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The Impact of Climate Change on International Tourism: Evidence from Egypt

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ABSTRACT

The tourism industry is one of the most important sectors that contributes to global growth. Climate change can have a significant impact on tourism since it requires appropriate weather conditions and a clean environment. Given the close relationship between climate change and tourism, the current study aims to investigate the impact of climate change on international tourism in Egypt from 1990 to 2020. This study aims to supplement the literature on tourism and environmental quality. The autoregressive distributed lag (ARDL) model used in this study to investigate both short and long-run estimates at the same time. Climate change was measured using changes in precipitation, carbon dioxide emissions, and temperature, with gross capital formation (% of GDP) and arable land (% of land area) serving as control variables. The results show that two climate variables (precipitation rate and temperature) have a positive impact but are not significant in the short and long run-on international tourism revenue. Furthermore, carbon dioxide emissions have a long-term negative impact on international tourism revenues.

Keywords: Climate Change, CO_2 Emissions, ARDL, International Tourism
JEL Classifications: Q54, Z32, P48

1. INTRODUCTION

Climate change is a critical challenge of our time. According to the Intergovernmental Panel on Climate Change, projected climate change will fundamentally reshape ecosystems and affect global development and well-being prospects (IPCC, 2022). Climate change, defined as the systematic alteration of climatic patterns and weather phenomena caused by human activities such as significant greenhouse gas (GHG) emissions and deforestation (Scott and Gössling, 2022). The observed warming in the global climate system is unequivocal. Temperatures have risen by 0.74°C on average over the last century, with the northern hemisphere warming faster than the southern hemisphere. Sea levels have risen by an average of 1.8 mm per year since 1961 and 3.1 mm per year since 1993, due to the thermal expansion of the oceans, permafrost melting, and the shrinking of polar ice sheets (Pachauri and Reisinger, 2008).

Since the pre-industrial era (1850-1900), human influence on climate systems has resulted in a 1.2°C increase in global temperature (IPCC, 2021). The record heatwave in western Canada and the United States, intensified forest fires from Canada to Greece to Siberia, drought in Brazil, and deadly floods in China and Germany all confirm this. According to (Callaghan et al., 2021), more than 85% of the world's population has already been subjected to extreme weather events exacerbated by climate change. (Munich Re, 2013) stated that climate change was responsible for 87% of natural disasters that occurred between 1980 and 2012. The study estimated 2.8 trillion dollars in economic losses. Other estimates place the economic costs of climate change at around 1 trillion dollars per year by 2050 (Hallegatte et al., 2013).

Climate change affects many economic sectors, including agriculture, labor, health, and national economic growth, as well as the tourism industry. This due to the fact that tourism necessitates a clean environment and favourable weather conditions in order for tourists to be satisfied (Atasoy and Atasoy, 2020). There is widespread evidence that changing climate conditions have profound effects on natural and human ecosystems, mountainous areas, and coastal environments, including marine systems such as coral reefs. As a result, it can be stated that this industry is highly vulnerable to climate change (Becken and Hay, 2012).

In the last five decades, the tourism sector has grown rapidly around the world, contributing to the accumulation of global GDP due to its leading role in promoting economic growth, job creation, poverty reduction, and inflation. Tourism has surpassed agriculture as the most important source of income in many countries around the world (Liu et al., 2019). As a result, the tourism sector is also seen as a boost to annual income because it generates many job opportunities in the tourism-related services sector, such as taxis, cruise ships, airlines, hospitality services, and entertainment venues, which leads to the growth of these industries, which is reflected in higher income levels in the host country (Sharif et al., 2017). Aside from being a significant source of foreign currency (Palmer and Riera, 2003), several studies have shown that tourism promotion benefits both developed and developing countries' economic development (Cortes-Jimenez and Pulina, 2010; Tang, 2011; Tang and Abosedra, 2014).

Despite this, the COVID-19 epidemic has had a huge impact on one of the world's largest economic sectors—the tourism industry. The World Travel and Tourism Council (WTTC) estimates that the tourism industry lost roughly 4.5 million dollars in 2020. Due to limits on transportation, its contribution to the world's GDP fell from 10.4% in 2019 to 5.5% in 2020. (WTTC, 2022). Given the considerable negative effects of climate change, such as temperature increases, changes in humidity, floods, droughts, and unpredictable weather conditions, climate change and its effects on tourism are long-lasting as opposed to a pandemic, which will swiftly wear off over time (Atasoy and Atasoy, 2020). Climate change has an impact on the international tourism movement because it reduces the attractiveness of many tourist destinations. For example, the demand for ski resorts will decrease due to the high temperatures that will affect the ice. Aside from the high sea level, which exposes beaches to drowning and causes coasts to disappear, natural attractions such as coral reefs and cultural attractions will also be affected (Conrady and Bakan, 2008). Furthermore, climate change will make it more difficult for tourists to reach their desired destinations due to higher transportation costs, which will rise due to fuel shortages and increased demand for tourism services (Gössling et al., 2012).

Tourism and climate change have a mutual relationship; tourism is a major contributor to the environmental problem. in 2005, the tourism sector's contribution to greenhouse gas emissions responsible for climate change was estimated to be (5.2-12.5%) (Scott et al., 2010). Although air travel accounts for only 17% of all tourist trips, it is responsible for 40% of all tourism-related emissions (Duffy and Stroebel, 2015). As a result, it said that while tourism can help the economy grow, its negative impact on environmental quality is also visible in the economy. Although tourism has significantly boosted economies, it also comes at a cost to people in the form of declining environmental quality (Beeton, 2006; Holden, 2016).

