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Marine Conservation and Promotion of Tourism: An Approach on Marine and Coastal Planning at Cat Island, Muscat, Oman

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Abstract
Oman is home to over 530 sqm of coral reefs. With the abundant coral species and reef fish, it became a popular destination for tourists. The economy has also increased because of the leading fishing industry, which serves as a point of export to nearby countries. Additionally, the capital Muscat is one of the top tourist spots due to its increasing water activities. However, in the past decade, the unforgettable cyclone Gonu destroyed the beautiful sea habitat, one of the environmental stressors for the marine ecosystem. Furthermore, the anthropogenic stressors, such as berthing, scuba diving, and overfishing, yield a decrease in natural coral reefs. Cat Island, known to be one of the diving spots in Muscat, is vulnerable to coral reef declination. This research focused on analyzing the present condition of coral reefs at Cat Island in relation to environmental and human activities. Moreover, there were studies conducted regarding the physical status of the coral reefs identifying the stressor of coral reef degradation. The researcher conducted a survey, phone and personal interviews, and distributed questionnaire forms to assess the site's character and understand the marine habitat from the primary user's perspective. Data from previous studies in the reefs of Oman and information from the government and non-government units were collected. As an outcome, it presented an imperative position towards marine and coastal planning by recommending policy enhancement and marine functional zoning in Cat Island. Additionally, it was shown that sustainable marine conservation and tourism promotion can be obtained through the aid of artificial reefs as a new habitat for the marine ecosystem. With this approach, these concepts can be used as a baseline in conducting research on another marine habitat in Muscat, Oman, which requires thorough study and future improvement.
Keywords: Marine and coastal planning; Marine functional zoning; Policy; Natural reefs; Artificial reef; Marine Habitat.

1. Introduction

Oman's coral reefs are over 530 square kilometers extended across one of Arabia's longest coastlines (Spalding et al., 2001; Burt et al., 2016). Oman reefs are home to over 100 coral species and 579 species of reef fish (Claereboudt, 2006; Grandcourt, 2012). In spite of their exceptional biogeographic setting and obvious standing to environmental and businesses, Oman's reefs are included in the less researched, accounting for less than 4% of regional reef-associated journals (Burt, 2013; Vaughan & Burt, 2015).
Cat Island as shown in figure 1 is one of the most visited areas in Muscat, Oman.

Figure 1. Cat Island Location.

With a maximum depth of 16m, activities such as diving, freediving, snorkeling, and fishing may be done.
As a result of environmental impact, aquatic system is greatly distressed (Halpern et al., 2008), and more than partial part of reefs are currently believed to be at great to acute risk as a consequence of these incorporated pressures (Burke et al., 2011; Burt et al. 2016).

1.1 Major Stressors to Oman's Marine Ecosystem

1.1.1 Coral reef degradation

Coral reefs have been subjected to numerous severe stressors in latest years, which have resulted to coral cover loss and community structure shifts; however, the effects of these occurrences vary perceptually and categorically (Glynn, 1993; Bauman et al., 2010; Coles et al., 2015).
Environmental impacts on Oman's reefs signify unusual and stressful conditions that corals in the Sultanate must accept. Principal impacts include the following: 1. Recreational activities, 2. enriched water discharges from sea farms, 3. litter, 4. fishing-related damage-causing coral reef breakage; caused by entangled nets and boat anchors, 5. discharges from desalination plant, 6. oil pollution, and 7. coastal destruction (Ministry of Environmental Climate Affairs [MECA], 2010).
Ras Al-Hamra Sub Aqua Club [RAHSAC] (1998), observed that the primary cause of damage to corals is boat anchoring for leisure diving and snorkeling.

1.1.2 Climate change

Climate change (CC) has enticed much public and scientific responsiveness over the last few years. Nowadays, it is generally recognized that humans' economic actions are in the lead to an essentially unrestrained surge in greenhouse gas (GHG) emission and the awareness of GHG in the earth's atmosphere.

1.1.3 Boat anchoring

Actual ravage from boat anchors and their related chains is a recognized cause of damage to coral reefs (Goenaga 1991; Flynn, 2015). However, boat anchoring is rarely the subject of official study (Johnstone et al. 1998; Flynn, 2015).

1.1.4 Scuba diving practice

Recreational scuba diving is a leisure and tourism activity affecting the communities, economies, and environments in various destinations, across all latitudes in both developed and developing countries (Al-Dujaili & Amen, 2018, Lucrezi et al., 2019). As coral reefs have become more accessible and facilities for visitors were improved, the quantity of people diving into this potentially fragile ecosystem has risen. Consequently, there is a widespread concern that significant reef degradation has resulted from tourism activities (Salm 1986; Ward 1990; Hawkins & Roberts, 1993).

