Valuing mangrove conservation attributes in Red River Delta, Vietnam: a choice experiment approach

Thanh Viet Nguyen, Michel Simioni, Hung Trung Vo

To cite this version:

Thanh Viet Nguyen, Michel Simioni, Hung Trung Vo. Valuing mangrove conservation attributes in Red River Delta, Vietnam: a choice experiment approach. Marine Resource Economics, 2022, 37 (3), pp.1-30. ⟨10.1086/720468⟩. ⟨hal-03708264⟩

HAL Id: hal-03708264
https://hal.inrae.fr/hal-03708264v1

Submitted on 29 Jun 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

HAL Authorization

Valuing mangrove conservation attributes in Red River Delta, Vietnam: A choice experiment approach[a]

Thanh Viet Nguyen[b], Michel Simioni[c], and Hung Trung Vo [d],

Abstract

The study aims at valuing mangrove ecosystem services in Xuan Thuy National Park, Red River Delta, Vietnam. A discrete choice experiment was employed to elicit household willingness to pay (WTP) for a community project to protect mangroves against climate change. A conditional logit model and a random parameter logit model were estimated to identify the relationships between WTP and the different attributes of the mangrove conservation project. The results suggested that local households exhibited strong preferences for mangrove coverage area and storm prevention capacity whereas biodiversity benefits were not greatly perceived by most respondents. High level of heterogeneity in household preferences was found for the high mangrove coverage, and high management level of biodiversity. Furthermore, marginal household WTPs were computed given a change in each attribute level. Hence, the findings will aid in the development of a comprehensive payment for mangrove preservation policy in Vietnam.

Keywords: Mangrove preservation, Environmental services valuation, Discrete choice experiment, Xuan Thuy National Park, Vietnam.

JEL Classifications: Q51, Q54, Q57, O13, D12. **Published** : https://doi.org/10.1086/720468

[a]The authors are very grateful for the constructive comments by anonymous reviewers, the Associate Editor and the Editor-in-Chief. This research is funded by Vietnam National University, Hanoi (VNU) under project number QG.17.35. ***All authors contributed equally to this work.***

[b]**Thanh Viet Nguyen** is an assistant professor at the Faculty of Natural Resource Sciences, School of Business and Science, University of Akureyri, Norðurslóð 2, 600 Akureyri, Iceland (***corresponding author***, email: thanh@unak.is.)

[c]**Michel Simioni** is a senior researcher at INRAE, and an associate researcher at Toulouse School of Economics, MOISA, INRAE, University of Montpellier, France (email: michel.simioni@inrae.fr).

[d]**Hung Trung Vo** is a lecturer at the Faculty of Economics, Thu Dau Mot University, 06 Tran Van On, Thu Dau Mot, Binh Duong, Vietnam (email: hungvo2910@gmail.com).

Introduction

Mangroves are remarkable forests that play an essential role in protecting the community from storm, reducing impact of flooding, and coastal erosion in the intertidal zone (Prance and Tomlinson, 1987; Blanco et al., 2012; Menendez et al., 2020). These forests have extensive root systems that not only form a great carbon reserve but also serve as an important nursery ground for marine organisms (Cummings and Shah, 2018; Polidoro et al., 2010). In addition, mangroves also support local livelihoods by providing timber, foodstuff, and raw material for traditional medicine (Millennium Ecosystem Assessment, 2005; Veettil et al., 2019). However, there has been a drastic reduction of coastal wetlands in the world due to natural factors and human actions that claimed coastal wetlands for agricultural and industrial development. Since the mid-1900s, 20% to 35% mangrove forests have been lost worldwide, three to four times faster than land-based forests (McNally et al., 2011; Polidoro et al., 2010).

It has been stated that around 34 to 42% of the world mangrove vegetation is located in Southeast Asia (Giesen et al., 2007). Vietnam has a long coastline of 3,260 kilometers, providing a supporting ground for mangroves with high ecological and economic importance (Do and Bennett, 2009; Veettil et al., 2019; Hung et al., 2020). Mangrove forests are found more extensive in the south and north than those in central Vietnam. A recent evaluation of global flood reduction benefits from mangroves in the world shows that Vietnam ranks first in terms of protected population (7.02 millions out of a total Vietnamese population of 97.09 millions of inhabitants), second in terms of averted land flooding (3,120 out of 331,210 km^2), and sixth in terms of property benefits that stem from protecting assets in exposed coastal areas (6.45 billions US dollar, or 3.14% of GDP) (Menendez et al., 2020).

Nevertheless, it was reported that 61% of mangrove forests have been lost in recent decades in Vietnam (Veettil et al., 2019; McNally et al., 2011). In 1943, prior to the onset of the conflicts in Vietnam, mangrove forests in Vietnam were reported to cover an area of 400,000 ha. The use of herbicides during the Vietnam wars from 1945 to 1975 destroyed more than 100,000 ha of mangrove forest (Veettil et al., 2019). The rise of shrimp farming since the mid-80s caused further destruction of mangrove forests. In 2005, only 157,500 ha of mangrove forests were found (McNally et al., 2011).

The removal of mangrove forests has undoubtedly led to many undesirable consequences such as decreasing the amount of clean water and organism as well as making local residents living near the coastline more susceptible to hurricanes. Mangrove degradation also speeds up soil erosion which leads to a coastal retreat of around 20 to 40 metres per year observed in coastal regions such as Kien Giang Province, the Mekong Delta (McNally et al., 2011).

Non-market values of mangrove ecosystem services such as the ability to lessen the damage from storms, the prevention of coastal erosion, the protection of bird habitats play an important role in maintaining mangroves for the future. These values could provide a baseline, not only for climate change mitigation actions to decrease national carbon footprint, but also national climate change adaptation plans to reduce flooding risks and enhance the local economy's resilience. However, measuring these values is not straightforward because the market settings for environmental goods are often absent.

Revealed preference and stated preference methods are two major valuation techniques to measure the environmental goods and services. Some wetland ecosystem services such as recreation and tourism could be valued using revealed preference methods. However, our objective is to estimate the willingness to pay (WTP) for non-use values which can be accomplished at best by stated preference methods such as contingent valuation method (CV) and discrete choice experiment (DCE). Contingent valuation is a method of estimating the willingness to pay for overall changes in the ecosystem service. For instance, Hung et al. (2020) recently used the contingent valuation method with double-bounded dichotomous-choice to elicit WTP for mangrove ecosystem restoration in Xuan Thuy National Park, Vietnam. The study found that income, perceived knowledge of mangrove benefits and interest in conservation activities influence WTP. Discrete choice experiment with more voices at the forefront of literature reveals WTP for changes in the component attributes of mangrove ecosystem services (Holmes et al., 2017). The existing wetland valuation studies that use discrete choice experiments include those by Birol et al. (2006) on the case of Cheimaditida wetland restoration in Greece; Rezende et al. (2015) on the restoration of mangrove forest in the northern region of Rio de Janeiro state, Brazil; Tan et al. (2018) on the coastal wetland restoration in Ximen Island Special Marine Protected Area, China.

In Vietnam, only one choice experiment was conducted by Do and Bennett (2009) to estimate biodiversity values at Tram Chim National Park, a typical wetland ecosystem in Mekong River Delta. The study applied conditonal logit and random parameter logit models to capture taste preference heterogeneity for different types of improved outcomes (mangrove coverage, the number of Sarus Cranes, the number of bird species, the number of households affected) associated with wetland restoration. Individual characteristics such as age, education, household income, knowledge of the study site, and perceived benefits of mangrove values for future generations were found to affect the WTP for wetland conservation program.

