Economic analysis of choices among differing measures to manage coastal erosion in Hoi An (a UNESCO World Heritage Site)

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Abstract

The paper presents one of the first economic analyses of residents' choice of different coastal erosion control measures in a developing country - Vietnam. Hoi An, a UNESCO World Heritage Site, was selected given the frequency of coastal erosion events which have caused increasing damages to property, tourism activities and the livelihood of local people in an iconic tourist destination. We designed a discrete choice experiment based on responses from 399 households in order to estimate the willingness to pay (WTP) for differing coastal erosion control measures. Using the generalized multinomial logit model, empirical results yield five important findings. First, residents prefer wider, more public beaches having both trees and restaurants and are willing to accept visible structures such as groynes and stair revetment to prevent further erosion. Second, residents place a higher value on a beach that is protected by robust permanent structures. In particular, residents have the highest WTP for groynes. Third, there exists preference and scale heterogeneity across respondents which are driven by level of education, knowledge of the problem, and the stated level of choice certainty. Fourth, knowledge and experience of coastal erosion are shown to have a strong influence on the valuation residents place on the choice of protective structures. Finally, on average, a resident is willing to pay USD 1.7 per year for a coastal erosion management program that increases beach width by additional 50 meters, beach access by additional 25%, restaurants and trees on the beach and groynes as the erosion protection structure.

Keywords: Coastal erosion, residents' valuation, discrete choice experiment, Vietnam.
JEL Classifications: Q26, Q51, Q54.

1 Introduction

Sandy beaches account for one-third of global coastlines and play a crucial role in the socioeconomic development of maritime nations. In particular, coastal beaches provide high values of recreation, tourism as well as ecosystem services. Coastal erosion therefore represents a significant threat to local residents in many forms including direct welfare loss due to damage to residential properties and households' livelihoods. This is particularly serious in areas heavily dependent on tourism activities. In the face of climate change, Vousdoukas et al. (2020) show that if no action is taken to stop the increasing trend of erosion, it is possible that half of the world's sandy beaches could be lost by the end of the century. The increasingly serious trend in this form of erosion poses a significant risk in highly populated regions of developing countries in South America, Africa and South East Asia. Hence, there is an urgent need for governments to effectively design and implement adaptive measures. This in turn requires a better evidence-based measure of the WTP for a variety of erosion protection programs draw from the insights and preferences of residents living in those areas. Literature on the preferences for coastal erosion prevention of local population has attracted increasing research interest (Huang et al., 2007; Castaño-Isaza et al., 2015; Halkos and Matsiori, 2018; Landry et al., 2020). Nevertheless, many past studies looking at residents' WTP for different erosion prevention measures have been conducted in developed countries or regions. While it is common for policy practitioners to transfer values estimated from research in developed countries and apply these values in the context of developing countries, this practice is exposed to high levels of error. For instance, the socioeconomic characteristics of populations in developed countries differ significantly from those in developing countries. Hence, estimated values for the willingness to pay for differing erosion protection programs of people living in developed countries are likely be different from those living in developing countries. To reduce the effect of such errors, studies on the WTP for coastal erosion protection measures should be conducted in similar contexts. Unfortunately, there lacks empirical research on WTP for prevention of coastal erosion in developing countries. This research aims to fill in this gap by providing an empirical study of attitudes of the local population in Hoi An, a popular tourist destination in Vietnam which was recognized as a UNESCO World Heritage Site in 1999.

Hoi An is a coastal tourism hot spot in Vietnam. Annually, about five million of tourists visit this town, contributing 60% of the local region's income. However, in recent years, Hoi An's coastline has been severely eroded, leading to extensive damage to coastal businesses and local tourism activities. Viet et al. (2015) estimate that the coastline surrounding Cua Dai beach - one of the most attractive beaches in Hoi An - has retreated by 200m, rendering the area unsuitable for tourism activities. The local authorities have implemented various measures including hard and soft structures to protect some parts of the coastlines. However, budget constraints arise and cost-effective mitigation strategies have become a crucial consideration (Thinh et al., 2019). Accordingly, more accurate knowledge on the preference of local residents for differing coastal erosion protection programs in Hoi An is needed and fed into the process of policy design and implementation.

This study uses a discrete choice experiment (DCE) model to investigate the values that the local population place on different coastal protection programs. This methodology is well known in the literature - see for example Louviere et al. (2000). The DCE model allows for a detailed examination of marginal WTP for various attributes of a policy. Such data can therefore help local authorities select the policy setting that is most desirable by local residents. Furthermore, as the DCE model belongs to the stated preference type of methodology it captures not only use values (e.g. beach recreational activities) but also non-use values associating with erosion protection services and aesthetic features. Our empirical strategy also allows us to account for respondents' taste heterogeneity caused by different experiences and knowledge of environmental goods. This is important as the literature notes that these variables can have a significant impact on respondents' valuation of the valued goods (Kularatne et al., 2021; Czajkowski et al., 2015, 2016). Moreover, our empirical study investigates the scale of heterogeneity which reflects residents' choice randomness and explores factors that drive the randomness in their choice decision.

The paper is organized as follows. Section 2 provides a brief literature review on economic valuation of coastal management. Section 3 introduces the case study of Hoi An. The methodology is presented in Section 4, followed by survey design and implementation in Section 5. Section 6 and 7 present estimation results and our conclusions.

2 Literature review

The literature on economic valuation of beach protection including beach erosion control is extensive and reviews on relevant studies have been provided elsewhere (e.g. Gopalakrishnan et al., 2016; Dribek and Voltaire, 2017; Landry et al., 2020). Many studies have shown that there is significant and positive demand for erosion management program (Huang et al., 2007; Halkos and Matsiori, 2018). In this section, we provide a brief review of those studies that investigate differences in the preferences with respective to differing programs of beach erosion prevention.

There are several techniques available to protect against coastal erosion which raises the question: which preventive measure can maximize social welfare? The various techniques can be classified into hard (or active) measures and soft (or passive) measures (Landry et al., 2020). Hard or active measures refer to direct defensive structures against erosion, such as the establishment of shoreline armouring with groynes or revetments. Soft or passive measures refer to more a subtle defence or management approach, including sandbagging, beach nourishment and shoreline retreat. Hard and soft measures can be useful in preventing further coastal erosion but at the same time can exhibit negative impacts on the overall beach quality such as loss of direct access to the beach or reduction of beach width. In many cases, hard measures can temporarily or permanently transform the beach into a construction zone or an area with permanent structures. The soft measures such as beach replenishment can improve beach width and dune height but may have negative impacts on the texture and colour of the beach in addition to direct impacts from sand mining and other replacement sites. Thus, while coastal erosion can result in diminished beach and dune quality, erosion prevention measures can also affect beach quality negatively.

Each of the techniques or measures to prevent coastal erosion may garner different levels of support among the general public, especially those who reside in the area. The techniques will also affect choice, experience, and value of beach recreational users as well. A shortcoming of the literature on coastal residents' value of beach quality is that there are only few studies that compare general public support and economic values among differing erosion management policies (Landry et al., 2020).

Loss of recreational area and direct access to the beach affects beach users' utility which translates into direct loss of welfare. Several authors have estimated damage of beach width loss in monetary terms. Castaño-Isaza et al. (2015), for example, estimated an aggregate loss of USD 72 million to tourism revenues for San Andres beaches when their width was eroded by half. Whitehead et al. (2008) measure the value of a policy that improves beach access and beach width. They find that improved beach access accounts for roughly 41% of annual aggregated benefit of southern North Carolina beach trips while improved beach width accounts for 8%. Respectively, per-trip individual consumer surplus for improved beach access and beach width is USD 25 and USD 7. Loss in beach width and accessibility also reduce visitors' intention to return and thus has a negative impact on tourism in the longer term. Schuhmann et al. (2019) show evidence that return decisions are sensitive to changes in all aspects of coastal and marine quality. Furthermore, the study of Landry et al. (2003) using hedonic pricing method, show that beach width is an important attribute affecting residential house prices. Interestingly, the authors shows that beach width does not only affect recreational and amenity values but can also mitigate flood and erosion risk. This study finds that house prices increase by USD 233 per meter of beach width. Recently, Landry et al. (2020) published a unique piece of research which showed significant welfare gains stemming from shoreline retreat, modest support for beach nourishment, and null values associated with shoreline armouring. Differences in the estimates of welfare gains across three distinct measures of coastal erosion management are based on estimated WTP of 803 households living in North Carolina (USA). Specifically, the authors estimate that the median WTP for shoreline retreat, beach nourishment and shoreline armouring at USD 22.20, USD 7.449 and USD 0.0998 per household per year, respectively. The study shows a clear preference of residents for soft measures over hard structures. As illustrated in Landry et al. (2020), knowledge of the preference of local residents can give an insight into which erosion management measures or policy would yield the largest social net benefits and into which preferences are more socially desirable. Unfortunately, such research in the context of developing economies such as Vietnam is not available in the literature – a gap our paper aims to fill.

