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The Effect of Implementing Climate Change Mitigation and Adaptation Strategies on the Marine Tourism Activities in the Gulf of Aqaba

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ABSTRACT

The research sought to determine the degree to which mitigation and adaptation methods are being used to address the consequences of climate change and their influence on marine tourist activities in the Gulf of Aqaba. To accomplish the study objectives, a quantitative approach was utilized to gather data. This was done through the distribution of a survey form to a deliberate sample of (213) faculty members from the faculties of tourism and hotels, arts and sciences, the Department of Science and Environment, as well as a group of specialists focused on climate change. Additionally, a group of diving and water sports trainers in the Gulf of Aqaba were included. The study's findings highlight a significant issue: there is a notable absence of authorized strategies to mitigate and adapt to the impacts of climate change on the marine ecosystem in the Gulf of Aqaba area. The study's findings suggest many key suggestions, with the most significant being the need to bolster the use of renewable energy sources, such as solar and wind power, in the area. Additionally, it is crucial to conduct initiatives aimed at rehabilitating damaged marine habitats, including coral reefs.

1. Introduction

Despite major reductions in emissions in recent decades, the EU needs to radically remodel its systems of production and consumption in order to realize climate neutrality by 2050. Reducing

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heat-trapping greenhouse gas emissions from main sources, such as industry, farms, automobiles, power plants, and forests, as well as from soil, oceans, and forests, is a significant component of climate change mitigation. Because emissions are a local as well as a global concern, lowering emissions demands altering everything from economic power, food production, travel, lifestyle, and consumption European Environment Agency, (2024).

Mitigating climate change requires reducing down on greenhouse gas emissions, which cause global warming. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, in order to satisfy the safety limitations, set forth in the Paris Agreement, global emissions must decline by 43% by 2030 and fast reach net-zero by 2050. The total impact of countries' stronger intention to lower emissions, according to the UNFCCC's 2023 NDC Synthesis Report, nevertheless falls short of the needed reductions. All sectors and stakeholders in the economy and government must work together to create a comprehensive strategy in order to attain net-zero targets. Significant modifications in the management of land, forests, beaches, and wetlands must be done in concert with the quick reduction of emissions from the generation of power, transportation, and the industrial sector gef, (2024).

On the other side, the phrase "climate change adaptation" highlights techniques for reducing the harmful consequences of climate change while grasping any new prospects. It comprises adjusting plans and tactics in response to actual or predicted climate changes. Adaptation may be proactive, taking place before the impacts of climate change are visible, or reactive, occurring in response to those effects. Anticipatory adjustments are frequently more effective than reactionary ones and will have lower long-term costs Mahmoud et al., (2018).

The significance of adaptation and mitigation in combating climate change is stressed in the fourth assessment report of the Intergovernmental Panel on Climate Change. Together, they can drastically lessen risks, even if none of them can halt severe consequences on its own. While adaptation decreases unavoidable damages, mitigation lowers the rate and scope of climate change Moustafa et al., (2023).

Both climate change adaptation and mitigation may be handled by one policy. For example, street tree planting addresses the danger of localized floods due to increased frequency and intensity of rainstorms by lowering storm water runoff (adaptation) and boosting carbon storage (mitigation) in urban contexts IPCC, (2022).

2. Literature review

2.1.Mitigation

Governments, organizations, and individuals may all take actions to prevent climate change by lowering or eliminating greenhouse gas emissions, which trap heat in the atmosphere. Since the beginning of the industrial revolution, greenhouse gas levels have grown owing to human activity, which has resulted in climate change and global warming. The quantity of greenhouse gas emissions is continually growing despite research and public understanding of the consequences. It is vital to minimize the growth in greenhouse gases in order to alleviate the worst consequences of climate change and slow down its pace of occurrence UNDP, 2024).

According to United Nations Climate Change, 2022), The concentration of greenhouse gases in the atmosphere and world average temperatures are intimately associated, therefore decreasing emissions into the atmosphere and increasing sinks—such as forests—are the keys to tackling the climate change problem. "Mitigation" refers to activities performed to enhance sinks and minimize emissions.

2.2.Adaptation

The process of modifying ecological, social, or economic systems in response to weather-related stimuli and their effects is known as adaptation. In order to limit probable damage or take advantage of opportunities brought about by climate change, it requires adaptations to processes, traditions, and organizational structures. Communities and countries must build adaptation strategies and put them into action Hoegh-Guldberg et al., 2014).

In other definition for adaptation is to safeguard our families, our economy, and the environment we live in from the effects of climate change, we must modify our behavior, systems, and—in some cases—ways of life. It will be simpler to adjust to the changes we can no longer prevent the more emissions we cut now WWF, (2022).

2.3.Difference between climate change mitigation and adaptation

According to Feisal et al., (2020). Climate change is represented by two strategies: adaptation and mitigation. While adaptation focuses on the repercussions of climate change, mitigation targets its causes. The alteration made in response to climate change is known as adaptation. Human intervention is employed in mitigation to lessen the negative consequences of expected risks or to manage potentially damaging events that have already transpired. Table 1. shows the key distinction between mitigation and adaptation.

Table1. the key distinction between mitigation and adaptation

Adaptation	Mitigation
It is the strategy to adjust to climatic change.	It is the strategy to reduce the impact of climate change.
It is localized and region-specific.	It is global and not localized.
These are long-term strategies.	These are short-term.
It involves taking appropriate measures to prevent the effects of climate change.	It involves the reduction of harmful effects of hazards and incidents that have already occurred.
The measures such as building flood barriers, effective utilisation of water, development of drought-resistant crops, etc. can be taken.	The major measures include using new technologies, clean energy resources, and making older technologies more energy efficient.

