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Coastal Erosion and Tourism Infrastructure in Lagos State

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Abstract

The work examined the Impact of Coastal Erosion on tourism infrastructures in Lagos State, especially; the Bar Beach and Lekki Peninsula. It identified sea level rises due to melting ice caps and torrential rainstorms as the major causes of bar beach erosion. The ineffective nature of the drainage channels especially in Lagos Island made it very difficult for storm surges to be managed effectively. Some of the Lagoons like Kuramuo, which expectedly serve as storm surge reservoirs have largely been blocked by urban wastes, making flowage of the lagoons very impossible. It was recommended that the application of a management and conservation approach through a systematic process of problem recognition, planning, implementation and monitoring would ensure proper management of the beaches and prevent coastal erosion.

Keywords:
Coastal Erosion, Sand Beaches and Tourism Infrastructure.

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Background to the Study

Current environmental debate, concern climate, together with predictions of causes and effects: (Nature, 2003; Mathews, 2003). Some of these predictions with respect to coastal sea-level rise could have notable consequences for management of beaches and coastal zones (Grainja and Carvarho, 2000, Rivis, Rates and Kont, 2002). Beach erosion possesses a threat to all stakeholders, especially tourism which has been described as the world largest industry. (World Tourism Organization, 2001). Houston (2002) reported that travel and tourism constitute the largest industry of the United States; highest employer of labour, and major earner of foreign exchange. He identified beaches as the major factor in the universal tourism market and that beach erosion constituted one major concern for tourism. Beaches exist in coastal areas where water is the dominant resource. These beaches include wet land in which water determines the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Kunle, (2002) observed that beaches vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors including human activities.

Coastal zones are often viewed as permanent assets but in reality, they tend to be dynamic, responding to human activities and natural processes (Eze, 2005). Kutchen (2010) identified six major spheres of human activities in the coastal zones. These include the following:

a. Residency and recreation
b. Industrial and commercial
c. Waste disposal
d. Military and strategic
e. Agriculture, fishing and aquaculture
f. Conservation

Kutchen, (2010) observed further that these activities appear to be in conflict with one another and with the natural processes, thus distributing the habit and aggravating coastal erosion. This is well observed in the study area.

The contentious issues therefore, is how to protect and manage our social resources while accommodating growing pressure for the development and maintenance of tourism infrastructure. This paper will discuss causes and effects of coastal erosion: effectiveness of soft and hard engineering responses, and advocate strategies for effective and sustainable management of tourism infrastructure in the coastal zones, especially the Lagos Bar Beach.

Kunle, (2002) noted that Lagos state of Nigeria consists of 3,755 sq.km of land with 70% of it being wet-lands and water bodies. He further added that the Bar beach and other locations in Lagos are attractive tourist zones which are being threatened by illegal dredging: illegal land reclamation and sand mining activities. These have substantially threatened sustainability of the coastlines resulting in ocean surges; flooding and negative environmental consequences. Lagos Beach erosion is reported to be averaging 0.3m per annum possessing a significant threat to coastal zones and tourism based economics. (Eze, 2005). In similar context, Nwakude, (2009) noted that even the rampaging coastal erosion has destroyed the important life sustaining wetland region of the Niger Delta which has led to annual loss of 5% of the 800km Niger Delta Coast Line.

Study Location

Lagos State is located approximately between longitude 20°,42' and 30°22' and 30° 22'E and Latitude 10°22' and 60°42'N. It is firmly located within the tropical rainforest with well amplified vegetal classification ranging from saltwater swamp to margins of fresh water swamp. It also has a well extended coconut (sand) beach especially along the Lekki Peninsula. Nonetheless, recent incidences of coastal erosion envisioned by global climatic in-balance has become a treat to the socio-economic values of the Bar beach.

Gemorphologically, Bar beach has largely been controlled by coastal dynamics like intense wave climate consisting of plunging waves reaching an average of 1.5m high and semi diurnal tides with tidal range of 1m as well as long shore currents and the absence of large rivers discharging into the sea (Awosika and Folorunsho, 2011). It falls within two geological zones; Coastal sands and recent deposits. Climatic conditions are grossly affected by the oceanic atmospheric interactions and the movement of the ITCZ (Inter Tropical Convergence Zone). Awosika and Folorunsho, (2011) further noted that the movement of the ITCZ is associated with the warm humid Maritime Tropical (MT) air mass with its southwestern winds and the hot and dry continental (CT) air mass with its dry north easterly winds. To this end mean monthly temperature is about 30°C while mean annual rainfall is 2000mm (Omojola and Elias, 2011). Figure 1 shows the rainfall trend between 1900 and 2008. While Figure 2 shows annual maximum temperature and trend from 1900 to 2008.

