

SUSTAINABLE USE OF GEOMORPHOLOGICAL FORMS IN TOURISM, THE CASE OF HALF MOON BAY, EASTERN REGION, KINGDOM OF SAUDI ARABIA

Mohamed Abdelhaleem Helmy NORELDEEN 

King Faisal University, Geography Department, Faculty of Arts, Alahsa, Saudi Arabia; Kafrelsheikh University, Department of Geography and Geographical Information system, Faculty of Arts, Kafrelsheikh, Egypt, e-mail: mnoreldeen@kfu.edu.sa

Wagih Mohamed Elsayed SALAMA 

King Faisal University, Geography Department, Faculty of Arts, Alahsa, Saudi Arabia, e-mail:welsayed@kfu.edu.sa

Insaf Sanhoury BABIKER 

King Faisal University, Geography Department, Faculty of Arts, Alahsa, Saudi Arabia;
University of Khartoum, Geology Department, Faculty of Science, Khartoum, Sudan, e-mail: isahmed@kfu.edu.sa

Citation: Noreldeen, M.A.H., Salama, W.M.E., & Babiker, I.S. (2023). SUSTAINABLE USE OF GEOMORPHOLOGICAL FORMS IN TOURISM, THE CASE OF HALF MOON BAY, EASTERN REGION, KINGDOM OF SAUDI ARABIA. *GeoJournal of Tourism and Geosites*, 50(4), 1276–1285. <https://doi.org/10.30892/gtg.50408-1126>

Abstract: The Coastal geomorphology of the Half Moon Bay in the Eastern Region of Saudi Arabia has created great opportunity for human interventions. Public and private tourism and entertainment facilities were established along the Bay cost leading to modifications of natural phenomena. Therefore, this study aims at assessing tourism uses of geomorphological forms in the Half-moon Bay and identifying practical aspects related to sustainable tourism. It was based on literature review, field survey, analysis of google earth satellite imagery, risk analysis and SWOT analysis. Depending on the characteristics of the different coastal forms, various tourist activities were developed in the study area. However, environmental alterations, such as change of direction, length and meander of coastline have been recognized mainly, due to land excavation and backfilling of shallow sea water. Despite some constrains, several opportunities are available in order to promote and develop sustainable tourism in the region mainly supported by a set of legislations, efforts and actions at the national and local levels.

Key words: Half Moon Bay, geomorphological forms, coastal tourism, environmental impacts, sustainability

* * * * *

INTRODUCTION

Coastal geomorphology which encompasses a wide range of phenomena such as storm waves, tsunamis and sea-level variations, has gained considerable attention especially with respect to alarming issues such as global climate change and human interventions. Coastlines are important natural phenomena that are highly dynamic in nature (Zeinali et al., 2017). Headlands are trimmed and sand barriers are built due to actions of waves and currents creating simple and straight coastlines (Davidson-Arnott, 2009). The impact of sea-level rise due to global warming on coastal communities and infrastructures cannot be ignored. Coastal geomorphology provides valuable knowledge that helps to predict the response of coastal landforms to sea level rise and other physical processes. This knowledge is crucial for effective coastal management, as it allows to make informed decisions about where to build infrastructure and how to protect coastlines from environmental hazards such as storm surges, erosion, and human interferences (Gomez et al., 2019).

As coastal populations continue to grow, so does the need for sustainable coastal management strategies. It is therefore, important to understand the complex interactions between landforms, oceanic processes, and meteorological conditions related to coastlines. This knowledge can then be used to develop effective risk reduction policies and decision-making processes, which are critical for preserving human systems, ecosystems, and the natural beauty of coastal regions which are relevant for the development of sustainable tourism practices (Aragón-Correa et al., 2023). The natural attraction of coast lines has led to rapid growth of coastal tourism (Mestanza-Ramón et al., 2020). They provide a wide range of entertainment, sport and recreational activities (Hall, 2001; Miller and Hadley, 2005). However, sustainability of coastal tourism is facing challenges related to the complex interactions between mankind, water and land (Satta et al., 2009). The recent study by Aragón-Correa and others (2023) pointed that the agglomeration of hotel facilities has accelerated human and environmental pressure in coastal areas creating difficulties of achieving a balance between ecological, social and economic profits (sustainability) (Neumann et al., 2017). Strong evidences indicate that degradation of coastal environments is attributed to increasing tourism activities where environmental regulations are ineffective in most of the countries specially under the context of Integrated Coastal Zone Management (ICZM) (Mestanza-Ramón et al, 2020).

Saudi Arabia is characterized by over 3000 km coast lines extending along the Red Sea on the west and The Arabian Gulf on the east. The eastern coast of the Kingdom of Saudi Arabia, front facing the Arabian Gulf, is rich in various coastal geomorphological phenomena which are affected by marine erosion in terms of their origin, formation and

* Corresponding author

development. Among these forms are coastal bays. Coastal bays appear in the form of water bodies partially surrounded by neighboring lands, their existence is linked to the presence of a group of geomorphological phenomena which determines their morphology and characteristics, such as: heads, spits, barriers, beaches and coastal lakes.

These forms are subject to morphological alterations from time to time due to changing marine and continental factors. The “Half Moon Bay” is one of the coastal bays that extend along the western coast of the Arabian Gulf that is the eastern coast of the Kingdom of Saudi Arabia. It is situated within the rapidly growing Eastern Region of Saudi Arabia and has become one of the most attraction and tourism sites in the eastern coast.

In order to achieve aims of the study, the geomorphological forms in the Half Moon Bay area and their utilization for tourism purposes shall be addressed. A group of distinctive land forms spread along the sea coast that reflects the action of natural waters, which has contributed greatly to placing the study area within the marine sedimentation zones. Therefore, the dominance of geomorphological phenomena resulting from marine sedimentation is clearly observed in the region. The sculpting factors transport sediments and collect them in different parts along the shore or under nearby shallow water. Then advanced sedimentary forms are then developed in different patterns, extensions, areas, and textures. It is obvious that the geomorphological phenomena in the study area have greatly contributed to giving the characteristics of the beautiful coastal landscape. The presence of all kinds of beaches, especially sandy beaches, sand spits and sand barriers, in addition to beach sand dunes and tidal flats have drawn the attention of stakeholders of the government and private sectors to invest in the Half Moon Bay beach for human activities, especially recreational and touristic activities.