3 Hoi An case study

Hoi An is a coastal city located in the south central coastal region of Vietnam, in Quang Nam province and was recognized by UNESCO as a World Heritage Site in 1999. The city has a natural boundary and extends over an area of 6,171 ha, of which 4,622 ha form an inland territory. It has a population of around 120,000.[1] This ancient city is considered both a cultural centre and an economic center of Quang Nam province and has made significant contribution to Vietnam's tourism development and economic growth. There were over four million visits by foreign visitors to Hoi An in 2019, accounting for over one-fifth of total foreign visits to Vietnam.[2]

However, Hoi An is among Vietnam's most severely damaged regions by coastal erosion. Viet et al. (2015) report that, over the period from 2004 to 2014, of the 9-km long coastline some 1.7km are extremely severely eroded (500m), 2.5km severely eroded (200m) and 2km moderately eroded (30-120m). Coastal erosion hinders tourism activities through damage to beaches and recreational infrastructures. This poses significant threats to properties and touristic experience which in turn can have a severe impact on the livelihood of the local population whose main economic activities rely on tourism. Since 2013, roads, sea dykes and coastal resorts along the beach have been damaged from erosion, and in some extreme cases, has led to permanent abandonment of million-dollars recreational establishments such as the Fusion Alya resort. The World Bank reports that over 80% of hotels in Quang Nam province are exposed to erosion and 15-40% are under threat of a 1-in-20-year coastal or riverine flood risk (Rentschler et al., 2020). Tourism revenue loss resulting from beach erosion in Hoi An using a hedonic pricing method is put at a substantial USD 29.6 million (Thinh et al., 2019). The situation has further worsened

[1] Hoi An City portal. http://hoian.gov.vn/pages/chuyenmuc_view.aspx?idchuyenmuc=552

[2] Vietnam National Administration of Tourism. https://vietnamtourism.gov.vn/index.php/statistic/international

given the increased occurrence of extreme climatic events due to climate change (UN-Habitat, 2014).

These developments clearly indicate the urgency with which local authorities need to implement more effective mitigation and adaptation strategies. However, Hoi An is faced with limited financial and technological capabilities (UN-Habitat, 2014). To facilitate effective coastal erosion management, information on WTP for differing erosion management measures by local residents of Hoi An is necessary.

4 Methodology

4.1 Discrete choice modelling

We use DCE which is a technique initially developed by Louviere and Hensher (1983) and Louviere and Woodworth (1983). In a DCE survey, first, each respondent is presented with a sample of hypothetical scenarios of two or more alternatives. Each alternative describes a set of varying attributes of interest, and each respondent is asked to select one alternative. The cost attribute plays an important role in DCE. This attribute allows for an estimation of a monetary valuation for other attributes of interest through the concept of WTP. According to utility theory, a respondent's choice reflects the option that yields the highest utility for that individual. The total utility derived from an alternative choice set is assumed to be dependent on the composition of the levels of each attribute of interest (Lancaster, 1966). Hence, the cost attribute allows an indirect computation of a respondent's WTP for each attribute included in the choice set. In this study, the choice experiment method is used to account for residents' preference relating to coastal erosion protection programs. This method allows the estimation of the marginal WTP for changes in coastal and marine qualities (beach sizes, amenities); a comparison between different management options (hard and soft measures) and the choice of a payment instrument (tourist tax, beach fee).

Louviere et al. (2000) develop a method that allows the integration of DCE with econometric analysis by applying the random utility model (RUM) (McFadden, 1974). Logit is the most widely used discrete choice model (Train, 2000). The respondent, i, faces a choice among J alternatives. The respondent obtains a certain level of utility U_{ij} from alternative j, with $j = 1, ..., J$. The respondent chooses the alternative that provides the greatest utility, i.e. alternative k if and only if $U_{ik} \geq U_{ij}$, for all $j \neq k$. Utility is decomposed accordingly -$U_{ij} = V(x_{ij}|\beta_n) + \epsilon_{ij}$- where $V(x_{ij}$ is the observed part and ϵ_{ij} is an unobserved part. The observed part of utility is usually specified as a linear function in parameters $V_{ij} = \beta_i X_{ij}$ where X_{ij} denotes a K-vector of observed attributes of alternative j. According to McFadden (1974), the ϵ_{ij} is assumed to be an independently, identically distributed extreme value and the parameter β_i is homogeneous across respondents. -i.e $\beta_i = \beta$ - which forms the classic multinomial logit (MNL) model:

$$U_{ij} = \beta X_{ij} + \epsilon_{ij} \tag{1}$$

A flexible model that is developed from the MNL model and is able to account for heterogeneity of preferences is mixed logit (MIXL) model. The most popularly used form is based on random coefficients (Train, 2009). The utility of respondent i from choosing alternative j has been rewritten as:

$$U_{ij} = \beta_i X_{ij} + \epsilon_{ij} \tag{2}$$

where β_i is a vector of parameters for respondent i and is assumed to follow a continuous density.

4.2 Generalized multinomial logit (G-MNL) model

While the MIXL model has shown its ability to capture heterogeneity in preferences over observed attributes, it does not take into account the potential scale heterogeneity, i.e., differences in the scale of the idiosyncratic error term. Scale heterogeneity represents an important issue in the DCE, as it captures the variation of randomness in respondents' decision-making process and hence different degrees of certainty across respondents when they are facing different choice tasks.

The G-MNL model has recently been proposed to deal simultaneously with the issues of taste and scale heterogeneities (Fiebig et al., 2010). In this model, utility weights are defined as

$$\beta_i = \sigma_i \beta + (\gamma + (1-\gamma)\sigma_i)\,\Gamma\eta_i \tag{3}$$

where σ_i is the scale of the idiosyncratic error term for respondent i, β is the vector of the mean attribute utility weights, and η_i is the vector of respondent i's specific deviations from the mean. These deviations can be correlated, with Γ denoting their covariance matrix. The parameter γ, with $\gamma \in [0, 1]$, governs how the variance of the residual varies with scale in a model. To better understand this, we must consider the two polar cases at the boundaries of the interval for γ. Thus,

$$\beta_i = \sigma_i \beta + \Gamma\eta_i \quad \text{if} \quad \gamma = 1 \;\; \text{(GMNL-I model) and} \tag{4}$$

$$\beta_i = \sigma_i(\beta + \Gamma\eta_i) \quad \text{if} \quad \gamma = 0 \;\; \text{(GMNL-II model)} \tag{5}$$

Note that, in either the GMNL-I or GMNL-II models, the vector of utility weights can be written as $\beta_i = \sigma_i\beta + \eta_i^*$ where the random variable σ_i captures scale heterogeneity and η_i^* captures residual taste heterogeneity. The main difference between the two models is that in model (4), the standard deviation of η_i^* is independent of the scaling of β, whereas in model (5), it is proportional to σ_i.

The description of the GMNL model is complete once the distribution of σ_i is specified. As it is a scale parameter, it should have positive support. It is then customary to assume that σ_i is distributed as log-normal, i.e., $\log \sigma_i \sim \mathcal{N}(\overline{\sigma}, \tau^2)$. Note that $\overline{\sigma}$, τ and β are not separately identified. Identification is achieved by calibrating $\overline{\sigma}$ so as to normalize $\mathbb{E}(\sigma_i) = 1$, allowing τ and β to be free.[3] Thus, the estimated β are interpretable as mean utility weights.

