ISSN: 2642-9020

Research Article

Journal of Marine Science Research and Oceanography

Evaluating Climate Change Impacts to Qatar's Marine Life: A Risk Assessment for SDG 14 (Life Below Water)

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Submitted: 2024, Nov 01; **Accepted:** 2024, Nov 23; **Published:** 2024, Dec 06

Citation: Sawh, S. K., Gilani, I. E., Siddique, A., Khatir, Z., Range, P., et al. (2024). Evaluating Climate Change Impacts to Qatar's Marine Life: A Risk Assessment for SDG 14 (Life Below Water). *J Mari Scie Res Ocean, 7*(4), 01-10.

Abstract

Marine life is integral to Qatar and the broader Arab region, serving as a cornerstone for biodiversity, economic activity, and cultural heritage. Despite the ambitious targets set by Sustainable Development Goal (SDG) 14, climate change is placing mounting pressure on conservation efforts. Recognizing that climate change cannot be entirely stopped, the focus should be on mitigating its effects through sustainable strategies. This study identifies twelve climate-related risks that impede Qatar's progress towards achieving SDG 14 - Life Below Water.

To understand the region-specific climate risks, this study engaged in a focus group discussion with representatives from the government, NGOs, private sector, and academia. The Climate Change Risk Assessment (CCRA) identified the most severe risks as flooding associated with rising sea levels, modified species biogeography, and compromised coral reef health. While other risks were rated low, such as risks to seagrass meadows driven by increasing sea temperatures. Other significant findings include the need for increased awareness of climate change impacts on both the local and global administrative platforms.

This risk assessment provides insights into the vulnerable facets of Qatar's marine environment, intending to guide forthcoming strategies for achieving SDG-14.

Keywords: Sustainable Development Goal 14, Climate Change, Risk Assessment, Climate Drivers, Marine Environment

1. Introduction

Climate change significantly threatens the achievement of Sustainable Development Goal (SDG) 14, "Life Under Water," which aims to conserve and sustainably use the oceans, sea and marine resources for sustainable development (UN, 2015). The intensifying impacts of climate change are creating significant uncertainties about the future of marine ecosystems and coastal zones [1-3]. Climate-related pressures, such as rising ocean temperature, sea level rise, ocean acidification, and changes in ocean circulation and nutrient dynamics, are altering the physical and chemical environment of the oceans. These pressures disrupt the physiological processes, distribution patterns and ecological interactions of marine species, leading to cascading effects on biodiversity, ecosystem functions and services provided by marine and coastal systems. This leads to shifts in community structure and ecosystem functioning, with pronounced impacts in sensitive regions like the poles and tropics, where species are adapted to narrow environmental conditions [4]. The complex interplay between climate change and other human-driven stressors, such as overfishing, pollution, and coastal development, further jeopardizes the health and resilience of marine ecosystems [5,6]. Addressing these compounding threats is crucial for achieving SDG 14 and

ensuring the long-term sustainability of marine resources and coastal communities. SDG 14 presents a comprehensive framework of 10 targets and indicators organized around marine resource conservation and preservation and sustainable fishing [7]. This approach facilitates the assessment of progress and identification of areas requiring focused attention, enabling policymakers and stakeholders to develop and implement effective strategies for the responsible stewardship of oceans, seas and marine resources (UN, 2019).

Qatar, with its expansive coastline and abundant marine biodiversity, faces significant climate change risks that jeopardise the realization of SDG 14 [8,9]. The Gulf region, including Qatar, has experienced a concerning 0.59°C per decade increase in surface water temperature over the past four decades, an indicator of climate change and global warming with the highest per capita carbon dioxide emission [10,11]. Projections indicate that Qatar and neighbouring countries like Oman and the UAE will be among the most severely affected, potentially facing up to a 30% decrease in fish catch by the end of the century [8, 9, 12].