The following will show how the hands of human development have been able to benefit from and to exploit the geomorphological phenomena in the region. In the past, the bay was known for fishing and sailing, then it has become favorable for swimming especially by oil workers and their families when operations of oil exploration have started. Thus, the Half Moon Beach became a recreational area for oil workers and their families over the last 80 years. The Half Moon Beach was even named by early foreigners who worked in the field of oil industry for Saudi Aramco. A recent study by Alkhalaf and Oran (2021) have found that 95% of the Half Moon Bay visitors were from the Eastern Province of the Kingdom of Saudi Arabia seeking coastal tourism and entertainment while enjoying sandy beaches and beauty of nature.

Since then, hands of tourism development, whether governmental or private, have begun to invest in the Half Moon Bay. The process has accelerated after the announcement of Saudi Kingdom’s ambitious vision of 2030 aiming at diversifying sources of the national income instead of relying solely on oil as the only resource. This has greatly increased the utilization of the study area and its characteristic geomorphological phenomena. Several tourist and entertainment facilities were found along shores of the Half Moon Bay (Table 1). In the following sections the study shall specify forms of utilizing the geomorphological phenomena in the Half Moon Bay.

Table 1. Tourist and entertainment facilities in the Half Moon Bay, based on google maps and field survey.

Type of facility	Resorts	Chalets	Public beaches	Private beaches	Water parks
Number	13	11	10	4	2

The study aims at monitoring the tourism uses of geomorphological forms within the Half-moon Bay, and to identify practical aspects that may be used to develop the coast at the same time, preserve its geomorphological balance. The study was based on literature review, field survey, analysis of google earth satellite imagery and risk analysis. Finally, SWOT analysis were applied in order to identify risks and highlight prospects of geotourism in the study area.

MATERIALS AND METHODS

The coastal land forms (geomorphological phenomena) in the Half Moon Bay were reviewed from literature and were described with the aid of satellite imagery of google earth and field survey. Coastal phenomena utilized for tourism were assessed and characterized in terms of purpose, degree of human intervention and potential impacts. Risk analysis was performed in order to identify the degree of harmful impacts of tourism on the natural environment of geomorphological forms. The strategic SWOT analysis was used to highlight points of strength and weakness regarding tourism activities in the study area as well to recognize constrains and available opportunities. The flow chart of methodology is shown in Figure 1.

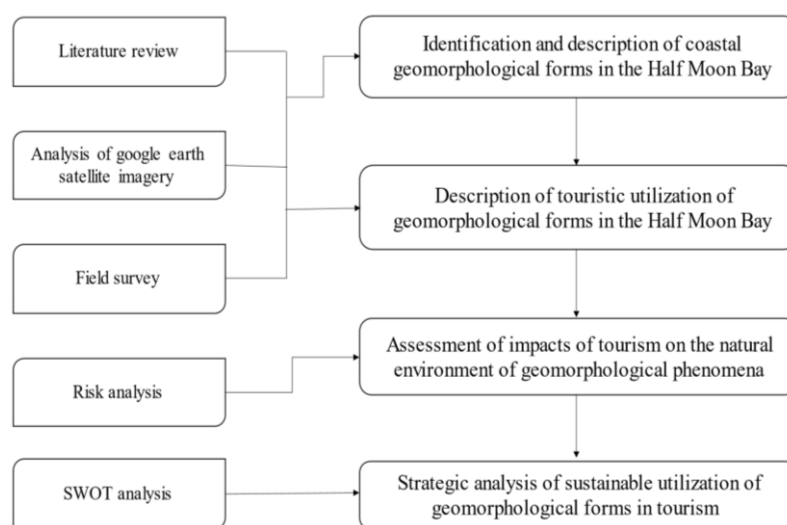


Figure 1. Flow chart of research methodology

The study area

Location of the study area: The study area is located between longitudes 55° 49' and 30° 10' 50" E, and latitudes 1°26' and 30° 12'26" N, representing part of the eastern coast of the Kingdom of Saudi Arabia. The Half Moon Bay is located about 15 km south of Dhahran, 25 km north of Uqair Beach and about 60 km north of Salwa (the border with Qatar). It is

located about 30 km west of the Kingdom of Bahrain and 46 km away from the city of Abqaiq (Figure 2). The Half Moon Bay extends from Ras Buraigt to Al Musa'idiyah forming an 81.4 km long semi-circular shape. The water arm extends for about 22.3 km into the land from south to north, the head of the Bay ends to the south of the "Cooperation Council Road" (the road leading to King Fahd Bridge that connects the Kingdom of Saudi Arabia with the Kingdom of Bahrain). The climate at Dammam station (10m a.m.s.l) ranges between arid to hyper-arid with a maximum temperature of 34.5° C and a minimum temperature of 20.3° C and 91.5mm annual rainfall. The maximum temperature during winter (December-February) ranges between 22 and 24 degrees centigrade associated with winter rainfall ranging between 8 to 20mm (National Center for Meteorology, 2023). Obviously, climate conditions are more pleasant during winter time compared to the rest of the year.