Source: Feisal, Z., Kader, A., & Haron, A. O. (2020). Coastal cities Resilience for Climate Change Case study: Egyptian North coast cities. In Journal of Urban Research (Vol. 35).

Both methods, however, have their share of complications. When it comes to alternatives, mitigation is perceived to be preferable to adaptation. However, mitigation is expensive. The majority of people and governments are hesitant to make the substantial financial investments required to carry out the plans. This leads to difficulties.

2.4.Climate change mitigation and adaptation strategies in marine environment

According to Climate Portal, **(**2023)**Mitigation strategies Focus on greenhouse gasses as following:**

1. **Reducing resources**

The largest source of greenhouse gas emissions from humans is the burning of fossil fuels; hence, nuclear and renewable energy sources are the main objectives of mitigation efforts. In addition, it may deal with additional greenhouse gas sources, including protecting forests and eliminating methane from waste sites.

2. **Enhancing sinks**

Carbon removal, which removes greenhouse gases from the atmosphere, is a component of mitigation techniques including forest growth and direct air capture devices. Large-scale application of these solutions is challenging, and they do not negate the need for considerable reductions in emissions. To prevent catastrophic climate change scenarios, scientists such as the Intergovernmental Panel on Climate Change believe that a certain level of carbon removal is essential.

According to Climate Portal, (2023) adaptation strategies Focus on climate impacts as following:

Global warming will finally stop if mitigation measures are successful in cutting greenhouse gas emissions. But even as temperatures stabilize, this will make the world warmer, upset weather patterns, and lock in future changes like sea level rise. These impacts could continue for millennia.

Local adaptations to climate change include storm drain system improvements, natural solutions like wetlands restoration, and changes in behavior and policy like growing different crops to endure droughts and warmer weather, or restoring wetlands to function as hurricane buffers.

Bangladesh's coastal city of Mongla is undertaking infrastructure expenditures in preparation of rising sea levels and saltwater intrusion. The purpose of this proactive technique is to avert additional damage and assist displaced persons succeed economically. If these activities aren't taken, communities may wind up needing to rebuild after climate change has already destroyed buildings, displaced inhabitants, and harmed their means of sustenance.

2.5.Climatic changes Mitigation and adaptation strategies for marine environment

2.5.1. Mitigation strategies

1. **Climate change mitigation to coral reefs**

According to Voolstra et al., (2023), Local stressors such as pollution, sedimentation, and eutrophication from land removal and fertilizer use aggravate the impacts of climate change. These components produce bio erosion and coral overgrowth, which modify the coral microbiome and increase the amount of infections. Reef-forming species and the coral microbiome are disrupted when coral bleaching and external stressors combine to impair calcification rates, limit reef

accretion, and degrade coral stress tolerance. The following are the most significant ways for mitigating climatic changes on coral reefs.

2. CO2 emission mitigation is a pre-requisite

It follows that conserving corals is vital to sustaining reefs. In order to protect and regenerate coral reefs, the International Coral Reef Society (ICRS) proposed three equally vital foundations. Mitigating CO2 emissions and risks to the global climate is the first. Crucially, every alternative decision is premised on the notion that mankind will ultimately become carbon neutral; in other words, every action done to safeguard coral reefs is related to every other action by "and," not "or.". Reducing carbon emissions is vital to keeping the increase in global temperature below 1.5°C, which would cause 99% of reefs to perish forever WWF, (2022). This will rebuild damaged reefs and protect healthy ones. Techniques for geoengineering, such as controlling solar radiation or pumping cold seawater into reef sections, are expensive and should only be investigated locally. Certain reefs that demonstrate stronger resilience to heat stress should need particular attention as their coral colonies have evolved a higher natural tolerance González-Espinosa & Donner, (2023).

3. Saving corals through restoration and rehabilitation

In order to conserve coral reefs and establish carbon neutrality, the International Coral Reef System (ICRS) is stressing restoration and rehabilitation. These efforts may be designed to concentrate on different coral holobionts, including micro eukaryotes and algal symbionts, and they may incorporate diverse approaches for the rehabilitation and restoration of reefs as figure 1 demonstrates. With the state of degradation that it is presently in, combined with continuous climate change and marine pollution, contemporary restoration strategies need to integrate concepts of prevention and rehabilitation. One may use the terms "prevention" and "restoration" interchangeably European Environment Agency, (2024).

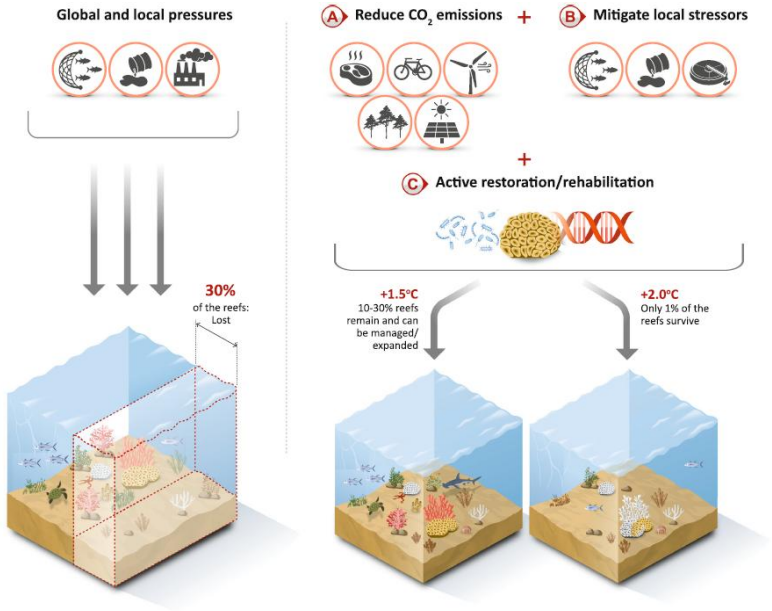


Figure 1. Techniques to prevent the degradation of coral reefs. Source: Voolstra, C. R., Peixoto,

R. S., & Ferrier-Pagès, C. (2023). Mitigating the ecological collapse of coral reef ecosystems. EMBO Reports, 24(4), 1–7. https://doi.org/10.15252/embr.202356826.

