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Negative Consequences of Climate Change on Marine and Coastal Tourism Activities in Ras Sudr: Evidence from Stakeholders

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Abstract

This paper investigates the connections between stakeholder awareness of climate change, government support, coping strategies and their impact on tourism activities in Ras Sudr. Using a quantitative research approach, data was collected via a survey administered to tourism sector employees and analyzed using SmartPLS 4. Findings revealed a concerning negative association between Stakeholder awareness of climate change and government support, emphasizing the need for increased government commitment to address climate change impacts on tourism. This paper highlights the critical role of government policies. Government support mediates the link between stakeholder awareness of climate change and negative consequences for tourism activities. Coping strategies moderate the relationship between government support and the adverse effects of climate change on coastal tourism activities and kite surfing tourism. Seasonal variations in these moderation effects were observed, with the fall season influencing coastal tourism activities more and the winter season affecting kite surfing tourism. This paper emphasizes raising public awareness about climate change and advocating for enhanced governmental support and effective coping mechanisms to mitigate detrimental impacts on tourism activities. Collaborative efforts among government authorities, tourism organizations and local communities are necessary to promote sustainable practices and climate-resilient infrastructure.

1. Introduction

Climate significantly shapes tourism destinations, influencing demand, travel timing and seasonal fluctuations. It also impacts the image and attractiveness of destinations and the operational aspects of tourism businesses (Bombana et al., 2023). Climate change is currently evident through rising temperatures, leading to global sea-level rise and intensified extreme weather events that affect marine biodiversity at various scales. Coastal and marine tourism worldwide heavily depends on natural resources like weather, beaches and the sea, making it vulnerable to climate change impacts (El-Masry et al., 2022), including rising sea levels, intensified storms, coastal erosion and altered temperature and precipitation patterns (IPCC, 2019). These changes threaten the sustainability and attractiveness of coastal activities like beach tourism, water sports and swimming, which rely on specific favorable weather conditions (UNEP, 2017).

Surf tourism is rapidly expanding globally and has become a crucial economic sector for numerous global destinations, driving growth, creating employment and promoting the sustainable utilization of coastal resources (Mach and Ponting, 2021; Porter & Usher, 2019). Egypt's abundant water resources and strategic location (Hilmi et al., 2018), with its white sandy beaches and breathtaking crystal-clear waters, as documented by Abd El Moneim (2021), make it a promising water sports destination. With captivating natural landscapes, favorable wind patterns and a temperate climate that serves as a key catalyst in the development of sports tourism, particularly surf tourism, as indicated by El Azazy (2022), Egypt has the potential to establish itself as a prominent hub for surf tourism (Abd El-Kafy, 2022).

Egypt offers favorable wave conditions, making it suitable for beginners and professionals alike. The peak surfing season aligns with summer, but optimal conditions extend from December to March, with an average of two to three favorable surfing days per week throughout the year (Surfguide, 2023). Given the implications of climate change on the tourism sector, it is crucial for destinations to anticipate future changes and propose appropriate adaptations to maintain resilience. Understanding the varying degrees of dependency on weather conditions and climate changes is essential in formulating effective planning and adaptation strategies for coastal and marine tourism (Scott et al., 2011).

This paper seeks to assess the varying degrees of dependency on weather conditions and climate changes in Ras Sudr and identify the specific vulnerabilities and resilience of different activities. By doing so, stakeholders can develop targeted approaches for managing risks, diversifying offerings and ensuring sustainability in the face of climate change challenges. This paper aims to investigate the specific negative consequences of climate change on tourism-related marine and coastal activities in Ras Sudr. By examining scientific evidence, this study seeks to shed light on the implications of climate change for the tourism industry, with a specific focus on kite surfing as a global water sport. Figure 1 displays the proposed relationships between Stakeholder awareness of climate change, government support, coping strategies and their interactions with coastal tourism activities, tourism-based marine activities and kite surfing tourism.

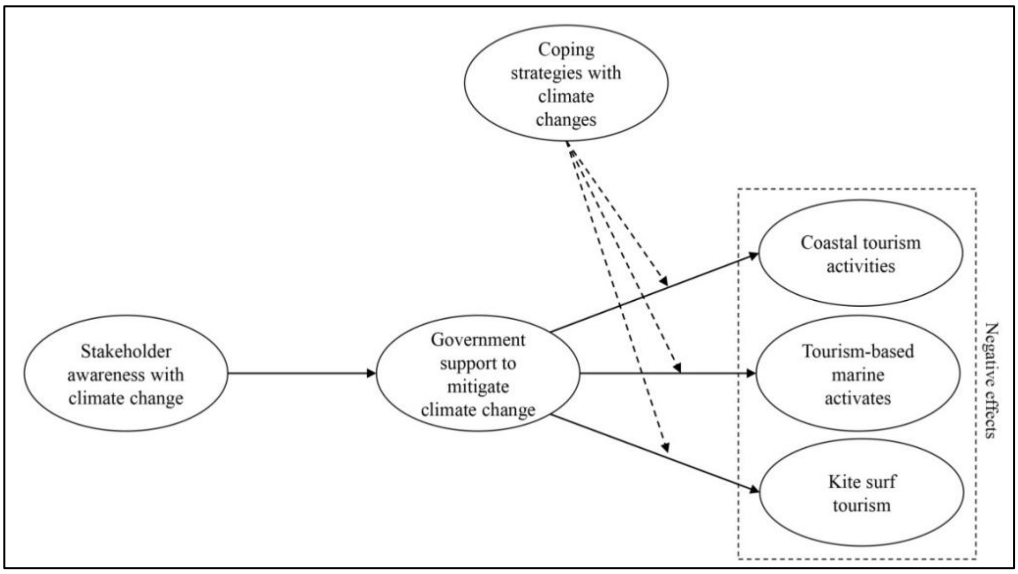


Figure 1. Research model.

2. Literature review

2.1. Negative effects of climate changes

Numerous research studies have underscored the vulnerability of coastal destinations, particularly in light of the impact of climate change. Intergovernmental Panel on Climate Change (IPCC) has conducted comprehensive assessments in 2019, exploring the global and sector-specific implications of climate change. These assessments have highlighted the susceptibility of coastal areas to various challenges, including the rise in global temperatures attributed to greenhouse gas emissions, leading to thermal expansion and polar ice melting. Consequently, these phenomena contribute to elevated sea levels, coastal erosion causing loss of land and infrastructure, and extreme weather events, significantly impacting coastal ecosystems and their valuable natural resources. Notably, beaches, as essential attractions for marine and coastal tourism, bear the brunt of these changes.

Coral bleaching is another consequence of climate change that directly impacts the health and vitality of coral reefs. Bleaching occurs when corals expel their symbiotic algae due to environmental stress, leading to the loss of color and potential mortality (Fezzi et al., 2023). The frequency and severity of coral bleaching events have increased significantly in recent decades, largely attributed to rising sea temperatures (Hughes et al., 2017). Such bleaching events have been observed in various parts of the world, including the Red Sea region. These changes in marine ecosystems can have severe implications for tourism activities centered on coral reefs, such as diving and snorkeling(Fine et al.,2019).

Coastal and marine tourism destinations play a crucial role in the global tourism industry, but they face high vulnerability to climate variability due to their strong dependence on weather conditions and climate factors (Gonzalez-Hernandez et al., 2023). Besides, climate-induced impacts, such as coral bleaching, Dead Sea grass and water turbidity, have significant ramifications on the economy, employment and overall well-being of coastal tourism destinations (Cuttler et al., 2018). Studies have revealed that these environmental influences directly influence tourists' choices concerning coastal destinations and profoundly impact the success of tourism businesses (Karani & Failler, 2020).