Tourism is an important source of national income in Egypt, but it is also one of the sectors most affected by the current global crisis Covid19, the tourism and travel sector's contribution to GDP fell from 8.5% in 2019 to 4.3% in 2020 before rising to 5.1% in 2021 (WTTC, 2022). Tourist arrivals in 2020-2021 reported roughly 4 million visitors compared to 9.24 million visitors in 2019, indicating a dramatic fall in the number of tourists by 56.7% from the prior year. A similar decline also was seen in tourism revenues, which dropped from 9.85 billion dollars in 2019-2020 to $4.86 billion in 2020-2021 (Ministry of Planning and Economic Development, 2022). These findings show that, despite the industry's recent start to rebound, which is progressing slowly, the tourism sector is the one most negatively impacted by the effects of the COVID-19 epidemic.

Egypt is highly vulnerable to the impacts of climate change. According to the Intergovernmental Panel on Climate Change (IPCC), the Nile Delta in Egypt is one of the world's three "extreme vulnerability hotspots" (IPCC, 2001). Sea level rise, water scarcity and deficit, and an increase in the frequency and severity of extreme weather events, including heat waves, flash floods, heavy rains, and sand and dust storms, are all predicted to be effects of climate change that Egypt may experience in the future (Ali and El-Magd, 2016). The coastal governorates of Alexandria, Port Said, Al Buhaira, and Kafr El Sheikh, together with other wetlands in Berlus and Manzala, will be the most susceptible areas in Egypt. Additionally, there are signs that between 2040 and 2050, the coastal cities of Damietta, Ras al-Birr, and Gamasa, as well as the regions near Lake Berlus, Lake Manzala, and Lake Bardawil, would flood. Because of the area's irregular topography, it was expected that the coastal region between Damietta and Rasheed would break up into different islands surrounded by water in all directions. Sea levels are expected to rise by up to 100 cm by 2100. (EEAA, 2016).

The study's significance stems from the fact that, while important for each of the travel and tourism industry, and given the high reliance of tourism on climate factors, other sectors with a lower economic weight have dominated the literature on the economic impacts of climate change, such as agriculture, which is estimated to account for 4.3% of global GDP (WBG, 2022), while the tourism and travel industry accounts for 6.1% of global GDP (WTTC, 2022). This can also be seen in the subsequent publications of the Intergovernmental Panel on Climate Change (IPCC), where tourism was only included in the most recent Fourth Assessment Report (IPCC, 2007). Due to the lack of research on the effects of climate change on the Egyptian tourist sector, this study complements prior literature by offering new data about the relationship between tourism and the environment, specifically in the instance of Egypt.

Hence, this study aimed to investigate the impact of climate change on international tourism in Egypt. For this purpose, this study has been divided into four sections: Section (I) introduction and literature review; section (II): data and methodology. Section (III): Empirical Results and Conclusions.

2. LITERATURE REVIEW

Since the turn of the century, the absence of literature on climate change and its relationship to the tourism sector has been linked to the removal of climate variables from tourism demand models (Goh, 2012). (Crouch, 1994) discovered that only a small number of scientific studies have included some climate variables as determinants in tourism demand models. According to the literature review conducted by (Witt and Witt, 1995), a meaningful explanation for this disregard is the interest of researchers in economic factors such as income and price elasticity as a means of achieving accurate forecasts of tourism demand, in addition to the uncertainty and complexity of expected responses to tourism demand (Rosselló-Nadal, 2014). This explains why time-series models are so popular.

Although climate determinants were previously ignored in tourism demand modelling, the incorporation of climate variables such as temperature, rainfall, wind, greenhouse gas emissions, and energy consumption into tourism demand models has recently become more common. Because estimation techniques typically require the isolation of each determinant, it is possible to assess the marginal contribution of climatic factors to tourism demand while the other variables remain constant. As a result, over the last 15 years, numerous quantitative studies have attempted to assess the impacts of climate change on tourism using various methodologies and perspectives. (Agnew and Palutikof, 2006; Álvarez-Díaz and Rosselló-Nadal, 2008; Amelung et al., 2007; Song and Li, 2008).

According to the various means and techniques through which climate affects tourism, studies on climate change and tourism divided into three categories:

a. Assessing the effects of climate change on the physical conditions required for tourism, according to this trend, the change in the depth of snow cover is a direct result of climate change, and the financial viability of winter tourism thus depends on favorable snow conditions. These studies are based on an evaluation of the material conditions that enable tourism in these areas for a specific activity, which is the provision of tourism services to a specific market segment (Koenig and Abegg, 1997; Harrison et al., 1999; Elsasser and Messrli, 2001; Scott et al., 2001)
b. Using climate indicators to compare the attractiveness of tourist destinations under different scenarios of climate change, this trend has been implemented in a number of studies, such as (Rotmans et al., 1994; Moreno and Amelung, 2009; Amelung et al., 2007; Scott et al, 2004, Amelung and Viner, 2006)
c. The third type focuses on modelling tourism demand with climate determinants included in the assessment of tourism demand. Agnew and Palutikof, 2001; Loomis and Crespi, 1999; Maddison, 2001; Lise and Tol, 2002; Hamilton, 2003; Englin and Moeltner, 2004; Richardson and Loomis, 2004. It is important to note that the analysis in this approach focuses on tourists rather than physical conditions. Three main approaches were used to model tourism demand: time series analysis (Rosselló-Nadal et al., 2011; Kulendran and Dwyer, 2012); discrete choice modelling (Eugenio-Martin and Campos-Soria, 2010; Bujosa and Rosselló, 2013); and aggregate tourism demand models (Hamilton et al. 2005a; 2005b; Rosselló and Santana, 2012; Hamilton and Tol, 2007).