Note that the MNL and the MIXL models can be viewed as special cases of the GMNL model by setting $\sigma_i = 1$ and $\eta_i = 0$, or $\sigma_i = \sigma = 1$, respectively. The scale heterogeneity (S-MNL) model proposed by Swait and Adamowicz (2001), which assumes that $\beta_i = \sigma_i \beta$, is also nested in the G-MNL model.

Moreover, the scale mean can vary across respondents with the addition of individual-specific characteristics. A random scale parameter can thus be written as:

$$\sigma_i = exp(\overline{\sigma} + \theta s_i + \tau) \tag{6}$$

where s_i is the vector of individual-specific variables.

Parameters in the MIXL and G-MNL models are estimated using maximum simulated likelihood, while those in MNL model can be estimated using classical maximum likelihood techniques (for the derivation of choice probabilities, see Keane and Wasi, 2013).

4.3 WTP-space

The WTP for a given attribute is defined as the marginal rate of substitution between this attribute and a monetary attribute (Train, 2009). In random utility models with linear utility specification and without any taste heterogeneity, WTP can be obtained by the ratio of the non-monetary attribute utility weights and the monetary attribute utility weight multiplied by minus one. Estimates of WTP can be easily recovered by taking the ratio of estimated values of the aforementioned utility weights. Train and Weeks (2005) proposed a direct way to estimate WTP, using the so-called the WTP-space. They point out that the estimation of models in WTP-space have greater behavioral implications. This has been confirmed by further studies such as that of Hensher and Greene (2011) and Rose and Masiero (2010). Moreover, Scarpa et al. (2008) reported that the fit of a model in WTP-space model is better than the fit in a preference-space model.

The WTP-space approach can be motivated as follows. Consider the simple case of the conditional logit model, where the vector of attributes is divided into to the monetary attribute,

[3] As $\mathbb{E}(\sigma_i) = \exp(\overline{\sigma} + \tau^2/2)$, normalization is achieved by setting $\overline{\sigma} = -\tau^2/2$.

p_{ij}, and non-monetary attributes, x_{ij}. In preference-space, the utility of alternative j for individual i then becomes:

$$U_{ij} = \beta^c p_{ij} + \beta^{nm} x_{ij} + \varepsilon_{ijt} \tag{7}$$

where β^c and β^{nm} are now utility weights for monetary and other non-monetary attributes. The WTP for non-monetary attributes is simply the ratio $-\beta^{nm}/\beta^c$.

The utility in WTP-space is obtained by dividing the attribute utility weights by the price coefficient as follows:

$$\begin{aligned} U_{ij} &= \beta^c \left[p_{ij} - \left(-\tfrac{\beta^{nm}}{\beta^c} \right) x_{ij} \right] + \varepsilon_{ijt} \\ &= \beta^c \left[p_{ij} - \phi x_{ij} \right] + \varepsilon_{ijt} \end{aligned} \tag{8}$$

The vector of WTP, or ϕ, can then be estimated directly using Equation (8), where monetary utility weight is normalized to minus one.

In the simple conditional logit (CL) model, writing utility in WTP-space corresponds to a one-to-one transformation of the parameters of original utility in preference-space. However, the transformation is more complicated when parameters are random and scale heterogeneity is considered. Nevertheless, Greene and Hensher (2010) and Hensher and Greene (2011) point to a special case of the GMNL model that can be reparameterized in WTP-space in the presence of both taste and scale heterogeneity, namely the GMNL-II model where $\gamma = 0$. Indeed, Equation (5) can be parametrized to become the GMNL model in WTP space by normalizing the utility weight for the monetary attribute to one inside the bracket, which results in:

$$\beta_i = \begin{pmatrix} -\beta_i^c \\ \beta_i^{nm} \end{pmatrix} = -\sigma_i \beta_i^c \begin{pmatrix} 1 \\ \frac{1}{-\beta_i^c}(\beta^{nm} + \Gamma^{nm}\eta_i^{nm}) \end{pmatrix} = -\sigma_i \beta_i^c \begin{pmatrix} 1 \\ \phi + \Pi^{nm}\eta_i^{nm} \end{pmatrix} \tag{9}$$

where Γ^{nm} and η_i^{nm} are Γ and η_i, excluding the monetary attribute weight. As pointed out by Train and Weeks (2005), the common denominator in ϕ and Π^{nm} induces correlation among all non-monetary attributes, even if they are not correlated in the GMNL model expressed in preference-space.

5 Survey design and implementation

5.1 Survey design

A seminar was organized in 2017 in Hoi An where local experts on climatology, hydrology and sociology who had worked on the morphological changes and consequences of Hoi An beaches discussed their findings. Additionally, local authority officers, non-governmental organizations (NGOs), environmental activists, and representatives from Hoi An residents were consulted regarding the preliminary design of the survey questionnaire. This process aimed to ensure that the design of the survey was in line with existing management strategy of the local authority and reflected major components of the subjective valuation for coastal and protection attributes of local residents. For instance, the types of beach facilities, protective structures and their combination with beach nourishment efforts were selected to form alternative measures of coastal erosion prevention. These were adapted from existing or planned protection measure developed by local authorities. A subsequent focus group discussion and a literature review were conducted after the seminar to further refine the preliminary version of the questionnaire. A pilot survey with a sample of 120 households was implemented followed by the final survey. The framework is illustrated in Figure 1.

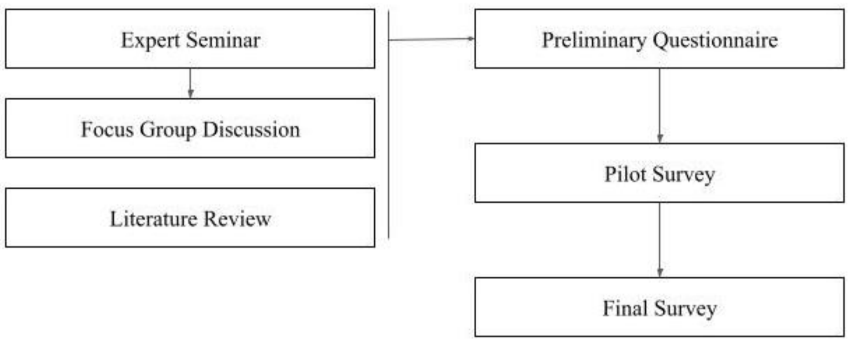


Figure 1: Questionnaire development framework

The final set of attributes detailed in Table 1 includes type of protection structure, beach width, public access portion, beach facility and local tax. Given the large population and property density in the survey region some soft protection measures such as shoreline retreat were not feasible. All protection policies considered were combinations between the implementation of a protection structure and beach nourishment efforts - indicated in an increased beach width.[4] It is accepted that payment vehicles must be binding, mandatory and popularly accepted within a given population (Mariel et al., 2020). In valuation of coastal management, examples of payment vehicles are parking fees (Oh et al., 2010; Dixon et al., 2012; Logar and den Bergh, 2014), contribution fee (Beharry-Borg and Scarpa, 2010), and household tax (Matthews et al., 2017; Christie et al., 2015; Ardeshiri et al., 2019; Spencer-Cotton et al., 2018). In a meta-analysis of wetland valuation, Brouwer et al. (1999) point out that tax generally results in the highest WTP and is better suited compared to other payment vehicles. In the case of Hoi An, we chose a local tax since it was expected to apply to the whole city population and not limited to only beach users.

