Climate Change and Tourism
An Egyptian Perspective

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Abstract

In Egypt, tourism industry is one of the main sources of foreign currency earning. Beside the well renowned historic sites in Upper Egypt, Sinai is one of the most important tourists magnets.
Sinai Peninsula, located between the Nile Valley in Africa and West Asia is one of the main heritage sites for Mankind, embracing a number of the most sacred shrines and ecologically - valued landmarks.
St. Katherine Monastery is one of the oldest of all Christian establishments. The original chapel is believed to be established in 330 AD on the site of where Burning Bush had been located. The present Byzantine fortress was constructed in the 6th century to protect the monks from marauders. Other sacred sites include, Sarabit El Khadim, Pelusium, and Ein Guderat and Gebel Moussa (Mountain Sinai), known throughout the world as the mountain where Moses received the Ten Commandments.
The pattern of dominant plant groups varies from mangrove forests to high mountain alpine shrubs. In some parts vegetation is sparse, but there is no vegetation - free desert areas. The vegetative diversity of Sinai, within this high pattern, is great and significant. There is about 1,000 species of which 270 are indigenous and not know in another part of the Egypt**.** Meanwhile, 39 of these species are found nowhere in the world but in Sinai.
Perhaps the most interesting flora and fauna of Sinai are not terrestrial, but aquatic. The coral of Aqaba are justly world famous. Among the large variety of coral growing to great depths along the entire Aqabah coast, and extending beyond Ras Mohamed towards Hurghada, is an even greater variety of fish.
Climate change is expected to have some significant impacts on Sinai environment. Impacts would include the influence of global worm up on coral reefs viability and abundance. Changes in the rate and pattern of precipitation are expected to affect the vegetation cover of Sinai, animal diversity and dominant predation patterns. Special measures should be taken to meet expected changes in order to maintain tourism industry in Sinai.

Introduction

Egypt is located on the north – east corner of the African continent, with a surface area of about one million square kilometres, representing about 3% of Africa (Zahran and Willis 1992).
Egypt has a diverse landscape that its geographical position has provided. Laying at the junction of four biogeographically regions, Saharo – Sindian, Irano – Turanian, Mediterranean and Afrotropical, Egypt has a unique mixture of vegetation types, which support a corresponding diversity of faunal elements (Kassas 1993). The Saharo – Sindian elements are well represented in Egypt's vast deserts, while Mediterranean and Irano – Turanian elements occupy fairly small areas along the Mediterranean cost and the Sinai highlands respectively.
The Nile River is one of the main landscape features of Egypt. The Nile River is the main source for freshwater in the country. The Nile River is a landmark in Egypt topography. On the east side the terrain encompasses mountainous areas, with the highest peaks in the country. While on the west side, the terrain is almost featureless, with prevailing desert land, littered with a number of oases.

Tourism is one of the main foreign currency earners in Egypt, with a significant influence on the balance of payment and employment opportunities. The remarkable wealth of Egypt's archaeological sites is the main magnet for strong appeal of thousands of tourists coming to Egypt from all parts of the globe. Egypt is the home of the 5 sites that are on the United Nations Educational Scientific Culture Organization (UNESCO) list of World Cultural Heritage.
With the growing interest in ecotourism that coincided with the world growing interest in environmental issues, new type of tourism industry has been thriving in Egypt, based on environmentally oriented tourists. In Egypt, it is estimated that around 5 million tourists visit marine protected areas

Sinai and Red Sea, a Sense of History

Egypt enjoys a lavish wealth of coastal shorelines of more than 3500 km, between the Mediterranean Sea and the Red Sea.
The Red Sea splits the two continents of Asia and Africa from the Indian Ocean to the Mediterranean Sea. In Sinai, it splits into the Gulf of Suez and the Gulf of Aqaba, while Sinai is engulfed in between occupying an area of around 60,000 km square. Being a land bridge between Asia and Africa, with close links with Europe, Sinai is a geographically distinguished place.
Sinai is most familiar to many as the "great and terrible wilderness" through which the Israelites wandered for forty years.
Sinai is also known for St Catherine Monastery the oldest continuing monastery on earth. Even after the Muslim conquest, the monks continued to greet pilgrims to the site of the Burning Bush, one of the most sacred shrines to all religions.
On the other hand, Sinai has witnessed a considerable number of historic milestones that include the campaigns of Ramsis 11, Alexander the Great, Napoleon Bonaparte, and again Salah El Dien the well know Arab worrier.

