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Tourism and beach erosion: valuing the damage of beach erosion for tourism in the Hoi An World Heritage site, Vietnam

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Abstract The Hoi An World Heritage site in Vietnam has faced increasing coastal erosion as a result of both natural and anthropogenic causes since the 2010s. Main drivers are the construction of hydropower dams on the Vu Gia and Thu Bon Rivers, illegal sand mining in the South China Sea, and sea level rise along the Central Coast Vietnam. Coastal erosion affects the tourism attraction of this area. A challenge for both the national government and the local authorities is understanding the nature of the contemporary coastal erosion; this includes the beach erosion and tourism relationship. This study deals with the damage valuation of the beach erosion in relation to the tourism revenue based on the hedonic pricing method. Cua Dai beach of Hoi An is structured into 23 beach sectors along the shore, each of which shows a relative homogeny in physical characteristics, anthropogenic activities, and socioeconomics. The beach value is function of morphological variables such as beach width and distance to the city center, and tourism variables such as tourist area, coastal businesses, the number of hotels, and the number of hotel rooms. The two-stage least squares (2SLS) of the custom-log model is the most accurate approach. The total projected revenue losses are more than an estimated 29 million US dollars by 2040. The present values of the total annual revenue losses in 2020, 2030, and 2040 are about 29.6, 21.4, and 14 million US dollars, respectively, at an interest rate of 5%. The results suggest mitigation strategies and policy recommendations. The proposal includes improving the adaptation capacity to coastal erosion using innovative, smart, and wise solutions. Beach nourishment and coastal defense structures can be sustainable management tools combating coastal erosion only if the multicausal coastal processes are properly considered and a detailed cost–benefit analysis is performed.

Keywords Economic valuation · Beach erosion · Tourism revenue · Cua Dai beach · Hoi An World Heritage · Vietnamese Central Coast

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1 Introduction

Beach erosion increases in coastal zones as a result of both natural and anthropogenic pressures in the context of global climate change (Hinkel et al. 2013; Logar and Bergh 2014; Semeoshenkova and Newton 2015). Beach erosion significantly threatens both environmental and economic values from the tourism and biodiversity and increases the negative effects and risks of land loss, and destruction of natural defenses and coastal areas. Erosion weakens coastal man-made defense construction, making the land more prone to flood risk (Granja and De Carvalho 2000; Vilibic et al. 2000; Jensen et al. 2001; Shivlani et al. 2003). Previous studies indicated that coastal erosion reduces the beach width, which has a negative impact on coastal biodiversity (Schlacher et al. 2007) and soil protection (Costanza et al. 2006). Erosion also provides difficulties for the comprehensive social regulation of the coastal management (Seino et al. 2015). Therefore, coastal erosion is of concern for coastal managers and researchers since many decades. Dewidar and Frihy (2010) used a combination of LANDSAT images and the Digital Shoreline Analysis System (DSAS) to calculate coastline change rates in the northeastern Nile Delta during 1972–2007. Monitoring the coastal dynamics with DSAS, along the shoreline between the Kanyakumari sea and the Tuticorin sea in India allowed indentifying main characteristics of this region (Sheik and Chandrasekar 2011). Prukpitikul et al. (2012) focused on shoreline erosion for coastal zone management goals in Thailand during 1999–2009. A linear analysis formula was used to increase the accuracy of the forecasted average change rates.