2.5.2. Adaptation strategies

1. Fisheries management

Fishing techniques are being adjusted to provide safe operating zones for coral reefs, seasonal constraints are being established for commercial fishing, and overfishing of endangered species is being regulated in Vanuatu and other Pacific SIDS. Community marine conservation zones serve as governance mechanisms for fisheries management in coral reef ecosystems, and inhabitants are supplied with transportation and modern amenities Fine et al., (2019).

2. Recreational activities

Through effective monitoring and social capital, recreational activity supervision and management strive to limit safe zones for coral reefs and endangered species Fine et al., (2019).

3. Artificial reef structures and fish aggregation devices (FADs)

Reef site recovery and fish abundance may be accomplished with the use of fish aggregation devices (FADs) and artificial reef structures. The reef area at Port Resolution was chosen for manufactured benthic structures because of its moderate slopes and limited natural structure. Artificial reefs may control the relationship between decreasing herbivorous fish population and the incidence of coral illnesses, as well as encourage the creation of new coral and shelter existing reefs from physical injury. They also minimize the severity of medium waves and function as a physical barrier to trawling Fine et al., (2019).

4. Water quality improvement plans (WQIPs)

The purpose of water quality improvement plans, or WQIPs, is to enhance the water quality in the coastal regions and catchments surrounding the Port Resolution reef site. They take into consideration land-based sources of water pollution, such as local communities, agriculture, and tourism. WQIPs assist the installation of sewage treatment plants, conversion of cesspools, optimal fertilizer usage, and care of septic systems in anticipation of future growth and tourism Fine et al., (2019).

5. Coastal land uses sustainable development plans

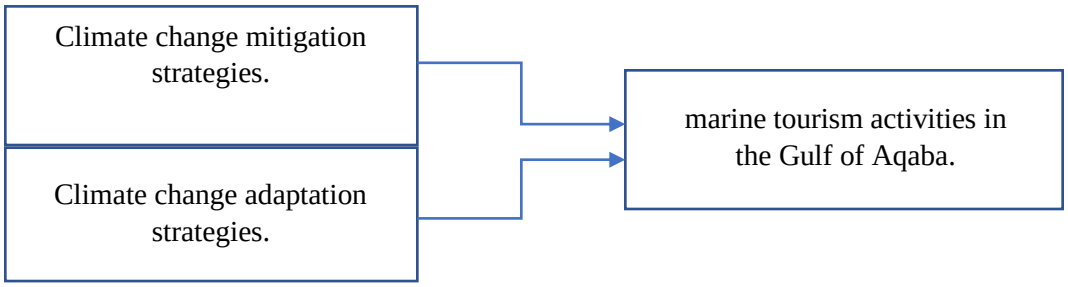
Plans for sustainable land use along the coast strive to limit waste, protect infiltration, halt sediment erosion, and extend discharge points offshore. They ignore the harmful relationship between the health of coral reefs and the population of coastal people. By enhancing pollution dispersion and lowering human activity near to reef habitats, Port Resolution's excellent coastal land use management may increase the quality of the water Fine et al., (2019).

3. Methodology

3.1.Conceptual framework and Study hypotheses

Based on the literature review of mitigation and adaptation strategies the conceptual framework of the current study has been developed. Figure (2) showed that independent variables which including mitigation strategies, adaptation strategies, have effect directly on the marine tourism activities in the Gulf of Aqaba. For that the current study tries to evaluate the following hypothesis:

Figure (2) Study framework



H1: There is a significant impact of climate change mitigation strategies on marine tourism activities in the Gulf of Aqaba

H2: There is a significant impact of adaptation strategies to the effects of climate change on the practice of marine tourism activities in the Gulf of Aqaba.

3.2.Research methods

The deductive approach employing quantitative method was used in this study to evaluate the hypothesized model. There are three constructs in the proposed research model Figure (2) The constructs are measured using a questionnaire form directed and distributed to the experts related to climate change mitigation and adaptation strategies to the climate change and divers and marine tourism in the Gulf of Aqaba. Statements used to measure the research constructs were developed from literature review as shown below Table 2. and a five-point Likert scale (1=strongly disagree to 5=strongly agree) was used to estimate the respondents' perceptions. The characteristics of the websites can be categorized into Four general factors, as shown below Table 2.

Table 2. Questionnaire Structure for the study.