Humidity is very high, 90-98% but the increasing high level of urbanization results into thermal discomfort, most especially in the metropolitan areas during the hot months (Omojala and Elias, 2011) Water and wetlands cover over 40 percent of the total land area of the state and another 12 percent of the remaining 60 percent is subject to flooding.

Correlation of Trend Values of Rainfall and Temperature, from 1900-2010

Table 1: Correlation Result of Precipitation and Temperature Trend, 1900-2010

		ANNUAL PRECIPITATION (mm)	TEMPERATURE
ANNUAL PRECIPATION (mm)	Pearson Correlation	1	-.0.96
	Sig.(2-tailed)		.328
	N	108	106
TEMPERATURE IN ()	Pearson Correlation	-.096	1
	Sig.(2-tailed)	.328	
	N	106	106

From Table 1, r = -0.096 signifying that correlation is very weak and since negative since it fell below the range of 00 – 19 which is classified as very weak. It presupposes that within the period rainfall results were not determined by temperature. Yardsticks for measuring the correlation coefficient is shown in Table 2. While Figure 4 outlines the rate of impact and line of best fit.

Table 2: Yardsticks for Measuring Correlation

1. 00-.19	"Very Weak"
2. .20-.39	"Weak"
3. .40-.59	"Moderate"
4. .60-.79	"Strong"
5. .80-1.0	"Very Strong"

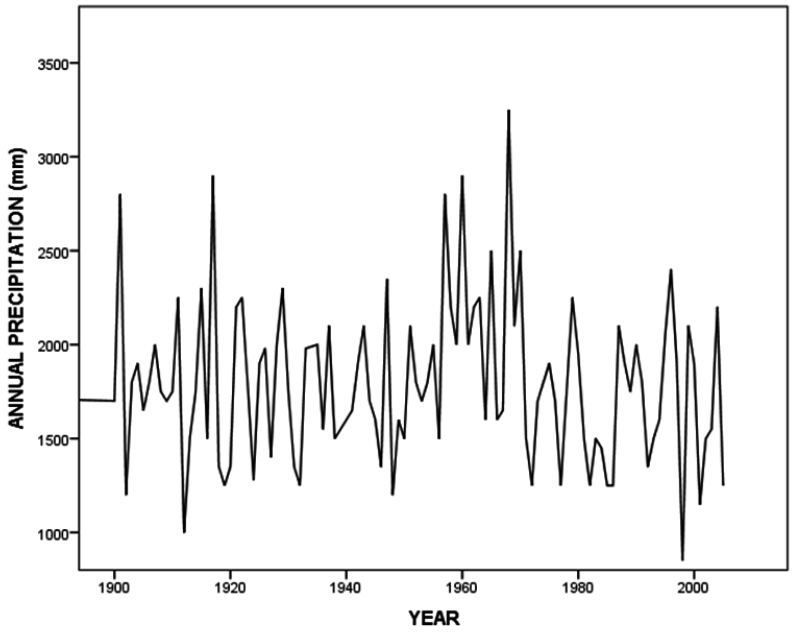

Fig 1: Showing Lagos Island annual precipitation trend between 1900 – 2010 (Source: Awosika and Fulorunsho, 2011)

