

Article

How Eco is Eco-Tourism? A Systematic Assessment of Resorts on the Red Sea, Egypt

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Abstract: Eco-tourism is a growing part of the tourism industry. However, there are no agreed-upon criteria of what constitutes eco-tourism, so the industry is currently self-identified, with eco-lodges simply declaring themselves so. Here we present the first systematic comparison of eco-tourism versus conventional (or mass) tourism, using as our study area a set of 37 resorts along the southern Red Sea coast of Egypt, all constructed on similarly oriented parcels between the sea and the Red Sea Mountain Range. We compared resorts based on their water, energy, and waste management (all virtually equivalent), and based on mappable environmental parameters such as swimming pool surface area, distance from mangrove patches, conflict with flood plains, extent of lawn area, and means of access to deep water. We found that the self-identified eco-tourism establishments were not significantly different from the conventional tourism resorts in terms of their stress on environmental resources. We recommend that future eco-tourism operations be modified in two key ways. First, on the planning level, by modifying the regional master plan created by the central government tourism authorities. Second, on the site design level, by introducing significant improvements to the design approval processes for the developments to ensure compliance with environmental requirements.

Keywords: eco-tourism; mass tourism; sustainability; Red Sea; Egypt

1. Introduction

1.1. Mass Tourism

According to Ceballos-Lascurain [1,2] the concept of eco-tourism developed in reaction to mass tourism and its impacts on the environmental and social fabric of the tourist destinations. Mainstream resorts in the Red Sea region are known as mass tourism especially as it has high numbers of resorts and rooms. The success of these are measured by the number of hotel rooms not the economic revenue. Mass tourism involves large groups of collectively organized tourists, staying in accommodation such as large hotels and resorts, with the presumed greater impact than would be the case for smaller-scale tourism, and an implied lack of concern for the environment in planning and development. Moreover, mass tourism is usually focused on attractions such as beaches, sun, and nightlife, which are not highly sensitive to impacts of crowds and large-scale development. A classic scenario might be an idyllic, unspoiled beach, which attract tourists, for whom large hotels are constructed, but whose waste is discharged in the marine environment, leading to polluted beaches and degrading the very experience sought by the tourist. Moreover, mass tourism has been seen to operate at an “industrial scale” accommodating large numbers of tourists who are not necessarily sensitive to natural and cultural heritage of their host countries.

Burkart and Medlick [3] and Fink [4] defined mass tourism as tourism occurring in large numbers and in organized groups. However, neither the United Nations World Tourism Organization (UNWTO),

a key repository for academic research in the field, nor the World Travel and Tourism Council (WTTC) have adopted a definition for mass tourism, nor specific criteria with which to distinguish it from other forms of tourism. This may be in part because of its pejorative connotation, and in part because the characteristics of mass tourism vary from one context to another. The cities Palma de Mallorca (Spain), Cancun (Mexico), Pattaya (Thailand), and Hurgada (Egypt) have been identified as destinations with a massive influx of tourists [5–10], but not much has been reported about the impact of these numbers and whether that impact is due to the number of people, the management practices of those destinations, or the surrounding land uses. Using the definition of Fink [4] and Vanhove [11], mass tourism is that form of tourism that includes: (i) participation of large numbers of visitors; (ii) collective organization of travel; (iii) collective accommodations; and (iv) integration of the holiday-maker in a traveling group.

1.2. *Eco-Tourism*

The term “eco-tourism” was introduced in the 1980s to refer to “travelling to relatively undisturbed or uncontaminated natural areas with the specific objective of studying, admiring and enjoying the scenery and its wild plants and animals, as well as any existing cultural aspects” [1]. The term has since evolved. Weaver [12] defined eco-tourism as a form of nature-based tourism that strives to be ecologically, socioculturally, and economically sustainable while providing opportunities for appreciating and learning about the natural environment or specific elements thereof. Nelson [13] defined eco-tourism as “a subset of tourism that relies on natural resources, a form of tourism in which conservationist and tourist interests work together to preserve environmental quality while mutually protecting tourism.” Fennell [14] reviewed definitions of eco-tourism across the academic and professional literature and identified these consistent themes (i) reference to where eco-tourism occurs, e.g., natural areas; (ii) conservation; (iii) culture; (iv) benefits to locals; and (v) education.

In addition to natural resources, cultural heritage attractions offer income-producing opportunities to some of the poorest (and some of the richest) communities in the world [15]. Archeological and other cultural sites are vulnerable to impacts from over-visitation that results from mass tourism, with delicate ancient buildings, sculptures, and other monuments vulnerable to breakage or defacement, severe erosion of the sites themselves and access routes, and other impacts such as raised or contaminated water tables from landscape irrigation or septic systems installed for visitors’ toilets. The eco-tourism approach would limit visitation, and would design facilities and visitor routes to minimize impacts.

1.3. *Criticism of Eco-Tourism*

While eco-tourism is widely assumed to provide a more environmentally benign alternative to mass tourism, and is encouraged by leading organizations such as the UN World Tourism Organization, its actual benefits have been questioned in multiple contexts [16,17]. Drawing on experience in Australia and New Zealand, Weaver [12] and Ormas [18] argue that the lofty aspirations of Eco-tourism have been largely unattained because of the influence of dominant market behavior and expectations of most tourists. Cater [19] critiqued eco-tourism in developing countries, arguing that without adequate understanding of environmental factors and without careful planning and management, it was likely to produce unsustainable outcomes. Irazábal [20] argued that bringing people to nature without appropriate planning and infrastructure would cause more harm than good to the natural resources. Lindberg and McKercher [21] argued that as eco-tourism ventures reached a stage of maturity and popularity, they inevitably degrade environments, and concluded that the promised benefits of eco-tourism are not actually in evidence. Weaver [12] argued that because eco-tourism actually brings visitors into natural areas where they would not have ventured on a conventional mass tourism trip, it is more likely to impact the original nature resource attraction, thereby defeating its purpose of protecting sensitive environmental areas. Weaver cited the degradation of Yosemite Valley and the Grand Canyon from motor vehicle traffic, intensity of visitation, and impacts from a variety of tourist activities (documented by the National Park Service) and concluded that eco-tourism sites suffered from too-intense use. Nelson [13] noted other adverse outcomes of eco-tourism, such as a

lack of economic retention, lack of education for both guest and host, lack of direct benefits to local people, and stresses on environmental and cultural resources. Husbands and Thompson [22] and Ogutu [23] also found that eco-tourism can have negative consequences on livelihoods, sometimes resulting in changes in the local economic base that marginalize the local community. Eco-tourism can also grow inappropriately and marginalize local stakeholders when highly controlled and exploited by the government, the private sector, and a few elite community members [24].