Indicator	Variables	Empirical studies
Mitigation Strategies.	There are approved strategies to mitigate and adapt to the effects of climate change on the marine environment.	(Moustafa et al., 2023)
	The various state agencies are committed to implementing mitigation and adaptation strategies to reduce the effects of climate change on the marine environment.	(Feisal et al., 2020)
	There are standards and determinants to measure the impact of climate change on the marine environment.	(Nasa, 2023)

	Current legislative measures are sufficient to reduce the severity of climate change on the marine ecosystem.	(Climate Portal, 2023)
	The state has established laws that specify specific areas for practicing water sports activities and are far from sensitive ecological areas exposed to risks as a result of climate change.	(Voolstra et al., 2023)
	The state has used clean energy technology as a strategy to mitigate the effects of climate change on the marine environment.	(Great Barrier Reef Foundation, 2022)
	The state has established measures to remove carbon or mitigate its severity as a strategy to mitigate the effects of climate change on the marine environment.	(Fine et al., 2019)
	The state has used geoengineering techniques, such as (solar radiation treatment or injection of cold salt water into coral reef areas) as a strategy to mitigate the effects of climate change on the marine environment.	(Fine et al., 2019)
	The state has established a set of policies and procedures to reduce pollution as a strategy to mitigate the effects of climate change on the marine environment.	(Voolstra et al., 2023)
Adaptation strategies.	The state has restored and rehabilitated coral reefs affected by the effects of climate change as a strategy to preserve coral reefs.	(European Environment Agency, 2024).
	The state has identified mechanisms to manage fisheries as a strategy to adapt to climate change on the marine environment.	(lberdrola, 2023).
	The state has used fish aggregation devices (FADS) and artificial coral reef structures as a strategy to adapt to the effects of climate change in order to restore the location of coral reefs and the abundance of fish.	(gef, 2024)
	The state has an effective adaptation strategy that works to maintain water quality such as (establishing wastewater treatment plants, optimal use of fertilizers) which maintains the health of the marine environment.	(European Environment Agency, 2024).
	The state has implemented adaptation strategies that work on the sustainable use of land along the coast, which works to reduce waste, maintain leakage, stop sediment erosion, and expand marine discharge points, thus preserving the marine environment.	(González-Espinosa & Donner, 2023).
The application of climate change mitigation and adaptation strategies had a positive impact on the	A positive change in the shape of the beaches has had a significant positive impact on marine tourism activities.	(Pathak et al., 2021)
	Reducing the intensity and direction of water currents, which has a positive impact on marine tourism activities such as diving and snorkeling.	(Shoaira et al., 2019)
	It has had a positive impact on the practice of tourism activities related to coral reefs.	(Chen et al., 2023)
	It had a positive impact on wind speed and direction, which affected marine tourism activities.	(Khalil et al., 2022).
	Reducing the temperature in the summer, which has a positive impact on the practice of some marine tourism activities and eliminating the seasonal phenomenon.	(Sharaan et al., 2022).

practice of marine tourism activities in the Gulf of Aqaba.	Reducing the temperature of surface water, which had a significant positive impact on the practice of tourism activities related to the marine environment.	(Hefny et al., 2019)

3.3.Study population and sampling

- **The study sample amounted to about (213) individuals divided as follows: Table 3:**

1. Faculty members related to the issue of climate change, their number amounted to 54 (professor - assistant professor - lecturer) from the colleges of tourism and hotels, science and literature, representing 25.4% of the sample size.
2. Specialists in the issue of climate change from various bodies and institutions mentioned above, their percentage amounted to 33.8%, equivalent to 72 individuals from the sample.
3. Divers and practitioners of marine sports activities, their number amounted to 87 from the sample, representing 40.8%.

Table 3. study sample

occupation		Frequency	Percent %
Valid	Faculty Members.	54	25.4
	Climate change specialists.	72	33.8
	Practitioners (divers - practitioners of marine sports activities).	87	40.8
	Total	**213**	**100.0**

Following the data collection phase, the obtained data was analyzed using the Statistical Package for Social Sciences (SPSS version 23). Various statistical operations were performed to derive the results of the targeted study. Both descriptive and quantitative measures were utilized to analyze the data.

- **Firstly, descriptive measurements.**
  - A. Frequency table
  - B. Measures of central tendency "mean" T. Measures of dispersion standard deviation "std"
- **Second: Quantitative measurements**

The quantitative measures used in the study were represented in testing the significance of the hypotheses through the relationship of influence and influence between the independent variables and the dependent variable through the simple linear regression equation, as it is the most appropriate statistical method to achieve the objectives of the study.

3.4.Time delineation

The present research is cross – sectional, which implies that data for two or more variables were obtained concurrently for multiple instances. This research consequently utilized a cross - sectional design. A total of 213 surveys were delivered at Intentionally to the specialists from March 2023 to August 2024.

4. Results and Discussion

4.1.Descriptive analysis

The descriptive analysis of the questionnaires that were distributed to the experts and divers (mean and standard deviations).

Table 4. mitigation strategies

Mitigation Strategies.	Mean	Std. Deviation
There are approved strategies to mitigate to the effects of climate change on the marine environment.	3.225	1.062
The various state agencies are committed to implementing mitigation strategies to reduce the effects of climate change on the marine environment.	3.085	1.104
There are standards and determinants to measure the impact of climate change on the marine environment.	3.254	1.046
Current legislative measures are sufficient to reduce the severity of climate change on the marine ecosystem.	2.545	1.130
The state has established laws that specify specific areas for practicing water sports activities and are far from sensitive ecological areas exposed to risks as a result of climate change.	3.141	1.098
The state has used clean energy technology as a strategy to mitigate the effects of climate change on the marine environment.	3.033	1.164
The state has established measures to remove carbon or mitigate its severity as a strategy to mitigate the effects of climate change on the marine environment.	2.976	1.160
The state has used geoengineering techniques, such as (solar radiation treatment or injection of cold salt water into coral reef areas) as a strategy to mitigate the effects of climate change on the marine environment.	2.668	1.114
The state has established a set of policies and procedures to reduce pollution as a strategy to mitigate the effects of climate change on the marine environment.	3.062	1.171
Weighted mean= 2.716 **Std. Deviation= 1.11**		