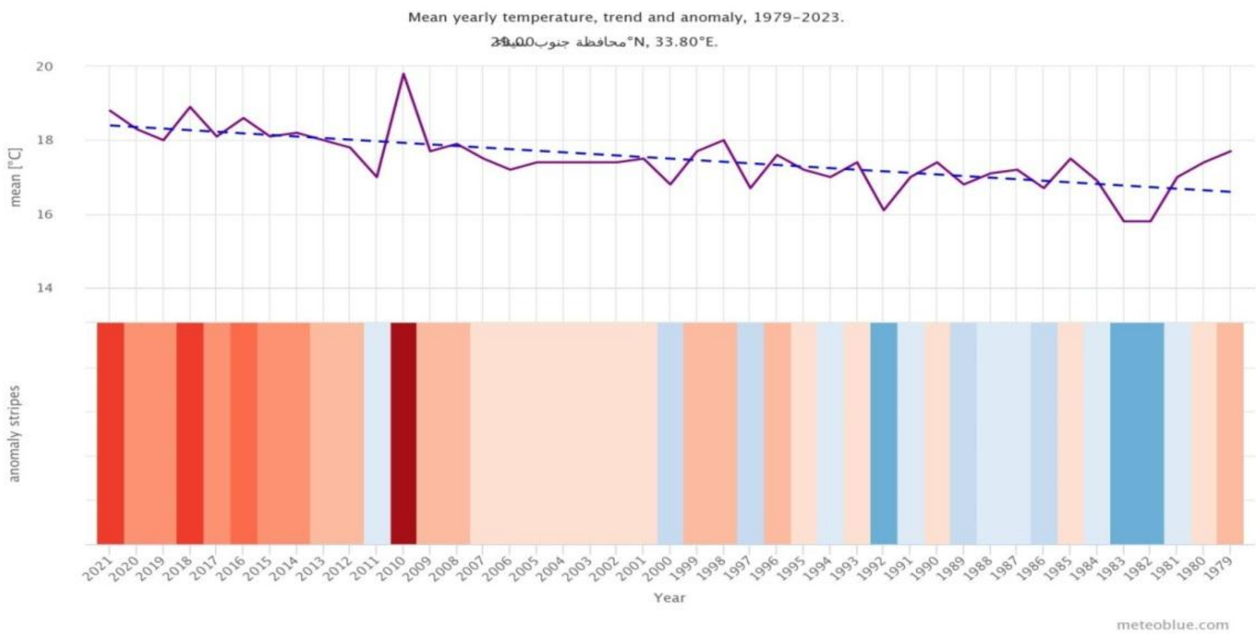
Numerous case studies emphasize the need for proactive measures to protect tourism-related assets and ensure tourist safety. According to Gössling et al. (2020), the effects of climate change can cause severe damage to coastal infrastructure, disrupt tourism operations and lead to a decline in visitor arrivals. United Nations Environment Programme, UNEP (2017) emphasizes the paramount importance of sustainable development and underscores the potential risks posed by climate change. González-Hernández et al. (2023) evaluated climate-related risks in coastal and marine tourism, revealing that adaptive capacity played a crucial role in determining the level of risk in these regions. This paper offered valuable insights to facilitate collaborative policy design and emphasized targeted adaptation strategies to strengthen resilience in various tourism areas confronted with climate challenges.

Existing research on the impacts of climate change on tourism has primarily focused on renowned destinations such as the Mediterranean or specific ecosystems like mountains and coasts. However, this body of work has often overlooked the diversity of recreational activities within these environments and their distinct weather requirements. Consequently, there are significant gaps in information, particularly concerning the specific negative consequences faced by tourism-related activities in Ras Sudr. Given the city's popularity as a tourist destination celebrated for its pristine beaches, vibrant coral reefs and diverse marine life, it becomes essential to examine the extent to which climate change affects the sustainability and attractiveness of marine and coastal activities in this particular location.

By addressing this research gap, the study aims to contribute to the existing literature on climate change impacts on coastal tourism while offering practical insights for fostering sustainable tourism development and effective management in Ras Sudr. In light of these findings, the implementation of adaptation strategies emerges as a critical imperative to ensure the long-term sustainability of coastal tourism in the region.

2.2. Climate change impacts on South Sinai

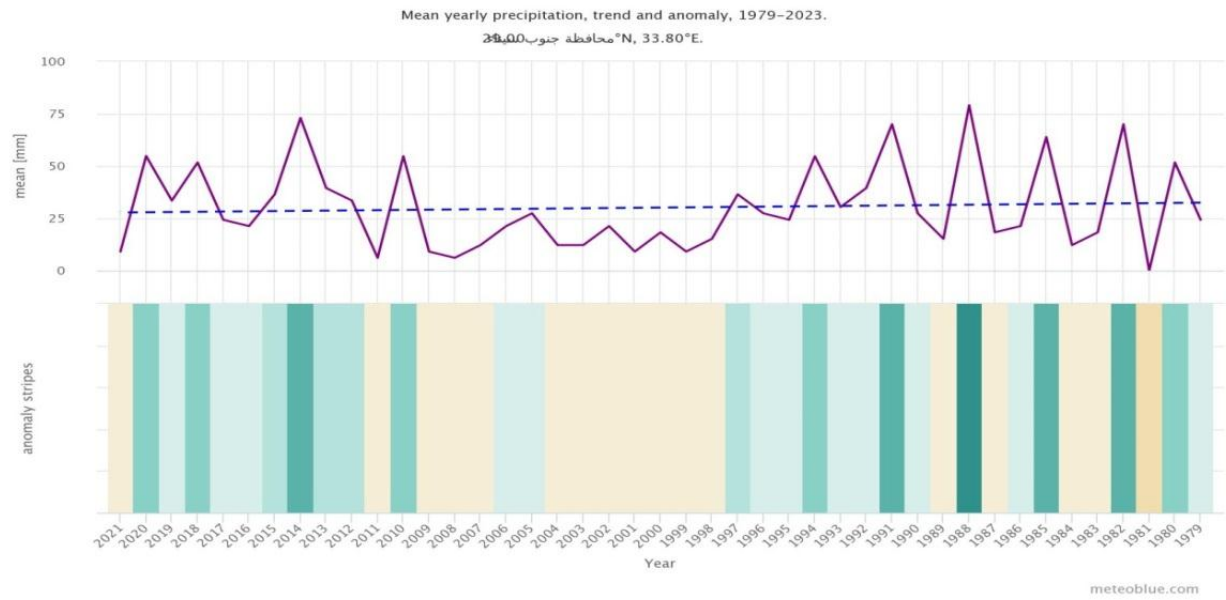
The presented charts depict the evident impacts of climate change on the South Sinai Governorate region over the last four decades. The data utilized in these charts is derived from ERA5, the fifth generation of the ECMWF Atmospheric Analysis of Global Climate, encompassing the period from 1979 to 2021 and featuring a spatial resolution of 30 km. The information showcased offers valuable insights into the observable changes in the region's climate over time.



Source: www.Meteoblue.com.

Figure 2. Annual change in temperature, South Sinai governorate.