Coastal and beach erosion provide significant threats to the coastal economy, of which tourism is an important factor. The market price method allows estimating the direct damage to local livelihoods, housing, infrastructure, crops, etc. (Logar and Bergh 2013; Jiang et al. 2016); the hedonic pricing method assesses revenue changes along eroded beaches (Parsons and Powell 2001; Alexandrakis et al. 2015); the prevention cost, contingent valuation, and travel cost methods allow to determine revenue-raising opportunities for coastal zone (Blakemore and Williams 2008) and coastal tourism managers (Birdir et al. 2013). Quantitative data on the economic damage are an important input for coastal management and sustainable use decisions and allow establishing priorities for sectors/fields. The Tobit model allows to investigate the willingness to pay (WTP) of visitors for a beach erosion control program at Maine and New Hampshire beaches (Lindsay et al. 1992). Factors influencing the WTP of beach users are the number of years they visit a particular beach, income, familiarity with beach protection regulations, the state of the residence of respondents, and the presence of sand dunes. Shivlani et al. (2003) studied the WTP of tourists for beach nourishment at three beaches in South Florida. The results showed that beach users would agree paying higher fees for an improved resource protection. Pendleton et al. (2012) studied the relationship between the initial beach width and the marginal value of the beach width in southern California. The value of the beach width depends not only on its width, but also on contact with water, sand quality, and pavement. Combining the contingent valuation method with the travel cost method allowed estimating the beach value and the economic damage of the erosion in Crikvenica, Croatia (Logar and Bergh 2014). Tourists at beaches with an entrance fee preferred paying 1.69€ per visit for beach protection initiatives and 2.57€ extra to visit the beach. Tourists, who have visited free beaches, said they are prepared contributing 2.08€ and a surplus of 1.74€ per visit. Alexandrakis et al. (2015) estimated the beach value of Rethymnon city (Crete, Greece) by using the hedonic pricing method. The beach value and tourism revenue losses were calculated in relation to the shoreline retreat the next 10, 20 and 30 years. An average revenue loss is

48.7 thousand €/m^2 per year after 10 years; the amount increases to 140.4 thousand €/m^2 per year in the next 30 years.

Beach erosion is a danger, which influences both coastal economies and heritage values (Semeoshenkova and Newton 2015; Khakzad et al. 2015; Semeoshenkova et al. 2017). During recent decades, a range of coastal heritage sites worldwide loses beaches as the result of coastal erosion. Examples include among others Anguilla, Antigua–Barbuda, Dominica, Grenada, Montserrat, Nevis, St Kitts, St Lucia, St Vincent and the Grenadines, Turks and Caicos Islands (http://whc.unesco.org). Vietnam has eight UNESCO-listed world heritage sites including five cultural ones (Central Sector of the Imperial Citadel of Thang Long—Hanoi, Citadel of the Ho Dynasty, Complex of Hue Monuments, Hoi An Ancient Town, and My Son Sanctuary), two natural ones (Ha Long Bay and Phong Nha-Ke Bang National Park), and a mixed one (Trang An Landscape Complex) (http://whc.unesco.org). Beach-island tourism in Vietnam accounts for about 70 percent of the total tourism activity, in which the most attractive sites are found along the Central Coast, where the Hoi An World Heritage is located. In this context, major issues to be addressed at Cua Dai beach of Hoi An include tourism revenue losses due to coastal erosion. The beach of Cua Dai was selected as a study area because the erosion progresses fast here especially since the 2010s. Coastal erosion causes narrow beaches, degrades the artistic value of coastal landscapes, and contributes to abandoning resorts, collapsed buildings, and damaged infrastructure. Coastal erosion affects directly the local economy and the livelihoods of local people, whose life depends on tourism revenues.

Among the listed studies on coastal erosion and tourism, the research on beach value of Rethymnon city (Crete, Greece) of Alexandrakis et al. (2015) is the most notable from the combination of environmental economic and geographic approach, which is effectively usable for the Cua Dai beach of Hoi An. This paper therefore applied the hedonic pricing method combining economic and environmental data to value tourism revenue losses due to beach erosion along geographic areas in the Hoi An World Heritage sites. The damage valuation results contribute partly to decision-making process of integrated coastal zone management (ICZM) in Hoi An particularly, and in Vietnamese coasts generally. The text is organized as follows: Sect. 2 presents the hedonic pricing methodology; the results of the beach value and projected tourism revenue losses are indicated in Sect. 3; finally, a conclusion on beach erosion mitigation strategies and policy recommendations for coastal management in Vietnam is drawn in more detail in Sect. 4.

2 Methodology

2.1 Study area

Hoi An Heritage is located in the Quang Nam Province along the Vietnamese Central Coast. In 1985, the artist and handicraft village of Hoi An was recognized as a Vietnamese National Cultural Heritage site. It became a Special National Cultural Heritage site in 2009. Hoi An Heritage is also one of the two core areas of the Cu Lao Cham-Hoi An Biosphere Reserve. (The other one is the Cu Lao Cham archipelago in the Quang Nam Province.) Cua Dai beach is part of the buffer zone between Hoi An and the reserve and is considered one of the most beautiful beaches along the Vietnamese Coast. Cua Dai beach is located in the mouth of the Thu Bon River (Fig. 1). The local economy heavily depends on tourism. In 2016, the total tourism revenue was about 8 million USD, the most important section of the local economy.