Just as there are no accepted definitions of mass tourism, there are no standards by which to identify eco-tourism, and it is unlikely that any definition of eco-tourism can be truly universal. As Fennell [14] argues, eco-tourism has a strong and prevailing element of cultural relativism. Consequently, what qualifies as eco-tourism in some regions or countries would not necessarily qualify true in others. As per Duffy [25], the definitions of eco-tourism are contested, and the term has become a kind of catch all phrase that is so expansive that it is rendered meaningless.

Eco-tourism is a self-adopted designation that has more to do with how the tourism operation wants to be positioned in a global tourism market than with specific practices. While the “eco” prefix suggests an association with “ecology”, in fact, eco-tourism developments are self-identified [26], and the assumption that eco-tourism is less impactful can be regarded as a myth [27]. This raises the question of whether in practice resorts self-labelled as “eco” have less impact on the environment than other resorts.

Warnken et al. [28] systematically compared energy and water consumption rates of five “fully accredited eco-resorts” with 30 other resorts in Queensland, Australia, and found that the eco-resorts did not perform better than their conventional counterparts. They stressed the challenges in making such a comparison, citing “a multitude of site specific characteristics such as age of building, building size and layout, nature of operation, extent of communal facilities, climate, etc.” all of which influence rates of water and power use.

Building upon the work of Warnken et al. [28], in this study, we analyzed a set of 37 resorts along the Red Sea coast of Egypt, in which we could hold more other factors constant, as all resorts had essentially the same general landscape setting (located between the Red Sea Range and the Red Sea). We measured indicators of sustainability for each to see how the two populations of resorts differed. The Egyptian Red Sea coast is ideal for such a comparative study because landscape position, climate, and type of tourism (i.e., beach, swimming, and diving) are essentially constant across a large group of resorts, and most resorts in the stretch of coast we studied were constructed within a relatively narrow window of time, from 2005 to 2010.

1.4. Eco-Tourism along the Egyptian Red Sea Coast

With its multiple layers of tourism attractions, Egypt is a prime tourist destination. Besides its incomparable monuments from Pharonic and Islamic times, it has breathtaking deserts, lush oases, a marine environment with coral reefs ideal for scuba diving, diverse historical built environments, shrines, citadels, and numerous Roman remains. Tourism represents one of the most important sectors of Egypt’s economy, with approximately 8.03 million tourists in 2017, contributing 200 billion EGP to Egypt’s GDP [29].

Over the last three decades, Egypt’s Ministry of Tourism has fostered extensive tourism development on the Red Sea coast. Since the inception of Red Sea development in the 1980s, the Tourism Development Authority (TDA) of Egypt has designated multiple similarly sized parcels along the shoreline, extending about 400 km from Hurghada in the North to Ras Banas in the South. The configurations of these coastal parcels are essentially identical: each encompasses land between the Red Sea mountain range and the sea. Though (as developers have discovered) the particulars of any given parcel may make it more or less advantageous than other parcels, there is a high degree of comparability in fundamental environmental characteristics between the parcels. As tourist facilities in this area progressed southward along the coast and as eco-tourism became more popular, developers have built both conventional mass-tourism and eco-tourism resorts. The first eco-tourism resort was

built at Port Ghalib, followed by others located southward along the 208-kilometer-long coastline to Ras Banas (see Figure 1).

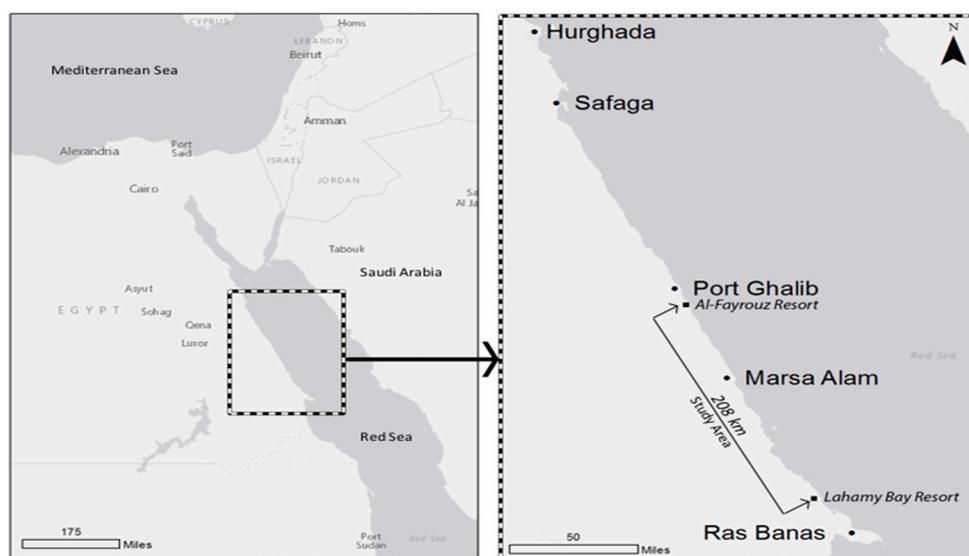


Figure 1. Red Sea tourism development area.

The resorts labeled as eco-tourism destinations or as eco-lodges aim to set a new trend in response to a perceived increase in the market segment for this kind of tourist facility. As documented by Shaalan [30] and the Red Sea Sustainable Tourism Initiative (RSSTI) project [31], the TDA has encouraged diversification of tourism opportunities throughout the country, including eco-tourism. Beginning just over a decade ago, some investors introduced eco-tourism within the context of the conventional land-parceling pattern along the Red Sea coast. The stated intention of eco-tourism development in this zone is to achieve higher compatibility with the inherent environmental characteristics of the sites. For example, in the pioneer investor Hossam Helmi's project Marsa Nakari, the resort's huts and tents were placed away from the salt marshes and on higher ground out of the flood plain (see Figures 2 and 3).



Figure 2. Marsa Nakari eco-lodge, an example of one of the leading eco-tourism initiatives in the study area (photo by Nader Makram, 2016).