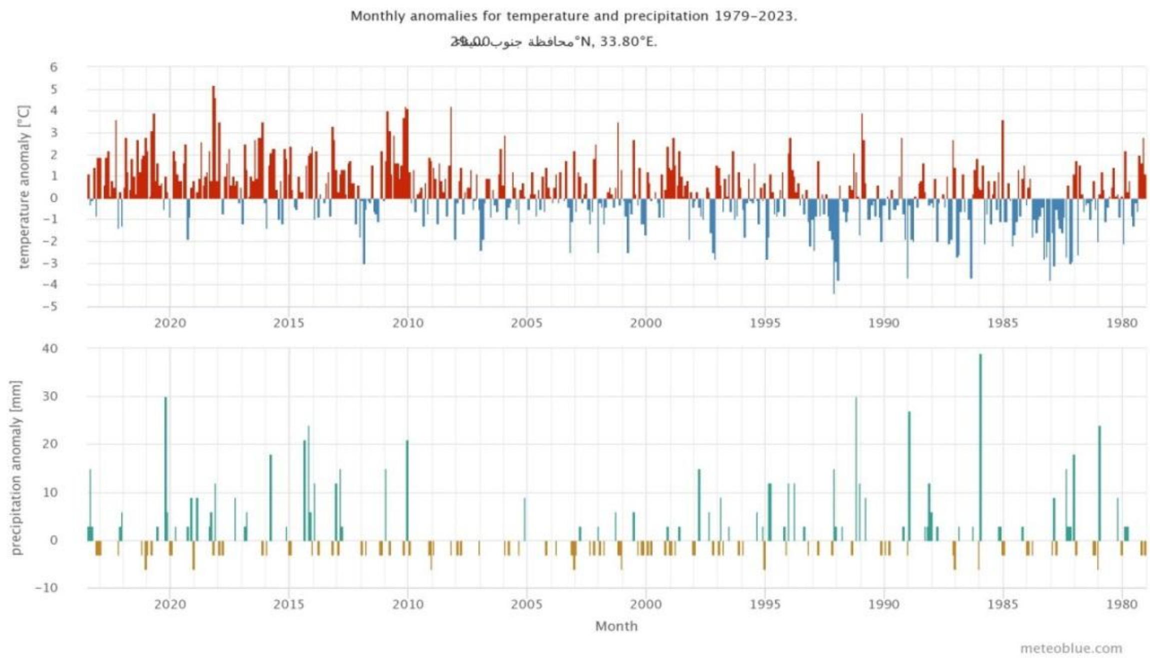
The upper chart illustrates the estimated annual mean temperature for the broader area of the South Sinai Governorate. The blue dashed line represents the linear trend of climate change. A rising trend from left to right indicates a positive temperature trend, signifying that the region is getting warmer over time by %1 due to the influence of climate change. If the trend line is horizontal, it suggests no clear trend in temperature change and if it is descending, it indicates that conditions in %1 are getting colder over time.



Source: www.Meteoblue.com

Figure 3. Annual change in precipitation - South Sinai governorate

The upper chart presents an estimation of the average total precipitation for the broader region of the South Sinai Governorate. The blue dashed line represents the linear trend of climate change. If the trend line is ascending from left to right, it indicates a positive precipitation trend, implying that the region is becoming wetter over time due to the impact of climate change. If the trend is horizontal, there is no clear trend in precipitation change and if it is descending, it suggests that conditions will become drier in the South Sinai over time.



Source: www.Meteoblue.com

Figure 4. Monthly deviations in temperature and precipitation - climate change, South Sinai

The upper graph displays the temperature deviations for each month from 1979 to the present. The anomaly indicates the extent to which the temperature was either warmer or cooler compared to the 30-year average climate during 1980–2010. Red months indicate significantly warmer periods, while blue months represent cooler conditions than the established norm. Over the years, there has been a noticeable rise in warmer months in many locations, reflecting the impact of global warming attributed to climate change. The lower graph displays the precipitation anomaly for each month from 1979 to the present. This anomaly indicates whether each month experienced more or less precipitation compared to the 30-year average climate during 1980–2010. Green months represent wetter conditions, while brown months signify drier periods than the established norm.

2.3. Surf tourism

Surf tourism encompasses a fusion of nature and adventure tourism, sport tourism, and marine tourism. It entails traveling to domestic or international destinations with the primary purpose of engaging in surfing activities, whether it involves active participation, spectating or learning to surf (Valencia et al., 2021). The global surfing community has witnessed significant growth, with approximately 20 million surfers worldwide, leading to a proliferation of surfing destinations across 181 countries in 2021 (Abd El-Kafy, 2022). Surf tourism offers various beneficial outcomes for tourist destinations, encompassing both economic and environmental dimensions. From an economic perspective, the arrival of surfers has a substantial impact on the local economy, generating employment opportunities and enhancing income levels within the host community (Mach and Ponting, 2021).

From an environmental standpoint, surf tourism is regarded as a sustainable form of tourism due to its positive and discernible contributions to the sustainable development of coastal destinations (Araújo et al., 2016). Sporting activities like windsurfing, kite surfing and diving have not only gained popularity among tourists but have also attracted professional athletes and sports enthusiasts from around the world. In turn, this leads to increased investments in infrastructure, sports facilities, and related services, further stimulating the local economy (Gabr et al., 2023).

2.4. Government support to mitigate climate change

In recent years, Egypt has shown its commitment to global climate action by actively participating in international climate agreements and initiatives. The government has submitted its climate plans to the UNFCCC and the Conference of the Parties (COP) meetings and engages in collaborative efforts to mobilize climate finance for sustainable projects(UNDP,2021).Notably, Egypt’s National Climate Change Strategy 2050 (NCCS) and Egypt Vision 2030 outline ambitious goals to reduce greenhouse gas emissions, increase renewable energy use and implement climate-resilient infrastructure. The country’s dedication to combating climate change is evident through investments in renewable energy, sustainable urban planning and green transportation projects. These efforts demonstrate Egypt’s determination to build a sustainable and resilient future for the nation.

2.5. Coping strategies with climate changes in the tourism sector

Intergovernmental Panel on Climate Change (2019) assured that there is a need for urgent global cooperation and comprehensive efforts to address climate change through adaptation and mitigation strategies to protect our planet and its inhabitants. Improving the resilience of coastal and marine tourism infrastructure to climate change requires implementing appropriate building codes and standards. However, there is limited awareness of climate-resilient building practices (Karani & Failler, 2020). The blue economy strategy offers a solution by integrating natural marine elements like wetland vegetation, sea grass, coral reefs and mangroves into shoreline stabilization efforts. This approach reduces ecological impacts, minimizes coastal erosion and enhances biodiversity value in man-made structures, mitigating the negative effects of tourism on the environment (Bennett et al., 2019).

Effective adaptation strategies rely on the precise and prompt detection of climate changes at regional and local levels worldwide (UNDP, 2021). An accurate understanding of these changes enables tailored adaptation measures to address unique impacts and vulnerabilities in each region. Decision-makers can then develop targeted strategies to mitigate climate change’s negative effects and enhance resilience in the face of these challenges. Incorporating tourists’ behavior into adaptation strategies is essential to improving the effectiveness of strategies developed by public stakeholders in each destination, leading to the accomplishment of objectives (Clemente et al., 2020).

A comprehensive understanding of how climate change may affect tourists’ activities, including their preferences and expectations, is crucial for destinations and businesses. This knowledge enables decision-makers to anticipate and proactively address potential changes in tourism demand, both in terms of location and timing. The receptiveness and adaptability of tourists to destination alterations caused by climate change significantly impact the overall success and sustainability of tourism activities on a global scale. Hence, this paper assumes that:

H1*. Stakeholder awareness of climate change negatively affects government support.*

H2a. *Government support negatively affects climate change on coastal tourism activities.*

H2b. *Government support negatively affects climate change on tourism-based marine activities.*

H2c. *Government support negatively affects climate change on kite surf tourism.*

H3. *Government support mediates the association between stakeholder awareness of climate change and a) coastal tourism activities, b) tourism-based marine activities, and 3) kite surf tourism.*

H4a. *Coping strategies moderate the association between government support and climate change on coastal tourism activities.*

H4b. *Coping strategies moderate the association between government support and climate change on tourism-based marine activities.*

H4c. *Coping strategies moderate the association between government support and climate change on kite surf tourism.*