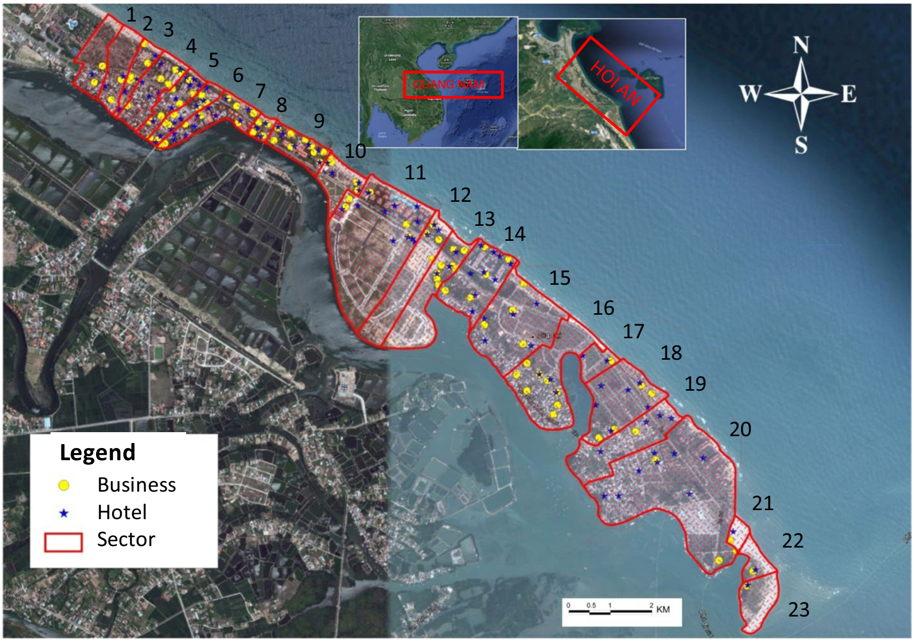

Fig. 1 Location of the Cua Dai beach in the Hoi An World Heritage site along the Vietnamese Central Coast. Numbers indicate the name of sectors

Over 75 percent of the local households are involved in tourism. Over 2.6 million tourists visited Hoi An in 2016, an increase of 17.92 percent as compared to 2015 (http://www.hoianworldheritage.org.vn). Tourists pass by Hoi An the year around. The most frequent attractions include the Hoi An ancient urban center, the old trading center, and the Cua Dai beach. Coastal erosion has damaged progressively the Cua Dai beach since the past 10 years. During early studies of the coastal erosion in this area, major causes of coastal erosion include the recent changes in sediment deposition as a result of the construction of new hydropower dams on the Vu Gia and Thu Bon Rivers, illegal sand mining near the coast in the South China Sea, and sea level rise. Coastal erosion causes beach shrinking and disappearance, damages hotels, resorts, and other infrastructure, and therefore affects negatively the tourism. The local government responded to this problem in various ways: A dam was built with sand bags during winter season and more dikes were constructed; however, these measures proved inefficient to beach erosion. Private companies invested millions of US dollars to construct breakwater infrastructure protecting the coast. Some local enterprises caused more problems than they solved because their actions were not coherent with the standards and the planning of their permits. State management agencies slowly decide because of the scientific uncertainty and disagreement and due to the lack of capital. Local enterprises as a rule only add to short-term solutions, often in a non-coordinated way.