We assessed Table 4. Upon inquiring the respondents on the existence of criteria and determinants to assess the influence of climate change on the maritime environment, it was determined that the general average of their thoughts was neutral, with 35.2% selecting this option, a mean value of 3.254, and a standard deviation of 1.046. The respondents' replies showed neutrality of 36.2% about the availability of authorized solutions to ameliorate the impacts of climate change on the maritime environment, with an arithmetic mean of 3.225 and a standard deviation of 1.062. Regarding the state's establishment of laws that specify specific areas for practicing water sports activities that are far from sensitive environmental areas exposed to risks as a result of climate change, the percentage of neutral choice was 32.9%, with an arithmetic mean of 3.141 and a standard deviation of 1.098. When the respondents were questioned about the commitment of different state agencies to pursue mitigation techniques to lessen the consequences of climate

change on the marine environment, their answer in selecting neutral was 33.8%, with an arithmetic mean of 3.085 and a standard deviation of 1.104. Regarding the state's establishment of a set of policies and procedures to reduce pollution as a strategy to mitigate the effects of climate change on the marine environment, the arithmetic mean of the respondents' responses was 3.062 with a standard deviation of 1.171, and the percentage of neutrality on this element was 34.3%. Regarding the state's adoption of clean energy technology as a method to alleviate the impacts of climate change on the marine environment, the respondents' replies leaned towards neutrality, as demonstrated by the arithmetic mean value of 3.033 and a standard deviation of 1.164. The proportion of neutrality was the biggest, reaching 36.2%. When the respondents were asked about the state's implementation of measures to remove carbon or mitigate its severity as a strategy to mitigate the effects of climate change on the marine environment, their answers tended towards neutrality at a rate of 31.9%, and the arithmetic mean value amounted to 2.976 with a standard deviation of 1.160. As for the state's use of geoengineering techniques, such as solar radiation treatment or cold saltwater injection in coral reef areas, as a strategy to mitigate the effects of climate change on the marine environment, the respondents' opinions tended towards neutrality at a rate of 39% with a standard deviation of 1.114 and an arithmetic mean of 2.668. As for the adequacy of present legislative actions to decrease the severity of climate change, climate on the marine ecology in the Gulf of Aqaba The respondents' views were neutral at a rate of 29.6%, with an arithmetic mean of 2.545 and a standard deviation of 1.130.

The weighted mean average of mitigation methods for marine environments in the Gulf of Aqaba was 2.716, which suggests that the trend of mitigation strategies is neutral as a general tendency according to a 5-point Likert scale as indicated in the above table because 2.716 lay in the internal (2.545-3.254).

The general average of the respondents' comments was neutral, which demonstrates that experts and divers need more knowledge regarding adopting climate change mitigation methods in the Gulf of Aqaba. By returning to previous studies in the theoretical framework of the study, it is clear that the opinions of Climate Portal, **(**2023) Voolstra et al., (2023) WWF, (2022) European Environment Agency, (2024) agreed on the importance of different mitigation strategies in order to limit the impact of climate change on the marine environment, which requires their application to the marine environment in the Gulf of Aqaba to reduce the severity of the different impacts of climate change on the practice of marine tourism activities there.

To summarize the above, the following chart 3. is a summary of the perspectives provided by the respondents with respect to mitigation techniques in the Gulf of Aqaba.

Figure 3. shows viewpoints expressed by the respondents in relation to mitigation strategies in the gulf of aqaba.