[4]The current beach width is about 0 to 50 meters depending on beach segments. The beach width was up to 180 meters 15 years ago (Fila et al., 2016). We selected the maximum of beach width level as 150 meters for its relevance

Table 1: Attributes in a coastal erosion protection policy alternative

Attribute	Definition	Level
Protection structure	Type of structure to be built along the coastline for erosion protection	No structure Sandbag Stair revetment Concrete revetment Groynes
Beach width (meter)	Average beach width measured at high tide. Beach width increase using beach nourishment technique.	0, 25, 50, 75, 100, 150
Public beach (%)	Percentage of beach freely accessible for all	0, 25, 50, 75, 100
Beach facility	Type of beach facility available	Nothing Tree Restaurant Tree and restaurant
Local tax	An annual local tax levied on Hoi An residents aged 18-60 and used to fund the erosion protection program	0, 50, 100, 150, 200 thousand VND

Each respondent is asked to choose from three alternatives including two alternative policies and a status quo option. Figure 2 is an example of a choice set.

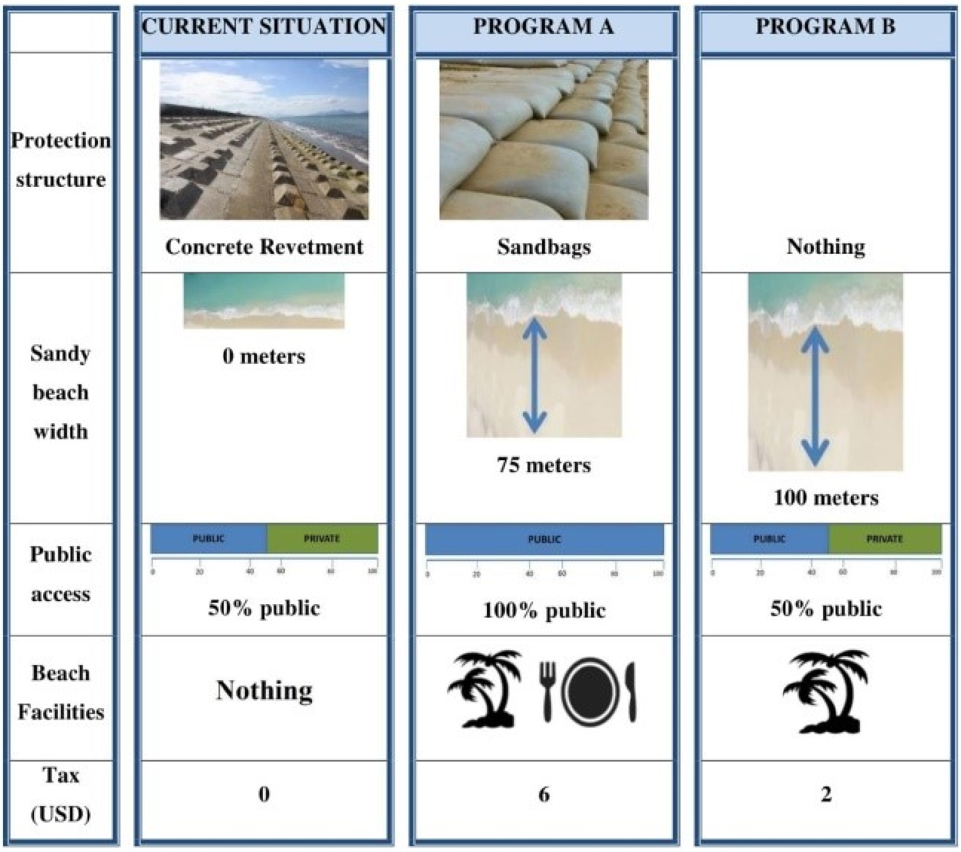


Figure 2: Example of a choice set

The coastline in Hoi An is characterized by segments which display different erosion rates and a variety of existing protective structure (Viet et al., 2015). Therefore, the coastline was divided into four separated segments.

Beach A This beach is most affected by erosion. Hence, a concrete revetment has already been constructed. It used to be a touristic destination with several hotels and resorts in the past but has been severely damaged by erosion to the extent that coastal tourism in this beach is restricted.

Beach B Beach B has lost 60 - 120 meters of beach width but currently no protective measure are implemented.

Beach C Beach C is a popular beach and attracts many tourists but is subject to an alarming level of coastal erosion. Sandbag protection is implemented on this beach.

Beach D Beach D is the least eroded and no current protective measure are in place. It is also the only beach with full public access.

The discrete choice survey was designed for these four beach segments. Each respondent was randomly assigned to a questionnaire of one beach segment. The respondent was asked to select one alternative among three, each with varying levels of the five attributes as described above. The design for the choice set was produced from the D-efficient design using *Stata* software and a prior from pilot data. 18 choice sets were produced for each beach segment, which are grouped into three blocks so that each respondent was presented with six choice sets.

The survey questionnaire consisted of four parts. Part 1 asked questions on the attitude and awareness of local residents toward coastal erosion. Boyer-Villemaire et al. (2014) remark that direct experience of coastal erosion can raises awareness and this in turn can have an effect on an individual's perceptions about the effectiveness of coastal management program. Part 2 consisted of the discrete choice survey. We employed a video survey which is suggested by several authors to help raise the engagement of survey participants and reduce choice error (Balcombe et al., 2015; Bateman et al., 2009; Matthews et al., 2017). Specifically, the video survey provided participants prior information about the current state of the beaches. This informed the assessment of the consequences of the erosion and a 10-year projection of the level of impact. Thus, providing this information helped respondents understand the current context of Hoi An beaches and reduced uncertainty associated with a lack information. Part 3 collected demographic characteristics and Part 4 presented questions on risk preference.

5.2 Survey implementation

The survey was presented in electronic form and data automatically collected through the application SurveyCTO. Each respondent was guided to give answers using a provided tablet. An incentive of VND 40,000 was given to each respondent upon completing the survey. Six local college students studying economics and environment were employed and instructed by two university lecturers. This provided a total of eight interviewers. The official survey was held in July 2018 with a sample of 399 households. Samples were selected using the stratified and random sampling method, thereby stratifying by administrative level and providing an arbitrary selection based on population proportion of the administrative level. A total of 73 villages within the boundary of 12 inland communes were included in this way. The number of respondents per village was selected based on the proportion of the village population to the city population. This method ensured the representativeness of the sample.

6 Result

6.1 Sample description

Table 2: Survey sample summary statistics

	Description	Our sample	VHLSS Sample*
Gender (% sample)	Female	31.3	34.5
	Male	68.7	65.5
Age	Mean	52	58.3
	Min	18	27
	Max	86	90
Education level (% sample)	High school diploma and lower	70.6	77.1
	University and higher	29.4	22.9
Household monthly income (% sample)	Below 10 million (VND)	62	80.3
	10 - 20 million (VND)	28	12.8
	Above 20 million (VND)	10	6.9
Beach visit (% sample)		90.6	
	Swimming	61.7	
Reason to visit beach (% sample)	Relaxing and Landscape	70	
	Seafood Restaurant	18	
	Working	7.8	
Acknowledge erosion in Hoi An (% sample)		94	
	Air pollution	2.7	
	Water pollution	2.9	
Severity of environmental issues (Mean)	Loss of biodiversity	2.5	
Likert scale, 1-Not serious, 5-Very serious	Temperature warming	3.4	
	Flood	3.3	
	Coastal erosion	4.3	
	Property loss (houses, lands, etc.)	1.9	
Impact of coastal erosion (Mean)	Loss of economic activities	2.3	
Likert scale, 1-No impact, 5-Very high impact	Loss of recreational activities	2.5	

*Source: Vietnam Household Living Standard Survey 2018, data description for the household leader.

Summary statistics for demographic characteristics of respondents, reason to visit, environmental attitudes and erosion experience are reported in Table 2.

There was an inequality in gender proportion in the survey sample - more than two-thirds of the respondents being male. The range of respondent age fell between 18 and 86 with an average of 52 years. The portion of residents with university degree or higher was less than 30%, although this did not seem to strongly affect the respondent's acknowledgement of erosion in Hoi An. Only 6% of the sample were unaware of the situation. A major portion of residents visited the beach for a number of reasons including swimming (61.7%) relaxation and enjoyment of the scenery (70%). About one-fifth of the sample also visited the beach restaurant and 7.8% of the respondents work at these facilities.

In comparison with the Hoi An sample in Vietnam Household Living Standard Survey (VHLSS) in 2018, our sample exhibited a similar share of gender and education level, but was slightly older and had a higher average level of income.