Despite the various methodologies used by previous studies to determine the impact of climate change on the tourism sector, the majority of studies in this regard have reached nearly identical conclusions regarding the negative impact of climate change on the sector. According to (Wall and Badke, 1994), climate change has an impact on many aspects of tourism operations, including water supply and quality, heating and cooling costs, snowmaking requirements, irrigation needs, pest management, evacuations, and temporary closures. According to (Boniface et al., 2020) climate is one of the most important factors influencing global tourism flows.

To study tourism demand, Scott et al. (2006) identified several climate variables that can affect tourism, such as rain, wind, temperature, and greenhouse gas emissions. Regarding the temperature variable, some researchers argue that rising temperatures can benefit the tourism industry by extending the warm season (Seetanah and Fauzel, 2018). Others claimed that rising temperatures would harm the tourism industry. In this context, Sookram (2009) confirmed the negative effect of temperature and rainfall variables on tourist arrivals on a sample of Caribbean islands from 1989 to 2007. Koenig and Abegg (1997) believe that a 2°C increase in temperature will have serious implications for the growth of Switzerland's tourism sector, particularly snow-dependent tourism. As predicted by Nunes et al. (2013), a projected decline in annual tourism flows in the Tuscany region of Italy (estimated at 13-17% by 2050) as a result of climate change, Lise and Tol (2002) discovered that global warming would have a devastating impact on the tourism industry in OECD countries.

Several studies in this field, on the other hand, have focused on studying the dynamic relationship between energy consumption, carbon dioxide emissions "as one of the variables expressing climate change," and the tourism sector, where carbon dioxide, a major greenhouse gas, is the single largest contributor to environmental pollution and climate change caused by human activity. (Butler, 2000) claims that tourists will not return to polluted places if alternative destinations are available. (Tugcu and Topcu, 2018) who investigated the impact of emissions on tourism revenues in the world's ten most important countries, discovered that emissions from oil consumption have a significant negative impact on tourism revenues, whether in the short or long term. The impact of natural gas consumption emissions on tourism revenues is positive and statistically significant. This may appear surprising at first because emissions are expected to have a negative impact regardless of the fuel used, but it makes sense that natural gas consumption has lower gas emissions than other fossil fuels. As a result, most countries regard natural gas as a relatively benign fossil fuel that is expected to play an important role in meeting emission reduction targets. (Jayasinghe and Selvanathan, 2021) investigate the relationship between India's energy consumption, CO_2 emissions, GDP, and international tourist arrivals. The findings show that energy consumption and tourism both contribute positively to CO_2 emissions. The study also discovered long-run unidirectional causality from energy consumption, GDP, and tourist arrivals to CO_2 emissions.

On the other hand, tourism is frequently cited as an important driver of environmental degradation around the world because it is an energy-intensive industry and a major global source of greenhouse gases (Becken et al., 2003; Gössling, 2013). As a result, some empirical studies have been conducted to assess the economic impact of tourism-related variables on CO_2 emissions.

Lenzen et al. (2018) measured global tourism-related carbon flows and carbon footprints among 160 countries and discovered that between 2009 and 2013, the global carbon footprint of tourism increased fourfold over previous estimates, accounting for approximately 8% of total GHG emissions. Solarin (2014) investigated the determinants of CO_2 emissions in Malaysia, with a particular focus on tourism development during the period 1972-2010. The study's findings revealed a long-term positive one-way causal relationship ranging from tourist arrivals to CO_2 emissions. The same conclusion was reached by Sharif et al. (2017) study, which investigated the relationship between emissions and the growth of tourist arrivals in Pakistan from 1972 to 2013, and (Durbarry and Seetanah, 2015) study, which analyzed the dynamic relationship between tourism development and environmental degradation using time-series data from 1978 to 2011 for the case of Mauritius. Their findings revealed that tourism is associated with increased CO_2 emissions and that environmental degradation may be associated with reduced tourism access.

(Katircioglu, 2014) conducted a study on a popular tourist destination in Turkey that receives 30 million visitors per year. The study discovered evidence of a long-term equilibrium between tourism, carbon dioxide, and energy consumption in Turkey and found that a 1% increase in the number of tourists visiting Turkey results in a 0.1 increase in emissions in the long run. In another tourist destination, (Katircioglu et al., 2014) discovered that there is cointegration between CO_2 emissions, energy consumption, and tourism in Cyprus and that a 1% increase in arrivals increases emissions by 0.03%. Furthermore, there is a one-way causal relationship in the short term from emissions to incoming tourism, whereas the causal relationship from tourist arrivals extends to CO_2 emissions in the long run.

According to (Solarin, 2014 and Al-Mulali et al., 2015), tourism and CO_2 emissions have a one-way causal relationship. (Atasoy and Atasoy, 2020) investigate the causality and long-term relationship between climate change and the Turkish tourism industry. The findings show that climate change has a negative and significant impact on the tourism industry. In contrast to previous research, the study of (Liu et al., 2019), which investigated the relationship between CO_2 emissions and tourism revenues in Pakistan, concluded that international tourism in Pakistan is environmentally sustainable, which means that tourism in Pakistan is environmentally friendly and tourism-related activities do not degrade environmental quality.

Despite the scarcity of studies on the impact of climate change in its various dimensions on the Egyptian tourism sector, the United Nations Development Program issued a report in 2013 on the potential effects of climate change on the Egyptian economy. The report forecasted the effects of climate change from 2030 to 2060. According to the study, Egypt's tourism industry is one of the most vulnerable to climate change. On the one hand, the anticipated temperature increase will result in the transformation of tourist attractions to the most appropriate temperatures (which will often be closest to the northern part of the globe). The report predicted a 20% decrease in annual tourist arrivals for the year 2060, which would reduce tourism revenues by (13-17) billion pounds annually. The other effect is linked to the extent of coral reef degradation caused by high temperatures. The report estimated that tourism losses would be around 19 billion pounds in 2030 and 85 billion pounds in 2060 (Smith et al., 2013).