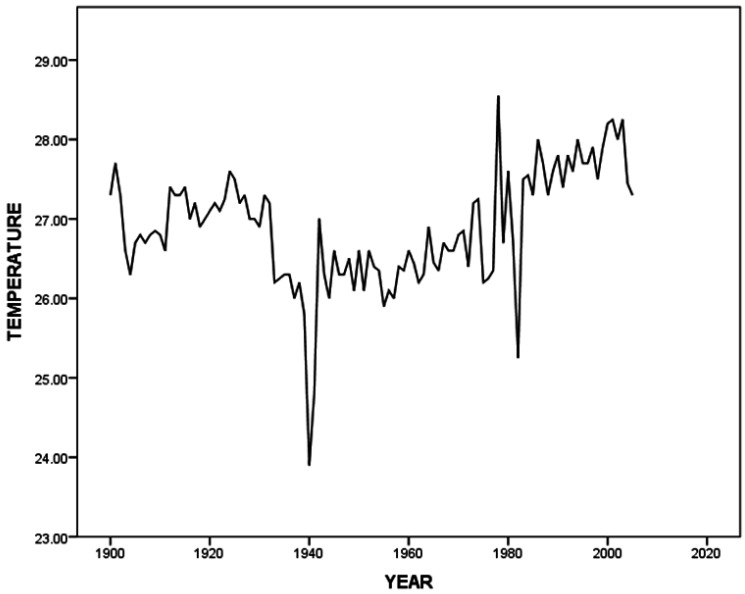

Fig 2: Showing Lagos Island annual temperature trend between 1900 – 2010 (Source: Awosika and Fulorunsho, 2011)

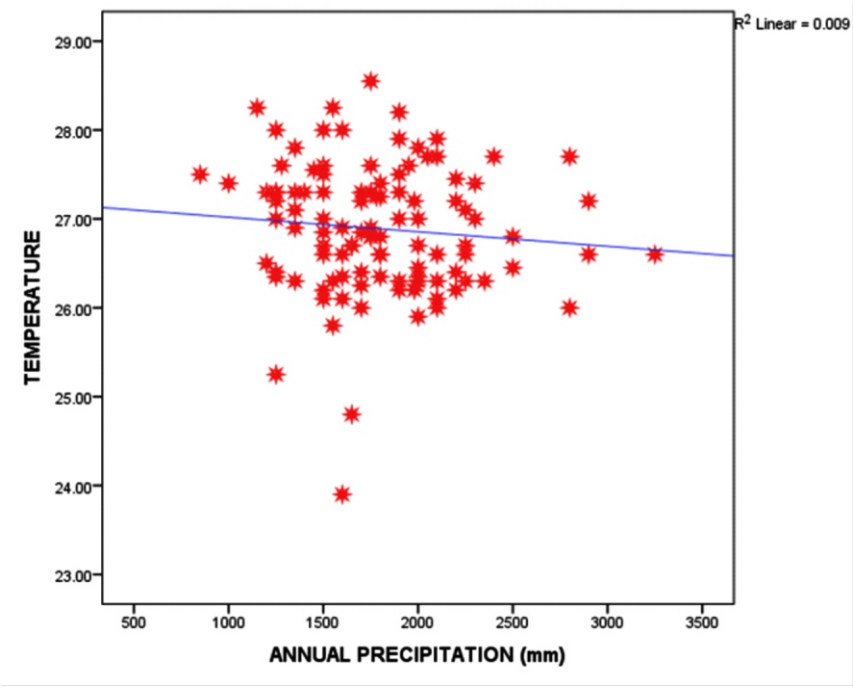

Fig 3: Showing Lagos Island correlation of annual temperature precipitation trend between 1900 – 2010

Lagos Bar Beach as a Tourism Infrastructure

Tourism is classified as temporary travels away from home or work for at least a night and for any purpose including a holiday, sightseeing, visiting places of attraction, visiting friends and relatives, going to a sport event either as a spectator or to participate and for purpose of business but the tourist must not take up job remunerated in the country visited. (WTO, 2008, Falade, 2011).

Falade, (2011) further distinguished the various kinds of tourism to include coastal and land based or rural and urban tourism infrastructure. Coastal tourism infrastructures include; hotels, resorts, restaurants, food industry, vacation homes, and sand beach.
Lagos has a coastline of 171km which is 18% of the nation's coastline of 963km (Folade, 2001). This is presented in Table 3.

Table 3: Coastlines of Nigeria by States

State	Length of Coastline in Km	% of Total Coastline
Lagos	171	17.76
Ogun	69	7.17
Ondo	84	8.72
Delta	117	12.15
Bayelsa	186	19.31
Rivers	111	11.53
Cross River	96	9.97
Akwa Ibom	129	13.40
Total	**963**	**100**

Source: Folade, (2011).

The Infrastructure provided in the Lagos bar beach which are under the threat of coastal erosion include; the sand beaches, fishing piers' recreational and boating habours.