Sinai Environment

Fauna and Flora
Sinaï environment is quite diverse. Because Sinai is contiguous to Africa, Asia and Europe, the range of vertebrates is exceptionally large; and because there are so few of each species, protection is rather crucial. Reptiles and insects are relatively profuse, as they have adapted themselves better to survive long periods of drought.
The pattern of dominant plant groups varies from mangrove forests to high mountain alpine shrubs. In some parts vegetation is sparse, but there is no vegetation - free desert areas. The vegetative diversity of Sinai, within this high pattern, is great and significant. There is about 1,000 species of which 270 are indigenous and not know in another part of the Egypt**.** Meanwhile, 39 of these species are found nowhere in the world but in Sinai (Boulos, 1995)

Coral Reefs
Perhaps the most interesting flora and fauna of Sinai are not terrestrial, but aquatic. The coral of Aqaba are justly world famous. Among the large variety of coral growing to great depths along the entire Aqabah coast, and extending beyond Ras Mohamed towards Hurghada, is an even greater variety of fish.
Coral Reefs are a beautiful and uniquely spectacular phenomenon of our marine world. Known as the Rainforests of the Oceans for their high productivity and biodiversity, they form a habitat for corals, plants, starfish, sponges, sea anemones, sea urchins, seahorses and exotic fish. They create diverse and complex ecosystems and are thought to be a habitat to a quarter of all marine life by providing protection for species and their developing young, and by providing a nutrient ‘oasis’ in an otherwise barren and unproductive environment. Many species found within them are currently unrecorded by science. Environmentally, coral reefs protect the nearby coastal areas from the detrimental effects of storms, floods and consequently erosion by providing a natural breakwater.
The coral reefs of the Egyptian Red Sea are among the most attractive of any in the world and harbour a unique and very diverse fauna. For centuries the coastline and desert landscape were devoid of any larger settlement with only a few Bedouin tribes inhabiting the area. As in many developing countries, the immense economic potential of the promotion of recreational activities such as SCUBA diving and snorkelling was recognized in recent decades and rapid development has given rise to hotels bordering the coastline of the Sinai Peninsula.
Among the hundreds of fish species encountered within the coral are clownfish, butterfly fish, angel fish, parrot fish, lion fish and turkey fish, barracuda, sharks and occasionally manta rays. Among the unique collection of corals in Egypt are the Huge Georgian fans and the rare Black Coral.

Landscape
The landscape of Sinai is quite diverse. Parts of Sinai are hilly, rocky and eroded. About 9 % can be considered as flat, and much of that is deeply eroded. Part of this flat land is intersected with high, walking dunes. The flat coastal plains are subject to storms that sweep in from the sea. The

mountainous interior has a climate of extreme cold winter, hot summers and long periods of wind storms in between.

Sinai Wetlands

Wetlands, as defined by the Ramsar Convention are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine waters the depth of which at low tide does not exceed six meters.

Wetlands are some of Egypt's most important habitats in terms of biodiversity, supporting both the greatest diversity and density of bird species. Most Egyptian wetlands have been degraded drastically within the last 50 years, drained and polluted, over fished and over hunted.

Sinai has some large coastal saline wetlands in the north, including Malaha, Bardawil and Zaranik. It also embraces some salt marches with mangrove in the south. Zaranik is a bottleneck area for migrant Palearctic water birds, while Bardawil is a Ramsar site. Meanwhile, Malaha holds some of the greatest densities and breeding water birds in Egypt.

