the 1969 Civil Liability Convention for Oil Pollution Damage (CLC) and the 1971 International Fund Convention (IFC). According to KI-39 (an international participant), "*With the support of IMO, the late 1960s and early 1970s marked the initial establishment of a global legal system for compensating damages from oil pollution*". Of the latter, the Protection and Indemnity (P&I) clubs are the most prominent, serving as mutual insurance associations to provide third-party cover for the operation of ships.

2.1 International conventions

There are four international conventions dealing with oil pollution compensation (Basedow & Magnus, 2007): (1) the 'International Convention on Civil Liability for Oil Pollution Damage (CLC); (2) the 1992 Protocol to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND 1992); (3) the Supplementary Fund Protocol, 2003; and (4) the Bunker Convention (Marano & Noussia, 2020).

2.1.1 The International Convention on Civil Liability for Oil Pollution Damage (CLC)

The CLC was established in 1969, and its Protocols of 1976 and 1992 emerged as a response from the international community to the unprecedented oil spill of the SS Torrey Canyon oil tanker off the west coast of Cornwall, England in March 1967

(Chetty, 2015). The 1969 CLC and its protocols were subsequently amended by the adoption of the 1992 CLC (Yang, 2017) which provided for a system of compulsory liability insurance and laid down a principle of strict liability for ship-owners (Yang, 2017) (see section 2.2). There are 116 member states of the 1992 CLC which applies to oil pollution damage resulting from spills from laden tankers suffered in the territorial sea of a Contracting State (Jacobsson, 1995). The only criterion for its applicability is where the damage occurred: the flag state of the tanker and the nationality of the ship-owner are not relevant for determining the scope of application of the Civil Liability Convention. The ship-owner is, under certain conditions, entitled to limit their liability under the amendment to CLC in 1992: the limited liability for small ships (5,000 tonnage or below) is US$ 6.3 million, while for larger vessels with a tonnage between 5,000 and 140,000 tonnages, it is US$ 6.3 million plus US$ 882 for each additional unit of tonnage beyond 5,000. Currently, in no case shall any amount of compensation exceed US$ 125.4 million (Kontovas et al., 2010).

2.1.2 1992 Protocol to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND 1992)

The 1992 Protocol established the International Oil Pollution Compensation Fund (IOPC Fund) to provide compensation for oil pollution losses that occur in member states' waters due to tankers' oil spills. According to Anyanova, (2012), it is an effective organization, providing additional funding when the amount payable by the ship owner and their insurance cover is insufficient to cover all of the damage Although established under the auspices of IMO, the Fund is an independent legal entity according to KI-41 (UK and Ireland Spill Association participant) said ' According to KI-41, (a participant from the UK and Ireland Spill Association) stated that *the IOPC is an efficient organization that offers supplementary funding in cases where the ship owner's insurance coverage is inadequate to cover the entirety of the damages'* . Only States may become Members of the IOPC Fund, which is an intergovernmental organisation outside the United Nations though it follows systems which are similar to those of the UN.

The IOPC contributions are based on the amount of oil received during the relevant calendar year, and they cover expected claims together with the costs of administering

the funds (IOPC, 2020). According to Gamassa, (2022), the IOPC funds are financed through levies imposed on anyone who has received in the relevant calendar year more than 150,000 tonnes of crude oil or heavy fuel oil in the ports or terminal installations of a member country after carriage by sea (IOPC, 2020). This is an example of the beneficiaries pays principle. These levies are based on reports of oil receipts from individual contributors that are submitted to the secretariat by the governments of member states (IOPC, 2020). Governments are not responsible for these payments unless they voluntarily accept this responsibility.

KI-39 (an IOPC fund participant) explained:

> *"The purpose of the IOPC Fund is to pay compensation to member states who have suffered oil pollution damage caused by oil tankers in cases where no liability arises under the CLC as the ship-owner is protected by one of the CLC exemptions, or the ship-owner is financially unable to meet the CLC obligations and the available insurance coverage is insufficient, or the damage exceeds the ship owner's CLC liability".*

According to the IOPCF Claims Manual, the Fund will not pay compensation if the claimant cannot prove that the damage resulted from an incident involving one or more ships as defined in the Conventions (IOPC, 2021). Claimants may be individuals, partnerships, companies, private organisations or public bodies, including states and local authorities. The IOPCF provides additional funding when the amount payable by the ship owner and their insurer is insufficient to cover all the damage (Soto-Onate & Caballero, 2017).

Billah, (2014) stated that the limitation of liability of ship owners and the level of compensation provided–by the IOPC Fund under the framework of CLC/Fund/ Supplementary Fund. The shipowner typically limits liability based on ship size. The 1992 Civil Liability Convention (CLC) governs liability for oil pollution damage:

- For ships up to 5,000 gross tonnage, the limit is 4,510,000 SDR (Special Drawing Rights).
- For ships between 5,000 and 140,000 gross tonnages, the limit is 4,510,000 SDR plus 631 SDR per additional ton.
- For ships over 140,000 gross tonnages, the limit is 89,770,000 SDR.

The 1992 Fund Convention, supplementing the CLC, provides up to 203 million SDR per incident. The 2003 Supplementary Fund Protocol, in effect since 2005, raises total compensation to 750 million SDR per incident is illustrated in Figure 5.1:

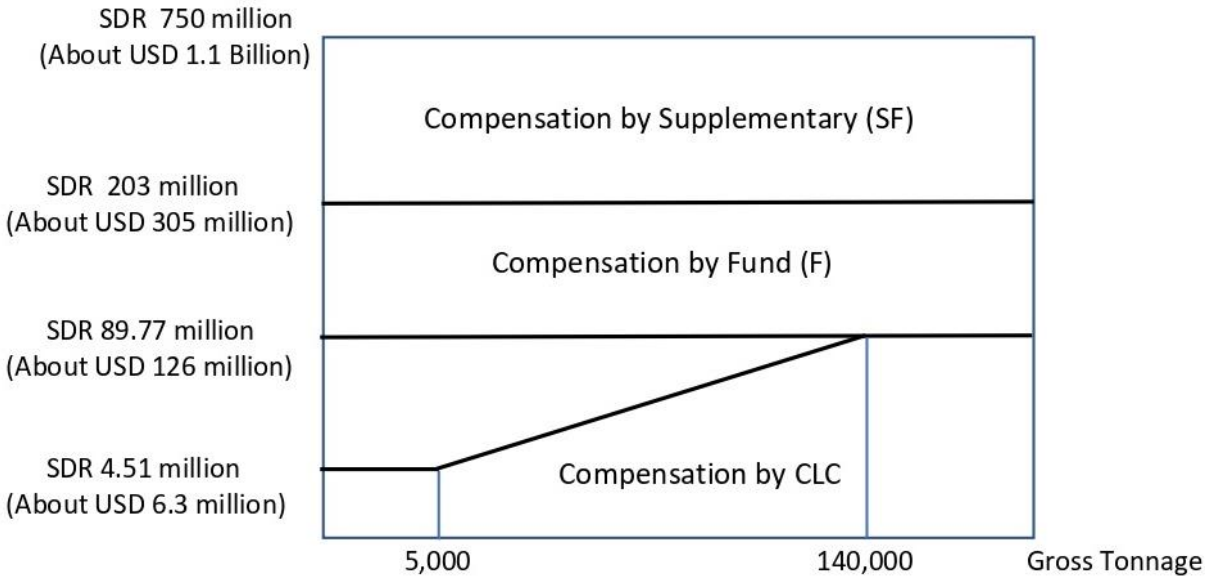

Figure 5.1 Limitation of Liability under CLC/Fund/ Supplementary Fund (Yang, 2017)

KI-39 (an international respondent) reported that *"In total, the IOPC Funds have dealt with 157 incidents and paid some £753.6 million as of 30 June 2023 (£331 million of which was in respect of the 1971 Fund)".* KI-39 provided a list of oil spill compensations obtained from the IOPC Funds for GCC countries (see Table 5.1) and reported that *"We had nine incidents in the Gulf Countries and in Oman we had two incidents in 2013 and 1994".* Table 5.1 shows that the compensation disbursed to Gulf Countries by the IOPC Fund.

Table 5.1 Compensation obtained from the IOPC Fund paid to the regional countries (source: IOPC Fund, 2023)

#	**Date**	**Incident Name**	**Flag State of ship**	**Place of incident**	**Area affected**	**Cause of incident**	**Quantity of spill (tonnes)**	**Compensation paid**
1	19.06.2013	Nesa R3	Saint Kitts and Nevis	Sultanate of Oman	Port Sultan Qaboos, Muscat,	Sinking	In excess of 250 tonnes	OMR 3 521 364 and BHD 8419
2	15.03.2003	Incident in Bahrain	Unknown	Bahrain	Bahrain	Unknown	Unknown	US$153 654 and BD 407 300

3	14.04.2001	Zeinab	Georgia	UAE	Dubai	Sinking	400	US$422 000 and Dhs 1 240 000
4	24.01.2000	Al Jaziah 1	Honduras	UAE	Mina Zayed, nearby islands and sand banks	Sinking	100-200	US$1 089 574 and Dhs 1 000 000
5	05.03.1998	Milad 1	Belize	Bahrain	Bahrain	Damage to hull	Unknown	BD21 168
6	07.01.1998	Pontoon 300	Saint Vincent and the Grenadines	UAE	Coastline of Sharjah, Ajman, Umm Al Quwain and Ras Al Khaymah	Sinking	8000	Dhs 7 978 483
7	30.03.1994	Seki	Panama	UAE and Oman	Fujairah and Sharjah coastline (UAE) and Musandam peninsula (Oman)	Collision	16 000	Nil
8	25.08.1987	Akari	Panama	UAE	Dubai	Fire	1000	Dhs 864 292 and US$187 165
9	26.12.1985	Rose Garden Maru	Panama	UAE	Umm al Qaiwain	Mishandling of oil discharge	Unknown	Nil

KI-29 (a regional participant) said *"We had an accident in 2003, and claims were submitted to the International Fund for Oil Pollution Compensation, and the required proofs, photos and analysis were submitted to the organization in order to obtain the necessary compensation for the damages and effects that occurred in the Kingdom. The total compensation was $153,854 and 407,300 Bahraini dinars".*

Several Gulf countries, notably the UAE, Saudi Arabia and Bahrain, have been successful in securing compensation for oil spills from the IOPC funds cases where

the responsible parties were identified, including incidents involving sinking, grounding, or explosions. According to KI-30 (a UAE participant), "*We were compensated many times".*

There are some rare cases where although no ship was ever identified, and the claimant could not prove that the spills were caused by ships as defined by the Conventions, the IOPC Fund nevertheless paid compensations for victims. These include the "Incident in the United Kingdom" in 2002 and the "Incident in Bahrain" in 2003. According to KI-29 (regional participant), the Bahrain case was an "*oil incident in 2003 when the oil was unloaded from one of the oil tankers, but it escaped. The claims were submitted to the International Fund for Oil Pollution Compensation, with proof of documents that spills were caused by oil tankers, including all costs and losses. The IOPC provided this compensation for all of us".*

2.1.3 The Supplementary Fund Protocol, 2003

The International Oil Pollution Compensation Supplementary Fund, 2003 (Supplementary Fund) was adopted in 2003. It provides extra compensation in circumstances where the protection afforded by the 1992 CLC and the 1992 Fund Convention is inadequate. One example of when the International Oil Pollution Compensation Supplementary Fund, 2003 (Supplementary Fund) was adopted is the Prestige oil spill incident in 2002. The Prestige, an oil tanker carrying 77,000 tons of heavy fuel oil, suffered a catastrophic hull failure off the coast of Spain, resulting in one of the largest oil spills in European waters (Chen, et al., 2019). The incident caused extensive environmental damage to coastal areas in Spain, France, and Portugal, leading to significant economic losses in the affected regions (Adshead, 2018). In response to the Prestige oil spill and similar incidents, the International Maritime Organization (IMO) adopted the Supplementary Fund in 2003. The Supplementary Fund provides additional compensation beyond the limits established by the 1992 Civil Liability Convention (CLC) and the 1992 Fund Convention in situations where the compensation provided by these conventions is insufficient to cover the damages caused by oil pollution incidents. This supplementary mechanism ensures that affected states and communities receive adequate compensation for the environmental, economic, and social impacts of oil spills, thereby enhancing the

overall effectiveness of the international regime for oil pollution compensation (Varsami & Tromiadis, 2018).

Under this Supplementary Fund, the total amount of compensation payable for any one oil spill incident for damage is SDR 750 million (about US$ 1.018 billion) for a State that is a member (Basedow & Magnus, 2007), including the amount payable under the 1992 Civil Liability and Fund Conventions (IOPC, 2020).

2.1.4 Bunker Convention

According to Gunasekera & Sathyadith, (2021), 'Bunker Oil' is defined as "any hydrocarbon mineral oil, including lubricating oil, used or intended to be used for the operation or propulsion of the ship, and any residues of such oil". Discharge of bunker oil is usually a deliberate act of cleaning out dirty residue from vessels' holds. The Bunker Pollution Convention was developed with the purpose of bridging the gap left by the CLC and the IOPC fund system with regard to oil pollution from bunkers, rather than to serve as an alternative to them (Linh, 2020). It covers strict liability for preventive measures/clean-up, damage to property, economic loss caused by contamination, and restoration of the environment (Hare, 2022).

Soto-Onate & Caballero, (2017) said the aim of the Bunker Convention is to guarantee that individuals who experience harm from oil spills, specifically when carried as fuel in ships' bunkers, have access to sufficient, swift, and efficient compensation. The UK has enacted domestic laws to hold ship owners, excluding those covered by the Civil Liability Convention, entirely accountable for pollution damage caused by bunker oil. Claimants are not required to demonstrate the shipowner's negligence.

Although different in their applications, these four conventions have many features in common. For example, they all apply primarily to spills in the waters of countries that have signed that convention (ITOPF, 2023). Also, claims for reimbursement of losses can be made under any of the conventions without the need to prove that the owner of the ship causing the pollution was at fault (ITOPF, 2022). Furthermore, they make it unnecessary for prosecutors to bear the expenses of seizing ships and implementing judgments after leakage accidents, which not only benefits claimants but ship owners also in that they can avoid delays in their trading schedules. The availability of these

systems to apply strict liability allows for a friendly solution of cases without litigation (Kesselheim et al., 2011). Features like strict liability, compulsory insurance, available funds (including Supplementary funds) and direct actions against insurance companies, benefit everyone (Chang, et al., 2014). There is, however, a time limit during which claims can be submitted (Safety4Sea, 2021). More importantly, there is one major gap in their collective coverage of incidents of pollution: they do not apply to oil spills caused by unknown polluters.

2.2 Private Insurance Corporations or P&I Clubs

The IOPC works closely with the Protection and Indemnity (P&I) Clubs, which are non-profit making private organizations controlled by ship owners and operators who communally indemnify certain third-party liability risks related to their businesses, especially their maritime businesses, in handling compensation claims (Dong, et al., 2015). P&I clubs offer an alternative option to the above Conventions for oil companies to protect themselves from crippling liability claims arising from accidental oil spills. P&I clubs insure the majority of tankers operating in international trade, providing insurance coverage of up to US$ 1 billion for compensation for damage by oil pollution from laden tankers as well as tankers in ballast (Singh, 2019).

The P&I Clubs are thus mutual insurance associations in the private sector that cover third-party liabilities relating to the use and operation of ships. P&I clubs provide cover for losses, claims, and damages arising from ship-sourced pollution damage, including oil pollution (bunkers and cargo), death and personal injury to passengers and crew, damage to fixed and floating objects such as terminals, gantry cranes, piers, wreck removal and cargo loss and damage (Weidemann, 2015; Gahlen, 2015). Coelho, (2023) states these clubs operate on a non-profit basis, with members pooling their resources to cover liabilities arising from third-party claims.

The International Group of Protection and Indemnity Clubs (P&I Clubs) comprises 13 mutual marine insurance associations which cover over 90% of world ocean-going tonnage and over 95% of ocean-going tankers (Al-Feky, 2018). P&I cover includes pollution damage from oil tankers, ship bunkers, hazard and noxious substances and costs of spill response measures (Varela Chouciño, et al., 2023; Mukherjee, et al.,

2013). P&I clubs have been active in the maritime industry for over a century, serving as a crucial component of risk management for shipowners (Theocharis, et al., 2018). P&I clubs play a vital role in maintaining the stability and sustainability of the global shipping industry by effectively managing and mitigating liabilities. Their expertise in maritime law, claims handling and risk management makes them a cornerstonnee of the maritime insurance landscape.

By contrast to the Conventions which primarily focus on liability for oil pollution damage caused by spills from tankers, P&I Clubs offer a broader range of coverage, not only for oil spills but also for a wide array of liabilities related to shipowners, charterers, and operators (Al-Feky, 2018). Another contrast is that the liability limits set by the Conventions are based on the tonnenage of the tanker, whereas the coverage limits provided by P&I clubs are typically higher and can be tailored to meet the specific needs of the shipowner or operator (Yu, 2023; Neacsu, 2011).

According to KI-42 (an international participant):

> *"The P&I Clubs support spill management by taking leading roles in cleanup process, facilitating third party claims including appointment of claims adjusters, specialist experts, handling, assessment and payment of claims, arranging funds to ensure timely payment of claims, media management and appointment of specialist counsels where necessary. Further, the Club provides advice and assistance on contractual arrangements through The International Group, conducts training and seminars, and participates in emergency drills and developing major response plans. Thus, the P&I Clubs' play a significant role in addressing the marine environmental damage through spills by providing expert resource and experience in handling pollution damage claims, arranging prompt security / payment of compensation to victims and coordinating with the State and other stakeholders in pollution incidents".*

3. Regional arrangements for Gulf Countries

There are several conventions at the regional level, especially among some European countries such as the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic, known as OSPAR and the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean Sea against

Pollution (the Barcelona Convention) (Feizabadi, 2018). These regional conventions were established to regulate pollution from activities in the marine environment that include sources of pollution derived from seabed activities (Carpenter & Kostianoy, 2018). However, none of them covers compensation to be paid for damages caused by mystery spills according to KI-30 (regional participant): *"We do not provide financial compensation to regional countries. Instead, we can engage with relevant organizations such as the IOPC Fund and P&I Club to explore compensation options if the source of oil pollution is identified. Generally, our assistance involves logistic support and coordination among the involved parties*".

In the Middle East, the regional arrangements are threefold. As Almutairi, (2016) showed, the coastal States of the Gulf Region with the assistance of UNEP developed the following three legal documents which were adopted at the Regional Conference of Plenipotentiaries on the Protection and Development of the Marine Environment and the Coastal Areas, held in Kuwait from 15 to 23 April 1978:

a) Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, 1978.
b) Protocol concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency, 1978.
c) Kuwait Action Plan (KAP) for the Protection and Development of the Marine Environment and the Coastal Areas, 1978.

3.1 Kuwait Convention

The first and third documents are known as the Kuwait Convention, which was adopted by the eight Gulf states to protect the Gulf marine environment from pollution (Khan, 2008). The Kuwait Convention, which is among the initial non-UNEP administered regional seas organisations, established a system of regional coordination to address issues of pollution triggered by oil alongside other dangerous chemicals (Alshemmari, 2021). Stressing the necessity for regional coordination and cooperation to protect the Gulf's marine environment for the satisfaction of all engaged parties, article III, entitled "General Obligation of the Kuwait Convention", states that the signatories shall jointly and/or individually consider all the relevant

strategies to combat, abate, and avert marine environment contamination in the sea area (Marsden, 2017).

Three additional Protocols have since been adopted as recommended by the Kuwait Action Plan's (KAP) legal component (Alshemmari, 2021): the Protocol on Marine Pollution Caused by the 1989 Continental Shelf Exploration and Exploitation; the 1990 Protocol for the Marine Environment Protection against Land-based Pollution; and the 1998 Protocol on Hazardous Waste and Other Waste Disposal and Marine Transboundary Movement Control. The Kuwait Convention on oil spills in the Gulf region effectively fostered regional cooperation among Gulf Cooperation Council (GCC) member countries, encouraging joint efforts to combat oil pollution. This collaboration aimed at preventing, preparing for, and responding to oil spills by facilitating coordination among signatory nations. Additionally, the convention served as a framework for member states, enabling the development of strategies, plans, and mechanisms for both preventing oil pollution and preparing comprehensive responses to potential oil spills (Aldosari, 2019).

However, the effectiveness of the Kuwait Convention has been called into question. For example, according to KI-28 (a regional organization participant), *"Despite the Kuwait Convention establishment, it encountered challenges in implementation, including financial constraints, differing national priorities, and disparities in technical capabilities among member nations"*. These obstacles have hampered effective coordination, hindering resource sharing, joint exercises, and the standardization of response protocols among the participating countries.

3.2 The Regional Organisation for the Protection of the Marine Environment (ROPME)

The second document led to the creation in 1979 of the Regional Organisation for the Protection of the Marine Environment (ROPME) in the Gulf Sea Area. The membership of ROPME comprises all eight Gulf states - Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

The Kuwait Convention established ROPME as a secretariat for the convention, which was signed on 23rd April 1978. MEMAC was established in accordance with the regional protocol that was a direct result of the Kuwait Convention, signed on

24th April 1978 (Naser, 2013) for which the member states adopted four protocols addressing marine emergencies, hazardous wastes, land-based activities and pollution from exploration and exploitation of the seabed. MEMAC, which was headquartered in Bahrain in 1983, plays a role in facilitating cooperation among states to combat oil pollution, as well as coordinating training, technological cooperation, and information exchange. Additionally, MEMAC provides member countries with a platform to develop and agree on regional treaties for transboundary movements and is responsible for coordinating efforts to deal with local pollution that affects multiple countries (Aldosari, 2019).

KI-28 (a regional participant) said:

> *"MEMAC's approach to dealing with incidents was outlined from verification of the incident, to collecting complete data about the incident, notifying and transmission of all data to all Member States, notifying local, regional and international private sectors working in the field of combating marine pollution to be on standby in case of necessity, continuous exchanging of incident data and follow-up., updating information about the incident status is continuously provided to all Member States, to putting and executing plans to avoid any similar incident".*

MEMAC, as the regional Protocol's secretariat, is the working arm of ROPME, and plays an important role in addressing environmental concerns, including mystery spills, for the Gulf countries. It offers a framework for cooperation, data sharing, and joint initiatives to tackle these challenges collectively. MEMAC can utilize satellite imagery and advanced technology for detecting and monitoring oil spills in the sea across its member countries (Zhao, et al, 2015; Al-Saqri & Sulaiman, 2014). It administers the ROPME Receiving Station and Satellite Imagery in Monitoring of Oil Pollution & Other Hazards in the ROPME Sea Area which was set up in 2003 to achieve early and accurate identification of oil spills, as well as detection and tracking of algal blooms (Alawadi, 2011). Satellite imagery is a valuable tool in identifying potential oil spills or other marine pollution incidents, providing an effective means of surveillance over large areas of the sea (Krestenitis, et al., 2019). KI-28 (a regional participant) pointed out that:

"ROPME has Receiving Station and Satellite Imagery in monitoring of oil pollution & other hazards in the ROPME Sea Area to achieve an early and accurate identification of oil spills will contribute towards the reduction of their impact on the marine ecosystem which was launched in Jan. 2003 and briefly outlined its capabilities".