This paper aims to trace out local preferences by examining how people responded to different types of outcomes associated with mangrove conservation programs at Xuan Thuy National Park (XTNP) at the Ba Lat estuary, Nam Dinh province, in north of Vietnam. The park was chosen as a study site because of its coastal protection capabilities and diverse wetland ecological system that are particularly important in the socio-economic development of the Red River Delta region. XTNP is also an incredible natural spectacle with thousands of wild birds migrating from the north to the park each year.

There is scant information on the values of wetlands in the Red River Delta. Hence, this study is necessary to reflect the relative values of resources in alternative wetland management in the region. We employed direct non-market valuation approach for valuing environmental goods by creating hypothetical markets where respondents were asked to state their preferences for improved environmental quality (Champ et al., 2017). Households valued access to mangrove ecosystem services with many benefits expressed in economic terms as household WTP in exchange for better mangrove ecosystem services. The findings will advise policy-makers to take important conservation measures to ensure wetland expansion, maintain coastal protection and preserve habitat for bird species.

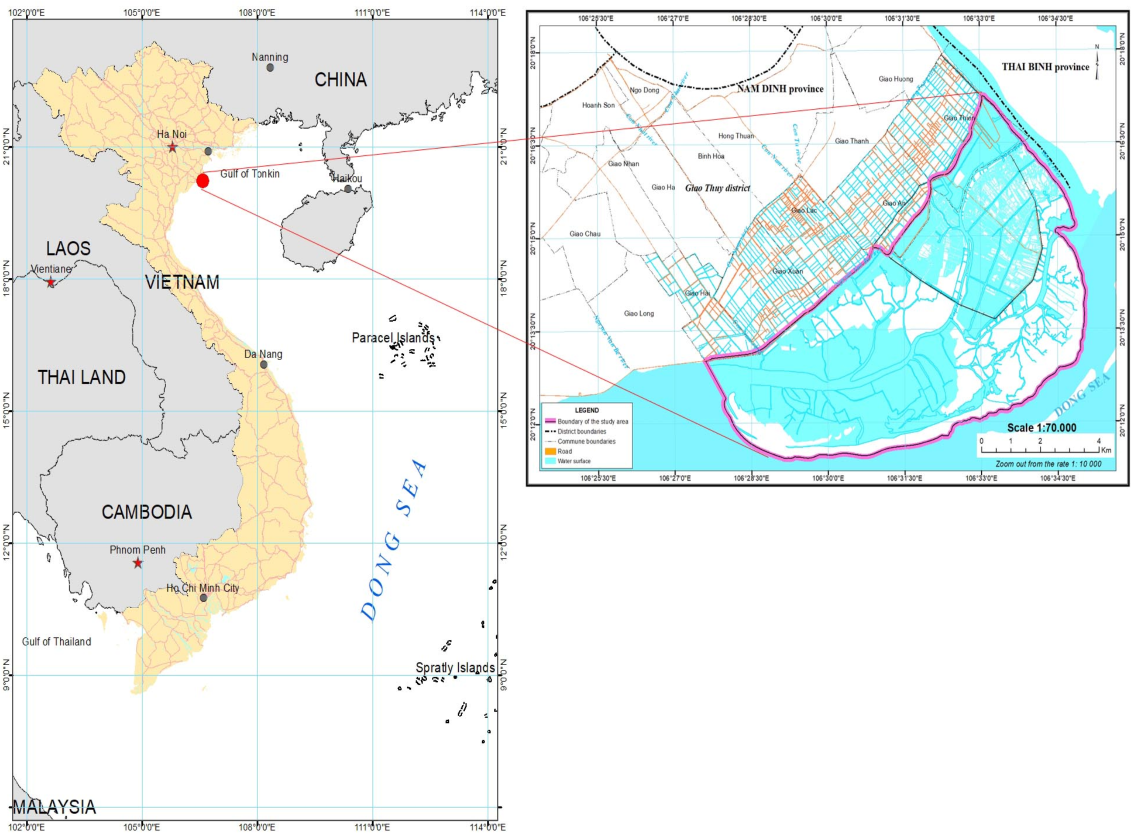
The paper is structured as follows. Section presents the background of the study site, survey methodology, sampling strategy and the econometric framework used in the paper. Section summarizes the main features of data. Main findings are discussed in section . Finally, main conclusions are drawn in section .

Methodology

Study site

Xuan Thuy National Park (XTNP) is a special nature reserve with vast areas of mangrove swamps located in the coastal zone of the Red River Delta and Ba Lat estuary (Thanh and Yabar, 2015). The park is divided in two main areas: a core zone (7,100 hectares) where human activities are strictly prohibited and a buffer zone (8,000 hectares) where human activities are managed to mitigate adverse impacts on the core zone (Pham Hong and Mai Sy, 2015). Figure 1 shows the map of XTNP including the five communes in the buffer zone that were chosen as the study site: Giao Hai, Giao Xuan, Giao Lac, Giao An and Giao Thien.

Figure 1
Map of Xuan Thuy National Park and the study site



XTNP was approved by the Bureau of the Convention on Wetlands of International Importance as the first Ramsar site in South-East Asia [1]. About 150 species of vascular plants, 111 species of

[1]The Convention on Wetlands is an intergovernmental treaty that provides the policy framework for national action and international cooperation for the proper management of wetlands and their resources.

floating aquatic plants, 500 species of benthos and zooplankton (shrimp, fish, crab, oysters, etc.) have been recorded at the park. This site is also internationally-recognized for many migrating birds with 219 bird species recorded. Many of them are listed in the Red List of Endangered species such as the Black-faced Spoonbill (*Platalea minors*), Spoon-billed Sandpiper (*Calidris pygmaea*), and Spotted Green-shank (*Tringa guttifer*) (Nguyen et al., 2011).

Nevertheless, there are a variety of issues that threaten wetlands in the area. Firstly, mangrove forests have been cleared and converted into agricultural lands for fish and shrimp farming. Secondly, the future of mangrove forests is very sensitive to climate variability such as sea level rise, elevated levels of temperature, rainfall. The local government protects XTNP from being exploited by enforcing strict rules with respect to fishing, hunting and harvesting plants inside the reserve. International organizations are finding solutions to preserve the mangroves for future generations and for locals to make a sustainable living.

Survey methodology

Questionnaire development The questionnaire was developed through an iterative design process. We first consulted with researchers and economists in the field of natural resource valuation to review different versions of the questionnaire. We then had several meetings with the board of XTNP to identify the opportunities for mangrove management. We also conducted meetings with local representatives of villages to understand the local livelihoods in the buffer zone. We wanted to know the local representatives' view on climate change impacts and how the risk of flooding varied depending on the location.

In addition, the local representatives gave important suggestions on how community funding for mangrove rehabilitation program could be used properly to cope with climate change. Concrete missions such as the construction of dykes to protect mangroves against sea rise, ensuring the sediment supply, mangrove planting were suggested by the local representatives. The information was very useful for our selection of attributes with the levels associated in the choice design.