Based on the foregoing, a summary of the existing literature suggests that studies investigating the impact of climate change on tourism are relatively limited, as are the methods used in these studies. However, no attempt was made to date to compile these findings in order to identify a systematic pattern for the development of some general principles. All of this suggests that the topic of climate change and tourism does not appear to be a high priority on the academic research agenda. As a result, this study attempts to investigate the extent to which climate change affects international tourism in Egypt.

The study's novelty stems from its distinction from previous research. Unlike most previous studies that described emissions as a function of tourism activities, this study models international tourism revenues as a function of climate variables such as carbon dioxide emissions. Furthermore, unlike previous studies that concentrated solely on CO_2 emissions, this one incorporates more than one variable to represent climate change (temperature, precipitation, and CO_2 emissions).

3. METHODOLOGY AND EMPIRICAL ANALYSIS

3.1. Data and Variables

The study relied on the theoretical aspect of previous studies when selecting variables and the availability of annual time series data during the study period to determine the impact of climatic changes on international tourism in Egypt. Although these variables differ from one study to another, the study of chosen according to the goal of being included in the form as shown in Table 1:

3.2. The Empirical Model

According to previous research, the following framework used to investigate the impact of climate change on international tourism:

$$RCPT_t = f(CO2_t, Prec_t, Tas_t, GDI_t, Land_t) \tag{1}$$

The formula for the equation can written in the following way:

$$lRCPT_t = \beta 0 + \beta 1 lCO2_t + \beta 2 lPrec_t + \beta 3 lTas_t + \beta 54 lGDI_t + \beta 5 llAND + \varepsilon t \tag{2}$$

Random Error Limit ε_t is inserted into the equation due to the probabilistic nature of the model.

3.2.1. Analysis method

The study used an autoregressive distributed lag (ARDL) model to investigate both the short- and long-term relationships between climate change and international tourism. The ARDL technique of cointegration was established by (Pesaran and Pesaran, 1997) and (Pesaran and Shin, 1999). The ARDL method has several advantages over other cointegration methods, including the ability of the model to separate the long-term effects from the short-term effects. Through this methodology, it is possible to determine the complementary relationship between the interpreted and dependent variables in the long and short term in one equation, which makes it easier to estimate and interpret its results. In addition to determining the strength of the effect of each of the interpreted variables on the dependent variable, the ARDL can be used regardless of whether the underlying variables are purely I(0), I(1), or mutually co-integrated (Pesaran and Shin, 1999). So the present study employs the ARDL methodology developed by Pesaran et al. (2001) due to its accuracy in predicting whether the variables are stationary at zero degree I(0), one degree I(1), or a combination thereof.

3.3. Empirical Results

3.3.1. 1-unit root test (Philips Perron test) PP

Unit root tests are one of the most important methods for testing the stability of time series, as they determine whether the time series of the variable is stable at its level or not. Augmented Dickey Fuller (ADF) and Phillip Perron (PP) unit root tests were adopted to investigate the stationary importance for long-term connections of time series data. However, the Philip Perron test is more accurate than the Augmented Dicky-Fuller test (ADF), especially when the sample size is small. As a result, if the results of the two tests disagree, it is preferable to rely on the "Philip Perron" test. Phillip Perron (PP) unit root tests Refer to investigate the stationary importance for long-term connections of time series data. The coefficients of this test are calculated using t-statistics (Phillips and Perron, 1988). PP unit root test based on the equation given below:

$$\Delta Y_t = \alpha + \rho x Y_{t-1} + \varepsilon_t \quad (3)$$

The results of the Philips Byron (PP) test are reported in Table (2), The results show that the variables are stationary at level I (0), and the first difference I (1). as indicated by the calculated tau value, which was greater than the tabular values at a significant level (1%, 5%, 10%), indicating that the variables are stationary at level I (0) and the first difference I (1).

3.4. 2- ARDL Framework

3.4.1. Optimal Lag-length selection

Table 3 shows the results of lag selection. The number of optimal lags (1) is calculated using the Akaike information criterion (AIC) and SC.

The AIC concluded that the optimal number that eliminates the model from the autocorrelation problem is (2, 1, 0, 1, 2, 2), as

Table 1: Data and variables

Variables	Indicator	Abbreviation	Source of data
International tourism	International tourism, revenues (% of total exports)	RCPT	World bank data base
CO_2 emissions	CO_2 emissions	CO_2	World bank data base
Precipitation	Annual rainfall	Prec	World bank data base
Temperatures	Average annual temperatures	Tas	World bank data base
Gross capital formation	Gross capital formation (% of GDP)	GDI	World bank data base
Arable land	Arable land (% of land area)	Land	World bank data base

Source: world Bank data base

Table 2: Phillips-Perron test result (PP)

Variables	Level	Tau	Tabulated value at 1%	Tabulated value at 5%	Tabulated value at 10%
	At level	−2.6390*	−3.6702	−2.9639	−2.621
RCPT	First difference	−6.9506***	−3.6793	−2.9677	−2.6229
	At level	−0.2654	−3.6702	−2.9639	−2.621
CO_2	First difference	−5.6254***	−3.6793	−2.9677	−2.6229
	At level	−4.4517***	−3.6702	−2.9639	−2.621
Prec	First difference	−15.6434***	−3.6793	−2.9677	−2.6229
	At level	−3.6756***	−3.6702	−2.9639	−2.621
Tas	First difference	−20.2528***	−3.6793	−2.9677	−2.6229
	At level	−3.5458***	−3.6702	−2.9639	−2.621
	First difference	−5.4684***	−3.6793	−2.9677	−2.6229
	At level	−3.4408**	−3.6702	−2.9639	−2.621
Land	First difference	−7.2260***	−3.6793	−2.9677	−2.6229