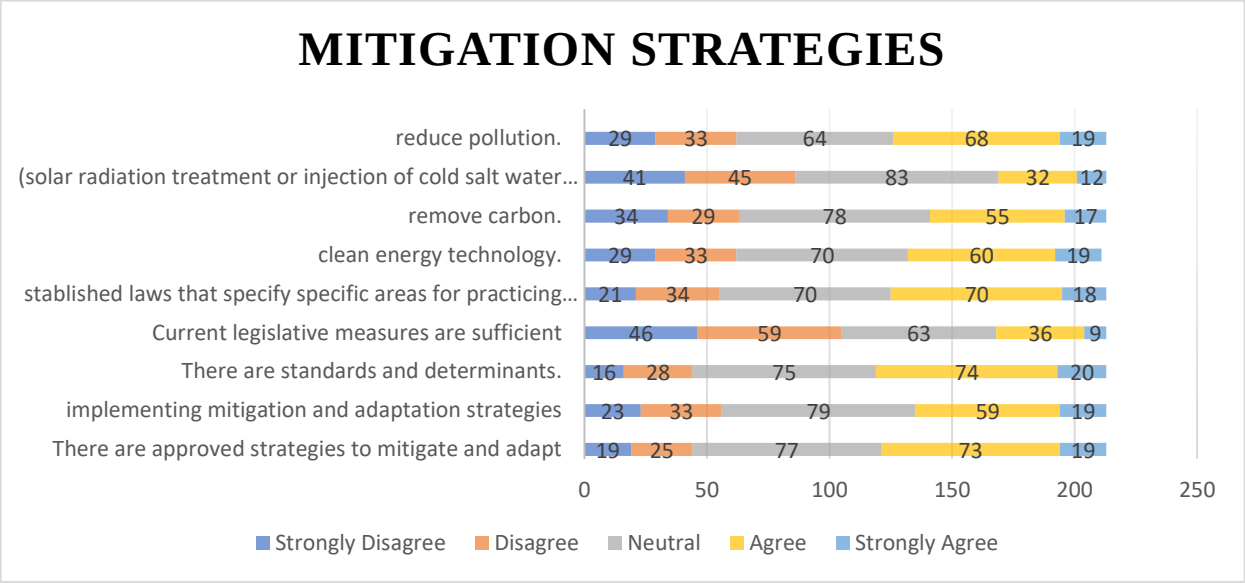


Table 5. adaptation strategies

Adaptation strategies	Mean	Std. Deviation
The state has restored and rehabilitated coral reefs affected by the effects of climate change as a strategy to preserve coral reefs.	2.791	1.208
The state has identified mechanisms to manage fisheries as a strategy to adapt to climate change on the marine environment.	3.109	1.100
The state has used fish aggregation devices (FADS) and artificial coral reef structures as a strategy to adapt to the effects of climate change in order to restore the location of coral reefs and the abundance of fish.	2.791	1.105
The state has an effective adaptation strategy that works to maintain water quality such as (establishing wastewater treatment plants, optimal use of fertilizers) which maintains the health of the marine environment.	3.090	1.165
The state has implemented adaptation strategies that work on the sustainable use of land along the coast, which works to reduce waste, maintain leakage, stop sediment erosion, and expand marine discharge points, thus preserving the marine environment.	2.972	1.202
Weighted mean= 2.950 **Std. Deviation= 1.156**		

Based on the assessment of Table 5. Upon inquiring, the respondents on the state have identified mechanisms to manage fisheries as a strategy to adapt to climate change on the marine environment. It was determined that the general average of their thoughts was neutral, with 33.8% selecting this option, a mean value of 3.109, and a standard deviation of 1.100. The replies of the respondents showed neutrality, with 34.3% recognizing the existence of The state has an excellent adaptation strategy that works to preserve water quality, such as building wastewater treatment facilities and appropriate use of fertilizers, which supports the health of the marine environment.,

with an arithmetic mean of 3.090 and a standard deviation of 1.165. Regarding the state having implemented adaptation strategies that work on the sustainable use of land along the coast, which works to reduce waste, maintain leakage, stop sediment erosion, and expand marine discharge points, thus preserving the marine environment., the percentage of neutral choice was 31.5%, with an arithmetic mean of 2.972 and a standard deviation of 1.202. When the respondents were questioned whether the state has repaired and rehabilitated coral reefs impacted by the impacts of climate change as a strategy to maintain coral reefs., their answer in selecting neutral was 32.4%, with an arithmetic mean of 2.791 and a standard deviation of 1.208. Regarding the state having used fish aggregation devices (FADS) and artificial coral reef structures as a strategy to adapt to the effects of climate change in order to restore the location of coral reefs and the abundance of fish., the arithmetic mean of the respondents' responses was 2.791 with a standard deviation of 1.105, and the percentage of neutrality on this element was 40.8%.

The weighted mean average of adaptation strategies for marine environment to the Gulf of Aqaba was 2.950 which indicates that the trend of adaptation strategies is neutral as a general tend according to 5- point Likert scale as shown in the above table since 2.950 lie in the internal (2.791-3.109).

The overall average of the respondents' replies was neutral, this proves that experts and divers require more information about implementing climate change adaptation strategies of the Gulf of Aqaba. By returning to previous studies in the theoretical framework of the study, it is clear that the opinions of Hoegh-Guldberg e t al., (2014), WWF, (2022), Feisal et al., (2020), Fine et al., (2019) agreed on the necessity of applying different adaptation strategies by applying a set of practices that would adapt to climate changes and the marine environment in the Gulf of Aqaba to facilitate the practice of various tourism activities throughout the year.

To summarize the above, the following chart 4, is a summary of the viewpoints expressed by the respondents in relation to adaptation strategies in the gulf of aqaba.

Figure 4. shows viewpoints expressed by the respondents in relation to mitigation strategies in the gulf of Aqaba

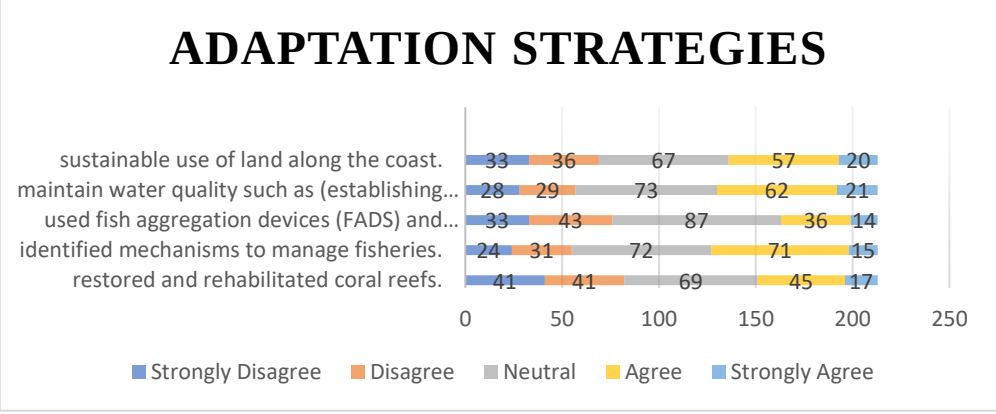


Table 6. The application of climate change mitigation and adaptation strategies had a positive impact on the practice of marine tourism activities in the Gulf of Aqaba