2.2 Methods

Resort beaches are natural resources generating value and capital for both the tourism and the housing market (Phillips and Jones 2006). Therefore, the hedonic pricing method is selected as it is used to estimate economic values for environmental services that directly affect market prices, and approximately calculate economic benefits or costs associated with environmental quality (Casado et al. 2017). This method allows combining both economic and environmental data to study coastal erosion and beach tourism: Economic data are used to estimate the beach value; environmental data are used to calculate tourism revenue losses as a result of coastal erosion (Gopalakrishnan et al. 2011). The beach value depends on its width, the area available for tourists, distance to the city center, coastal businesses, number of hotels, and number of hotel rooms (Bin et al. 2008). The research was designed in the following steps: (1) divide the beach into (beach) sectors; (2) build an economic model to express the dependence of beach value on other factors; (3) estimate the beach erosion by sectors; and (4) estimate beach value and tourism revenue loss by beach erosion until 2040. Cua Dai beach is structured in 23 sectors, each of them showing a relative homogeny in physical features (the estuary, sand dunes, sediments, etc.), anthropogenic activities, and socioeconomic characteristics (transport, land use, housing, and other infrastructures) (Fig. 1). Each beach sector is described using morphological variables (beach width—BW, distance to the city center—DS) and tourism variables (tourist area—TA, coastal businesses—CB, number of hotels—H, number of hotel rooms—HB). The beach value (BV) of each sector is expressed by Eq. (1):

$$\mathrm{BV} = f(\mathrm{BW}, \mathrm{DS}, \mathrm{TA}, \mathrm{CB}, \mathrm{H}, \mathrm{HB}) + \mathrm{C}, \tag{1}$$

where *BW* is beach width, *DS* is distance to the city center, *TA* is tourist area, *CB* is coastal businesses, *H* is number of hotels, *HB* is number of hotel rooms, and *C* is coefficient.

The description of these variables is summarized in Table 1. Land value was collected from local government records. Morphological variables were calculated using remotely sensed data. Three LANDSAT images (July 16, 2005, July 14, 2010, and August 13, 2015) were used to define the coastlines. A flowchart extracting coastlines from LANDSAT images published by Alesheikh et al. (2007) was used. The procedure included radiometric calibration, histogram threshold on band 5, applying the $b2/b4 > 1$ and $b2/b5 > 1$ conditions on images, multiplying two images, and converting raster to vector data. Tourism variables were collected in different ways. Surface of the tourist area (TA) was provided by the local authorities. The number of coastal businesses (CB) and the number of hotels (H) were determined using Google Earth images. Data on the number of hotel rooms (HB) was collected using a questionnaire survey and controlled on the hotel's Web sites.

The relationship between beach value and beach width calculated by formula (1) is clear (Bin et al. 2008). The independent variable is the natural logarithm of the beach value

Table 1 Description of variables used in the hedonic pricing method

Variables	Code	Methods	Statistics			
			Mean	Min	Max	SD
Land value (USD/m^2)	BV	Local government records	234.87	70.86	434.89	123.35
Beach width (m)	BW	LANDSAT images	32.26	1.00	61.00	15.50
Distance (m)	DS	LANDSAT images	1886.60	645.87	3726.42	965.82
Tourist area (m^2)	TA	Local government records	1421.67	272.31	3156.36	734.19
Coastal business	CB	Google Earth images	5.00	1.00	15.00	3.78
Number of hotels	H	Google Earth images	4.70	1.00	11.00	2.64
Number of hotel rooms	HB	Questionnaires, Web sources	70.04	3.00	308.00	86.72

(BV). The baseline value was estimated by using the regression analysis with ordinary least squares (OLS) and two-stage least squares (2SLS) methodology. Three regression models were applied to select an appropriate functional form of the beach value (BV). The first model is a semi-log specification addressing the question of the percentage of change of the beach value if the beach width changes 1 unit. The second model calculates the percentage of change of the beach value if the beach width changes 1%. This model uses a double-log transformation, which increases the consistency of the model. The third model uses a custom-log specification and entails the explanatory variables (BW, HB, TA, and DS) as natural logs, while others (CB and H) are not.

The damage of tourism revenue in the future caused by beach erosion (beach narrowing during the period of 2020–2040) is calculated using Eq. (2) (Cambers 1998):

$$\mathrm{BW} = d(n \times a + b + c), \tag{2}$$

where d is safety factor, n is period of the prediction (years), a is the average rate of coastal erosion during this period, b is the irregular erosion rate, and c is speed of erosion due to sea level rise.