Ocean stratification, driven by temperature and salinity differences, regulates the distribution of nutrients, dissolved gases, and heat, influencing biological productivity and ecosystem functioning [4,13]. The relationship between water column stratification and low dissolved oxygen levels was established in Qatar [14]. Hypoxic conditions, with oxygen levels falling below critical thresholds of 2mg/L, have been observed in the deeper zones of Qatar's marine environment, leading to mass mortality events among coral reef organisms [9]. The deepest zones of Qatar's marine environment (more than 50m) are experiencing significant hypoxia, with oxygen levels falling below 2 mg/L. Oxygen depletion serves as a major driver of mortality for many coral reef organisms [15].

Addressing these challenges requires a comprehensive, evidence-based approach that integrates climate change risk assessment (CCRA) with targeted conservation and resilience-building strategies. By leveraging the insights and perspectives of diverse stakeholders, from government entities to NGOs and academia, Qatar can develop tailored CCRA frameworks to inform effective decision-making and mitigation efforts, ultimately safeguarding its marine resources and achieving the ambitious goals of SDG 14 [16].

2. Methods

2.1 Risk Assessment

The risk assessment methodology integrated frameworks from the UK Climate Change Risk Assessment (CCRA, 2012), C40 Cities Climate Risk Assessment Guidance, and UAE Ministry of Climate Change and Environment (MOCCAE, 2019) [17]. The four-step process included: (1) context establishment and stakeholder analysis, (2) climate driver identification through historical and projected data analysis, (3) risk identification, analysis, and evaluation based on vulnerability and impact assessments, and (4) risk prioritization and ranking for resource allocation and strategic planning. This approach enabled comprehensive climate-related risk management.

2.2. Stakeholder Engagement

Three focus groups were conducted with experts and representatives from Qatar's government, private sector, academia and non-governmental organizations. Participants provided insights on Qatar's current state, immediate risks and ongoing initiatives, emphasizing inter-sectoral collaboration. Six thematic question sets, derived from sources in Figure 1, guided the discussions [18].

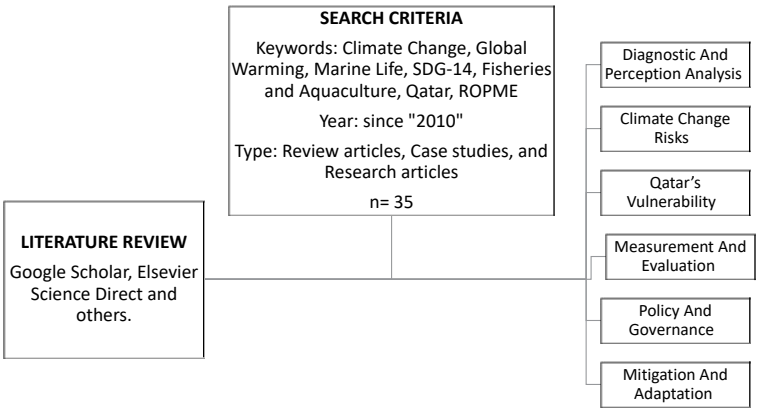

Figure 1: Decision Criteria for the Design of the Focus Group Questionnaire

2.3. Identifying Climate Pressures

Climate pressures are factors influencing long-term patterns and variations in Earth's climate, operating on various timescales and complex interactions. A comprehensive literature review identified key climate drivers and pressures in Qatar. Given its geographical and environmental conditions significant pressures include extreme temperatures, sea level rise, and unusual precipitation patterns.

A. Extreme Temperatures: Qatar experiences extremely high temperatures, particularly during the summer months. The shallow coastal region of Qatar has shown spatially consistent warming trends, with significant warming trends observed in Doha across various indices. This warming trend is exacerbated by the urban heat island effect, particularly in densely populated and built-up areas [19,20].

B. Sea Level Rise (SLR): Qatar's vulnerability to sea level rise is particularly concerning due to its low-lying coastal topography and the concentration of its population in urban areas along the coast. These factors heighten the risk of flooding, coastal erosion and habitat loss, threatening both human settlements and natural ecosystems, posing serious challenges to urban planning and development (Ministry of Municipality and Environment, n.d.). This risk is compounded by Qatar's rapid urbanization and the concentration of economic activities and infrastructure in coastal regions [21].

C. Unusual Precipitation Patterns: while Qatar generally experiences low precipitation, changes in precipitation patterns, including unusual extreme precipitation events, can have significant implications for the country. These highly variable events affect water resources, agricultural production and urban infrastructure.