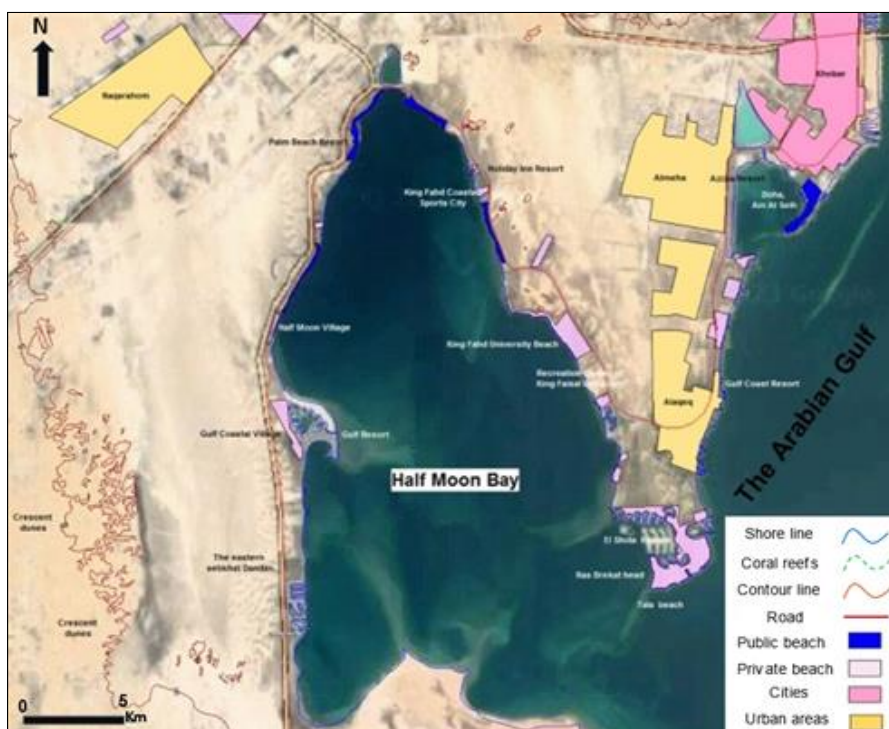


Figure 2. Location of the study area

Geomorphology of the Half Moon Bay

The 700 kilometers long Gulf coast of the Kingdom of Saudi Arabia, forms a wide coastal plain that was formed during Late Quaternary Sea transgression. Average spring tide of the Arabian Gulf is 1.5 meters high while currents are low and wind-driven (Bird, 2010). Morphologically, the Half Moon Bay is formed of the Dammam Peninsula and the Ras Abu Uriqat on the east, the Jafurah sand dunes on the west and Ras Al-Qurayyah on the south (Weijermars, 1999). Distinguished land forms are found along marine shorelines which reflect action of natural and chemical water properties in the Half Moon Bay region. These natural properties have placed the study area among marine sedimentation zones. This explains the wide distribution of geomorphological phenomena resulting from marine sedimentation. Erosion factors transport and accumulate sediments in different sectors along coast line or under near-by shallow water portraying a set of developed depositional forms with varying shape, area and texture. Some sediments accumulate along coast line such as beaches and sand bars others extend seaward such as marine spits (Bird, 2008). Following, are examples of geomorphological forms found in the study area. Beaches: they extend along many terrestrial/marine borders making a few-to-hundreds of meters wide zone extending between tidal range and maximum limits of wave action. Beaches may be straight, gently curved, sharply carved, long or short (Bird, 2008). Beach forms in the Half Moon Bay differ depending on shape and size of sediments resulting in the two main patterns; sandy beaches that are composed of fine sediments less than 1mm size in diameter originating from different sources such as marine erosion and aeolian deposition of terrestrial sand dunes. Pebbly beaches that were formed in certain sectors of the Half Moon Bay coast facilitated by the dominant tidal system in the study area. These beaches are composed of pebbly sediments and rock chips that are 25 to 35 mm and 5 to 7 cm in size with, respectively. They are transported and deposited by tidal waves on beaches depending on the speed of movement.

Heads and Cuspate: are triangular extensions based on land and pointing seaward formed of sorted sediments accumulated by the forward and backward movements of sea waves. They are formed during the collision of stronger waves approaching the shore at an angle and a weaker direct onshore wave (Bird, 2008).

Sand spits: are elongated accumulations of loose sediments extending from coast line into the sea, so that one end is linked to the land while the other one ends in the sea making a right angle to the coast line. Shore currents, sediment input and river processes influence the formation and development of spits (Gül et al., 2020). During early development, they grow up increasing in length until they reach deep water where the action of destructive waves starts. Their shape is controlled by wave patterns striking the shore obliquely (Bird, 2008). Sand spits may be supplied with sands eroded from cliffs or shores or with fluvial sediments derived to a river mouth (Bird, 2008). Two main spits could be recognized in the

Half Moon Bay; one on the western coast and the other in the eastern coast. The end of the former spit has recurred landward making a “hook” shape due to wave refraction or variable wave directions along the sides (Goudie, 2006).

Sand barriers: are elongated sandy or mixed coarse sediments that are deposited parallel/semi parallel to coast line forming islands that extend above average highest tide level and may enclose lakes or water bodies between them and the coast (Bird, 2008). They represent submerged hills formed of fine marine sediments as large bodies in the shallow waters that emerge above sea level separating the coastline from the open sea. Tidal flats: are water flats that are formed parallel to beaches due to alternating high and low tides. They extend for 2 to 15 meters making different shapes according to beach patterns. They were named as “marine erosion shelves” after Bird (1984) because of successive inundation of these water flats during high tide which activates humidity action awhile low tide exposes these flats to air leading to dryness and facilitates chemical weathering especially under high temperature and slight sloping seaward.

Coastal salt flats (sabkhas): are low lands close to groundwater level or sea level their bottoms are covered with salty mud formed by accumulation of coastal water. Sabkhas in the study area are among coastal flats that are covered with salt, located above high tide level and are sloping gently towards the sea by around 0.4 m/km (Weijermars, 1999).

Rios-Reyes et al. (2021) have recognized similar coastal landforms as potential geosites for geotourism activities around Santa Maria (Colombia). Never the less, authors have looked into geoeducational and conservation issues related to proposed geosites in a holistic approach. Geodiversity is considered as an asset that should be recognized, appreciated and protected. Sustainable geotourism activities are achieved through efficient environmental management based on regulations and guidelines set to ensure proper development of tourism infrastructures, spread of environmental awareness and natural conservation. Developing coastal tourism with more benefits to tourists, local community and the natural environment represents the major challenge in achieving sustainability (Satta et al., 2009).

RESULTS AND DISCUSSION

Tourist use of sandy beaches

The Saudi government, represented by the governorates and municipalities, especially the Eastern Province Municipality, the Dhahran Municipality and specifically the Beach Services Department, were able to establish many public beaches whose locations were chosen with great care. Many public beaches agreed in their extension with the phenomenon of sandy beaches distributed in the northern, eastern and western sides of the bay (Figure 3A, B, C and D). They were provided with many rest houses, chapels, toilets and children's outdoor games which are maintained clean and in good condition by the Beach Services Department. The municipal rest houses were constructed in different geometric shapes in order to reduce the effect of salt erosion, a characteristic phenomenon of coastal areas. On the other hand, a few beaches were improperly established on pebbly beaches which contain pebbles that pose risk to beach users especially during tides (Figure 4), this has definitely, limited their use for water entertainment purposes.