However, the effectiveness of MEMAC in preventing significant marine pollution from oil activities and providing compensation is uncertain despite the fact that all the Gulf countries are signatories to it (Aldosari, 2019). There are question marks over the adequacy of resources allocated to it; the extent of cooperation between member states, the level of technical expertise available, and the implementation of agreed-upon strategies. Challenges such as financial constraints, divergent national interests, and variations in the technical capacity of member nations limit the efficacy of MEMAC in swiftly and comprehensively addressing mystery spills and providing compensation. According to KI-29 (a regional interviewee) "*Since 1998, there have been numerous oil spill incidents in the Gulf waters which were communicated with MEMAC. However, out of these, approximately* [only] *10 incidents have received compensation through arrangements facilitated by MEMAC, involving both the IOPC and P&I club*". Moreover, it is important to note that not all incidents identified through satellite imagery as "oil spills" are actually related to petroleum. For instance, occurrences like red tide, which are caused by algal blooms, can sometimes appear similar to oil spills in satellite images (Yekeen & Balogun, 2020).

3.3 The GCC Emergency Management Centre (EMC)

The GCC Emergency Management Centre (EMC) is an organization that operates within the Gulf Cooperation Council (GCC) nations of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (EMC, 2022). The EMC is overseen by the GCC Secretariat and employs professionals in emergency management from the region (Peterson, 2019). Its establishment was aimed at facilitating a well-coordinated and efficient response to emergencies and disasters in the area, which includes both natural and industrial accidents. Among the EMC's key objectives are the development of emergency management policies, plans, and strategies for the GCC region, along with coordinating exercises and training to

enhance emergency response capabilities. Additionally, the centre offers technical support and expertise to member countries in the areas of risk assessment, emergency response, and hazard mitigation (Shehata, 2016; Abdmouleh et al., 2015). According to KI-25 (a regional participant):

> *"The effectiveness of the GCC Emergency Management Centre (EMC) in managing oil spills in the Gulf is underscored by its multifaceted approach. It plays a key role through various mechanisms, beginning with its function as a hub for seamless communication and information exchange among GCC member nations during oil spill emergencies. This platform facilitates swift sharing of crucial data, knowledge, and expertise regarding oil spill incidents. Furthermore, in response to oil spills, the EMC aids in consolidating resources, specialized equipment, and technical expertise from member countries, assisting in the deployment of response teams and providing guidance on optimal containment strategies for efficient cleanup operations. Beyond immediate response, the EMC focuses on enhancing member states' capabilities through targeted training sessions and workshops, effectively equipping emergency response personnel and agencies to manage oil spill incidents adeptly. Additionally, the EMC contributes to the development of comprehensive policies, guidelines, and standardized procedures related to oil spill response, ensuring a unified and cohesive approach among GCC member nations. Moreover, through active collaboration with key stakeholders, including regional and international organizations, environmental agencies, and industry partners involved in oil spill management, the EMC fosters a collaborative and comprehensive strategy, further strengthening collective efforts in efficiently handling oil spill incidents within the Gulf."*

According to Aldosari (2019), the Gulf Cooperation Council (GCC) Emergency Management Centre (EMC) demonstrates its effectiveness in managing oil spills in the Gulf facilitating communication and information exchange among GCC member nations.

Regarding compensation for oil spill damage in the Gulf, however, the EMC's direct involvement is limited. Compensation for oil spill damage often involves complex

legal and financial processes, which do not fall directly under the mandate of the EMC. Therefore, while the EMC within the GCC contributes significantly to the management of oil spills by coordinating response efforts, when it comes to addressing compensation for oil spill damage, this is the responsibility of a broader framework within the GCC rather than a direct duty of the EMC itself.

4. National Oil Spill Compensation Regimes

In addition to the above international and regional organisations for dealing with compensation for oil spills, there are several countries that have established their own national systems. Canada, USA, China, New Zealand and Finland are the most important examples. Canada and the USA have robust frameworks, incorporating mechanisms to address not only identified but also unattributed oil spills. Their proactive approach involves comprehensive legislation and financial instruments, contributing to a more adaptable response. On the other hand, in countries like China, New Zealand, and Finland, while the establishment of national systems is a positive step, there may be gaps in their implementation and the extent to which they cover the diverse scenarios of undefined oil spills.

The effectiveness of these national systems depends on their adaptability, inclusiveness, and the extent to which they consider the evolving nature of oil spill incidents. A critical examination of each country's system could shed light on potential areas for improvement in their responses to unattributed oil spills.

4.1 Canada: The Ship-source Oil Pollution Fund (SOPF)

Canada has established the most effective national system for dealing with claims for compensation for marine oil spills that take place within Canadian waters up to 200 nautical miles from shore. The Ship-source Oil Pollution Fund (SOPF) is a comprehensive Canadian system that addresses all types of marine oil spills, whether the source is traceable or untraceable. KI-46 (a Canadian participant) said:

> *"the SOPF compensates victims of oil pollution for damages caused by any type of oil, from any ship or boat and anywhere in Canadian waters*

> *whether traceable or mystery or major or minor …. We compensate these types of damages; preventive measures, clean-up costs, costs for reinstatement of the environment, property damage, economic loss, fisheries losses, tourism losses and loss of subsistence living".*

This fund compensates for the damages suffered as a result of ship-source oil pollution, including property damage; economic loss; loss of subsistence living; cultural losses; preventive measures such as the cost of reasonable measures taken to prevent, repair, remedy, or minimize oil pollution damage; environmental reinstatement which use environmental impact studies; and measures taken to accelerate the natural recovery of the environment; KI-46 affirmed that *"Any person in Canada that has suffered damages by oil spills can claim to the fund…,* [It covers] *All levels of government such as ports, marinas, fishing and tourism industries, indigenous communities, individuals, and coastal landowners and owners of impacted ships or boats"*. KI-46 pointed out that *"the administrators of the fund take great care to recover costs from polluters once the Fund pays a claimant, all reasonable measures are taken to recover from the shipowner or other responsible person like court action, out-of-court settlement and arrest of the polluting ship or any other ship owned by the same person".*

According to CSCRMS (2019), SOPF is funded through a tax levied by the Canadian government on all vessels, not only oil carriers but also cargo and container ships, tugs and barges, cruise liners, passenger ships, ferries, pleasure craft, fishing vessels, as well as abandoned, derelict, and wrecked vessels. This comprehensive approach underscores SOPF's commitment to addressing every kind of marine oil pollution incident in Canadian waters, both known sources and mystery spills. It includes reimbursing costs related to preventive measures, clean-up efforts, and restoration of the environment. Additionally, compensation is provided for property damage, economic losses incurred by individuals or businesses, as well as losses suffered within the fisheries and tourism sectors. According to KI-46 (Canadian participant),

> *"If it took $200 just to clean your sailing boat, because the guy beside had an overflow when refueling at the marina, this becomes a spill. And if the guy doesn't pay* [reimburse] *you* [your cleaning costs] *or you just prefer to go to*

the Fund, I would pay you these $200. It's just as simple as: if really minor spill had some impact, that's fine - it's covered by the compensation regime".

4.2 USA: Oil Spill Liability Trust Fund (OSLTF)

The Oil Spill Liability Trust Fund (OSLTF) is a federal fund established by the United States government in 1986 to ensure that adequate resources are available to respond to oil spills in U.S. waters (Hemminger, 2021). The fund is administered by the U.S. Coast Guard and covers both marine and terrestrial oil and other petroleum spills (Opaluch, 2020). KI-47 (a USA participant) said, "The OSLTF provides for the payment of removal costs, damages, and other costs that may arise from oil spills, both on land and in water. It covers a wide range of costs, including those associated with containment and clean-up efforts, damages to natural resources, and lost profits suffered by those affected by an oil spill". According to Ramseur, et al., (2023), the OSLTF is funded by tax on imported oil, oil movements by the oil industry and OIL Pollution ACT (OPA) penalties, and it functions as a secondary source of compensation where a Responsible Party is unable to satisfy claims made under the Act or where a Responsible Party cannot be identified. It addresses mystery spills in instances where the source cannot be tracked down.

According to KI-47,

"*if the oil spill is mystery or the polluter unable to pay, they went bankrupt, or the company no longer exists, then our oil spill liability trust fund provides the money for the claims and for people or fisherman either damages for their fishing gear or maybe the season for a certain type of fish is canceled because of the spill and they're unable to make their income. So, they can provide damages and lost income as well".*

The Oil Spill Liability Trust Fund (OSLTF) in the United States provides coverage for certain costs associated with mystery oil spills when responsible parties cannot be identified or are unable to fully cover the expenses for the affected victims.

4.3 China: The Vessel-Source Oil Pollution Compensation Fund (CVOPCF)

China's 2012 Compensation Regime for Vessel Source Oil Pollution operates on a dual-tiered system (Liu & Zhu, 2014). The primary tier requires the ship owner responsible for the oil pollution and their liability insurer to provide compensation (Yang, 2017). The secondary tier is managed by the Vessel-Source Oil Pollution Compensation Fund (CVOPCF), which is financed mainly by entities receiving crude oil and heavy fuel oil (Yang, 2017). This is an example of the beneficiaries pays principle. These entities are obligated to make financial contributions to the CVOPCF based on the volume of oil they receive. The CVOPCF utilizes these funds to provide compensation to victims of oil pollution in all cases from either known or unknown sources, aligning with the stipulations of the Compensation Fund Regulation.

The CVOPCF covers the following costs: (1) cleanup costs: The CVOPCF addresses the reasonable expenses associated with measures taken to prevent, reduce, or alleviate damage from oil pollution, including the costs of cleanup operations. (2) property damage: Compensation is extended by the CVOPCF for damage to property resulting from oil pollution, covering losses related to fishing gear, beaches, and other affected assets. (3) economic losses: The CVOPCF provides reparation for economic losses incurred due to oil pollution, encompassing income loss, profit loss, and the loss of subsistence use of natural resources.

China's 2012 Compensation Regime for Vessel Source Oil Pollution includes provisions aimed at compensating for incidents of mystery spills. It stipulates that when the responsible party for an oil spill cannot be identified, a compensation system is in place. This system may utilize government funds or mechanisms established to compensate victims of such incidents.

4.4 New Zealand Oil Pollution Fund (NZOPF)

Maritime New Zealand, (2022) stated that the New Zealand Oil Pollution Fund is primary financial backing for preparedness and response activities related to oil pollution which is governed by the Maritime Transport Act 1994. The New Zealand Oil Pollution Fund operates under the polluter pay principle for cost recovery in oil pollution incidents. It acknowledges that it may not always be feasible to identify a liable party, as outlined in section 331 of the Maritime Transport Act (Ellis, et al.,

2017). Part 24 of the Maritime Transport Act charges the NZOPF with "Financing plans and responses to protect the marine environment from marine oil spills". According to the Maritime Transport Act of 1994, it is mandated that Maritime NZ establish and oversee this fund, which is obliged to cover the following expenditures (Environment Canterbury Regional Council, 2022):

1. Procurement of equipment or any other necessary resources for the execution or facilitation of a regional or national response to maritime oil spills.
2. Reasonable expenses incurred by Maritime NZ or a regional council in the process of investigating a suspected maritime oil spill, as well as in the containment, dispersion, and clean-up of said spill.
3. Expenditures related to services essential for the planning and response to maritime oil spills, provided under contractual agreements.
4. Costs borne by Maritime NZ or a regional council in implementing measures to prevent maritime oil spills.

De Cola (2020) reported that, when mystery spills occur, the Oil Pollution Fund will cover the costs of response. However, it is important to note that,

- Before the fund pays the costs, every reasonable effort must be made to identify and / or pursue payment from the responsible party.
- The fund is limited in size and permission to pay for any cost exceeding the fund balance at that time would need to be sought from central government.

Funds for this purpose are generated through the Oil Pollution Levy (Farnworth, 2017) which is imposed on:

- Ships, both domestic and foreign vessels, that exceed 24 meters in length overall and have a gross tonnenage exceeding 100.
- Oil facilities, including floating production units, storage and offloading units, oil pipelines, and oil platforms.

The Fund covers both the internal waters of New Zealand and its marine waters (its 200 nautical mile EEZ. According to Read (2023),

> "when mystery oil spills occur, [and] we apply the "polluter pays" principle to cost recovery for oil pollution events it is recognised that it is not always possible to identify a responsible party. To this extent the oil pollution fund will cover the costs of a response. However, it is worth noting a couple of key

points; (1) Before the fund pays the costs every reasonable effort must be made to identify and / or pursue payment from the responsible party. (2) The fund is limited in size and any cost exceeding the fund balance at that time would need to be sought from central government".

4.5 Finland: Finnish Oil Pollution Compensation Fund (FOPCF)

The Finnish Oil Pollution Compensation Fund, managed by the Ministry of the Environment, is used to compensate for the costs of oil spills and oil spill response on land and at sea when the party that caused the accident is not known or the culpable party is unable to reimburse the costs (Finnish Ministry of the Environment, 2020). The Finnish Oil Pollution Compensation Fund serves as a supplementary source of compensation for addressing oil spills and the associated response expenses. Although overseen by the Ministry of Environment, it operates autonomously with its own management board tasked with determining compensation decisions, as outlined by Parviainen et al. (2022). The Finnish strategy for responding to oil pollution is to act as fast and efficiently as possible on the sea. The Finnish Oil Pollution Compensation Fund's operations are funded through the oil damage duties collected on all oil imported to Finland or transported through Finland. If oil is transported by a vessel whose cargo section is not completely double hulled, a double rate of oil damage duty is collected (Haapasaari and Tahvonen, 2013)

5. Oman's framework for seeking compensation in response to marine oil spills

Oman has established a formal framework for seeking compensation in response to oil spill incidents, particularly those related to oil spills by known sources (Albusaidi, 2019). This framework is designed to ensure that prompt and effective measures are taken to address the environmental impact caused by such incidents. It involves close coordination between various stakeholders, including government agencies, industry players, and international organizations.

5.1 Oman's system for dealing with oil spills

To comprehend Oman's policy on compensation, we have to understand its overall policy on oil spills. Oman has several laws and regulations in place to prevent and

respond to oil spills which can have significant ecological and economic impacts on the country's coastal areas and marine life (Albusaidi, 2019). Oman has aligned its environmental laws and regulations with standards and norms professed by international agreements such as the Law of the Sea Convention and the International Maritime Organization (IMO). Similarly, for oil spill compensation, Oman relies on established international regimes like the International Oil Pollution Compensation (IOPC) fund and Protection and Indemnity (P&I) clubs. Since becoming a member of the 1982 Law of the Sea Convention, Oman has actively joined many international treaties related to the protection of the marine environment in general and of maritime activities in particular (MARPOL 73/78, the CLC 92, IOPC Fund 1992, Bunker 2001), fulfilling its statutory obligations to members of the LOS Convention (Environment Authority, 2015).

According to KI-02 (an Oman government participant), *"Oman government is a party to the MARPOL 73/78 Convention and the 'International Convention on Oil-Pollution Preparedness, Response and Cooperation (OPRC) spill response, Also Oman signed the CLC and Fund convention and their Protocols except Supplementary Fund 2003 and is a party to the Bunker convention".* KI-17 (another government participant) said:

> *"In case of pollution and emergencies, MECA cooperates with MEMAC dealing with the shipping companies via their agencies, and with the ship owners Protection and Indemnity Clubs (P&I). Depending on the specifics of the case with regard to compensation, CLC and Fund Convention are activated, and/or the International Petroleum Industry Environmental Conservation Association (IPIECA) and the International Tanker Owners Oil Pollution Federation (ITOPF)".*

The primary law governing environmental protection in Oman is the Law on Conservation of the Environmental and Prevention of Pollution issued under Royal Decree No. 114/2001. This law establishes the legal framework for protecting Oman's environment and natural resources, including measures to prevent and respond to oil spills (Choudri, et al., 2016). This law adopts the polluter pays principle, which holds the polluter responsible for the damage caused and requires them to restore the environment to its previous state and compensate those who have suffered losses. The

penalties for violating this law vary from OMR 200 to OMR 1 million, and in extreme cases, the offender may face life imprisonment (ROYAL DECREE No. 114, 2001).

In addition to the Environmental Protection and Pollution Control Law, Oman has several regulations that specifically address oil spills (Omanuna, 2023). These include:

1. The Marine Pollution Control Regulation, issued under Ministerial Decision No. 43/2006, which establishes measures to prevent marine pollution and outlines procedures for responding to oil spills in Omani waters.
2. Oil Pollution Control Regulation, issued under Ministerial Decision No. 44/2006, which sets out requirements for preventing and responding to oil spills in Oman's territorial waters.

Oman issued the National Oil Spill Contingency Plan in 1985, subsequently updated in 1992 and 1995 and currently undergoing further updates (Environment Authority, 2022). The plan outlines response procedures for oil spills that occur within the country's Exclusive Economic Zone (EEZ) and serves as a comprehensive guide to the oil spill response policy of the Sultanate. This plan involves collaboration between the government and private sector in combating oil spills, working in conjunction with the Environmental Authority (Andersson & Liu, 2012). KI-17 (an Oman Government participant) stated that:

> "*The National Plan has adopted a three-tiered approach for managing oil pollution incidents, which is structured as follows: (1) The first tier, which falls under the jurisdiction of the Environment Authority, addresses incidents where the leaked amount of oil is less than 100 tonnes. (2) The second tier, also under the purview of the Environment Authority, deals with incidents where the leaked amount of oil is between 100-500 tonnes. (3) The third tier addresses large-scale emergencies where the leaked amount of oil exceeds 500 tonnes, and external assistance from regional or international organizations is necessary. The responsibility falls under the National Civil Defense Committee for Crisis Management".*

5.2 Compensation claims

As specified by Oman's National Oil Spill Contingency Plan, KI-02 (an Omani government respondent) explained there are two stages for compensation claims - an information gathering stage and an application stage:

> *"The process of compensation for oil pollution is carried out as these steps: first, when there is an oil spill that causes problems of oil pollution, the authorities will engage in the oil spill response, handling and conducting evidence collection, determination and assessment of damages from the incident. After the damage valuation, the party causing the pollution and the party damaged by the oil pollution incident will conduct the negotiation and agreement on the damages claim* [compensation]. *Then, if the involved parties have success in negotiation on all matters related to compensation for oil pollution compensation, there will be no further problem needed to be solved among involved parties. Second, claimants can file claims against the ship owner, their insurer, and the IOPC Fund by submitting necessary forms along with supporting documents. Experts designated by the IOPC Fund and P&I Club oversee the clean-up progress and authorize payment for damages. Following the assessment, the IOPC and P&I Club communicate the results to the claimants. If the claimants accept the decisions, compensation is disbursed. Alternatively, if the claimants disagree, they can seek a re-evaluation by submitting further documentation or by pursuing the case in a local court"* (Figure 5.2).

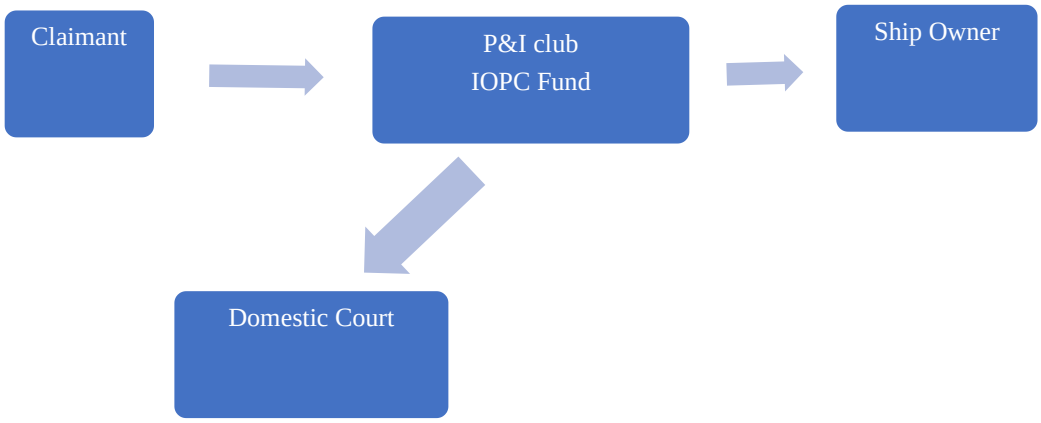

Figure 5.2 the process of oil spill claims in (Oman's Environmental Authority, 2022)

All this assumes the polluter can be identified. In Oman, oil spill compensation is obtained through established frameworks to address various oil spill incidents by known sources. This process involves thorough documentation and submission of claims directed towards responsible parties such as ship owners, insurers, or relevant funds. Expert assessments and communication with claimants are key steps in determining the amount of compensation. The system is designed to ensure that affected parties, including local communities and industries such as fishing or tourism, receive due restitution for losses incurred as a result of these incidents.

However, there is considerable controversy over whether the oil spill compensation system in Oman works effectively. On the one hand, some respondents claim the system works well for known sources. For example, KI-30 (a regional participant) said *"Actually, our company got the compensation, they have had compensated after cleanup oil spills because we are a third party".* Likewise, KI-13 (a government participant) claimed: *"people in Oman were compensated when oil spill was by known sources after counting the affected equipment and the estimated fishing quantities for each fisherman compared to previous years and the affected fishing sites, so most of the fishermen affected in the area affected by the oil pollution were compensated".*

On attributable spills, Oman's record of obtaining external compensation is good, as Table 5.2 shows. During the past decade, Omani waters have witnessed five significant traceable oil spills – occurring in 2013, 2017, 2018, and two incidents in 2019 – all of which have been duly compensated (see Table 5.2). The 2013 spill was effectively addressed through collaboration with either the IOPC or P&I club according to KI-17 (a government participant) concluded in the table 5.2 below.

Table 5.2 the total compensation obtained in Oman from traceable oil spill incidents according to KI-17 (Oman government participant).