1.1.5 Fishing practice

One of the largest fish producers is Oman and an exporter of fish products (FAO, 2019).
Damage from fishing activities, including the effects of gillnets, anchors, ropes, fishing lines, and debris, were the most frequently identified and most severe effects by human impacts. Breakage is often triggered by unwanted fishing equipment, linger on the reef over time, resulting serious and long-lasting damage.
With this, it is imperative that marine and coastal planning approach should be considered in marine habitat conservation and promotion of tourism in Cat Island. Coral reef degradation is caused by natural and human stressors such as climate change, cyclone, boat anchoring, scuba diving practice, and fishing practice.
The marine and coastal planning approach will fill in the gaps missing in the study and research of natural coral reefs and make people aware of the actual scenario of marine habitat. By seeking evidence regarding the state of coral reefs, the introduction of zoning and policy will improve the island's conservation efforts to support artificial reefs as a new ground for marine habitat, thus promoting tourism.

1.2 Objective

The marine and coastal planning at Cat Island, Muscat, Oman, aims to adapt sustainable marine conservation and tourism approach.
The main objective is to adapt sustainable marine conservation and tourism approach. Therefore, the specific objectives of the research are as follows:
1. To determine the most relevant present condition affecting marine habitat in terms of the following:
A. Environmental condition in relation to natural coral reef
B. Human activities

b.1 Berthing practice
b.2 Scuba diving practice
b.3 Fishing practice
2. To assess the most important aspect in relation to natural and artificial coral reef to promote tourism in terms of the following:
A. Environmental policy
B. Ecotourism policy
3. To recommend the most adaptable sustainable marine conservation and tourism approach in terms of marine and coastal planning from the following strategies:
A. Policy
a.1 Marine policy
a.2 Coastal policy
B. Controlled zoning
b.1 Marine area
b.2 Coastal area
Cat Island is one of the diving locations and is a well-known tourist spot in Muscat, Oman. However, the current situation presents threats to coral reefs due to environmental conditions and physical activities.
The intention of providing Cat Island's new feature based on marine and coastal planning will be a baseline and pattern to other diving locations in Oman, that have started to deteriorate. Due to continued visits and water activities, the Daymaniyat has started to experience reef deterioration, such as coral bleaching and broken corals. With this as an example, Cat Island may survive its ongoing stressors.
Additionally, Cat Island's physical characteristics provide more opportunities in terms of ecotourism. Ecotourism is another form of sustainability that can benefit the people of Muscat, Oman.
The outcome of this study will assist the government, stakeholders, community, future researchers, and readers in promoting awareness on the importance of sustainable marine conservation by providing artificial coral reefs as a new habitat for the marine ecosystem. Awareness of the current situation will help them be socially responsible with their activities in the marine habitat. This study will be a benchmark of further investigation and future studies that may enhance the schemes regarding policy and zoning.

1.3 Scope and Limitations

This study focused on the general approach of marine and coastal planning by using marine functional zoning. The selected location for the study is Cat Island. The study was conducted from March 2021 up to July 2021. .
This paper synthesized the present condition of marine habitat in terms of environmental aspects related to the natural coral reef. It identified human activities such as berthing practice, scuba diving practice, and fishing activities. Also, this study provided policy and controlled zoning that are designed to boost tourism in Cat Island. Moreover, it delimited the contribution of coral reefs in promoting tourism that subscribes to environmental policy and ecotourism.
The master planning will not be part of this research; hence, this will be considered when doing the Comprehensive Land and Marine Use Planning.

1.4 Current Physical Condition of Cat Island, Muscat, Oman

1.4.1 Environmental Condition in relation to the natural coral reef

The southwest monsoon (wet season) is the most important climatical influence for the nearshore habitat and coral sites in Oman throughout the summertime from June to August (Brock & McClain, 1992, Sheppard et al., 2010; Burt et al., 2016).
Cyclone. The strongest tropical cyclone Gonu in 2007 was ever recorded at Arabian Sea (Fritz et al., 2010). Oman sea corals were severely affected by the cyclone, presenting significant loss of coral cover and reduction in habitat complexity (Maghsoudlou et al., 2008; Taylor, 2009; Foster et al., 2011).
Climate change. CC is an urgent environmental problem characterized by a global increase in the Earth's temperature due to an uncontrolled increase in greenhouse gas (GHG) emissions. It is now widely accepted that human economic activities contribute to CC (Lama & Devkota, 2009). Global warming is projected to be between 1.4 and 5.88°C by 2100 compared to 1990.
According to Mansour (2020), there is overwhelming global concern about the impacts of climate change (CC) on ecosystems and habitats of various species.
Climate change (CC) and related sea acidification will exacerbate the effects of local stressors in the coming decades.

1.4.2 Human Activities in relation to the natural coral reef.

Human recreational activities in the marine environment can harm coral reefs by the breakage of coral colonies and with the direct contact such as walking, touching, kicking, standing, gear contact, trampling, breakage, or overturning of coral colonies from boat anchors, changes in marine life behavior such as feeding or harassment by humans, water pollution and trash, invasive species, and debris deposited in the marine environment.