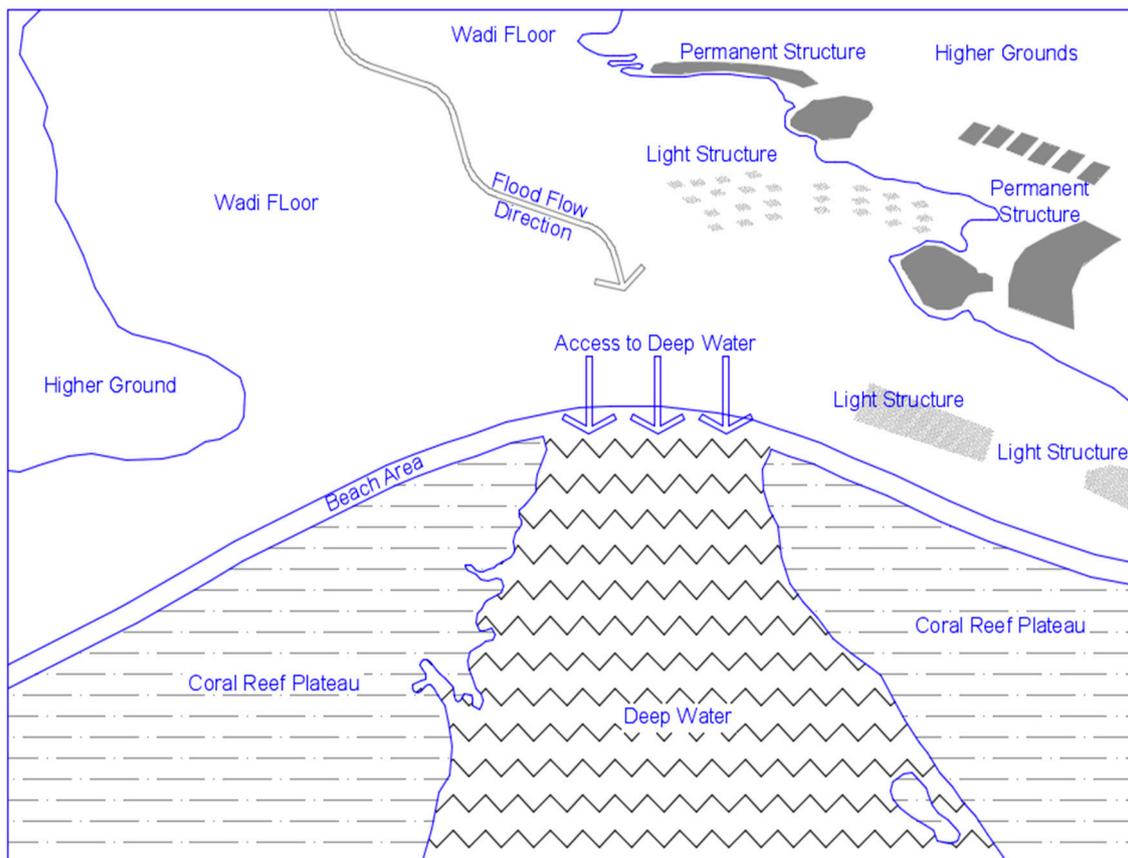


Figure 3. Illustrative diagram showing the permanent structures on high ground [32].

1.5. Factors Affecting Environmental Footprint of Red Sea Resorts

1.5.1. Locational Constraints and Site Planning

While all land parcels sold by the government (TDA) to developers along the Red Sea coast were roughly similar in scale, encompass upland areas, and have a coastal edge, the parcels differed in important ways, and the way that resort developers have responded to the constraints has likewise differed.

The coast is flanked almost continuously along the length of the coast by fringing reef, which prevents human access to deep water. The fringing reef is interrupted at intervals by the mouths of wadis. Where wadis enter the sea, they form *sharm* or *marsa*, with ecotones between fresh and brackish water, and offering natural deep-water access [33]. However, some resort land parcels are located far from any such access points. All the Red Sea resort parcels have some frontage along the Red Sea, offering a scenic setting for sunning on the beach, but the fringing reef prevents swimming directly from many of the beaches, because the water adjacent to the beach is too shallow for adult swimming, and in some cases even this is inaccessible due to topography (Figure 4). Thus, whether a resort has natural access to water deep enough for swimming is an important locational factor, and lack of such access has motivated construction of access features, as described below.



Figure 4. Happy Life Resort 38 km North of Marsa Alam. An example of a resort that is on the Red Sea coast but has no access to the Red Sea water [32].

The wadis are also important as hazardous sites for human occupation because of the threat of flash flooding. While floods occur infrequently (periods between floods can be a decade or more) they can extract a high toll in property damage and loss of life, as reflected in recent floods in Jeddah, Saudi Arabia, across the Red Sea [34]. As they cross the coastal plain to reach the Red Sea, wadi floors can be tens or hundreds of meters wide. They offer flat surfaces with loose sediment in which foundations are easily excavated, so they are attractive sites for construction—but only if the flood risk is ignored, as it has been at many sites. Thus, an important factor is whether resorts have placed buildings on wadi floors, exposing guests and infrastructure to flash floods.

Mangroves are an important and sensitive part of the coastal ecosystem. Egyptian environmental law [35] protects mangroves and prohibits construction within mangrove patches, but does not provide a fixed no-disturbance buffer around mangrove patches. Even if buildings are kept far from mangroves, tourism activities near the mangroves such as boating, leisure, and beach activities, can impact the health of the mangroves and undermine the connectedness of the ecosystem [36,37]. Resorts and lodges that have mangroves on their property or are built adjacent to mangrove patches have potential to impact mangrove health.

Similarly, salt marshes play an important role in the coastal ecosystem, but some resorts have built over former salt marshes. Thus, the extent of development over former salt marshes is a useful measure of environmental impact of a resort development.

1.5.2. Design Factors

The planning and design of the resorts (the layout of the permanent components of the resort or camp, such as buildings and infrastructure) determine their impact on the environment (Figure 5). Thus, areal extent of built area (i.e., the footprint of buildings), of green lawns (requiring as they do, frequent irrigation in this arid climate), and of swimming pools are all useful indicators of resource use and environmental impact measurable from aerial imagery with field verification. Likewise, the presence and extent of features that impact the coral reef, such as marinas and piers, can be useful indicators of impact.