D. Coastal Water Salinity: the Arabian gulf surrounding Qatar exhibits high salinity with an average of 42psu (practical salinity unit), ranging between 39 and 57 psu, due to high evaporation rates and limited freshwater inflow. In southern embayments the salinity exceeds 50 psu and may reach higher values greater than 70 psu in evaporative lagoons [22]. This elevated salinity affects the marine environment, influencing the biodiversity and ecological dynamics of the region [23,24].

E. pH: the present direction of pH trends is uncertain. However, within the Arabian Gulf, there has been an observed overall reduction in average pH. Specifically, between 1960 and 2000, there was a decrease of approximately 0.1 pH units in the upper 50 meters and 0.2 pH units at deeper waters [25]. According to Rivers et al., coastal-seawater pH measurements typically fluctuate within the range of 8.0 to 8.6, with higher pH values observed during winter and spring (8.35 ± 0.23) compared to the fall (8.19 ± 0.42) [26].

2.4. Identifying and Scoring Risks

2.4.1. Risk Score Calculation

Risk scores were calculated using the equation:

$$Risk = (Proximity \times Likelihood) \times 100$$

Proximity values, adapted from Maltby et al. (2022), were assigned based on event timing: 4 (current), 3 (within 25 years), 2 (25-50 years), and 1 (50+ years), then converted to 1, 0.75, 0.50, and 0.25, respectively. Likelihood scores were derived from focus group discussions, calculated as the number of affirmative responses divided by the total participants present (Risk/17 or 16).

2.4.2. Risk Categorisation

Risk scores were categorized as low (0-12.5), moderate (>12.5-25), and high (>25-37.5) by dividing the highest score by 3. Risk categories were determined by intersecting risk scores and confidence levels: severe (high confidence, high risk), moderate (high confidence, medium risk; medium confidence, high or medium risk), and low (any confidence, low risk).

3. Results

Stakeholders from various sectors shared insights on climate change risks and vulnerabilities in Qatar. Identified risks, listed in Table 1, include extreme weather events, biodiversity loss, and associated socio-economic costs. Initial diagnostic questions revealed all participants understood climate change impacts, while 56.25% were familiar with SDG 14 indicators and targets. Key risk factors identified were sea level rise, unusual precipitation and increasing temperatures, contributing to high-severe risks such as increased flooding, marine species migration shifts and coral health deterioration. Table 1 summarizes stakeholder discussions and ongoing efforts in Qatar.

Targets		Reports	Remarks
14.1	Reduced marine pollution	- National Development Strategy (NDS) by 2030 including initiatives to reduce pollution. - NGOs initiatives like (DEAP: Doha Environmental Actions Project) - Underwater clean-up campaigns by Qatar Marine	- Qatar has taken steps to address marine pollution, particularly from land-based activities. Initiatives such as beach clean-ups and bans on single-use plastics aim to reduce the influx of pollutants into the marine environment, aligning with the target to significantly reduce marine pollution by 2025.
14.2	Protect and restore ecosystems	- Major coral restoration efforts and compensation projects.	- There is expression of interest but no actual implementation. - Initiatives to battle SLR.
14.3	Reduce ocean acidification	- National Development Strategy (NDS) by 2030 include initiatives to reduce pollution. - Reports indicated that Qatar has made moderate improvements (Sachs et al., 2023)	- While global in scope, the challenge of ocean acidification necessitates local action. Qatar's investment in renewable energy sources and efforts to reduce carbon emissions contribute indirectly to mitigating ocean acidification.
14.4	Sustainable fishing	- Qatar National Vision 2030 - National Biodiversity Plan 2015/2025 Sustainable Development Report (Sachs et al., 2023) has indicated that there has been significant target achievement.	- Participants stated that the interests in promoting this target were clear, but no actual work has been done.
14.5	Conserve coastal and marine areas	- Ministry of Environment and Climate Change (n.d.) stated that there will be the establishment of marine protected areas, covering 30% of Qatar's waters.	- Lack of management plans, including enforcement, for existing ones and no actual preparations for establishing new MPAs