Berthing practice. Unfortunately, some of the best-known dive sites in Oman do not have buoys to which boats can be secured until today. This forces boats to use anchors, breaking fragile corals and disrupting the ecosystem (ESO, 2009). Hansen et al. (2018) state that recreational boating and related moorings are associated with reduced cover of aquatic vegetation constituting important habitats for juvenile fish.

In addition, Dasgupta (2019) noted that grounding and mooring dilemmas have been recorded since 1970s. Most worryingly, a reef which was damage by anchor certainly not able to recuperate, and even if it can, it could be around 50 years.

Scuba Diving practice. While diving tourism enjoys continued growth worldwide, there are concerns that it contributes to the degradation of coral communities biologically and aesthetically (Worachananant et al., 2008). Accordingly, the desire to escape the physical constraints of land and be enchanted by the sight of technicoloured reefs, sunken ships and otherworldly creatures is becoming increasingly popular - despite the cost and training required to explore the ocean depths (Merchant, 2012).

Coral reefs globally attracts a growing number of scuba divers, thus leading to an increasing concern on its impact to coral reefs. Pre-dive briefings are insufficient to reduce diver damage (Barker & Roberts, 2004).

The study by Worachananant et al. (2008) shows that 93% of divers had contact with the seabed during a 10-minute monitoring period, with an average of 97 contacts per hour of diving. Additionally, he stated that two-thirds of divers caused damage to corals, with an average of 19 corals broken per dive hour. There were significantly more coral breakages and fragments of live coral in high use areas than in low use areas (Hawkins et al., 2007).

Fishing practice. The study of Fisheries sustainability in Oman by Alhabsi and Mustapha (2011) states that overfishing is an outcome of changes in the absolute and relative abundance of many important commercial species in Omani waters.

1.5 Contribution of coral reef in promoting tourism

1.5.1 Environmental policy in relation to the aquatic environment

Oman's Marine Pollution Control Law of 1974 aims "to avert, decrease, and reduce all forms of contamination of the waters which are adjacent to the territory of the Sultanate of Oman as to preserve the ecology of the area."

Through Mansour's (2020) discovering, it is clear that gainful arrangement activities reduce regular dangers to coral cover across the Oman Sea coasts, explicitly as far as the improvement of hazard maps and spatial plans to ensure the most helpless, delicate, and touchy coral reef biological systems.

1.5.2 Ecotourism

Healthy corals are the foundation of the ocean food chain. Thus, making it a significant part of the economy. This contributes to livelihood and tourism.

1.5.3 The Benefit of Using Terracotta as Artificial Reefs

Artificial reefs are increasingly being boosted to mitigate impacts from human actions in coastal urban areas (Burt et al., 2009).

There should be additional assistance from the government or the States Craft's council to promote the Craft at National Level (Ghosh, 2014).

Lange et al. (2020) exhibited that 3D-printed earthenware counterfeit reefs appear to be the fate of coral reef protection.

Since the undertaking commencement was as yet in its beginning phase, there was restricted information concerning the venture's reasonability. Regardless of this, the analysts engaged with the program trusted that this new strategy for making fake reef tiles will support all the more successfully reestablishing corals and preserving biodiversity, contributing essentially to continuous worldwide endeavors to save corrupted coral reef frameworks in metropolitan regions.

1.6 Case Studies

Reducing Use Conflicts through Marine Functional Zoning. Reducing use conflicts through marine functional zoning by Fang & Ma (2018) focuses at Xiamen as a coastal city located at the southeast coast of Fujian Province, PR China. Marine functional zoning (MFZ), developed and implemented in the Xiamen Sea areas, has proven to be an effective management tool in minimizing multiple-use conflicts in coastal waters.

The MFZ in Xiamen was a successful showcase in moving ICM conceptual framework into concrete practice.
The MFZ is efficient in the conservation and improvement of environmental quality. Since implementing MFZ, the marine environmental quality of the sea areas remained stable, and endangered wild species, such as Chinese white dolphins and egrets, were protected (Jiang & Fang, 2015) without hampering the designated sea space for economic development.

Coastal and marine tourism development (Case Study Persian Gulf)

Coastal and marine tourism development by Ghasemnia et al., (2011), focuses on Iran, along the Persian Gulf islands. Marine tourism includes a set of services, such as management, training, marketing, tourism, transport, customs, insurance, and advertising.
The objectives of coastal and marine tourism are as follows: identify the uses of sea for tourism purpose; make a variety of facilities, institutions, making floats, beach and offshore industry; ecosystem-based marine tourism (ecotourism); tourism based on seafood; social development and empowerment of local communities; make water sports recreational, and design sea tourism; and recreational activities, sports, culture and science in the aquatic and coastal environment.

1.7 Conceptual Framework

Lack of proper policy and awareness is one of the root causes of the conflicts. It is evident since coral degradation is revealed in the physical characteristics of the reef. The proposal drew motivation and ideas from different studies on policy and zoning, which the researcher cites.
Sea use conflicts have become a considerable management challenge for sustainable utilization of resources in coastal waters worldwide. MFZ scheme was developed in order to decrease multiple-use conflicts in coastal waters and harmonize human use and nature conservation, (Fang & Ma, 2018).
Table 1 illustrates the research paradigm that intend to adapt sustainable marine conservation and tourism approach.