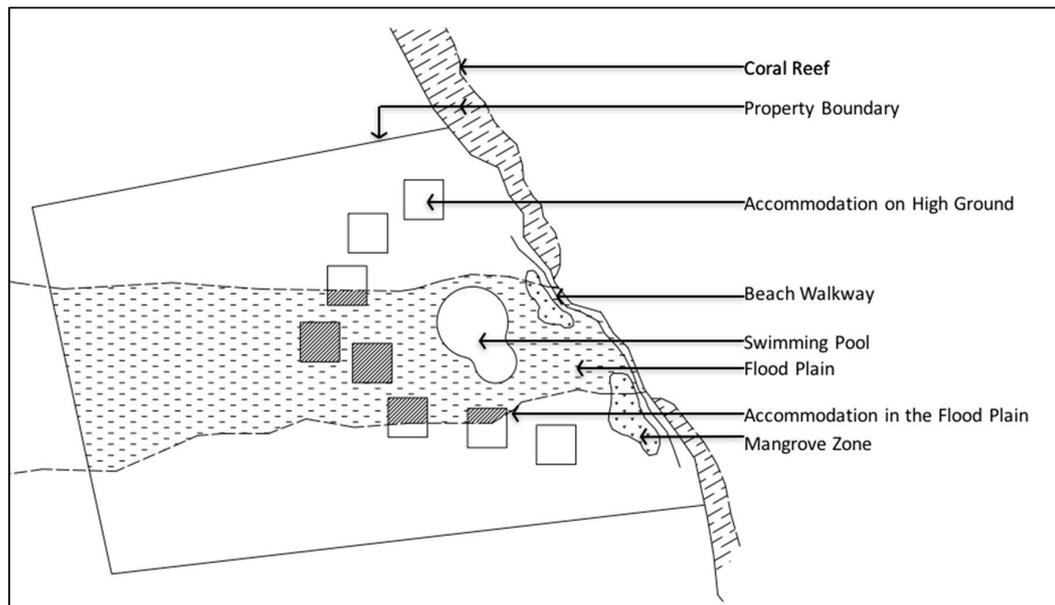


Figure 5. A conceptual diagram showing the typical site layout of a tourism establishment.

1.5.3. Management Factors

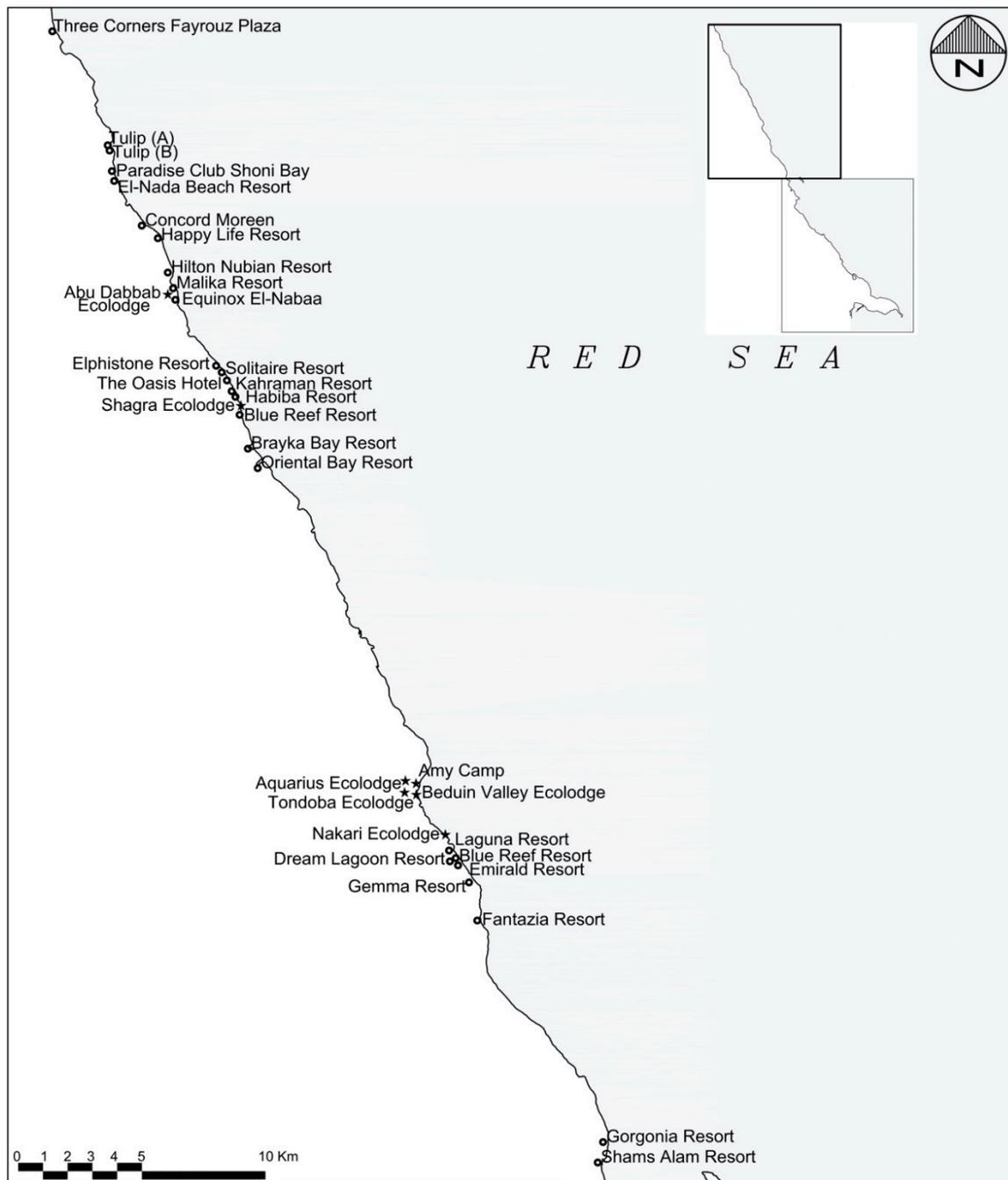
The ongoing management of a tourist facility determines much of its impact on the local environment. Tourism produces additional externalized burdens on local infrastructure (water supply, energy, and solid waste disposal), with concomitant environmental impacts. For water supply, two main freshwater pipes from the Nile provide the water supply to resorts along the northern part of the Red Sea coast, but south of Hurghada, (including our study area) resorts must rely on sources such as desalination or trucking water from elsewhere [38]. Thus, water is difficult to obtain and a valuable resource to conserve. Water management (how water is obtained, treated for consumption, used, and how wastewater is treated and re-used) is an important component of the environmental footprint of a resort.

Likewise, the energy generation and efficiency of use is also an important contributor to the environmental footprint. Unlike resorts to the North, the resorts in our study area are not on the power grid and must produce their own electrical power, so power generation and energy conservation are important factors. Solid waste disposal is another important factor influencing the footprint of the resorts. The region experiences strong winds and a ready source of trash to be transported by the winds, thanks to a history of casual waste disposal practices, including surface dumps. The coastal landscape in the study area is festooned with colorful “flowers”, which upon closer inspection turn out to be plastic bags (or portions thereof) caught on bushes and dried-out annual plants, and such bags are also routinely encountered when diving coral reefs offshore. Thus, it is important that the resorts not contribute to the supply of wind-born debris. Finally, the transportation of guests from the airport (typically the Marsa Alam airport, which receives many charter flights from Europe) to the remote resorts is a further contribution to the environmental footprint of the resorts.