14.6	End subsidies contributing to overfishing	- While specific policies targeting subsidies are not detailed, Qatar's commitment to sustainable fishing practices indirectly addresses the need to end harmful subsidies	- Specific actions in Qatar regarding this target are not explicitly documented.
14.7	Increase economic benefit from sustainable use of marine resources	- The Qatar National Tourism Sector Strategy 2017-2023 - Aim to develop sustainable tourism, including eco-tourism, to increase economic benefits from marine resources.	
14-8	Increase scientific knowledge	- Qatar National Research Strategy 2012 and Qatar Research, Development and Innovation Council 2030 vision - Encourages research and development in marine sciences to enhance understanding and management of marine ecosystems.	- There is urgency to spread awareness from primary level and increase society involvement through social media
14-9	Support small scale fisheries		- Qatar is working towards implementing legal and policy frameworks that recognize and protect access rights for small-scale fishers.
14-A	Law implementation and enforcement	- Qatar complies with international laws and agreements, such as the United Nations Convention on the Law of the Sea (UNCLOS), to ensure the sustainable use and conservation of the oceans.	- Regulations exist but no enforcement nor active monitoring

Table 1: SDG 14 Indicators and Highlighted Remarks from the Focus Group Discussion with Stakeholders

Urbanisation, pollution, overfishing, rising temperatures and infrastructure expansion were recognized as the immediate consequences of climate related drivers generally referred to as associated pressures, contributing to low-severity risks like habitat destruction, harmful algal blooms, fish mortality, and threats to vital ecosystems such as seagrass meadows, mangrove forests, species like dugongs and sea turtles, and proliferation of jellyfish. Industry vulnerabilities to floods and unusual precipitation were identified, potentially disrupting services and operational effectiveness. Other identified risks were regulation and provisioning of services derived from the marine environment. These services include the management of fisheries resources, ensuring freshwater availability through desalination plants, and coastal protection measures [27].

Rising sea levels as well as extreme unusual precipitation are expected to result in flooding, potentially leading to displacement and property damage and the loss of essential amenities. The RSA coastal regions, with substantial population and urban developments, are particularly vulnerable [28,29]. Over the past 30 years, RSA sea temperatures have increased by an average of 1°C, with shallow areas warming more rapidly. For example, in 2020, Kuwait recorded its highest-ever sea surface temperature of 37.6°C [30]. Oxygen Minimum Zones (OMZs) are persistent features in the RSA, with continuous hypoxia observed near Qatar. Salinity levels have reached 70 PSU in some areas, the highest in the RSA, with increases of 5-10 PSU since the 1950s due to elevated air temperatures, increased evaporation, reduced freshwater input, and brine outflows from desalination plants [26,30,31]. Desalination plants face challenges from fluctuating coastal water conditions, with efficiency impacted by rising temperatures, increased salinity, and mass jellyfish and algal blooms. Figure 2 and Table 2 illustrate the identified risk categories, confidence levels, and risk scores. Table 3 presents the associations between calculated risk and confidence index scores for each SDG 14 target.