Table 1. Research Paradigm

INPUT	PROCESS	OUTPUT
•Relevant present condition affecting marine habitat •Important aspect of coral reef in promoting tourism •Adaptable sustainable marine conservation and promotion of tourism	•Photographic survey. •Survey thru Google form, interviews, & questionnaire forms. •Data gathering using related literature, journals, & similar case studies. •Policies/ laws of the Oman government	•Recommend the most adaptable sustainable marine conservation and promotion of tourism approach

2. Material and Methods

2.1 Research Design

The descriptive method was used to gather data about the Cat Island's existing condition as shown in Figure 2.

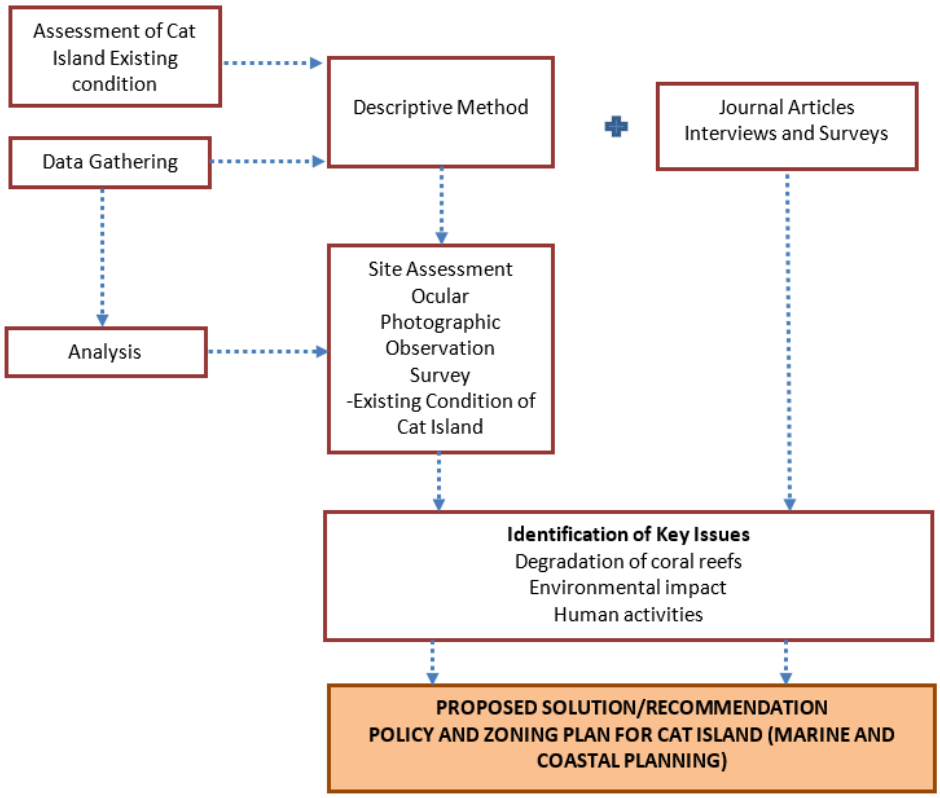

Figure 2. Framework of the Research Methodology

2.2 Demographics

The research demographics consist of 309 people working mainly for the diving centre, fishermen, divers, and tourists that visited the place for recreational diving or snorkelling as shown in Table 2.

These are the ideal group of people to answer the survey since they have the experience going underwater and have more interaction with marine life. They provided valuable insights which influence the proposed policy and zoning plan.

Table 2. Breakdown of respondents

#	Origin		Total
1	Respondents from Google **Survey**	Boat owner, Diving centre	20
		Fishermen	2
2		Diving Instructor	20
3		Divers, Snorkelers, Students, Tourists	263
4	Respondents from **Interview**	Phone Interview	2
5		Personal Interview	1
6	Respondents from **Questionnaire Form**	Digital questionnaire	1
Overall			**309**

2.3 Research Instruments/Tools

The tools used in the research were surveys through Google form, interview, questionnaire form, related literature, journals, similar case studies, and photographic survey/ observation. These tools assisted in the proposed policy and zoning plan.

3. Results and Discussions

3.1 Present Environmental Condition of the Natural Coral Reef

Through the years, the effect of unexpected calamity that hit Muscat showed a declination of natural coral reef. One of the known solutions is to provide cement blocks and terracotta surrounding Cat Island. The researcher attempted to investigate through an interview with Dr. Claereboudt from Sultan Qaboos University. He responded that there

was no evidence of the terracotta study was conducted. Furthermore, there was also no record nor published research about it.

3.1.1 Current Condition of Cat Island through the Lens

The current condition of Cat Island is analyzed through photographic documentation of coral reefs underwater as shown in Figure 3.

Figure 3. Underwater photos of Cat Island with the vast marine ecosystem.