The application of climate change mitigation and adaptation strategies had a positive impact on the practice of marine tourism activities in the Gulf of Aqaba, as follows:	**Mean**	**Std. Deviation**
A positive change in the shape of the beaches has had a significant positive impact on marine tourism activities.	3.٤59	.962
Reducing the intensity and direction of water currents, which has a positive impact on marine tourism activities such as diving and snorkeling.	3.479	1.007
It has had a positive impact on the practice of tourism activities related to coral reefs.	3.٣95	.959
It had a positive impact on wind speed and direction, which affected marine tourism activities.	3.376	1.059
Reducing the temperature in the summer, which has a positive impact on the practice of some marine tourism activities and eliminating the seasonal phenomenon.	3.٢18	.978
Reducing the temperature of surface water, which had a significant positive impact on the practice of tourism activities related to the marine environment.	3.٣34	1.044
Weighted Mean= 3.٤19 **Std. Deviation= 1.02**		

Based on the assessment of Table 6. Upon inquiring the respondents on the reduction of the intensity and direction of water currents, which has a positive impact on marine tourism activities such as diving and snorkeling., it was determined that the general average of their thoughts was neutral, with 39.4% selecting this option, a mean value of 3.479, and a standard deviation of 1.007. The replies of the respondents showed neutrality, with 42.3% recognizing the existence of The beneficial alteration in the form of the beaches has had a major positive influence on marine tourist activities., with an arithmetic mean of 3.459 and a standard deviation of.962. Regarding whether it has had a favorable influence on the practice of tourist activities linked to coral reefs., the proportion of the neutral option was 33.3%, with an arithmetic mean of 3.395 and a standard deviation of.959. When the respondents were questioned about whether it had a favorable influence on wind speed and direction, which impacted maritime tourist activities., their answer in selecting neutral was 48.4%, with an arithmetic mean of 3.376 and a standard deviation of 1.059. Regarding reducing the temperature of surface water, which had a major beneficial influence on the practice of tourist activities connected to the marine environment,' replies were 3.334 with a standard deviation of 1.044, and the proportion of neutrality on this aspect was 43.8%. The responses of the respondents indicated neutrality by 45.3% regarding reducing the temperature in the summer, which has a positive impact on the practice of some marine tourism activities and eliminating the seasonal phenomenon., with an arithmetic mean of 3.212 and a standard deviation of.978.

The weighted mean average of The application of climate change mitigation and adaptation strategies had a positive impact on the practice of marine tourism activities in the Gulf of Aqaba

was 3.419 which indicates that The application of climate change mitigation and adaptation strategies had a positive impact on the practice of marine tourism activities in the Gulf of Aqaba is neutral as a general tend according to 5- point Likert scale as shown in the above table since 3.419 lie in the internal (3.212- 3.479).

The overall average of the respondents' replies was neutral, this proves that experts and divers require more information about The application of climate change mitigation and adaptation strategies had a positive impact on the practice of marine tourism activities in the Gulf of Aqaba. By returning to previous studies in the theoretical framework of the study, it is clear that the opinions of European Environment Agency, (2024), gef, (2024), Mahmoud et al., (2018), Moustafa et al., (2023), agreed that if mitigation and adaptation strategies are implemented to limit the effects of climate change on the marine environment in the Gulf of Aqaba, there will be a positive impact on the practice of marine tourism activities.

4.2.The Regression

The study's assumptions were evaluated using the linear regression coefficient, and the findings are shown in the tables below.

- **Regression analysis and hypothesis testing as following:**

1. Table 7. Measures the correlation of the independent and dependent variables' coefficients of determination
2. Table 8. F-test used in ANOVA to evaluate if there is a significant relationship between the effect of independent variables and the marine tourism activities in the Gulf of Aqaba.
3. Table 9. Regression of the independent variables and their effect on the dependent variable.

Table 7. Coefficient of determination (R^2) between independent variables and the marine tourism activities in the Gulf of Aqaba.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.238[a]	.057	.048	.77747
a. Predictors: (Constant): mitigation strategies, adaptation strategies.				

It is noticed from the previous analysis of the Model Summary Table that there is a link between mitigation and adaptation strategies (the independent variables) and the marine tourism activities in the Gulf of Aqaba (the dependent variable), as the correlation coefficient between these variables equals. 238a. This means that the correlation is weakly positive from 0.1 to 4.9 and that these mitigation and adaptation strategies impact the marine tourism activities in the Gulf of Aqaba only 5.7%, while the rest of the percentage of effect is attributable to other variables. This is considered conclusive material evidence of the weakness or lack of implementation of strategies to mitigate the severity of climate change on the marine tourism activities in the Gulf of Aqaba or to adapt to these climate changes. Therefore, the responsible authorities must design plans to minimize and adapt to the severity of the impacts of climate change on the marine tourist operations in the Gulf of Aqaba that are obvious and publicized and are executed effectively.

Table 8. F-test used in ANOVA to evaluate if there is a significant relationship between the effect of independent variables and the marine tourism activities in the Gulf of Aqaba.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.654	2	3.827	6.332	.002[b]
	Residual	126.937	210	.604		
	Total	134.592	212			
a. Dependent Variable: marine tourism activities.						
b. Predictors: (Constant): adaptation strategies, mitigation strategies.						

It is noticed from the preceding variance analysis table that the varied mitigation and adaptation strategies have a considerable and actual influence on the marine tourism activities in the Gulf of Aqaba. This is obvious from the result (F) = 6.332 at a significance level of .002[b] (less than 0.05).

Table 9. Regression of the independent variables and their effect on the dependent variable.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.881	.190		15.176	.000
	Mitigation strategies	.291	.128	.322	2.274	.024
	Adaptation strategies	-.077	.109	-.100	-.707	.480
a. Dependent Variable: marine tourism activities.						