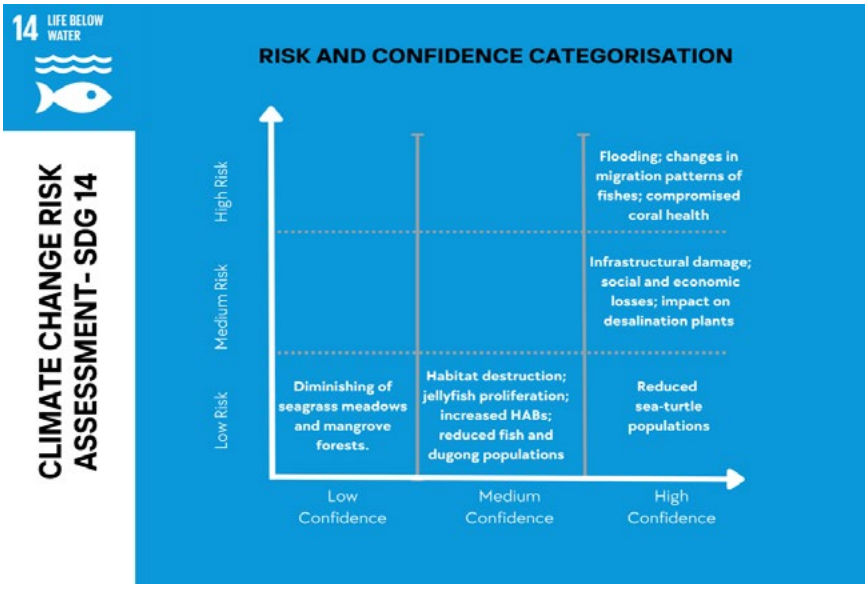

Figure 2: Risk and Confidence Categorisation

Primary Pressures	Risk	Proximity	Likelihood	Risk Score %	Confidence	Risk category
Sea level rise	Flooding on coastal communities and built environments.	0.75	0.5	37.5	High	Severe
Ocean warming	Changes to the migration patterns of fishes (groupers, snappers, jacks) leading to reduce fisheries catch	0.75	0.41	30.8	High	Severe
Ocean warming Ocean acidification	Compromised coral health	0.5	0.59	29.5	High	Severe
Increased Salinity	Impact on desalination plants and coastal infrastructure	0.75	0.24	18	High	Moderate
Extreme unusual precipitation events	Infrastructure Damage, social and economic losses	1	0.25	25	High	Moderate
Ocean warming	Diminishing seagrass meadows	0.75	0.12	9	Low	Low
Sea level rise	Diminishing mangrove forests (Habitat loss)	0.5	0.18	9	Low	Low
Ocean warming Sea level rise	Reduced dugong populations linked to reduced seagrass meadows	0.75	0.06	4.5	Medium	Low
Global warming Ocean warming Sea level rise	Reduced sea turtle populations	0.75	0.12	9	High	Low
Ocean warming Ocean acidification Eutrophication	Increasing jellyfish populations	1	0.06	9	Medium	Low
Sea level rise Ocean warming Ocean acidification	Degradation of natural coastal and marine habitats	0.75	0.06	4.5	Medium/ High	Low
Ocean warming Ocean acidification Pollution-Eutrophication	Harmful Algal Blooms leading to increasing hypoxic conditions	0.5	0.12	6	Medium	Low
Ocean warming Anthropogenic factors (Overfishing, land-based pollution)	Decreasing fish populations	0.67*	0.12	8	Medium*	Low
**Fishes associated with coral reefs (Proximity = 1, High confidence), pelagic (Proximity = 1, low confidence) and demersal fish (Proximity = 0.75, low confidence)*						

Table 2: Major Risks Identified by Stakeholders During Group Discussions, Risks Were Scored and Ranked According to Frequency and Classification Results from [31]

	Flooding in coastal communities and built environments	Degradation of natural coastal and marine habitats	Infrastructural damage; social and economic losses	Changes to migration patterns of fishes	Harmful Algal Blooms	Decreasing fish populations	Compromised coral health	Diminishing seagrass meadows	Diminishing mangrove meadows	Reduced dugong populations	Reduced sea turtle populations	Increasing jellyfish populations
14.1 Reduce marine pollution	●				●							
14.2 Protect and restore ecosystems		●	●	●	●	●	●	●	●	●	●	●
14.3 Reduce ocean acidification	●											
14.4 Sustainable fishing			●	●	●	●	●	●	●	●	●	●
14.5 Conserve coastal and marine areas	●	●		●	●	●	●	●	●	●	●	●
14.6 End subsidies contributing to overfishing					●							
14.7 Increase the economic benefits from sustainable use of marine resources	●	●	●	●	●	●	●	●	●	●	●	●
14.8 Increase scientific knowledge, research and technology for ocean health												
14.9 Support small scale fishers	●	●	●	●	●	●	●	●	●	●	●	●
14.A Implement and enforce international sea law		●			●							

● Severe Risk ● Moderate Risk ● Low Risk

Table 3: Identified Risks and their Potential Impact on Achieving each of the SDG 14 Targets

4. Discussion

The State of Qatar has made moderate strides towards achieving the SDG 14 as each target requires a set of unique management and implementation strategies [32]. This Climate Change Risk Assessment (CCRA) for Qatar reveals the acute challenges to ecosystems and communities arising from increased temperatures, sea-level rise, and extreme weather events, among other factors. We categorized 12 climate-associated risks, with flooding, extreme temperature events, and coral reef health deemed severe. Moderate risks include infrastructural damage, social and economic losses, other risks, such as those to sea-turtle communities, carry a high confidence but low risk score. Remaining risks were categorized as low though they were classified with moderate confidence level.