The private sector has followed a different approach for developing the sandy beaches of the study area. It has established many chalets on those beaches (Figure 3E and F), in order to maximize benefits of tourist resorts through providing accommodation facilities allowing beneficiaries to stay overnight for more than one day. The nature of the charming sandy beaches offers an aesthetic view to their coastal tourist facilities.

A photography by the author, March 2021 (A) Public beach east of the study area (Half Moon beach swimming), looking west - X 50.071 - Y26.141; (B) Public beach west of the study area (Amwaj Beach), looking East - X 50.001 - Y 26.138; (C) Public beach north of the study area (Alluwlu Beach), looking East- X 50.060- Y 26.184; (D) Public beach west of the study area (Almahar Beach), looking South- X 50.051- Y 26.191; (E) A private beach west of the study area (Mina holiday Beach), looking East - X 50.066- Y 26.174; (F) A private beach east of the study area (Qaryat Nisf Alqamar Beach), looking west - X 49.988- Y 26.120.



Figure 3. Public and private recreational beaches in the study area



Figure 4. Public beaches established in the pebbly beach on the northwestern coast of the study area (Source: by the author, March 2021, Alluwlu Beach, looking north, X 50.060- Y 26.184)

A photography by the author, March 2021, (A) Public beach east of the study area (Half Moon beach swimming), looking west - X 50.071 - Y26.141; (B) Public beach west of the study area (Amwaj Beach), looking East - X 50.001 - Y 26.138; (C) Public beach north of the study area (Alluwlu Beach), looking East- X 50.060- Y 26.184; (D) Public beach west of the study area, (Almahar Beach), looking South- X 50.051- Y 26.191; (E) A private beach west of the study area, (Mina holiday Beach), looking East - X 50.066- Y 26.174; (F) A private beach east of the study area (Qaryat Nisf Alqamar Beach), looking west - X 49.988- Y 26.120

Tourism use of sand spits

This pattern of use appears in the tourist resorts that follow the private sector investments in developing the region, where the sandy spits of the study area were transformed into extension areas on which the buildings of the tourist resorts were established (Figure 5 and 6). These features represent a weak marine sedimentation on the rocky formations, which requires strong foundations for construction, their main component however are the sandy sediments that are carried by waves and deposited due to change of direction and tendency to precipitate. Figure (5) shows how the "Holiday Inn" resort was able to extend its construction in the form of chalets on one of the sand spits extending out of the eastern coast that falls within the limits of its ownership. The spit is a source of beauty in itself, yet, it is a source feeding the resort beach with sands transforming it into an urban use in the form of Chalets extending into the sea.

As shown in Figure (6), a complete resort was built along the main sand spit on the western beach of the Half Moon Bay. Part of the sand spit was cut off in order to allow the water of the Arabian Gulf to enter the territory of the resort and extends into the beaches inside, the extensions of the sand spit were then utilized to build the chalets in the waters of the Gulf. This presents a nice view of the site as clearly seen in the Gulf Resort and Al Dana Beach Resort established along the western beach of the study area, where the natural shape of the sand spit has been greatly modified.

The tourist use of the marine heads

Human intervention on geomorphological phenomena in the study area has largely deformed their original forms and the secret of their natural beauty, in order to establish tourist facilities and to generate economic profit. This can be again, observed in Ras Braiket, which is the main head of the Half Moon Beach area where backfilling and excavation have greatly modified the natural features of the head (Figure 7).

The pattern of sculpting and sedimentation of the marine head has changed when water channels were dig to allow Gulf water to enter into the heart of the resort (Figure 7), a thing which has ceased the sedimentation processes prevailing in the head area.

Moreover, the extension of the head area was modified, for example, the natural shape of the head has been transformed into different man-made geometric forms of the Emerald Beach Resort. Another example could be observed in the sanctuary of Ain Al-Seih, where the Sunset Marina and Spa has been developed. The construction of the resort has taken advantage of the elongated extension of the head in the southwest direction benefiting of the double-side beaches; the



Figure 5. The extension of the chalets of the Holiday Inn Resort on the sandy spit on the eastern coast of the Half Moon Bay (Source: author March 2021, Qaryat Nisf alqamar Beach, looking west, location: X 49.988 - Y 26.120)



Figure 6. The Tourist use of sandy spits by the Dana Beach Tourist Resort and the Gulf Resort on the western beach of the study area (Source: Google Earth image, 2021)



Figure 7. The Tourist use of marine heads in Ras Braiket by the Torch Tourist Resort on the eastern shore of the study area (Source: Google Earth image, 2021)

southeastern side is facing Doha while the opposite one facing the Gulf. Once again, the resort construction may have caused disturbance of the geomorphological process prevailing in the head area.

Tourist use of tidal flats

Tidal flats are marine forms that may be recreated by backfilling and transformed into urban areas allowing their use as tourist resorts extending towards the sea. This will lead to deterioration of marine plants and wildlife, in addition to the devastation of one of the important geomorphological phenomena, which directly contribute to protecting shores from sea inundation. Figure (8) shows areas of tidal flats that were filled seaward in order to expand the lands of the tourist resort (Holiday Inn). Obviously, the filling expanded significantly outside the tidal flats reaching the waves breaking area and even further to deeper waters than tidal flats zone.

Generally, backfilling or reclamation of tidal flats leads to changing the coast line and increasing its meanders, which causes imbalance of natural sculpting and sedimentation processes. Moreover, it results in disturbing movement of coastal water currents which ultimately, changes the shape of the coast and associated phenomena.

Tourist use of the cutoff lakes

The main cutoff lake is located in the north of the study area; is about 0.77 km² in area. It is formed due to construction of King Fahad Road that goes around the Half Moon Beach reaching Al-Khobar city. This cutoff lake was utilized by the La Fontaine Lake Resort to represent a different style of tourist attraction in the study area that is based mainly on water sports entertainment. Various water sports, rest houses on beaches and opposite tourist chalets are common features associated with this cutoff lake as shown in Figure (9) and Figure (10). The La Fontaine Lake Resort is located southwest of the lake, extending over an area of 90,000 m² and extending along the coast for 400 meters taking advantage of calm waters of the lake and wave-free sea currents, in water sports, which distinguishes the La Fontaine resort from other resorts in the region.