Furthermore, a pre-test survey was conducted with 20 households in the buffer zone to get some estimates of their minimum and maximum WTP for a mangrove conservation program. This preliminary survey was helpful in formulating the contribution rates for the improved scenarios in the choice sets.

Hypothetical setting In our choice experiment survey, respondents were presented with a series of scenarios or choice sets of mangrove preservation programs that described the hypothetical market for the attributes. The future climate change scenario (see Appendix) provided by the Ministry of Natural Resources and Environment (MONRE), Vietnam[2], released in 2016, gave sea level, temperature rise trajectory, and minimum rainfall variation whereas the report by the XTNP's management board provided the estimated rate of mangrove degradation (Tran et al., 2016; Management Board of Xuan Thuy National Park, 2014). Our enumerators demonstrated clearly to respondents what would happen without feasible plans on restoration of mangrove ecosystem. The hypothetical market needed to be understandable and plausible to respondents so that they firmly believed that environmental change would happen.

Attribute definition The choice of attributes and their associated levels were based on many references. First, the report "The current state of biodiversity at XTNP" (Management Board of Xuan Thuy National Park, 2014) helped us gain a basic understanding of the mangroves at the study site and their benefits in the context of climate change. Initially, a list of 15 potential attributes characterizing mangrove conservation programs was introduced. These attributes included areas of mangroves planted at intertidal zone, areas of lagoons for aquaculture, average daily income from fishing in the wetland, number of fish species, number of the black-faced Spoonbill, number of bird species, number of tourists, and ability to prevent saline water intrusion, storms and coastal erosion.

After several meetings with experts, local representatives in charge of mangrove conservation, and households, we decided to shorten the list of attributes to three (Table 1 gives their definitions and levels.). The first two are ecological attributes: the total area of tidal flat which has mangrove coverage being described in terms of hectares of mangroves protected, and biodiversity defined as the number of the black-faced Spoonbill preserved at the Ba Lat estuary. The third attribute was storm

[2]The climate change scenario introduced by MONRE in 2016 was built upon the 5th assessment report of the Intergovernmental Panel on Climate Change (IPCC). MONRE developed a technique to take global and regional climate information from the scenarios defined by IPCC and then zoomed onto much finer details of small regions in Vietnam. Hence, these projections provide more specific, regional information that local authorities and researchers need for their climate adaptation action plans in the studied regions.

prevention ability measured in terms of expected economic losses from storm level, high or low. The avoided storm losses are linked to a recent event (Tropical Storm Mirinae) in order to tie an attribute of a hypothetical good to a real (consequential) event experienced by respondents.

The selected attributes were consistent with those chosen in other studies on wetland valuation (Brouwer et al., 1997; Do and Bennett, 2009; Tan et al., 2018). The number of attributes were also compatible with cognitive capacities of respondents at the study site. Indeed, all attributes represented important aspects of mangrove ecosystem services at Ba Lat estuary to respondents. Each choice option is based on a combination of attributes' levels and respondents' choices indicated how they valued these attributes. Last column of Table 1 gives the values corresponding to status quo.

Table 1
Wetland Management Attributes and Levels in the CE.

Attribute	Description	Management Levels	Status Quo
Area	The total area of tidal flat which has mangrove coverage, providing a better habitat for animal species and increasing yields of eco-friendly shrimp ponds.	Low: 1661 ha Average: 1900 ha High: 2100 ha	Low
Loss	The expected economic losses from storm level 10 (equivalent to tropical storm Mirinae in late July 2016) indicates the storm-prevention capacity.	Low: losses of 300 billion VND[a] High: losses of 622 billion VND	High
Biodiversity	The number of endemic species (e.g., Black-faced spoonbill preserved at Ba Lat estuary.	Low : 62 species Average: 80 species High: 100 species	Low
Payment	A one-off payment of each household goes to the Wetland Conservation Fund.	4 payment levels: 200,000, 300,000, 400,000, and 600,000 VND[b]	0 VND

[a] 1 USD ≈ 23,245 VND Hence, 300 billion VND and ≈ 12,776,298 USD. 622 billion VND ≈ 26,488,318 USD.
[b] 200,000 VND ≈ 8.51 USD. 300,000 VND ≈ 12.77 USD. 300,000 VND ≈ 17.03 USD. 600,000 VND ≈ 25.54 USD.

A payment instrument was added to the list of attributes. Income tax is the most widely used payment instrument in developed countries. Nevertheless, this payment instrument could be inappropriate in Vietnam, and especially, in Nam Dinh province, due to a lack of transparency in tax system and low population coverage (Do and Bennett, 2009). Hence, households' donations to the Fund for Wetland Conservation of the Mangroves in the Ba Lat estuary were used as our payment instrument.

Our survey targets households because community driven projects often require household contribution in Vietnam, especially for rural households that have low budgets. In addition, we did not conduct interviews with multiple members of the household because doing so would require multiple visits that might push up the cost of the survey considerably and the enumerators might have incentives to obtain information as quickly as possible.

Choice sets elaboration. The choice of attributes and their levels resulted in 72 potential choice options. Ngene software was used to implement a fractional factorial design for defining choice sets (ChoiceMetrics, 2018). A subset of complete factorials was chosen to capture efficiently the effects of interest according to the D-optimal criterion (Reynaud et al., 2018). 24 choice sets were constructed and grouped into four versions of the choice experiment presented to respondents. Each version contained six choice sets with varying levels of attributes in order to get a range of environmental goods and payments.

In each choice set, respondents were presented with two options. The first option was the status quo, keeping the entire mangrove forest intact (see last column in Table 1). All attribute levels were kept at their current levels and required zero payment from respondents. The second option proposed improved levels of the restoration program but with some payments. An example in which respondents were asked to choose between the status quo and the alternative scenario with an increase in payment for more mangrove coverage given the climate change projection is provided in Table 2.

Sampling strategy The survey was conducted in Nam Dinh Province, which is located in the North East of Vietnam. Nam Dinh province has 72-kilometers coastline and is often affected by saline intrusion and tropical storms throughout the year (Leslie et al., 2018).

The sampling strategy was implemented as follows. We first chose Giao Thuy district to be the study site because this is the location of Xuan Thuy Wetland Nature Reserve. Then, 5 communes including Giao Thien, Giao An, Giao Xuan, Giao Hai and Giao Lac (out of 20 communes in Giao Thuy

Table 2
Example of a Choice Set

Comparing the current scenario with the improved scenario, what is your selection?

Attribute	**Current Scenario A**	**Proposed Scenario B**
Mangrove coverage area	1661 ha	1900 ha
Biodiversity	62 species	62 species
Loss	622 billion VND	622 billion VND
One-off payment	0 VND	200,000 VND
I would prefer	☐ **Choice A**	☐ **Choice B**

District) were selected because these communes constitute mostly the buffer zone at XTNP. Then, 145 households were chosen from the village listing of registered households. These representative households came from 74 hamlets in the Giao Thuy District.

Multi-stage sampling was used to select villages and households. At the first stage, two villages were selected by random sampling from the list of villages in each commune. At the second stage, 145 households were surveyed by convenience sampling, i.e. surveying any household in each village without any prior notice given their proximity to enumerators.