No	The incident	Year	The liability	The cost
1	Nesa R3	2013	IOPC fund	OMR 3,521,364 and BHD 8,419 (USD 9,169,333.24)
2	Georgios	2017	The owner of ship	OMR 50,000 (US$129880)
3	Raysut-II	2018	P&I Club	OMR 70,530 (US$ 183,209.72)
4	Pink Rose	2019	The owner of ship	OMR 10,000 (US$ 26,000)
5	Viviana and Ji mei shunha bulk ship	2019	P&I Club	OMR 120,012.868 (USD 311748,55)

So Oman has successfully secured compensation from identified sources responsible for oil spills (Billah, 2014). But compensation for mystery spills is another matter. FGD- 3 (local fishermen) said *"the government should pay us as victims by oil spills at first stage, then look for the violators".* It seems that Oman's policy is to look for compensation from international or regional organisations before handing out compensation to its citizens. However, as we have seen, international and regional organisations rarely provide compensation for mystery spills. For example, a serious drawback of the IOPCF is that the identity of the polluting ship owner must be known. According to KI-39 (an international participant), *"IOPC fund will not pay compensation if the claimant cannot prove that the damage resulted from an incident involving one or more ships as defined in the Conventions. Where the oil spills are from undocumented sources, they are not within the scope of IOPC*". In such cases, the Omani government has had to pay for clean-up operations and other expenses, as in the following incident which was caused by an unknown source, and for which Oman did not receive compensation from any external organisation. According to KI-12 (an Oman government official):

> *"In October 2019, fishermen informed Environment Authority* (EA) *via the hotline number of the Pollution Operation Monitoring Centre complaining about oil pollution in their village "Dorsany Khadr" beach in the form of black oil spread across the sea in several locations. This beach is considered one of the most important fishing areas with an abundance of fish. Cleaning the affected areas involved employing the Royal Air Force of Oman and the Royal Navy of Oman to monitor the quantities of pollution and to identify the source of these pollutants by using a CASA plane and Navy ships. Unfortunately, the source of the spill was not found. Samples of pollution were taken for analysis in order to discover the type of oil and the carbon fingerprint . Then, EA coordinated with Khasab Municipality and volunteers to provide equipment to clean the affected beach and coordinated with the Royal Oman Navy to transport equipment and individuals to the beach, as there is no road, but only sea access to that beach. A diving exercise was carried out by volunteer divers to extract bitumen from coral reefs and get rid of oil pollutants in the surrounding area. However, Oman did not find out which vessel was responsible for this oil pollution and therefore has been unable to obtain compensation for the*

costs of its clean-up operation. So, the cost of clean-up operations and environmental rehabilitation was paid by Oman government".

So, Oman's strategy for obtaining external compensation to sufferers of mystery spills seems to fail. In cases where the sources remain unidentified, Oman has yet to receive any external compensation.

5.3 Levels of satisfaction among recipients of compensation

The majority of victims expressed a preference for financial compensation rather than in-kind goods. According to KI-1 (an Omani government official), "*Financial compensation is the preferred option".* International organizations have expressed concern that the amount of compensation provided for oil spills is insufficient, particularly for fishermen and other affected individuals who experience major disruptions to their businesses for extended periods. For example, according to KI-47 (an international participant), "*they're not happy because they're not out fishing. They're not renting jet skis to people for fun. So, they've lost business, so they're usually not happy, but the compensation does help. It helps to kind of make them whole, at least for that period and helps them pay their bills".*

On the other hand, many individuals, particularly members of the local community, find the compensation received for oil spills adequate. This sentiment is particularly prevalent among government staff according to KI-22 (a government participant), *"It may be satisfactory".* And KI-01 (another government interviewee) said *"Everyone is in some way satisfied with the matter".* KI-13 (a third government participant) differentiated between most employees, who were satisfied with the compensation they received, and fishers who were not satisfied with their compensation:

"*Most of the employees are satisfied with the reward, as the work is part of their work, and it is in exchange for other additional burdens for their routine work. As for the fishermen, the fishermen consider that the sea belongs to them. Whatever is compensated, they are not satisfied with it, on the pretext that the stock is decreasing, and the fish migrate and considers himself to have lost the fish wealth".*

KI-26 (from a service provider company) cautioned that "*while financial compensation may offer a degree of satisfaction, it is crucial to acknowledge that the environmental impacts of oil pollution are immeasurable. The complexities involved in restoring the environment to its original state render monetary compensation insufficient in addressing the full extent of the damage incurred".*

5.4 Compensation challenges faced by fishers and other residents in isolated communities in Musandam

In Musandam, the community is structured around a tribal system led by a sheikh who serves as the representative for submitting grievances to the government. When oil spills occur in the vicinity of the Strait of Hormuz, a substantial portion of the oil is often carried towards the villages located along the western coast of Musandam. These villages are semi-isolated, lacking direct road connections to urban centres like Khasab or Daba. Their primary mode of transportation is boats, and they are inhabitants of communities such as Leema, Kumzar, Shaboos, Balad, and Sheisa. The oil dispersed along the shoreline prevents the fishermen from venturing out for their usual fishing activities. This leads to serious financial losses for them. Furthermore, when the oil comes into contact with their fishing equipment, it causes extensive damage, necessitating costly replacements. When oil spills occur in Omani waters and drift towards the Musandam shores, such fishermen are inevitably exposed, either directly in their fishing zones or through their equipment [add ref]. Consequently, fishermen impacted by oil pollution convene with their sheikh to register their complaints and seek compensation. Unfortunately, these complaints frequently go unanswered, leading to a sense of resignation among the fishers. Consequently, the pursuit of compensation through complaints has ceased. Where fishing grounds abundant with valuable fish stocks are affected, fishermen initiate their own clean-up efforts. They bear the costs of these endeavors, including hiring divers, to restore these areas to their former state. According to KI-50 (Khasab fisherman), "*We have not received any compensation for economic loss our fishing at all, when spills occurred, I paid from my pockets. We always made complaints to the Sheikh but no benefit"*.

Likewise, KI-60 (local community participant) said,

> *"There is no government sector authorized to submit a request for compensation as a result of oil spills…, there is no clarity for any specific authority to deal with it to sue in the event of compensation for damage resulting from oil pollution, as the damages affect several aspects such as the economic aspect for the fisherman, hotel owners, marine activities and the amateur health side, we were not ever compensated previously".*

According to KI-49 (a local fisherman*), "Fishermen have never been paid when oil spills occurred in Musandam, they paid from their pocket when the spill occurred".* KI-51 (local fisherman) said, *"No compensation has ever been paid to fishers* [in Musandam]". All the focus group discussions with fishermen in Musandam claimed that none of them had received any compensation.

In Musandam, residents and private entities, including fishermen, local communities, hotels, diving centers, and fishing markets, all incurred expenditure in response to oil spill incidents. This expenditure included expenses related to the clean-up of oil pollution within fishing areas and the replacement or refurbishment of contaminated fishing equipment, as well as costs associated with the cancellation of tourism bookings and disposal of contaminated fish within the markets. KI-64 (local fisherman) stated *"We lost lots of money when oil spills occurred for engine maintenance and boat painting, it took about OMR 300* [£600] *. The nets usually last for three years, but when polluted with oils, they are damaged directly. Their cost ranges from OMR 500 to OMR 6,000* [£1,000 – 12,000]*".* FGD-1 (Kumzar fishermen) said, *"We lost nets and traps which cost about OR 3000* [£6,000] *when oil spills occurred".* KI-62 (hotel partnership participant) said "*oil spill impacts are too much for my activities either the hotel or diving center and my tourism trip as we don't have a place to complain and no compensation…. We paid many tourists groups compensation when their trips were cancelled due to oil spills in the region about 100,000 dollars but we didn't get the total benefits due to the oil spills*". Another hotel participant, KI-66, said, *"I am responsible for three hotels, and we lost tourists many times which led to a financial loss for hotels".*

The fishermen and other residents in local communities in Musandam lacked awareness regarding the existence of oil spill compensation and were unfamiliar with

the appropriate department for filing claims. Information about this matter only reached them through the interlocutor: FGD-1 (Kumzar fishermen) said, "*This is the first time we hear about oil spill compensation*". According to KI-3 (a government participant located in Musandam), *"I have never heard about oil spill compensation"*, and KI-5 (another government participant) said he did not "*have any idea about compensation".* None of the respondents from the Musandam region, including victims, government personnel, company employees, and volunteers actively engaged in oil spill remediation efforts, have applied for or received oil compensation. All participants in this study unanimously concurred that polluters should be held accountable for providing compensation in the event of an oil spill. KI-9 (defense participant) said, "*The polluter must pay the compensation".*

6. Conclusion and recommendations

In conclusion, this chapter has examined the issues of compensation for oil spills with a specific focus on Musandam. We have found that some international organisations, including the IOPC, are quite effective in providing compensation for spills that can be traced to particular oil tankers. However, whilst in principle the Fund may also pay for compensation for spills from unidentified ships, claimants must prove that the spill came from a ship transporting contributing oil as cargo, which is difficult. So IOPC focuses almost exclusively on oil spills from known tankers. Regional organizations such as the Kuwait Convention and MEMAC which cover the Gulf region, have been only moderately successful in providing compensation for marine oil spills in cooperation with international funds. Some individual states have their own agencies for providing compensation. the most successful of these are in Canada, USA, China, New Zealand and Finland which cover both traceable pollution and mystery spills. Canada's compensation scheme is often commended for its comprehensive coverage, offering compensation for a wide range of damages caused by oil spills. The compensation scheme in the USA is praised for its extensive liability framework, which holds responsible parties accountable for cleanup costs and damages resulting from oil spills. China's compensation scheme has been noted for its emphasis on preventive measures and early response mechanisms to mitigate the impact of oil spills. New Zealand's compensation scheme is lauded for its proactive approach to risk management and community engagement in oil spill response planning. Finland's

compensation scheme is often highlighted for its emphasis on environmental restoration and biodiversity conservation efforts following oil spills. So each country's compensation scheme has its strengths. However, there are also areas for improvement to ensure timely, fair, and comprehensive assistance to those affected by oil spills. For example, according to Hage, (2015), there was a capped limit of $161 million for the fund, suggesting that the SOPF in Canada might lack adequate funds to address exceptionally large spills, as noted also by Rowe, (2020). The OSLTF in USA encountered difficulties in fully addressing the expenses and losses stemming from the Deepwater Horizon oil spill which occurred in 2010. These challenges arose from constraints in funding, potential reductions in proportional claims, restricted coverage, and reliance on additional sources of funding, highlighting the challenges faced by the OSLTF in situations of large-scale oil spills (Theodotou, 2018). Likewise, in China according to Zhu, et al., (2013), the maximum compensation offered by the CVOPCF falls short compared to that of the 1992 International Oil Pollution Compensation Fund (IOPC Fund), the Ship-Source Oil Pollution Fund (SOPF), and the Oil Spill Liability Trust Fund (OSLTF), potentially leaving compensation inadequate for major oil spill incidents. The New Zealand Oil Pollution Fund (NZOPF) does not offer compensation for loss of profit resulting from property damage caused by oil spills, according to Judd, (2014). Also, Diprose, et al., (2016) claims that a limitation of the New Zealand Oil Pollution Fund (NZOPF) is its failure to fill the regulatory gap concerning the prevention of sea protestors from disrupting petroleum industry operations. According to Parviainen, et al., (2022), the Finnish Oil Pollution Compensation Fund (FOPCF) is vulnerable to the criticism that when confronted with a major spill, the costs of cleanup, environmental restoration, and compensating for damages might surpass its financial capacity. Continued evaluation and refinement of these schemes is therefore essential to ensure their effectiveness and resilience in addressing future environmental disasters.

The effectiveness of oil compensation schemes established by those countries should consider several factors. Firstly, the scope and coverage of the schemes in terms of the types of oil spills and the extent of damage they cover should be assessed. Additionally, the transparency and efficiency of the compensation process, including the ease of access for affected parties and the timeliness of payouts, are crucial aspects to evaluate. Furthermore, the adequacy of the compensation provided in

relation to the actual costs incurred and the extent of environmental damage should be scrutinized. Moreover, the extent to which the schemes incentivize preventative measures and promote environmental stewardship within the oil industry should be considered. Finally, the overall fairness and equity of the compensation schemes, including their ability to address the needs of marginalized communities and vulnerable ecosystems, should be critically appraised.

In the case of Musandam, no compensation appears to have been paid out from the Oman government or anywhere else to fishers, divers, and hotel owners for loss of income and damage to equipment caused by either traceable or mystery spills. Moreover, the clean-up of small-scale spills is often carried out by residents at their own expense.

It is worth noting that examples of compensation for oil spills from unidentified sources are infinitesimal compared to the number of incidents of oil spills that are uncompensated because they cannot be attributed to a source. No research has been published that calculates how large this latter number is. According to Ng and Song (2010), a dearth of research exists regarding the evaluation of environmental impact costs associated with pollutants generated by routine shipping operations, possibly attributed to the comparatively smaller scales and implicit nature of these pollutants when contrasted with major disasters.

Another finding is that many of these compensation practices embody both the polluter pays principle and the beneficiary pays principle, applying the axioms of 'internalization of environmental costs', and 'cost-sharing by beneficiaries' (Farrington, 2013). Moreover, where the known polluter or their insurance company is unable to pay the complete costs of clean-up, national, regional or international funds may be applied for to pay the shortfall – funds which are provided by the oil industry. All this is a welcome improvement on previous practice which did little to deal with marine oil pollution. However, nearly all the compensation practices have one shortcoming: they very rarely cover unattributed marine oil pollution. Although domestic compensation arrangements in Canada, USA, China, New Zealand and Finland accept claims to compensation for marine oil pollution caused by unknown sources, few other countries do so, and no international or regional fund does so.

If the principles of environmental justice were applied to oil compensation, it would necessitate a reevaluation of traditional approaches. In cases where the polluter cannot be identified, relying solely on the polluter pays principle may prove challenging. This highlights the importance of adopting innovative strategies. One potential solution lies in the establishment of a regional compensation fund financed by levies from vessels passing through sensitive areas (Chen, et al., 2019). This fund could serve as a reliable source of funding for clean-up operations, economic restitution, and environmental restoration efforts. Moreover, this fund could support the integration of advanced technologies such as satellite imagery and aerial surveillance which would greatly enhance the capacity to detect and respond to spills in real time, even when the source remains untraceable (Klemas, 2010).

The following recommendations suggest ways of improving the process of obtaining compensation for oil spills in Omani waters:

1. Omanian laws need to issue legal documents with specific guidelines for the implementation of damage assessment and compulsory insurance for entities engaged in maritime and petroleum activities.
2. Omanian laws need to be updated to comply with the 1992 CLC and IOPC fund conventions to which Oman is a contracting member.
3. Oman should increase investment in its law enforcement team to ensure the process of compensation for damages is timely and effective.
4. The regional states in the Gulf should establish a regional standard for the rates of the cost of assistance (the Oil Spill Response Limited (OSRL) list can be used as reference)
5. There should be created a Gulf regional compensation fund, solely dedicated to oil spill compensation for both traced and mystery spills. This fund, which would be financed by contributions from Gulf states, could be managed either by an existing regulatory body such as the GCC or a new independent organization responsible for overseeing compensation claims.
6. There should be mandatory liability insurance for all entities engaged in maritime activities, including shipowners, operators, and oil companies in the Gulf. This would ensure that there is a readily available source of compensation in the event of a spill according to the IMO Circular No. MEPC.1/Circ.803- 11 February 2013 “MARITIME EMERGENCY RESPONSE AND SALVAGE CO-ORDINATION

UNIT IN THE ROPME SEA AREA" (MERCU). Note that MERCU has not yet been implemented by the Gulf States.

7. Public-Private Partnerships should be encouraged to foster collaboration between government agencies, non-profit organizations, and private industry to collectively manage and administer compensation funds.
8. There should be investment in state-of-the-art monitoring technologies to detect and respond to oil spills promptly, reducing the potential for extensive damage and facilitating quicker compensation processes.
9. Public awareness should be raised about the importance of oil spill compensation and the role individuals and communities can play in reporting incidents and pursuing claims.
10. More funds should be allocated for research and development of new technologies and methods for oil spill response and compensation.

This chapter links the theoretical framework and the empirical findings regarding the subject of compensation. The empirical data shows that stakeholders endorse the compensation principle as a matter of justice, indicating their belief that prevention measures might not always be entirely effective. Additionally, the polluter pays principle is observed to be insufficient or ineffective in practice to deal with mystery spills Thus, the study underscores the necessity of establishing a comprehensive mechanism that ensures justice through adequate compensation for affected parties in cases of environmental damage from both traceable and mystery spills.

The chapter contributes to the overarching argument of the thesis, which aims to safeguard the marine environment from marine oil spill pollution, be it from identified or unidentified sources, and to hold accountable those responsible for pollution incidents and require them to compensate their victims. This chapter on compensation links to the next chapter, which concentrates on the problem of untraceable oil spills. In a sense, all the previous chapters lead up to Chapter 6 on untraceable oil spills, because the problem of dealing with mystery spills is the central focus of the thesis.

CHAPTER 6. Untraceable Oil Spills

1. Introduction

Oil spills in the sea are a major threat to the environment and the economy because of their harmful impact on humans and the marine and terrestrial environment (Pärt, et al., 2021). Both international maritime regulations and national environmental laws strictly prohibit the intentional or accidental release of any type of oil into water bodies (Carpenter, 2019). Stringent measures are in place to prevent and respond to oil spills under the MARPOL 73/78 convention. However, vessels can legally discharge substances contaminated with less than 15 parts per million oils. According to KI-28 (member of a regional organisation), *"if the ships would like to discharge on the middle oceans like the Atlantic and Pacific Indian Ocean, they have to discharge it by releasing* [no more than 15] *5ppm article per minute for the oil".*

The problem of untraceability in oil spills refers to the challenge of identifying the specific source or origin of spilt oil in a maritime incident where the responsible party cannot be readily identified (Escobar, 2019). A large majority of untraceable spills happen during the night and holidays, exploiting lower surveillance and response capacities. Many vessels evade supervision and cost by illegally dumping waste oil in international waters instead of disposing it properly in ports or designated areas. Chen, et al., (2019) reported that most oil tankers and ships discharge oil into water because the ocean is vast and it is difficult to detect them. Regrettably, many of these spills eventually reach the coastline causing environmental damage.

Section 2 of this chapter provides examples of mystery oil spills. Section 3 reports the proportion of spills from untraceable culprits. Section 4 describes the difficulties in tracing mystery spillers. Section 5 outlines the steps that are being taken to track down untraceable culprits. Finally, Section 6 concludes the chapter with a summary of the chapter and nine key recommendations aimed at dealing with the problem of untraceable oil spills.

2. Examples of mystery spills

Although most mystery spills are small-scale, some are very large. For example, Staff & Agencies (2021) reported that in February 2021, Israel experienced a massive oil spill that affected over 100 miles of coastline along the Mediterranean Sea. The source of this spill remains a mystery to this day. The Israeli government mobilized a massive clean-up effort, with thousands of volunteers and soldiers working to remove the oil from the beaches and the sea. The government also deployed booms and other barriers to contain the spread of the oil and prevent it from reaching sensitive areas (Grubesic,.et al., 2019). The clean-up effort was complicated by the fact that the oil had penetrated deep into the sand and rocks, making it difficult to remove.

According to Escobar (2019), there was a large mysterious oil spill on Brazil's coast in 2019 putting a vital biodiversity hotspot at risk in the South Atlantic. In the area known as Abrolhos Bank, thousands of tonnes of crude oil from an unknown source began to circulate on the north-eastern coast of Brazil in late August 2019 polluting hundreds of beaches, estuaries, coral reefs and mangroves along a 2,500 km coastline. Over 980 beaches and roughly 3000 kilometers of Brazil's coastline, comprising protected marine areas and fragile ecosystems like mangroves, coral reefs, estuaries, and sandy beaches, experienced serious impacts. The origin of the oil spill, whether it stemmed from a singular incident or a series of events, remains unknown (Brito, et al., 2023).

In some locations, major mystery spills occur relatively frequently. For example, KI-46 (an international participant) reported that *"Canada has received many claims for mystery spills. In total, the SOPF has paid $1.7M in compensation due to these spills. A recent mystery spill claim was submitted on December 1, 2021, from the Canadian Coast Guard (CCG) who informed of an oil sheen on the water near Postville, Newfoundland and Labrador"*. In the UAE, according to Haza, (2017), Fujairah experienced its fourth major mystery oil spill in three months between March and May 2017. The most recent of these were in Fujairah in 2021, and affected approximately 300 boats and around 250 fishermen, resulting in major damage to their trading activities and livelihoods, along with substantial costs for repairing damaged equipment.

In Oman, all the respondents from Oman in the present study, including officials from the government, members of local communities, and fishermen, said that all oil spills in the Musandam area were categorized as untraceable. According to KI-17 (a government participant), *"All spills in Musandam are mystery spills".* A major case of marine oil pollution in Oman by an unknown source, according to the Environment Authority (2019), occurred in October 2019. Fishermen contacted the Environment Authority via the hotline of the Pollution Operation Monitoring Centre complaining about oil pollution in their village Doursany Khawr beach. Cleaning the affected areas involved employing the Royal Air Force of Oman and the Royal Navy of Oman to monitor the quantities of pollution by using a CASA plane and Navy ships. But since this was a mystery spill, the cost of clean-up operations and environmental rehabilitation was paid by the Oman government.

3. Proportion of marine oil spills that are mystery spills

Finding the exact proportion of oil spills caused by untraceable sources is difficult because a significant amount of the spilled oil evaporates or disperses, making it hard to gather evidence, and because it changes depending on the context and location. Also, mystery spills are often unreported: KI-39 (an international respondent), said "*the untraceable spills have not been reported to the* [IOPC] *FUND.* And KI-40 (Oil Spill Response Limited company participant) said, "*No report of an untraceable spill has been filed"*. According to KI- 42 (an international participant) "*data from mystery spills is very hard to compile …. There may be more mystery spills around the world that we are not aware of".* The polluter may be difficult to identify, such as when a spill is caused by illegal or unregulated activities. Arinze, et al., (2023) stated that spills caused by illegal activities, such as oil theft or illegal discharges, are a more complex issue and are harder to trace to a specific polluter. The proportion of spills caused by illegal activities is not well documented. According to feedback from regional participants, a prevailing sentiment is that the majority of oil spill incidents attributed to unknown sources far outnumber those with identifiable origins. For instance, according to KI-30 (regional participant), "*You can make the calculation, for example, this year we had one known source of oil spill and around 20 spills by unknown source. So, it is around 95%".* On the other hand, according to KI-34

(another regional participant), "the *proportion of oil pollution incidents in the Sea from unknown sources is 30 percent".*

The research revealed that in the Black Sea, the annual count of identified oil spills varied from 290 to 350 incidents. These occurrences were predominantly linked to tank cleaning activities conducted in open waters and unauthorized discharges. Furthermore, the Black Sea emerged as a region marked by extensive tank cleaning operations and unlawful discharges from ships, resulting in notable instances of large-scale oil spills detected through radar satellite surveillance (Ivanov & Kucheiko, 2016).