2. Methods

We conducted fieldwork in the region throughout the past decade, but this systematic field investigation took place in 2017. There are 37 functioning resorts along the 208-kilometer stretch of Red Sea coastline from Al-Fayrouz Resort, 75 km north of Marsa Alam City, to the southernmost resort on the coast in Egypt, Lahamy Bay Resort (Figure 6a,b). Nine of these are self-labeled as eco-lodges or eco-camps, while the remaining 28 were more typical resorts that we classified as mass tourism resorts. We documented the specific development characteristics of each resort to assess its environmental

performance—essentially, to determine how “eco” each resort is. We measured the environmental impact of each resort using three categories of measures, related to location, design, and management.



(a)

Figure 6. Cont.



Figure 6. (a) The tourism establishments in the southern region of the Red Sea (from Three Corners North to shams Alam). (b) The tourism establishments in the southern region of the Red Sea (from Kite Village to Lahamy Bay).

2.1. Mapping from Satellite Imagery and Field Surveys

From remotely sensed data and field visits conducted in 2017 to each of the 37 resorts, we identified the general nature of buildings (multi-story, single-story, dispersed camp structures), and mapped the areal extent of resort features such as total built area (measured as total footprint of buildings, access roads, etc.), pool area, lawn area, and (if present) constructed piers across the fringing reef and marinas. We used imagery from ESRI Digital Globe. In addition, we field checked the mapping from satellite imagery by ground-truthing using GPS to locate our field observations.

We measured the total developed areas of the resorts, areas devoted to lawn and pools, and the extent of features such as piers built to provide access to deep water. We also calculated these areas on a per-room basis.

2.2. Interviews

We conducted semi-structured interviews [32] with resorts owners, hospitality managers, and engineering managers to determine the source of water, water management practices, sources of electrical power, energy conservation practices, transporting of guests from/to the airport, and disposal of liquid and solid waste. At all the resorts, there was at least one knowledgeable member of staff willing to answer our questions, but the extent of knowledge and available data varied. Some data, such as the relative split of electricity produced by generators vs. solar panels, and total volumes of wastewater processed and reused, were not available from most resorts, meaning that we could not use these as variables to compare the environmental footprint of the various resorts.

2.3. Critique of TDA Land Parceling

We analyzed the land subdivision allocation by the Tourism Development Authority in relation to locational factors, notably exposure to flood hazard, whether the parcel has access to deep water, adjacency to the mangrove patches, and extent of salt marshes within the likely development footprint of the parcel. We superimposed boundaries of the vector georeferenced land parcels obtained from the TDA on flood paths traced from the 1:50,000 Scale Topographic Maps published in 1989 and obtained from the Egyptian Survey Authority. We identified areas of conflict (notably buildings built on wadi floors) and delineated these.

3. Results

3.1. Overall Development Footprint

Of the 37 resorts, we found that the total number of rooms serving mass tourism to be 6615 rooms versus 442 rooms for eco-tourism (Table 1). The form and overall areal extent of the resorts varied widely, in response to specific features of the parcels the developers had to work with, and the design approach of the developers and their consultants.

Table 1. Overall comparison between mass tourism resorts (MT) and eco-tourism resorts (ET).

	MT Total 6615 Rooms	ET Total 442 Rooms
Total Built Area (m ²)	377,910	31,481
Total Ratio (room/m ²)	1/57	1/74
Total Lawn Area (m ²)	729,392	8331
Total Ratio (room/m ²)	1/110	1/18.8
Total Pool Area (m ²)	9650	394
Total Ratio (room/m ²)	1/1.4	1/0.9

3.2. Location of Resort Features Relative to Geomorphic Setting

With respect to conflicts with flood-prone areas (wadi floors), we identified five distinct types of development patterns (Figure 7) and classified resorts as falling into one of these categories:

1. Conventional resorts with the parcel located dominantly away from wadi floors (e.g., Shams Alam Resort).
2. Conventional resorts with the parcel located dominantly on wadi floors (e.g., Lahamy Bay Resort).
3. Eco-lodges with the parcel located dominantly away from wadi floors (e.g., Deep South camp).

4. Eco-lodges with the parcel located dominantly on wadi floors which:
- placed buildings outside the wadi floor, (e.g., Marsa Shagra Eco-lodge), or
 - placed some buildings within the wadi floor (e.g., Abu Dabbab)