Tourist use of beach dunes

To the northeast of the study area, sand dunes directly face the Half Moon Bay, representing one of the geomorphological phenomena in the region which was utilized for quad biking sport using (beach buggies). A center for this sport was established near those sand dunes in the study area. Practicing this sport leads to destruction of some secondary geomorphological phenomena, such as the "neem" (sand ripples) which represent natural indicator for wind direction, strength, and speed. Human intervention in the natural environment represented by the geomorphological forms, has devastating effects on these phenomena, especially in the study area, that is subject to dynamic change factors such as sea waves, sea currents, tides and winds. Such that, any intervention shall disturb the balance between sculpting and sedimentation processes, changing range of sculpture with respect to range of deposition which has been taking place in the study area.

Many sites were subject to human intervention through backfilling of near-shore sea zone in order to accommodate several tourist resorts, making the shore line more subject to sculpting and retreat by sea waves despite the relatively calm nature of sea waves in the Half Moon Bay. The geomorphological effects identified in the study area include; changing shape, direction, length and meandering of the coastline, and associated geomorphological forms such as spits, sandy beaches, tidal flats and lagoons. Instead of the destructed geomorphological forms, other natural and anthropogenic phenomena have emerged. The natural phenomena were due to prevailing marine action while man-made phenomena were in the form of tourist resorts constructed for human benefits. In anyway, geomorphological forms in the study area have



Figure 8. The Tourist use of tidal flats by a resort (Holiday Inn) on the eastern shore of the study area. Source: Google Earth image, 2021

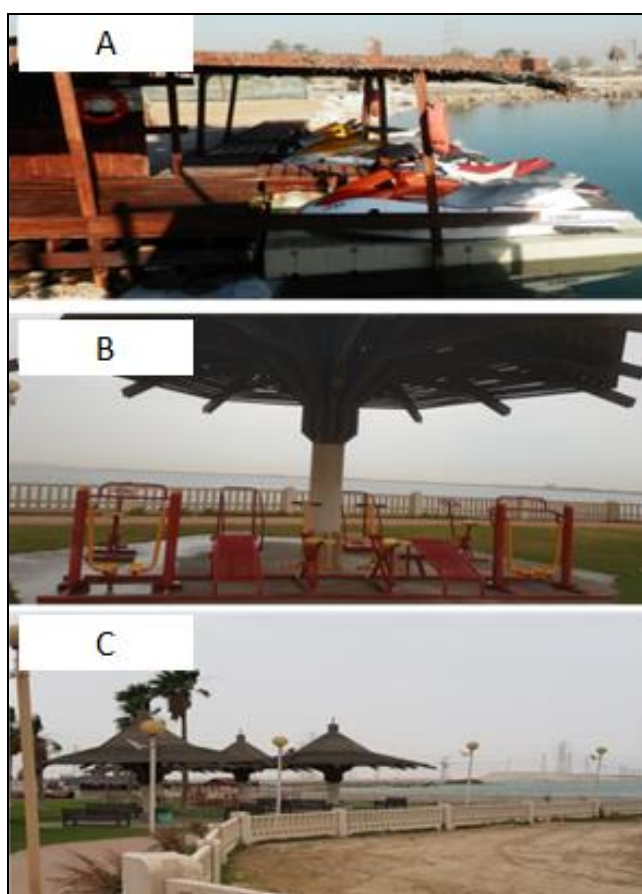


Figure 9. The use of the cutoff lake in various recreational activities at La Fontaine Lake Resort on the northern shore of the study area (Source: by the author, March 2021, (A) Water sports (Dana Bay) looking South - X 50.009 - Y 26.078; (B) Sport kits (Hajar Castle) looking North - X 50.024 - Y 26.193; (C) Resting place (Hajar Castle) looking North - X 50.024 - Y 26.193

been completely or partially modified, the natural ecosystem was disturbed and the marine processes have lost equilibrium. Also, extension of sea backfilling behind waves breaking line has widened areas exposed to carving operations resulted in marine erosion of synthetic constructions, material removal and deposition in other areas.

One of the important modifications to the geomorphological phenomena in the study area is the introduction of new elements constituting rock masses that were not previously existing in the sediments of the area i.e., changing the mineral composition of sediments during the filling operations. Generally, artificial spits that extend in the water perpendicular to the shore line occupied by tourist facilities are the most common variation patterns in the study area. These spits remained limited in length because of the destructive action of sea waves at deeper waters which could sculpt away the filling material. Nevertheless, alteration of coastal geomorphological phenomena has affected aspects of life in terms of fauna including microorganisms and crustaceans that feed on algae, in addition to flora represented by algae.

From the above, we note that the most important impacts on geomorphological phenomena in the study area include; the imbalance between the sculpting, transport and sedimentation processes in the beach area, problems related to the overlap between natural action and land use in the region, as well as the disturbance of marine ecosystems.

Recent years have witnessed a strong focus on the Half Moon Beach as a tourist attraction area in the Eastern Region, therefore, tourism investments and projects have been established and concentrated along sea coast of the Bay. The study area is located close to major urban communities, represented by the city of Al-Khobar with its waterfront, the city of Dammam and the city of Dhahran from the north and located to the east of the city of Hofuf, Mubarraz, Al-Amran, and Abqaiq. Thus, the study area represents the recreational beach for these urban centers, with a population number of about 2.6 million people, according to population census in 2010 (General Authority for Statistics, 2010). Obviously, the study area represents the coastal outlet for the population of urban centers of the eastern Region providing beach entertainment and recreation despite the fact that there are some coastal cities in the region such as Dammam and Al-Khobar.