Due to the natural stressors experienced by the marine ecosystem, Figure 4 shows the effect which the coral reefs are facing in Cat Island.

Figure 4. Underwater photos of Cat Island with degradation of marine life due to natural stressor.

3.2 Present Human Activities in Cat Island

3.2.1 Berthing Practice

Davenport and Davenport (2006) mentioned also that as the ocean recreational activities and the linked traffic from boat increased quickly in many locations of the globe resulting to the increase of physical damage to the reef. Moreover, previous research and studies have rarely addressed the community-wide impacts from severe anchor damage (Flynn & Forrester, 2019).

With the work of RAHSAC (1998), they directed an eager venture that will secure and breed coral reefs and placement of artificial reefs (reef ball) to decrease the harm to coral due to mooring of boats for leisure scuba diving and snorkeling hobbies. The club additionally asked the setting up of extremely durable securing floats at various well-known destinations around the island.
Enumerating the involvement of mooring to coral reef deteriorate should assist to notify the design of best administration exercises for anchoring the boat near reef habitation (Flynn, 2015).
An adequately installed mooring buoy will have a minimal initial impact on the reef and can then be used almost indefinitely without further damaging the reef (ESO, 2009).
The surrounding area of Cat Island do not have available mooring buoys that boat can anchor to. Apparently, the boat owners do not have a choice but just to drop the anchor when berthing. The dropped anchors incur harm and drastically rupture the reefs.

3.2.2 Scuba Diving practice

Leisure diving is extensively recognized as one of the leisure industry's quickest producing businesses (Ong & Musa, 2001; Musa et al., 2006; Kirkbride-Smith et al., 2013).
Rouphael and Inglis (1997) stated that the increased participation in marine recreation and tourism has been accompanied by concern for the impacts that these activities have on coral reef environments.
To protect the aquatic resources, the Marine Conservation Department at the Ministry of Environment and Climate of Oman presented stringent scuba diving guidelines (Ministry of Environment & Climate Affairs, 2009).
Classifying the several factors that define diver manners results may aid administrators to improve better procedure on operational training, pre-dive brief, site policy, etc., to avoid or decrease the occurrence of damage reef (Rouphael and Inglis, 2001).
The majority of interactions were triggered by fluttering and touching with fins, verifying related outcomes from the study conducted at the Red Sea (Prior et al., 1995; Zakai and Chadwick-Furman, 2002).
As stated by Hannak et al. (2011), it is agreed that sensible tactics included offering environmental education courses for snorkelers and divers.
The survey shows for 263 respondents illustrates that 30 (11.4%) hit corals reefs accidentally (by fins or other foreign objects), 30 (11.4%) they touch the coral reefs accidentally (by hands), 23 (8.7%) of them take coral in the surface, and 197 (74.9%) did not do anything. This relates to the study done by Chabanet et al. (2005) and Hannak et al. (2011) that direct snorkeler or diver impacts such as trampling, fin contact, standing on corals and resuspension of sediment.
Additionally, Mcbride (2021) stated photographers contacted the reef significantly more than those divers without cameras.
The most anthropogenic concerns in recreational diving activities are acts resulting in coral breakages. These acts include trampling, touching the corals, stepping on sand, dropping anchors in coral beds, dragging dive gear, dealing damage from fin kicks, diving with a camera, and disturbing sand and sediments that clutter and cover the corals. Furthermore, Figure 5 also shows the scuba diving practices that lead to coral degradation. Accidentally or not, divers' negative behavior indicates a detrimental effect on marine life.

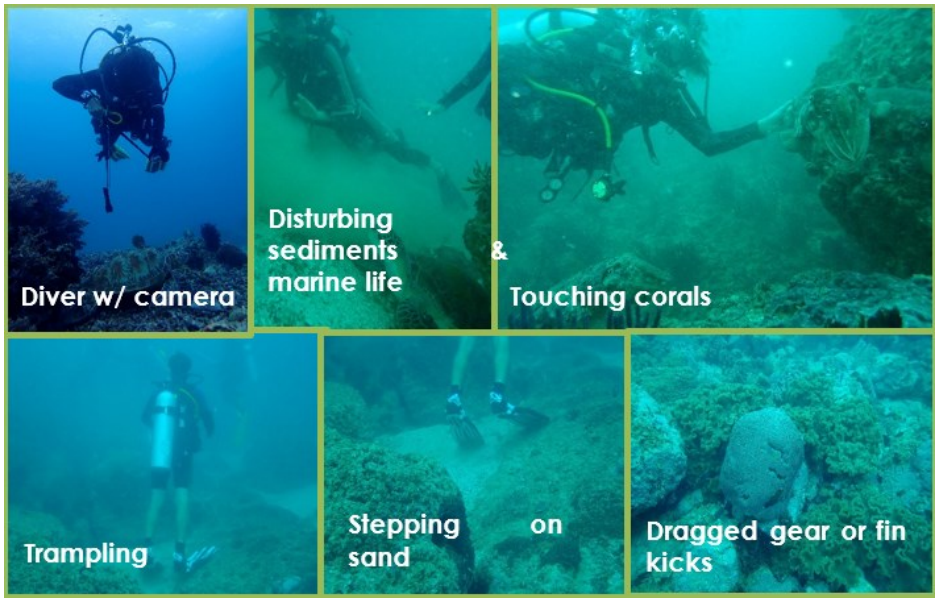

Figure 5. Underwater photos of Cat Island with scuba diving activities.