Face-to-face interviews were carried out in March and April 2017. All enumerators were students from Hanoi University of Natural Resources and Environment (HUNRE) and Vietnam National University, University of Economics and Business (VNU-UEB), Hanoi, Vietnam. Before reaching the households, we contacted the head of the XTNP's management board for a formal approval for the survey. Our enumerators mentioned clearly the official approval of the survey at the beginning of each interview with the households. Most respondents in the survey were household heads or their spouses.

Discrete choice models

Random utility framework. Building upon the characteristics theory of demand (Lancaster, 1966), random utility models, or RUMs, have become the basis for the econometric analysis of DCE.

These models assume that the utility for an alternative j in in a particular choice task k perceived by respondent i, or U_{ijk}, can be decomposed into observed, or V_{ijk}, and unobserved, or ε_{ijk}, parts. Assuming that those parts are additive, RUM ends up with the following utility specification:

$$U_{ijk} = V_{ijk} + \varepsilon_{ijk} \tag{1}$$

Most RUMs assume then that the observed part of utility V_{ijk} can be expressed as a weighted sum of observed attribute levels of each alternative.

Conditional logit model. The most basic RUM is the conditional logit model, or CL, which assumes constant (homogeneous) weights for each attribute over all respondents (McFadden, 1974). CL model assumes that the random part of utility, i.e. ε_{ijk}, is identically and independently extreme type 1 distributed. Omitting indexes for simplicity, the specification for the deterministic utility function for the CL model is:

$$V = ASC \cdot (\alpha) + Area \cdot (\beta) + Loss \cdot (\zeta) + Biodiversity \cdot (\mu) + Payment \cdot (\kappa) \tag{2}$$

where $Area$ is a dummy variable equal to 1 for the area of tidal flat with average or high mangrove coverage respectively (reference category is low mangrove coverage), $Loss$ is a dummy variable equal to 1 if a potential storm level 10 yields low economic losses (300 billion VND) in comparison to the high losses for the status quo, $Biodiversity$ is a dummy variable equal to 1 if there are 80 or 100 individuals of endemic species preserved at Ba Lat estuary respectively (reference category is 60 individuals of endemic species), $Payment$ is the one-off payment of each household (in thousand VND) for different conservation management levels (no payment is made for the status quo). An alternative specific constant (ASC), which is a dummy variable that equals to one when the alternative scenario is chosen and to zero when the status quo is chosen, is also added to the model (Hoyos, 2010; Reynaud et al., 2018; Adamowicz et al., 1998).

Random parameter logit model. More flexible models, such as random parameter logit model, or RPL, have been developed to overcome some restrictive assumptions of CL model: no random taste variation, restrictive substitution patterns and no correlation of unobserved factors as captured by ε_{ij} (Train, 2009). RPL model introduces taste heterogeneity by allowing for some or all utility weights to be individual specific, i.e. $\beta_i = \beta + \eta_i$ where η_i is a vector of individual i-specific deviations from the mean utility parameters β. These deviations vary with density $f(\eta_i|\theta)$, where θ is a vector of unknown parameters describing the distribution of β_i (for example their covariance matrix). RPL model allows modeling unobserved preference heterogeneity across respondents. The utility-specification of an RPL model can be written as

$$U_{ijk} = \beta_i x_{ijk} + \varepsilon_{ijk} \tag{3}$$

The specifications of the indirect utility function for the RPL model, after omitting indexes for simplicity, are:

$$\begin{aligned} V_i =& ASC \cdot (\alpha + \eta_{\alpha,i}) + \text{Area} \cdot (\beta + \eta_{\beta,i}) + \text{Loss} \cdot (\zeta + \eta_{\zeta,i}) \\ &+ \text{Biodiversity} \cdot (\mu + \eta_{\mu,i}) + \text{ Payment } \cdot (\kappa) \end{aligned} \tag{4}$$

For each attribute and for the ASC, we have a mean preference parameter, for example, α for ASC, and a standard deviation coefficient, such as the standard deviation of $\eta_{\alpha,i}$ for ASC, to represent random taste variation for mangrove restoration services. Each of the individual utility parameters is assumed to be normally distributed. But, for the sake of ease and accuracy of WTP computation, individual payment utility parameter is supposed to be be fixed in the RPL model.

Willingness-to-pay. Coefficient estimates in the utility function do not have any real meaning, except for their significance and sign (Reynaud et al., 2018). To get a more concrete, interpretable result, it is important to compute the marginal WTP for a change in the attribute. The marginal WTP for an attribute is described as the marginal rate of substitution between this attribute and the monetary cost to maintain the same level of utility (Train, 2009). This is done by dividing the vector of non-price parameters by the price parameter, or

$$WTP_{attribute-level,i} = -\left(\frac{\beta_{\text{attribute}-\text{level},i}}{\beta_{\text{price},i}}\right) \tag{5}$$

Confidence intervals of the estimated marginal WTP can be computed by applying the non-parametric bootstrap technique proposed by Krinsky and Robb (1986) with a large number of simulations from the chosen distributions in the different models presented above.

Data

Individual characteristics

Table 3 displays the respondents' socio-demographic characteristics. In this sample, the number of female participants (50.3% of the 145 respondents) was almost equal to the number of male participants, ensuring that gender balance was represented in the survey. Almost 60% of the total sample aged over 45. This suggests that the middle-aged and elderly (over 45) people tend to work in the villages and were available for the interviews while younger people might commute to work outside of the village and did not show up in the interviews. Married individuals accounted for 91.72% of the sample. 76.6% of the respondents could not complete high school, reflecting the fact that most people in rural areas obtain low education level [3]. In this study, farmers or fishermen constituted 57% of the total sample. The other main categories of jobs such as business owners, and hired employees from the public or private sectors, comprised about 29% of the sample. Students, retirees, housewives, and unemployed people represented the remaining sample.

One-third of the respondents (33.33%) reported having a monthly household income lower than 3 million VND (about 129 USD). 39.58% of the respondents reported receiving a monthly household income between 3 and 6 million VND (about 129-258 USD). 13.89 % of respondents said that they received a monthly income of over 10 million VND (about 430 USD). There were about 1 to 8 people in the surveyed households. The mean household size of the sample was around 4.08, representing normal family size in Nam Dinh Province. Interestingly, most respondents (84.83%) were very passionate about environmental conservation activities. Finally, 76.6% of the respondents reported that their agricultural activities were affected to a certain degree by natural disasters in the past 5 years.

[3] The comprehension or engagement in face-to-face interviews was independent of respondents' low education level. Respondents were intrinsically connected to the sea and their lives depend on it. Hence, they were keen on expressing personal concerns about climate change and their answers were important to our survey.

Table 3
Sample Description

	Category	Frequency	Percentage
Gender	Female	73	50.30
	Male	72	49.70
Age	18-25	9	6.21
	26-35	27	18.62
	36-45	22	15.17
	46-55	45	31.03
	>= 56	42	28.97
Marital status	Married	133	91.72
	Single	12	8.28
Education	Below high-school	111	76.55
	High-school or above	34	23.45
Career	Farmer/fisherman	84	57.93
	Business owner/self-employed	14	9.66
	Public sector employee	7	4.83
	Private sector employee	21	14.48
	Students	3	2.07
	Retired/housewife	16	11.03
Household size	1	5	3.45
	2	20	13.79
	3	18	12.41
	4	43	29.66
	5	42	28.97
	6	10	6.90
	7	5	3.45
	8	2	1.38
Monthly Income of household (million VND)	Low income (up to 3)	48	33.33
	Lower middle (between 3 and 6)	57	39.58
	Upper middle (between 6 and 10)	19	13.19
	High income (over 10)	20	13.89
Passion for environmental protection	No	3	2.07
	Like a little	19	13.10
	Like a lot	123	84.83
Mangrove dependency[a]	Yes	65	18.70
	No	282	81.30
Natural disaster impact[b]	Yes	111	76.55
	No	34	23.45

[a] Mangrove dependency refers to households that were direct beneficiaries of mangroves for their livelihood activities such as fish and wood.
[b] Household agricultural activities, and income affected by natural disasters in the past 5 years.