The question of whether mystery spills are increasing, decreasing or remaining constant is also difficult to determine. KI-9 (an Oman Air force participant) said currently they were frequent: "*untraceable spill accidents are frequent and almost monthly, the last of which was approximately two weeks ago, and all of them are by unknown source".* KI-8 (an Oman Navy respondent) stated that "*the untraceable spills have been increased because of the development in the regions and the need of crude oil internationally*". But other respondents, especially international and regional participants, said mystery spills were decreasing or constant. Figure 6.1 provides a graph of the number of participants in each category of respondent who answered this question.

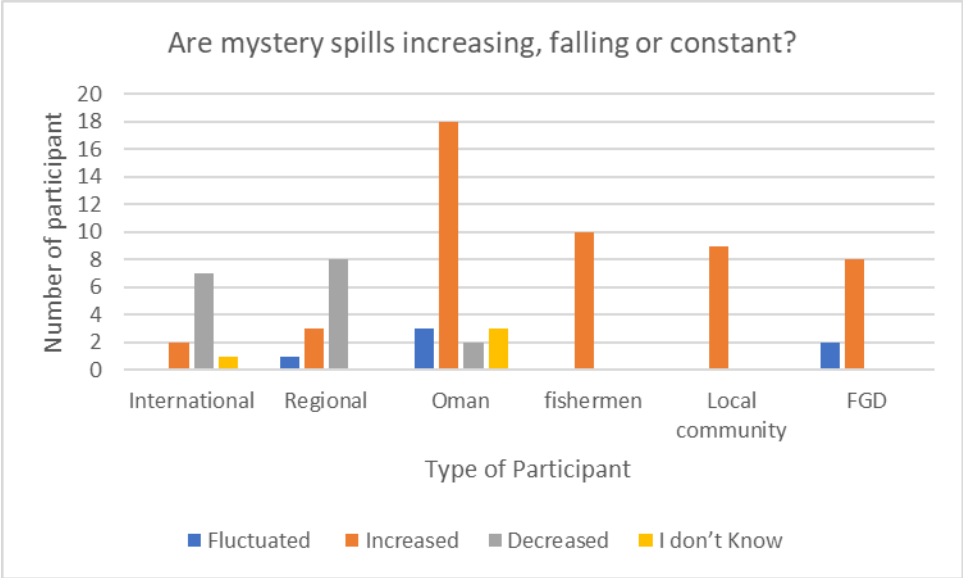

Figure 6.1 Respondents' views on whether mystery spills are increasing, falling or constant.

4. Difficulty of tracking marine oil spillers

For several reasons, it is difficult to identify the ships causing oil pollution. For one thing, pollution spots may shift from one site to another, making it hard to pinpoint the source of pollution (Hassler, 2016). For another thing, it could take days for the oil pollution to reach the shores, making it challenging to identify the offending vessels if they have already left the scene. As Singh & Singh (2017) noted, over time, oil spills can dissipate and become less visible due to natural processes like evaporation and emulsification with water.

The difficulty in identifying ships causing oil pollution poses a significant challenge in the realm of environmental protection. Numerous factors contribute to this complexity, ranging from the vastness of maritime spaces to the constant movement of vessels (Chen, et al., 2019). The lack of immediate and reliable identification mechanisms for ships engaged in oil pollution hinders swift response and accountability. Some vessels may engage in illegal discharge practices or accidental spills, making it challenging to attribute responsibility accurately. This difficulty is exacerbated by the sheer volume of maritime traffic and the prevalence of unregistered or poorly monitored vessels (Moore & Clodagh, 2021).

According to KI-6 (a government participant), "*identifying ships responsible for oil pollution is a complex task, dependent on factors such as the timing and duration of pollution at sea. This information can be difficult to obtain without specialized knowledge".* According to KI-34 (a regional participant), authorities are "*unable to track vessels which are to blame for oil spills because these reasons such as spill happening far from shore; ship not being stable and drifting from position; ship leaving the scene and making it impossible for sampling; ship being inaccessible; ship owner or shipping company being located in other countries in most cases*". KI-16 (defense respondent) said "*The perpetrators are often difficult to identify, as they may discharge the waste while in motion, making it challenging to catch them after the fact"*. Also, spills that cannot be traced often occur during night-time or adverse weather conditions (Singh & Singh, 2017). Moreover, obtaining contaminant samples from the sea to establish a fingerprint and collecting samples from all vessels that have passed through the polluted area are complex operations (Singh & Singh, 2017). According to KI-42 (an international interviewee), "*The problem is to determine which ship the oil came from in a busy shipping area is very hard. Often chemical*

analysis is required which is very expensive and often it is hard to get samples from the passing ships to do a comparison".

Several respondents claimed that most deliberate spills occurred outside territorial waters because they were more likely to escape detection offshore. For example, KI-45 (international participant) said "*These spills from unknown sources, is under the general banner of mystery spills, and usually happen when vessels discharge illegally offshore, usually outside territorial waters where they think they are not likely to get caught".* Singh & Singh (2017) confirmed that untraceable spills are more common in offshore locations rather than inshore areas. According to Ng and Song (2010), pollutants discharged during routine shipping operations, such as agents, ballast water, garbage, gray water, persistent floaters, and oil spills, present significant threats to the marine environment. These routine maritime activities represent the primary origin of oil spills, contributing to over 53% of all documented oil spill incidents in marine environments (Ng and Song, 2010).

According to Liu et al. (2021), the prevalence of illegal spills represents a substantial menace to the marine environment. Research indicates that the volume of waste oil intentionally released by ships surpasses the occurrences of oil spills resulting from accidents, establishing it as the primary contributor to marine oil pollution.

Illicit oil spills in marine environments frequently result from actions like the routine release of oil waste from cargo vessels, with a predominant contribution from unauthorized vessel oil discharges. These incidents commonly occur in international waters, with specific regions recording a noteworthy frequency of such spills. Furthermore, the characteristics of identified oil spills can offer insights into the maneuvers or pauses of vessels during unauthorized discharge events, along with indications of the spill's age and the prevailing oceanic conditions at the time of detection (Sankaran, 2019). This made traceability hard. KI-47 (international contributor) said, "*the open expanse of the sea poses a significant challenge in terms of monitoring every ship*" (see Table 6.1). Legal complexities exacerbate the problem of traceability, as KI-44 (international respondent), pointed out: "*Legal intricacies further compound the challenge. Determining liability and apportioning clean-up costs become formidable endeavors when the responsible party remains unidentified,*

and this legal ambiguity can impede swift and effective response efforts, rendering affected communities and ecosystems vulnerable".

Table 6.1 Challenges in Tracking Untraceable Oil Spills: Participant Perspectives

Challenges in tracking untraceable spills	**International participants (N=10)**	**Regional participants (N=12)**	**Oman government and private sectors (N=45)**	**Focal Group Discussion (N=10)**
Illegal discharge	7			
Jurisdictional complexities	2			
Technology support	8			
Limited resources	6			
Financial support	9			
Delayed or inadequate clean-up	3			
The complexity of oil spill investigations	3			
Musandam is remote place	5	5	40	10
The Siting of Musandam	4	12	38	8
High traffic vessels	6	12	42	9
Lack of resources in Musandam		6	10	2
Surveillance infrastructure			15	8
Insufficient material resources			6	
Unstable weather and climate conditions	3	5	16	
Weak legal framework for oil incidents	4	6	16	
Absence of immediate reporting in some cases			30	10
Time constraints	2	7	35	
The identification of unknown oil spills	7	5	40	10
Navigational challenges		5	8	
Lack of awareness	8	10	19	10

The location of Musandam exemplifies these traceability problems. Many participants in this study said that the Strait of Hormuz often experiences a dense concentration of maritime activity and a high volume of maritime traffic, with numerous vessels passing through busy shipping lanes. Monitoring the Strait of Hormuz around the clock presents a formidable challenge: with a ship passing through the Strait approximately every six minutes, maintaining continuous surveillance becomes a

formidable intricate task. According to KI-28 (a regional participant), *"we have an average of 45,000 per year, passing the Strait of Hormuz, about 60% is tankers and the others 40% for cargo and others".* Among this multitude of ships, pinpointing the one responsible for an oil spill is very hard, as KI-29 (a regional participant) said,

> "*Indeed, the process of identifying the ship that discharged the oil into the water is difficult, especially when there is a gathering of a large number of ships. An area that passed by means more than one ship at the same time, the same moment can mean technical burdens and the process will be more difficult to determine the source, if the oil pollution in the anchorage area is crowded with many ships waiting for their turn to enter the port, so identifying that ship becomes tough".*

KI-24 (a private sector participant) pointed out that *"Gathering strong evidence such as photographic evidence or oil spill samples taken directly from the suspected vessel is necessary to determine the exact ship causing the pollution",* but that "*the identification of the vessels responsible for oil pollution in Omani waters is challenging due to the high traffic of vessels crossing international waters."*

Another challenge is the lack of resources, as Musandam is a relatively poor region with limited resources. This makes it difficult to invest in new technologies and infrastructure to improve oil spill detection, tracking, and response. According to KI-10 (a government participant), "*this is a significant challenge for the country to get the cost of human and financial resources".* Continuous monitoring, which is necessary because of the high intensity of ship traffic, requires considerable efforts from authorities such as the Royal Navy of Oman, the Coast Guard Police, the Royal Air Force of Oman, and the Environment Authority. However, this can be very costly as it involves human resources, equipment, and devices. According to KI-16 (a defence participant), *"The cost is approximately between 2,500 to 4,000 OMR* ([$8,000]) *per hour including the operational cost, fuel and maintenance".*

The scarcity of resources poses significant challenges to addressing oil spill incidents and implementing sustainable response strategies, underscoring the importance of leveraging new technologies in mitigation efforts (Ivshina, et al., 2015).

Li, et al. (2016) outlined various key challenges in oil spill response and mitigation, including the complexity of legislation and implementation processes, time management, uncertainties surrounding the effectiveness of regulations, limitations imposed by environmental conditions, the absence of integrated approaches, insufficient research efforts, and difficulties in evaluating the risks associated with offshore oil spills.

Timing is a further challenge facing traceability in Musandam. The absence of immediate reporting in some cases, where the staff or fishermen or local community do not promptly report an oil spill, can delay the initiation of investigative efforts, ultimately hindering the task of tracing the source. Additionally, adverse weather conditions or difficult-to-reach locations can further exacerbate these time constraints. According to KI-16,

> *"time constraints present a significant challenge in dealing with oil pollution incidents. Although the pollution may be reported promptly, our resources may be occupied with other tasks, with national security taking precedence. In some cases, the delay in responding to the report may diminish our chances of identifying and apprehending the polluter."*

Likewise, KI-17 (a government respondent) said:

> *"the identification of unknown oil spills is challenging, and the success of the operation depends on the response time. The quicker and more immediate the response, the higher the possibility of identifying the source of the spill. However, taking oil samples from affected beaches for comparison with crude oil from tankers passing through the Strait of Hormuz can be difficult. It is important to obtain fresh oil samples to be able to compare the oil spill characteristics with the tanker's crude oil. Unfortunately, in some cases, the oil reaches the beach after several days, and the unique characteristics of the oil can be lost, making it difficult to determine the source".*

An additional traceability problem in Musandam is caused by its rugged coastal terrain and intricate waterways which impedes rapid response efforts, especially during adverse weather conditions. Strong currents and unpredictable weather patterns can swiftly disperse spilt oil, erasing any discernible trail. Over time, this dispersion effect intensifies, further complicating efforts to identify the spill's origin (Chen, et

al., 2019). The rapid dispersal of spilled oil is attributable to intricate interplays between ocean currents and meteorological conditions, as highlighted by Zodiatis et al. (2017). This dynamic process underscores the challenges in containing and mitigating the impacts of oil spills on marine ecosystems and coastal areas.

Another obstacle for Musandam is international freedom of navigation regulations. The Strait of Hormuz is recognized as international waters. According to Elmahjoub, (2023) mentioned the matter of international freedom of navigation concerning the Strait of Hormuz holds paramount importance for Musandam due to its position at the strait's entrance. Acknowledged as international waters, any hindrance to the unimpeded passage through this vital maritime route could carry substantial repercussions for global maritime commerce and security. Therefore, it is imperative for all nations to adhere to international regulations safeguarding the freedom of navigation in strategic chokepoints like the Strait of Hormuz.

It is a strategically vital passage that connects the Persian Gulf with the Sea of Oman and the Arabian Sea. As international waters, the Strait of Hormuz is subject to the principles of freedom of navigation and the right of innocent passage for vessels from any nations, allowing for the unimpeded movement of ships through this critical maritime corridor (Radha, et al., 2022). Any interference by Oman with vessels traversing the Strait of Hormuz could provoke considerable pushback from their flag states.

5. Solutions to the difficulties of tracing oil spillers

Participants agreed that the traceability issue in Musandam is made more difficult by the absence of integrated control measures, including satellite images and ground surveillance. Using these tools requires a large budget and consistent funding. This would ensure constant monitoring, instilling a sense of vigilance among potential violators and ultimately mitigating future pollution. Considering this, one respondent proposed the establishment of a compensation fund, a portion of which would be earmarked for bolstering marine monitoring. According to KI-12 (a government participant), "*The main challenge lies in securing the necessary financial resources, especially in cases of oil incidents in Musandam with unknown sources. I suggest establishing a compensation fund dedicated to pollution control operations and a part*

of it should be assigned to enhance marine environmental monitoring, which entails substantial costs for both aerial surveillance and specialised vessels".

Alpers, et al. (2017) emphasized the significance of remote sensing technologies, particularly Synthetic Aperture Radar (SAR), as essential tools for monitoring oil spills. These technologies offer data irrespective of the time of day and prevailing weather conditions.

Many respondents asserted that the best way to meet these traceability challenges was to employ advanced technology. Satellite imagery, aerial surveillance, and sophisticated drift modelling would contribute significantly to reconstructing the spill's trajectory, offering valuable leads for investigators (Barker, et al., 2020). According to KI-43 (an international respondent), satellite surveillance deterred spillers:

> *"It has been proven by CleanSeaNet that systematic surveillance using satellites, coupled with verification activities of Member States create a long-term deterrent effect for pollution. Therefore, in my view that is the most efficient way to the protect maritime environment: systematically monitor, investigate, and enforce, thus creating a deterrent effect to polluters".*

Ivshina et al. (2015) said satellite images can help identify oil spills in the ocean, tracking their movements to help find the source of pollution; aircraft can be used to collect oil samples from oil slicks. Aircraft can be equipped with specialized aerial sampling devices, include scoops or containers attached to the aircraft, which can be deployed and retracted during flight to collect representative samples, which can be analysed to identify the type and source of the spill; and ships can deploy buoys (barriers) to trap the spills to be collected. By taking into account variables such as currents, winds, and waves, oil spill models may be able to accurately predict the movement of an oil spill and thereby identify potential sources of the spill. According to KI-30 (a regional participant), this entails military involvement: *"particularly, we concern to find the polluter. In order to find the polluter, you need to have effective satellite imagery detection and engage in aerial surveillance. When we talk about aerial surveillance, we need to engage military forces in this in order to be a really effective mechanism to stop all oil spills".*

Of course, all this is time-consuming, as KI-40 (An international organization participant) notes: *"Investigations into oil spills can be intricate and time-intensive endeavours".* It is also expensive. Nevertheless, such strategies are beginning to be applied. According to participants in this study, various initiatives are being undertaken internationally, regionally, and locally, to track down untraceable culprits. Internationally, the first measure involves the deployment of advanced surveillance technologies tailored for detecting oil spills. This includes the use of satellite imagery, aerial surveillance, and specialized sensors that enable rapid and accurate identification of oil slicks on water surfaces. According to KI-46 (an international participant), *"I would say that the key element of Canada, especially for what was called the mystery spills on the east coast of Newfoundland is aerial surveillance".* This is the meticulous tracking of ship movements by continuous monitoring and recording of vessels' positions, routes, and activities using advanced technologies like Automatic Identification System (AIS) and radar systems. According to KI-1 (a government participant), *"Ship movements can be tracked using satellite imagery and other technologies".* KI-41 (an international participant), referred to the use of AI and AIS technology:

> "*I think it depends on access to technology which can help! We now have multiple owners of modern satellites offering an increasing availability of high-resolution imagery available across the world. We also have wonderful, generally small, innovative organizations like Orbital EOS, which use AI to interrogate these images. This technology linked to AIS tracking of vessels means that it is possible to track rogue vessels that pollute. If there is a sample taken of the spill which can then be matched to a sample of the product on board the rogue vessel and a prosecution can be concluded".*

According to Zhou et al. (2019), the utilization of Automatic Identification System (AIS) data plays a crucial role in analyzing ship behavior within ports. By furnishing essential details on ship positions, speeds, and other behavioral characteristics at defined time intervals during sea voyages and port activities, AIS data facilitates the monitoring and examination of ship behavior patterns. This capability aids in comprehending the navigation of ships within port zones and their interactions with one another.

KI-29 (a regional participant), also highlighted AIS:

> *"With the new technology* (AIS), *where there is a station to track ships and tankers, in addition to satellite images, it helps in identifying and adding those responsible for oil pollution, but in the Gulf region, we may need to increase our capabilities in this field, for example, if we rely on satellites and ship tracking* (AIS). *We used oil pollution tracking using specialized software for wind and wave movement that will help us determine the source of the pollution".*

KI-43 (a respondent from the European Maritime Safety Agency (EMSA) described cross-referencing with vessel reporting systems:

> *"CleanSeaNet provides detection of possible pollution and identification of potential polluters, providing this information to Member States for further investigation. The identification of the polluters is done by cross-referencing with vessel reporting systems (AIS, LRIT and VMS) and trying to cross-check the vessels that can be the origin of the spill. This is somewhat straightforward if there is high frequency of satellite monitoring and low traffic… but difficult in high traffic areas where multiple vessels can potentially be the culprits".*

KI-47 (an international interviewee) explained how Trajectory Modelling worked to identify mystery spillers:

> *"Our primary method is going out and putting eyes on and looking at it and seeing if something is obvious based on where the spill is. We work with NOAA to do Trajectory Modeling, so they'll plug in images or information about oil and where it's at and they can run a drift model to maybe see where it came from or how old that oil might be. We also rely on taking samples of the oil and then we send those samples to a lab. Then, if we do find a vessel that is suspect of discharging oil, we can match our sample with the oil that's on board that vessel. The Gulf region also utilizes the Trajectory model, which NOAA forms for the Gulf region".*

KI-37 (a regional interviewee) explained how the Vessel Traffic Control System (VTCS) worked alongside other systems:

> *"According to the new monitoring system, let us talk about the Vessel Traffic Control System (VTCS). This is the main thing in addition to the Automatic Identification System (AIS). So, these two systems are going to show us the first lines to start our investigation to know which ship caused the oil spill or which ship caused the oil incident. Then the field inspection. In addition to other monitors, satellite images or aircraft by helicopter or fixed-wing aircraft. Also using drones which provide live monitoring and high-resolution pictures".*

Emerging technologies such as drones have become indispensable in contemporary times for efficiently detecting oil spills offshore. According to KI-41 (an international respondent) *"Adding drone capability at your high-risk points on vulnerable coastlines, enables you to maintain security".*

INTERPOL, the International Criminal Police Organization, which has established a specialized unit dedicated to addressing environmental crimes, plays an important role in looking for solutions to mystery spills (Borlini, 2022). This organization conducts coordinated global operations focused on combating marine pollution. These operations target a range of offenses related to pollution at sea, including oil spills, improper discharging, and ballast water infractions (Costa, 2022). In collaboration with coast guard and environmental agencies, INTERPOL actively investigates the origins of mysterious spills occurring at sea (Environmental Security Programme, 2022; Gibbs, et al., 2015).

However, these sophisticated and powerful technologies are not guaranteed to trace mystery oil spillers. The limited accuracy of satellite-based oil spill detection often leads to substantial validation expenses, as ships or aircraft need to be dispatched to confirm the satellite's initial observations as stated by KI-43, representing the European Maritime Agency in the surveillance domain, despite *"the sophistication and potency of modern technologies, there is no assurance of effectively identifying anonymous perpetrators of oil spills. The inherent limitations of satellite-based oil spill detection frequently result in considerable validation costs, necessitating the dispatch of ships or aircraft to verify initial satellite observations. Furthermore, satellite technologies often lack the capability to accurately estimate the volume of oil*

discharged into the sea, a crucial aspect necessary for legal prosecution proceedings". Also, satellite technologies fall short in providing an estimate of the volume of oil released at sea, which is a pivotal piece of information for legal prosecution purposes. Furthermore, on its own, satellite evidence may not hold sufficient weight for conviction in any court of law; it should be used in conjunction with other forms of evidence. As a powerful supplementary piece of evidence, visual confirmation must ideally come from an eyewitness on the ground to be admissible as proof (Leboeuf, 2012).

Despite the widespread use of satellite-based oil spill detection, the significant validation expenses incurred due to the limited accuracy of satellite observations raise concerns about the cost-effectiveness of this approach. Moreover, the reliance on satellite data may introduce delays in response efforts, particularly when speedy verification through ships or aircraft is required. Additionally, the inability of satellite technologies to provide accurate estimates of oil volume released at sea poses challenges for legal prosecution, potentially undermining efforts to hold responsible parties accountable. These issues highlight the complexities and shortcomings associated with current surveillance technologies for addressing oil spills in marine environments.

6. Conclusion and recommendations

The problem of untraceable oil spills is a formidable challenge that can complicate efforts to respond to and remediate oil spills. Mystery oil spills are a serious concern in the Strait of Hormuz for the environment and for the people who live and work in the area. It is difficult to say whether the proportion of oil spills caused by untraceable culprits is increasing or decreasing, as the data on these spills are limited and not always easily accessible. The overall number of major oil spills has decreased significantly over the past few decades especially, but small spills are often clandestine or result from accidental or unnoticed releases. Consequently, such incidents are frequently underreported and therefore omitted from the dataset. It is likely, therefore, that small-scale spills are on the rise, and as a result, the number of mystery spills is probably increasing since most mystery spills are small-scale.

All forms of environmental pollution typically trace back to human causes; however, in the case of mysterious oil pollutions, identifying their owners or sources becomes challenging due to several factors. These factors include considerations like cost reduction or time constraints, contributing to the evasion of responsibility.

To transform untraceable spills into traceable ones, it is imperative to implement a multi-faceted approach. This includes the utilization of advanced technology such as satellite imagery and the deployment of drones. Additionally, the provision of a specialized laboratory for collecting samples and conducting fingerprint analysis is crucial. The strengthening of international regulations is necessary to mandate immediate reporting of oil spills by ships and the provision of information about their cargo and destination. Governments can engage in partnerships with other nations in areas susceptible to oil spills to promote international cooperation in oil spill detection and tracking. It is also crucial to increase public awareness regarding the issue of untraceable oil spills and to promote the reporting of any suspicious maritime activity. However, it is important to recognise that even with the implementation of all these measures, we would not be able to end the problem of untraceable oil spills. All we can hope for is, by taking these steps, to reduce the risk of these spills and their impact on the environment and human health.