Figure 10. The Tourist use of the cutoff lake by Lafontaine Lake Resort on the northern shore of the study area (Source: A photography by the author, March 2021, and Google Earth image, 2021)

Impacts of tourism

The use of geomorphological phenomena as tourism attraction sites have gained great attention in recent years leading to emergence of a new style of tourism that is, “geotourism” (Pralong, 2006). On the other hand, several direct and indirect impacts of tourism on natural land forms are anticipated (Bogdan, et al., 2009). It is believed that coastal tourism, in particular, has rapidly grown over the last decades contributing to national economies and community welfare worldwide (Satta et al., 2009). Despite of the clear economic benefits and recreational value of coastal tourism, sustainability and environmental conservation are still unresolved challenges. Miller and colleagues (2002) proposed three mechanisms in order to attain sustainability of coastal tourism systems including: planning, management and education. The report of the United Nations Environmental Programme (Satta et al., 2009) proposed an integrated coastal zone management (ICZM) approach involving sustainable tourism together with other related sectors such as energy, water and transport. On the other hand, in order to assess the effectiveness of coastal landforms for tourism development it is necessary to evaluate their distribution, characteristics, evolution and dynamics (May, 1993; Davis et al., 2021). Coastal landscape produced by specific geomorphological processes must be recognized and preserved as it provides opportunity for coastal tourism however, these phenomena are subject to different kinds of threats (May, 1993). The Kingdom of Saudi Arabia has recognized the importance of sustainable development and promotion of coastal and marine tourism. The Ministry of Tourism has signed

an agreement with the Greek Ministry of Tourism during the Coastal and Maritime Tourism Conference in Athens in order to share knowledge and experience related to environmental-friendly and sustainable investment of coasts and marine environments in the tourism and entertainment business (Alsharq Al-Awsat, 2021). From the above, three levels of potential impacts on the geomorphological phenomena and natural system of the Half Moon Bay region could be identified. They are expected to occur as a result of changes associated with population activity in general and tourist activity in particular. The extremely dangerous impacts, the medium-risk impacts and low risk impacts. In the following sections the three levels of impacts on the study area are discussed.

Extremely dangerous impacts

These are the effects whose destructive results appear in a short period of time, and they occur as a result of sea backfilling and reclamation works aiming at building various tourist resorts on tidal flats. These actions have led to alterations of coastal geomorphological phenomena, especially the morphology of the coastline in terms of length, meander and direction. A group of heads were established by concrete construction of tourist villages in the face of attacking waves, which led to carving and consequently erosion of marine forms such as spits as in the case of the "Holiday Inn" resort, where the backfilling operations extended beyond the waves breaking line. A recent study by Gül et al. (2020), indicated that uncontrolled sand extraction, inhibition of long-shore currents and walking along the spit of Kizkumu (SW Turkey), have caused intense erosion. The inherent danger of backfilling operations and land expansion at the expense of sea water appears in the destruction of geomorphological phenomena in the area and the creation of a new industrial forms, which harms the components of the natural environment, especially distinction of some biotic species. A recent study by Zhang et al. (2023) have indicated that tidal flat reclamation has significant influences on tidal and suspended sediment dynamics based on numerical modeling.

Medium-risk impacts

Human influences of medium severity in the study area result in dangers that appear in a longer period of time than the previous group of impacts. They include effects related to environmental concerns of marine pollution from unmanaged waste disposal by owners and visitors of tourist resorts. The direct impact of this problem is recognized after a while when the natural and chemical properties of sea water start to change affecting the vital marine ecosystem especially the delicate coral reefs. According to Wang et al. (2023), reduction of values of ecosystem services such as soil retention, habitat quality, carbon storage and water conservation has been observed in two coastal regions of China over 15 years attributed to tourism development and other factors. Potential impacts on marine properties include variations in sea water temperature, transparency, and oxygen content, which directly affects living organisms and lead to distinction coral reefs. The severity of these impacts varies depending on type and amount of pollutant, dumping locations, absorption ability of sea water and sea water regeneration.

Table 2. The SWOT analysis of tourism in the Half Moon Bay

	Strengths	Weaknesses
Internal	<ul style="list-style-type: none"> The importance of the Eastern Province in respect to The strong tourism attraction of the eastern coast in general and the Half Moon Bay in particular 	<ul style="list-style-type: none"> Lack of environmental awareness of local tourists about conservation of nature
	<ul style="list-style-type: none"> The reasonable climate especially during winter season 	<ul style="list-style-type: none"> Urban growth and changing land sue of the region Close by activities of oil industry which may present sources of pollution
	<ul style="list-style-type: none"> Proximity of the region to neighboring Gulf countries 	<ul style="list-style-type: none"> Lack of accurate commitment of tourism industry to environmental practices
	<ul style="list-style-type: none"> Availability of variety of tourism and accommodation facilities in the region 	<ul style="list-style-type: none"> Seasonality of tourism in the region
	<ul style="list-style-type: none"> Good accessibility via local road network. 	<ul style="list-style-type: none"> Shortage in monitoring of public tourism facilities
	<ul style="list-style-type: none"> Preference of local population of the Eastern Province 	
	Opportunities	Threats
External	<ul style="list-style-type: none"> Saudi government directions towards tourism as a potential source of national income 	<ul style="list-style-type: none"> Potential negative environmental impacts of tourism
	<ul style="list-style-type: none"> Recent legislations in the Kingdom of Saudi Arabia facilitating conditions for tourist visa 	<ul style="list-style-type: none"> Attraction of local tourist to other tourism or entertainment locations inside or outside the Kingdom of Saudi Arabia
	<ul style="list-style-type: none"> Very high level of income of Saudi residents 	<ul style="list-style-type: none"> Saudi tourism competitiveness compared to Gulf countries especially cost wise
	<ul style="list-style-type: none"> Flow of visitors from gulf countries passing through on their way to Riyadh, Mekkah or Al-Madinah which provides an opportunity to recognize and appreciate the natural attraction of the region 	<ul style="list-style-type: none"> Alteration or loss of coastal land forms due to urbanization and land use development
	<ul style="list-style-type: none"> Increasing job opportunities related to tourism in the region especially for Saudi citizens 	<ul style="list-style-type: none"> Adverse impacts of environmental variations such as climate change on natural ecosystems
	<ul style="list-style-type: none"> National efforts to enhance conservation of natural areas 	
	<ul style="list-style-type: none"> Declaration of digital tourism strategy in in the Kingdom of Saudi Arabia Plans of Saudi government to attract foreign investments especially in the tourism industry 	

Low risk effects

These are effects which result in dangers that take a much longer period of time to emerge, they are linked to the increase of population density of the region and associated harmful impacts. They include impacts of fishing behaviors, especially overfishing of some rare aquatic organisms and the use of wrong fishing tools such as spears, poisonous gases, and types of violating nets. As mentioned by Pradhan et al. (2022), socioeconomic developments and human interventions have resulted in coastal erosion which affected the natural habitat for nesting of sea turtles in the eastern coast of India. In addition to establishment of many ports and anchorages for yachts and boats which results in the distribution of pollution in a wider area. Practices such as driving boats close to rare living environments and dumping anchors without giving attention to locations of fragile coral reefs shall ultimately lead to destruction of those environments on the long run.