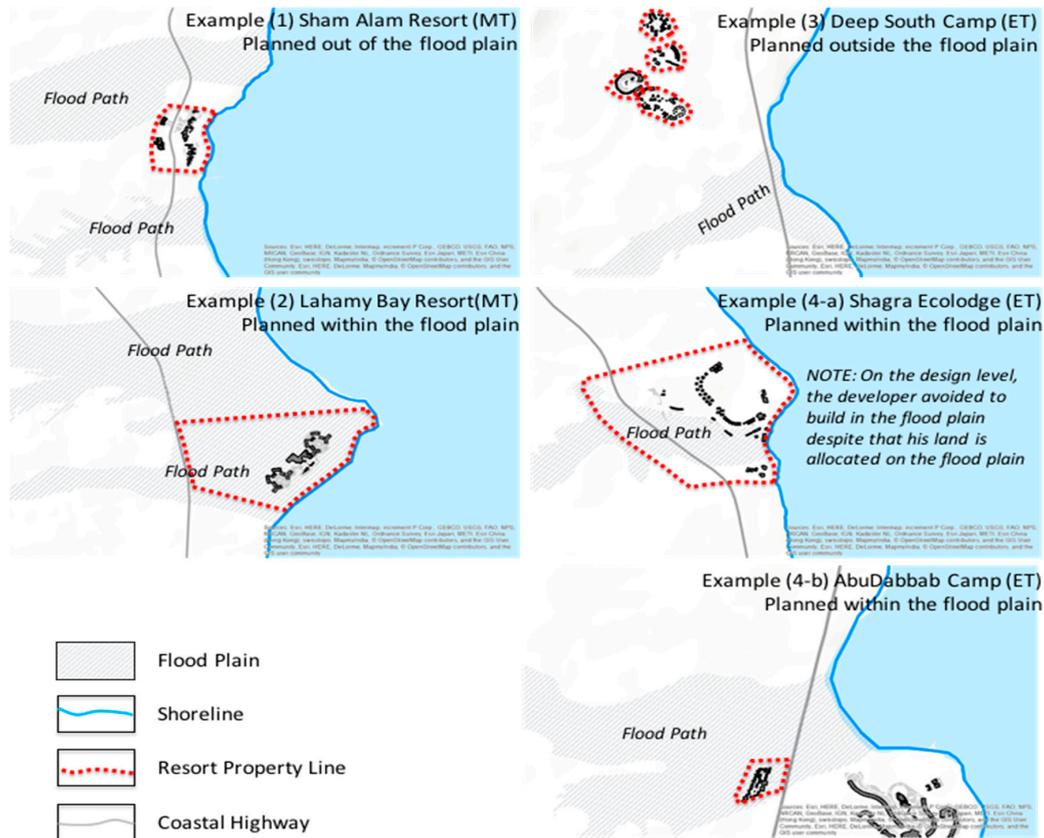


Figure 7. Four examples of resorts in relation to the flood plain; the red line shows the property boundary and the grey hatch shows the flood path [32]. Note: In this typology, no conventional resort was found to have a parcel within wadi floors and with buildings placed outside the wadi floors.

Overall, within the entire study area, four out of nine of the eco-lodges were situated on wadi floors, while only 8 out of the 28 conventional resorts were built on wadi floors (Table 2). Where mangroves were present on a parcel, on nearby parts of an adjacent parcel, or within the 50 to 400 m buffer from resorts, we identified 2 out of 28 mass tourism resorts in conflict with mangrove (7%), and 2 out of 9 eco-tourism resorts in conflict with mangrove (22%) (Table 2). Some parcels had no mangroves visible on current aerial imagery, and thus, for these resorts, setback from mangroves was not a relevant variable. Our analysis may have underestimated impacts to mangroves from coastal development because we did not try to determine whether mangroves had formerly existed on a site and were destroyed in the course of building the resort. While building over former mangroves was likely common during development of resorts to the north in the 1980s and 1990s, such practices were unlikely for the more recent developments in our study area in light of current regulations and awareness.

Table 2. Conflict with saltmarshes and mangrove patches, and access to deep water for mass-tourism resorts (MT) and eco-tourism resorts (ET).

	Mass-Tourism Total Number of Resorts 28		Eco-Tourism Total Number of Resorts 9	
Land Parcels in Visible Conflict with Saltmarshes	8	28%	4	44%
Land Parcels in Visible Conflict with Mangrove Patches	2	7%	2	22%
Land Parcels with Direct Access to the Deep Water	8	28%	3	33%

We found that 44% of the eco-lodges have buildings located on former saltmarshes, while only 28% of the conventional resorts had these impacts. Examples of resorts whose buildings were located entirely on filled saltmarshes include the Abu Dabbab camp ecoresort (where eyewitnesses present during construction reported the marsh was covered with earth fill between 1.5 and 2.0 m deep) and the conventional Lahamy Bay Resort, also located entirely on former salt marsh. In contrast, the Shagra diving camp eco-lodge placed its buildings on higher ground, above the level of the wadi floor, which transitioned into salt marsh in its lower reaches; this allows for the free passage of flash floods and preservation of the salt marsh habitats (Figure 8), reflecting a better-informed approach to locating development within a parcel.

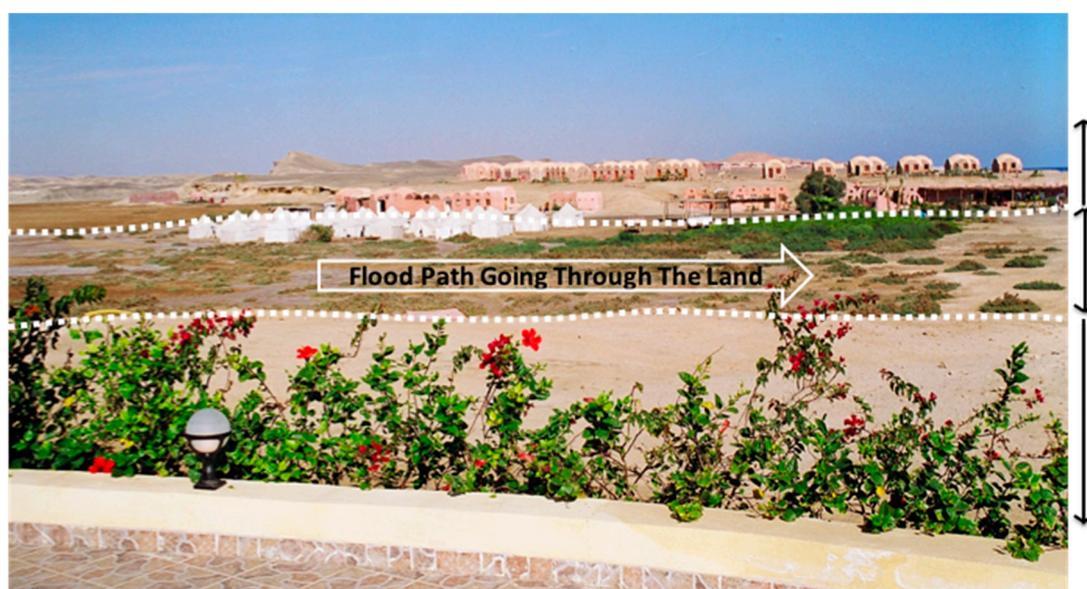


Figure 8. Example of resort that avoided construction on salt marshes (placing buildings on adjacent high land) even when the allocated parcel was primarily marsh. View of Shagra Eco-lodge, looking north across Wadi Shagra. (Photo by Gohar, January 2004).

Of the 28 conventional resorts, only 28% had natural access to deep water. The other 72% accommodated tourist water access by other methods, such as constructing piers or marinas, features whose construction significantly degrades the coral reef. More than half (66%) of the eco-lodges also lacked natural deep-water access, and employed similar approaches to provide deep-water access.

Whether a resort has deep-water access is of course a function of the way parcels were allocated by the TDA (i.e., without accounting for local geography), and lack of such access was a constraint inherited by some resort developers. However, the constructed responses to provide access come with a non-trivial environmental impact on the coral reef. We could expect that eco-lodges might have greater access to deep water because eco-lodges would be preferentially located at sites with natural deep-water access, because of the greater importance of coral reef access for the eco-lodge market. Because deep-water access features, sharms and marsas, occur at the mouths of wadis, this could also lead to many eco-lodges having buildings in wadi floors and over former saltmarsh, which co-occur with sharms and marsas.