On average, respondents seemed to be aware of the presence of environmental issues, and in particular the more serious issues of pollution, climate change and natural disasters. Interestingly, coastal erosion was regarded to have the highest level of severity (4.3) among all environmental issues. This reflected the general acknowledgement of erosion as a serious issue among Hoi An residents. Regarding damage from coastal erosion, most respondents believed that the loss of economic activities and recreational activities were more problematic than the damage to local properties and infrastructure.

6.2 Estimation result

The models were estimated by *gmnl* package in R (Sarrias and Daziano, 2017). Choice probabilities were simulated using Halton draws (Train, 2009), taking into account the panel structure of the data. We used effect coding for categorical attributes, including structures and facilities. This required that the reference level was coded -1, the presented attribute level coded 1 and the other levels 0. All parameters were assumed to be normal distributed. We added an alternative-specific constant (ASC) to account for the status quo effect (Scarpa et al., 2005). Parameters were scaled according to Equation (5), except ASC parameter. Fiebig et al. (2010) show that scaling the ASC can result in the estimates becoming exceptionally large as τ and the standard errors of estimated utility weights can take on very large values. We chose to estimate the GMNL-II specification with correlated attributes because this specification can be reparameterized in WTP-space, avoiding computational issues encountered when computing WTP using estimation results in preference-space. Table 3 presents a description of variables.

Table 3: Description of variables

Variables	Value	Description
Width	Continuous variables in kilometers	Width attribute
Access	Continuous variables in percentage	Access attribute
ASC	1 if respondent choose status quo option 0 if respondent doesn't choose status quo option	Status quo option
Tax	Continuous variables in USD	Tax attribute
Restaurant Restaurant-tree Tree	Dummy variable 1 if the facility is chosen 0 if the facility is not chosen	Facility attribute
Groynes Sandbag Concrete revetment Stair revetment	Dummy variable 1 if the structure is chosen 0 if the structure is not chosen	Protection structure attribute
Being impacted	1 if respondent is highly impacted by erosion 0 if respondent is less impacted by erosion	Ranking of impact of coastal erosion on respondent's own life
High rate of severity	1 if ranking by respondent is above 3 0 if ranking by respondent is equal or below 3	Respondent's ranking of severity level of coastal erosion in Hoi An by Likert scale
Acknowledgement	1 if YES 0 if NO	Respondent thinks that Hoi An is facing problems due to coastal erosion
Tourism related	1 if YES 0 if NO	Respondent works in economic activity that is related to tourism
Education	1if YES 0 if NO	Respondent has a college degree or above
Certainty	1 if ranking by respondents is above 3 0 if ranking is equal or below 3	Respondents' ranking of their certainty about their choice by Likert scale

6.2.1 Results in preference-space

Valuation of residents

The views of residents on coastal erosion management programs are presented in Table 4. Generally, residents favour a wider and highly accessible public beach, as the parameters for Width and Access are significantly positive in estimations of the MNL, the MIXL and the GMNL models. These findings align with previous studies (Dixon et al., 2012; Rolfe and Flint, 2018).

With respect to beach facilities, estimations indicate an inclination of residents to have more diverse facilities on the beach, preferentially having both restaurant and trees. Concerning protection structures, parameters for groynes, concrete revetments and sandbags are significant and positive, indicating that residents place a greater value on the presence of protective structures along the coastline than having nothing. Groynes are the most preferred structure. As explained by Boyer-Villemaire et al. (2014), the preference for an erosion management option could be attributed to the awareness of the local population arising from their direct experience with erosion. However, we note that while there is a consensus in their preferences for a protection policy, the literature often indicates respondents view visible protective structures as a disutility (Matthews et al., 2017). Moreover, the significance of the standard deviation in the MIXL and GMNL estimations indicates a preference heterogeneity across respondents on most of the attributes including beach access, width, all protection structures and facilities.

Table 4: Preference of residents towards coastal erosion management program

Attributes	MNL	MIXL	GMNL	GMNL with scale drivers
Tax	-0.122(0.011)***	-0.285(0.027)***	-3.712(0.367)***	-25.854(9.497)***
ASC	0.098(0.079)	-0.073(0.195)	-0.514(0.19)***	-0.514(0.223)**
Width	4.014(0.638)***	6.805(1.368)***	10.035(1.618)***	32.383(14.311)**
Access	0.431(0.079)***	0.908(0.18)***	1.076(0.21)***	8.671(3.303)***
Restaurant	-0.01(0.055)	0.059(0.101)	0.019(0.112)	-1.159(0.847)
Restaurant-tree	0.271(0.041)***	0.371(0.099)***	0.334(0.114)***	3.168(1.34)**
Tree	-0.098(0.045)**	-0.145(0.088)*	-0.063(0.098)	-1.721(0.828)**
Groynes	0.187(0.065)***	0.497(0.132)***	0.456(0.146)***	2.726(1.546)*
Concrete revetments	0.091(0.051)*	-0.173(0.134)	0.185(0.138)	3.689(1.523)**
Stair revetments	0.049(0.064)	0.162(0.124)	0(0.152)	0.997(0.876)
Sandbags	0.044(0.051)	0.348(0.109)***	0.142(0.116)	1.869(1.21)
Standard deviation				
Tax		9.83(1.954)***	14.133(2.134)***	90.252(34.358)***
ASC		2.268(0.224)***	2.792(0.326)***	2.984(0.281)***
Width		2.141(0.265)***	2.466(0.333)***	19.917(7.455)***
Access		0.342(0.032)***	3.88(0.37)***	25.116(9.266)***
Restaurant		0.173(0.156)	0.148(0.153)	1.955(1.066)*
Restaurant-tree		1.03(0.138)***	0.972(0.14)***	6.623(2.441)***
Tree		0.474(0.128)***	0.439(0.121)***	2.486(1.03)**
Groynes		1.354(0.145)***	1.837(0.182)***	11.181(4.223)***
Concrete revetments		1.117(0.179)***	1.62(0.237)***	9.61(3.675)***
Stair revetments		1.285(0.219)***	1.666(0.221)***	9.604(3.623)***
Sandbags		1.9(0.194)***	2.112(0.236)***	12.022(4.507)***
Scale parameter drivers				
τ			0.538(0.083)***	0.849(0.078)***
Acknowledgement				-2.186(0.386)***
Certainty				0.677(0.163)***
Education				0.925(0.17)***
Loglikelihood	-2415.98	-1951.04	-1933.38	-1427.04
AIC	4853.96	4056.09	4022.77	3016.07
BIC	4917.55	4501.20	4473.66	3463.60

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Scale heterogeneity

The estimation of GMNL model in the fourth column in Table 4 reveals a significant scale heterogeneity (τ), reflecting choice randomness among respondents. It can be seen that distribution of the scale heterogeneity for residents has a wide spread. The main part of the estimated scale parameter is below one, and thus the weight that respondents put on the deterministic part of utility is lower than one. This reflects that residents have a relatively high degree of choice randomness.

A possible explanation for the observed choice randomness is the existing relationship between scale heterogeneity and prior experience of the good being valued (Czajkowski et al., 2015), the level of education (Czajkowski et al., 2014), the availability of information preceding the survey (Czajkowski et al., 2016), task complexity, and the cognitive ability of respondents (Christie and Gibbons, 2011). In order to explore which factors drive the scale heterogeneity in our study, three variables representing education level, acknowledgment of the problems caused by coastal erosion, and stated level of choice certainty were incorporated in the mean of the scale. The final column in Table 4 presents the estimation results of the GMNL model with these factors.

Estimation results show that "Education" and "Certainty" significantly increase the scale mean, whereas "Acknowledge" shows that respondents who have a higher level of education and who display greater certainty in their choice question tend to make less random choice decisions. On the other hand, those who think that coastal erosion causes issues in Hoi An exhibit a higher level of randomness in their choice decision. That is, their choice is driven more by the error term than by interpreting the attributes in the choice tasks.