From all of the above, the previously discussed environmental concerns reflect the adverse impacts of human activities in the study area that will drive the region to lose its most important tourist resource, represented by the natural view of coastal geomorphological features and the existence of coral reefs. This will finally reduce the level of tourist attraction of the region, cause loss of tourist facilities and may cease the tourist activities at all.

SWOT analysis of tourism activities in the Half Moon Bay

Given the above-described level of utilization of the geomorphological phenomena in the Half Moon Bay, the economical merits and potential impacts, SWOT analysis have revealed the Strengths versus Weaknesses and Opportunities versus Threats of tourism in the study area (Table 2). Indeed, several points of strength have been pointed out as internal assets for the Half Moon Bay including its distinct location in the vicinity of neighboring Gulf countries, the strong tourism attraction among other sites in the Eastern Region and the well-developed road network and tourism infrastructure. On the other hands, the growing urban land use and industrial activities, threatens the sustainable development of tourism in the region. The analysis outlined some major constrains facing tourism in the Half Moon Bay, such as the expected adverse environmental impacts, loss of natural environments and land forms and competition with other attraction sites. However, the new trends of Saudi government towards tourism as an alternative source of income, facilitation of tourism visa, continuous flow of passing by visitors from Gulf countries and efforts of natural conservation represent the main available opportunities to promote and develop sustainable tourism in the region.

CONCLUSIONS AND RECOMMENDATIONS

The Half Moon Bay is characterized by a set of natural properties including location, surface topography, geological formation, climate, marine processes (waves, tides and currents) in addition to a number of geomorphological phenomena which have made it suitable for human interventions. This has encouraged public and private sectors to benefit economically from the natural potentials of this region in tourism investment leading to interventions and modifications of natural phenomena. Alterations constitute change of direction, length and meander of coastline in the region due to land excavation and reclamation of shallow sea water.

Changes in different sectors of the Half Moon Bay were recognized. Clearly, the eastern cost was found to be the most variable, followed by the western cost, while the northern coast was the least variable. Variations were in terms of coastline properties and outlines of geomorphological phenomena. Natural geomorphology (action of nature) has been transformed into synthetic morphology (action of man) in addition to destruction of coral reefs environment and loss of biodiversity.

Presumed impacts on the natural environment of the Bay region were classified into three levels based on the degree of risk; the highly dangerous impacts, whose effect appears in a short period of time and result from backfilling of sea water, the medium risk effects, whose impact appears in a bit longer period of time and results from sea water pollution, and the low-risk impacts, whose effect appears in the long run and result mainly from human misconduct during tourism activities.

Despite some constrains, several opportunities are available in order to promote and develop sustainable tourism in the region mainly supported by a set of legislations, efforts and actions at the national and local levels.

The study was concluded with a set of recommendations, including:

1. It is necessary to identify harmful environmental impacts of human intervention on the geomorphological phenomena **and associated natural processes in order to ensure sustainability of tourism business as well as to preserves the environment.**

2. Increase of environmental awareness among tourists in order to avoid inappropriate behavior harmful to the environment, and monitor and control sanitation practices of tourist facilities in terms of waste disposal.

3. Preservation of unaffected geomorphological phenomena in the Half Moon Bay especially in the middle sector of the northern beach through avoiding future interference in this zone. This shall protect the existing geomorphological phenomena, avert environmental deterioration as well preserve the natural assets of the region, the main point of tourist attraction.

Author Contributions: Conceptualization, M.N. and W.S.; methodology, M.N. and I.B.; software, I.B. and W.S.; validation, M.N. and W.S.; formal analysis, I.B. and M.N.; investigation, M.N. and I.B.; data curation, W.S. and M.N.; writing - original draft preparation, M.N. and I.B.; writing - review and editing, I.B.; visualization, W.S. and M.N.; supervision, I.B.; project administration, M.N. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, Saudi Arabia [Grant No 4,522].

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study may be obtained on request from the corresponding author.

Acknowledgments: The research undertaken was made possible by the equal scientific involvement of all the authors concerned.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