In conclusion, Chapter 6 has explored the complexities surrounding untraceability, shedding light on the challenges it poses. It underscores the ongoing efforts utilizing advanced satellite systems and sophisticated methodologies aimed at enhancing vessel tracking and implementing fingerprinting techniques. These technological advances signal a proactive approach towards addressing the technical hurdles posed by untraceable sources of pollution, paving the way for potential solutions to mitigate their impact and strengthen environmental accountability, thereby meeting the prime demand of environmental justice. This chapter lies at the heart of the thesis, demonstrating the current intractability of the problem of dealing with mystery spills but pointing the way to potential solutions in the future by the employment of advanced technological tools, including AI. The lessons learned in this chapter are taken up in the next chapter where there is a wide-ranging discussion of the four main issues raised by the research.

CHAPTER 7. Discussion: The Problem of Mystery Spills

1. Introduction

This Discussion chapter will focus on four main issues which have emerged during this research. First, why have policy makers and environmental NGOs largely ignored small-scale mystery oil spills in Musandam? Second, why are mystery spills so difficult to trace to their perpetrators? Third, what are the solutions to deal with mystery spills put forward by the literature and key informants? Fourth, how viable is the proposal to establish a Gulf Regional Fund for dealing with mystery oil spills?

2. Why have policy makers and environmental NGOs in Oman largely ignored small-scale mystery oil spills in Musandam?

2.1 Large-scale and small-scale oil spills in Oman

Oman has experienced relatively few large-scale oil spills from known sources in the past decades: they occur on the Omani coasts at a rate of only one every five years (IOPC Fund, 2022; Environment Authority, 2020a; Environment Authority, 2023). The government of Oman follows up on these rare incidents, either alone or in cooperation with international organisations to pursue the perpetrators, to obtain clean-up funds and compensation for victims, and to restore the marine environment (El-Habr & Hutchinson, 2008). However, the picture is very different for small-scale oil spills from untraceable sources. There are no official figures nor any published research on such spills, but KI and FGD participants in the current study confirmed the occurrence of numerous small to medium-sized mystery oil spills, particularly in Musandam waters. According to FGD-1, (Kumzar fishermen) "oil spills have been very common in Musandam Peninsula for more than 50 years, occurring sometimes offshore and along the beaches".

These participants all said these spills pose a grave threat to the marine environment in Musandam, affecting not only aquatic ecosystems but also the livelihoods of coastal communities as they added *"these spills pose a grave threat to the marine environment in Musandam, impacting not only aquatic ecosystems but also the livelihoods of coastal communities"*.

This study has examined the prevalence of mystery spills in the Musandam area which mainly occur on a small to medium scale (less than 700 tonnes). Despite concerted efforts to identify the responsible parties, a conclusive source is seldom determined in the aftermath of these incidents according to KI-8, (representing the Airforce) noted that despite possessing modern equipment such as the CASA plane equipped with cameras and sensor tools, it remains challenging to cover all of Oman's extensive coastal zones, which stretch over more than 3,165 kilometers. It is crucial to underscore that while these mystery spills may not reach the magnitude of large-scale events, they still inflict serious damage on the coastal fishing industry and the local economy (Ivshina, et al., 2015).

2.2 Reasons for little attention to small-scale oil spills

The question arises, therefore, why has so little attention been paid to the issue of small to medium scale oil spills in Musandam? Is it a case of 'out of sight out of mind'? In other words, is it because the Musandam Peninsula is such a peripheral part of Oman that its problem of small oil spills falls below the radar of political concern in Oman, the Gulf region and the international community? This explanation gains credibility when we consider how tempting it might be for Muscat to ignore the plight of Musandam. The governorate of Musandam is geographically remote from the capital – 600 km – and the cost of transporting oil spill detection and remediation equipment by sea or air (overland would be through the UAE which raises diplomatic issues) to deal with small oil spills is disproportionately expensive. Also, Musandam comprises a very small population -only 49,698 people in a country of 4,527,446 people in 2021 – i.e., 1.1 % (The National Centre for Statistics and Information, 2022).

Moreover, there may be a class dimension to the neglect of Musandam residents in that they could be described as working-class victims of environmental injustice at the hands of two elite groups: (1) a foreign elite of wealthy oil tanker owners who dump oil on their shores and invariably escape detection and compensation claims for clean-up and loss of income (external environmental injustice) (Ashok, 2021; Environment Authority, 2019); and (2) a domestic elite of the ruling class in Muscat who are blind to the inequitable distribution of environmental harm between different communities within Oman (internal environmental injustice). It seems that the government has

ignored the concept of environmental justice in its policy towards Musandam stakeholders.

2.3 Cultural factors

It is worth asking why the residents of Musandam, including fishermen and other sea-dependent individuals like divers, have not been more active in complaining to the authorities. For instance, why have they not organized boycotts or direct-action during visits by government officials to the governorate? The answer to this question may be because the Musandam people are mostly tolerant and conservative by nature: they do not protest on the streets against governmental policies which they perceive as unfair According to Ottaway and Ottaway (2020), the term "quiescent" is used to depict citizens who are docile, reflecting a state of inertia and resignation experienced in the middle east. Consequently, the political elite has not felt compelled to address the citizens' demands more earnestly. There is a culture in the Peninsula that is quiescent to the point of inertia and resignation. One example of this resignation is the fact that most fishers have given up reporting oil spills to the Environment Agency in Muscat because they have received little or no response on many previous occasions. As a result, the grievances felt by fishers in Musandam when oil spills prevent them from fishing or selling their contaminated fish are expressed in private and do not reach the public domain. KI-59 (local resident and Khasab city Council) stated that *" When the oil spill occurred in Dorsany village in 2019, all the fishermen dependent on the sea were unable to fish for a period exceeding two weeks. Unfortunately, their grievances were only communicated as far as the city of Khasab and did not reach the wider public opinion".*

An obstacle to public protest exists in the form of low levels of education in Musandam, which often hampers the socio-economic development of local communities. Considering the insights provided by Oloyede and Ogunfolaji (2021), it is crucial to recognize that barriers to public protest, such as low levels of education, can impede the socio-economic progress of local communities. Limited education among individuals may result in a lack of essential knowledge and skills needed for advocating their rights and participating in endeavors that foster socio-economic advancement. Furthermore, inadequate education levels can restrict economic prospects and diminish access to resources, thereby exacerbating the challenges faced

by communities in achieving development goals. There is an intricate relationship between the low level of education and the empowerment of local voices in these regions: the community voice is interconnected with the level of education. In Musandam, the first school was established in the mid-1970s, so most of the population lacked formal education before then. In the 2020s, there is still much illiteracy in Musandam (The Directorate General of Education in Musandam Governorate, 2022). This low level of education is associated with restricted civic engagement within local communities, as illiteracy and a lack of awareness hinder community members' active participation in democratic processes and advocacy for their rights. During the early years of the petroleum boom from the 1960s to 2000, the region faced a dual challenge: the absence of a robust regulatory framework to deter and penalize oil polluters, and a general lack of awareness in society regarding the crucial importance of environmental preservation (Chilvers, et al., 2021; Okonkwo, 2020).

2.4 Communication issues

Kimutai and Aluvi, (2018) pointed out that communication challenges, such as illiteracy and ignorance, were identified as significant obstacles in Kisumu County, where 55% of respondents cited this issue. They emphasized that insufficient understanding of government procedures among community members hampers the extent and effectiveness of public participation in the county, potentially resulting in limited awareness of democratic processes and citizens' rights, thereby impeding active engagement in governance and advocacy efforts. The study proposes intensifying civic education as a solution to these challenges to enhance both the scope and quality of public participation in Kisumu County.

This situation understandably leads to a sense of isolation and marginalization among those affected, which reveals a flaw in the political system - a tendency to side-line communities on the periphery, erroneously deeming them less important than residents on the mainland (Sylvestre, et al., 2018). This is unacceptable: no group, regardless of their physical location, should be dismissed or marginalized, as their concerns and well-being are equally valid to those of every other group in Oman.

Is this failure to communicate to the Oman government the injustice of undealt-with oil spills in Oman due to the non-democratic nature of the political system in the

country? Oman's political system is monarchical not democratic: the Sultan is an unelected holder of supreme power (Peterson, 2016). However, there are consultative bodies, including the national Shura Council which serves as a kind of parliament and has members who are elected every four years; the elected Municipal Councils; and the Sunnan Al-Bahar committees (Sea Code) in the coastal states whose function is to alert the government to public opinion in the country. So, although in Oman there is no commitment to the principle of democracy, there is a commitment to the principle of consultation. The residents of Musandam have representatives who are meant to convey their concerns to decision-making bodies in Muscat. Why have these representatives from Musandam not taken more assertive action to draw the government's attention to this critical issue? Their role should be to amplify the voices of the affected community, making their concerns heard and pushing for meaningful change. The apparent silence or lack of advocacy from Musandam raises concerns about whether these representatives are effectively fulfilling their duty to represent the interests of their constituents. This situation calls for a closer look at the advocacy structures in place and whether they need to be strengthened to better serve the community of Musandam. According to KI-64 (Sheikh of the local communities), the Musandam region's considerable distance from the capital, Muscat, coupled with its separation from the rest of the country by the UAE and its relatively low education levels, resulted in the limited reach of the voices and concerns of the people and residents to the government.

2.5 Stakeholder participation deficit

In theory, Oman is committed to the stakeholder participation principle in environmental justice, at least so far as it endorses the notion of consultation (Cottonne & Mahroos-Alsaiari, 2015). This implies that stakeholders such as people in local communities, environmental organizations, industry representatives, and government agencies, should have access to accurate and up-to-date information regarding oil spill incidents, their potential impacts, and proposed mitigation measures (Walker, et al., 2018). This could involve providing them with reports, studies, and data related to the spills. Also, it implies that the concerns, perspectives, and recommendations of stakeholders should be taken into account when formulating policies or making decisions related to oil spills. This would demonstrate a genuine

commitment to incorporating their input. Moreover, this engagement with stakeholders about oil spills could be permanently maintained, even when there are no immediate decisions to be made, because this helps build confidence and mutual trust. Effective stakeholder engagement in the remediation process would lead to more informed, inclusive, and sustainable outcomes for all parties involved (Walker, et al. 2015). Why, then, is there little or no such consultation undertaken currently by the Oman government in the Governorate of Musandam on residents' grievances about oil spills?

2.6 Other principles of environmental justice

This deficiency is especially puzzling given Oman's endorsement of other principles of the concept of environmental justice. For example, according to the National Centre for Statistics and Information, (2023), the government of Oman has enthusiastically embraced the principle of sustainable development by placing a strong emphasis on the 'Blue Economy' which entails formulating specific strategies aimed at preserving fish populations, ensuring the sustainable use of marine resources, and maintaining the cleanliness of seawater. The key initiatives of the Blue Economy are as follows:

- Collaborating with FAO and the World Bank to develop a comprehensive national strategy for fish abundance up to 2040.
- Identifying the fish sector as a promising area of focus within the Ninth 5-year development plan.
- Implementing measures, aligned with Objective 14-4, to regulate fishing activities effectively, curbing overfishing and combating illegal practices.

Sustainable development seeks to promote economic prosperity in a way that does not compromise future generations' ability to meet their own needs (Pedersen, 2013; Mensah & Casadevall, 2019). It demands safeguarding the environment, supporting communities, and promoting responsible resource management for the well-being of both present and future generations. This would seem to require effective oil spill remediation to safeguard industries dependent on clean and healthy environments, such as fisheries and tourism, and also measures to guarantee social equity to ensure that all members of society benefit from development efforts and that vulnerable

communities are protected from disproportionate harmful impacts (Wali, et al., 2017). So why does the Oman government not apply this commitment to sustainable development to the oil spill problem in Musandam?

Oman's endorsement of another principle of environmental justice can be seen in the country's legislation for the protection of the natural environment which explicitly approves of the polluter pays principle (Zekri, 2020). The Environmental Protection and Pollution Control Law (Royal Decree No. 114/2001) establishes the legal framework for environmental protection and pollution control in Oman. Article 10 of this law states that "the polluter shall bear the costs of cleaning up pollution and rehabilitating the environment to its natural condition". The Environmental Impact Assessment (EIA) Regulation, issued under Royal Decree No. 15/92, explains that the polluter pays principle ensures that potential polluters, such as companies engaged in industrial projects, are responsible for assessing and mitigating their environmental impacts. This includes the allocation of resources for environmental protection measures.

Oman also appears to accept a third principle of environmental justice - the beneficiary pays principle – which requires that those who benefit from activities such as oil-related operations that may lead to environmental harm should bear the costs of preventing or mitigating that harm. Oman applies the beneficiary pays principle across various sectors associated with the marine environment. For example, it has levied licensing fees on commercial fishing operations, directing the proceeds towards the oversight and regulation of the industry (Al-Busaidi & Jukes, 2015). Moreover, in the realm of port and maritime activities, Oman has imposed fees and charges on entities engaged in shipping, port operations, and related maritime ventures to pay for the maintenance and enhancement of port infrastructure and navigational channels, and to implement measures for environmental protection (Choudri,.et al., 2016) Furthermore, companies involved in coastal development projects have been required to allocate funds for habitat restoration and to support research and educational initiatives focused on marine conservation and sustainable resource management and environmental protection (Bartholomew, et al., 2022).

Oman's legislation regulating the oil production industry explicitly holds the industry responsible for its externalities. This regulation requires that oil production companies

are liable for the costs associated with preventing, responding to, and mitigating potential pollution, including expenses for equipment, training, clean-up efforts, and compensation to affected parties (Masan, 2016). This approach aligns with the beneficiary pays principle by placing the financial responsibility on those who directly benefit from or contribute to activities affecting the marine environment, requiring them to shoulder a portion of the costs associated with environmental protection, conservation, and sustainable resource management. This approach effectively internalizes environmental costs, fostering responsible practices. Why does the Oman government not apply the same regulations to the oil transporting sector?

Two more principles of environmental justice have been adopted by Oman – the prevention principle and the precautionary principle. Oman applies the prevention principle across various sectors, prioritizing proactive measures to mitigate environmental risks. For example, strict industrial regulations are enforced to prevent environmental harm (Amna, et al., 2023). This entails setting emission standards and waste disposal protocols and implementing safety measures to minimize the risk of accidents. For coastal development projects, Oman requires rigorous environmental impact assessments. In addition, the country has established environmental guidelines for tourism activities near coastal areas, including rules for waste management, wildlife protection, and responsible tourism practices. The prevention principle is also visible in Oman's acceptance of the ruling by international organisations that ships transporting oil must be double-hulled, which represents a significant advance in maritime safety and environmental protection (Zhang et al., 2021). In double-hulled vessels, one hull holds ballast water for stability, while the other is filled with oil. A participant KI-2 (Omani government participant) highlighted *"the adoption of this strategy as a crucial measure to safeguard the marine environment, thereby underscoring the government's commitment to responsible and environmentally conscious practices in maritime activities and aligning with international efforts to enhance maritime safety and environmental protection"*. So why does the Oman government not apply the prevention principle to the situation of small-scale mystery oil spills in Musandam?

2.7 Environment Authority

The precautionary principle is evident in some of the policies practised by Oman's Environment Authority (EA) which is the government agency tasked with developing plans and initiatives to protect the environment and conserve natural resources (Al-Awadhi, et al., 2022). The precautionary principle entails taking proactive measures to minimize the impact of potential oil spills even in the absence of complete scientific certainty that such measures are necessary. One example of a precautionary measure taken by the EA is outlined in the Oman National Oil Spill Contingency Plan where part of its remit is to carry out practice drills in anticipation of future spills (Environment Authority, 2022). These regular and realistic emergency response drills are designed to test the effectiveness of protocols to deal with spills, helping to identify weaknesses and enabling adjustments to be made in procedures.

However, the EA fails to implement the precautionary principle in many other ways in dealing with oil spills (Oman observer, 2023). For example, it does not have a comprehensive oil spill response plan that specifies actions, resources, and protocols for immediate and effective response in the event of a spill. It does not apply advanced monitoring technologies such as satellite imagery, drones, and remote sensing to enhance early detection of spills and assess their extent and impact. It has no plan to create protective buffer zones around ecologically sensitive areas to minimize potential damage in the event of a spill. It does not foster collaboration between government agencies, industry stakeholders, environmental organizations, and research institutions to share expertise and resources for improved spill prevention and response.

The EA claims it takes seriously its duty of responding quickly and effectively to oil spills, but critics reply that if true, this is only in the case of large-scale spills when their source is known. However, in the case of small-scale mystery spills, Musandam residents claim, the EA is nowhere to be seen. Numerous key informants (KIs) and participants in focus group discussions (FGDs) in the Musandam area, when asked about the apparent lack of any visible presence of remediation equipment, claim to have never encountered any such equipment in the region. According to them, remediation and clean-up operations have primarily been carried out in Muscat and

other regions on the mainland that have experienced major oil spill incidents, which typically occur from known sources.

All this signifies a lack of political will on the part of the Oman government to take the problem of small-scale mystery oil spills in Musandam seriously as an issue of environmental justice, despite its commitment to the application of several principles of environmental justice in other areas of policy. Perhaps the government takes the view that enforcement of this legislation is too costly for the sake of what government officials regards as a minor breach of environmental justice. Perhaps the government's lawyers have said the difficulties of enforcing the polluter pays principle in Musandam - particularly in identifying who is responsible and to what extent they are responsible and what the consequences might be for holding polluters responsible (including bankruptcy) - are so great that they outweigh the likely benefits. Perhaps the issues of determining a fair rate of compensation are too formidable, particularly regarding the assessment of long-term damage since there is an ongoing debate about the extent to which ecosystems and communities are affected by oil spills, and how enduring these impacts may be.

3. Why are mystery spills so hard to attribute to their perpetrators?

3.1 Legal gap

Currently, there is a notable absence of any regional or international agreement explicitly addressing the issue of liability for damages arising from mystery oil spills. While international maritime law has made considerable strides in regulating oil pollution incidents, it primarily focuses on scenarios where the responsible party is identified (Giannopoulos, 2019). Mystery spills, characterized by their elusive origins, present a formidable challenge as no specific entity can be held accountable (Aladwani, 2020). This legal gap leaves affected parties, including coastal communities and ecosystems, without a clear framework for seeking compensation or assigning responsibility, and this is a breach of the concept of environmental justice. There is a pressing need for the development of regional and international agreements that specifically address the complex nature of mystery oil spills and establish clear

guidelines for liability and compensation. Such agreements would serve to safeguard both the environment and the interests of communities impacted by these incidents.

3.2 Technical problem

Is the difficulty of dealing with mystery spills in Musandam a technical problem; a logistical problem; a financial problem; a political problem; or a combination of them all? The technical problems are immense. Satellite evidence is difficult to obtain because of the vast areas of sea in the Gulf to cover. Moreover, relying solely on satellite data may not provide conclusive evidence of oil spills that would stand up in court: it must be complemented by sample collection or human verification. Furthermore, identifying the ships responsible for oil pollution is a challenging task that depends on the timing of pollution monitoring and the duration of pollution at sea, which are difficult to determine without specialized knowledge. Pollution spots may shift from one site to another, making it hard to pinpoint the source of pollution. The sheer volume of ship traffic passing through the Strait of Hormuz further complicates the issue, with many vessels transiting the waterway every hour (Modarress et al., 2012; Al-Maamary et al., 2017). Moreover, it may take several days for the oil pollution to reach the shores, by which time the violating ship may have left the area, making it almost impossible to identify the offending vessel (Amir-Heidari, & Raie, 2019; Zhang, et al., 2019).

However, technical solutions are being developed all the time. For example, advanced satellite imagery and remote sensing technologies provide real-time monitoring capabilities, enabling prompt identification and tracking of oil slicks over vast expanses of water (Shamsudeen, 2020). This swift detection allows for quicker response times, minimizing the potential environmental impact. Additionally, specialized sensors and detectors, both onshore and onboard vessels, have become increasingly sophisticated, enabling precise measurements of oil concentrations in water. This level of accuracy is crucial for assessing the extent of contamination and implementing targeted clean-up efforts. Furthermore, unmanned aerial vehicles (UAVs) and autonneomous underwater vehicles (AUVs) equipped with specialized sensors can access hard-to-reach or hazardous areas, providing invaluable data for response planning. Infrared cameras can also be used to enhance the system’s

detection abilities, allowing the system to collect valuable information in real-time, including during the night, allowing faster responses (Kato, et al., 2017). Other methods like oil fingerprinting refer to a set of techniques being used to analyse and identify the source or origin of a specific oil sample (Ismail, et al., 2016). So, although the technical problems of identifying the sources of mystery spills are immense, researchers are rapidly developing solutions to solve them, and the possibility of employing artificial intelligence (AI) adds a boost to confidence that these solutions will become even more robust in the not-too-distant future (Bukin, et al., 2021).

3.3 Logistical problem,

The logistical problem is an important challenge because tracking oil spills between neighbouring countries presents multifaceted issues (Aldosari, 2019). First, shared waterways, such as seas, oceans, or large lakes, mean that an oil spill originating in one country's waters can easily cross into the territory of another, necessitating close communication and cooperation between the affected nations (Zacky, et al., 2021). In addition, transboundary currents, influenced by ocean currents and tides, can transport spilled oil over vast distances, making it difficult to predict its precise trajectory and complicating the determination of which country bears primary responsibility for clean-up efforts (Barker, et al., 2020). Moreover, establishing legal jurisdiction over the spill can be difficult as the spill's exact location and the point at which it crosses into another country's waters may not align with geographical or political boundaries, potentially leading to disputes over responsibility (Zhang, et al., 2021).

In regions lacking comprehensive surveillance systems, delays in detecting and reporting oil spills can occur, allowing them to spread and potentially affect neighbouring countries before even being identified (Asif, et al., 2022). Prompt coordination for containment and clean-up is vital, but response time can be hindered by delays in communication, decision-making, and resource mobilization, especially in cases involving several countries (Chen, et al., 2019). Effective collaboration necessitates transparent and open communication between neighbouring countries, including sharing critical information about the spill's characteristics, location, and potential impacts (Barker, et al., 2020). However, issues related to data sharing, national security concerns, or diplomatic considerations may sometimes impede this

process (Carnegie & Carson, 2020). Finally, the equitable distribution of responsibilities and resources for oil spill response can be a logistical challenge, particularly when neighbouring countries possess varying levels of resources, equipment, and expertise, potentially leading to imbalances in capacity (Scarlett & McKinney, 2016).