Coastal Erosion in Lagos State

Awosika and Folorunsho, (2011) observed that in the study area, coastal erosion is the result of deficit of sand caused both by natural and anthropogenic activities. Identifiable natural causes include; low lying coastal topography, intense wave and tidal climate, vulnerable soil characteristics, nature of shelf width, topography, and the occurrence of offshore cayons. Anthropogenic activities of importance responsible for the high rates of erosion include; damming of rivers, construction of habour protecting structures and jetties, Bar beach Sand Mining, dredging activities and deforestation of coastal vegetation (Awosika, Ojo, Ajayi (1991). Between 1908 and 1912, average annual erosion rates along the Bar beach was 25 to 30m, but it receded to 1.5km after the construction of moles, but the updraft side of the light house beach has accreted by over 500m (Awosika and Fulorussio, 2011). In Table 4, rates of coastal erosion along the Bar beach as recorded by the Nigerian Institute for Oceanography and Marine Research (N10MR) between 1991 and 1994 were presented.

Table 4: Erosion/Accretion rates of N10MR monitoring stations between August 1991 and June 1994 (+denotes accretion –denotes erosion).

Station (With description of Location	Width of nourished beach as at 8/8/91 (m)	Width of beach eroded as at 10/6/94 (m)	Beach remaining as at 10/6/94 (m)
NPA Yard	95	-85	10
NIOMRFence	110	>-140	No Beach Remaining
Oniru Palace	131	-121	10
FG Guest House	131	-100	31
Cross River State Liaison Office	104	-100	4
Rivers State			
Liaison Office	92.5	>-92.5	No Beach Remaining
IMB Building	93	>-93	No Beach Remaining
NICON NOGA (uncompleted)	95	-84	11
Eko Hotel	106	62	44
Kuramo Waters	75	18	57
Maroko Village	1.62	11	51
Maroko Village	2.92	+14	106
Maroko Village	3.11	+15	125

Source: Awosikwa and Fulorunsho, 2011

The data presented in Table 4 shows the nature of coastal erosion along the Lagos Bar Beach between 1991 and 1994. It was observed that 5 Million cubic meters of sand was pumped and spread on the beach in 1991 but by 1994, it had almost been washed back to the sea. Again between 1995-1997, further 2 million cubic meters of sand had also been pumped and spread on the beach, yet by January 1991, the sea had already indaunted a critical section of the Ahmadu Bello Way (Awosika, Florunsho and Jublin Green,2000).

Causes of Lagos-Bar Beach Erosion

Lagos Bar-Beach is of particular concern to the tourism industry in Nigeria. Sea-level rise couple with storm surges and high-tide poses severe problems for beach managers, coastal engineers, and Tourism business, especially along Victoria Island, Lekki and Ikoyi Island. Jensen,(2010) reported that since 1960 there had been an increase in storm floods along the German north sea coastline predictably suggesting an increase in storm surge in the Atlantic ocean which incidentally affected Lagos Bar Beach coastal zone. For instance in 2010, 2011 and 2012, considerable damages were done to coastal infrastructure, business activities, employments and sociology. The storm surges had severe implications for the low-lying areas in Lagos like Ajegunle, OrileIgamu and LekkiPenisula.

It is equally important to note that the consequences of coastal erosion is global even as it was highlighted by Puvh (2000) when he noted that three-quarters of the World population may be living within 60km of the shore-line by 2020, and concluded that there would be an increase in demand for coastal and tourism facilities. It therefore behooves on the government to act respectively so as to reclaim preserve and conserve the Lagos bar beach. The following issues have been identified as responsible for Lagos Bar Beach erosion.

Causes of Lagos Bar Beach Coastal Erosion

1. Sea Level Rise

Sea level rise is the major cause of coastal erosion; especially as it is observed along Lagos Bar Beach. Inter Government Panel on Climate Change (IPCC) report of 2007 stated that the average temperature of the earth has increased during the 20th Century by about 0.6°C ±0.2° (IPCC, 2007).

Awosika and Fulorunsho, (2011) further suggested that rise in global temperature is likely to generate sea level rises due to the expansive sea water and melting glaciers. Once this happens, adjacent coastlands including Lagos Bar Beach will intensively be washed away.