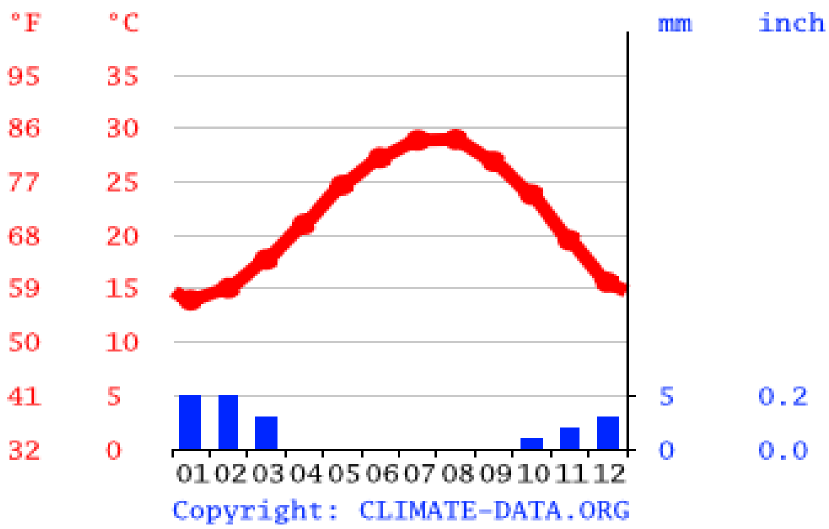
3. Research Methods

3.1. Research Rationale

Ras Sudr is an Egyptian coastal town located on the Gulf of Suez and the Red Sea coast. Its geographical coordinates are approximately 32° 43’ East longitude and 29° 35’ North latitude. It is part of the South Sinai Governorate and has three areas: Wadi Sudr, Abu Sudr and Soera. The town offers a 95-kilometer beach coastline suitable for swimming and water sports (Ramadan et al., 2022). The beaches of Ras Sudr are particularly appealing to beach lovers and water sports enthusiasts who can partake in various activities, including swimming, sailing, windsurfing, kite surfing, and jet skiing, capitalizing on the advantageous coastal conditions. Its strategic location and reliable winds have also rendered it a renowned venue for windsurfing competitions and events, elevating its status as a vibrant marine tourism destination (Abu Ahmed et al., 2022).

Kitesurfing enthusiasts can enjoy the sport in Ras Sidr with wind speeds ranging from 8 to 10 knots (3 Beaufort) up to 20 to 27 knots (6 to 7 Beaufort), depending on sail type, skill level and experience. The Egyptian coasts, particularly during the summer months, offer favorable winds that blow parallel to the shore, providing ideal conditions for kitesurfing. Ras Sidr experiences an amazing climate, with summer temperatures ranging from 28 to 35 degrees Celsius. The best wind conditions occur from March to November, with average speeds ranging from 16 to 25 knots. The strongest winds occur from the end of August to the end of September, reaching up to 30 knots on certain days.

According to the Köppen-Geiger climate classification, Ras Sudr has what is called a desert climate. There is virtually no rainfall during the year. The average annual temperature in Ras Sudr is 21.9 °C (71.5 °F). In a year, the rainfall is 19 mm (0.7 inch). Summer begins at the end of June and ends in September. The best times to visit are May, June, September and October. The hottest month is August (31 °C AVG), the coldest month is January (15 °C AVG), the wettest month is January (3.4 mm AVG) and the windiest month is June (8 mph AVG). The driest month is April. There is 0 mm (0.0 inch) of precipitation in April. Most of the precipitation here falls in January, averaging 5 mm or 0.2 inches.



Source: www.climate-Data.org

Figure 5. The average annual temperature in Ras Sudr

Between the years 1991 and 2021, data was collected on various climatic factors in the region. The minimum temperature ranged from 9.5°C (49.1°F) to 11.4°C (52.5°F), while the maximum temperature ranged from 17.8 °C (64.1°F) to 19.5°C (67.2°F). The precipitation or rainfall, varied from 1mm (in) to 5mm (in). Humidity levels also showed fluctuations throughout the year, with the highest relative humidity recorded in December at 58.47% and the lowest in May at 41.44%. In terms of rainy days, January experienced the most with an average of 1.67 days, while June had the fewest with only 0.07 days.

Additionally, between the years 1999 and 2019, the average sun hours were recorded, providing valuable insights into the region's sunlight patterns. Furthermore, the data revealed a variation of 5 mm (0 inch) in precipitation between the driest and wettest months and an overall temperature fluctuation of 15.0 °C (27.1 °F) throughout the year. Ras Sudr experiences varying levels of sunshine throughout the year, with June being the sunniest month, boasting an average of 12.29 hours of sunshine per day and a total of 380.97 hours for the entire month. On the other hand, January is the month with the least amount of daily sunshine, averaging 8.6 hours for a total of 266.59 hours for the month.

On an annual basis, Ras Sudr enjoys an average of 3857.83 hours of sunshine, resulting in an average of approximately 126.76 hours of sunshine each month. Ras Sudr experiences an annual average water temperature of approximately 22.50°C (72.50 °F). The warmest water temperatures are observed in August, reaching a monthly average of 27.00°C (80.60 °F), while the coldest temperatures occur in February, with an average of about 18.20°C (64.76 °F). The highest water temperature of the year, 27.00°C (80.60 °F), typically occurs around August 21, whereas the lowest value, 18.20°C (64.76 °F), is usually observed around February 11.as Shown in (Table 1).

Table 1. Differences in water temperature during the year in Ras Sudr

	January	February	March	April	May	June	July	August	September	October	November	December
Min. Water Temperature °C (°F)	18.3 64.9	18.2 64.8	18.3 64.9	19.2 66.6	20.7 69.3	23 73.4	24.8 76.6	26.5 79.7	26 78.8	24.3 75.7	22.2 72	19.8 67.6
Avg. Water Temperature °C (°F)	18.9 66	18.3 64.9	18.7 65.7	19.9 67.8	21.8 71.2	23.9 75	25.7 78.3	26.8 80.2	26.5 79.7	25.2 77.4	23.2 73.8	20.9 69.6
Max. Water temperature °C (°F)	19.7 67.5	18.4 65.1	19.1 66.4	20.6 69.1	22.8 73	24.9 76.8	26.5 79.7	27 80.6	26.9 80.4	26 78.8	24.3 75.7	22.2 72

Source: *https://en.climate-data.org/africa/egypt/south-sinai-governorate/ras-sudr-9248/#climate-table*

3.2. Measurement Development

All scale items were extracted from previous literature related to marine and coastal tourism activities and climate changes in the tourism sector (Clemente et al., 2020; Kostianaia & Kostianoy, 2021). As such, four items were employed to gauge tourism stakeholder awareness of climate change, while five items were generated to assess government support to mitigate climate change in tourism activities. Likewise, five items were refined to gauge coping strategies with climate change in tourism activities. Furthermore, the negative effects of climate change were assessed in three aspects: 1) coastal tourism activities with five items; 2) tourism-based marine activities and 3) kite surfing tourism with ten items. All measuring items were graded on a 7-point Likert scale.

Three academic professionals who are fluent in Arabic and English back-translated all items. Thus, 48 participants (29 males and 19 females) took part in a pre-test to assess the construct validity and see whether there are any further climate change restrictions affecting Ras Sudr's tourist industry. Employees of travel agencies, tourism organizations and airlines in Ras Sudr or Sinai South government took part in this pilot test. Following an attention-grabbing phrase in the survey that stated, "Choose to strongly disagree/agree with all items," participants were asked to read all intended items and rate the degree to which they sounded relevant to the survey's objectives. To guarantee that respondents provided honest responses, those who used this strategy were disqualified.

3.3. Data collection and sampling

Referring to the different effects of climate change on tourism activity seasonally, as shown in Table 2. Survey Monkey was employed to collect data from September 12–29,

2022. Because the number of employees in the Egyptian tourist sector in South Sinai is not limited, simple random sampling was employed. As a result, 1127 cases were obtained. Unengaged cases were omitted from the ultimate data set (i.e., outliers and partial responses). Overall, 839 of 1127 valid cases were kept. The sample size was determined to be sufficient because it exceeded 200 instances to conduct partial structural modeling (PLS).