Local awareness about mangrove restoration in XTNP

Table 4 indicates the local subjective views of mangrove benefits. Over 67% of respondents believed that the mangroves in the XTNP played an important role in controlling flood, storms and soil erosion.

The results also indicate that a major number of the respondents (37.9%) realized that mangroves have been a vital source of aquatic products, raw material for their production and consumption.

Table 4
Perceived Benefits from Mangrove Forests

Benefits from Mangrove Forest	Percentage
Aquatic products, raw material for production and consumption	37.9
Recreation, tourism	0.7
Prevention of storms, floods, tides, and coastal erosion	67.6
Underground water protection, preventing salinization	7.6
Climate regulation, carbon dioxide absorption	18.6
Preserving silt, sea encroachment	6.9
Habitat for fish and animals	29.7
Biodiversity	2.1
Other	6.9
Do not know	10.3

Table 5 displays respondents' perceived reasons for mangrove degradation. 41.4% of the respondents perceived human activities such as aquaculture, fishery, etc. as the major threat to mangrove forests. 20% of them perceived that climate change posed threat to the survival of mangroves.

Table 5
Perceived Causes of Mangrove Degradation

Reasons	Percentage
Human activities: aquaculture, fishery, etc.	41.4
Pollution	12.4
Climate change	20.0
Other	11.0
Do not know	1.4

Table 6 shows perceived motives for mangrove protection in the Ba Lat estuary. In order to answer the questions, respondents were clearly explained how the mangroves in the Ba Lat estuary have been degraded overtime. Given various scenarios of the mangroves in the context of climate change, respondents were asked Likert scale questions to rate the importance of reasons to protect the mangroves, on a scale from 1 to 5, with "1 = Not at all important", "2 = Not so important", "3= Neutral" , 4= Important", and "5= Very important". Respondents could also choose "not able to evaluate" option. These results suggest preventing the coastal zone against floods, erosion, salinization and providing benefits for future uses were the two most important motives. Biodiversity preservation was the third most important motive for mangrove rehabilitation.

Table 6
Perceived Motives for Mangrove Conservation

Reason	Not at all Important	Not so Important	Neutral	Important	Very Important
Provides wood, fish, and raw materials	6.2	21.5	30.6	22.2	19.4
Provides recreation	1.4	8.3	20.1	40.3	29.9
Prevents floods, erosion, salinization	0	1.4	2.1	9.7	86.9
Conserves biodiversity	1.4	4.2	19.4	33.3	41.7
Benefits for future uses	0.7	2.8	4.1	17.2	75.2

Our multi-stage sampling ensures a statistically viable sample size for the choice experiment study. We excluded respondents who reported a zero-probability belief in all proposed options in most choice sets. It was not worth studying how much these respondents are willing to pay because they believed that the proposed conservation programs were not going to take place. That turned out to be about 13.7% of the sample excluded from our statistical analysis. The remaining 125 households were given 6 choice sets, making up a total of 750 observations (choice occasions) in the statistical analysis. In addition, the random sampling guarantees that the sample is representative of Nam Dinh population that lived near mangrove forests and had some exposure to climate change impacts.

There are around 13,000 households in the five surveyed communes, given the desired margin of error at 5%, a statistically viable sample size is about 380 observations [4]. By using experimental design theory, we have increased the statistical efficiency of the parameters estimated so that smaller samples may be used (Holmes et al., 2017). The minimum sample size necessary for choice studies is suggested about 50 decision makers for each alternative or about 300 observations (choice occasions) for 6 choice sets (Hensher et al., 2015, p. 194).

[4] The sample size $n = \left(\frac{N}{1+N*\varepsilon^2}\right)$.

Results

Different versions of the models presented in section were estimated using a set of variables with descriptions given in Table 7.[5] The alternative specific constant (ASC), which is a dummy variable that equals to one when the alternative scenario was chosen and to zero when the status quo was chosen, was also added to the models (Hoyos, 2010; Reynaud et al., 2018; Adamowicz et al., 1998). In addition to a CL, a classical RPL with only individual parameters heterogeneity was considered. Individual parameters heterogeneity was captured using normal distributions.

Table 7
Description of Variable.

Variable	Description	Value
Attributes of the CE		
AreaAverage	Total mangrove coverage (hectare) is average	1 = Average 0 = Low
AreaHigh	Total mangrove coverage (hectare) is high	1 = High 0 = Low
BioAverage	The number of endemic species preserved at Ba Lat is average	1 = Average 0 = Low
BioHigh	The number of endemic species preserved at Ba Lat is high	1 = High 0 = Low
LossLow	Total loss caused by storm level 10 (billion VND) is low	1 = Low 0 = High
Payment	Payment levels (thousand VND)	Level= 0; 200; 300; 400; 600

Estimation results are reported in Table 8. These results are discussed starting from the most commonly used specification in the literature, namely the CL model, and moving towards a richer content model in terms of analysis of choice behaviors (the RPL model).

Conditional Logit. For the CL model, there were consistent preferences in the sample. The insignificant coefficient on the ASC means respondents had no preference for which program was chosen on average. The statistically significant, positive coefficients on mangrove coverage attributes indicate that respondents wanted to have more mangroves preserved either at the medium (1991

[5]The GMNL package in R was used to estimate the models (Sarrias and Daziano, 2017). Following Train (2009), the distribution simulations in the RPL model were based on 1000 sequence Halton draws.

ha) or high management level (2100 ha). There are positive and significant coefficients on the total loss incurred by a storm at low levels (losses of 300 billion VND or less presumably). Therefore, if respondents were given a choice with a high flood prevention ability, everything else being held constant, they were more likely to say yes to the alternative program. Interestingly, there was no preference for the medium or high management level of biodiversity (80 or 100 individuals of endemic species, respectively). Hence, the lack of interest in biodiversity benefits indicating that biodiversity conservation plan might not be prioritized by households in the coastal area since it might only affect their livelihoods in the short-run. The negative coefficient on payment makes general sense. As respondents disliked the higher cost, they were less likely to pick the alternative program.

Random parameter logit. The RPL adds unobserved random variation in preferences between individuals to the classical CL specification. Random effect is demonstrated by normal distribution, the most commonly used distribution within RPL literature (Train, 2009). By knowing the mean and standard deviation for each attribute level, it is then possible to know what percentage of respondents likes or dislikes it.

It should be noted firstly that the RPL model nests the CL model. Then, the null hypothesis that the standard deviation coefficients are all equal to zero in the RPL model can be tested using classical log-likelihood test comparing log-likelihoods of the two models. The null hypothesis is then rejected at a 95% confidence interval, implying that improvement in the model fit is achieved with the inclusion of unobserved individual heterogeneity when using the RPL model.