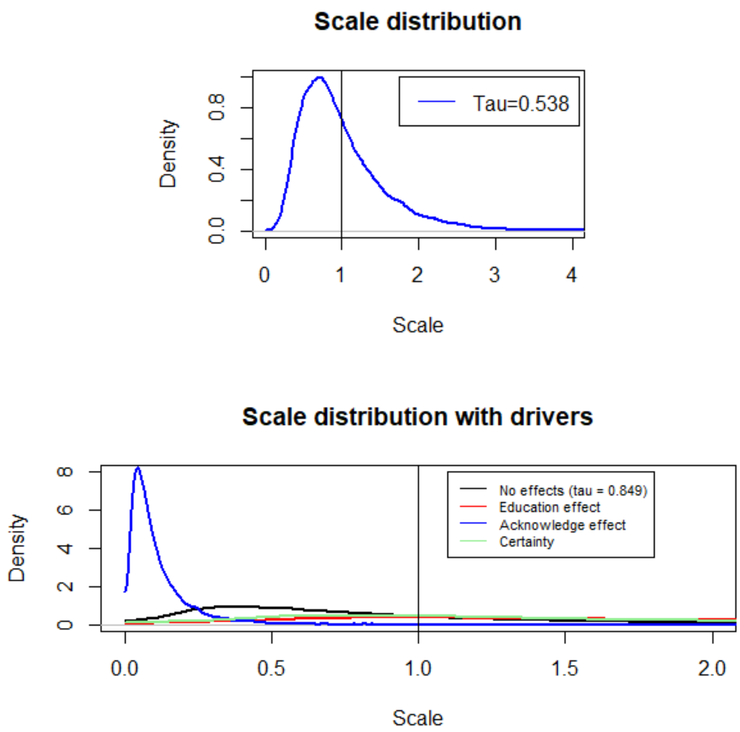


Figure 3: Scale distributions with scale parameter drivers

Figure 3 shows how the density of the scale parameter evolves with significant drivers. Due to the effect of the acknowledgement of the issues caused by erosion, the distribution of the scale parameter moves to the left side of one with a high probability for values close to zero. This implies that in accepting coastal erosion as a problem in Hoi An, this leads respondents to put a very small weight on the deterministic part of utility. This in turn suggests that, for respondents who think that coastal erosion causes problems in Hoi An, the choice decision about the coastal erosion protection program is less driven by interpreting the choice experiment. It is also noteworthy that most residents (94%) are known to be aware of the issue of erosion in Hoi An. The high level of education and certainty causes the density of the scale parameter to be concentrated above one, which decreases the weight that respondents put on the error term for utility. Thus, the respondents who have college degrees or higher (18.8% of residents) seem to pay more attention to evaluating attributes than others do when they make their choice in the DCE.

In summary, it may be more challenging for most residents in Hoi An to analyze the choice task with different scenarios and attributes due to the level of task complexity. However, where there is an acknowledgment that Hoi An is facing a problem due to coastal erosion, this makes their choice less driven by their interpretation of the DCE.

Interaction effects

To account for the observed preference heterogeneity of Hoi An residents, we tested the interaction effect of attributes with three variables introducing experience and acknowledgement of residents towards coastal erosion issues and one variable representing the economic activity of respondents using the MNL model. The significant interactions are presented in Table 5.

Negative interactions relating to the high rate of severity with tree and beach width indicate that residents who think that there is severe coastal erosion are less inclined to want a wider beach or a beach having only trees than other respondents. Likewise, respondents who are aware of the high impact level erosion has on beaches have a disinclination to accept the current situation of either only trees or restaurants on the coastline. Moreover, residents who think that coastal erosion is causing a problem in Hoi An place a higher value on all type of protective structures than other respondents. Similarly, residents who are highly impacted by coastal erosion are shown to have a greater preference for concrete revetments than those who are less impacted. In addition, the significant and positive interaction of the variable "Tourism related" suggests that people who work in tourism related activities tend to prefer beaches with both restaurants and trees. With regards to protection structures, this group of respondents inclines to groynes, stair revetments and sandbags. These structures not only protect the coastline from erosion but also provide visitors with better access to the sea.

Table 5: Interaction effects

Interaction effect	Coeff
Tree x high rate of severity	-0.352(0.196)*
Width x high rate of severity	-0.003(0.002)*
Tax x being impacted	0.003(0.001)**
Restaurant x being impacted	-0.449(0.259)*
Tree x being impacted	-0.681(0.231)***
Concrete revetment x being impacted	0.569(0.221)**
Tax x acknowledgement	-0.004(0.002)*
Groynes x acknowledgement	0.751(0.439)*
Stair revetment x acknowledgement	1.143(0.411)***
Concrete revetment x acknowledgement	1.411(0.342)***
Sandbags x acknowledgement	0.636(0.301)**
Restaurant-tree x tourism related	0.309(0.17)*
Groynes x tourism related	0.469(0.223)**
Stair revetment x tourism related	0.42(0.224)*
Sandbags x tourism related	0.35(0.175)**

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

6.2.2 Estimation in WTP-space

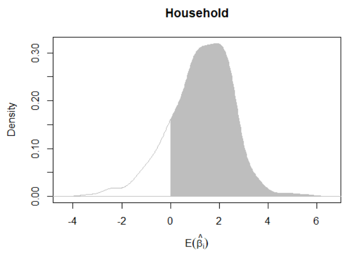
Estimations in WTP-space are presented in Table 6 with starting values taken from the correlated MIXL model. Generally, residents are willing to pay more for a beach having both trees and restaurants - USD 0.39. Residents are willing to pay USD 0.464 to USD 0.676, respectively for a beach that is protected by groynes and stair revetment. WTP for access and width are approximately USD 0.0127 and USD 0.0107 for additional public access and one additional meter of beach width, respectively.

Table 6: WTP-space estimation

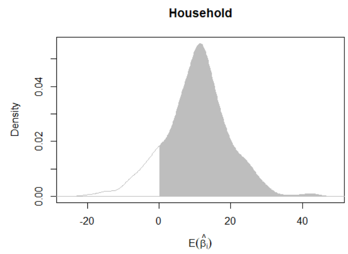
Attribute	WTP-space	Standard deviation
ASC	2.045(0.181)***	2.408(0.212)***
Width	10.724(1.363)***	12.244(1.533)***
Access	1.266(0.183)***	0.456(0.124)***
Restaurant	0.082(0.097)	1.309(0.123)***
Restaurant-tree	0.39(0.099)***	0.547(0.127)***
Tree	0.03(0.085)	1.321(0.175)***
Groynes	0.464(0.123)***	1.758(0.228)***
Concrete Revetment	-0.314(0.126)**	0.915(0.199)***
Stair Revetment	0.676(0.111)***	2.44(0.214)***
Sandbags	0.193(0.124)	1.705(0.159)***
Scale parameter		
τ		0.071(0.089)

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

The distributions of conditional estimates of individual WTP (Greene, 2018) are displayed in Figure 4-6 using a kernel density estimator (Silverman, 1986). Most residents are willing to pay for a wider public beach. In relation to facilities, most residents are willing to pay more for a beach with more facilities. Figures 6 shows that more than half of residents are ready to pay for sandbags, groynes and stair revetments, but only 43% of resident show a WTP for concrete revetments.