3.4 Financial problem

The financial challenge is a significant hurdle when it comes to addressing mystery oil spills (Zacharias, et al., 2021). The costs associated with clean-up, remediation, and long-term environmental restoration efforts can be substantial (Egan, et al., 2021). In cases where the source of the spill is unknown, governments and responsible parties may struggle to allocate the necessary resources. This financial burden is compounded by the fact that some spills may cross international borders, further complicating the allocation of costs and responsibilities among affected countries. As a result, finding sustainable funding mechanisms to address mystery spills is a critical aspect of effective environmental management. Controlling and monitoring systems are very expensive if operated 24/7. The costs encompass a range of factors, including equipment maintenance, personnel wages, energy expenses, and technology upkeep (Feng, et al., 2021).

3.5 Political problem

Finally, political challenges can significantly affect the response to mystery spills. These challenges can arise on both domestic and regional levels (Zacharias, et al., 2021). Domestically, political dynamics within a country may influence decision-making processes, resource allocation, and accountability measures related to oil spill response. Regionally, coordinating efforts among neighboring countries or across regions can be complicated by geopolitical considerations, differing national policies, and diplomatic relations, especially in the Gulf where relations between states are often fraught. Member states have to try and ignore such political conflicts as they share the Guld waters and work under the umbrella of the Kuwait Regional Convention and its Protocol, which are both obligations for them. Additionally, economic considerations, such as differing capacities to fund clean-up efforts, may create disparities between member states in their ability to address spills (Katsanevakis, et al., 2015).

3.6 Oman's options

However, whatever the problems of dealing with mystery spills, the Oman government must address them. Some other countries have managed to do so. Canada, the USA, China, New Zealand and Finland are among the countries that have established national oil compensation funds which to some extent cover mystery spills. It is true that these five countries are relatively affluent, and three of them have strong environmental credentials and well-established green parties and NGOs that keep their governments up to the mark. Countries in the global south like Oman may not have the resources to allocate millions of dollars for compensating their citizens for spills originating from unknown sources, nor do they have powerful green NGOs barking at their heels according to KI-2, (an official participant representing Oman), *"the government of Oman is unable to provide compensation for fishermen and victims impacted by mystery oil spills. Compensation has been provided solely when the source of pollution is identified, typically through the IOPC fund or P & I club, furthermore, we lack influential NGOs to amplify our concerns. ".*

However, Oman does have the resources to address at least some of the problems posed by mystery spills as a critical issue of environmental protection. First, the Oman government could acknowledge publically that there is a problem of mystery spills in Musandam and clarify the definition of mystery spills in legal terms as a scenario where the responsible party cannot be readily identified (Kurtz, 2013). Second, Oman could conduct comprehensive risk assessments to identify potential sources of oil spills and their associated risks (Chang, et al., 2014). Third, the government could develop detailed contingency plans outlining prevention measures, response strategies, and resource allocation (Shi, et al., 2019). Fourth, it could set out mandatory reporting and notification protocols for any suspected or observed mystery spills (Ziccardi, et al., 2015). Fifth, it could familiarise itself with the latest technologies and innovations in oil spill prevention and identification. Sixth, it could outline procedures for thorough investigations to determine the source and party responsible for mystery spills. Seventh, it could establish a liability framework for mystery spills, including provisions for compensation to affected parties (Hemminger, 2021). Eighth, it could enforce a stringent regulatory framework for governing oil-related activities with strict standards for equipment maintenance, operational procedures, and spill prevention measures (Iheriohanma, 2016). Ninth, it could lay

down penalties for non-compliance with reporting, notification, and investigation requirements (Chioke, 2021). Tenth, it could establish channels for collaboration between governmental agencies, industry stakeholders, and regional and international organizations to share information and expertise in addressing mystery spills (Liverani, et al., 2018).

4. What are the solutions put forward by the literature and key informants?

The most important sources of solutions to the problem of dealing with small-scale spills in Musandam are literature: for example, Crini & Lichtfouse (2019) and the key informants. Table 7.1 lists the eight most favoured solutions from both sources and outlines their respective advantages and disadvantages.

Table 7.1: An overview of the advantages and disadvantages of the solutions proposed by the literature and key interviewees for dealing with unattributable marine oil spills in the Gulf. (Sources: multiple sources) and KI interview transcripts)

#	Solution type	Advantages	Disadvantages
1	The establishment of an oil spill fund for the Gulf region, financed by a levy on oil tanker companies.	• Implementing the IMO Circular No. MEPC.1/Circ.803 will provide MERCU as a system to establish a fund. • It will establish a permanent regional fund to deal with current and future oil spills (Clark, et al., 2018). • It will bridge funding gaps for climate and sustainable development. (Zubedi, A., et al., 2018). • It will facilitate the development of sustainable financial mechanisms (Wang, & Zhi, 2016). • It will support research and innovation. • It will provide long-lasting solutions to marine environmental problems in the Gulf (Chang, et al., 2014). • It will enable clean-up operations to be carried out directly. • It will strengthen regional cooperation. • It will make available money to disburse, even if revenue sources are delayed (De Cola, 2020).	• No legal provisions exist at present for the existence of such a fund. • It will increase costs for shipping industries. • It will create political controversy over who will manage the fund (Frynas, 2012). • It may not deter potential polluters. • There may be difficulty in enforcing compliance with its decisions.
		• Early detection of oil spills. • Cost savings.	• Needs sophisticated connectivity, including

2	Technological solutions	• Sensors can identify both crude and refined oils. • Oil can be detected on the water and on the beaches. • Fully functional in low visibility or darkness so day and night detection in real time could be possible. • Can improve enforcement and compliance. • Provides a better overview of spreading oil spills. • Has a low false alarm rate. • Allows for remote monitoring of ships and sea areas. • Will improve accuracy of monitoring and control capabilities for oil spills (Ivshina, et al., 2015)	internet access (Fingas & Brown, 2014). • New technology is costly to develop, manufacture, install, maintain and update. • It presents a security risk of data misuse or loss: technologies often malfunction, resulting in the deletion of images and videos. • False alarm detectors are expensive (Shamsudeen, 2020). • Monitoring is not accurate e.g., red tide algae on the surface of water can be mistaken for oil. • Operations combining use of satellites, ships and aircraft for surveillance is extremely costly. • Difficulties in locating oil spills in areas with high wind speeds and swift currents (Li, et al., 2016). • Satellite images do not always identify polluting ships.
3	Monitoring solutions.	• Monitoring reduces violations. • It facilitates real-time notifications. • It makes possible the modelling of oil drifts (Zhang, et al., 2019).	• Financial and staff resources in Oman are limited, which means a small number of staff is tasked with patrolling vast sea areas along with their other duties. • Extensive shoreline surveys are time-consuming and costly (Obida, et al., 2021). • Sediment samples are required that need to be analysed in laboratories which are expensive.
4	Monetary penalty solutions	• They increase state revenue. • They deter oil spillers (Ramseur, et al., 2023).	• Serious crimes need a more adequate response than fines (Faure, 2010). • Wealthy criminals will continue to violate the law because they will always be able to pay fines. • Poor culprits may be unable to pay fines. • The source of pollution must be known.
5	International	• Helps achieve common benefits between states (Ostrom, (2017). • Produces a comprehensive, integrated regional pollution	• Conducting joint exercises with other countries requires considerable logistical preparation and political sensitivity

	agreement solutions	regime. • Creates opportunities for effective collective action. • Allows the successful implementation of regional marine environmental protection measures. • Overcomes the free-rider problem of regional marine pollution. • Establishes political, administrative, institutional and legislative frameworks for such collaboration to take place (Knol & Arbo, 2014). • Promotes regional unity in protecting the environment by adopting a harmonized system. • Transparency between regional countries on oil spill preparedness plans allows for smoother response processes (Ishak, et al., 2020). • Facilities the construction of a regional database and geographic information system that helps in the timely identification of oil spills (Moroni, et al., 2019).	(Aldosari, 2019). • Ratification of regional pollution conventions requires national legislation by supporting countries which can be problematic. • Sharing of port state control requires considerable diplomatic skill. • Poor national levels of environmental protection make regional regulations difficult to accept. • Regional conventions take time to establish. • Regional regulations are difficult to enforce
6	Capacity building solutions	• Enables individuals to be able to deal with oil spills during emergencies (Colten, et al., 2012). • Pollution prevention seminars and workshops can be effective in developing self-help. • Particularly helpful in facilitating contingency management plans in high-risk areas. • Leads to local initiatives in clean-up, restoration, and containment. • Increases knowledge of prevention measures among staff	• Requires additional funding for training. • May not be sufficient to deal with the aftermath of oil spills (Al-Majed, et al., 2012).
7	Awareness-raising solutions	• Increases the willingness of the public to report oil spills and therefore expedite speedy remediation (Rossi, 2022). • Improves community engagement in oil spill remediation.	• Depends on the receptivity of the public.
8	Government funding solutions	• Encourages research to be conducted (Cao & Chang, 2022). • Provides compensation to victims of mystery spills. • Tackles oil pollution quickly.	• Requires the government to prioritise oil spill remediation in its budgets (Grubesic, et al., 2019). • Requires the Environment Agency to give priority to oil spill remediation. Gaps in administration especially given the fact that law enforcement officials are tasked with many other responsibilities by the law making it difficult to perform their duties.

5. How viable is the proposal to establish a Gulf Regional Fund for dealing with oil spills?

The centerpiece of recommended solutions to the oil spill problem in Musandam proposed by key informants is to establish a Gulf Regional Fund. If that were done, all the other seven solutions in Table 8 could be incorporated within the framework of this Fund. For example, under the auspices of the Fund, technological research could be carried out to develop sophisticated satellite and other investigative devices to detect oil spills in real time; monitoring protocols could be put in place to scan the entire Gulf area; a system of monetary penalties could be agreed and implemented; international cooperation with other Funds could be coordinated; capacity building could be enhanced; public awareness could be stimulated; and government funding could be pooled with other states' funds to finance much more effective collective action.

The most favoured version of this solution is the creation of a regional oil spill fund, financed through the imposition of levies and taxes on all tankers, ships, and cargo vessels transiting through the Strait of Hormuz, as well as on oil companies engaged in the export or import of oil as cargo. This fund would serve as a dedicated financial resource, specifically earmarked for addressing oil spills and related environmental incidents in the region. The establishment of a regional oil spill fund is particularly needed in the Gulf because of the interconnected nature of the marine environment in this area and the risk of oil pollution spreading across borders. A regional fund would not only enhance the capacity to respond swiftly but also promote a more comprehensive and coordinated approach to protecting the marine environment in the Gulf. By levying charges on vessels and oil companies, this fund could ensure that those entities most directly involved in the transportation and trade of oil bear a proportionate responsibility for the associated environmental risks – an exemplification of the beneficiary pays principle of environmental justice. The contributions from these stakeholders would collectively constitute a secure financial foundation, enabling swift and effective responses to oil spills within the region. This solution could cover claims for damage and clean-up costs where the identity of the ship responsible for the oil spill cannot be established (Soto-Oñate & Torrens, 2022).

The following details provide a template for this proposed Gulf Regional Oil Spill Compensation Fund. The membership would constitute Oman, Saudi Arabia, Kuwait, Iran, Iraq, Qatar, UAE, and Bahrain. The functions of the Fund would include providing financial resources for responding to oil spills in the Gulf and compensating for damages caused by such incidents, covering preventive measures, clean-up costs for reinstatement of the environment, property damage, and economic losses, especially in fisheries and tourism. The Fund would be financed by levying a transparent, non-discriminatory service charge on oil receivers and shippers operating in the region. This charge would be proportional to the amount of oil shipped through the region (Molenaar, 2014). For example, 5 US cents per 1 GT (Gross Tonnes) could be imposed on all tankers upon arrival at the first port of call (loading/unloading facility, jetty, or terminal) in the Gulf. Upon payment, a receipt would be issued to the vessel which would be valid for all port facilities in the Gulf for 30 days from the date of collection. This suggested financial arrangement follows the model put forward by MEMAC for its proposed Marine Emergency Response Coordination Unit (MERCU) which has not yet been implemented according to KI-28 (a regional participant) expressed, *"I previously proposed the establishment of MERCU, a regional initiative. I believe that if implemented, this could address over 90% of the problem. Unfortunately, it has not been put into practice".* The service charge collected would be used to defray the costs of investigation, remediation and compensation for oil spills in the Gulf region (Li, 2012). The Fund would be managed by a governing body comprising representatives from the eight member states, affected communities, and industry stakeholders.

How viable is this proposal to establish a regional compensation fund for oil spills between the Gulf countries, including Iraq and Iran? There are some promising precedents for such an initiative. For example, the Kuwait Regional Convention for marine environment protection from pollution, which operates independently of the UNEP administration, marked a significant step towards collective environmental protection in the Gulf. The subsequent establishment of the Regional Organisation for the Protection of the Marine Environment (ROPME) was also a pivotal development (Al-Janahi, 2008). Encompassing the sea areas of the United Arab Emirates, Saudi Arabia, Iran, Oman, Iraq, Kuwait, Qatar, and Bahrain, ROPME plays a central role in safeguarding the Gulf's marine environment, serving as a hub for member states to

collaborate on marine environment protection, including response to oil spills (Aldosari, 2019). The Marine Emergency Mutual Aid Centre (MEMAC) emerged as a useful tool within ROPME, providing operational support in emergencies, mobilizing resources and expertise for member states' response efforts (Alawadi, 2011).

The Riyadh Memorandum of Understanding on Port State Control, instituted in 2004, further contributed to regional cooperation in environmental management. Additionally, the establishment of the Gulf Cooperation Council (GCC)'s Emergency Management Centre (EMC) in late 2016, bolstered collaborative efforts in addressing environmental concerns including developing strategies for handling oil spill incidents. There is also the precedent of RECOFI, the regional commission for fisheries management in the Gulf, which was created in 1999 to coordinate efforts by the eight Gulf states to conserve the region's marine resources (not only fish) and its aquaculture industry. These organisations have focused on coordinating the efforts of member states towards safeguarding the waters within the Gulf. However, while their initiatives have been fruitful in several spheres of environmental protection, their actions in response to oil spills have been limited. MEMAC could step up to the plate to take a leading role in the proposed regional compensation fund, as it possesses the capability to coordinate responses in the event of oil spills from known sources, though not from unknown sources.

The argument of this thesis is that the Omani government should spearhead the establishment of a regional compensation scheme specifically designed to address mystery spills. At present, there are two international funds and five national funds that in theory compensate for mystery spills. The two international funds, IOPC and P&I Club, focus much more on large-scale spills rather than on small-scale spills, and concentrate almost exclusively on traceable polluters rather than mystery spillers. The five nation states - Canada, China, the USA, New Zealand and Finland - have established their own national funding organisations for dealing with oil spills, including both small-scale spills and mystery spills within their remits. The majority of participants in this study advocate the establishment of a comprehensive fund to support the victims of various forms of oil pollution, including the mystery spills that persistently afflict the coastal residents of Musandam Governorate. But it seems evident that Oman is either unable or unwilling to expand its current inadequate system for dealing with mystery oil spills in Musandam into a national fund on the

scale of those in Canada, China, the USA, New Zealand and Finland. The question arises, therefore, whether Oman can persuade the other seven Gulf states to join with it in establishing a regional fund to deal with oil spills, large and small, traceable and untraceable, in the Gulf.

6. Conclusion

During the last 25 years, the number of large-scale marine oil spills has decreased markedly, and as a result, many people think the problem of oil pollution at sea has been solved. That is not true, because small-scale mystery spills have continued to occur and may be increasing in number. They are often underreported, thereby receiving less attention than known spills. Additionally, there is limited research conducted on mystery spills, leading to a lack of comprehensive understanding of their effects. They tend to operate under the radar, escaping widespread notice, but they are responsible for considerable damage to the marine ecosystem and to coastal residents and need to be addressed.

This thesis is a wake-up call to dispel the self-congratulatory idea that there is no longer a problem of marine oil spills. In truth, there has been a major failure at the heart of attempts to deal with the problem. One reason for this failure is that policy makers are ignorant of the extent of the problem of mystery spills, and this ignorance is partly because the people who are being harmed do not have a platform to voice their concerns. This lack of a platform is a breach of the environmental justice principle of stakeholder participation according to which stakeholders are entitled to fair and meaningful participation in environmental decision-making. Efforts to reduce known sources of pollution have been effective in decreasing the number and extent of large-scale spills from known sources. It is imperative to broaden the scope of attention to include the elusive mystery sources of pollution to comprehensively address environmental protection and the well-being of affected populations. Oman should confront mystery spills as an important element of its duty of environmental protection: it is a matter of justice for the country to adopt regulations and laws to deal with such incidents effectively, and to take steps to initiate a regional oil spill compensation fund to pay clean-up costs and meet reimbursement claims. It is time to put an end to the unjust practice of 'out of sight, out of mind'.

CHAPTER 8. Conclusion

1. Introduction

This Conclusion has six sections. First, it summarizes the findings of the thesis and their implications. Second, it describes the contribution the thesis makes to the literature. Third, it outlines recommendations for policymakers to deal more effectively with the problem of small-scale mystery oil spills. Fourth, it explains the limitations of the study. Fifth, it suggests directions for future research. Sixth, it offers reflections on my PhD journey.

2. Summary of the findings and their implications

There are five main findings. The most important finding is that contrary to popular understanding, marine oil spills are not a thing of the past but a real and present danger today. While it is true that the number of large-scale spills has sharply decreased during the last 30 years, small-scale spills remain numerous and may even be increasing. There are several reasons for this contrast. Large-scale spills are invariably accidental and traceable and cause enormous damage which is very expensive for vessel owners to rectify. Large-scale oil spills often occur as a result of accidents involving vessels or ships, such as collisions, groundings, or sinking incidents. Oil tanker companies have taken steps such as installing double hulls to prevent leakage in the event of a collision or grounding. By contrast, small-scale spills are usually deliberate (to avoid paying cleaning services in ports or as a means of saving time) and unattributable (mystery spills), and the perpetrators invariably escape detection and financial penalties. So, there is little incentive for vessels to stop discharging oil waste.

The second finding is that the failure by the Oman government to track down mystery spillers in Musandam is a breach of environmental justice. This injustice is manifested in the absence of accountability of the polluter and the disproportionate burden placed on local inhabitants in Musandam, including fishers and small diving centre businesses, who bear most of the clean-up costs. Findings from the key informant interviews and focus group discussions indicate that in Musandam, no compensation

has been paid out from the Oman government or anywhere else to fishers, divers, and hotel owners for loss of income and damage to equipment caused by mystery spills (Svendsen, 2024). Oman has received some compensation for oil spills attributed to known sources from the IOPC and P&I club, but none of this compensation has reached Musandam residents and there has been no compensation for mystery spills. This situation violates the polluter pays principle; the beneficiary pays principle; and the sustainable development principle (Pellegrino & Di Paola, 2023). Moreover, in places such as Musandam, it also violates the stakeholder participation principle in that it marginalises a remote population, excluding them from making their voices heard.

The third finding is that there is nothing inevitable about failing to track down mystery spills. It is true that at present, because of the high density of vessel traffic in the Strait of Hormuz, satellite-based oil spill detection is of limited accuracy and entails substantial verification expenses because ships or aircraft need to be dispatched to confirm the satellite's initial observations. However, satellite technology for identifying the source of small spills is being developed at pace, and with the promise of assistance from AI, the likelihood is that mystery spillers will become identifiable within the next few decades. But such technology is costly to purchase and operate over large areas and at all times. Oman is unlikely to prioritise such expenditure on its own. However, the regional Port State Control Memorandum of Understanding (PSC MOU), which serves as a critical monitoring mechanism for Gulf States to ensure the proper implementation of international maritime conventions and standards bug has not yet been fully implemented, could facilitate the use of such technologies.

This leads us to the fourth finding – that the failure to track down mystery spills in the Gulf is a deficiency of political will on the part not only of Oman but also of the other seven Gulf states, many of which are extremely wealthy and could easily afford to fund a regional agency with the capacity to monitor the waters of the Gulf and the Sea of Oman and identify mystery spillers.

The fifth finding is about the organisational provision of compensation for mystery marine oil spills. At present, there are two international organisations to which states can turn to obtain compensation for large-scale marine oil spills if the spillers cannot

pay for the damage. However, neither of these organisations explicitly covers mystery spills. There are also five individual states outside the Gulf which have established their own national agencies to deal with compensation claims, two of which cover mystery spills. There is, however, no regional compensation organization which covers mystery spills. In the Gulf, there are two regional organisations that play a limited role in dealing with marine oil spills - the Regional Organization for the Protection of the Marine Environment (ROPME) and the Gulf Cooperation Council (GCC). ROPME facilitates scientific cooperation among states and coordinates training, technological cooperation, and information exchange under r the Kuwait Regional Convention. Connected to ROPME, MEMAC facilitates cooperation among states to combat oil pollution and coordinates training, technological collaboration, and information and data exchange. The GCC established the Emergency Management Centre to facilitate a coordinated response to emergencies and disasters in the area and to enhance response capabilities. However, neither of these organisations offers compensation.

The thesis argues for the establishment of a Gulf Regional Compensation Fund under the auspices of the ROPME organization. Given its jurisdiction over the eight countries surrounding the Strait of Hormuz, ROPME is uniquely positioned to address oil spills, including mysterious ones, and safeguard the marine environment in the region. By centralizing control under ROPME, the fund could operate neutrally, efficiently compensating those who suffer economic losses due to oil discharges from ships and tankers. Furthermore, ROPME, with its regional authority, could trace the origin of these spills. This would enable the organization to seek compensation either from international entities like the IOPC or P&I club or directly from the responsible ship's owner, thereby ensuring accountability and mitigating the environmental and economic impact of such incidents in the Gulf region.

The wider implications of these findings include the fact that they reveal a gap in the national, regional and international systems for dealing with marine pollution. International organizations have historically focused their efforts on addressing major spills to safeguard the marine environment, paying little attention to small-scale mystery spills. While their proficiency in handling major spills is commendable, their success should lead them to switch focus to what is becoming a more pressing

problem – small-scale mystery spills. It seems the imperative for protecting the marine environment from oil pollution currently stops at the point of major incidents. Small-scale spills are not a political priority because they do not attract the kind of public attention that large-scale spills generate. The assumption of policy makers appears to be that small-scale spills do not cause much damage; are short-lived; quickly disperse because of the natural forces of winds and waves; and would require a disproportionate investment of human and financial resources to deal with for a very limited benefit to comparatively few victims. However, such an assumption conveniently ignores the harm that repeated small oil spills inflict on local communities in locations such as Musandam. Worldwide, data on small-scale spills is very limited and localized and is not documented in academic literature. So, finding material on small-scale oil spills with a focus on their impact on fishing and fishermen is extremely difficult.