Avifauna of Sinai

Avifauna is an important component of Egypt's biological resources, indeed it is the most diverse and prominent of all of the country's non – aquatic vertebrate fauna. More than 470 bird species are known from Egypt (Fishpool 1997), compared to 110 species of reptiles and amphibians and about 130 mammals species. Most of the bird species found in Egypt are non – breeding migrants, which pass through the country or spend only the winter and are of Palearctic origin. These wintering and transient bird populations although not resent in Egypt all or most of the time are an important component of the country's biodiversity. Only about 150 species can be considered resident breeding birds, although some of these also migrate further south during the winter.

The majority of international bird areas in Egypt are lying in the eastern portion of the country, largely east of the Nile, and Sinai has the largest number of them (about 13 sites). Sinai embraces Lake Bardawil, a Ramsar site, Zaranik Lake and Mallaha Lake, one of the most important sites for bird watching and a potential magnet for ecotourism industry.

Lake Bardawil is an important site for wintering birds (Meininger and Atta 1994) White breasted Cormorant and Greater Flamingo winter are present in significant numbers. Meanwhile, the importance of Zaranik is primarily as a bottleneck area for migrant Paleearctic waterbirds.

Climate Change and Expected Impacts

Global climate change is one of the most serious problems that face Mankind, with numerous impacts. The effects are expected to be harshest in developing countries, as these countries depend on primary production as a major source of income in terms of loss of life, effect on investment, and effect on economy. Moreover, several reports indicated that in many African countries to view wildlife is a major contributor to gross national product (GNP). Worldwide, ecotourism is estimated to provide US$ 500 billion to 1 trillion annually to the global economy (Munasinghe and McNeely, 1994).

Changes of climate could reduce the population of some of the species people are willing to pay to see (Allen- Diaz, 1996).

A new independent report funded by WWF warned that today degradation of coral reefs threatens the nearly US$ 30 billion in net benefits that these ecosystems provide each year in goods and services to world economies, including tourism, fisheries and coastal protection. The report, The Economics of Worldwide Coral Reef Degradation indicates that coral reef systems long known for their immense biological richness are also crucially important for economic reasons with a global ass's value of nearly US$ 800 billion. However, with almost 60 % of the planet's coral reef systems either permanently lost or at risk of being destroyed during the next 30 years, decrease of vital revenues and loss of jobs and food resources will seriously imperil the lives of millions of people.

According to the study, poverty – stricken developing countries in whose waters the majority of coral reef systems are located will be particularly affected.

Egypt is one of the vulnerable countries to climate change. Low laying land in the Nile delta region is considered to be especially at risk from the effects of any sea level rise resulting from global warming (El Raie et al. 1995).

The impact of global warming up on Egypt is manifested in a variety of influences which includes, water resources, agriculture and food resources and coastal zones.

The coastal zones of Egypt extend for over 3500 km, along the Mediterranean Sea and the Red Sea coasts.

The Mediterranean Sea shoreline is particularly vulnerable to sea level rise because of its relatively low elevation. Several general analyses of the potential impact of sea level rise on the Nile Delta coast have been carried out (Sestini, 1989, El Raie et al., 1995, Stanely et al., 1993).

As a result, areas of high vulnerability in the Nile Delta and possible socio economic impacts have been generally defined. These high risk areas include some coastal cities including Alexandria, Port Said, Matrouh and Lake Bardawil.

Impacts on Corals

Coral reefs are fragile ecosystems - they are thought to be the most sensitive ecosystem to long-term climate change as they can only tolerate a narrow temperature range. Global mean sea-surface temperatures are expected to increase by about 1-2C by the year 2100. An increase in sea temperature could lead to the death of coral by bleaching -when ocean temperatures get too high, corals turn white, or "bleach," and eventually die.

Corals are highly sensitive to climatic influences and appear to be among the most sensitive of all ecosystems to temperature changes, exhibiting the phenomenon know as coral bleaching when stressed by higher than normal temperatures. During bleaching corals loose their symbiotic algae (and Their colour), undergo changes in physiology and in extreme cases die. In 1998, a mass bleaching event of unprecedented global scale occurred and the associated mortality devastating corals and in some cases entire reefs (Wilkinson and Hodgson 1999). Coral bleaching follows positive sea temperature anomalies more than 1oC above long-term monthly averages ("hot spots") during the summer season.