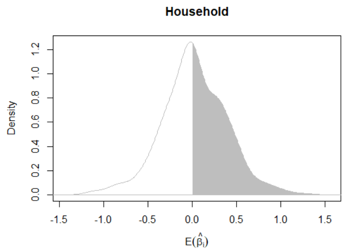


(a) Access

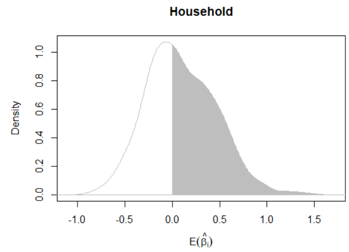


(b) Width

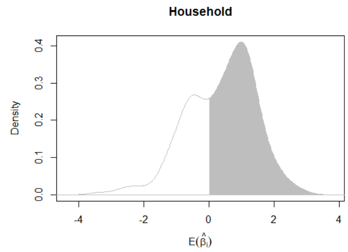
Figure 4: Individual-specific WTP-space distribution for Access and Width



(a) Trees

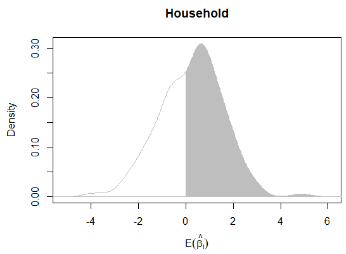


(b) Restaurants

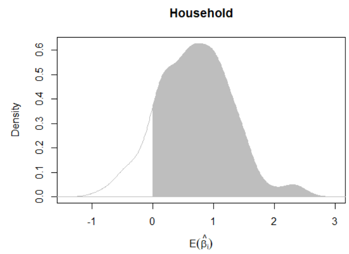


(c) Restaurant-tree

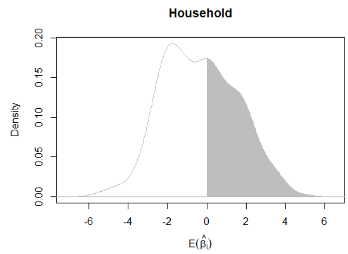
Figure 5: Individual-specific WTP-space distribution for facilities



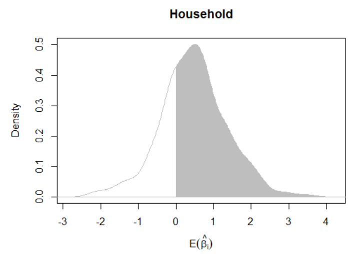
(a) Sandbags



(b) Revetment stairs



(c) Concrete revetment



(d) Groynes

Figure 6: Individual-specific WTP-space distribution for protection structures

7 Conclusion

This paper presents residents' valuation of different measures proposed for coastal erosion protection management in Hoi An, a city which has been seriously affected by coastal erosion. Empirical results show that residents value a wider and more public beach but interestingly are inclined to favour a beach that is protected by visible structures such as groynes and stair revetments. This suggests that a combination of coastal defence structures and beach nourishment is a preferred management program by the local population. With regards to beach facilities, residents prefer to have both restaurants and trees.

Our results indicate a preference heterogeneity across respondents. Knowledge and experience about coastal erosion can influence their valuation for a protection program. Residents who are highly impacted by coastal erosion or have knowledge of the coastal erosion problem in Hoi An tend to place higher values on the construction of protection structures. Being highly impacted by erosion leads residents to be willing to pay a tax to be used for erosion management. At the same time, residents who work in the tourism sector prefer protection structures that are not only capable of mitigating erosion but also allow visitors easy accessible to the sea. Using the G-MNL model, we find a strong scale heterogeneity (high level of randomness) across respondents. This may reflect the presence of respondents with set/lexicographic approaches to choice and who therefore express strong preferences for some specific attributes, regardless of other attributes. Respondent randomness is mainly driven by prior knowledge of coastal erosion, and by difficulties in interpreting the choice tasks of the DCE. This result confirms that scale heterogeneity is affected by the complexity of the choice set and by the cognitive ability of respondents. Contrary to the finding of Czajkowski et al. (2014), we report that respondents with higher education levels are more deterministic in their choices.

Our empirical results provide several important policy implications. First, local residents are willing to contribute to funding which is used for coastal erosion management in Hoi An. For example, a program that increases beach width by additional 50 meters, beach access by an additional 25%, has restaurants and trees on the beach and groynes as the erosion protection structure, can generate an average WTP of USD 1.7 per year per resident. Second, a combination of beach nourishment and construction of protection structures rather than only beach nourishment is preferred by residents.

Through this research we have demonstrated that the potential financial contribution of Hoi An's population to coastal management programs are significant, as there has been for other environmental programs in Vietnam such as flood risks reduction in Nghe An (Reynaud and Nguyen, 2016), insurance for natural disasters (Reynaud et al., 2018), mangrove forest restoration of the Cat Ba Biosphere Reserve in Hai Phong (Pham et al., 2018), coral conservation and control of marine plastic pollution in Nha Trang (Börger et al., 2021).

Future studies can examine the uncertainty associated with multiple attributes among residents so as to understand and categorize major groups of behaviours and preferences. Moreover, due to the different location of respondents, WTP estimates and values may vary across space (Glenk et al., 2020). A further exploration on spatial preference heterogeneity could therefore be examined. In addition, using a split-sample, differences of preferences for different coastal erosion management program on different beach segments could be explored. Lastly, this study could be expanded to investigate compatible payment vehicles for funding in a developing country context.

References

Ardeshiri, A., J. Swait, E. Heagney, and M. Kovac (2019). Willingness-to-pay for coastline protection in New South Wales: Beach preservation management and decision making. *Ocean & Coastal Management 178*.

Balcombe, K., I. Fraser, and E. McSorley (2015). Visual attention and attribute attendance in multi-attribute choice experiments. *Journal of Applied Econometrics 30(3)*, 447–467.

Bateman, I. J., B. H. Day, A. P. Jones, and S. Jude (2009). Reducing gain–loss asymmetry: a virtual reality choice experiment valuing land use change. *Journal of Environmental Economics and Management 58(1)*, 106–118.

Beharry-Borg, N. and R. Scarpa (2010). Valuing quality changes in Caribbean coastal waters for heterogeneous beach visitors. *Ecological Economics 69(5)*, 1124–1139.

Boyer-Villemaire, U., P. Bernatchez, J. Benavente, and A. Cooper (2014). Quantifying community's functional awareness of coastal changes and hazards from citizen perception analysis in Canada, UK and Spain. *Ocean & Coastal Management 93*, 106–120.

Brouwer, R., I. Langford, I. Bateman, and R. Turner (1999). A meta-analysis of wetland contingent valuation studies. *Regional Environmental Change 1*, 47–57.

Börger, T., Q. T. K. Ngoc, L. Kuhfuss, T. T. Hien, N. Hanley, and D. Campbell (2021). Preferences for coastal and marine conservation in Vietnam: Accounting for differences in individual choice set formation. *Ecological Economics 180*, 106885.

Castaño-Isaza, J., R. Newball, B. Roach, and W. W. Lau (2015). Valuing beaches to develop payment for ecosystem services schemes in Colombia's Seaflower marine protected area. *Ecosystem Services 11*, 22–31.

Christie, M. and J. Gibbons (2011). The effects of individual "ability to choose" (scale heterogeneity) on the valuation of environmental goods. *Ecological Economics 70*, 2250–2257.

Christie, M., K. Remoundou, E. Siwicka, and W. Wainwright (2015). Valuing marine and coastal ecosystem service benefits: Case study of StVincent and the Grenadines' proposed marine protected areas. *Ecosystem Services 11*, 115–127.

Czajkowski, M., N. Hanley, and J. LaRiviere (2015). The effects of experience on preference uncertainty: theory and empirics for environmental goods. *American Journal of Agricultural Economics 97(1)*, 333–351.

Czajkowski, M., N. Hanley, and J. LaRiviere (2016). Controlling for the effects of information in a public goods discrete choice model. *Environmental and Resource Economics 63*, 523–544.

Czajkowski, M., T. Kadziela, and N. Hanley (2014). We want to sort! Assessing households' preferences for sorting waste. *Resource and Energy Economics 36(1)*, 290–306.

Dixon, A. W., C.-O. Oh, and J. Draper (2012). Access to the beach: Comparing the economic values of coastal residents and tourists. *Journal of Travel Research 51(6)*, 742–753.

Dribek, A. and L. Voltaire (2017). Contingent valuation analysis of willingness to pay for beach erosion control through the stabiplage technique: A study in Djerba (Tunisia). *Marine Policy 86*, 17–23.

Fiebig, D. G., M. P. Keane, J. Louviere, and N. Wasi (2010). The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. *Marketing Science 29(3)*, 393–421.

Fila, J., M. Kampen, K. Knulst, R. Marijnissen, and R. van Noort (2016). Coastal erosion Hoi An: multidisciplinary project. unpublished.