- Alkhalaf, F., & Orams, M.B. (2021). Coastal Tourism in Saudi Arabia. An Exploratory Study of Half Moon Beach. *Tourism in Marine Environments*, 16(3), 183-194 <https://doi.org/10.3727/154427321X16270454534433>
- Aragón-Correa, J.A., Torre-Ruiz, J.M., & Vidal-Salazar, M.D. (2023). Agglomerations around natural resources in the hospitality industry: Balancing growth with the Sustainable Development Goals. *Business Research Quarterly*, 26(1) 11-26 <https://doi.org/10.1177/23409444221103283>
- Alsharq Al-Awsat (2021). Saudi Arabia, Greece Collaborate to Boost Sustainable Coastal, Marine Tourism, 7th June, 2021, (accessed 25/4/2023) <https://english.aawsat.com/home/article/3013946/saudi-arabia-greece-collaborate-boost-sustainable-coastal-marine-tourism>
- Bird, E.C.F. (1984). *Coasts: an introduction to coastal geomorphology*, third edition, Basil Blackwell, Oxford, United Kingdom.
- Bird, E. (2008). *Coastal Geomorphology: An Introduction, Second edition*. John Wiley & Sons Ltd, West Sussex, England.
- Bird, E. (2010). Saudi Arabia, Persian Gulf Coast. In *Encyclopedia of the World's Coastal Landforms (1045–1046)*. Springer, Dordrecht, The Netherlands https://doi.org/10.1007/978-1-4020-8639-7_194
- Davidson-Arnott, R. (2009). Coastal geomorphology. In *Introduction to Coastal Processes and Geomorphology (10-16)*. Cambridge University Press, Cambridge, United Kingdom <https://doi.org/10.1017/CBO9780511841507.003>
- Davis, P., de P., Jailson, C.L., Eduardo, L.B., & Jader de O.S. (2021). Coastal erosion and tourism: the case of the distribution of tourist accommodations and their daily rates. *Geography, Environment, Sustainability*, 14(3), 110-120 <https://doi.org/10.24057/2071-9388-2021-018>
- Gomez, C.A., Hart, D.E., Wassmer, P., Kenta, I., Matsui, H., & Shimizu, M. (2019). Coastal Evolution, Geomorphic Processes and Sedimentary Records in the Anthropocene. *Forum Geografi*, 33 (1), 1-24 <https://doi.org/10.23917/forgeo.v33i1.7551>
- Goudie, A.S. (2006). *Encyclopedia of Geomorphology*, I (A-D), (ed.), Taylor & Francis e-Library.
- Gül, M., Küçükuysal, C., Çetin, E., Ataytür, Ö., & Masud, A. (2020). Coastal Erosion Threat on the Kızılkumu Spit Geotourism Site (SW Turkey): Natural and Anthropogenic Factors. *Geoheritage* 12, 54 (2020) <https://doi.org/10.1007/s12371-020-00477-0>
- Hall, C.M. (2001). Trends in ocean and coastal tourism: the end of the last frontier? *Ocean & Coastal Management*, 44(9-10), 601-618 [https://doi.org/10.1016/S0964-5691\(01\)00071-0](https://doi.org/10.1016/S0964-5691(01)00071-0)
- May, V. (1993). Coastal Tourism, Geomorphology and Geological Conservation: The Example of South Central England. In: Wong, P.P. (eds) *Tourism vs Environment: The Case for Coastal Areas*, 3-10, 26, The GeoJournal Library, Springer, Dordrecht. The Netherlands https://doi.org/10.1007/978-94-011-2068-5_1
- Mestanza-Ramón, C., Chica-Ruiz, C.J., Anfuso, G., Mooser, A., Botero, C.M., & Pranzini, E. (2020). Tourism in Continental Ecuador and the Galapagos Islands: An Integrated Coastal Zone Management (ICZM) Perspective. *Water*, 12(6), 1647(2020) <https://doi.org/10.3390/w12061647>
- Bogdan, M., Reynard, E., Werren, G., Savulescu, I., Sandric, I., & Chitu, Z. (2009). Impacts of tourism on geomorphological processes in the Bucegi Mountains in Romania. *Geographica Helvetica*, 64(3), 134-147 <https://doi.org/10.5194/gh-64-134-2009>
- Miller, M.L., & Hadley, N.P. (2005). Tourism and Coastal Development. In: Schwartz, M.L. (eds) *Encyclopedia of Coastal Science. Encyclopedia of Earth Science Series*. Springer, Dordrecht, The Netherlands https://doi.org/10.1007/1-4020-3880-1_328
- Miller, M.L., Auyong, J., & Hadley, N.P. (2002). *Sustainable Coastal Tourism: Challenges for Management, Planning, and Education*. In Proceedings of the 1999 International Symposium on Coastal and Marine Tourism: Balancing Tourism and Conservation, (eds.) University of Washington, Oregon State University and Oceans Blue Foundation, Seattle, WA, USA, 3-20.
- National Center for Meteorology, (2023). Reports of seasonal climate conditions found at. (Accessed 6/5/2023) <https://ncm.gov.sa/Ar/MediaCenter/Reports/Pages/medialibrary.aspx?folderID=a8807580-fef8-425c-8981-c757ec9f33ea>
- Neumann, B., Ott, K., & Kenchington, R. (2017). Strong sustainability in coastal areas: A conceptual interpretation of SDG 14. *Sustainability Science*, 12(6), 1019–1035 <https://doi.org/10.1007/s11625-017-0472-y>
- Pradhan, U.K., Mohantym, P.K., & Mishram, P. (2022). Coastal erosion: a threat to sea turtle nesting habitat, east coast of India. *Rendiconti Lincei. Scienze Fisiche e Naturali*, 33, 153–167 <https://doi.org/10.1007/s12210-022-01046-z>
- Pralong, J.P. (2006). Geotourism: A New Form of Tourism Utilizing Natural Landscapes and Based on Imagination and Emotion. *Tourism Review*, 61(3): 20-25 <https://doi.org/10.1108/eb058476>
- Rios-Reyes, C.A., Manco Jaraba, D.C., & Castellanos Alarcon, O.M. (2021). Geotourism Potential and Challenges of the Coastal Region Around Santa Marta (Colombia): a Novel Strategy for Socioeconomic Development. *Cuadernos de Geografía: Revista Colombiana de Geografía*, 30(1), 106-124 <https://doi.org/10.15446/rcdg.v30n1.81239>
- Satta, A., Trumbic, I., Skaricic, Z., & Markovic, M., (2009). *Sustainable Coastal Tourism: an integrated planning and management approach*. United Nations Environment Programme, Priority Actions Programme, ISBN: 978-92-807-2966-5.
- Wang, P., Zhang, J., Ma, J., Guo, L., Yang, L., Ma, X., Sun, F., & Cao, S. (2023). What impacts ecosystem services in tropical coastal tourism cities? A comparative case study of Haikou and Sanya, China. *Journal of Environmental Management*, 342, 118227 <https://doi.org/10.1016/j.jenvman.2023.118227>
- Weijermars, R. (1999). Quaternary evolution of Dawat Zulum (Half Moon Bay) Region, Eastern Province, Saudi Arabia. *GeoArabia*, 4(1), 71-90.
- Zeinali, S., Dehghani, M., Rastegar, M.A., & Mojarad, M. (2017). Detecting shoreline changes in Chabahar Bay by processing satellite images. *Scientia Iranica, Transactions on Civil Engineering (A)*, 24(4), 1802-1809 <https://doi.org/10.24200/SCI.2017.4271>
- Zhang, R., Chen, Y., Chen, P., Zhou, X., Wu, B., Chen, K., Sun, Z., & Yao, P. (2023). Impacts of tidal flat reclamation on suspended sediment dynamics in the tidal-dominated Wenzhou Coast, China. *Frontiers in Marine Science*, 10:1097177 <http://doi.org/10.3389/fmars.2023.1097177>