2. Melting Glaciers and Ice Caps

The melting of glaciers and ice caps also result to the rising of sea levels. IPCC (2001) report noted that the melting of ice sheets of Green land and Antarctica between 1993 to 2003 many have likely contributed to the sea level rise noticed within the period. The report further suggested that the global warming will still continue even if there is considerable reduction in greenhouse gas emissions. By 2300, thermal expansion will result to sea level rise of 0.3 to 0.8m. For the next decade increase in temperature will stabilize at 0.2°C resulting to sustained thermal expansion it is expected that the thermal expansion would lead to the shrinking of both Artic and Antarctic, which would contribute immensely to sea rise (Awosika, Fulorunsho, 2011).

3. Excessive Rainfall Resulting to Storm Surge

IPCC (2007) Report suggested that, it is very likely that tropical storms and hurricanes increase in number over the Atlantic Ocean in the last 100 years, corresponding to temperature increase. For this reason, Lagos Bar Beach and entire Nigeria Coasts will always experience more storm surges especially in the months of April to June and September to October annually. This is also similar to what Fulorunsho, and Awosika (1995) observed; that the months of April and August are usually associated with the development of low pressure systems developing in the Atlantic Ocean (RoaringFoites). These low pressure systems which generate large swells at sea travel landwards depending on the fetch. Normal wave heights along Victoria Island Beach is between 0.9m to 2m, but with these swells it can rise up to 4m. They further, observed that on August 17, 1995 between 0.600 to 10.00 GMT a swell that occurred unleashed uncontrollable surges on Victoria Beach, flooding parts of the Island; streets, drainage channels and overwhelming the Kuramo Lagoon which hitherto was separated by strip of land, from the Atlantic Ocean. Socio economic activities were massively disrupted both in Victoria Island and Ikoyi within the period, the flood lasted. The storm surges further resulted in the erodiment of Victoria Beach.

Impacts of Lagos Bar Beach Erosion on Tourism in Restrictive

Awosika, French, Nicholls and Ibe (1993) estimated that Victoria Island and Lekki lost over 584 and 602 square kilometers of land from erosion while some sections of Lekki barrier system were submerged. The Monetary worth of this loss was estimated to be well over US $12 Billion. By 2011 it was observed that many of the sandy beaches in Lagos coastline had been washed away. Awosika and Fulorunsho, (2011) attributed it to the low lying nature of the coast lines which is not more than 3 meters above mean low water level.Some places at Lekki are close to sea level. They were also affected heavily by the increase in sea level.

Drainage system provided to absorb and divert storm surges after rainstorms have been most ineffective in the major parts of Lagos coastal landscape, hence putting low land areas at direct risks. Such areas like Lagos sea ports, Lekki; and other new suburb have severally witnessed sea water surges. There could also result to the contamination of low marshes and Lagoons with salt water.

Remedies

Protection of coastal zones presents a growing dilemma for many nations. It has been reported that the difficulties faced by coastal managers when deciding on appropriate responses to coastal erosion are further complicated because some coastal defense themselves cause erosion (Collins, 2003: Turne, 2003).

In Nigeria, policy for the protection of coastline is influenced by the available techniques with due consideration to their cost and sustainability.

Ezeodum, (2010), observed that strengthening coastal and river flood defenses to withstand climate change could constitute major challenges over the next half a century. Given that tourism infrastructure in these areas are mostly likely to be affected, strengthening the defenses along Bar beach Lagos Nigeria, to contain ocean waves, and sea level rise becomes imperative saving the beach from being eroded, protect tourism and economic infrastructure along the beach has galloped over thirty Billion Naira from 1950's to 1990's (Ezeodun,2010).

Table 5: Measures Taken to Control Coastal Erosion in the Bar Beach, Victoria Island since 1988.

Period	Remedial Measures Applied
1958	Construction of a groyne at the foot of the East Mole to avoid the undermining of the mole by erosion.
1958-1960	Dumping of the sand dredged from the Commodore channel at the extremely of the East mole for dispersal along the beach by waves.
1961-1968	Permanent pumping station built at the inner Harbour near the East Mole supplied an average of 0.66 M illion cubic meter p.a of fine sand from the Commodore Channel to the beach. In 1964, a zigzag timber groyne (palisades) running parallel to the coastline was driven 26m from the shoreline.
1969-1974	Some artificial sand replacement but reliable records of quantities or frequency are not available.
1974-1975	3 Million cubic meters of sand dumped and spread on the beach
1984	2 Million cubic meters of sand dumped and spread on the beach
1985-1986	3 Million cubic meters of coarse -grained sand dumped and spread on beach from borrow pit located about 13km Nautical Miles Offshore using Trailing Hopper Dredge.
1990-1991	A million cubic meters of coarse -grained sand dumped and spreads on beach using Trailing Hopper Dredgers from borrow pit located about 13 Nautical Miles offshore. ii. Contract for the construction of two offshore breakwaters awarded in 1990 as part of a permanent solution could not take off because of funds constraints.