3.3. Design Factors

Diagrammatic maps of all 37 resorts are presented in Figure 9a,b, showing the layout of all resort developments at the same scale, and showing areas of lawn, pool, and built areas. The environmental sensitivity of the master plans varied widely, from insensitive and impactful designs to those that carefully placed permanent buildings on uplands and avoided damage to coral reefs, such as the Marsa Nakari Eco-lodge.



Figure 9. Cont.



Figure 9. (a) Tourism establishments from Al-Fayrouz plaza north to Marsa Shagra. Note: some of the boxes above include more than one resort to maintain all in the same scale [32]. (b) Tourism establishments from Blue Reef to Lahamy Bay Resort South. Note: some of the boxes above include more than one resort to maintain all in the same scale [32].

The built areas of conventional resorts had larger footprints than those of eco-lodges, reflecting the larger scale of conventional mass tourism, but when the larger built area is divided by the number of rooms, the conventional resorts are seen to have a lower footprint per-room. The total built area of conventional resorts was 377 thousand m^2 , accommodating 6615 rooms, or an average of $57 m^2$ built area per room. For eco-lodges the corresponding values were 31 thousand m^2 of built-up area accommodating 442 rooms, for an average of $74 m^2$ built area per room (Table 1). This result probably reflects the fact that the conventional mass tourism hotels tend to be higher-rise structures, while guests at an eco-lodge would expect single-story buildings or tents, reflecting a more rustic style but obviously a lower density.

Similarly, eco-lodges have less total area of green lawn, but their lower number of visitors results in a higher lawn area per room, $13.8 m^2$ per room, compared with $9.4 m^2$ per room in conventional resorts. The prevalence of lawn may be a matter of scale, such that a certain area may be needed

to visually balance buildings, which may be proportionately larger (per room) for small, low-rise buildings typical of eco-lodges than for conventional resorts with high-rise towers.

The area of swimming pool is smaller for the eco-lodges than for conventional resorts, both in total area and per room, with only 0.9 m² per room in eco-lodges compared to 1.4 m² per room in conventional resorts. As noted above, the eco-lodges would tend to emphasize swimming, snorkeling, and diving in the Red Sea itself, and some eco-lodges have no pool, which would be unthinkable for a conventional resort.

Piers constructed to provide access to deep water vary in length as a function of the width of the fringing reef, from a small, light pier 13 m long at the Nakari Eco-lodge, to a massive 670 m pier at the conventional Tulip Resort (Figure 10). Consistent with the earlier discussion about eco-lodges preferentially being located near wadis and deep-water access, eco-lodges have far fewer and smaller piers than conventional resorts.



Figure 10. (a) Nakari Eco-lodge jetty; (b) Tulip Resort jetty, presented on the same scale.

3.4. Management

All the resorts in our study area face similar constraints of no piped water supply and no electrical grid, all must ship their solid waste to a facility in Marsa Alam, and all must transport guests from and to the airport. Our interviews with resort owners, managers, and heads of engineering and maintenance indicated that all 37 resorts have adopted similar practices for water supply: pumping and desalination of typically brackish groundwater, or if such groundwater was unavailable, more costly desalination of water from the Red Sea, or (also very costly) trucking water from a larger desalination plant in Marsa Alam.

All resorts practice water conservation, by minimization of landscape water demand through selection of drought-tolerant plant species (though this practice is offset in many resorts by irrigating areas of green lawn) and use of water-saving plumbing fixtures throughout the resort). Landscape irrigation has been identified as a major factor in water use of tourist hotels [39,40] so the area of lawn is likely to be an important predictor of water use. However, wastewater from the hotels and other buildings is treated in plants located on-site, and the reclaimed wastewater is used for landscape irrigation. Using reclaimed wastewater for landscape irrigation was universal among all resorts we studied, and, ironically, it requires sufficient occupancy of the resort to produce enough wastewater to irrigate the plantings.

The lack of power transmission lines down the coast means that all resorts must be self-sufficient in energy production. The primary source of electricity across the resorts studied was diesel generators. All resorts have diesel generators, and some resorts have installed limited photovoltaic solar capacity. We were initially surprised that photovoltaics were not more widely used at the resorts given the reliable sun nearly year-round, but in our interviews we learned that the subsidized cost of diesel fuel makes the generators very economical sources of power. Thus, there is little financial incentive to invest in photovoltaic panels and to integrate this second source of power into the resorts' power systems.

The use of rooftop solar water heaters was universal among the resorts. As these systems work by direct solar gain, they have been readily integrated into the plumbing systems of the resorts, both conventional and eco-lodges. As explained to us by one of the managers, they had to buy some kind of water tank anyway, so why not buy black tanks that fit on the roof and absorb heat from the sun, allowing the resorts to avoid significant water heating costs. As the use of this technology was universal across the 37 resorts, we could not use this as a distinguishing variable. Our interviews with resort managers indicated that all resorts encourage guests to re-use towels (rather than wash them daily), saving water as well as energy, and incorporate power-saving devices in the hotel rooms.

All resorts need to transport guests from and to their arrival points, which in most cases is the Marsa Alam airport, about 50 km north of the town of Marsa Alam. The required transport distance is a function of the resort location on the north-south gradient, with the northern-most resorts being within a 10 km drive of the airport, and the southern-most resort being over 160 km away. Thus, the energy required to transport guests is simply a function of the distance to the airport, which in turn was inherited from the location of the parcel allocated by the TDA.

All resorts dispose of their solid waste at the Marsa Alam solid waste disposal site, which is located about 2 km south of the center of Marsa Alam. All resorts contract with HEPCA (the Hurghada Environmental Protection and Conservation Association, an NGO established in the 1980s to improve environmental practices of resorts along the Red Sea) to transport their solid wastes to Marsa Alam after sorting the waste into recyclable and other streams. Thus, as with the airport transportation, all resorts employ the same practices, though the energy required varies with the resort as a function of distance from the disposal site, which is essentially a condition inherited from the original parcel allocation by the TDA.

4. Discussion

There is growing embracing of adventure tourism, wellness tourism, and eco-tourism, sometimes considered together as growing faster than the tourism industry as a whole. Many of these tourists report positive impacts on their lives as a result of their experiences, especially from their experiences with nature [41]. Thus, while there is evidence of positive effects of the nature experiences offered by such tourism, the assumption that its impacts are less and that it is inherently more sustainable is not necessarily supported, and can be viewed as a myth [27]. The results of our study are consistent with those of Warnken et al. [28] and provide support for the skepticism about the sustainability of eco-tourism expressed by Weaver [12] and Ormas [18]. Even when tourism developments seek to reduce impacts and adopt sustainable features, attracting tourists and operating resort facilities for them will inevitably produce some environmental impact, which can be especially severe in the developing world context [19]. In our study area along the Red Sea, whether a resort called itself eco-tourism or not was not a dominant factor determining its relative impact, consistent with the findings of Warnken et al. [28] for resorts in Queensland, Australia.