Several reports have illustrated the influence of global warming on water body's recreational opportunities, as a result of warmer climates. Recreational uses of lakes, including bird watching could be affected as lakes become more eutrophic and likely to be degraded by law water clarity and increased blooms of green algae, hence introducing some major changes on bird's habitats.

UV- B radiation can be harmful to freshwater organisms (Bothwell et al., 1994; Williamson and Zagarese, 1994). Absorption of UV- B is lower in clearwater lakes. Reduction of colored DOC entering lakes during greater harm to organisms (Yan et al., 1996).

Climate Change and Egypt's Wetlands

The ecosystem of wetlands in the northern part of Egypt could be severely affected as a result of climate change and related factors. Reduction of Nile flow, an expected consequence of the influence of climate change on the rate of precipitation pattern on the Ethiopian plateau and equatorial lakes such as lake Victoria is bound to affect the velocity of water in Egypt's lakes. Other impacts could include salt water intrusion caused by rising sea level and changes in water salinity, biome, faunal and floral settings and ecological niches necessary for breeding migrant birds.

Impacts on lake Bardawil would include irreversible losses of biodiversity with drastic shifts of biodiversity rich biomes.

On the other hand, rising sea level and intrusion of sea water could inflect some significant damage to some of the distinguished historical sites in many places in Egypt, affecting their management and accessibility.

A scenario of sea level rise of 0.5 m, 1.0 ml, and 2.0 m over the next century was assumed. Analysis for the three scenarios indicates the vulnerability or particular areas and activities in Egypt. The study indicated that if no protection action is taken the agricultural system would be the most affected with some losses amount to 93 %, followed by industry, being affected at a rate of about 65%. The study has rated tourism as the third most affected activity, with impacts of about 55% due to sea level rise of 0.5 m. Studies have also revealed the likelihood of loses of some beaches that attract local holiday makers, creating thousands of employment opportunities.

There is an urgent need for information on the impacts of climate change of biodiversity and on the development of ideas and efforts to deal with these impacts. While there may be some important information already available, much of this remains outside of the public domain, while, further research is clearly still needed.

Tourism is the main foreign currency earner of other activities reported in this study, i.e. agriculture and industry. Reduction of tourism revenue would result in a significant impact on the country's balance of payment and economic performance.

The socio economical repercussions of climate change in Egypt could be massive, including loss of jobs, food security that may lead to some political and civil unrest. The need to address such impacts seems rather imminent.

Future Perspective

Climate change is one of the real challenges that the whole world has to face. Developed countries are probably the most responsible for this threat as they are the major producers of carbon dioxide, one of the main green house gases (table 1). The full spectrum of impacts climate change may bring on tourism is not quite comprehendible at the current state of knowledge. However it is almost certain that some serious impacts are bound to happen with significant repercussion on tourism. Egypt emission of green house gases is far beyond critical threshold (Figure 1, 2, and 3). A national drive is already underway to replace the use of mazot (heavy oil) with natural gas in a number of facilities such as brick factories and others to minimize emission ever more. On the other hand, developed countries should heed their role in minimizing emission of green house gases through a variety of measures that would include sustainable consumption especially in the field of heating where a massive volume of energy is spent with huge volume of green gases emission. Other possibility is to search for other alternative for energy generation rather than the use of fossil oil.

Table 1
Countries With the Highest Rate of Emission of CO_2
A World Survey

Rank	Country	CO2 Emission Million metric tons	Rank	Country	CO2 Emission Million metric tons
1	United States	4931630	27	Venezuela	121604
2	Former USSR	3581179	28	Argentina	115848
3	China	2543380	29	Belgium	102079
4	Japan	1091147	30	Thailand	100896
5	Germany	969630	31	Nigeria	91930
6	India	703550	32	Yugoslavia	87225
7	United Kingdom	577157	33	Egypt	81667
8	Iraq	520281	34	Greece	72866
9	Canada	410628	35	Pakistan	68487
10	Italy	402516	36	Hungary	63574
11	France	374113	37	Denmark	63054
12	Mexico	339873	38	Malaysia	61196
13	Poland	308164	39	Austria	60331
14	South Africa	278695	40	U.A.Emirates	59459
15	S.Korea	264647	41	Norway	58672
16	Australia	261818	42	Colombia	57503
17	N.Korea	243235	43	Bulgaria	56675
18	Iran	222361	44	Algeria	55194
19	Spain	219877	45	Sweden	53489
20	Brazil	215601	46	Finland	52047
21	Saudi Arabia	214919	47	Philippines	44587
22	Czechoslovakia	191356	48	Libya	43008
23	Indonesia	170468	49	Switzerland	41843
24	Turkey	142555	50	Portugal	41792
25	Netherlands	138990			
26	Romania	138027			