4.1 Risk to the Marine Environment (14.1, 14.2, 14.3, 14.5)

SDG 14.1 aims to prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities. As of 2020, Qatar has been monitoring the concentration of nutrients in its coastal waters, which is a key driver of harmful algal blooms. However, the data does not provide a clear picture of whether Qatar is on track to achieve this target by 2025 or any indication of increasing or decreasing levels [33]. Climate change has the potential to exacerbate this issue, as more frequent and intense rainfall events may result in increased runoff, leading to elevated nutrient loads in coastal waters and can alter the mobilisation of marine debris. While ocean acidification, a direct consequence of rising atmospheric CO2 levels, can modify the toxicity of pollutants in marine environments, potentially increasing the harmful effects of existing pollutants in Qatar's waters. Although marine pollution related to marine debris and other waste has seen a marked reduction since 2016, a study from 2020 showed that in some locations, 100% of the marine debris consisted of plastic with a national coastline average of 71.4%, with the majority of plastic litter sourced from polyethylene terephthalate (PET) bottles, 47% of which is driven by wind and current from neighbouring countries [34]. Given the unique marine topography of Qatar and the hydrodynamics of the Gulf, a regional management plan is necessary to address and mitigate these climate change-related pollution issues effectively. Such a plan must account for the transboundary nature of marine pollution and the compounded impacts of climate change on marine ecosystems.

SDG 14.2 and 14.5 seek to manage and protect marine and coastal ecosystems to avoid significant adverse impacts. From discussions several species and key habitats were identified but not considered to be under severe risk apart from coral reefs. While Qatar has

not designated new areas for protection since 2008, it has reported that all EEZ are managed using ecosystem-based approaches [32,33]. Panel discussions also revealed that there is an increasing concern with the lack of attention paid to the designation of marine protected areas or the implementation of current management policies. Indicative that Qatar will unlikely achieve this target by 2030. While an extremely important target, this cannot be said to be directly hindered by the impacts of climate change but rather the political will power of the governing body.

SDG 14.3 aims to minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels. The local report from Qatar shows a reduction in ocean acidification in various locations ranging from 7.7 to 8.4, which are within the maximum permissible limit for average acidity according to Qatari Law No. 3 of 2005 (6.5 - 8.3 grams per liter) [3]. This information suggests that Qatar is making progress towards achieving SDG 14.3, however, it's important to note that ocean acidification is a complex issue that can vary significantly across different regions and over time. Therefore, while these results are encouraging, ongoing monitoring and efforts to reduce greenhouse gas emissions, which are a major cause of ocean acidification, will be crucial for Qatar to continue making progress towards this target.

The Arabian Gulf, which includes Qatari waters, is experiencing deoxygenation primarily due to reduced ventilation induced by local warming. This deoxygenation, alongside increased warming, and acidification can trigger extreme marine events such as, dead zones and coral bleaching, [35,36]. This 'deadly trio' of ocean acidification, sea warming, and deoxygenation lead to reduced catches of commercially important fisheries and decrease the capacity of marine ecosystems to store carbon. In the context of Qatar, these impacts are already being observed and are expected to intensify in the future [12]. Coral reefs and seagrass habitats in Qatar are crucial components of the Arabian region's most biologically diverse and socio-economically important ecosystems [37]. However, discussion revealed that there is mounting concerns that these critical ecosystems are not receiving the necessary attention to ensure Qatar meets its Sustainable Development Goal (SDG) targets.