3.2.3 Fishing Activities

Overfishing is considered stressor to ecosystem (Roberts, 1995). Overfishing results to transformations in the absolute and relative richness of several important commercial species in Omani waters. Current fishery management strategies emphasis primarily on target fish populations, although may not be appropriate when fishing initiates changes in the reef ecosystem (Jennings & Polunin, 1996). Based on the observation by the researcher, the fishermen use gear such as line, net, or spearfishing in Cat Island.

Reef fishing activities are inclined to cause coral damage which may be irreversible and can impair the processes which guarantee future fish production because there is no habitat in the marine. The survey found out that out of 305 respondents, 199 (65.2%) have tried fishing with line, and 219 (71.8%) tried spearfishing. Large debris as mentioned by Ballesteros et al. (2018) such as discarded fishing gear is a huge component of litter on coral reefs. Also, corals have fragile carcasses and soft tissues that can simply become damaged when they get in contact with lost fishing equipment.

4. Discussions

4.1 Replacing Natural Coral Reefs with Artificial Reefs

It is discovered that scuba divers develop an extraordinary level of fulfilment from diving in artificial reefs (Kirkbride-Smith et al., 2013).

As a result, whether it is natural or anthropogenic activities, it is well known that coral reefs' hazards come from both physical and natural sources. Artificial reefs change the local abundance and distribution of fishes and other organisms, thus enhancing fisheries' resources and creating fishing and diving opportunities (Bohnsack, 1991).

An experiment done at Cat Island. The soft and hard corals have attached to the cement blocks. However, there were no further documentations as recalled by M. Claereboudt.

4.2 Environmental Policy that Relates to Contribution of Coral Reef

Conventional customs targeted at managing diver effects on reefs have accepted the idea of ecological carrying capacity (Hawkins & Roberts, 1997; Schleyer & Tomalin, 2000). Despite the good concept, Kirkbride-Smith et al. (2013) assessed that the basic resolution is insufficient by just supervising coral reefs. Diving allocations can be appropriate in delicate locations since the impact at a site is persuaded by visitor count (Barker & Roberts, 2004). The scheme of providing a limit—a “carrying capacity” of human usage—requires acceptance by the community to guarantee the protection of the natural resources (Salm et al., 2000). Currently, carrying capacity have been tried in numerous efforts to estimate popular dive sites visitors (Davis and Tisdell, 1995). However, the outcome of the evaluations varies widely among diverse locations around the globe (Dixon et al., 1993; Chadwick-Furman, 1997; Harriot et al., 1997; Hawkins et al., 1999; Schleyer and Tomalin, 2000; Zakai and Chadwick-Furman, 2002).

Presently, Oman participates to 13 key regional and international protocols and green agreements that offer values, global study, and legal for ecological protection in coastal environment and the sea (van Lavieren et al., 2011). In additional, the Sultan endorsed sufficient policies to strengthen maritime preservation with presently above 8 Royal

Decrees supported with Ministerial Decisions that relate to maritime environmental security matters (Ashrad & Sayer,2012).
This Ministerial Decision 55/2004 regulation does not permit the establishment of artificial reefs without a license.
To regulate diving activities, Oman's Ministerial Decision No. 40/2009 focuses on the specific regulations imposed in marine habitat during diving activities outside the limits of marine protected areas.
Royal Decree No. 53/81, a decree promulgating the Law of maritime fishing and protection of aquatic living resources, has been implemented. According to the summarized statement from the website of FAO (2021), this Law, applies to fishing waters, inland water, the seabed, and its subsoil.
In general, the Royal Decree No. 20/2019 provides framework law, sustainable development, fishery management, conservation and methods, protection of the environment, artisanal fisheries, promoting further research on the aquatic environment, and protecting aquatic plants transporting storage of fish.

4.3 Environmental Policy that Relates to Coastal Area That Have Developed Coral Reefs

Ministerial Decision No. 20/90 coastal policy was focused on setbacks. However, an extensive coastal policy that associates with the marine life such as coral reefs was not discussed.

4.4 Contribution of The Coral Reef to Ecotourism

Coral reefs have become an important feature for promoting international tourism (Lemay et al., 1991).
Marine tourism is related to increasing employment, increasing revenues, boosting the economy, expanding international cooperation, and improving the quality of life and livelihoods.
Based on the survey conducted, among 305 respondents, 246 (80.7%) sighted a substantial marine ecosystem in Cat Island. 240 (78.7%) noticed that there are broken and damage corals while 47 (15.4%) did not observe marine ecosystem.