Shoreline retreat of the Cua Dai coast has been estimated for 2020, 2030, and 2040, where the estimated corresponding sea level rise is, respectively, 0.08, 0.13, and 0.17 m (MONRE 2016). The Digital Shoreline Analysis System (DSAS) was used to estimate the average coastal erosion rate: It calculates gaps between the shoreline positions during defined period and makes the basic data available to estimate the shoreline changes based on shoreline geometry indicators (Thieler et al. 2009). The DSAS methodology applied in a Vietnamese coast has been described in detail by Nguyen and Hens (2017). The end point rate (EPR) value was calculated for each sector in 2005, 2010, and 2015. EPR measures shoreline change in Cua Dai beach by dividing the distance of the shoreline between its initial (2005) and the most recent position of shoreline (year 2015). In total, 209 transects, each 20 m wide, were analyzed. The average rate of coastal erosion by sectors was determined as the mean of EPR value of all transects distributed among each sector.

3 Results

Table 1 shows the descriptive statistics for the considered variables by beach sector. The average land value (BV) is 234.87 ± 123.35 USD/m^2; the highest value is 434.89 USD/m^2; and the lowest value is 70.86 USD/m^2. The average beach width (BW) is 32.26 ± 15.50 m; the widest beach is over 61 ms, whereas the narrowest beach is only about 1 m. Distances from the sector centers to the city center (DS) differ: While the average distance is 1886.60 ± 965.82 m, the most remote beach (3726.42 m) is about six times farther than the one that is closest to the center (645.87 m). The surface which can be used by tourists (TA) is also quite variable: The average area the tourists use by sector is 1421.67 ± 734.19 m^2; the largest tourist area (3156.36 m^2) is about twelve times bigger than the smallest area (272.31 m^2). The average numbers of tourism facilities such as coastal businesses (CB) (restaurants, souvenir shops, cafes), hotels (H), and hotel rooms (HB) per sector are 5.00 ± 3.78, 4.70 ± 2.64, and 70.04 ± 86.72, respectively.

Table 2 shows the econometric results of the beach values as demonstrated by the hedonic pricing model. In the semi-log model with ordinary least squares (OLS), just only an explanatory variable number of hotel rooms (HB) have a negative value, while others are positive. Most variables are not statistically significant, except for the beach width (BW) and the tourist area (TA) ($p < 0.1$) in the OLS. Similar results were found using the semi-log model with two-stage least squares (2SLS). The comparison of the results of the semi-log model, with those of the double-log model shows the same explanatory variable coefficients. The beach width (BW) and tourist area (TA) are significant at the 1% level in both the OLS and the 2SLS.

The results of the custom-log model show that the tourist area (TA) variable is significant at 10% in the OLS, but it is not statistically significant in the 2SLS. Three dependent variables are significant in the OLS: Beach width (BW) reaches 5% significance, whereas coastal business (CB) and tourist area (TA) reach 10% significance. In the 2SLS, the number of hotels (H) and tourist area (TA) are not statistically significant. Beach width (BW) and the distance to the city center (DS) are significant at the 1%. Coastal business (CB) reaches 5% significance in the 2SLS, as compared to its statistical significant at 10% in the OLS.

For the 2SLS, two instrumental variables are used for beach width. The first instrument is the presence of a coastal road next to the beach (CR). The coastal road was built primarily for transport and tourism. The second instrument is the length of sector (L) affected by coastal erosion. As a result, the beach width (BW) is an endogenous variable. The beach width was determined using a first-stage regression, of the coefficient of determination ($R^2 = 0.8$) between the boundary of the beach width (BW), the beach (CR), and the sector length (L). F-statistic and Durbin–Watson statistic are 6.95 and 1.5, respectively, and show that this second instrument is weak. Therefore, the null hypothesis was rejected.