With a beta coefficient value of .291 and a significance level of.0٢٤, less than (0.05), it is evident from examining the preceding regression table that mitigation strategies impact the marine tourism activities of the Gulf of Aqaba. This supports the first hypothesis, which states that There is a significant impact of climate change mitigation strategies on marine tourism activities in the Gulf of Aqaba.

With a beta coefficient value of -.077 and a significance level of .480, more than (0.05), it is evident from examining the preceding regression table that adaptation strategies non-impact on the marine tourism activities of the Gulf of Aqaba. This unsupported the second hypothesis, which states that There is a significant impact of adaptation strategies to the effects of climate change on the practice of marine tourism activities in the Gulf of Aqaba.

5. Conclusion and recommendations

This study is useful for countries suffering from the effects of climate change on the marine environment and related tourism activities. This is done by identifying the most prominent mitigation strategies and adaptation to successive climate changes on the marine environment and thus improving the practice of related tourism activities. Based on the analysis of the results in the previous tables, the study concluded a set of results as follows:

1. The experts and divers require more information about The application of climate change mitigation and adaptation strategies had a positive impact on the practice of marine tourism activities in the Gulf of Aqaba. By returning to previous studies in the theoretical

framework of the study, it is clear that the opinions of Climate Portal, **(**2023) Voolstra et al., (2023) WWF, (2022) European Environment Agency, (2024) agreed on the importance of different mitigation strategies in order to limit the impact of climate change on the marine environment, which requires their application to the marine environment in the Gulf of Aqaba to reduce the severity of the different impacts of climate change on the practice of marine tourism activities there.

2. The experts and divers need more knowledge regarding adopting climate change mitigation methods in the Gulf of Aqaba. By returning to previous studies in the theoretical framework of the study, it is clear that the opinions of Hoegh-Guldberg e t al., (2014), WWF, (2022), Feisal et al., (2020), Fine et al., (2019) agreed on the necessity of applying different adaptation strategies by applying a set of practices that would adapt to climate changes and the marine environment in the Gulf of Aqaba to facilitate the practice of various tourism activities throughout the year.
3. Experts and divers need more knowledge regarding adopting climate change adaptation methods in the Gulf of Aqaba. By returning to previous studies in the theoretical framework of the study, it is clear that the opinions of European Environment Agency, (2024), gef, (2024), Mahmoud et al., (2018), Moustafa et al., (2023), agreed that if mitigation and adaptation strategies are implemented to limit the effects of climate change on the marine environment in the Gulf of Aqaba, there will be a positive impact on the practice of marine tourism activities.

3.1.Recommendations

Recommendations for decision-makers related to the legislation of climate change mitigation and adaptation strategies at the Egyptian Ministry of Environment and Tourism as following:

- **Mitigation Strategies recommendations**

1. Promote Low-Carbon Tourism

- Encourage the use of renewable energy sources (solar, wind) in hotels, resorts, and other tourism facilities.
- Implement carbon offset programs where tourists can contribute to local environmental projects that mitigate carbon emissions.

2. Enhance Marine Protected Areas (MPAs)

- Expand and enforce MPAs to limit harmful activities like overfishing and unregulated tourism, thereby preserving biodiversity and ecosystem services.
- Integrate sustainable tourism practices into MPA management, ensuring that tourism does not contribute to environmental degradation.

3. Waste and Pollution Management

- Implement stringent waste management protocols for all tourism-related activities to prevent pollution of marine environments.
- Promote the reduction of single-use plastics and encourage recycling and reuse initiatives within the tourism sector.

4. Sustainable Infrastructure Development

- Promote the construction of eco-friendly infrastructure that minimizes environmental impact, such as using green building materials and technologies.
- Implement guidelines for sustainable coastal development that avoid critical habitats and reduce erosion and other negative impacts.
- **Adaptation Strategies recommendations**

1. **Diversify Tourism Activities**

- Develop and promote alternative tourism activities that are less vulnerable to climate change, such as cultural tourism or eco-tourism focused on land-based attractions.
- Create educational tourism experiences that raise awareness of marine conservation and climate change.

2. **Enhance Climate Resilience of Tourism Facilities**

- Retrofit existing tourism infrastructure to withstand extreme weather events and rising sea levels.
- Develop early warning systems and emergency response plans for tourism operators to mitigate the impact of extreme weather on tourism activities.

3. **Monitor and Respond to Environmental Changes**

- Implement continuous monitoring of coral reefs, water temperature, and other key environmental indicators to assess the impacts of climate change.
- Use data from monitoring to adjust tourism activities, such as temporarily closing certain areas to tourism during periods of environmental stress.
- **Policy Recommendations**

1. Develop a Comprehensive Climate Action Plan

- Create a national or regional climate action plan specifically addressing marine tourism, with clear goals, timelines, and responsibilities.
- Incorporate climate resilience into all levels of tourism planning and policy-making.

2. Incentivize Sustainable Practices

- Offer financial incentives or subsidies to tourism operators who adopt sustainable and climate-resilient practices.
- Develop certification programs for eco-friendly tourism businesses to promote sustainability within the industry.

3. Enhance Regulatory Frameworks

- Strengthen regulations on coastal development, waste management, and marine resource use to ensure long-term sustainability.
- Enforce compliance with environmental standards through regular inspections and penalties for violations.

Therefore, future studies should be conducted to identify the extent of the impact of mitigation and adaptation strategies to climate change on the marine environment and associated tourism activities in order to protect marine life and biodiversity in the Gulf of Aqaba, which are important tourism resources for marine tourism activities in the region.

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