4.5 Marine and Coastal Planning

With the advancement of modern technology, it is straightforward to propose a concept integrating land and water in the design and deliver it to a prospective client. However, the systematic approach of such presentation tends to be oblivious to the impacts during and after site construction.
According to a Naval Architect (interview with a questionnaire), experienced in his field:

> *I have worked with a company before that construct hotels on man-made islands. Just the concept of it, you would know that a portion of the reef gets destroyed. Although they try to compensate by propagating the reef somewhere else, it would never be enough to replace what has naturally existed for hundreds or thousands of years. (J. Ponce, personal interview, April 25, 2021)*

Integrated coastal zone management (ICZM) has resulted in the government developing legislation for coastal zone protection, management plans, recovery and governance, and awareness-raising programs.

4.6 Controlled Zoning

With the advent of maritime/marine spatial planning (MSP), marine space concepts have received renewed and much-deserved attention (Gee & Siedschlag, 2019). With the concept of zoning management to mitigate the development of sea conservation conflicts, advocates are utilizing the zoning idea to protect marine habitat. The use of controlled zoning allows the local and national authorities to regulate and control the sea use to guarantee the function and capability of the marine area to be beneficial to all stakeholders. The researcher recommends a controlled zoning scheme that can be utilized in Cat Island in order to promote a more resilient and healthier marine environment.
Since the project site is small, the sea use types used in Cat Island were classified into three categories according to the types and characteristics of sea uses and natural resources found in the site. Each of the sea areas was zoned to various uses to identify how safe and valuable it is. These are artificial reefs, artisanal fishing, and tourism. The zoning around Cat Island was divided into four major zones. The west side is for artisanal fishing and tourism; the east side is for artificial reefs (which can be developed in a later phase) and tourism; and the north and south side are for artificial reef, artisanal fishing, and tourism. The tourism area will be available for water activities such as scuba diving, freediving, and snorkeling. Artificial reef area will be protected from tourism until such time that the reefs became mature. For the artisanal fishing, the only allowed fishing activities will be fishing with line and spearfishing. Fishing with net will be controlled to avoid destroying the natural reefs. Mooring buoys will also be distributed strategically around the marine area in order to avoid anchoring to the seabed. Figure 6 and 7 shows the results of the controlled zoning.