Secondly, taking into account unobserved individual heterogeneity in preferences does not modify the direction of the effects of attribute levels. Indeed, the signs and significance of the mean utility parameters in the RPL model are similar to those in the CL model. But now, the analysis of these mean effects is enriched by the knowledge of the standard deviations associated with them.

Standard deviations are not statistically significant in the effects of storm prevention capacity as well as mangrove coverage and biodiversity at the average management levels. Nonetheless, there was a considerable preference heterogeneity among respondents in the effects of mangrove coverage and biodiversity at the high management levels. Some people prefer a high management level of biodiversity and high level of mangrove coverage because they perceived a great deal of positive benefits. Some people, on the other hand, might dislike high levels of management as they prefer more mangroves to be converted into short-term profitable alternatives like shrimp ponds, or they simply could not perceive the ecological and social benefits of having high management levels for these attributes. It is noted that the mean coefficient of having high management level for biodiversity is negative and not statistically different from zero. For the CL model without accounting the variances of tastes, we would conclude that having biodiversity at high level of management is irrelevant to people's choices. However, it is still relevant to respondents' choices in the presence of taste variation. Some respondents really wanted biodiversity while other respondents did not see the benefits of having more biodiversity. On net, the negative and positive effects average each other out and the mean coefficient of high biodiversity level was close to zero. The same case is for the coefficient on the ASC given its significant standard deviation but insignificant mean coefficient. The statistically insignificant ASC means that WTP is not statistically different from zero in the status quo scenario. In addition, this is another instance where the random parameters model finds heterogeneity across respondents since the ASC standard deviation is greater than the mean.

Willingness-to-pay estimates. Table 9 displays the marginal WTPs for conservation attributes for the two specifications, i.e. the WTPs to change from the status quo to the improved scenario given a change in each of the attribute level.

The estimation results for the attributes were found to be highly consistent for the two specifications. Furthermore, the results demonstrate fairly significant WTPs for households for mangrove coverage and flood prevention across the two specifications. In the CL specification, for instance, to move from low mangrove coverage (1661 ha) to medium coverage (1900 ha), households were willing to pay an additional 213,126 VND (9.19 USD) per household. The confidence interval for this is the range of marginal WTP between 123,539 VND to 319,080 VND per household. This confidence interval potentially containing the true population parameter is fairly tight around the estimate, which is a good sign.

For a greater extension of mangroves, households on average were willing to pay 157,816 VND (6.81 USD) per household to have from 1661 ha to 2100 ha of mangroves preserved in the park. Surprisingly, household WTP for the highest level of mangrove coverage was lower than that for

Table 8
Maximum Likelihood Results

Variable	CL Model	RPL Model
<u>Coefficients</u>		
ASC	0.167(0.25)	0.378(0.297)
AreaAverage	0.767(0.194)***	0.876(0.211)***
AreaHigh	0.565(0.197)***	0.569(0.254)**
BioAverage	0.068(0.191)	0.076(0.203)
BioHigh	-0.131(0.195)	-0.311(0.267)
LossLow	0.534(0.158)***	0.676(0.179)***
Payment	-0.004(0.001)***	-0.005(0.001)***
<u>Standard deviations</u>		
ASC	NA	0.456(0.2)**
AreaAverage	NA	0.011(0.778)
AreaHigh	NA	1.213(0.403)***
BioAverage	NA	0.005(0.437)
BioHigh	NA	1.172(0.448)***
LossLow	NA	0.015(0.369)
Observations	750	750
Log likelihood	-464.50	-457.51
AIC	943.00	941.03
BIC	975.34	1000.29

Note: Standard errors are in parentheses. *($p<0.1$); **($p<0.05$); ***($p<0.01$).

the medium level of mangrove coverage. Respondents would be likely to vote against the proposed program for the greater coverage of mangroves due to higher payment. For protection against storms, the level of household WTP tied around 151,803 VND (6.55 USD).

However, it should be stressed that there was no statistically significant effect from biodiversity, whether it was just the medium or the high management level across the two specifications. Confidence intervals that range from some negative numbers to large positive numbers indicate that there is no confidence about how precisely these estimates are. This could be explained by the fact that respondents were not aware of the biodiversity benefits on their livelihoods or they paid more attention to other aspects of the ecosystem services.

In addition, the confidence intervals in the RPL model shows a wider range around the mean WTP for all attributes than those in the CL model, implying a relatively inconsistent preference across the sample. For instance, in the RPL model specification, the confidence interval indicates much variation of marginal WTP for the highest level of mangrove coverage around the mean estimate from -347,245

Table 9
Marginal WTP (in thousand VND) for Conservation Attributes

Variable	CL Model	RPL Model
AreaAverage	213.126	190.884
	[123.539, 319.080]	[-76.133, 474.889]
AreaHigh	157.816	122.123
	[64.873, 258.865]	[-347.245, 593.129]
LossLow	151.803	149.120
	[74.836, 248.224]	[7.520, 300.556]
BioAverage	20.222	16.759
	[-65.734, 110.495]	[-148.485, 184.129]
BioHigh	-36.680	-67.060
	[-132.494, 52.516]	[-544.966 , 383.357]

Note: For the CL,CIs are computed with 1000 bootstrap replications (Krinsky and Robb, 1986). The negative values mean willingness to accept to abandon the proposed scenario.

VND to 593,129 VND. This is due to the preference heterogeneity among respondents over mangrove coverage obtained at a larger scale. The negative value implies some respondents were even willing to accept to abandon the proposed scenario, due to the higher cost associated with the higher attribute level.

It is worth noting that the ranking of attributes with regards to household WTP was fairly consistent in the two specifications. The highest marginal WTP was found for medium level of mangrove coverage based on the benefits and the costs associated with the attributes. There was a slight variation in the ranking of the marginal WTP for the highest level of mangrove coverage and storm protection attribute, reflecting how taste preferences were modeled differently across the specifications.

Attribute scope. This section considers how attribute scope in a choice experiment affects preferences for mangrove management policy. Insensitivity of respondents to the scope of environmental goods has been a concern in the non-market valuation literature (Smith, 1992; Kahneman and Knetsch, 1992; Czajkowski and Hanley, 2009; Whitehead, 2016). There is a conflict of scope insensitivity in real world settings and economic theory which states that WTP is increasing with more quantity or quality of a good. The scope test is important to determine economic significance in addition to statistical significance for an efficient level of policy (Whitehead, 2016). Various types of scope tests have been proposed to infer how elicited values are sensitive to changes in quantity or quality of environmental goods, but they yielded mixed empirical evidences. Here, we adopted the internal test proposed by Spencer-Cotton et al. (2018) for the scope effect on the forest area attribute. This approach allows us to test whether WTP could be derived from changes in quantity of valued mangrove coverage (the LIN model) or be considered as a reflection of motivation for having the public goods (the DIFF model). The deterministic part of the utility for the three model specifications for the CL model is as follows:

$$\begin{aligned} V =& \alpha_1 ASC + \beta_1 \text{ AreaAverage} + \beta_2 \text{ AreaHigh} + \zeta_1 \text{ LossLow} \\ &+ \mu_1 \text{ BioAverage} + \mu_2 \text{ BioHigh} + \kappa_1 \text{ Payment} \end{aligned} \tag{6}$$

$$\begin{aligned} V =& \alpha_1 ASC + \beta_1 \text{ Area} + \zeta_1 \text{ LossLow} + \mu_1 \text{ BioAverage} \\ &+ \mu_2 \text{ BioHigh} + \kappa_1 \text{ Payment} \end{aligned} \tag{7}$$

$$\begin{aligned} V =& \alpha_1 ASC + \beta_1 \text{ Area(Low, Average, High)} + \zeta_1 \text{ LossLow} \\ &+ \mu_1 \text{ BioAverage} + \mu_2 \text{ BioHigh} + \kappa_1 \text{ Payment} \end{aligned} \tag{8}$$

For Eq. 6 (ID model), mangrove area is presented as 'individual dummies' whereas mangrove area (with three attribute levels: 1661, 1900, 2100) enters Eq. 7 (LIN model) as a continuous variable so that utility is a linear function of the attribute. For Eq. 8 (DIFF model), area attributes are included as dummy variables, but their coefficients are restricted to be equal. The specifications used for internal scope tests for the RPL model are similar to those of the CL, but incorporating η_i as individual deviations from the mean coefficients on most variables, except for payment (see Eq. 4).