(*) stationary at 10% significance level, (**) stationary at 5% significance level, (***) stationary at 1% significance level

Table 3: Lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	145.9996	NA	2.08e-13	−12.17388	−11.87766	−12.09938
1	225.3960	110.4645*	5.38e-15*	−15.94748*	−13.87396*	−15.42599*

Source: Author's estimation

Table 4: ARDL model estimation results

Dependent Variable: LRCPT				
Method: ARDL				
Sample (adjusted): 1990 2020				
Selected Model: ARDL (2, 1, 0, 1, 2, 2)				
Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**Prob.***
LRCPT (−1)	−0.573587	0.231856	−2.473890	0.0385
LRCPT (−2)	−0.261668	0.165212	−1.583830	0.1519
LCO2	0.835121	1.139187	0.733085	0.4844
LCO2(−1)	−1.412427	1.187744	−1.189168	0.2685
LPRECIPITATION	0.433108	0.306197	1.414473	0.1949
LTASMEAN	2.597609	2.106128	1.233358	0.2524
LTASMEAN (−1)	4.090822	2.984568	1.370658	0.2077
LGDITOTL	1.375079	0.585977	2.346641	0.0469
LGDITOTL (−1)	−0.092177	0.691121	−0.133374	0.8972
LGDITOTL (−2)	1.614649	0.547698	2.948065	0.0185
LLAND	1.040067	0.832629	1.249136	0.2469
LLAND (−1)	−1.113503	0.993885	−1.120354	0.2951
LLAND (−2)	2.390736	1.015350	2.354594	0.0463
C	−11.57724	13.78166	−0.840047	0.4253
R−squared	0.891367	Mean dependent var		−1.510223
Adjusted R−squared	0.714839	S.D. dependent var		0.245104
S.E. of regression	0.130887	Akaike info criterion		−0.967844
Sum squared resid	0.137050	Schwarz criterion		−0.273545
Log likelihood	24.64629	Hannan-Quinn criter.		−0.804288
F-statistic	5.049437	Durbin-Watson stat		2.580916
Prob (F-statistic)	0.013921			

Source: Author's estimation

shown in Table 4.

The regression equation test results in Table 4 show the relative quality of the estimated statistical model. This is accomplished through the relatively high value of the adjusted coefficient of determination $R^2 = 0.71$, which indicates that the model explains approximately 71% of changes in international tourism and that the results of the relationship are not spurious.

This is demonstrated by the fact that the Durbin-Watson DW = 2.58 value is greater than the coefficient of determination R2. In addition, the F statistic indicates that the model is significant at a level below 5%, so the model can be relied upon in economic analysis.

3.4.2. Residual series (ECT) stationary test

Since the time series of the study variables are stationary at the level and first difference, so to estimate the model, the stationary of the series of residuals at the level must be studied by Dickie-Fuller test (ADF).

The results in Table 5 indicate that the residual series of the model variables are stationary at the level, and thus the study model can be estimated.

3.4.3. ARDL bounds cointegration test

To test the cointegration relationship between the variables of the study, the method presented by Pesaran et al. (2001) can be used to test the extent to which the equilibrium relationship between variables is achieved under the error correction model (ECM). This method known as the "bounds test approach." Therefore, we can use the ARDL bounds test of cointegration to examine the long-run relationship between the series because the variables are stationary at the first difference based on the results of the unit root tests. According to this method, the model takes the following form:

$$\begin{aligned}\Delta RCPT_t &= \alpha_0 + \sum \propto_1 \Delta RCPT_{t-i} + \sum \propto_2 \Delta CO2_{t-i} \\ &+ \sum \propto_3 \Delta PREC_{t-i} + \sum \propto_4 \Delta TAS_{t-i} + \sum \propto_5 \Delta GDI_{t-i} \\ &+ \sum \propto_6 \Delta LAND_{t-i}\, \varphi ECT_{t-1} + \beta_1 RCPT_{t-1} + \beta_2 CO2_{t-1} \\ &+ \beta_3 PREC_{t-1} + \beta_4 TAS_{t-1} + \beta_5 GDI_{t-1} + \beta_6 LAND_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

Where Δ is First Difference, $\propto_0$ is Intercept, $\propto_1$: $\propto_6$ Short term parameters, β_1: β_6 Long term parameters, φ Error Correction Term, ε_t residuals.

Equation No. (4) can be divided into two equations as follows:

The first equation: represents short-term information, which is also called the error correction model and takes the following form:

$$\begin{aligned}\Delta RCPT_t &= \alpha_0 + \sum \propto_1 \Delta RCPT_{t-i} + \sum \propto_2 \Delta CO2_{t-i} \\ &+ \sum \propto_3 \Delta PREC_{t-i} + \sum \propto_4 \Delta TAS_{t-i} + \sum \propto_5 \Delta GDI_{t-i} \\ &+ \sum \propto_6 \Delta LAND_{t-i}\, \varphi ECT_{t-1} + \varepsilon_t \end{aligned} \quad (5)$$

The second equation represents long-term information and takes the following form:

$$\Delta RCPT_t = \beta_1 RCPT_{t-1} + \beta_2 CO2_{t-1} + \beta_3 PREC_{t-1} + \beta_4 TAS_{t-1} + \beta_5 GDI_{t-1} + \beta_6 LAND_{t-1} + \varepsilon_t \quad (6)$$

Table 6 sums up the results of the ARDL bounds testing. The calculated F-statistics are 8.052331, which exceed the lower bound tabulated value of 3.41 as well as the upper bound critical value of 4.68. Our findings indicate that there is a long-run relationship between international tourism and other independent variables.