Table 2. Differences in climate change during four seasons in Ras Sudr

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	13.9 °C (57) °F	15 °C (59.1) °F	17.7 °C (63.9) °F	21 °C (69.8) °F	24.7 °C (76.4) °F	27.2 °C (81) °F	28.9 °C (84) °F	28.9 °C (84.1) °F	26.9 °C (80.4) °F	23.8 °C (74.8) °F	19.5 °C (67.1) °F	15.6 °C (60) °F
Min. Temperature °C (°F)	9.5 °C (49.1) °F	10 °C (50.1) °F	12.1 °C (53.8) °F	14.7 °C (58.4) °F	18.2 °C (64.7) °F	20.9 °C (69.6) °F	22.8 °C (73) °F	23.1 °C (73.6) °F	21.5 °C (70.7) °F	19.1 °C (66.4) °F	15.1 °C (59.1) °F	11.4 °C (52.5) °F
Max. Temperature °C (°F)	17.8 °C (64.1) °F	19.5 °C (67.1) °F	22.8 °C (73) °F	26.6 °C (79.8) °F	30.4 °C (86.8) °F	33.1 °C (91.5) °F	34.4 °C (94) °F	34.3 °C (93.7) °F	32.1 °C (89.8) °F	28.4 °C (83.2) °F	23.8 °C (74.9) °F	19.5 °C (67.2) °F
Precipitation / Rainfall mm (in)	5 (0)	5 (0)	3 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	2 (0)	3 (0)
Humidity(%)	58%	53%	48%	43%	41%	43%	45%	48%	53%	57%	57%	58%
Rainy days (d)	1	1	1	0	0	0	0	0	0	0	1	1
avg. Sun hours (hours)	8.5	9.3	10.4	11.4	12.1	12.5	12.3	11.7	10.8	10.0	9.2	8.6

Source: https://en.climate-data.org/africa/egypt/south-sinai-governorate/ras-sudr-9248/#climate-table

3.4. Data analysis

PLS-structural equation modeling (PLS-SEM) was run for the final dataset analysis. PLS-SEM has more advantages over covariance-based SEM (Assaker & O’Connor, 2023). First, this approach is more appropriate for exploratory investigations where measurement scales are less well-established (Guenther et al., 2023). Second, PLS-SEM is good for residual distribution requirements (Cheah et al., 2023). Third, PLS has a better ability to handle complex models (Rasoolimanesh, 2022). PLS-SEM was chosen as the appropriate tool for this paper since it is both an exploratory and predictive study based on SmartPLS 4.

Prior to conducting hypothesis testing, all scales were evaluated for validity and reliability. The calibration sample (n = 266) and the validation sample (n = 573) were each given a group of 839 participants, who were randomly assigned to one of the two samples. Using exploratory factor analysis (EFA), scale dimensionality was extracted. To complete the outer model for the validation sample, a confirmatory composite analysis (CCA) was utilized, as advised by Hair et al. (2020). Paths analysis was performed utilizing our dataset in light of the EFA and CFA findings.

4. Findings

4.1. Participants' profile

Among the calibration sample (Table 3), 88.3% of participants were males and 59% of those were ages 37 to less than 49. Regarding the professional experiences of participants, 37.2% had 1 to less than 4 years, followed by 28.6% of those with 4 to less than 7 years.

Lastly, most participants (41%) asserted that climate change affects tourism activities in Ras Sudr during the summer season. For the validation sample (Table 1), 90.2% of participants were males and 71.6% of those were ages 37 to less than 49. Regarding the professional experiences of participants, 36.3% had 1 to less than 4 years, followed by 28.1% of those with less than one year. Lastly, most participants (39.8%) asserted that climate change affects tourism activities in Ras Sudr during the summer season.

Table 3. Respondent profile.

Category	**Calibration sample (n = 266)**		**Validation sample (n = 573)**	
	Frequency	**%**	**Frequency**	**%**
Gender				
Male	235	88.3	517	90.2
Female	31	11.7	56	9.8
Age (Years)				
< 21	56	21.1	89	15.5
21 to < 36	12	4.5	28	4.9
37 to < 49	157	59.0	410	71.6
≥ 50	41	15.4	46	8.0
Professional experiences (Years)				
< 1	67	25.2	161	28.1
1 to < 4	99	37.2	208	36.3
4 to < 7	76	28.6	140	24.4
≥ 7	24	9.0	64	11.2
Any season climate change affects tourism activities?				
Winter	76	28.6	163	28.4
Summer	109	41.0	228	39.8
Fall	59	22.2	143	25.0
Spring	22	8.3	39	6.8

4.2. Common method bias and non-response error

The overall sample (n = 839) including calibration and validation samples was employed to screen for common method bias (CMB). The first component only explained 40.56% of the variation using the Harman test. As a result, our dataset ruled out the CMB problem. A t-test was utilized to check for non-response problems at the 0.05 level. Next, running Mann-Whitney test to compare between two groups in SPSS v.27, Levene's test findings (see Table 4) proved that p value exceed .50, assuming any differences between the 518 earliest and 321 last responses (Selem et al., 2023).

4.3. Exploratory factor analysis

Principal component analysis was employed on the calibration sample (Hair et al., 2020). Items that loaded less than 0.70 [GSP3, GSP5, CST2, CST4, TMA2, KST1, KST3, KST4, KST5, KST8, KST10] were eliminated (Table 4). According to Hair et al. (2020), the six Cronbach's alpha scores exceed 0.70, showing adequate reliability. Variance values show that all measures are completely different from each other, as shown in Table 5. Lastly, the values of means and standard deviations indicate a high score for each construct (Table 4).

Table 4. Mann-Whitney test and EFA results.

Independent sample test										
Samples		Levene's test		t-test equality of means						
		F	Sig	t	df	Sig (2-tailed)	Mean difference	Std error difference	95%CI of difference	
									Lower	Upper
	Equal variances assumed	1.453	.307	-1.324	67	.173	-.692	.432	-1.397	.266
	Equal variances not assumed			-1.873	57.221	.139	-.692	.401	-1.345	.174

Code	Construct items	Factor loadings
	Stakeholder awareness of climate change *(Mean = 4.93, SD = 1.186, Cronbach's alpha = .878, Variance ratio = 8.36%)*	
SAC1	Climate change is a significant global issue that affects marine tourism.	.776
SAC2	Climate change has a direct impact on the tourism industry in Ras Sudr.	.716
SAC3	Climate change threatens the stability of tourism activity in Ras Sudr.	.750
SAC4	Public awareness about climate change needs to be increased in Ras Sudr.	.759
	Government support to mitigate climate change *(Mean = 5.08, SD = 1.063, Cronbach's alpha = .879, Variance ratio = 32.81%)*	
GSP1	Our government ___________________ Implemented effective policies to mitigate climate change in the previous year.	.791
GSP2	Provides sufficient financial resources for climate change research and initiatives.	.759
GSP3	*Actively promotes renewable energy sources to reduce greenhouse gas emissions.*	*.612*
GSP4	Collaborates with international organizations to address climate change on a global scale.	.789
GSP5	*Engages in public awareness campaigns to educate citizens about climate change.*	*.611*
	Coping strategies with climate changes *(Mean =5.06, SD =1.294, Cronbach's alpha = .905, Variance ratio = 3.45%)*	
CST1	Developing resilient infrastructure is crucial for coping with the impacts of climate change.	.778
CST2	*Encouraging sustainable agriculture practices is an effective strategy for adapting to climate change.*	*.599*
CST3	Enhancing water management systems is essential for dealing with climate change-induced water scarcity.	.738
CST4	*Implementing nature-based solutions (i.e., ecosystem restoration) can help mitigate the effects of climate change.*	*.490*
CST5	Promoting climate-resilient urban planning and design is necessary for adapting to changing climate conditions	.710
	Negative effects on coastal tourism activities *(Mean = 5.11, SD = 1.218, Cronbach's alpha = .896, Variance ratio = 4.76%)*	
CTA1	Climate change has led to changes in the weather patterns affecting coastal tourism activities in Ras Sudr.	.761
CTA2	Rising sea levels due to climate change have negatively impacted coastal tourism infrastructure in Ras Sudr.	.753
CTA3	Changes in water quality caused by climate change have affected the attractiveness of coastal tourism destinations in Ras Sudr.	.728
CTA4	Climate change has increased the frequency and intensity of storms, leading to disruptions in coastal tourism activities in Ras Sudr.	.807