A summary of these tests is presented in Table 10. For both CL and RPL models, the restriction in the LIN model is not possible to reject (p values > 0.1 in both cases). It indicates that there is no statistical difference between the LIN model and the ID model; hence, marginal utility is constant. The restriction to the DIFF model is also not possible to reject (p values > 0.1 in both cases), indicating no statistical difference between the DIFF model and the ID model. It implies that all additional increases beyond 1661 hectares are valued the same. The results of the tests reveal both LIN and DIFF specifications are comparable model fits. Respondents are generally willing to pay to increase mangrove areas at XTNP and their supports are also sensitive to changes in the levels of

Table 10
The atribute scope test results

	CL model	**RPL model**
Estimation models		
Log likelihood	-465.50	-457.51
LIN model		
Log likelihood	-468.29	-463.92
Test N(0,1)	0.1768 (0.8596)	-0.4949 (0.6206)
DIFF model		
Log likelihood	-465.05	-459.64
LRT $\chi^2(2)$	1.097 (0.2948)	4.2461 (0.1197)

Note: p values are in parentheses. $p < 0.1$,* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Vuong test (Vuong, 1989) is applied for comparing non-nested models (ID versus LIN model).
Log-Likelihood Ratio test is applied for comparing nested models (ID versus DIFF model).

area attribute. This might reflect a scope effect in which the more mangrove areas are offered to respondents, the more they are willing to pay for those areas. The results from table 9 confirm that mangrove forests are valued by local residents, and we would expect a positive marginal WTP for 1900 ha relative to the status quo. Nonetheless, scope sensitivity is not observed because marginal WTP for 2100 ha is lower than that for 1900 ha. The difference in findings from table 9 and 10 could be explained by policy bias in which some respondents valued the whole policy package differently from the sum of individual parts (Spencer-Cotton et al., 2018). The standard deviation on the high hectares coefficient confirms that there is a wide range of individual coefficients. If individual WTP is considered, some respondents would pass the scope test while others would see the additional hectares as a bad. Individuals that are insensitive to area levels had "preference satiation" in which marginal WTP for additional area diminishes rapidly to zero given the higher payment (Rollins and Lyke, 1998; Whitehead, 2016).

Concluding remark and policy implication

A choice experiment was employed for eliciting households' preferences for mangrove rehabilitation program at the Ba Lat estuary, Nam Dinh province. The survey consisted of choice sets in which respondents had to choose between two options: a status quo option and an improvement option based on different combinations of attributes such as the area of the restored mangrove forest, the number of preserved "Black-faced Spoonbill", the total damages caused by storms, and the contribution rate. In addition to questions on socio-demographic characteristics of the respondents, various questions were asked about the awareness of the respondents with respect to mangrove ecosystem services in a climate change context.

Two econometric specifications were used to capture households' preferences: a) Conditional multinomial logit (CL model) which assumes homogenous preferences across respondents; b) Random parameter logit (RPL model) which accounts for unobserved preference heterogeneity .

We found that mangrove coverage extension (at the medium or high management level), storm prevention ability, and contribution rate were all statistically significant in explaining household WTP across the two specifications. Surprisingly, biodiversity conservation either at the medium or high management level was not statistically significant in explaining household WTP. The unobserved heterogeneity of tastes in the sample was found for the high mangrove coverage, and high management level of biodiversity. Some respondents might have incomplete understanding of the way biodiversity maintains the value of ecosystem services and were not willing to pay for this management attribute. If these respondents knew more about biodiversity aspects, they would value differently. Our results thus suggest a scope for training and education in order to raise local awareness of biodiversity benefits.

Marginal WTP per household for each attribute was estimated according to each specification. Our results reveal some different levels of WTP for mangrove conservation depending on the attributes and the management levels. The findings shed light on non-market values of wetland management attributes at Ba Lat estuary in the context of climate change, taking with caution the fact that people are different in their choice preferences.

We acknowledge that our study is subject to several shortcomings. Firstly, in order to expand the scope of the study, future studies could include additional improvement options in each choice set or incorporate other wetland management attributes such as the improvement of water quality, eco-tourism facilities. Another interesting avenue for further research is to examine whether these social norms or morals play an important role in determining households' WTP for mangrove conservation (Czajkowski et al., 2017). Secondly, more information on the project costs should be included in the current valuation so that policy makers can have a comprehensive cost benefit analysis of the coastal wetland restoration projects. Thirdly, our scope test points out a scope sensitivity of households to the area of the forest, however, the reported marginal WTP estimates for this attribute do not indicate this. This implies taste variation of individuals with respect to the scope of mangrove areas that requires further assessment. The small sample size could reduce parameter precision. A split-sample design survey with a larger sample size could be conducted to assess how respondents value different segments of the forest with different characteristics, for instance, a variation of mangrove degradation rate, speed of coastal erosion, vulnerability to natural disasters. This design allows for testing some hypotheses which deepen the scope effects for mangrove management policy implications and improve the statistical analysis of the WTP.

Appendix

This appendix presents the scenario as part of the household questionnaire survey.

Future climate scenario Climate change poses a major threat to coastal areas in Vietnam. In 2016, the Ministry of Natural Resources and Environment projected that the average temperature in the Ba Lat estuary would increase by about 0.6°C by 2030 in comparison to the period of 1986-2005. Meanwhile, sea level would likely rise by an additional 20 cm and maximum rainfall per day would increase from 20 to 30 ml in the Ba Lat estuary. As a consequence, a large area of the mangroves would be in severely degraded condition. According to the board of directors at XTNP, the number of animal species would be declined by about 5% each year in comparison to the present if conservation measures are not taken with caution.

Suppose the mangrove restoration project plans were implemented by the local authority at Ba Lat over a period from now to 2030 to implement new measures for the conservation of the wetland. All households living in 5 communes including Giao Thien, Giao An, Giao Lac, Giao Xuan and Giao Hai would make a lump sum payment to the Fund for Wetland Conservation in the Ba Lat estuary. The funding would be used for the following activities: a) holding regular training workshops with community members to bring awareness, education, and knowledge exchange regarding mangrove biodiversity values to local communities, b) building artificial shelters to protect young mangroves trees from rising sea levels, c) engaging local interests in planting mangroves, d) developing alternative livelihood to generate sustainable income for local people such as planting mushrooms, making various honey products, or ecotourism initiatives. (There are a number of options for the contribution as well as the impact of the project that can be presented as follows)

References

Adamowicz, W., P. Boxall, M. Williams, and J. Louviere (1998). Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. *American Journal of Agricultural Economics 80*(1), 64–75.