All this reveals a disjunction between the concerns of authorities, who are focused on large-scale traceable spills, and the concerns of local residents, who are focused on small-scale mystery spills. Authorities tend to overlook the issue of small-scale mystery spills, whereas local communities view themselves as victims of it. The lack of action by the Omanian government on small-scale mystery spills may stem from financial constraints, making it difficult to allocate sufficient resources for costly clean-up operations and victim compensation. The country enjoys a comfortable position in terms of resources, but it does not possess an inexhaustible fund, especially given the current lower oil prices. Consequently, there are constraints in allocating substantial resources for high-cost endeavours like intensive monitoring and observation. Moreover, although the small-scale mystery spills primarily impact the coasts of Musandam, they also affect the eastern coast of the UAE (Fujaira and Dibba) and the eastern coast of southern Iran. Consequently, it seems unreasonable to expect Oman to comprehensively address this issue on its own.

There might be a perception that the Omani government does not accord Musandam the attention it deserves because of the peninsular's geographical separation from the rest of Oman or because of the relatively poor socio-economic status of its residents. This sentiment is echoed among the population of Musandam, who feel marginalized and believe that the government shows minimal concern for the region. This

underscores a systemic shortcoming in Oman's political structure, as no community should be disregarded simply because of its peripheral location or low socio-economic status. According to the concept of environmental justice, every group, regardless of their physical proximity should be deemed equally important and deserving of attention, while economic disadvantage should entitle Musandam to greater, not less, consideration.

Another question raised by the study is why have there not been protests against this environmental injustice. It is noticeable that no NGO has taken up the cause of the Musandam residents. It is also striking that the residents themselves have not engaged in demonstrations or direct action to draw the government's attention to their plight. This inertia may be because Musandam residents tolerate these hardships since they are emotionally tied to their communities as their home and as a way of life, not as an economic or transactional space. So they do not naturally engage in legalistic wrangling about their contractual rights

This tolerance may also be because of their low level of education. As we saw from the discussion chapter, the level of education is poorer in Musandam than in other areas such as Muscat. It is likely that if there were lots of small-scale marine oil spills near the capital, there would be government action much more speedily and effectively than for spills in Musandam because of complaints from highly educated elites living in and around the capital. Community voices correlate with the level of education, In Musandam, the first school was established in 1973, initially up to level 6 in Khasab and in Daba in 1974. This low level of education is associated with restricted civic engagement within local communities, as illiteracy and a lack of awareness hinder community members' active participation in consultative processes and advocacy for their rights. Many Musandam residents are politically passive or fatalistic and are not comfortable confronting authority, and they have little awareness of their environmental rights and no knowledge of how to organise themselves to demand those rights. Although Omani law dictates equal treatment for all citizens, it may be that the government has overlooked addressing oil spills in Musandam due to the lack of pressure from the fishermen and local community.

One way for Musandam residents to obtain redress would be to campaign for their environmental rights to clean coastal waters by making use of guidance published by the World Resources Institute in 2020 (WRI, 2020) entitled a Community Action Toolkit: A Roadmap for Using Environmental Rights to Fight Pollution, which provides communities with practical guidelines on how to challenge pollution:

> "This toolkit offers civil society organizations and local community activists practical guidance on how to use their environmental rights to fight air, water, and solid waste pollution. It is designed to support civil society, local community activists, and those concerned about pollution with the knowledge and tools needed to conduct policy research, collect and use pollution information in relevant decision-making forums, work together to develop advocacy campaigns, and use an environmental rights approach to engage government and the private sector about their concerns".

3. The contribution the thesis makes to the literature.

The study's focus on the Musandam Peninsula provides a unique case study, making eight specific contributions to the discipline. First, it is the only study to investigate the issue of marine oil pollution in Musandam. Second, it is the first study to draw attention to the fact that while the number of large-scale marine oil spills has dramatically decreased in recent years, the number of small-scale spills has not fallen but in all likelihood has increased. Third, unlike previous studies that exclusively focus on larger spills, this research uniquely investigates the impact of small-scale spills on coastal communities.

Fourth, the thesis demonstrates for the first time the connection between small-medium scale marine oil spills and mystery marine oil spills. Fifth, the thesis is the first to report the extent of compensation for mystery marine oil spills provided by national and international organisations. Indeed, it is the first research to scrutinize the compensation mechanisms for mystery spills. It reveals that only a very small number of mystery spill sufferers have received compensation from international organizations like the IOPC Fund.

Sixth, the thesis is the first to make the case for establishing a regional organisation in the Gulf countries to deal with mystery marine oil spills. It breaks new ground as the inaugural study to scrutinise the adequacy of existing compensation mechanisms in the Gulf for mystery marine oil spills. It acknowledges the work of MEMAC in monitoring large-scale oil spills and coordinating efforts to deal with them but makes a case for the creation of a bespoke organisation to take action against mystery spillers. Seventh, the thesis is innovative in its characterization of mystery marine oil spills as instances of environmental injustice, shedding light on the unequal distribution of the impacts and consequences associated with such spills. By recognizing and articulating the environmental justice dimensions of mystery marine oil spills, the thesis draws attention to the serious inequity of the problem.

Finally, the thesis adds to the literature by underlining the importance of community involvement in decision-making processes related to oil spill responses. In doing so, the study contributes to the growing literature on the marginalisation of vulnerable groups – especially small-scale fishers - in coastal marine settings, whose futures are subordinated to the interests of more powerful stakeholders. This framework has potential applicability beyond the Musandam Peninsula, opening avenues for further research and application in similar contexts globally.

4. Recommendations for policymakers to deal more effectively with the problem of small-scale mystery oil spills.

Recommendations for policy makers in Oman fall into three categories: political; technical; and organisational. The political recommendation is that the Oman government should devote more attention to facilitating better communication with the residents of Musandam. Musandam people must be given a more meaningful voice in determining their own destiny, not expected to accept without question the decisions (or non-decisions) emanating from Muscat. The environmental justice principle of stakeholder participation requires that the government must listen to, not ignore, the opinions of its citizens in Musandam. Consultation processes should be developed to reflect the mindsets of the local communities the government is dealing with. This is not an easy task: achieving local community participation in oil spill

management is difficult because Musandam communities are diverse, differing from each other ecologically, organizationally, economically, culturally, and technologically. Homogenous measures will not work – one size does not fit all – each community must be treated as *sui generis* because the situations of different communities in relation to mystery oil spills are very varied. For example, Dorsani, Subaita and Sheisa villages communities located in the east of the Strait of Hormuz are the most badly affected by mystery spills and deserve special consideration.

The technical recommendations are twofold: first to identify the mystery spillers, and second to improve the response to mystery spills. In identifying mystery spillers, the integration of Automatic Identification System (AIS) data with satellite imagery enables the tracking of vessel movements through source identification. Automated detection algorithms, driven by artificial intelligence and machine learning, can play a crucial role in real-time identification of spillers. In improving the response to mystery spills, mapping/monitoring of coastal vulnerability to oil-polluted seawater is a critical aspect of environmental management and response strategies. This process involves assessing the susceptibility of coastal areas to potential oil spills and understanding the likely impacts on sensitive ecosystems, communities, and economic activities. In addition, investing in the development of early-warning and forecasting systems for oil spills would allow authorities to detect spills automatically from satellite images and forecast their drift so that the government agencies can devise an effective oil containment strategy to identify which coastal areas are likely to be affected. This involves a multi-faceted approach, including cutting-edge satellite technology and aerial surveillance systems. High-resolution satellite imagery and Synthetic Aperture Radar (SAR) can capture detailed images of the sea surface, even in adverse weather conditions. This approach includes the deployment of drones equipped with specialized sensors to facilitate rapid response efforts. These drones can swiftly reach affected areas, assess the extent of the spill, and collect oil samples for further analysis. Furthermore, establishing a specialist laboratory dedicated to analysing the fingerprints of oil samples allows for precise source attribution. This integrated approach greatly enhances the capacity to detect, track, and respond to mystery spills, ultimately minimizing their environmental impact.

The organisational recommendations are both domestic and external. Domestically, there is a need to improve synergy and coordination between related agencies in Oman. This entails increased coordination between local government and stakeholders to respond to incidents effectively. It also entails strengthening the legal framework which is a crucial step in effectively addressing mystery spills. This includes a comprehensive review and update of existing laws and regulations to cover spills from untraceable sources. Clarity in responsibilities and liabilities is essential to ensure that parties responsible for the mystery spills are held accountable. This requires defining more precisely the obligations of all stakeholders, including vessel operators, government agencies, and clean-up entities.

Externally, collaboration with neighbouring countries and engaging with international organisations is imperative. Coordinated efforts are vital in situations where spills may impact several regions or cross international boundaries. Establishing protocols and agreements for joint response measures would ensure a unified approach to mitigate the environmental consequences of mystery spills. This collaborative approach includes establishing a regional compensation fund which should be overseen by a neutral third party which could be a government agency or a non-profit organization. This fund should be sustained by levying Service Charges on tankers and vessels navigating from the Strait of Hormuz to the numerous ports in Gulf countries, and on oil companies and other relevant organizations. The fund would investigate all spills in the Gulf and provide compensation for both traceable spills where perpetrators were unable to pay compensation, and mystery spills.

5. Limitations of the study

Inevitably there are some limitations in this study. One limitation is that it has focused primarily on the extent and impacts of mystery spills in a relatively small community, Musandam, so its findings may not be applicable to other parts of Oman let alone to other countries. Another limitation is that it draws heavily on respondents' memories, and undocumented memories vary in their reliability. For example, damage to the marine ecosystem may be wrongly attributed by respondents to oil spills when its real cause lies elsewhere, including climate change. The method of selecting respondents

is vulnerable to the charge that it focused on working adults aged 18 and above, potentially excluding groups such as children, local women, and the elderly who may not have participated for socio-cultural, ethical, or practical reasons. This exclusion could have implications for the quality and representativeness of the data collected. Finally, the fieldwork data used in this study covers a limited timeframe (2022) and might not fully represent the current state of affairs.

6. Suggestions for future research

This study proposes the following topics for future research in both social and natural sciences.

6.1 Suggestions for future social science research on the topic of mystery oil spills

One important line of future social science enquiry would be to compare and contrast the way the Oman government conducts stakeholder consultation exercises on the topic of marine spills with its consultation practices in other sectors of public policy. Such a study could be widened into a critical analysis of the place of consultation in Oman's political system as a whole, as well as the role of community-based decision-making in the country.

Another possible social science follow-on from the present study might be a more extensive case study approach, encompassing a broader range of cases over a longer period to capture a more comprehensive understanding of the problem of mystery oil spills in Oman's waters. This would facilitate enable a comparison of the findings of this study on mystery spills with findings in different regions of Oman and in different countries in the Gulf to discern whether the situation in Musandam is typical or atypical. In particular, it would be very valuable if examples could be found of successful ways of dealing with mystery oil spills. Also, comparative research could be conducted into the incidence of small-scale oil spills in other governorates in Oman and other regions in the Gulf. and whether or not they are compensated.

Another under-researched area that could also be explored is the role played by Gulf states, individually, bilaterally and multilaterally, in attempting to deal with mystery marine oil spills. In particular, the contributions made by the GCC, ROPME, and

MEMAC would be worth studying in more detail. This could entail exploring opportunities for enhanced collaboration among neighboring countries and international organizations to improve information sharing, joint response efforts, and capacity-building for mystery spill incidents. It could also entail analysing the effectiveness of international legal frameworks in addressing mystery spills with a view to enhancing regional international agreements. Finally, research could be conducted into ways of raising funds to establish the proposed regional fund for oil spill compensation in the Gulf countries.

6.2 Suggestions for future natural science research on the topic of mystery oil spills

Natural science research could be carried out on the development and application of cutting-edge technologies, such as hyperspectral imaging, autonneomous underwater vehicles, remote sensing, biomarker analysis, isotopic fingerprinting and artificial intelligence tools and algorithms for more accurate and rapid detection of mystery spills. Also, further research could be undertaken to develop new technologies for oil spill clean-up, including oil-eating bacteria, absorbent materials, and robotics. In addition, comprehensive risk assessment methodologies could be developed to quantify the potential risks associated with mystery spills and to create tailored preparedness plans for high-risk areas.

6.3 Recommendations for immediate action

Five measures to deal with oil spills could be applied immediately in Musandam. First, satellite surveillance techniques could be introduced to track all oil tankers passing through Musandam’s waters. Second, all small spills could be reported by Musandam residents to the Environment Agency who would check them against surveillance records to help identify the sources. Third, a compensation framework with adequate funds could be established to deal comprehensively with claims for clean-up and payment for economic losses. Fourth, a quicker response system by the Environment Agency to oil spills in Musandam could be put into place. Fifth, the Omanian government could take the initiative in proposing the establishment of a regional scheme for providing compensation for mystery spills anywhere in the Gulf. Such a scheme could be funded through a levy on oil transporters.

7. Reflections on my PhD journey

This thesis is a product of various stages of my thinking. I am a resident of Musandam, and I have been employed for 8 years in dealing with marine pollution in the Governorate. After I finished my Master's program in 2016 which focused on Computer-based Identification of Coral Reef Substrates using Underwater Images, I started thinking about a doctoral programme. My initial preference was to conduct a natural science investigation into the extent and depth of marine oil pollution in Musandam waters. But after several months of desk research and in conversation with my supervisors, I came to the conclusion that a social science study of the problem of small-scale mystery marine oil spills in the area and beyond was a more original and important exercise, not least because it raised questions about environmental injustice which is close to my heart. There is very little literature on mystery marine oil spills and even less on their environmental injustice, so my method of investigation involved obtaining data from key informants who either had personal experience of the harm done by mystery spoils or professional knowledge of such experience. The spread of Covid 19 from 2020 onwards meant many of my key informant interviews took place remotely. However, the quality of those remote Zoom interviews was high, and I managed to obtain 76 transcripts of which more than 50 contained rich data. I enjoyed interviewing respondents, and I was surprised at how open and uninhibited many of them were.

Although I have lived in Musandam all my life, and I have worked on environmental impact issues there for more than fifteen years, the interviews with resident respondents provided me with a new perspective on oil pollution, helping me to understand how badly their businesses have been affected by oil spills; how ineffective they think the clean-up operations were; how both oil spills and clean-ups have impacted their communities' social and cultural well-being; and how poorly they judge the government's lack of response to their claims for compensation. Another new perspective came after the analysis of my first data sets (KIs and FGD) which showed that the solution to the problem did not lie within the local community in the Musandam area, but in cooperation with the Omani government and in its coordination with neighbouring countries under the aegis of a regional organisation.

By the end of 2020, I resolved to extend my focus to the Oman government, regional agencies and international organisations, and I was convinced that I could find a solution to the mystery spill problem either in advanced countries or through international institutions. However, I soon realised that my positive conviction about the effectiveness of state and international institutions had more to do with my own ignorance than with empirical evidence. The faith I had in these institutions was based on their impressive track record in dealing with large- scale known oil spills. What my research told me was that their record on small-scale mystery spills was dire. So, although my findings add some solutions to the problem of mystery spills, my journey through this research process has opened up another area of research on this subject. This is the insight that mystery spills pose threats to public health and the environment in the same way as large spills and are now more damaging since decisive preventive action has now been taken to avoid large spills occurring.

Overall, I feel I have properly investigated an important environmental problem (mystery marine oil spills) and reached convincing conclusions about how it has been poorly dealt with in the past and how it might be more effectively dealt with in the future. It is my belief that this study has uncovered the motivation, behavior, and perspectives of stakeholders with skin in the game of mystery marine oil spills. It has also thrown light on the successes and shortcomings of Omanian governmental policy, as well as formulating recommendations that can improve its performance. I hope that the study provides policymakers, community workers, and environmental institutions with an alternative strategy to inertia to solve this problem before the people's voices are raised in appeal to social media, international communities and global organisations.

Finally, I feel I have learned an enormous amount about the subject matter and about the techniques of social science research. My PhD journey has been much more demanding than I imagined it would be four years ago, but I am proud to be the first person from the Musandam Governorate to have completed a Ph.D. degree in the United Kingdom.

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Appendices

Appendix A: KI Questionnaire

Al-Kamzari A. Interview questions for KIs

The main key informants (KIs) for this study are people who have expertise in the issues raised by marine oil pollution in Oman. They include government officials, scientific experts, policy makers, and members of regional and international organizations. The questions asked are semi-structured and open-ended, and the researcher will encourage respondents to expand on their initial answers by asking them follow-up questions. The questions are grouped into six sections: (1) the nature and extent of marine oil pollution in Oman in general and Musandam in particular; (2) the steps taken to clean up this pollution; (3) the difficulties of determining which vessels are responsible for the pollution; (4) the attempts made by Oman to obtain compensation from the owners of the polluting vessels; (5) the effectiveness of international organizations established to provide compensation; and (6) personal information.

(1) The nature and extent of marine oil pollution in Oman in general and Musandam in particular

a) What is the meaning of the term 'marine oil pollution'?
b) How concerned are you about oil spills in Oman waters in general and Musandam in particular? '
c) For how long has Oman and Musandam been suffering from marine oil spills?
d) How many oil pollution incidents do you notice every year in (i) Oman and (ii) Musandam?
e) Have oil pollution incidents increased in recent years?
f) When was the last time Musandam experienced an oil spill?
g) Are all oil spills that occur in (i) Oman and (ii) Musandam reported to the authorities? If not, why? What proportion are not reported?
h) What proportion of the incidents reported/unreported have been serious?
i) What are the main reasons being for oil spills in Oman and Musandam?
j) What are the main effects of the oil spills in Oman and Musandam?
k) Does oil pollution harm the marine ecosystem in the Musandam Sea? If so,
   (i) Has it resulted in the loss of any key marine species or habitat or shelter? If so, what?
   (ii) Has it caused harm to the coastline, beaches and terrestrial ecosystem? If so, what harm?
   (iii) Do you think oil spills will cause permanent environmental damage? If so, what?
l) What are the impacts of oil pollution on human activities in the Musandam Sea? For example, what are the potential impacts of oil spill on socioeconomic activities like fishing, tourisms, desalination etc., in Oman?

(2) The steps taken to clean up this pollution

a) What are the difficulties of oil spill clean-up processes?
b) Are the oil spills in Musandam cleaned up quickly and effectively? If so, how?
c) What are the advantages of natural processes of clean-up by rain and tidal movement compared to human interventions?
d) Describe how you cope with the impacts of oil spills?
e) What are the costs involved for a complete survey of oil spills?
f) How many ships/ air planes do you have for oil spills survey?
g) How many times have you detected oil spills?
h) When did you operate these ships/ planes?
i) How sustainable are these coping strategies?
j) Does clean-up cause environmental damage? If so, how?

1

k) Who carries out the clean-up? Do local communities participate in oil spill clean- up? Are other stakeholders involved in clean-up operations? If so, who are they? How are they involved?
l) Do you think it is important to involve stakeholders in clean-up operations? If so, in what way?
m) Are volunteers compensated for helping in the oil spill clean-up?
n) Who should pay the local communities to carry out clean-up operations?
o) What steps, if any, has the government taken to prevent marine oil pollution occurring in the Musandam Sea? If so, have they been effective?
p) Do local communities receive any assistance during the incidence of the oil spill?
    (i) If so, who provided the assistance?
    (ii) What kinds of assistance?
    (iii) How satisfied were you with the assistance received?
q) How long would it take for the marine environment to recover from the damage caused by an oil spill?
r) Is there any post-spill environmental monitoring of restoration activities?
s) What are the main challenges facing your role?

(3) The difficulties of determining which vessels are responsible for the pollution

a) Is it hard to discover which vessels are to blame for the oil spills? If so, why?
b) What proportion of oil pollution incidents in the Musandam Sea are from known sources?
c) How has Oman managed to track these vessels down to their owners or hirers?
d) What proportion of oil pollution incidents in the Musandam Sea are from unknown sources?
e) Why has Oman been unable to track these vessels down to their owners or hirers?

(4) The effectiveness of international laws and organizations established to provide solution

a) Are there any rules imposed by international law to prevent marine oil pollution of coastal waters?
    (i) If so, what are these rules?
    (ii) How effective are they?
    (iii) Why did they not prevent oil pollution occurring in the Musandam Sea?
b) What is the most cost-effective policy to protect the marine environment from unattributable oil spills?
c) Do you know any policy tools that have been applied to address oil spills caused by unknown sources?
d) Can you suggest any mechanism for dealing with oil spills from undefined sources?

(5) The attempts made by Oman to obtain compensation

a) Has Oman managed to obtain compensation from the companies who own or hire the vessels responsible for oil pollution in the Musandam Sea?
b) If so, what amounts of compensation have been obtained, and from which companies?
c) What are the amounts of cost for cleaning-up the coast? For example, the cost of (M^2) of sand beach or rocky beach or off shore clean-up, depending on oil type?

2

(6) Personal information

a) What are your current roles and responsibilities related to marine oil pollution?
b) What is your gender? 1. Male 2. Female
c) What is your age group? 1. 18-25 2. 26-45 3. 46-60 4. Above 60
d) What is your position in your organization? 1. Employee 2. Middle management 3. Senior management 4. Chief Executive level
e) How many years of experience have you had in this position?

3

Appendix B: Coastal residents and tourist's questionnaires

Al-Kamzari A. Interview questions for coastal residents, tourists, & hoteliers

Participants in this part of the study are people who have experienced at first hand oil pollution on the beach areas of the Musandam peninsula coastline. They include residents of coastal communities, tourists, and hotel staff. The questions asked are semi-structured and open-ended, and the researcher will encourage respondents to expand on their initial answers by asking follow-up questions. The questions are grouped into seven sections: (1) first-hand experience of marine pollution in the Musandam coastal areas (2) knowledge of clean-up operations; (3) view of the long-term harm done to the coastal ecosystem (4) perception of the economic impact of the oil spills (5) description of any compensation received (6) ideas and suggestions on how to prevent such pollution happening in the future and (7) personal information.

(1) First-hand experience of marine pollution in Musandam coastal areas

a) Have you experienced at first hand marine oil pollution in Musandam's coastal areas? If so, please give details of the times, places and extent of the oil spills you have experienced.
b) Are marine oil spill incidents common in your area? If so, how common?
c) Were the culprits of those oil spills identified? If so, who identified them and how?
d) What aspect of your life would you say has been mostly affected by oil spill?
e) Has your health or that of your family been harmed? If so, please give details.
f) Have such incidents seriously reduced your enjoyment of the coastal area? If so, in what ways?
g) Have oil spills prevented you from visiting the coastal area? If so, for how many days? Were you forbidden access by the government or did you choose to stay away?
h) Have you noticed an increase or decrease in the number of oil pollution incidents in Musandam Area in recent years? If so, please give details
i) Have you noticed any quality issues in seafood from Oman waters due to oil pollution? If so, please provide details

(2) Knowledge of clean-up operations

a) Have you seen clean-up operations in progress? If so, what forms of clean-up operation have been undertaken? Did the government take charge? Approximately, how many people were involved in the clean-up operations?
b) Do you think volunteers should be involved in clean-up operations? If so, why?
c) Did you take part? If so, what was your role?
d) Do you approve of stakeholders helping with clean-up operations? If so, why? If not, why not?
e) Have clean-up operations prevented you from visiting the affected area? If so, how, for how long and how did that affect your everyday essential needs?
f) Have you been negatively affected economically or socially by oil spills? If so how and to what extent?
g) Were clean-up operations timely, quick, and effective?
h) Do clean-up operations themselves damage the marine ecosystem? If so, how?
i) Do you prefer to allow natural processes such as rain and tidal movements to remove and disperse the pollution rather than have clean-up operations? If so, please explain why.