CTA5	Climate change has resulted in the loss of biodiversity, affecting the overall appeal of coastal tourism in Ras Sudr.	.783
Negative effects on tourism-based marine activites *(Mean = 5.26, SD = 1.157, Cronbach's alpha = .892, Variance ratio = 5.33%)*		
TMA1	Climate change has affected the availability and distribution of marine species, impacting marine tourism in Ras Sudr.	.777
TMA2	*Coral bleaching caused by climate change has reduced the attractiveness of marine sites.*	*.630*
TMA3	Climate change has led to the degradation of marine ecosystems, affecting marine tourism experiences.	.734
TMA4	Changes in ocean temperature and acidity due to climate change have impacted marine wildlife, affecting marine tourism activities.	.751
TMA5	It is important for marine tourism operators to adopt sustainable practices to mitigate the effects of climate change.	.748
Negative effects on kite surf tourism *(Mean = 5.29, SD = 1.025, Cronbach alpha = .909, Variance ratio = 3.03%)*		
KST1	*Climate change has affected the wind patterns in kite surfing spots in Ras Sudr.*	*.613*
KST2	Rising sea levels caused by climate change have altered the coastal landscape, impacting kite surfing areas in Ras Sudr.	.754
KST3	*Changes in weather patterns due to climate change have influenced the overall kite surfing experience in Ras Sudr.*	*.592*
KST4	*Climate change has increased the occurrence of extreme weather events, affecting the safety of kite surfers in Ras Sudr.*	*.580*
KST5	*Suitable wind conditions for kite surfing have been impacted by climate change.*	*.526*
KST6	Climate change has led to changes in water temperatures, affecting kite surfing conditions in Ras Sudr.	.749
KST7	I believe that climate change mitigation efforts are necessary to preserve kite surfing spots in Ras Sudr.	.767
KST8	*Kite surfing organizations in Ras Sudr should raise awareness about climate change and its impact on the sport.*	*.651*
KST9	Local authorities in Ras Sudr should take action to protect kite surfing areas from the effects of climate change.	.791
KST10	*I am willing to support eco-friendly practices in kite surfing in Ras Sudr.*	*.264*
KMO = .938, Bartlett's test of sphericity = 6189.297, p < 0.001. Note: Italicized items were omitted.		

4.4. Measurement model

Through PLS-CCA, the outer model was evaluated (Hair et al., 2020). All indicator loadings were over the threshold of.708 and AVE and composite reliability values were also above .70 and .50 (Table 5). Furthermore, descriptive statistics showed a high score for all items of the scales used (Table 5). The Heterotrait-Monotrait Ratio (HTMT) was conducted to check discriminant validity. According to Table 6 findings, all constructs had HTMT scores that were less than 0.85 (Becker et al., 2023), indicating adequate discriminant validity.

Table 5. CCA results.

Constructs	Code	Mean	SD	Factor loadings	Composite reliability	AVE
Stakeholder awareness of climate change	SAC1	4.93	1.427	.850	.910	.717
	SAC2	4.85	1.373	.854		
	SAC3	4.98	1.393	.822		
	SAC4	4.96	1.354	.860		
Government support to mitigate climate change	GSP1	5.05	1.336	.870	.876	.702
	GSP2	5.10	1.232	.838		
	GSP4	5.11	1.278	.804		
Coping strategies with climate changes	CST1	5.08	1.476	.888	.920	.794
	CST3	5.14	1.526	.891		
	CST5	4.87	1.604	.894		
Negative effects on coastal tourism activities	CTA1	5.28	1.570	.837	.931	.731
	CTA2	5.12	1.437	.862		
	CTA3	5.02	1.379	.854		
	CTA4	5.08	1.401	.871		
	CTA5	5.04	1.453	.858		
Negative effects on tourism-based marine activities	TMA1	5.36	1.364	.865	.916	.732
	TMA3	5.26	1.359	.874		
	TMA4	5.24	1.394	.899		
	TMA5	5.18	1.406	.797		
Negative effects on kite surf tourism	KST2	5.28	1.482	.814	.900	.693
	KST6	5.26	1.380	.791		
	KST7	5.37	1.363	.836		
	KST9	5.20	1.308	.886		

Table 6. Discriminant validity (HTMT).

Constructs	1	2	3	4	5	6
1. Coping strategies with climate changes						
2. Government support to mitigate climate change	.366					
3. Negative effects on coastal tourism activities	.528	.508				
4. Negative effects on kite surf tourism	.431	.407	.476			
5. Negative effects on tourism-based marine activities	.316	.459	.520	.391		
6. Stakeholder awareness of climate change	.429	.475	.425	.362	.512	

4.5. Inner model

The direct paths (H1-H2c) were supported based on PLS calculations for the validation sample, as displayed in Figure 4 and Table 7. Government support (19.2%), negative consequences on coastal tourist activities (16.4%), negative consequences on marine tourism-based activities (47.4%) and negative consequences on kite surfing tourism (45.3%) all had moderate variance explanations according to the proposed model (Table 7). According to

Khalilzadeh and Tasci (2017) claims, H1-H2c paths also have a large effect size. Thus, our model was suitable for an exploratory paper.

The bootstrapping approach was run with a 5000-sample sample and the confidence interval not exceeding zero to examine indirect paths (Hair et al., 2020). Findings presented in Table 7 show a partial competitive mediation of government support in linkages between stakeholder awareness of climate change and negative effects on coastal tourism activities ($\beta = .177$, $p < .05$, CI = .051, .388), negative effects on tourism-based marine activities ($\beta =$ .30`, $p < .01$, CI = .131, .483) and negative effects on kite surfing tourism ($\beta = .295$, $p < .001$, CI = .130, .463). These findings proved that H3a-H3c were supported because direct effects were significant and negative, while indirect and total effects were significant and positive.

Table 7. Paths coefficients' findings.

Direct effects						
Paths	β	T-value	p-value	f^2	R^2	Supported?
H1. Stakeholder awareness of climate change → Government support	-.438***	3.794	.000	.237	.192	Yes
H2a. Government support → Negative effects on coastal tourism activities	-.405***	3.748	.000	.196	.164	Yes
H2b. Government support → Negative effects on tourism-based marine activities	-.689***	10.568	.000	.702	.474	Yes
H2c. Government support → Negative effects on kite surf tourism	-.673***	9.628	.000	.621	.453	Yes
Indirect effects						
Paths	β	T-value	p-value	LLBC	ULBC	Remark
H3a. Stakeholder awareness of climate change → Government support → Negative effects on coastal tourism activities	.177*	1.987	.047	.051	.388	Partial mediation
H3b. Stakeholder awareness of climate change → Government support → Negative effects on tourism-based marine activities	.301***	3.337	.001	.131	.483	Partial mediation
H3c. Stakeholder awareness of climate change → Government support → Negative effects on kite surf tourism	.295***	3.502	.000	.130	.463	Partial mediation

4.6. Multigroup analysis

Respondents who indicated that climate change has an effect on tourism in Ras Sudr during any season (i.e., winter, fall, spring and summer samples) had their mean differences of constructs across four subgroups examined. Prior to analyzing the path coefficient differences between these groups, the measurement invariance of composites technique was employed (Henseler et al., 2016). As Table 8 shows, the moderation effect of coping strategies with climate change was examined using MGA analysis during four seasons.

Our findings proved that the interaction effect of coping strategies*government support on negative effects of climate change on coastal tourism activities ($\beta_{\text{winter sample}} = -.205$, $p > .05$, $\beta_{\text{fall sample}} = -.680$, $p < .01$, $\beta_{\text{spring sample}} = .191$, $p > .05$, $\beta_{\text{summer sample}} = -.306$, $p > .05$). The differences in the supported results showed that coping strategies strengthened the negative effect of government support to overcome climate change by reducing its negative effects on coastal tourism activities in favor of the fall sample. Thus, H4a was supported.

Lastly, the interaction effect of coping strategies*government support on negative effects of climate change on kite surfing tourism ($\beta_{winter\ sample} = -.275$, $p < .01$, $\beta_{fall\ sample} = -.217$, $p > .05$, $\beta_{spring\ sample} = -.521$, $p < .05$, $\beta_{summer\ sample} = .296$, $p > .05$). The differences in the supported results showed that coping strategies strengthened the negative effect of government support to overcome climate change by reducing its negative effects on kite surf tourism in favor of the winter sample. Hence, H4c was supported.