Glenk, K., R. J. Johnston, J. Meyerhof, and J. Sagebiel (2020). Spatial dimensions of stated preference valuation in environmental and resource economics: Methods, trends and challenges. *Environmental and Resource Economics 75*, 215 – 242.

Gopalakrishnan, S., C. E. Landry, M. D. Smith, and J. C. Whitehead (2016). Economics of coastal erosion and adaptation to sea level rise. *Annual Review of Resource Economics 8*(1), 119–139.

Greene, W. H. (2018). *Econometric Analysis.* Pearson, Harlow, UK.

Greene, W. H. and D. A. Hensher (2010). Does Scale Heterogeneity Across Individuals Matter? An Empirical Assessment of Alternative Logit Models. *Transportation 37(3)*, 413–428.

Halkos, G. and S. Matsiori (2018). Environmental attitudes and preferences for coastal zone improvements. *Economic Analysis and Policy 58*, 153–166.

Hensher, D. A. and W. H. Greene (2011). Valuation of travel time savings in WTP and preference space in the presence of taste and scale heterogeneity. *Journal of Transport Economics and Policy 45*, 505–525.

Huang, J.-C., P. J. Poor, and M. Q. Zhao (2007). Economic valuation of beach erosion control. *Marine Resource Economics 22(3)*, 221–238.

Keane, M. and N. Wasi (2013). Comparing alternative models of heterogeneity in consumer choice behavior. *Journal of Applied Econometrics 28(6)*, 1018–1045.

Kularatne, T., C. Wilson, B. Lee, and V.-N. Hoang (2021). Tourists' before and after experience valuations: A unique choice experiment with policy implications for the nature-based tourism industry. *Economic Analysis and Policy 69*, 529–543.

Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy 74*(2), 132–157.

Landry, C. E., A. G. Keeler, and W. Kriesel (2003). An economic evaluation of beach erosion management altenatives. *Marine Resource Economics 18*, 105–127.

Landry, C. E., J. S. Shonkwiler, and J. C.Whitehead (2020). Economic values of coastal erosion management: Joint estimation of use and existence values with recreation demand and contingent valuation data. *Journal of Environmental Economics and Management 103*, 40 – 53.

Logar, I. and J. C. V. den Bergh (2014). Economic valuation of preventing beach erosion: comparing existing and non-existing beach markets with stated and revealed preferences. *Journal of Environmental Economics and Policy 3:1*, 46–66.

Louviere, J. J. and D. A. Hensher (1983). Using discrete choice models with experimental design data to forecast consumer demand for a unique cultural event. *Journal of Consumer Research 10*(3), 348–361.

Louviere, J. J., D. A. Hensher, and J. D. Swait (2000). *Stated Choice Methods.* Cambridge University Press.

Louviere, J. J. and G. Woodworth (1983). Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. *Journal of Marketing Research 20*(4), 350–367.

Mariel, P., D. Hoyos, J. Meyerhoff, M. Czajkowski, T. Dekker, K. Glenk, J. Jacobsen, U. Liebe, S. Olsen, J. Sagebiel, and M. Thiene (2020). *Environmental Valuation with Discrete Choice Experiments. Guidance on Design, Implementation and Data Analysis.*

Matthews, Y., R. Scarpa, and D. Marsh (2017). Using virtual environments to improve the realism of choice experiments: A case study about coastal erosion management. *Journal of Environmental Economics and Management 81*, 193–208.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), *Frontiers in Econometrics*, pp. 105–142. New York: Academic Press.

Oh, C.-O., J. Draper, and A. W. Dixon (2010). Comparing resident and tourist preferences for public beach access and related amenities. *Ocean & Coastal Management 53*, 245–251.

Pham, T. D., N. Kaida, K. Yoshino, X. H. Nguyen, H. T. Nguyen, and D. T. Bui (2018). Willingness to pay for mangrove restoration in the context of climate change in the Cat Ba biosphere reserve, Vietnam. *Ocean & Coastal Management 163*, 269–277.

Rentschler, J., S. de Vries Robbé, J. Braese, D. Huy Nguyen, M. van Ledden, and B. Pozueta Mayo (2020). Resilient Shore: Vietnam's Coastal Development Between Opportunity and Disaster Risk. Technical report, The World Bank, Washington, DC.

Reynaud, A. and M.-H. Nguyen (2016). Valuing flood risk reductions. *Environmental Modeling & Assessment 21*, 603 – 617.

Reynaud, A., M.-H. Nguyen, and C. Aubert (2018). Is there a demand for flood insurance in Vietnam? Results from a choice experiment . *Environmental Economics and Policy Studies 20*, 593– 617.

Rolfe, J. and N. Flint (2018). Assessing the economic benefits of a tourist access road: A case study in regional coastal Australia. *Economic Analysis and Policy 58*, 167–178.

Rose, J. M. and L. Masiero (2010). A Comparison of the impacts of aspects of prospect theory on WTP/WTA estimated in preference and WTP/WTA space. *European Journal of Transport and Infrastructure Research 10*(4), 330–346.

Sarrias, M. and R. Daziano (2017). Multinomial Logit Models with Continuous and Discrete Individual Heterogeneity in R: The gmnl Package. *Journal of Statistical Software, Articles 79*(2), 1–46.

Scarpa, R., S. Ferrini, and K. Willis (2005). Performance of error component models for statusquo effects in choice experiments. In R. Scarpa and A. Alberini (Eds.), *Applications of Simulation Methods in Environmental and Resource Economics*, pp. 247–273. Springer.

Scarpa, R., M. Thiene, and K. Train (2008). Utility in willingness to pay space: A tool to address confounding random scale effects in destination choice to the Alps. *American Journal of Agricultural Economics 90(4)*, 994–1010.

Schuhmann, P., R. Skeete, R. Waite, P. Bangwayo-Skeete, J. Casey, H. A. Oxenford, and D. A. Gill (2019). Coastal and marine quality and tourists' stated intention to return to Barbados. *Water 11(6)*, 1265.

Silverman, B. W. (1986). *Density Estimation for Statistics and Data Analysis.* Chapman & Hall, London.

Spencer-Cotton, A., M. E. Kragt, and M. Burton (2018). Spatial and scope effects: Valuations of coastal management practices. *Journal of Agricultural Economics 69(3)*, 833 – 851.

Swait, J. and W. Adamowicz (2001). Choice environment, market complexity, and consumer behavior: A theoretical and empirical approach for incorporating decision complexity into models of consumer choice. *Organizational Behavior and Human Decision Processes 86*(2), 141–167.

Thinh, N. A., N. N. Thanh, L. T. Tuyen, and L. Hens (2019). Tourism and beach erosion: valuing the damage of beach erosion for tourism in the Hoi An World Heritage site, Vietnam. *Environment, Development and Sustainability 21*, 2113–2124.

Train, K. (2000). Halton sequence for mixed logit. *Department of Economics, UCB*.

Train, K. (2009). *Discrete Choice Methods with Simulation* (2 ed.). Cambridge, United Kingdom: Cambridge University Press.

Train, K. and M. Weeks (2005). Discrete choice models in preference space and willingness-to-pay space. In R. Scarpa and A. Alberini (Eds.), *Applications of Simulation Methods in Environmental and Resource Economics*, Chapter 1, pp. 1–16. The Netherlands: Springer.

UN-Habitat (2014). Hoian, Vietnam- Climate change vulnerability assessment.

Viet, N., V. Hoang, and H. Tanaka (2015). Morphological change on Cua Dai Beach, Vietnam: Part i image analysis. *Tohoku Journal of Natural Disaster Science 51*, 81–86.

Vousdoukas, M. I., R. Ranasinghe, L. Mentaschi, T. A. Plomaritis, P. Athanasiou, A. Luijendijk, and L. Feyen (2020, March). Sandy coastlines under threat of erosion. *Nature Climate Change 10*(3), 260–263.

Whitehead, J. C., C. F. Dumas, J. Herstine, J. Hill, and B. Buerger (2008). Valuing beach access and width with revealed and stated preference data. *Marine Resource Economics 23*, 119–135.