Tourism industry is influenced by a variety of other factors that could inflect some potential damage such as sewage discharge, spillage and human handling. Moreover, tourists pressure and the frequent dwelling of tourists in coral areas are posing some threats to the integrity of these fragile creatures with some possible irreparable damage.

At the local level, efforts should be taken not to let such activities exacerbate the problematic situation already created by climate change. On the international level, some more stringent efforts should be taken to bring down the rate of green house gases emission. Moreover, countries with high rate of emission should have some significant contribution in the expenditure of maintaining wild life sites affected by climate change in developing countries.

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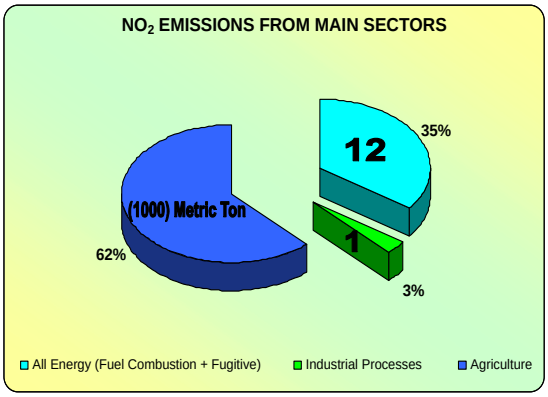

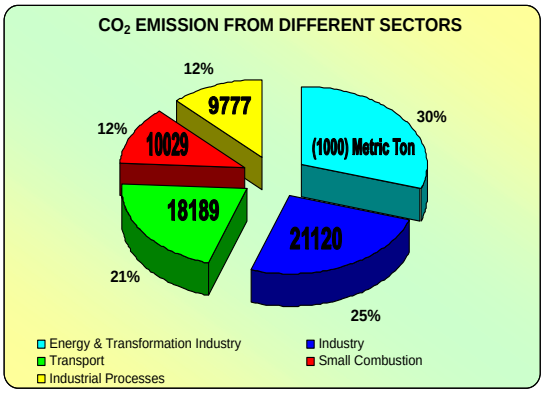

Figure 1
Inventory of NO_2 Emission in Egypt

Figure 2
Inventory of CO_2 Emission in Egypt

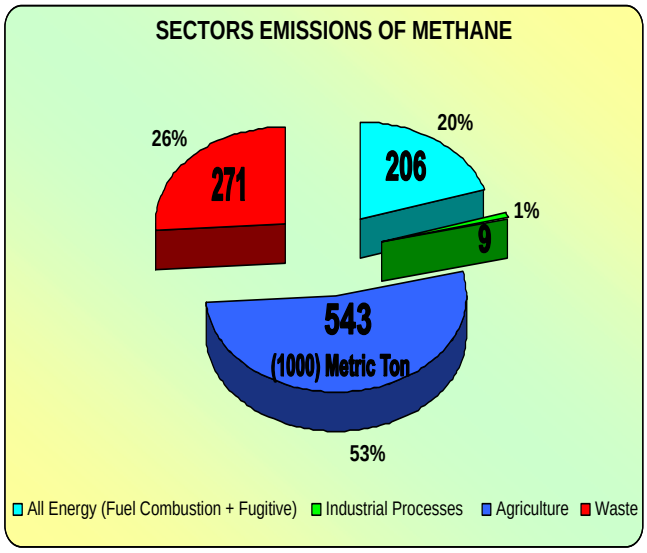

Figure 3
Inventory of Methane Emission in Egypt