3.5. Results of Autoregressive Distributed Lagged Long Run

After determining the presence of cointegration between the variables, the short- and long-run coefficients of the variables must be estimated. The ARDL model can perform both short-run and long-run estimates of the variables at the same time. The long-run result of ARDL (Table 7) demonstrates that there is a strong and significant inverse relationship in the long run between international tourism and carbon dioxide emissions, as well as a strong and significant positive relationship between international tourism and each of the following variables (gross capital formation, percentage of arable land). In addition, there is a positive but not strong relationship between average temperatures, rainfall, and international tourism on the other hand, but this relationship is not very significant, in the sense that there is a relationship, but it is rather weak and unclear.

3.6. Results of Autoregressive Distributed Lagged Short Run and Error Correction Model

Table 8 shows that the error correction coefficient takes a negative signal, which is a statistically significant signal at a significant level less than (1%), and its value was (1.835255), confirming that the macroeconomic system corrects short-term imbalances in the independent variables from the previous year to the current year at a rate of (183.52%) to achieve long-run equilibrium. The value (−1.835255) indicates that it takes approximately 0.544 years (1/1. 1978 = 0.544) for the economic system to return to equilibrium. However, the short-term coefficients of independent variables (average annual temperatures, gross capital formation, and the percentage of arable land) were all significant, indicating a short-term correlation between the international tourism index and these independent variables. A short-term relationship exists between carbon dioxide emissions and foreign tourism, but it is insignificant.

Finally, the short-run test reveals that the correlation coefficient (R2), estimated at 0.84, represents 84% of changes in overseas tourism calculated by combining changes in independent variables.

Table 5: Results of the residual stationary test

Variable	TAU	Level	PROB
ECT	−***5.966734	Level	0.0001
	−6.997400***	First Difference	0

(*) stationary at 10% significance level, (**) stationary at 5% significance level, (***) stationary at 1% significance level

Table 6: Bounds test results

Test statistic	Value	K
F.Statistic	8.052331	5
	Critical Value Bonds	
Significance	1 (0) Bound	1 (1) Bound
10%	2.26	3.35
5%	2.62	3.79
2.50%	2.96	4.18
1%	3.41	4.68

Source: Author's estimation

Table 7: ARDL long-run coefficients

Long run coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCO2	−0.314565	0.162814	−1.932045	0.0894
LPRECIPITATION	0.235993	0.161651	1.459895	0.1824
LTASMEAN	3.644415	2.160589	1.686769	0.1301
LGDITOTL	1.578827	0.303928	5.194733	0.0008
LLAND	1.262658	0.625800	2.017669	0.0783

Source: Author's estimation

3.6.1. 3- Diagnostics tests

After researching and analysing long-term and short-term relationships, it is necessary to run some diagnostic tests to ensure that the model is predictable and does not have any fundamental flaws that render its results unreliable.

i. Autoregressive conditional Heteroskedasticity (ARCH)

The results in Table 9 show that the value of the (F statistic) is equal to (0.977553) with a probability of (0.3352), which is greater than the level of significance (5%), and thus the null hypothesis cannot be rejected (that there is heteroskedasticity between the residuals).

ii. Breusch -Godfrey serial correlation LM test:

Table 10 reveals a value (F statistic) of 1.252671 with a probability of 0.3511, which is greater than the level of significance (5%), indicating that there is no autocorrelation between the residuals.

iii. Normality distribution

Figure 1 revealed that the value of Jarque-Bera was 0.3590 and the probability (Prob = 0.83) was greater than the level of significance (5%). As a result, the null hypothesis that the residuals follow the normal distribution is accepted.

iv. Stability of short run model (CUSM-CUSM square test)

According to (Brown et al., 1975), these two tests are regarded as the most critical stability tests for clarifying structural changes in the data under study and determining the consistency of the long-term and short-term parameters. According to the CUSUM Test and the CUSUM of Squares Test, we discover that structural stability of the estimated model's parameters is achieved if the graph falls within the critical limits at a significant level (5%). The results of the tests are denoted in figures 2 and 3, respectively. The figures show that the estimated model was structurally stable during the study period.

v. Predictive Capacity Test of the Unrestricted Error Correction Model

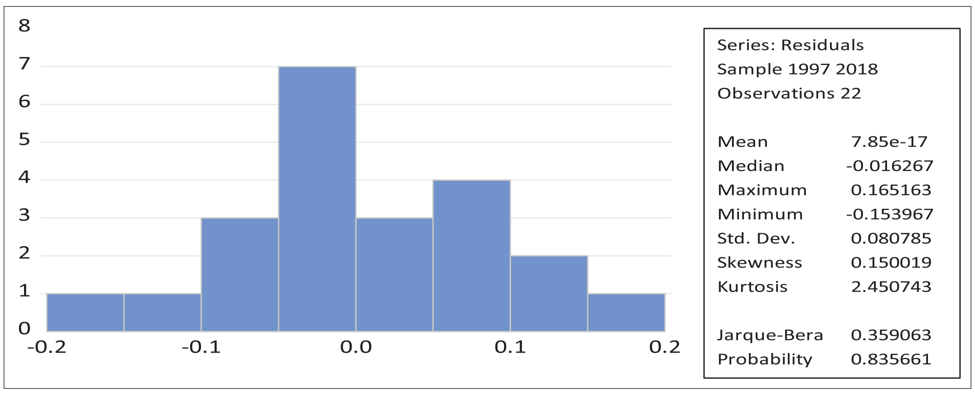
The Theil Inequality Coefficient is used, and its value is around 0.034, which is very close to zero and reflects the model's ability to predict, as shown in Figure 4.