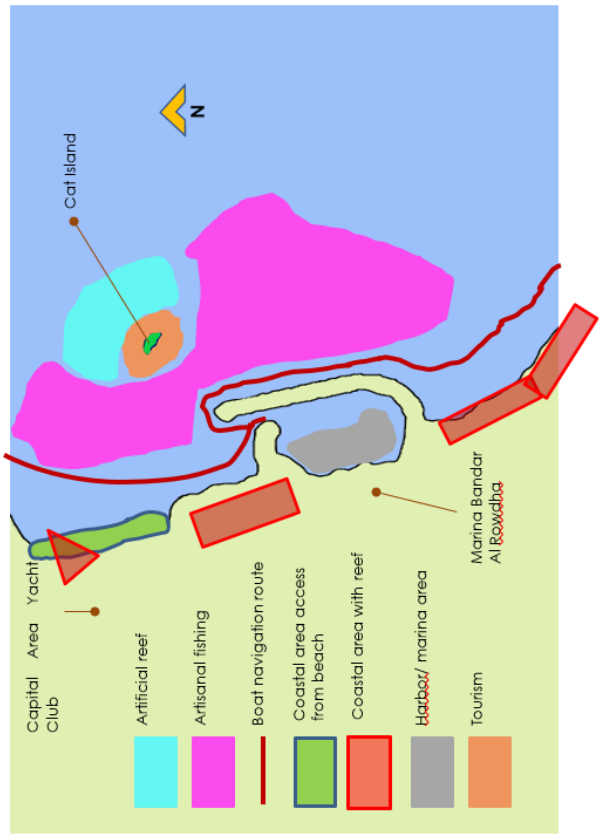

Figure 6. Cat Island Controlled Zoning

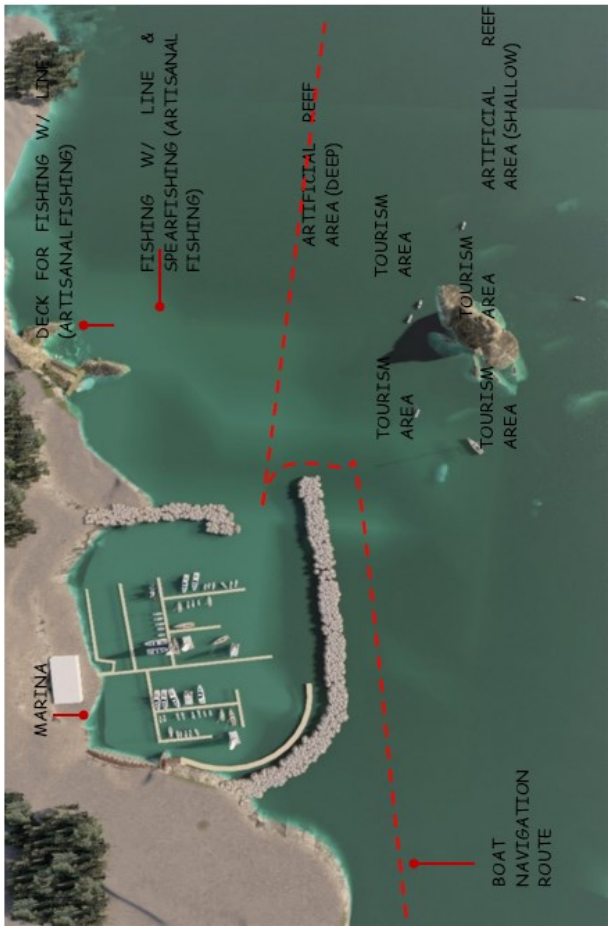

Figure 7. Master Site Development Plan

5. Conclusions

Most relevant present condition affecting marine habitat. Human and natural factors both affected coral reefs in Oman, causing widespread and significant degradation. Coral reefs provide several ecosystem goods and services but are susceptible to multiple environmental and anthropogenic stressors. These stressors include cyclone, climate change, berthing practice, scuba diving practice, and fishing activities. Among these, the most relevant stressor that affect marine habitat are anthropogenic activities. Management of boat anchoring, diving practice, and fishing must encourage coral reef resilience and at the same time permitting constant sustainable tourism and recreation.

Most important aspect in relation to natural and artificial coral reef. The most important aspect concerning the promotion of tourism through the natural and artificial reef is policymaking. Policy needs to be strictly implemented and enforce adherence to it. Current Oman administration policies are ineffectual and unsatisfactory in protecting coral reefs and other marine habitat.

Recommended most adaptable sustainable marine conservation and promotion of tourism approach. The Coast of Oman concentrates on tourism, urbanization, and other development activities and is subject to changes in physical progressions, causing substantial natural environment alterations. It is imperative that the government of Oman further study and consider operating comprehensive coastal zone management plans towards the protection of coral reefs. Currently Integrated coastal zone management (ICZM) has resulted in the government developing regulations for coastal zone protection, management plans, recovery and government authority, and mindfulness in raising programs. Though these policies are well written, it does not still help to aid in protecting the natural and artificial coral reefs. The reason behind this is that there is a lack of strict implementation from the government. Controlled zoning is an applicable instrument in minimizing several conflicts in the vicinity of Cat Island, which can sustain the value of the natural resource thus emphasizing sustainable marine conservation and promotion of tourism approach.

6. Recommendation

Natural and anthropogenic stressors surrounding marine habitat can be reduced if all the community members will be conscious of the environment and be responsible for protecting the sea.

To minimize the abuse of coral reef declination, the researcher recommends the following:

6.1 Policy Reformation

The legislation related to the coral reef in Oman has minimal information and guidance looking after natural reefs, especially regarding artificial coral reefs. A policy reform initiative protecting the marine habitat, whether it is natural or artificial reef, should commence.

Berthing Practice. In this research, there was no evidence that a law/ policy was ever passed related to berthing practice. The researcher recommends a policy on berthing on shallow water to protect the natural and artificial reefs. A preferred means of berthing is the deployment of permanent mooring buoy entrenched in the seabed. Boat anchoring should also be prohibited in the area to protect the coral reefs.

Scuba Diving Practice. Ministerial Decision No, 40/2009 is recommended to be revisited. With the increasing tourism in the area and all over the diving spots in the capital, a recommended Ecotourism Environment Carrying Capacity (EECC) should be implemented. In this way, there will be prevention of over-crowding tourists. The ecotourism environmental carrying capacity (EECC) refers to the adequate quantity of visitors that can be expected in a particular area, which can meet the needs of tourists, benefit the tourism industry, protect the environment, and reduce the impact of over-crowding.

Material used on Artificial Reef. It is recommended that a policy be formulated to provide for the production of artificial reefs made from terracotta. With this, business owners and laborers producing clay designs will be protected. Moreover, passive income will be generated for the locals. Since terracotta has earthly components, this may be used sustainably without harming the marine ecosystem.

6.2 Controlled Zoning

The recommended controlled zoning scheme could be adjusted according to the dominant development without sacrificing environmental veracity. This idea can also evolve a new formulation of a new zoning scheme that can be utilized in another part of Oman. Regulation and policy about sea use-controlled zoning should ensure compliance with and implementation of the formulated controlled zoning.

In the long run, the controlled zoning and policy review will have a highly significant effect to the sea use conflicts, thus warranting proper and orderly use of the sea area. Additionally, the controlled zoning and policy analysis can accommodate emerging sea uses that will promote social awareness, labor increase, and potential gross domestic product (GDP). Furthermore, promoting policy enhancement and tactically providing controlled zoning will support

a better marine environmental quality by reducing coral degradation and enhancing marine habitat by providing sustainable marine conservation while boosting its economy in tourism.

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Conflict of Interests
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