Table 8. MGA findings.

	Negative effects of climate change on …………					
	H4a. Coastal tourism activities		H4b. Tourism-based marine activities		H4c. Kite surf tourism	
	β	Supported	β	Supported	β	Supported
Coping strategies × Government support during winter season	-.205 (.170)	No	-.423*** (.000)	Yes	-.275** (.002)	Yes
Coping strategies × Government support during fall season	-.680** (.004)	Yes	-.541** (.002)	Yes	-.217 (.191)	No
Coping strategies × Government support during spring season	.191 (.451)	No	-.308* (.024)	Yes	-.521 (.398)	No
Coping strategies × Government support during summer season	-.306 (.231)	No	-.400** (.001)	Yes	.296 (.109)	No
Differences are in favor of ………..	Fall sample		Fall sample		Winter sample	

To further justify the moderation effects, the slopes of the high and low levels were employed. Findings presented in Figures 6 and 7 prove that whenever local communities adopt strategies to confront climate change in Ras Sudr during the fall season, the Egyptian government, especially tourism agencies affiliated with the Ministry of Tourism, supports these strategies to reduce the negative impacts on tourism activities that are practiced on the coasts or on Red Sea waves. This season is considered one of the most stable seasons of the year with fewer climatic fluctuations, which increases the seasonality of tourism activity.

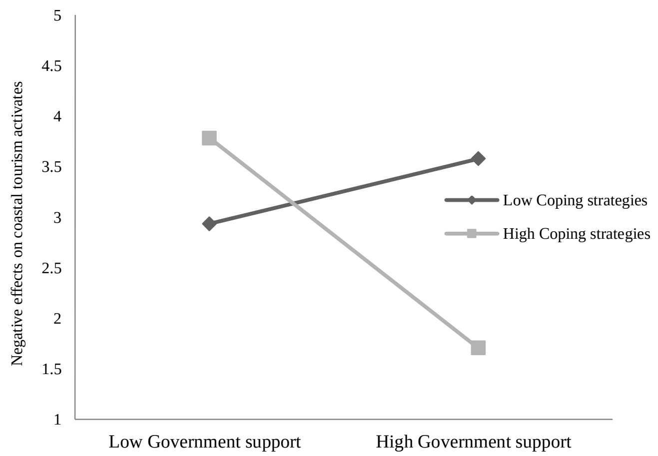


Figure 6. Moderation effect of coping strategies in linkage government support with negative effects on coastal tourism activities in the fall sample.

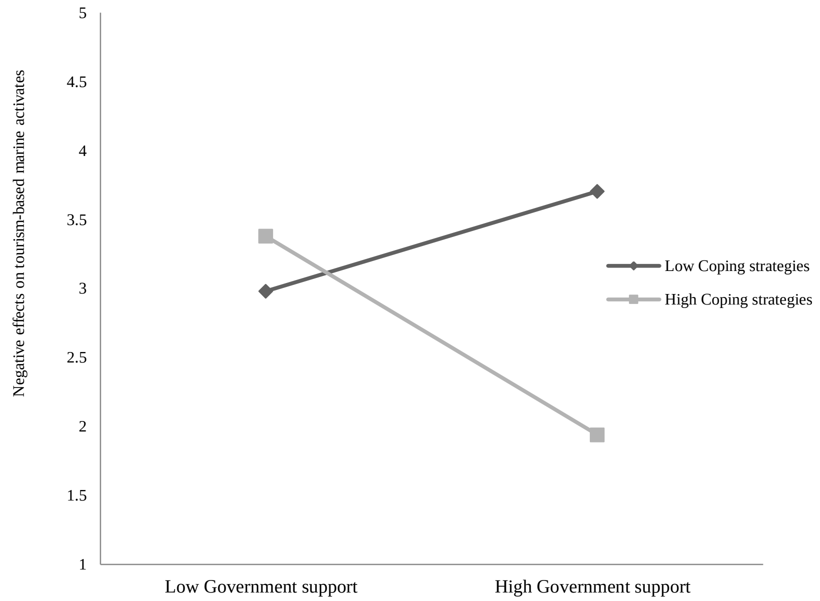


Figure 7. Moderation effect of coping strategies in linkage government support with negative effects on tourism-based marine activities in the fall sample.

On the other hand, the high levels of coping strategies (Figure 8) showed that the Egyptian tourism authorities and organizations have the ability to deal with climatic changes during the winter season, which prompts the government to exert moral and material efforts in developing strategic plans to reduce the potential impacts of these changes on kite surfing tourism in Ras Sudr.

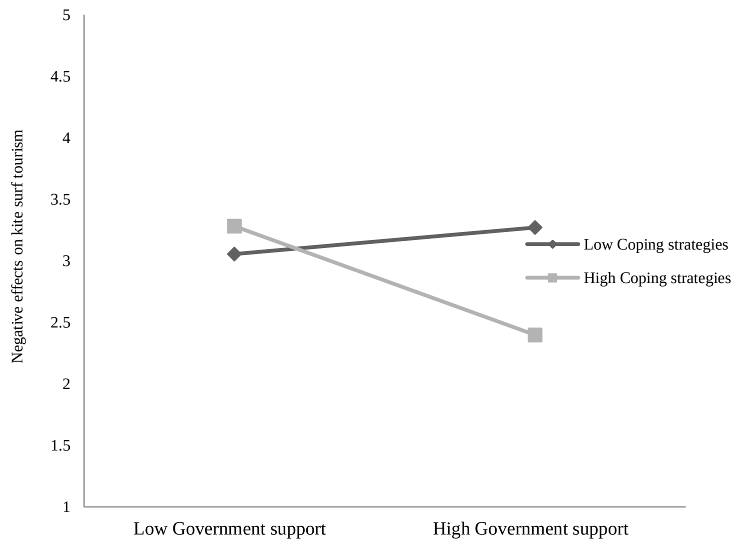


Figure 8. Moderation effect of coping strategies in linkage government support with negative effects on kite surf tourism in the winter sample.

5. Discussion

The study's findings indicate that stakeholder awareness of climate change have a negative influence on the level of government support for climate change mitigation (H1). This result aligns with previous studies that has highlighted the significant role of climate in shaping tourism destinations and influencing various aspects of the tourism industry, including demand, travel timing and seasonal fluctuations (Bombana et al., 2023). Moreover, this paper reveals that higher government support for climate change mitigation is associated with reduced negative impacts of climate change on coastal tourism activities, tourism-based marine activities and kite surfing tourism (H2a–H2c). This finding is consistent with previous research that has emphasized the vulnerability of coastal and marine tourism to climate change impacts, including rising sea levels, intensified storms, coastal erosion and altered weather patterns (El-Masry et al., 2022; IPCC, 2019).

Coping strategies are found to partially mediate the relationship between stakeholder awareness and negative effects on tourism sectors. This finding aligns with previous research emphasizing the importance of adaptation and resilience strategies in coastal destinations (Araújo et al., 2016). Coping strategies, including climate-resilient infrastructure and disaster preparedness plans, strengthen the role of government support in mitigating adverse climate impacts on tourism sectors. The study also reveals the importance of government support in mitigating climate change effects on coastal tourism activities, tourism-based marine activities and kite surfing tourism. This finding is consistent with the literature, which emphasizes the role of government policies and actions in protecting coastal environments and reducing vulnerability to extreme weather events (Abd El-Kafy, 2022).

Government support plays a vital role in maintaining the attractiveness of tourism activities that rely on specific weather conditions, such as beach tourism and water sports. However, it also highlights the need for additional coping strategies, especially during seasons with pronounced climate impacts. Proactive coping measures can enhance the effectiveness of government support and tailored approaches are necessary to adapt to climate change challenges in the tourism sector. Furthermore, the study emphasizes the importance of prioritizing resilience and sustainability strategies in coastal destinations. By fostering collaboration among government, local communities, and tourism operators, effective climate change mitigation and adaptation can be achieved (Bennett et al., 2019). Tailored approaches, based on the specific needs and vulnerabilities of each destination, are necessary to effectively adapt to climate change challenges in the tourism sector.