4.2. Risk to Fisheries (14.4, 14.6) and Socio-Economic Risks (14.7)

Worldwide, target 14.4.1 (biologically sustainable fish stock) is measured as very far from being achieved by 2030 according to the latest available data from 2019 [38]. Ending overfishing and exploitation is the main objective of this indicator, however, data insufficiency poses an obstacle in addressing the progress level that has been made here. Perhaps, this indictor is the most underachieved and not expected to be satisfied globally by 2030 [10]. In contrast, data from the Qatari Planning Spatial Analysis noted that between 2016 to 2019, fish stock within biologically sustainable levels has increased from 80 to 85% and anticipated to keep on increasing [33]. Data on illegal unreported and unregulated (IUU) fishing show that there is good progress in meeting this target and by 2022 it has been classified as “close to achieve”. In 2021, Qatar ranked as 98 on a global level with IUU score of 2.15 which is 0.12 higher than in 2019 when the country ranked at 122. This decline in state was based on decreased national response to IUU laws. Notably, Qatar has a unique assembly of fishing vessels type where fishing is fully reliant on small scale fisheries consisting of launches and speed boats [39,40]. Each vessel is obliged to provide information on number of personnel on boat, destination, estimate number of fishes intended to be caught, species, season, fishing methods and used gear. Small-scale fisheries, representing the majority of fisheries fleet in Qatar, are a major source of food and employment for people around the world. They account for 90% of global fishers and 40% of the global catch. Managing small-scale fisheries sustainably is essential for achieving SDG 14 especially in a country (Qatar) that lacks industrial fishing vessels [2,39].

Fisheries management involves a partnership between the government and local fishermen, such that they are involved in the decision-making process, or fisheries management entirely by local fishers is often seen as the best way to govern small-scale fisheries [41]. As a step forward in this direction, the Qatari ministry of Environment implemented a new law (No. 86) in 2015 that necessitates monthly meetings with the Living Aquatic Resources Committee and stakeholders to regulate fishing practices [42]. Climate change plays a crucial role in affecting Qatar's fishing industry and the livelihoods of those dependent on it. The size, distribution and species composition of fish catch is affected by climate change. Changes in sea surface temperatures, ocean currents and the distribution of marine species, as discussed earlier, can and will affect fish stocks and the productivity of fishing activities [30,43]. Although the risk –fish mortality- was classified as low, it can hinder achieving the targets of SDG 14. Qatar, along with Oman and UAE are the most vulnerable nations in the Gulf Sea in terms of catch potential, Qatar alone is estimated to suffer the loss of around 35% of its catch potential by 2090. Within the same time frame, Qatar is expected to lose more than 15% of its suitable marine habitats and 18.2% of its land if sea level rise by less than 5 meters [12,21]. Consequently, economic benefits are foreseen to decline. Nevertheless, between 2012 and 2016, Qatar succeeded in increasing its sustainable fisheries as a proportion of GDP from 0.09 to 0.19 but there were no data on the economic value after that date, so, current progress of 14.7 remains ambiguous [42].

4.3. Awareness and Education (14-A)

The achievability of Sustainable Development Goal (SDG) 14, is closely tied to the level of education and awareness regarding climate change impacts in Qatar. Stakeholders highlighted the critical role of embedding climate change education from the primary level to foster a society capable of addressing related risks. Secondly, participants recognised social media as a significant tool, useful for disseminating information and raising awareness. Its capacity to reach a broad audience can significantly contribute to the public's understanding and engagement with marine conservation efforts. Furthermore, promoting grassroots efforts and local initiatives, like coastal clean-up campaigns, play a critical role in mobilizing

community action towards sustainable practices. Such engagement not only broadens the inclusion of diverse perspectives but also facilitates the exploration of additional evidence, leading to a more comprehensive understanding of the challenges at hand (Ocfemia, 2023).

Moreover, regional-level risk assessments have been beneficial in identifying transboundary risks and supporting decision-making at broader scales. However, these assessments have also highlighted challenges, particularly when risks are not uniformly relevant across all sub-regions, leading to difficulties in addressing specific local needs [31]. Addressing these challenges requires tailored strategies that consider the specific environmental and socio-economic contexts of each community.

These efforts collectively contribute to a more informed and proactive approach towards mitigating the impacts of climate change on marine environments and advancing towards the targets set under SDG 14.