Table 8: Estimating short-run relationship and error correction model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−11.57724	1.307322	−8.855692	0.0000
D (LRCPT (−1))	0.261668	0.118324	2.211463	0.0579
D (LCO2)	0.835121	0.812773	1.027495	0.3342
D (LTASMEAN)	2.597609	1.110985	2.338114	0.0476
D (LGDITOTL)	1.375079	0.360456	3.814828	0.0051
D (LGDITOTL (−1))	−1.614649	0.360451	−4.479530	0.0021
D (LLAND)	1.040067	0.501792	2.072704	0.0719
D (LLAND (−1))	−2.390736	0.613812	−3.894897	0.0046
CointEq (−1)*	−1.835255	0.207125	−8.860600	0.0000
R-squared	0.901099	Mean dependent var		−0.001616
Adjusted R-squared	0.840237	S.D. dependent var		0.256880
S.E. of regression	0.102676	Akaike info criterion		−1.422390
Sum squared resid	0.137050	Schwarz criterion		−0.976054
Log likelihood	24.64629	Hannan-Quinn criter.		−1.317247
F-statistic	14.80556	Durbin-Watson stat		2.580916
Prob (F-statistic)	0.000023			

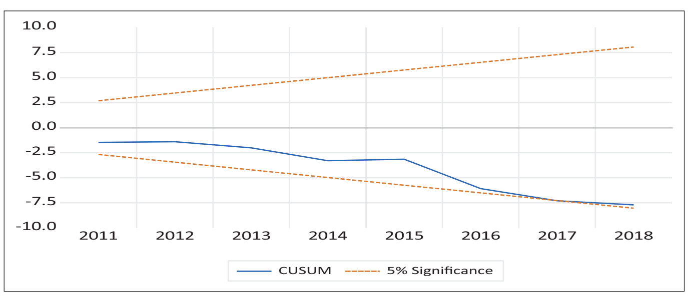
Source: Author's estimation

Figure 1: Normal distribution



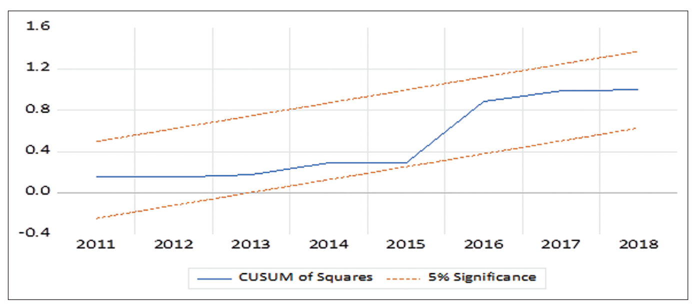
Source: Data generated using Eviews12

Figure 2: (CUSUM) plot



Source: Data generated using Eviews12

Figure 3: Plot of (CUSUM of Squares)



Source: Data generated using Eviews12

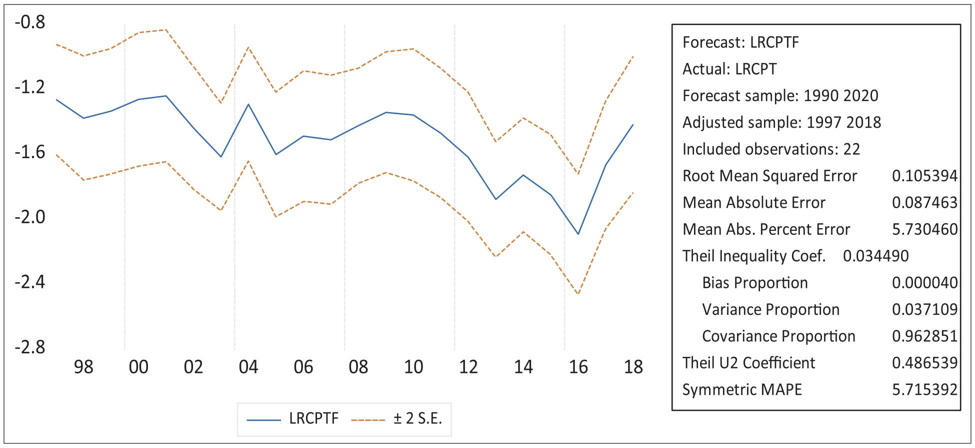
Based on the previous results, the estimated model is free of the most prominent problems that impede the model's proper functioning, implying that the results can be relied on to estimate and be used in forecasting and policymaking.

4. DISCUSSION AND CONCLUSION

Using autoregressive distributed lag (ARDL), this study attempted to examine the impact of climate change on international tourism in the Arab Republic of Egypt from 1990 to 2020. The results indicate the model's overall significance, which supported by statistics (the F statistic) at a level of 5% significance, indicating that the model can be relied on in economic analysis.