A key factor was the locational setting of each resort, which was determined by the TDA's (i.e., the central government's) land parceling and allocation system. The resort parcels, while similar in size and general setting, were not equivalent in terms of locational advantages such as natural access to deep water and high ground on which to build. Details of the parcellation scheme and parcel allocation are not publicly available, so we can only speculate about the degree to which developers understood relative advantages of different parcels. In any event, incremental land purchases by developers and building of the resorts has, over time, produced the current development pattern. Later purchasers probably had fewer desirable parcels from which to select.

The next question is what did the developers do with the parcels they received? How well did they plan and design to take advantage of the parcel features, and to avoid building over wadi floors or saltmarsh, and to avoid impacts to the reef from construction of piers? There are examples of excellent design and planning that avoided many impacts, such as the Movenpick conventional resort, whose layout avoided putting structures on the wadi floor or building an access pier, and the

Shagra Eco-lodge, whose buildings were clustered on high ground above the wadi. These examples are contrasted by the many resorts that built over wadis and saltmarsh, and that built piers or marinas, which damaged the fringing reef.

One striking pattern was the preferential location of eco-lodges in sites with natural deep-water access, which occur at the mouths of wadis. This location minimized the need to construct deep-water access piers, but it would imply that more of the parcel consisted of wadi floor and saltmarsh, increasing the likelihood of building on wadi floor and saltmarsh, unless the master planning for these resorts took these features into account and made a point of avoiding them.

Overall, the built area and lawn area were higher for eco-lodges on a per-room basis than conventional resorts. This was a somewhat surprising result, but can be explained by the expectation that an eco-lodge would not be a high-rise hotel. Recall that 'eco-tourism' implies both an experience with nature and sustainability. A high-rise hotel would be less compatible with a nature experience than, for example, a traditional hut by the beach. Thus, eco-lodges would tend to be single-story and accordingly have a larger areal extent for a given number of rooms. The higher per-room area of lawn does not seem intuitive, as some eco-lodges have no lawn at all. This may be a scale effect, such that to surround the more extensively built-out eco-lodges with lawn, a greater lawn area is implied. The smaller per-room area devoted to swimming pools at eco-lodges is consistent with emphasis on natural access to deep water, based on the expectation that guests would prefer a more natural swimming experience, and specifically access to coral reefs.

Questions of sustainability of developments usually prompt questions about consumption of water and energy, and management of wastes, and one might expect that the eco-lodges along the Red Sea would have lower footprints than conventional resorts. However, all resorts along the Red Sea face similar constraints of being off the electrical grid and without piped water supply, and their responses have been essentially the same. Although rooftop solar water heaters are universally used, the principal source of electrical power for both conventional resorts and eco-lodges is diesel generators. Despite the strength of the sun year-round, the subsidized price of diesel fuel has made generators the most economical choice to date, although as photovoltaic panel prices decrease, they may become more competitive and more widely adopted. Water conservation is promoted and treated wastewater is used for landscape irrigation in all resorts, be they eco-lodges or conventional. Likewise, all resorts have a contract with an NGO to collect their (sorted) solid waste for disposal at a single facility, eliminating any potential for distinctions in these practices between eco-lodges and conventional resorts. Thus, while having all 37 resorts located along the coast with a broadly similar setting allows us to hold other factors constant and thereby detect differences between eco-lodges and conventional resorts, the constraints of the setting also suppress some potential differences in the management factors of energy and water use and solid waste disposal. This was a limitation of our study.

5. Conclusions

As interest in eco-tourism and the number of eco-lodges increase, it is good to bear in mind that there are no accepted standards for what constitutes eco-tourism, and thus eco-lodges are self-labelled. We sought to determine whether the nine self-labeled eco-lodges among 37 Red Sea resorts had lower environmental footprints than conventional resorts.

The eco-lodge experience implies (1) an experience with nature, and (2) a lower environmental impact (i.e., more sustainable resort). We did not attempt to document or measure the nature experience, focusing instead on the sustainability dimensions, which we measured in terms of locational factors (which depended on where the developer's parcel happened to be sited with respect to wadis and other features), design factors (how the developers responded to the site), and management factors (energy, water, and solid waste management).

So finally, how 'eco' is eco-tourism? As argued by Cater [19], in some cases, eco-tourism may result in greater impacts than mass-tourism that is better confined to a small concentrated area. In our study on the Red Sea, we found that the footprints of built area and lawn for eco-lodges were smaller

overall, but larger when expressed on a per-room basis, because of the greater density afforded by the multi-story buildings of conventional resorts. Eco-lodges were more likely to be located at wadi mouths with natural deep-water access, reflecting the strong interest of this market in swimming and snorkeling the coral reefs. As a result, eco-lodges were less likely to construct artificial access to deep water across the reef, but it also made them more likely to place buildings on wadi floors and saltmarsh.

As argued by Weaver [12], eco-tourism can be viewed as a variant of mass tourism, and whether it has greater or lesser impacts depends on how it is implemented. For any tourism, impacts will vary widely depending on the inherent site properties and how tourist facilities are developed and operated. Thus, measuring impacts of eco-tourism depends on where the resorts are located and what you take into account. Indeed, in their study comparing the environmental impacts of resorts in Queensland, Warnken et al. [28] found that site factors, activities offered by the resorts, and other such local variables had a big influence on resort impacts. These inherent factors, alongside the question of what variables are measured, pose a challenge to comparing eco-resorts with conventional resorts. In many ways, our study provided a better setting to assess differences between resort types, as the resorts we studied shared the same basic landscape position between the mountains and the Red Sea. However, the factors that made all the resorts variations on a single theme also limited some degrees of freedom of the resorts. The resorts differed mostly in how they responded to local site conditions, such as whether they had natural deep-water access and how well they kept buildings out of wadi floors and former saltmarsh. In terms of water, energy, and solid waste management, which are often emphasized in impact assessments, the constraints of the setting meant that all resorts were essentially equivalent. In the final analysis, some eco-lodges were in fact more sustainable by most measures, but some self-identified eco-lodges had impacts equivalent to or greater than nearby mass-tourism resorts. Future research in a range of settings will be needed to shed light on the sustainability of (self-identified) eco-resorts relative to conventional resorts.

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