The three models provide the same sign for the explanatory variables. The custom-log model results in the lowest statistical significance: Four out of the six explanatory variables are statistically significant in the 2SLS. As the beach width (BW) is an endogenous variable, the 2SLS of the custom-log model is considered the most accurate. The statistically

Table 2 Econometric analysis results by influencing variable

Independent variable: ln BV (natural logarithm of BV)

Number of observations: 23

Semi-log			Double-log			Custom-log		
Variables	OLS	2SLS	Variables	OLS	2SLS	Variables	OLS	2SLS
Coefficient (C)	1.197	−4.171	C	−1.484	−6.216	C	−2.505	−5.564
Beach width (BW)	0.071*	0.112*	ln (BW)	1.140*	1.369*	ln (BW)	1.124**	1.276***
Coastal businesses (CB)	0.090	0.113	ln (CB)	0.265	0.309	CB	0.043*	0.043**
Number of hotels (H)	0.112	0.108	ln (H)	0.058	−0.035	H	0.104	0.107
Number of hotel rooms (HB)	−0.001	0.001	ln (HB)	0.175	0.237	ln (HB)	0.030	0.048*
Tourist area (TA)	0.001*	0.003*	ln (TA)	0.294*	0.586*	ln (TA)	0.398*	0.583
Distance to the city center (DS)	0.001	0.001	ln (DS)	0.229	0.476	ln (DS)	0.297	0.459***
Coefficient of determination (R^2)	0.680	0.500		0.800	0.81		0.81	0.80
F-statistic	5.592	2.750		11.11	6.44		11.65	6.95
Durbin–Watson statistic	2.490	1.9		1.71	1.43		1.69	1.5

***Statistical significance at 1% ($p < 0.01$)

**Statistical significance at 5% ($p < 0.05$)

*Statistical significance at 10% ($p < 0.1$)

significant variables in three models and the variables of the 2SLS with custom-log specification are used in Eq. (3):

$$\ln(\mathrm{BV}) = 1.276\ \ln(\mathrm{BW}) + 0.043\ \mathrm{CB} - 0.107\ \mathrm{H} + 0.048\ \ln(\mathrm{HB}) + 0.583\ \ln(\mathrm{TA}) + 0.459\ \ln(\mathrm{DS}) - 5.564. \tag{3}$$

Equation (3) was used to project beach value until 2040, and the results of the beach width by sector are shown in Table 3. DSAS results show that 166 transects decline, while the beach in 31 transects increases. The end point rate (EPR) value indicates that the average rate of decline is 10.6 m per year, while the average rate of beach expansion is 0.13 m per year. Beach values and tourism revenue losses are shown in the right columns of Table 3. Sectors 1–7 show an accretion trend, while other sectors erode. By the year 2040, the expectation for sectors 9–23 of Cua Dai beach is complete erosion and disappearance. The expected loss in tourism revenue is significant. Total revenue losses are forecasted to exceed 29 million US dollars in 2040. The present value (PV) in 2020, 2030, and 2040 is expected to be about 29.6, 21.4, and 14 million US dollars, respectively, taking into account an interest rate of 5% per year.

Table 3 Beach value and revenue losses by sectors

Beach sector	Beach width (m)				Beach value (1000 US dollars)				Revenue losses (1000 US dollars)		
	2015	2020	2030	2040	2015	2020	2030	2040	2020	2030	2040
1	49	28	33	37	1022	3419	1149	1138	0	0	0
2	43	20	22	23	1227	2585	2547	2530	0	0	0
3	43	20	22	23	1481	784	771	765	697	710	716
4	34	10	12	12	1809	406	397	394	1403	1412	1415
5	27	4	5	5	1136	89	85	84	1047	1051	1052
6	23	0	1	1	955	9	41	39	863	914	916
7	21	0	0	1	1530	97	64	38	1433	1466	1492
8	34	8	4	0	987	464	531	0	523	456	987
9	22	0	0	0	2197	0	0	0	2197	2197	2197
10	35	0	0	0	2439	0	0	0	2439	2439	2439
11	32	0	0	0	3644	0	0	0	3644	3644	3644
12	61	18	0	0	2340	1673	0	0	667	2340	2340
13	44	0	0	0	2412	0	0	0	2412	2412	2412
14	1	0	0	0	54	0	0	0	54	54	54
15	14	0	0	0	1372	0	0	0	1372	1372	1372
16	25	0	0	0	819	0	0	0	819	819	819
17	7	0	0	0	143	0	0	0	143	143	143
18	7	0	0	0	353	0	0	0	353	353	353
19	35	0	0	0	398	0	0	0	398	398	398
20	49	0	0	0	3139	0	0	0	3139	3139	3139
21	45	0	0	0	513	0	0	0	513	513	513
22	43	0	0	0	963	0	0	0	963	963	963
23	48	0	0	0	2288	0	0	0	2288	2288	2288
Total					33,221	9609	5585	4988	27,367	29,083	29,652