The study's findings suggest that there is a cointegration relationship between climate change indicators and international tourism within the study model, implying that environmental changes have an impact on international tourism revenues. The analysis concluded with the expected results in terms of controlled variables, where gross capital formation is one of the most important macroeconomic indicators. Because it has a strong influence on GDP and is affected by it, and many studies have proven that there is a long-term direct relationship between GDP and gross capital formation (Ugochukwu and Chinyere, 2013;

Figure 4: Predictive capability test of unrestricted error correction model



Source: Data generated using Eviews12

Table 9: (ARCH) test

Heteroskedasticity test: ARCH			
F-statistic	0.977556	Prob. F (1,19)	0.3352
Obs*R-squared	1.027587	Prob. Chi-Square (1)	0.3107

Source: Author's estimation

Table 10: LM test results

F-statistic	1.252671	Prob. F (2,6)	0.3511
Obs*R-squared	6.480341	Prob. Chi-Square (2)	0.0392

Source: Author's estimation

Kanu and Ozurumba, 2014). As a result of this relationship, it is reasonable to expect a positive relationship between GDP and arable land (as an investment in infrastructure); so, countries with higher GDPs are better able to provide services such as transportation, lodging, and catering. These countries also have a competitive advantage in marketing and protecting tourist attractions when compared to competitors with lower incomes. Thus, in general, the higher their GDP, the higher their tourism receipts. This conclusion is congruent with the findings of (Nepal et al., 2019 and Alam et al., 2016).

According to the long-term positive relationship between capital formation and tourism, 1% increase in capital formation increases tourism revenues by 1.37%. In Egypt, tourism-related investments accounted for only 0.7% of total capital investments in 2019 and 2020 (Ministry of Planning and Economic Development, 2022). Tourism investments are marginal in terms of relative importance (<1% of total investments) because they are limited to the hotel and restaurant sectors rather than other tourism-related activities. As a result, increased government spending on public infrastructure, such as road networks, as well as foreign direct investment in tourism sectors such as hotels and restaurants, is critical for continued growth in tourist arrivals.

On the other hand, carbon dioxide emissions have a significant negative long-term impact on international tourism revenues, which is consistent with many previous studies (Butler, 2000; Atasoy and Atasoy, 2020; Durbarry and Seetanah, 2015). As a result, the tourism industry is often cited as an indicator of environmental degradation; tourists will not return to contaminated areas if alternative destinations are available at comparable prices.

Energy consumption is the primary link between tourism and environmental quality because it causes greenhouse gas emissions. Given Egypt's energy mix, we find that oil and natural gas already account for 98% of total primary energy consumption in Egypt, compared to 1.5% for hydropower and 0.4% for solar and wind energy (IEA, 2022). As a result, total GHG emissions increased by 31% between 2005 and 2015, with CO_2 emissions accounting for 73% of total emissions. Since 1990, carbon dioxide emissions have increased by 141.93%. (EEAA, 2018; IEA, 2022).

The study also found a positive relationship between temperatures and rainfall in the short and long term. However, the study's findings differ from the findings of most previous studies at this point, which believe that high temperatures can harm the tourism industry (Lise and Tol, 2002; Sokram, 2009). However, it agrees with (Seetanah and Fauzel, 2018), who argue that high temperatures can benefit the tourism industry by extending the warm season. This disparity can be explained by the fact that most studies on the impact of temperature and rain on winter tourism, particularly in Europe (Koenig and Abegg, 1997; Harrison et al. 1999), predict that rising temperatures will have a negative impact on the ice and thus on the tourism industry. As a result of rising temperatures, some countries, particularly those in the Mediterranean, including Egypt, will benefit. Conrady and Bakan (2008) agree, believing that tourist visits to these countries will increase during the spring and winter seasons.

5. CONCLUSION

Climate change will be a challenge for Egypt's economy in the coming decades. Unlike all other factors that may affect the tourism sector and have a short-term impact, such as terrorism or health crises like COVID-19, climate change has a long-term impact on tourism due to its impact on tourist seasons and tourist attractions.

The study's findings revealed a cointegration relationship between the international tourism index and the independent variables within the model, as well as a strong and significant inverse relationship in the long term between international tourism and carbon dioxide emissions. There is also a strong and significant positive relationship between international tourism and both gross capital formation and arable land. There is also a positive but not significant relationship between average temperatures, rainfall, and international tourism, in the sense that there is a relationship, but it is somewhat weak and unclear.

Based on previous findings, it has become necessary to research and develop a national strategy for climate change adaptation. While adaptation to climate change does not always imply preparing for the worst, it can imply a willingness to take advantage of new opportunities. To develop climate adaptation strategies in tourism activities, it is necessary to investigate the future positive and negative consequences of climate change. Although the National Climate Change Council has already been established to develop strategies, policies, and action plans for climate change adaptation and mitigation, the Ministry of Tourism has no official representation in the National Council or the National Climate Change Committee, which is one of the gaps. In addition to the foregoing, coastal management plans must consider the need to protect tourist facilities from rising sea levels to maintain tourist destinations' comparative advantages.

While adaptation actions are expected to increase the tourism sector's resilience to such risks, mitigation actions are also required, specifically to rationalize the use of fossil fuels and reduce carbon dioxide emissions. As a result, the study recommends that the concept of "carbon management" be adopted by imposing a carbon tax on activities that pollute the environment, especially since, according to the experiences of some countries, very high levels of carbon taxes would result in significant changes in emissions. The study also recommends paying more attention to the impact of carbon dioxide emissions in the design of tourism development policies in collaboration with the country's energy planners.

Finally, the findings of this study are consistent with global environmental concerns about the effects of climate change on the tourism industry, with many significant changes expected in the future, as well as many non-climate pressures (such as potential increases in oil prices), It is difficult to provide reliable scenarios for the industry in the medium and long term, and future tourism research will have to delve deeper into politics, geopolitics, and other aspects. This may necessitate new research approaches capable of critically dealing with these highly complex and interconnected issues—or perhaps interdisciplinary research involving the multifaceted nature of industry and the fundamental relationships between human interests, economic values, and environmental values.

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