(3) View of the long-term harm done to the coastal environment

a) Have you noticed any long-term effects of oil pollution on the flora and fauna in the coastal area? If so, please give details of these effects on particular species
b) How serious have these impacts been?
c) Do you think these impacts on flora and fauna can be minimized? If so, how?

(4) Perception of the economic impact of the oil spills

a) Has the oil spill affected the tourism sector such as hotels for a long-term period? If so, please give details. How serious have these effects been?
b) Have oil spills/clean-ups had a negative impact on your livelihood? If so, please explain what that impact has been
c) Is the health of the marine environment important for your organisation's profitability? If so, have oil spills and clean-up operations reduced your profits? If so, please give details?

(5) Description of any compensation received

1

a) What aspect of your life would you say has been most affected by oil spill?
b) Have you applied for compensation for the loss of income caused by oil spills/clean-up operations?
c) Have you been granted any compensation? If so, would you please say when, why, from whom, what amount, and whether you regard it as adequate?
d) Do you know of any international laws that require compensation for oil spills, and any international organizations established for paying out that compensation? If so, please provide details.

(6) Ideas and suggestions on how to prevent or deal with such pollution happening in the future

a) Which government or agency in Oman is responsible for dealing with marine oil pollution?
b) Does this agency do a good job? If so, in what way? If not, why not?
c) Should local residents/tourists/hoteliers participate in decisions on how to prevent/mitigate damage from oil spills and clean-up operations? If so, why?
d) Should Oman increase its citizens' knowledge and awareness of the importance of a clean marine environment? If so, how?
e) Should stricter laws, both national and international, be enacted to punish perpetrators of oil spills? If so, what kinds of laws would you recommend?
f) Who should pay for clean-up? (the vessel's owner? an international compensation fund? the vessel owner's government? or the Oman government?). Explain the reasons for your choice
g) What proportion of oil pollution incidents in the Musandam Sea are from known or unknown sources?
h) Are new forms of international organization needed to identify and fine vessels that either accidentally or deliberately discharge oil into the Musandam Sea? If so, what kinds of organisations?
i) Do you know of any policy tools that can be applied to deal with oil spill caused by unknown sources? If so, please describe them
j) Do you think new kinds of international agreements are needed to provide compensation for oil pollution caused by known and unknown sources, or both? If so, what kinds of agreements would you recommend? How should they be funded?

(7) Personal information

a) Are you a resident in the coastal area of Musandam? If so, how long have you been living there?
b) Are you a tourist? If so, where do you come from? Do you often visit Musandam coastal areas?
c) Are you employed in the hotel industry? If so, how long have you been working worked in Musandam? Are you in a junior or senior position?
d) Circle gender: 1. Male 2. Female 3. Other
e) Circle your age group? 1. 18-25 2. 26-45 3. 46-60 4. Above 60
f) What is the highest level of education you have achieved? 1. Primary school 2. Secondary school 3. Tertiary 4. Other (please describe)

2

Appendix C: Fisher's questionnaires

Al-Kamzari A. Interview questions for fishers

Participations in this part of the study are people who have first-hand experience of oil pollution in the inshore waters of the Musandam Peninsula area in Oman. They include commercial and recreational fishermen, commercial and recreational divers and staff at fisheries stores and diving centres. The questions asked are closed, semi-structured, and open-ended and the researcher will encourage respondents to expand on their initial answers by asking follow-up questions. The questions are grouped into six sections: (1) personal experience of marine oil pollution in Musandam' s coastal waters (2) perception of the effectiveness of clean-up operations; (3) evaluation of the harm done to the marine ecosystem (4) calculation of the negative impact of the oil spills on their businesses (5) description of any compensation received and (6) ideas and suggestions on how to prevent such pollution happening in the future.

(1) Personal experience of marine oil pollution in Musandam' s coastal waters

a) How would you define "marine oil pollution"?
b) Are you concerned about marine oil pollution in Musandam' s coastal water? If so, how much are you concerned?
c) Have you personally experienced marine oil pollution in Musandam' s coastal waters? If so, please describe that experience, outlining, for example, how many incidents you have experienced, where they occurred and how serious they were.
d) Have you noticed any increase or decrease in the number of oil pollution incidents in Musandam Area in recent years?
e) In your opinion, what was the cause of such marine oil pollution?
f) Do you report to the authority when you find oil spills? If not, why not? What proportion of oil spills in Musandam are not reported?
g) Are you aware of the source of oil pollution in Musandam water? If so, please give more details?
h) What is the proportion of oil pollution incidents in the Musandam Sea from known and unknown sources?
i) What do you do if you come across an oil spill?
j) How long does it take the ocean to recover from an oil spill?
k) What was the largest oil spill ever recorded in Musandam?
l) How do most oil spills affect the animals around the spill area and their habitats?
m) What are the major seafood quality issues and consumer health risks that you have noticed in Oman due to oil pollution?

(2) Perception of the effectiveness of clean-up operations

a) How quickly are clean-up operations performed?
b) Who carries out the clean-up operations? Are fishers recruited to help the clean-up? If so, are they paid to do so? Have you taken part? Do volunteers take part?
c) In such oil spill incidents, what do you think the role of the government? Please explain.
d) Does the Omani government have sufficient resources (people and equipment) to carry out clean-up operations? Please explain.
e) If the local communities take part in clean-up operations, should they get financial support from the government?
f) After clean-up operations, do you think that the surrounding marine environment will recover and become healthier?
g) Do the clean-up operations themselves cause further damage? If so, how, and how seriously?
h) If the removal of the polluting oil be left to rain and tidal movement, how long will that take and are there any negative effect will be noticed on sea creatures?
i) What are the different methods of cleaning up an oil spill?
j) How long does it take to completely clean up an oil spill?

1

(3) Evaluation of the long-term harm done to the marine ecosystem

a) Do you know whether the oil spills and/or the clean-up have caused long-term ecological damage to the marine environment?
(b) If so, please describe what marine organisms have been harmed

(4) Calculation of the negative impact of the oil spills on fishers' businesses

a) Has your fishery/diving business been harmed economically from the oil spills and/or the clean-up? If so, please explain how and to what extent.
b) Have you noticed any fish species die from oil pollution? If so, please explain.
c) What are the detrimental effect of oil pollution on your fishing equipment such as engines/transmission systems/fishing nets of your vessels?
d) What are the effect of the coastal area that were polluted by oil spill on marketing of fish that caught by nets or gears being pulled over the land?
e) Has your catch level of commercial fish/ornamental species declined as a result of the oil spills? If so, for which species, and to what extent?
f) Has the quality of the commercial fish you caught or ornamental organisms you observed deteriorated as the oil spills? If so, for which species, and to what extent?
g) Have you found that the price you get for your fish declines after an oil spill? If so, how long have these negative results lasted?
h) Have oil spills prevented you from going fishing or diving? If so, is this because the government has forbidden fishing/diving in affected areas, or because you have chosen not to fish or dive?
i) Any area that you know that has not been affected by the oil spill? Please provide details.
j) How much fishing or diving time have you lost because of oil spills?
k) Have you experienced any adverse medical effects of oil spills? If so, please describe.
l) How much money approximately have you lost because of oil spills?
m) Who pays for oil spill clean-up and restoration?

(5) Description of any compensation received

a) Do you think polluters should always pay for clean-up? If so, who should pay when the polluters cannot be identified?
b) Have you received any compensation for economic loss to your fishing or diving business from the oil spills and/or the clean-up operations? If so, how much compensation were you given, and from whom? Do you regard that compensation as adequate?
c) Who should be responsible for paying out compensation for damage caused by oil spills and/or clean-up operations? the vessels' owners? their country's government? an international insurance fund? or the Omani government?
d) What is the most cost-effective policy to protect the marine environment from unattributable oil spills?

(6) Ideas and suggestions on how to prevent such pollution happening in the future

a) Which government or agency in Oman is responsible for dealing with marine oil pollution?
b) Does this agency do a good job? If so, in what way? If not, why not?
c) Is there any way that oil pollution of the Musandam Sea can be prevented in the future? If so, what preventive measures could be put in place? For example, can technology, such as remote sensing to monitor ships and tankers help to avoid marine oil pollution?
d) Who should be responsible for paying for such measures? For example, should the shipping industry pay for such measures?
e) What kind of awareness the government or agencies should raise in community to protect the marine environment from oil pollution?

(3) Evaluation of the long-term harm done to the marine ecosystem

a) Do you know whether the oil spills and/or the clean-up have caused long-term ecological damage to the marine environment?
(b) If so, please describe what marine organisms have been harmed

(4) Calculation of the negative impact of the oil spills on fishers' businesses

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g) Have you found that the price you get for your fish declines after an oil spill? If so, how long have these negative results lasted?
h) Have oil spills prevented you from going fishing or diving? If so, is this because the government has forbidden fishing/diving in affected areas, or because you have chosen not to fish or dive?
i) Any area that you know that has not been affected by the oil spill? Please provide details.
j) How much fishing or diving time have you lost because of oil spills?
k) Have you experienced any adverse medical effects of oil spills? If so, please describe.
l) How much money approximately have you lost because of oil spills?
m) Who pays for oil spill clean-up and restoration?

(5) Description of any compensation received

a) Do you think polluters should always pay for clean-up? If so, who should pay when the polluters cannot be identified?
b) Have you received any compensation for economic loss to your fishing or diving business from the oil spills and/or the clean-up operations? If so, how much compensation were you given, and from whom? Do you regard that compensation as adequate?
c) Who should be responsible for paying out compensation for damage caused by oil spills and/or clean-up operations? the vessels' owners? their country's government? an international insurance fund? or the Omani government?
d) What is the most cost-effective policy to protect the marine environment from unattributable oil spills?

(6) Ideas and suggestions on how to prevent such pollution happening in the future

a) Which government or agency in Oman is responsible for dealing with marine oil pollution?
b) Does this agency do a good job? If so, in what way? If not, why not?
c) Is there any way that oil pollution of the Musandam Sea can be prevented in the future? If so, what preventive measures could be put in place? For example, can technology, such as remote sensing to monitor ships and tankers help to avoid marine oil pollution?
d) Who should be responsible for paying for such measures? For example, should the shipping industry pay for such measures?
e) What kind of awareness the government or agencies should raise in community to protect the marine environment from oil pollution?

2

Appendix D: Focus Group Discussion questionnaires

Focus Group Discussion Sessions

Focus groups discussion (FGD) are a data gathering technique to discuss topics using group interaction. In this study, FGDs will focus on stakeholders' perceptions of the problem of oil pollution on the Musandam coastline including its socio-economic impact; of steps taken by the Oman government to clean-up oil spills and mitigate their effects on coastal communities; and of attempts that have been made and might be made in the future to find solutions to the problem of compensation for clean-up costs. Seven FGDs are planned; two focus groups of 6-10 fishermen will be arranged to take place in Khasab and Daba; two focus groups of 4-6 representatives of government officials with knowledge of marine oil spills will be conducted in government offices in Muscat; two focus groups of 4-6 oil tanker vessel owners will be carried out wherever is convenient for the owners; and one focus group will be conducted with representatives of NGOs, including environmental NGOs, probably in Muscat. The questions asked FGDs will be both semi-structured and open-ended. The researcher will encourage discussants to expand on their initial answers by asking follow-up related questions. The initial questions fall into the following six categories:

(1) Extent of marine oil spills in Musandam

a) What do you know about marine oil spills?
b) Are you very concerned/mildly concerned/unconcerned about marine oil pollution in Musandam' s coastal waters?
c) For how long have Oman and Musandam been suffering from marine oil spills?
d) What are the main reasons for oil spills in Oman and Musandam?
e) Have you noticed any increase or decrease in the number of oil pollution incidents in the Musandam Area in recent years?
f) What is the proportion of oil pollution incidents in the Musandam Sea from known and unknown sources?

(2) Effect of marine oil spills on the coastal ecosystem

a) What words or phrases come to mind when you think of the effects of marine spills on coastal ecosystems?
b) How do most oil spills affect the flora and fauna around the spill areas and their habitats?
c) Have oil spills resulted in the loss of any key marine species or habitat or shelter? If so, what?
d) Have oil spills caused harm to the coastline, beaches and terrestrial ecosystem? If so, what harm?
e) Do you think oil spills will cause permanent environmental damage? If so, what?
f) What are specific issues, concerns, or problems you've faced when oil spills happened?

(3) The socio-economic impact of oil spills

a) What are your general feelings about the impact on Omanis of oil spills?
b) What are the impacts of oil pollution on human activities in the Musandam Sea?
c) What are the potential impacts of oil spills on socioeconomic activities like fishing, tourism, and desalination in Oman?
d) Are there any major seafood quality issues and consumer health risks that you have noticed in Oman due to oil pollution? If so, what are they?
e) Have oil spills affected your livelihood? If so, how?
f) Have you changed your source of livelihood as a result of oil spills? If so, please explain.
g) Has the quality of the commercial fish you caught or ornamental organisms you observed deteriorated because of oil spills? If so, for which species, and to what extent?
h) Whom do you think is the largest loser from oil spills?
i) Who pays for oil spills clean-up and restoration?

j) What aspect of your life would you say was affected the most by oil spills?

(4) Remediation issues

a) How familiar are you with oil spills clean-up processes?
b) What are the different methods of cleaning up oil spills?
a) Which of these methods do you prefer, and why?
b) Who carries out the clean-up operations? Are they paid to do so? Do volunteers take part?
c) Do you think it is important to involve stakeholders in clean-up operations? If so, in what way?
d) After clean-up operations, do you think that the surrounding marine environment will recover and become healthier?
e) How long does it take to completely clean up an oil spill?
f) Do the clean-up operations themselves cause further damage? If so, how, and how seriously?
g) What are the advantages of natural processes of clean-up by rain and tidal movement compared to human interventions?
h) Do local communities receive any assistance during the incidence of the oil spills?
   (i) If so, who provided the assistance?
   (ii) What kinds of assistance?
   (iii) How satisfied were you with the assistance received?

(5) Compensation challenges

a) Do you think polluters should always pay for clean-up? If so, who should pay when the polluters cannot be identified?
b) Is it hard to discover which vessels are to blame for the oil spills? If so, why?
c) If the local communities take part in clean-up operations, should they get financial compensation from the government?
d) Have you received any compensation for economic loss to your fishing or diving business from the oil spills and/or the clean-up operations? If yes, was that adequate? If not, why?
e) Who should be responsible for paying out compensation for damage caused by oil spills and/or clean-up operations? the vessels' owners? their country's government? an international insurance fund? or the Omani government?
f) Should the Omani government obtain compensation from the companies who own or hire the vessels responsible for oil pollution in the Musandam Sea? If so, please explain why and how?
g) Do you know of any international laws that require compensation for oil spills, and any international organizations established for paying out that compensation? If so, please provide details.
h) How could Oman obtain compensation from offending vessels that are unidentifiable?
i) Do you think the Oman government should routinely monitor (e.g., by satellite surveillance) the movements of ships in the Strait of Hormuz so that in the event of an oil spills in Oman waters, it could track the perpetrators?
j) Under international law, what are the legalities of such monitoring? Is such monitoring technically and financially feasible?

(6) Ideas and suggestions on how to prevent or deal with such pollution happening in the future

a) Is there any way that oil pollution of the Musandam Sea can be prevented in the future? If so, how?
b) Should the Omni government raise awareness of the problem of protect the country's marine environment from oil pollution?
c) Do you think new kinds of international agreements are needed to provide compensation for oil pollution caused by both known and unknown sources? If so, what kinds of agreements would you recommend, and how should they be funded?

(7) Participant information

	Names	Jobs /affiliations
1		
2		
3		
4		
5		
6		

[There might be more questions asked depending on how the discussants respond to the initial questions]

Appendix E: Information letter and consent form for invitation to be interviewed.

Hope this email finds you healthy and safe during these uncertain times. I am Amran Al Kamzari - director of Environment Emergency Centre at Environment Authority. I am currently studying for a PhD in Natural and Environmental Sciences at Newcastle University, UK. Actually, I would like to inform you that I am conducting interviews in connection with my doctoral research on the topic of 'Investigating barriers to the effective international management of untraceable oil pollution and I am contacting you to invite you to take part in this research study by agreeing to be interviewed by Zoom meeting or Teams.

In the questions, I will ask you questions related to your knowledge and experience of oil pollution affecting the the sea and the transportation. All your responses will be kept anonymous and no one will be identifiable in the research.

Please let me know if you agree to be involved in this research and I will appreciate your reply.

Best wishes,
Amran Al kamzari

Appendix F: Consent form

Consent Form for all interviewees

My name is Amran Al-Kamzari and I am currently studying for a PhD in Natural and Environmental Sciences at Newcastle University, UK.

I am conducting interviews in connection with my doctoral research on the topic of 'Investigating barriers to the effective international management of untraceable oil pollution: towards greater protection of the Musandam Peninsula Coastline, Sultanate of Oman', and I am contacting you to invite you to take part in this research study by agreeing to be interviewed.

In the interview, I will ask you questions related to your knowledge and experience of oil pollution affecting the Musandam Coast. The interview will last approximately 60 minutes, and will take place in a mutually-agreed location. All your responses will be kept anonymous and no one will be identifiable in the research. This study has been approved by the Newcastle University ethical committee.

I would like you to answer the following questions:

Are you happy to answer questions on this topic?

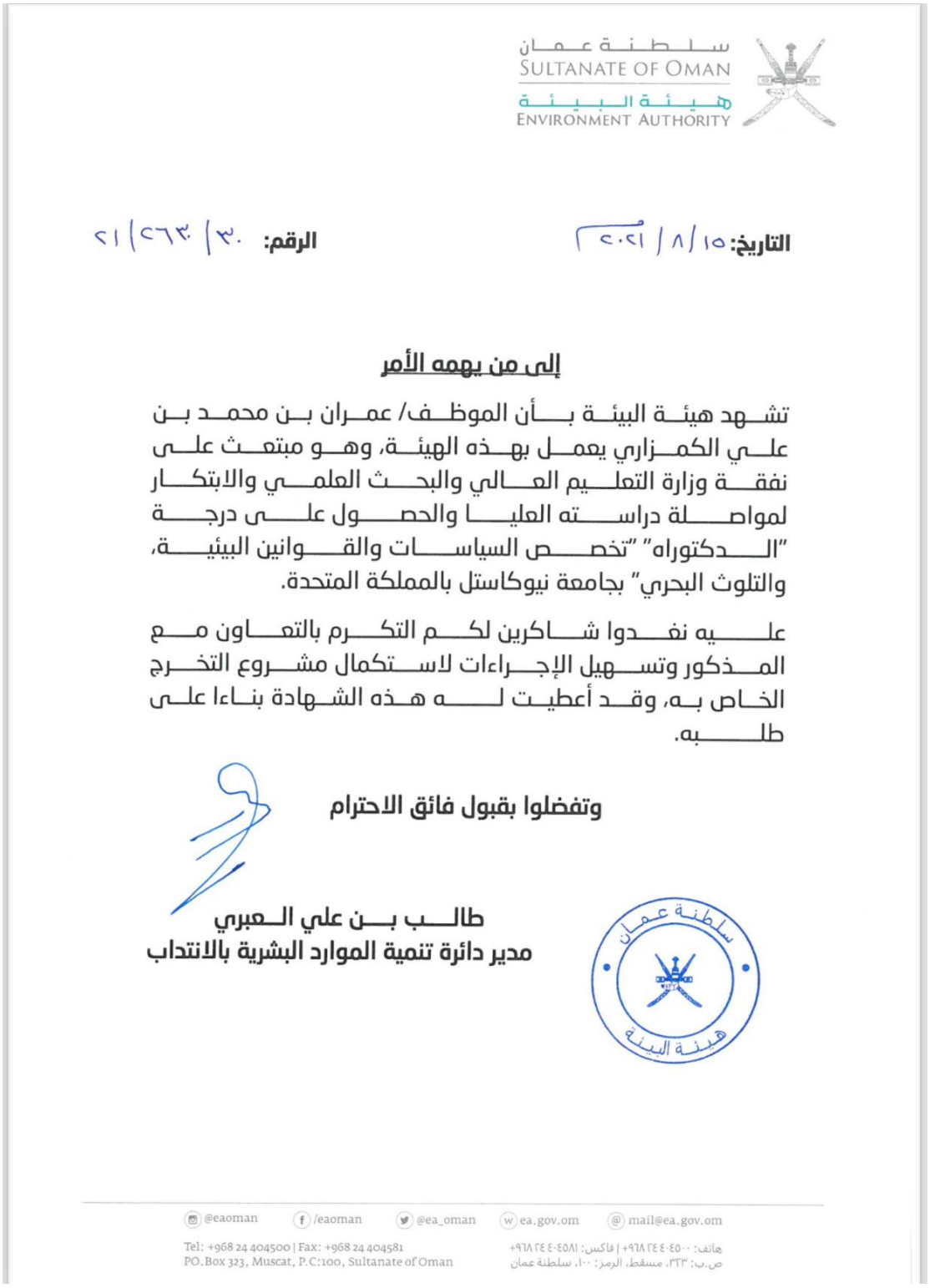
Are you happy for me to tape-record the interview?

Are you happy for me to transcribe the recording and send you the transcript to check its accuracy?

Are you happy for me to use your words in my thesis and any subsequent publication, on the strict condition that the words will be anonymised so that you cannot be identified as the source?

Once completed please email this form back to me at a.al-kamzari@newcastle.ac.uk

Appendix G: Permission letter obtained from the Environment Authority



سلطنة عمان
SULTANATE OF OMAN
هيئة البيئة
ENVIRONMENT AUTHORITY

التاريخ: ١٥/٨/٢٠٢١ الرقم: ٣٠/٢٦٣/٢١

إلى من يهمه الأمر

تشهد هيئة البيئة بأن الموظف/ عمران بن محمد بن علي الكمزاري يعمل بهذه الهيئة، وهو مبتعث على نفقة وزارة التعليم العالي والبحث العلمي والابتكار لمواصلة دراسته العليا والحصول على درجة "الدكتوراه" "تخصص السياسات والقوانين البيئية، والتلوث البحري" بجامعة نيوكاستل بالمملكة المتحدة.

عليه نغدوا شاكرين لكم التكرم بالتعاون مع المذكور وتسهيل الإجراءات لاستكمال مشروع التخرج الخاص به، وقد أعطيت له هذه الشهادة بناءا على طلبه.

وتفضلوا بقبول فائق الاحترام

طالب بن علي العبري
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