4 Conclusion and discussion

Mitigation measures counteracting the erosion of the Cua Dai beach of the Hoi An World Heritage site should be properly analyzed from a technical point of view and should take into account the economic feasibility. Measures mitigating beach erosion are imperative especially in the 14 beach sectors: 3–13, 15, 20, and 23, which show the highest beach erosion until 2020. Taking into account the projected tourism revenue losses for the next 20 years (2020–2040), sectors 3–8 and sector 12 need beach erosion mitigation action by priority. Beach sectors 9–11 and 13–23 are not expected to provide any revenues since these beach areas are projected to disappear by 2020. Targeted interventions in combination with localized protection actions can have a significant mitigation cost.

Protecting the tourism activities near Hoi An necessitates mitigation interventions over 8 km (sectors 11, 12, 13, 15, and 16) including the construction of an underwater breakwater using pre-constructed modules without a beach nourishment plan. The estimated cost for the breakwater construction exceeds 40 million US dollars, which might be raised by both the public and the private sectors. These actions aim at halting coastal erosion and stabilizing the present shorelines. Existing mitigation has proved insufficient. Beaches sectors 9–11 and 13–23 are projected to disappear. This will cost the sector approximately 21 million US dollars of income. Action is targeted to protect the remaining, less endangered sectors.

Beaches provide income for tourism in Hoi An. Protecting the benefit of resorts is a major challenge, since they illustrate prominently the balance between the economic and environmental aspects. Coastal erosion not only threatens properties, but also causes beach erosion in Cua Dai beach. Innovative, smart, and wise solutions for beach protection should be applied here. Two engineering categories of erosion abatement strategies exist: hard and soft interventions. Soft engineering is a more sustainable, long-term, and potentially cheaper approach to coastal protection, working with natural processes to protect the shoreline. Hard engineering is more expensive, has a shorter lifetime, and is as a rule more intrusive than soft engineering, providing a temporary solution to the engineering problem. Hard engineering interventions often relocate the problems causing more problems elsewhere. In particular, the effects of the defense structures on the sediment deficit of the beaches are worse for coasts with a fast changing sediment transit (Bernatchez and Fraser 2012). For Cua Dai beach, the option of coastal protection should be considered carefully because it is crucial that “coastal protection” in this area means “beach protection.” Beach nourishment adding offshore sand might be a vital management option for tourism because of the relatively low investment and the direct recreational benefits (Shivlani et al. 2003; Phillips and Jones 2006). The technique is effective along more energetic coastlines and optimized by the installation of submerged breakwaters, which reduce the energy of the waves and help retaining the sand. The case of the Rethymnon beach of the island of Crete was described in detail (Alexandrakis et al. 2015). Beach nourishment was used to counteract erosion in many places along the US Atlantic and Pacific coasts, Europe, and Italy (Gopalakrishnan et al. 2011; Prati et al. 2016; Oriando et al. 2017). In China, sandy coast nourishment is the most widespread and contributes to the rising of coastal tourism and real estate activity (Luo et al. 2016).

Beach erosion is on the urgent all over the coasts of the Red River Delta, Central Region, and Mekong Delta of Vietnam. In practice, its relation with tourism was studied (Duc et al. 2012; Noshi et al. 2015; Chu et al. 2015). Vietnamese government should take measure reducing beach erosion in a cost and benefit context (Feagin et al. 2014; André et al. 2016). In the cost–benefit analysis of beach protection, it is important to realize that investments are for present generation, while the benefits will be part of the future. Uncertainties about the possible options entail among others the timing of the benefits, and the nature and extent of the benefits. Beach protection and recovery measures can only be sustainable if coastal processes are fully considered and a detailed cost–benefit analysis is performed. Additional policies should support the management plans for beach tourism (Alexandrakis et al. 2015). Overall, the results of this study provide a scientific basis for the decision-making process on integrated coastal zone management (ICZM) in the Hoi An World Heritage site and along the coasts of Vietnam.

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