The study underscores the urgency for increased government commitment to address climate change impacts. This finding is in line with global climate change agreements and initiatives, highlighting the need for proactive measures to protect tourism-related assets and ensure the safety of tourists (UNDP, 2021). Sustainable policies and the active involvement of government authorities in climate change mitigation efforts are crucial for protecting the tourism sector and the local economy.

In conclusion, the study's results highlight the intricate relationship between stakeholder awareness, government support, coping strategies and their combined impact on coastal and marine tourism in Ras Sudr. These findings are consistent with existing literature on climate change impacts on coastal destinations, surf tourism and the importance of government commitment and collaboration for effective climate change mitigation and adaptation. By addressing these findings, stakeholders can develop targeted strategies to protect the tourism sector, enhance resilience, and ensure the long-term sustainability of coastal and marine tourism in Ras Sudr and similar destinations worldwide.

6. Implications

The study's implications hold significant relevance for policymakers, tourism industry stakeholders and local communities involved in coastal and marine tourism in Ras Sudr, Egypt. Firstly, the research underscores the imperative of increased government support and investment in climate change mitigation and adaptation measures. Policymakers should allocate financial resources for climate change research, promote renewable energy sources to reduce greenhouse gas emissions and collaborate with international organizations to address global climate challenges. Secondly, the study highlights the crucial role of local communities and tourism operators in adopting coping strategies that complement governmental initiatives. Implementing resilient infrastructure, encouraging sustainable agricultural practices and employing nature-based solutions are pivotal for enhancing climate resilience in coastal and marine tourism regions.

Furthermore, this paper focuses on the seasonality aspect of climate change's impacts on tourism activities in Ras Sudr. Policymakers and stakeholders need to adopt tailored strategies, considering the specific seasons during which negative effects are more pronounced, such as fall for coastal tourism and winter for kite surfing tourism. Overall, the study provides valuable insights into the intricate interactions among stakeholder awareness, government support, coping strategies and their influence on tourism activities in Ras Sudr. Policymakers, tourism stakeholders, and researchers can utilize these findings to devise more effective and targeted interventions that promote sustainable tourism practices, ensuring the long-term resilience and viability of the coastal and marine tourism industries in the region. Emphasizing proactive measures to address climate change challenges will be instrumental in safeguarding the tourism sector and fostering its enduring sustainability.

7. Conclusion and Recommendation

While the study utilized a quantitative approach with a sizable sample size, tourism activities can be influenced by numerous external factors that were not accounted for in the analysis. Future studies could incorporate qualitative methods or consider a broader range of variables to gain a more comprehensive understanding of the tourism sector's vulnerability to climate change. In summary, the study's findings underscore the urgent need to address the negative impacts of climate change on tourism activities in Ras Sudr. Policymakers, industry stakeholders and local communities must work together to develop effective adaptation strategies. The study utilized a quantitative approach, employing surveys and advanced statistical analysis to assess stakeholder awareness, government support, coping strategies and the negative effects of climate change on tourism activities.

The participants' profiles revealed that most respondents were male, aged between 37 and less than 49 years old and had 1 to less than 4 years of professional experience. The majority of participants believed that climate change impacts tourism activities during the summer season. To ensure data validity and reliability, various analyses were conducted, including exploratory factor analysis, confirmatory composite analysis and Heterotrait-Monotrait Ratio. The study's focus on Ras Sudr is particularly relevant, as coastal destinations heavily depend on marine and coastal resources to attract tourists. The findings can serve as a valuable case study for other coastal regions facing similar challenges, aiding in the development of tailored strategies to address climate change impacts on their tourism industries.

The following recommendations can be adopted:

- **Increase Climate Change Awareness Campaigns**: Policymakers should allocate resources to raise awareness about climate change among various stakeholders, including local communities, tourism operators, and visitors. Educational programs and campaigns can help build a collective understanding of climate-related risks and the importance of sustainable tourism practices.

- **Enhance Government Support:** Recognizing the crucial role of government support in mitigating climate change impacts, policymakers should allocate sufficient financial resources for climate change research, monitoring, and adaptation efforts. Collaboration with international organizations and experts can further bolster these efforts.
- **Promote Sustainable Energy Sources:** Policymakers should prioritize renewable energy sources to reduce greenhouse gas emissions in the tourism sector. Incentives and policies supporting the adoption of clean energy technologies can contribute to a more sustainable tourism industry.
- **Develop Climate-Resilient Infrastructure:** Investment in climate-resilient infrastructure, such as coastal protection measures and disaster preparedness plans, should be a priority. These infrastructure improvements are essential for safeguarding tourism assets and ensuring the safety of tourists during extreme weather events.
- **Adopt Coping Strategies:** Local communities and tourism operators should proactively adopt coping strategies tailored to their specific needs and vulnerabilities. This includes the development of climate-resilient infrastructure, nature-based solutions, and sustainable agricultural practices.
- **Collaborate on Resilience Measures:** Collaboration among local communities, tourism operators, and government authorities is essential for effective climate change mitigation and adaptation. Engaging in joint efforts to protect coastal environments and enhance resilience will contribute to the long-term sustainability of tourism activities.

Overall, this research contributes valuable insights into how climate change awareness, government support, and coping strategies interact to influence the resilience and sustainability of coastal and marine tourism in a specific destination. These findings have practical implications for those involved in the tourism industry and climate change mitigation efforts in Ras Sudr and similar coastal regions.

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الآثار السلبية لتغير المناخ على الأنشطة السياحية البحرية والساحلية في رأس سدر: الأدلة من الجهات المعنية

مروة على عبد الوهاب الهام غريب صغير

قسم الدراسات السياحية – كلية السياحة والفنادق – جامعة قناة السويس

معلومات المقالة	الملخص
الكلمات المفتاحية تغير المناخ؛ الأنشطة البحرية؛ سياحة ركوب الأمواج؛ رأس سدر؛ أصحاب المصلحة. **(JAAUTH)** **المجلد ٢٤، العدد٢، (٢٠٢٣)،** **ص ٧٠٩-٧٣١.**	يهدف هذا البحث إلى دراسة الارتباطات بين الوعي لدى أصحاب المصلحة بتغير المناخ، ودعم الحكومة، واستراتيجيات التكيف، وتأثيرها على الأنشطة السياحية في رأس سدر. باستخدام منهج كمي، تم جمع البيانات من خلال استبانة تم توزيعها على موظفي قطاع السياحة وتم تحليلها باستخدام SmartPLS 4. تظهر النتائج ارتباطاً سلبيًا مقلقًا بين وعي أصحاب المصلحة بتغير المناخ ودعم الحكومة، مما يؤكد على ضرورة زيادة التزام الحكومة للتعامل مع تأثيرات التغير المناخي على السياحة. كما تسلط الدراسة الضوء على الدور الحاسم للسياسات الحكومية. حيث يؤدي دعم الحكومة إلى التوسط في الارتباط بين وعي أصحاب المصلحة بتغير المناخ والعواقب السلبية لأنشطة السياحة. تعمل استراتيجيات التكيف على التعديل على العلاقة بين دعم الحكومة والآثار الضارة لتغير المناخ على الأنشطة السياحية الساحلية ورياضة ركوب الأمواج. لوحظت تباينات موسمية في تأثيرات التعديل هذه، حيث أثر موسم الخريف بشكل أكبر على الأنشطة السياحية الساحلية وموسم الشتاء على رياضة ركوب الأمواج. يؤكد هذا البحث على ضرورة رفع الوعي العام حول تغير المناخ والدعوة إلى تعزيز الدعم الحكومي واعتماد آليات تكيف فعالة للتخفيف من الآثار الضارة على الأنشطة السياحية. يتطلب الترويج للممارسات المستدامة والبنية التحتية المتينة للمناخ تعاونًا بين السلطات الحكومية والمنظمات السياحية والمجتمعات المحلية.