1995-1997	6 million cubic meters (2 million cubic meter per year) dumped and spread on the beach using Trailing Hopper Dredgers from Borrow Pit about 13 Nautical Miles offshore
1998	A T -Groyne of rubble mound construction built at the backshore of the School of Fisheries under the auspices of the Government of Japan to safeguard the school
1999-2000	2 million cubic meters of sand dredged from nearby offshore burrow pits.

Source: Awosika and Fulorunsho, (2011).

In Table 5, Awosika and Fulorunsho(2011) articulated remedies employed by the various governments (both state and federal to combat coastal erosion, these methods were earlier on captured by Ezeodum, 2010 as traditional methods and integrated coastal zone management system.

i. Traditional Methods

Traditional methods of coastal zones management include hard engineering structures like; sea walls, and piers, used to manage storms and tides for protection of developments within coastal zones. These techniques are said to have adverse effects as they tend to promote erosion by the formations of rip current (Ezeodum, 2010). The Institute of Oceanographic Science concluded that human intervention including port developments and sea wall construction had been the main traditional erosion control mechanism along coastal areas of countries like South Wales, Tuscany and Praziri(Bullen, 1999).

Another traditional method is to protect the seaside resort by erecting a hard structure at each kilometer of coastline. This method without its limitation has indeed been erected to prevent coastal beach submergence. Attempt to provide permanent protection against perennial ocean surge in Lagos bar-beach comprised the construction of 1000km length of shoreline protection to the end of Almadu Bello Way bothering the Bar-beach. The Eko Atlantic City project targeted the restoration of land lost to coastal erosion since 1950's and the provision of a robust sea wall along the coastline. Kunle (2002) observed that the development has a length of 7500m along the Atlantic and an average width of 1.200m.

ii. Integrated Coastal Zone Management System

The integrated coastal zone management system of tidal erosion combines coastal conservation with tourism development. This approach has been adopted by Lagos State Government which created Ministry of Infrastructural Development in 2007 charged with the provision of quality infrastructure for the development of water fronts to curtail surge, flooding at the same time protect the environment. n addition develop the state to a tourist haven and attract international tourists (Oni,2008).

The integrated management system seeks to solve problems associated with hard engineering practice and the reduce maintenance cost of alternative soft engineering techniques that work in conjunction with natural coastal processes. Three of such methods are not entirely new, they had been previously suggested by Cipraini, Lannotaa and Pranzini, (2004), they include:

a. Construction of submerged breakwaters that reduced effective depth offshore and consequently reduced wave power and erosion of the beach.
b. Groyne field techniques that promote sediment deposition and control shore line erosion.
c. Beach nourishment which is a soft engineering solution for the benefit of tourism industry.

Recommendations

We recommend that in Lagos Bar beach, the management and conservation approach should be adopted which will include persuading the society to undertake gradual and planned retreat from the water front. Secondly, rehabilitation of the last areas can be reclaimed. Coastal areas of Nigeria are important resources base for both visitors and residents. There is need for integrated management to ensure erosion control, protection of the landscape and implementation of effective urban planning measures to ameliorate tourism pressures. This approach will ensure an attractive environment for visitors, and ultimately assist in maintaining Nigeria position as a major player in the global tourism market.

Conclusion

Beach erosion poses a significant threat to recreation and tourism and consequently the economy of many localities and regions. General consensus among coastal scientists is that there will be an increased incidence of storm surge and general rise in sea level. Coastal managers will need to adopt coastal management strategies that work with the natural processes to successfully manage eroding beaches. Adopt a cyclic process of problem recognition, planning, implementation and monitoring, as an appropriate response to coastal erosion. This is proper can be developed as a raw material supporting the tourism industry.

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