4.4 Law Enforcement in Qatar Considering Climate Change and SDG-14

Qatar has implemented measures to enforce international and national laws aimed at protecting its marine resources, aligning with SDG 14-C which emphasizes strengthening the implementation of international law related to oceans. The country operates a small, traditional fishing fleet confined to its territorial waters and banned from trawling, effectively preventing overfishing in Qatar EEZ and international zones. Additionally, it was emphasized that no fishing vessels from outside Qatar's territorial waters have ever docked at the country's fishing ports [42].

Key legislations such as Law No. 4 of 1983 and Law No. 30 of 2002, which cover various environmental protections including the management of oil discharge, hazardous substances, and sewage in marine environments, support these efforts (Al Meezan - Qatari Legal Portal | Legislations | Law No. 30 of 2002 Promulgating the Law of the Environment Protection) [44]. Furthermore, several ministerial resolutions regulate specific fishing practices and amateur fishing, ensuring sustainable utilisation of marine resources.

The Ministry of Environment and Climate Change (MECC) plays a crucial role in this framework, developing regulations to prevent violations against marine life and habitats, and collaborating with relevant organizations to monitor and address environmental threats [42]. In support of these environmental initiatives, Qatar launched the "Qatar National Vision 2030 (QNV 2030)" focusing on sustainable development across human, economic, social, and environmental domains [45]. The subsequent National Development Strategies (NDS-1 in 2011 and NDS-2 in 2018) set specific environmental targets including water preservation and biodiversity conservation. By 2016, NDS-1 achieved only two out of fourteen targets, such as a 30% reduction in gas from energy production and a decrease in domestic waste generation. However, the first strategy achieved only two of its fourteen targets, highlighting challenges such as unclear prioritization and inadequate institutional coordination. NDS-2 acknowledged shortcomings in policy planning and execution, citing unclear prioritization, inadequate coordination, and limited capacity at the institutional level as factors contributing to unmet targets [46]. These shortcomings should be addressed during the ongoing updating of the National Biodiversity Strategy and Action Plan (NBSAP) and the development of the country's National Adaptation Planning (NAP) aiming to enhance climate change resilience and reduce Qatar's vulnerability to climate change, both conducted by MECC [47-58].

5. Conclusion

Qatar has shown ambition and drive to achieve sustainable development, particularly in pursuing Sustainable Development Goal (SDG) 14. However, during panel discussions various obstacles were identified that impede the achievement of this goal. The discussions highlighted both progress and challenges in safeguarding marine ecosystems and resources, mainly fisheries. The nation is committed to Sustainable Development Goal 14 by monitoring and addressing marine pollution, implementing measures to protect coral reefs, and engaging in sustainable fisheries management. Notably, the focus on small-scale fisheries, involving local communities in decision-making, showcases a holistic approach to achieving SDG 14 targets.

The observed increase in fish stocks within biologically sustainable levels and progress in combating illegal fishing are positive indicators. Yet, the future vulnerability of Qatar's fisheries to climate change necessitates ongoing vigilance and adaptive management strategies. Panelists during discussions highlighted that while significant funding is allocated to research, there is a gap in translating these findings into policies and actions. This disconnection between research and implementation undermines the practical application of scientific knowledge for sustainable marine resource management. Additionally, where management plans exist, such as in the case of Marine Protected Areas, there is a lack of clarity in their actual implementation and enforcement. This hinders effective conservation efforts and compromises the preservation of marine biodiversity.

However, the emphasis on awareness and education highlights the importance of public engagement in achieving SDG 14. The enforcement of laws related to oceans and marine resources, as highlighted in Qatar's legal frameworks, signifies a robust commitment to international agreements and responsible marine resource management. In summary, while Qatar has made commendable strides toward SDG 14, continuous efforts, enhanced monitoring, and adaptation to evolving challenges are essential for the sustainable preservation of its marine ecosystems and fisheries. The nation's proactive legal measures and collaborative initiatives position it favourably on the path towards the conservation of Life Below Water.

Acknowledgment

This research was supported by the Qatar University, Graduate

Research Assistantship Program. The statements made herein are solely the responsibility of the authors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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