Birol, E., K. Karousakis, and P. Koundouri (2006). Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of cheimaditida wetland in greece. *Ecological Economics 60*(1), 145 – 156.

Blanco, J. F., E. A. Estrada, L. F. Ortiz, and L. E. Urrego (2012). Ecosystem-Wide Impacts of Deforestation in Mangroves: The Urabá Gulf (Colombian Caribbean) Case Study. *ISRN Ecology 2012*, article ID 958709.

Brouwer, R., I. H. Langford, I. J. Bateman, T. C. Crowards, and R. K. Turner (1997). A meta-analysis of wetland contingent valuation studies. *Working Paper - Centre for Social and Economic Research on the Global Environment GEC 97-20*.

Champ, P. A., K. J. Boyle, and T. C. Brown (2017). *A Primer on Nonmarket Valuation*. Dordrecht, NL: Springer.

ChoiceMetrics (2018). *Ngene 1.2: User Manual & Reference Guide*. Australia: ChoiceMetrics.

Cummings, A. R. and M. Shah (2018). Mangroves in the global climate and environmental mix. *Geography Compass 12*, e12353.

Czajkowski, M. and N. Hanley (2009, jun). Using Labels to Investigate Scope Effects in Stated Preference Methods. *Environmental and Resource Economics 2009 44:4 44*(4), 521–535.

Czajkowski, M., N. Hanley, and K. Nyborg (2017, Apr). Social norms, morals and self-interest as determinants of pro-environment behaviours: The case of household recycling. *Environmental and Resource Economics 66*(4), 647–670.

Do, T. N. and J. Bennett (2009). Estimating wetland biodiversity values: a choice modelling application in vietnam's mekong river delta. *Environment and Development Economics 14*(2), 163–186.

Giesen, W., S. Wulffraat, M. Zieren, and L. Scholten (2007). Mangrove Guidebook for Southeast Asia. Technical report, Food and Agriculture Organization of the United Nations.

Hensher, D. A., J. M. Rose, and W. H. Greene (2015). *Applied Choice Analysis* (2 ed.). Cambridge University Press.

Holmes, T. P., W. L. Adamowicz, and F. Carlsson (2017). *Choice Experiments*, pp. 133–186. Dordrecht: Springer Netherlands.

Hoyos, D. (2010). The state of the art of environmental valuation with discrete choice experiments. *Ecological Economics 69*(8), 1595 – 1603.

Hung, T. V., V. N. Thanh, and M. Simioni (2020). Willingness to pay for mangrove preservation in xuan thuy national park, vietnam: do household knowledge and interest play a role? *Journal of Environmental Economics and Policy 0*(0), 1–19.

Kahneman, D. and J. L. Knetsch (1992). Valuing public goods: The purchase of moral satisfaction. *Journal of Environmental Economics and Management 22*(1), 57–70.

Krinsky, I. and A. L. Robb (1986). On approximating the statistical properties of elasticities. *The Review of Economics and Statistics 68*(4), 715–719.

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

Leslie, M., S. T. Nguyen, T. K. D. Nguyen, T. T. Pham, T. T. N. Cao, T. Q. Le, T. T. Dang, T. H. T. Nguyen, T. B. N. Nguyen, H. N. Le, T. T. Tran, T. C. T. Bui, N. A. Tran, M. H. Natascha, and Y. Chris (2018). Bringing social and cultural considerations into environmental management for vulnerable coastal communities: Responses to environmental change in Xuan Thuy National Park, Nam Dinh Province, Vietnam. *Ocean and Coastal Management 158*, 32–44.

Management Board of Xuan Thuy National Park (2014). The current state of biodiversity at xuan thuy national park. Technical report, Management Board of Xuan Thuy National Park.

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

McNally, R., A. McEwin, and T. Holland (2011). The Potential for Mangrove Carbon Projects in Vietnam. Technical report, Smart Development Works.

Menendez, P., I. J. Losada, S. Torres-Ortega, S. Narayan, and M. W. Beck (2020). The global flood protection benefits of mangroves. *Scientific Reports 10*(4404).

Millennium Ecosystem Assessment (2005). Ecosystems and human well-being: Synthesis. Technical report, Island Press, Washington, DC.

Nguyen, T. N., Y. Higano, and H. Yabar (2011). Analyse Wetland Economic Value: Case Study in Xuan Thuy National Park, Viet Nam. (October), 1–7.

Pham Hong, T. and T. Mai Sy (2015). Vulnerability to climate change of mangroves in Xuan Thuy National Park, Vietnam. *Journal of Agricultural and Biological Science 10*(2), 55–60.

Polidoro, B. A., K. E. Carpenter, L. Collins, N. C. Duke, A. M. Ellison, J. C. Ellison, E. J. Farnsworth, E. S. Fernando, K. Kathiresan, N. E. Koedam, S. R. Livingstone, T. Miyagi, G. E. Moore, V. N. Nam, J. E. Ong, J. H. Primavera, S. G. Salmo, J. C. Sanciangco, S. Sukardjo, Y. Wang, and J. W. H. Yong (2010). The loss of species: Mangrove extinction risk and geographic areas of global concern. *PLoS ONE 5*, e10095.

Prance, G. T. and P. B. Tomlinson (1987). The Botany of Mangroves. *Brittonia*.

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*(3), 593–617.

Rezende, C. E., J. R. Kahn, L. Passareli, and W. F. Vásquez (2015). An economic valuation of mangrove restoration in brazil. *Ecological Economics 120*, 296 – 302.

Rollins, K. and A. Lyke (1998). The Case for Diminishing Marginal Existence Values 1. *Journal of Environmental Economics and Management 36*.

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

Smith, V. (1992). Arbitrary values, good causes, and premature verdicts. *Journal of Environmental Economics and Management 22*(1), 71–89.

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.

Tan, Y., D. Lv, J. Cheng, D. Wang, W. Mo, and Y. Xiang (2018). Valuation of environmental improvements in coastal wetland restoration: A choice experiment approach. *Global Ecology and Conservation 15*, e00440.

Thanh, H. T. and H. Yabar (2015). Climate Change Challenges for Sustainable Coastal Wetland Management in Xuan Thuy Ramsar Site, Vietnam. *British Journal of Environment & Climate Change 5*(53), 214–230.

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

Tran, T., V. T. Nguyen, T. L. H. Huynh, V. K. Mai, X. H. Nguyen, and H. P. Doan (2016). Climate Change and Sea Level Rise Scenarios for Vietnam. Technical report, Ministry of Natural Resources and Environment of Vietnam.

Veettil, B. K., R. D. Ward, N. X. Quang, N. T. T. Trang, and T. H. Giang (2019). Mangroves of vietnam: Historical development, current state of research and future threats. *Estuarine, Coastal and Shelf Science 218*, 212 – 236.

Vuong, Q. H. (1989). Likelihood ratio tests for model selection and non-nested hypotheses. *Econometrica 57*(2), 307–333.

Whitehead, J. C. (2016). Plausible responsiveness to scope in contingent valuation. *Ecological Economics 128*, 17–22.